AGENDA

EARTHQUAKE-INDUCED LANDSLIDE WORKING GROUP

Friday, February 27, 2004
Utah Department of Natural Resources building, room 1060
1594 W. North Temple, Salt Lake City

8:30 Introduction (Francis Ashland)

8:45 Working Group input on 2003 UGS earthquake-induced landslide studies

- Catastrophic rockslides – the value of demonstrating a seismic origin
- Reactivation of pre-existing landslides – methods and opportunities
- Shallow, disrupted slides and falls – the hunt for the Northridge type landslide
- Combining paleoliquefaction and earthquake-induced landslide studies – demonstrating a seismic origin; developing a scenario for magnitude 5 and larger earthquakes
- Make revisions to Research Option 4 of the 2003 plan

10:00 Break

10:15 Approaches and next steps to implementing the rest of the plan

- Is the existing shear-strength data sufficient to proceed with Element 1?
- Landslide inventories that include earthquake-induced landslides – pilot project
- User groups' perspective – how will an earthquake-induced (shallow, disrupted slide/fall) map be used? A basis for building setbacks at the base of steep slopes?
- Make revisions to Research Option 1 of the 2003 plan
- Choosing the next study area for Harp and Noble (1993) type studies
- Make revisions to Research Option 2 of the 2003 plan
- Implementing Research Option 3 using landslide inventory mapping of the Kaysville quadrangle (upcoming State Map project)
- Make revisions to Research Option 3 of the 2003 plan
- Future earthquake-induced landslide grant proposals
- The need for additional elements of the plan

12:00 noon Lunch

1:00 Adjourn

Tentative Agenda
Earthquake-Induced Landslide Working Group
Room 1050, Department of Natural Resources
Salt Lake City
July 21, 2003

8:30 am: Utah Earthquake-Hazards Working Groups - Gary Christenson, UGS

8:35 am: Introductions
Each attendee discusses expertise, present work, research interests, and expected participation level

8:45 am: History of previous studies in Utah – Francis Ashland, UGS
Keaton and others, 1987
Case, 1987
Harp and Noble, 1993
Solomon and others, 2002

9:00 am: Methods and results: landslide maps for a M7 scenario SLC EQ –
Barry Solomon, UGS

9:20 am: Discussion on existing products, UGS projects and database
Landslide inventory maps
Harty 30'x60' maps
Lowe 7-1/2' maps
Landslide susceptibility and special-study maps
UGS Projects
Inventory/detailed mapping of Salt Lake County landslides
Identifying suspected earthquake-induced landslides in Wasatch Front
UGS Database
Soil shear-strength database

9:40 am: Mapping earthquake-induced landslide hazards in California –
Tim McCrink, CGS

10:00 am: Summary of USGS efforts and research interests – R. Jibson, USGS

10:15 am: Break

10:30 am: Discussion: the need for earthquake-induced landslide susceptibility/probability maps in the Wasatch Front
Define user group/map scales
Do landslide susceptibility maps (static) already define potential earthquake hazard?

11:00 am: Scientific needs to prepare new maps/improve existing regional-scale maps
- Other methods
- Adequate shear-strength data

11:30 am: Related and interim research
- Seismic rock-fall susceptibility
- Performance of pre-existing landslides
- Performance of modified slopes – cut slopes
- Vulnerability of other deposits – sensitive clays
- Catastrophic failures – large rock slides
- Other

12:00 noon: Defining a research plan
- Priorities
- Opportunities for cooperative research
- Potential NEHRP proposals

12:30 pm: Lunch – informal discussion

Attachment 1

Earthquake-Induced Landslide Working Group Members and Invited Observers

Randy Jibson, U.S. Geological Survey
Leslie Heppler, Utah Department of Transportation
Fulvio Tonon, Department of Geology and Geophysics, University of Utah
Tim McCrink, California Geological Survey
Francis Ashland, Utah Geological Survey
Gary Christenson, Utah Geological Survey
Barry Solomon, Utah Geological Survey

Ben Everitt, Utah Division of Water Resources
Loren Anderson, Department of Civil and Environmental Engineering, Utah State University
Robert Pack, Department of Civil and Environmental Engineering, Utah State University
Danny Horns, Department of Earth Science, Utah Valley State College
Jim Nordquist, Applied Geotechnical Engineering Consultants, Inc.

Darlene Batatian, Salt Lake County Geologist
Barry Welliver, Utah Seismic Safety Commission (USSC), Chair
Joergen Pilz, USSC Geoscience Committee, Chair
Greg Schlenker, Utah Section, Association of Engineering Geologists, Chair
Kent Hartley, Utah Geotechnical Group, American Society of Civil Engineers, Chair
Bob Carey, Utah Division of Emergency Services
Dave Marble, Utah Dam Safety

Attachment 2

NEHRP Funded Projects: Earthquake-Induced Landslides

1. University of Missouri - Dr. J Rogers 20030170 03HQGR002

Seismically-induced land slippage in the Benton Hills and Crowley's Ridge, New Madrid seismic zone, Missouri and Arkansas

2. William Lettis and Associates - Dr. Scott Lindvall 20030176 03HQGR0075

Evaluating the repeatability of lateral spreading

3. Utah Geological Survey - Mr. Gary Christenson 20030440 03HQAG0008

Database compilation, coordination of earthquake-hazards mapping, and study of the Wasatch fault and earthquake-induced landslides, Wasatch Front, Utah

4. University of Arizona - Scott Merry 20020229 02HQGR0015 PN

Ground failure resulting from the 2001 Nisqually earthquake

5. State University of New York - Buffalo - Dr. S Thevanayagam
20010226 01HQGR0032

Role of intergranular contacts on mechanisms causing liquefaction and slope failures in silty sands

6. Jonathan Bray 00HQGR0083

Evaluation of Seismic Slope Stability Procedures Through Shake Table Testing

7. Utah Geological Survey - Barry Solomon 99-HQ-GR-0091

Seismic-hazard scenario for a MW 7 earthquake along the Salt Lake City segment of the Wasatch fault zone, Utah

UTAH PLAN FOR DEVELOPING THE NEXT GENERATION OF EARTHQUAKE-INDUCED LANDSLIDE-HAZARD MAPS

Utah Earthquake-Induced Landslide Working Group*
July-September 2003

Future moderate and large earthquakes in Utah may cause damaging landslides including 1) the reactivation of pre-existing landslides and triggering of new deep-seated landslides in susceptible areas, 2) shallow landslides on moderate to steep slopes, and 3) rock falls from steep mountain slopes.

OBJECTIVE: Develop maps that illustrate the potential for earthquake-induced landsliding, including on slopes where otherwise a landslide hazard may not exist. These maps will be used for raising public awareness, emergency preparedness and response, urban planning, and risk analyses by land-use planners (special-study maps), emergency managers, and lifeline managers including the Utah Department of Transportation.

Research Options

(1) Investigate and select an approach, possibly that of McCrink (2001), for generating earthquake-induced landslide-hazard maps as a pilot project. The pilot project would evaluate several options to map geologic units with similar shear strengths based on: 1) the existing shear-strength database, supplemented by a renewed search of data available from consulting firms and state agencies, 2) additional laboratory testing to obtain shear-strength data (if funding becomes available), and 3) the use of "best estimates" from an expert panel. Criteria for selecting a pilot project study area include the availability of 1:24,000-scale geologic mapping, shear-strength data, an adequate landslide inventory, and 10-meter digital elevation models (DEMs). Sensitivity analyses should evaluate the relative importance of these criteria in the final map outcome. The pilot project should address the relation between static and earthquake-induced landslide-hazard maps, and methods to produce dual-purpose maps. The feasibility of incorporating SINMAP (Stability Index Mapping) software into the project will be evaluated.

(2) Create earthquake-induced rock-fall susceptibility maps using the methods of Harp and Noble (1993) in study areas along the Wasatch Front urban corridor (Ogden-Provo) and/or important transportation/lifeline corridors in mountain areas. Evaluate the practicality of the technique for covering large areas and define methods for determining runout distances and potential for larger rock avalanches.

(3) Inventory existing landslides in an area of similar geology (such as the bluffs in the Weber River delta complex), collect data (such as slope, dominant grain size, and ground-water conditions) that provides an understanding of stability/susceptibility to reactivation or local failure (including failure of slopes adjacent to landslides) during an earthquake, and assess the likely effects of

earthquakes to improve our understanding of the actual hazard from earthquake-induced landslides.

(4) Identify possible earthquake-induced landslides in the Wasatch Front and assess whether subsurface investigations could reveal ages of deposits or movement events allowing correlation with documented Wasatch Front surface-faulting earthquakes. Perform "paleoseismic" investigations of selected landslides and characterize site conditions that contribute to earthquake-induced landsliding.

*Earthquake-Induced Landslide Working Group

Randy Jibson, USGS	Fulvio Tonon, U of U	Bob Pack, USU
Tim McCrink, CGS	Loren Anderson, USU	Barry Solomon, UGS
Jim Nordquist, AGEC	Leslie Heppler, UDOT	Francis Ashland, UGS
Danny Horns, UVSC	Jim Higbee, UDOT	Gary Christenson, UGS

DRAFT

MEETING SUMMARY AND POSSIBLE RESEARCH OPTIONS: DEVELOPING A PLAN FOR THE NEXT GENERATION OF EARTHQUAKE-INDUCED LANDSLIDE-HAZARD MAPS IN UTAH

Utah Earthquake-Induced Landslide Working Group*

21, July 2003

Although the Earthquake-Induced Landslide Working Group meeting did not complete the task of finalizing a research plan for the study of earthquake-induced landslides in the Wasatch Front, several valuable discussion points were raised that may form the basis of future research. I have attempted to summarize the main discussion points from the meeting and outline possible research options. These options may define future research efforts by the Utah Geological Survey (UGS) that include opportunities for collaboration with the U.S. Geological Survey (USGS), other state agencies, local universities, and private companies. I thank everyone again for their participation in the meeting.

The Working Group discussed the potential benefits of the maps. One direct benefit is that the maps will likely illustrate the potential for landsliding on slopes where otherwise a landslide hazard may not necessarily exist; suggesting differences between landslide susceptibility under static conditions and during earthquake ground shaking. The group summarized the three basic landslide scenarios that are anticipated: 1) reactivation of pre-existing landslides and triggering of new deep-seated landslides in susceptible areas, 2) shallow landslides on moderate to steep slopes, and 3) rock falls from steep mountain slopes. A question arose whether earthquake-induced landslides in the Wasatch Front were worthy of future research given the lack of occurrence in the last 150 years. However, moderate earthquakes elsewhere in Utah, including the 1992 Saint George

earthquake that caused damaging landsliding, and the 1988 San Rafael Swell earthquake that caused widely distributed rock falls, suggest a significant landslide and rock-fall hazard exist in the Wasatch Front from a moderate or large earthquake. Whereas non-earthquake-induced landslides and rock falls are widely recognized hazards in Utah, we anticipate difficulty convincing some users to consider earthquake-induced landslides independently. User groups identified for the maps included land-use planners (special-study maps), emergency managers, and lifeline managers including the Utah Department of Transportation. Possible projects discussed at the July 21 meeting that will form the basis for a draft plan are listed below.

Research Options

(1) Evaluate the feasibility of using and/or modifying the California Geological Survey (CGS) approach for generating earthquake-induced landslide-hazard maps as a pilot project. Shear-strength data are limited or lacking in much of the Wasatch Front, and the UGS has begun compiling available shear-strength data. The pilot project would evaluate several options to map geologic units with similar shear strengths based on: 1) the existing shear-strength database, supplemented by a renewed search of data available from consulting firms and state agencies, 2) additional laboratory testing to obtain shear-strength data (if funding becomes available), and 3) the use of "best estimates" from an expert panel. Some criteria for selecting a pilot project study area include the availability of 1:24,000 geologic mapping, shear-strength data, an adequate landslide inventory, and 10-meter digital elevation models (DEMs). Sensitivity

analysis was suggested to evaluate the relative importance of these criteria in the final map outcome. A pilot project that falls within the study area of an earlier study (Keaton and others, 1987) would allow comparison of the results, taking into consideration that the Keaton and others (1987) study lacked the currently available landslide inventories and shear-strength data. Another suggestion is that the pilot project address the relation between static and earthquake-induced landslide-hazard maps, and methods to produce dual-purpose maps.

(2) Create earthquake-induced rock-fall susceptibility maps using the methods of Harp and Noble (1996) in study areas along the Wasatch Front urban corridor (Ogden-Provo) and/or important transportation/lifeline corridors in mountain areas. Evaluate the practicality of the technique for covering large areas and define methods for determining runout distances and potential for larger rock avalanches.

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Invited Observers

Greg Schlenker, AEG	Dave Marble, UDDS	Barry Welliver, USSC
Dalene Batatian, SLCo	Joergen Pilz, USSC	Kent Hartley, ASCE