California Integrated Seismic Network

CGS USGS OES Caltech UC Berkeley

Report to the CISN Advisory and Steering Committees from the CISN/PMG 6th Report: October 2003 to September 2004

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Program Management Group

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Introduction

The purpose of the PMG report is to provide the CISN Advisory and Steering Committees with an update on current CISN activities. To keep the report short, we do not include routine operation and maintenance work. This report covers the last three quarters of effort. The 'After Action Reports' of the San Simeon and San Diego earthquakes were also produced by the PMG during that time.

Seismicity

From 10/1/2003-9/15/2004, the CISN processed over 31,281 earthquakes statewide. Many of these events are associated with the December 22 M6.5 San Simeon earthquake (during the same time period a year ago, the number of earthquakes analyzed was just over 22,000). Northern California analysts are still working to deal with the backlog of events. As of June 30, the analysts were working to reduce the backlog of 9300 events since the mainshock (Figure 1). Almost all of the backlog occurs in the first three months of the sequence. In particular, the first week of the sequence presents a challenge to process because aftershocks were occurring in rapid succession.

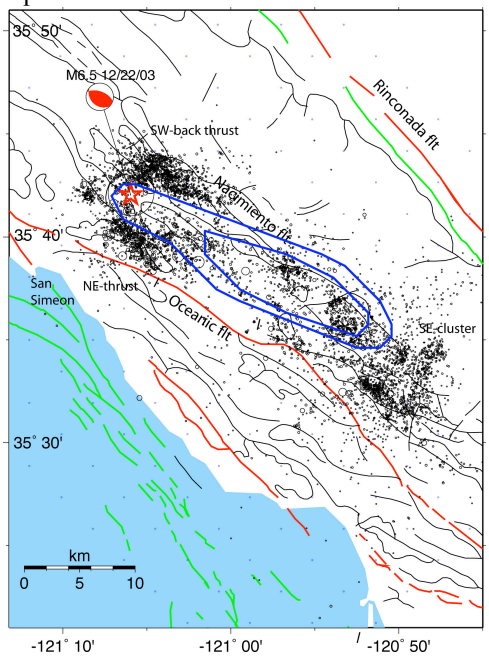

Figure 1 San Simeon mainshock rupture area (blue contours), moment tensor, and relocated aftershocks.

Given the current staffing levels, it may take almost 2 years to process all of the data.

The aftershock sequence continues to be active. Over 69 ShakeMaps were generated for earthquakes in the San Simeon area alone, most recently for an M4.0 on August 30th. The San Simeon earthquake and the response of the CISN was described in the PMG report (04/05/04) (www.cisn.org/docs/CISN_SanSimeon.pdf).

Other significant events include a small swarm in the Livermore area (largest magnitude M3.5) in January, a M4.4 near the Geysers on February 18th, a M4.3 near Wheeler Ridge, an M4.3 near San Juan Bautista on March 16th, and an M4.2 near King's Beach (Lake Tahoe) on June 3rd. In addition, the CISN recorded aM4.3 near Clear Lake Reservoir on July 22 and a M4.0 near the Pinnacles on August 30th.

The 2nd largest mainshock in the reporting period was a Mw5.0 on June 15, located offshore 44 miles west-southwest of Coronado, near San Diego. It was widely felt (10,542 CIIM felt reports) in the greater San Diego area, with a few reports coming from as far away as Ventura & Twentynine Palms. Peak intensity was Modified Mercalli IV.

Communications Backbone

We have installed the CISN data communication backbone to improve the capabilities of the CISN institutions to share data and to back each other up in the case of a major earthquake. The backbone consists of five T1 links that form a ring connecting Pasadena, Menlo Park, UC Berkeley, CGS, OES, and back to Pasadena.

As described in previous reports, the CISN ring is up and operational (Figure 2). It is being used to transmit seismic waveform data and parametric data, including strong motion parameters, between the management centers and to distribute Shake-Maps to OES.

During this time period, the CISN performed a test to verify the fail-over and redundancy capabilities of the CISN ring. The goals of the test were to 1) verify that if a single segment of the CISN ring fails, the backbone routers will detect the outage in a timely fashion and will reroute traffic to all CISN sites around the remaining CISN ring segments, and 2) verify that if a site is completely disconnected from the CISN ring, the backbone routers will detect the outage in a timely fashion and will reroute traffic to/from that site over the backup Internet tunnels between the disconnected site and all other CISN sites. The test conducted demonstrated that the CISN routers and ring are performing according to design.

Unfortunately, the configuration of the CISN ring is still incomplete at OES. The CISN OES routers do NOT have public Internet connections, so they have no Internet tunnel connections. If the CISN T1 circuits were to go down at OES, OES would be completely isolated from the CISN network and all CISN partners. This continues to be an issue of major concern because this lack in capability may prevent CISN from delivering ShakeMap to OES.

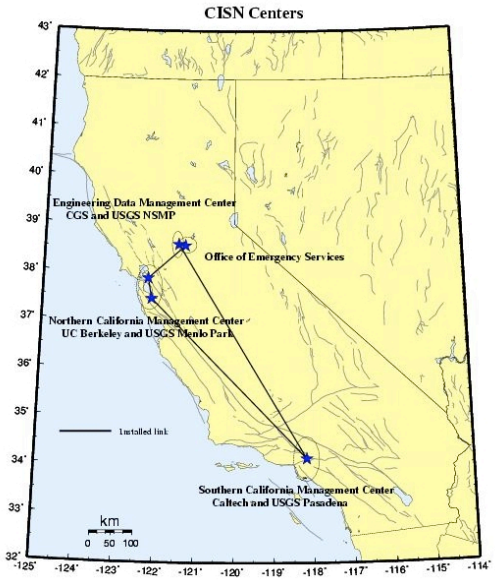

Figure 2. Diagram of the CISN backbone.

As part of an effort to increase robustness at the CISN centers, and to comply with computer network security guidelines, the CISN partners have formed a security committee that includes membership from OES.

Seismic Stations Transmitting to Two Data Processing Centers

As part of the TriNet project, CGS and Caltech/USGS Pasadena implemented dual data transmission from several CGS seismic stations in southern California, as a step to increase robustness. One copy of the data is sent to CGS in Sacramento while the second copy is sent to Pasadena. As part of CISN, this mode of data sharing, by having 15 southern California stations send data to both Pasadena and UC Berkeley and 15 northern California stations send data directly to UC Berkeley and Pasadena,

has greatly enhanced the robustness and backup capabilities of CISN.

This task is almost complete and 35 dual feed stations are operational. In addition, three CGS

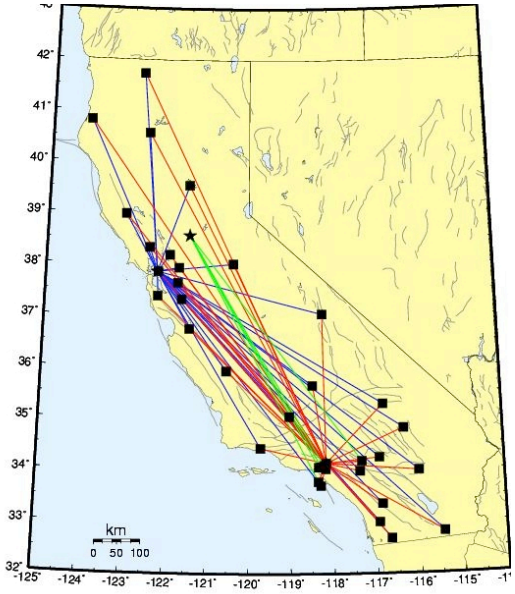

Figure 3. Diagram illustrating dual station data feeds to improve robustness.

stations are being shifted to dual feed, with a second data stream going to the Pasadena center. These stations located off the coast, near offshore platforms near Newport Beach, Oxnard, and Pt. Arguello, are being brought online with dual feeds. Being off the coast, they bring an important additional dimension for locating events in the offshore fault systems in southern California.

Product Standardization

A major goal of CISN is product standardization to ensure that products mean the same across the state. In particular, this includes hypocenters, magnitudes, focal mechanisms, and ShakeMaps.

The CISN is working on several fronts to develop a statewide processing system and to standardize and improve the earthquake monitoring systems.

After extensive testing, we have produced a configuration for integrated statewide detection and location of earthquakes that works well. For example, the system performed well for the San Simeon sequence.

Work to standardize magnitudes has been going on in several areas. A draft magnitude reporting hierarchy (order of preferred magnitudes) has been established. However, details about when Mw will be reported are still being determined.

Efforts to determine a unified set of ML station adjustments and a statewide attenuation relationship are underway, but have been complicated by the observation that there is a systematic difference between the MLs estimated by Berkeley and Caltech for the same earthquakes. The difference is on the order of 0.14 magnitude units, with the Berkeley magnitudes larger than the Caltech magnitudes. A number of tests are underway to understand this discrepancy.

In the meantime, the NCMC has implemented the software developed in southern California under the TriNet project to compute continuous amplitudes. As part of the implementation of this system in northern California, we have developed the tools to allow center-center exchange of the continuous amplitude time series. At present, test systems are running at USGS Menlo Park and Berkeley to produce the continuous amplitude data, and a system at Berkeley to use the data for local magnitudes and ground motion parameters.

A third area of the development is the modification of the software to compute coda magnitudes (Md). Work is currently underway to modify the post-processing software package developed in southern California, to provide coda magnitude capabilities. This is an important extension for northern California, where the distribution of broadband stations is sparse.

In the fall of 2003, the CISN metadata working group proposed a plan for sharing station information between the Northern and Southern California Management Centers, based on database replication. The plan is currently being implemented using a small number of database tables and the preliminary results indicate that this is a robust method for exchanging metadata.

More recently, the metadata working group developed a model for exchanging station information between the Engineering Data Management Center (EDC) and the Northern/Southern California Management Centers. Under this plan, the EDC will generate "dataless" V0 files which contain the necessary station information but no waveform data. The Northern California Management Center is

currently working on software to process the dataless V0 files to populate the database.

The NCSN completed the project to generate metadata for all of the waveforms archived at the NCEDC for the period 1984-present. NCEDC staff have populated the database with this information and it is now possible to obtain full SEED volumes for NCSN data.

The CISN adopted a standard for the use of "location" codes (part of the Standard for the Exchange of Earthquake Data (SEED) nomenclature to describe a time series based on network-station-channel-location) in the late fall of 2003. Over the past few months, USGS and UC Berkeley developers have been working to modify the Earthworm software to support the use of location codes. This effort is nearly complete and the centers are working on a plan to begin migration to the modified codes.

Over the last nine months, the Southern California Management Center (SCMC) has improved and enhanced software developed under TriNet to facilitate its use in CISN. Commercial Oracle interface software, called Roguewave, has been replaced with an open-source library called OTL. Similarly, a commercial message passing software system, called SmartSockets, is being replaced with a system called 'CISN Messaging System' that benefits from the message passing systems developed for CISN Display.

ShakeMap Enhancements

A high priority of CISN is to improve data availability and to improve the distribution of ShakeMap to ensure that it is available following a major earthquake.

All three centers have installed and are using the latest version of the ShakeMap software. Although most of the changes introduced by V3.0 were "under the hood", a few of the changes (such as compression of files for downloading) did create problems for a few users. New ShakeMap computers were installed at the USGS Menlo Park and Caltech/USGS Pasadena, which has significantly improved the speed of the ShakeMap generation. As of July, the NCMC and SCMC are now pushing ShakeMaps to a ShakeCast server located in southern California.

As a result of issues raised by the San Simeon earthquake, the CISN ShakeMap working group has a number of issues on its plate, including efforts to quantify the uncertainties in ShakeMap as well as to address issues such as notification when ShakeMaps are updated. The working group is also discussing issues such as bias determination and map resizing as well as working to standardize the ShakeMap configurations at the three centers.

Engineering Data Center

The CISN Engineering Data Center has responsibility for producing engineering data products and distributing them to the engineering community.

Communication between the Engineering Data Center in Sacramento and the Southern Data Center in Pasadena has now been shifted over completely to the T-1 ring. As part of this development, the EDC has shifted all of its internal network communications, developed under TriNet, from serial to Ethernet communications. Speed and robustness is improved throughout.

The EDC has had an extensive review performed of the security vulnerabilities of the center, located at CGS in Sacramento. Several items were identified, some simple and some more complex, that will bring it into compliance with State guidelines, as well as reduce its already-low vulnerability. These necessary changes and equipment purchases will be completed during the 2004-2005 fiscal year.

The EDC incorporates contributions from the CISN partners, and in particular the CGS SMIP and USGS NSMP centers. To improve the NSMP center, planning and development have begun for modernizing the strong-motion processing and analysis system. The objectives are to reduce personnel time needed for routine record processing and state-of-health monitoring; improve processing, storage, and web access of engineering strong-motion data and associated metadata for ANSS; and to assure compliance with USGS IT security requirements and other ANSS and CISN standards. When completed, the system will improve the speed of providing NSMP data to the CISN EDC, and will provide similar service and support to the other regions of ANSS. The first component of the system, an interactive processing and analysis workstation, will begin beta testing in October 2004, and will interface with the existing data file structure of NSMP. Additional modules will be designed

and developed during the coming year. Funding for this project is provided by ANSS.

CISN DISPLAY

The CISN is developing CISN Display to provide statewide real-time earthquake information. The CISN Display is an integrated 24/7 Web-enabled earthquake notification system. The application provides users with real-time seismicity, and following a large earthquake, will automatically make available other earthquake hazards information such as ShakeMap.

The CISN Display continues to be beta tested and has undergone several refinements in anticipation of an October, 2004 release of version 1.0, including streamlined user features and various bug fixes. Some of the new features include automatic removal of old downloaded ShakeMap data files, zoom-scale view options to location layers, and a product-message cache to handle product messages that arrive before their associated event message. Other recent improvements include error-handling when files for configured layers are missing, modification of product-buttons widths to prevent "ShakeMap" button label from getting truncated on some systems, and ShakeMap auto-download improvements. Special new features include user-configurable display of product-buttons that can highlight products of interest like Tsunami warnings or ShakeMaps, ShakeMap-stations layer download, and automatic HAZUS-files download. CISN Display now can display global earthquakes on top of layers of all the continents and global cities.

CISN Web services

Design and content of www.cisn.org and other CISN Web sites continues to evolve. The Web is an important tool for CISN outreach as well as for communication and documentation among the CISN partners.

There has been significant progress at www.cisn.org in FY03/04. A year ago, the CISN shared the Web server at the Northern California Earthquake Data Center. Today, two new web servers, located at Berkeley and Caltech, support the site. The Web servers are set up so that the load is distributed between them, providing improved access during times of high demand. ShakeMaps are now served directly from the CISN Web site, in addition to being available from several USGS Web servers and the CGS.

In early December, the CISN began offering a sign-up for earthquake notifications by email. Although both northern and southern California have offered individual sign-ups in the past, the new service provides uniform notification messages for earthquakes of M3.5 and higher in California. In addition, users can sign up to be notified when ShakeMaps are generated.

Also in FY03/04, the CISN established a Web site dedicated for emergency managers. Following a suggestion from the Advisory Committee, we have designed a Web site to provide personalized access to earthquake information. Known as "myCISN", the Web site is accessible at eoc.cisn.org. Users can create a personalized view of earthquake information, selecting what types of information they want to see as well as organizing the layout. New features include a section of user-selected favorite links. Access to the Web site is limited to registered users in order to provide highly reliable access.

At present, "myCISN" is a single Web server located at UC Berkeley. However, modifications to the database are underway to allow for multiple servers in the future. A second computer was purchased with FY03/04 funds and will be installed in either Sacramento or southern California.

Efforts to enhance and improve access to engineering data products such as the Internet Quick Reports continued in the past year. IQRs were produced for 5 earthquakes and made available through the Engineering Data Center at www.cisn-edc.org.

The EDC continues to expand the engineering data available with the addition of data sets for important events that occurred prior to the start of CISN. The EDC has also incorporated usage tracking to as a mean to monitor and improve effectiveness for users. Tracking shows an increasing number of engineering users, both from within California as well as design centers and universities outside of California, where many California buildings are designed and where many design engineers are trained.

Outreach Activities

CISN outreach efforts are led by OES, with major contributions from the CISN partners. In the past year, the CISN established an Outreach Working Group.

Several events commemorating the January 17, 1994 Northridge earthquake were held. The California Emergency Services Association, Southern Chapter in cooperation with the Department of Geology at the California State University, Northridge sponsored a seminar that focused on the current earthquake threat in southern California. Caltech, USGS, CGS, and OES hosted a well-attended earthquake expo on the campus of Caltech on January 17 that attracted over 3,000 people who viewed exhibits and films, heard seminar speakers, and received literature on earthquake preparedness and home hazard mitigation.

During this year, OES and the USGS collaborated in producing several ShakeMap-HAZUS earthquake scenarios for local governments and one university. All scenarios included ShakeMap and HAZUS loss estimates that were organized into a presentation for exercise participants, poster sized maps for the actual exercises and technical assistance.

In addition to the earthquake exercise scenarios, other efforts are underway to promote the use of ShakeMap. An instructional video is being finalized for promoting the use of ShakeMap among TV journalists in reporting an earthquake.

After the Keilis-Borok earthquake prediction was released in early January, there were a number of activities involving CISN organizations to assist local government and the private sector in understanding the prediction. Question and answer pages were posted on all CISN organizational websites, including the CISN website, several presentations were made to local government emergency managers and elected officials.

The Outreach Working Group has developed a draft plan for coordinated activities related to CISN products. The Working Group has been working with representatives of ANSS outreach to develop a brochure for CISN as a region of ANSS. Additional materials have been developed to support the transfer of CISN Display to users. CISN Outreach has been actively involved in recent revisions to the popular pamphlet entitled "Putting Down Roots in Earthquake Country."

Seismic Stations, Upgrades and New Deployments

Each of the CISN partners has been involved in the deployment and/or upgrade of seismic instrumentation. These efforts are described in terms of the activities of the three management centers.

Northern California Management Center

The Berkeley Seismological Laboratory (BSL) completed the installation of the seismic station MNRC in the past year. Although the physical installation of the station was completed at the end of FY02/03, the telemetry installation was not completed until this spring. Because of the site's remote location, a multi-hop radio link was needed to bring the data out and into the SBC frame-relay network at Napa. The BSL began installation of the GASB site in June. This site is a collaborative effort between the CISN and the CREST project. The vault and the pier have been constructed. The BSL is planning to begin the installation of a site at Marconi this fall. This site will be a CISN/NSN/IRIS collaboration.

Although installations of new UCB stations are taking place, combination of factors has left the BSL with a field staff of two engineers, reduced from six in the spring of 2003. As a result of this reduction, maintenance work is often being delayed.

During the first 9 months of FY 2004, the NCSN continued installation of ANSS stations in the San Francisco Bay area between Calistoga and south San Jose. Thirteen new urban sites with tri-axial accelerometers and continuous digital communications were installed primarily in fire stations. The NCSN installed or upgraded five regional stations in the Bay area to digital with 4-channel capability (a tri-axial accelerometer and a single-component vertical seismometer). The NCSN also upgraded analog equipment at two stations near Parkfield to digital dataloggers with triaxial broadband and strong motion sensors.

The NCSN converted the telecommunications at the analog microwave site at Williams Hill in the Santa Lucia range to digital via satellite. The NCSN also completed a similar conversion at its analog microwave site at Geyser Peak, but this digital data is now transmitted to Menlo Park via digital microwave telemetry. It also completed the conversion of data recorded by the California Department of Water Resources from analog to digital and DWR transmits the data via private FrameRelay circuits to Menlo Park. Work was nearly completed on a similar conversion for seismic data recorded at the Lawrence Livermore National Labs, but this data will be sent via the Internet.

Southern California Management Center

We continue to improve data quality from existing sites through equipment upgrades or in some cases by relocating the stations. The equipment upgrades, may consist of new power systems, new dataloggers, new sensors, or improved data communications. In the last 12 months we have relocated the following sites. The Salton Sea Wildlife station (SSW) near the south end of the Salton Sea was moved a few miles to the north to (RXH) Rock Hill. On the north shore of the Salton Sea, the station (NSS) was moved approximately 1000 ft, within the same cluster of buildings) and is now referred to as (NSS2). The station in the middle of Edwards Air Force Base (EDW) was moved 2 miles to the west to a new site with the code EDW2. The station at Wheeler Ridge (WER) in the southern San Joaquin Valley was moved to Arvin (ARV) on the Tehachapi Ranch. Similarly, the station Joshua Ridge (JRC), near Coso in eastern California, was moved about 0.5 miles and is now referred to as (JRC2). Offshore, the station on Santa Cruz Island (SCZ) was moved away from nearby buildings and is now referred to as SCZ2.

Engineering Data Center

The CGS SMIP program continues to upgrade stations from analog film instruments to modern digital stations, with communication when possible. Being done cooperatively with the base SMIP projects, this will provide a substantial increase in the number of stations providing data in a rapid enough time frame for use by ShakeMap. Over 25 stations were upgraded during this period. The gaps in the overall CISN network coverage are still extensive, but some important progress is being made.

In cooperation with a NSF-NEES project, ANSS/NSMP provided funds to procure a 12-channel digital recorder for installation at the site of the downhole liquefaction array at the Wildlife Refuge site in the Imperial Valley to record both accelerometers and piezometers.

New digital instrumentation has been or is being installed to replace analog instrumentation in several structures. In cooperation with the U. S. Department of Veterans Affairs (VA), 30-year-old analog systems at ten VA hospitals within the CISN region were upgraded to provide both structural and reference data. These installations are located in Fresno, Livermore, Loma Linda, Los Angeles (Brentwood, Sepulveda, and Wadsworth), Menlo Park, Palo Alto, San Diego, and San Francisco. Also, new digital 24-channel systems were installed in a 33-story office tower on Wilshire Boulevard, Los Angeles, and a 7-story office building in Norwalk. The reference station at the 5-story San Bernardino County Services building was also upgraded.

Near-real-time accelerographs have been purchased with ANSS funding and are being installed at new reference stations at the City Hall in Berkeley and at the Channing House retirement facility in Palo Alto. The structures were previously instrumented using ANSS funding.

ANSS funding has been provided to purchase four ground response accelerographs and add accelerometers at the surface above a borehole instrument adjacent to the Factor Building on the UCLA campus, to complement the existing structural array. A USGS external grant supplement has been awarded to UCLA to install and operate the instrumentation.

In a cooperative effort with the University of California, Irvine (UCI), NSMP has purchased a real-time, 42-channel, structural/downhole system to be installed at a new 4-story building currently under construction on the UCI campus. In a cooperative effort with the Metropolitan Water District of Southern California (MWD), NSMP is in the process of installing 6 strong-motion channels at the new Moreno Valley inlet feeder facility, located approximately 100 m southwest of the San Jacinto fault. Three channels have been installed at a reference site, and three additional channels will be installed on the foundation of the main pipeline. New digital accelerographs are being installed by NSMP at 2 additional MWD facilities this calendar year, at Skinner Dam and Live Oak Reservoir.

In a cooperative effort with the U. S. General Services Administration, NSMP is in the process of instrumenting the new 8-story, Federal Courthouse at Fresno with a 30-channel, near-real-time system. The system should be on line by the end of the calendar year. In addition to the above structures with new instrumentation, nine structures with existing digital instrumentation were provided with telephone service to establish near-real-time data access.

In a cooperative effort with the California Office of Statewide Health Planning and Development (OSHPD), the 2-story UCSD Hospital in La Jolla was instrumented with 16 sensors. In addition,

the 4-story Kern County Hospital in Bakersfield was instrumented with 12 sensors, and the 2-story hospital in King City was instrumented with 12 sensors. The instrumentation for each hospital includes a reference station on the grounds that also serves as ground response station providing data for ShakeMap.generation. In addition, the new base-isolated St. Johns hospital in Santa Monica, replacing the building heavily damaged in Northridge, was instrumented with 18 sensors, also with a freefield station on the grounds.
Los Angeles City Hall, retrofit after Northridge with isolators and dampers, was instrumented with 27 sensors. At 32 stories and 450 feet tall, it is at this time the tallest base-isolated building in the U.S.

In cooperation with Caltrans, several major toll bridges were instrumented during this period. The new Carquinez Bridge on I-80, the first suspension bridge in California in 30 years, was instrumented just prior to its official opening in November. The bridge, whose deck is a suspended steel box girder, has over 100 sensors, and includes a downhole array at one end. In addition, the west span of the Oakland – San Francisco Bay Bridge was instrumented with 80 sensors as the retrofit was completed in the spring. Planning has been completed for the instrumentation of the new east span, now under construction. The Golden Gate Bridge retrofit and strengthening is also underway, and the sections being strengthened are being instrumented with additional sensors by CSMIP in a cooperative effort with the Bridge District. A new freefield station at the north end of the bridge will also serve as a new input station for ShakeMap.