

# HAZUS-MH: Earthquake Event Report

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**Region Name:** Provo Segment Mw 7.2 ShakeMap Scenario

**Earthquake Scenario:** Provo Segment Mw 7.2 ShakeMap Scenario

**Print Date:** October 19, 2009

*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.*

## 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 29 county(ies) from the following state(s):

Utah

Note:

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

The geographical size of the region is 84,798.76 square miles and contains 496 census tracts. There are over 773 thousand households in the region and has a total population of 2,474,258 people (2005 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 653 thousand buildings in the region with a total building replacement value (excluding contents) of 131,629 (millions of dollars). Approximately 95.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 54,677 and 9,370 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### **Building Inventory**

HAZUS estimates that there are 653 thousand buildings in the region which have an aggregate total replacement value of 131,629 (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 46% 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 56 hospitals in the region with a total bed capacity of 6,868 beds. There are 1,076 schools, 358 fire stations, 133 police stations and 7 emergency operation facilities. With respect to HPL facilities, there are 599 dams identified within the region. Of these, 212 of the dams are classified as 'high hazard'. The inventory also includes 711 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 64,047.00 (millions of dollars). This inventory includes over 8,874 kilometers of highways, 3,009 bridges, 242,427 kilometers of pipes.



**Table 1: Transportation System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># locations/ # Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Highway</b>	Bridges	3,009	3,453.80
	Segments	1,303	46,184.60
	Tunnels	4	2.00
	Subtotal		<b>49,640.40</b>
<b>Railways</b>	Bridges	33	3.90
	Facilities	12	32.00
	Segments	1,485	2,821.00
	Tunnels	0	0.00
	Subtotal		<b>2,856.90</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	24	63.90
	Segments	24	37.20
	Tunnels	0	0.00
	Subtotal		<b>101.10</b>
<b>Bus</b>	Facilities	10	10.70
	Subtotal		<b>10.70</b>
<b>Ferry</b>	Facilities	2	2.70
	Subtotal		<b>2.70</b>
<b>Port</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Airport</b>	Facilities	30	319.50
	Runways	46	1,746.30
	Subtotal		<b>2,065.90</b>
		Total	<b>54,677.60</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	2,948.60
	Facilities	2	65.30
	Pipelines	0	0.00
	Subtotal		<b>3,013.90</b>
<b>Waste Water</b>	Distribution Lines	NA	1,769.20
	Facilities	56	3,655.00
	Pipelines	0	0.00
	Subtotal		<b>5,424.20</b>
<b>Natural Gas</b>	Distribution Lines	NA	1,179.50
	Facilities	8	8.50
	Pipelines	957	2,089.80
	Subtotal		<b>3,277.80</b>
<b>Oil Systems</b>	Facilities	31	3.00
	Pipelines	465	733.60
	Subtotal		<b>736.60</b>
<b>Electrical Power</b>	Facilities	26	2,802.80
	Subtotal		<b>2,802.80</b>
<b>Communication</b>	Facilities	128	12.50
	Subtotal		<b>12.50</b>
		<b>Total</b>	<b>15,267.90</b>

## Earthquake Scenario

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

<b>Scenario Name</b>	Provo Segment Mw 7.2 ShakeMap Scenario
<b>Type of Earthquake</b>	User-defined
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	NA
<b>Latitude of Epicenter</b>	NA
<b>Earthquake Magnitude</b>	7.20
<b>Depth (Km)</b>	NA
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	NA

## Building Damage

### Building Damage

HAZUS estimates that about 68,574 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 9,868 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 summaries the expected damage by general occupancy for the buildings in the region. Table 4 summaries the expected damage by general building type.

**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	202	0.04	105	0.10	99	0.23	81	0.51	34	0.34
<b>Commercial</b>	10,214	2.13	2,245	2.14	2,096	4.91	2,806	17.56	3,719	37.69
<b>Education</b>	577	0.12	83	0.08	88	0.21	74	0.46	63	0.63
<b>Government</b>	1,255	0.26	161	0.15	190	0.45	149	0.93	115	1.17
<b>Industrial</b>	3,329	0.69	988	0.94	834	1.95	879	5.50	1,371	13.90
<b>Other Residential</b>	52,273	10.89	12,439	11.88	8,879	20.78	2,206	13.81	310	3.14
<b>Religion</b>	1,773	0.37	306	0.29	317	0.74	241	1.51	172	1.75
<b>Single Family</b>	410,328	85.49	88,370	84.40	30,229	70.74	9,538	59.71	4,085	41.39
<b>Total</b>	<b>479,950</b>		<b>104,698</b>		<b>42,733</b>		<b>15,973</b>		<b>9,869</b>	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	239,642	49.93	50,927	48.64	6,990	16.36	2,477	15.51	796	8.07
<b>Steel</b>	2,899	0.60	568	0.54	686	1.60	703	4.40	1,362	13.80
<b>Concrete</b>	2,606	0.54	413	0.39	502	1.17	690	4.32	971	9.84
<b>Precast</b>	1,337	0.28	152	0.15	246	0.58	572	3.58	1,383	14.02
<b>RM</b>	97,336	20.28	13,411	12.81	6,202	14.51	1,841	11.53	1,203	12.19
<b>URM</b>	109,074	22.73	38,207	36.49	27,480	64.31	9,563	59.87	4,103	41.57
<b>MH</b>	27,056	5.64	1,021	0.98	628	1.47	126	0.79	50	0.51
<b>Total</b>	<b>479,950</b>		<b>104,698</b>		<b>42,733</b>		<b>15,973</b>		<b>9,869</b>	

\*Note:

RM      Reinforced Masonry  
URM     Unreinforced Masonry  
MH      Manufactured Housing

## **Essential Facility Damage**

Before the earthquake, the region had 6,868 hospital beds available for use. On the day of the earthquake, the model estimates that only 5,859 hospital beds (85.00%) 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 5: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	56	0	0	50
Schools	1,076	0	0	915
EOCs	7	0	0	6
PoliceStations	133	0	0	118
FireStations	358	0	0	333

## 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	1,303	0	0	1,303	1,303
	Bridges	3,009	231	165	2,780	2,808
	Tunnels	4	0	0	4	4
Railways	Segments	1,485	0	0	1,485	1,485
	Bridges	33	1	0	33	33
	Tunnels	0	0	0	0	0
	Facilities	12	1	0	12	12
Light Rail	Segments	24	0	0	24	24
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	24	0	0	24	24
Bus	Facilities	10	0	0	10	10
Ferry	Facilities	2	0	0	2	2
Port	Facilities	0	0	0	0	0
Airport	Facilities	30	0	0	30	30
	Runways	46	0	0	46	46

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	2	0	0	2	2
Waste Water	56	8	0	45	56
Natural Gas	8	0	0	8	8
Oil Systems	31	2	0	28	31
Electrical Power	26	3	0	22	26
Communication	128	8	0	128	128

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	147,432	7347	2558
Waste Water	88,459	5811	2023
Natural Gas	4,166	40	44
Oil	2,370	1	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	773,352	245,826	232,465	202,949	81,563	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 66 ignitions that will burn about 2.79 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 9,448 people and burn about 552 (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 6.400 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 38.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 256,160 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 14,675 households to be displaced due to the earthquake. Of these, 13,467 people (out of a total population of 2,474,258) 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
<b>2 AM</b>	Commercial	98	31	5	11
	Commuting	1	1	2	0
	Educational	0	0	0	0
	Hotels	3	0	0	0
	Industrial	162	52	9	17
	Other-Residential	985	262	41	81
	Single Family	5,737	1,502	222	437
	<b>Total</b>	<b>6,986</b>	<b>1,849</b>	<b>279</b>	<b>547</b>
<b>2 PM</b>	Commercial	5,746	1,819	317	623
	Commuting	8	11	18	4
	Educational	2,557	815	143	280
	Hotels	1	0	0	0
	Industrial	1,192	381	65	127
	Other-Residential	141	36	6	11
	Single Family	769	200	30	56
	<b>Total</b>	<b>10,413</b>	<b>3,262</b>	<b>578</b>	<b>1,101</b>
<b>5 PM</b>	Commercial	4,758	1,490	259	501
	Commuting	291	394	657	128
	Educational	484	157	28	54
	Hotels	1	0	0	0
	Industrial	745	238	41	79
	Other-Residential	392	105	17	32
	Single Family	2,311	624	96	180
	<b>Total</b>	<b>8,982</b>	<b>3,007</b>	<b>1,097</b>	<b>974</b>

## Economic Loss

The total economic loss estimated for the earthquake is 12,023.19 (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 11,286.99 (millions of dollars); 25 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 28 % 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
<b>Income Losses</b>							
	Wage	0.00	9.38	465.00	23.00	114.23	611.62
	Capital-Related	0.00	4.02	408.16	13.94	33.61	459.74
	Rental	102.28	72.07	257.27	10.02	38.67	480.30
	Relocation	370.04	50.87	383.60	47.63	402.35	1,254.50
	<b>Subtotal</b>	<b>472.32</b>	<b>136.34</b>	<b>1,514.04</b>	<b>94.59</b>	<b>588.87</b>	<b>2,806.16</b>
<b>Capital Stock Losses</b>							
	Structural	444.28	59.35	517.83	126.97	361.36	1,509.80
	Non_Structural	1,326.80	237.97	1,607.35	518.47	1,122.89	4,813.48
	Content	432.23	65.05	747.54	334.00	474.00	2,052.82
	Inventory	0.00	0.00	26.88	74.14	3.72	104.74
	<b>Subtotal</b>	<b>2,203.30</b>	<b>362.37</b>	<b>2,899.61</b>	<b>1,053.58</b>	<b>1,961.98</b>	<b>8,480.83</b>
	<b>Total</b>	<b>2,675.62</b>	<b>498.71</b>	<b>4,413.64</b>	<b>1,148.17</b>	<b>2,550.85</b>	<b>11,286.99</b>

## 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	46,184.62	\$117.93	0.26
	Bridges	3,453.84	\$186.09	5.39
	Tunnels	1.96	\$0.09	4.59
	Subtotal	<b>49640.40</b>	<b>304.10</b>	
Railways	Segments	2,821.00	\$5.96	0.21
	Bridges	3.92	\$0.11	2.83
	Tunnels	0.00	\$0.00	0.00
	Facilities	31.96	\$2.91	9.09
	Subtotal	<b>2856.90</b>	<b>9.00</b>	
Light Rail	Segments	37.15	\$0.04	0.11
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	63.91	\$8.73	13.65
	Subtotal	<b>101.10</b>	<b>8.80</b>	
Bus	Facilities	10.68	\$0.79	7.42
	Subtotal	<b>10.70</b>	<b>0.80</b>	
Ferry	Facilities	2.66	\$0.00	0.11
	Subtotal	<b>2.70</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Airport	Facilities	319.53	\$11.04	3.46
	Runways	1,746.34	\$3.74	0.21
	Subtotal	<b>2065.90</b>	<b>14.80</b>	
	<b>Total</b>	<b>54677.60</b>	<b>337.40</b>	

**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	65.30	\$0.05	0.07
	Distribution Lines	2,948.60	\$40.28	1.37
	Subtotal	<b>3,013.92</b>	<b>\$40.32</b>	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	3,655.00	\$161.03	4.41
	Distribution Lines	1,769.20	\$31.86	1.80
	Subtotal	<b>5,424.20</b>	<b>\$192.89</b>	
Natural Gas	Pipelines	2,089.80	\$0.49	0.02
	Facilities	8.50	\$0.03	0.33
	Distribution Lines	1,179.50	\$34.05	2.89
	Subtotal	<b>3,277.83</b>	<b>\$34.57</b>	
Oil Systems	Pipelines	733.60	\$0.00	0.00
	Facilities	3.00	\$0.08	2.73
	Subtotal	<b>736.60</b>	<b>\$0.09</b>	
Electrical Power	Facilities	2,802.80	\$130.57	4.66
	Subtotal	<b>2,802.80</b>	<b>\$130.57</b>	
Communication	Facilities	12.50	\$0.34	2.74
	Subtotal	<b>12.54</b>	<b>\$0.34</b>	
	Total	<b>15,267.88</b>	<b>\$398.78</b>	

**Table 14. Indirect Economic Impact with outside aid**  
(Employment as # of people and Income in millions of \$)

	LOSS	Total	%
<b>First Year</b>			
	Employment Impact	190,966	24.58
	Income Impact	399	1.39
<b>Second Year</b>			
	Employment Impact	82,249	10.59
	Income Impact	64	0.22
<b>Third Year</b>			
	Employment Impact	1,994	0.26
	Income Impact	(212)	-0.74
<b>Fourth Year</b>			
	Employment Impact	114	0.01
	Income Impact	(293)	-1.02
<b>Fifth Year</b>			
	Employment Impact	6	0.00
	Income Impact	(297)	-1.03
<b>Years 6 to 15</b>			
	Employment Impact	0	0.00
	Income Impact	(297)	-1.03

## **Appendix A: County Listing for the Region**

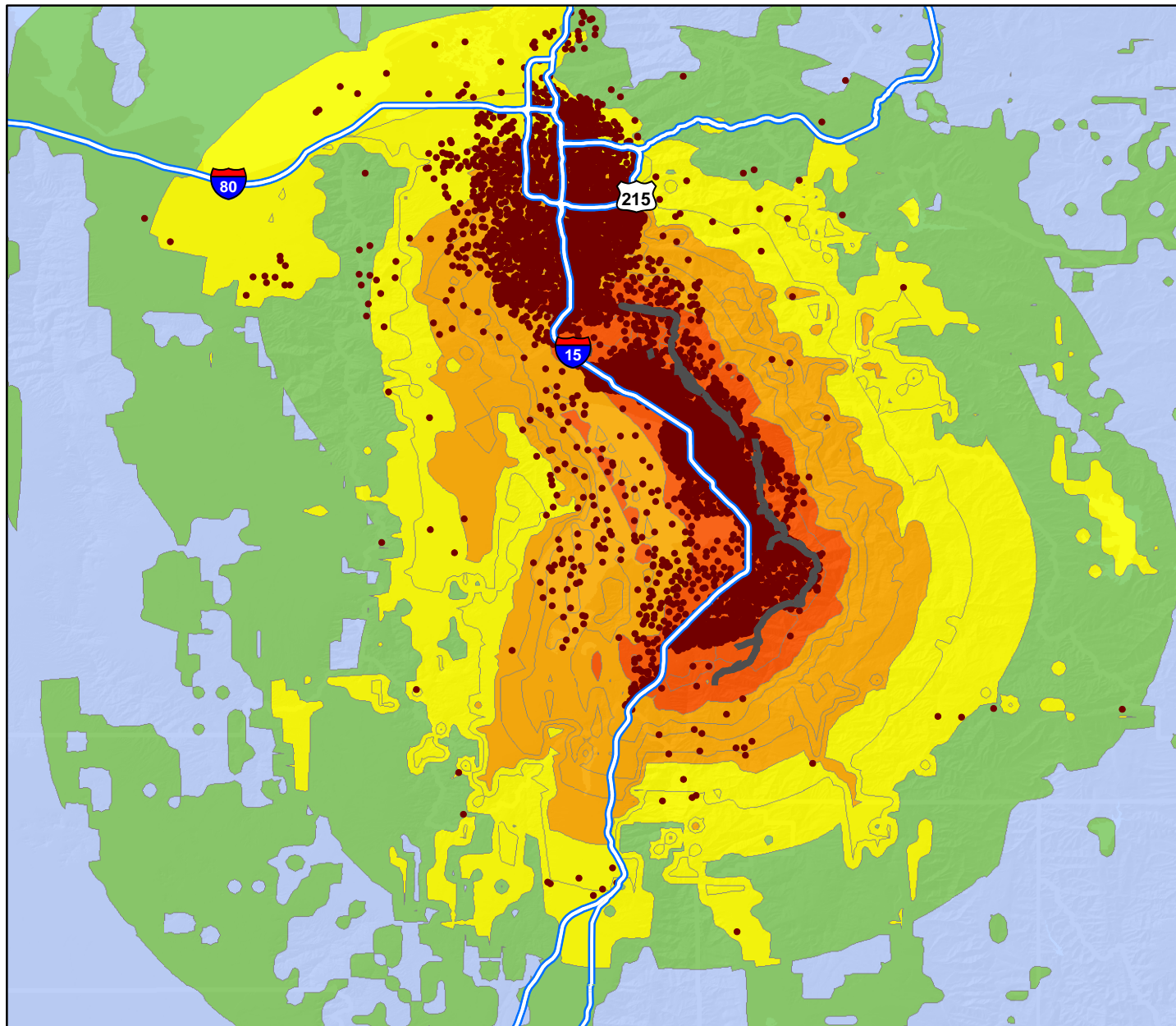
Beaver,UT  
Box Elder,UT  
Cache,UT  
Carbon,UT  
Daggett,UT  
Davis,UT  
Duchesne,UT  
Emery,UT  
Garfield,UT  
Grand,UT  
Iron,UT  
Juab,UT  
Kane,UT  
Millard,UT  
Morgan,UT  
Piute,UT  
Rich,UT  
Salt Lake,UT  
San Juan,UT  
Sanpete,UT  
Sevier,UT  
Summit,UT  
Tooele,UT  
Uintah,UT  
Utah,UT  
Wasatch,UT  
Washington,UT  
Wayne,UT  
Weber,UT

## Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Utah	Beaver	6,295	252	89	341
	Box Elder	45,659	1,658	687	2,346
	Cache	100,585	3,382	1,703	5,085
	Carbon	19,947	825	395	1,220
	Daggett	884	74	18	92
	Davis	270,344	10,230	3,870	14,101
	Duchesne	15,233	496	248	744
	Emery	10,885	403	142	546
	Garfield	4,957	276	94	370
	Grand	8,891	350	195	546
	Iron	37,498	1,323	741	2,065
	Juab	9,240	291	190	481
	Kane	6,385	323	127	450
	Millard	12,713	447	233	681
	Morgan	7,910	305	139	444
	Piute	1,439	69	24	93
	Rich	2,327	249	38	288
	Salt Lake	962,837	39,526	18,636	58,162
	San Juan	14,341	443	164	608
	Sanpete	24,037	708	387	1,095
	Sevier	19,623	697	315	1,013
	Summit	35,804	2,598	708	3,307
	Tooele	50,184	1,782	564	2,347
	Uintah	26,973	851	460	1,312
	Utah	429,727	9,780	6,285	16,065
	Wasatch	18,879	0	89	89
	Washington	113,489	3,900	1,839	5,739
	Wayne	2,590	115	38	154
	Weber	214,582	8,462	3,369	11,831
Total State		2,474,258	89,815	41,787	131,615
Total Region		2,474,258	89,815	41,787	131,615



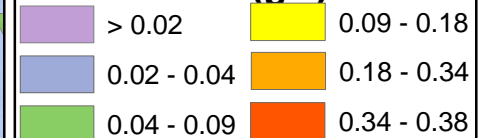
# Direct Building Economic Loss - Earthquake Scenario: Provo, UT



## M 7.2 Provo Earthquake

● 1 Dot = \$1,000,000

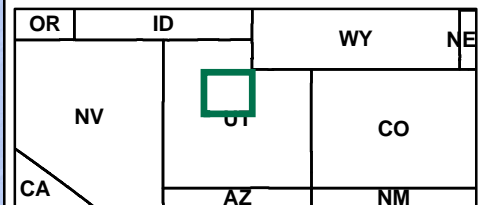
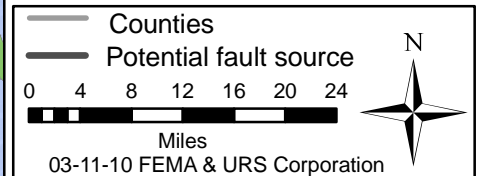
### PGA (g's)



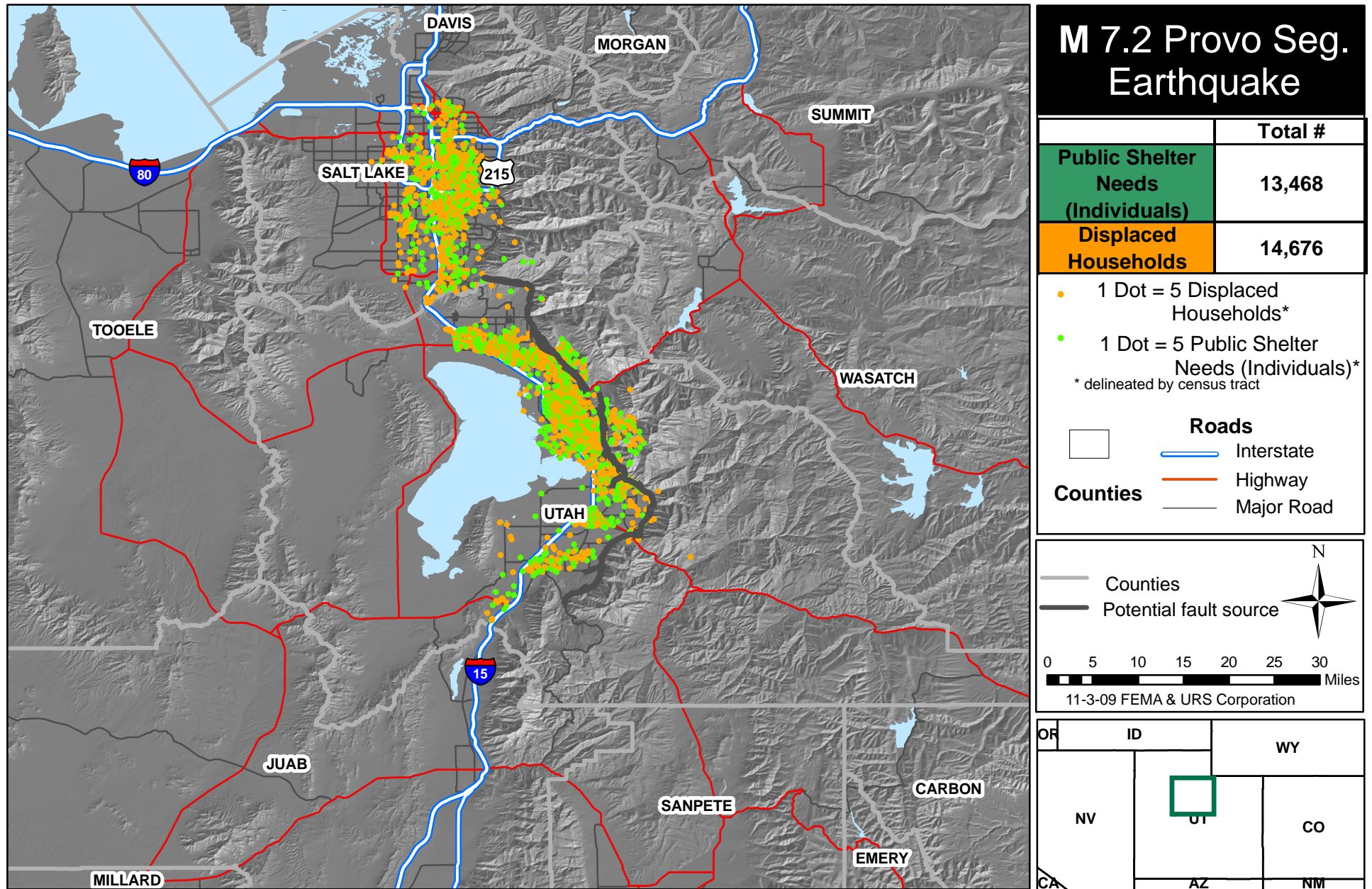
County	Cost Structural Damage	Cost Non-Structural Damage	Total Loss*
Davis	\$6 M	\$21 M	\$45 M
Juab	\$1 M	\$3 M	\$7 M
Salt Lake	\$489 M	\$1,370 M	\$3,377 M
Sanpete	\$0 M	\$1 M	\$2 M
Summit	\$0 M	\$2 M	\$4 M
Tooele	\$2 M	\$6 M	\$13 M
Utah	\$1,010 M	\$3,407 M	\$7,828 M
Weber	\$1 M	\$3 M	\$8 M
Total	\$1,509 M	\$4,812 M	\$11,284 M

All values are millions of dollars

\* Total loss = structural, nonstructural, contents, and inventory damage, as well as income losses resulted from relocation, capital related losses, wage loss, and rental income loss

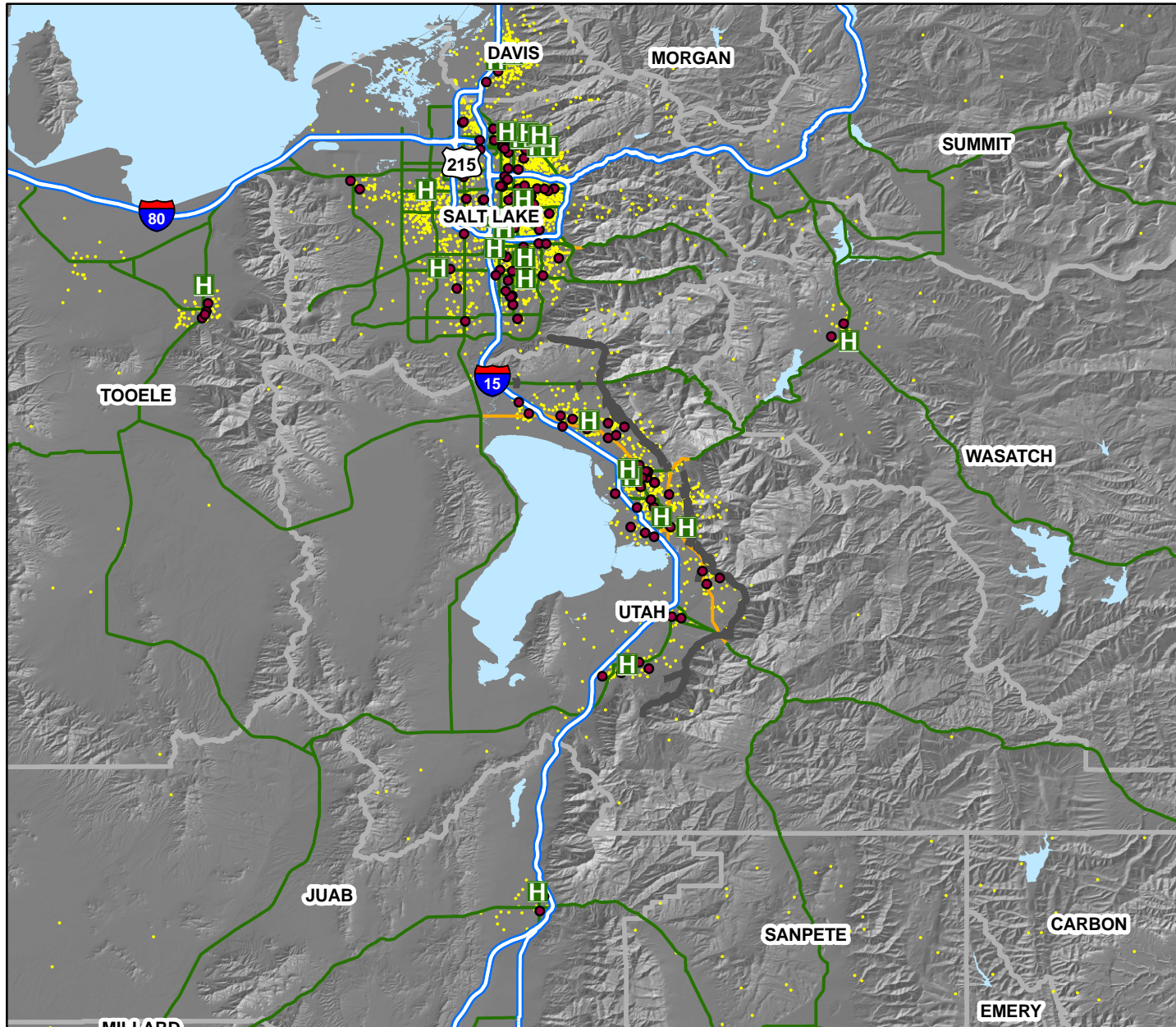


# Estimated Displaced Households & Short Term Public Shelter Needs - Earthquake Scenario: Provo, UT





# Distribution of Elderly, Impaired Hospitals (Day 1), & Hospital Bed Availability - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

### Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

- 1 Dot = 30 People over 65
- Nursing Home
- Highway: high (red), moderate (orange), low (green)

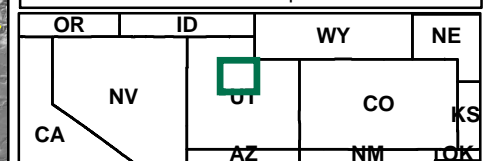
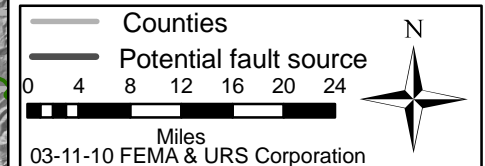
### Impaired Hospitals (Day 1)

Damage is expressed as the probability that a given hospital will realize at least moderate damage.

- High (red 'H')
- Moderate (yellow 'H')
- Low (green 'H')

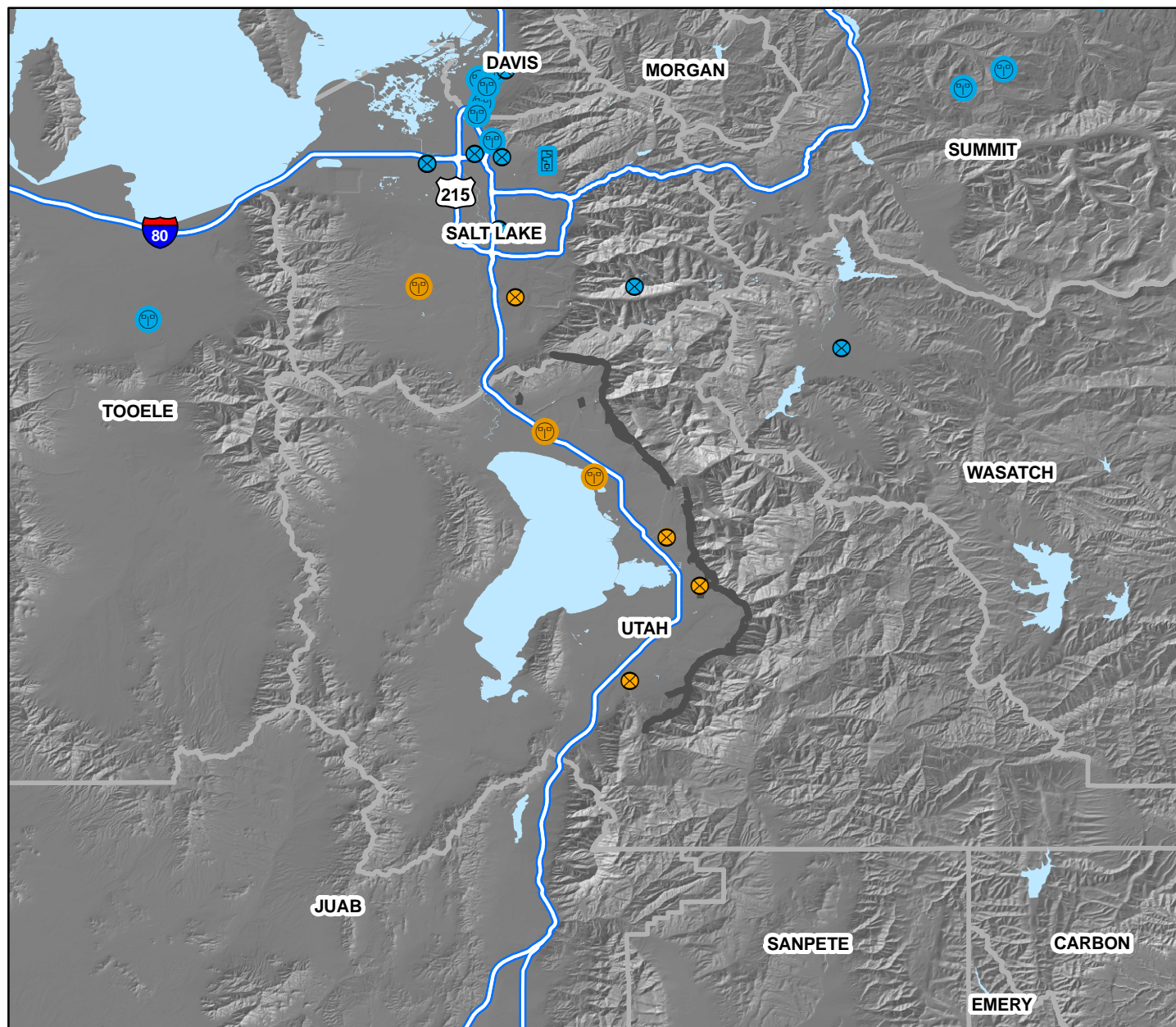
County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm*
Juab	31	28	1
Salt Lake	3,440	2,801	1548
Tooele	118	113	3
Utah	1,013	249	12689
Wasatch	20	19	1
Weber	655	654	2
<b>Total</b>	<b>5,277</b>	<b>3,864</b>	<b>14,244</b>

\* Injuries are of severity 1, 2, & 3.





# Electrical, Natural Gas, and Oil Facility Damage - Earthquake Scenario: Provo, UT






## M 7.2 Provo Seg. Earthquake




### Utility Damage (at least moderate)

Damage is expressed as the percentage chance that a given Utility System will realize at least moderate damage.




#### Oil Facility

-  low
-  moderate
-  high

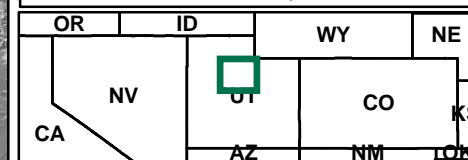
#### Electric Power Facility

-  low
-  moderate
-  high

#### Natural Gas Facility

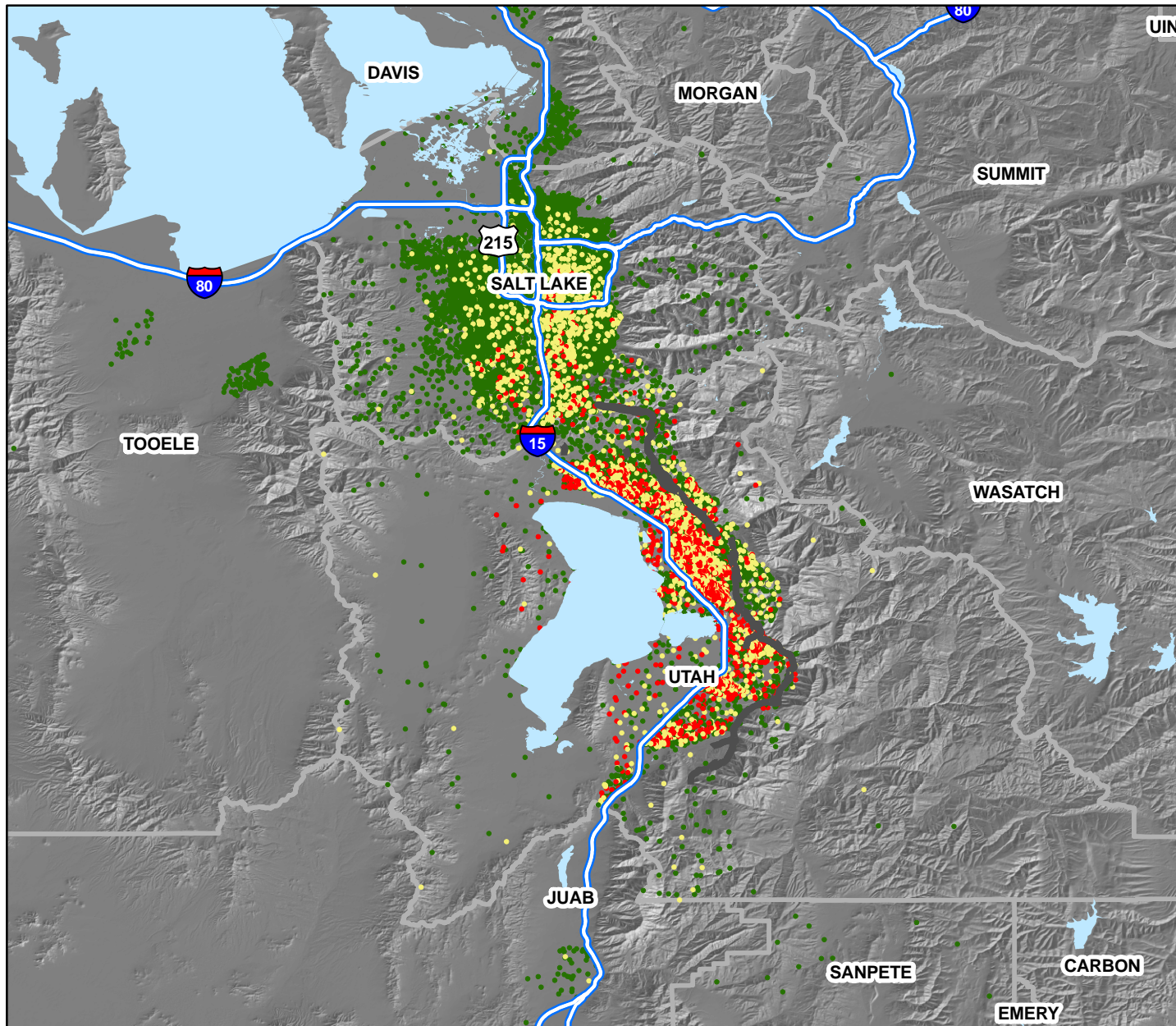
-  low
-  moderate
-  high

— Counties  
— Potential fault source  
0 4 8 12 16 20 24  
Miles  
03-11-10 FEMA & URS Corporation





# Estimated Building Inspection Needs - Earthquake Scenario: Provo, UT

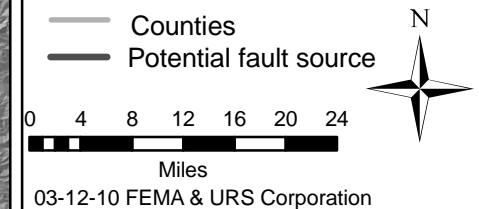


## M 7.2 Provo Seg. Earthquake

	Estimated # of Structures	Estimated # of Inspectors Needed
Red (Complete)	9,869	66
Yellow (Extensive)	15,973	213
Light Green (Slight/ Moderate)	147,427	983
Total	173,269	1,262

\*Estimated number of inspectors needed to complete inspections in 30 days.

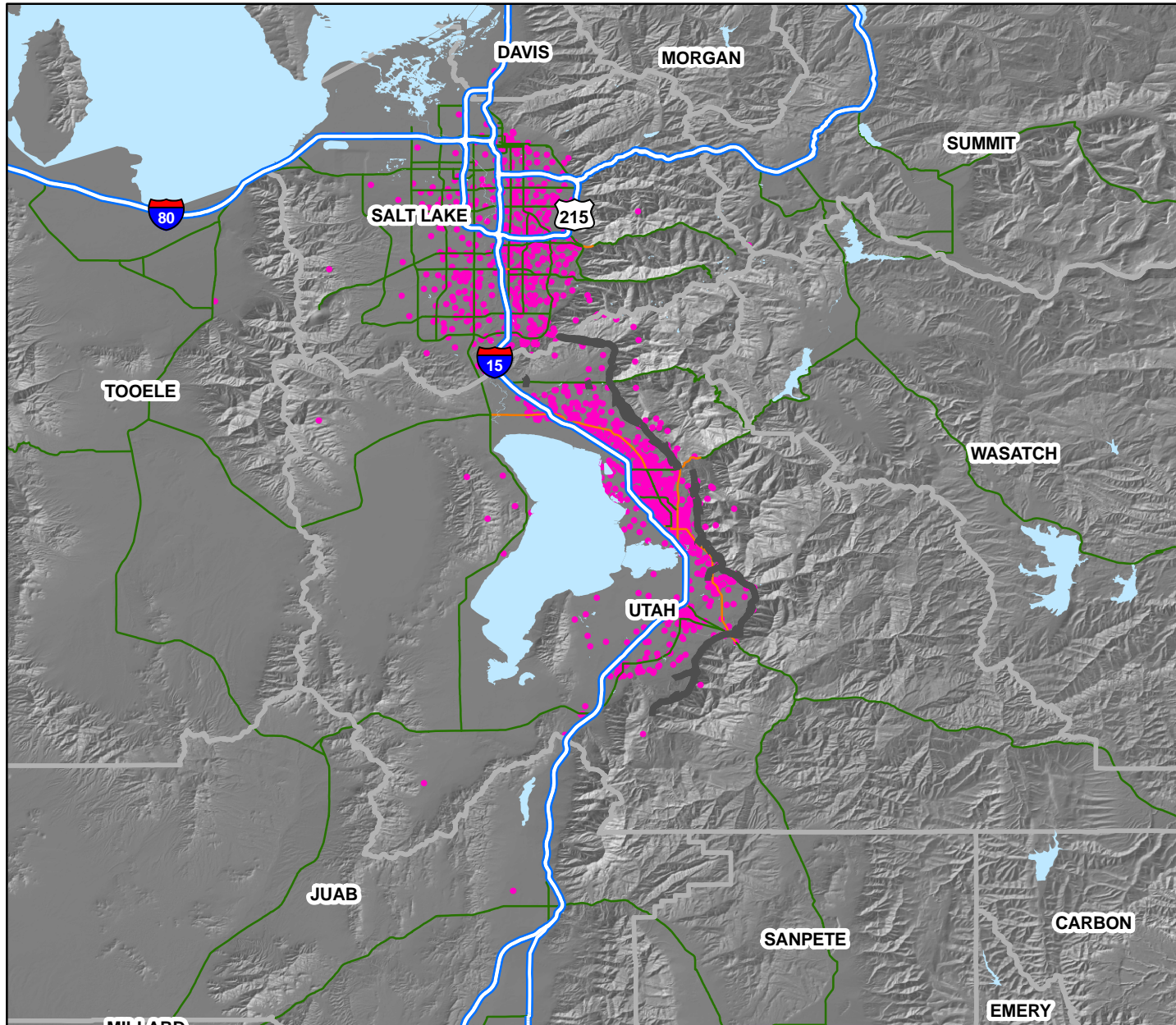
- 1 Dot = 10 (by census tract)
- Red Tag  
(Complete Damage)
- Yellow Tag  
(Extensive Damage)
- Green Tag  
(Slight/Moderate Damage)



OR	ID	WY
NV	UT	CO
CA	AZ	NM



# Estimated Concrete, Steel Debris and Highway Impacts - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

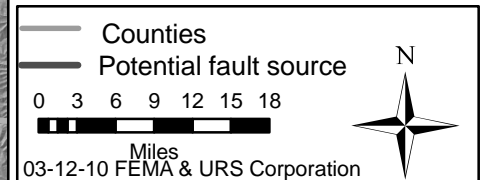
- 1 Dot = 5 thousand tons of Concrete and Steel Debris (by census tract)

### Highway Impacts (at least moderate)

- low Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.
- moderate
- high

County	Brick and Wood (tons)	Concrete and Steel (tons)	Estimated Truck Loads*
Davis	16,000	5,000	840
Juab	2,000	1,000	120
Salt Lake	1,457,000	1,127,000	103,360
Sanpete	2,000	0	80
Tooele	6,000	1,000	280
Utah	954,000	2,826,000	151,200
Weber	5,000	0	200
<b>Total</b>	<b>2,442,000</b>	<b>3,960,000</b>	<b>256,080</b>

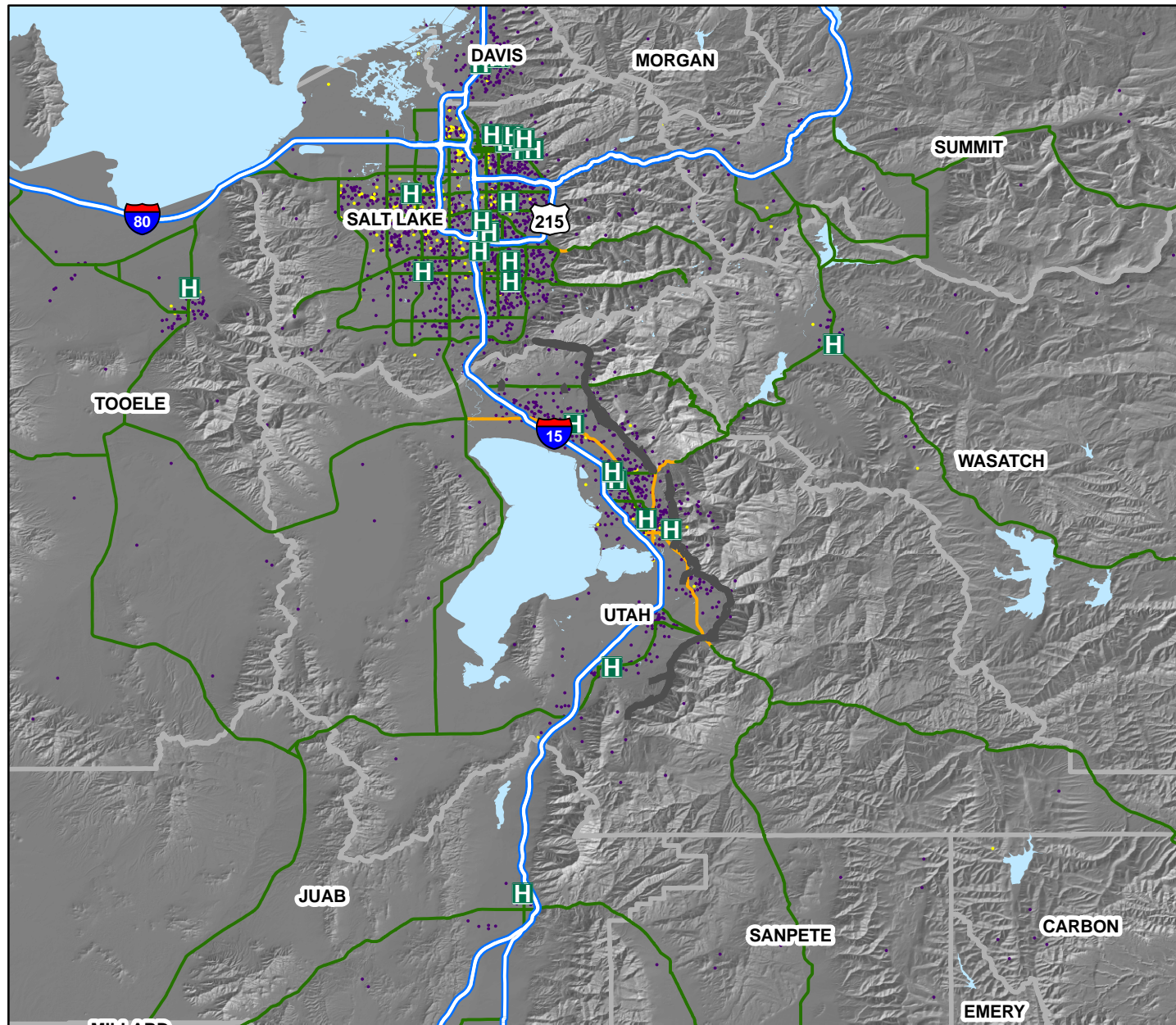
\* Truck loads estimated at 25 tons per truck



OR	ID	WY
NV	UT	CO
CA	AZ	NM



# Demographic Distribution and Highway Impacts - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

### Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

Highway

- high
- moderate
- low

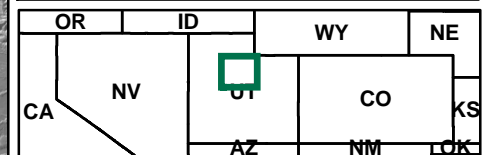
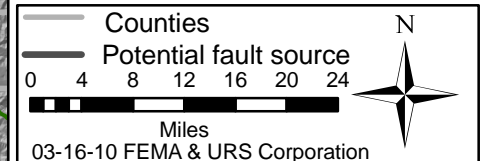
### Demographics

1 Dot = 500 People (by census tract)

- English Speaking
- Potentially Non-English Speaking

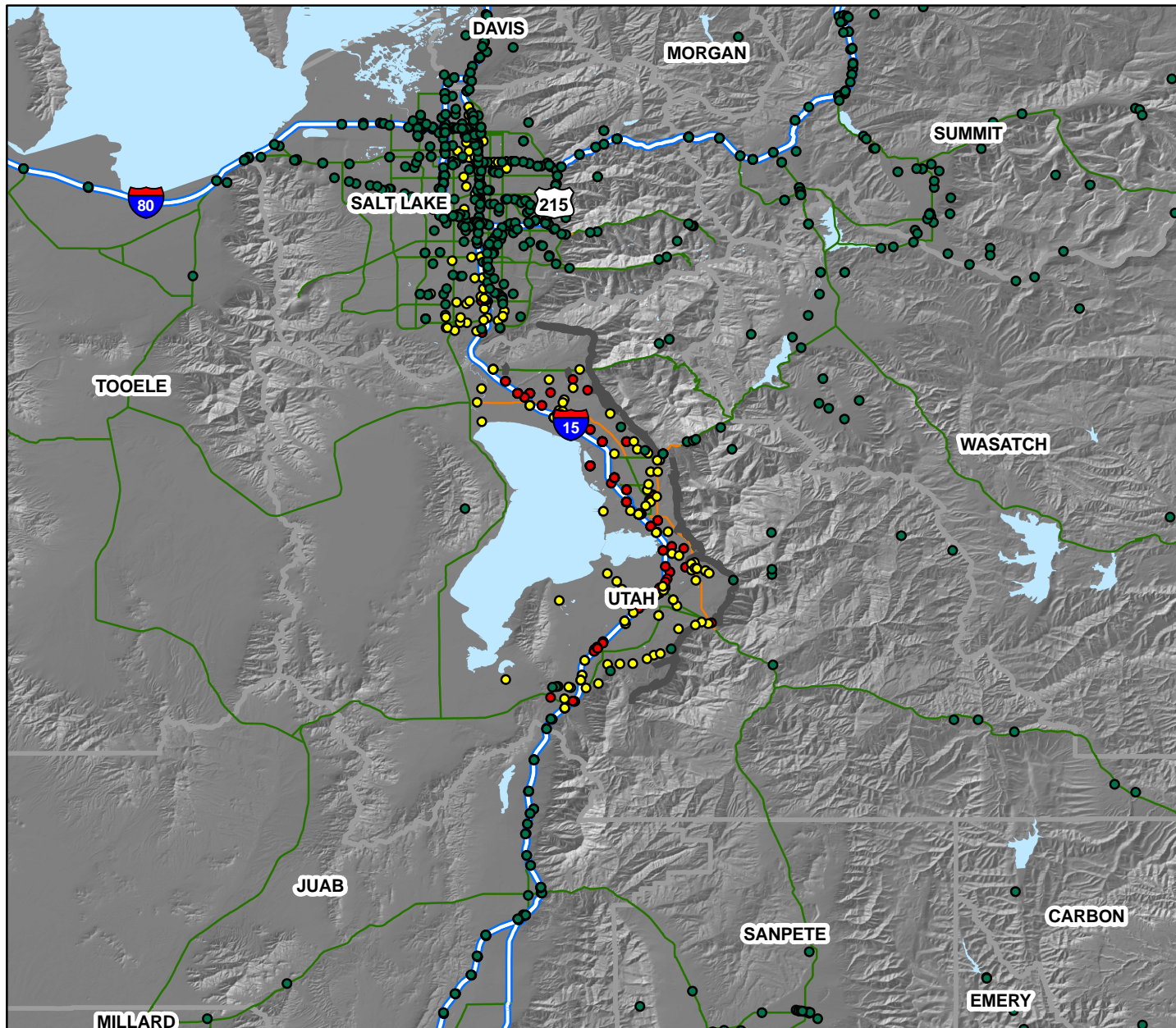
### Impaired Hospitals (Day1)

- H high
  - H moderate
  - H low
- Damage is expressed as the probability that a given hospital will realize at least moderate damage.





# Estimated Highway Infrastructure Impacts - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

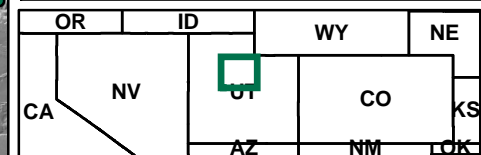
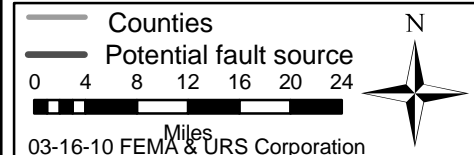
### Highway Impacts (at least moderate)

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

Highway Segment	Major Roadway Bridge
— low	● low
— moderate	● moderate
— high	● high

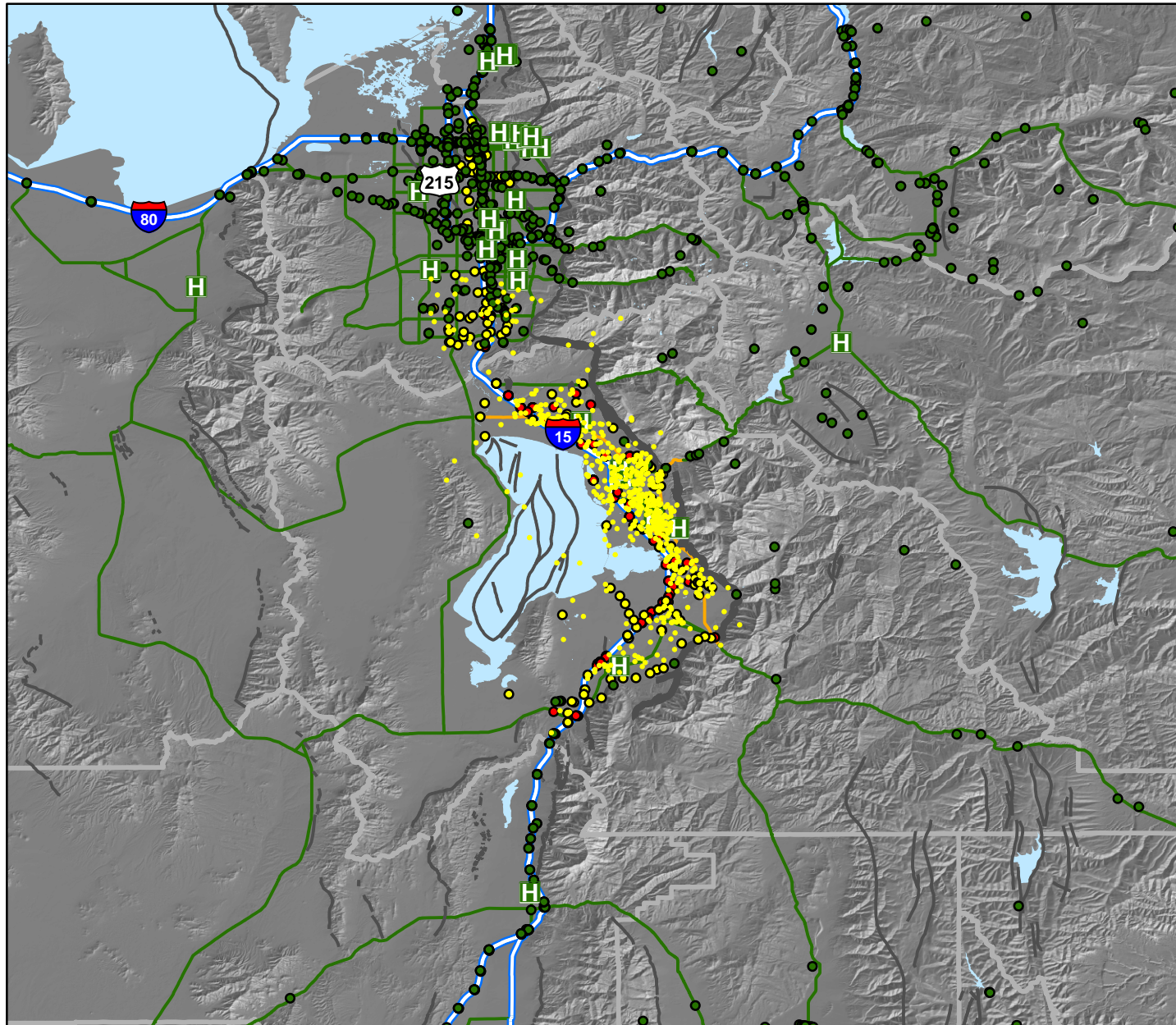
County	# of Bridges Needing Inspection	# of Bridges Needing Priority Inspection	# of Bridge Engineers Needed*
Davis	131	0	17
Juab	80	0	11
Morgan	80	0	11
Salt Lake	607	18	81
Sanpete	38	0	5
Tooele	54	1	7
Utah	314	19	42
Wasatch	25	0	3
Weber	141	0	19
<b>Total</b>	<b>1,470</b>	<b>38</b>	<b>196</b>

\* For priority inspections only, assuming that 2 engineers can inspect 5 bridges a day for 3 days





# Injuries (2pm), Impaired Hospitals (Day 1), Hospital Bed Availability, & Highway Functionality - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

### Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

Bridge Seg.	Highway
● high	— high
● moderate	— moderate
● low	— low

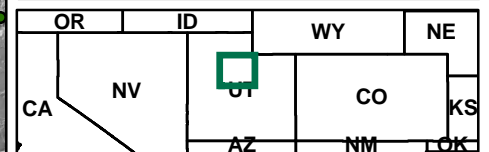
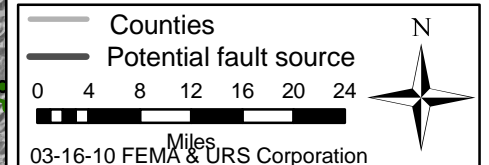
1 Dot = 1 Life Threatening Injury (Severity Level 3 delineated by census tract)

### Impaired Hospitals (Day 1)

Damage is expressed as the probability that a given hospital will realize at least moderate damage.

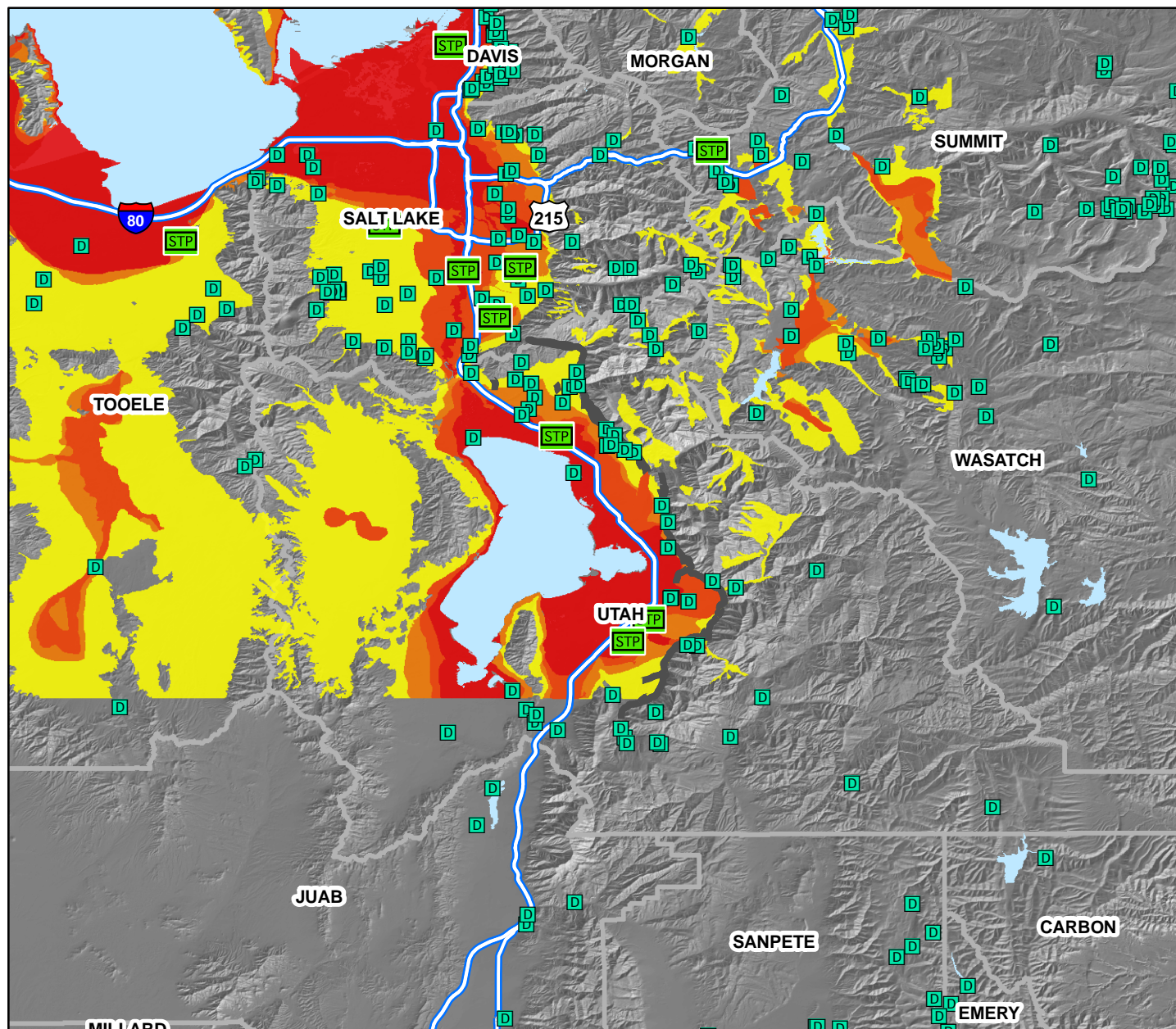
■ high
■ moderate
■ low

County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm*
Box Elder	107	102	5
Cache	158	158	1
Davis	468	400	392
Salt Lake	3,440	3,437	12
Utah	1,013	1,012	0
Weber	655	287	1399
<b>Total</b>	<b>5,841</b>	<b>5,396</b>	<b>1,809</b>





# Water Line, Sewage Treatment Facility Distribution and Liquefaction Susceptibility - Earthquake Scenario: Provo, UT



## M 7.2 Provo Seg. Earthquake

### Liquefaction Susceptibility (ends at boundary of the data)

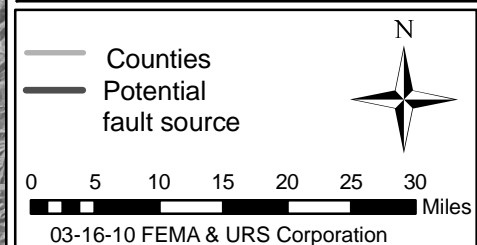


STP Sewage Treatment Facilities

Dams

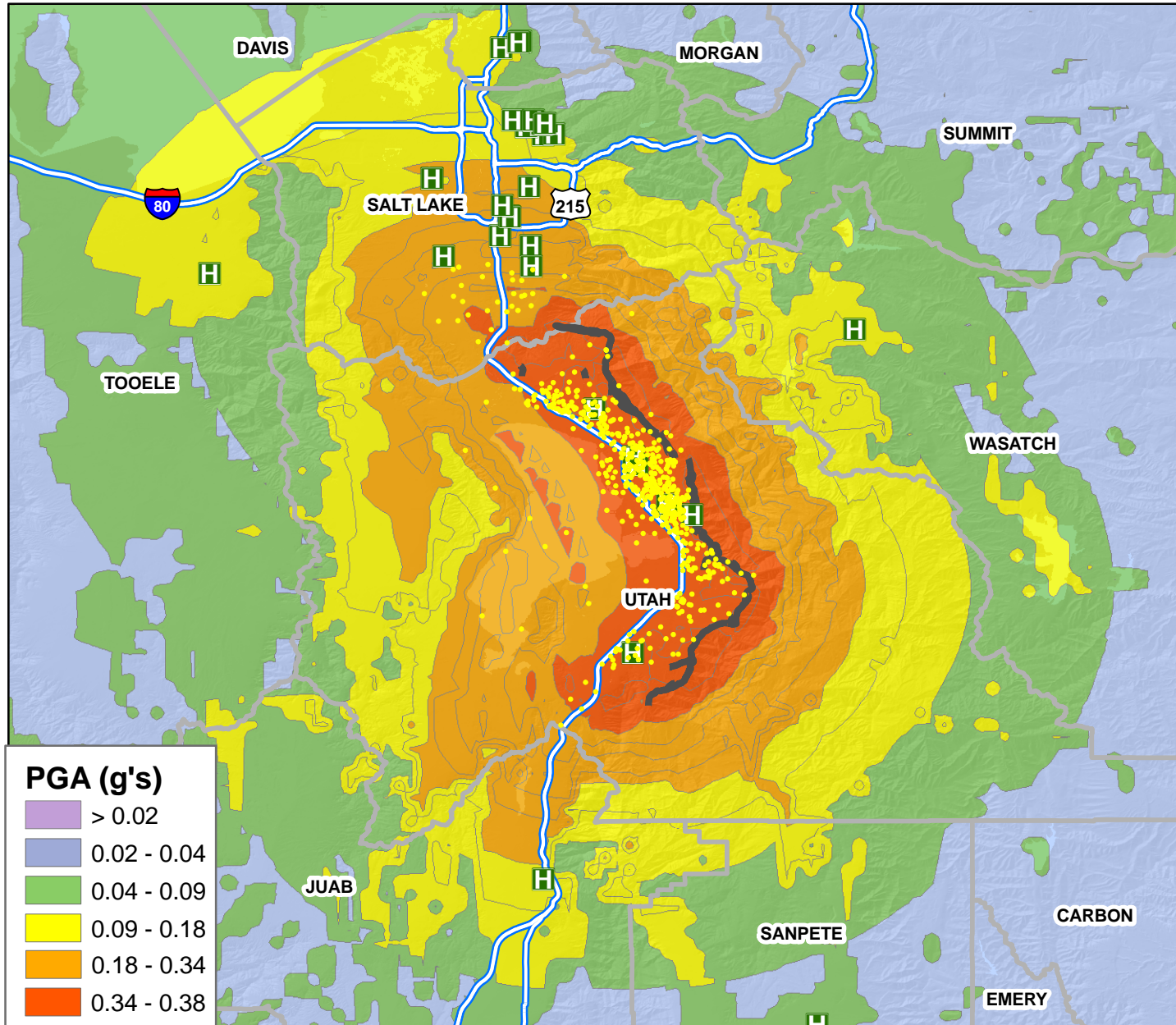
County	# Households without Potable Water (at Day 1)	Daily Potable Water Needs Per Person (Gallons/day)	Number of Truckloads needed Daily
Salt Lake	144,578	433,734	91
Utah	101,248	303,744	64

\* Based on U.S. Army Corp Mission Guidebook  
(Daily water is based on an estimated 3 people per household.  
One truck can transport an estimated 5000 gallons of water.)



OR	ID	WY	
NV	UT	CO	
CA	AZ	NM	

# Potential Search and Rescue Needs - Earthquake Scenario: Provo, UT



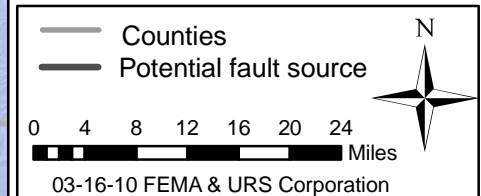
## M 7.2 Provo Seg. Earthquake

### Impaired Hospitals (Day1)

- H** high Damage is expressed as the probability that a given hospital will realize at least moderate damage.
- H** moderate
- H** low
- 1 Dot = 1 Life Threatening Injury (Severity Level 3\*)

Structure Type	Red (Complete)	Collapse Rates for Complete Damage	Total Collapse
Wood	796	3%	24
Steel	1,362	6%	82
Concrete	971	10%	97
Precast	1,383	13%	180
Reinforced Masonry	1,203	10%	120
Unreinforced Masonry	4,103	15%	615
Manufactured Housing	50	3%	2
Total	9,868		1,120

\*Severity Level 3 is defined as injuries that require hospitalization and can become life threatening if not promptly treated.



OR	ID	WY
NV	UT	CO
CA	AZ	NM



# Correctional and Daycare Facilities, Impaired Hospitals (Day 1), and Highway Functionality - Earthquake Scenario: Provo, UT

