Comments and Concerns from February 5, 2016 NGL Workshop

Les Youd

1. The NGL team are to be commended for getting this project underway and finding and accumulating funding to press onward.
2. NGL is modeled after the NGA Ground-Motion Prediction Project, which has successfully produced improved consensus ground motion prediction equations. The improved equations, however, are not new equations, but improvements and enhancements of past pioneering modeling efforts. I expect that the products generated by NGL will be similar. For example, the final models and procedures with respect to lateral spread prediction most likely will be enhancements of the pioneering work by Bartlett and Youd and by Zhang and Robertson. Thus new case histories added to the data base should collected to include the information necessary to apply, verify and improve previous models.
3. Similarly, next generation for prediction of free field ground settlements will likely be enhancements and improvements to the pioneering models developed by Tokimatsu and Seed and Ishihara and Yoshimine. Case history data needs to be collected with information necessary to apply, verify or improve the previous procedures.
4. On this note, I encourage Professor Nakai and those collecting data from areas that did and did not liquefy in Chiba, Japan to collect quantitative data on free-field ground settlements. Supplementing the case histories with this data will increase their value.
5. This Chiba data collection issue brings up a major concern. It appears that the NGL data collection efforts are being separated from the NGL modeling and analysis efforts. My past experience is that such a division of effort is a recipe for disaster. Modelers should be sufficiently involved in collection effort to review on the fly the data and information being collected from each uniquely different case history site. It is unlikely that adequate specifications can be developed that will assure that the all of the available and pertinent data and information will be collected in each gathering effort. Asking one group to collect data for another group to analyze will likely lead to frustration and inferior final products. In all of the data collecting and modeling efforts in which I have been involved, have incorporated close cooperation between field investigators and modelers. For example, I believe that modelers of ground settlement will be frustrated and hindered by the lack of measured ground settlements at Chiba case history sites.
6. I suggest that the NGL steering committee formulate important modeling needs from case history sites. For example, for lateral spreads, future needs include: a. Assessment of

susceptibility or lack of susceptibility of fine grained sediment to lateral spread. Field case histories to data indicate that fine-grained sediment such as those beneath Adapazari, Turkey, although susceptible to liquefiable, were not susceptible to lateral spread. Also clay-like soils appear to be immune to lateral spread. According to the findings of Bartlett and Youd, lateral displacement decreases markedly with increasing fines content. All of these apparent findings need confirmation and further definition. My review as a consultant of predicted lateral spread displacements based on the Zhang and Robertson procedure do not similarly demonstrate the impeding effects of fine-grained soils. Thus more confirmative case histories from fine grained soils need to be collected.

7. Another need for more well documented case histories from lateral spreads is influence of thinness of the liquefiable layer ion lateral spread displacement. The thinnest layer in the Bartlett and Youd dataset in which lateral spread occurred is about 1.0 meter. In a review as a consultant of a recent lateral spread analysis at a proposed major development, displacements I noted that up to several feet of displacement was predicted, but most of that displacement originated from layers a few to several inches thick rather thinly layered sediments. I believe those displacements are greatly over predicted. The proposed cost developed by the consultant for ground modification to stabilize these layers against lateral spread exceeds $60 million (likely several times the amount of hoped for NGL funding). Thus, we (NGL) need to better define the influence of layer thickness on lateral spread displacement.
8. Similarly, the profession needs more carefully documented field case histories to demonstrate the influence of fines content and thickness of liquefiable layers on ground settlement.
9. A more minor concern to me is to develop more accurate terminology, as mentioned by others at the workshop. I was concerned about the apparent confusion between occurrence of liquefaction and surface evidences of liquefaction, such as sand boil deposits. There are several sites where liquefaction is known to have occurred at depth without generation of sand boils, such as instrumented sites where a shift of natural frequency, as discussed at the workshop, but without the eruption of sand boils.
10. Although not mentioned at the workshop, many of most useful case histories have come from instrumented sites. For example, the Wildlife Site, near Brawley, California, for which I was a principal investigator in instrumenting the site in 1982, produced invaluable records of ground motions above and below a liquefying layer and pore pressures within the layer as liquefaction developed during the 1987 Superstition Hills earthquake. Instrumentation at that site was replaced and greatly expanded in 2003 as a NEES field instrumentation site. A few other sites have subsequently been instrumented,

but have not yet produced significant records. Important additional earthquake records have been collected from the Wildlife Site since that re-instrumentation, but, another large liquefaction-producing earthquake has not occurred. However, the site is in a highly seismic area with high probability for liquefaction generating earthquakes. NEES has pulled the plug on funding for the Wildlife. Jamie Steidl, the present principal investigator, has scraped together enough funding, including some from the Nuclear Regulatory Commission, to temporarily keep the site in operation, but long-term funding has not been secured. I believe that the Wildlife Site, now called the Wildlife Liquefaction Array (WLA), is an important asset to NGL and, if not already considered, should be considered and supported as an important liquefaction case history site. NGL may wish to invite Jamie to make a presentation on the site at a future NGL meeting.

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Sjoerd van Ballegooy

1. In terms of lateral spreading – if known it would be important to record in the NGL database the observed eye witness accounts of the timing of the lateral spreading relative to the strong shaking motions. In the case of the Christchurch earthquakes, lateral spreading was not observed to occur during the strong motions, but was observed to start approx 5mins after the strong motions had occurred. Unsure when the lateral spreading ceased, because 10mins after the ground motions the land was covered with ejected sand and water
2. Free field liquefaction observations should not be connected with a single CPT, because as in the case of Christchurch, liquefaction ground failure has been demonstrated to be also dependent on spatial variability and spatial continuity of the soil layers. Therefore, similar to lateral spreading, I recommend that multiple surrounding investigation records should be able to be included in the database for each case history.
3. Also, the severity of ground failure observations at "free field" case histories are dependent on topography and land use and should be included in the NGL database for each case history.
    1) For example in Christchurch properties typically subsided more than roads (by 100 to 200mm) because properties were approx 500mm higher than the adjacent roads for storm water management purposes. Therefore, topographic maps for each case history site are important to include in the NGL database.
    2) Similarly, there are cases in Christchurch were the ground failure severity was significantly exacerbated by infrastructure such as buried pipes and manholes that uplifted puncturing the non-liquefying crust, creating preferential paths for ejecta. Also power poles and streetlight poles that rocked backwards and forwards during

the shaking created an annulus and hence a preferential path for ejecta in the non-liquefying crust. Conversely, liquefaction manifestations in adjacent parks and farmland that was flat and not developed were not as severe. Therefore, land use descriptions, maps and photos for each case history site are important to include in the NGL database.

4. I didn't hear whether other investigation types (in addition to CPT and boreholes with SPT and lab tests) could also be included in the database. Test pit logs which are available for some case history sites in Christchurch are extremely valuable to show the spatial variability and continuity of the soil layers at case history sites as well as capturing the paelo-liquefaction history at the sites. Also, many case history sites have good geophysical investigation data (Vs to measure the in situ small strain stiffness and Vp to measure the in-situ partial saturation).
5. Finally, there 55 case history sites throughout Chch with very detailed observations across all the 2010-2011 events that were not mentioned that we are currently working compiling that have a large quantity of investigations in close proximity including CPT, boreholes with SPT, lab tests, crosshole and downhole Vs and Vp profiles and piezometer ground water records. Many of these 55 case history sites are cases where the B&I 2014 CPT-based liquefaction procedures either over predict or under predict liquefaction relative to the observations for one or more of the Chch events. I think that these case histories would be very important to include in the NGL database and would be happy to provide them.