SUMMARY
WORKING GROUP ON UTAH EARTHQUAKE PROBABILITIES
KICKOFF MEETING
Wednesday/Thursday, February 10 & 11, 2010
Utah Department of Natural Resources Building, Room 2000 (2nd floor)
1594 West North Temple, Salt Lake City

WELCOME AND INTRODUCTION

Bill Lund (Utah Geological Survey [UGS]) Working Group on Utah Earthquake Probabilities (WGUEP) Coordinator called the WGUEP kickoff meeting to order at 8:00 a.m. After welcoming remarks and introductions of WGUEP members (see attachment 1), Bill turned the meeting over to Ivan Wong (URS Corporation; WGUEP Chairperson) who discussed the need for the working group, defined a proposed study region, and presented a tentative scope of work and schedule for future meetings. Ivan also discussed the Senior Seismic Hazard Analysis Committee (SSHAC) guidelines and their possible use as a model for conducting WGUEP activities.

Summary of Ivan's Presentation

Information on past earthquakes along the Wasatch fault and regional seismicity and geodetic data are now sufficiently robust to provide the basis for making probabilistic estimates of future large earthquakes within the Wasatch Front area. The methodologies necessary to estimate probabilities have been developed and refined by the various California working groups, and their experience can now be applied in Utah. There are both critical scientific and hazard-mitigation needs for a formal, consensus-based estimate of earthquake probabilities along the Wasatch Front. Wasatch Front urban hazard maps are planned by the U.S. Geological Survey (USGS) and time-dependent probabilities can be incorporated into the probabilistic seismic hazard analyses (PSHA) that will form the basis of those maps. Time-dependent hazard estimates will also eventually be incorporated into the USGS National Seismic Hazard Maps and the National Earthquake Hazard Reduction Program building code provisions. An earthquake forecast can also be directly incorporated into site-specific PSHAs for the design and safety evaluation of critical structures and facilities. Additionally, a consensus-based estimate of earthquake probabilities for the Wasatch Front developed and reviewed by the earth science community can be incorporated into public policy that will drive greater and more sustained earthquake mitigation efforts in Utah.

Ivan presented a proposed Wasatch Front study region map that showed the Quaternary–active faults in the region that would be considered in the WGUEP earthquake forecast (figure 1). The map, with minor boundary changes on its north, west and east sides, was later adopted as the WGUEP study region.

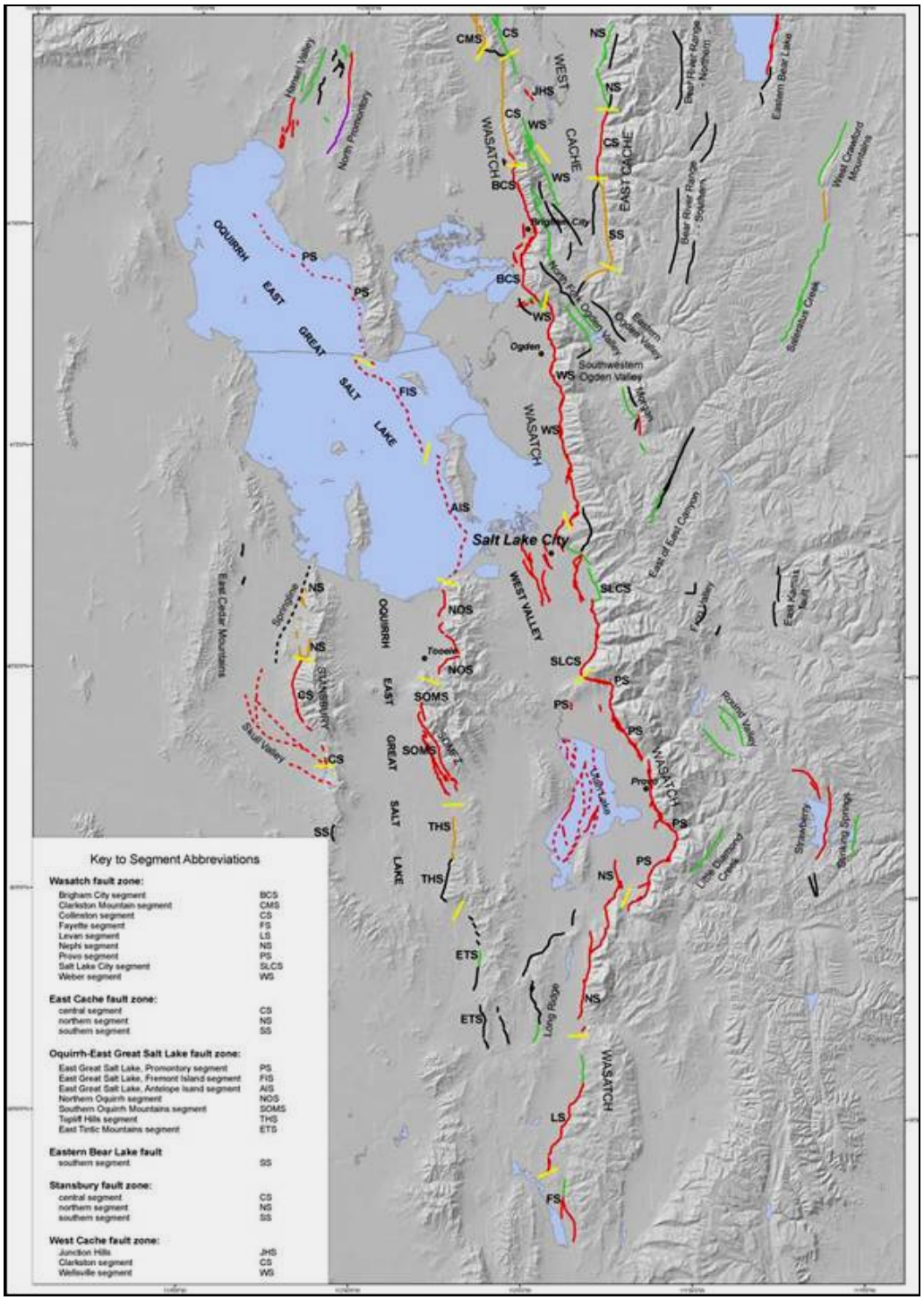

Figure 1. Map of proposed Wasatch Front study region showing Quaternary-active faults to be considered in the WGUEP earthquake forecasts. This map with boundary changes to the west (western boundary moved eastward to the west edge of Great Salt Lake) and east (eastern boundary moved westward to the easternmost extent of back-valley faults) was later adopted as the WGUEP study region.

Ivan briefly described the difference between time-independent and time-dependent earthquake forecasts. In a time-independent forecast, the probability of each earthquake rupture is completely independent of the timing of all others. Time-dependent models are based on the concept of stress renewal – the probability of a fault rupture drops immediately after a large earthquake releases tectonic stress on the fault and rises again as the stress is regenerated by continuous tectonic loading. The WGUEP forecast will include both time-dependent and time-independent probabilities for the Wasatch fault and other faults in the Wasatch Front region (e.g., East Great Salt Lake fault) depending on data availability; the forecast will also address background earthquakes.

An approach similar to that taken by the various California working groups will be followed in preparing the Wasatch Front earthquake forecast. The WGUEP will convene a series of workshops and meetings over a two-year period to review and develop forecast model components. Four models will be implemented in the forecast process: (1) fault model, (2) deformation model, (3) earthquake rate model, and (4) probability model. Epistemic uncertainties in all model input parameters will be explicitly addressed by the WGUEP. Ivan proposed that the WGUEP follow a SSHAC Level 2 process while performing their work. That proposal resulted in considerable discussion among the WGUEP members familiar with the SSHAC guidelines, with most members expressing reservations about following a formal SSHAC process. In the end, it was agreed that the WGUEP would follow the "spirit" of the SSHAC Level 2 guidelines, but would not aspire to formal SSHAC certification.

The WGUEP process will include calculating the probability of a large earthquake ($M \geq 6.5$) in the Wasatch Front region for a range of intervals varying from annually to 100 years. This is in contrast to the California working groups which emphasized a 30-year probability, which is appropriate given the high slip rate along the San Andreas transform plate boundary. However, deformation rates along the Wasatch Front are an order of magnitude lower than in California and the WGUEP will therefore of necessity consider longer intervals. The earthquake forecast will also include earthquakes in the $5 \leq M \leq 6.5$ range to account for potentially damaging background earthquakes. Earthquake probabilities to be estimated include: (1) segment-specific for the Wasatch fault, (2) total for the Wasatch fault, (3) fault-specific for other major faults in the area, and (4) total for the Wasatch Front region. The final WGUEP earthquake forecast will undergo a formal internal USGS review, and will also be sent to the National Earthquake Prediction Council for review and comment. Media release of the WGUEP results will be handled by the UGS. Project results will be presented at meetings for the general public and at professional and scientific society meetings.

Ivan ended his presentation by presenting a WGUEP meeting schedule and general scope of work for the next two years (table 1). He emphasized that the WGUEP has a two-year time limit and that the resulting earthquake forecast is meant to be based on available data. Future, more refined forecasts will undoubtedly follow this initial effort as they did in California, but the current WGUEP process represents an essential first step in that longer process.

Table 1. WGUEP meeting schedule and general scope of work.

Meeting	Purpose
1	Kickoff: Review WGCEP process and WGUEP scope of work.
2	Develop rupture scenarios for the Wasatch fault.
3	Develop time-dependent and independent recurrence rates for the Wasatch fault.
4	Develop time-independent recurrence rates for other Wasatch Front faults.
5	Review preliminary earthquake probability calculations.
6	Review and adopt final results.

TECHNICAL PRESENTATIONS

Following Ivan's presentation, the remainder of the meeting on Wednesday (February 10) and much of the meeting on Thursday (February 11) were devoted to technical presentations relevant to the start up of the WGUEP process. The PowerPoint slide shows accompanying each of the technical presentations below are available at http://geology.utah.gov/ghp/workgroups/wguep.htm.

Wednesday, February 10

- Overview of UCERF2[1] — Mark Petersen, USGS
- Overview of WGCEP02[2] — David Schwartz, USGS
- Overview of Wasatch Fault — Chris DuRoss, UGS
- Overview of Forecast Model Inputs — Ivan Wong, URS Corp.
- Overview of UQFPWG[3] Model — Bill Lund, UGS
- Time-Dependent Earthquake Recurrence Studies Along the Wasatch Front, Utah — Susan Olig, URS Corp.

Thursday, February 11

- Overview of University of Utah Earthquake Catalog — Jim Pechmann, UUSS
- Overview of Seismicity, Background Earthquakes, and Modeling Earthquake Rates in Utah — Walter Arabasz
- Overview of Geodetic Data — Bob Smith, UUGG
- Incorporation of Geodetic Rates into Forecast — Bob Smith, UUGG

[1]Uniform California Earthquake Rupture Forecast Version 2, [2]Working Group on California Earthquake Probabilities 2002, [3]Utah Quaternary Fault Parameters Working Group

ISSUES RAISED DURING THE MEETING

Several issues were raised during the presentations that will need to be addressed during the course of the project:

- Uncertainty still remains regarding segment boundaries on the Wasatch fault. Based on trench data, apparent spillover from one segment to another, e.g., 1983 Borah Peak, appears to have also occurred on the Wasatch fault.

- Do the Provo and Nephi segments, or portions of these segments, rupture coseismically?

- The Brigham City segment early Holocene earthquake record appears to be still incomplete. This incompleteness will need to be addressed in assessing recurrence along this segment.

- Questions remain regarding the timing, recurrence, and extent of mid- to late-Holocene earthquakes on the Weber segment. Discussions with the original paleoseismic investigators may help resolve these uncertainties.

- The relation of the West Valley fault zone (WVFZ) to the Salt Lake City segment (SLCS) of the Wasatch fault zone remains uncertain. Hopefully, upcoming UGS investigations on the SLCS and WVFZ will reduce the uncertainties.

- Over what time period is the paleoseismic record complete for the Nephi segment? Are the three most recent (late Holocene) earthquakes temporally clustered?

- What is the best coefficient of variation (COV) or range of COVs to be used in the time-dependent models?

- Is the strand of the Wasatch fault located east of Salt Lake City and the East Bench fault of the SLCS at the base of the range active?

- What is the best way to convert horizontal geodetic extension rates to fault dip slip rates?

- The magnitudes of pre-instrumental earthquakes within the Wasatch Front, particularly those near Salt Lake City need to be revisited. Current estimates rely on the Gutenberg-Richter frequency-magnitude relation or on Modified Mercalli intensity estimates.

TASK LIST

Following the end of technical presentations on Thursday, Ivan summarized the results of the two days of meetings, discussed topics for future meetings, and reviewed the assignments made for various working group members. Current assignments include:

1. Re-examine background seismicity recurrence with an emphasis on pre-instrumental seismicity. Note that the region we have defined for the forecast may not exactly match the region for which the recurrence has been calculated (Walt and Jim).

2. Write up the calculation of COV for the Wasatch fault (Susan).

3. Perform OxCal analyses of remaining segments of the Wasatch fault (Chris, Susan, Tony, Steve, and Bill).

4. Comparison of the extensional strain rates from the geodetic and slip rate data (Mark).

5. Develop the list of faults in the forecast region (Bill).

6. Create Strawman rupture scenarios for the Wasatch fault (Chris).

7. Complete report on the megatrench and distribute to other working group members (Susan).

8. Establish a password protected website for the working group (Steve Bowman).

The next WGUEP meeting is scheduled for July 14-15, 2010 in Room 2000 of the Utah Department of Natural Resources Building (1594 West North Temple, Salt Lake City**,** Utah**).**

ATTACHMENT 1

Members
Working Group on Utah Earthquake Probabilities

Walter Arabasz, UUSS
Tony Crone, USGS
Chris DuRoss, UGS
Nico Luco, UGS
Bill Lund, UGS, Coordinator
Susan Olig, URS Corporation
James Pechmann, UUSS
Steve Personius, USGS
Mark Petersen, USGS
Dave Schwartz, USGS
Bob Smith, UUGG
Ivan Wong, URS Corporation, Chair

*Steve Bowman, UGS Liaison

ATTACHMENT 2

AGENDA
WORKING GROUP ON UTAH EARTHQUAKE PROBABILITIES
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10 February 2010

7:30 – 8:00	Continental Breakfast	
8:00 – 8:15	Welcome and Introductions	Bill Lund
8:15 – 9:00	Purpose, Tentative Scope of Work, SSHAC Process, and Schedule	Ivan Wong
9:00 – 9:30	Overview of UCERF2	Mark Petersen
9:30 – 10:15	Issues Associated with UCERF2	David Schwartz
10:15 – 10:30	Break	
10:30 – 11:00	Discussion on UCERF2	Mark Petersen/David Schwartz
11:00 – 12:00	Overview of Wasatch Fault	Chris DuRoss
12:00 – 1:00	Lunch	
1:00 – 2:00	Overview of Forecast Model Inputs	Ivan Wong
2:00 – 3:00	Overview of Utah Quaternary Fault Working Group Model	Bill Lund
3:00 – 3:15	Break	
3:15 – 4:15	Review of Wasatch Time-Dependent Probabilities	Susan Olig
4:15 – 5:00	Discussion	
5:00	Adjourn	

11 February 2010

7:30 – 8:00	Continental Breakfast	
8:00 – 9:00	Overview of Seismicity Catalog	Walter Arabasz/Jim Pechmann
9:00 – 9:30	Incorporation of Background Seismicity into Forecast	Walter Arabasz/Jim Pechmann
9:30 – 9:45	Break	
9:45 – 10:45	Overview of Geodetic Data	Bob Smith
10:45 – 11:30	Incorporation of Geodetic Rates into Forecast	Bob Smith
11:30 – 12:30	Lunch	
12:30 – 3:00	Issues (integration of geodetic data, segmentation, multi-segment rupture, recurrence models, etc.)	Ivan Wong
3:00 – 3:15	Break	
3:15 – 4:00	Path Forward	All
4:00	Adjourn	

WGUEP Members

Ivan Wong, URS (Chair)	Jim Pechmann, UUSS	Chris DuRoss, UGS
Bill Lund, UGS (Coordinator)	Steve Personius, USGS	Susan Olig, URS
Walter Arabasz, UUSS	Mark Petersen, USGS	Bob Smith, UUGG
Tony Crone, USGS	David Schwartz, USGS	Nico Luco, USGS