

Attendees: Names: Rob Jackson, Michael Haughey, Matt Morgan, Will Levandowski, Chuck Mueller, Robin McGuire, Keith Porter, Sean McGowan, and Mark Zellman.

Approval of minutes from 12 September 2019 meeting motioned, seconded, and approved.

Agenda Items:

Sean McGowan will present an overview of FEMA grant funding available to states for mitigation projects with an emphasis on funding retrofit projects.

Sean M. presented a step-by step process for school retrofits that involve the following seven (7) generalized steps:

- Step 1) Training; FEMA P-154 Training (rapid visual screenings to produce coarse inventory) and FEMA E-74 (Reducing the Risks of Nonstructural Earthquake Damage), 2) Define an area of interest for the study (either based on proximity to areas of high ground motions, active faults, etc.), 3) Evaluation of the schools within the area of interest using FEMA P-154 methods to produce a ranked list, 4) (Optional step) have engineers further look at rapid visualization findings to refine the engineering analysis within funding through NEHRP, 5) pursuit of CO division of Homeland Security and Emergency Management (DHSEM) pursue competitive mitigation grants to retrofit high-risk schools, 6) Pursuit of another NETAP training for school (or hospital mitigation), 7) Retrofit - using funds from Step 5 and techniques learned from Step 6 to retrofit the structure.
- Motion to apply and encourage application for NETAP funding for FEMA-154 and E-74 funding for 2020. To be proposed by Colorado Geological Survey (CGS) and pending internal approval by CGS. Motion was voted on and approved by CEHMC.

Developing a Critical Facilities Inventory Subcommittee -Keith Porter and Mark Zellman:

- **National Earthquake Technical Assistance Program (NETAP) and opportunities for 2020.**
 - CEHMC will pursue funding for FEMA 154 and E-74 training in 2020. CEHMC will advertise the training to local agencies and organizations and seek volunteers for the school assessment from within those groups. Keith will lead the effort to assemble an initial list of organizations for where the training can be advertised. K. Porter has mentioned that CU Boulder classrooms with room for 200 could be used for the potential training location.
 - Preferred training dates – Summer-Fall 2020.
- **Colorado schools inventory. Mark has the state's school location data.**
 - **Candidate locations:** Summit County, San Luis Valley, Select Front Range sites, and Steamboat area/Aspen based on 2014 NSHM.

- **Outline of possible steps to develop a coarse, then more detailed facility inventory with training and volunteer hours leading to selected retrofits.**

Keith presented several key steps to develop a CEHMC subcommittee to develop the critical facilities inventory:

- Potential Allies: UC EERI chapter, ASCE Denver, Structural Engineering Institute, CO Department of Education, CDOT, SEAC.
- Training programs - NETAP training programs (see above).
- Funding (via FEMA). Investigated previous FEMA funding for “bang-for-the-buck” retrofits. There is precedent for projects of this scope. Examples from other states:
 - URM project in Utah and many other locations
 - Seismic hazard safety program for mobile homes in California
- Plan to establish a subcommittee: 1) recruit members from CEHMC and other local organizations, 2) meet monthly, 3) Select candidate projects, review with Steve Board and Sean M. to see if the projects have promise, and 4) report back to CEHMC.

Review and comments on recently updated brochure on Colorado earthquake hazards.

- Deferred discussion till a later date.

2019 Cheraw fault trenching update

- M. Zellman provided a brief update about the Cheraw fault trenching that occurred earlier in the year. Some ages have come back from the lab, and analysis of ages has begun. However, we are still waiting for additional ages. Also, we are working to finalize trench logs. The trench may show at least one more surface faulting event that was not interpreted in the original USGS trench excavated ~25 years ago.

Other items:

CEHMC roster discussion

- Update contact information for the active members.
- Determine which members are inactive and inquire if their interest in continued involvement.
- Recruitment – mostly an organic process through existing member contacts. There is group interest in the involvement of state officials from schools, buildings, and hazards.
 - Present at the state buildings meetings
 - Involvement at SEAC.

Future Speakers:

Mark Petersen and Chuck Mueller January 23 – NSHM updates.

Date of next meeting:

January 23, 2020; Tetra Tech Offices, Golden, CO; NOTE: 4TH NOT 3RD Thursday of the month)

2020 Meeting Schedule:

Jan 23, March 19, May 21, July 16 Sept 17 and Nov 19

Attendees: Names: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller, S. Joellen Thiel, Robin McGuire, Will Levandowski, Keith Porter, Rob Jackson, and Sean McGowan.

Approval of minutes from 18 July 2019 meeting motioned, seconded, and approved.

Agenda Items:

Steven Boand, State of Colorado Hazard Mitigation Officer, will speak on the update to the state's Hazard Mitigation Plan

Steven presented an overview of the state hazard mitigation program and the recent Colorado Emergency Operations Center Earthquake Exercise (held October 2019). Below are a few key take-aways from the presentation:

- A map was presented that shows how the plans rank seismic hazards (from low to high). In some instances, it shows an apparent mismatch between relative hazard level and the presence or absence of historic earthquakes and Quaternary faults. For example – some counties with Quaternary faults are shown to have relatively lower seismic hazard ranking than other counties with lower rates of seismicity and/or absence of Quaternary faults.
- There is no clear definition for what low, medium, and high seismic hazard means.
- The state hazard mitigation plan uses a superseded version of the Quaternary fault map. The current version shows the Anton scarp.
- 98.22% of CO population lives in a county with a building code.
 - 14 counties in CO do not have building codes.
 - Of the existing codes most communities have low scoring building codes based on the Building Code Effectiveness Grading Schedule (BCEGS).
- Oct 2019 – Colorado Emergency Operations Center Earthquake Exercise
 - Scenario event for a fault in Colorado.
 - Open invitation to CEHMC to view the exercise.
- Steven will provide his presentation to the group along with the segment for CO state hazard mitigation plan that covers seismic hazards and the State's building code status.
- Steven invited CEHMC to provide input on how to evaluate how seismic hazards are treated in the Colorado State Hazard Mitigation Plan.

Review and comments on recently updated brochure on Colorado earthquake hazards.

- Deferred to later date.

Review of WSSPC Policy Recommendations updates to be voted on in 2020 annual meeting. A new Policy Recommendation has been added which recommends the creation, implementation, and maintenance of Seismic Safety Councils and Commissions for all WSSPC member states, provinces, and territories.

- There is general curiosity from the CEHMC meeting attendees about what this recommendation means and CEHMC's role within WSPC.

CEHMC Meeting

12 Sept 2019

- CEHMC is not an official state entity we are not an official Seismic Safety Council and Commission extension of the state.

ShakeOut planning for 2019: CEHMC ShakeOut letter transmitted to State of Colorado was included in March and April newsletters.

- Rob J. made a brief note about the upcoming 2019 ShakeOut and the letter that was transmitted to the State of Colorado advertising the date of the event.

City of Denver seismic amendments for adoption of the 2018 IBC

- Voting to take place this afternoon. Rob J. to attend and defend the seismic amendments. (Post meeting note: the amendments all passed the committee voting.)

Discussion of the National Earthquake Technical Assistance Program (NETAP) and opportunities for 2020

- Sean McGowan will present a funding overview in November.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening.

The group deferred detailed discussion of this to a later meeting, but the following topics and questions were mentioned:

- What other states have done this story of study?
- CEHMC needs to develop a scope for this study.
- Funding avenues – what are they? Sean M. mentioned possible of funding this program via the PDF grant program.
- An idea was raised to pair demonstration of this program with the CO State EQ evaluation (rupture scenario of the Gore Range frontal fault.
- Mark Z. will share school database in November.

SAP training October 13th in Boulder

- Free post-disaster safety evaluation of building and infrastructure (SAP training) – 6-7 hrs. Sunday Oct 13 8 to 5pm.
- ACT-20, ATC-45, and Cal OES SAP training.

Future Speakers:

Keith Porter, TBD

Date of next meeting:

Nov 21, 2019, Tetra Tech Offices, Golden, CO

2019 Meeting Schedule:

Jan 17, March 21, May 16, July 18, Sept 19, and Nov 21

CEHMC Meeting Minutes, July 18, 2019

Attendees: Jaclyn Kurle, Steven Boand, Joellen Thiel, Robin McGuire, Rob Jackson, Michael Haughey, Chuck Mueller, Sean McGowan, Will Levandowski

Robin McGuire moves to approve May meeting minutes, Chuck Mueller seconds.

Recap of current state of encouragement of ShakeOut participation in Colorado schools, deficiency of Colorado participation relative to surrounding states with similar hazard.

Steve Boand described the BRIC program (Building Resilient Infrastructure and Communities; administered by FEMA, from National Disaster Fund) which will increase national mitigation funding from \$300 million to over \$2 billion and may provide an opportunity to renovate/mitigate high-risk schools, particularly those with unreinforced masonry. The National Disaster Fund total annual funding is set at 6% of the funds spent on disasters last year (\$90b x 0.06 = \$5.4B). Timely for Colorado, where full-day kindergarten for all will begin in 2019-2020 school year.

The program is targeted toward existing structures in high-hazard areas.

Discussion about hazard (i.e., probabilistic ground motion amplitude) vs. risk: Areas near Dillon and Silverthorne (Williams Fork Fault), Steamboat, Aspen/Glenwood Springs, and obviously eastern margin of San Luis Valley.

Much of San Luis Valley may have no building code: Steve stated that 35 municipalities in Colorado have no building code whatsoever, although schools do fall under the IBC which is adopted for schools at the state level. Steve will forward a list of these municipalities.

FEMA audit of states' compliance with states' own regulations: Colorado Dept. of Education "has problems" with compliance with state regulations on flood plain management.

Policy recommendations from WSSPC:

Mitigation and identification of unreinforced masonry

Seismic design and construction of new schools (Currently recommends that there be a minimum seismic design category, other than A, for schools)

Earthquake early warning; Monitoring networks

Structural Engineers Association of Colorado liaison with City of Denver → Adoption of 2018 IBC. Seismic amendments will be discussed in coming months, which will bring the current Class-B minimum in City of Denver under review. Michael Haughey mentioned that the exemptions for non-structural elements, still allowed under Denver amendments, should be reconsidered similar to the CEHMC recommendation to the State for schools.

NETAP Opportunities: School building inventory? This could be paired with FEMA 154 training.

SAP training at CU-Boulder on October 13. Currently planned as single day training for ATC20 and SAP certification through Keith Porter's volunteer training of evaluators. A two-day

program on building assessment (FEMA 154) and post-earthquake evaluations (ATC20) would require NETAP funding but this is possible as well. Advertisement through SEAC newsletter and CO Dept. Fire Prevention discussed. Sean will write specifics for inclusion.

Future speakers: Steven Boand offers to speak on September 12 about the update to the state hazard mitigation plan.

Attendees: Names: Rob Jackson, Michael Haughey, Phil Sirles, Joellen Thiel, Will Levandowski, Kyren Bogolub, Mark Zellman, Matt Morgan, Chuck Mueller, Darlene Cysper, Sean McGowan.

Approval of minutes from 21 March 2019 meeting motioned, seconded, and approved.

Agenda Items:

2019 Cheraw fault trenching and review.

- The Cheraw fault trench excavated in 1994 by Tony Crone, Mike Machette and others from the USGS was re-excavated in June 2019. The project was funded by CGS, and work included excavation and logging of the trench and two test pits on adjacent alluvial surfaces. The purpose of the re-opening of the trench was to better constrain surface faulting event timing by collecting samples of bedded fine-grained sand for OSL analysis. This material was not dated during the original work in 1994 because the methods to date the material did not exist at the time. The work was completed by Dean Ostenaa, Mark Zellman, CGS, USGS, and Paul Rindflesh of the USDA.
- Samples have been submitted for laboratory analysis, and results are pending.

ShakeOut earlier planning for 2019: CEHMC ShakeOut letter transmitted to State of Colorado was included in March and April newsletters.

- Notification of ShakeOut has been published in the newsletter.
- So far, no schools have registered for ShakeOut.

Items from Western States Seismic Policy Council (WSPC) annual meeting April 25, 26.

- Annual meeting held in SLC. R. Jackson attended.
- Next meeting will be March 2020 in San Diego. It will be a joint meeting for EERI and WSPC.
- Building code group met Thursday evening.
 - Call-in participation was limited due to logistical problems.
 - CEHMC comments were submitted
 - Due to limited participation – few actions were taken other than editorial comments to the WSPC policy.

Review and comments on recently updated brochure on Colorado earthquake hazards

- Comments submitted by B. Kirkham, H. Janowicz, R. Jackson, and V. Matthews. CGS is incorporating the edits into the brochure.
- 2nd round of edits coming after updates are complete. Looking to reduce the amount of text and add images.
- It was suggested that Kyren track the incoming comments and her action on them. Next issued version will include a sheet showing the comments and responses.

City of Denver seismic amendments for adoption of the 2018 IBC

- R. Jackson provided the amendments to the CEHMC in a recent email.

- Structural Engineers Association of Colorado (SEAC) works with the city of Denver to provide amendments for the adoption of the 2018 IBC. Amendments include: No seismic design category A; methods for the determination of site class in the absence of shear wave velocity measurements; among others.
- SEAC has suggested that R. Jackson be present for the City of Denver Technical Advisory committee meeting(s) when the 2018 IBC Denver seismic amendments are up for discussion

Discussion of the National Earthquake Technical Assistance Program (NETAP) and opportunities for 2020

- Can provide free training for Colorado if interest exists. Needs at least 25 people. Open to the public.
- Could be a method for evaluating URM schools.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening.

a. Status of State of Colorado database development

- Seismic vulnerability data is being entered into the database now. Site class information is entered into the database when soils reports are issued, when a new school built, or when a school is renovated.
- Currently 82 projects, of those only about 10 are renovations or new construction.

Other Topics:

- **CGS Seismic Network update:**
 - Red Feather Lakes Station – currently down. Hoping to reconnect with T-mobile.
 - Weld County – Briggsdale site - (Greely Area) – one of CO's most used stations. CO State Land Board is installing an O&G access road near the current station, and it will need to be moved. CGS will look to move it to one of the station locations being pulled by Anne Sheehan later this summer.
 - CSU Mountain Campus Site: CGS tests station to be installed at the CSU mountain campus.
 - Idaho Springs: Station to be installed in or around Edgar mine in Idaho Springs. Will be used by CSM. CSM will assist with installation and utilize the data for classes. CGS had been considering installing a station at Rocky Flats but are planning to move it to Idaho Springs. CSM
 - ASPEN – CGS is looking to replace the station the USGS is going to decommission.
- **2019 SSA annual meeting in Seattle 27-30 April:**
 - Kyren: made connections with other state seismologists for intermountain west states; Call for papers about regional seismic network publication opportunities through SRL.

CEHMC Meeting
16 May 2019

Future Speakers:
Keith Porter, TBD

Date of next meeting:
July 18, 2019, Tetra Tech Offices, Golden, CO

2019 Meeting Schedule:
Jan 17, March 21, May 16, July 18, Sept 19, and Nov 21

Attendees: Names: Rob Jackson, Michael Haughey, Robin McGuire, Chuck Mueller, Matt Morgan, Mark Zellman, Kyren Bogolub, Sean McGowan.

Approval of minutes from 17 January 2019 meeting motioned, seconded, and approved.

Agenda Items:

Recent Colorado earthquakes on the Sangre de Cristo fault and near the Paradox Valley.

- CEHMC Discussed Bob Kirkham's summary of the recent Sangre de Cristo earthquakes. He notes that the recent events are located on the footwall of the Sangre de Cristo. Based on felt reports, Bob suggests the epicenter may be a few km to the west. Cluster of EQs mostly M1 & M2, but up to M3.8. located on the footwall of the Sangre de Cristo fault.
- On March 4th Paradox Valley M4.6 occurred on March 4th. Injection well related?
- Glenwood Springs area – cluster of EQs. Up to M3.6. December. Evaporite tectonism related?

WSSPC policy recommendations.

WSSPC Policy Recommendations will be voted on at the Annual Business Meeting in Salt Lake City on April 26. The recommendations are available at the following location: <https://www.wsspc.org/public-policy/2019-wsspc-draft-policy-recommendations/>.

R. Jackson requested feedback from CEHMC members, and M. Haughey responded with the following 5 recommendations:

- DRAFT_PR_19-4_Bldg_Codes_Version3_111518.docx
 - Recommend code and ASCE 7 sections that could/should be made more stringent, such as using minimum site class B, deleting non-structural exemptions, and deleting one and two family dwelling exemptions unless they meet specific construction criteria (such as frame construction and a minimum wall shear rating).
- DRAFT_PR_19-10_Schools_Joint_Policy_Version3_111518.docx
 - Provide some guideline as to what is meant by "*earthquake resilient school buildings*". Recommend importance factors, increasing site class, and deleting non-structural exemptions.
- DRAFT_PR_19-1_Tsunami_Evacuation_Version3_111518.docx
 - For near-source Tsunamis, include a recommendation to develop physical evacuation routes or towers where present routes require more time than might be available in an event.
- DRAFT_PR_19-11_Lifeline_Infrastructure_Version3_111518.docx
 - Add the development of standards for minimum lifeline resiliency
- DRAFT_PR_19-12_Gas_Shutoff_Devices_Version3_111518.docx
 - Add a requirement for easily accessed, clearly labeled (purpose and buildings served), and easily operated backup manual valves.

EERI Public Policy and Advocacy Committee.

R. Jackson – A Policy Position is in development for the “Adoption of Effective Seismic Building Codes, among others; upcoming meeting to be held in Vancouver Canada.

ShakeOut debrief and earlier planning for 2019. Status of letter transmitted to State of Colorado for inclusion in newsletter.

[Detailed discussion deferred] CEHMC has submitted a letter to the State of Colorado that discusses ShakeOut and encourages participations by Colorado Schools. The letter is supposed to be included in a monthly news letter and sent to school superintendents.

Pamphlet on Colorado seismicity, spelling out the differences between natural and induced seismicity, fracking, etc.

CGS is preparing an informational pamphlet that presents earthquake hazard information on a single sheet (front and back). It is currently in draft status. R. Jackson was asked to provide building code information. No specific release date but aiming for late 2019. CGS has requested group input on the pamphlet text and content. Will share a word file of the text for edits/comments.

CGS updates

CGS meeting and discussing roles and partnerships with the USGS.

- USGS will be the collection point for the CGS seismograph data.
- CGS is reviewing seismograph records to detect small magnitude earthquakes that are not being reported by the USGS. Detected event locations are being provided to the USGS to supplement their reporting.
- Seismographs:
 - N23a – seismograph near Red Feather lakes is currently down and needs to be moved. CGS will visit the site when the snow melts.
 - New permanent station to be added to Rocky Flats.
 - Replacing a station at Snowmass to replace the USGS station that’s being pulled.
 - New station at CSU Mountain campus near Estes Park, CO.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening.

- **Status of State of Colorado database development.**

Deferred discussion since Division of Fire Safety representative was not in attendance.

- **Structural inventory as an “eligible activity” under a NEHRP grant.**

[Deferred to next meeting] R. Jackson sent email to C. Burnett indicating support for the database and requested that it include site class, structure type, etc. (See R. Jackson email dated 11/28/2018.) C. B. email response dated Dec. 3, 2018 indicated support for this and J. Thiel e-mail of January 17, 2019 confirmed that the Site Class and Seismic Design Category will in fact be collected and associated with the site rather than the projects.

National Institute of Building Sciences report on its multi-year study on the benefits of investing in hazard mitigation. Natural Hazard Mitigation Saves: 2018 Interim Report

This report defends the adoption of “modern” (current IBC) codes and encourages design beyond the code in higher hazard areas.

Other Topics:

- DMNS— reorganizing 1st floor. Looking for ideas. M. Morgan has reached out previously but has not received a response. will try again.
- Quakesmart: CO again in a few years (hopefully), WY could not fill the room so it was canceled.
- Fort Carson: M. Morgan and S. McGowan discussed EQ hazards with Ft Carson emergency operations center. Ft. Carson requested information about earthquakes. S.M provided them a list of information needed for a full HAZUZ model but has not received a response.

Future Speakers:

Keith Porter, May 2019.

Date of next meeting:

May 16, Tetra Tech Offices, Golden, CO

2019 Meeting Schedule:

Jan 17, March 21, May 16, July 18, Sept 19, and Nov 21

CEHMC
January 17, 2019
Tetrattech Offices

Notes (by Will Levandowski and Rob Jackson)

Attendees: Rob Jackson, JoEllyn Thiel, Matt Morgan, Kyren Bogolub, Will Levandowski, Holly Janowicz

Introductions

Review and approval of previous meeting's minutes: Rob Jackson moves to approve; Will Levandowski seconds.

Discussion of letter encouraging schools to take part in ShakeOut.

Colorado's participation lags behind neighboring states in the Intermountain West. Rob Jackson suggests—and the group agrees—that awareness of earthquakes in Colorado may be a limiting step. The experience of most attendees is that when historical earthquakes (e.g., 1882 M~6.6 Northern Colorado event) are discussed, the public is surprised and their interest piqued.

There is some discussion of reaching out to other states to learn how they encourage participation. JoEllyn will talk to others at the State of Colorado to possibly set the groundwork for a meeting on ShakeOut and school seismic issues in the future.

Hopefully the ShakeOut letter can be sent out to the schools by the end of the month.

Discussion of State school database.

Database is being updated to standardize building name, address, et cetera. This is a Records Management System through Salesforce. Current sorting is only by project and for code review record purposes. Once the database is done, it may be possible to determine the nominal seismic design category of each building.

National Institute of Building Sciences report.

Keith Porter has agreed to present on the report (March meeting??) (*Post-meeting note: Keith will present in May.*)

One highlight--12:1 payback for earthquake risk mitigation

Additions to the agenda

Matt reported the following:

Per Anne Sheehan the USGS has pulled out of the Snowmass site. Could not do maintenance due to site issues. A new site is to be found by CGS.

Additionally, a new station will be installed on the CSU mountain campus near Estes Park.

The USGS is now plotting all earthquakes in Colorado regardless of magnitude. The recent Sangre de Cristo earthquakes were located by Colorado Mesa University.

CEHMC Meeting Notes
November 12, 2018
TetraTech Golden Office

Attendees: Rob Jackson, Matt Morgan, Robin McGuire, Holly Janowicz, Will Levandowski, Mike Haughey

Rob Jackson nominates Robin McGuire for CEHMC membership. Levandowski seconds the motion.

Shakeout debrief: Sean McGowan has suggested earlier preparation for 2019 ShakeOut. Matt Morgan emphasizes a goal to involve more schools in ShakeOut. Matt suggests that the State Geologist send a letter to the State Department of Education encouraging participation. Given the greater experience of CEHMC with ShakeOut, providing Karen with a draft based off information on the ShakeOut website is suggested. Rob, Matt, and Holly plan to collaborate on a draft to be completed for review at the January meeting.

Discussion of pamphlet on CO seismicity: Distilled version of CGS Earthquakes in Colorado poster. NEHRP funding could be used for production costs. Members would develop content. Matt Morgan offers to begin assembling a draft/outline.

Darlene Cypser—an attorney who has published on the legal implications of induced seismicity—is mentioned as a possible future speaker. (Cypser maintains the website InducedEarthquake.com, a compilation of references.)

Discussion of possibility of requesting NETAP training (National Earthquake Training Assistance Program), handled by Applied Technology Council. Request must be made by the end of November.

Keith Porter has offered to teach post-disaster (California) Safety Assessment Program training, January 13, 2018.

School database development: Rob Jackson suggests contacting the State building chief and encouraging the inclusion of year of construction, construction type, number of stories, Seismic Design Category and Site Class in a statewide building database for schools.

Options include a letter or email to the fire/building chief requesting the type of building, at least if unreinforced masonry or not, site class, seismic design category. Subsequently, selected high-risk school buildings could be assessed for FEMA 154 by volunteer engineer(s). Possible areas of initial focus could be Grand County, Pitkin County, Routt County, the San Luis valley and Summit County.

Announcements: CGS has deployed a new seismometer in southeastern Colorado, north of Lamar and around 30 miles east of the Cheraw fault. The Steamboat seismometer is installed. Another station is planned for the CSU mountain campus in northern Colorado this summer. Kyren Bogolub (CU PhD candidate) has been hired at CGS as temporary part-time seismologist. Cheraw Fault paleoseismology report is completed and will be available in CGS bookstore within a week or so.

CEHMC Meeting
20 Sept 2018

Attendees: Names: Rob Jackson, Michael Haughey, Mark Zellman, Matt Morgan, Sean McGowan, Will Levandowski, Chuck Mueller

Approval of minutes from 19 July 2018 meeting motioned, seconded, and approved.

Agenda Items:

FEMA Quakesmart Workshop Recap.

FEMA Quakesmart meeting was held yesterday, 20 Sept 2018, at the Colorado School of Mines. Approximal 40 people were in attendance which included business owners, municipality representatives, presenters, and FEMA personnel. Presentations from CEHMC members included Matt Morgan, Robin McGuire, Rob Jackson, and Mark Zellman. CEHMC members Chuck Mueller and Will Levandowski attended.

EERI Promoting Safe Buildings for School Children Power Point.

Rob Jackson presented the EERI presentation on Promoting Safe Buildings for School Children.

- The presentation was given at the last EERI meeting in Los Angeles
- It provides an overview of school building seismic vulnerability.
- Presented at the last 2018 EERI meeting in Los Angeles
- R. Jackson is hoping to modify the presentation for Colorado use.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening. Possible focus for the fall ShakeOut.

Not discussed.

Actions to encourage and facilitate the involvement of Colorado schools in the October 2018 ShakeOut activities.

There is too little time left before the ShakeOut (Oct 18th); thus, no action by CEHMC for 2018.

New meeting location/s for 2019.

CEHMC needs to find a new meeting location for 2019 because the current space at the CSM campus will not be available for 2019. Suggestions for new meeting areas include: the Tetra Tech office in Golden (W. Levandowski), the USGS office on the CSM campus (C. Mueller), the FEMA office at the Lakewood Fed Center (S. McGowan).

Status of Colorado Division of Dam Safety seismic design criteria review comments

This topic is postponed until input from CO Division of Dam Safety is available.

CEHMC Meeting
20 Sept 2018

Other Topics and Resources:

- NA.

Future CEHMC Speakers:

TBD.

Date of next meeting:

November 15, 2018 at Hill Hall, Room 300.

2018 Meeting Schedule:

Jan 18, March 15, May 24, July 19, Sept 20, and Nov 15

Attendees: Names: Rob Jackson, Robin McGuire, Roland LaForge, Mark Zellman, Michael Haughey, Mark Petersen, Will Levandowski, Chris Brunette, Ivan Wong (by phone). Sean McGowan.

Approval of minutes from 24 May 2018 meeting motioned, seconded, and approved.

Agenda Items:

Follow-up discussion from the May 2018 meeting about the treatment of the Rocky Mountain zone background seismicity rate in the USGS hazard maps.

The U.S. Geological Survey (USGS) is updating the National Seismic Hazard Map (NSHM) and is considering changes to how the Northern Rocky Mountain background seismicity rates are assigned. In the May 2018 CEHMC meeting, Chuck Mueller, Mark Petersen and Ryan Gold of the U.S. Geological Survey (USGS) discussed the weighting of the background seismicity rate for the Rocky Mountain background seismic source zones (Colorado Plateau, Craton, Extended Margin) in the USGS National Seismic Hazard Map (NSHM) (Petersen et al., 2014). The topic is being revisited for the July 2018 CEHMC meeting to allow participation of some CEHMC members who were unable to attend the previous meeting.

In the July 2018 CEHMC meeting, the group revisited the discussion about the treatment of background seismicity for the USGS's Northern Rocky Mountain source zone. The USGS re-stated their goal of ensuring that they are applying a defensible method for determining the rate of background seismicity for the NRM zone.

This discussion covered how the rates are currently applied for the Northern Rocky Mountain source zone and how that differs from other zones, and how changing the rates might affect NSHM estimated ground motions. A plan for how to treat the background seismicity rate was not determined.

The upcoming Colorado FEMA Quakesmart workshop format and potential speakers.

The Quakesmart workshop will occur on 19 September 2018 from 9am-3pm at the Colorado School of Mines. CGS is spearheading the effort to fill speaking slots. CEHMC discussed the status and need for speakers:

- CGS to fill several speaking slots
- R. McGuire has been approached to speak about induced seismicity
- M. Zellman will discuss Cheraw fault
- R. Jackson will speak on seismic resiliency of CO schools.
- S. McGowan encouraged the appointment of additional speakers and topics.
- R. Jackson suggested presentation of the EERI seismic school safety presentation (discussed below).

Recent 11th National Conference on Earthquake Engineering and EERI meetings In Los Angeles.

R. Jackson and R. McGuire attended the EERI National Conference. Rob discussed Norm Abrahamsen's comments on uncertainty with Ground Motion Models.

Ivan W. discussed the EERI school earthquake safety presentation that is available and was discussed at the recent EERI conference.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening. Possible focus for the fall ShakeOut.

R. Jackson discussed the CEHMC recommendation on the seismic design of schools that was submitted November 1, 2017. C. Burnette says that the State is not at a point where they can adopt new guidelines yet, but welcome's CEHMC input when public meetings begin.

Rob J. informed Chris of the CEHMC's initial ideas to work towards the development of a database of vulnerable school buildings. Chris pointed out that the State of Colorado is now developing a reference management system that will include information about Colorado School structures. Chris concurred that the Seismic Design Category can also be included in the database.

Actions to encourage and facilitate the involvement of Colorado schools in the October 2018 ShakeOut activities.

W. Levandowski suggests connecting scientists with K-12 schools in Colorado to promote Shakeout activities.

EERI has school earthquake school safety presentation that is available and was presented at the recent EERI conference discussed above. R. Jackson discussed that this presentation could be adapted for use locally in Colorado for an earthquake school safety program.

Status of Colorado Division of Dam Safety seismic design criteria review comments

This topic is postponed until input from CO Division of Dam Safety is available.

Other Topics and Resources:

- July 6, 2018 M 2.3 earthquake near Estes Park.
- NIST Community Resilience Planning Guide (SP 1190)
- National Institute of Building Sciences Multihazard Mitigation Council 2017 Interim Study; http://www.wbdg.org/files/pdfs/MS2_2017Interim%20Report.pdf
- Sept 6. Webinar for the P1000 School Natural Hazard Safety document. 1pm on Sept 6th.

CEHMC Meeting
19 July 2018

- Regional Induced Seismicity Collaborative recently held their kick-off presentation on induced seismicity on July 9, 2018, "Seismicity Research Activities by State Geological Surveys, Southern Mid-Content of the US". Webinar and the slides:
www.beg.utexas.edu/files/risc/video/RISC_WebinarSeries_01.mp4
<http://www.beg.utexas.edu/files/risc/docs/Webinar%20Slides%20201807.pdf>

Future CEHMC Speakers:

TBD.

Date of next meeting:

September 20, 2018 at Hill Hall, Room 300.

2018 meeting schedule:

Nov 15

CEHMC Meeting
17 May 2018

Attendees: Names: Rob Jackson, Matt Morgan, Mark Petersen, Chuck Mueller, Michael Haughey, Ryan Gold, Bill M^cCormick, Will Levandowski, Mark Zellman, Sean McGowan

Approval of minutes from 15 March 2018 meeting motioned, seconded, and approved.

Agenda Items:

Presentation: Presentation by the USGS on background seismicity in the Rocky Mountain region. The background seismicity model is an input parameter for the hazard map and changes to the model would result in changes in the hazard map.

Chuck Mueller, Mark Petersen and Ryan Gold of the U.S. Geological Survey (USGS) discussed the weighting of the background seismicity rate for the Rocky Mountain background seismic source zones (Colorado Plateau, Craton, Extended Margin) in the USGS National Seismic Hazard Map (NSHM) (Petersen et al., 2014). This procedure is described in the text below from the 2002 USGS NSHM (Frankel et al., 2002) (<https://pubs.usgs.gov/of/2002/ofr-02-420/OFR-02-420.pdf>).

“Another change in the updated maps is the weighting assigned for the background zone in the Rocky Mountain region, which is in the CEUS attenuation region for the maps. In the 1996 maps, an adaptive weighting scheme was applied such that the background zones for the CEUS were given a weight of 0.2 for those grid cells in which the spatially-smoothed historic seismicity rate was lower than the seismicity rate for that cell derived from the historic seismicity rate of the background zone. The models from the spatially-smoothed seismicity were given a total of 0.8 weight for these cases and full weight otherwise. This procedure provides a hazard floor where historical seismicity was low. This adaptive weighting scheme caused an apparent embayment of lower hazard in northern Colorado (compared to western Colorado), even though this is the area where the M approximately 6.5 earthquake occurred in 1882 (Spence et al., 1996). This apparent embayment of hazard is caused by the higher hazard estimates to the southwest and north caused by the more numerous magnitude 3 and 4 earthquakes in those areas. For the 2002 maps, we assigned a weight of 1.0 for the Rocky Mountain background zone in areas where the gridded seismicity rate was lower than the background rate, in effect replacing the smoothed seismicity rate with the background rate. This causes a modest increase (about 10%) in the probabilistic ground motions along the Front Range of Colorado and generally aligns the ground motion contours parallel to the Front Range (approximately north-south). We justify the special treatment for the Rocky Mountain zone by noting the short record of historic seismicity in this region and the attendant high uncertainty in hazard estimates...”

The question asked by the USGS was: Should the background seismicity weighting for the Rocky Mountain zone continue to be applied in future versions of the NSHM, or should background seismicity be treated the same way as in the other zones (i.e. gridded historical seismicity)? The CEHMC discussed how the cessation of this treatment would lead to a standard approach for background seismicity across the NSHM zones. Some participants voiced concerns that this approach would lead to reduced hazard along the populated Rocky Mountain Front Range which could lead to reduced seismic design standards in the building code. A consensus recommendation was not reached during the meeting, and the group plans to further discuss this topic in subsequent meetings.

The upcoming Colorado FEMA Quakesmart workshop format and potential speakers.

- The meeting will be held on Sept. 19 from 9am to 3pm at CSM student center ballroom D and E
- Will present EQ hazards in a nontechnical format – for residents and business people.
- Similar recent workshop was held in Oklahoma.
- The program is broken into 5 modules - and speakers are needed for each module.
- Some possible topics discussed by the group:
 - Discussion about natural and induced EQs. General presentation of earthquakes in the state of Colorado. (Rob J.)
 - School representation (Rob J.)
 - Important of building resiliency (Mike H.)
 - Discussion of all hazards and how EQs rank comparatively (Mike H.)
 - Hazard prep analogies – recent preps for tornadoes in Windsor prepared them for the large tornado ~10 years ago. In other ways, Prep matters. (Mike H.)
 - Hazard mitigation plans (Bill M.)
 - Colorado - Office of resiliency (Bill M.)
 - Input from municipal and business community needed. (see OK example) (Matt M.)
 - HAZUS results (Sean M.)

Recent SSA and WSSPC annual meetings. Comments and discussion from those who attended.

Mark Zellman, Chuck Mueller, Mark Petersen, and Ryan Gold attended the meeting and gave an overview of the topics, and discussions, and content they observed.

Seismic vulnerability of schools, particularly unreinforced masonry buildings, in higher hazard areas of the state. Path forward to encourage and facilitate FEMA 154 Rover database development and screening.

Possible focus for the fall ShakeOut.

Deferred till next week.

Future CEHMC Speakers:

TBD.

Date of next meeting:

July 19, 2018 at Hill Hall, Room 300.

2018 meeting schedule:

Sept 20, and Nov 15

CEHMC Meeting
15 March 2018

Attendees: Names: Rob Jackson, Holly Janowicz, Nicole O’Hearne, Rob Williams, Bob Kirkham, Chuck Mueller, Will Levandowski, Matt Morgan, Mark Zellman, Sean McGowan, and Michael Haughey.

Approval of minutes from January 18, 2018 meeting motioned, seconded, and approved.

Agenda Items:

Presentation: Stuart M. Ellsworth, Engineering Manager for the Colorado Oil and Gas Conservation Commission will present “COGCC Underground Injection Program & Induced Seismicity”.

CEHMC involvement in newly funded Quakesmart activities in Colorado. Some NEHRP funding is available to have activities at the Colorado School of Mines campus. Matt has details.

<https://www.fema.gov/quakesmart>

Open Discussion:

- S. Ellsworth mentioned need for support for basement structure map. CEHMC will discuss this at next meeting.
- CGS has received funding to facilitate a meeting that will discuss seismicity, EQ hazards, etc. within the state of Colorado. The meeting will be open to the public and be held at the CSM campus. CGS envisions CEHMC involvement. The goal is to be outreach oriented (less technical) to educate the public about earthquake hazards in the state of Colorado. CGS needs assistance for this: an agenda and invitation list need to be developed, topics and overall material are needed.

Future CEHMC Speakers:

TBD.

Date of next meeting:

May 17, 2018 at Hill Hall, Room 300.

2018 meeting schedule:

May 17, July 19, Sept 20, and Nov 15

CEHMC Meeting
18 January 2018

Attendees: Names: Rob Jackson, Jamie Delano, Emily Wolin, Holly Janowicz, Chuck Mueller, Jenny Nakai, Will Yeck, Harley Benz, Will Levandowski, Matt Morgan, Mark Zellman, Sean McGowan, Michael Haughey.

Approval of minutes from November 16, 2017 meeting motioned, seconded, and approved.

Agenda Items:

Presentation: Jenny Nakai (CU Doctoral Student) presented “A Possible Causative Mechanism of Raton Basin, New Mexico and Colorado Earthquakes Using Recent Seismicity Patterns and Pore Pressure”

Review status of the CEHMC Policy Recommendation for Seismic Design of Colorado Schools, which was updated and re-submitted to the State of Colorado on November 1.

R. Jackson briefly discussed the aspects of the policy recommendations CEHMC submitted to the State of Colorado for seismic design of CO Schools.

WSSPC Survey:

R. Jackson completed the WSSPC survey on behalf of the CEHMC. Discussed CEHMC policy recommendations to the state for seismic design category upgrades for schools.

Interface with the Structural Engineers Association of Colorado:

Discussed ways CEHMC may interact with SEAC. R. Jackson sees at least 3 possible avenues for interaction:

- Via the Seismic committee (R. Jackson chair)
- Via the Structural Engineers Emergency Response (SEER) and the Existing Buildings Committees
- Via Holly Janowicz who is the SEAC representative to the national NCSEA Resilience Committee

Open Discussion:

- M. Morgan announced that CGS has finally had permit approval to install a seismograph station in Steamboat Springs.
- CGS is still working on getting a station installed in SE Colorado.

Future CEHMC Speakers:

Stuart Ellsworth of the Colorado Oil and Gas Conservation Commission (COGCC).

Date of next meeting:

March 15, 2018 at Hill Hall, Room 300.

2018 meeting schedule:

March 15, May 17, July 19, Sept 20, and Nov 15

CEHMC Meeting
16 Nov 2017

Attendees: Rob Jackson, Matt Morgan, Robin McGuire, Chuck Mueller, Marty Zaleski, Mark Zellman, Lisa Block, Allison Shumway, Mark Petersen, Will Levandowski, Michael Haughey.

Approval of minutes from Sept 21, 2017 meeting motioned, seconded, and approved.

Agenda Items:

Presentation: Lisa Block (US Bureau of Reclamation) “Induced seismicity from 26 years of deep brine injection at Paradox Valley, Colorado”

Lisa presented information about induced seismicity related to the U.S. Bureau of Reclamation’s brine injection well in Paradox Valley, Colorado. The presentation covered a history and progression of seismicity in the region related to operation of the injection well. The presentation was followed by a question and answer session.

Review status of the CEHMC Policy Recommendation for Seismic Design of Colorado Schools, which was updated and re-submitted to the State of Colorado on November 1.

Rob J. discussed the policy recommendations, revisions, and resubmission to the State of Colorado.

Open Discussion

- W. Levandowski informed the group that Colorado College geology majors – endowed student internship program for 3-10 week internship. Direct any questions towards W. Levandowski.
- Colorado statewide school building database. There is no statewide database of Colorado schools that documents the structural integrity and construction types of schools (i.e unreinforced masonry, non-ductile concrete, soft story buildings, etc). Discussion of how CEHMC might improve this situation and how CEHMC might use this information.

Future CEHMC Speakers:

Jenny Nakai (CU Doctoral Student) will present on her JGR research article “A Possible Causative Mechanism of Raton Basin, New Mexico and Colorado Earthquakes Using Recent Seismicity Patterns and Pore Pressure” and prior research.

Date of next meeting:

January 18, 2018 at Hill Hall, Room 300.

2018 meeting schedule:

Jan 18, March 15, May 17, July 19, Sept 20, and Nov 15

CEHMC Meeting
21 Sept 2017

Attendees: Rob Jackson, Matt Morgan, Holly Janowicz, Chuck Mueller, Bob Kirkham, Mark Zellman, Michael Haughey, Rob Geislinger, and Sean McGowan

Approval of minutes from July 20, 2017 motioned, seconded, approved.

Agenda Items:

Recap of FEMA P-154, ATC-20 (SAP version) and ROVER training in Colorado on August 23-24.
R. Jackson gave an overview of the FEMA and ROVER training. The training program covered building assessment and database development for assessed structures.

ShakeOut plans

- S. McGowan provided an overview of 2017 ShakeOut plans which is scheduled for Thursday October 19, 2017. M. Morgan states that CGS is available to help, and has requested direction from FEMA on what sort of support would be useful. The group identified Colorado schools as an ideal candidate for involvement, but a point of contact in the school district needs to be identified.
- M. Morgan spoke with the Denver Museum of Nature and Science, and was told that DMNS is interested in hosting a Colorado fault and earthquake hazard display.
- Action Items: H. Janowicz will get in touch with a point of contact in CO schools; M. Morgan will follow up with DMNS regarding the museum display.

Advocacy for NEHRP reauthorization STATUS

NEHRP reauthorization is included in Senate Bill 1768, which is cosponsored by CO Senator Cory Gardner. CEHMC has not yet submitted an official letter of support, but R. Jackson contacted the office of Diane Feinstein and indicated that CEHMC supports this bill. In a previous meeting, CEHMC decided to submit a letter of support. R. Jackson will contact EERI to determine the proper course of action for how to craft the letter of support and where to send it.

Review, update and Resubmit (to the state of CO) the Policy Recommendation for Seismic Design of Colorado Schools

The last time CEHMC submitted policy recommendations for seismic design to the state of Colorado was November 1, 2012. R. Jackson suggests that it is now time to revisit the previous policy recommendations, and make updates where needed. Among other updates and recommendations, CEHMC will recommend that the minimum design standard be set to seismic design category B, rather than A. R. Jackson also suggests that we should consider including WSSPC and EERI policy recommendations.

B. Kirkham suggests that it would be helpful to include a section stating why we believe these changes are needed. M. Morgan will check CGS for text that will fit this need.

CEHMC Meeting

21 Sept 2017

Additions to Agenda:

- Discussion of Mexico City, M7.1 earthquake discussion.
- Discussion of Idaho Soda Lake earthquake swarm.
- Colorado International Code Council (ICC) to offer a safety assessor training program.
- Status of Colorado statewide inventory of public school structural assessment and identification of URM structures; CEHMC to table discussion till next meeting.

Future CEHMC Speakers:

Lisa Block of U.S. Bureau of Reclamation on 16 Nov 2017 to discuss work at Paradox Basin.

Date of next meeting:

November 16, 2017 at Hill Hall, Room 300.

20 July 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Michael Haughey, Robin McGuire, Sean McGowan

Note taker: Michael Haughey / Rob Jackson

Approval of minutes from May 18, 2017 motioned, seconded, approved.

Agenda Items:

- FEMA P-154, ATC-20 (SAP version), and ROVER training in Colorado on Aug 23-24. –ATC 20 Training, inspections, for 2nd responders. Pre-event & post event. Similar training available from ICC, free to members, otherwise \$500.
Aug 23 & 24 has a slight chance of postponement
Rover – for looking at buildings – electronic computer-based database, can be used on a phone or laptop (device independent)
State of Colorado says they have an emergency responder credentialing program now in progress (first and maybe second responders)
- Shakeout
Mark Benthien (Shakeout leader) and Karen Berry were in Broomfield for natural hazards workshop
FEMA Region – phone call – Montana – Colorado – Utah
Put a Colorado story on the Colorado Shakeout page – 1882, Rocky Mtn Arsenal, Trinidad earthquakes
- USGS & FEMA data
Question as to how long and in what manner data will be provided and catalogued.
- Status of Colorado Division of Dam Safety seismic design criteria review comments (deferred at this time).
- Future CEHMC task. Review, update and resubmit (to the State of Colorado) the Policy Recommendation for Seismic Design of Colorado Schools.
- Future CEHMC speakers. Lisa Block (US Bureau of Reclamation) to speak about Paradox injection well at Nov 16th meeting.

Date of next meeting:

21 September 2017 at Hill Hall Room 300.

2017 meeting schedule: Sept 21, and Nov 16

18 May 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Matt Morgan, Mike H., Mark Zellman

Note taker: Mark Zellman

Approval of minutes from March 16, 2017 motioned, seconded, approved.

Agenda Items:

SSA April 18-20 meeting in Denver

Meeting was held last month in Denver. The meeting had the largest attendance for any SSA annual meeting. Gov. Hickenlooper addressed the group doing the Policy Luncheon. SSA member participation included: Sean McGowan, who chaired a session and Mark Zellman, who presented and co-lead a field trip.

WSSPC annual meeting April 27-28, Oklahoma City

National Earthquake Program Managers Meeting (NEPM) and WSSPC held back-to-back meetings in Oklahoma City. R. Jackson, M. Morgan and S. McGowan attended.

NEHRP reauthorization was widely discussed at the NEPM meeting. Some topics covered were:

- Desire for an increased role of implementation of NEHRP by state programs
- Need for more state emergency managers on NEHRP panel
- Increase NEHRP funding for states (27% of funding desired, currently 1%)
- Push to discontinue cash funding match (currently 50/50)
- FEMA gets smallest parts of NEHRP funds.
- Accountability. A system is needed to track how funding is applied.

Induced (triggered) seismicity items:

Discussion regarding the ASCE Structures Congress in Denver April 5-7 which included a session on induced earthquakes and building codes and presentations by Robin McGuire, Nico Luco, Abbie Liel and others.

R. Jackson was a moderator of the induced seismicity session. R. McGuire was a presenter.

Cheraw Fault update (Mark)

Learned at SSA about a few active injection wells in the vicinity of the northeast extension of the fault.

2017 ShakeOut plans (Sean)

Not much new to report. At the meeting we discussed ideas for how to S. McGowan might increase CO involvement.

- Handout – CO shakeout info.
- Involvement of CPR.

18 May 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

- Museums – DMNS, Colorado History Museum, etc
- Academic Institutions – CU Boulder, CSU, DU, etc...

Advocacy for NEHRP reauthorization – Emphasis at EERI meeting – CEHMC position / support?

In 2 weeks the NEHRP reauthorization bill will be brought forth. A draft of the bill is available (HERE). CEHMC voted at the last meeting (March 16, 2017) to draft and submit a letter of support for NEHRP reauthorization. R. Jackson is working on a draft of the letter.

Status of Colorado Division of Dam Safety seismic design criteria review comments (deferred at this time).

- No word – deferred at this time to a subsequent meeting.

Future CEHMC speakers

- Lisa Block (US Bureau of Reclamation) to speak about Paradox injection well at Nov 16th meeting.

Other announcements:

- Update of the CEHMC roster / email distribution list.
- Permanent seismometer to be installed by CGS near Blue Lake in southeastern Colorado.
- M. Morgan – suggests an exhibit at DMNS which showcases CO tectonic setting, active faults, etc. add seismograph and active wiggle traces.

Date of next meeting:

20 July 2017 at Hill Hall Room 300.

2017 meeting schedule: July 20, Sept 21, and Nov 16

16 March 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Matt Morgan, Michael Haughey, Robin McGuire, Arash Zandieh, Andy Seifried, Holly Janowicz, Chuck Mueller, Will Levandowski, Mark Zellman, Sean McGowan

Note taker: Mark Zellman

Approval of minutes from Jan 19, 2017 motioned, seconded, approved.

Agenda Items

Discussion regarding today's March 16 joint meeting of the Structural Engineers Association of Colorado (SEAC) and the Colorado Association of Geotechnical Engineers (CAGE) which included presentations by Robin McGuire, Mark Zellman and Rob Jackson Colorado seismicity and related issues.

R. Jackson, R. McGuire, and M. Zellman spoke at the joint CAGE and SEAC breakfast meeting this morning. The presentations were well received. R. Jackson spoke about building codes and application of seismic design category A. R. McGuire presented an overview of Colorado historic earthquakes, and M. Zellman presented information about active faults in Colorado.

Overview of EERI Annual Meeting in Portland, March 7 to 10

Andy Seifried mentioned that at the meeting he detected a change in dialogue and approach which favors seismic safety of the community as opposed to seismic safety on a building by building approach.

R. Jackson mentioned discussions at EERI about the re-authorization of NEHRP. The program is currently operating under out-of-date guidance and is in need of updating. (Also, addressed below in separate discussion topic)

Induced (triggered) seismicity items:

The ASCE Structures Congress in Denver April 5-7 will include a session on induced earthquakes including discussion of how these earthquakes may affect structural engineering and building codes. Rob Jackson will moderate this session which will include presentations by Robin McGuire, Nico Luco, Abbie Liel and others.

Anne Sheehan will lead a 2017 SSA field trip to Rocky Mountain Arsenal, the "Epicenter of Induced Seismicity".

Updated 2017 USGS 1-year hazard forecast maps have been published.

Cheraw Fault update

The draft final report for Cheraw fault trench has been submitted to Colorado Geological Survey.

Sean McGowan will discuss 2017 ShakeOut plans at the next CEHMC meeting.

Updates postponed until next meeting.

16 March 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Advocacy for NEHRP reauthorization – Emphasis at EERI meeting – CEHMC position / support?

R. Jackson says NEHRP is looking for letters of support for their reauthorization, and he asked of the CEHMC meeting attendees would support a CEHMC letter of support. No attendees of today's meeting voiced opposition to CEHMC providing a letter of support for NEHRP reauthorization. R. McGuire motioned for CEHMC to provide a letter of support. M. Haughey seconded the motion. R. Jackson and M. Morgan will create a draft letter for the group to review.

Status of Colorado Division of Dam Safety seismic design criteria review comments (deferred at this time).

CEHMC comments were provided to B. McCormick, no updates at this time.

Future CEHMC speakers

M. Zellman to contact Lisa Block at the US Bureau of Reclamation.

Other announcements:

- 2017 SSA meeting (and field trip) to be held in Denver in April.
- CGS seismic network: 5 stations; one is installed. Greeley (active), Steamboat (to-be), Cheraw, Chafee, TBD, all stations will be broadband seismometers.
- CGS will be working with Cathy Haller to update the Colorado Quaternary fault database.

Date of next meeting:

18 May 2017 at Hill Hall Room 300.

2017 meeting schedule: May 18, July 20, Sept 21, and Nov 16

19 January 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Chuck Mueller, Andrew Seifried, Matt Morgan, Mark Zellman, Robin McGuire, Tom MacDougall.

Note taker: Mark Zellman

Approval of minutes from Nov 17, 2016, motioned, seconded, approved.

Agenda Items

Rob Jackson will give a brief presentation showing the current Colorado ground motion contour break-points approximating the applicability of ASCE / IBC Seismic Design

Category A:

Rob Jackson presented his power point slides showing the current S1 and Ss 2% in 50 year probability of exceedance contours and the ASCE / IBC seismic design category A breakpoints.

Discussion regarding the March 16 joint meeting of the Structural Engineers Association of Colorado (SEAC) and the Colorado Association of Geotechnical Engineers (CAGE) which will be a presentation by Robin McGuire and Mark Zellman discussing Colorado seismicity and related issues:

Rob Jackson, Robin McGuire, and Mark Zellman discussed plans to present at the upcoming SEAC / CAGE meeting. The meeting will start @ 7:30am on 16 March 2017 at the Renaissance Hotel on Quebec St. in Stapleton, Colorado. The presentation will cover seismicity, earthquake history, seismic sources, and seismic design in Colorado.

Induced (triggered) seismicity items: The ASCE Structures Congress in Denver April 5-7 will include a session on induced earthquakes including discussion of how these earthquakes may affect structural engineering and building codes. Rob Jackson will moderate this session which will include presentations by Robin McGuire, Nico Luco, Abbie Liel and others:

Rob J. discussed the induced seismicity presentations at the upcoming ASCE Structural Congress meeting in Denver.

Cheraw Fault update:

Mark Zellman stated that the report "Paleoseismic Investigation of the Cheraw fault at Haswell, Colorado" is being finalized and will be submitted to Colorado Geological Survey when complete. This document will report the findings from the paleoseismic investigation of the Cheraw fault that was performed in March 2016 near Haswell, CO.

ShakeOut plans

No updates. Seemed to have low 2016 participation, and Fran was not present to provide details

19 January 2017 meeting of the Colorado Earthquake Hazard Mitigation Council

Advocacy for NEHRP reauthorization

NEHRP reauthorization has not occurred for many years. Aspects of the current situation will be discussed at EERI meeting in March to develop a strategy to best advocate for the reauthorization.

Status of Colorado Division of Dam Safety seismic design criteria review comments.

This topic is deferred until a later discussion.

Other topics:

- R. Jackson discussed multiple policy recommendations that have been approved by EERI and are being considered by WSSPC.
- M. Morgan provided an update on CGS seismic network: A new seismograph was installed near Briggsdale, CO; a new seismograph to be installed in Hayden (near Steamboat); a station will be installed in Otero, CO near the Cheraw fault; and another seismograph to be installed near Chaffee County.
- FEMA is preparing to publish "FEMA 366 – Annualized Earthquake Losses for the US.
- FEMA is planning a training session for ATC 20 and P154 earthquake damage assessment of structures.

Date of next meeting:

16 March 2017 at Hill Hall Room 300.

2017 meeting schedule: Jan 19, March 16, May 18, July 20, Sept 21, and Nov 16

17 November 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Justin Pearce, Kathy Haller, Mark Zellman, Matt Morgan, Robin McGuire, Paul Earle, Allison Shumway, Michael Haughey, Chuck Mueller, Bruce Presgrave, Mark Petersen, Harley Benz. ,

Note taker: Mark Zellman

Approval of minutes from Sept 15, 2016, motioned, seconded, approved.

Agenda Items

Paul Earle of the USGS will discuss the USGS-NEIC real-time operations and earthquake catalog production.

Paul Earle gave a presentation to the visiting CEHMC group covering the USGS-NEIC real-time operations and earthquake catalog production. Bruce Presgrave provide additional operational details. Harley Benz led a facility tour of the NEIC.

WSSPC Policy recommendations. Update on the Policy for New Schools.

Rob and Fred Turner of the State of California have developed a revised version of the current policy. The policy is still subject to final acceptance by the WSSPC Board. The updated version strengthens the language regarding mitigation of non-structural hazards, emphasizes the pre-designation of schools as shelters, recommends the use of Risk Category III as a minimum for all schools (not just those with more than 250 students) and continues the recommendations for minimum Seismic Design Category but in more detail.

Induced (triggered) seismicity items:

No new items to discuss.

Status of Colorado Division of Dam Safety seismic design criteria review comments:

Further discussion of the CO Division of Dam Safety seismic design criteria review has been deferred until spring 2017.

Date of next meeting:

19 January 2017 at Hill Hall Room 300.

15 Sept 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Kathy Haller, Mark Zellman, Matt Morgan, Andrew Seifried, Robin McGuire, Shiling Pei, Keith Porter, Will Levandowski, Michael Haughey, Chuck Mueller, Nicolas Luco, Paul McKinney, Ryan Lanham, Steven Kordziel, Dena Hout, Heather Barnes, Luis Mauricio, Chad George, Sean McGowan.

Note taker: Mark Zellman

Approval of minutes from July 21, 2016, motioned, seconded, approved.

Agenda Items

Presentation by Keith Porter, PE, PhD, University of CO Boulder: "Not Safe Enough: The Case for Resilient Seismic Design".

Keith discussed how a change in ASCE 7 of the design importance factor from 1.0 to 1.5 could drastically reduce the amount of building damage during large earthquakes, as well as the ethical aspects, public opinion, and cost related to such a change. Following Keith's presentation, the group discussed the pros, cons, and feasibility of implementation of such an initiative.

ShakeOut plans:

Rob noted the upcoming ShakeOut event and that AECOM has registered. The group discussed the need to contact Colorado schools, establish points of contact, and encourage ShakeOut involvement.

Cheraw fault update:

No updates since last meeting.

Status of Colorado Division of Dam Safety seismic design criteria review comments:

CEHMC is expecting to discuss policy document review comments with Bill McCormick, but a date for this discussion has not yet been confirmed.

Induced (triggered) seismicity items:

The ASCE Structures Congress will meet in Denver in April 2017. Session on induced earthquakes including discussion of how these earthquakes may affect structural engineering and building codes.

Future CEHMC speakers:

Bill McCormick (date not confirmed); Paul Earle (possibly November; *later confirmed after the meeting*)

Date of next meeting:

17 November 2016 at Hill Hall Room 300 (*later changed to NEIC after the meeting*)

21 July 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Mark Zellman, Sean McGowan, Will Levandowski, Michael Haughey, Matt Morgan, Robin McGuire,.

Note taker: Mark Zellman

Approval of minutes from May 19, 2016, motioned, seconded, approved.

Agenda Items

Cheraw fault update:

- Draft trenching report has been submitted to CGS, currently waiting for USGS to finalize age analysis.
- CGS – LiDAR data is available and processed showing ~42km of scarp.

ShakeOut Plans:

The 2016 ShakeOut is scheduled to take place on October 20, 2016. S. McGowan and FEMA are looking to raise participation of local Colorado entities (businesses, utilities, academic institutions, etc.) in ShakeOut events. This effort will focus on academic involvement, and needs to start with identification of a point of contact at each target organization.

Earthquake speakers needed for SEAC/CAGE meeting next January:

R. Jackson discussed the need for speakers at the upcoming SEAC/CAGE joint meeting. The meeting will occur on the 2nd or 3rd Thursday of January. R. Jackson suggested either the Cheraw fault or induced seismicity as topics to be presented.

Induced (triggered) seismicity items:

- Isabel White's presented her MS thesis work on induced seismicity at CSM, July 13. R. Jackson and C. Mueller attended.
- ASCE Structures Congress in Denver in April of 2017. Session on Induced earthquakes including discussion of how these earthquakes may affect structural engineering and building codes.

Future speaker Keith Porter:

Keith is a structural engineering professor at CU Boulder. He has experience with California-based seismic projects, post-disaster evaluation, and building code evaluations.

Other Items:

- National Earthquake Technical Assistance Program (NETAP) provides regional and state earthquake program managers. FEMA is looking to increase participation in the NETAP program in CO.
- CGS has installed a single seismometer NE of Greeley, CO. It's not online yet. Another seismometer will be installed at Steamboat Springs in early fall

21 July 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

2016. 3 additional instruments have been purchased but have not yet been received.

- EERI school safety initiative webinar happened in mid-July.

Date of next meeting:

15 September 2016 at Hill Hall Room 300.

19 May, 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Mark Zellman, Kathy Haller, Chuck Mueller, Wayne Charlie, Sean McGowan, Victor deWolfe, Will Levandowski, Rob Williams, Danya Abdelmamel, Michael Haughey.

Note taker: Mark Zellman

Approval of minutes from March 17, 2016, motioned, seconded, approved.

Agenda Items

Cheraw fault update:

M. Zellman discussed preliminary findings from the recent Cheraw fault paleoseismic trenching project at Haswell, CO. Bedrock and alluvial deposits exposed in the trench show evidence of Quaternary deformation. He is currently analyzing the data, completing the fault trench logs, and compiling the project report. The report will be published by the Colorado Geological Survey.

WSSPC annual meeting:

R. Jackson attended the meeting and represented CEHMC. Provided an oversight of the meeting and discussion topics.

R. Jackson specifically mentioned the following policy updates:

- Policy regarding the installation of earthquake automatic shut off devices
- International Building Code adoption – recommending that building codes be adopted
- Earthquake clearing houses approved
- Reliability of lifeline services
- Seismic design of new schools was not voted on.

ShakeOut Plans:

Planned for October 2016. F. Santagata not present to discuss upcoming plans.

Earthquake speakers needed for SEAC/CAGE meeting next January:

R. Jackson announced the need for speakers at the SEAC/CAGE meeting next January.

The ASCE structures congress

R. Jackson is on the planning committee for the April 2017 meeting, and is planning a session on induced seismicity. Speakers will include Robin McGuire, A. McGarr, and A. Yeck. R. Williams suggests inviting Oklahoma based engineers to discuss how increased EQ risk/ground motion are being factored into projects without existing building codes to support more stringent design standards.

Future speaker Keith Porter

Structural engineer Professor at CU Boulder. Has been involved with CA-based seismic projects. Post disaster evaluation and building code evaluations.

Date of next meeting:

21 July 2016

March 17, 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Chuck Mueller, Bill McCormick, Dean Durkee, Aimee Corn, David Butler, Matt Morgan, Jeff Martin, Robin McGuire, Guy Lund, Erin Gleason, Darren Brinker, Mark Zellman. Victor deWolfe, Michael Haughey, Tom MacDougall.

Note taker: Mark Zellman

Approval of minutes from January 21, 2016, motioned, seconded, approved.

Agenda Items

Seismic Analysis of the Strontia Springs Dam presented by Guy Lund:

Guy Lund discussed seismic design of dams which covered the dynamic analysis of dams, evaluation criteria for seismic hazards, and seismic hazard analysis through a presentation which focused on his evaluation of Strontia Springs Dam.

Seismic Analysis of the Gross Dam enlargement presented by Darren Brinker, Jeff Martin and Erin Gleason:

Darren Brinker, Jeff Martin, and Erin Gleason of Denver Water discussed seismic hazard analysis aspects of three dams in their system: Dillon Dam, Strontia Springs Dam, and Williams Fork Dam. The primary discussion points were their application of a mixed CEUS and WUS attenuation model to these dams, the use of PSHA vs DSHA, and their process of dealing with assessing seismic hazards in Colorado.

Denver Water's next seismic hazard analysis will be for Gross Reservoir. Gross Reservoir has a concrete gravity dam that will be raised 131' to become the tallest dam in CO. The group discussed the characterization of the Golden fault which is the closest mapped Quaternary fault (Class B).

The group then discussed:

- Aspects of seismic hazard analysis, specifically DSHA vs. PSHA and FERC's requirements for investigators to perform DSHA analysis.
- The limited seismic source characterization of the Ute Pass fault
- Spectral matching from representative earthquakes.

Discussion about CEHMC review of the Seismic Design criteria and associated rules in the Colorado Rules and Regulations for Dam Safety and Dam Construction:

Multiple members of CEHMC have reviewed and commented on the existing document. Comments have been compiled by CEHMC and submitted to Bill McCormick.

Discussion of the CEHMC as part of a larger agency:

No updates. Karen Berry is aware of this initiative, but has not had a chance to review or make comment.

Date of next meeting:

19 May 2016

January 21, 2016 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Matt Morgan, Mark Zellman, Aimee Corn, Michael Haughey, Victor deWolfe, Bill McCormick, Sean McGowan, Kathy Haller, Chuck Mueller.

Note taker: Mark Zellman

Approval of minutes from November 19, 2015, motioned, seconded, approved.

Agenda Items

Colorado Rules and Regulations for Dam Safety and Dam Construction: Seismic Design Criteria (Mr. Bill McCormick):

The current version of the Colorado Seismic Design Rules for Dam Safety was last updated in 2007 (prior update was 1988). However, updates can occur at any time when new information becomes available. Mr. McCormick is seeking input for what part of rules need to be updated because the guidelines are outdated information, the guideline is incomplete, or for other reasons. Mr. McCormick is also seeking suggestions for what other subject matter experts they might engage to for input. These regulations apply to >400 high hazard dams in Colorado and exclude federally owned dams and tailings dams. Federal dams and tailings dams fall under another set of regulations.

Some questions and points raised during the discussion:

- C. Mueller discussed state of USGS induced seismicity report and implication of induced EQs on dam safety considerations.
- Is there a need within the state of CO for probabilistic and/or deterministic seismic hazard analysis for high hazard dams??
- CEHMC will review the document formally and submit a single version w/ comments and citations back to Bill.
- A single document will be sent to CEHMC and distributed among CEHMC members for comments.

Discussion of the CEHMC as part of a larger agency:

No updates. Karen Berry is aware of this initiative, but has not had a chance to review or make comment.

Status of the investigation and trenching of the Cheraw fault:

Not awarded.

Other Items:

M. Morgan stated that the Colorado Geological Survey (CGS) will install new seismometers at: Greeley in March, Steamboat (later), and two additional seismometers later in the year at other sites which have not yet been determined. Anne Sheehan (UC Boulder) will install a micro-network to help properly site the new seismometer in Greeley.

M. Morgan also announced that CGS will be conducting a major LiDAR data collection program soon (valued at ~\$1.5M); They plan to collect data for every county which crosses I-70, the counties of Mesa , Jefferson, Douglas, Teller, and the Arkansas River Valley corridor from Pueblo to state border.

R. Jackson mentioned that the topic(s) of Colorado seismicity and induced seismicity are planned for the annual Structural Engineers Assoc. of Colorado and CAGE joint meeting next January (2017). SEAC is looking for speakers for the meeting. Perhaps CEHMC could provide the speaker(s).

Date of next meeting:

17 March 2016

November 19, 2015 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Rob Jackson, Matt Morgan, Michael Haughey, Chuck Mueller, Rob Williams, Peter Barkmann, Mike O'Keefe, Kassandra Lindsey, Lia Lajoie, Kathy Haller, Wayne Charlie, Mark Zellman

Note taker: Mark Zellman

Approval of minutes from September 17, 2015, motioned, seconded, approved.

Agenda Items

Will Levandowski Presentation and Discussion:

Will presented his analysis of lithospheric stress in the US High Plains.

State's First Primer:

M. Zellman introduced the document for discussion. The group discussed the management and mitigation policy recommendations proposed in the text. Rob Jackson suggested that there might be potential for CEHMC to suggest policies to manage/mitigate induced seismicity through WSPCC. Rob Williams notes that the document lacked input from industry which could have aided greatly in the understanding of induced seismicity.

M. Morgan said CGS is looking into creating a basement structure map that could be used as an avoidance map for future injection wells.

Discussion of the CEHMC as part of a larger agency:

CEHMC is currently an Ad-Hoc organization and at this meeting discussed the pros/cons of affiliating the organization with either the Colorado Geological Survey or the Department of Emergency Management. Matt Morgan has spoken with Karen Berry about this topic and received positive feedback. The purpose of this move would be to provide policies and guidance created by CEHMC more "teeth". Moving CEHMC under CGS would require approval from Colorado School of Mines.

Rob Jackson mentioned that CEHMC was at one time part of the Colo Natural Hazards Research Council and funded by the State of Colorado.

Action item identified: Rob will try to find any existing by-laws.

WSSPC and EERI policy recommendations:

EERI's School Earthquake Safety Initiative may provide policy input for safe school buildings. EERI is currently trying to increase awareness of earthquake hazard awareness.

WSSPC and EERI are discussing how to encourage pro-active code designation of new schools that may be used as emergency shelters. WSSPC and EERI also want to

encourage non-structural improvements. Currently non-structural improvements are exempt in low to moderate hazard areas.

10-yr strategic plan for ANSS:

Rob sent the plan to the CEHMC group and introduced the document for group discussion. ANSS is looking for comments and feedback on the document.

October 15, 2015 Great Colorado Shakeout:

Rob reports that AECOM was enrolled in the great shakeout. The perception of CEHMC was that the Great Colorado Shakeout was not as well publicized this year as it was in 2014.

Status of the investigation and trenching of the Cheraw fault:

M. Zellman announced that the USGS NEHRP FY2016 Cheraw fault study was recommended for funding but final outcome on funding won't be available until January 2016.

Date of next meeting:

21 January 2016

September 17, 2015 meeting of the Colorado Earthquake Hazard Mitigation Council

Present: Matt Morgan, Michael Haughey, Chuck Mueller, Rob Jackson, Dan Mullins (Structural engineer with Martin and Martin), Robin Maguire

Note taker: Matt Morgan

Approval of minutes from May 21, 2015, motioned, seconded, approved.

Note: Add "Colorado" to Bill Bischoff, not Denver

Use and designation of schools for use as emergency shelters in event of an earthquake or other emergency/non-structural attachments-Dan- not a Colorado-centric issue, if a movement occurs here that is great but requirements should be made at the national level. Michael- each community has the power to adopt their own codes but do not realize that. Need to be educated. Rob-Acquisition of feedback from community is of utmost importance. Dan-a structure that is designated as an emergency shelter should have a high code standard and should have national implications. Rob says the national committees will say that it is a state issue. Michael-community should be required to designate their emergency shelters, typically is always a school.

Shakeout October 15-Rob signed the CEHMC up.

Status of investigation and trenching of Cheraw fault-Mark Zellman email outlining final report; waiting to hear outcome of 2016 NEHRP proposal.

Update on seismometers in Co- Matt

Two new instruments will be installed; one near Greeley and one near Steamboat. Probably in spring.

Will Levandowski-USGS post-doc give a talk at a future CEHMC meeting. Chuck will ask him.

Next CEHMC Meeting on November 19, Hill Hall, CSM Campus.

Minutes from the July 16, 2015 CEHMC Meeting

Present: Rob Jackson, Matt Morgan, Bob Kirkham, Chuck Mueller, Bill Bischof (Denver Fire Prevention and Control), Philip Hunt (Denver OEM)

Scribe: Matt Morgan

Minutes from May 21 motioned, seconded, approved

Topic 1 - Designation of school buildings as emergency shelters-If the school is designated as an emergency shelter, the IBC would call it and "Essential Facility." Fred Turner from CA on the WSSPC call said their school buildings are adequate enough to be used as essential facilities. CA is much more strict on their code requirements. Mike Mahoney (EERI) is in the process of drafting a code amendment regarding the risk category of new school buildings and their use as emergency facilities. Nothing is retroactive. Bump up from Cat A to B in areas of low seismicity (like CO).

Rob says CO should have a good inventory of URM and non-ductile concrete schools buildings. This change is also very important for wind/tornado hazards.

Phil-Denver does not use schools as shelters because there are other options. Rec centers are being used instead. Denver is involved in design process so they can also be used as medical centers. Denver doesn't normally designate buildings before they are built. School buildings seem less appropriate-most are not ADA compliant and are subject to lawsuits (there have been lawsuits after tropical storm Sandy). City of Denver has more control over rec center usage, not so much over schools. If you want to open a shelter during school year it impacts the students and parents. Rec centers you just cancel a couple of classes. Bill-if the building has an occupancy load less than 300 it could be designated a seismic design category 2 or less; however, once designated as an emergency shelter it would jump to a 4 (Category B in Denver).

Adoption of these codes is a tough job on the State level since they need an act of congress (Bill).

Topic 2 - WSSPC Earthquake Emergency Handbook for First Responders

Rob was on call the other day. Craig DePolo spoke about how the first responders needed a handbook. Rob said there is a lot of existing resources out there already that can be used. They are not far along. They got a little bit into the clearinghouse as well.

Topic 3- Project 117 is open for public comment on issue prioritization and identification of additional issues. BSSC and USGS are collaborating to examine the basis for the national seismic design value maps and the design procedure that references them.

Miscellaneous discussion

Chuck Mueller spoke about the Irving, TX events do not have a known link to injection at least at this time. Doug Bausch presented a M4.8 and M5.6 HAZUS simulations to emergency managers in the area. Nothing major structurally from these runs. M4.8 has probability of 1.5% per year and a M5.6 event at 0.6% per year. Irving, TX events as large as M4 but most below M3.

Future Speakers-We need speakers. Let Rob know if you have anyone that would be interested.

Next Meeting September 17, 2015

Minutes from 21 May 2015 CEHMC Meeting

Present: Rob Jackson, Matt Morgan, Chuck Mueller, Wayne Charlie, Michael Haughey, Mark Zellman

Note taker: Mark Zellman

Minutes from September motioned, seconded, approved.

Additional Item 1:

Wyoming emergency management has received a NETAP grant which will fund school seismic safety projects.

Additional Item 2:

CGS is planning to install 2 new seismic stations and add to their network in CO. New locations might be Greeley area and Steamboat.

Additional Item 3:

USGS has released a report which incorporates induced seismic hazard zones into the national seismic hazard maps.

Topic 1: Review of April 24 Western States Seismic Policy Council meeting in Pasadena

Rob Jackson attended the meeting and discussed the meeting aspects including presentations and discussions regarding seismic design policies of schools.

Mike Mahoney had previously sponsored a motion to change school risk category to category 4. This plan was rejected. Mike is planning to reintroduce a recommendation during the next IBC code cycle. In this plan a school building will be classified as risk category 4 unless the school is not designated as an emergency shelter, in which case the school can be classified as risk category 3. In addition, the lowest seismic design category for any shelter would be B.

Matt Morgan and Mark Zellman called into the Basin and & Range Province Committee Meeting which occurred as part of the WSSPC meeting in Pasadena. Matt Morgan was a participant, and Mark Zellman was an observer. At this meeting, Policy Recommendation 15-3 "Definitions of Recency of Surface Faulting for the Basin and Range Province" was voted on and passed.

Topic 2: CEHMC letter of support for further investigation and trenching of the Cheraw fault.

CEHMC has provided a letter of support to Mark Zellman that was included with his USGS NEHRP proposal to further investigate the Cheraw fault through a new paleoseismic investigation. A response from the USGS is expected sometime in December 2015

Topic 3: Future speakers

Some suggestions for future speakers include: Roger Bilham to discuss the recent Nepal earthquakes; Will Levandowski, USGS post-doc.

Topic 4: Next Meeting 16 July 2015;

Minutes from 8 April 2015 CEHMC Meeting

Present: Rob Jackson, Matt Morgan, Chuck Mueller, Bill Bischof, Mark Zellman

Note taker: Mark Zellman

Minutes from September motioned, seconded, approved.

Additional Item 1:

Discussion with B. Bischof about seismic design criteria, and building codes. Colorado has adopted 2015 building codes. The state of CO adheres to the 2015 plan, but is restricted from requiring additional design requirements due to policy. He also discussed a move within building policy to a “defend in place” tactic.

Topic 1: CUSEC Webinar “Shaken: A remarkable story of community resilience”. This presentation documents the experience of the superintendent of schools of Louisa County schools during and after the Mineral, VA earthquake of 2011.

Topic 2: EERI sponsored School Earthquake Safety Initiative (SESI) and the Code Update and Improvements subcommittee goals as established at the EERI annual meeting.

EERI annual meeting occurred in Boston, MA this year. R. Jackson was chairman of the Code Update and Improvements subcommittee. The subcommittee discussion included (among others):

- Schools used as shelters needing to have higher seismic design criteria.
- Development of an awareness pamphlet for post-earthquake use of schools.
- A push to include multi-hazard design criteria for schools.

*Mark Zellman departed meeting at this time – End notes by M. Zellman

Topic 4: Reviews of western states seismic policy Council Policy Recommendations

Topic 5: Status of the Cheraw fault study

Topic 6: Future speakers

Minutes from the January 22, 2015 CEHMC Meeting

Present: Rob Jackson, Michael Haughey, Robin Maguire, Matt Morgan

Approval of Minutes-motioned, seconded and approved

Topic 1 - History of the CEHMC-Rob will work on incorporating Kirkham's history document into his. This will be brief and for the website.

Topic 2 - Matt Morgan attended the Basin and Range Province Seismic Hazards Summit III in Salt Lake City, January 12-17. Presented the top 5 hazardous faults in Colorado that are not in the National Seismic Hazard Maps. CO is the lowest funded IMW for NEHRP, but we also turn in the fewest proposals. USGS would like to see more from CO but typical projects are funded between 15 and 25k.

Topic 3-Members

Have Bureau of Rec folks contact Rob

Dropping Wally Prebis and Pedro Fernandez

Topic 4-EERI-February in San Francisco

4 subcommittees, Rob leading Code Updating and Improvements subcommittee for the School Seismic Safety initiative.

Topic 5-ATC-20/FEMA-154 training for 2015 NETAP funding

Rob responded and said there is interest in this. Training s participants could be Safety Assessment Program certified through the State of California. Likely held in Sept or earlier. Likely a 2 day event. Training would be free.

Topic 6-Domain name for CEHMC paid by Matt. Cost was \$15.34

Minutes from 20 November 2014 CEHMC Meeting

Present: Rob Jackson, Matt Morgan, Chuck Mueller, Doug Bausch, Michael Haughey, Mark Zellman

Notetaker: Mark Zellman

Minutes from September motioned, seconded, approved.

Additional Item 1: News Article Announcement

Announcement about news article in KRDO about updated HAZUS results for the Rampart Range and Ute Pass faults on Colorado Springs.

Additional Item 2: Colorado Natural Hazards Mitigation Council

Rob Jackson discussed the history of the Colorado Earthquake Hazard Mitigation Council and the predecessor organizations, the “Colorado Society for Natural Hazards Research” and the “Colorado Natural Hazards Mitigation Council”. He shared documents that were published by the group.

Topic 1: Presentation by Chuck Mueller: “The 2014 USGS National Seismic Hazard Maps”

Chuck discussed changes between the 2008 and 2014 USGS hazard models. He presented ratio maps for 5Hz spectral acceleration ratio, fault source model, gridded seismicity and ground motion models these maps depict the changes which were a result of the change in geometry, recurrence, updated seismicity, and new seismicity gridding techniques. Changes to the hazard within Colorado are a result of 1) 2008 Raton was included and removed in 2014, 2) New fault sources added to Colorado (see below), 3) Change to fault sources due to the adoption of new magnitudes rates based on the EPRI/NRC CEUS model.

Other topics discussed by Chuck:

- The NRC/CEUS Hazard model was used as input for the 2014 USGS Hazard model, and provided details of the CEUS Hazard model (fault sources, GMPE’s, and Catalog-based sources).
- Earthquake catalogs used for the 2014 Model, EQ completeness, min-max models, removal of induced events, etc.
- Induced Earthquakes are removed with space/time filtering process (Rocky Mtn. Arsenal, Rangely, Raton, Youngstown, Paradox, etc...). The removal process of induced events for the 2014 model is the same as in 2008, but the rationale has changed because of the need to convey a consistent presentation of hazard. It was recognized by the USGS that induced events should be removed from the earthquake catalogs and not combined with naturally occurring earthquakes to present hazard. As a result, the induced events have been deleted from the building code hazard maps.
- Two new fault sources have been added to the 2014 USGS model within Colorado
 - Gore Range Mountain Fault (Derouin et al., 2010)
 - Williams Fork Fault (Kirkham, 2004)

*The group discussed the implications of removing or keeping induced earthquakes in the earthquake catalogs used to create the 2014 hazard maps

Doug Bausch added that the 2014 USGS model has been incorporated into the most recent version of HAZUS

Topic 4: Presentation by Nico Luco: “Updates to Building Code Maps for the 2015 NEHRP Recommended Seismic Provisions”.

Nico presented “Changes in Seismic Design Mapping”, a presentation he gave at EERI (Anchorage, 2015). He listed several Design Mapping Issue Team Proposals, and he focused on one – “Updated MCE_R , MCE_G & Risk Coefficients maps for the conterminous US” To address this proposal they devised two solutions: The short term solution is to modify site factors, and the long term solution is for USGS to provide more detailed information for conterminous sites including more site specific analysis.

Full list of proposals:

- New MCE_R , MCE_G & Risk Coefficient maps for American Pacific Islands (Guam, Northern Mariana Islands, & American Samoa) available.
- Reference to underlying uniform-hazard and deterministic ground motion maps & values on the USGS website
- Updated maximum response scale factors
- Updated MCE_R , MCE_G & Risk Coefficients maps for the conterminous US
- Longer-period (than 1s) design maps & site coefficients (postponed)

He listed a few updates 1) Fragility Parameter has been changed and 2) Updated design map values, and he discussed changes between the 2008 and 2014 hazard models. Many changes are a result of updated fault characteristics, implementation of UCERF3, and other factors. UCERF3 allows for multi-fault ruptures in part to remove UCERF2 over-prediction.

A definition for “active” faults has been included to determine which faults to include in the determinist models. “Active” faults have been defined as: *“those with Holocene (last ~12k years) displacement/slip, or with slip rate > 0.1 mm/yr. All other faults have been excluded.”*

Nico presented a map showing where seismic design category requirements have been increased and/or decreased. Changes in Colorado were discussed and are mostly related to updated seismicity catalog and new faults added to the 2014 hazard model.

Next USGS national seismic hazard map model update proposed to be 2017(?).

Topic 5: Doug Bausch asked if CEHMC is interested in participating in Structural Engineers Association of Colorado rapid visual inspection training. Rob will follow up and look into participation.

Roster Review and Membership Updates

Topic 6: Basin and Range Seismic Hazard Summit (Salt Lake City, UT; January 2015)

Matt Morgan mentioned that he will participate and represent Colorado. He’ll discuss the top 5 hazardous faults in CO. Faults in CO that were previously presented at the last summit: 1)Golden fault, 2)Rocky Mtn. Arsenal - remove and replace with Gore Range fault, 3) Rampart Range fault, 4) Ute Pass fault, 5) Williams Fork faults.

Topic 7: Cheraw Fault NEHRP. This study was highly ranked and recommended for funding.

Topic 8: 2014 Colorado ShakeOut. 2014 ShakeOut occurred. Fran was not present to discuss the results.

Topic 9: Annual Report to WSSPC. Rob provided the annual report letter via email – no comments suggested.

Topic 10: EERI sponsored school seismic safety initiative working group strategic action plan.

Rob discussed the upcoming meeting and the major objectives. He will share the results of the discussion in subsequent CEHMC meetings.

Topic 11: Future Speakers. No suggestions at this time

Date of next meeting 01/15/15: Hill Hall, CSM Campus

Minutes from the 9-18-2014 CEHMC Meeting

Present: Rob Jackson, Michael Haughey, Chuck Mueller, Fran Santagata, Paul Morgan, Matt Morgan, Mark Zellman

Notetaker: Matt Morgan

Minutes from July motioned, seconded, approved

Topic 1-Plans for the Colorado ShakeOut

Conference call on Sept. 17. Nationwide, the Shakeout numbers are low, but this is common until October. Wells Fargo signed up and they have a big presence in Denver. TIAA-Cref is also supposed to sign up. Fran trying to engage the schools. Difficult sometimes to get initiatives like this to move into the schools. This Saturday is GeoHazards day (Sponsored by Dinosaur Ridge), last event with Radio Disney from 10 AM-2 PM. Drop cover and hold and other activities. Prepare-a-thon partnering with ShakeOut with media campaign.

Topic 2-EERI School Seismic Safety Retreat on Monday July 20.

Rob attended. Four webinars, one of which Rob gave. Goals creating over the next 2-5 year, 6 goals that were proposed.

1. Define explicitly and measurably what is the role of life safety.
2. URM-free by 2033. Unreinforced masonry buildings –how to deal with them.
3. Create how-to documents. Engineers and designers-how to communicate effectively.
4. Increase inventory and quality of rapid screenings of school buildings
5. Establish classroom education module
6. ShakeOut activities at every school

Topic 3-Raton Basin earthquakes

Chuck gave a short summary of the findings of the Rubinstein et. al. paper. Paul Morgan (CGS) questioned the depth of events not correlating with the depth of the disposal wells. Mark Zellman mentioned a gravity anomaly over this area and eastern Colorado

Chuck-The Trinidad earthquakes were left out of the National Hazard Maps because they turn on and off, but are designated as “zones”. Time is an issue...time when injection started, time when eq starts, time when larger events start? Many logic tree branches. Paul mentioned CDPHE just changed rules on disposal of water, so Pioneer now has to dispose of more underground than on the surface. Residents are upset because they depend on the surface water for agriculture and livestock. Most water is quite

good. Gas prices have decreased and this field is marginal and Pioneer is drilling very few (1) wells. Jobs have dropped from 300 to 125. Paul said the Pioneer will release the data to CGS once Pioneer has a report completed.

Topic 4-Greeley earthquakes

Matt-COGCC now requiring seismic monitoring of all new injection wells.

Next meeting 11-20-2014, Hill Hall, CSM Campus

July 17, 2014 Colorado Earthquake Hazard Mitigation Council Meeting

Present: Rob Jackson, Michael Haughey, Matt Morgan, Bob Kirkham, Anne Sheehan, Jon Weir, Robert Chase, Paul Earle, Harley Benz, Emma Myers, Nicole McMahon, Chuck Mueller, Oliver Boyd, Morgan Moschetti, Robert Williams, Mark Zellman, Robin McGuire

Topic 1- The 2014 Greeley Earthquakes by Anne Sheehan and co-authors

According to the USGS Felt Report the events were felt at intensity II-IV (weak to moderate)

Largest was M 3.2.

Anne's neighbor felt it, who is a seismologist.

There is an injection well close to epicenter. Near the epicenter, there were a few homes that had chimney damage and one had a picture knocked off the window sill. Closest seismograph at the time was in Idaho Springs. However, the Red Feather Lakes station was used to help with the location as well. Right after the event it was listed on the USGS website as an M 3.7, located at 7.8 km depth +/- 8 km; with horizontal accuracy of 1.7 km +/- 7.4 km. The event was later downgraded to M 3.2 at a depth of 1.2 km.

Some describe thinking a truck hit house and others say it sounded like explosion.

USGS and St. Louis University solved it as a normal fault with E-W extension, a strike of NNW-SSE, dip to NE.

Many Class I injection wells in area; 4 are within 3 miles of epicenter. One is less than a year old, is 10,000 feet deep, and injects 300 thousand bbl/month at 1000 psi. Injection is into the Fountain Formation at high rates.

Anne and her team installed 4 stations within 4.5 miles from epicenter, and another about 15 miles to NE and another being installed this week (week of July 17).

Injection started on 5/31/2014 went up to 350,000 bbl/month. The first earthquake was in November, 2013 that registered about M 0.75 and there have been more since.

Some residents felt the M 2.6 about 2 weeks after the M 3.2 June event.

On June 22 there were a large number of small earthquakes.

On Jun 23, COGCC asks operator to stop injecting. This is a temporary 20 day shut-in. First time in CO this had been requested.

On July 10 injection test/spinner test yielded an M 2.1 earthquake.

On July 11-The Bottom 400' of the hole was cemented off.

On July 17-May start injection again.

Preliminary data- The aftershocks as of June 8-20; events had NW -SE trend with a horizontal uncertainty ~500 m. Depths <5km. Depth uncertainty 0.5 km.

Anne thinks Trinidad earthquake depths are a “red herring”.

Next steps

CU-Continue monitoring through Dec 2014. This will include seismology –pore pressure modeling – working on getting permission to see 3D seismic of area –hope to get industry velocity info from the area.

COGCC looking into traffic light system (red-yellow-green). Explore increasing seismic coverage in CO. Induced seismicity working group proposed. Considering EQ monitoring requirement.

NGL (Company doing the injection)-Injection to begin under yellow light. Incremental increases every 20 days.

1000 psi or about was pressure of injection.

Oklahoma proposed traffic light example:

Red Light – A. Mw 1.8 or verifiable felt earthquake. B. If rate of earthquake increases after injection begins. C. If the probability based on Gutenberg-Richter law is 95% for at least one M1.8 earthquake in the next 7 days.

Topic 2-IBC Discussion by Jon Weir and Rob Jackson-Looking at adopting the 2012 IBC series next year. Seismic issues are still the same as the 2006 series. Use ASCE7 for non-structural attachments. Want a dialog with the CEHMC and its members at the State level to increase. Has to be designated as a shelter by FEMA or a under State order. Some are designated informally but Jon requires a written statement stating as such. Then the design for a higher seismic design category can be given. All public school buildings should be Category 4. State resistant to amend any of the codes we adopt (Jon). Need to connect the Category 4 somehow, draw the numbers together. CEHMC recommends Category B for whole state. Greely is Category A. CEHMC is willing to participate at a higher policy making level. Our recommendation is not rigid; we want to be involved at any level. Jon-Local code does not override the national code even if local code is more stringent. Most jurisdictions that Jon deals with exceed code.

Topic 3-Cheraw fault NEHRP Proposal-

Mark Zellman-Six letters of support from institutions and individuals. Even if no funding, they will move forward. Interesting fault structures; some may go to basement.

Topic 4-WSSPC Policy Meeting-Rob encourages members to call in. Rob attending EERI meeting in Anchorage.

Chuck Mueller can give a talk on the Nat Hazard Maps at the next meeting.

Next Meeting is Thursday September 18.

Minutes for the CEHMC Meeting of May 15, 2014

Present: Nicholas Graehl (Lettis Consultants International), Michael Haughey, Rob Jackson, Robin McGuire, Carlos Mendoza (Fugro Consultants), Chuck Mueller, John Nicholl, Dean Ostenaar (Fugro Consultants), Fran Santagata, Mark Zellman

Notetaker: Rob Jackson

Minutes from the March 27, 2014, motioned, seconded, approved.

Added Topics: None

Mark Zellman, PG, GISP, with Fugro Consultants, Inc., gave a presentation on "Preliminary Results from New Investigations of the Cheraw Fault, Southeastern Colorado." The abstract is given below:

Additional mapping, evaluation of seismic data, and new topographic profiles based on the National Elevation Data (NED) 10-meter Digital Elevation Model (DEM) across the mapped trace of the Cheraw fault and an unmapped extension to the NE show added trace complexity and consistent morphologic expression along the entire length. Most vertical slip appears to be accommodated along the main fault trace, coincident with the most prominent northwest-facing topographic scarp, but smaller, subparallel scarps, often associated with strike changes in the main scarp are common. The maximum apparent vertical offset across the scarps along much of the fault appears to be about 5-6 m. Southwest of Haswell, CO along the unmapped extension, northeast oriented fractures in Niobrara Shale suggest apparent down-to-the-northwest deformation consistent with the topographic scarp. Preliminary processing of three shallow 2D seismic lines collected at the Crone et al. (1997) trench location and three additional lines collected in areas underlain by Rocky Flats Alluvium show velocity contrasts which appear to define the fault at depth and may constrain vertical offset of the base of Pleistocene-age Rocky Flats Alluvium. Well data and several industry collected 2D time-domain seismic profiles show a down-to-the-northwest style monoclinical warp with consistent vertical throw across deformation zones of varying widths that are coincident with the mapped trace of the fault and the unmapped extension to the NE. Preliminary analysis indicates that 1) the Quaternary trace of the Cheraw fault likely extends at least 15 km further to the NE than shown by Crone et al. (1997), 2) shallow and deep seismic data indicate that apparent vertical offset along the fault is locally distributed in a broader zone that is more complex than the present single-trace map depiction, and 3) surface profiles consistently suggest 4-6 m of vertical offset along the length of the mapped fault and NE extension, of which at least 3.2 m is late Quaternary based on trench data from Crone et al. (1997). The consistency of structure and offset along the Cheraw fault and NE extension may suggest additional late Quaternary offset, and may provide a basis for testing the full history of faulting on the Cheraw fault since early Quaternary.

The CEHMC will provide a letter of support for further investigation of the Cheraw fault.

Topic 1 - National Earthquake Program Managers meeting will take place in Denver this year at the Denver Federal Center May 21-22.

Topic 2 - School safety discussion. Shortly after the March meeting Rob Jackson contacted Bill Bischof who is the Interim Chief Building Official for the State. Bill is personally supportive of the CEHMC policy recommendation. Bill told Rob that he had not seen any Seismic Design Category A schools being built in Colorado.

Topic 3 – The WSSPC Policy Recommendations that are to be considered for approval at the Annual Business meeting in Anchorage, July 21 can be read at <http://www.wsspc.org/public-policy/draft-recommendations/> No discussion at this meeting. Comments should be forwarded to Rob Jackson by the middle of June.

Topic 4 - EERI sponsored School Seismic Safety Initiative Retreat in Anchorage on Monday, July 20th. A series of four webinars will be conducted prior to the retreat in order to make sure that all participants are knowledgeable about the current state of school seismic safety efforts throughout the U.S. and have the opportunity to learn about some best practice case studies. Rob Jackson will attend the retreat.

Topic 5 - On-going activities and plans for the 2014 Colorado ShakeOut. Fran Santagata presented a Preparedness Assembly on May 6 to Our Lady of Fatima School in conjunction with Radio Disney. 180 kids participated in “drop, cover and hold-on.” Fran also did a school safety fair in Commerce City at the Adams City Middle School and spoke with the teachers as well as the students. She handed out some 30 of the Colorado hazard maps and info sheets. The school is an older school. The teachers were especially interested in learning that Commerce City was home to a 5.3 earthquake.

Topic 6 - Status of Trinidad area hazard mapping. The Trinidad events and other events that the USGS attributes to injections will not be included in the upcoming hazard maps. These hazard maps will be included in the next ASCE and IBC codes, however. The USGS may issue separate maps for what they consider to be “man made earthquakes.” How, or if, the separate maps would be referenced by building codes is not determined.

Future speakers – Possibly Nico Luco on the BSSC involvement with the National Seismic Hazard Maps (Chuck Mueller to contact), Murray Hitzman on induced seismicity (Matt Morgan to contact) or Bob Kirkham

Next meeting July 17, 2014

Minutes for the CEHMC Meeting of March 27, 2014

Present: Rob Jackson, Michael Haughey, Chuck Mueller, Ken Brink, Robin McGuire

Notetaker: Rob Jackson

Minutes from the January 16, 2014, motioned, seconded, approved.

Added Topics:

Ken Brink reported that the National Earthquake Program Managers meeting will take place in Denver this year at the Denver Federal Center May 21-22.

Rob Jackson reported that USGS ENS indicated a M2.7 earthquake occurring yesterday, March 26, near Mount Blanca, a few miles east of the Sangre De Cristo fault. Given the accuracy of these initial readings it would appear to be possible that this activity was actually on the fault itself.

Chuck Mueller mentioned a new study regarding the incremental cost of incorporating the design of earthquake resistant construction in Memphis TN. (Chuck provided the link later:

http://www.nist.gov/customcf/get_pdf.cfm?pub_id=915569

The major conclusion of this NIST-funded study is that construction cost premiums associated with meeting current national standards for earthquake resistance are small; generally 3% or less over design for wind only, and 1% or less over what is currently required for seismic design in the Memphis area. Jim Harris, a member of the CEHMC, was the project director for this joint venture of ATC and CUREE.)

Topic 1-On-going activities and plans for the 2014 ShakeOut- Fran Santagata (Shakeout coordinator with COEM) was not able to attend. However, she reported by e-mail on the Radio Disney (multi-hazard) Preparedness assemblies at Pennock Elementary in Brighton. There were two sessions of 600 students each session. Ken stated that the state PIO may be at the CEHMC May or July meeting. Possible options: CEHMC might consider partnering with "History of Colorado" for activities centering on the 1882 earthquake anniversary date. Local weather broadcasters such as Mike Nelson could include ShakeOut and /or 1882 earthquake items in the broadcasts around that time.

Topic 2- Status of Trinidad area USGS Hazard Mapping. The answer as to what to do with induced seismicity as it relates to the hazard maps is still being evaluated. But as previously noted in these minutes, the Trinidad area events, and events in other areas that could be attributed at least in part to injections, will not be included in the upcoming USGS hazard maps. This issue is challenging and the answers are not straightforward. A group has been established to look at the areas in question with regard to the time onsets relative to injections and other parameters. The goal is to evaluate the issue in a ("agnostic") manner without presupposition as to whether the activity has been induced or not. Rate changes during injection activities and after the source is discontinued would be applied in varying logic trees with consideration as to whether the events are likely temporary or a "new normal." Bill Ellsworth

is heading up this effort for the USGS. A Stanford Consortium of Independent Study is also looking at this issue. See <https://pangea.stanford.edu/researchgroups/scits/>

The timing of the upcoming map revisions relative to the upcoming revisions to the building codes (IBC and ASCE7) was questioned. Rob will look into this.

Topic 3 - School safety discussion. Bill Bischof is the Interim Chief Building Official for the State. Rob Jackson will contact him regarding the CEHMC policy recommendation. The Colorado Association of School Boards could also be contacted regarding the policy recommendation.

Topic 4 - ASCE 41-13. Hazard level in lower seismic regions for Tier 1 and Tier 2 evaluations and deficiency- only retrofits. The hazard level in the new code for these evaluations is about 1/3 of the previous hazard in ASCE 41-06 and ¼ of that required for new buildings. The ASCE 41 committee is reviewing this.

Possible future speakers:

Nico Luco on the BSSC involvement with the National Seismic Hazard Maps (Chuck Mueller to contact);

Murray Hitzman on induced seismicity (Matt Morgan to contact).

Next meeting May 15, 2014

Minutes for the CEHMC Meeting of January 16, 2014

Present: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller, Ken Brink, Fran Santagata

Notetakers: Matt Morgan / Rob Jackson

Minutes from the November 21, 2013, motioned, seconded, approved.

Added Topics:

Discussion of the September 2013 flooding In Northern Colorado. The magnitude of the event(s) has created a greater public awareness of the possibility of the occurrences of large impact but infrequent natural hazard disasters in Colorado. Fran has reinforced this point in her presentations to the schools. Rob has also spoken to this in presentations to the Colorado ASCE Structural Engineering Institute and at the November 13, 2013 meeting in Las Vegas with the other consortia. Since the disaster affected a widespread area and involved many of the responders that would be mobilized in an earthquake, the flooding served to better prepare the State for earthquakes should they occur. The Colorado USAR Taskforce and the Colorado Structural Engineers Emergency Response group from SEAC were deployed to evaluate structures damaged in the flooding.

Ken Brink reported on the status of State funds through NETAP. There are still 2013 funds available. They are to expire at the end of March but may be extended another year. The money is a 50/50 match. Hours from CEHMC members could serve as matching funding. Could cover some travel, ATC 20/45 training, manuals and the cost of acquiring a Cal OES speaker to provide for credentialing at the training. Rob pointed out that if Jim Barnes or another Cal OES trained speaker provides the training then the participants can become California SAP (Safety Assessment Program) certified. A card is issued to the participant. This credentialing was a requirement for deployment in the flooding for those deploying through the State and Colorado ICC since Colorado does not have its own credentialing program.

The attendees pitched in contributions to reimburse Matt for the web site domain costs. The costs were \$36.34.

Topic 1-Rocky Mountain ShakeOut- Fran Santagata (Shakeout coordinator with COEM) reported on continued activities with Colorado schools. Elbert County and Brighton have each signed up two schools for the Radio Disney activities. The North Central Region is also interested. There have been about 300 children in each assembly. The assemblies include having the kids develop a family communication plan, emergency kit etc. Cost ~\$7500 per assembly. NETAP funds have been used. In anticipation of the next ShakeOut in 2014, Fran is continuing to work with other groups including BOMA and the owners of the downtown Republic Plaza and Wells Fargo buildings. A Governor's proclamation may be requested, including a letter for State employees notifying them of the ShakeOut. Lt. Governor Garcia is the head of the State Department of Education. He will be requested to send a letter to the State schools to request their participation per the standard ShakeOut letter. Other possibilities include the CU Hazards center.

Topic 2- Status of Trinidad area USGS Hazard Mapping. The answer as to what to do with the induced seismicity appears be even less clear now. As it stands, the Trinidad area events will not be included in the next mapping. This will result in a “yo-yo” effect since there was a fairly significant increase in the ground motion values in the 2008 maps. Instead of another even more significant increase based on the recent earthquakes, the values will be even less than the 2008 mapping. Rob suggested that the CEHMC may want to be involved and possibly present an opinion on this subject. A formal roll-out of the maps may occur by May 2014. The Building Seismic Safety Council (BSSC) is reviewing.

Topic 3 - School safety discussion. Steven Stokes is no longer the Chief Building official for the State. Bill Bischof is the Interim Chief Building Official. Rob Jackson will contact him regarding the CEHMC policy recommendation.

Possible future speakers:

Nico Luco on the BSSC involvement with the National Seismic Hazard Maps (Chuck Mueller to contact);

Murray Hitzman on induced seismicity (Matt Morgan to contact).

Next meeting March 20, 2014

Minutes for the CEHMC Meeting of November 21, 2013

Present: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller

Notetaker: Matt Morgan

Minutes from the September 19, 2013, motioned, seconded, approved.

Topic 1-Rocky Mountain ShakeOut-Idaho was not in the Rocky Mountain Shakeout (they did their own). Rob had the maps at his office along with other topical info and building emergency procedures. Rob got an email summary from Fran Santagata (Shakeout coordinator who works for CDEM) who said that she was doing seminars along with Radio Disney at a few local schools. Working on two up north and two near Trinidad. They gave out kits with our map and other items. Matt heard ShakeOut commercial on Radio Disney and thought it was well done.

Topic 2-Pass the hat for CEHMC web domains delayed until January meeting.

Topic 3-2014 USGS Hazard Maps. The last hang-up was what to do with induced seismicity. They removed those areas. The maps are liberal near those induced seismicity areas. Within 2-3 months there will be "research" maps available provide to engineers and the general public in these areas and they will come to the USGS for guidance. These "research" maps would account for different assumptions about how big and how current induced seismicity affects future seismic hazard.

Topic 4- November 13, 2013 joint meeting with NV, ID, UT. Talked about NEHRP funding for 2014. Funding is to go to consortia and contract groups. Doug and Rob talked about funding ATC-20 training for evaluating structural integrity of buildings through NETAP. Utah talked about having 58,000 URM in the state. Rob presented on Seismic Design Category A issues. Approximately 40 people attended.

Next meeting January 16, 2014

Minutes for the CEHMC Meeting of September 19, 2013

Present: Michael Haughey, Rob Jackson, Chuck Mueller, Matt Morgan, Tom MacDougall

Notetaker: Matt Morgan

Minutes: Motioned, seconded, approved

Topic 1- EQ Map- Earthquake Hazard map at the printer. Matt can distribute more copies to Rob and possibly USGS pub sales, schools?

Topic 2- ShakeOut: Now is the time to get the community interested since awareness is high from the flooding. Tom said he will send an email to Bill McCormick and make him aware of the ShakeOut. Tom will send something to the Boy Scouts as well. What about doing a press release for the ShakeOut from the CEHMC? Tom can draft up a letter to submit for review. OEM would be the best agency to put out the press release.

Topic 3-WSSPC Policy recommendation updates. Rob says we should use the policy recommendation for more leverage, for instance, seismic safety for schools. According to Chuck, the workshops are very important and have direct inputs into the national seismic hazard maps. Recommends developing a manual for what to do during an earthquake so it specifically earthquake related, unlike similar documents put out by FEMA that have a manual for a multitude of hazards.

Topic 4-Planning for the November 2013 joint meeting in Las Vegas. Rob is attending and is hoping Ken Brink (COEM) can make it. There will be some discussion on the WSSPC policy recommendations. Michael says to add a category for non-structural components to the discussion.

Next meeting: November 21, 2013

CEHMC Meeting Minutes from 7-18-2013

Michael Haughey, Rob Jackson, Matt Morgan, Ken Brink, Chuck Mueller, Bob Kirkham

Notetaker: Matt Morgan

Approval of Minutes as amended: Motioned, seconded, approved

Topic 1 - Update of Colorado Earthquake Hazards Map

- Rob will check on the intensity of the Trinidad EQ, thinks it should be higher than a V.
- Add Bureau of Rec. faults on Uncompahgre. Lucy Piety may be the person to contact. Matt tried to contact her, but no success.
- East side of Gore Range fault should be red.
- Add Williams Fork Mountains fault
- Explain on map why we label them.
- Add the hillshade to the map.
- Check permanent seismic stations, add more if needed.

Topic 2 - ShakeOut Drill

- Added to CGS Facebook page
- Rob will contact professional organizations to get them interested
- Ken gathering future speakers for CEHMC meeting related to ShakeOut
- Ken working on updating the ShakeOut page; some changes made, others not.
- Ken trying to get schools to do a ShakeOut drill
- Radio Disney is helping out to put on some events at school
- Should contact DPS emergency person and see about making some activities out of this.
- Add the San Luis Valley schools to the list of potential outreach candidates; Judy Lopez.

Topic 3 - November 2013 joint meeting with Arizona, Nevada, Idaho, and Utah in Las Vegas

-Points of discussion on fragility curves, Hazus, recent seismic activity in Basin and Range, building codes, ShakeOut

-Looking for involvement by any and all interested parties

-Ken, what are we trying to achieve? Agenda with a time line? Joint meeting should be a separate day.

-Possible agenda items:

- School Safety/Shelter

- Are there any agencies adopting school safety policies formally?

- What about including NM and WY?

Next meeting: September 19, 2013

Future Speaker: Fran Santagata, Preparedness Coordinator for CDEM

Suggestions for future speakers: Murray Hitzman on induced seismicity (Matt Morgan will contact)

Next meeting: September 19, 2013

CEHMC Meeting Minutes 5-16-2013

Present: Rob Jackson, Kathy Haller, Michael Haughey, Chuck Muller, Larry Anderson, Ken Brink, Matt Morgan

Notetaker: Matt Morgan

Approval of Minutes from the March meeting: motioned, seconded, approved

Topic 1: Presentation by Chuck and Kathy on the current status of the 2014 National Seismic Hazard Maps.

-CEUS Changes under consideration

- Add new sources and update catalog (2012)
- Update methods for identifying and treating induced earthquakes
- Update methods for treating magnitude uncertainty
- Create a moment magnitude catalog (with corresponding changes in seismicity recurrence parameters and m_{\min}
- Implement adaptive smoothing
- Expand m_{\max} distribution
- Update New Madrid model, add CGL, Marianna
- Update GMPs

New CEUS-SSC catalog

- Use Mm, comprehensive analysis of magnitude conversions
- Use original sources when possible
- New source catalogs
- Extend to smaller magnitudes
- Complete analysis of non tectonic earthquakes

We need to extend the CEUS-SSC catalog in both space and time

2008 NSHM: ~3100 eq $m_b \geq 3$

New NSHM: 3435 eq $M_w \geq 2.7$

CEUS-SSC: 3467 eqs $M_w \geq 2.7$ (w/induced)

$b=1.06$, a key parameter, recurrence model, b was 0.95 in 2008

New completeness zones for counting earthquakes that recognizes settlement patterns.

Floor rates will count everything in the margin and get an average, calculated by taking $0.8 * \text{Historical Rate} + 0.2 * \text{Background Rate}$

Rates of observed eqs are biased high

Rates of converted eqs are biased low

Hazard- $1/2$ wt USGS + $1/2$ SSC (agrids and MMax)

Induced quakes

- Are the potentially hazardous

- M_{\max} limit

- Seismicity seems well correlated with injection history of some wells, but not others. Some cases have little/no injection hist.

- Process can and does stop arbitrarily.

- How do we account for induced seismicity in a way that is consistent with the rest of the NSHM?

- Should we make a base case hazard map without induced eqs, and let practitioners deal with them on a case by case basis?

- What do engineers want? (Building Seismic Safety Council engineers)

- The Trinidad earthquakes are TBD if they will be included in the final maps as natural or induced. It is possible the largest events may be left in. The induced areas do affect the maps, significantly in places.

Update status-Colorado fault source model

by Kathy Haller

In 2008, these faults were included for Colorado:

- Cheraw

- N Sangre

- S Sangre

- S Sawatch

2014 additions:

-Gore Range

-Williams Fork

Cheraw 0.15mm/yr MCE 7-7.2

N Sangre 0.18mm/yr MCE<7.5

S Sangre 0.13mm/yr MCE <7.5

S Sawatch 0.062 mm/yr MCE M<7-7.2

Gore Range 0.04 mm/yr MCE<7-7.2

Williams Fork 0.1 mm/yr M<6.5-7

Magnitude considerations

-Sources modeled with additional scaling relations to formally address uncertainty

-Wells and Coppersmith (1994), seems to underestimate magnitude.

-Anderson et al (1996) (predicts higher magnitude in CO than Wells and Coppersmith) and Stirling et al (2002).

-Source mag 6.5 to maximum mag

-Dip uncertainty 50+-15 deg

Toward a geologically consistent model

-Characterize the M-frequency distribution appropriately

-Test prediction by comparing the paleoseismic record to the model

Topic 2-Ken Brink, Rocky Mountain Shakeout

The Shakeout is an annual earthquake drill when millions of people practice drop, cover, hold on. The Shakeout inspires discussion about earthquakes, eq prep and eq hazards

2014: 19.4 million participants

For Colorado:

Use links from CGS EQ page. Doug Bausch's statement. Partnerships.

Proposed activities

CEHMC

- Revise eq hazard map events, maybe the table on the back side.
- Outreach to hazard related pro organizations.
- Development /input on new risk and info products

CGS

- EQ content from CGS eq page
- Eq hazard map revision
- Development /input on new risk and info products

CDHS and Emergency Management

- Project coordination
- Public information

Fed Partners?

NEXT Meeting: July 18, 2013, Hill Hall, CSM Campus.

March 21, 2013 Minutes of the Colorado Earthquake Hazard Mitigation Council

Present: Dave Butler, Michael Haughey, Wayne Charlie, Rob Jackson, Larry Nelson, Matt Morgan, Vince Matthews, Ken Brink, Hal Macartney, Chuck Muller, Bob Kirkham, Chris Eisinger

Approval of Minutes from the January meeting - motioned, seconded, approved

Raton Basin Seismic Study by Hal Macartney, Pioneer Natural Resources

Raton Basin geology consists of Raton and Vermejo Formations (producing coalbed methane), Trinidad Sandstone and the Pierre Shale below the aforementioned units. Water that is relieved from the sediments is re-injected under no pressure (gravity). Igneous dikes cross cut the areas as well. Not a lot of surface faulting mapped. The Raton Basin (RB) is one of few sedimentary basins in the US that has high geothermal heat flow. RB is eastern edge of the Rio Grande Rift. Aeromagnetic map may show other faults, but they are difficult to discern, and there is a small volcanic anomaly just to the south. Not many earthquakes in the San Juan Basin, which has widespread production as well. There are many more earthquakes in the Raton Basin. Recently - 2001 (M 4.3), 2006 (M 5.0), 2011 (M 5.3). There were several before these as well, of similar magnitudes.

USGS studies:

-2001 could not be pinned on injection, however, it was not ruled out

-2011 USGS believes somehow tied to "oil and gas activities."

Pioneer study:

-Differentiate tectonic (natural) vs. induced seismicity.

-Understand mechanics of induced events, if any.

-Prepare mitigation plans, if needed.

-Inform decision makers and policy makers.

Injection wells in this area are 4000 feet deep (22 total)

Coalbed Methane wells are 2000 feet deep.

Seismometers and 4 strong motion sensors are deployed. The regular seismometers can saturate if the motion is strong. These are typically deployed at depths around 1500 feet. Able to get almost real-time emails with the event. Then there is a 7 day report of that week's events.

Dec. 20-Jan. 20, 2012, 341 events located, 500+ detected.

Now there are 15 borehole, 4 post-hole, 3 surface, 3 strong.

Over 7000 microseismic events through Feb. 24 which are clustered. Deepest was 117,000 feet below SL, shallowest 7000-9000 below SL. Most below M 1.5. Average about 15000 feet deep. The vast majority are in the basement, well below wells.

Induced examples:

Usually pressured injection

Into or near basement

Swarms close to TD of well

Faults often unseen on seismic logs

The movie of the year-long study on the Parsons swarm (NE-SW trend) clearly show the aftershocks in the basement and propagating at depth. Not propagating from a well bore. 2012 and 2013 Raton events appear to show a roof, maybe related to the geothermal anomaly. Approximate 45 days periodicity of the spiking of events.

Challenge: If induced, how?

-Pore pressures-data and modeling

-Pressure-stress diffusion with depth

-Hydraulic connection?

-Cumulative? Rate/head driven?

-Geomechanics

Key Objectives

-Locate accurately

-Characterize events

-Examine pore pressure and geomechanics of flow

-Communicate with CO authorities

-Assemble expert peer-review group

-Participate in national-level dialog

-Explore alternative causes

Conclusions

12-18 month study

- Compliment USGS efforts
- Gather data to differentiate tectonic vs induced seismicity
- Assess and evaluate activity

Results to date

- 6 active clusters
- No clear tie to fluid injection/production
- Different from usual cases of induced seismicity

Topic 2-Colorado ShakeOut, October 17, 2013. Some school districts should be involved. How many earthquake hazard maps are still in stock? Reach across the state. Include the new Hazus runs? Ken suggests having a Colorado Hazard Week. Ken, Technical Assistance Partnership- How do we engage our partners more effectively and efficiently. Ken said there may be money available to create or print more publications. Would like to see more tie in with State mitigation plan and CEHMC.

Topic 3-Colorado Regional Chapter of the Earthquake Engineering Research Institute Ivan Wong looking for interested parties that are willing to set this up. Ivan needs 10 EERI members to get it moving. How much overlap with EERI and what we are doing? Not sure, but there is room for more. Would encourage more research and more student involvement.

Next Meeting: May 16, 2013, Hill Hall, CSM Campus. 12 pm-2 pm.

January 24, 2013

Participants: Michael Haughey, Rob Jackson, Victoria Smith-Campbell, Chuck Mueller, Wayne Charlie, Doug Bausch, Matt Morgan

Notetaker: Matt Morgan

Approval of November 2012 minutes-motioned, seconded and approved

-Letter to the State of Colorado from the CEHMC. Rob had discussed the letter with Steven Stokes, the State of Colorado Building Official. Colorado is a "home rule" state and does not have a state building code per se although the IBC is adopted for use on schools, junior colleges and modular housing. In any case, the building codes that are adopted are enacted through the State rules (the Colorado Revised Statutes). In order for the State to amend the code they would have to have a rule change that could entail a vote. In short, this is not an easy task and Colorado has adopted no amendments to the building code thus far. Currently using the 2006 code. At least the CEHMC made their point and the State is aware of it.

-American Clearing House on Educational facilities (ACEF) resource publication on best practices in school design. Rob wrote the seismic section focusing on design, construction and project management practices to improve the seismic resilience of schools. Target publication date is first quarter of 2013. The section is also included on the Seismic Safety of Schools page of the EERI website.

-Chuck and Kathy Haller will present in May about changes to the 2014 National Seismic Hazard Maps (NSHM).

-Ken Brink (OEM) was looking into funding opportunities with OEM and the CEHMC. More discussion on this in March when Ken is in attendance.

-Doug spoke of the October 2013 ShakeOut drills. Visit <http://www.shakeout.org>. Would be good to have a one or two page proposal from the CEHMC of what we would like to be in the ShakeOut, such as suggested links to the website, review of the scenarios, outreach and involvement on the day of the activity. What are the State's goals for the ShakeOut? Schools have historically made up around 80% of the participants. Getting message in Schools; what do you do to protect you and your home. What does your business need to do to be prepared? Rob suggesting adding engineers and building inspectors to the list of participants. Doug would like to see a Rocky Mountain group for the ShakeOut which would include CO, WY, MT and possibly NM. There was much discussion as to whether to participate in a Rocky Mountain Shakeout or leave Colorado as-is. Victoria made some points in favor leaving CO alone-easier to find and browse; we have great info, more focused, and better for its citizens to be part of.

The Shakeout is targeted for 10:17 am on 10/17. Idaho may also be interested. Colorado's participation will be statewide although a particular focus may be on the San Luis Valley. Utah had 20 scenarios. Mark Benthien of USC and Southern California Earthquake Center (SCEC) would do the Shakeout webpage. The website should be up before the end of the school year (in May).

Future speakers: Hal Macartney (Pioneer), March 2013

Next meeting, March 21, Ted Adams Room, Green Center

November 15, 2012

Notetaker: Rob Jackson

Present: Ken Brink, David Butler, Michael Haughey, Rob Jackson, Robin McGuire and Chuck Mueller

Approval of minutes from September 20, 2012 meeting: motioned, seconded, approved.

Noted that November 7, 2012 was the 130 year anniversary of the 6.6M 1882 earthquake in Colorado.

Topic 1 - Annual report to WSSPC. Rob Jackson has developed a draft. Ken Brink will discuss with Marilyn Galley as to how the OEM report information will be provided. The report is due prior to the start of the year but should be submitted sooner rather than later.

Topic 2 - Status of updated letter to the State of Colorado on the CEHMC recommendation for the seismic safety of school buildings. The letter, signed by Rob and John Nicholl, was mailed November 1, 2013. Rob has a call in to Paul Cooke.

Topic 3 -The CEHMC collaborated with FEMA Region VIII, the Structural Engineers Association of Colorado and the Colorado Office of Emergency Management to provide a full day of training on ATC-20, FEMA 154 and ROVER on November 2, 2012. The training was held on the University of Colorado at Denver campus. Vince Matthews started the day with a talk on Colorado earthquakes. Doug Bausch coordinated the program and Ken and the Colorado OEM funded the manuals. The training was free. Over 50 people attended. Ken said that a representative from the State Office of Risk Management was there. They may try to incorporate the FEMA 154 methodology into assessments and development planning.

Topic 4 - Rob is a member of the Earthquake Engineering Research Institute (EERI) Committee on the Seismic Safety of Schools. The American Clearinghouse on Educational Facilities (ACEF), the educational facilities clearinghouse funded by the United States Department of Education, is currently developing a resource publication which will provide best practices in school design as a proactive measure for natural hazards. At the request of EERI, Rob is leading the development of the seismic section of the publication. Michael had a suggestion on the non-structural portion of the document and will e-mail to Rob. The final version is planned for completion by the end of November for submittal to the Department of Education. Publication is planned for December 2012.

Topic 5 - Potential meeting with USGS and the CEHMC to review the upcoming map changes for the 2014 National Seismic Hazard Maps (NSHM). The last topical workshop is next month. The final user group workshop will be in California in May or June. An informal presentation to the CEHMC by Chuck Mueller and Cathy Haller will be planned for the March 15, 2013 CEHMC meeting. The status of the fault database and the mapping will be presented. The issue of induced seismicity and how to handle it in a half dozen locations around the country, including the Trinidad area, is still being discussed.

Topic 6 -Joint meeting of the CEHMC with the Utah Seismic Commission. Rob has had another brief exchange of e-mails. Nothing set. Not clear where we would have such a meeting. Ken mentioned the Colorado OEM offices if the meeting were to be electronic.

Topic 7-2013 USGS/ Earthquake Hazards Program budget. Chuck will look into the status. Rob will then draft letter.

Other discussion –

Ken talked to Pat Williams (City of Denver). Denver is planning an earthquake table top scenario. USGS can help with scenario planning. CGS HAZUS modeling would be used. Rob suggested that Denver Public Schools participate.

Ken brought up the concept of the CEHMC providing a technical advisory function in partnership with the State of Colorado. Also “in kind” volunteer work (videos, mapping, etc.) by CEHMC membership might help the state in providing matching funds for projects or products.

Future Speakers-Hal MacCartney (Pioneer Natural Resources) – will speak on Raton Basin in January. Chuck Mueller and Cathy Haller in March.

Next meeting: January 17, 2013 in room 300 of Hill Hall on the CSM campus.

September 20, 2012

Notetaker: Matt Morgan

Present: Rob Jackson, Bob Kirkham, Vince Matthews, Victoria Smith-Campbell, Matt Morgan, Chuck Mueller, Wayne Charlie, Michael Haughey

Approval of minutes from July 26, 2012 meeting: motioned, seconded, approved.

Additions

Change to CDEM interim Recovery Manager is Ian Hyde. Remove "Lost Recovery Manager" statement. Addition: Item 4 on the Agenda, CGS will do a press release about the 1882 earthquake and place on Facebook page.

Addition: Move the meeting place. Fed Center? Golden Library? Chuck will look into it.

Topic 1-2013 USGS/ Earthquake Hazards Program budget. Chuck thinks October is when the USGS will know about budget. Rob will draft up a letter over the next month.

Topic 2-Status of updated letter to the State of Colorado on the CEHMC recommendation for the seismic safety of school buildings. Rob has been trying to keep in touch with Steven Stokes. Rob has emailed a couple of times and has not heard back from him. Try to follow up with a phone call. If he doesn't hear from him, Rob says we should just send the letter out again. Rob is on the EERI seismic safety of schools committee. They asked Rob to lead the EQ section of a natural hazards resource publication on best practices for school design. This publication will be published by the American Clearinghouse on Educational Facilities (ACEF) and is sponsored by the US Dept of Education.

Topic 3-Potential meeting with CEHMC and USGS to review upcoming map changes. Rob spoke with Mark Peterson at the national earthquake conference. Chuck thinks it would be a great idea. Spring 2013 would be a good time for CEHMC to think about and implement changes. Shoot for March. Chuck could get Cathy to give a talk on Colorado. Vince-What drives certain areas on the map? Would like to hear more from USGS. What about the 5.3 in Trinidad?

Vince-Cathy Haller trying to set up a meeting with CGS as well. Vince says CGS does not have any real new data. Bob asks about any new data in Uncompahgre? Vince will check.

Topic 4-Joint meeting of the CEHMC with the Utah Seismic Commission-Rob has not heard anything from Utah.

Rob-Communication with Pat Williams (City of Denver) asking about State of CO and design of school buildings. She says City of Denver has category "B" minimum for everything but does not differentiate on essential facilities.

Future Speakers-Hal MacCartney (Pioneer Natural Resources) - Speak on Raton Basin (Vince's suggestion). Really good talk on earthquake depths and anomalies. Rob Williams from the USGS.

Next meeting: November 15, 2012 in room 300 of Hill Hall on the CSM campus.

July 26, 2012 CEHMC Meeting

Notetaker: Matt Morgan

Present: Rob Jackson, Dave Butler, Matt Morgan, Chuck Mueller, Victoria Smith-Campbell, Robin McGuire

Approval of minutes from the May 17, 2012 meeting: motioned, seconded, and approved.

Roundtable discussion: Victoria says that CDEM is now part of the Department of Public Safety. Effective July 1. CDEM lost their Recovery Manager. Lost 6 staff to other departments.

Topic 1-Offer a letter of support for the USGS/Earthquake Hazards Program? The letter would be written to both Colorado senators. Rob can draft up a short letter and send out to the members. Will wait to hear from Chuck to see if we should go ahead with the letter.

Topic 2-Potential meeting with USGS to discuss changes to the 2014 NSHM.

Chuck-The model changes are at the level of detail (fault dips, etc.). The model will develop over the next 10 months. USGS would like to present the model and then we can discuss. Perhaps Cathy Haller can be invited. Chuck says they will probably de-cluster some hot spots and put a cap on the M-max or change in the distribution slope.

Topic 3-Potential joint meeting of the CEHMC with the Utah Seismic Commission. Rob spoke with their chair and said this may be a possibility in the future.

Topic 4- Updates to the WSSPC Policy Recommendations, including a new recommendation that would be joint with the EERI Seismic Safety of Schools Committee.

Rank schools and develop a program to reduce seismic vulnerability. Rob has been in contact with Steven Stokes who is the Chief Building Official for the Colorado Department of Public Safety. The State does not have a structural engineer that reviews the buildings. We added that vulnerable schools can be upgraded to meet seismic design under a FEMA program. With a little money, people, and initiative, evaluation could easily happen. Utah is actively evaluating their schools.

The newest recommendation is joint WSSPC with EERI Seismic Safety of Schools Committee. Completion of all seismic retrofitting for schools by 2033. If you have recommendations please send them to Rob. Bob asks if the WSSPC policy recommendations are having any effect. Some, but It is good because it keeps the conversation moving and generates dialogue.

Topic 5- Current status of the CEHMC recommendation to the State of Colorado for the seismic safety of school buildings. Resubmit the letter to the Department of Public Safety? Victoria- Need to figure out when would be an appropriate time to resubmit it. Perhaps the fall when the fire danger is lower.

Next meeting: September 20, 2012 in the GREEN CENTER (Ted Adams Room), Room 270, southwest corner.

May 17, 2012 CEHMC Meeting

Location: Room 300, Hill Hall, Colorado School of Mines, Golden, Colorado

Notetaker: Rob Jackson

Present: Rob Jackson, Michael Haughey, Chuck Mueller, Jana Pursley (New Mexico Tech), David Butler, Anne Sheehan, Abbie Liel (University of Colorado), Celia Shiffman (CU student), Roger Bilham (University of Colorado), Vince Matthews, Ken Brink, Tom MacDougall, Doug Bausch

Approval of minutes from the March meeting: motioned, seconded, and approved

Doug Bausch discussed ATC-20, FEMA 154 and ROVER (Rapid Visual Screening of Buildings for Potential Seismic Hazards) training opportunities and applications:

CEHMC could sponsor this training which would probably take place on a Friday in October on the UCD campus. FEMA 154 has not been presented locally before. Keith Porter of CU would probably present the FEMA 154 portion. The ATC 20 and FEMA 154 forms are now automated with a website version of ROVER and the capability to input pictures in lieu of sketches. There is a website only as well as a hand held version. The class would earn CEU's. SEAC will sponsor this as well. The ATC manuals may have to be purchased by the attendees.

Doug also mentioned some other FEMA courses including E94 (non-structural hazards), ASCE 31 (seismic evaluations of buildings), FEMA P767 (earthquake mitigation for hospitals) and the schools rehabilitation / retrofit webinar.

According to Doug, of the homes inspected following the August 2011 Virginia earthquake, some 7200 homes were found to have at least slight damage. Thirty (30) had extensive or complete damage.

Chuck Mueller gave a talk on the "Earthquakes at Trinidad and Implications for Seismic Hazard":

In the hazard calculation, non-tectonic seismicity is excluded if: 1. The seismogenic process has stopped (*e.g.*, Rocky Mountain Arsenal) or; 2. The seismogenic process is ongoing but significant hazard is not expected (*e.g.*, mining blasts, coal bumps, rock bursts, fluid injection?)

The 1960's Rocky Mountain Arsenal events were excluded but in 1975 they were turned on again so that the 1981 event was included in the hazard calculation.

Every earthquake in the final declustered catalog contributes hazard. The USGS does not believe that non-tectonic earthquakes imply hazard in the same way as natural earthquakes, so they are removed from the hazard calculation.

Non-tectonic events are identified by special studies such as those for mining, fluid injection or nuclear tests, ad hoc inquiries and an "explosion flag" in the PDE listings. Exclusion is

implemented via a “special case” listing” or an “exclusion zone” (preferably with known begin and end dates). Examples of exclusion zones:

Central Utah: coal mining, 1900-?

Rangely, CO: fluid injection, 1957-?

Rocky Mountain Arsenal, CO: fluid injection, 1962-1975

Cogdell, TX: oil production, 1974-?

Paradox Valley, CO: fluid injection, 1985-?

Dagger Draw, NM: oil production, 1998-?

Paonia, CO: coal mining, 2001-?

In the 2008 National Seismic Hazard Mapping update there was not a consensus that the Trinidad local seismicity was man-made. Declustering removed some earthquakes from the catalog used for the hazard analysis; there was no special treatment of the catalog.

Although now disbanded, the Senior Seismic Hazard Advisory Council (SSHAC) developed a report and process (with subsequent updates) for using expert opinion in a systematic and consistent way to target consensus in hazard determinations. The group includes seismologists and sociologists. The process has been approved by the NRC, and they now generally require it for hazard studies that they fund.

More research is needed on the attenuation functions used in the Rocky Mountain Colorado Plateau. The WUS and CEUS attenuation boundary is very close to the Trinidad area.

Numerous earthquakes have occurred within 100 km of Trinidad:

CEUS declustered $m_b \geq 3$ catalog

- 1963-1996: 8 earthquakes, m_b 3.0-4.5 (~ 4-yr recurrence)
- 2002 update (1997-2001):
 - + 2 earthquakes, m_b 3.3,4.5 (incl. Sep 2001, m_b 4.5)
- 2008 update (2002-2006):
 - + 12 earthquakes, m_b 3.0-5.0 (incl. Aug 2005, m_b 5.0)
- Since 2008 update (2007-2011):
 - + 9 earthquakes, m_b 3.0-5.4 (incl. Aug 2011, m_b 5.4)

WUS declustered $M_w \geq 4$ catalog

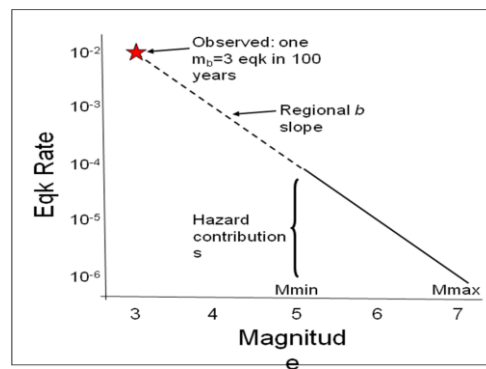
- Aug 2004, $M_w 4.3$

The p_g from the USGS maps has about doubled in the Trinidad area from 2002 to the 2008 maps.

Hazard issues and questions:

How large can non-tectonic events be?

Should more complex models be considered with alternative recurrence (changes to the regional b slope) or M_{\max} ?



These earthquakes are controlled by processes that can start or stop “arbitrarily”. How to accommodate this in PSHA?

What should they be called? non-tectonic, man-made, induced, triggered, industrial, anthropogenic?

Chuck included some slides from Bill Ellsworth’s EPA briefing:

Initial production of the coal bed methane field along the Colorado/New Mexico border west of Trinidad began in 1994 and significantly expanded in 2000. 7 sequences with $M > 4$ earthquakes occurred in the Raton Basin after injection began (1994-2011) and only 1 occurred in the 24 preceding years (1970-1993). The probability of this occurring randomly is 1.0%. The increase in seismicity began with the 2001 swarm directly beneath an injection well. The seismicity beneath this well declined after the injection volume was reduced.

The August 2011 $M 5.3$ earthquake occurred near two high-volume injector wells in the shallow basement (4 km depth).

The earthquakes are deeper than the injections so pressure is the real issue.

Vince Matthews commented that the M 5.3 earthquake is actually still being located. Vince also presented a map showing earthquakes in this area. A linear alignment of events is evident from the map. This appears to identify a definite fault.

There is a gap in the linear grouping implying that other events may yet occur in the gap area.

Rob Jackson discussed some items from the meetings of the State Seismic Safety Commissions and WSSPC meetings at the National Earthquake Conference in Memphis:

There is potential for a meeting to be held with USGS and CEHMC to review the upcoming map changes for the 2014 National Seismic Hazard Maps (NSHM). Also a workshop will be held June 13-14 in Salt Lake City to review the Inter-Mountain West (IMW) earthquake sources under consideration for inclusion in the maps.

Also, Rob is discussing with Roger Evans the possibility of a joint meeting of the CEHMC with the Utah Seismic Commission.

The EERI Seismic Safety of Schools Committee met at the Conference. The committee is now a standing EERI committee rather than ad hoc. Emphasis on school safety is a nation-wide and world-wide issue. WSSPC policies are being revisited and expanded.

Future speakers - Possibly Keith Porter, CU Professor

Next meeting: Thursday, July 26 (Note: 4th Thursday, July only) Noon to 2 PM, Room 300, Hill Hall, CSM.

March 15 2012 CEHMC Meeting

Notetaker: Rob Jackson

Present: Rob Jackson, Michael Haughey, Victoria Smith, Bob Kirkham, Chuck Mueller, Hussam Mahmoud

The meeting was held at the National Earthquake Information Center (NEIC).

Waverly Person provided us with a discussion and presentation of the current status and capabilities of the NEIC. The NEIC was established in 1967. There were 20 major earthquakes last year throughout the world which is a very high number compared to prior years. The USGS can determine the magnitude of an earthquake within 4 minutes and it is usually very accurate. However, Waverly prefers to base the magnitude on surface waves which can take up to 20 minutes. Waverly discussed the Japan earthquake and tsunami. There were reportedly 7 waves. The first wave arrived in 20 minutes after the earthquake and was ~ 100 feet high. The others were around 80 feet high. The waves rolled inland ~ 26 miles. The group then discussed the Colorado hazard and risk including the vulnerability of school buildings.

A brief meeting was then held in the NEIC conference room.

Approval of minutes from the January meeting: motioned, seconded, and approved

We reviewed the Questionnaire for State Seismic Safety Commissions for the upcoming WSSPC Annual Meeting at this year's National Earthquake Conference in Memphis (April 10-14). The status of the seismic safety of schools and the lack of response from the Colorado Division of Fire Safety regarding the CEHMC recommendations has been identified as a topic for discussion at the SSC meeting at the National Earthquake Conference.

The 5.3 M Trinidad earthquake was a missed opportunity for earthquake awareness communication. However, the CGS is preparing a paper on the event. The CEHMC may want to present the findings in further communications regarding vulnerability and risk.

Discussion of shelters. According to Victoria, many shelters are determined by the Red Cross but some communities have specific plans for the choice of shelters. Schools may be shelters. However, for children the issue is "shelter in place" since they should not be told to "get out of the building" as occurred in the recent Virginia event. Also, no major earthquake has occurred during school hours in the United States since the 1933 Long Beach earthquake which prompted the adoption of California's Field Act. Victoria volunteered to contact Ken Brink and perhaps find a Red Cross contact to present to the CEHMC more detail on sheltering plans.

The State is still planning on evaluating their state buildings (approximately 7600). Rob recommended that the Rapid Visual Screening of Buildings for Potential Seismic Hazards (R.O.V.E.R.) (FEMA P-154) procedure be used in conjunction with the evaluation.

According to Victoria there will be a Shakeout event April 16-19 in Utah. Region 8 will participate in the scenario.

Future speakers - Possibly Doug Bausch. Keith Porter CU Professor. Dan Levish, Bureau of Rec.

Next meeting: Thursday May 17, 2012 Noon to 2 Pm, Room 300, Hill Hall, CSM, Golden, CO

The July meeting may be rescheduled to a different day in July.

January 18 2012 CEHMC Meeting

Notetaker: Matt Morgan

Present: Rob Jackson, Michael Haughey, Ken Brink, Tom MacDougall, Dave Butler, Matt Morgan, Chuck Mueller, Hussam Mahmoud

Approval of minutes from the September meeting: motioned, seconded, and approved.

CEHMC Website-Hat was passed and domains paid for another year.

Topic 1-Not much discussion of Colorado earthquakes any longer. The VA quake lasted longer in the media. 14 million people felt it. DEM and FEMA sponsored a HAZUS workshop in Denver during the first week of January.

Topic 2-Dave Butler talk on Measurement of V_s 30.

7 techniques-Crosshole seismic, down hole seismic, P-S- suspension logging, shear wave refraction, cone penetrometer, multichannel analysis of surface waves, Refraction Microtremor (ReMi)

Dave summarized each technique. ReMi model for Denver has $V_{2100'} = 1198$ ft/s.

Summary of Denver area V_s 30s

$N = 22$

Avg 1329 ft/s

Avg Std Dev 38 ft/s

$V_s < 1200$ ft/s 7 sites

$V_s > 1200$ ft/s 15 sites

Smallest 905 ft/s

Largest 1620 ft/s

Engineers may go with either Site class D or C with this value since it is at a break point. Dave says seismic hazard in Denver is way under characterized. RM Arsenal fault is really something to be concerned about.

Rob-How this is used if building a structure. Say it comes back as Site Class C. Then you go into the code with your values from the USGS maps (S_1 S_2) multiply by F_a F_v , which are based on the Site Class; and multiply that by 2/3 to get to design values. For short period response then divide by R and multiply by the importance factor to get the response coefficient, C_s .

Topic 3-CEHMC recommendations to the State. The CEHMC is already conservative in their recommendations. Existing buildings have not been addressed. New NREL building is brought up. Used untested connections of columns and repurposed oil pipe that is corroded and pitted. How would this hold up to a seismic event? There may not be much in the code to validate the use of these materials for the building.

Topic 4-CEHMC Annual Report to WSSPC. Rob sent to the group.

Topic 5-CEHMC collaborating with State for project funding and grant acquisition.

Rob has not contacted Steven Stokes from the State. Was on minutes from last meeting. DEM is trying to encourage local govt's to include earthquake in their hazard assessments. Require mitigation actions that had more teeth in regard to earthquakes than in the past. Michael-What have communities designated as shelters during events? Ken says that DEM (they would not do the work) would like to review State buildings for their seismic capabilities. DEM is speaking with Office of Risk Management. This is for State workers and not necessarily the public. But in general schools are what are to be used for shelters. Locals need to take a fresh look at their critical facilities; know where and what they are.

Michael-Help local communities include seismic design/eq hazard in their local hazard plan. Similar to what Ken is speaking of. Reference a few standards or guidelines. Visit a couple local communities and see what they identified as a shelter and see if it will withstand an eq.

Topic 6-Future Speakers-Possibly Doug Bausch. Keith Porter CU Professor. Dan Levish, Bureau of Rec.

Next meeting: Thursday March 15, 2012 Noon to 2 Pm, Room 300, Hill Hall, CSM, Golden, CO

CEHMC Meeting of September 15, 2011

Notetaker: Matt Morgan

Present: Rob Jackson, Vince Matthews, Matt Morgan, Bob Kirkham, Ken Brink (CDEM), Marilyn Gally, Wayne Charlie

Additions to the agenda - None

Approval of minutes, motioned, seconded, approved.

Topic 1 - WSSPC Policy Recommendations – Comments due October 10, 2011.

Topic 2 - Discussion of recent earthquakes – Most damage in Segundo/Valdez; two structures need to be demolished. 54 properties damaged. No monies from the SBA will be given out. Was not declared a disaster area. There will be a recovery center in Trinidad to assist with those affected. In Segundo, there were 25 applications for assistance at the DEM assistance center that was active for 2 days. Donations may be the way to go. The SBA looks at the “event” and not at multiple events. Would have to make an argument for a swarm or aftershocks. The good-The building inspector became familiar with the people assured them he wasn’t looking for “code violations”. People started to come forward. What to take? Invite Pat Coil to speak about building codes. Had coordination meetings with other state agencies. Structural Engineers Emergency Response Committee has a list of the people that have been trained by FEMA. Doug Bausch (FEMA) asked about this. Since there was no declaration, structural engineers were not called; no money to hire anyone.

Topic 3 – Seismic safety of School Buildings. Rob has not heard anything back from the State of Colorado. Rob will invite Stephen Stokes to come and give a talk to CEHMC.

Topic 4 – NETAP – Tom MacDougall would like to get us motivated to get grants for projects. Tom is not here. Marilyn-Use of NEHRP money-DEM will throw \$2000 into the contracts and require an earthquake section in the local plans. Will force the locals to think and plan about earthquakes.

Discussion outline for CEHMC roles in hazard mitigation-What does the CEHMC do? We prepared an earthquake hazard brochure that was passed out at the recovery center in Segundo. We helped the CGS purchase and locate additional seismographs that were used to better locate the earthquake.

Marilyn discussed the Hazard Identification and risk Assessment, which is a piece of software that determines amount of state allocated money based on the formula of 50% population, 25% risk (hazards?), 25% threat (terror?). She is not sure what all this means but be aware this does now exist.

CEHMC Meeting of July 21, 2011

Notetaker: Matt Morgan

Present: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller, Larry Anderson, Henry Berglund, Kathy Haller, Tom MacDougal

Approval of Minutes from July 21, 2011. Motioned, seconded, approved.

Additions to Agenda-Condolences for Damon Runyon who passed away.

Topic 1-Henry Berglund presentation on "Distributed deformation across the Rio Grande Rift Region".

The Rio Grande Rift (RGR) is a group of N-S trending basins in south-central CO that runs southward, bisecting NM. Earliest extension began approximately 29 Ma, with 8 km of extension in the Albuquerque Basin. Sedimentation started ~21 Ma to present. Active faults showing one or two Magnitude 7 events in last 2 Ma. There is also elevated surface heat flow. No clear pattern of seismicity from the ANSS from 1962-2006, outside of the Socorro Magma Body. Extension dominates in CO and NM. Previous estimates 0.2-1mm on the upper range of amount of extension. Compare that to the San Andreas with is about 3 cm/yr.

RGR GPS experiment installed between 2006-07. Processed using GAMIT/GLOBK program. Combined RGR, CORS, and PBO position estimates to make time series. Can estimate velocities at each site. Established a reference frame by using a predetermined set of prior coordinates in the central "stable" North America.

Results: Sites east of CO and NM move slowly with respect to the North American base frame; velocities increase in magnitude from E-W; large-scale clockwise rotation about an axis east of ID. E-W extension occurs between the Great Plains and the western margin of the Colorado Plateau (avg. 1.2 nstrn/year). A nstrn is dimensionless. Quaternary (last 2 Ma) fault displacements from USGS suggest that extension has not been distributed evenly during the Quaternary. Results show very low rates of extension over a very large area with no significant increase across individual faults or the RGR. Implications: Individual faults may be closely spaced enough to prevent our displacement rate estimates from distinguishing strain localization across the RGR. Conclusion: 1.2 nstrn/yr across CO Plateau, the RGR and W Great Plains, E-W extension over the region. E-W deformation may be much broader than indicated by surficial geologic boundaries; broad accumulation of strain may explain why the RGR is not clearly defined by seismicity.

Topic 2-Location of CEHMC meetings. Results of voting. CSM for now; USGS wins if we need to move later in the year.

Topic 3-Potential role from CEHMC with State of Colorado for funding projects and grant acquisitions (NETAP, etc.). Tom MacDougal-Contacted Tony Crone at USGS and asked him if he had interest forming a similar group in CO. His answer was probably not. He mentioned a group that looked at the seismic hazard in the IMW excluding UT. The group decided that it would be better to have a north and south research group. Tom will get back in touch with Tony. \$5 million research dollars for NEHRP next year; very competitive. According to this group the Golden fault is ranked #3, Rampart Range is #8 and Rocky Mtn Arsenal is #14. What would money be used for? Rob likes school building ratings; Tom would like to reduce risk through analyses or through an emergency action plan (table top exercise) or scenarios. Larry-How do you prioritize when all want a piece of the pie? Tom-Maybe structure this for funding outside of NEHRP, looking for more localized funding. Michael-Get a group of states together, create categories and prioritize. Bob-Subgroup of WSSPC like there exists in Nevada.

Topic 4-Future speakers?? Jim Harris may be interested.

CEHMC Meeting of May 19, 2011

Notetaker: Matt Morgan

Present: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller, Vince Matthews, Marilyn Galley, Deanna Butterbaugh, Ian Hyde, Victoria Smith, Tom MacDougal

Approval of Minutes from March 17, 2011. Motioned, seconded, approved.

Topic 1: New location of CEHMC meetings- Meet at CSM through July. Options are the Fed Center, the South Metro Fire Rescue Bldg, CSM, and URS. Straw poll indicates Fed Center is the winner.

Topic 2: Colorado Safety Resource Center

Vince said they had asked for information on activities for teachers and kids. Vince sent links to various websites. They also wanted to know about earthquakes.

Topic 3: WSSPC Recap. Rob: A lot of interest in school safety. WSSPC is hoping to write an initiative on school safety. Ron Lynn chair of the Nevada WSSPC said once his term is up for the International Code Council he will try and get schools upgraded from occupancy category 3 to OC 4. Utah has volunteer engineers go out and evaluate school buildings. Are there groups in CO willing to do this? Rob thinks so. But the first step is an ordinance issue and that needs a support group. Vince: If you can find people and funding it would be great to do a survey of school buildings, but changing things in building code requires support. We don't have that. Rob: Having a code is a benefit. Vince: But no one enforces it in CO. Rob thinks we need to keep active in WSSPC and keep giving the State the the message.

Tom says that UT has 3 working groups:

Liquefaction

Ground Shaking

Quaternary Faulting

Once a year they meet and set research priorities for the state.

Vince: UT has had a tremendous amount of money to investigate their faults. CO has not.

Tom: Try to organize and coordinate our efforts; is this group or State Survey have interest in trying to set up something similar to UT? Vince is focusing on awareness. Tom approached Rob about writing a NEHRP grant, and he talked to Bill Lund and said USGS has given UT a separate grant for keeping their working groups going. Perhaps CO should do this to focus its interest. Vince says CGS has no one to write grants anymore. CGS has received NEHRP funding in the past. Mark Petersen called a meeting of the NEHRP Inter-mountain West group and created a ranking of the top 5 faults in the region; the Golden fault is within the top 5. CGS is interested but cannot devote much time to grant writing.

Marilyn: Getting schools evaluated for seismic would be a huge contribution. These are also emergency shelters. For schools CODEM would receive the grant, if one was awarded. Tom will pursue the NEHRP grant more. Matt: NEHRP grant for HAZUS datasets. Victoria and Marilyn are interested in cooperating with CGS on updating the datasets.

Future Speakers: ?

Next Meeting: Thursday July 21, 2011, CSM.

March 17, 2011 CEHMC Meeting Minutes

Present: Larry Anderson, Wayne Charlie, Michael Haughey, James Horne, Rob Jackson, Tom MacDougall, Robin McGuire, Chuck Mueller

Scribe: Rob Jackson

Additional agenda items. Chuck Mueller will discuss the recent Japan earthquakes.

Approval of minutes for January 20, 2011; motioned, seconded, approved.

Business Topics:

Topic 1: New members. Votes were taken and added to prior votes received via e-mail. All votes being "yes," both Tom MacDougall and Pedro Fernandez are now members of the CEHMC.

Topic 2: Possible new location for the CEHMC meetings due to parking problems at the Mines campus. Attendees were able to park without much difficulty at this meeting. It involved more walking. Immediately south or east of the campus signage worked for some.

Link to a page briefly describing CSM parking rules:

<http://minesonline.net/s/840/NHindex.aspx?pgid=862&gid=1>

Link to CSM campus parking map:

http://www.mines.edu/UserFiles/File/Visitor_Map.pdf

Red lots are now off limits. The east side of Washington Street and the public lots in downtown Golden (the old Foss and Meyer Hardware lots) are free. Limited two-hour parking may be available around the Foothills Art Center on 15th. A parking permit can be purchased for ~\$1.50/hour or daily (\$8) from the automated kiosk on the east side of the Green Center, 15th and Arapahoe. There are 10 spaces designated in this lot O for visitors. Visitors can also pay to park in the F, J, and Q lots using the kiosks. The map shows (in green) the restricted zones adjacent to the campus, but doesn't extend far enough to show the whole area of restricted parking.

Alternatives to be decided on prior to the September meeting:

1. Maintain the current location at Hill Hall on the CSM campus.
2. Return to the USGS/NEIC building on Illinois St. on the CSM campus (a building that is a short walk from Lots F and J and is closer to the periphery of the campus). However, security is involved.
3. New location at USGS, Denver Federal Center (check in at gate and at the building).
4. New location at URS Denver Tech Center offices (need badges and escort).

The May and July meetings will continue to be held at Hill Hall on the CSM campus. Decision on a new location is to be made prior to the September meeting.

Topic 3: Chuck Mueller spoke briefly on the March 11, 2011 Japan Mw 9.0 earthquake. The earthquake occurred along the subduction zone plate boundary between the Pacific and North American plates. Japanese hazard mapping at the Japan trench assigns magnitudes by segments. The highest assigned magnitude was 8.5 but it was well south of this earthquake. In the segments that ruptured, the magnitude assigned was 7.7 to 8.0. In one area, where ground accelerations reached around 0.6 g, rupture of one segment is believed to have triggered the rupture of another. A peak acceleration of 2.755g was recorded at one station. The earthquake was preceded by a series of large foreshocks over the previous two days beginning with an M 7.2 event on March 9.

Topic 4: Policy recommendation on seismic safety of schools. A letter was mailed January 3, 2011 to the Colorado Division of Fire Safety transmitting the updated version of the CEHMC policy recommendation on the seismic safety of schools. Steven Stokes is the new Chief Building Official for the State of Colorado. Rob met him at the February meeting of the Colorado Chapter of the International Code Council. Rob has given him a copy of the recommendation and the letter.

Topic 5: WSSPC 2011 Annual Meeting, April 4, in Boise Idaho. Rob will attend.

WSSPC has also e-mailed a notification out for an invitation to submit comments to an expert panel considering a potential reevaluation of the New Madrid seismic hazard. Some of this reevaluation may be in response to a book by Seth Stein, entitled "Disaster Deferred – How New Science is Changing Our View of Earthquake Hazards in the Midwest." The book questions the risk of further damaging earthquakes in the New Madrid region. Michael Hamburger, for one, has critiqued this position in a Science Magazine review of Stein's book.

Topic 6: EERI ad-hoc committee on Seismic Safety of Schools. The workshop was a success. Ivan Wong attended and reported that the attendance and audience participation was good and that the workshop also could have gone on longer. Ivan has recommended to the EERI Board of Directors that school safety be a part of the main program at next year's National Earthquake Conference/EERI meeting. The workshop presentations are available in pdf form at <http://www.eeri.org/site/meetings/2011-annual-meeting/presentations> (See presentations from Saturday, February 12, 2011.)

Topic 7: ASCE 31/41 Seismic Rehabilitation of Existing Buildings on-going meetings. ASCE 31 and 41 are being revised and updated into a combined document. Balloting is on the ASCE 31 changes now. There are some revisions being made in the definitions of seismicity with the intent being to be consistent with ASCE 7-05. Rob is working on the General Provisions subcommittee.

Webinar: "Earthquake Safety and Mitigation for Schools." The information is based on *FEMA 395: Incremental Seismic Rehabilitation of School Buildings (K-12)*. The CEHMC attendees watched the

Webinar although technical difficulties existed for the first 20 minutes of the hour long FEMA sponsored Webinar.

The publication is free and available at <http://www.fema.gov/library/viewRecord.do?id=1980>

The webinar can still be viewed at through a link at the ATC web site:

<https://www.atcouncil.org/On-Demand-Training/>

(The PowerPoint slides from this Webinar were e-mailed to the CEHMC attendees in May.)

Date of next meeting: Thursday, May 19, 2011 from noon to 2 p.m.

CEHMC Meeting of January 20, 2011

Notetaker: Matt Morgan

Present: Rob Jackson, Michael Haughey, Matt Morgan, Chuck Mueller, Pedro Fernandez, Wayne Charlie

Approval of Minutes from November 18, 2010. Motioned, seconded, approved.

Topic 1: New location of CEHMC meetings- Chuck will check into USGS on campus and Fed Center.

Topic 2: Policy Recommendation.-Letter mailed but no response yet. State of CO strategy focuses more on local governments to create requirements for their buildings. We have more seismographs in Colorado than ever before. Fault activity definitions very close to what WSSPC has adopted. URM structures have not been identified in Colorado. Obstacle- seismic risk is generally perceived as low and not a priority at this point. Rob will send out a policy recommendation to the CEHMC.

Topic 3: Post-earthquake Technical Clearinghouse-No Technical Clearinghouse right now. WSSPC meeting is April 4 in Boise. EERI meeting, in conjunction with working group on Seismic Safety of Existing Buildings.

Topic 4: ASCE 31/41 in San Francisco, "Seismic Rehabilitation of Existing Buildings."

Topic 5: Webinar- Unable to watch. We briefly discussed the FEMA document "Incremental Rehabilitation of School Buildings."

Other topics: CEHMC could support a survey of school buildings and soil conditions. CEHMC could educate local government officials; we are the best (only) group to do-so. Rob will see if he can get someone from the City of Denver to come to a meeting.

Enconunited.com-look at Pedro's white paper on Seismic Design Category B. Pedro is presenting an introduction to seismic to the ICC Annual Meeting. He should give to CEHMC - "Wind and Seismic Provisions of ASCE 7".

Future Speakers: Anne Sheehan, local government officials, Pedro Fernandez.

Next Meeting: March 17, 2010. Webinar will be shown.

November 18, 2010 CEHMC Meeting

Present: Wayne Charlie, Michael Haughey, Rob Jackson, Bob Kirkham, John Nicholl, Damon Runyan

Scribe: Rob Jackson

Topic 1: Approval of the minutes for September 16, 2010; motioned, seconded, approved.

John Nicholl commented on the item regarding a potential meeting topic on “geothermal and induced seismicity.” John pointed out that the site location of geothermal projects is often based on the existence of active seismicity in the area.

Topic 2: Presentation by Jerry Schnepf and Nate Deibler of PVC Specialties, representative of Mason Industries.

Jerry and Nate discussed the mechanical and electrical seismic anchorage requirements as required by the International Building Code and ASCE 7. Discussion ensued as to the intent and detail of the non-structural attachments portion of the CEHMC policy recommendation on seismic safety of schools. The CEHMC recommendation does not specify the I_p factor but it may be inferred to be 1.5 since the exemptions of ASCE 7, Section 13.1.4 do not apply. However, the CEHMC recommendation does not specifically state that I_p is to be taken as 1.5, so the application beyond 13.1.4 could be on a case by case basis. Examples where this could be significant are in the case of piping and in-line ductwork components. Unless $I_p = 1.5$, for values of $R_p > 4.5$, 2 inch diameter and smaller pipe is normally exempt as are in-line ductwork components weighing less than 75 lb. Neither does the policy recommendation specifically require the Occupancy Category to be upgraded from III to IV, although that is the approach that WSSPC has taken in their Policy Recommendation.

The approximate costs of implementing all the essential facility anchorage requirements for a new school building would be in the range of \$4- \$4.50 per sq ft. For a \$200 per sq ft facility this is about 2% of the total cost.

Topic 3: Policy recommendation on seismic safety of schools.

A vote was taken and unanimously passed to send the updated version of the CEHMC policy recommendation to the Colorado Division of Fire Safety with a transmittal letter similar to that which was previously sent in 2008 to the CGS. The text of both the new letter and the recommendation are to be unchanged from the draft as previously sent to the membership for review last week.

Topic 4: CEHMC comments on the 2011 Draft WSSPC Policy Recommendations

On October 12, the following comments were sent to WSSPC regarding the 2011 Draft WSSPC Policy Recommendations:

“The Colorado Earthquake Hazard Mitigation Council has comments on the 2011 Draft WSSPC Policy Recommendation 11-4, Identification and Mitigation for Unreinforced Masonry Structures:

1. Page 2, first paragraph under "Implementation." Question if there is a threshold for this program, such as a certain level of hazard above which risk would be determined and structures inventoried and assessed. Also are houses intended to be included in the program?
2. Paragraph 3: Unreinforced chimneys and masonry veneer may be hazardous even if not built on a URM structure per se. Should the recommendation include reference to unreinforced chimneys and masonry veneer that are constructed as part of wood buildings?"

Topic 4: Noted that Walter Arabasz has retired from ANSS. New IMW Coordinator is Dr. Kris Pankow of the University of Utah.

Topic 5: EERI ad-hoc committee on Seismic Safety of Schools

Rob reported that this committee is seeking to facilitate a workshop at the February 2011 EERI Annual Meeting to advocate for improved seismic safety in schools on a national basis but with a regional focus. Presentations and participation would include examples of both mitigation and retrofit programs.

An hour long FEMA sponsored Webinar will take place on January 20, 2011 from 1:00 PM to 2:00 PM MST. The Webinar is entitled "Earthquake Safety and Mitigation for Schools." The information is based on *FEMA 395: Incremental Seismic Rehabilitation of School Buildings (K-12)*. Since the Webinar occurs during the CEHMC normal meeting time, we will incorporate it into the agenda. The Webinar is free.

Open discussion:

Damon reported on Anne Sheehan's findings from her geodetic work in conjunction with EarthScope. A uniform movement of 1 mm per year over the state has been measured via GPS stations from I-70 to New Mexico, over 5 east-west profiles from 2007 to 2010. The data is compiled by one of Anne's graduate students at CU. So from the Kansas border all the movement is to the west. A differential movement of only 1 mm per 1000 km was measured.

Since parking has been a problem at CSM, the use of a different location was discussed. John Nicholl may be able to offer the URS (Tufts Street) office in the DTC. May try this for the January meeting.

Future speakers. Perhaps ask Anne Sheehan regarding her recent work.

Next Meeting: Thursday, January 20, 2011, 12:00 to 2:00. (FEMA Webinar at 1:00 PM)

July 15, 2010 CEHMC Meeting

Present: Rob Jackson, Damon Runyon, Larry Anderson, Matt Morgan, Wayne Charlie, Marilyn Galley

Scribe: Matt Morgan

Topic 1: Approval of minutes; motioned, seconded, approved

Topic 2: Rob Jackson presentation "Seismic Design of School Buildings in Colorado and other Low to Moderate Hazard Areas: Is the IBC adequate?"

IBC is an excellent code, but paper focuses on a few elements in the IBC that could use improvement.

- Seismic Design Category (SDC) A is intended for use only in lowest areas of seismic risk
- SDC A is being used in low to moderate risk areas based on soil class.
- The use of 1% is lower by a factor of 3-8 when compared to mapped values and the usual equivalent lateral force.
- Seismic design of schools is not required to be any different than for ordinary buildings where SDC A is allowed.
- There are 2 different spectral acceleration thresholds for the use of SDC A
- **A CODE CHANGE is recommended to allow use of SDC A only in areas of lowest seismic risk**

SDC A

- The IBC references ASCE 7 for seismic design. The definition of "SDC" is as follows" A classification assigned to a structure based on the Occupancy Category and the severity of the design earthquake ground motion at the site."
- The assignment of a SDC is not based on Occupancy Category for SDC A. SDC A does not meet requirements for SDC.

How to determine SDC:

- Find S_s and S_1 from maps
 - Is the structure exempt from some or all of the IBC Seismic requirements?
 - The site class can vary from A to F. C is common along the Front Range
 - Determine design spectral response accelerations for short periods (S_{DS}) and for one second periods (S_{D1}).
 - Determine the **Occupancy Category**. Occupancy Category IV is for essential facilities. Schools with over 250 students are currently considered Occupancy Category III.
- Next, Tables 11.6-1 and 11.6-2 are used to determine the **Seismic Design Category**. These are based on S_{DS} and S_{D1} and are also supposed to be a function of the Occupancy Category. The more stringent of the two tables determines the SDC.

Limitations of SDC A:

- No differentiation of Occupancy Categories; ordinary structures same as essential facilities
- No requirement for linear or exponential increase in the vertical distribution of seismic forces
- No structural limitation on height of building

- No differentiation of regular or irregular structures

From 2003 NEHRP regarding the 1% value

- Many low-rise, heavy structures may be controlled by nominal 1% acceleration
- SDC is somewhat arbitrary
- The level of design chosenas to not present an undue burden on the design of structures in zones of **very low seismic** activity.

NEHRP Regions 2003

Three regions based on fault sources and seismicity, they are:

1. Regions of negligible seismicity with very low probability of collapse
2. Regions of low and moderate to high seismicity
3. Regions of high seismicity near known fault sources with short return periods

Handling low seismicity in Region 2

- Increase region 1 areas to get low seismic areas out of Region 2, or
- Require a higher level of minimum ground motion in Region 2

$S_s \leq 0.25$ and $S_1 \leq 0.10$ for boundary between Regions 1 and 2. Based on instrumental recordings during Northridge event and correlation to observed damage and Modified Mercalli Intensities.

New 2008 maps have shifted the SDC contours to the west in Colorado.

Rob did some calculations and showed an Equivalent Lateral Force values ranging between 102 (Site Class B) kips and 246 (Site Class D) kips depending on which site class is used. Compare this with 30 kips for SDC A.

Rob's Recommendations for code changes: if SDC A is to be used it should only truly be used in areas of low seismicity. Structures may be assigned to SDC A per the ASCE 7-05 Sect. 11.4.1 ($S_s < 0.15$ and $S_1 \leq 0.04$) based only on the mapped spectral response accelerations, S_s and S_1 .

And exemptions for structural attachments not be allowed for schools.

Topic 3: WSSPC Report

Bob Kirkham and Pat Rogers received the Lifetime Achievement Awards. Marilyn-Utah has been interesting, very media driven and everyone knows about earthquakes. People just don't think that "stuff" will happen to them. No big earthquakes have occurred there. UT puts out pamphlets, articles in newspapers; 1 in 5 people have sought out earthquake information.

Had Seismic Safety Councils and Commissions Meeting-Talked about collaboration. CEHMC has common ground with UT.

All WSSPC Policy Recommendations passed. Rob-Bring this up to the State when we make our recommendations.

Topic 4: Unreinforced Masonry Buildings. Damon-What kind of structural seismic criteria would you use to say that type of building stock (schools) is a risk? Life safety is the criteria, but that doesn't address structural damage. Rob cannot say; it is a function of many factors: distance, PGA, soil conditions; probably a magnitude 5 or greater. Rob is saying to evaluate URM buildings based on FEMA (?) criteria; they are inherently vulnerable to earthquakes. Identify where the URM schools are. Marilyn-The school superintendents have an annual meeting and it would be good to give a presentation about earthquakes to them (Vince?). School Safety Resource Center (State of CO) would be another great venue to present. CDEM is working on inventorying shelters across the state.

Next Meeting: Thursday, Sept. 16 (or 23).

CEHMC Minutes 5-20-2010

Present:

Rob Jackson, Michael Haughey, Robin Maguire, Damon Runyon, Matt Morgan, Vince Matthews

Scribe: Matt Morgan

Approval of Minutes from the March 18, 2010 Meeting. Motioned, seconded, approved.

Topic 1: Participation in the Natural Hazards Center Annual Workshop meeting in July 2010. Rob, Vince and Bob were thinking of presenting but the Hazards Center wanted something broader than Colorado. They thought they had a program that would have focused on schools in low to moderate seismic hazard areas. Was not approved by the Hazards Center. There is still the obligation for the CEHMC to present the State reports and discuss with other groups at the WSSPC annual meeting that precedes the Hazard Center Workshop. Would be great to talk about the Earthscope seismographs.

LiDAR coverage of the Arkansas River Valley-great for fault studies. CGS will be kicking in 100k, the USGS 200k. Talking to other agencies to seek the remaining 100k. State Parks is very interested. Resolution will result in a 1m DEM. Vince recommended that CSM (Dag Nummedal) start an Induced Seismicity Institute. This was not created; however, they will be looking at this under their geothermal program. May be a good topic to present at the WSSPC meeting. Darlene Cypser put together a bibliography of Induced Seismicity on the internet.

Vince would like to see CEHMC officially give a lifetime achievement award to Pat and Bob. The Utah Seismic Council gave Bill Lund a similar award last year. CEHMC will get a plan together and CGS will pay for the award.

Topic 2: Seismic safety of schools. Rob has emailed Joe Montoya several times and has never received a return email. He also cc'd Kevin Klein. Rob said we need to update our recommendations based on the 2009 code. Michael could see writing it in a language that would allow it to be adopted by local governments. Rob likes the idea. Put in the section numbers used in the code. No major changes to the document.

Topic 3: Adoption of Earthscope seismographs-

Four purchased by a consortium lead by the Colorado Geological Survey. Contracted with IRIS to maintain the stations. Harley at the USGS is connected to them already. Vince brought in a hand-drawn map of where the new seismographs are located. Red Feather Lakes, Divide, Creede, and Trinidad are the locations. Vince would appreciate if the CEHMC would send a letter to each of the landowners. CU, CSU and CC have contributed to the effort. The instruments have already helped accurately locate the several events, in particular, 2 in SE Colorado.

Topic 4-ASCE 7-10. Rob. Maximum Credible Earthquake has slightly different terminology. Non-structural components basically the same. The MCE ground motion parameter map has contours going out and forming a bullseye to the Cheraw fault indicating 20% g at 0.2s (Ss). Breakpoint for Seis Design Cat A and B is 19%.

Vince-does wind design really cover CO for earthquakes? Rob looked at this in the past. Rob: Highly, unlikely that 1% of gravity will govern over wind. Vince: What would wind design do for you if you have 0.5% gravity? In the case of high-rise buildings it gets you quite a bit of strength. Long and narrow buildings, not so much. But there are so many other factors to take into account. Population is not considered in the building codes. This is a big deal along the Front Range. Rob mentioned the new CU medical buildings that are being constructed at Fitzsimmons may want to be in Seismic Design Cat A. Vince says that money is better spent in preparedness since the building owners want to save every penny and cut corners on construction.

Future speakers: Rob will talk on Seismic Design of School Buildings in Colorado and other low to moderate hazard areas: is the IBC adequate.

CEHMC Minutes 3-18-2010

Present:

Bob Kirkham, Bill McCormick, Kathy Haller, Damon Runyon, Matt Morgan, Dave Butler, Rob Jackson, Michael Haughey, Chuck Mueller, Nicolas Luco

Scribe: Matt Morgan

Approval of Minutes from the January meeting: changes by Rob, other people on panel clarified in document sent to Matt.

Topic 1: Presentation by Dr. Nicolas Luco “Project 07-Reassessment of Seismic Design Procedures and Development of New Ground Motions for Building Codes.”
EERI Seminar on Next Generation Attenuation Models

New Ground Motion Criteria

- Key Concepts

 - Risk targeted GM

 - Maximum direction ground motion

 - 84th percentile deterministic ground motions

- Example Values of New Ground Motions

 - 34 US city sites

2009 NEHRP Provisions-Life Safety + Point of View

- Provisions are minimum recommended requirements for design and construction of buildings and other structures to resist EQ GM

- Intent of the provisions

 - Avoid serious injury and loss of life

 - Avoid loss of critical facilities

 - Minimize nonstructural repair costs

- Objectives addressed by:

 - Avoid structural collapse in very rare extreme ground shaking

 - Limiting damage to structural and nonstructural systems that could lead to injury and loss for smaller more frequent ground motions.

Seismic Codes and Source Documents-Past

NEHRP and SEOC were in parallel

NEHRP fed into ASCE7 (seismic)

NEHRP fed into Standard Building Code

Standard + BOCA + ASCE became IBC

IBC, NFPA 5000 Building Codes, California Building Codes referred to ASCE7.

For Ground Motions: NEHRP>ASCE7>IBC

For NEHRP updates:

Building Seismic Safety Council (BSSC) for FEMA

- Provisions update committee (PUC)

Sesimic Designs Procedures Reassessment

For ASCE updates

Structural Engineering Inst. (SEI)

Min design loads on buildings and other structures committee

Task Committee for Seismic Provisions

For IBC updates

Codes and Standards, IBC-Structural Committee

Public Hearing

Project 07 – Joint effort of the BSSC, FEMA, USGS

Scope: Revisit products of Project 97

Develop revised seismic design maps and procedures, reflecting these new data for inclusion in 2009 NEHRP Procedures

Technical Topics Investigated by SDPRG:

Level of Uniform Hazard or Risk?

Ground Motion Intensity Pattern?

Spectral Shape Definition?

Proposal SDPRG-1R4-2009 NEHRP Provisions (Done):

SDPRG Proposal Development – June 06-Sep 07

BSSC PUC Review and Approval-Oct 07-Sep 08

BSSC Membership Review and Approval – March 2009

Proposal GM-CH11-ASCE 7-10 (Done)

ASCE 7 SSC Review and Approval – Sep 08-May 09

ASCE 7 MC Review and Approval-July 2009

Ground Motion Proposal – 2012 IBC (in the works).

New Ground Motions

Approach and Key Components

Revise Seismic Design Criteria

Incorporate USGS Seismic Hazard Data

Key Technical Improvements

Differences between ASCE 7-10 and 2009 NEHRP

Risk-Targeted Maximum Considered EQ GM (MCE_R). Slightly different MCE symbol and definition

Changes to the Notational Illustration of Design Earthquake (Project 07)-Spectrum

1% in 50 yr risk

2/3 x 1.8x Deterministic

Maximum Direction on vertical axis

Hazard Curves

Risk-Targeted approach looks at entire shape of hazard curve, multiple probability levels rather than just one (2% in 50 years). Designing for uniform hazard ground motions does not necessarily result in buildings with uniform probability of collapse in 50 years.

New Risk-targeted ground motions are based on a uniform collapse risk objective of 1% in 50 years.

New Risk-targeted ground motions are calculated assuming generic collapse fragility that has 10% collapse probability given MCE ground motions.

Risk-targeted Ground Motions

Calculated iteratively by combining GM Hazard Curves from USGS, Building Fragility Curves defined by Project 07, Probability of Collapse in 50 yrs = 1% via a “Risk Integral” (e.g. ATC 3-06).

Comparison of Seismic Design Values

34 cities in US

High seismic regions (No. California, So. California, Pacific NW)

Population centers

Most are in the west, dead zone in middle of US

Comparisons of Current ASCE 7-10 relative to 7-05

Southern Cal +5%

No Cal +8

Pacific NW -1

InterMW -7%

CEUS -19%

All Regions -1%

A word of Caution for building design

NEW USGS Hazard data and maps (eg. Based on new NGA relations) should be used with new building design procedures (ASCE 7-10).

Search for “EERI NGA Seminar Presentations” on line or email nluco@usgs.gov.

Topic 2: Earthscope. Vince said trying to get a site in Longmont but landowners were reluctant.

Topic 3:

Seismic Safety of Schools. Joe Montoya not returning Rob’s calls. Marilyn Galley sent rob a meeting notice that dealt with schools though homeland security issues.

Topic 4: No activity on WSSPC Workshop.

Rob has a paper in Canadian Conference-Will email to me. May present at next meeting.

CEHMC Meeting Minutes 1-21-10

Present: Rob Jackson, Bob Kirkham, Damon Runyon, Matt Morgan, Michael Haughey, Matt Morgan, Bill McCormick, Chuck Mueller, Tom MacDougal

Note taker: Matt Morgan

Approval of Minutes from the November meeting. Motioned, seconded, approved.

Topic 1-Website status-Bob asked his provider and we would have to pay a fee to host. Matt will look into hosting service (1and1.com Michael's service). Look at content after the ISP list is compiled.

Topic 2- Adoption of Earthscope Seismographs. Letter drafted stating the CEHMC supports this. Vince informed Rob of status. Vince's letter states that there are commitments of \$12,000 (Universities) + \$20,000 (CDEM) and CGS will have to pick up the remaining \$106,000 for 4 stations. How about Prof. Engineering Societies? \$21,000/yr for maintenance. Rob will follow up with Vince to clear up the monetary confusion between these figures and those stated in November. What about asking AEG? Suppliers that sell restraint equipment? Tom asked Parker Water and they were interested in providing a few thousand dollars. Bill-Bureau of Reclamation Dam Safety? Bob-Use already existing data and try and better locate earthquakes we already have, for instance, Trinidad. Would be nice to get a thesis or paper out of it. Anne Sheehan may know how to tackle this.

Topic 3-WSSPC policy recommendation survey on existing policy recommendations. What action has your state taken on the following (CEHMC best-guess answers):
Has your state created an earthquake planning scenario-No
Have loss reduction actions or policy identified result of scenario-NA
Have you put in loss reduction actions in state hazard plan-We do not know.
Have you adopted the WSSPC definition of (active) faulting-The state has not. The CEHMC map has a similar breakdown of faults, but not exact numbers.
What activities has your state taken to support ANSS? CEHMC has drafted letters of support.
What is your estimate of number of strong motion instruments in your state? At least 3.
Has it increased in 2009? No.
Has adopted a plan to identified un-reinforced masonry structures? No.

Topic 4-Update on WSSPC draft policy recommendations
WSSPC will vote on these in July. They are on their website.
CEHMC policy recommendations to CGS. Rob spoke with Joe Montoya. Joe will meet with Kevin Klein (his boss) and there may be an opportunity for us to meet with them and discuss the policy. This is a move in the right direction.
Who inspects new schools? Typically delegated to local jurisdiction who has authority.

Topic 5- Planning for CEHMC involvement in WSSPC Natural Hazards Conference in Boulder. Had to have our input in by Dec. 15, 2009. We were planning a panel discussion. They said it was too narrowly focused on Colorado. Rob had spoken with chair of EERI seismic school committee, and tried to take it beyond Colorado. They came up with the title “Challenges of Seismic Hazard Mitigation for Schools in Areas where Earthquakes are Infrequent.” Will be a panel (Rob moderator) discussion.

Included on the panel will be Robin McGuire and Steve Besemer (Earthquake Program Manager for Missouri SEMA).

Vince noticed the 1882 earthquake was not listed on the USGS “significant earthquake” list. It is in the hazard map catalog according to Chuck. Rob will follow up.

Future speakers-Nicko Luco? Chuck will ask him. Update from Larry Anderson on the Paradox Valley. Ivan Wong-Hazard analyses in Colorado. Robin McGuire on Cherry Creek dam area.

CEHMC Meeting Minutes 11-19-2009

Present: Rob Jackson, Matt Morgan, Bob Kirkham, Damon Runyan, Chuck Muller, Doug Bausch, Dave Butler, Katrin Hafner, Michael Haughey, James Horne

Notetaker: Matt Morgan

Minutes from last meeting. Bob will send corrections. Motioned, seconded, and approved.

Topic 1: FEMA

Money added to FEMA base funding, next year CO will make the cut. CO would be close to the base of 50k in 2010. Marilyn's shop (DEM) would be the applicant and will do quarterly reporting. Outreach, education, risk assessment, preparedness. Equipment is OK but need agreement for maintenance. Application should be ready by end of 2009. These funds should be available each year. CEHMC is welcome to apply.

Since Colorado has an earthquake program including CEHMC, this has helped obtain the approval. (for what year's \$?)

Topic 2: Design of CEHMC website and funding

Use CEHMC.org. Order that. Check on coloradoearthquakes.org or others.

Bob will check with his ISP and see if he can host. Can we send out email when updates are posted.

Subcommittee on website content-Matt, Bob, Rob, Wayne, Michael.

Topic 3: Adoption of Earthscope seismographs and CEHMC's role Katrin Hafner, IRIS Chief of Operations.

Passed out maps of Earthscope station locations and earthquakes. 200 that move from west to east side of array. Want to leave a legacy of stations. Can pick a station and look at signal ahead of time. Would be getting an operating station that has been in operation for 2 years. FEMA funded equipment in AZ. IRIS (under the EARN program) provides service to keep station running, quality control, keep archive running. Required to keep the data stream running and archived. If under the agreement with IRIS they will repair some of the items, but will not replace a sensor. The fee to IRIS is between \$4,000 and \$6,850. The process of taking over the equipment, IRIS approaches landowner and explains that you are interested in keeping it running. The NSF always wants an explanation. The new owner is put into contact with the landowner and you work out permitting issues. IRIS sets an official date when the money will be transferred. Cannot reoccupy a site once the equipment is removed.

Vince Matthews and others sent in a proposal to adopt several of these stations. CO may end up with as many as 13. Colorado College, CSU and CU are all interested in adopting a station. Vince is trying to talk Pioneer Nat Resources into getting one. Proposal to NRC states that CGS provide 15% match. CEHMC needs to put out a letter of support for the NRC by the end of next week. Addressed to Vince. The NRC will be used to purchase 3 stations at \$30k each. Bob will put it together and circulate it.

4 stations that have been active will be left and 2 additional left in Kit Carson and Maybell (total of 6 stations). There are 4 that are in Vince's proposal (Q24, N23, S22, T25(Pioneer)). There are 3 that may be adopted by the universities, for a total of 13. The universities are trying to avoid paying the annual maintenance fee and use graduate students.

Topic 4-WSSPC Policy Recommendations and CEHMC policy recommendation on seismic safety of schools

Rob contacted Joe Montoya (Public School Construction Program Manager) and sent him the email chain and link to WSSPC site. Rob didn't hear from him for a month. Said he never received it so Rob sent again. Joe said while state does adopt the IBC for schools, they do not amend it. Use it as-is. Their code (State) overrides any local code. CGS probably will not be the prime organization to implement code changes, but Joe's group would be. He offered, if OK with Kevin Klein (Director), to put the recommendations on their website. If we spoke to these school districts we need to know how much additional cost is involved. This should be put on hold until the new Director (after Jan 1) takes office. Then schedule a meeting with Joe and Kevin or invite to meeting.

Damon-The bigger issue is to get past the practice of not being able to amend the code. Have DEM come to a meeting and provide support. Possibly Red Cross? Michael will look into *it the Red Cross.*

WSSPC Policy update-Rob, there was a phone discussion. New school buildings, we added in Seis Design Cat C and they also chose IV. Both made it in. Nothing has been formally edited on the WSSPC site. Too extreme a move to retrofit existing buildings. They will not proceed with the 10-9 Policy Recommendation.

Post the recommendations to the CEHMC website.

Topic 5-Participation in 2010 WSSPC/Natural Hazards Center annual conference

Bob-Session ideas? 1/2 or 1/4 day. A session that would be policy-centered and of more interest to earthquake folks. Doug-Expand the NEIC tours part of the Natural Hazards conference. Post disaster inspection.

Minutes

Earthquake Hazard Mitigation Council Meeting
September 17, 2009

Present:

Anne Sheehan, Michael Haughey, Bob Kirkham, Cathy Haller, Doug Mueller, Doug Bausch, Damon Runyan, Larry Anderson, Vince Matthews, Dave Butler, Tom MacDougall, Matt Morgan

Notetaker: Matt Morgan

Topic 1: Approval of Minutes, motioned, seconded, approved.

Topic 2: FEMA state assistance

Last year only states with seismic design with C or higher could participate. Doug supports assistance to all states with active earthquake programs. Doug is on a committee that will look to distribute funds in 2010 to states with active programs, not only those with seismic design category C or higher. Base-level assistance award is \$50k per state plus additional money that may be able to go to CO (probably through Marilyn). It shall be used for EQ awareness, mitigation, and preparedness planning. It may be possible to use the money for equipment, but maintenance is the issue. Operations and maintenance would have to be addressed through some other means. First step is getting CO into the program. Doug will facilitate but needs help from CEHMC.

Topic 3: WSSPC award-Nominate CO EQ Map

Who will write the letter? Due date is October 2, 2009.

Topic 4: CEHMC and CGS School Policy

Rob Jackson followed up with Karen Berry. He was under the impression that she felt like there were other ways to deal with the issue other than changing code. He will call Joe Montoya (Dept. of Fire and Public Safety). Rob felt like she was not very proactive; our approach to invoke a code change was not well supported by her. Rob was hoping that she would have some advice on whom to talk with at a high level. Vince says Karen knows how these municipalities react and what avenues need to be taken. Vince says we need to get the lower level folks educated and on-board with this. Going to the top is not always the right path.

Vince says if Rob can get the IBC code changed, do it, it is a slam dunk. CGS can support that move. Bob likes waiting for WSSPC to get their policy finalized before going to Fire Safety. Then use the WSSPC statement and go to Fire Safety.

Topic 5: Talk by Chuck Mueller on the USGS probabilistic seismic hazard maps.

USGS in charge of national-scale maps for US and US territories

Maps are used primarily for building codes, but also for emergencies, land use planning, insurance rates, research priorities, and retrofit priorities.

Goal: use defensible, transparent, reproducible, nationally uniform methodology.

Use consensus for best current science.

Use peer reviewed info.

Suppose the location of fault and earthquake are uncertain-the fault can generate other events and sizes and rates so how can you estimate the hazard? What is the degree of activity on a fault? The PSHA approach accounts for: multiple seismic sources and ground motion estimates, distributions of parameters, and uncertainties. Base the seismic design on the corresponding “probabilistic ground motion”.

To make the map: create a hazard curve for each site on a grid, select the engineering risk level (10% prob. of exceedance in 10 years), pick the probabilistic ground motion off the hazard curve and map it.

Current state of practice:

Specific fault sources where possible.

Historical seismicity where eq's cannot be associated with faults.

Truncated exponential magnitude-frequency relationships to model eq rates.

Logic trees with weighted branches/

Published ground motion estimates, strong motion empirical data from seismological or hybrid models.

Time independent.

The USGS approach

Use specific fault sources with recurrence times determined from geologic investigations.

Use spatially smoothed historical seismicity.

Use background zones based on broad geologic criteria.

Colorado Hazard

Model most of CO like CEUS region

CEUS catalog ($M_w > 3$)

CEUS ground motions

Rio Grande Rift (WUS)

WUS cat $M_w > 4$

WUS extensional ground motions

Special treatment for man made seismicity

Faults: Cheraw, No Sangre De Cristo, So. Sawatch, faults in No. NM

Future research

Fault characterization

Catalogs

Are Rocky Mountain and Colorado Plateau ground motions similar to CEUS ground motions? WUS? Neither?

Topic 6: Election of another co-chair.

Rob Jackson is the only volunteer for the co-chair position being vacated by Bob Kirkham. Rob was elected by acclamation.

Topic 7: Adoption of Earthscope Seismographs

NW Colorado will leave Oct 2009. One instrument will stay in Maybell. One in eastern CO will stay. Will leave for 10 years. Someone has to agree that it will be monitored for damage. Vince hasn't heard if anyone has taken that responsibility. Anne says IRIS wants them to be part of the backbone, so it will be taken care of, possibly USGS or Anne. Since the FEMA program won't work for purchase, the Nuclear Regulatory Commission is an option. Cannot go over \$100k. Each station is \$30k for equipment and \$10k for com links.

Vince-Daag Numendal is conducting a study that will look at the triggering mechanism and mitigation practices of fault rupture from CO2 sequestration.

CEHMC Meeting 7-15-09

Present: Damon Runyan, Bill McCormick, Larry Anderson, Matt Morgan, Rob Jackson, Michael Haughey, Vince Matthews, Chuck Mueller

Scribe: Matt Morgan

Additions to Agenda-FEMA state assistance program. Added as Topic 3.

Topic 1: Approval of Minutes; e-mail changes made from Rob; motioned, seconded, approved.

Topic 2: Search for a new co-chair to replace Bob Kirkham at the end of 2009. Rob Jackson would be willing to take over.

Topic 3: FEMA state assistance program.

Doug Bausch sent out emails about this. Centers on whether the state has areas that require Seismic Design category D. Colorado had been left out. San Luis Valley and Lake City area could potentially be under D. Why were we left out? Perhaps these areas are too small. This funding was to be used for mitigation. Vince and Doug were in discussion about this, but Rob has not heard if any funding for Colorado will come out of it. Perhaps the CEHMC should write a letter of support. This is an on-going funding source.

Topic 4-Adoption of EARTHSCOPE seismographs and CEHMC's role

Vince spoke with the director of EarthScope at ANSS meeting and person in charge of Nuclear Regulatory Commission, perhaps get money from them and purchase the ANSS stations. Maximum of 3 instruments. Probably 2. Probably not going to get any in western part of state since they will be moving this fall. However, there is no one in Colorado to maintain these. IRIS will do it for \$5000/yr per station. Where will money come from? USGS is not interested in maintaining. IRIS has identified leaving 2 stations, but you need to agree to be a host, for 10 years. One is in NW Colorado the other is on NE border of state with Nebraska. If station goes down the host will check on its status and report to IRIS. Anne Sheehan and Vince are working on a proposal to the NRC for additional monies to buy stations. Vince and Anne spoke with Bob Woodward about securing some funding for 5 years.

Topic 5- WSSPC 2010 Awards-Nominate the Colorado Earthquake Map.

Topic 6-Participate in the 2010 WSSPC/Natural Hazards Center annual conference in Boulder. Vince-Get someone from the NHC on the CEHMC; start a relationship. The CEHMC will want to participate somehow. Rob will make some calls and see what we can do.

Topic 7-Policy recommendation to CGS on seismic safety of schools; WSSPC's policy recommendation and EERI Seismic Safety of Schools Committee.

Rob has been in communication with the head of the EERI Seismic Safety of Schools Committee and monitoring what people in other states are doing.

Oregon has a consensus that there is a potential of a Mw 9 event that can affect the schools. This enables them to get things done.

Rob sent the CGS recommendations to Ron Lynn of Clark County Nevada on July 14, but has not heard back from him. Ron is trying to reclassify School Bldgs from Occupancy Category 3 to Occupancy Category 4 which would help the component design, but not Seismic Design Category A problem.

Referring to the May minutes-

Correction that CGS would not stand by CEHMC recommendations. Not true.

CGS has no land use authority at all. Nothing requiring that the developers or municipality follow our recommendations. Only influence CGS has is the credibility factor. Have they identified hazards on site and have they proposed measures to mitigate. As it was set up, the Department of Oil and Public Safety was responsible for school sites, however legislation this spring put school inspections under Fire and Public Safety. In this legislation, CGS will have to submit their comments before the school site is approved. However, they are not required to follow them but the recommendations will be on record. The CEHMC should outreach to Director of the Division of Fire and Public Safety and say we are the CEHMC, we put together some recommendations and back it up what has happened in other countries. Use ties to EERI and WSSPC. More powerful coming from CEHMC than CGS. CGS will support it. Rob will call Karen and discuss our efforts. Change the recipient from CGS to Division of Fire and Public Safety.

Correct the May minutes-IBC is adopted for school buildings in the State of Colorado; there is no state building code.

Topic 8-Vince, should be designed so that a search on Google and such for Colorado Earthquakes, the CEHMC comes up. We put it under the CGS so we could maintain it. CGS cannot maintain an external site. There are good security measures at the State. Matt will look into domain redirect. The committee says to go with cehmc.org. Vince and Matt will go through and make changes for the CEHMC to see.

Other items:

Colorado DEM is hosting an exercise on a magnitude 6.5 Rocky Mountain Arsenal Event on July 16th at the State Emergency Operations Center in Englewood. Vince and Matt are attending.

Ask State Reps to attend a meeting and give a presentation.

Present to the Colorado Chapter of the International Code Council.

Future topics-Overview on National Hazard Maps by Chuck Mueller.

Next Meeting is September 17th, 2009.

CEHMC Meeting 5-21-09

Present: Bob Kirkham, Michael Haughey, Damon Runyon, Chuck Mueller, Matt Morgan, Rob Jackson

Scribe: Matt Morgan

Additions to Agenda: Need a volunteer to replace Bob as co-chair of the CEHMC. Bob will finish out the year.

Topic 1: Approval of Minutes; e-mail changes made; motioned, seconded, approved.

Additional change- "construction supervisor" to "construction manager", this was said by Karen and not Bob.

Topic 2: New member, Chuck Mueller (USGS), introduction. Will replace Waverly Person. Has a strong background in seismic hazards.

Topic 3: Finish synopsis of WSSPC Annual Meeting-Rob Jackson

In the WSSPC annual report, Doug Bausch pointed out at the 2008 National Earthquake Managers meeting that seismic vulnerability is still a major issue in Utah and surrounding states. The WSSPC Annual Award given to Oregon for their State Seismic Needs Assessment. Write up on CEHMC and CGS School Recommendations included in program. Yemei Wang from Oregon has developed a computer program for the evaluation of buildings. She is very outgoing and at the forefront of earthquake hazard reduction research. Next WSSPC meeting in Denver July of 2010. FEMA initiative to businesses website <http://www.Quakesmart.org>. Construction and Building Codes Committee (WSSPC) went from Category III to IV. Trying to get help on construction components for non-structural hazards. Rob suggested they contact Michael Haughey. WSSPC Basin and Range World Earthquake summit planned for 2010. There was a discussion on the Post-earthquake Technical Clearinghouses. Discussion on EMAC-MOU's between the states. Discussion of MOU's between State Geological Surveys. Go to www.wsspc.org for more information.

Topic 4: School site review policy recommendations-CGS is not willing to adopt our policy recommendations. By the time it comes to CGS it is too late to adopt and enforce the recommendations. The site review doesn't always happen until construction even begins. CGS would have to raise the issue to force the review to come before construction. The enforcement seems very loose and that needs to change. There has been a recent policy change, so maybe that is why things are a bit loose. Maybe because there is no state building code, so no one is there to enforce this. The Division of Oil and Public Safety would issue the permits, but no one was on staff to do the inspections or do them in a timely manner. This will now be done by the Department of Fire Safety. The AG's office took the CGS out of the current legislation because of redundancy. Get a hold of Oil and Public Safety folks and see who is in charge of this. Bob will contact

Karen Berry and get an update. Of all western states only CO has not adopted a state building code.

WSSPC policy recommendation on seismic design of schools. Neither Bob nor Rob has heard anything from them. Rob suggests talking to Ron Lynn.
Rob said it is still in draft form on website.

Topic 5-Additional topic

Rob was contacted by the ASCE local chapter to see if he would like to meet with State legislators and discuss the Colorado Report Card for Infrastructure (ASCE). Met at end of May. Rob had lunch with Jean Libuda (his local representative) to discuss this and Colorado earthquake hazards. Told her about school buildings and the CEHMC initiatives.

Topic 6-Additional topic

Next Round of National Hazard Maps won't be released for 4 or 5 years.

It goes from NEHRP to ASCE to the IBC

IBC 2006 was tied to ASCE 2005.

International Code Council is planning to issue the code earlier than they had planned.

ASCE is on a 5 year code rollout so the organizations are out of sync.

Topic 7-Bob is relinquishing his co-chair duties. We need to find a new volunteer by the end of the year.

Next Meeting is July 15th, 2009.

CEHMC 3-19-09

Notetaker: Matt Morgan

Present: Bob Kirkham, Steve Personius, Mike West, Larry Anderson, Alan Nelson, Cal Ruleman, Sarah Derouin, John Nicholl, Lee-Ann Bradley, Kathy Haller, Lucy Piety, J. Zebulon Moharrey, Michael Haughey, Matt Morgan, Damon Runyan, Chuck Mueller, Bill McCormick, Karl Kellogg, Tony Crone, Bruce Bryant, Mark Peterson, Rob Jackson, Russ Wheeler, 6 others,

Topic 1: New Members Bill McCormick and James Horne were announced. They were unanimously elected via email voting prior to the meeting.

Topic 2: Larry Anderson, USBR, gave a talk on "Gore Range Frontal Fault-Preliminary Results from LiDAR Survey and Field Reconnaissance"

The Gore Range fault is a 45 km long, NW-striking normal fault that dips to the NE. The U.S. Bureau of Reclamation is interested because the fault is about 3.5 km from Green Mtn. Dam. The fault is one of the northernmost Quaternary faults within the Rio Grande Rift. It places Precambrian rocks against Mesozoic sedimentary rocks. There is very little known Late Cenozoic fill on the downthrown side of the fault. The Gore Range is extensively glaciated and landslides are very common. Lots of trees make it difficult to see fault scarps in conventional aerial photography.

In 2007, preliminary field work did not find strong evidence of significant late Quaternary tectonic displacement. The USBR determined LiDAR would be great to see through trees and look for fault scarps. Color aerial photos were flown in conjunction with the LiDAR. Scarps are clearly visible on LiDAR compared to conventional photos. Many of the scarps are in wilderness, so access is difficult. NW of lower Cataract Lake is a 8 m high scarp on a drainage divide. A 20 m high scarp north of Boulder Lake appears to be part of landslide complex. North of South Rock Creek there is 6-10 m high scarp associated with a graben that appear to cut latest Pleistocene deposits. At Buffalo Mountain there is a 2 m scarp in debris flow levee (mapped by Kellogg) and 10 m high scarp in Quaternary landslide deposits (also mapped by Kellogg). East of Salmon Lake there is a 7 m high, NE facing scarp that cuts pre-Bull Lake or Bull Lake deposits.

Conclusions: They were able to identify scarps that appear to be from recurrent late Quaternary tectonic activity. Questions that remain: What is the age of most recent faulting? Is the GRFF segmented? What is the slip rate? What is the recurrence interval? Is there evidence of 2 or 3 late Quaternary events.

Future work: Collect more scarp profiles; soil pits; cosmogenic dates (?)
Cost of LiDAR: The 50 km X 80 km swath cost \$160,000; has resolution of 5-8 ft; can generate topographic maps with 5 ft contour interval; Data could be useful to USFS, because 1st return data comes from tops of trees. The difference between tree top returns and ground surface returns would yield tree heights. Aerometrics collected the data and USBR processed the data and created images.

Topic 3: Synopsis of WSSPC meeting by Rob Jackson

Could tour Wasatch fault or go to Utah State Capitol Building and see seismic design upgrade (Rob took the tour). EERI has a newly-formed ad-hoc committee on seismic safety of schools (WSSPC also has a similar committee for engineering, construction, and building codes). There

is an opportunity for us to get involved with this. Over 2/3 of UT has emergency plans in place for families for EQ events. Construction and buildings codes committee of WSSPC suggests schools should be moved up from Occupancy Category III to Occupancy Category IV.

Post EQ Technical Clearinghouse Committee- Policy recommendation is up for review; will be sending out more info on this. Used a virtual/cyber clearinghouse for Wells, NV event. Seemed to work well. Because of a seismic network in the area, they were able to detect a build up of EQ activity before the main event. Go to EERI Website>Meetings>2009 Business Mtg for more information.

John Parrish, Chair of WSSPC Board, said that if we need support with our school policy recommendation, they would be willing to support us with a letter.

A presentation was given on the FEMA Existing Buildings (ATC 71) Project and NEHRP Workshop. Most of the workshop participants were familiar with ASCE 31 and 41. Most members thought increasing the political will to support mitigation was the way to go.

Topic 4: Update on CGS policy recommendation.

Bob spoke with Vince and Karen Berry this morning. Rob noticed in the new regulations for Colorado State Division of Oil and Public Safety, that the clause that required consultation with CGS (Geologic Hazard Review) for permit applications has been removed. The Attorney General's Office recommended that the Division remove that from their requirements. Karen said that HB 1151 proposes to move the school inspection to the Department of Public Safety Division of Fire Safety. Michael thinks we should take a presentation to local school boards. Karen and Vince are trying to insert additional language into HB that Department of Public Safety Division of Fire Safety will need to consult with CGS. Karen said we shouldn't randomly go to school districts; go to construction manager's representatives first. The professional that represents the client/school could then ask the engineering consultants to upgrade the seismic design. Rob thinks we should talk directly to the owners/schools, who are the ones holding the purse strings. Michael suggests that the criteria needs to go to design teams. Bob recommends that we prepare site-specific presentations if we go directly to individual schools or their representatives. We might also consider going to the part of the community that doesn't care what the code says, but wants a safe school. Michael says it will cost about 1-4% extra to the redesign and build seismic upgrades to the mechanical system.

Topic 5: Earthscope seismographs.

Bob gave a very brief presentation. Two of the Earthscope stations are considered backbone stations (Kit Carson and one in NW part of state). The plan calls for them to continuing operating for about 10 years after the Earthscope array moves on. CGS and DEM are working on a proposal to use FEMA money to adopt other stations. Anne Sheehan and students probably would be involved in the operation and maintenance of the additional stations.

Topic 6: Date, time, and location of future meetings.

CEHMC voted via email to continue to meet at CSM in Golden, at 12 noon. A decision was made to move the meeting to the 3rd Wednesday of the month, pending availability of the room.

Topic 7: New Projects.

It was suggested that we should update the website. Due to time constraints, this topic was tabled until the next meeting.

Meeting adjourned shortly after 2 PM.

1-22-09

Note taker: Matt Morgan

Present:

Bob Kirkham, Matt Morgan, Damon Runyon, Michael Haughey, Bill McCormick, James Horne, John Nicholl, Dave Butler, Rob Jackson, Pat Rogers, Marilyn Gally

Approval of minutes from November, 2008. Some changes:

Topic 4-Discussed need for representatives on council from USGS and Bureau of Rec.

Topic 3- 3rd paragraph, 4th line....your total loss can change by over 50%.

Motioned, seconded, approved.

Topic 1: WSSPC Annual Meeting-Rob Jackson is our official representative. Marilyn will transfer her right to vote to Rob. No topics suggested for Rob to pass along at the meeting. He will give a summary of what the CEHMC has accomplished over the last year.

Topic 2: Update on CGS Policy Recommendation

CGS does not have enforcement capability, just advisory. If the CGS does decide to adopt and use this, the CEHMC will be involved in making presentations to engineers, planners, so they are not blindsided. CGS will push the Division of Oil and Public safety to get behind this.

Topic 3: Adoption of EarthScope Seismograph

40 or 50 instruments are installed in Colorado right now for the next month. Then will be moved eastward. There is the option to buy some of these instruments. They are already installed, machines are up and running. Anne Sheehan, Vince Matthews, and Doug Bausch are putting together a proposal to adopt 5 instruments. Dave Wolny(?) might be interested in looking after the sites in western Colorado. Two of EarthScope sites are being considered for backbone sites; 10 year time frame. One is Kit Carson and one in NW part of state. Anne's Snowmass station is not working due to an equipment failure. CEHMC can help put together some justification for this. A subcommittee would help out with this aspect of the proposal. Bob, Marilyn, and Rob will do this. Others?

What type of money would we be going for; i.e. what is the source of funding? Bob does not know at this point; possibly FEMA. Tie into the State and local government planning process (Marilyn, if going for FEMA money). Cost for one instrument is \$30k + \$5k per year to operate. What is each of the 3 parties involved objectives? Would still tie into the USGS system but still available to students or whomever to do more detailed studies.

What are benefits of these instruments?

Improve accuracy and detection threshold. Overtime this should better characterize any structures that are there. Earthquake swarms need more study. Risk and probability of damaging events; dam safety. Reservoir induced seismicity vs. natural.

Topic 4: CEHMC Members from USGS, USBR, & SEO

Bill McCormick from the State Engineers Office is here. Bob has sent email to the reps from other agencies to get them to come. Bob called Mark Peterson (USGS), he would like to but is very busy with other items. He will talk to the local chief of hazards for USGS and will ask her to choose a person from USGS. Larry Anderson (Bureau of Rec) has run into meeting conflicts on Thursdays. But he will still be the USBR rep.

Topic 5: Discussion of new meeting location, date, or time.

The CSM location is good. John Nicholl has offered up use of his conference room in Tech Ctr. Possible days are the 2nd Thursday or 3rd Wednesday of each month or as is currently. Time stays the same.

Topic 6: Bank Balance

Nothing new. John needs to track down more paperwork. Wachovia could not find the account.

Topic 7: New projects

Presentations to building inspectors; maybe wait to see how the CGS policy recommendation shakes out. Improving recommendations to the State inspectors or someone from Oil and Public Safety on how they do inspections.

Update CEHMC Website.

Topic for next meeting/talks

Rob will give recap.

Larry Anderson talk on Gore fault.

Dave Wolny on his seismic network.

Next Meeting March 19, 12-2 PM.

11-20-08 CEHMC meeting

Present: Rob Jackson, Bob Kirkham, Damon Runyon, Matt Morgan, Marilyn Gally, Rich Hansen, Michael Haughey, Paul Santi

Note taker: Matt Morgan

Topic 1: Approval of minutes from September 18 meeting, motioned, seconded, approved

Topic 2: Celebrate completion of policy recommendation to CGS-Bob brought some sparkling juices. Update on this each meeting.

Topic 3: EERI Workshop Presentation-Matt and Rich

In essence, the workshop was organized to allow those in attendance to have input into the "Guidelines for Developing an Earthquake Scenario" document

(<http://mitigation.eeri.org/files/Developing.a.Scenario.pdf>). Several suggestions were made, including: defining what a scenario is, the ultimate scope of the scenario, identifying the key stakeholders, identifying the development team with more specifics (workgroups), create a more effective Gant (work flow) chart, choosing the proper project manager, explain the secondary effects of an earthquake event (liquefaction, landslides, etc.), and a listing of possible funding sources (many people couldn't name ONE).

The morning sessions were invited speakers, several summarized the results of their scenarios (Seattle fault, 1906 San Francisco, So. Cal Shakeout, Wasatch fault). The Southern California Shakeout (<http://www.shakeout.org/>) was one of the more interesting scenarios in that it will involve millions of people in Southern California that will be part of an earthquake drill on November 13th. The scenario will model a Mw 7.8 event on the southern San Andreas fault. Be sure to watch the videos on the above link. They are spectacular.

Hope Seligson gave a nice presentation on Hazus and strongly encouraged all of those who use it to customize their own data. Get better building data from your assessor; get a more detailed landslide and liquefaction coverage. By doing these can change your total losses by up to 50%. I think this made many jaws drop (including mine).

Why do we run scenarios? This was asked by several people. The discussion went on, but in general the answers were: to pass legislation, increase community awareness, and to change building codes to reduce the hazard.

Ivan made some key points at the end of the workshop that he wanted me to pass along. They dealt with getting the word out and keeping up the interest after the scenario was run.

-Effective presentation is critical to public awareness

-Identify stakeholders first

-Make your message relevant to the audience (ex. Say the" EQ would cause \$40 billion in damage to insurers; 50% of houses like yours would be destroyed to the general public")

-Create a distribution list of all interested parties

-Make your message compelling

-Good graphics are essential. Maps very important

-Show EQ damage pictures

-Use the MEDIA!

-At every opportunity, try to get your audience to commit to action

-Don't stop communication after your present your final results

-Avoid giving single numbers for losses, for ex. Say 40-400 deaths

-Photo opportunities with those in high places, then use for your presentation

EERI is looking for comments in regard to the Guidelines booklet. If you would like to submit comments, you can do so at: www.nehrpsenario.org.

Topic 4: CEHMC members from USGS & USBR

Mark Petersen (USGS)-Talk to him directly, and let him determine the proper channels for USGS approval. Larry Anderson (USBR)-Ask him who could be an official rep for the USBR. DWR at the DNR? New director, so it would be good to introduce the CEHMC to him.

Topic 5: New meeting location, date, and time

Bob to send out an inquiry to all the members and ask about a change in venue.

The current venue is probably the best around. Stick with 3rd Thursday for now.

Topic 6: Transfer of bank balance from CSNHR

John Nicholl tracked down the money, currently residing at Wachovia (Wells Fargo). What are appropriate avenues to transfer money over to CEHMC?

Topic 7: Should CEHMC be a Seismic Safety Commission

Appointed by a higher gov't entity? Damon says in Hawaii, it was self-defined, but a formal organization. Hopefully we would get some funding, to promote hazard awareness. Do we want to get involved with government? No real consensus.

Other topics for future meetings:

Earthquake technical clearinghouse, seismograph purchase.

9-18-08

Note taker: Tom MacDougall

Present:

Bob Kirkham, Damon Runyon, Michael Haughey, Rob Jackson, Wayne Charlie, Marilyn Gally, Tim Greer, Tom MacDougall

Item 1: Amendments to the Agenda. A request to add discussion regarding House Bill 08-1335. There was some discussion as to what is the review and permit process for schools. HB-08-1335 relates to creating a new department regarding building/retrofitting of schools within the department of education. Specifically, two FTEs are appropriated. There was a suggestion to group natural hazards to increase the success of guarding against earthquake (i.e., say natural disaster such as flooding, tornados, and earthquakes).

Item 2: Approval of minutes from July 17, 2008 – Should change the date of the next meeting to September 18, 2008. Revised minutes were unanimously approved.

Item 3: Policy Recommendation to the Colorado Geological Survey on the Seismic Design of Public Schools.

Jill Carlson, with the CGS land-use review team, provided suggestions on the proposed CEHMC policy recommendation. Comments included:

- The version with the non-structural components was preferred by her.
- The CEHMC should assist CGS in publicizing the CEHMC policy recommendation to groups like AEG, CAGE, SEAC, etc. Perhaps the recommendation should be included in their organization's newsletters.

We discussed our approach. Generally it was agreed that we wait to publicize until the policy is accepted by CGS and State Department of Labor Employment, Division of Oil and Public Safety. Most concurred; no one voiced opposition. Then CEHMC members could assist in publicizing to regional professional groups.

Item 4: Vote on which version of the policy recommendation is preferred.

Council voted on which version to adopt (includes in-person & emailed votes).

Council vote for **with** non-structural components = 9

Council vote for **without** non-structural components = 0

one vote was received that either version was acceptable

Vote is closed. Version **with** non-structural components wins.

Item 5: Minor modification of wording in recommendation:

1. The new first sentence recommendation will read:

The International Building Code Seismic Design Category A shall not be used for design of schools in Colorado. Colorado schools shall be ...

2. Include Document title and chapter and Section when referencing ASCE documents.
3. Under “Background Information”, 4th Paragraph, last sentence, include the word “officially” prior to the word “designated” and add the words “as build under this rule”.

Item 6: Discussion of changing meeting time, location. Bob Kirkham will send an email requesting input from members.

****NOTE:** There was additional discussion related to the exact wording of the Policy Recommendation that was not recorded in these notes.

Next Meeting: November 20, 2008.

7-17-08

Note taker: Matt Morgan

Present:

Bob Kirkham, Matt Morgan, Damon Runyon, Michael Haughey, Rob Jackson, Jim Harris, Wayne Charlie, Pat Rogers

Approval of minutes from March and May
Change ASCE 7-03 to 7-02 in May minutes.

Topic 1: Rich Hansen and Matt Morgan have been approved to go to EERI Earthquake Planning Meeting Workshop in October.

Topic 2: Policy recommendation to CGS for school site reviews.

Review of FEMA's Risk Management Series Design Guide for Improving School Safety in Earthquakes, Floods, and High Wind-Jan 2004, Chapter 4. Use performance-based design if code-based design does not meet acceptable risks. What is performance-based design?

Performance-based design refers to a sophisticated response to earthquake ground motion-calculating the time history of the response, and calculating all the uncertainties on a probabilistic basis. Tries to attach statistical models to the event. Enormous up-front cost. There has been a push to set down better guidelines on to what goes into performance-based designs. It varies by city. In Colorado, at least in the near-term, this will likely not be used for our schools or any structures for that matter. The economics are not there.

The State has made things worse more than better, effectively removing local control over design. This document helps to overcome this.

Modifications to the CEHMC document. Jim: in Seismic Design Category D, don't worry about anything lightweight and close to floor. In C, exempt mechanical and electrical items are exempted. In B, most architectural things are exempted.

Doesn't want to lose action on the policy if someone picks it apart and says this non-structural stuff is not economically reasonable. Michael: These unattached non-structural items can cause death if they fell on you-guaranteed. All you need is a wire, strap, or clamp to attach most items. Boilers and chillers will cost more, but the overall cost is very minimal.

Change the sentence above the stipulation to "therefore propose that a RECOMMENDATION be placed upon..."

Going with changing Seismic Design Category B to C. No A.

Jim suggests we consider sending a letter to all on the roster with this attached and get comments. Then call for the vote.

Bob suggests providing the document with the non-structural attachments and one document without it. Submit these two documents to the Committee.

Of the 5 subcommittee members, 2 are for including the non-structural attachments in the document; 2 are on the fence and 1 is against.

Seismic Design Parameters program from USGS.

<http://earthquake.usgs.gov/research/hazmaps/interactive>; java ground motion parameter calculator

Next Meeting: September 18, 2008

5-15-08

Note taker: Matt Morgan

Present:

Bob Kirkham, Matt Morgan, Damon Runyon, Michael Haughey, John Nicholl, Dave Butler, Rob Jackson

Approval of minutes from March – next time

To do:

PDF files of the EQ Map to the website and mailed to members

Press release of 125th anniversary of 1882 event, sent to members

Press release for EQ and Fault Map

Topic 1: Publication status of EQ hazard map.

Map is printed and ready for distribution.

Topic 2: Candidates nominated for EERI earthquake hazard scenario workshop in San Francisco. Rich Hansen (CDEM Mitigation Recovery Team) and Matt Morgan (CGS) are nominated; one candidate will be selected. The workshop is in September.

Topic 3: Policy recommendation to CGS for school site reviews.

Rob put together the next draft of the policy with Jim Harris, Michael Haughey, and Wayne Charlie. Jim suggested we go from Seismic Design Category B to C.

Only time you are in Occupancy Category III is if you have over 250 kids; for a college it is over 500 kids. In any case, we suggest using Jim's recommendation.

Need to put in a sentence about the non-structural attachment exemptions, that refers also to ASCE-7-02. The current document refers only to ASCE-7-05.

We are on board for going from A to B. What is the effect of going from B to C? More detailing, more....for next time.

The subcommittee needs to get Jim's thoughts on Michael's non-structural text.

Rob's feeling is if we are going to C, we already crossed the line and going beyond the code. He doesn't have a problem with the non-structural text.

The non-structural comes into play for Design Category C only if it is designated an emergency shelter as well. If he is on board, let's finalize it and send it to the mailing list.

Topic 4: Transfer of bank balance

No progress.

Topic 5: Recent CO Earthquakes

On average 2 per month from February on. This is likely due to more instruments.

Future talk: Dave Noe, final results of Anton trench

Next Meeting: July 17

3-20-08

Notetaker: Matt Morgan

Present:

Bob Kirkham, Matt Morgan, Damon Runyon, Anne Sheehan, Michael Haughey, Doug Bausch, Wayne Charlie, Rob Jackson

Approval of minutes from the January meeting, motioned, seconded, approved.

Topic 1: Publication status of EQ hazard map

Copy the folding pattern of the old version of the map. Note the fold on the bottom.

Topic 2: Policy recommendation to CGS

There have been multiple communications with Jim Harris. He said he would get to it. That was back in January. Maybe we should write it and give to Jim for review. Rob will write up a draft within the next couple of weeks. Circulate it amongst the subcommittee and Bob.

Topic 3: Transfer of bank balance from CSNHR

Going to try and access the account, change name on account and names on signature card. John Nicholl is looking into it.

Topic 4: Update on new seismographs (ANSS & USARRAY)

Anne Sheehan update. Earthscope is an NSF experiment with a 10 year duration. Portable seismic station. There are permanent stations in conjunction with USGS and IRIS. Anne is working with IRIS to get control of those since USGS is dropping out. IRIS is encouraging states and institutions to adopt the stations. \$20,000 to buy and \$5,000/year to maintain. Anne thinks we could justify having these stations. Doug will see how AZGS does it, since they are going after FEMA monies. Tom MacDougall said he might have some dam owners that may have some money to put toward this.

Anne also has a GPS project that will last until 2011. See her website for more details. See if the Rio Grande Rift is propagating north. Going to also reoccupy 26 sites that were used in 2001. See what movement was over 7 years.

Topic 5: 1882 compilation of reports

Would be great to have a digital publication on the CGS website. Wayne is putting together several articles. Matt will devote some time to this and start putting together a digital archive.

Topic 6: National earthquake conference and proxy for WSSPC

April 22-26 Seattle. Vince could act as a proxy for the CEHMC.

Topic 7: Preliminary discussion on becoming a Seismic Safety Commission

Damon-We do not really have any official authority and this would give us more credibility and we would be more effective. Rob says the roots of this group are quite official and we are not ad-hoc. But it would be a good way to get more sources of funding; we do not have any now. It has helped Utah to endorse, sponsor resolutions, sponsor legislation. It would likely be up to CGS and DEM to lobby for us.

Future talk: Dave Noe, final results of Anton trench; Steven or Shawe on young faulting CO piedmont.

Next Meeting: May 15

CEHMC Minutes
November 11, 2007

Notetaker: Matt Morgan

Present: Marilyn Galley, Bob Kirkham, Paul Santi, Damon Runyon, Wayne Charlie, Tom MacDougal, Hans Callum, Jill Carlson, Rob Jackson, Michael Haughey

Topic 1: Approval of minutes from the September meeting; motioned, seconded, approved.

Topic 2: Presentation by Jill Carlson on the Colorado Geological Survey Land-Use Review Program. School sites, areas of state interest (public facilities) require a review by CGS. SB35 sends most of the work to CGS-subdivision planning. Look at natural hazards, primarily geologic hazards like landslides, rockfall, mudslides and debris flows, swelling soils. Subsidence from old mines, methane seeps, avalanche paths, collapsible soils and sinkholes, and floods have numerous hazards.

CGS is a non-regulatory agency. Any enforcement must come from the local government agency. CGS makes recommendations to specific lots in regard to moving them out of a hazard area. Most counties require an engineering study at the time of the permit. CGS reviews the suitability of the site for building. What about seismic in reviews? There is a lack of felt earthquakes within the review sites, typically, so there is not much time spent on seismic hazards in the review.

Review process:

1) Receive a file from the developer that contains architectural info, drainage report, topographic map, occasional geotech report, or general geology write-up. If school site, CGS gets the plans as well. Check for consistency between plans and geotech report.

2) Use available geologic information and site visit to review potential building site.

3) Draft letter to planner making recommendations based on CGS geologic investigations: feasibility of development, identify hazard areas, referencing specific lots, additional investigations (if needed), potential development constraints and hazard mitigation methods. Also, attend meetings and provide resubmittal of reviews.

Topic 2: Policy recommendations to CGS school site reviews

Rob- Should be seismic design category B (minimum) for Denver, but how far do we extend this? Damon doesn't agree with this idea; suggests we get Jim Harris's opinion on the matter. Ground acceleration would be covered by the code requirements. Do we need to factor in surface rupture of a fault? Rob-there are near-fault requirements in the code (includes rupture and liquefaction). Michael recommends getting rid of exemptions for non-structural attachments. This would be the second part of the plan.

Topic 3: 1882 press release was released on 11/1/2007.

Topic 4: Earthquake hazard map. Update the EQs with most recent events. See Bob for comments. DEM will certainly cost-share with CGS. Committee would like to have a pub number given to it maybe as an MI. FEMA federal funding should be stated on the map. See old map.

Topic 5: WSSPC Policy Recommendations. Active fault definition for basin and range province. Did Colorado adapt these definitions?

Next meeting January 17, 2008.

CEHMC Minutes
September 20, 2007

Notetaker: Matt Morgan

Present: Bob Kirkham, Michael Haughey, Dave Butler, Larry Anderson, Pat Rogers, Wayne Charlie, Tom MacDougall, Rob Jackson

Topic 1: Approval of minutes from July 19, meeting motioned, seconded, approved.

Topic 2: Earthquake hazard map review. See Bob for comments.

Topic 3: 1882 Press Release-Input from committee. Scan or excerpts from old newspaper articles. New York Times article. Present the CGS's Hazus scenarios but also state the cost to upgrade and enforce. Mention there is no state building code. Vince should prepare and then email to the CEHMC. Send the press release to Colorado Historical Society as well to get in the "This date in history.."

Topic 4: School site reviews or lack thereof. Wayne Charlie-Any school must get approval from the Colorado Division of Oil and Public Safety. Under section 4-5-1 it states the "preliminary review package should include...the results of Consultation with the Colorado Geological Survey, as required by C.R.S. 22-32-124 (1)."

Possible guest speaker: Celia Greenman about school site reviews.

CEHMC Meeting of July 17, 2007

Notetaker: Matt Morgan

Present: Bob Kirkham, Vince Matthews, Dave Butler, Matt Morgan, Michael Haughey, Tom MacDougall, Damon Runyan, Larry Anderson, Lucy Piety, Tim Greer

Topic 1: Additions to agenda; USArray: Every state has the opportunity to purchase these seismic stations and keep permanent. The USArray is an 18 month operation that will commence in approximately in late 2008 for Colorado.

Topic 2: Minutes motioned by Vince Matthews, seconded by Tim Greer. Minutes approved.

Topic 3: Lucy Piety from the U.S. Bureau of Reclamation gave a presentation of the Log Hill Mesa and Busted Boiler faults on the southeast edge of the Uncompahgre. Busted Boiler fault is west-facing with the scarp uphill facing. Multiple drainages were captured and eroded along the fault. Approximately 60 meters of Dakota Sandstone are offset to the north. It is difficult to say if this is an eroded ancient fault or a fault that has offset during the late Quaternary. Trench P8- 2 events at about 50 ka and 9.2 ka, faulted bedrock and colluvial wedge deposited during the 9.2 ka event. Trench P2- 2 events at about 15-20 ka and 5-7 ka. Trench P4- One event at 5 ka. Trench P7- Alluvium sheared at 8-9 ka. On the north end of the fault, the youngest event is at 8-10 ka, older event <50 ka. Quaternary deposits displaced in trenched P6-P8. The south end of the fault the youngest movement is at 5 ka and the oldest between 15-25 ka.

Topic 4: Earthquake hazard map text – Send to Kirkham. How many map 2.5 or greater earthquakes are there? Send Bob a clean copy of EQ text.

Topic 5: Policy recommendations to CGS for school sites. CEHMC should recommend incorporating something about seismic design in school site reviews. Rob Jackson suggests eliminating seismic design category “A”; Michael Haughey suggests eliminating exemptions from non-structural attachments. Damon Runyan is concerned about the CEHMC making recommendations that fly in the face of the rest of engineers.

Next Meeting Sept. 20, 2007.

CEHMC Meeting of May 17, 2007

Notetaker: Marilyn Gally

Present: Rob Jackson, Bob Kirkham, David Butler, Michael Haughey, Damon Runyon, Larry Anderson, Wayne Charlie, Marilyn Gally

1) March minutes passed. Rob Jackson had a few changes previously submitted for January and March minutes.

2) Review of EQ hazard map

Nearly the entire meeting focused on changes to the map and text. Vince Matthews submitted his comments in writing to Bob, since he could not attend the meeting.

- Discussion of whether to remove Rulison and other nuclear blasts.
- Discussion of changing “known” to “suspected”, or eliminate “known”.
- Discussion of clarifying Modified Mercalli Intensity section (probably not) and maybe adding “reported”.
- Discussion of making the color of circles and boxes different (probably not).
- Discussion of fault from Lake City to Creede (Larry suggest we refer to USBR Silverjack report).
- Many text changes were discussed. Some follow:
- Changes: First column (panel) “Starting in the 1950s” to 1960s. Maybe reword “to locate and measure the magnitude of”. Add “If seismographs ‘were more numerous’ and ... Change by to be. Change “are determined” to “are estimated”. Move “Most damaging earthquakes ...” sentence to first sentence of paragraph. Change “on the back side of the sheet” to “accompanying”. Thousands of other faults ... then add “but few have been studied in detail. Change which to that. Remove some commas. Map development – add “potentially” hazardous faults. Remove “The map is revised and updated ...”
- Changes: Second column (panel) The group decided to keep working on the first paragraph. There was some discussion about changing this section because it took so long to write the first time. Potentially add “Some potentially active faults cannot be seen on the Earth’s surface”. Change “should” to “could”. Add “based on recent studies” after “... magnitude to 6 ½ to 7 1/4”.
- Third column (panel) Change one last COEM to CDEM in 3rd column.
- Set consistent type and format on 4th column.

3) Policy recommendation for CGS – subgroup needs to get together and will ask Vince for guidance on how to prepare a policy statement. Can check with Celia Greenman also because she would be implementing.

4) WSSPC draft policy recommendations due tomorrow. None prepared.

5) A press release sounds good for the 125th anniversary of the 1882 earthquake. Can CGS prepare it? Put on the next agenda.

6) Vince-AASG report to Steering Committee for ANSS.

7) Microseismic network in Paonia – Dave reports there are ~10 stations that have run for ~1.5 years. Network monitors for earthquakes, primarily ones related to active

coal mines. Network installed in response to concerns about stability of nearby water reservoir due to ground shaking. Landslides also affect the reservoir.

CEHMC Meeting of March 15, 2007

Notetaker: Matt Morgan

Present: Rob Jackson, Bob Kirkham, Paul Santi, Vince Matthews, Dave Butler, Matt Morgan, Michael Haughey, Tom MacDougall, Damon Runyon, Larry Anderson, Pat Rogers

Topic 1: Send minutes from January 18, 2007 meeting to Bob

Topic 2: Review of EQ hazard map

Dave Butler sent a message to John Nicholl about the magnitude and intensity section of the write-up. Dave has heard nothing. Mail copies to the interested members. CGS will publish if DEM will not have available funds.

Magnitudes for RMA events on map-Leave as is (USGS). Add a sentence about uncertainty of the magnitude into the magnitude and intensity section.

Topic 3: Policy recommendation to CGS for reviews of school sites. Pat Rogers championed this a few years ago to have a positive effect on building codes for schools. Rob Jackson had made recommendations to ASCE. He recommends changing, for an Occupancy Category III and IV (both pertain to schools and essential facilities), the seismic design category from A to B. The problem is the 1% is only 1/8 of the equiv lateral force that the current code and the USGS maps would otherwise require. Dave Butler suggests the CEHMC should endorse this. Vince (CGS) said he will gladly listen to the proposal; it would be useful coming from the CEHMC; however, ultimately, it is up to the counties if they choose to adopt. Michael Haughey suggests we should move it to seismic design category C, and forgo A and B. This is a level where it would actually help during an EQ. There is objection within the CEHMC to this. Tom MacDougall suggests we put together a subcommittee to better determine the CEHMC opinion on the matter before moving forward. This discussion will be continued as there is interest in it.

A subcommittee is motioned, seconded, approved. Michael, Damon, and Rob will work up some verbiage for the May meeting.

Vince abstained from vote.

Topic 5: Website address: Matt spoke with DNR Web Admin. The address will be fixed once the new website is up and running. Vince and Matt are working on this now.

Topic 6: CGS purchase of seismic stations-Vince looking into how to convert EARTHSCOPE seismographs to ANSS. USGS however, needs money to keep the instruments operating. Does the money go to CGS or ANSS?

Topic 7: ANSS-Rob-John Price from NV Bureau is new chair of ANSS. No info on Colorado stations.

Topic 8: Post EQ Technical Clearinghouse Plan-Vince suggests that we put this aside for now until after the WSSPC meeting.

Topic 9: Model ordinance for local governments. CEHMC should stay focused on the policy recommendations first and decided upon.

Topic 10: Rob's proposed code. See Topic 4 above. Should CEHMC draft a letter of support to provide to ASCE?

Next Meeting May 17, 2007.

CEHMC Minutes January 18, 2007

Notetaker: Matt Morgan

Present: Bob Kirkham, Pat Rogers, Michael Haughey, Rob Jackson, Dave Butler, Tom MacDougall, Vince Matthews

Topic 1: Additions to agenda

-New business: Michael Haughey would like to see the exemption for non-structural attachments removed.

Topic 2: Approval of minutes from Sept. 21 and Nov. 16, 2006. Approval of minutes motioned, seconded, and approved.

Sept. 21 comments: "Adopting seismic design category B for all structures", and "less than .67% G values for S1 (short period spectral acceleration)."

Topic 3: Review of new EQ hazard map

John Nicholl and Dave Butler will edit and re-write the magnitude and intensity section of the text.

Vince suggests we not use the term Richter. Richter initially did the magnitude scale but the NEIC now uses just the word magnitude.

Title: "Colorado Earthquake and Fault Map" with subtext

Showing location of historical earthquakes and known or suspected geologically young faults. Not everyone agrees the title should be changed

See Bob for other comments not addressed here.

Move "what to do" into 4th column, reduce size of Acknowledgements and Map Server and merge Map Server with More Information.

Move Mag and Intensity and MM Scale into 3rd column.

Photo caption: last...these 14,000-foot+ peaks loom 6500 feet above the valley floor.

Displacement of late Quaternary deposits by this fault document multiple, strong earthquakes during the last 130,000 years. Add white line to photo.

Random earthquake sentence (Bob). Sentence about our ability to accurately locate earthquakes, especially felt reports, which have an even higher positional uncertainty.

Sentence will be written on-line through email.

Remove fault "zones".

Primary hazards include surface displacement and severe ground shaking in epicentral area (Pat).

Check the EQ table, are those accepted magnitudes at the arsenal? Check with USGS and Stover.

Future: EQ Map text. Update CEHMC EQ fact sheet.

CEHMC Meeting of November 11, 2006

Notetaker: Matt Morgan

Present:

Vince Matthews, Bob Kirkham, John Nicholl, Anne Sheehan, Marilyn Galley, Matt Morgan, Mark Peterson, Kathy Haller, Larry Anderson, Monica Guerra, Rob Jackson, Tom MacDougall, Pat Rogers, Damon Runyon, Paul Santi

Approval of minutes-No minutes from last meeting

Topic 1: Earthquake Hazard Map--Continued discussions and development of the map. Suggested modifications included the following:

Tone down DEM. Change EQ symbols from yellow to magenta. Intensity squares should be brightened and same color as EQs. Add to text that "An interactive map is available on-line" and that detailed information for each fault on the map is available on-line. Briefly describe what they will see in the on-line database. Subdue the road labels. Only show EQs >3.0 and above. Make the spread bigger for symbol sizes. Anne will attempt to match intensity sizes to magnitude. Add Mesa Verde ANSS station.

Break out faults into 2 categories; one is faults with movement during past 130,000 years and second is faults with movement during Quaternary. Remove evaporite areas. Bob has additional notes on the hard copy of the map examined at the meeting.

Topic 2: Web address, DNR still fixing.

Topic 3: ANSS: USArray will be going through Colorado in 1 ½ years. Earthscope GPS, Seismic. USArray will have 400 broadband stations with 70-80 km spacing. 2 year deployment. GPS will be deployed for ~10 yrs according to the Plate Boundary Observatory (PBO) website. Perhaps CEHMC should draft a letter for purchasing seismic stations from IRIS or USArray. About \$30k each.

Topic 4: Post EQ Technical Clearinghouse Plan. Marilyn Galley-New director (George Epp) of DEM will have a look at the PEQTCP. Tim suggests pre-leasing trailers from Qwest then we can have a full computer lab and place to work.

Next Meeting: January 18, 2007

CEHMC Meeting of September 21, 2006

Present: Michael Haughey, Damon Runyan, Rob Jackson, John Nicholl, Laura Nay, Bob Kirkham

Notetakers: Bob Kirkham & John Nicholl

Topic 1: Additions to Agenda:

- Another EQ swarm in Raton Basin
- New data for USGS seismic hazards maps

Topic 2: Approval of minutes from July 20 meeting: Motioned, seconded, approved

Topic 3: Old business

- Potential new members: Keith Morgan-City of Denver structural engineer; Patrick O'Connell-Jeffco Geologist; Ben Cook-J.R. Harris & Assoc.
- Updated CDEM earthquake hazard map: not yet ready for review; will be main topic of Nov. meeting
- Policy recommendation to CGS for reviews of school sites: Much of the meeting was spent discussing the pros and cons of the council preparing a policy recommendation for use by CGS when reviewing school sites. Some council members present at the meeting were strongly in favor of this, and others were hesitant. It was suggested that an email be sent to all council members asking whether they felt it was appropriate for us to initiate such an effort. One option might be to recommend that all school sites adopt category B of IBC as a minimum. Rob mentioned that Jim Harris supported the City of Denver doing this. Damon suggested that we prepare a map showing which areas in the state would be affected by such a move. Rob indicated it probably would apply only to areas between the 0.04 and 0.06 %g contours. This topic will be discussed at future meetings.
- CEHMC web address: No new information on this topic
- ANSS update: Briefly discussed the document by Nevada to increase ANSS funding. Also discussed need to follow up on our request to Colorado's congressional members, especially Senator Allard, for an earmark for more ANSS seismographs in Colorado.
- Model ordinance for local government: Postponed to future meetings
- Post-Earthquake Technical Clearinghouse Plan: CDEM will be getting a new director in the coming months. We should delay seeking approval of the plan until the new director is in place.

Next Meeting- Nov. 16

CEHMC Meeting of July 20, 2006

Present: Bob Kirkham, Matt Morgan, Michael Haughey, Damon Runyan, Rob Jackson, Pat Rogers

Note taker: Matt Morgan

Topic 1, Additions to Agenda:

- Update member list
- Update Website-Matt is unable to because of a new CGS website. Templates are not installed yet and CGS does not have a webmaster.

Topic 2, Approval of minutes from May 11 meeting: Motioned, seconded, approved

Topic 3, Old business

- CEHMC Web address: Matt spoke with DNR webmaster who will submit the cehmc.state.co.us during the next round in late Sept.
- Possible new members: Keith Morgan, Denver building plans reviewer and stuct engineer; Patrick O'Connell, Jeffco Geologist; Ben Cook, Jim Harris & Co.
- Post earthquake technical clearinghouse: Ready to go. Stuart Sipkin will be USGS representative.
- ANSS funding request: Allard tried to get the money earmarked. They were unable to do so; however, they would like to work with CEHMC to seek new funding sources. Bob will call them since the email was returned. Jim Price, the Nevada State Geologist, is trying to get funding. There will be a 2 day meeting in Utah in Sept. on the ANSS project (according to Rob).
- Nevada also wants to use GPS to monitor crustal movements and trying to get more money for NEHRP.
- Rob Jackson wrote letter of support for National Dam Safety Program due to the increase of the number of non-safe dams from 1983 to 2001.
- Colorado Earthquake Hazards Map – show only ANSS stations or other specified purpose seismographs. Why not active seismographs? PDF to the group eventually for review.
- Policy recommendations: Need discussion with Vince Matthews (Colo State Geologist). Minimum code recommendations for schools throughout state or in certain zones. Rob suggests minimum seismic category B for schools.

Next Meeting- Sept. 21.

CEHMC Meeting of May 11, 2006

Present: Bob Kirkham, Matt Morgan, Dave Butler, Larry Anderson, Wally Prebis, Rob Jackson, Marilyn Galley, Paul Santi, Damon Runyon, Vince Matthews, Michael Haughey, Pat Rogers

Notetaker: Matt Morgan

Topic 1: Approval of minutes, motioned, seconded, approved.

Additions to agenda: Mesa County is interested in running HAZUS scenarios and using CGS HAZUS results. This is a tabletop scenario then becomes full-scale after a certain period of time. Will happen shortly, Vince sent CGS' results this week.

Topic 1: Old business

- CEHMC web address- Matt look into it at DNR
- New reps needed from City of Denver and USGS. What about county reps?
- Post EQ technical clearinghouse plan-Letter from AAPG? Bob will check. The plan is done CGS and CDEM will need to enact the plan. EERI and AEG have offered the use of an employee. Marilyn has to run the plan by the new DEM director.
- CGS/DEM earthquake map - Suggestions for the text. Just Quaternary faults on map; no dams; grey DEM, ANSS and other seismic stations; qualify ANSS from other stations. What about the USGS hazard maps? Those could be added as small inset maps; need to edit the text, much can be made smaller. If the USGS Haz maps are put on the plate, just state that these are maps that are used in driving the building codes, they are still controversial, and refer to the appropriate websites. No more than this is needed. Maybe they shouldn't be on the map...because each building site/location should be characterized individually and these maps give a false sense of security. Have a paragraph on how structures are designed, they use USGS map and the maps drive the code then refer to appropriate websites.

Vince suggests to put the map on the back and use Bob's small write-up.

Change the title?

Matt, can you have a draft map by next meeting. No text, but will try.

Topic 2: New business

- Report on WSSPC- Basin and Range policy was adopted; some small changes. Presentation by IBC folks, lifetime achievement award to Lloyd Cluff and Christopher Rohan. About 1/2 of the other states had joined WSSPC. Meeting by Basin and Range Earthquake Working Group-stated the USGS should incorporate info on uncertainties of slip rates and recurrence intervals on BRP faults; have regional working groups are needed to develop consensus slip-rate/recur interval distributions on significant faults; USGS should continue to develop time-dependent maps as a research project, focus more on timing of most recent events, avg. recurrence, and coefficients of variation for recurrence.
- Projects

- Development of CO EQ Scenario-Mesa County, above. Palsiade, Fruita, GJ will be included. CGS working on publishing results of HAZUS scenarios for Colorado. Will be put on web, but committee should be given the opportunity to review.
- Bob update on Williams Fork-Still waiting on some of the dates from USGS. About ½ are in.
- Small seismic networks being put in at 2 new coal mines near Paonia.

Topic 3- Future Speakers- Award winning coal mine near Paonia. Wally Prebis, code issues.

Next Meeting- July 20.

Colorado Earthquake Hazard Mitigation Council

March 16, 2006

Notetaker: Matt Morgan

Present:

Bob Kirkham, Michael Haughey, Rob Jackson, Dave Butler, Tim Greer, Lauren Heerschap, Matt Morgan, Marilyn Gally, Vince Matthews, Damon Runyon, Pat Rogers

Topic 1: Approval of minutes from November, 2005 and January, 2006, motioned, seconded, approved.

Topic 2: Change date of next meeting to May 11, 2006.

Topic 3: Old business

ANSS-

Bob reported that John and he had sent requests to earmark additional ANSS funds for Colorado seismographs to Colorado's entire congressional member. John also forwarded a copy of our letter sent to Senator Allard to Harley Benz, USGS. That apparently prompted the USGS to finally respond to our past communications to them. In an email from Alena Leeds, USGS, she stated that the cost of ANSS seismographs is dependant on the type of station. A regional broadband station typically is around \$45k. If the station cannot be transmitted by line of site to an internet drop and a VSAT is needed, that would add about \$1500 for the equipment and \$200/month for satellite service. An ANSS backbone station, such as the one as Sand Dunes National Park is around \$55,000-\$75,000. If the site is remote, the costs related to VSAT would have to be added. We had requested an earmark of \$150,000 for 3 stations, which have covered the cost for 3 regional broadband stations, but not 3 backbone stations.

Diana DeGette's office showed the most interest to our letter, and suggested that we should send an appropriations request to her office. We also received responses from the offices of Senators Allard and Salazar and from Representative Salazar. All responding congressional members asked that we submit any earmark requests using their specific appropriations request forms. If our request to earmark additional ANSS funds for Colorado this year, we should consider doing it again next year, but we will need to start earlier, as the deadline is typically around March 1. Future requests should begin by contacting each congressional Legislative Director in Washington to build support for the request prior to submittal and to clearly establish which of the members will be supporting the request.

Alena explained that the USGS decided to forego the Kit Carson station because of noise problems and the fact that they are proceeding with the installation of a station in Ogallala, Nebraska, which will help to locating EQs in northeast Colorado. She also stated that the station near Maybell is delayed because they learned that the USBR is installing a high quality regional broadband station in NW Colorado that may supplant the need for a station near Maybell and because of difficulties encountering while attempting to permit a station in a cooperative relationship with Dinosaur National Monument.

In comparison to Colorado's 3 existing ANSS stations, Montana and Utah each have about 45 stations, and Oklahoma has 14. Each of these 3 states have their own independently operated seismograph networks.

CDEM earthquake map-

Paul Santi asked about adding landslide susceptibility, and liquefaction.

Are the dams needed? They are controversial and what does it add? No qualifying information is included for the dams., and all of the shown dams have not been studied to determine their seismic resistance. What is the basis for their susceptibility to earthquakes?

Mark Petersen (USGS) recommended to one of the Council members that areas with salt tectonism be identified to avoid confusing Quaternary faults associated with salt tectonism with seismogenic Quaternary faults.

A discussion centered around whether Late Cenozoic faults should be shown on the map. Bob suggested that most paleoseismologists would include only the Quaternary and not the late Cenozoic ones, however, we might want to include a statement that there are other faults in the state that may be other potentially hazardous faults which are not shown on the map, chiefly because they have not been studied in sufficient detail. There also was discussion about whether the suspected Quaternary faults should be symbolized differently from the known Quaternary faults, and whether existing seismic stations should be shown on the map.

The Committee voted against showing the late Cenozoic faults on the map. It also voted to exclude the dams from the new maps. The earthquakes should be shown in a manner similar to that on the old map.

Discussions were also held on what text should be included on the map, and whether the USGS probabilistic maps and the few faults used in that analysis should be included on the map.

This topic will be continued to next meeting.

CEHMC Letterhead-The letterhead style was approved. It was suggested that we should use a more meaningful web site URL for CEHMC, perhaps a ghost address. As it currently stands, our web site is buried deep within the CGS web site.

It was mentioned that our USGS member, Waverly, has retired, and our City of Denver member, Rob, has changed jobs and now is in the private sector. Perhaps we should look into having new members from USGS and the City of Denver.

Topic 4: New Business

-WSSPC asked CEHMC to join their organization. This would provide some official recognition to CEHMC. There is no cost to CEHMC to join WSSPC. We need to select a representative to WSSPC. Their primary responsibility is to vote on issues at the annual meeting. We can also select a proxy for CEHMC who plans to attend the WSSPC annual meeting. The Council voted unanimously to join WSSPC.

Colorado Earthquake Hazard Mitigation Council Meeting Minutes 1-19-06

Attending:

Vince Matthews, Marilyn Gally, Michael Haughey, Rob Jackson, Dave Butler, Bob Kirkham, Tim Greer, John Nicholl, Laura Nay

1. Approval of minutes-No minutes at meeting. Postponed till March meeting.

2. Miscellaneous old business:

CEHMC Letterhead. Letterhead is approved. Bob will make changes to the text as requested.

ANSS. Discussed content of ANSS letter and made minor modifications. Marilyn suggested the draft letter be reviewed by the Director of CDEM prior to submittal. Letter will be cc'd to congressional delegation, Gov office, and Executive of DNR. Question: If money is earmarked for the installation of new seismographs, will the USGS maintain them? Utah's net is run by the Univ of UT, but they are seeking ANSS money to support it. Vince will pursue this topic at higher levels over the next few months.

3. Update the EQ Hazard map for CO. CGS will generate a new plate with updated earthquakes. Maybe one without dams and one with. Vince will send copies of the old ones to all CEHMC members.

Description of CEHMC-Good to have, maybe for a press release or the website. Send it out to members and discuss at next meeting.

4. Post-EQ technical clearinghouse-Still waiting for letter from AEG. DWR doesn't need to be a participant, just aware when a clearinghouse is activated. ASCE One more group to contact-. Need to formalize each agencies approval on tasks. Add phone numbers for all agencies listed. Who coordinates within the state for multi-jurisdictional response? DEM is creating a plan for the Emergency Operations Center that will cover the response. The local jurisdictions should know who to call say if building needs tagged.

Other issues:

-Seismic codes

Colorado Earthquake Hazard Mitigation Council Meeting
Minutes for 11-17-05 meeting

Topic 1: Approval of September minutes; motioned, seconded, approved.

Topic 2: John van de Lindt, possible new member. He is a structural engineer who specializes in wood-frame, seismic and wind. <http://www.engr.colostate.edu/~jwv>.

Topic 3: Update on Colorado's Post-EQ Technical Clearinghouse Plan.
Bob called AEG, who said they thought they were already signed up and they were supposed to send the plan to Vince. Vince says the local chapter should do it, but they won't unless the national chapter will. Bob asked them to say in their letter that they support the PEQTCP. John Nicholl will ask Denver Water Dept. if they want to be part of plan. Their participation is not essential, but they should be aware of it, at a minimum. How about the Dam Safety Division of DWR? Bureau of Rec is on board. Bob will send current version of plan to Vince. Vince will run the plan through DNR as an informational document, so they are aware.

Topic 4: Earthquake monitoring updates

Strong motion-Bureau of Rec. has two strong motion instruments, one at Blue Mesa and the other at Ridgeway. Three are in Paradox Basin. Network in Paradox will continue to run, but long-term future of other instruments is uncertain.

ANSS-Kit Carson site on indefinite hold because of noise problems. Should CEHMC look for another, less noisy site? When was the last look at the site? How many sites and how many stations does Colorado need? Must have input from Sheehan, Nicholl. Bob should ask Alena Leeds to address these issues in her visit with the CEHMC, which is tentatively scheduled for January meeting.

ANSS-Rocky Mtn region telephone conference: 2005 budget is 8 million. NEIC will now have staff in office 24-7. 2007 budget announced in January, but Katrina may reduce funding for next year. A letter will be going around to IMW State Geologists to "get on board" with funding priorities for IMW ANSS.

Letter to Senator Allard on ANNS funding-Comments were solicited during the meeting and via email and in this meeting. Use banner from CEHMC website as a graphic to create CEHMC letterhead. Left side would have list of agencies. Matt Morgan will create prototype of letterhead. List disciplines and affiliations? Alphabetical?

Vince will meet with Ken Salazar's staff next week. He would deliver a letter to him.

Next meeting January 19, 2006.

CEHMC MINUTES 9-15-05

Present:

Matt Morgan, Bob Kirkham, Wayne Charlie. Tony Lowry, Vince Matthews, John Nicholl, Michael Haughey, Pat Rogers, Rob Jackson, John Van de Lindt

Topic 1: Approval of September minutes; motioned, seconded, approved.

Topic 2: WSSPC Conference summary (Vince Matthews).

Katrina was a hot topic at the conference. Unfortunately, no FEMA employees and many state emergency managers did not attend because of the response to Katrina. There was a lot of discussion about using Katrina for hazard awareness. Denver Post ran articles about preparedness for natural disasters. Business Week also ran an article. One of Vince's concerns and goals is to make sure local emergency managers are ready to respond to a future significant earthquake in Colorado. They also discussed the need to get more legislative support for ANSS.

The Basin and Range definitions for Holocene, late Quaternary, and Quaternary faults were adopted at the conference. They will leave the ages associated with each time period as written.

Next year is the 100th anniversary of the 1906 San Francisco earthquake. The 2006 WSSPC conference will be coordinated with the meetings of other EQ-related groups to recognize the 1906 earthquake.

Topic 3: Update on Colo. Post-Earthquake Technical Clearinghouse Plan.

Efforts to finalize the plan, which has been on hold for many months, should be re-initiated. AEG and the Denver Water Department were the last agencies whose participation needed to be confirmed. Vince and Rob presented the plan to AEG last year, and it was received favorably. AEG wanted to be added to management team. AEG was supposed to send a follow up notification, but nothing has been received. Vince asked Bob to re-initiate contact with AEG and finalize their commitment to participate. Someone, perhaps John Nicholl, should contact DWD. Bob also is to examine the files relating to the plan and determine if it needs additional attention prior to being readied for approval.

CGS and DEM will be the lead agencies of the clearinghouse when it is activated. CGS likely will be the primary lead, as DEM resources would be devoted to emergency response.

A brief discussion on the possible creation of a Seismic Hazard Commission for Colorado occurred.

Topic 4: History of strong motion instruments in CO (led by Bob)

1. A report by the Colorado Masonry Institute on the Park Lane Towers, built in the 1970s, indicated that permanent strong motion instruments were installed in the structure.
2. The May 1979 minutes of the Colo Society of Natural Hazards Research mentioned plans to purchase an instrument and have Father Downey or CSM operate it.

3. The March 1980 minutes of the CSNHR discussed the need to maintain the society's strong motion instruments, which suggested the society had installed instruments prior to this meeting.
4. The AEG Bulletin (in 1980s) included a paper on the "Geology of Denver", which mentioned that there was one operational instrument in the Regency Inn.
5. In the May 1983 CSNHR minutes Roy Spitzer reported that he and Emil Gadeken "picked up one of our strong motion instruments from the City-County Building in Denver on April 28th. The machine was not operational."

Current status of these instruments is unknown. Bob will ask the US Bureau of Reclamation if they operate any strong motion instruments in Colorado. John Nicholl will ask the Denver Water Department if they have any operational strong motion instruments.

Topic 5: Updates by Vince on the Anton trench and by Bob on the trench on the Williams Fork Mtns fault.

The Anton trench has been extended another 500 feet further east. An unconformity was found in the trench, but no fault. A possible Clovis artifact was exposed in the trench. According to Vince, about 1200 feet of trench is needed to fully study the scarp. However, a wetland east of the existing trench poses a potential environmental conflict that may prevent further extension of the trench, which is currently filled with about 15 feet of water from a recent intense thunderstorm.

A subsidiary scarp on the downthrown side of the main Williams Fork Mtns fault was trenched in June. This site was the only location that could be studied in the available time frame. No fault was observed in the trench, however, a monoclinical fold in soft, weakly consolidated Miocene mudstones underlay and mimicked scarp. The fold probably transitions into a fault at depth. The scarp is a young geomorphic feature, which suggests the folding is recent.

Topic 6: Update on ANSS

Vince said that NSF has agreed to fund the remaining 100 backbone ANSS stations. This is good news. Most ANSS money will be directed toward strong motion instruments in California, Washington, Oregon, and Albuquerque. Some people want to use ANSS money to support their regional seismic networks. Other states have gotten ANSS money earmarked for certain projects in their states. Perhaps Colorado also should contact their legislators to support our interests.

The Snowmass site was recently installed and is recording EQs. This brings the total number of NEIC stations in Colorado to three.

Topic 7: Discussion of Projects

CSNHR: The advantages and disadvantages of re-establishing the Colo Natural Hazard Research Council were discussed. Vince has been looking into the history of the Council. The council was originally set up by an executive order from Gov. Romer. Ron Cattany was the head of the council. The council included several committees, including the Geologic Hazards Committee. The chairs of committees were official members, others were ad hoc members. The Geologic Hazards Committee was chaired by Pat

Rogers. Pat created an Earthquake Subcommittee within the Geologic Hazards Committee.

An executive order can be deactivated simply by not funding it. This led to the gradual demise of the council. Most committees eventually ceased to meet, however, the Earthquake Subcommittee did continue to regularly meet. The Earthquake Subcommittee eventually evolved into our group, the Colorado Earthquake Hazards Mitigation Council, when it was realized that the council was essentially disbanded.

ANSS support letter: Vince's idea of an ANSS support letter to our congressional delegation was discussed and adopted. Vince will write a draft of a letter to Senator Allard and circulate it the CEHMC members for their review.

Michael Haughey mentioned recent newspaper articles that reported Representative Udall urged Governor Owens to increase emergency preparedness in Colorado. The public expects to be protected. Michael pointed out that there is typically a very short window of opportunity following natural disasters in which one can improve awareness and preparedness for future natural disasters. He suggested that we also compose a letter to Owens and Udall offering our support. Colorado can and will someday have a damaging large EQ. We could lay a parallel to Katrina. Is there interest in writing this letter? Concern was expressed that the CEHMC should avoid getting in the middle of political battles, so might not want to step into this one.

EQ scenario: A publication describing a recent scenario for a major Cascadia earthquake received considerable attention. Perhaps the CEHMC should use HAZUS to develop a scenario for a repeat of the 1882 EQ or a M=6 event at the Rocky Mountain Arsenal. Matt suggests we really should update all the default datasets in HAZUS. FEMA knows the default datasets are a weak link in the model, but they don't have the resources to update the datasets. Vince thinks we can explain the limitations of the default datasets when preparing a Colorado scenario. By bringing attention to the potential risk of earthquakes, we might generate enough interest to acquire the funding needed to update the datasets.

IBC soils: Rob mentioned that soils play a big role in the IBC seismic design requirements. Additional soils data would be useful for HAZUS and for local building codes and inspectors. The IBC soil classifications for Denver are mostly C and D. Lowry is D. Soil depth also is important. In the absence of a soils report, Denver assumes a soil classification of D.

Next Mtg is Nov. 17, 2005.

7/21/05 CEHMC Meeting Minutes

In attendance:

Bob Kirkham, Damon Runyan, John Nicholl, Matt Morgan, Lauren Heerschap, Marilyn Gally, Vince Matthews, Tony Lowry, Paul Santi, Jim Harris, Ben Cook, Rob Jackson, Dave Butler, Tim Greer, Michael Haughey

Notetaker: M. Morgan

Topic 1: Approval of minutes; motioned, seconded, approved.

Topic 2: Lauren Heerschap, CGS, presentation on "Earthquake Damage Estimates for Selected Faults in CO".

Because so little is known about earthquake hazards in Colorado, probabilistic evaluations give low values for expected damage if an earthquake did occur somewhere in the state. This study looks at the actual damage that would be expected if earthquakes of varying magnitudes were to occur on selected Quaternary faults in the state. The results demonstrate that emergency managers across the state need to be aware of the consequences of an earthquake in their area and incorporate it into disaster planning.

An evaluation of a M 6.0 earthquake at the Rocky Mountain Arsenal provides an instructive tool for demonstrating the power of FEMA's HAZUS software in helping emergency managers plan for the consequences of an actual earthquake. The analysis indicates economic losses >\$12 billion, 15,370 households displaced, and >4,000 casualties. Maps show the locations of damage to various types of facilities: bridges, hospitals, airports, schools, gas facilities, police and fire stations, etc. Acceleration maps for a repeat of the 1882 (Mw 6.5) earthquake agree quite well with the mapped intensities from the actual earthquake, thus supporting the conclusion that the epicenter was near Estes Park. A repeat of that earthquake would create \$2.5 billion in economic losses.

These analyses emphasize the importance of gaining a better understanding of the attenuation factor (Q) in Colorado. The USGS hazard maps use both the western U.S. (WUS) and eastern U.S. (CEUS) Q factors for different parts of Colorado. Scenarios on each fault were run using both CEUS and WUS Q values supplied in HAZUS. The damage results are three to five times greater for the CEUS scenarios.

Topic 3: WSSPC-Annual conference in Sept. 11-14, 2005.

A lively discussion was held on whether the Council should provide comments to WSSPC on their review of WSSPC's seismic policy recommendation on the definitions of active faults. An important part of the recommendation is the recognition that defining an active fault as one which has moved during the Holocene may not be appropriate for the Basin and Range Province. Some large historical earthquakes in the Basin and Range Province occurred on faults which last moved long before the beginning of the Holocene (~10,000 years ago). For example, the fault that caused the 1887 Sonoran earthquake last moved about 200,000 years ago. John Nicholl mentioned that the next earthquake in the Basin and Range Province could occur on a previously unmapped Holocene fault. John also noted that the use of "dangerous" in the policy recommendation was imprecise,

because the definition of dangerous varies from one person to the next. Bob Kirkham pointed out that the age limits used in the policy recommendation for the Holocene and Quaternary time periods did not agree with the currently accepted ages. He suggested that WSSPC use the currently accepted ages for these time periods in the policy recommendations, or to insert “approximately” before the cited age (e.g. “A Holocene criteria (~10,000 years)”. Dave Butler was opposed to the Council supporting the WSSPC policy recommendation and did not want the CEHMC to define an active fault, in part because we do not know what “active” means. Rob Jackson pointed out a problem with the sentence “Two fundamental pieces of information characterize fault activity: the rate at which earthquakes occur and the average recurrence interval between those earthquakes.” Rob feels that it is the slip rate of the fault that is important. Dave, John, and Bob will evaluate whether CEHMC should formally comment on the WSSPC policy recommendation prior to the WSSPC annual meeting.

Topic 4: Because the meeting was running late, and some of the members present infrequently attend our meetings, a decision was made to postpone the remaining agenda items and initiate a discussion of how CEHMC might have influence on building codes. Jim Harris pointed out that most jurisdictions in Colorado have adopted or intend to adopt the IBC. The seismic requirements in the IBC are driven by the USGS Hazard Maps, which are updated about every four years. The USGS maps are based upon faults, historical earthquakes, and attenuation (Q) factors. Geologists and seismologists who want to provide input into the USGS Hazard Maps should participate in the regional meetings held by the USGS as they develop updated hazard maps. The CEHMC likely would have more influence on the codes via the USGS route than directly addressing the code groups. Better soil maps are needed. This may be a topic that the Council could contribute to. Another way to have influence on the code is through AEG, who may participate in a code review group (ASCE VII?). Tim Greer mentioned that the life safety or fire codes address safety issues other than structural concerns, and that there might be opportunities to influence the life safety codes.

Topic 5: Possible future presentations:

Oliver Boyd, PhD at CU Boulder under Anne Sheehan. Worked on Q factor in CO

Minutes from the May 19, 2005 meeting of the Colorado Earthquake Hazards Mitigation Council

Present: Bob Kirkham, Vince Matthews, Matt Morgan, Michael Haughey, Rob Jackson, Damon Runyan, Paul Santi, Pat Rogers, Tony Lowry, Larry Anderson

Notetaker: Matt Morgan

Topic 1: Approval of Minutes from March, 2005 Meeting; motioned, seconded, approved

Topic 2: New Member Induction: Matt Morgan, approved, official Secretary of CEHMC

Topic 3: "The Colorado Earthquake Map Server" by Matt Morgan

The Colorado Geological Survey has compiled a database of over 570 earthquakes in Colorado from the years 1870 through 2005. The data include information such as date, location, time, magnitude, and intensity. To quickly disseminate earthquake information to the public, we transformed this non-spatial database into a searchable map layer that can be displayed along with other spatial information. The end result is a user-friendly, internet-based Geographic Information System (GIS) that can be easily explored or used for analysis.

Utilizing the map server interface, the end-user can browse the earthquake information by clicking on an event and viewing a report generated from a relational database. Where available, isoseismal maps are included on the event report. Earthquake locations are subdivided into magnitude (mechanically instrumented or estimated) and intensity (felt reports); event symbols are graduated and color-coded depending on earthquake strength. Moving the map cursor over an earthquake point location generates a pop-up "maptip" that displays the event magnitude and date. Locations of active and inactive seismic stations are also displayed. The end-user can activate and query other map layers such as faults, trench locations, topography, and cultural information.

Internet map server applications revolutionized the way data is updated, viewed, and distributed to the public. Once added to a map server, non-spatial databases can be manipulated and updated in near real-time to allow quick dissemination to the end-user. This allows the end-user to obtain newly acquired information from a single application, that previously, was much more time-consuming and laborious.

The Colorado Earthquake Map Server is available for viewing on line at <http://geosurvey.state.co.us>.

Topic 4: "Culebra Graben: A major intrarift structure in the San Luis Basin, Rio Grande Rift" by Robert Kirkham

The Culebra graben in southern Colorado is one of three north-trending structural depressions along the eastern margin of the San Luis basin, which is the largest basin in the northern part of the late Cenozoic Rio Grande rift. Recent geologic mapping, subsurface data from an oil test well, a new high-resolution aeromagnetic survey, and

existing regional gravity data are combined with previous studies summarized by Wallace (2004) to characterize the structural framework of the Culebra graben. This new structural framework improves our understanding of earthquake hazards in this part of the rift.

The Culebra graben coincides with a topographically anomalous region in southern Colorado named the Culebra Reentrant by Upson (1939). To the north and south of the reentrant, the western front of the Sangre de Cristo Mountains is sharp and abrupt, is controlled by the Sangre de Cristo fault, and has the typical geomorphology of a tectonically active range front. Within the reentrant, the range crest is recessed as much as 30 km eastward, and foothills underlain by syn-rift sedimentary and volcanic rocks of the Santa Fe Group occupy a broad area between the range crest and valley floor. Proterozoic rocks exposed at the range crest are downdropped into the Culebra graben by multiple late Cenozoic faults, including the active Sangre de Cristo fault.

Much of the post-Miocene extension across the Rio Grande rift at this latitude is restricted to the narrow part of the Culebra graben, which is bounded on the east by the Sangre de Cristo fault and on the west by the San Luis fault, a newly named structure on the eastern margin of San Pedro Mesa and the Basaltic Hills. Miocene deformation occurred along faults as far east as the range crest and beyond. Proterozoic rocks within the graben are downdropped about 3.6 km relative to equivalent rocks at the range crest. If rifting initiated 25 m.y. ago, then the average long-term uplift rate of the east side of the graben is about 145 m/m.y. Pliocene Servilleta basalt flows are offset at least 0.5 km across the Sangre de Cristo fault, which yields a vertical slip rate of 123-136 m/m.y., depending on whether the top or bottom of the flow sequence is used in the calculation.

Topic 5: Discussion of selected projects to undertake-

Update Colorado Earthquake Hazards Map? The predecessor to this map was the first earthquake map of Colorado. The Committee reviewed it. Pat Rogers suggests calling Marilyn Galley and bringing it under a CGS/CSM umbrella. Maybe the committee should just oversee it or perhaps work on it as a project. The situation with CGS becoming a division could have an impact on future earthquake projects. Some feel updating this mpa is not necessary.

Other project suggestions include: paleoliquefaction awareness in housing foundations, training and using volunteer staff to help work on projects, photocatalog of areas of earthquake/fault interest.

Building Code Survey (Rob Jackson)-currently updated, being sent out to structural engineers. There is a seismic design component now. We could actively do a building survey/test to see if certain buildings meet seismic design categories. This could cost several thousand dollars per building. But we could look at 2 building, 2 bridges, etc.

Where are strong motion instruments in Denver?

Seismic characterization of school sites.

Earthquake display at Denver Museum.

Topic 6: Future topics/presentations

Lauren Heerschap from the CGS on Determination of Q and HAZUS results.

CEHMC Meeting
March 17, 2005

Present:

Bob Kirkham, Michael Haughey, Damon Runyon, Paul Santi, Vince Matthews, Rob Jackson

Note Taker: Matt Morgan

Topic 1: Approval of Minutes of Nov and Jan minutes: motioned, seconded, approved.

Topic 2: Open planning forum on future of CEHMC

Are presentations at meetings desirable? They are informative and educational, they help to bring in people who otherwise might not attend, and they stimulate great discussions.

Are we accomplishing our mission? In general, yes, but we need to do more to stimulate and increase awareness of earthquake hazards, risk, and mitigation measures in Colorado.

Should we seek official government recognition? Yes, but after CGS has re-acquired status as a separate division. Also, it may be desirable and possible to re-establish the Natural Hazards Research Council, of which our group was once affiliated.

Can or should we seek funding for projects? Yes! Government agencies are possible funding sources. Some manufacturers of equipment or materials utilized for seismic safety in structure or seismic restraint devices have funded educational projects. CGS is a possible funding source if it becomes a separate division. EMD (formerly OEM) also is a potential funding source.

We should develop plans for projects first, then seek funding.

Potential project ideas include:

- Producing maps and running seminars.
- Developing education program on codes.
- Establish state-wide building code for seismic considerations? Gather the data on existing codes throughout the state, determine where inspectors are located, and team up with engineering organizations.
- Conduct survey to determine if buildings around the state, especially schools, buildings, hospitals, fire departments, and police stations are designed to withstand earthquakes and continue to function.
- Create an earthquake awareness flyer or poster. Print and distribute to local building departments and emergency management offices, engineering and geologic organizations, engineering and geology departments at universities and colleges around the state, the Association of High School Teachers, etc. Display it at public places like the Denver Museum of Nature and Science, university museums, county museums, etc.

-Prepare a letter summarizing the problems with Seismic Design Categories vs Site Class maps (Rob Jackson). Maybe this could stir up some things in Colorado in regard to the IBC.

Include an agenda item in which anyone could briefly discuss their current projects that relate to the CEHMC. It might be beneficial to send out an email to the entire mailing list prior to each meeting asking for this information, which could be mentioned at the meeting even if that person did not attend the meeting.

Topic 3: ANSS Update
Nothing to report

Topic 4: PEPP Update
Anne Sheehan recently acquired the Westminster PEPP instrument when the teacher responsible for it retired. She asked Bob Phinney, who runs the PEEP program at Princeton if they wanted the instrument. Bob said there is no current funding for PEPP, including the installation or upkeep of instruments. He said it would be fine for Anne to store or use the instrument.

Topic 5: Suggestions for future topics and presentations

Wally Prebis current status of pre-stress concrete.
Bob Kirkham, Matt Morgan GSA Talks
McCalpin (Roubideau) and Piety (Busted Boiler)
Waverly Person on Tsunami and Iran
Continue with the project discussion.
Post-earthquake technical clearinghouse.

Next meeting is May 19, 2005. Matt Morgan and Bob Kirkham will each present the short talk that they are preparing for the Geological Society of America meeting in Grand Junction.

Colorado Earthquake Hazard Mitigation Council Meeting
January 20, 2005

Present:

Marilyn Galley, Russ Wheeler, Dean Ostenaa, Matt Morgan, Dave Noe, Paul Santi, Dave Butler, Damon Runyon, Rob Jackson, John Nicholl, Chris Krall, Kathy Haller, Wayne Charlie

Note taker: Matt Morgan

Topic 1: Approval of minutes skipped; will be approved at the March meeting.

Topic 2: Presentation on the Anton scarp – Dave Noe, CGS

Regionally, the Cheraw fault is an anomaly on the eastern plains. It gives us a reason to look on the plains for more faults. The Anton scarp is located on High Plains about 125 miles east of Denver. It is visible as a prominent scarp on DEMs. Horsts and grabens show up well on trend surface residual maps and topographic profiles. Stream downcutting (problematic) is less on downthrown side (east). The geology of the area, as depicted on the Tweto (1979) Geologic Map of Colorado, is Qe (eolian) on upthrown side and To (Ogallala) on downthrown side. Stream offsets when crossing the scarp are an indication of possible left-lateral movement. The feature steps in some places to the east which could be Riedel shears. The feature has a potential of producing a M 7.6 earthquake according to the Wells and Coppersmith (1994) relationships to fault length and magnitude.

Why study this feature?

Potential earthquake hazard. Petroleum exploration. Water Resources. Science.

Paleoseismic investigations-

Seismic refraction survey and trench were placed across the scarp. The trench was 189 meters long, 6 meters deep, and exposed 22 meters of section.

¹⁴C and OSL dates were collected. Drilled 10 core holes with CDOT.

Cheyenne Gas Pipeline trench crossed scarp.

Results-The seismic refraction survey showed that upper Quaternary deposits were pinching out. In the trench, the upper part was sandy silt and massive silt. (15,600 OSL years, Peoria loess), dipping 2-4 deg back to W.

In the lower part, several calcareous paleosols were cut into by channels.

A few buried A soil horizons were found. Upper A dated at 5220 Ybp and 39,000 Ybp for the lowest. These did not show up elsewhere in trench.

No evidence of faulted beds. No sediment deformation. Refutes dip-slip movement.

Drilling revealed thinner Quaternary section at top. Ash beds below, then gravels (possible Ogallala)

Cheyenne Pipeline trench -“Brown Zone” where scarp should be. Appears to be burrowed. A lot of depressions with buried soils. Possible ice wedges.

Topic 3: ANSS Update, a lot more strong motion instruments in place than had been previously identified. Montana and Idaho, WY, UT. 12 strong motion instruments in Trinidad, CO on dam.

End of Meeting

Minutes from CEHMC Meeting of November 18, 2004

Present: John Nicholl, Matt Morgan, Paul Santi, Rob Jackson, Michael Haughey, Vince Matthews

Notetaker: Matt Morgan

Topic 1: Minutes for July 15 and Sept 16 meeting motioned, seconded, and approved.

Topic 2: National Earthquake Conference Summary, Rob Jackson

National Earthquake Conference, St. Louis MO. September 2004

1. Meeting of the Seismic Safety Commissions / Boards

- Focus on anniversary dates of historical earthquakes for the dissemination of information. For example, the 100th anniversary of 1906 SF Earthquake is coming up. A conference in April of 2006 in San Francisco will coincide.
- Focus on schools and emergency facilities. Ask school parents and faculty and hospital personnel what the facility has been designed for in terms of seismic resistance
- Also, increase awareness of the hazard for students and teachers
- Don't give up between events. Prepare the path ahead of time
- Need support from legislators and private sector engineers. If commission is affiliated with state agency does this impede the ability to influence legislators? California commission is independent, but most are affiliated with the state.
- Utah structural engineering community is divided over the level of hazard in Utah.
- States should adopt building codes. Oregon is adopting the 2003 IBC.
- Involve persons from large international firms that have been impacted by earthquakes abroad
- Be prepared for the question of "cost / benefit" when discussing earthquake measures
- 40% of businesses go out of business after a major disaster
- California's Seismic Commission has a completed a state plan for earthquake research. See http://www.seismic.ca.gov/pub/CSSC_04-03ResearchPlan.pdf
- Could FEMA provide links to the State Commissions for posting of notable successes and products? Could EERI help with this?
- Commissions need to "speak with one voice."

2. "Plan and prepare for an earthquake and you can respond to any disaster."

3. 6.0 M Parkfield EQ occurred on 9/28 during the conference.

4. Lloyd Cluff discussed a major success in the design of the trans-Alaska pipeline crossing of the Denali fault. Supports for 2000 feet of pipeline straddling the fault were designed to accommodate 5' vertical and 20' lateral displacements over the 2000'. The 7.9 M EQ resulted in actual displacements of 3.5' vertical and 19' lateral. No oil was spilled.

5. Rick Howe presented along with JR Harris. Rick is a structural / seismic risk consultant in Tennessee. There is an initiative by seismologist Seth Stein and structural engineer Joseph Tomasello along with another seismologist from Los Alamos to discredit the USGS/NEHRP/IBC approach to infrequent but high hazard earthquakes in the Central US, most notably the New Madrid seismic zone. It is a Tennessee issue for now and is

- characterized as a “pro-seismic” vs. “anti-seismic” debate. Rick is a supporter of the IBC and of increased seismic monitoring to enhance ground motion data and building response.
6. NIST was not in attendance. There was concern among attendees as to how well prepared NIST is to takeover FEMA’s role in leading NEHRP.

Topic 3: ANSS (Advanced National Seismic System) and NEES

A summary of a 1.5-hr teleconference of the ANSS-IMW Regional Advisory Committee held on November 12, 2004, is available online at <http://www.seis.utah.edu/anss/imw-rac.shtml>

[As an item of note, Walter Arabasz stated that “since the RAC includes three state geologists (ID, MT, UT), at some time in the future, RAC may want to consider gathering a supportive letter from all the state geologists in the IMW Region, together with their counterparts from state emergence management offices to push for IMW needs in ANSS.]”

A "Summary of ANSS Needs for the Intermountain West (IMW) Region" (with a revised foreword including a summary of recommendations from the Regional Advisory Committee) is available online at <http://www.seis.utah.edu/anss/imw-needs.pdf>

NEES (Network for Earthquake Engineering Simulation)

The “Grand Opening” of NEES occurred on Monday, November 15 with a media briefing and webcast from Arlington VA. Live demonstrations were also presented from various NEES sites around the country. The University of Colorado has one of the structural sites where a Fast Hybrid laboratory is in operation. See <http://nees.colorado.edu>

NEES is comprised of three components:

1. The fifteen equipment sites consisting of four types (structural, geotechnical, field sites and a tsunami site).
2. The NEESgrid. This has been designed by the National Center for Supercomputing Applications at the University of Illinois. NEESgrid links earthquake researchers across the U.S. with leading-edge computing resources and research equipment, allowing collaborative teams (including remote participants) to plan, perform, and publish their experiments.
3. The NEES Consortium. The NEES Consortium will be the single entity operating the NEES collaboratory for the ten-year period from 2004 through 2014.

Topic 4: Suggestions for future presentations

Jim Harris, discussions on education and outreach

Barry Solomon (Utah Geol. Survey), talk on liquefaction

Mayor Hickenlooper on struggles with public policy related to earthquakes

Next Meeting: January 20, 2005

Minutes from CEHMC Meeting of September 16, 2004

Present: John Nicholl, Damon Runyon, Paul Santi, Robert Kirkham, Wayne Charlie, Rob Jackson, Don Doehring, Larry Anderson, Ivan Wong, Pat Rogers, Vince Matthews

Notetaker: Bob Kirkham

Topic 1. Minutes from the July meeting were not available for review. They will be distributed with the September minutes prior to the November meeting.

Topic 2. Presentation by Ivan Wong, URS Corp. titled "Evaluating seismic hazards in central Colorado: Dealing with the same old issues and now some new ones". He discussed issues relating to evaluation of seismic hazards in Colorado; the historical seismic record and Quaternary faulting; the contemporary seismicity of the central Front Range; site specific case studies and the National hazard maps versus site-specific hazard analyses.

- The 1882 event demonstrates there may be a significant, although poorly understood, seismic hazard in Colorado.
- Reworked the microseismic data set collected by MGC for the Denver Water Department. Many of the relocated epicenters do not appear to be associated with surface traces of "potentially active" faults, although some events cluster near the ends of a few faults.
- No proven late Quaternary faults in central Front Range.
- Central Front Range seismicity is persistent and moderate. Other areas in western US with similar seismic rates generally have known late Quaternary faulting.
- Focal mechanisms are consistent with normal and strike-slip faulting in western part of area and reverse and strike-slip in eastern portion. Could reflect a transition zone that separates extension in the western US from compression in the Midwest.
- 3 possible explanations are consistent with evidence:
 - deep seated rupture with little or no surface rupture;
 - long recurrence intervals of several 10s of thousands to >100,000 years;
 - Miocene and younger faults are not seismogenic and EQs like 1882 may occur on buried or undiscovered faults.
- Presented case histories for a few projects, including one in the Rio Grande Rift.
- Attenuation is an important factor in hazard analyses and needs much further work.
- Paleoseismic investigation of Williams Fork Mountains Fault is needed
- Hazard is lower in central Colorado than Wasatch Front or Rio Grande Rift, yet risk in central Colorado could be relatively high due to large population, building inventory, and historically low seismic designs.

3. Topic 3. ANSS.

- An email from Anne Sheehan containing an update on ANSS was read. A cooperative CU/USGS ANSS broadband station is being installed near Aspen at Snowmass Mountain.
- Walt Arabasz has requested that each member state appoint two representatives to the ANSS-IMW Regional Advisory Committee. Although Anne was not at the meeting, we

assumed that she would continue to be active in ANSS through the Technical Advisory Committee. Rob Jackson and John Nichol were unanimously selected as Colorado's representatives to the IMW Regional Advisory Committee.

Topic 4. A continuing discussion of educational and outreach issues occurred. We again agreed that we should have Jim Harris attend a future meeting and provide advice on this topic. Pat Rogers suggested that the CEHMC develop formal recommendations for seismic designs for schools. These recommendations could be presented to CGS, who in turn could use the recommendations in their land use review program

Topic 5. Possible future topics and presentations include:

- Continuing discussions on education and outreach, with a presentation by Jim Harris.
- Vince Matthews on the Anton scarp.
- CDOT on seismic design of bridges.

Next Meeting: November 18, 2004.

CEHMC Meeting of July 15, 2004

Present: Robert Kirkham, Matt Morgan, Tony Crone, Damon Runyon, Wayne Charlie, John Nicholl, Rob Jackson, Michael Haughey, Dave Butler, Marilyn Galley, Chris Krall, Tammy Tanoue

Notetaker: Matt Morgan

Topic 1 – Minutes motioned, seconded, approved

Topic 2 – Tony Crone presentation on the Sange de Cristo fault.

Probably does not behave as a single, individual fault. In fault databases, it has been divided into 4 sections in CO: Crestone, Zapata, San Luis, Blanca. Crestone and Zapata sections exhibit well-defined triangular facets and steep range front. The trend of the fault changes to nearly E-W in the Blanca section, and in the San Luis section the fault is lies well east of the range crest, and the Neogene Santa Fe Group forms the footwall of the fault. Near the creek of Rito Seco (in San Luis Section) the fault is several kilometers west of range crest. Scarps are discontinuous but locally prominent. Two trenches were excavated at the Rito Seco site across a single scarp whose heights are 6.6 m in older alluvium and 2.6 m in younger alluvium.

Trench in younger alluvium (south trench):

Correlative stratigraphy on both sides,

Age of fluvial gravel ~15 ka,

Deposits offset by one event; single colluvial wedge

Fluvial channel cut into scarp and backfilled.

Faulting event older than radiocarbon age of 5593 cal yr BP on unfaulted channel fill deposits.

Awaiting TL dates.

Trench in older alluvium (north trench):

Correlative stratigraphy on both sides

Age of fluvial gravel ~130 ka

Deposit offset by multiple events; three colluvial wedges

Fluvial channel cut into toe and backfilled

No age dates yet for events

Preliminary interpretations for Holocene:

Only one event younger than 15 ka

Stratigraphic throw + 2.3m

Scarp height ~ 2.7m

mid-Holocene event; older than 5593 cal yr BP

Age of MRE slightly older than previously thought

Perhaps an earthquake with Mw of 6.8-7.0 caused these displacements

Preliminary interp for late Quaternary:

At least 3 Quaternary surface rupturing events in last 130 ka

Min stratigraphic throw of 6.75 m

Scarp height ~6.6 m
Vertical displacement 2-2.5m/event
late Quaternary slip rate = 0.05mm/yr
Avg. recurrence interval = 40-45 ky

Topic 3 Group discussion on education and outreach related to seismic codes and restraint.

New codes = performance based design. Seismic Design Cat A does not differentiate between essential facilities based on Acceleration Coefficient from National Map and effect of soil type. Concerned about communities “grandfathering” in with Cat A. Wind forces govern on Seismic Design Cat A, but seismic forces govern beyond that.

We had codes in 1997 that were more strict than codes now; the IBC waters down areas like CO where National Maps do not show a very substantial seismic risk. Because CO is a lower risk state, we are more likely to have a Mw 5.5 than a larger eq. We need to be looking at unrestrained objects that may be loosened during this size event. Need to get more data on what goes into National Maps. Get rid of exceptions for attachments; restraint should be required. There are no requirements to attach things to structures; this needs to be changed. Have to educate public and code officials. Committee should draft up a seismic ordinance for Colorado, perhaps use Denver as a guide. Utah has a state code already.

FEMA Pre-Disaster Mitigation Competitive grant program has funds available for mitigation projects for national disasters. The CEHMC should look into putting a project forth.

4. Future topics and presentations: Ivan Wong, URS, to speak at next meeting. Rob and John will contact Jim Harris and ask if he will discuss code issues at a future meeting. Also, discussions on education and outreach related to seismic codes will continue during the next meeting.

Next Meeting Sept. 16, 2004.

Minutes for the CEHMC May 27, 2004 Meeting

Present:

Bob Kirkham, Matt Morgan, Dave Butler, Doug Bausch, Marilyn Gally, Vince Matthews, Michael Haughey, Becky Murray, Richard Christiansen, Rob Jackson, Tim Greer

Notetaker: Matt Morgan

Topic 1 – Approval of March minutes; motioned by Vince Matthews, seconded by Tim Greer.

Topic 2 – Overview of the HAZUS-MH by Doug Bausch, FEMA Region VIII
HAZUS is a GIS-based damage simulation program for earthquakes, hurricanes and floods. Compared to the older versions of HAZUS, HAZUS-MH contains new building stock datasets that are broken down into the census block level; over 8 million census block levels for the U.S. Many of the datasets are customizable by the user; they can modify, delete, or add data. For the earthquake module HAZUS-MH accommodates different PGV values that destroy different types of building stock: 0.3 PGV tends to damage small structures where 1 PGV damages larger structures. Earthquake loss estimation is extremely detailed. For example, damage estimates can be made for earthquakes at 2 AM, 2 PM, and 5 PM. Nationwide datasets include: demographics, building stock, essential facilities, transportation, utilities, and high potential loss facilities. HAZUS really helps with mitigation strategies, response/recovery, awareness/preparedness.

Topic 3 – HAZUS-MH simulations in Colorado by Matt Morgan, Colorado Geological Survey. Faults causing greatest economic loss:

1. Golden fault - \$22.08 Billion
2. Rampart Range fault - \$18.26 Billion
3. Ute Pass fault zone - \$9.77 Billion
4. Frontal Fault - \$1.72 Billion
5. Mosquito fault - \$1.52 Billion

Runners up: Walnut Creek and Cheraw

Damage estimates based on Max. Credible Earthquake magnitudes published in Widmann and others, 1998.

Golden fault: M=6.5

Damage estimate for counties within 150 km radius = \$22.08 Billion, 719 fatalities, 7.3% loss ratio

In Jefferson County: \$8.14 Billion, 322 fatalities, 21.7% loss ratio

In Denver County: \$4.73 Billion, 164 fatalities, 11.8% loss ratio.

Rampart Range fault zone: $M=7.0$

Damage estimate for counties within 150 km radius = \$18.26 Billion, 671 fatalities, 5.7% loss ratio

In El Paso County: $M=7.0$ = \$8.15 Billion, 596 fatalities, 23.5% loss ratio;

In El Paso County: $M=6.0$ = \$830 Million, 12 fatalities, 2.4% loss ratio.

Highest Loss Ratio

1. South Sawatch fault; $M=7.25$; Chaffee County – 24.1%
2. Rampart Range fault; $M=7$; El Paso County – 23.5%
3. Golden fault; $M=6.5$; Jefferson County – 21.7%
4. Frontal fault; $M=7$; Summit County – 20.1%
5. Cheraw fault; $M=7$; Otero County – 18.2%

Probabilistic Scenarios

State-wide scenarios

$M=6.5$, 100-year period: \$27.0 Million

$M=6.5$, 500-year period: \$1.5 Billion

Topic 4- ANSS Station Updates by Bob Kirkham. New Sand Dunes visitor center under construction. Will have a seismic display that utilizes their ANSS station. Further work on Kit Carson station on hold; USGS wants to focus on more backbone stations before searching for a quieter site for Kit Carson station. Only limited NPS support for a station to be sited in Dinosaur National Monument; USGS will start looking for a site on BLM land east of the monument. Kit Carson and Aspen sites both need solar power to run station. There have been some problems with the solar power system a contractor developed for the seismographs, which has slowed progress on the solar-powered sites. Plan to select a site for the Aspen seismograph this summer.

Topic 5-Vince and Doug reported on the Basin and Range seismic hazards meeting. A draft policy recommendation for the Western States Seismic Policy council was developed during the meeting. The policy recommendation title is “Projects supported by the National Earthquake Hazards Reduction Program through the USGS should focus on work that has significant impact on the reduction of earthquake risks in the near to mid term”.

Topic 6 – Future committee topics and presentations

Critical review of the Quaternary faults in the Widmann and others database Colorado. Would like for a group of experts to review these faults. Recent small earthquakes near Paonia have caused damage in the coal mines. Network of stations may go in near the Rocky Mountain Arsenal.

March 18, 2004 EQ Meeting

In attendance:

John Nicholl, Vince Matthews, Matt Morgan, Damon Runyan, Michael Haughey, Paul Santi, Pat Rogers, Larry Anderson, Doug Boyer, Rob Jackson, Tim Greer, Waverly Person.

Topic 1-Minutes motioned and seconded; approved.

Topic 2-Tim Greer welcomed.

Topic 3-Doug Boyer discussion, Colorado Department of Water Resources (CDWR), "Review of State and Bureau of Reclamation Earthquake Evaluations of Dams in Colorado". The rules and regulations were last updated in 1988. CDWR is updating with USGS supplied accelerations, so they can rank the dams as far as seismic risk. Seismic evaluation has been in the regulations, opposite of rumors circulating. What has been submitted to state? No requirement for deterministic or probabilistic. State should have a probabilistic requirement. There is a range of PGA values: 0.2-0.3g northern metro area and 0.1-0.15g southern metro area. These should be standardized. There is no guidance for liquefaction. We need better communication between CGS and CDWR; CGS could help review the seismic criteria for dams. Many PGA may be over or underestimated and could be a problem when they get in the literature. 0.05g is default value for Colorado.

Bureau of Rec looks at a return period of 10-50 ka. Montana State Geological Survey is publishing their own seismic hazard maps by then end of 2004.

BREC involved in 3 different projects in Colorado:

- Comprehensive Facility Review
- Issue Evaluations
- Paradox Basin Seismic Network
- Possibly mapping and trenching on Loghill Mesa and Busted Boiler faults

Topic 4- Update on post earthquake technical clearinghouse. Presented plan to AEG executive committee. They were pretty interested in it. Gave positive input to the plan.

Topic 5-Updates on ANSS. Anne Sheehan is head of that. Not present.

Topic 6-CGS Fault Map of Front Range. Matt Morgan, CGS. Contains fault traces for all published geologic maps in the Front Range. Available from CGS on CD-Rom, contains 2 map plates and shapefiles for GIS.

Topic 7- AEG-RMS presentation on CEHMC by V. Matthews. Went well, well received. Many didn't realize committee existed.

Future presentation-Wong, Ake on Seismic Hazard for Colorado. CDOT on Bridges.

Colorado Earthquake Hazard Mitigation Council

Meeting Date: January 15, 2004

Present: Bob Kirkham, Matt Morgan, Michael Haughey, Vince Matthews, Wayne Charlie, Tim Greer, Paul Santi, Rob Jackson, Richard Christenson, Mark Peterson, Don Doehring

Topic 1 – Minutes for the November 20 meeting were approved

Topic 2 – Introduction of Tim Greer, proposed council member, and with the Colorado Intergovernmental Risk Sharing Agency (CIRSA). CIRSA insures 250 municipalities for property liability compensation in Colorado in addition to municipalities all over the west. It is a “quasi-government” agency.

Topic 3 – Presentation by Michael Haughey entitled “It Can’t Happen Here – the Case for Seismic Code Enhancement and Enforcement.”

- Purpose is to develop materials for the public, highlight what is needed for structural controls, and to make the awareness message “personal”.
- Since 1975, population and building stock in Colorado has doubled.
- Common comments from local governments and companies include:
 - “Wind load exceeds seismic-not familiar with internal attachment of equipment”-Boulder
 - “If a building is designed for seismic, we will enforce; if not, we won’t”.
 - “Haven’t required seismic design, but soon it may be” – Denver
 - “We don’t worry about seismic in Colorado, except where NREL requires it”-M&E firm in CO.
 - “Seismic design in the area is not usual and not normal” – Major M&E firm in CO.
- Cost is a big factor; M&E aspects of the code and won’t be enforced unless it is required
- About ½ of all injuries from earthquakes come from non-structural damage (something falling, flying, breaking). Non-structural damage is responsible for much of the total the damage during lower intensity earthquakes, like those that occur in CO.
- Code requirements, non-structural
 - 1997 UBC – Denver in Zone 1
 - 2000 IBC – Denver, mostly in Seismic Design Categories A & B; C for site classification E. Most of Denver is in A.
 - 1997 UBC – Restraint design required for all except floor or roof mounted equip < 400 lbs.
 - 2000 IBC exemptions – most of Mechanical and Electrical components in Denver area are exempt.
- What can this Council do?
 - Should be addressed later as an agenda item

Topic 4 – Presentation by Bob Kirkham entitled “Recent faulting in the Williams Fork Valley, Colorado”

- Fault scarps are present in young surficial deposits (late Quaternary) along the 18-km-long northern section of the Williams Fork Mountains Fault, which is on the west side of the Wm. Fork Valley
- Williams Fork Mountains Fault has experienced multiple surface ruptures during the late Quaternary, including at least one rupture during the Holocene.
- Well-preserved faceted spurs occur along the east side of the Wm. Fork Mountains
- Cross-faults within the interior of the graben offset and tilt 150-200 ka alluvial terraces; these terraces are offset as much as 36 m
- Fault on east side of graben has not moved in recent past (~last 100 ka).
- 19 topographic profiles were measured across tectonic scarps along the northern section of the Wm Fork Mtns Fault; 6 soil pits were excavated into the faulted deposits
- Middle Mule Creek site offers some of the best paleoseismic opportunities. Scarps are present in deposits of three different ages of deposits
- The 18 km-long northern section of the Wm. Fork Mtns Fault could generate an earthquake of $M=6.5$; if the 18-km-long southern section of the fault ruptured coseismically with the northern section, a $M=6.9$ earthquake is possible.
- Estimated slip rate for the northern section of the Wm. Fork Mtns Fault is 0.1 to 0.3 mm/yr

Topic 5 – Earthquakes near Ft. Garland on 12-27-03

- M 3.1 & 3.5
- Bottles fell off shelves in Blanca liquor store
- Student working nearby collecting felt reports to create an intensity map.

Topic 6 – Updates on ANSS and PEPP (Princeton Earthphysics Project)

- One PEPP station was originally installed in Durango. The teacher responsible for the instrument left the high school and gave the seismograph to Ft. Lewis College. The college later gave the seismograph to Mancos high school, who will eventually install it.

Topic 7 – Future presentations or topics

- Revisit the mission statement
- Action plan of council
- Dam safety from State perspective
- Hanging Lake bridge
- May meeting-Doug Bausch on HAZUS
-Move May meeting to 5/27/04

Next meeting 3/18/2004

Note taker: Matt Morgan

Earthquake Hazard Mitigation Council Minutes

Meeting Date: November 20, 2003

Present: Vince Matthews, Michael Haughey, Bob Kirkham, Matt Morgan, Dave Butler, Paul Santi, Anne Sheehan, Dan McNamara, Art Frankel, Damon Runyon, Rob Jackson

Topic 1: July minutes motioned, seconded and approved

Topic 2: Speaker, Dan McNamara, "Lg Q Across the Continental US"

1/Q = attenuation. High Q is low attenuation. Lg is a wave produced in the crust that scatters off faults, rock units, etc, comes in as energy and is measured. We can see Lg wave 12-200 km out from earthquake epicenter.

Lg is used for: tectonics, crustal structure, explosion discrimination (explosions don't generate large Lg and in most cases no Lg at all). USGS uses Q models to predict ground shaking for: shakemaps, National Hazard maps, ANSS magnitude thresholds. For Colorado Q studies: 150 Lg raypaths used to calc Q for Colorado Plateau. Five bands (MHz frequency) are used for Lg. The Q is the slope of the line of the amplitudes of Lg vs. distance from epicenter. For the Colorado Plateau this value is $354f^{0.51}$. Compared to Basin and Range Province value of $235f^{0.56}$. Higher the Q the more stable, in general. This is mostly western CO.

Tomography is used to collect the wave paths. The country is divided into a 2.5 X 5 degree grid. Q solved for each grid cell. Coverage is best in Basin and Range Province. Q is higher in east, lower in the west. Colorado is in a transitional area. Results are consistent with seismic (discreet) model above.

Implications for seismic hazards in CO: USGS National Hazard maps have used Eastern US (EUS) Q values for CO, however, CO Q is lower than EUS Q. New CO Q predicts weaker ground shaking than calculated for hazard maps using EUS Q.

Topic 3: Post-earthquake technical clearinghouse

National officers with the AEG are currently considering whether to participate in the post-eq technical clearinghouse plan. Bob is waiting to hear back from them. Two main sponsors of the plan would be CGS and OEM. Vince says situation at CGS is unsettled now, and that we should wait for a bit to see how the proposed changes may affect CGS's ability to sponsor the plan.

Topic 4: ANSS update

Have selected a site for the station in Aspen. It did not get installed this fall. Won't be in until next summer at earliest. Maybell station will be at Dinosaur National Park. Noise from natural gas compressors was high at the proposed site in the Kit Carson area. Further work on a site in this area has been delayed.

Topic 5: Approval of Mission Statement

Vince moves to adopt with changes, seconded by Anne, unanimous.

Topic 6: Roster issues

Ask people who are on the roster but seldom participate in council meetings and council activities if they are interested in participating in the council or want removed from the council roster. Those who are interested in the work of the council but lack the time to participate in council activities will be placed on the email list so they can stay abreast of council activities.

Topic 7: Future presentations

Ask American Society of Civil Engineers to give talk about seismic design relative to state dams. Invite State Engineers office to speak on regulations for dam construction.

Speakers for the Jan. 15 meeting are: Michael Haughey on code issues and the lack of seismic awareness in building (non-structural) industry; and Bob Kirkham on recent faulting in the Williams Fork Valley.

Minutes recorded by Matt Morgan

Earthquake Hazard Mitigation Council Minutes

Meeting Date: July 18, 2003

Present: Bob Kirkham, Matt Morgan, Michael Haughey, Rob Jackson, Damon Runyan, Dave Butler, Anne Sheehan, Paul Santi

Topic 1- Revisions to Agenda? None.

Topic 2-Approval of minutes from May 15. Minutes approved, motioned by Kirkham and seconded by Sheehan.

Topic 3-Presentation by Paul Santi on "Earthquake-induced Hazards Along Transportation Routes in Colorado"

Problem: Transportation routes are very vulnerable.

- They cross difficult terrain and geology.
- Not critical enough to receive large budgets for hazards.
- Not constructed as well as structures (buildings, etc.).

Types of hazards that affect transportation routes: landslides, liquefaction, dam failure, strong ground motion, fault rupture.

Very little has been done on transportation routes to protect from geologic hazards; even outside of Colorado. In regard to earthquakes, past work has been done on Hwy 60 near New Madrid. Study looked at the effects of liquefaction, slope stability, and flooding about 50 km away from earthquake epicenter.

Sensitivity analysis for liquefaction:

- Depth of soil least important
- Depth to water table 2X important as depth of soil
- Soil density 4X important as depth of soil
- FS (factor of safety), EQ, EQmag 6X important as depth of soil
- If water depth increases by 10%, (N1)60 (normalized blow count) decreases 4.5%, and inverse
- If soil density increases by 10%, (N1)60 increases 9%, and inverse
- If soil depth increases by 10%, (N1)60 increases 3%; if soil depth decreases by 10%, (N1)60 decreases by 5%

Sensitivity analysis for landslides:

- Depth to groundwater least important for those <100 c.y. in volume
- Friction angle 2X important as depth to groundwater
- Cohesion, soil density are 8X important as depth to groundwater
- Slope angle 10X important as depth to groundwater
- EQ acceleration 15X important as depth to groundwater

For larger slides (>10,000 c.y. in volume):

- Depth to groundwater least important

- Soil thickness, soil density, slope angle, cohesion, friction angle are 2X as depth to groundwater

Most vulnerable areas are central-western Colorado, which is where the highest predicted ground motions occur, in areas where there are saturated, clayey soils (residual, glacial, alluvial).

Future work

- Use CDOT data for site-specific soil information
- Develop state-wide and large city hazard maps

Topic 4-Progress report on post-earthquake clearinghouse

- NIST is not interested, no funding right now
- AEG, no response yet
- FEMA and USGS plans are published as Circular 1242.
- In the event of a destructive EQ there is a State agency that is looking for a location to meet; State Universities are most likely.

Topic 5-Mission statement; submit corrections to Kirkham

Topic 6-New members? Dr. Paul Santi, CSM voted in.

Topic 7-Future presentations and new business

Speaker possibilities:

Don McNamara, attenuation study of the IMW

David Wald (sp?), expert on shakemaps

Bob Kirkham, William Fork Valley

Jim Harris

Eric Erslev, Golden fault

Future topics-

CSM building codes project with Michael Haughey

Draft Minutes for the Colorado Earthquake Hazard Mitigation Council meeting held on May 15, 2003

Present: Vince Matthews, Matt Morgan, Damon Runyan, Michael Haughey, Mark Meremonte, Anne Sheehan, Sara Brush (FEMA representative), Jill McCarthy, Waverly Person, Rob Jackson, Dave Butler, Mark Meremonte (USGS), Alena Leeds (USGS)

Topic 1: Minutes approved from January, minutes 1st Vince, 2nd Anne; minutes approved.

Topic 2: ANSS update by Jill McCarthy, USGS

Through 2002, there have been 350 Urban Reference Stations installed across the United States. In FY '03, 67 more URS will be installed. One broadband and probably one strong motion instrument per site.

ANSS IMW Backbone and Update on Colorado sites:
For the Maybell site, Dinosaur National Monument is the probable area.
The Kit Carson site is dependent upon final VSAT vendor choice, will re-site Kit Carson according to potential feasibility of a solar powered site. Also, there is considerable background noise and more sites will have to be evaluated.

Regional Station Status:
Paradox Valley-Two Bureau of Reclamation sites are being upgraded and a third upgrade is pending. There are plans for Laramie, Rawlins, Buffalo, and Teton County, WY.

Budget:
2001- \$1.6 Million
2003- \$3.6 Million
2004- probably \$2 million

To try and help curtail this funding cut, it may work to try and write your congressperson. But we hope there is someone in Congress that will support the continued funding. Ask THEM to write a letter as well. Would be nice if the group put together a letter and sent it up to the governor. Ben Nighthorse Campbell and Bob Beauprez are two people to target. May and June is when the budget is appropriated.

Topic 3-Post-earthquake technical clearinghouse plan.
The authors have received review comments on the draft and it is coming along well. NIST (National Institute of Science and Technology) would like to be involved in the clearinghouse, but are unable to participate due to funding limitations. To be a cooperator you must commit to be involved in the items described in draft. Where do clearinghouse members meet? What is the chain of command? Will FEMA plan override this plan if there is a significant damaging event?
Will probably need multiple meeting places throughout Colorado. OEM probably has these places already. It would be beneficial to have a homeland security component in the plan as well.

Topic 4-Mission statement

Everyone should think of a statement and email it to Anne Sheehan.

Topic 5-Suggestions for future presentations.

| Building codes.

Paul Santi-CSM, Liquefaction, ask to be a member as well.

Other members?

Topic 6 – Tour of USGS seismic instrumentation laboratory, led by Alena Leeds and Mark Meremonte. Mark and Alena showed committee members seismometers and digitizers used in ANSS sites, as well as solar panel stands and instrument enclosure. Alena described noise studies of Kit Carson and other sites. Mark showed real-time data from new broadband seismograph site in Northeast Kansas.

Earthquake Hazard Mitigation Council Minutes

Meeting Date: January 9, 2003

Present: Matt Morgan, Bob Kirkham, Vince Matthews, Michael Haughey, Wayne Charlie, Rob Jackson, Marilyn Galley, Damon Runyan, Paul Freeman, Doug Bausch, Dave Butler, John Nicholl, Waverly Person, Anne Sheehan.

Topic 1-Approval of minutes. Minutes Approved, motioned and seconded.

Topic 2-Presentation by Paul Freeman on "Issues in Insuring Earthquake Risk"

Major burden on banks (like World Bank) to provide resources for hazard reconstruction.

Issues important in insuring earthquake risk:

- Issues related to event causing damage (hazard info)
- Hazard and vulnerability
- Insurance aspects (portfolio construction)

Insurance can adapt to ambiguity (precision) by pricing. These levels are different for insurance vs. science. Be sure to look at "Earthquakes and Volcanic Eruptions" (book by Swiss Re), good reference on overview of hazards, risk, and insurance. The science of earthquakes is an element used by the insurance industry. Same with exposed structures (buildings, roads), also fire and explosion, business interruption, hazard and vulnerability of structures. In addition to these things, insurance companies need to know rating models, deductible, indemnity limits, maximum loss. Insurance usually covers random events in large groups, which spreads the risk out over time. With earthquakes, however, there is much exposure is one event. Insurance companies must limit the number of policies in high hazard areas. State insurance commission regulates rates. Earthquake insurance blends science with nontraditional insurance theory and is complicated by high risk/low probability consequence nature of loss.

EQ insurance not required in Colorado.

The cost for creating policies is great for companies and they must look at how many potential purchasers of insurance they will have.

Topic 3-ANSS update by Anne

Sand Dunes site up and running.

Kit Carson is a bit behind schedule. Noise tests were not favorable. They are having trouble finding a quiet site on public lands.

Search for a site near Maybell continues. Would like someone from the Council to assist with search.

Would like to use the CU equipment at a site between Boulder and Aspen, or perhaps near Steamboat.

Laramie, WY station is in, but may be moved due to noise.

USGS is placing some stations in SW Wyoming.

Council is charged with coming up with a priority list of sites and seeking funds for more stations.

USGS will maintain seismographs over the long term.

Approximate cost is \$15,000 for seismometer and \$15,000 for digitizer.

Recent M=2.9 EQ near Aspen was confidently located, thanks to the recently installed seismograph at the Sand Dunes.

Anne proposal to analyze the PASCAL data set for local earthquakes was funded by NEHRP.

Topic 4-Post-earthquake clearinghouse plan. Draft clearinghouse plan was approved by CGS and COEM. Draft of plan is unanimously approved by the Council. Next step involves contacting the potential cooperating agencies and organizations and getting their commitment to participate in the clearinghouse. USGS will be an active participant. State Buildings and Real Estate Program, in Div. of Finance and Procurement, is developing relationships with state colleges and universities around the state to provide meeting rooms for groups to use following a disaster. The Clearinghouse is eligible for this program.

States need to develop reciprocal interstate MOUs that will commit employees from one state to assist with the operations of a clearinghouse in another state. Each state should be prepared to send at least one representative to other states in event of a disaster.

Topic 5-Need for new council members? Bob is retiring at the end of month, and will not be able to attend the meetings regularly. He was wondering if he should step down as co-chair. The Council felt that he should continue as co-chair and attend as many meeting as possible. In the event that both Bob and John are absent from a meeting, an acting co-chair will be appointed to run the meeting in their absence.

A recommendation was made that the meetings be held on the 3rd Thursday of every other month. This change was acceptable to the members present. Therefore, the third Thursday of every month will be the new meeting date. Next meeting will be held on March 20.

Topic 6-State Hazard Mitigation Plan

Local gov't plans are due late in 2003. The State plan is due on Nov 1, 2004. Marilyn requested that someone be available to help her with the geologic hazard part of the plan. Vince suggested that Marilyn work with Dave Noe at CGS, as he runs the engineering geology section and should be the first point of contact. Because of the schedule, plans for local governments are the first priorities; the State plan will follow. FEMA has developed a list of criteria and regulations which counties should include in their plans. State plan must evaluate vulnerability of all critical facilities.

Topic 7-Work on our mission statement was postponed to a future meeting.

A discussion occurred relating to a topic for the March meeting. The Council decided to focus on ANSS. Anne will lead the discussion and hopefully get USGS personnel, like Harley Benz and Alena Leeds, to attend.

Colorado Earthquake Hazard Mitigation Council: Minutes for 11-14-02 meeting

Attendees: Bob Kirkham, Vince Matthews, Damon Runyon, Rob Jackson, Michael Machette, Marilyn Gally

Topic - Minutes for Sept 12 meeting were approved.

Topic – Updates on current NEHRP studies and future USGS work Colorado and work:

Mike Machette updated the subcommittee on USGS's current involvement in Alaska. Major strike-slip surface rupture occurred during the EQ. Seismographs are being deployed. Fortunately, the weather is still mild enough to work in the area after the events.

USGS continues to monitor the Trinidad area. About 2 EQs/month still occur in the area. They plan to remove 2 seismographs from the area this calendar year and leave 2 for awhile longer. USGS has installed one portable seismograph near the Rocky Mountain Arsenal, but as of yet not seen much EQ activity. They still don't have permission to locate one on the arsenal property.

USGS hopes to initiate geologic studies of young faulting in Colorado during this fiscal year. Unfortunately, there are no dollars yet approved for work in Colorado, but they have begun project planning. Mike expects to do reconnaissance in the southeaster part of the San Luis basin in the spring. In addition to the Colorado work, the USGS Intermountain West EQ project proposal included other small projects, including work in the El Paso-Juarez region and around Salt Lake City. Total project is funded at about \$400,000.

Bob Kirkham gave an update on his NEHRP work in the Williams Fork Valley. All field data has been collected. There is no evidence of young faulting along the southern part of the fault, but there is strong evidence in the northern and central parts of the fault. The geomorphology of the range front there includes faceted spurs, suggestive of recent uplift. Many scarps are present in young deposits along the fault, including many that coincide with fault-line scarps and which are likely of tectonic origin. One part of the range front lacks geomorphic features suggestive of young faulting. This part of the mountain range maybe affected by massive landsliding. About 20 profiles were measured across suspected tectonic scarps. Six soil pits were dug by hand into faulted deposits in an effort to estimate the age of the faulted sediments. Jim McCalpin helped to analyze the soils exposed in the pits. The data collected in the field this summer will be evaluated during the winter. Finding sites suitable for trenching will be a challenge. The scarps occur on both Forest Service and private land. Access and permitting issues were discussed.

Vince updated us on CGS work on the Northern Front Range NEHRP project. Matt Morgan digitized and created digital and hard copy maps "Published Faults of the Colorado Front Range". A fault near Arapahoe Pass had not previously been mapped. No felt reports for the 1882 EQ have been discovered by Geo-Haz while reviewing Estes Park diaries.

Topic -ANSS update:

Sand Dunes station is up and operating. The Kit Carson station: USGS had hoped to have a site already finalized, but have had some delays. They currently are conducting noise tests on 3 or 4 sites, so are making progress. They hope to finalize a site sometime in the next month or so. A site in the vicinity of the 4 Corners area will likely be on the Navajo Reservation. NW Colorado site: Anne Sheehan (via Bob) is looking for assistance to select a site within about 50 km of Maybell. Anne can find travel funds if someone wants to help scout it out. Proposed CU-USGS cooperative site (from Anne via Bob): probably install in 2003. Harley Benz suggested Aspen. Anne would like to be somewhere near Boulder. Bob suggests somewhere around Estes Park. Vince suggests Rocky Mountain National Park. No one recommends going south of Boulder. 2003 Nationwide ANSS plan: Anne would like for the EQ Council to recommend 5-6 additional locations for seismographs and to help with possible funding sources. Rob and Vince volunteered to work with Anne to seek funding sources.

Topic – Selected name for the EQ Subcommittee:

A variety of names were proposed via email to Bob. A slight majority of emailed responses favored “**Colorado Earthquake Hazard Mitigation Council**”. Following a discussion of all proposed names, those in attendance at the meeting voted unanimously to adopt “Colorado Earthquake Hazard Mitigation Council” as our new name. Damon suggested that we develop a new mission statement that reflects our re-organization and new name. This will be a topic for future meetings.

Topic – Technical Clearinghouse:

Review changes. CGS will need to take on a bigger role. Questions were raised about the proposed USGS plan to coordinate NEHRP-supported post-earthquake investigations, which will include activation of a clearinghouse. It was decided to temporarily postpone further work on the state’s clearinghouse plan until we get clarification of how the USGS clearinghouse plan might affect the need for a state-run clearinghouse or how the federal and state clearinghouses might cooperate. Bob will contact Tom Holzer, the chair of the USGS clearinghouse plan, as well as WSSPC and EERI. Other questions – does this plan need a signature page or to be run through the AG’s office or governor’s office?

Other topics: Possibly contact CIRSA about interest in working with the committee. Discuss the earthquake component of the State Hazard Mitigation Plan and, including the risk assessment, at our next meeting.

Next meeting - January 9, 2002. Dr. Paul Freeman will speak on the insurance industry’s view of earthquake risk.

Earthquake subcommittee Minutes from 9-12-02 meeting

Attendees: Bob Kirkham, Matt Morgan, Vince Matthews, Mark Petersen, Damon Runyon, Richard Christenson, Rob Jackson, Waverly Person, Anne Sheehan

Topic 1-Minutes approved with addition of Michael Haughey comments.

Topic 2-ANSS update

New strong motion instrumentation is in jeopardy, thus no strong motion instruments for Colorado. Having a strong motion instrument would be a plus for the State. However, consensus at ANSS meeting was we should be shooting for weak motion instruments. There were strong motion instruments installed in Denver back in the 1970s and early 1980s. Locations and conditions are presently unknown. Bob read an excerpt from a Colorado Society for Natural Hazards Research memo dated May 17, 1983. It stated that Roy Spitzer and Emil Gadeken picked up one of "our" strong motion instruments from the City and County of Denver Building on April 28, 1983. The machine was not operational.

USGS currently has seismographs running in Idaho Springs and at the Great Sand Dunes National Monument. Efforts are underway to site one near the town of Kit Carson. We may also get a station in NW part of state (maybe Maybell), in addition to some near Rock Spgs and Laramie, WY; northwest New Mexico as well.

Plan for 2003? Cost sharing is encouraged by USGS and will improve chances of funding. Anne has a couple of broadband stations, so these could be used as match. Connect up with a university? Possibly Mesa College, CU-Boulder, Colorado College. Other locations? Glenwood, Steamboat, North Park, Denver, Thornton-Westminster, Ridgeway. USGS recently installed a portable broadband near Rocky Mtn. Arsenal. This is not an ANSS-supported site. Maybe the Bureau of Reclamation would be interested in using some of their stations from the Ridgeway network as match, since it is being dismantled. Our group should come up with a list of 5-6 locations to propose. Lay out a more in-depth plan as well, for 2003. A committee for 03, could take care of some leg work to help Anne out. Look at historical seismicity and set priorities.

Topic 3-WSSPC meeting in Denver-Comments by Vince.

Topic 4-Future of EQ Subcommittee.

We are "part" of the Colorado Natural Hazards Mitigation Council, which no longer exists. There is a need to reorganize. Options? State Seismic Safety Commission, State Earthquake Advisory Board, Colorado Earthquake Council or Committee, "Concerned citizens" Group, etc. Utah Seismic Safety Commission was created thru a legislative act, which also decided type of members. Vince proposes we leave it as is. Tough to get response from legislature or governor support.

"It works, don't mess with it".

Sponsorship under CGS? Uncertain, but supported by CGS director and staff. However, this is unlikely for the next few years.

Anne, Damon, likes the CGS sponsorship idea. Name change? What is committee vs council, vs. commission, working group.

Other topics-Need a few more reps from academia, insurance agencies.

Next meeting-November, 14, 2002.

Earthquake subcommittee meeting of July 11, 2002

In attendance: Jennifer Steck, Bob Kirkham, Michael Haughey, Richard Christenson, Waverly Person, Wayne Charlie, Dave Butler, Matt Morgan, Damon Runyon, Mark Petersen, Pete Bemelen, Alexander Abel, Jim Geist, Chengyu Li, Rob Jackson, Vince Matthews, Mike Piper

Topic 1-Minutes from May meeting approved.

Topic 2-Presentation by Vince Matthews, Colorado Geological Survey - "Earthquake Hazards in Colorado"

Most of the public does not believe earthquakes occur in Colorado.

FEMA ranked CO as 30th in "Annualized EQ Losses".

Estimated losses for Atlanta is 50 times that of Denver according to FEMA.

On USGS OFR-92-347 Colorado 1882 earthquake does not make it to the list, even though it is large enough.

There is strong evidence that CO is active tectonic province. CO has very high heat flow. Has highest average elevation in US (6800 feet. Over 90 Quaternary faults and folds in Co based on report released in 2000. Many faults cut old rock, but their recent history can not be assessed because young deposits are not in contact with the fault.

Colorado is an excellent lab for human-induced earthquakes. Most well-known happened in the 1960's at the Rocky Mtn Arsenal. During the 1970's, an experiment to start and stop earthquakes was successfully conducted at the Rangely Oil Field,. During the past several years, salt water injection in Paradox Valley has triggered earthquakes, and a reduction in well pressure has diminished the size of the earthquakes.

Issues: Faults are not well mapped. Most earthquakes are poorly located.

Recent studies place the 1882 EQ in the northern Front Range; additional studies are currently underway to further evaluate this EQ.

Why has the CO EQ hazard been downplayed or ignored?

- CO Faults were long thought to be Laramide or older in age.
- Quaternary faults not recognized or described in literature prior to 1970.
- Induced earthquakes drew attention away from natural earthquakes.
- The 1882 earthquake was not definitively located until 1986.
- Paleoseismic investigations in other states took funding away from CO.

However, things are looking up for CO:

- Joint USGS/CGS field conference.
- 2 ANSS permanent seismic stations in 2002/2003.
- 2 NEHRP grants, one FEMA grant for CGS.
- CGS taking proactive role in USGS EQ Hazard maps.
- CGS mappers on alert for Quaternary faults
- CGS effort to raise academic participation.
- CGS urban fault search.

CGS resources:

- Kirkham and Rogers earthquake CD-ROM.

- Earthquake Reference Collection.
- Online Late Cenozoic Fault and Fold database.

Topic 2: Update on ANSS

- \$3.9 million is budgeted for FY 2003
- 2 of 5 new stations in Intermountain West region to be installed in CO
- Rocky Mtn Arsenal may get a permanent strong motion instrument.
- Planning session in Salt Lake City for FY03 planning July 17-18. Ivan Wong is representative for Intermountain West region

Topic 3: WSSPC annual conference

- Flyers for conference are out; try to attend if possible

Other topics:

There is a new paper on “Suggested Modification to the Seismic Design Category of the IBC” by S.K. Gosh, S. K., published in Southern Building, May/June 2002, pp. 19-23.)

It is difficult to attack national building code, but would be good to recommend to local municipalities. Focus on Denver first, since other municipalities look to Denver as a guide. City of Denver could ask when assistance from Subcommittee is needed. They don't want too many voices at this time, but input is valuable.

Look for education opportunities for the sub-committee – particularly code, architectural, and engineering groups.

Proposed topics for next meeting:

Future of committee
Mission Statement
Sponsorship under CGS

MINUTES

Colorado Earthquake Subcommittee Meeting held on May 9, 2002

In attendance: Michael Haughey, Matt Morgan, Bob Kirkham, Art Frankel, Rob Jackson, Doug Bausch, Marv Koleis, Wayne Charlie, Anne Sheehan, Damon Runyan. Others came in late.

Minutes from March 7, 2002 meeting were finalized and approved.

Topic 1–New members

Art Frankel and Richard Christiansen became new members of the subcommittee. Mark Petersen will be added to our mailing list and invited to attend future meetings.

Topic 2-Action plan for code issues

Rob, Michael, Doug, Damon

It was suggested that subcommittee should consider proposing a code change or changes to IBC. Anyone can recommend a code change. Code changes to the IBC are, of course, made at the national level. There are mainly two areas of the IBC about which committee members are concerned. Rob Jackson has previously called into question the appropriateness of the use of Seismic Design Category “A.” In fact, the City of Denver’s adoption of the IBC will disallow the use of Seismic Design Category “A,” requiring SDC “B” as a minimum. This is really no major change, but just maintains the status quo for earthquake ground motion design in Denver. The use of SDC “A” would allow a substantial reduction in equivalent lateral forces along much of the Front Range. Michael Haughey has previously discussed the lack of enforcement of the current UBC 97 provisions for the seismic design of anchorage for equipment supported by structures. Even so, the IBC provisions lessen these requirements significantly even for Seismic Design Category “B” and higher.

For a national code change, there is a need for people behind it, so the subcommittee is a good choice as a starting point. Maybe the Structural Engineers of Colorado might be interested in supporting a code change? The Colorado ICBO mainly recognizes the results of the national code process. Not much support from ICBO has yet been gained. There appears to be an earthquake hazard awareness issue even among the structural engineering community and the building code community. Need to get structural, mechanical, civil engineers and architects involved. Maybe Rob or Vince can give presentations to these groups?

A local amendment process may be a better way to go, but it requires adoption on a city by city or county by county basis. If the State of Colorado had a State Building Code requirement then the process could start there, but Colorado’s State requirements are minimal, applying only to pre-fabricated housing and supposedly to hotel/motel construction and do not address seismic design directly. Fundamentally, going to the IBC will lower some design criteria. This net effect needs to be pointed out to IBC. There are counties and municipalities that do not have any building codes either. Again, the issue of statewide consistency in code requirements and enforcement needs to be addressed.

Perhaps, the subcommittee should have a CDOT member, although the IBC does not regulate transportation systems.

The main problem is that the great majority of people believe there is no seismic hazard in Colorado. The committee needs more outreach to demonstrate what the hazard is.

ICBO-website shows those jurisdictions that have adopted the IBC 2000.

Vince will give his earthquake talk at the next meeting. Invite folks from Structural Engineers of Colorado, CDOT, Denver Water, and Federal Highway Authority.

Topic 3-ATC-20

The Applied Technology Council publishes a document entitled ATC-20, "Procedures for PostEarthquake Safety and Evaluation of Buildings." ATC-20 uses a color code tagging system to identify the level of safety of buildings following disasters. The procedures have been used for California earthquakes and most recently for post-disaster evaluation of the buildings in the vicinity of the World Trade Center site in lower Manhattan. ATC-20 was also used as a guideline for the Colorado ICBO Damage Assessment Manual for Buildings. Doug has arranged for free ATC-20 training on Aug 22-23. The training will be in Colorado Springs on the 22nd, Denver on the 23rd. . The training will lead off with local presentations, including an earthquake presentation. Training is focused toward engineers and building inspectors.

Topic 4-Colorado EQ Hazard Conference

A conference on Colorado earthquake hazards was held in Crestone on April 22-24. Most participants were affiliated with the USGS and CGS. Other attendees represented FEMA, the Bureau of Reclamation, universities (CU and CSU), and consulting groups. Meeting started with a half-day of presentations. Next full day was devoted to a field trip to examine the Sangre de Cristo and Villa Grove Faults, including a trench across the Villa Grove Fault that was still open. There were more talks and panel discussions on the morning of the 3rd day. Posters were on display throughout the meeting. One of the conclusions of the meeting was that we know enough about Colorado's earthquake hazards to know that we need to know much more.

Part of the discussion related to the USGS National Seismic Hazard maps, especially how to get more Colorado faults included in maps. As currently proposed, only 3 of Colorado's faults would be included, the Sangre de Cristo, Sawatch, and Cheraw faults. Initially it was stated that a fault had to be well studied and have a published slip rate to warrant inclusion in the database used to generate the maps. However the Chase Gulch Fault, which had numerous trenches excavated across it and had published slip rates was not included in the database. Subsequent to the conference in Crestone, CGS requested that the Chase Gulch Fault be added to the database.

A fault with a low slip rate, like those in Colorado, has almost no impact on maps with short return periods. A suggestion was made that national standards need to be developed

to clarify which faults are eligible for inclusion in the database, and what type of data is needed for those faults.

All agreed that additional seismographs are needed for Colorado. The proposed seismographs to be installed in Great Sand Dunes National Monument and near Kit Carson were discussed.

The USGS has revised their NEHRP grant program so that the Intermountain region will become one of their research priority areas. This should improve the likelihood of funding for NEHRP proposal that address Colorado. A recommendation was made that the CGS be responsible for coordinating earthquake hazard studies in Colorado and act as a statewide clearinghouse.

Topic 4-Network for Earthquake Engineering Simulation (NEES)

NEES is an initiative of the Engineering Directorate of the National Science Foundation to create a collaborative environment in which universities and researchers in earthquake engineering can conduct research using shared equipment. Univ. of Colorado at Boulder is one of the participating schools. The types of equipment available for use will include shakatables, tsunami wave basins, geotechnical centrifuges, and large-scale structural testing equipment. NSF has awarded \$30 million this year for NEES.

Next meeting will be held on July 11, 2002 at noon-2 pm in Rm 520, USGS Building at 17th and Illinois Str., CSM campus, Golden. Vince Matthews will give a presentation on earthquake hazards in Colorado, and the main topics of discussion will be the future of the Earthquake Subcommittee and need to develop a mission statement.

Notetaker: Matt Morgan

MINUTES

March 7, 2002

Earthquake Subcommittee meeting

Members in attendance:

Rob Jackson, Bob Kirkham, Vince Matthews, Matt Morgan, Jim McCalpin, Marilyn Gally, Marv Koleis, Waverly Person, Damon Runyon, Doug Bausch, Frederick Blume, Wayne Charlie, Michael Haughey

Topic 1: Minutes approval – Minutes need to be approved before they are put on the website. Email draft minutes to members prior to the following subcommittee meeting. Draft minutes will be revised/amended/approved at the following meeting.

Topic 2: Presentation- Start of Long-Term Neotectonic Studies in the San Luis Valley by Jim McCalpin, Geo-Haz Consulting and Crestone Science Center.

In 2001, the Crestone Science Center's class on "Field Methods in Neotectonics and Paleoseismology" studied the Villa Grove fault zone at the northern end of San Luis Valley. This work is part of a long-term effort to study in detail the part of the Sangre de Cristo fault (SDCF), which Jim researched for his Ph.D. dissertation. In 2002, the class will trench near Great Sand Dunes National Monument. The 2001 class measured scarp profiles, used GPS to map the scarps, and trenched a 2.5-m-high scarp near the southeastern end of the VGFZ. The height of scarps along the VGFZ increases with age, indicating recurrent movement on the fault. The fault traces exposed in the trench were subtle; changes in clast imbrication occurs at the faults; organic-rich and poorly cemented material was present on the downthrown side of the fault. Evidence of two prior fault ruptures with a total of about 3.3 m of displacement was exposed in the trench. Relative age dating techniques, such as relative soil development, clast weathering, development of weathering rinds, etc., were used to constrain the ages of deposits found along the scarps and exposed in the trench. Charcoal was collected from three of the deposits in the trench, but they have not been ^{14}C dated due to a lack of funds (~\$1800). No slip rates were determined, because of the lack of absolute ages. The class used Corel Draw to digitize the trench log, and then used retrodeformation techniques to reconstruct pre-faulting conditions. There are few scarps along the SCDF north of where the VGFZ splits off from it. As scarp heights along the northwestern end of the VGFZ diminish, scarps begin to reappear along the range-bounding fault

Topic 3: International Building Code (IBC) Issues for Colorado by Rob Jackson

There are some changes in the new IBC relative to the Uniform Building Code that the IBC is replacing. Colorado, by and large, is adopting the IBC, but adoption of the IBC is up to local governments. The IBC uses a Seismic Design Category (SDC) for determination of the structural design criteria for a building. It is a new parameter from the NEHRP Guidelines and is indirectly similar to the former "Zones." However, the SDC is not just a function of the region of the country but also of the soil, the building's use and the Maximum Considered Earthquake (MCE) ground motion contour maps

derived from the USGS hazard maps. For parts of Colorado where SDC A would be allowed, softer soils do not result in a higher design category; neither does the use of or type of building. For instance, a hospital can be classified as SDC A the same as for a residential dwelling. Seismic Design Category A is only a bit better than the former Zone 0. A greater percentage of state, therefore, would now have lower seismic design requirements in the new IBC than in prior codes. Where SDC A is allowed, it essentially eliminates the requirement for seismic design in Colorado east of the Front Range. One mitigating factor is that if there are no soils data, Site (Soils) Classification D must be used which will result in SDC B as a minimum. Rob Jackson's point – City of Denver is adopting IBC, but not allowing the use of Seismic Design Category A.

Further discussion from the group pointed out that there are exceptions to requirements for the UBC/IBC, for non-structural attachments (mechanical/electrical), and exemptions for attachments for all non-critical structures in all zones. Problem: More dilution of the code. It is understood that nearly 50% of damage comes from non-structural items. Adoption of codes does not necessarily mean enforcement. Dam safety is regulated by the State, but most non-federal dams apparently are not required to address seismic issues. Vince says the fundamental problem regarding the IBC stems from the National Hazard Map. We must support research on these faults to change the map.

Next meeting date – May 9th. Same time, same place.

Agenda items: Mission statement and future of subcommittee; action item on code issues.

Note taker: Matt Morgan

Minutes

January 8, 2002 of the Earthquake Subcommittee Meeting

Colorado Natural Hazards Mitigation Council

DATE: February 8, 2002

MEMBERS IN ATTENDANCE: Damon Runyan, Doug Bausch, John Nicholl, Anne Sheehan, Dave Butler, Rob Jackson, Vince Matthews, Bob Kirkham

TOPIC 1: Minutes from the Nov. 15, 2001 meeting are awaiting final approval by the subcommittee co-chairs. When finalized, they will be emailed to each member and posted on the subcommittee web site.

TOPIC 2: Doug Basch, FEMA, described FEMA's role in earthquake hazard mitigation, including FEMA's staffing and NEHRP role, grant and mitigation programs related to earthquakes, Region VIII projects, and FEMA products like HAZUS. Doug mentioned the Emergency Management Performance Grant, which replaces the former line-item grants provided to state offices of emergency management. The new style of grants gives each state more flexibility, but hazards that are perceived as less hazardous by each state's office of emergency management, such as earthquakes in Colorado, may receive less attention.

The Disaster Mitigation Act of 2000 updates the Stafford Act, the law under which FEMA operates. Pre-Disaster Mitigation replaces Project Impact. The Emergency Management Planning Assistance (EMPA) is a flexible and discretionary fund under the jurisdiction of the regional director.

Among the current Region VIII Special Projects are the Lewis & Clark Advanced HAZUS study, Salt Lake City HAZUS, Teton County Schools Retrofit, and Web-Mounted Hazard Maps, and recent grant for \$15,000 that Doug obtained for Colorado through EMPA. The subcommittee discussed possible ways to use the grant, including new trenches across young faults, determination of slip rates for faults that have been studied in some detail but which lack published slip rate values, low-sun-angle photography for the Trinidad area, and supplementing the upcoming CGS NEHRP grant to investigate the Williams Fork Valley faults, which was only partially funded by NEHRP.

HAZUS99 SR-2 is due to be released next month. It will include metadata, and should offer better 3-D fault modeling. Large census tracts have become an issue for gridding methodology. The Lewis & Clark HAZUS project will be a case study using smaller gridding tracts. HAZUS '03 is anticipated to be released in December 2002. It will include flood, hurricane, wind, and a revised earthquake module, and will use 2000 census data.

TOPIC 3: Recent activities related to the recent Trinidad earthquakes were briefly discussed by subcommittee members, based largely on information provided to them by Mark Meremonte. Earthquake activity has decreased. Both the number and size of events is diminished. The weak motion instruments were removed just before Christmas. A total of only 10 earthquakes were recorded during the 7-week period preceding removal of the weak motion instruments. According to NEIC, a magnitude 3.1 earthquake occurred in the Trinidad area shortly before Christmas and after the weak motion instruments were removed. There is some question about the location of this event, as its wave form was different from previously recorded earthquakes in the Trinidad area. There presently are 5 strong motion instruments still deployed in the Trinidad area. Two of

these will be removed sometime in January. The remaining three instruments will continue to monitor in the Trinidad area for about 1 year. Mark is working on an open-file report that will be published on the USGS web site. He provided a draft version of this paper to Bob Kirkham. The USGS hopes to begin installation of some of the removed instruments in the vicinity of the Rocky Mountain Arsenal in February or March. They intend to install 3 or 4 seismometers near the Arsenal to determine if small earthquakes continue to occur in this area.

TOPIC 4: The discussion of a mission statement for the subcommittee was postponed until the next meeting. This topic will be a major agenda item for that meeting. We anticipate having general discussions about the content of the mission statement during the March meeting. A work group will also be established at the next meeting. Their purpose is to prepare a draft mission statement that incorporates the ideas discussed by the entire subcommittee at the next meeting.

TOPIC 5: Based on information provided by Lynda Lastowka to Bob, USGS, work continues on the installation of 2 backbone seismographs that will be installed as part of ANSS. The proposed location at the Great Sand Dunes National Monument needs to be "noise" tested prior to final selection and design of the site and seismograph. USGS decided to purchase new equipment to conduct the noise test, since they will be needing such equipment for all new sites. They anticipate conducting the noise test in late January or February, pending receipt of the new equipment. If the site proves suitable, the permanent seismograph should be installed in late spring or early summer.

TOPIC 6: New or upcoming studies on Colorado earthquake hazards: The CGS received partial funding from NEHRP to study the faults in the Williams Fork Valley. This grant should start on April 1. NEHRP grants have also been received by the CGS and Geo-Haz Consulting (ie. Jim McCalpin) for collaborative work related to the 1882 earthquake. Jim will be studying faults in the immediate vicinity of Estes Park and looking for additional felt reports for the 1882 earthquake, while the CGS, primarily Vince, will conduct a regional search of the northern Front Range for possible causative faults for the 1882 earthquake.

See Topic 2 for a description of a FEMA grant that Doug Bausch recently received.

We also discussed the need for funding to analyze local earthquakes recorded during the mantle tomography experiment by Anne Sheehan. There is an urgent need to convert the data stored on the tapes during the original project, as the tapes may be deteriorating.

TOPIC 7: The 2002 annual meeting of WSSPC will be held in Denver on September 15-18. One of the sessions will probably be on induced earthquakes and their relevance to seismic hazard analyses. A field trip is tentatively planned to visit Rocky Mountain National Park, where sackungen will be examined, and the 1882 earthquake will be discussed. Another field trip will tour the facilities of FEMA, COEM, and NEIC.

NEXT MEETING: Noon on Thursday, March 7, 2002 in Room 520, USGS/NEIC Building at 17th and Illinois, CSM campus, Golden.

SUBJECT: Minutes from the November 15, 2001 Regular Meeting of the Earthquake Subcommittee of the Colorado Natural Hazards Mitigation Council

DATE: December 17, 2001

PRESENT: Damon Runyan, Michael Haughey, Doug Bausch, Matt Morgan, Wayne Charlie, John Nicholl, Marilyn Gally, Dick Vnuck, Anne Sheehan, Rob Jackson, Vince Matthews, Bob Kirkham, Tony Crone

1. TOPIC - Mission Statement for the website.

Will look back at old documents and see what there is. Mitigation should be the underlying idea in the mission statement.

2. TOPIC - An Earthquake Swarm in Trinidad, Colorado by Meremonte, Lahr, and Frankel. Presented by Mark Meremonte.

The USGS national seismic network has recently recorded twelve earthquakes in the Trinidad area. Their closest seismograph to the epicenters is about 290 km distant. The largest EQ in the swarm was Mag 4.6, and it was felt as far north as Walsenburg. The NEIC detection threshold is about 2.8. Curiously, the earthquakes appear to have occurred in 5 pairs over 2.5 weeks within 2-3 hours of one another. This is anomalous in an aseismic area, but why?

The USGS installed 12 local seismographs by the end of September. Some measurements began Sept 8-9. The recorded microseismicity has a strike of about 42 degrees to the NE and extends for a distance of about 5 km. The seismicity appears to define a fault plane. A water injection well related to coal-bed methane production is located near the swarm. The well began injecting produced water into the Dakota Formation at a depth of about 1.5 km in 1997, but is not a pressure injection well. Other wells in the region began injecting as early as 1988.

Another swarm of earthquakes occurred in this same area in 1973. Six of these events were recorded by the NEIC network. There also was an earthquake in 1966 that caused some damage in Segundo/Valdez area and was felt in Pueblo.

9 of local seismographs will be removed at the end of Nov. Three will stay for an additional year or so. Mark plans to give a talk to the public in Las Animas County. COGCC asks not to show well locations on handouts. Frankel is concerned that a 5km long

fault could cause larger and more damaging quake in future.

USGS plans to install 3 of the portable instruments that are being removed from Trinidad at the Rocky Mountain Arsenal.

3. TOPIC - Lineaments and faults near Trinidad.

Vince Matthews and M. Morgan are studying the surface geology of the area where the recent earthquakes occurred. Trend surface residual maps indicate a NE-trending high is present. Structural anomalies (i.e. changes in dip) and slickensides are visible on a fault in this area. Trends are NE. First motion indicates dip to SE.

4. TOPIC – Presentation on paper titled “Magnitude recurrence relations for Colorado Earthquakes” by Charlie, Battalora, Siller, and Doebling. Will be published in *Earthquake Spectra*. Wayne Charlie gave the talk.

This study used earthquake data in Kirkham and Rogers (1981; 2000) and fault data in Widmann and others (1998). They modified the Kirkham and Rogers (2000) catalog by removing “non-earthquakes”, foreshocks, aftershocks, and probable injection events. Only 14 states have experienced a historical EQ larger than M= 6.0 ML, and Colorado is one of those states. The 1882 Colorado EQ had an estimated magnitude of 6.5 or 6.6, while the largest instrumentally recorded EQ was 5.5 ML.

They determined a mean recurrence interval of 420 yrs. for a 6.5 ML or larger earthquake. A magnitude 6.6 ML or larger earthquake has a 10% Poisson’s probability of exceedance in 50 years, while a 7.5 ML earthquake has a 2% Poisson’s probability of exceedance in 50 years. Analysis of independent intensity data gives a mean recurrence interval of about 190 years for an earthquake of the size of the Nov 7, 1882 event.

Several concerns of this analysis were raised. Seismologists are concerned about the purely statistical nature of this analysis, and the physical meaning of the results. The final values are significant extrapolations of incomplete data from a number of different geologic regimes. A valid question is what do the extrapolated results really mean? Another concern is that a casual observer could easily misuse the analysis results, without specific seismologic and geologic considerations.

5. TOPIC- ANSS. USGS plans to install at least 2 backbone stations in

Colorado, one near Ft. Garland and a second one near Kit Carson. Bob Kirkham recently met with Lynda Lastowka, USGS, and examined sites near Ft Garland. The most favorable site is within Great Sand Dunes National Park. The park employees are looking forward to having the instrument at the park, and are hopeful that they can install an educational exhibit with real-time seismograms at the visitor's center.

Finding a suitable site near Kit Carson will be a greater challenge. If any subcommittee members know of a good site near Kit Carson with bedrock, electricity, year round access, etc., please contact Bob Kirkham.

NEXT MEETING: Noon on Tuesday, January 8, 2002 in Room 520, USGS Building, 17th and Illinois, CSM campus, Golden.

**SUBJECT: Minutes of the September 13, 2001 Regular Meeting of the
Earthquake Subcommittee of the Colorado Natural
Hazards Mitigation Council**

DATE: November 7, 2001

**PRESENT: Bob Kirkham, Vince Matthews, Anne Sheehan, Jim Milne,
Waverly Person, Doug Bausch, Matt Morgan, Brian Mackey,
Jim Dewey, Tony Crone, Michael Haughey, Rob Jackson,
Bob Chesson, Marilyn Galley, Loren Avis, Wally Prebis**

**1. TOPIC - Recent Colorado Earthquakes Near Trinidad and Glenwood
Springs by Jim Dewey and Tony Crone**

**Jim Dewey-Felt reports for earthquakes are now input via
USGS website (<http://earthquake.usgs.gov>) by public and
are referenced by zip code. A “felt” magnitude was
approximated. 17 responses in Trinidad, specifically the
Segundo area; MM intensity 6 highest reported intensity.
Final intensities will have professional input (engineer
and/or seismologist). The web method is very fast, maps
prepared automatically, however it is susceptible to
hoaxers. Results and turnout would have been better if the
web site was advertised in local paper. On October 2, 1966,
a similar earthquake in Trinidad was magnitude 4.6. The
events of 2001 have much tighter felt areas, and therefore
are likely shallower than those of 1966 (maybe a different
source?). A “6” intensity is justified because objects fell
off shelves, pictures fell from walls, and masonry cracked.
Segundo is very close to epicenter.**

**On July 22, there was an intensity 4 quake near Florissant
and an intensity 4, magnitude 4 quake on August 9 near
Glenwood Springs.**

**Tony Crone-USGS deployed portable seismographs to
record the flurry of EQ activity. Two instruments are K-2s**

(strong motion instruments) that were installed in the town of Cokedale and on Trinidad Reservoir dam. A sequence of 5 stations also deployed to locate EQ hypocenters. Events that have been recorded by the NEIC regional network are believed to have epicentral locations accurate to about 5 km. All located events are in a well-defined area; depths have been arbitrarily assigned to 5 km. One event has been recorded on all recently deployed instruments. Reports indicate that the earthquake was heard, then felt. When heard, then the earthquake is usually shallow. Sensitivity is about magnitude 1.0. Twelve events of magnitude 2.0 or greater have been detected. Scientists are not sure why earthquakes are happening. Studies indicate tension in a NW-SE direction. Maybe on trend of Cheraw fault. Using data recorded by newly installed instruments are deployed, we should be able to get resolution to less than 0.5 km. Water injection related to methane production in the area occurs at depths of ~2.1 km at most (Dockum Fm). The earthquakes are at least 2X as deep.

2. TOPIC - Earthquake Subcommittee Web Page – Matt Morgan

-Matt Morgan has developed a Web page for our Earthquake Subcommittee. The URL is

<http://geosurvey.state.co.us/pubs/quake/subcommittee/subcommittee.htm>

Please check out the web page and pass any comments or recommendations for other material to add to the web site to Matt (303-894-2171).

3. TOPIC – WSSPC

The annual Western States Seismic Policy Council meeting will be held in Sacramento, CA from Oct 22-25. WSSPC will pay airfare for two representatives from Colorado to attend meeting. Vince is the geoscience rep and Marilyn Galley is the emergency manager representative.

WSSPC has developed a draft policy on post-earthquake technical clearinghouse. Vince will accept comments on draft and present them to the group. The policy encourages States to put together a clearinghouse, between State Geological Survey and OEM. Colorado should put together a plan like Utah has. A working group to address this topic was created. Doug Bausch, Bob Kirkham, Anne Sheehan, Michael Haughey, Rob Jackson, and Marilyn Galley volunteered to be in the working group. Any other subcommittee members who would like to help out should contact Bob Kirkham.

CGS and OEM will host the 2002 annual WSSPC conference. Field trip ideas? Sackungen and 1882 earthquake in Rocky Mountain National Park. Meeting would be around 12-18-September, 2001. Possibly 100-150 people will attend.

CGS publication Bulletin 51 wins WSSPC 2001 Award of Excellence for use of new technology.

4. TOPIC - ANSS Implementation Plan

There are two committees involved with the ANSS in the Intermountain West. They are the Intermountain Working Group (Anne Sheehan represents CO) and the Intermountain Advisory Group (Rob Jackson represents CO).

Vince Matthews described the National Backbone, which forms the basis for nation wide seismographic coverage. Page 5 of the report states that there should be an expansion of broadband stations in Colorado. MT, CO, West TX, have need for strong motion instruments. CGS should and will get more involved in getting out earthquake information to public. Vince also stated that earthquake risk in CO (e.g. Denver, Colo. Springs) has been underestimated. FEMA had previously assured him that a state's seismic risk ranking according to HAZUS would not affect how resources were allocated. HAZUS ranks CO very low (30th in nation). Ground motion data used in HAZUS is

from the USGS National Earthquake Hazard Maps. Remember, CO has not had research like NV, NM, UT, MO, SC, therefore CO data is lacking and thus, the low risk. Seismicity in intermountain region - what is the difference between seismicity in CO and NM? Not much, but NM is getting a lot more funds. Broadband seismometer stations – none in CO, but Albuquerque, NM is getting a one, again this has HAZUS roots. But there is *proven* Holocene movements on faults in Albuquerque. CO and WY do not have seismic network, this may be a function of state funds. CO has to be proactive. NORAD may get more funding. Can CO get a seismic network through them?

New stations are needed in SW and S-Central CO. Anne Sheehan would like to get together a proposal to the State Legislature for funding a seismic network. Vince would like to work with CU to do that as well. Would Trinidad or Las Animas County be interested in funding permanent network there? Who would run it? We need a strategy. Maybe backbone onto USGS or have USGS increase stations to CO. CGS could get money to make offer. Also, CGS should get involved in Colorado Springs PROJECT IMPACT, where there may be room for earthquake research according to Doug Bausch.

5. TOPIC – PEPP

Daryl Speer ran a NSF funded work shop last summer to train high school teachers about seismology. Three PEPP instruments are down, but should get them up and running. The Ignacio instrument was given to Ft. Lewis College. However, they did not want to return it, apparently unaware that the instrument belongs to Princeton.

6. TOPIC - USGS deployment of seismic stations at Rocky Mountain Arsenal

USGS was denied access on Arsenal grounds. All instruments now temporarily in Trinidad. Future sites?? Northglenn or Thornton, Fitzsimmons Science Center.

7. TOPIC - Progress on funding? No progress.

8. TOPIC - Future topics?

Working group on post-earthquake technical clearinghouse. Seismic Network Station Group. Project IMPACT group. Code issues. FEMA to sponsor CU-Denver HAZUS training class, maybe November, available every Friday or in January sometime.

NEXT MEETING: November 15, 12pm-2pm, Room 520, USGS Building, 17th and Illinois, CSM campus, Golden. Wayne Charlie presentation on Seismic Hazards in Colorado. Update on USGS portable seismometer network in Trinidad area.

Recorded by Matt Morgan

SUBJECT: Minutes of the July 12, 2001 Regular Meeting of the Earthquake Subcommittee of the Colorado Natural Hazards Mitigation Council

DATE: July 19, 2001

PRESENT: Doug Bausch, Tony Crone (speaker), Marilyn Gally, Mr. Hayes, Rob Jackson, Bob Kirkham, Mike Machette (speaker), Vince Matthews, Matt Morgan (notetaker), Damon Runyon, Anne Sheehan

1. TOPIC – Introduce Doug Bausch

Doug comes to the committee from FEMA, where he is a natural hazards specialist for region VIII. He is the replacement for Steve Pratt. Doug spoke of the new HAZUS service release that is due out anytime. A class on HAZUS and mitigation will be taught on August 22 at EMI in Emmitsburg, MD. Doug brought up the possibility of having a HAZUS class taught in Denver at the end of September or October. The Fed Center and the USGS office in Golden are possible locations for the training.

2. TOPIC – Recap meeting on the Intermountain West region of ANSS, March 28.

Funding issues were a major part of the meeting. Reno and Albuquerque are to receive strong motion instruments. Rob Jackson was elected as Colorado's representative to IMW Regional Advisory Committee of ANSS.

3. TOPIC – Summary of WSSPC Meeting, March 26-27.

Created a draft policy recommendation that encourages States to form a technical clearinghouse following large earthquakes. WSSPC will develop a model clearinghouse plan and post it on their web site. CGS and COEM need to work together to develop a plan for Colorado

- 4. TOPIC – Summary of ATC-USGS “Second National Earthquake Ground-Motion Mapping Workshop”, May 10-11. Rob Jackson attendee.**

Meeting dealt with code-related issues and hazard maps. The hazard maps that will be used for ATC are the seismic hazard maps currently being updated by the USGS. The meeting dealt with issues like what are the maps and how will they be used, what impact will they have on the engineering community, are the maps time-dependent in certain areas, and some of the maps deal with areas where there is uncertainty (i.e. Colorado).

- 5. TALK – “Prehistoric Surface Ruptures on the Cheraw Fault, Southeastern Colorado” by Anthony J. Crone, Michael N. Machette, Lee-Ann Bradley, and Shannon Mahan. Tony and Mike gave a very informative talk on the Cheraw fault, which has experienced 3 surface ruptures in the past 20-25 thousand years.**

6. NEW TOPICS--

- Candidate faults for future paleoseismic investigations?**
- Vince Matthews discussed recent CGS-USGS discussions on seismic hazards, including the USGS seismometer deployment seismographs at Rocky Mtn. Arsenal. Local earthquakes recorded during the crustal study that Ann Sheehan was involved with should be analyzed. How can we get Colorado universities active in Colorado earthquake research?**
- Ann Sheehan discussed a GPS monitoring project for Colorado. Last geographic data was collected in 1991; old stations will be re-occupied during her GPS study. Are there critical locations that should be monitored?**
- Where is a good location for a field trip during the WSSPC meeting to be held in Denver in 2002?**

NEXT MEETING: September 13, 2001, 12pm to 2pm, Room 520, USGS Building , 17th and Illinois, CSM campus, Golden.

Recorded by Matt Morgan

SUBJECT: Minutes of the May 10, 2001 Regular Meeting of the Earthquake Subcommittee of the Colorado Natural Hazards Mitigation Council

DATE: May 14, 2001

PRESENT: Bob Kirkham
Marilyn Gally
Rus Wheeler (guest)

Michael Haughey
Vince Mathews

1. TOPIC: Replacement for Frank Patete

The meeting started with a short discussion of how to replace Frank Patete, who formerly served as secretary to the EQ subcommittee. Marilyn Gally explained that because of funding and programmatic changes, it was necessary for COEM to divert the funds they had used to support Frank's work as our secretary. Frank now concentrates on the CSM EPICS program. We tentatively decided that the co-chairs will be responsible for reserving the meeting room and arranging for any equipment needed by speakers. A volunteer will record the minutes for each future meeting.

2. TOPIC: Presentation on data for Colorado used in the 1996 USGS seismic hazard analysis by Rus Wheeler, USGS

Most of the meeting focused on the presentation by Rus, which was very informative and interesting. There were many questions posed, and most were answered. One of the questions that remains to be answered relates to seismicity near the Rocky Mountain Arsenal. None of the earthquakes at or near the arsenal were included in the catalog used for the 1996 analysis. Based on the information presented by Rus, the RMA seismicity occurred in two clusters. The first cluster occurred between 6/18/62 and 11/29/72 and most scientists believe they were induced by fluid injection. After a 5-6 year period with no recorded earthquakes, the second cluster initiated on 6/10/78 and continued until 11/8/89. There is not consensus regarding the origin of the earthquakes in the second cluster. Rus described 2 arguments that favor an induced origin for the second cluster and 2 arguments that favor a natural tectonic origin. The largest earthquake in the second cluster is the 4/2/81 mb 4.3 event. Since the USGS model includes only earthquakes in excess of M=3, the 4/2/81 EQ is the only event in the second cluster that would be included in the USGS catalog. The USGS will rerun their hazard analysis with the 4/2/81 EQ included in it to determine if it changes to ground motion probabilistic maps.

3. TOPIC: Other Agenda Items

Other items on the agenda were not discussed at the meeting. They will be included in the agenda for the next meeting.

6. TOPIC: Next Subcommittee Meeting

The next meeting will be Thursday, July 12, 2001 May 10 at the same location. Tony Crone, USGS, will give a presentation on paleoseismic investigations of the Cheraw fault, a Holocene fault in southeastern Colorado.

Submitted by Bob Kirkham

SUBJECT: Minutes of the Regular Meeting of the Earthquake Subcommittee of the Colorado Natural Hazards Mitigation Council

DATE: March 8, 2001

PRESENT: Bob Kirkham	Michael Haughey
Rob Jackson	Vince Mathews
Damon Runyan	Marvin Koleis (guest)
Dave Sullivan (guest)	Kim Stiegelmeier (guest)

1. TOPIC: Earthquake Program Coordinator

It was announced that Frank Patete will no longer be the Earthquake Program Coordinator as funding for such a position has been withdrawn by the Colorado Office of Emergency Management (OEM). Damon Runyan volunteered to take minutes for the meeting. This situation was discussed further at the end of the meeting with questions raised but not answered with regard to whether OEM actually has an Earthquake Program and what impact the absence of funding has on the overall Hazards Mitigation Council.

2. TOPIC: HAZUS Analysis for Denver

Marv Koleis handed out results summaries of three HAZUS scenarios for earthquake damage in Denver:

1. The M5.3 1967 Event
2. 500-year MRI (probabilistic analysis)
3. 2500-year MRI (probabilistic analysis)

Dave Sullivan and Kim Stiegelmeier from Denver Emergency Management were present for the presentation and discussion.

The summaries presented projected damages by facility type, casualties and dollar value. The results from the 1967 Event and the 500-year MRI were surprisingly similar in total dollar value. There was much discussion concerning the significance of various input to the result with much uncertainty remaining, because no one present fully understands both the HAZUS program and the significance of the various input parameters. It has been emphasized by FEMA that non-technical operators should stick to probabilistic scenarios, i.e. comparing the 1967 Event run and the 500-year MRI run is inappropriate.

Marv will write reports for the two probabilistic scenarios, with possible input from the Committee. It was suggested that FEMA should review the reports. There is no set schedule for report completion at this time.

3. TOPIC: USGS Seismic Hazard Mapping Methodology and Input Data; USGS Seismic Hazard Workshop

The mapping methodology and input data were generally discussed. Vince will make a presentation to the workshop, which will be held on March 28 and 29.

4. TOPIC: Colorado's Representatives to ANSS

This topic was postponed until next meeting.

5. TOPIC: WSSPC Meeting on Post-Earthquake Technical Response

Bob and Vince will attend on March 26 and 27.

6. TOPIC: Next Subcommittee Meeting

The next meeting will be Thursday, May 10 at the same location. Tony Crone, USGS, will give a presentation on their paleoseismic investigation of the Cheraw fault.

SUBJECT: Minutes of the Regular Meeting of the Earthquake Subcommittee of the
Colorado Natural Hazards Mitigation Council

DATE: January 11, 2001 (meeting date)

PRESENT: Bob Kirkham	Waverly Person
Wayne Charlie	Rob Jackson
Frank Patete	Michael Haughey
John Nicholl	Damon Runyon
Marilyn Gally	Marvin Koleis (guest)
Jon Ake	

1. TOPIC: Western States Seismic Policy Council Meeting, September 16-23, 2000

The subcommittee discussed four topics that were on the WSSPC meeting agenda.

- a. Seismic Safety Commissions. Bob Kirkham stated that WSSPC viewed our subcommittee as the organization responsible for seismic safety in the state of Colorado. Bob also stated that the Council felt that Colorado was well organized and staffed in relation to several other western states. Each state commission was interested in finding funding sources, but no obvious sources were discussed at the meeting.
- b. Post-earthquake Technical Clearinghouse. WSSPC believes there is a need for each of the member states to develop a plan for a post-earthquake technical clearinghouse. An earthquake disaster in Colorado will attract a large number of earthquake professionals with the intent to learn lessons and lend assistance. However, without a plan for coordinating their investigations and integrating their findings into emergency management, their efforts may be duplicative or overlapping, and would not be directly useful in response, damage assessment and early recovery activities. Bob believes CGS/COEM should take the lead in coordinating this effort, and that our committee also has a role to play in preparing a plan for Colorado. The subcommittee members were provided a draft plan to review and were asked to provide their comments concerning the plan at the next meeting. A WSSPC sponsored meeting will be held this spring in Salt Lake City, March 26-27, to further discuss this concept.
- c. HAZUS Used by FEMA to Estimate Annualized Earthquake Losses for the US. Stu Nishenko, FEMA, gave us a presentation on this topic at our last subcommittee meeting.
- d. ANSS, (Advanced National Seismic System). Efforts are underway to form regional committees that will be responsible for making recommendations to the national ANSS group. Colorado is included within the Intermountain West (IMW) Region, which had an organizational meeting last June. At that meeting they set up a preliminary management structure that involved 1) a Regional (or Oversight) Subcommittee and 2) a Regional Working Group. The Regional Oversight Subcommittee is primarily concerned with policy and planning, while the Regional Working Group addresses implementation issues. Our Earthquake Subcommittee will likely be asked to nominate two of our subcommittee members to serve as members on each of the two IMW Regional subcommittees. We will discuss and select our nominations at the next meeting.

2. TOPIC: HAZUS Analysis for Denver

Marvin Koleis, COEM informed the subcommittee that the City of Denver OEM, working with COEM, used the HAZUS software program to run three earthquake risk scenarios for the City of Denver. These scenarios were probabilistic runs at 250 and 2500 year return periods and a historical run of magnitude 5.3, the largest Rocky Mountain Arsenal event and, for comparative purposes, two for Fort Morgan (probabilistic runs at 250 and 2500 year return periods). Marv would like for the subcommittee to review the reports prior to their being finalized for the Denver OEM. Marv will send copies of all five HAZUS reports and CDROMs containing the technical manuals to Bob Kirkham for distribution to subcommittee members interested in reviewing them. Contact Bob if you would like to review the reports and/or get a copy of the technical manuals. Please refer to the technical manuals, call or email the HAZUS help line, or call or email Marv with questions you may have. Hopefully most questions can be addressed prior to our

next meeting. Marv will be making a presentation on these HAZUS analyses at the next meeting, and there will be time for a few remaining questions to be answered then.

3. TOPIC: EQ Hazard Analyses at CSU

In March, 1997, Ray Battalora provided to the subcommittee two copies of his CSU thesis titled "Earthquake Magnitudes and Recurrence Intervals in Colorado". Wayne Charlie, Don Doehring, and Ray have updated the thesis and written a paper summarizing the results. The paper has been tentatively accepted by EERI for publication in their quarterly journal, Earthquake Spectra. Wayne Charlie would like for the subcommittee members to review and comment on the document prior to publication. Contact Wayne at 970-491-5048/5354 or wcharlie@engr.colostate.edu. He will also bring copies to our next meeting.

4. TOPIC: PEPP Update

Bob received an e-mail from Darell Speer, science teacher at Rocky Mountain High School. Darrell stated that they will be offering a work shop for 30 teachers this summer at his high school and through Colorado State University. The participants will get a stipend of \$400, two hours credit, a dorm room on CSU campus and travel expenses for one full week of training on using PEPP and other seismology data sources in the class room. Six of the 30 will be trainers. Darell is in the process of training the trainers now. It is his intention to have each of the trainers be responsible for four of the participants throughout the 2001-02 school year. He will be sending a flyer out to over 500 teachers some time after January 1st. Priority will be given to those applicants with strong physical science and earth science backgrounds. He will also be selective by location since it is his intention to train those that will manage a seismograph.

5. TOPIC: National Seismic Hazard Probabilistic Maps

Following the WSSPC Post-earthquake Technical Response meeting in Salt Lake City, Art Franko, USGS, will host a meeting on March 28, addressing updates to the National Seismic Hazard Probabilistic Maps. Our subcommittee believes that we have relevant seismic data for Colorado that should be included in the five-year update of the maps. A working group, consisting of Bob Kirkham, John Nicholl, Jon Ake and any other subcommittee members who would like to contribute, will develop a list of information that should be discussed with Art and addressed in the next version of the hazard maps. The recommendations will be discussed and, if need be, revised at our next meeting, prior to submittal to the USGS.

6. TOPIC: Next Subcommittee Meeting

The next meeting will be held at noon, Thursday, March 8th, 2001, on the 5th floor, (Rm. No. 520) USGS Building, 17th and Illinois Street, Colorado School of Mines campus, Golden, Colorado. Once again, please bring your ideas concerning projects that you would like the subcommittee to address to this meeting.

Submitted by,

/Signature/

Frank Patete

SUBJECT: Minutes of the Regular Meeting of the Earthquake Subcommittee of the
Colorado Natural Hazards Mitigation Council

DATE: November 9, 2000 (meeting date)

PRESENT: Bob Kirkham	Waverly Person
Wayne Charlie	Rob Jackson
Frank Patete	Michael Haughey
Jon Ake	Wally Prebis
John Nicholl	Damon Runyon
Anne Sheehan	Vince Matthews
Don Doehring	Marvin Koleis (guest)
Phil Sirles (guest)	Dave Butler
Joe Miller (guest)	Rus Wheeler (guest)
Stu Nishenko (guest)	

1. TOPIC: Estimated Annualized Earthquake Losses for the United States

Stu Nishenko, with FEMA in Washington, D.C. gave an excellent presentation on loss estimates generated by Hazards U.S. (HAZUS), a GIS-based earthquake loss estimation tool, developed by FEMA in cooperation with the National Institute of Building Sciences (NIBS). The HAZUS computer software tool provides an approach to quantifying future earthquake losses that is national in scope, uniform in application, and comprehensive in its coverage of the built environment. This study estimates seismic risk in all regions of the U.S. by using two interrelated risk indicators:

1. The Annualized Earthquake Loss (AEL), which is the estimated long-term value of earthquake losses to the general building stock in any single year in a specified geographic area (e.g. state, county, metropolitan area).
2. The Annualized Earthquake Loss Ratio (AELR), which expresses estimated annualized loss as a fraction of the building inventory replacement value.

This loss study is an important milestone in a long-term, FEMA-led effort to analyze and compare the seismic risk across regions in the U.S. and contributes to the long-term goal of the National Earthquake Loss Reduction Program (NEP). The goal is to reduce future losses from earthquakes in the U.S. through the adoption and implementation of earthquake mitigation measures. The results of this study are useful in at least four ways:

1. Improving our understanding of the seismic risk in the U.S.
2. Supporting the adoption and enforcement of seismic provisions of building codes.
3. Comparing the seismic risk with that of other natural hazards, (i.e., hurricanes and floods).
4. Providing a baseline for earthquake policy development and the comparison of mitigation alternatives.

FEMA is also developing HAZUS models to estimate hurricane and flood losses. Additional information on all of these programs can be found on their web site, www.fema.gov/hazus.

2. TOPIC: Paradox Valley Project

Jon Ake, with the U.S. Bureau of Reclamation in Denver did a superb job of discussing the research project being conducted by his organization near Bedrock, Colorado. The exact study location is Paradox Valley on the Colorado-Utah border. The objective of the study is to reduce the salinity of the Colorado River system. To accomplish this task, the Bureau began removing brine from the Delores River, (a tributary of the Colorado River) in the Paradox Valley complex in 1991. The brine is being injected, under pressure, into a 15,271 foot deep well drilled in the valley floor. The injection interval is from 14,100 to 14,500 feet. Numerous seismograph stations have been installed in the area to monitor and record seismic activity prior

to and during the injection process. The Bureau expected the brine, as it was pumped into the well and moved under pressure along the fractures beneath the ground to trigger small magnitude earthquakes.

From 1991 to 1995, approximately 164 million gallons of brine was injected into the well, triggering 667 earthquake events, with the highest recorded magnitude earthquake being $M=2.6$. The majority of the earthquake epicenters were near the well head. From 1996 to May, 2000, 576 million gallons have been injected, causing about 3000 events. The highest magnitude event recorded in 1998 was $M=3.0$, in 1999 the highest recorded event was $M=3.5$, and on May 27, 2000, an event of $M=4.3$ occurred. The test results show that in the last few years the earthquake epicenters have moved several kilometers away from the well head (up to 4 kilometers), have become more frequent, and of a higher magnitude.

Jon stated that earthquakes of the magnitude recorded in May, 2000 is unacceptable and that the Bureau is in the process of reevaluating their operating techniques. Jon feels in order to reduce the number and magnitude of the earthquakes in the future, the Bureau will have to reduce the quantity of brine pumped into the well and also lower the pressure on the system. The exact pressure and quantity of fluid pumped into the well in the future is still under study. He stated that the research project is accomplishing its objective of reducing the salinity of the River system and that the program is cost effective. He does feel that a second well would significantly benefit the overall study effort.

For more information on this fascinating research project, please contact Jon on his web site, jake@do.usbr.gov.

3. TOPIC: HAZUS Analysis for Denver

Rob Jackson informed the subcommittee that the City of Denver Office of Emergency Management, working with the Colorado Office of Emergency Management recently used HAZUS to run five earthquake scenarios for the City of Denver and the surrounding communities. In running the scenarios, the two organizations used the probabilistic ground motion maps compiled by USGS for most of the scenarios. A $M=5.2$ earthquake (the largest historic event at the Rocky Mountain Arsenal) was used for one scenario. For each scenario, the HAZUS program generated an analysis of the earthquake hazard vulnerability for each location, summarizing the impact of the earthquake on people, residential, commercial and industrial buildings, infrastructure, shelters, economic losses, and so forth. Rob stated that the people participating in the program are benefiting immensely from the study and that most feel the HAZUS program is a good management tool. Rob also stated that he felt the Earthquake Subcommittee should be consulted when future earthquake scenarios are run to insure appropriate earthquake data is used.

4. TOPIC: Next Subcommittee Meeting

The next meeting will be held at noon, Thursday, January 9th, 2001, on the 5th floor, (Rm. No. 520) USGS Building, 17th and Illinois Street, Colorado School of Mines campus, Golden, Colorado. Once again, please bring your ideas concerning projects that you would like the subcommittee to address to this meeting.

Submitted by,

Frank Patete

SUBJECT: Minutes of the regular meeting of the Earthquake Subcommittee of the Colorado Natural Hazards Mitigation Council

DATE: September 14, 2000 (meeting date)

PRESENT:	Bob Kirkham	Vince Matthews	Damon Runyon
	Anne Sheehan	Mike Haughey	Darell Spear
	Kaye Shedlock	Rob Jackson	

1. TOPIC: New Subcommittee Member

Discussion: Vince Matthews, Senior Science Advisor for the Colorado Geological Survey has been nominated for membership to our committee.

2. TOPIC: Advanced National Seismic System (ANSS)

Discussion: Kaye Shedlock, of the USGS, presented a program on the ANSS. As a result of the Northridge and Taiwan earthquakes, Congress has become more concerned with seismic monitoring. The USGS has the assigned Federal responsibility to "monitor seismic activity" in the United States. Seismic monitoring faces many problems and challenges including outdated instrumentation, lack of coverage and a lack of uniform standards. As a result, goals for an Advanced National Seismic System have been established. These goals include real time monitoring with modern equipment, enhanced strong motion measurements and automatic broadcast of early warnings and alerts plus close to real time post-event information, such as calculated peak ground accelerations, for response and recovery. Plans include the expansion of the United States National Seismograph Network (USNSN) from its present configuration of 56 stations to backbone of 100 modern seismographs. Kaye mentioned a possible grid spacing of around 275 km for these stations. Potential locations in Colorado include Idaho Springs and possibly Ft. Garland and another site in western Colorado. A total of 6000 strong motion instruments are planned for urban seismic monitoring. Denver was not included based on the USGS assessment of hazard and risk relative to other cities. Colorado is to be a part of the Intermountain West Region, including Wyoming, Montana, New Mexico and Utah. Arizona, Idaho and Nevada may or may not be in the region. Our earthquake subcommittee will provide a member to serve on this region's ANSS oversight subcommittee. Additional seismic monitoring and consideration for Colorado funding through ANSS may be pursued. The USGS has a publication on ANSS. It is U.S. Geological Survey Circular 1188, "Requirement for an Advanced National Seismic System."

3. TOPIC: Princeton Earth Physics Project (PEPP)

Discussion: Darell Speer, of Rocky Mountain High School, presented a discussion on the recent NFS grant. The Colorado Princeton Earth Physics Project was allocated an \$85,000.00 grant from the National Science Foundation to train three teacher/trainers at Rocky Mountain High School. 35 other Colorado teachers will be trained to use PEPP materials, and Darell plans to get the all Colorado PEPP seismographs on line. This grant was written by Darell Speer and his colleagues, Nazli Nomanbhoy and Judy Hannah from the Earth Resource Department at Colorado State University. The first phase will involve training the trainers to use PEPP data and the seismograph to do real time research in the classroom on seismology. The second phase will be implemented the summer of 2001, when a workshop will be offered for 35 other Colorado teachers. These teachers will be trained to use PEPP materials and be chosen through an application process. Phase three, Darell Speer will go to the four other seismograph sites in Colorado and get them up and running to archive data. These seismographs are located in Springfield, Durango, and Westminster. The fourth site will be determined. CGS will be willing to archive the data. (The stations are single component monitoring only and may not meet ANSS criteria.) The final phase of the grant will be holding workshops at professional conferences around the nation. Darell Speer's website is

<http://www.psd.k12.co.us/schools/rocky/science/speer/dspeer%20homepage/dspeer.htm>

4. TOPIC: FEMA's HAZUS program being run for the City and County of Denver
Discussion: Rob Jackson related that the Denver Office of Emergency Management has begun working with the State of Colorado to develop a HAZUS analysis for the City of Denver. John Nicholl, Bob Kirkham, Vince Matthews and Rob Jackson met with Kim Stiegelmeier and State OEM and GIS personnel on August 4. The State will run five trial HAZUS runs; two probabilistic runs for Denver with 500 and 2500 year MRI, two for eastern Colorado (as a presumed minimum comparative baseline) also with 500 and 2500 year MRI, and one deterministic run based on a 5.3 M event in the vicinity of the Rocky Mountain Arsenal. The preliminary results will be presented on October 20th. These runs will not yet reflect any specific input from the subcommittee or any of its members as to the technical input parameters in HAZUS. Our earthquake subcommittee will be a resource for the evaluation of the results from these runs. The committee also should serve to establish and review input parameters as necessary for this and further HAZUS runs throughout the State. More information is still necessary on the input parameters of the HAZUS program as it currently is used. The results presented on October 20th are anticipated to be a discussion item for the November subcommittee meeting.

4. TOPIC: WSSPC meeting (9/16 - 9/23)

Discussion: Bob Kirkham will be attending the Western States Seismic Policy Council meeting. This is also known as the National Earthquake Risk Management Conference. A meeting of the Seismic Safety Commissions from each state will occur on Sunday prior to the conference. Our earthquake subcommittee is the Seismic Safety Commission for Colorado. Each Commission is to report on its accomplishments and to share experiences relating to common interests. Discussion of our earthquake committee's accomplishments ensued and the following were listed:

- Developed and reviewed "earthquake fact sheets" as a source of public information on the seismic hazard in Colorado. The first one of these was done in conjunction with CSU's Colorado Earthquake Hazard Reduction Program (CEHRP). Most recently the latest sheet has been included on the Colorado Earthquake Hazards Map developed by the Colorado OEM. The recent fact sheet is on the CGS web site.
- Mentored seismic research projects through the Colorado School of Mines "EPICS" program.
- Facilitated and reviewed the development and initiation of the Princeton Earth Physics Project (PEPP) for seismometers at 5 of Colorado's high schools.
- Facilitated and reviewed a survey of city and county building code requirements within the state.
- Provided review comments on HAZUS program applications.
- Promoted and encouraged the development of an earthquake library and clearinghouse for Colorado seismic records and publications.
- Provided pertinent and balanced seismic information to the press for earthquake related articles.
- Provided a continuing active forum for seismic related discussions and presentations including representatives from CGS, USGS, State and local emergency management, structural engineering, geological and geophysical, insurance and building code communities.

5. TOPIC: Next Subcommittee Meeting

The next meeting will be held at noon, Thursday, November 9, 2000 on the 5th floor, (room number 520) USGS Building, 17th and Illinois Street, Colorado School of Mines campus, Golden, Colorado.

Submitted by,

Rob Jackson