United States Department of Agriculture

Natural Resources Conservation Service

316 W. Boone Ave, Suite 450
Spokane, WA 99201-2348

Phone 509-323-2900
Fax 509-323-2979

November 4, 2015

SUBJECT: ENG – Trip Report
Quileute Indian Nation
Thunder Road Site 1 – Culvert
Clallam County, WA

File Code: 210-0

TO: Larry Johnson
State Conservation Engineer
Spokane, WA

PURPOSE

On October 27, 2015, we visited the Thunder Road Site 1 to explore geotechnical foundation conditions for removal of an existing culvert and replacement with a larger culvert. The new culvert will improve conditions for the passage of aquatic organisms (Figure 1). The site is located on an unnamed tributary to the Quillayute River along Thunder Road.

PARTICIPANTS

Joe Gasperi, State Geologist, Spokane, WA
Wes Durheim, Civil Engineering Technician, Spokane, WA
Jim Farley, Civil Engineering Technician, Olympia, WA
George Riley, Soil Conservation Technician, Chehalis, WA
Shawn Stanley, Engineer, WA Department of Fish & Wildlife, Olympia, WA

DATA COLLECTION

We drilled one exploratory hole through the centerline of Thunder Road: DH1, 20 feet east of the existing culvert. The general location of the drill hole is shown in Figure 2. Figure 3 shows the drill rig set up at DH1.

Figure 1. Image looking upstream at existing culvert crossing.

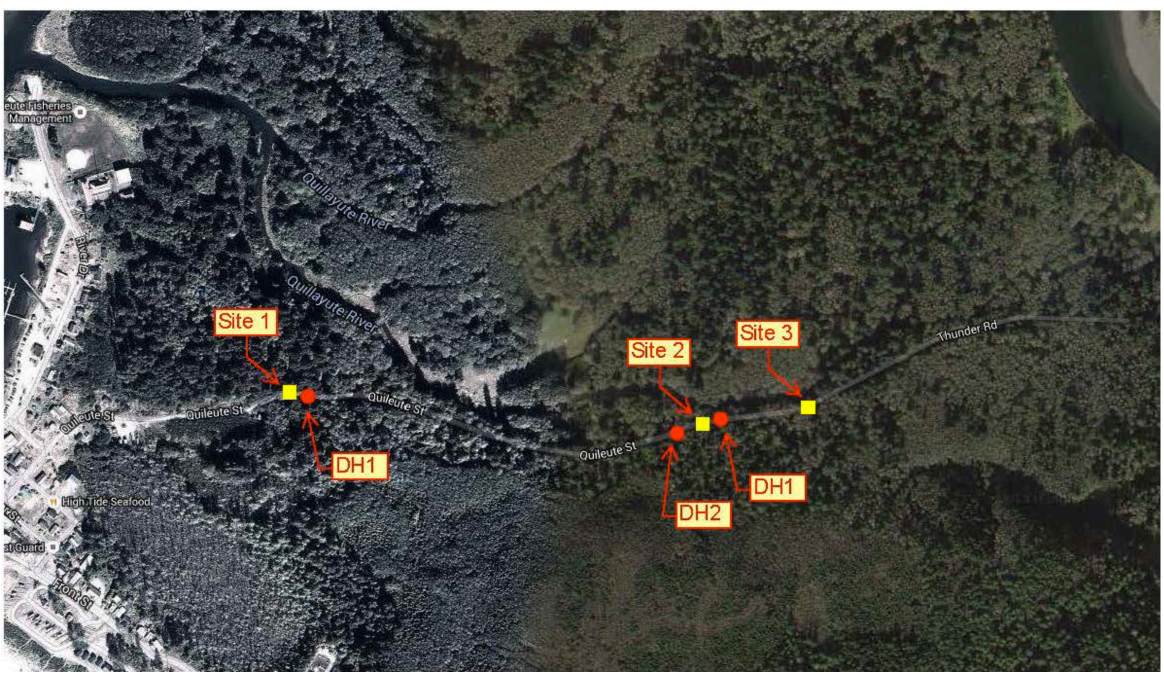

Figure 2. Aerial view shows approximate location of project sites and exploratory drill holes along Thunder Road. North is towards top of page.

Figure 3. Drill rig set up at Site 1, DH1. Photo looking west.

Drill Hole 1

SPT	Number of Blows
2.5 to 3.0 feet	set sampler
3.0 to 3.5 feet	2
3.5 to 4.0 feet	1
Blows per foot, N =	3

3.0 to 4.0 feet: OH, high-plastic organic silt with woody fragments, saturated, gray-brown, soft consistency (Figure 4). Sample collected for laboratory classification.

Figure 4. View of sample recovered from a depth of 3.0 to 4.0 feet.

SPT	Number of Blows
5.0 to 5.5 feet	sank
5.5 to 6.0 feet	0
6.0 to 6.5 feet	1
Blows per foot, N =	1

5.5 to 6.5 feet: OH, high-plastic organic silt with woody fragments, saturated, gray-brown, very soft consistency, sampler sank the first six inches under the weight of the hammer (Figure 5). Sample collected for laboratory classification.

Figure 5. View of sample recovered from a depth of 5.5 to 6.5 feet.

SPT	Number of Blows
7.5 to 8.0 feet	sank
8.0 to 8.5 feet	1
8.5 to 9.0 feet	1
Blows per foot, N =	2

8.0 to 9.0 feet: OH, high-plastic organic silt with woody fragments and charcoal, saturated, gray-brown, soft consistency, sampler sank the first six inches under the weight of the hammer (Figure 6). Sample collected for laboratory classification.

Figure 6. View of sample recovered from a depth of 8.0 to 9.0 feet.

SPT	Number of Blows
10.0 to 10.5 feet	sank
10.5 to 11.0 feet	0
11.0 to 11.5 feet	0
Blows per foot, N =	0

10.5 to 11.5 feet: ML/OH, silt to high-plastic organic silt, saturated, reduced, blue-gray/brown, very soft consistency, sampler sank under the weight of the hammer (Figure 7). Sample collected for laboratory classification.

Figure 7. View of sample recovered from a depth of 10.5 to 11.5 feet.

SPT	Number of Blows
12.5 to 13.0 feet	sank
13.0 to 13.5 feet	0
13.5 to 14.0 feet	0
Blows per foot, N =	0

13.0 to 14.0 feet: ML/OH, silt to high-plastic organic silt, saturated, reduced, blue-gray, very soft consistency, sampler sank under the weight of the hammer (Figure 8). Sample collected for laboratory classification.

Figure 8. View of sample recovered from a depth of 13.0 to 14.0 feet.

SPT	Number of Blows
15.0 to 15.5 feet	sank
15.5 to 16.0 feet	0
16.0 to 16.5 feet	0
Blows per foot, N =	0

15.5 to 16.5 feet: ML/OH, silt to high-plastic organic silt, saturated, free water, reduced, blue-gray, very soft consistency, sampler sank under the weight of the hammer (Figure 9). Sample collected for laboratory classification.

Figure 9. View of sample recovered from a depth of 15.5 to 16.5 feet.

*Drilling stopped a depth of 15.0 feet due to the lateness of the day and lack of light.

FINDINGS

1. Seasonal High Water Table

Soil indicators suggest a seasonal high water table at a depth of less than 3.0 feet below ground surface. Replacement of the existing culverts will likely encounter water during construction.

2. Bearing Capacity

The foundation soils consist of very soft to soft consistency high-plastic organic silt, OH and very loose relative density silt, ML, to a depth of at least 16.5 feet below the road surface. Given the very low densities of these soils it is reasonable to expect significant consolidation when they are loaded. NRCS technical guidance does not provide a presumptive bearing value for these soils because they are of such low density. Consider methods to improve the bearing capacity of the soils prior to placement of the new culvert.

We did not drill to sufficient depth to find a firm foundation, so the design engineer is left with a greater uncertainty about the potential for consolidation. As options, we can return to the site and drill to a greater depth in hope of finding a more consolidated soil layer or the design engineer could consider engineering a surcharge load to pre-consolidate the foundation soils prior to placement of the new culvert. These are just a few examples of the available options the design engineer may choose to address concerns regarding consolidation and bearing strength. There are many other approaches that may be worth consideration.

3. Differential Settlement

The site has a moderate to high potential for differential settlement due to the weakly consolidated mix of mineral and organic soils that extend to a depth beyond 16.5 feet.

4. Liquefaction Potential

According to the 2008 seismic hazard mapping by the USGS National Earthquake Hazards Reduction Program (NEHRP) the site has a 10% probability in 50 years of experiencing a peak ground acceleration (pga) of 0.32g assuming an average shear-wave velocity in the top 30 meters of 180 meters/second, NEHRP Site Class DE (Figure 10).

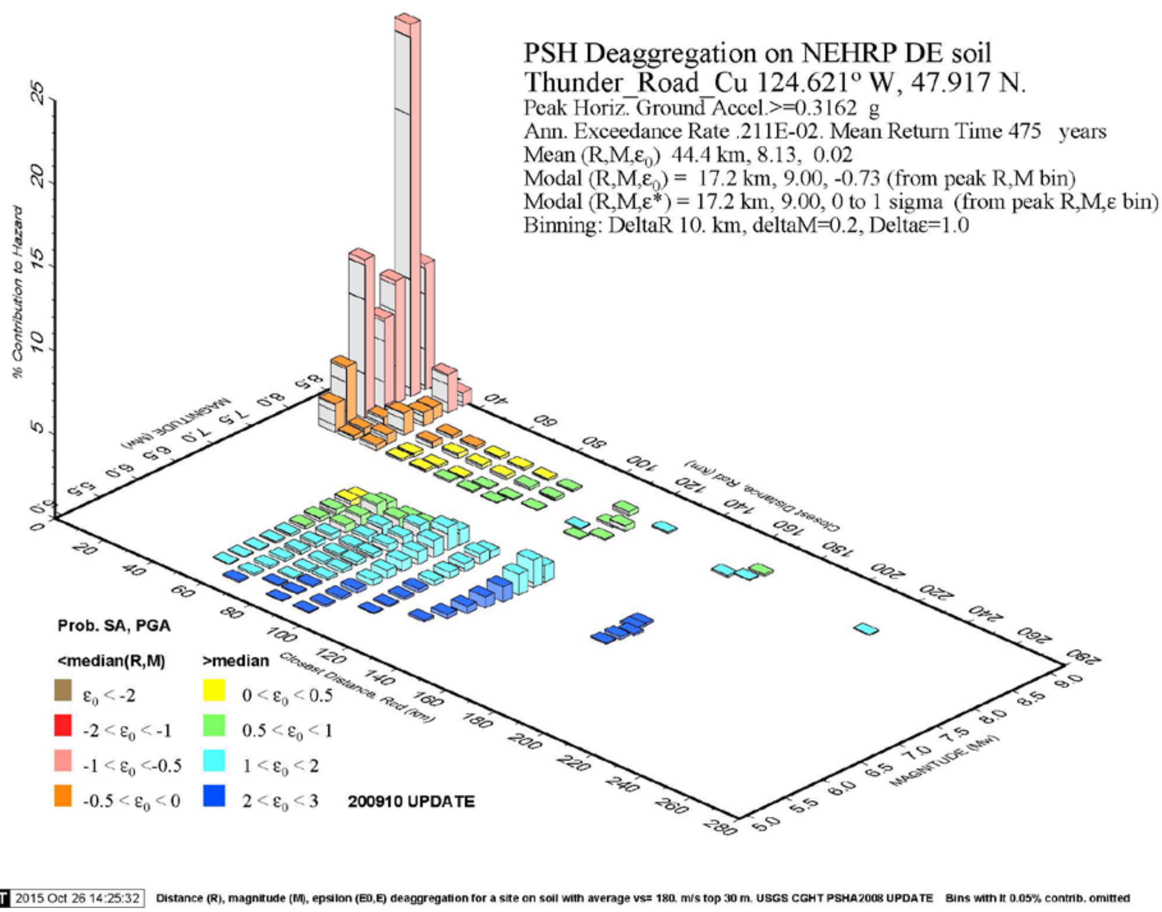

Figure 10. This figure shows an image of NEHRP peak ground acceleration estimate based on 2008 deaggradation model for 10% PE in 50 years and a shear-wave velocity in the upper 30 meters of 180 meters per second.

The site has a high potential for failure due to liquefaction because of the poorly consolidated silt and organic silt and saturated conditions. However, the deaggregation plot indicates that the major contributor to ground shaking felt at the project site would come from a large magnitude

Cascadia subduction zone event. When an earthquake of this magnitude occurs, we can expect massive failure of local infrastructure and potential tsunami inundation damage as well.

The foundation soils at this site pose a challenge for stable placement of a culvert because of the potential for significant consolidation or bearing failure. Consider measures to increase the relative density of foundation soils or other options such as piles to provide a stable base for the new culvert.

JOE GASPERI
Geologist

cc: Paul Gleason, acting District Conservationist, Lake Stevens, WA
Jim Poffel, Resource Conservationist, Port Angeles, WA
Molly Dawson, Civil Engineer, Olympia, WA
Nicole Rasmussen, Water Quality Biologist, Quileute Nation, LaPush, WA
Erik Dahlke, MLRA Soil Survey Office Leader, Mount Vernon, WA