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March 28, 2016

SUBJECT: ENG – Trip Report
Quileute Indian Nation
Thunder Road Site 4 – Bridge
Clallam County, WA

File Code: 210-0

TO: Larry Johnson
State Conservation Engineer
Spokane, WA

## PURPOSE

On March 22, 2016, we visited Thunder Road Site 4 to explore geotechnical foundation conditions for removal of an existing culvert and replacement with a bridge. The new bridge 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
Jim Farley, Civil Engineering Technician, Olympia, WA
George Riley, Soil Conservation Technician, Chehalis, WA

## DATA COLLECTION

We drilled one exploratory hole through the centerline of Thunder Road about 10 feet east of the centerline of the existing culvert. The general location of the drill hole and Site 4 is shown in Figure 2. Figure 3 shows the drill rig set up at DH1. We did not drill the west abutment due to rainy conditions that posed a safety hazard.

Figure 1. Image looking downstream at inlet of existing culvert at Site 4 along Thunder Road.

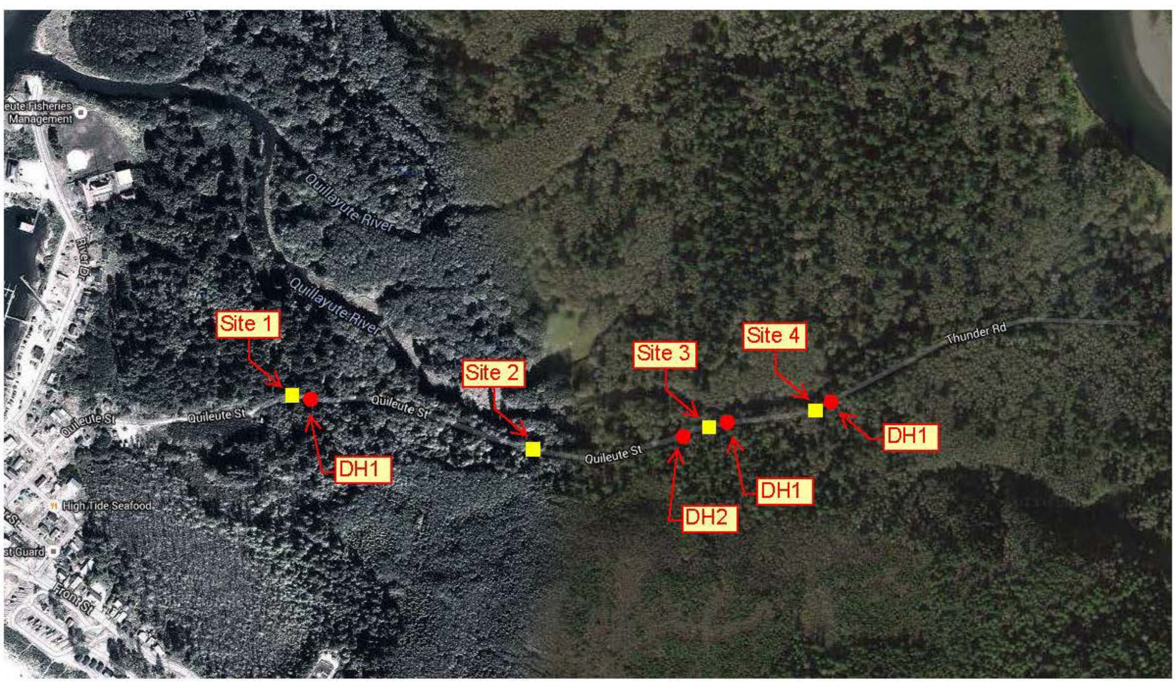


Figure 2. Aerial view shows approximate location of project sites (yellow squares) and exploratory drill holes (red dots) along Thunder Road.  North is towards top of page.

Figure 3. Drill rig set up at Site 4, DH1.  Photo looking east.

**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 | 0 |
| Blows per foot, N = | 2 |

3.0 to 4.0 feet: GM, silty gravel, road fill, oxidized, red-brown, saturated, very loose relative density (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 | set sampler |
| 5.5 to 6.0 feet | 2 |
| 6.0 to 6.5 feet | 1 |
| Blows per foot, N = | 3 |

5.5 to 6.5 feet: ML/OH, silt with organics, reduced, blue-gray, saturated, soft consistency (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 | set sampler |
| 8.0 to 8.5 feet | 1 |
| 8.5 to 9.0 feet | 2 |
| Blows per foot, N = | 3 |

8.0 to 9.0 feet: ML, silt with wood fragments, organics and thin silty sand (SM) layers, reduced, blue-gray, saturated, soft consistency (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 | set sampler |
| 10.5 to 11.0 feet | 3 |
| 11.0 to 11.5 feet | 2 |
| Blows per foot, N = | 5 |

10.5 to 11.5 feet: ML/SM, silt to silty sand with organics and wood fragments, reduced, blue-gray, saturated, medium consistency/loose relative density (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 | Set |
| 13.0 to 13.5 feet | 6 |
| 13.5 to 14.0 feet | 6 |
| Blows per foot, N = | 12 |

13.0 to 14.0 feet: SM, silty sand with gravel and woody debris, reduced, blue-gray, saturated, medium relative density (Figure 8). Sample collected for laboratory classification.

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

*Drilling was stopped at a depth of 15.0 feet due to at least ten inches of soil heave. We measured standing water at a depth of 6.5 feet below ground level when the hollow-stem auger was removed.

## FINDINGS

### 1. Seasonal High Water Table

Redoximorphic soil indicators, saturation of soil samples and observations of free water 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 unconsolidated alluvial silt, sand, gravel, organic debris and wood fragments typical of wooded floodplain deposits. From the surface to a depth of 12.5 feet the soils are mostly soft consistency silt (ML), very loose relative density silty gravel (GM) and loose relative density silty sand (SM) with organic material and wood fragments. These soils have a presumptive bearing capacity of 0.25 tons per square foot. From 12.5 to 14.0 feet, we encountered medium relative density silty sand (SM) with gravel. These soils have a presumptive bearing capacity of 1.50 tons per square foot.

To reduce the potential for consolidation or bearing failure, consider over excavating to the top of the medium relative density silty sand (SM), and replacing the low density soils with an engineered fill before placing abutments for the new bridge. For design purposes, assume a presumptive bearing capacity of 1.50 tons per square foot for a structure founded on the underlying medium relative density silty sand (SM).

**3. Differential Settlement**

The site has a moderate to high potential for differential settlement due to the poorly consolidated mineral and organic soils in the upper 12.5 feet. Removing the poorly consolidated materials and replacing with an engineered fill may improve foundation conditions and reduce the potential for differential settlement of the bridge abutments.

**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 9).

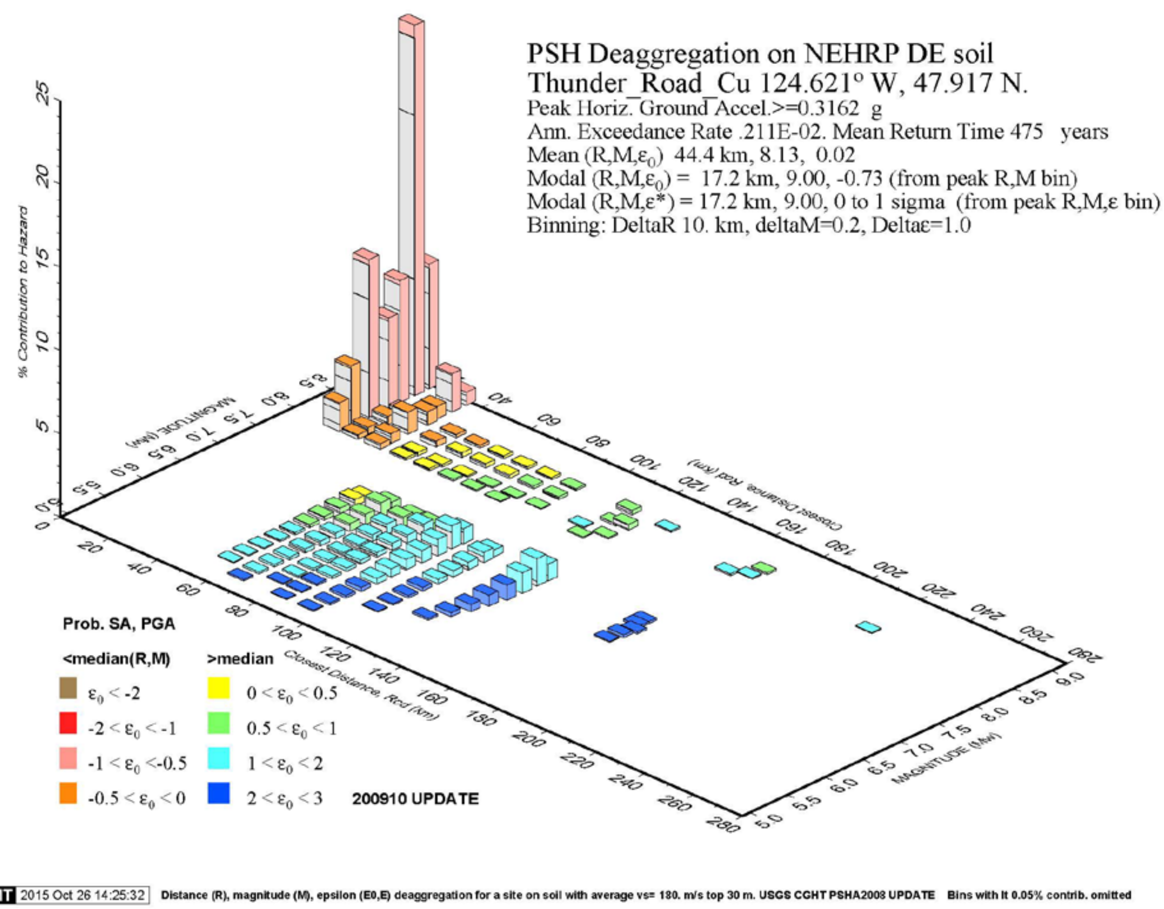


Figure 9. This figure shows an image of NEHRP peak ground acceleration estimate based on 2008 deaggradation model for 10% PE in 50 years and a shear-wave velocity in the upper 30 meters of 180 meters per second.

The site has a moderate to high potential for failure due to liquefaction because of the poorly consolidated noncohesive soils 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.

JOSEPH GASPERI

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