STATEMENT OF
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Chairman Costa, Congressman Lamborn, Members of the Subcommittee, thank you for inviting the U.S. Geological Survey (USGS) to testify at this hearing on the reauthorization of the four-agency National Earthquake Hazards Reduction Program (NEHRP). The USGS is proud to be a partner in NEHRP, which is led by the National Institute of Standards and Technology (NIST) and also includes the Federal Emergency Management Agency (FEMA) and the National Science Foundation (NSF). The Department strongly supports H.R. 3820 to reauthorize NEHRP, which has proven to be a successful partnership that continues to make valuable contributions to the Nation's resilience to earthquakes and other hazards.

NEHRP is predicated on the belief that while earthquakes are inevitable, their consequences on our built environment are not, and there is much that we can do as a Nation to improve our resilience to earthquakes and other natural hazards. The heart of this partnership is a shared commitment to translate research results into implementation actions that can reduce earthquake losses. That commitment involves collaboration that goes beyond these four agencies to include other Federal partners, plus State and local governments, universities, and the private sector.

Carrying out its role within NEHRP, the USGS strives to deliver the information and tools that emergency managers, public officials and citizens need to prevent earthquake hazards from becoming earthquake disasters. With its partners, the USGS reports on earthquake size, location, and shaking intensity; develops regional and national hazard assessment maps and related products; supports targeted research to improve our monitoring and assessment capabilities; and builds public awareness of earthquake hazards.

Delivering Rapid Information for Emergency Response

In the minutes after an earthquake strikes, as the recent events in Haiti have demonstrated, knowing where shaking was most intense can save lives by providing emergency responders with the situational awareness they need to concentrate their efforts where they matter most. In addition to its responsibilities authorized under NEHRP, the USGS has the lead Federal responsibility delegated by FEMA under the Stafford Act (P.L. 93-288) to provide notifications – including forecasts and warnings where possible – for earthquakes, volcanoes and landslides. To carry out these statutory roles, the USGS provides rapid reports of potentially damaging earthquakes to the National Command Center; the White House; the Departments of Defense, Homeland Security (including FEMA), Transportation, Energy, and the Interior; State and local emergency managers; numerous public and private infrastructure management centers (for

example railroads and pipelines); the news media, and the public. These earthquake notifications are also delivered as e-mails and text messages to over 100,000 users. A suite of information products are available through the USGS Earthquake Hazards Program website, which receives an average of two million hits per day.

The 2000 reauthorization of NEHRP established the Advanced National Seismic System (ANSS) to modernize and expand the Nation's seismic monitoring infrastructure in order to improve the delivery of earthquake information to those who need it most. The ANSS consists of a national backbone network, regional networks operated by State and university partners, the USGS National Earthquake Information Center (NEIC), and ground- and structure-based instruments concentrated in high-hazard urban areas. Funding for ANSS, currently $8.3 million in fiscal year (FY) 2010, has resulted in 886 new and upgraded stations out of a total of 7,100 identified in ANSS plans for full implementation of the system (USGS Circular 1188). It has also resulted in considerable modernization of network operations, the initiation of 24/7 on-site operations at NEIC, and new product development. These investments have greatly improved the information available for emergency responders, engineering performance studies, and long-term earthquake hazard assessments. The ANSS has been carefully planned and executed, as reflected by its repeatedly being the highest-rated information technology major capital investment in the Department of the Interior. A report by the National Research Council on the costs and benefits of seismic monitoring found that the benefits of fully deploying ANSS outweigh the costs many times over.

The ANSS has enabled dramatic changes in the way that earthquake information is conveyed. Products such as ShakeMap showing the geographic distribution and intensity of ground shaking are made available via the Internet directly after a potentially damaging earthquake. Systems such as ShakeCast push information directly to critical users and allow them to directly estimate potential damage to facilities. Currently, many ShakeMaps are based on models rather than real-time sensor data, due to sparse and heterogeneous station coverage. As the ANSS is deployed and additional sensors are installed, these maps will improve in resolution and accuracy. A substantial increase in the number of ANSS stations, and in data processing and product generation capabilities, will be realized in 2010 and 2011 as a result of economic stimulus funding. The USGS has allocated $19 million of the $140 million dollars it has received under the American Recovery and Reinvestment Act (ARRA) to the modernization component of ANSS. Outdated equipment at hundreds of legacy seismic stations is being replaced with modern digital equipment. ARRA funding has been allocated to 13 cooperating partners, which will perform the station and network upgrades. In addition to station modernization, ARRA funds are being used to upgrade communications and processing software, and also to complete some critical software development tasks. At the conclusion of the ARRA-funded upgrades, ANSS will be approximately 25 percent complete.

In California, the ARRA upgrades are being used to replace many of the older, slower recording instruments. This will allow existing systems to provide much timelier earthquake alerting and support development of a prototype system capable of delivering automated warnings after an earthquake occurs but before strong ground shaking arrives at sites away from the epicenter. For the past three years, USGS has been working with the consortium universities that operate the ANSS California Integrated Seismic Network to test early-warning algorithms, and we recently

began the second phase of this partnership to build a prototype statewide earthquake alerting system. Even a few seconds of advanced warnings may be useful for students to seek refuge under their desks, for utilities to rebalance electricity distribution and possibly shut off gas lines; for hospitals to initiate auxiliary power systems; for public transit systems to reduce speeds, and for other targeted uses. Any developments in earthquake warning coming from ANSS investments in California will be propagated nationwide as ANSS is more fully realized.

The science of geodesy, measuring deformation of the Earth's surface, holds particular promise for its use in the monitoring and study of earthquake processes. Networks of sensors use precise Global Positioning System (GPS) techniques to measure minute changes in the shape of the Earth's surface that help reveal how strain accumulates on earthquake faults, and how those faults are slipping at depth. Precise geodetic data provides new constraints on the likely rate of large earthquakes in a region. Funds provided to support geodetic monitoring by the American Recovery and Reinvestment Act (ARRA) will benefit USGS and its cooperators by making possible much-needed upgrades of obsolete GPS and strainmeter equipment, upgrades of data transmission links, acquisition of new high-resolution elevation datasets using LiDAR technology, and software development. Equipment and telemetry upgrades at GPS stations will improve our capacity to receive and process data in real-time.

In order to report on all significant seismic events worldwide, the USGS NEIC relies on the Global Seismographic Network (GSN), which the USGS has developed in partnership with the NSF and the Incorporated Research Institutions for Seismology (IRIS) consortium of universities. Supplemental funds following the Sumatra earthquake and Indian Ocean tsunami enabled the USGS to modernize NEIC facilities and initiate 24/7 onsite staffing. Those funds also made it possible for the USGS and its partners to make considerable strides in enhancing the GSN with new seismic monitoring stations in the Caribbean, which enabled USGS to provide rapid and accurate data on the recent Haitian earthquake, and improved data telemetry worldwide. These capabilities have, in turn, significantly improved our ability to support NOAA's tsunami warning capabilities, which rely on data from the GSN and other USGS seismic networks. The USGS has committed $4.7 million of ARRA funding for the lifecycle replacement of obsolete equipment at GSN stations worldwide. Combined with a similar-size investment in the GSN being made by NSF, the entire network will be modernized by 2015. This will allow the network's data, which is critical for hazard warning, nuclear treaty monitoring and scientific research, to continue uninterrupted into the future. Moreover, these investments will improve data quality and allow for more efficient management of the network.

Based on data from the ANSS and the GSN, the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) system provides rapid estimates of population exposure to shaking in the same timeframe as ShakeMap. The PAGER system overlays the estimated shaking intensity with a population database to estimate population impact. This gives emergency responders and aid agencies a rapid estimate of the extent of the likely response required. Such information is particularly valuable in cases where communications may be down as was the case in Haiti last week. The first PAGER estimate was available within 20 minutes of the event, showing that nearly 2 million people had been exposed to violent shaking – even before news reports began to filter in, the scope of the humanitarian disaster was clear to aid agencies, relief organizations and others who mobilized to respond to the crisis. Domestically,

PAGER complements the rapid loss estimates that are generated using FEMA's HAZUS software in conjunction with USGS ShakeMaps

Assessing the Nation's Earthquake Hazards

Earthquakes are a national challenge with 75 million people living in moderate to high hazard areas stretched across 39 states. One of the most important achievements that NEHRP has made is the translation of research into models of the location and expected severity of earthquake shaking nationwide within specified time periods. These models are used to generate maps that are incorporated into the seismic safety elements of model building codes and for other purposes.The maps are the culmination of a multi-year process to incorporate the best available science, including geologic information about faults, evidence of prehistoric earthquakes, instrumental and historical earthquake catalogs generated by seismic monitoring, and ground deformation measurements. In 2008, the USGS released the latest update of the National Seismic Hazard Maps.

The delivery of the updated seismic hazard maps was timed to fit into the development of the next generation of building codes, a process that involves close cooperation among the USGS, FEMA, the Building Seismic Safety Council, the American Society of Civil Engineers, the International Code Council, and many other organizations. Earlier versions of the USGS maps are the basis for seismic design maps in the International Building Code and the International Residential Code, which have been adopted in almost all states. The maps are also used by insurance companies to set rates for properties in various areas of the country, by civil engineers to estimate the stability and landslide potential of hillsides, by the U.S. Environmental Protection Agency to set construction standards that ensure the safety of waste-disposal facilities, and by FEMA to plan the allocation of assistance funds for earthquake education and preparedness.

Complementing the national maps, urban seismic hazard maps combine state-of-the-art modeling techniques and detailed information about near-surface materials that affect shaking strength to provide more detailed information on local site conditions for use in engineering and planning. Urban seismic hazard maps have been released in the past four years for Memphis and Seattle, with others currently being developed for the St. Louis and Evansville (Indiana) areas. Those maps show how forecasted earthquake shaking levels vary at scales useful for urban planning, earthquake response planning, engineering guidance for major structures, and public education. Such maps require detailed mapping of surficial geology and knowledge of subsurface geology in order to incorporate the local effects into estimates of shaking. Developing these maps would not be possible without significant involvement of local and regional scientists, engineers, emergency managers, and the business community. Demand has been high for the Seattle urban seismic hazard map, which is being used in the preliminary design of the new Route 520 bridge across Lake Washington and for prioritization in a city program to strengthen, or retrofit, buildings.

Using Earthquake Forecasts to Better Prepare

As reported by FEMA, California is home to over half the Nation's earthquake risk due to high hazard and large at-risk population. In 2008, the USGS combined forces with the Southern

California Earthquake Center (SCEC) and the California Geological Survey, with support from the California Earthquake Authority, to deliver the first-ever statewide earthquake rupture forecast. The new study determined the probabilities that different parts of California will experience earthquake ruptures of various magnitudes. According to the forecast, California has more than a 99% chance of a magnitude 6.7 or larger earthquake within the next 30 years. When striking urban areas, such earthquakes can be deadly, as shown by the 1989 magnitude 6.9 Loma Prieta and the 1994 magnitude 6.7 Northridge earthquakes.

The most likely sources of magnitude- 6.7 or greater earthquakes are the San Andreas Fault and the Hayward-Rodgers Creek Fault in the East San Francisco Bay Area. Both of these faults have been the focus of major public preparedness activities in the past two years. On the 140th anniversary of the last large earthquake on the Hayward Fault in October, 2008, emergency management offices for the 10 San Francisco Bay Area counties conducted a response drill based on a scenario of likely impacts from such an event. The USGS and its partners developed a wide array of scientific and educational products, similar to those developed for the earthquake preparedness campaign linked to the centennial commemoration of the 1906 San Francisco earthquake, to increase the level of preparedness and resilience in the Bay area.

In southern California, improving earthquake preparedness was one important goal of the USGS Multi-Hazards Demonstration Project in Southern California, a community-focused initiative in which dozens of partner organizations are working with the USGS to improve the use of our information products. The top priority products identified by stakeholders were scenarios of potentially catastrophic hazard events, starting with the impacts of a magnitude-7.8 earthquake on the southern San Andreas Fault, including its long-term impacts on the complicated social and economic interactions that sustain the region. By identifying the consequences of a major earthquake in southern California, the scenario is intended to help the public identify what they can change *before* the earthquake to avoid catastrophic impact *after* the inevitable earthquake occurs. In November 2008, the scenario served as the basis for the largest public preparedness exercise in U.S. history, the Great Southern California ShakeOut, which attracted over 5 million Californians – many schoolchildren – to practice earthquake safety drills and take additional actions. The ShakeOut has led to a number of positive outcomes, including efforts to reduce lifeline vulnerability, retrofit critical structures, improve monitoring systems, and educate residents. In October 2009, it also led to the first-ever statewide preparedness drill, called the Great California ShakeOut, with nearly 7 million participants.

Another way that the USGS works to make earthquake hazards understood is through education and outreach products developed in concert with Federal agency, university, and local government partners, including the FEMA-supported regional earthquake consortia, the NSF-supported IRIS consortium, and the Southern California Earthquake Center (SCEC), which is jointly supported by the NSF and the USGS. Millions of copies of earthquake preparedness handbooks have been distributed in California, Alaska, and many other states. As part of an effort to reach underserved populations, both the southern California and Bay Area versions of *Putting Down Roots in Earthquake Country* have been translated into Spanish, and a shortened version of the Bay Area *Putting Down Roots* has been translated into a number of Asian languages and distributed through Asian-language newspapers. A version for the central U.S. is

being developed in time for the bicentennial commemoration of the New Madrid sequence of earthquakes that struck the heartland in the winter of 1811-12.

Targeted Research

Both USGS assessment and monitoring activities depend on the targeted geoscience research that is the third major USGS responsibility within the NEHRP partnership. External research supported by the USGS through grants to and cooperative agreements with universities, State geological surveys, and geotechnical consultants augments the USGS' internal research capabilities. This targeted research is awarded on the basis of merit, and provides a bridge from the NSF's investments in fundamental research to generate critical advances in understanding that underpin development of the national and urban seismic hazard maps and rapid earthquake response products. Ongoing collaboration with the academic community is one of the great strengths of the USGS in regard to earthquake research. Two particular examples are the jointly USGS-NSF supported SCEC university and government consortium and our important research partnership with the NSF's EarthScope facility.

The ability to characterize the earthquake hazard in the Pacific Northwest, where active faults are obscured by vegetation, has been revolutionized by high-resolution LiDAR topographic imaging. LiDAR uses laser technology to "see" through vegetation, revealing fault scarps and other features.. Since LiDAR acquisition began in 2000 in the Puget Sound region, the USGS has used this data to document recent surface deformation on seven major crustal faults. The USGS, using Congressionally authorized funding for the Multi-Hazards Initiative, is also acquiring significant LiDAR data in eastern Washington over the area thought to be the location of a historic magnitude-7 earthquake.

Although the search for effective short-term earthquake prediction was one of the drivers for the establishment of NEHRP in 1977, experience has shown that such predictions are an elusive goal. In addition to focusing its energy on rapid post-event situational awareness and long-term hazard assessments, USGS supports both internal and external researchers studying the underlying processes that determine earthquake nucleation and growth. In addition, USGS seeks to improve the predictive capabilities of effects from large, damaging earthquakes.

Conclusion

The Department strongly supports reauthorization of NEHRP, which has proven to be a successful partnership that continues to make valuable contributions to the Nation's resilience to earthquakes and other hazards. The organizational structure established by the 2004 reauthorization has worked well with NIST as the lead agency. The current legislation, H.R. 3820, makes a number of changes in USGS responsibilities that reflect the current state of the program, for example acknowledging the importance of seismic monitoring of structures by the ANSS, the role of geodesy in earthquake monitoring, and the long-standing USGS external research support activity. The USGS does not oppose the transfer of responsibility for coordination of post-earthquake investigations to NIST as this is an appropriate responsibility for the lead agency and such a shift will not affect the many important post-event responsibilities that USGS carries out.

Mister Chairman, this concludes my remarks. I will be pleased to answer any questions you or the Subcommittee may have.