SUMMARY OF ANSS NEEDS FOR THE INTERMOUNTAIN WEST (IMW) REGION

Prepared for
U.S. Geological Survey and
ANSS National Implementation Committee

Prepared by
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and Contributors from Individual IMW States

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Foreword revised November 16, 2004

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FOREWORD

The ANSS National Steering Committee (NSC) has asked for "needs statements" from each ANSS region in advance of a meeting of the NSC on November 18–19, 2004.

For the eight-state Intermountain West (IMW) Region (AZ, CO, ID, MT, NV, NM, UT, WY), ANSS participants in each individual state were asked in late September to submit to me a needs statement—as short or as detailed as desired— for compilation, review by the ANSS-IMW Regional Advisory Committee (as well as by state-level ANSS advisory committees in the cases of Colorado, Nevada and Utah), and presentation to the NSC. The submitted statements are included here as sequential appendices, ordered alphabetically by state.

Various circumstances significantly color these contributions, including (1) the expectation of basically static ANSS funding and (2) ongoing projects involving coordination between USGS/ANSS managers and individual states in the IMW Region. For example, no submission was made for the state of Wyoming, which lacks a resident seismic-network operator. But the state of Wyoming is directly coordinating with the USGS to complete and enhance the new Teton seismic network and to complete a jointly funded Wyoming-USGS project to install five regional broadband stations throughout the state. Another factor affects the submitted needs statements: only Utah and Nevada have seismic networks receiving significant (albeit partial) support from USGS-ANSS funding (Montana recently began to receive minor USGS funding for its network operations).

As a result of the above, the needs statements here are chiefly conceptual. Many implementation details will depend on ANSS funding constraints and USGS decision-making as it relates to ongoing projects in individual IMW states.

An examination of the aggregated needs statements makes one thing evident. One of the most important ANSS needs for regional seismic monitoring in the IMW Region—in order to advance beyond the existing patchwork of seismic-network coverage—is a strategic regionwide plan for dealing with earthquake geography and uniform recording and response. At the same time, any such planning has to recognize the fundamental importance of individual state earthquake programs, particularly in terms of their local expertise and the need for earthquake information outlets in individual states.

Review by Advisory Committees

This *Summary of ANSS Needs for the Intermountain West (IMW) Region* was reviewed by the IMW Regional Advisory Committee (RAC) (http://www.seis.utah.edu/anss/imw-rac.shtml). The RAC held a 1.5-hour teleconference on November 12, and the minutes of that conference are accessible online at the above URL.

The needs statement for Utah (Appendix G) was also reviewed by Utah's ANSS state-level advisory committee—the Utah Advisory Committee for Urban Strong-Motion Monitoring (http://www.seis.utah.edu/urban/membership.shtml). The latter committee held a 1.75-hour teleconference on November 15 (minutes not yet posted).

Recommendations from RAC

Because the November 12 teleconference did not include a majority of members of the RAC, pulling together recommendations necessarily had to be tentative. Walter Arabasz reviewed for the participants a list of recommendations that the RAC had formulated for FY2002 based on much greater deliberation (see http://www.seis.utah.edu/anss/summary.pdf). That was the last time the RAC made a full-blown effort to make a list of recommendations (no-growth ANSS funding was a factor in following years). In abbreviated form, the FY2002 recommendations were as follows (with those most relevant to discussions during the November 12 conference call in italics):

- *Need for good balance between new instrumentation for urban strong-motion monitoring and regional/national broadband seismic monitoring because of (a) dramatic population growth in metropolitan areas at moderate to high seismic risk and (b) large gaps in broadband coverage of extensive, seismically active areas within the IMW Region.*
- Justification for keeping momentum going in developing urban strong-motion networks in Nevada (Reno-Carson City and Las Vegas areas and Utah (Wasatch Front urban corridor).
- *High-priority importance to augmenting broadband coverage in the IMW Region by adding new national backbone stations (significantly under way).*
- ~~Cost-effective proposal by University of Wyoming to cooperatively fund and install, together with the USGS, five broadband stations throughout Wyoming~~ (already acted upon)
- *Emphatically urging the USGS to consider relatively low-cost ways to help small network operators with technical support—including making available traveling technician and computer professional support and facilitating periodic meetings/workshops.*
- Recognizing that state-level earthquake information centers are a desirable part of the structure of ANSS in the IMW Region.
- *Not using results of HAZUS (FEMA 366) as the only guide to prioritizing ANSS resource allocation in the IMW Region.*
- *Funding for at least one collective meeting of the RAC, possibly a joint meeting with the IMW Working Group (of network operators)* :

The following recommendations emerged from the RAC's November 12 teleconference:

- ***the need for a coherent regionwide plan for seismic monitoring in the IMW Region***
- ***helping "have not" networks and states in the IMW Region***
- ***need for the availability of portable seismograph arrays to augment inadequate seismographic coverage in the IMW Region***

- ***need to capture strong-motion data for large normal-faulting earthquakes, even if it means instrumenting areas with low population density***
- ***need for USGS to continue refining and developing ShakeMap and ShakeCast***
- ***need to convey the IMW perspective to the ANSS National Steering Committee, especially fundamental, first-order needs for seismic monitoring in the IMW***

Recommendations from Utah Advisory Committee for Urban Strong-Motion Monitoring

During their November 16 teleconference, Utah's ANSS state-level advisory committee unanimously endorsed the Utah working group's highest-priority instrumentation need—the addition of strong-motion stations in populated areas at risk outside the Wasatch Front urban corridor (see Appendix G for description and justification). The committee deferred to the Regional Advisory Committee for prioritizing other instrumentation needs on a region-wide basis.

Note: Additonal guidance on or endorsement of Nevada's needs statement (Appendix E) may yet be provided by Nevada's state-level ANSS advisory committee.

Walter J. Arabasz
IMW Regional Coordinator
November 16, 2004

APPENDIX A — ARIZONA

Needs Statement

Submitted by Dave Brumbaugh, Arizona Earthquake Information Center, Northern Arizona University, October 27, 2004

I. Background Information

Northern Arizona University (NAU) operates the Arizona Earthquake Information Center (AEIC) as well as a small network of stations in the northern part of Arizona. The Center and network are supported by a base level budget by the state of Arizona through NAU. Information distribution is primarily through the Arizona Division of Emergency Management and Arizona Geological Survey. FY 2003 and 2004 has seen the permitting of a new site for the MTLO station and the installation and initiation of an Earthworm connection to the University of Utah seismological laboratory through the generous support of U of U.

II. Support needed for FY 2005

Statewide budget cuts in FY2004 have resulted in minimal level of support for AEIC and the network. Outside funding will become critical for the first time. ANSS financial support for technicians is currently the most important need. Presently the budget barely supports a field technician for the network on a trip/contract basis, and leaves no funds for contract software work or upgrading of our equipment.

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APPENDIX B — COLORADO

State of Colorado ANSS Report and Needs Statement for FY 2005

Submitted by Rob Jackson, City and County of Denver, with input from the State of Colorado Earthquake Hazard Subcommittee, October 28, 2004

The State of Colorado has a rapidly growing population, active tectonics, and a seismicity that has never been surveyed statewide. Earthquake hazards in Colorado are poorly understood and may be underestimated. Buildings continue to be built and building codes continue to be revised at a pace that substantially outstrips any meaningful increase in the information necessary to better characterize the seismicity and earthquake hazard in the State. Colorado does not as yet have a statewide seismic network.

I. Current Status

The state now has two operating USNSN stations, one at Idaho Springs, ISCO, and the other at Sand Dunes National Park, SDCO. Additional sites are planned and in progress (Alena Leeds, Task Leader for Field Operations and Engineering, USGS/NEIC, written communication).

Current activities for the new sites and improvements at the existing sites are as follows:

SMCO (Snowmass, CO) — The US Forest Service has given verbal approval for the site based on concurrently completing the permitting process. Approval has been received from Aspen Ski Company to finish the installation, pending their acceptance of an MOA that includes a letter of indemnification from the USGS and a promise to pay our part of the electric bill that is related to the VSAT equipment. Subject to suitable weather conditions, the site should be online soon. The University of Colorado at Boulder (Dr. Anne Sheehan) is collaborating with the USGS on this station.

KCCO (Kit Carson, CO) — Site selection is still in progress, and it assumes that a solar-powered design will be used. Some equipment issues relating to the solar-power system had to be worked out, and a new site will need to be located far from pumping and pipeline noise associated with natural gas production in the area. Hopefully a suitable site will be finalized during the fall of 2004, which would allow for a late spring/early summer installation in 2005.

MBCO (Maybell, CO) — The Maybell (or Dinosaur National Monument) site has experienced some permitting snags due to confusion about the locations of a proposed Designated Wilderness area. Also, one potential site apparently was too near to an historical cabin. A different site somewhere else in that area may be required but may have to go to private land.

ISCO (Idaho Springs, CO) — is the recipient of a major, ongoing upgrade courtesy of EarthScope. ASL engineers were in the tunnel during October 2004 to install new lighting and upgrade the vault. A new seismometer and data logger should be installed at the site within the next month.

OGNE (Ogallala, NE) — The site, which is near the northeast corner of Colorado, has been selected and permitted. The USGS plans to meet with the landowner and finalize the exact location in the near future. Construction could then proceed. The solar-power prototype has been tested and has performed at an acceptable level. The short term prioritization for work at this site may be deferred to other more weather sensitive sites in the northern US and the mountains.

The southern Wyoming stations will improve our coverage in Colorado as well, particularly northern Colorado.

II. Needs statement

Short term (1-2 years):

- Complete the installation of and initiate operations at the above described in-progress sites.
- Add a broadband station in SW Colorado, unless the USGS has one close by and operational in nearby states
- The United States Bureau of Reclamation (USBR) is upgrading two sites in the Paradox Valley Seismic Network to full digital capability. The station should be operational by late fall, 2004. This station may then function at the level required for a USNSN backbone station. If not, one should be added.
- Add a broadband station in southeast Colorado, unless the USGS has one close by and operational in nearby states.
- Add a broadband station in north-central Colorado, unless one of the southern WY stations adequately covers that need.

Long term (5 years):

- Add a strong motion network in the Denver Metropolitan area.

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APPENDIX C — IDAHO

State Report and General Needs

Submitted by Roy Breckenridge, Idaho Geological Survey, October 29, 2004

Date: Fri, 29 Oct 2004 13:01:03 -0700
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Subject: ANSS-IMW
To: "Arabasz (E-mail)" <arabasz@seis.utah.edu>
Cc: "Stephen Weiser (E-mail)" <sweiser@bds.state.id.us>

Walter,

In response to your request for an Idaho representative to the ANSS-IMW Regional Advisory Committee, our group has asked Robb Clayton to represent Idaho and he has accepted.

We believe some progress is being made toward our ANSS vision for Idaho <http://www.bhs.idaho.gov/disaster/earthquake/anss.htm >. Funding issues and homeland security distractions have been challenges to implementing the vision, and clearly we have much to accomplish. Nevertheless, we can point to a partial list of successful outcomes:

Our group has met several times to facilitate communication between network operators (BSU, U of I, INL, BYU-I), the Idaho Bureau of Homeland Security and the Idaho Geological Survey. We also held a teleconference to discuss USArray, Earthscope plans for Idaho.

We have established a virtual site on the Idaho Geological Survey homepage at <www.idahogeology.org> that provides Idaho earthquake information through shared links with operators in the region.

Several operators are currently refining Earthworm systems to share station information and BYU-I has added some new stations. We have serious problems with station upkeep, infrastructure, and state coverage. Yet as a group we are optimistic in developing a coordinated monitoring effort in the state and region and committed to building a strong consensus base.

And, although not included in the vision, Idaho will be host to the 2005 Western States Seismic Policy Council Annual Meeting in Pocatello on September 24-28. We see this as an opportunity to promote “rural earthquake” issues and link to ANSS in our IMW region.

Sincerely,

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APPENDIX D — MONTANA

ANSS Needs for Montana

Submitted by Michael Stickney, Montana Bureau of Mines and Geology, with input from Edmond Deal and Mike Brown, October 22, 2004

I. Background Information

The Montana Bureau of Mines and Geology (MBMG) operates a regional seismograph network that is focused on western Montana, but recently added stations provide some coverage for central and eastern Montana also. The network has grown in a piecemeal, opportunistic fashion over the past 24 years and now includes 34 short-period telemetered stations.

During the 2004 field season, two new U.S. National Seismic Network (USNSN) broadband stations, operated cooperatively with MBMG, became operational in eastern Montana, bringing the total number of backbone stations operating in Montana to four. The new backbone stations are located in extreme northeastern Montana (near Dagmar, Montana; DGMT) and in southeastern Montana (central LASA site; LAO). Analog seismic equipment formerly operated near Missoula (MSO upgraded to a backbone station in the summer of 2002) was reinstalled at a new site near the town of Victor along the west edge of the Bitterroot Valley, a rapidly growing population center without any seismic monitoring coverage. A significant level of recent field effort has been devoted to repairing and modernizing analog seismographs and their telemetry links—some of which were deployed 10-20 years ago—to improve reliability and reduce telemetry noise.

II. Instrumentation Needs

We have tentative plans to select sites and install the remaining two USNSN backbone stations planned for north-central and south-central Montana during the coming year in cooperation with the USGS. Even with the full complement of six USNSN backbone stations, several significant gaps exist in seismic monitoring coverage in seismically active parts of western Montana; specifically, in the Dillon area of southwestern Montana, along the Rocky Mountain front, and in the Libby area of extreme northwestern Montana.

One possibility for inexpensive additional network coverage involves adding a weak-motion sensor to existing USGS National Strong Motion Program (NSMP) instruments currently operating in Montana. The four channels of data (vertical weak motion plus three components of strong motion) could then be streamed in real time via Internet to the MBMG Earthquake Studies Office in Butte for inclusion in routine data processing and archiving.

Advantages of this idea include relatively low cost (price of a short-period seismometer and hardware to provide the Internet connection, perhaps $2000-$2500 per site), on-scale digital data for moderate to large magnitude local events, and improved network coverage for several areas of western Montana not well covered by the current configuration. Possible disadvantages of this idea are that the existing strong motion stations may be fairly noisy environments for weak-motion stations and Internet access may not exist at all sites.

However, the strong-motion instruments at Montana State University in Bozeman and at Carroll College in Helena are bedrock sites and Internet access at these two campuses along with the University of Montana, Western in Dillon should present no problem. Of course any modifications of NSMP instrumentation would need to be implemented with full cooperation and assistance of NSMP personnel. In as much as a stated goal of ANSS in the integration of weak-motion and strong-motion monitoring efforts, I believe this idea bears further investigation.

III. Other Requests

The Montana regional seismic network has benefited tremendously from the Earthworm data acquisition and analysis system implemented in 1999 and 2000 with considerable assistance from the USGS. Since June of 2000, data from all Montana stations and numerous surrounding stations are available for analysis in real time.

The MBMG is running an Earthworm-driven Oracle database that has operated reliably since 2001. However, the event-review capabilities, methods for inserting non-triggered events, and unresolved issues concerning catalog generation, backup and archival of the database have prevented me from using the database for routine analysis of seismicity. The current method of routinely analyzing and archiving network data is rather convoluted, involving command-line transfer of trace data from wave tank machines to a Unix machine, phase picking with SAC, manual editing of phase pick corrections, and manually constructing earthquake catalogs. The evolution of this convoluted system resulted from the need for continuity of earthquake cataloging procedures through several data collection and analysis systems, and limited technical support for designing and developing other possible solutions.

A primary unmet need of the Montana regional seismograph network is an integrated and flexible method for analyzing, cataloging, and archiving network data collected with an Earthworm system.

Remote Earthworm nodes at Ronan and Missoula comprise two crucial data concentration and retransmission points in the Montana network. The computers at these remote nodes should receive scheduled (semi-annual?) inspection, maintenance and upgrades by persons with expertise in Earthworm systems, firewalls, and Internet communications issues.

The un-interruptible power supply (UPS) at the MBMG Earthquake Studies Office was installed in 1999, before the upgrade to Earthworm occurred. The existing UPS is now five years old and is required to power a significantly larger system that originally designed for during power outages. Recent scheduled power outages demonstrated some of the short falls of the existing UPS. We need professional assistance to design an adequate UPS for the Earthquake Studies Office.

Finally, I would like to see at least a small amount of technical assistance for institutions that have attempted, or are seriously contemplating implementing Earthworm systems to gather and exchange seismic data for research and education. Although the two institutions that prompt this request are in Idaho, it is relevant to bring the issue up here because Montana and Idaho share a common border as well as earthquake hazards. Data collection and sharing between multiple institutions will strengthen the efforts of all parties. Some general requirements of an institution receiving technical assistance might include that they operate their own stations and share the data (i.e. they must contribute some original data to the

ANSS, not simply record data from others) and demonstrate a long-term commitment to their network, data acquisition and data sharing.

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APPENDIX E — NEVADA

Needs Statement, Nevada ANSS Seismic Network Operations

Submitted by Glenn Biasi and John Anderson, University of Nevada Reno, with input from other colleagues at UNR's Seismological Laboratory, November 7, 2004

I. Five Year Goals

Goals presented here have been tempered by funding expectations and are intended to reflect realistic network and system improvements achievable with level-of-effort investments by ANSS. Goals reflect improvements necessary to approach draft performance standards circulated at the September 27–28, 2004 National Implementation Committee meeting. These goals do not represent a full "wish list" or a statement of how Nevada monitoring is to achieve the full vision of USGS Circular 1188. Beneath the needs indicated as discrete items, the more pressing need is for stable funding of professional, computer systems, and technician personnel to implement ANSS goals and maintain reliable operations.

Moment tensor capability for M4.0 and larger events in Nevada.

Broadband station spacing at 70 km in the west, ~100 km spacing for balance of state. Quiet broadband stations are required for moment tensor computation. A spacing of 70 km would ensure that two or more stations would be within one wavelength at a 20 second period. Broadbands at our present Reftek stations would be the most economical way to begin to satisfy this goal in northern Nevada. Co-deploying strong-motion instruments would provide at least some constraint to ShakeMaps outside the urban areas of the state. Siting would consider the location of existing NSN and US Array BB stations. UNR hosting of a central Nevada NSN backbone station would be part of this new station coverage.

Improved station coverage for southern Nevada.

Station coverage of southern Nevada in general, and the Las Vegas Valley in particular, is sparse compared to areas of similar hazard. Little is known about the seismicity of faults posing a hazard to Las Vegas in part because station coverage is not sufficient for precise hypocentral locations. In addition the urban area is growing into new areas of poorly known hazard. Thus augmenting both the weak- and strong-motion monitoring capability is required. Seismicity is relatively low, so it is important to glean what we can from smaller events. New stations from a Lawrence Livermore National Laboratory initiative planned for FY 2005 deployment will help but not complete this need.

Strong motion coverage in northern Nevada.

We envision two goals for strong-motion coverage. The first is to augment strong-motion coverage in growth areas of the high northern Nevada, particularly north and east of Reno and south of Carson City. The second addresses a broader need in hazard assessment. Near-field strong-motion recordings of large normal-mechanism earthquakes are exceptionally rare, so uncertainties in ground-shaking amplitudes and in attenuation are large compared to other faulting styles. In addition precarious rock and physical modeling

evidence suggest that there may be a large asymmetry in shaking between the hanging wall and the footwall. In Nevada normal and strike-slip faulting trade off and accommodate about a quarter of the Pacific-North America relative motion. Thus Nevada faults are among the best in the U.S. to catch a large normal fault. We envision hanging-wall, foot-wall pairs of instruments, beginning with the fault-bounded valleys of northern Nevada. Initially instruments would be installed to compliment urban strong-motion coverage.

On-line backup acquisition and ShakeMap capabilities.

Presently, single systems run acquisition, processing, and ShakeMap generation. A computer failure could negatively affect network operation for hours to perhaps a day. Needs include a second high-capacity server and disk array, a second analog digitizer, and computer systems engineering time for integration. A dedicated computer is required immediately to run ShakeMaps.

IP upgrade of microwave backbone.

The long-haul telemetry system in Nevada is by analog microwave. Upgrading is needed for several reasons bearing on the ANSS mission. A basic reason is that our microwave telemetry frequencies are on the list for auction, and could be sold in the intermediate future. Like many other networks, Nevada operates an extensive collection of analog, low-bandwidth vertical component stations. The telemetry in many cases would not easily be converted to full digital, but as a compliment to microwave upgrades, on-scale recording by a simpler upgrade to 6-channel, 16-bit digitization scheme could be possible, upgrading data quality and quantity at a fraction of the cost. The present microwave system has proven to be an economical alternative to leased lines and satellite communications.

Station Vs(z) Metadata for ShakeMap and Related Applications.

Station Vs(z) metadata is important for calibrating attenuation relations and ensuring that biases in ShakeMaps can be evaluated on the basis of actual conditions. Station Vs(z) metadata can be obtained economically at using surface wave methods developed at UNR. Results have been benchmarked against well-documented borehole velocity profiles and shown to return comparable results at a fraction of the cost of drilling.

Instrumentation of two structures.

The Nevada Regional Advisory Committee identified several types of structures of potential interest to the community and of likely interest to the engineering community at large. Instrumentation of structures having priority with Nevada engineers would confirm ANSS interest in regionally significant issues.

II. Nevada Network Needs — One to Two Years

BB sensor upgrades — For three or more western Nevada digital stations. This would comprise a first increment toward the capability to record data suitable for moment-tensor inversions. We would seek funding to integrate an MT inversion capability with available broadbands into the real-time system.

Central Nevada backbone station — Siting and instrumentation for the "Duckworth" dot. A separate cooperation with US Array transportable array will result in a station siting person being headquartered at UNR. With a person available, siting and installation of the central Nevada station will become feasible. This station would co-broadcast to NEIC and UNR. The importance of a central Nevada station was confirmed by recent seismicity in central Nevada - M3.5 events with the nearest station almost 100 km away.

Earthscope cooperation funding — Support to enable us to grow ANSS capability building on Earthscope installations. We want to be able to supplement Bigfoot installations, were they fit our goals, to permanent station quality. Support would involve a small increment for siting support to obtain permanent siting authorization and contributions to improve sites beyond Bigfoot standards. We also anticipate some radio telemetry to UNR to avoid satellite continuing costs after Bigfoot has moved on.

In-filling strong-motion coverage — Approximately 10 strong-motion instruments divided between northwest and southern Nevada. Proposed coverage would include 3-4 among Lemmon Valley, Stead, Sun Valley, Silver Springs, Dayton, and Gardnerville. Rock references are needed in Carson Valley. Likewise, a rock reference is needed on the west side of the Las Vegas Valley. Coverage in the Las Vegas Valley is not yet complete, and four new stations are proposed.

Systems integration and performance improvements — ANSS Draft Performance Standards constitute demands that will require resources to address. Specific, achievable improvements include converting ShakeMap from a cron-driven to event-driven model to shorten event-to-ShakeMap time by five to eight minutes; implementation of a prioritization queue and automatic magnitude threshold adjustment; upgrade to ShakeMap 3; implementation of versioning on ShakeMaps; implementation of first-motion focal mechanisms; systemization of current and archive station metadata in ANSS format (anticipating that a format will become available); development of a real-time export mechanism for strong-motion data to CISN; implementation of import, export, integration of NSMP dial-up station data for ShakeMaps; and implementing improvements in real-time earthquake locations.

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APPENDIX F — NEW MEXICO

Needs Statement

Submitted by Rick Aster, New Mexico Institute of Mining and Technology, October 29, 2004

I. Background Information

New Mexico Tech operates stations in central and southeastern New Mexico (FDSN Network code SC). The Center and network are supported by funding from Westinghouse Corporation (for WIPP site regional monitoring). Additional development of the network has been made possible by using the network as a test site for efforts elsewhere (e.g., Antarctic projects). Information distribution is through the EES department's Geophysics Website <www.ees.nmt.edu/Geop/NM_Seismology.html> and Program contacts Rick Aster and Susan Bilek, with raw data also flowing to the IRIS DMC via EarthWorm 2004 has seen the upgrading of station CAR to include continuous GPS and an intermediate period (Guralp 40-T) sensor.

II. Activities in FY 2004

We have been in close contact with the USGS (e.g., via Kent Anderson) to facilitate the installation of a new ANSS site on the Navajo Nation, co-sited with one of our stations from the NSF Geophysics RISTRA experiment. We have also provided leads to USGS regarding possible additional ANSS sites in the Deming area, and have offered one of our WIPP-region sites (CPRX) as an already permitted site that is suitable for upgrading to an ANSS site. The addition of these two sites in New Mexico would complete the ANSS footprint for New Mexico and would produce valuable additional data for NMT seismology outreach and research over the long term. We have also been working with USGS on radio upgrades through contacts with Robert McClearn.

III. Support Needed

The completion of the three regional ANSS sites mentioned above, and distribution of their data via EarthWorm would be very valuable to our regional research, reporting, and general monitoring efforts. Continued general support for Earthworm is also of critical interest (we currently host the EarthWorm mail service, earthw@lyris.nmt.edu). Network efforts are presently supported through Westinghouse and miscellaneous funds at a very low level. Obtaining support for a technician and field work necessary to maintain the network would be extremely valuable at this time and may become critical in the near future.
(See also addendum on next page.)

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ADDENDUM TO APPENDIX F — NEW MEXICO

From: Richard Aster <aster@ees.nmt.edu>
Subject: ANSS-IMW needs comments
Date: Wed, 10 Nov 2004 07:56:52 -0700
To: Walter Arabasz <arabasz@seis.utah.edu>
Cc: John Schlue <schlue@ees.nmt.edu>, Allan Sanford <sanford@dutchman.nmt.edu>,
Sue Bilek <sbilek@ees.nmt.edu>, Dave Love <dave@gis.nmt.edu>

Dear Walter -- I think that our general comments and thoughts on New Mexico have been fairly represented in [the IMW Needs Summary]. The general support situation here in New Mexico is that we continue to maintain Al Sanford's legacy Socorro region network on a shoestring basis, and we have a contract with Westinghouse to maintain the WIPP area network in the southeastern part of the state. I should also mention that we have a proposal pending with LANL to do new work (seismology and geodesy) over the Socorro magma body during the next few years. As I mentioned earlier, our new station efforts include ongoing interactions with USGS to get stations established in eastern and southern New Mexico, as well as to complete the new station already under construction in northeastern AZ.

The general needs of ANSS and New Mexico are best served by finding some path for adequate support to help keep the short-period stations (and associated data collection) running, while also completing the full contingent of ANSS stations in the state and surrounding regions.

For example, perhaps standardized low-cost, Earthworm-compatible digital telemetry for the most important of these short-period stations would be something that the USGS could eventually support. Combined with peer-reviewed efforts like the LANL proposal above, we can thus continue to enjoy the best fruits of network seismology here at NMT for monitoring, public outreach, teaching, and research.

I have class duties on Friday and thus won't be able to make the 10 am conference call, unfortunately.

Best Regards,
Rick

APPENDIX G — UTAH

ANSS Report & Needs, University of Utah's Urban/Regional Seismic Network

Submitted by Walter Arabasz, Kris Pankow, Jim Pechmann, and Relu Burlacu; University of Utah; October 18, 2004

I. Background Information

In FY 2000, the University of Utah began developing an ANSS urban strong-motion network in Utah's densely populated and seismically hazardous Wasatch Front region. A basic real-time earthquake information system was successfully completed in time for the 2002 Salt Lake City Winter Olympics. The real-time urban network currently includes 75 ANSS strong-motion stations, seven of which have collocated broadband sensors (Figures 1 and 2). For details of the urban network, see http://www.seis.utah.edu/urban/index.shtml.

Outside of California, Utah's ANSS urban network has become a model for integrating new strong-motion instrumentation into a traditional regional seismic network. For an overview of the University of Utah's 200-station urban/regional network, see http://www.seis.utah.edu/Reports/usgs2004/index.shtml. We've taken a lead among non-California network operators in dealing with ShakeMap implementation and real-time earthquake alerts—and in engaging engineering, emergency response, and earth science stakeholders. We've also taken a lead in dealing with practical issues relating to field installation procedures, telemetry, calibration, and continuous real-time recording of strong-motion data.

Utah's ANSS urban network has catalyzed great interest among local structural and geotechnical engineers and among earth scientists interested in issues of ground-motion modeling and local site response. We are directly involved in new initiatives started by the USGS under its NEHRP external research program aimed at addressing issues of site response, basin modeling, and ground-motion modeling in the Salt Lake Valley and adjacent parts of the Wasatch Front area.

II. Activities in FY 2004

No new ANSS instrumentation was added to the Utah Region during FY2004 because of stagnant ANSS funding. Among other things, our ANSS-supported efforts focused on:

- Upgrading and Improving the reliability of our existing Earthworm data processing and alarm systems
- Stabilizing digital radio networks used for continuous data transmission from subsets of our real-time strong-motion stations
- Collaborative planning and studies of ground-motion modeling in the Wasatch Front area
- Creating Scenario ShakeMaps for use by emergency managers in planning and emergency-response exercises
- Continuing a major refinement of our instrumental earthquake catalog

- Providing technical help to other network operators with Earthworm and ShakeMap implementation and in troubleshooting/upgrading field installations
- Site selection and noise-testing for two new broadband stations in southern Utah—a cooperative ANSS national backbone station in the Cedar City area of SW Utah and a University of Utah broadband station in the Henry Mountains of SE Utah
- Promoting and coordinating activism by ANSS partners in the IMW Region to increase ANSS funding and to improve seismic monitoring in the IMW Region

III. Needs Statement

We present our needs in two categories—(1) *Instrumentation* and (2) *Data Processing/Analysis*. The prioritized outline below of instrumentation is intended to guide requests over more than one year, depending on the availability of ANSS program funding. The needs for data processing and analysis are immediate.

Instrumentation (ranked in order of importance)

1. *Strong-Motion Stations Outside the Wasatch Front Area* — We've been asked by the Utah Division of Emergency Services and Homeland Security to expand our capability to create ShakeMaps throughout the entire state of Utah for emergency response and to enable rapid integration of ShakeMaps into HAZUS. But lessons learned from the **M** 6.5 San Simeon, California, earthquake of December 2003 make clear the need for some station control for ShakeMaps in populated areas where mapped ground motions would otherwise be based solely on predictive extrapolation (see http://www.cisn.org/docs/CISN_SanSimeon.pdf).

   In order to achieve minimal control for ShakeMaps in the vicinity of earthquake-prone population centers in Utah outside the Wasatch Front area, we see a clear need for adding strong-motion stations (a minimum of one per locale), with near-real-time capabilities, near the following population centers (see Figure 1): St. George, Richfield, Cedar City, Beaver, Moab, and Vernal. In the Price area in east-central Utah, we've already achieved reasonable local control for ShakeMaps in the form of cooperative strong-motion stations installed at surface rock sites for monitoring coal-mining-induced seismicity.

2. *Improved Network Coverage to Meet ANSS Performance Standards* — Draft performance standards for ANSS seismic monitoring recently put forward by an ANSS technical working group (http://www.ceri.memphis.edu/~withers/TIC/) would call for establishing a uniform magnitude of completeness of at least **M** 3.0 for our entire Utah study region and the ability to generate moment magnitudes for all events of **M** 4.5 and greater. This will require expanding our network coverage into relatively uninstrumented areas of Utah—notably into eastern Utah (see Figure 1). At a minimum, we need at least one broadband station in SE Utah and several additional short-period stations—still arguably cost effective—in all of eastern Utah as well as in SW Wyoming and western Utah. Ideally, we would add broadband stations in both northeastern and southeastern Utah and fill the gaps (as mentioned above) with short-period stations. Where feasible, these "short-period stations" might consist of a short-period sensor hooked to a three-component accelerograph.

3. *Added Strong-Motion Stations in and Near the Wasatch Front Area* — In order to meet other ANSS performance standards in the above-mentioned document, we will progressively have to add strong-motion stations in the Wasatch Front region to achieve a 10-km station spacing in the urban areas and 20-km spacing in marginal areas adjacent to the urban centers.

Data Processing/Analysis

1. *Earthworm Support* — We need a strong, responsive "Earthworm Central" software support team. This is crucial—not only for maintaining and improving our near-real-time capabilities but also for help in continuing to modernize our ANSS network operations (e.g., upgrading our existing, but outdated, interactive data processing routines to an Earthworm-compatible processing system.)

2. *Disk Capacity and Upgraded Computers* — Loads on our Earthworm system—both for current applications (e.g., data acquisition, waveform handling, Webicorder displays, etc.) and especially to handle added stations—require expanded disk capacity. Further, some of the existing computers in our Earthworm system will soon have to be upgraded to reliably handle the kind of loads we're encountering.

3. *Code Development* — To meet specific ANSS goals, we need code developed to allow us to archive our accelerographic data in a format suitable and convenient for use by the engineering community, such as the COSMOS format.

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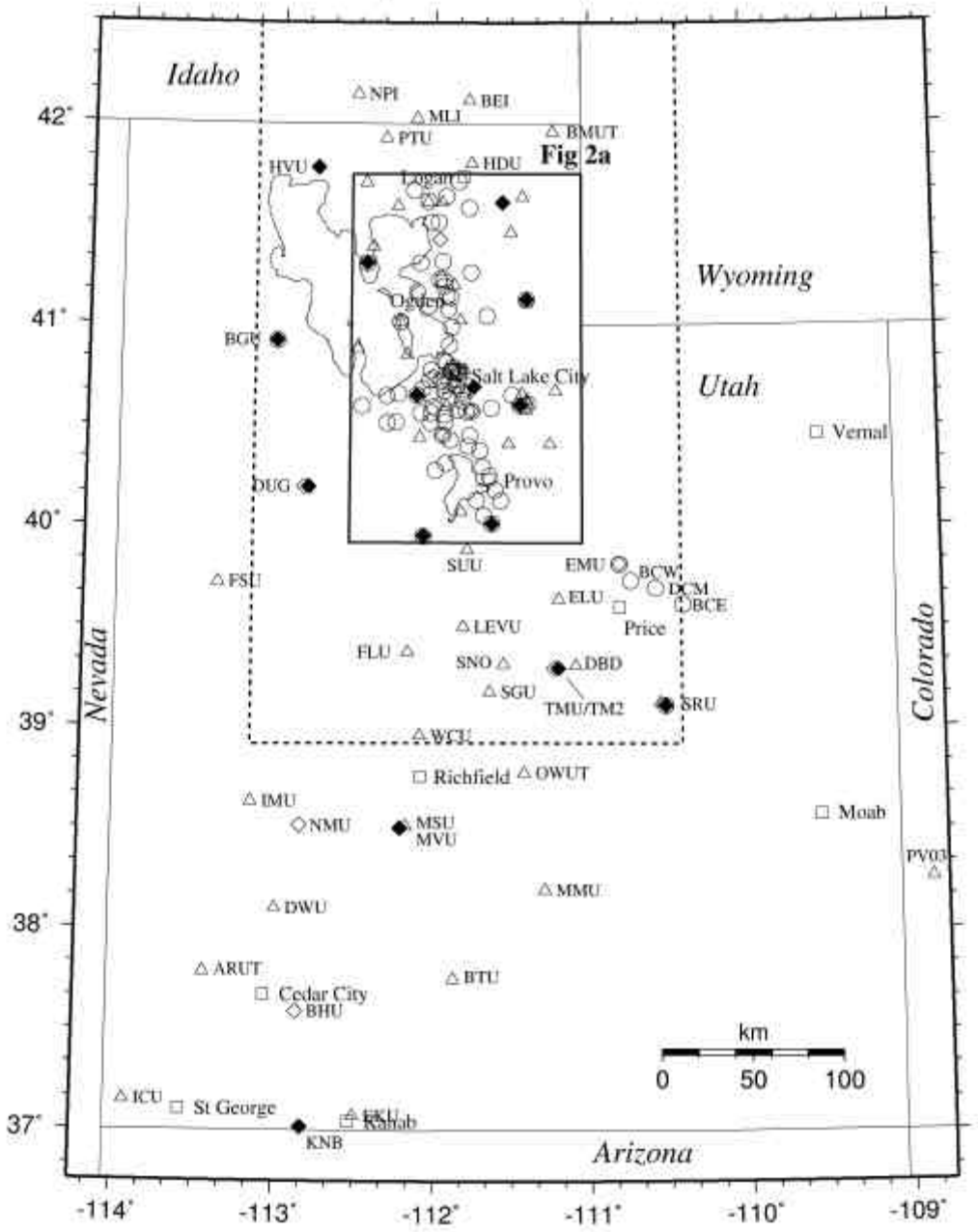

STATION KEY

△ = single-component, analog-telemetry, short-period
◇ = multi-component, analog-telemetry, short-period
◆ = multi-component, digital-telemetry, broadband
○ = multi-component, digital-telemetry, strong motion

Bounds of map correspond to standard "Utah Region"; dashed rectangle, traditional "Wasatch Front Area."

Figure 1

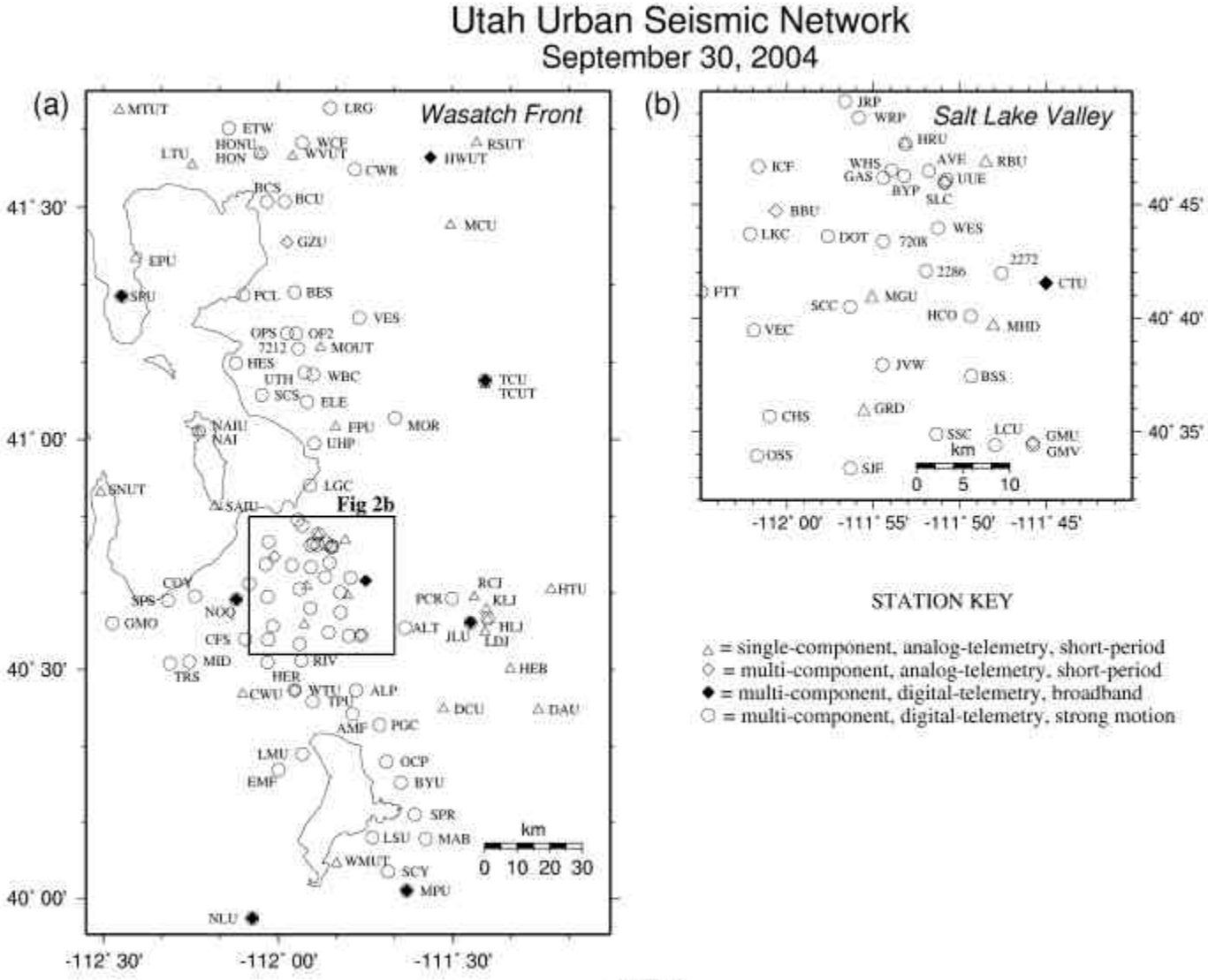
Utah Urban Seismic Network
September 30, 2004
(a)
Wasatch Front
(b)
Salt Lake Valley
Fig 2b
km
0 10 20 30
0 5 10
41° 30'
41° 00'
40° 30'
40° 00'
40° 45'
40° 40'
40° 35'
-112° 30'
-112° 00'
-111° 30'
-112° 00'
-111° 55'
-111° 50'
-111° 45'
STATION KEY
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Figure 2