

## Summary Minutes

### Nevada Earthquake Safety Council

20 May 2009

The Nevada Earthquake Safety Council (NESC) met from 8:30 a.m. to 4:39 p.m. at the Wells Fire Hall, 516 7<sup>th</sup> Street, in Wells, Nevada. The meeting was held jointly with the Utah Seismic Safety Commission (USSC). 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:

Rick Allis, Utah Geological Survey  
 John Anderson\*, Nevada Seismological Laboratory  
 Walter Arabasz, Utah Seismic Safety Commission  
 Doug Bausch, Federal Emergency Management Agency, Region VIII  
 Alan Bennett\*, City of Reno  
 Steve Bowman, Utah Geological Survey  
 Bob Carey, Utah Emergency Management  
 Wayne Carlson\*, Nevada Public Agency Insurance Pool  
 Press Clewe, who held the proxy for Bernie Anderson\*, Nevada Assembly  
 Evan Curtis, Utah Seismic Safety Commission  
 Joe Curtis\*, Storey County Emergency Manager  
 Craig dePolo, Nevada Bureau of Mines and Geology, who held the proxy for Ian Buckle\*, University of Nevada, Reno – Center for Civil Engineering Earthquake Research  
 Fred Doehring, Utah Seismic Safety Commission  
 Brian Dozier, Los Alamos National Laboratory, Las Vegas  
 Chris DuRoss, Utah Geological Survey  
 Roger Evans, Utah Seismic Safety Commission  
 Johanna Fenton, Federal Emergency Management Agency, Region IX  
 Terri Garside, Nevada Bureau of Mines and Geology, who held the proxy for Wanda Taylor\*, UNLV Department of Geoscience  
 Matt Holford, Homeowner, Wells, Nevada  
 Rob Hood, Nevada Division of Emergency Management  
 Bruce Hurley, U.S. Department of Energy  
 Thomas Ingersoll, Elko County Building and Safety  
 Gary Jaceobneer, Wells, Nevada  
 Alfreida Jake, Elko Band Council  
 David Linge, Wells Public Works  
 Ron Lynn\*, Clark County Department of Development Services  
 Larry Macias\*, American Institute of Architects, Reno  
 Thalia Marin, Elko Band Council  
 Pete McDonough, Utah Seismic Safety Commission and Questar Corporation  
 Greg Moss\*, The Moss Group  
 Marcia Moss  
 Thurle Moss  
 Mathias Mueller, Utah Seismic Safety Commission  
 Jim O'Donnell\*, Geophysical Contractor, Las Vegas  
 Kris Pankow, University of Utah Seismograph Stations  
 Glen Palmer, Palmer Engineering, Pleasant Grove, UT  
 Jon Price\*, Nevada Bureau of Mines and Geology  
 Barry Smith, Utah Seismic Safety Commission

Ken Smith, Nevada Seismological Laboratory  
 Cal Stark, Wells Vice Mayor  
 Jolene Supp, Wells City Manager  
 Mark Stephensen, Idaho Bureau of Homeland Security  
 Rusty Tybo, Wells Mayor  
 Jim Walker\*, Nevada Department of Transportation  
 Barry Welliver, Utah Seismic Safety Commission  
 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:

Scott Ball\*, Engineering Geologist, MWH Americas, Inc., Las Vegas  
 Mike Blakely\*, Blakely, Johnson, and Ghushn  
 Greg Flanigan\*, Farmers Insurance  
 Warren Hardy\*, Nevada State Senator  
 Jenelle Hopkins\*, Clark County School District, Las Vegas  
 Steve Koenig\*, Bellagio Resorts  
 Jim Reagan\*, NV Energy

Craig dePolo introduced Rusty Tybo, Mayor of Wells, who, along with Jolene Supp, City Manager, welcomed NESC and USSC to Wells.

Ron Lynn chaired the meeting, asked individuals to introduce themselves.

The minutes of the 17 February 2009 meeting were unanimously approved.

### **Update on USSC Activities**

Pete McDonough discussed the establishment of the USSC and its membership and standing committees. Their Awareness and Education Committees has produced a newspaper supplement/booklet on “Putting Down Roots in Earthquake Country – Your Handbook for Earthquakes in Utah.” They may have it translated into Spanish. Utah celebrated Earthquake Preparedness Month in April 2009. The USSC supports a student research grants program and ATC-20 training.

The USSC Geosciences Committee includes the Utah Earthquake Program, which responded to the Wells Earthquake. At its 2008 and 2009 meetings, the Utah Earthquake Working Group helped to determine parameters for Utah faults. These feed into the United States Geological Survey (USGS) probabilistic seismic hazard analysis, which, in turn, feeds into the International Building Code.

The USSC Legislation Committee supported a 2009 Joint Resolution on unreinforced masonry buildings (URMs). Although without funding, this legislation tasks the USSC with conducting an inventory of public URMs.

In 2008 the Utah Legislature passed HB 177, a bill regarding county and municipal land-use regulations regarding geologic hazards. A Utah School Seismic Hazard Inventory bill did not pass in either the 2008 or 2009 Legislature.

Craig dePolo praised the Utah “Putting Down Roots” document as the best of its kind. Bob Carey noted that Utah newspapers are required to do a certain amount of pro bono work for education. The cover art

(which includes a humorous stratigraphic layer with a fossil saber-tooth tiger chasing a fossil human) was created by Utah's most famous political cartoonist.

### **Update from the Nevada Earthquake Safety Council**

Ron Lynn described the makeup and functions of the NESC. There is good balance from northern and southern Nevada, rural and urban areas, and various areas of expertise.

The NESC Education and Awareness Committee has produced a number of useful publications, including a "Living with Earthquakes" booklet that is similar to the Utah document. Craig dePolo noted that about 1,000 copies of the Nevada document were distributed to citizens about 30 hours before the biggest of the Mogul earthquakes in April 2008. Citizens took action; this was the first time that nonstructural mitigation was undertaken before an earthquake because of an outreach effort of this sort.

Ron noted that a lot of work has been done by NESC on nonstructural mitigation.

The NESC Research Committee sponsors many activities. Most recently, the Nevada Bureau of Mines and Geology produced a new map on "Quaternary Faults in Nevada." A number of presentations have been made at scientific meetings about the 2008 Wells and Mogul earthquake sequences.

The NESC Strategic Planning Committee annually reviews NESC's strategic plan.

If funds are available, grants are provided for various projects through a process developed by NESC and funded through the Nevada Division of Emergency Management. ATC-20 classes are provided for professionals in all parts of the state. Larry Macias noted that the American Institute of Architects will be providing an ATC-20 class, with FEMA's assistance, on September 16 and 17 in Las Vegas. Specific FEMA-supported classes for hospital professionals were also given through NESC recently.

During the 2007 legislative session, the Governor vetoed legislation on URMs because of possible fiscal impacts. Wayne Carlson noted that the Nevada Public Agency Insurance Pool, in collaboration with the Nevada Bureau of Mines and Geology, has proposed to FEMA, through the Nevada Division of Emergency Management, to collect available URM inventory data from county assessors' offices. Depending on construction types, the project will make the assumption that brick, stone, or block buildings constructed prior to 1973 may be URMs. This project should provide stimulus for mitigation in the future.

Ron Lynn noted that both NESC and USSC participate in the Western States Seismic Policy Council (WSSPC). This includes current development of policies regarding URMs and seismic safety in schools.

### **Report from the Federal Emergency Management Agency**

Johanna Fenton noted that FEMA has a new director, with experience in emergency management in Florida. She stated that the decision has been made that FEMA will remain in the Department of Homeland Security (DHS), rather than make it an independent agency, as it had been before the creation of DHS. There will be some state grants specifically regarding earthquakes in fiscal year 2009, but the dollar amounts are not known.

Johanna noted that on October 15, 2009 California will have a statewide exercise similar to the Great California Shakeout exercise in 2008.

FEMA released the QuakeSmart program for business preparedness. One forum was given in Reno in 2008. FEMA is working on smaller scale forums that could be regional or tailored for smaller communities than what has been offered so far with this program.

Doug Bausch is working on an atlas of earthquake scenarios in the Salt Lake City area using the USGS ShakeMap product, data from county assessors' offices, and HAZUS, FEMA's loss-estimation model. Doug has figured out how to move the population in HAZUS from the centroid of the census tract to the location of the actual population centers. This should improve the applicability of HAZUS in rural areas, where census tracts often include large areas with few people.

FEMA works with a Regional Interagency Steering Committee in Region VIII. This group involves all federal agencies that respond to large hazard events. The 50<sup>th</sup> anniversary of the Hebgen Lake Earthquake in Montana will be recognized in August of 2009.

There may be a new risk-based guidance regarding FEMA hazard-mitigation grants. FEMA hopes that there will be fewer Congressional earmarks on the hazard mitigation grant program.

FEMA is adding about four positions with a focus on earthquakes. For FY'09 funding, FEMA funds to states for earthquake-related work will be channeled through the FEMA's regional offices, rather than from headquarters in Washington, DC..

Johanna noted that California is forming a statewide earthquake alliance that incorporates groups in the Los Angeles-San Diego area, San Francisco Bay area, and the northern coastal counties. Dennis Meletti has advised them to repeat the same message about earthquake issues from different perspectives. The alliance has discussed using the term "readiness" to replace both "mitigation" and "preparedness."

### **Report on Recent Seismicity in Utah**

Walter Arabasz gave an overview of the seismicity of Utah and surrounding areas. Most of Utah's seismicity has been concentrated along the Intermountain seismic belt, including the densely populated Wasatch Front. The largest historical earthquake was a magnitude 6.6 in 1934 in northern Utah, near the north end of Great Salt Lake. Approximately 80% of Utah's 2.7 million people live within 15 miles of the Wasatch fault. There have been no earthquakes in Utah with magnitude 5 or greater since 1992; this raises some concern, because the average recurrence of a magnitude 5 or greater event in Utah has been about once every four years since 1930.

Walter noted that we are still not able to resolve fine details of fault planes associated with background seismicity because the distribution of seismic stations is not dense enough, particularly outside the Wasatch Front area.

A prominent band of seismicity occurs east of the main Wasatch fault in northern Utah. There is also a prominent zone of seismicity in east-central Utah that is related to underground coal mining. The largest mining-related earthquake in recent years had a magnitude of 4.2.

In central Utah, the generally north-south trending Intermountain seismic belt (more or less following the eastern boundary of the Great Basin) bends to the southwest, then west across southern Nevada, into a series of mostly strike-slip faults, rather than normal faults along the Intermountain seismic belt to the north.

There has been a concentration of historical earthquakes in central Utah at the northern end of the Marysvale volcanic field. Earthquake swarms in Utah are also distinctly concentrated in this same area.

Walter showed an analysis of seismicity bounded within 20 kilometers of the main trace of the Wasatch fault on the downdip side and within 10 km on the updip side. Observed seismicity is consistent with the characteristic earthquake model, but it is uncertain whether the sampled earthquakes occurred on the Wasatch fault itself. With better instrumentation, researchers working with the University of Utah Seismograph Stations can demonstrate that some earthquakes close to the Wasatch fault are not actually occurring on the fault itself. Rather than a characteristic model (in which the rate of small earthquakes is related to that of large earthquakes), a “maximum magnitude” model may apply to the Wasatch fault. That is, the fault may generate only large earthquakes, and smaller earthquakes in its vicinity may be occurring on secondary faults.

The National Science Foundations U.S. Array/EarthScope transportable stations have been removed from most of Utah, as they were from Nevada. In Utah, three stations have been retained in the coal-mining area to help monitor mining-induced earthquakes (caused by underground coal extraction). Four of the EarthScope vaults have also been retained for possible installation of seismic equipment at those locations when funding permits.

### **Report on Seismicity in Nevada**

John Anderson discussed seismicity in Nevada. He touched on seismicity rates, hazard curves, and connections between southern Nevada and Utah. Nevada is third most seismically active state (behind Alaska and California but close to Hawaii) in the country, when measuring large (magnitude 7 or larger) earthquakes. Utah also ranks in the top ten states. Relative to stable North America (a point east of the Colorado Plateau), the Pacific Plate is moving about 50 mm per year to the northwest, and the Sierra Nevada is moving about 12 mm per year, also to the northwest. Western Utah is moving about 2 mm per year away from stable North America. This difference in strain rate probably accounts for the higher rate of seismicity in Nevada than in Utah.

From earlier observations of small earthquakes in northeastern Nevada, we anticipated that there would be a magnitude 6 or greater earthquake about once every 100 years and a magnitude 7 about once every 1,000 years in this region. Statewide, however, earthquakes occur more frequently. There were four magnitude 7 or greater earthquakes in the central Nevada seismic belt in the 20<sup>th</sup> century; the most recent one was in 1954.

Throughout Nevada there have been about 6,500 earthquakes of magnitude 2 or greater since January 1, 2000. It appears that the aftershock sequences from the Wells and Mogul earthquakes have died off. The current rate of earthquakes (in the last few months) has returned to a value approximately equal to the average rate during the current decade (not counting increased rates during major earthquake swarms).

Using hazard curves showing peak acceleration plotted against annual exceedance rate, and using the USGS’s probabilistic seismic hazard analysis maps, John noted that Las Vegas and Wells have similar earthquake hazards. This illustrates that all parts of Nevada (and Utah) have significant earthquake hazards.

John showed a few slides from Dr. Corné Kreemer (geodesist with the Nevada Bureau of Mines and Geology) illustrating how the Utah-Nevada region is deforming based on geodetic measurements using the global positioning system (GPS). Corné’s model has 1 to 2 mm/year of left-lateral shear north of Las Vegas (in the Paranagut shear zone), about 1 mm/year of extension in the Las Vegas area, about 1 mm/year along the extension of the Hurricane fault into northern Arizona, and about 2 to 3 mm/year across the Wasatch Front. John expects that the official USGS probabilistic seismic hazard maps will show an increase as the USGS incorporates these new geodetic data into their model.

### **Introduction to the 2008 Wells Earthquake**

Craig dePolo discussed how the February 21, 2008 Wells earthquake provides major learning opportunities for USSC and NESC. He encouraged members of the councils to use lessons learned from the Wells experiences in other communities in Utah and Nevada.

The Wells earthquake is the 23<sup>rd</sup> historic (in the last 150 years) earthquake of magnitude 6 or greater in Nevada. It was a “background earthquake,” which means that it occurred on a small, unmapped fault with no surface rupture. It affected a rural community. The response was successful, and the recovery, although still ongoing, has been successful.

Craig provided the following profile of Wells. It has a population of 1657; it is at the crossroads for Interstate 80 and U.S. Highway 93 there are about 450 homes and 80 other buildings; the town uses the 1997 Uniform Building Code; and about 64% of the residents live in low-income housing. As John Anderson noted, the earthquake hazard for Wells is lower than in many other parts of the state, but the probabilities become irrelevant when an earthquake actually occurs.

Unfortunately, the seismicity in the northeastern and east-central parts of Nevada is usually poorly recorded. The Nevada Seismological Laboratory and the U.S. Geological Survey are currently not able to routinely recognize earthquakes of magnitude 3 or smaller.

For the Wells earthquake, the magnitude was 6.0. The epicenter was about 5.5 miles north of town. The fault, along which the earthquake occurred, ruptured within 1 to 2 miles of town. Three homes were lost, and over 60 chimneys were damaged. Thirty-five other buildings were damaged; and three natural gas leaks (propane, one liquid; and two gas lines in manufactured homes) were quickly controlled. There were three minor injuries and no deaths.

There is much new information coming from recent scientific studies in the Wells area. Much of this will be summarized, along with information on damage, emergency response, and recovery, in a volume to be published by the Nevada Bureau of Mines and Geology. This will be free on the web and include numerous pictures. Nevada Bureau of Mines and Geology geologists have mapped some new faults, ones that were not previously recognized. There was at least one rupture within the last 130,000 years just north of Wells along a fault that may be the same one that moved during the 2008 earthquake but didn't rupture the Earth's surface. There was a discernable footprint of the earthquake seen on geodetic interferometric synthetic aperture radar (InSAR) satellite data (comparing satellite imagery before and after the earthquake). A high-quality portable seismic array was rapidly installed to record aftershocks (with collaboration among the University of Nevada, Reno's Nevada Seismological Laboratory, the University of Utah Seismographic Stations, the USGS, and local citizens).

There were approximately 600 safety inspections the first day after the earthquake. The incident command center was in an elementary school classroom. People from surrounding communities in Elko County, Nevada, and Utah came to help immediately. The citizens showed a pioneering spirit to get the job done. Media coverage was good, caring, and provided an important communication service.

Craig stressed that we need to learn to better survive future earthquakes. We need to take the lessons learned from Wells to our other communities. Had the Wells earthquake occurred in the afternoon, deaths may well have occurred.

### **The Seismicity of the 2008 Wells Earthquake**

Ken Smith described the seismicity of the Wells earthquake sequence. Good epicenter controls on the mainshock and early aftershocks (pre-portable deployment period) were achieved thanks to the EarthScope transportable array that was deployed in the area at the time. It is important to deploy

additional seismic instruments as early in a sequence as possible since many larger aftershocks tend to occur shortly after the main shock. Portable instruments were deployed by the University of Utah, University of Nevada, Reno (Nevada Seismological Laboratory), and the USGS. Substantial support was received from the Elko Sheriff's Department, Wells Rural Electric Company, the State's information technology group (DOIT), Nevada Department of Transportation, and others.

The best determination of the hypocentral depth of the mainshock is 8 km; this is based on definition of the mainshock fault plane from aftershock relocations. It occurred on a 55-degree southeast-dipping, N40E-striking fault. Aftershocks occurred both northeast and southwest of the main event. The lack of aftershock activity near the mainshock hypocenter is interpreted to be the area that ruptured during the main event. A year before the earthquake, starting in February 2007, a few earthquakes, some of which were felt by local residents, occurred near the nucleation zone of the main event and were recorded by the U.S. Array/EarthScope deployment. These may be considered foreshocks to the February 2008 earthquake. The largest foreshock was a magnitude 3.69 on February 28, 2007. Most of the initial aftershock activity, (activity within the initial 40 hours after the main shock on February 21, 2008) was located between the mainshock and the town of Wells. The initial USGS location of the hypocenter was mislocated at 12 km to the southeast, because the USGS was not incorporating information from the EarthScope instruments. Within minutes, however, the Nevada Seismological Laboratory had a more accurate location.

The Wells fault plane projects to the surface along the east side of the Snake Mountains, the mountains north of Wells. The fault plane dips southeast at 55 degrees (from the surface horizontal plane). Most aftershocks occurred within a depth of 12 kilometers, below and above the main shock.

The InSAR image generated by John Bell (Nevada Bureau of Mines and Geology) is a classic for a normal fault. The maximum displacement at the surface was about 15 mm, although there was no surface rupture associated with this earthquake.

There were few aftershocks within a radius of about 4 km from the hypocenter. Slip during the mainshock was estimated to be between 55 and 83 cm based on moment and rupture area estimates.

With various assumptions, a return period of 450 years would generate the 2 km of subsidence in Town Creek Flat estimated by David Ponce of the USGS from gravity data with about 20,000 magnitude 6.0 Wells-type earthquakes over 9 million years (estimate of initiation of extension in the Wells area). That is, no surface ruptures need to have occurred to create the alluvial basin below Town Creek Flat with repeated Wells-type events in Town Creek Flat. The assumed vertical slip rate is 0.2 mm/yr, similar to the Ruby Mountains fault, along which there have been many surface-breaking earthquakes in the geologic past.

### **Damage from the Wells Earthquake**

Craig dePolo described the damage from the earthquake. The Modified Mercalli Index from the earthquake was a strong VII to weak VIII. The worst damage was in the old part of town, on Front Street near the railroad. Most of these damaged buildings were one-story URM's built around 1900. There were also a few two-story buildings (the Nevada Hotel, San Marin Hotel, and Bullshead Bar).

The San Marin Hotel was the only totally collapsed building. That building was not occupied; and the gas was not turned on. There would have been few safe places in this building; had people been in the building during the earthquake, they would have likely died. Perhaps safety boxes could be used for workers trying to rehabilitate such URM's.

Other buildings experienced major damage. The Nevada Hotel had major roof failure. The Mint Saloon's roof was crushed by bricks from the Nevada Hotel. The Mint Saloon itself is a wood-frame building.

The large glass windows on the front of the Nevada Hotel did not break; Ron Lynn suggested that the window frames, which appear to be new, helped to preserve the glass. The balcony on the back of the Nevada Hotel caught all the bricks that fell off the facades near the roof.

The El Rancho Hotel also had partial failure of its walls. There were five people in that building at the time of the earthquake. The walls were brick that were not well attached to the steel and wood-frame structure.

People recognized about 30 to 40 seconds of shaking. It began with a loud, explosion-like bang.

Essentially all buildings in Wells had some cracks, but there was only moderate to light damage to modern buildings. The average home had about \$500 in nonstructural damage.

About 35 of the 80 nonresidential buildings were damaged, 10 severely to heavily. More than 60 chimneys were damaged (10 to 15% of all chimneys). Three out of the 450 homes were destroyed, including one mobile home.

Items in the High School shop moved about 10 centimeters away from the epicenter of the earthquake.

During the earthquake, buildings pounded into one another.

Crowning bond beams (at the top of brick buildings), some of which are poured concrete, fared poorly. Several toppled and could have killed people had they tried to exit the buildings during the intense shaking. The Bullshead Bar was a wood-frame building with a brick veneer. The balcony collapsed when the crowning bond beam fell on it.

Among the unreinforced brick buildings, ten of the 15 were moderately or severely damaged (67%); these had potentially life threatening damage. Four of the 15 had partial to total collapse (27%). Two of the 15 would have been potentially deadly staying inside (13%), had people been there at the time. Fifteen of the 33 exits from these buildings had potentially deadly debris (45%). The two-story buildings had much more damage than the one-story buildings.

The most critical incident was a leak from a 500-gallon liquid propane tank. The temporarily positioned tank rolled over and broke its connection and turn wheel (that could have been used to close off the leak). It created a meter-deep propane cloud. Propane expands about 270 times its volume from liquid to gas. Mike Tate, technician with Wells Propane, responded quickly, knew how to close the tank, and avoided a serious disaster.

There was a waterline break in a ductile iron pipe from the main shock, and another break from an aftershock. There have been other waterline breaks recognized after the earthquakes; these may have been caused by the main earthquake or aftershocks but were not recognized at the time.

Fortunately, electricity stayed on after the earthquake. A transformer moved a few inches, but not enough to cause failure. Some water tanks moved but did not fail. A bulge (elephant's foot) formed on one tank.

Craig stated that a program should be developed in Nevada to brace and anchor parapets and crown bond beams.



Craig further emphasized that when consequences are high, small probabilities matter.

### **NESC Awards in Excellence**

Ron Lynn presented Awards in Excellence from the Nevada Earthquake Safety Council to the following individuals and groups:

Jolene Supp, Wells City Manager, is recognized for outstanding leadership, management, and perseverance as the Wells City Manager during the response and recovery of the 2008 Wells Earthquake. Jolene's attitude and actions show a deep dedication to the people of Wells.

Rusty Tybo, Wells Mayor, is recognized for outstanding community leadership and representation during the response and recovery of the 2008 Wells Earthquake.

Dale Lotspeich, Elko County Sheriff, for outstanding leadership and command of the emergency response to the 2008 Wells Earthquake.

Rich Harvey, Incident Commander, Nevada Division of Forestry, is recognized for outstanding leadership and critical management during the 2008 Wells Earthquake disaster as the Incident Commander.

David Linge, Wells Public Works Director, for outstanding response to infrastructure damage from the 2008 Wells Earthquake and management of building inspections throughout the recovery phase.

Thomas Ingersoll, Elko County Building and Safety Division, is recognized for outstanding performance in management and assistance with post-earthquake building inspections during the response and recovery of the 2008 Wells Earthquake.

Michael Tate, Propane Technician, Wells Propane, is recognized for outstanding experienced response to the liquid propane leak and ground-hugging propane cloud capable of a significant explosion resulting from the 2008 Wells Earthquake. Actions resulted in the stoppage of the leak and mitigation of the hazard without further incident.

Scott Egbert, Stake President, Church of Latter Day Saints, is recognized for outstanding organization of volunteers for the recovery from the 2008 Wells Earthquake and organization of the interfaith groups that assisted in recovery efforts.

Lavon Thompson, Elko Chamber of Commerce, is recognized for outstanding volunteer work round up items for auction at the Wells Earthquake Recovery Rally. This Rally brought in over \$100,000 of relief money.

Mike Nannini, is recognized for outstanding efforts in assisting with post-earthquake recovery efforts from the 2008 Wells Earthquake, including having a major role in organization of the Wells Recovery Rally.

John Carpenter, is recognized for outstanding efforts in assisting with post-earthquake recovery efforts from the 2008 Wells Earthquake, including having a major role in organization of the Wells Recovery Rally.

Wayne Carlson, Nevada Public Agency Insurance Pool, is recognized for outstanding long-term encouragement of earthquake policies and risk mitigation in Nevada public agencies, including the City of Wells, Elko County School District, and Elko County, all with 2008 earthquake damage that was insured. His long-standing efforts have heightened earthquake awareness in the state and helped to protect many Nevada communities from large-scale earthquake losses.

Wells Volunteer Fire Department, is recognized for outstanding response and support actions during the 2008 Wells Earthquake response and recovery. The volunteer firemen worked selflessly and tirelessly for the community and were critical to the successful response effort.

Wells City Hall Staff, are recognized for outstanding, dedicated, and persistent service to the government, residents, businesses, and property owners of Wells during the response and recovery efforts for the 2008 Wells Earthquake. This effective “behind-the-scenes staff” provided administrative support for the incident command and did “all that needed to be done” down to the smallest things that are important for success.

Wells Public Works Staff, is recognized for outstanding and dedicated service to the residents and businesses of Wells in working as hard and fast as possible to restore disrupted services, and participation in the recovery efforts for the 2008 Wells Earthquake.

Wells Interfaith Group, is recognized for outstanding leadership, guidance, and allocation activities for the community recovery from the 2008 Wells Earthquake. This Group serves as a model for similar needs elsewhere.

Elko County Commission, is recognized for leadership, experience, support, and resources given to the City of Wells and surrounding Elko County during the response and recovery from the 2008 Wells Earthquake.

Utah Engineering Task Force, is recognized for cross-state assistance supporting the response and recovery effort with several professional volunteers for building inspections following the 2008 Wells Earthquake. The Utah Engineering Task Force members serve as a model for cross-border support when a neighboring state has been impacted by a disaster.

Church of Jesus Christ of Latter Day Saints, is recognized for earthquake rehabilitation of the Wells Ward LDS church beyond what was required to repair the earthquake damage. Churches are regularly used public places that hold large numbers of people, posing a potentially high seismic risk. Earthquake rehabilitating of this church substantially reduces this risk.

Roman Catholic Diocese of Reno, is recognized 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.

Utah Geological Survey, is recognized for rapid field reconnaissance and assistance with posting information on the Web after the 2008 Wells Earthquake.

Dr. Craig M. dePolo, is recognized for his dedication to the citizens of Nevada and for his leadership on earthquake response after the 2008 Wells Earthquake and on risk reduction through the Nevada Bureau of Mines and Geology, the University of Nevada, Reno, and the Nevada Earthquake Safety Council.

#### **Tour of Earthquake Damage in Wells**

Craig dePolo and Glen Palmer led a tour of damaged buildings.

### **Earthquake Recovery**

Craig dePolo described the recovery efforts. Business interruption lasted from one day to two weeks. No businesses were lost. The greatest damage was concentrated in the old town area; the notion of restoring old town has been severely set back. Some people suffered from post-traumatic stress syndrome.

Direct costs of the earthquake are estimated to be approximately \$6,860,000, broken down as follows:

Emergency response	\$ 300,000
Buildings (structural damage)	
High School gym and auditorium	2,400,000
LDS Church	500,000
El Rancho Hotel	800,000
Nevada Hotel	800,000
Bullshead Bar	250,000
Wells Chalet	250,000
Seven other buildings	560,000
Wells City buildings	>1,000,000

Nonstructural damage, contents, personal professional, and business losses are estimated to be \$612,000, broken down as follows:

350 homes and businesses @ \$500	\$175,000
4-Way Casino (damage & loss)	100,000
Hardware Store (content loss)	30,000
Wells Rural Electric (damage)	30,000
Bonneville Transloader (damage)	22,000 (renter loss \$1,500/month)
Wells Propane (inspection costs+)	70,000
Two cars @ \$5,000	10,000
Other public insurance claims	15,000 (Elko County: \$60,000 regional cost)
Loss of business revenue (estimated)	80,000
Cost of hired public adjuster	>80,000 (8% of insurance claims)

Relief from disaster insurance, recovery funds, and loans is estimated as \$5,658,000, broken down as follows:

Nevada Emergency Response Fund	\$ 112,000
Nevada Homeowner's Disaster Assistance	123,000*
Small Business Administration Loans	388,000*
Donations (relief fund and recovery rally)	258,000*
Federal Omnibus Recover Relief	940,000*
Nevada Public Agency Insurance Pool	\$3,800,000
Private insurance	37,000

\*These numbers are used in the estimate of the earthquake cost (total of \$1,709,000).

Overall, Craig's preliminary estimate of the total cost of the earthquake is \$9 million, and he estimates the relief funds to be about \$5.66 million.

Community-recovery actions included making public dumpsters available; building inspections "fix-up Saturdays," which included as many as 300 volunteer worker; the Wells Recovery Rally that raised about \$110,000; the interfaith group that dispersed the relief funds; and community planning assessment.

Ron Lynn noted that there was no formal call (to Clark County) for building inspectors to help assess building damage and tag buildings red, yellow, or green.

Reconstruction efforts, some of which are ongoing, included stabilization (e.g., plastic covers over structurally damaged buildings to prevent further damage from rain and snow) and rehabilitation.

One of the homes that was lost has been replaced with a new manufactured home.

The pace of recovery has to be rapid to avoid business failures. Delays can be caused by improper documentation (not all the receipts).

Good media relations and a caring media are important. Overall, people are the biggest asset for a speedy recovery.

### **Lessons Learned from the 2008 Wells Earthquake**

Craig dePolo summarized some of the lessons learned from the earthquake. These are broken into categories:

#### (A) Lessons for Nevadans

1. Earthquakes can occur anywhere in Nevada.
2. 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.
2. Nevadans should secure, relocate, replace, or remove dangerous items that can fall on people and hurt them.
3. If you are inside a building during an earthquake, stay inside; if you are outside, get away from buildings, if it is safe to do so.
5. Volunteers were essential to the success of the response and early recovery efforts at Wells. Nevadans need to continue to be willing to help their own or neighboring communities in earthquakes and other disasters. Nevadans should be encouraged to get Community Emergency Response Training (CERT).
6. When a strong earthquake occurs, check on your neighbors and make sure they are all right, and no dangerous situations exist for them.

#### (B) Lessons about buildings

1. The seismic provisions in modern building codes are important to use in Nevada.
2. Unreinforced masonry buildings (URMs) and unanchored masonry veneers are extremely vulnerable to earthquake damage and failure.
3. Balconies and sidewalk coverings may be able to be strengthened to provide protection against falling bricks from URMs during earthquakes.
4. Crown 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. Crown bond beams on unreinforced buildings should be braced and anchored to the structure to keep them in place, or should be removed.
5. Buildings that are in severe disrepair, or have partially collapsed, or have incomplete structural systems, may be subject to total collapse during earthquakes.
6. Unreinforced brick and masonry chimneys can collapse during earthquakes, causing injuries and severe damage.
7. Earthquake insurance was a wise investment in Wells and should be considered seriously by communities and individuals.

#### (C) Lessons about infrastructure

1. 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.
2. The electric system stayed up through and following the earthquake, which helped in numerable ways, such as keeping people warm on cold nights and having power for the emergency response. A well-maintained electrical system is partly credited with this success.

(D) Lessons about emergency response

1. The resources and trained emergency personnel available in Wells, Elko County, and the State of Nevada were adequate and effective for the scope of this earthquake disaster. Similar emergency resource allocations and emergency personnel training should continue throughout the State.
2. Communication systems can be severely hampered during an emergency response if robust, uniform systems are not used. Cellular telephones should not be used as the primary emergency-response communication system.
3. All Nevada communities should have emergency plans that can be used for rapid decision-making and include redundant incident command locations.
4. A satellite-communications truck may be important for incident command communications, especially if an alternative location is being used that has fewer capabilities than needed.
5. A large number of placards (red, yellow, and green) for posting the condition of buildings should be stored at two separate locations in each county seat and should be distributed to earthquake-affected areas within a day.

(E) Lessons for Earthquake Monitoring in Nevada

1. An adequate statewide seismic monitoring system needs to be completed to rapidly and accurately locate and measure earthquakes.

(F) Lessons for Earthquake Fault Mapping in Nevada

1. Significant Quaternary faults (those that have moved in the last 1.8 million years) capable of producing earthquakes of magnitude 6 or larger, have been discovered near Wells; these were unrecognized because of lack of study prior to the earthquake. Quaternary faults should be mapped and studied within 25 km of each rural Nevada community to assure that the earthquake hazards are adequately characterized for these communities.

Craig asked that comments on these lessons learned be sent to him by e-mail (cdepolo@unr.edu).

### **Review of Joint Meeting Findings and Future Plans – Open Discussion**

Pete McDonough thanked NESC and the City of Wells for their hospitality. He made the general comment that while people should know how to turn off their natural gas, they should not do so unless they smell a leak or otherwise know that there is a problem. Much of the risk from natural gas leaks comes from domestic water heaters with potential breaks in the gas connections.

Pete mentioned that the American Society of Civil Engineers is holding an international conference on infrastructure between June 28 and July 1 in Oakland, California. He noted that Utah has a tremendously large number of URMs.

Rusty Tybo thanked everyone for coming to Wells. If one thing surprised him, it was how unprepared many smaller communities are – they don't have emergency plans in place. Wells had training in emergency management (for range fires, but equally applicable to the 2008 earthquake), but many smaller

communities haven't received such training. A citizen from Wells advocated a local response rather than depending on top-down directives from international-federal-state-and county levels.

Jolene Supp noted that "Wells is focused on the future. The earthquake has motivated us to determine what our future is and strive toward it. The City Council is more engaged with the High School and others in the community than every before. It has helped to create a vision for the future."

Johanna Fenton noted that FEMA has many resources to help small communities, many of which are on the FEMA website.

Wayne Carlson noted that Ken Smith, Jim O'Donnell, and he worked to develop a system of seismometers in high schools; these are linked to the Nevada Seismological Laboratory. A new device (simpler than the initial ones, which were not as robust as they needed to be) may be redeployed this fall for the rural school districts.

Berry Welliver emphasized that the USSC and NESC need to engage the younger generations. A priority needs to be to make our schools safe.

Greg Moss suggested that regular short courses be developed for business recovery.

Ron Lynn suggested that the Nevada Organization of Building Officials could distribute red-yellow-green placards to the counties, so that they are available in the first few hours after an earthquake.

Ron noted that we leave a legacy for future generations. The USSC and NESC have a synergy of professionals who share common goals of earthquake risk reduction.

#### Public Comments

There were no additional public comments.

Ron Lynn announced that future meeting dates for NESC are as follows:

Wednesday, August 26, 2009, in Reno at NV Energy

Wednesday, November 4, 2009, in Las Vegas

The meeting adjourned at 4:39 p.m..

### REVIEW OF ACTION ITEMS

#### ITEMS REMAINING FROM THE 12 November 2008 and 17 February 2009 MEETINGS

John Anderson will compare ground motions for different earthquakes in the Las Vegas area at the next NESC meeting.

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

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.

Terri Garside will place voting on acceptance of the NESC Annual Report of Activities for Plan Year 2008 on the agenda for the next NESC meeting.

Ron Lynn will inquire with the LPG board to ask if they regulate temporary LPG tanks.

Werner Hellmer and the Ad-Hoc Committee on Anchoring Propane Tanks will investigate preparing a proposal for shake-table experiments to test key aspects of movement of LPG tanks during earthquakes.

Terri Garside should alert NESC committees to generate proposals for possible year-end funding from FEMA/DHS through DEM. These should be discussed at the August NESC meeting.

respectfully submitted by Jon Price, 20 May 2009

Nevada Earthquake Safety Council  
c/o Nevada Bureau of Mines and Geology  
University of Nevada/MS 0178  
Reno, Nevada 89557-0178  
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