Final Technical Report

Pacific Northwest Seismic Network ARRA Upgrades

USGS Cooperative Agreement G09AC00472

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1. Executive Summary

This Final Technical Report covers all work done to upgrade seismic stations reporting under the UW and UO network codes. All upgrades funded under this award are complete. Eighteen broadband stations in the PNSN (15 UW, 3 UO stations) were upgraded to widen the frequency response to 120 seconds. Two broadband stations the ET network were upgraded to widen the frequency response to 120 seconds and to add 3 channels of strong motion recording. Ten strong motion stations were upgraded from ageing hardware to modern units. Fifteen short-period analog stations were upgraded to digital data acquisition on site, with 3 additional strong motion channels added, and switched to digital communications. Four locations that are analog data receive sites received much-needed tower upgrade and re-wiring work.

2. Detailed Summary

43 station upgrades were performed in the PNSN (Figure 1). The stations upgraded included stations of the UW network, and the UO network. Additionally, upgrades of 4 telemetry stations were accomplished, which involved subcontracts to private companies to perform hazardous and skilled tower work. The upgrades involved the close coordination and collaborative fieldwork of personnel at the University of Washington and the University of Oregon.

The station upgrades were of three types of seismic stations.

Ten 3-component strong motion stations were upgraded from ageing and failing IDS instruments to modern RefTek 130SM units (red stars in Figure 1).

Eighteen 6-component stations (3 broadband, 3 strong motion components at each station) were upgraded. Previous sensors were typically 30-second Guralp CMG40T seismometers with RefTek A-07, or IDS dataloggers. New instrumentation includes 120-second Trillium 120P broadband seismometers and Reftek RT130 data acquisition systems (Kinemetrics “Episensor” accelerometers at each old site were typically not changed). The previous sensors were more than 15 years old and the upgrades provide new equipment with a wider recorded frequency band and significantly greater dynamic range. Nine sites were either moved to newly-constructed vaults nearby to the original site, or moved up to several kilometers away.

Fifteen short-period vertical seismometers (typically Mark Products L-4 4-hz sensors) with analog data telemetry were upgraded to 4-component (3 strong motion plus 1 short period vertical sensitive) stations with digital acquisition and telemetry.

The fidelity has been dramatically improved in time, frequency, and amplitude (e.g., Figure 2) with increased operational and maintenance efficiencies.

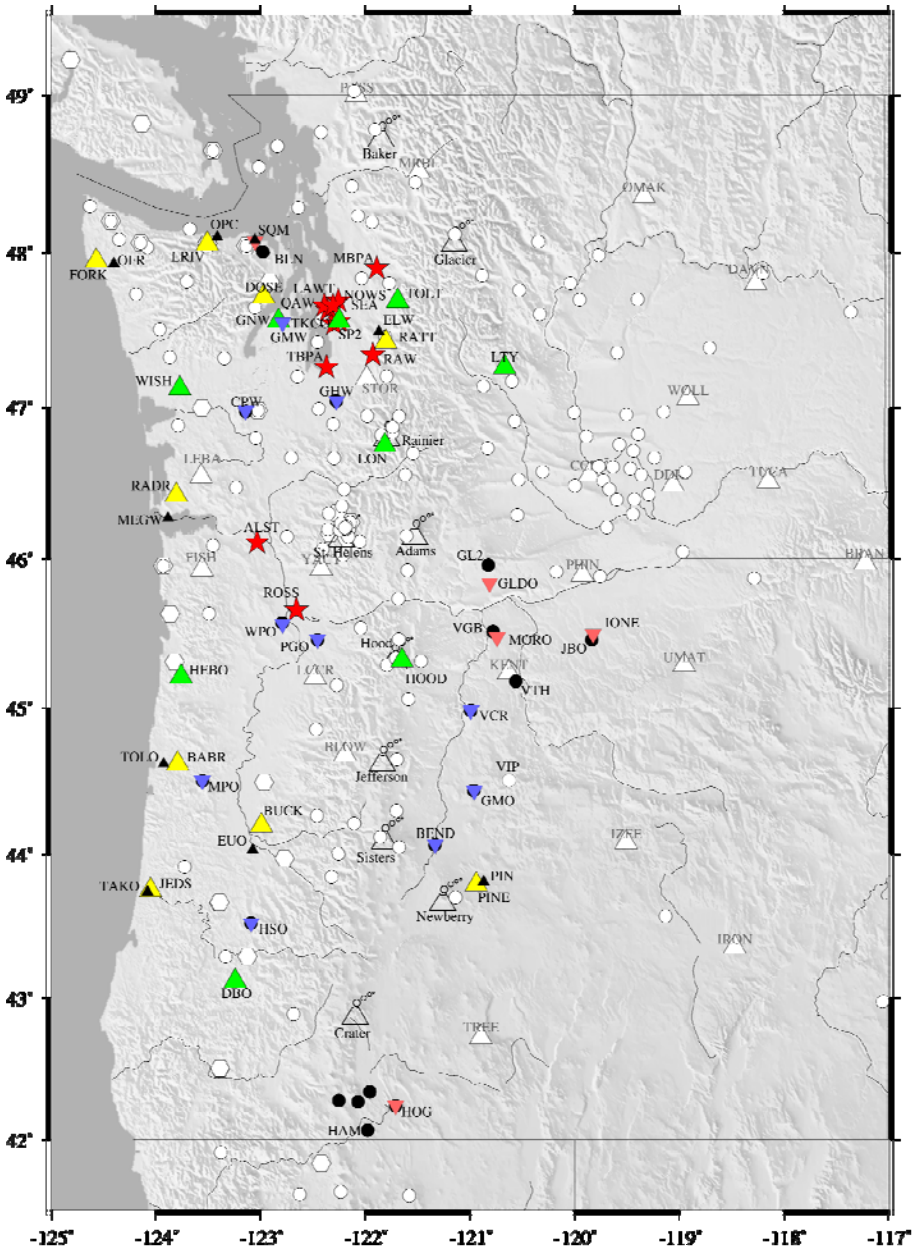

Figure 1. Map of seismic stations upgraded by ARRA funded work at the University of Washington and the University of Oregon. Brightly colored symbols represent final upgraded station locations. Red stars show locations of 10 Strong Motion upgrades. Yellow and Green triangles are broadband stations. Green used existing or nearby vaults, Yellow were new constructions; small black triangles (and labels) show locations of pre-ARRA broadbands. Smaller inverted triangles are the locations of previously analog short period stations upgraded to 4-component 24-bit digital stations. Blue symbols occupy the same site as pre-ARRA station, Salmon colored symbols show completely new sites. Black circles are pre-ARRA short period analog stations that were retired as a result of ARRA upgrades.

Analog telemetry nodes were upgraded at West Portland BPA (Bonneville Power Administration) headquarters, the University of Washington Atmospheric Sciences/Geophysics building (PNSN central receive), Capital Peak, WA, and Striped Peak, WA.

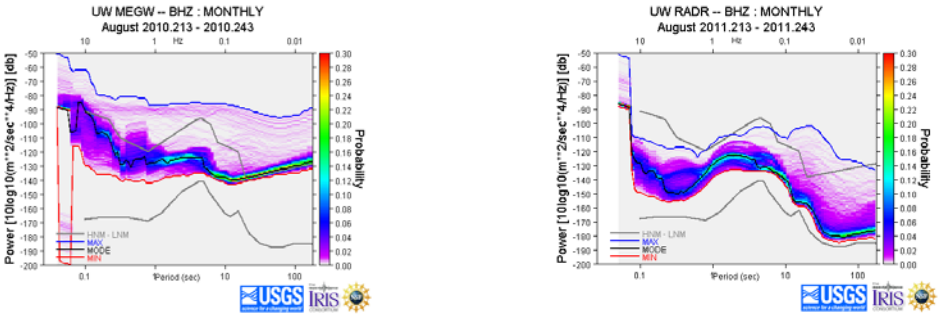

Figure 2. Example of improved station performance resulting from ARRA upgrade. Left: noise Probability Distribution Function (PDF) for pre-ARRA station MEGW, Right: noise PDF for ARRA-upgrade replacement site RADR. Both noise PDFs represent monthly sample of vertical data, for MEGW August of 2010, for RADR August of 2011. Significant reduction of the noise floor at high frequencies is due to moving station out of culturally noisy BPA facility, and at long periods due to better vault and use of a sensor with 120 second corner period. Remaining wide microseism peak in the 1-10 second period range is a feature of nearly all sites on the coast of Oregon and Washington, and arises from ocean/land interactions.

Additionally, 20 NetQuakes strong motion stations were installed by PNSN, acquired by ARRA funds. Stations, all in urbanized areas of the Puget Sound region, are given in Figure 1.

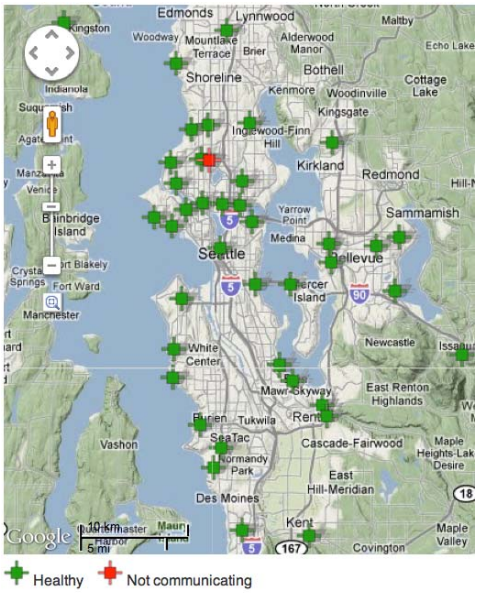

Figure 3. NetQuakes in the greater Seattle Metropolitan region. 20 of these stations were acquired with ARRA funding as part of the PNSN network upgrades. Stations are: QBAY, QMIN, NQ19, NQ20, QADA, QBGD, QBOG, QBOV, QCOR, QEGA, QGNG, QHRH, QLBR, QNKP, QNPB, QNWT, QOCS, QPAL, QPRK, QRCR. The data are incorporated into standard regional PNSN processing, and used in the generation of ANSS earthquake data products. More information at: http://earthquake.usgs.gov/monitoring/netquakes/map/pacnw/