Summary Minutes

Nevada Earthquake Safety Council

26 August 2009

The Nevada Earthquake Safety Council (NESC) met from 9:15 a.m. to 3:00 p.m. in the conference room of NV Energy, 6100 Neil Road, Reno, Nevada. These and previous minutes are posted on the Web site for the committee (http://www.nbmg.unr.edu/nesc/index.html).

Ron Lynn chaired the meeting. Individuals attending the meeting are members of the Council:

Elizabeth Ashby, Nevada Division of Emergency Management
Scott Ball*, Engineering Geologist, MWH Americas, Inc., Las Vegas
Alan Bennett*, City of Reno
Mike Blakely*, Blakely, Johnson, and Ghusn
Ian Buckle*, University of Nevada, Reno – Center for Civil Engineering Earthquake Research
Wayne Carlson*, Nevada Public Agency Insurance Pool
Craig dePolo, Nevada Bureau of Mines and Geology, who held the proxy for Larry Macias*, American Institute of Architects, Reno
Diane dePolo, Nevada Seismological Laboratory
Greg Flanigan*, Farmers Insurance
Terri Garside, Nevada Bureau of Mines and Geology, who held the proxy for Jenelle Hopkins*, Clark County School District, Las Vegas
Graham Kent, Nevada Seismological Laboratory, who held the proxy for John Anderson*, Nevada Seismological Laboratory
Steve Koenig*, Bellagio Resorts
Ron Lynn*, Clark County Department of Development Services
Rick Martin, Nevada Division of Emergency Management
Robert Martinez, Nevada Division of Water Resources
Janice Moskowitz, Nevada Division of Insurance
Greg Moss*, Allied Nevada Gold Corp. (Hycroft mine)
Glade Myler, Office of the Attorney General, representing Nevada Division of Emergency Management
Jim O'Donnell*, Geophysical Contractor, Las Vegas
Jon Price*, Nevada Bureau of Mines and Geology
Jim Reagan*, NV Energy
Ken Smith, Nevada Seismological Laboratory
Gennady Stolyarov, Nevada Division of Insurance
Wanda Taylor*, UNLV Department of Geoscience
Jim Walker*, Nevada Department of Transportation
Jim Werle*, Converse Consultants

* indicates member of the Board of Directors.
A quorum of directors (the necessary 11) was present.

Board Members unable to attend or send a proxy included:

Bernie Anderson*, Nevada Assembly
Joe Curtis*, Storey County Emergency Manager
Warren Hardy*, Nevada State Senator

The minutes of the 20 May 2009 meeting were unanimously approved.

Awareness and Education Committee

Diane dePolo reported that the Committee is planning a poster contest for K-8 students during Earthquake Awareness Week (late February of 2010). They will be asking for free radio broadcasts to announce the winners. Please e-mail ideas for the theme for Earthquake Awareness Week to Diane at diane@seismo.unr.edu. They are also looking at new ways for getting messages out to the media, particularly after earthquakes but also at safety fairs and other venues.

Rick Martin noted that NDEM has a new Public Information Officer (Gail Powell). NDEM is supporting a major public outreach effort through their website at http://dps.nv.gov/PlanAheadNevada/index.shtml. This program targets elementary-school-aged children.

Ron Lynn suggested that the Awareness and Education Committee combine efforts with other safety efforts and weeks.

Research Committee

Wanda Taylor is planning a fault-trenching study on the Stateline fault in Stewart Valley, along the California border in Nye County. This is one of the major faults in the Eastern California shear zone and Walker Lane.

Craig dePolo has been visiting a water-pipeline trench (up to 3 meters deep) near Mogul, where a swarm of earthquakes occurred in the spring of 2008. A few faults have been found in this trench. One is a northwest-striking fault juxtaposing Cretaceous granite against Tertiary mud flow breccia; this may be the fault along which the largest of the Mogul earthquakes occurred.

Craig distributed a draft of the "Lessons Learned from the 2008 Wells, Nevada Earthquake." Please e-mail comments to him at cdepolo@unr.edu. He noted that progress is being made on reviews of the full Wells report.

Wayne Carlson stated that one of the recovery issues for the City of Wells is deciding whether to repair or replace damaged facilities. This has caused some delays in spending insurance payments.

Plans are underway to update and upgrade the booklet "Living with Earthquakes in Nevada." Some funding is available for reprinting and minor updates. Please e-mail Craig with ideas on upgrading the document.

Craig suggested that NESC support a conference on "Unreinforced Masonry Buildings – Ending the Deadly Earthquake Risk" that would focus on solving the worst of the earthquake problems. Ron Lynn suggested expanding the meeting to include other western states, perhaps through the Western States Seismic Policy Council.

Policy Recommendations Committee

Wayne Carlson noted that the Committee did not meet during the last quarter. The grant to collect information from Nevada counties on unreinforced masonry buildings (URMs) has been awarded by FEMA; it is being managed by the Nevada Bureau of Mines and Geology (NBMG). NBMG will add county assessors' information to a database, create various maps and reports from the data, and integrate the information as an upgrade to HAZUS, FEMA's loss-estimation computer model.

ACTION ITEM: Wayne Carlson, at Ron Lynn's suggestion, will check whether any of the new Western States Seismic Policy Council (WSSPC) policy recommendations ought to be adopted by NESC.

Strategic Planning Committee

The Council unanimously approved the 2008 annual report of NESC, prepared by Jim Reagan on behalf of the Strategic Planning Committee. The report is posted on the NESC website.

Ad-Hoc Committee on Anchoring of Propane Tanks

Ron Lynn noted that the Liquefied Petroleum Gas (LPG) Regulation Board does not regulate temporary tanks. There are no standards for these tanks.

ACTION ITEM: Werner Hellmer will report at the next meeting on progress regarding possible shake-table experiments to test key aspects of movement of LPG tanks during earthquakes.

Ad-Hoc Committee on Visitors

No report.

Nominating Committee

Rick Martin will discuss with Frank Siracusa replacing John Anderson in the NESC position for Seismology with Graham Kent, the new Director of the Nevada Seismological Laboratory. John stepped down as the Director to return to full-time teaching and research. (Note after the meeting: Graham has been appointed to this position.)

Division of Emergency Management Report on Current Activities, Funding Sources, and Training Activities

Rick Martin reported that NDEM has a new Operations Manager, Kelli Barratti. She is preparing a daily situation report that includes Nevada information as well as events in FEMA Region IX (California, Arizona, Nevada, Hawaii, Guam, American Samoa, Commonwealth of the Northern Mariana Islands, Republic of the Marshall Islands, and the Federated States of Micronesia). Please contact Rick Martin at rmartin@dep.state.nv.us if you would like to be included on the distribution list.

Rick also noted that Paul Burke, who has a strong background in law enforcement and search and rescue, has joined the NDEM staff as the Planning, Training, and Exercise Manager. Please see the NDEM website (http://dem.state.nv.us/) for details.

The American Institute of Architects is holding a conference titled “Surviving and Thriving in the New Nevada,” September 16-19 at the Historic Fifth Street School in Las Vegas. They are offering the Applied Technology Council course on post-earthquake safety evaluations of buildings (ATC-20) and the Federal Emergency Management Agency’s course on rapid visual screening (FEMA 154) for fees at this conference. Registration can be made through www.aialasvegas.org.

The next large exercise will be the National Level Exercise 2010, including Clark County, the State of Nevada, other states, and the federal government (May 17-21, 2010). Jim Reagan stated that there will be some need for geological and seismological input. Glade Myler noted that recovery planning will be an important part of this exercise.

Rick reported that NDEM is working on several recovery-related plans for local governments, including ones for donations management, volunteer management, and debris management.

Through the State's Emergency Assistance Account, the City of Wells has received about $145,000 to help pay its uninsured expenses from the 21 February 2008 magnitude 6.0 earthquake that struck the town; this covered approximately half of the City's emergency response expenses.

NDEM expects that base funding for NESC is secure, but there is no anticipated year-end funding, although some may become available if grant funds are unused by some of the local governments.

Wayne Carlson said that a large cost from the Fernley canal breach will be attorneys' fees and lawsuits. The Nevada Public Agency Insurance Pool is defending the City of Fernley in these lawsuits.

Wayne also noted that Michael Lynch, former member of NESC, has been appointed a Deputy Insurance Commissioner.

Introduction of Dr. Graham Kent, Director, Nevada Seismological Laboratory

Dr. Graham Kent joined the UNR faculty as Director of the Nevada Seismological Laboratory in early August. A graduate of the San Diego State University and Scipps Institution of Oceanography at the University of California, San Diego, his expertise is largely in active-source seismology (using man-made explosions and other sources to generate seismic waves for studying Earth structure). He has been a research geophysicist at the Scripps Institute of Geophysics and Planetary Physics. He described his recent research on seismic hazards along the southern part of the San Andreas fault and the Salton Sea area, the part of the San Andreas fault that is most likely to have the next great earthquake.

Graham has also studied the West Tahoe fault on the west side of Lake Tahoe. Although in California, this fault poses significant risk for Nevada. It last ruptured about 4,100 to 4,500 years ago (magnitude 7.3), has a slip rate (approximately 1 mm/year) similar to that of the Genoa fault, and is probably near the end of its characteristic earthquake cycle. That is, it could have a major earthquake at any time. A large earthquake on this fault could generate a 10-meter (33-foot) high seiche or tsunami wave that would hit all parts of the lake within two to four minutes. Recent modeling of the McKinney Bay landslide (50,000 years ago or so) suggests that it may have generated a 130-meter (420-foot) high wave when it moved a considerable amount of rock into the lake. The rock debris is easily seen on bathymetric maps of the lake.

Graham discussed new opportunities and directions for the Nevada Seismological Laboratory. He anticipates new funding from the National Science Foundation for studies of crustal structure in the Walker Lane, the zone of northwest-striking faults in western Nevada. He and Ken Smith are working on a plan to take advantage of the fact that larger Apple computers have accelerometers built into the hardware of the computer. By networking these computers in homes and businesses throughout the region, there could be a quantum leap in understanding earthquakes.

Report on Seismic Activity in 2009

Ken Smith reported that the Nevada Seismological Laboratory has recorded 3,216 seismic events so far in 2009. The distribution in 2009 mirrors the historical record, with most activity in the Walker Lane-Eastern California shear zone, Central Nevada seismic belt, and along the Pahranagat seismic zone in southern Nevada.

There was a small earthquake swarm in July in Sun Valley, north of Reno. The largest earthquake of this swarm was a magnitude 2.4 on July 31. It was a normal faulting event. There were also a number of earthquakes at the northwest end of Pyramid Lake. Seismicity has been relatively low in the Mogul area. There were also a few small earthquakes near Boulder City and Las Vegas.

Ken also discussed efforts to recognize false events reported in the automatic e-mail notifications from the Nevada Seismological Laboratory. These typically occur in the areas where seismic instruments are sparse, particularly in northern Nevada and far southern Nevada. By evaluating the difference in arrival times for the P and S waves and by analyzing the frequency signal, a seismologist can quickly determine whether an automatic pick is a distant earthquake or a nearby earthquake.

In the future, moment magnitudes and moment tensor solutions will also be generated automatically for earthquakes of magnitudes greater than 4.

Presentation and Ranking of Proposals Received for Potential Year-End Funding

After presentations on five proposals for year-end funding, the Council ranked the proposals as follows (#1 = highest priority; #5 = lowest).

1. Dense Low-Cost Real-Time Urban Strong Motion Network ($26,310 in federal funds)
2. Reviewed Nevada Earthquake Catalog Database ($16,790 in federal funds)
3. Earthquake Map of Nevada, 1840s to 2009 ($35,886 in federal funds)
4. 1915 Pleasant Valley Earthquake: Description and Intensity ($21,147 in federal funds)
5. 1933 Wabuska Earthquake: Description and Intensity ($21,147 in federal funds).

ACTION ITEM: Terri Garside will transmit the prioritized NESC list of proposals, along with the one-page NESC Project Proposal Forms, to the Nevada Division of Emergency Management for their consideration should year-end funding become available.

Retrofit of the Saint Thomas Aquinas Cathedral and St. Mary's in the Mountains

Mike Quilici with the Roman Catholic Diocese of Reno described the structural retrofit of the Saint Thomas Aquinas Cathedral in downtown Reno. It involved constructing a steel structure inside the old building.

Paul Ferrari and Robert Wright described the structural and architectural retrofit of the historic St. Mary's in the Mountains Church in Virginia City. The National Park Service provided a grant to partially cover the costs. The roof was not tied into the unreinforced, 30-inch-thick brick walls. A loft that had provided some support was removed in the 1950s. After recognizing that structural integrity had been impaired when the loft was removed, the church then covered walls with gunite that was tied into the bricks. With the recent funds, they built new structural concrete beams between the side windows to tie the roof to the rest of the structure, and they built new concrete shear walls on the front and back of the building. The grand opening will be September 12, 2009. Cost was approximately $1.5 million.

Award in Excellence to the Roman Catholic Diocese of Reno

Ron Lynn presented a NESC Award in Excellence to the Roman Catholic Diocese of Reno "for earthquake rehabilitation of the Saint Thomas Aquinas Cathedral in Reno and St. Mary's in the Mountains in Virginia City. Churches are regularly used public places that hold large numbers of people, posing a potentially high seismic risk. Earthquake rehabilitating of these churches substantially reduces this risk."

Update on Lessons Learned from the 2008 Wells Earthquake

Craig dePolo updated the Council on lessons learned from the 2008 Wells earthquake. He requested that comments be e-mailed him by the end of September.

Assessing Earthquake Risks in Nevada – Update on Current HAZUS Runs

Jon Price described progress on earthquake loss-estimation modeling using FEMA's HAZUS program for earthquakes of magnitude 5.0, 5.5, 6.0, 6.5, and 7.0 for 38 communities in Nevada. HAZUS for Nevada has been upgraded from the 2000 census data to include new information on critical facilities and 2005 population estimates. An additional improvement to HAZUS has been the location of population centers within census tracts; Doug Bausch with FEMA-Region VIII helped override the default locations at the geographic centers of the census tracts and put the populations in more appropriate locations. The new HAZUS data for Nevada will be available through the Nevada Bureau of Mines and Geology (NBMG), and the results of the HAZUS runs for the 38 communities will be released as an NBMG open-file report, with HAZUS summary reports for each scenario available on the NBMG website (www.nbmg.unr.edu). The report will also tabulate probabilities for earthquakes of these sizes occurring within 50 years and within 50 kilometers of each community; these probabilities are taken from maps produced by the U.S. Geological Survey as part of its probabilistic seismic hazard analysis. Among the 38 communities, Dayton, Carson City, Virginia City, Reno, and Sparks rank highest in terms of probability, in that order, from highest to lowest, and Laughlin, West Wendover, Mesquite, Ely, Pioche, and Pahrump rank lowest, in that order, from lowest to highest.

Jon distributed a series of preliminary data tables that will be part of the open-file report. The 21 February 2008 Wells earthquake provides a good comparison of total economic loss from a magnitude 6.0 earthquake.

Table illustrating the HAZUS estimates for total economic loss from a magnitude 6.0 earthquake and probabilities of earthquakes of this size or greater occurring within 50 years and within 50 kilometers of the communities.

Community	Total Economic Loss	Probability in 50 years within 50 km
Wells	$30 million*	9%
Elko	$160 million	10 to 15%
Las Vegas	$7.2 billion	12%
Stateline	$590 million	60 to 70%
Reno	$1.9 billion	67%

* The Wells earthquake on 21 February 2008 caused approximately $9 million in economic loss, according to the latest estimates of Craig dePolo.

Old Business

Ron Lynn reviewed action items remaining from previous meetings. Several remain for future NESC meetings.

Wanda Taylor did discuss the Task Force on Propane Tanks, particularly modeling (dynamic analysis), with Aly Said, UNLV engineering professor.

Jim O'Donnell reported on his measurements of shear-wave velocity in Wells. Shear-wave velocity can be used to estimate the soil classification, which is important input for engineering design and is used in HAZUS estimates of loss from earthquakes. The "old town" area, the high-school, and the court house received most of the damage from the 21 February 2008 magnitude 6.0 earthquake. Jim measured shear-wave velocity using the refraction microtremor method in these three areas as well as other areas. He used 470-foot long lines to measure velocity with depth. The data appear to indicate a higher-velocity layer at a depth of 20 to 40 feet below old town. His measurements indicate the following soil classifications:

Old town, D (stiff soil) (velocity = 1,180 and 1,150 ft/sec at a depth of 100 feet)
High school C (very dense soil and soft rock) (~1,320 ft/sec)
Court house: C (~1,300 ft/sec).

Ron Lynn noted that WSSPC's annual meeting will be July 9-13, 2010, in conjunction with the annual meeting of the Natural Hazards Center.

Ron Lynn announced that future meeting dates for NESC are as follows:
Wednesday, November 4, 2009, in Las Vegas
Wednesday, February 10, 2010, in Reno
Wednesday, May 26, 2010, in Las Vegas
Wednesday, August 25, 2010, in Reno
Wednesday, November 17, 2010, in Las Vegas.

Public Comments

There were no additional public comments.

The meeting adjourned at 3:00 p.m..

REVIEW OF ACTION ITEMS

ITEMS REMAINING FROM THE PREVIOUS NESC MEETINGS

During upcoming NESC meetings, Craig dePolo will report on activities of an Ad Hoc Committee on Visitors, which Ron Lynn tasked to update the guide for hotel owners. Steve Koenig volunteered to help Craig with this effort.

NEW ACTION ITEMS

Wayne Carlson, at Ron Lynn's suggestion, will to check whether any of the new Western States Seismic Policy Council (WSSPC) policy recommendations ought to be adopted by NESC.

Terri Garside will transmit the prioritized NESC list of proposals, along with the one-page NESC Project Proposal Forms, to the Nevada Division of Emergency Management for their consideration should year-end funding become available.

Werner Hellmer will report at the next meeting on progress regarding possible shake-table experiments to test key aspects of movement of LPG tanks during earthquakes.

respectfully submitted by Jon Price, 6 October 2009

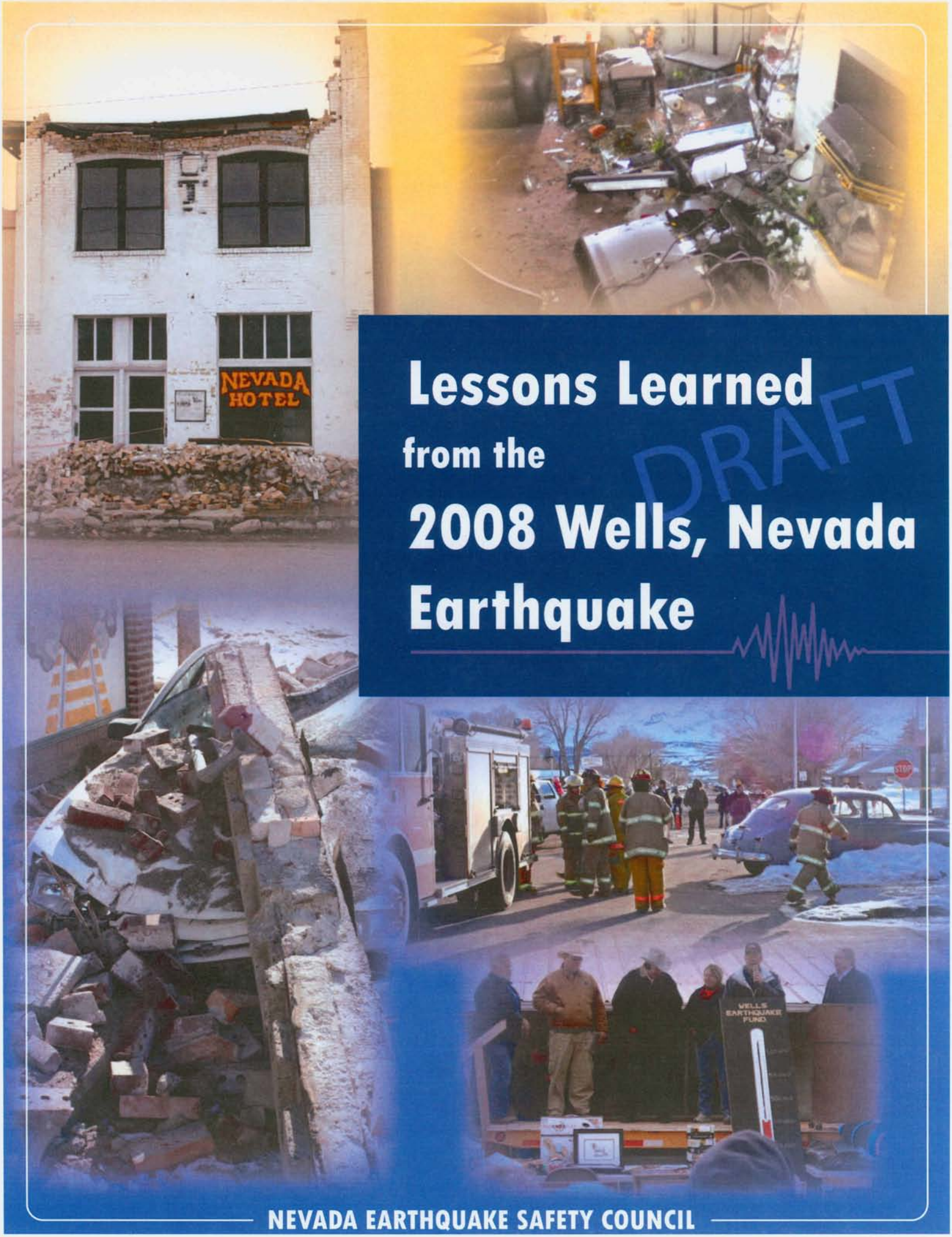
Nevada Earthquake Safety Council
c/o Nevada Bureau of Mines and Geology
University of Nevada/MS 0178
Reno, Nevada 89557-0178
775/784-6691 ext. 5

NEVADA EARTHQUAKE SAFETY COUNCIL
Members of the Board of Directors and Officers
(as of 4 October 2009)

Business and Industry, Southern Nevada	Steve Koenig Bellagio Resorts
Business and Industry, Northern Nevada	Larry Macias American Institute of Architects
Insurance Industry (statewide)	Greg Flanigan Farmers Insurance (Las Vegas)
State Government (statewide)	Jim Walker Nevada Department of Transportation
Local Government, City	Wayne Carlson Nevada Public Agency Insurance Pool (Carson City)
Local Government, County	Joe Curtis Storey County Emergency Management
Seismology (statewide)	Graham Kent Nevada Seismological Laboratory (UNR)
Geosciences, Southern Nevada	Scott Ball MWH Americas, Inc. (Las Vegas)
Geosciences, Northern Nevada	Jonathan G. Price Nevada Bureau of Mines and Geology
Engineering, Southern Nevada	Jim Werle Converse Consultants (Las Vegas)
Engineering, Northern Nevada	Mike Blakely Structural Engineers Association of NV
Education (statewide)	Jenelle Hopkins Clark County School District, Las Vegas
Community Organizations, Southern Nevada	vacant ***
Community Organizations, Northern Nevada	Jim Reagan NV Energy
University, Southern Nevada	Wanda Taylor UNLV Geoscience Department
University, Northern Nevada	Ian Buckle UNR Center for Civil Engineering Earthquake Research
Building Official, Southern Nevada	Ronald L. Lynn Clark County Department of Development Services
Building Official, Northern Nevada	Alan Bennett City of Reno
State Senate	Warren Hardy Nevada State Senator (Las Vegas)
State Assembly	Bernie Anderson Nevada State Assemblyman (Sparks)
Member at Large, Southern Nevada	Jim O'Donnell UNLV
Member at Large, Northern Nevada	Greg Moss The Moss Group

Members of the Executive Committee

Chair	Ronald L. Lynn
First Vice Chair-South	vacant
First Vice Chair-North	Jim Reagan
Second Vice Chair-South	Jim Werle
Second Vice Chair-North	Greg Moss
Secretary	Jonathan G. Price
Past Chair	John Anderson
Division of Emergency Management Representatives	Rick Martin
Senior Deputy Attorney General, counsel for NESC	Glade A. Myler



Lessons Learned from the 2008 Wells, Nevada Earthquake

DRAFT

NEVADA EARTHQUAKE SAFETY COUNCIL

With Contributions and Support from:

Nevada Bureau of Mines and Geology

Nevada Seismological Laboratory

Nevada Division of Emergency Management

Federal Emergency Management Agency

United States Geological Survey

City of Wells

2008-2009 Nevada Earthquake Safety Council Members

Bernie Anderson	Nevada State Assemblyman
John Anderson	Nevada Seismological Laboratory
Scott Ball	MWH Americas, Inc.
Alan Bennett	City of Reno
Mike Blakely	Blakely, Johnson, and Ghusn Engineers
Ian Buckle	UNR – Center for Civil Engineering Earthquake Research
Wayne Carlson	Nevada Public Agency Insurance Pool
Joe Curtis	Storey County Emergency Manager
Greg Flanigan	Farmers Insurance
Warren Hardy	Nevada State Senator
Jenelle Hopkins	Clark County School District
Steve Koenig	Bellagio Resorts
Ron Lynn	Clark County Department of Development Services
Larry Macias	American Institute of Architects
Greg Moss	The Moss Group
Jim O'Donnell	Geophysical Contractor
Jon Price	Nevada Bureau of Mines and Geology
Jim Reagan	Nevada Energy
Wanda Taylor	UNLV Geoscience Department
Jim Walker	Nevada Department of Transportation
Jim Werle	Converse Consultants

Non-Voting Members	
Elizabeth Ashby	Nevada Division of Emergency Management
Craig dePolo	Nevada Bureau of Mines and Geology
Diane dePolo	Nevada Seismological Laboratory
Johanna Fenton	Federal Emergency Management Agency, Region IX
Terri Garside	Nevada Bureau of Mines and Geology
Rick Martin	Nevada Division of Emergency Management
Glade Myler	Nevada Attorney General's Office

Lessons Learned from the February 21, 2008 Wells, Nevada Earthquake

August 26, 2009 *(DRAFT)*

The Wells, Nevada Earthquake was a testament to good building design and construction, the virtues of a well trained emergency response, and the resiliency of the rural environment executing an admirable recovery effort. The earthquake damaged half of the non-residential buildings in Wells, 10 of these severely, and caused widespread nonstructural damage. Fortunately, the early morning earthquake caused only four relatively minor injuries and no deaths. But the nearly instantaneous disaster cost about $9 million dollars and severely disrupted the community of Wells for several months. The 2008 Wells Earthquake was a background event, one that can occur anywhere in Nevada. It is the kind of event that all Nevada communities need to be able to readily survive and recover from. Unfortunately, earthquakes as large as magnitude 7.5 can occur near several of our communities, and these should prepare for much stronger and longer shaking than Wells received. On the fortunate side, people are the most important participants in making their lives safer from earthquakes; people have the power to make their homes, offices, and stores safer from falling contents, to create places to take cover from falling things, and to learn the potentially life-saving behavior of drop, cover, and hold for when an earthquake occurs.

Studying a major earthquake and its affects on a community is critical for learning how to design for, prepare for, respond to, and recover from future Nevada earthquakes. Even reaffirming expected types of damage, such as partial collapse of unreinforced brick buildings, should kindle a determination to rid our communities of this potential risk through strengthening, controlling access, or demolition of these buildings. When viewing a community that has been struck by an earthquake, we look at things that went "wrong" and devise strategies to avoid this in the future, but we also have to look for clues within what went "right", to do even better. These lessons are powerful because they occurred in a Nevada community, within recent memory, helping to remove the doubt of whether such an event can happen, which can be a hindrance to action.

The Nevada Earthquake Safety Council wants to gain insight into this event and note major lessons from the 2008 Wells Earthquake. What was done well that should be emulated, what can be improved on, and how can these findings be applied to Nevada to reduce our earthquake risk?

As with all recommendations given for earthquake readiness, these lessons do not guarantee your safety during an earthquake. They are some common sense ideas intended to enhance safety and minimize property loss from future earthquakes. They are presented to highlight some lessons from one of Nevada's most recent damaging earthquakes and to promote a dialog on how we can best survive future Nevada earthquakes.

Contents:

Lessons for Nevadans:

Lessons about Buildings:

Lessons about Utilities:

Lessons about Emergency Response to Earthquakes:

- Emergency resource allocations and emergency personnel training contributed to a successful emergency response and should continue throughout the Nevada
- Communication can be severely hampered during an emergency response if robust, uniform or otherwise connected communication systems are not used
- All Nevada communities should have emergency plans that can be used for rapid decision-making and include redundant Incident Command Post locations
- A satellite-communication truck may be important for incident command and emergency response communications in rural earthquake disasters
- A large number of placards for posting the condition of buildings should be stored at multiple locations within each county and should be distributed to earthquake affected areas within a day

Lessons about Community Recovery from an Earthquake Disaster:

- Nevada Communities should development Plans for Recovering from a Major Earthquake Disaster

Lessons about Earthquake Monitoring in Nevada:

- An adequate statewide seismic monitoring system needs to be completed to rapidly and accurately locate major earthquakes in Nevada

Lessons for Earthquake Fault Studies in Nevada:

- Quaternary faults should be mapped and studied within 25 miles of each Nevada town to assure earthquake hazards are adequately characterized for these communities

Lessons for Nevadans:

Earthquakes can occur anywhere in Nevada.

All of Nevada has a significant earthquake threat, and earthquake preparedness needs to be taken seriously. The earthquake hazard in Wells is moderate at a national scale, but for Nevada, it is one of the lowest hazard areas of the state. According to the U.S. Geological Survey's probabilistic seismic hazard analysis (http://eqint.cr.usgs.gov/eqprob/2002/index.php), the hazard for Wells is actually less than that for the Las Vegas urban area and much less than that for the Reno-Carson City urban area. Specifically, the probability of a magnitude 6.0 earthquake occurring within 50 km of Wells, Nevada within 50 years is approximately 9%, but the probability of the same magnitude earthquake occurring within 50 km (~31 miles) of many other Nevada communities is considerably higher: 12% for Las Vegas, 67% for Reno, and 70% for Carson City. The next damaging earthquake won't necessarily occur where we think earthquakes are most likely. An earthquake the size of the 2008 Wells event can occur anywhere in Nevada. All people and communities in Nevada need to be prepared for earthquakes.

Nevadans need to know what to do if there is a strong earthquake. Make sure you, family, friends, and employees know to *Drop, Cover, and Hold* during an earthquake and how to turn off natural gas if there is a gas leak.

There were two residential gas line breaks from the 2008 Wells Earthquake and in both cases, the residents identified the gas leak by the smell and turned off their gas, preventing a possible explosion or fire. This was a great response, but not all Nevadans know how to turn the gas off in a similar situation. All Nevadans need to be prepared for earthquakes and know how to appropriately respond to an earthquake. Preparation includes having at least five days of provisions (water, food, medications) to survive on your own until help can arrive. Nevada business owners also need to be prepared, mitigate shaking hazards, and have a post-earthquake action plan.

Nevadans should secure, relocate, or remove dangerous items that can fall on people and hurt them.

Falling building contents caused the two injuries that occurred during the earthquake and caused some close calls that could have resulted in death or serious injury. Nevadans need to secure the areas where they, their loved ones, their friends, their employees, and their customers spend a lot of time, making sure they are free from falling hazards. *Safety spots*, such as a sturdy table or desk where people can take cover from falling objects should be identified in

each room. When an earthquake occurs: *Drop, Cover, and Hold: drop* to a lower level taking *cover* under an object that can protect you and stay under it by *holding* onto it. Exit ways that will be needed following an earthquake should be kept clear of falling hazards as well.

If you are inside a building during an earthquake, stay inside; if you are outside, get away from buildings, especially older ones, if it is safe to do so.

Some of the potentially most deadly situations from the 2008 Wells Earthquake occurred at exit ways and along the sidewalks adjacent to buildings, especially in old town, where bricks and concrete beams fell from the shaking. Fifty-five percent of unreinforced brick building exits had deadly debris shed across them, whereas only one building collapsed, and other partially collapsed buildings had survivable interior space (several people were inside a partially collapsed building and survived uninjured). Thus, it was clearly safer to have stayed inside the buildings, and *Drop, Cover, and Hold* than to have run outside.

Volunteers were essential to the success of the response and recovery efforts at Wells. Nevadans need to continue to be willing to help their own, or neighboring communities, in earthquake and other disasters. Nevadans should be encouraged to get Community Emergency Response Training (CERT).

The citizens of Wells, their neighbors in Elko County, other Nevadans, and people from as far away as Utah, Idaho, and California all came together during and following the 2008 earthquake to help with relief and recovery of the town. There were fix-up Saturdays where hundreds of volunteers helped clean-up damage and make repairs to homes and community centers. There was a Wells Recovery Rally put on by volunteers and donations that produced $110,000 of recovery money. There was $100,000 donated by Nevadans that were used in helping Wells citizens and businesses recover. All of these were important to helping the recovery of Wells. In future disasters, Nevadans will need to lend-a-hand to their neighbors in a similar fashion, which not only helps the affected community, but keeps us strong as a state. Community Emergency Response Team (CERT) training can give formal training to Nevada citizens who want the skills to help in an emergency response. CERT teams can be critical to helping in the overwhelming early response to an earthquake, when professional emergency responder's capacities are exceeded.

When a strong earthquake occurs, check on your neighbors, and make sure they are all right and no dangerous situations exist for them.

Wells residents checked on each other and especially checked on people who might need a little more help getting around or cleaning up. In a similar or larger earthquake in Nevada, some of the success of the emergency response may depend on neighbors checking on each other, identifying when there are injuries or dangerous situations, and communicating these to emergency personnel. Checking on each other also reaffirms a strong social connection we have with one another, that can help in coping with situations such as strong earthquakes. Further, many non-emergency 911 calls may be eliminated if people have the opportunity to talk to another person.

Lessons about Buildings:

The seismic provisions in modern building codes are important to use in Nevada.

Most of the modern and well-built buildings in Wells survived the 2008 earthquake structurally intact. Wells uses building codes which likely contributed to this success. Seismic events can strike anywhere in the state, therefore it is wise to have the basic requirements for buildings that provide life-safety during earthquakes, which is the building code's primary goal.

Unreinforced masonry buildings and unanchored masonry veneers are extremely vulnerable to earthquake damage and failure.

Engineers will quickly point out that this is not a new observation, but there are many unreinforced masonry buildings in Nevada's rural communities and in its cities, such as Reno, so it is important to reiterate the point. Earthquake damage in Wells exposed rubble infill of walls, use of weaker un-fired bricks and adobe bricks, and large areas where brick courses in walls are not tied together with soldier course cross bricks, especially in the upper parts. These defects appear to make these walls even weaker than might be expected during shaking. Unreinforced buildings remain one of Nevada's greatest earthquake risks and hazard to both life and property. These were the most severely damaged buildings from the 2008 Wells Earthquake. Damage from unreinforced masonry buildings can also severely impact adjacent buildings.

Unreinforced masonry buildings in Nevada should be inventoried to understand the extent of the risk and Nevada needs a long-term strategy to make these types of buildings more seismically resistant or to eliminate them.

Balconies and sidewalk coverings may be able to be strengthened to provide protection against falling bricks and other debris from unreinforced masonry buildings during earthquakes.

In one case a balcony caught all the bricks that fell off the building protecting an exit way and in another case an awning caught bricks protecting a bench adjacent to the building. It is possible that balconies and sidewalk coverings around unreinforced brick buildings can be strengthened to capture and hold falling bricks (and other debris?) which could provide some protection to people in those areas. Obviously there are limits that any covering can take, but this or similar measures should be considered as short-term safety enhancements for exit ways from unreinforced masonry buildings and public sidewalks around these buildings. Even if people stay inside these buildings as is suggested, they will have to exit after the shaking stops.

Crowning bond beams on top of walls are particularly dangerous elements of unreinforced brick buildings during earthquake shaking and are particularly susceptible to falling as large, coherent masses. Crowning bond beams on unreinforced buildings should be braced and anchored to the structure to keep them in place, or should be removed.

A crowning bond beam is a concrete cap on the top of an unreinforced brick wall. These were one of the most destructive and potentially deadly failures of the unreinforced masonry buildings from the 2008 Wells Earthquake. In one case, large coherent sections of the beam fell smashing through a balcony so fast and hard that the columns were left standing in place. In another case a parked car's passenger compartment was crushed by a crowning bond beam. Additionally, the upper parts of walls with crowning bond beams tend to be weaker with fewer cross-ties and a minimum two-brick wide thicknesses, apparently relying on the weight of the bond beam to provide strength.

Buildings that are in severe disrepair, have partially collapsed, or have incomplete structural systems may be subject to total collapse during earthquakes.

A building that was in disrepair collapsed during the 2008 Wells Earthquake. These buildings may be off-limits to the public, but they may be populated by workers beginning to renovate the building. Bracing and safety boxes should be considered in such situations to protect workers until the building is strengthened.

Unreinforced brick and masonry chimneys can collapse during earthquakes, causing injuries and severe damage.

Although many communities in Nevada have changed from having unreinforced brick and stone chimneys to having stove pipes in new construction, there remain many of these chimneys across Nevada. During the 2008 Wells Earthquake, 10% to 15% of the masonry chimneys were damaged and several of these had significant sections collapse. Residents in buildings should take note of brick or stone chimneys and stay away from the area around the chimney during and following a major earthquake. They should also know to extinguish any fires following an earthquake and not to start any fires until the chimney can be inspected to avoid possibly setting fire to the house because of breaks that expose flammable parts of the house or building.

Earthquake insurance was a wise investment in Wells and should be considered seriously by communities and individuals.

The city government, school district, and county government had earthquake insurance on their buildings, contents, and for business disruption which helped them financially survive the earthquake damage and helped in the overall recovery of the town. Of the three lost homes, one of them had earthquake insurance, which ended up paying off the mortgage of the destroyed home. Unfortunately, very few homes in Nevada have earthquake insurance.

Most people do not realize that earthquakes are not covered on the typical insurance policy and must be added to their policy as a form of endorsement. A larger earthquake will result in very large uninsured losses today. Nevada is earthquake country and for significant losses that may be hard to recover from, earthquake insurance should be considered.

Lessons about Utilities:

Liquid propane leaks are particularly dangerous because the liquid expands 270 times into a vapor cloud and requires a local evacuation. Research should be conducted to assure that standard propane tank practices in Nevada are adequate to prevent liquid propane leaks from the strongest shaking that can occur in the state. Temporary propane tanks pose significant seismic risks if they are not installed properly.

A propane tank on a temporary, unapproved foundation was toppled by the 2008 Wells Earthquake, breaking the connection and the turn wheel, leaking liquid propane, and creating a potentially explosive propane cloud. Although it is unlikely that the tank would have toppled had it been on a proper foundation, the leak, the situation, and the associated evacuation highlight this potential hazard.

Given the consequences of this situation, it would be prudent to be assured that standard practices in Nevada are adequate to prevent liquid propane leaks under levels of shaking that are near the largest that can reasonably be expected. Preventing such leaks would help protect people and property and help limit the scope of the required emergency response to an earthquake.

The electric system stayed intact through, and following, the earthquake which helped in numerable ways, such as keeping people warm on very cold nights and having power for the emergency response. A well-maintained electrical system is partly credited with this success.

With cold temperatures and damaged chimneys, home and space heaters were the only source of heat for many homeowners and businesses. It was a great benefit to the people of Wells and the emergency response, relief, and initial recovery efforts that the electricity stayed on immediately following the 2008 earthquake. The local power company credits this partly to a very robust power system that is subjected to other natural hazards, such as high winds and dirty rains. A major transformer was shifted on its foundation to its functioning limits by the earthquake. Had the transformer shifted further and severed connections, or just become dangerous to operate, the power system to Wells would have been turned off and may have been off for a day or more as a crane that could lift the transformer was brought in and the repair made. Consideration should be given to anchoring large electric transformers mitigating this potential loss from ground motion.

Lessons about Emergency Response to Earthquakes:

The resources and trained emergency personnel available in Wells, Elko County, and the State of Nevada were adequate and effective for the scope of the 2008 earthquake disaster. Similar emergency resource allocations and emergency personnel training should continue throughout the State.

The emergency response for the 2008 Wells Earthquake was admirable, with the most critical incidents being handled by the Wells personnel within the initial 40 minutes before the first outside help arrived. The incident command structure, in the final iteration helmed by a trained incident commander from Nevada Department of Forestry, worked well coordinating response efforts and the personnel involved were well trained and practiced making the operation effective. About 600 safety inspections were conducted on the first day. Even though a larger disaster would have begun to tax the system, the success of this emergency response indicates Nevadans are on the right track in preparing to respond to disasters, and should continue making sure that emergency response training and resources continue in the State. Earthquake disasters require a

familiarity with the different levels of response and protocols needed to get needed resources.

Communication can be severely hampered during an emergency response if robust, uniform communication systems are not used. Cellular telephones should not be used as primary emergency response communication systems.

Cellular telephones are unreliable in an earthquake disaster and will likely be saturated by users causing a long delay in obtaining a dial tone. Additionally cellular telephone towers may suffer damage from the shaking. The Wells Volunteer Fire Department used cellular telephones during the 2008 Wells Earthquake and experienced delays in getting dial tones when trying to call for additional personnel for incidents. A professional radio system is recommended. There were also two different emergency radio systems in use during the Wells Earthquake, a VHS system and an 800 MHz system, that initially could not talk to each other. A Nevada Department of Transportation communications expert patched the two systems together on Day Two. An inventory of the emergency communication systems used in Nevada and what potential patches might be needed to different communication systems which might be combined would speed up the needed interoperability of emergency communications in future disasters. Cellular telephones are not sufficient for a primary emergency response communication system. An additional communication resource during disasters is the Amateur Radio Emergency Service.

All Nevada communities should have emergency plans that can be used for rapid decision-making and include redundant safe Incident Command Post locations.

Emergency plans were used in the response to the 2008 Wells Earthquake and were effective for this event. One aspect that stretched the plan to its limit was that the first and second choices for locating the Incident Command Post were deemed unsuitable because of damage and the search for a suitable location had to be conducted during the response operation. Several locations should be listed in community emergency response plans that have been inspected and found suitable for emergency response needs and safety. A mobile command center might also be considered for earthquake-affected areas.

A satellite-communication truck may be important for incident command and emergency response communications, especially if an alternative command location is being used that has fewer capabilities than needed.

Initially, there was only one telephone available at the Incident Command Post for the 2008 Wells Earthquake and cellular telephones had to be used. This was corrected relatively quickly, but a satellite-communications truck could have significantly enhanced communications early on in the response, especially if the cell telephone system had failed.

A large number of placards for posting the condition of buildings should be stored at multiple locations within each county and should be distributed to earthquake affected areas within a day.

In Wells, responders were clever and used what they had to indicate the condition of buildings, but spray painting snow was too temporary and flagging was a bit confusing because flags were similar in color and were combined. Green, yellow, and red placards work the best but they have to be made before an earthquake and stored regionally to get them to the community as fast as possible. When used the public has to be educated as to what the placards indicate and how long they are to be left up.

Lessons about Community Recovery from an Earthquake Disaster:

A rapid and effective recovery from an earthquake disaster is critical for maintaining a community's existence and vitality, and the development of Plans for Recovering from a Major Earthquake Disaster should developed by Nevada Communities.

Recovering from an earthquake disaster has to occur rapidly if the negative effects of procrastination are to be avoided. One of the largest of these negative effects is the failure or relocation of businesses out of a community, which means less income for individuals and local government and the loss of services to a community. The City of Wells placed a high priority on restoring businesses and government services rapidly and consequently not a single business failed because of the earthquake. They inspected businesses first, encouraged early relief aid to business reconstruction, and were responsive to requests from the businesses when safety allowed. This is an example of a good recovery strategy.

An important tool for having a rapid recovery, especially Nevada's larger cities, is a *Disaster Recovery Plan*. The stressful post-earthquake environment is not the best situation for decision makers to envision solutions and strategies that can

help avoid cascading failures of businesses, seek out opportunities, and get a community on a track to rapid recovery. It is much easier to tailor the strategies of a recovery plan to the situation at hand than to have to create them in response to arising needs.

Lessons for Earthquake Monitoring in Nevada:

An adequate statewide seismic monitoring system needs to be completed to rapidly and accurately locate major earthquakes in Nevada.

During the Wells Earthquake a temporary array of state-of-the-art seismometers was operating in Nevada (the Earthscope, http://www.earthscope.org, USArray; a National Science Foundation Experiment) providing coverage in the eastern part of the state. Seismic monitoring in eastern Nevada is very poor otherwise and most earthquakes <M3 are not recorded. The USArray network allowed the Nevada Seismological Laboratory to develop a reliable initial earthquake location for the Mw 6.0 Wells event. By August of 2008 the USArray instruments had been removed from Nevada and the ability to accurately locate earthquakes in northeastern and eastern Nevada has returned to the pre-USArray level. In order to accurately locate and develop reliable earthquake magnitudes, seismic monitoring in large portions of Nevada needs to be increased.

Lessons for Earthquake Fault Studies in Nevada:

Significant Quaternary faults (those that have moved in the last 1.8 million years), capable of magnitude 6 or larger earthquakes, have been discovered near Wells that were previously unrecognized. Quaternary faults should be mapped and studied within 25 miles of each Nevada town to assure earthquake hazards are adequately characterized for these communities.

Quaternary fault studies are commonly focused on the higher risk urban cities, leaving smaller communities relatively unstudied and their earthquake hazards potentially inadequately characterized. Studies should be conducted that identify and characterize all known, previously unrecognized, or suspected Quaternary faults within 25 miles around each Nevada community (further when needed for fault studies). More detailed studies (such as trench exploration) may be required for certain faults to understand their paleoearthquake history and how active they are. Completing these studies is a long term endeavor, but steady progress has to be made to achieve this goal, and the sooner the information is gained, the sooner it can be incorporated into the planning and building design within the community. Within Nevada's urban communities, the detailed mapping of Quaternary faults that should be avoided by construction to prevent earthquake surface rupture damage is also critical.