Earthquake Hazards in Washoe County

23 February 2010

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Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities, including those in Washoe County





Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Map 167, *Quaternary Faults in Nevada*, is now available not only as a poster but also as an interactive map (Open-File Report 09-9) on line at <u>www.nbmg.unr.edu.</u> You can use it to locate your home or business.







www.nbmg.unr.edu





Easy to pinpoint an address



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Quaternary Faults in Nevada - Online Interactive Map WWW.Nbmg.unr.edu





Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.

1001 E 9th St, Reno, NV, 89512

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Display faults, colored by age of most recent movement, on topographic or aerial photographic base maps.





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Look for a fault | Find Address

Results

Zooming in – Mount Rose Highway and Callahan Ranch Road

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Faults are shown as 1,000-meter (3,281-feet) swaths, inside which geological studies should be conducted to precisely locate the faults relative to building sites.

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Individual faults are sometimes visible as breaks in the slope (scarps), which appear as shadows or lines of vegetation on aerial photographs.

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Look for a fault | Find Address



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The USGS integrates (1) fault, (2) earthquake, and (3) geodetic data into its probabilistic seismic hazard analysis.

(1) Active faults occur nearly everywhere in Nevada, including Washoe County.



(2) Earthquakes have occurred throughout Nevada.



(3) Geodetic data indicate that the **Basin and Range** province is gaining about 1.3 acres of area per year through crustal extension, and that western Nevada is accommodating ~20% of the North American-**Pacific plate** interaction.

Kreemer and Hammond (2007)



In Nevada, much of the right-lateral shear between the North American and Pacific plates occurs along northwest-striking strike-slip faults of the Walker Lane.

Extension largely is accommodated along N- to NE-striking, basin-bounding normal faults.

Walker Lane

40 60 kilometers

Earthquake hazards are high in Washoe County because we have both Walker Lane strikeslip faults and normal faults.

The hazard: expressed in terms of probability of an earthquake of a given magnitude occurring within 50 years and within 50 km of the community.

	% Probability of magnitude greater than or equal to magnitude				
Community	5.0	5.5	6.0	6.5	7.0
Dayton	>90	~80	70-75	50-55	12-15
Carson City	>90	~80	70	50-55	12-15
Reno	>90	~80	67	50	12-15
Sparks	>90	~80	67	50	12-15
Incline Village	>90	~80	60-70	40-50	10-12
Stateline	>90	~80	60-70	40-50	10
Fallon	80-90	~60	35	20-25	6-8
Gerlach	40	~25	10-15	6-10	2-3
Las Vegas	40-50	~30	12	4-5	<0.5
Elko	30-40	~25	10-15	6-8	0.5-1
Wells	30-40	~20	9	6	0.5-1
Laughlin	10-20	~5	2-3	0.5-1	< 0.5

Data are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php. Values for magnitude 5.5 are extrapolated between 5.0 and 6.0. Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, demonstrates that the consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.





Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's lossestimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis. These loss estimates are useful in hazard-mitigation planning, in building scenarios for emergency response and recovery exercises, and in helping emergency managers and the Governor make decisions on official disaster declarations after an actual earthquake.



Earthquake risks in Nevada are assessed by the Nevada Bureau of Mines and Geology using the Federal Emergency Management Agency's lossestimation model, HAZUS-MH, and the U.S. Geological Survey's probabilistic seismic hazard analysis.

NBMG Open-File Report 09-8, *Estimated Losses from Earthquakes near Nevada Communities*, contains HAZUS scenarios for magnitude 5.0, 5.5, 6.0, 6.5, and 7.0 earthquakes near 38 communities in Nevada.

Uncertainties in the location of epicenters, depths, and magnitude, when combined with changing population and uncertainties in local effects (soil and rock types, assumptions about attenuation, basin geometry, liquefaction potential, and directivity), make loss estimates generally consistent within one order of magnitude (a factor of 10), although experience with urban earthquakes in the US has generally yielded numbers within a factor of 2 or 3 of the actual damages.

HAZUS estimates for total economic loss from a magnitude 6.0 earthquake and probability of an earthquake of this magnitude or greater occurring within 50 years and within 50 km of the community.

Community	Total Economic Loss	Probability in 50 years within 50 km
Las Vegas	\$7.2 billion	12%
Reno	\$1.9 billion	67%
Sparks	\$1.8 billion	67%
Incline Village	\$510 million	60 to 70%
Elko	\$160 million	10 to 15%
Fallon	\$110 million	35%
Gerlach	\$39 million	10 to 15%
Wells	\$30 million	9%

Total economic loss is from HAZUS. Probabilities are from the USGS at http://eqint.cr.usgs.gov/eqprob/2002/index.php .

Estimated total economic losses from a magnitude 6.0 earthquake on the Quaternary fault closest to the community

Gerlach: \$39 million

Reno: \$1.9 billion

Sparks: \$1.8 billion

Incline Village: \$510 million

The probability of a magnitude 6.0 earthquake occurring within 50 km of Wells, Nevada within the next 50 years is approximately 9%. It happened on 21 February 2008.



The probability of a magnitude 6.0 earthquake occurring within 50 km of Reno or Sparks within the next 50 years is approximately 67%, 7.4 times higher than for Wells.

> 0.80 0.75 0.70

> 0.65 0.60 0.50

0.40 0.30

0.20

0.10

0.05 0.00



HAZUS estimates (total) economic loss:



HAZUS estimates building damage:



HAZUS estimates public shelter needs:



HAZUS estimates hospital needs:



HAZUS estimates fatalities:



Earthquake faults occur throughout Nevada, and potential losses from earthquakes are high for many communities.

The consequences of earthquakes can be huge in Nevada, particularly if individuals are not prepared.

A. Be prepared to respond.

B. Mitigate structural risks, largely through building codes and avoiding faults and areas of liquefaction.

C. Mitigate nonstructural risks.

Unreinforced masonry building (URM) that collapsed during the Wells earthquake on 21 February 2008

View from back, 20 May 2009

View from front, 20 May 2009



Nonstructural damage often can be easily prevented.









Thank you!

And thanks to Craig dePolo, Gary Johnson, Christine Ballard, Heather Armeno, Irene Seeley, Linda D. Goar, and Jordan T. Hastings for their work on the open-file reports (OF 09-8 and 09-9), which are available as online documents at www.nbmg.unr.edu.

From there, go to online documents at http://www.nbmg.unr.edu/dox/dox.htm, then scroll down to OF 09-8 or 09-9. Link to the fault map from OF 09-9.







GREAT BASIN SCIENCE SAMPLE AND RECORDS LIBRARY

Nevada Bureau of Mines and Geology University of Nevada, Reno

on the Campus of the Desert Research Institute 2175 Raggio Parkway, Reno, NV 89512 Cuttings from oil, gas, and geothermal exploration and production wells 6 May 2009



Seismic base isolation for storage racks in the warehouse section, 6 May 2009





4 May 2009

The Great Basin Science Sample and Records Library, which houses geological samples managed by the Nevada Bureau of Mines and Geology and is located on the campus of the Desert Research Institute, has seismic base isolators for its storage racks.

Large earthquakes can cluster in time and location.

Large historical earthquakes in 1954-1959 near Fallon, preceded by a possible large earthquake in 1852

Date	<u>Magnitude</u>	Near
1852?	7.3	Fallon
July 6, 1954 (a)	6.6	Rainbow Mtn.
11 hours later (b)	6.0	Fourmile Flat
August 24, 1954 (c)	6.8	Stillwater
December 16, 1954 (c) 7.1	Fairview Peak
4 minutes later (e)	6.8	Dixie Valley
March 23, 1959	6.3	Dixie Valley

On the basis of historical seismic records, the Nevada Seismological Laboratory estimates that

there is a 2% probability that a given earthquake is a foreshock of an earthquake with a magnitude 1 unit higher within the next 10 days, and that

there is a 5% probability that a given earthquake is a foreshock of an earthquake with a magnitude 0.5 unit higher within the next 10 days.

The Mogul-Somersett earthquake swarm lasted a few months in 2008, but the region is still seismically active.

Mogul-Somersett Earthquake Swarm February – May 2008

Damage to flume from magnitude 4.7 earthquake on April 25, 2008

Photo: Craig dePolo, NBMG



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N .0.02.62



119 57'0'W

N .D.SE. 60

N.D.02.62

119 540 W

119 51'0'W

N.D.02.62

N D.SE. 60





The April 25 Magnitude 4.7 earthquake measured with geodetic GPS

William Hammond, Nevada Bureau of Mines and Geology



The Mogul earthquakes measured with interferometric synthetic aperture radar (InSAR)

John Bell, Nevada Bureau of Mines and Geology

Envisat Track 27 Frame 2817 Orbits 27135-32646 9 May 2007 to 28 May 2008 Bp = 21 m Cumulative Numbers of Earthquakes of Different Magnitudes Near Mogul



Nevada Seismological Laboratory, UNR



HAZUS loss-estimation model results for Mogul earthquake scenarios

Magnitude

	5.0	5.5	6.0	6.5
Total Dollar Loss	~\$70M	\$100M to \$500M	\$400M to \$1.4B	\$900M to \$3.5B
Utility damage	~\$13M	~\$32M	~\$73M	~\$150M
# Buildings with major damage	30 to 40	100 to 200	1,000 to 2,000	3,000 to 4,000
# People needing shelter	10 to 20	60 to 70	200 to 300	900 to 1,000
# People needing hospital care	~1	4 to 7	20 to 40	60 to 140
# Fatalities	none	0 to 1	2 to 7	9 to 40
Probability				
in 1 year	~8%	~5%	~2%	~1.3%
in 50 years	>90%	~80%	~67%	~50%

Magnitude

	5.0	5.5	6.0	6.5
Probability for	Mogul			
in 10 days	~0.2%	~0.1%	~0.06%	~0.04%
in 1 year	~8%	~5%	~2%	~1.3%
in 50 years	>90%	~80%	~67%	~50%

By comparison, in Nevada

there is a 2% probability that a given earthquake is a foreshock of an earthquake with a magnitude 1 unit higher within the next 10 days, and

there is a 5% probability that a given earthquake is a foreshock of an earthquake with a magnitude 0.5 unit higher within the next 10 days.