Geotechnical Design Report

TYPE OF SERVICES  Geotechnical Engineering Services

PROJECT NAME  Western Placerville Interchanges Phase 2.2
               (EA 03-37282)

LOCATION  US 50 East Bound, PM 16.4 – PM 16.8, El Dorado County

CLIENT  R.E.Y. Engineers, Inc.
         905 Sutter Street, Suite 200
         Sacramento, CA

SIERRA GEOTECH PROJECT NO.  RL2019103

DATE DOCUMENT ISSUED  March 27, 2020
                       Revised April 8, 2020
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1. INTRODUCTION

The City of Placerville (City) is planning to construct a new eastbound on-ramp at the Ray Lawyer Drive interchange on US Highway 50. This project is Phase 2.2 of the Western Placerville Interchanges (WPI) Project, which provides improvements to two connections on US Highway 50 (US 50) – the Placerville Drive/Forni Road/US 50 Interchange and the Ray Lawyer Drive/US 50 Interchange. Phase 1A and 1B of the WPI Project have been completed, and Phase 2 was completed recently in Fall of 2019. The approximate site location of the project site is shown on Figure 1, Vicinity Map. The site is located at Latitude 38.72672°, Longitude -120.8244°.

Major components of the project include adding a new on-ramp from Ray Lawyer Drive to US 50 eastbound. The proposed US 50 on-ramp will require cutting through the existing stockpile west of Ray Lawyer Drive overcrossing (OC) of US 50 along with the cut and fill slopes to the east. The proposed improvements are depicted on Figure 2, Conceptual Design Exhibit.

1.1. SCOPE OF SERVICES

Our scope of services was presented in our proposal and sub-consultant agreement dated April 18, 2019 and consists of preparing this geotechnical design report (Task 7.1 of the RFP). Specifically, our geotechnical scope of work is as follows:

I. Review project plans,
II. Discuss proposed improvements with the design team,
III. Review pertinent reports and historical geotechnical information,
IV. Obtain necessary permits for geotechnical field investigation,
V. Undertake the field investigation consisting of four (4) borings, two (2) exploratory test pits and refraction seismic investigation,
VI. Assign laboratory tests for select samples collected from field investigation,
VII. Prepare logs for the borings,
VIII. Perform necessary engineering analysis and calculations, and
IX. Prepare a Geotechnical Design Report.

1.2. KEY EXCLUSIONS FROM OUR SCOPE OF WORK

Sierra Geotech scope of work does not include environmental services. If environmental concerns are determined to be present during future evaluations and/or construction, the project environmental consultant should review our geotechnical recommendations for compatibility with the environmental concerns. Sierra Geotech scope of work also does not include corrosion screening and flood risk assessment.
2. EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

2.1. EXISTING FACILITIES

US 50 in the project area consists of two travel lanes in each direction with paved shoulders and center median between the eastbound and westbound lanes. There is an existing stockpile of soil at the southwest corner of the Ray Lawyer Drive Overcrossing of US 50. The material in the stockpile is from construction of the US 50 on-ramp on the north side of the freeway.

2.2. PROPOSED IMPROVEMENTS

Phase 2.2 will complete one quadrant of the partial cloverleaf interchange with construction of the loop eastbound on-ramp at Ray Lawyer Drive. In addition to cut slopes through the existing stockpile, construction of the on-ramp will also require cut and fill slopes to the east of Ray Lawyer Drive overcrossing of US 50 as shown in Figure 2, Conceptual Design Exhibits.

3. PROJECT PLANS

In preparation of this Geotechnical Design Report, Sierra Geotech reviewed the following documents:

- Slope alternatives at cut and fill locations, dated 12/02/19
- Conceptual Design Exhibit and cross-sections, dated 02/04/20
- Geocon Geotechnical Design Report, WPI Phase 2, dated 11/28/16

At the time this report was prepared, no available information (GEODOG and BIRS) regarding the construction and fill placement of the existing stockpile was available for review.

4. PHYSICAL SETTING

4.1. CLIMATE

The nearest climate recording station is the Placerville Station #046960. Climate data obtained from this station is presented in Table 1. Monthly Climate Summary (Source: Western Regional Climate Center at www.wrcc.dri.edu). The monthly data at this station was recorded from 1900 to 2011, and the station is located at Elevation 1890 feet.

Table 1. Monthly Climate Summary

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
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<th>Annual</th>
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<tbody>
<tr>
<td>Avg Max Temp (F)</td>
<td>53.4</td>
<td>56.9</td>
<td>60.5</td>
<td>66.3</td>
<td>74.8</td>
<td>83.9</td>
<td>92.7</td>
<td>91.4</td>
<td>85.7</td>
<td>74.8</td>
<td>61.3</td>
<td>53.8</td>
<td>71.3</td>
</tr>
<tr>
<td>Avg Min Temp (F)</td>
<td>32.6</td>
<td>35.0</td>
<td>37.6</td>
<td>40.5</td>
<td>46.3</td>
<td>51.9</td>
<td>57.2</td>
<td>56.2</td>
<td>52.1</td>
<td>45.0</td>
<td>37.4</td>
<td>33.1</td>
<td>43.8</td>
</tr>
</tbody>
</table>
The mean annual temperature is 57.5°F. Extremes of temperatures expected range from an average daily maximum of 92.7°F in July to average daily lows of 32.6°F in January. The highest and lowest temperatures on record at Placerville station are 114°F and 8°F.

Precipitation in Placerville averages about 38.16 inches per year, primarily confined to the months of November through April. December and March usually have the most precipitation accumulation, averaging about 5.76 to 6.92 inches per month.

4.2. TOPOGRAPHY AND DRAINAGE

Based on information provided by R.E.Y. Engineers, Inc., the existing ground elevations in the project area range from a low of approximately 1,850 feet at the proposed on-ramp shoulder to a high of approximately 1,905 feet at the top of the existing stockpile. Drainage in the project area is generally to the south/southwest. Past roadway improvements in the area have modified the topography and drainage of the site. Site vegetation consists of a light to moderately thick cover of grass and weeds.

4.3. MAN-MADE AND NATURAL FEATURES OF ENGINEERING AND CONSTRUCTION SIGNIFICANCE OUTSIDE CALTRANS RIGHT-OF-WAY

The man-made features adjacent to the project site include roadways, embankments, drainage basin and Ray Lawyer Drive overpass bridge. We do not expect the project improvements (ramp embankments and cuts) to have a significant geotechnical impact to adjacent man-made features.

4.4. REGIONAL GEOLOGY

The project is located within the foothills of the Sierra Nevada geomorphic province of California. The Sierra Nevada has a general northwest topographic trend and is on the order of 430 miles long and 40 to 80 miles wide. Rock of the Sierra Nevada was created roughly 120 to 130 million years ago when sediments as thick as 30,000 feet along with volcanic rocks were buckled and warped resulting in a series of low mountain ranges. The roots of these mountain ranges were then intruded by granitic rock. The Sierra Nevada was tilted upward as a result of faulting along the east edge of the mountain ranges. In the higher elevations of the Sierra Nevada, much of the older sedimentary rock has been eroded to expose granitic rock. Older rocks that remain have been metamorphosed and are exposed in the foothills of the Sierra Nevada. Most of El Dorado County is underlain by Mesozoic-age metavolcanic and metasedimentary rocks. The metamorphic rock structure is dominated by a series of northwest-trending faults and fault zones that mark the boundaries of various rock types.

| Avg Total Precip. (in.) | 6.92 | 6.65 | 5.76 | 3.19 | 1.51 | 0.44 | 0.07 | 0.09 | 0.54 | 2.13 | 4.40 | 6.47 | 38.16 |
4.5. LOCAL GEOLOGY

Published geologic mapping by Wagner\(^1\) and Busch\(^2\) shows Jurassic-age meta-volcanic and metasedimentary rock throughout the project area. We show local site geology on Figure 4, based on Busch (2001). During our surface reconnaissance of the project area and in our subsurface explorations, we did not observe rock containing serpentinite, a host rock for NOA, or significant bands of visible fibrous (asbestiform) minerals. As discussed above, NOA mapping (Figure 5) does not show the project site within an ultramafic rock area, although the project is near mapped rock formations known to contain naturally occurring asbestos.

4.6. REGIONAL SEISMICITY

Our review of published geologic mapping and site review did not reveal the presence of Late Quaternary (displacement within the last 700,000 years) or younger faults within or adjacent to the project site. The site does not lie within or adjacent to an Alquist–Priolo Earthquake Fault Zone for fault rupture hazard, and no known active faults cross the project location. The closest fault considered in ground motion analysis is the DeWitt Fault, which is part of the Foothills fault system – North Central Reach section (Caltrans Fault Identification No. 423) located approximately 19.1 miles northwest of the site. We consider the potential for fault rupture at the site to be low.

5. FIELD EXPLORATION

To characterize subsurface conditions at the site, Sierra Geotech observed the drilling, and sampling of 2 borings (A-19-101 and A-19-102) in May 2019. Boring depths were 51.5 ft below the ground surface (bgs). The locations of both borings performed for this project are presented in Figure 6. The logs of the borings and the Legend of Logs are in Appendix A. Sierra Geotech planned the location and depth of exploration points based on 1) proposed developments, 2) site access, 3) anticipated soil and rock conditions, and 4) the presence of existing fill. Sampling during drilling was performed in general accordance with the 2010 Caltrans Soil and Rock Logging, Classification and Presentation Manual. We advanced the borings using 8-inch diameter hollow stem auger. Sierra Geotech obtained disturbed soil samples at various intervals using 3-inch outside-diameter (O.D.) Modified California and 2-inch OD Standard Penetration Test split barrel drive samplers.

Modified California sampler (MCS) equipped with 2.4 inch I.D. brass liners. Standard Penetration Testing (SPTs) was performed by driving a 2-inch O.D. split-spoon sampler 18 inches in general accordance with ASTM D1586. Near continuous sampling was obtained starting from depths of 0.5 feet bgs to the terminal depth of borings. We sealed the MCS liners with plastic caps. We also obtained bulk soil samples from auger cuttings. We located borings with a handheld GPS and estimated elevations based on available topographic mapping. Boring locations are not surveyed.


A Sierra Geotech licensed civil engineer logged the borings and retrieved samples for laboratory testing. The soils encountered in the exploratory borings were classified in accordance with the 2010 Caltrans Soil and Rock Logging Manual. Upon completion of the field exploration program, the exploratory borings were backfilled with neat cement grout and capped with soil cuttings in conformance with the El Dorado County Environmental Health Boring Permit requirements.

In September 2019, Sierra Geotech performed another geotechnical investigation consisting of hand augers and test pits. Two (2) locations were explored during the September 2019 geotechnical investigation and extended to a maximum depth of 12 feet and 4 feet at Sta.571+50 and Sta.575+50, respectively.

In January 2020, Sierra Geotech performed another geotechnical investigation consisting of hollow-stem auger and rock coring at two (2) locations along the existing slope. These borings were advanced using a combination of hollow-stem augers and coring methods. Hollow-stem augers were about 8 inches in diameter and the core bit was approximately 3.8 inches in diameter (HQ). Rock sampling was performed using the HQ wire-line rock coring techniques.

5.1. SITE GEOLOGIC MAPPING

Sierra Geotech checked the mapped geologic conditions presented in the references during our fieldwork. We recorded previously placed fill, in-situ soil, and intensely to completely weathered (decomposed) metavolcanics rock fragments within the stockpile material.

5.2. GEOPHYSICAL STUDIES

Gasch Geophysical Services, Inc., under supervision of Sierra Geotech performed seismic refraction investigation at 2 locations in the proposed cut areas along the proposed on-ramp. Each line was 180 feet in length. A detailed report including the locations and interpreted seismic velocity profiles are included in Appendix B.

Both seismic refraction lines consisted of 17 active geophone stations placed at 10 foot intervals. Geophones used for data acquisition were single 28-Hz, digital grade units manufactured by OYO Geospace Corporation. Compressional wave energy (P-waves) were generated using multiple impacts of 16-pound sledge hammer striking a steel plate on the ground surface. Data collected during the investigation was acquired and processed using the computer program Rayfract® version 3.36.

5.3. INSTRUMENTATION

The exploration program did not include the installation of geotechnical instrumentation.

6. GEOTECHNICAL TESTING

Sierra Geotech completed the following laboratory tests on representative soil samples from exploratory borings:

- California Test Method 226 – Moisture Content
- California Test Method 212 – Unit Weight
7. GEOTECHNICAL CONDITIONS

7.1. SITE GEOLOGY

Based on our geologic reconnaissance and subsurface exploration, site geology is consistent with published geologic mapping and previous site exploration by Geocon.

7.2. NATURAL AND BUILT SLOPE STABILITY

Published mapping that we reviewed does not show landslide features within the project area. Natural slopes and highway cuts within the project area do not show signs of instability (e.g., significant rockfall or slope failure). We did not observe evidence of significant geologic hazards, including landsliding, settlement, very soft soils, severe erosion, springs, etc., within the site. We did not observe any areas of distress (such as slumps, distortion or severe erosion) along the slopes of the stockpile or underneath the Ray Lawyer Drive bridge abutments next to the stockpile.

7.3. SOIL CONDITIONS

We completed our exploration points in areas of the proposed on-ramp improvements and associated cut. Figure 6 shows the approximate location of the explorations performed for this project. Two (2) out of four (4) borings were performed in the existing stockpile area, which was created using the excavated material from the on-ramp construction on the northside of the US 50. These borings encountered random fill to the terminal depth of borings. The fill typically classified as loose to medium dense clayey gravel with sand and metavolcanics rock fragments in sandy silty soil matrix. The composition of the stockpile may vary significantly from the soils encountered at the exploration locations, including the possible presence of significantly oversized materials or debris. Total in-situ unit weight of the fill soils varied from 103 to 133 pounds per cubic feet (pcf) with moisture content varying from 8 to 27 percent. Blow counts (N<sub>60</sub>) values generally varied from 8 to 40 blows per foot with some blow counts in excess of 50 blows per six inches, which are generally considered as refusal. Rock boulders within the stockpile material may have caused inflated blow counts and/or refusal. Test pits encountered dense to very dense clayey gravel with sand, cobbles and large boulders. Appendix A contains the logs of borings.

7.4. ROCK

Two (2) out of the four (4) borings performed for this project were in the proposed cut areas and included rock coring. Below the residual soil in Borings A-20-101 and A-20-102, metavolcanic rock of the Logtown Ridge Formation or Mariposa Formation was encountered to the maximum depths

- California Test Method 204 – Plasticity Index
- California Test Method 202 – Gradation
- California Test Method 301 – R- Value
- California Test Method 643 – pH
- California Test Method 417 – Sulfates
- California Test Method 422 – Chlorides

Results of unit weight and moisture content testing are presented on the boring logs and all other lab test results are presented in Appendix A.
explored. The rock formations encountered in our investigation generally consisted of slightly to intensely weathered, weak metavolcanic rock. Rock bedding in the borings is predominantly northwest/northeast and fractures with a dip angle of 60°-80° were also noted. Rock is very randomly fractured with very short, stepped, blocky fractures. Due to the highly weathered nature of the rock, it is considered as weak and is not suitable material for very steep slopes such as 1H:1V and 1.2H:1V.

Seismic refraction studies shows that the recorded seismic velocities range from 1,500 to 5,000 feet per second (fps) in the upper 50 feet of the subsurface as measured from the top of the hill. The highest seismic velocities were measured at the maximum depth of exploration on both lines. Low velocity material was encountered near the surface on both lines, which suggests highly weathered/fractured rock and soil or fill. The moderate velocity range of 3,000 to 5,000 fps, suggests soil/fill to weathered/fractured rock.

7.5. GROUNDWATER CONDITIONS

Groundwater was not encountered in the borings and test pits performed for this project. However, perched water was encountered at variable depths in both explorations performed within the stockpile.

7.6. SURFACE WATER

At the time of our field work we have not observed flowing water in the project vicinity. In general, surface water drainage along the highway and roadways is directed along existing ditches.

7.7. SCOUR

No active year-round water courses exist within the project limits; therefore, scour is not expected to affect the proposed improvements.

7.8. EROSION

Soil erosion is typically associated with high-intensity precipitation, steep slopes, and nature of surficial soil. Based on the site topographic features, climate data, and the surficial materials encountered during our investigation, the proposed project may be impacted by soil erosion. All slope areas should be protected by suitable erosion control measures.

7.9. GROUND MOTIONS

Regional faults that may cause ground motions at the site are discussed in Section 4. It is our opinion that the site could be subject to ground shaking in the event of an earthquake along faults in Northern California. However, we do not consider the site to possess any greater risk than that of the surrounding developments. The maximum earthquake event along the controlling faults may generate a horizontal peak ground acceleration of approximately 0.22g at the project site.

7.10. GROUND RUPTURE

Our review of published geologic mapping did not reveal the presence of Late Quaternary (last 700,000 years) or younger faults within or immediately adjacent to the project site. Therefore, the potential for ground rupture at the site is low.
8. GEOTECHNICAL ANALYSIS AND DESIGN

8.1. LIQUEFACTION

Liquefaction occurs when the pore pressures generated within a soil mass approach the effective overburden pressure. Liquefaction of soils may be caused by cyclic loading such as that imposed by ground shaking during earthquakes. The increase in pore pressure results in a loss of strength, and the soil then can undergo both horizontal and vertical movements, depending on the site conditions. Other phenomena associated with soil liquefaction include sand boils, ground oscillation, and loss of foundation bearing capacity. Liquefaction is generally known to occur in loose, saturated, relatively clean, fine-grained cohesionless soils at depths shallower than approximately 50 feet. Factors to consider in the evaluation of soil liquefaction potential include groundwater conditions, soil type, grain size distribution, relative density, degree of saturation, and both the intensity and duration of ground motion.

The site is not located within a state-designated Zone of Required Investigation for Liquefaction. Because of the presence of relatively dense, very dense soils/rock identified at the site along with the lack of a permanent groundwater in the upper 50 feet of the site soils, it is our opinion that the potential for earthquake-induced liquefaction at the site is low.

8.2. CUTS AND EXCAVATIONS

8.2.1 Stockpile cuts

Based on the preliminary project cross sections provided by R.E.Y. Engineers. Inc., a maximum cut of up to 40 feet deep will be required in the stockpile for the construction of proposed on-ramp. There are no retaining walls proposed in this area.

Slope stability of the proposed cut into existing stockpile was evaluated using a limit equilibrium method based on Spencer’s procedure of slices as coded in the program SLOPE/W (2012). Design groundwater was anticipated to be below the excavation depth and will not influence the slope stability.

Slope stability was analyzed for both static and pseudo-static conditions. Drained strength of the fill soils was used in the analyses for the static conditions. To compute the factor of safety of the slope during earthquake loading, we applied a pseudo-static seismic coefficient of 0.073g to the center of the slice for the slip surface having the minimum computed static factor of safety. This pseudo static seismic coefficient is equal to approximately one-third of the estimated peak horizontal ground acceleration of 0.22g.

Per the Caltrans Geotechnical Manual, Soil Cut Slopes Module, 2020, Factor of Safety, the minimum required factor of safety should generally conform to the AASHTO LRFD Section 11.6.2.3, “where the geotechnical parameters are well defined, and the slope does not support or contain a structural element, \( \Phi = 0.75 \) (equivalent to a Factor of Safety of 1.3 ). The results of our analyses are summarized in the Table 2.
Table 2. Results of Slope Stability Calculations with 2H:1V ‘Cut’ Slope in Stockpile

<table>
<thead>
<tr>
<th>Loading Conditions</th>
<th>Sta. # 565+00</th>
<th>Sta. # 566+00</th>
<th>Sta. # 567+00</th>
<th>Minimum Required Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static</td>
<td>1.3</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Pseudo Static</td>
<td>1.1</td>
<td>1.0</td>
<td>1.1</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Based on our analyses, the computed minimum (critical) factor of safety for the static conditions ranges from 1.2 to 1.3. The computed minimum (critical) factor of safety for the pseudo-static conditions ranges from 1.0 to 1.1. It should be noted that a minimum slip surface depth of 5 feet was used in the analyses. Based on a review of the analyses results presented above, it is our opinion that the proposed 2H:1V ‘Cut’ slopes are marginally stable in the existing stockpile soils except at Sta 566+00 where the slopes do not have the required factor of safety. Results of the slope stability analyses with 2H:1V cut slopes are presented as Figures C-1 through C-6 in Appendix C.

Sierra Geotech performed the slope stability analyses with a 2.5H:1V cut slope and the results of our analyses are summarized in the Table 3.

Table 3. Results of Slope Stability Calculations with 2.5H:1V Slope in Stockpile

<table>
<thead>
<tr>
<th>Loading Conditions</th>
<th>Sta. # 565+00</th>
<th>Sta. # 566+00</th>
<th>Sta. # 567+00</th>
<th>Minimum Required Factor of Safety</th>
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<td>Pseudo Static</td>
<td>1.3</td>
<td>1.3</td>
<td>1.2</td>
<td>1.05</td>
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Based upon the results of the slope stability analyses, all of the analyzed sections provide the minimum factors of safety with a 2.5H:1V slope.

8.2.2 Stockpile Fill

Construction of the on-ramp will also require fill slopes along the stockpile (left hand side of the ramp in driving direction). The fill slopes will be constructed using the material derived from the cuts in the stockpile or other rock cuts planned as part of the project. Fill slopes constructed using on-site material and in accordance with Section 19 of the Standard Specifications will be stable at 2H:1V slopes (or flatter). The on-site fill material will be ‘rocky’ and special provisions for rocky fill compaction are presented in Section 11 of this report.

8.2.3 US 50 Embankment Fill

Construction of the on-ramp will also require expanding the existing US 50 embankment by filling the existing valley between the hills. The fill slopes will be constructed using the material derived from the cuts in the stockpile or other rock cuts planned as part of the project. Fill slopes constructed using
on-site material and in accordance with Section 19 of the Standard Specifications will be stable at 2H:1V slopes (or flatter). The on-site fill material will be ‘rocky’ and special provisions for rocky fill compaction are presented in Section 11 of this report.

8.2.3  Rock Cut Underneath Ray Lawyer Drive

Based upon the existing information contained on the LOTB for the Ray Lawyer Drive OC, the bedrock consists of highly weathered metasedimentary and metavolcanics rocks which increase in competency with depth. For this project, these materials were treated as soil following the Caltrans Geotechnical Manual, Rock Cut Slopes Module (2013) which states, “the stability of highly weathered to decomposed rock slopes is often not controlled by discontinuities, but rather by a Mohr-Coulomb failure mode (circular) more typical of soil slopes. Underneath Ray Lawyer Drive, where the rock cut height will be relatively less, a cut-slope of 1.5H:1V is recommended in order to avoid the existing bridge abutments.

8.2.4  Rock Cut along US 50 (Easternmost Area of the Project)

Based upon the information obtained in the two borings performed in this cut, the materials in this area are residual soils transitioning into highly weathered metasedimentary rock which increases in competency with depth and for this project, the materials were treated as soil following the Caltrans Geotechnical Manual, Rock Cut Slopes Module (2013). Based on the results of the geotechnical exploration, we expect that the proposed cut-slopes will be stable at a gradient of 2H:1V (or flatter).

9. PAVEMENT

Based on laboratory testing, Resistance Values (R-Values) of 16 and 24 were obtained from representative samples of stockpile material. Presented below are pavement design recommendations based on design R-value of 20 for subgrade constructed with material currently stockpiled at the site. Table below summarizes our recommended pavement structural sections using HMA and Class 2 AB based on Traffic Indices (TI) of 6, 7, 8, 10, and 12. The pavement sections were developed in accordance with Chapter 630 of the Caltrans Highway Design Manual (HDM) and a 20-year design life. Pavement structural sections provided below correspond to the subgrade soils encountered in the improvement location and/or anticipated soils to be used for fill below the proposed improvement.

Table 4. Pavement Structural Sections.

<table>
<thead>
<tr>
<th>Traffic Index</th>
<th>Design R-Value = 20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HMA¹ (ft)</td>
</tr>
<tr>
<td>6.0</td>
<td>0.30</td>
</tr>
<tr>
<td>7.0</td>
<td>0.35</td>
</tr>
<tr>
<td>8.0</td>
<td>0.40</td>
</tr>
<tr>
<td>10.0</td>
<td>0.55</td>
</tr>
<tr>
<td>12.0</td>
<td>0.65</td>
</tr>
</tbody>
</table>
1. HMA = Hot-mix Asphalt, 2. AB = Aggregate Base (Class 2)

Use of Rubberized Hot Mix Asphalt (RHMA, a non-structural wearing course) can be implemented in this project by subtracting 0.1 feet of HMA in the above table and adding 0.2 feet of RHMA as the surficial layer of asphalt. This RHMA section consists of 0.1 feet as the sacrificial layer and 0.1 feet as the top of the surface layer (which reduces the HMA layer by 0.1 feet).

The recommended alternative pavement sections are based on the following assumptions:

1. Wherever new structure pavement is to be placed, either in new area or where the existing pavement is to be reconstructed, compaction of the subgrade should conform to the requirements described in Section 19-5.03 of the latest Caltrans Standard Specifications.

2. For the upper 2 ½ feet (30 inches) below the finished grade for the width of the travel way including 3 feet on each side, or 12 inches below subgrade, whichever is deeper, the subgrade soils should be ripped and/or overexcavated, moisture conditioned as required, and compacted to 95 percent of maximum dry density as determined by CTM 216.

3. Class 2 AB has a minimum R-Value of 78 and meets the requirements of Section 26 of latest Caltrans Standard Specifications.

4. Class 2 AB is compacted to 95% or higher relative compaction at or near optimum moisture content. Prior to placing HMA, the AB should be proof rolled with a loaded water truck to verify stability.

10. MATERIAL SOURCES

Construction materials and engineered fill for the project can be obtained from either on-site borrow sources, or public and/or private sources. Private sources of construction materials (including sand, gravel, aggregate base, and hot mix asphalt) were not specifically investigated, but several suppliers of these materials are in the general vicinity of the project site were researched. Table 5 below provides aggregate and Portland Cement concrete suppliers which are within an hour drive of the project site.

Any import borrow for use on the project should be granular, non-expansive (EI<20), non-plastic (PI<12), Sand Equivalent of 20 or greater, R-value greater than 20, and free from organic materials. All proposed import borrow materials to be used as engineered fill should be tested and approved by Sierra Geotech prior to being implemented on the project.

Properly crushed and processed asphalt concrete and any Portland Cement Concrete may be used as construction materials for this project. As long as the recycled materials meets the minimum grading requirements and quality requirements of the State of California Department of Transportation Standard Specifications, recycled materials can be re-used as Class 2 or Class 3 aggregate base throughout the project. This recycled asphalt concrete will have a swell factor of approximately 1.1 with respect to the in-place volume when recycled into Class 2 or Class 3 aggregate base. Recycled asphalt concrete can be blended with base rock and additional Class 2 aggregate base materials to meet the gradation and Sand Equivalent requirements, if required.
Table 5. Material Source Contact Information

<table>
<thead>
<tr>
<th>Owner</th>
<th>Location/Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sand and Gravel/Aggregate Base</strong></td>
<td></td>
</tr>
<tr>
<td>Vulcan Materials Company</td>
<td>Sacramento/ (916) 682-0850</td>
</tr>
<tr>
<td>Teichert Aggregates</td>
<td>Sacramento/ (916) 386-6896</td>
</tr>
<tr>
<td>Granite Construction - Bradshaw Facility</td>
<td>Sacramento/ (888) 256-4568</td>
</tr>
<tr>
<td><strong>Portland Cement Concrete</strong></td>
<td></td>
</tr>
<tr>
<td>Vulcan Materials Company</td>
<td>Sacramento/ (916) 682-0850</td>
</tr>
<tr>
<td>Teichert Aggregates</td>
<td>Sacramento/ (916) 386-6896</td>
</tr>
<tr>
<td>Granite Construction - Bradshaw Facility</td>
<td>Sacramento/ (888) 256-4568</td>
</tr>
</tbody>
</table>

11. MATERIAL DISPOSAL

Cuts and fills are anticipated along the project alignment. If required, information regarding disposal of potentially unsuitable and/or surplus materials should be provided by the Resident Engineer and District Materials Engineer outside of Right of Way.

12. CONSTRUCTION CONSIDERATIONS

12.1. CONSTRUCTION ADVISORIES

Proposed improvements are located along Ray Lawyer Drive, East Forni Road, US 50 and El Dorado Trail access. Traffic control with lane and shoulder closures are anticipated during construction. Underground utilities should also be expected, and Contractor should plan construction activities accordingly.

12.2. CONSTRUCTION CONSIDERATIONS THAT INFLUENCE SPECIFICATIONS

All grading should be performed in conformance with Section 19 of Caltrans’ Standard Specifications or equivalent.

12.3. CONSTRUCTION MONITORING AND INSTRUMENTATION

All earthwork activities should be observed by a suitably qualified soils technician working under direct supervision of the Geotechnical Engineer of Record. Quality control, quality assurance and field observations of various earthwork elements will be required during construction. We do not expect geotechnical instrumentation will be necessary for this project. Appropriate field tests should be conducted to provide quality control, quality assurance for structural fills and related earthwork elements.
12.4. HAZARDOUS WASTE CONSIDERATIONS

This geotechnical study did not include the determination of the existence of possible hazardous materials. If any hazardous materials are identified during construction, regulatory officials should be notified immediately.

12.5. DIFFERING SITE CONDITIONS

The subsurface conditions we have described in this report depict conditions encountered only at locations explored. Subsurface conditions between and/or beyond the explored locations can vary. Upon recognition of any subsurface conditions that differ from those described in this report, the Geotechnical Engineer of Record must be notified immediately for obtaining additional recommendations.

12.6. GROUNDWATER

Groundwater encountered during grading activities would likely be locally perched and, during dry season construction, controllable with sump pumps or similar dewatering methods.

12.7. NATURALLY OCCURRING ASBESTOS

While rock containing naturally occurring asbestos (NOA) was not observed during our site exploration, rock containing NOA could occur within the project. Considering that there is a potential for encountering NOA, we recommend preparation of an Asbestos Hazard Mitigation Plan in compliance with provisions of El Dorado County Air Quality Management District (EDAQMD) Rule 223-2 and California Air Resources Board requirements, as applicable. In addition, we also recommend periodic visual monitoring of rock exposed during construction for the potential presence of NOA. If construction activities expose NOA, comply with the applicable provisions of EDAQMD Rule 223-2 and the State of California Asbestos Airborne Toxic Control Measure (ACTM), CCR Title 17, Section 93105, and perform earthwork in areas containing NOA in accordance with Section 19 of the Standard Specifications and Section 19-910 of the 2006 Standard Special Provisions. In addition, prepare a worker health and safety program for excavations in areas with NOA in accordance with all regulatory requirements, including CAL OSHA.

12.8. PERCHED GROUNDWATER AND OVER-OPTIMUM SOIL MOISTURE

Perched groundwater may be encountered during and shortly following the rainy season within shallow soils. If perched groundwater or surface water is encountered, sump pumps may be required to facilitate construction. Excessively wet (over-optimum) soil conditions can make proper compaction difficult or impossible. Wet soil is commonly encountered during the winter and spring months, or in excavations where groundwater or perched groundwater is encountered.

12.9. PREPARATION OF EXISTING FILL LOCATIONS

Clear and grub existing fill surfaces and bench into the fill slopes in accordance with the Caltrans 2018 Standard Specifications. The geotechnical engineer of record must approve fill surfaces prior to placement of embankment fill. Where existing slopes are steeper than 5H:1V, new embankment fill should be benched into the existing slope in accordance with the earthwork specifications.
12.10. Rippability

Bedrock within the exploration depths East of Ray Lawyer Drive overcrossing consists of highly weathered metavolcanic rock. Based on our review of cuts, results of our seismic refraction investigations, and CAT Performance Handbook for a D8R/D8T dozer or equivalent, rippability should not be problematic to the planned depths. Excavation progress may be slower if zones of higher velocity material are encountered at isolated locations.

12.11. Special Provision for Rocky Fill Compaction

Material generated from the stockpile and other cuts along the proposed ramp will be “rocky” material. Embankment fill construction with “rocky” fill material shall be in accordance with Section 19-6.03C Placing and Compacting of Caltrans Standard Specifications (latest version). Moisture condition the fill uniformly to at least 2 percent over the optimum moisture content (visual manual method) prior to compaction. For 90 percent relative compaction, compact each lift of rocky fill with a minimum of five passes of a Caterpillar (CAT) 825 padded drum compactor making overlapping passes until coverage is complete. For 95 percent relative compaction, compact each lift of rocky fill with a minimum of seven passes of a CAT 825 compactor making overlapping passes until coverage is complete. Based on actual equipment used and observed compaction results, the compaction criteria may be modified the geotechnical engineer of record.

13. Recommendations and Specifications

13.1. The stability of cut slopes is generally governed by the composition and competency of the excavated soils/weathered rock materials. We recommend that all cut slopes be observed by our geotechnical engineer or geologist during grading to determine if adversely oriented bedding planes or other features that may impact the stability exist. To mitigate potential erosion, slopes should be vegetated as soon as possible, and surface drainage should be directed away from the tops of slopes. Placing V-ditches across tops of slopes will aid in reducing the potential for surficial erosion. These V-ditches should be sloped to provide positive drainage and not allow collected water to pond.

13.2. Based on the results of the geotechnical investigation, the following cut and fill slopes are recommended for the project.

*Table 6. Permanent Cut/Fill Slope Recommendations*

<table>
<thead>
<tr>
<th>Scenario #</th>
<th>Description</th>
<th>Recommended Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Existing Stockpile Cut</td>
<td>2.5H:1V or Flatter</td>
</tr>
<tr>
<td>2</td>
<td>Existing Stockpile Fill</td>
<td>2H:1V or Flatter</td>
</tr>
<tr>
<td>3</td>
<td>Rock Cut Underneath Ray Lawyer Drive</td>
<td>1.5H:1V*</td>
</tr>
<tr>
<td>4</td>
<td>US 50 Fill</td>
<td>2H:1V or Flatter</td>
</tr>
<tr>
<td>5</td>
<td>US 50 Cut</td>
<td>2H:1V or Flatter</td>
</tr>
</tbody>
</table>
Cuts adjacent to existing stockpile will expose the existing fill, which will control overall slope stability. Bedrock was not encountered in any of the explorations performed in stockpile area and will generally not control slope stability, except for the cut underneath Ray Lawyer Drive bridge where bedrock will be encountered. Sierra Geotech did not identify any stockpile As-build or construction records as to the type and placement of the existing stockpile materials. During grading, the existing slope will be evaluated and any areas which appear less competent or in a loose condition will be remediated on a case by case basis. Remediation measures may consist of overcutting the slope and rebuilding it to flattening the slope in the area of less competent material.

13.3. Cut slopes must be reviewed by the geotechnical engineer upon completion to evaluate exposed soil and rock for conditions that may influence slope instability. Crown ditches and slope rounding at the top of cuts is recommended to reduce slope erosion.

13.4. For temporary slopes, OSHA requirements must be followed by the Contractor. A competent person must classify each soil deposit as Type A, Type B, or Type C. We expect stockpiled soils to be classified as Type C, which require a maximum allowable slope of 1.5H:1V for excavations less than 20 feet deep. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

13.5. Based on the subsurface conditions we observed and tested, and our experience with similar conditions, we expect typical, heavy-duty excavation equipment to be adequate for excavating existing fill, native soil and weathered rock, to planned grades. We do anticipate that large intact pieces of rock can be encountered in both the native material and stockpile. In order to remove may require the use of a large (11,000 foot-pound) hydraulic ram in order to remove and break up these larger rock pieces.

13.6. In general, the moisture content of the stockpiled material we have encountered in our borings ranged from 8 to 27 percent at the time of our exploration. We expect the soil to be both dry of optimum and wet of optimum depending on location and depth.

13.7. Excavated stockpile material may be re-used as engineered fill provided it is free of organics, debris and other unsuitable materials. Unsuitable materials include surface strippings, broken concrete, and other non-native material encountered during general grading. Based on laboratory test results and our engineering judgement and experience, we anticipate that stockpiled fill soils will experience approximately 10 to 20% volume shrinkage when re-compacted as engineered fill (oversized 'rocky' material is not included in this calculation). Actual volume changes can vary from our estimate due to variations in soil density, moisture content, and the degree of compaction achieved during grading.

13.8. Based on review of subsurface information obtained from the project borings, the majority of material generated from the proposed cut along US-50 (east of Ray Lawyer Drive) will break down to dimension of less than 8 inches and be suitable to use in project fills. However, oversized material (greater than 8 inches in diameter) will also be generated and should not be included in grading factors. Hard rock that will not readily break down may be encountered in isolated areas. For usable fill material, we estimate an overall earthwork factor (calculated as in-place volume/recompacted volume) ranging from 0.95 to 1.15 for materials placed at 90% to 95% relative compaction (per CTM 216). For material balance purposes, a factor of
1.0 is recommended. However, actual site conditions and placement methods will heavily influence grading factors.

13.9. All ramp embankments should be constructed in accordance with Caltrans “2018 Standard Specifications” (including Section 19, “Earthwork”). Where new fill is to be placed onto existing fill slopes or on natural slopes steeper 5H:1V, fully bond into the existing slope using horizontal benches cut into the slope and below any loose/soft or otherwise unsuitable materials. Bond benches shall be provided which are at least 10 feet in width and at least 2 feet in key depth. The area beyond the toe of fill shall be sloped for sheet overflow or a paved drain shall be constructed thereon. The Geotechnical Engineer or his assigned designee shall inspect and approve the cut as being suitable for the on-ramp and placement of fill material before any fill material is placed on the excavation.

13.10. It is the contractor’s responsibility to assess the actual conditions in the field at the time of construction and to make their own interpretation of the Cal/OSHA soil/rock type for design of the excavation and trench slopes or the need for excavation shoring.

13.11. Soil erosion is typically associated with high-intensity precipitation, steep slopes, and nature of surficial soil. Based on the site topographic features, climate data, and the surficial materials encountered during our investigation, the proposed project may be impacted by soil erosion. All slope areas should be protected by suitable erosion control measures. Embankment slopes and areas disrupted by grading are susceptible to erosion from surface runoff. Runoff should be controlled with curbs, dikes, crown-ditches, down-drains, etc. Finished slopes must be vegetated to reduce erosion potential.

13.12. Corrosion tests were performed on the samples collected for this project. Based on these test results and results from 2016 geotechnical investigation (by others), the site would not be considered corrosive according to Caltrans Corrosion Guidelines. Sierra Geotech does not practice in the field of corrosion engineering. For corrosion sensitive improvements (if any), we recommend further evaluation by a suitably qualified corrosion engineer. While native soils are unlikely to be corrosive to buried culverts, such may not be the case with imported soils or native soils intermixed with imported soils.

14. CLOSURE

Sierra Geotech should review the grading plans prior to final design submittal to determine if additional analysis and/or recommendations are required. The opinions, conclusions and recommendations presented in this report have been formulated in accordance with accepted geotechnical engineering practices that exist in Northern California at the time this report was prepared. No warranty expressed or implied is made or should be inferred. The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. No analysis or investigations were performed to determine the stability of the existing US 50 embankment, which is considered out of our scope of services. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Sierra Geotech should be notified so that supplemental recommendations can be provided. The findings of this report are valid as of the date of this report. However, changes in the conditions of the project can occur with the
passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside Sierra Geotech’s control. Therefore, this report is subject to review and should not be relied upon after a period of five years.
15. REFERENCES


i. United States Department of Agriculture (USDA), 2015. Soil Survey Area: El Dorado County, California, USDA-Natural Resources Conservation Service,

WPI PHASE 2.2 EAST BOUND ON-RAMP
CONCEPTUAL DESIGN EXHIBIT
FEBRUARY 4, 2020

FIGURE 2
WPI PHASE 2.2 EAST BOUND ON-RAMP
2:1 SLOPE AT FILL WALL LOCATION
DECEMBER 12, 2019

FILL VOLUME: 3,800 CY

WPI PHASE 2.2 EAST BOUND ON-RAMP
2:1 SLOPE AT FILL WALL LOCATION
DECEMBER 12, 2019

FIGURE 3C

SCALE 1"=40'
WESTERN PLACERVILLE INTERCHANGES
PROJECT PHASE 2.2
EA 03-37282
CROSS-SECTION 568+50
RAY LAWYER DRIVE OVERPASS

EXISTING GROUND
EXISTING MEDIAN
PROPOSED GROUND
1:1
20:1
1.5:1

OVERPASS 1887.2±
SOFFIT 1882.6±
EXISTING GROUND AT ABUTMENT 1880.5±
BOTTOM OF FOOTING 1875.0±

EXISTING MEDIAN

SOURCE OF INFORMATION:
ABUTMENT DETAILS OBTAINED FROM CALTRANS
AS-BUILTS FOR RAY LAWYER DRIVE OVERCROSSING
DATED 2-24-1998.
REGIONAL GEOLOGIC MAP

PROJECT LOCATION

Source: Lawrence L. Busch, 2001, Generalized Geologic Map of El Dorado, California, 1:100,000, Division of Mines and Geology, OFR 2000-03

Copper Hill Volcanics
Mariposa Formation
Mariposa Formation, Bower Creek
Gopher Ridge Volcanics
Logtown Ridge Formation
Tuttle Lake Formation

WESTERN PLACERVILLE INTERCHANGE
Placerville, California

Job No. RL2019103
Figure 4
May 2019
APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING
GROUP SYMBOLS AND NAMES

Graphic / Symbol | Group Names | Graphic / Symbol | Group Names
--- | --- | --- | ---
GW | Well-graded GRAVEL | CL | Lean CLAY
GW | Well-graded GRAVEL with SAND | Lean CLAY with SAND
GW | Poorly graded GRAVEL | SANDY lean CLAY
SW-GM | Well-graded GRAVEL with SILT | SANDY lean CLAY with GRAVEL
SW-GM | Well-graded GRAVEL with SILT and SAND | GRAVELLY lean CLAY with SAND
GW-GC | Well-graded GRAVEL with CLAY (or SILTY CLAY) | SILTY CLAY
GW-GC | Well-graded GRAVEL with clay and SAND (or SILTY CLAY and SAND) | SILTY CLAY with SAND
GP-GM | Poorly graded GRAVEL with SILT | SILTY CLAY with GRAVEL
GP-GM | Poorly graded GRAVEL with SILT and SAND | SANDY SILTY CLAY
GP-GC | Poorly graded GRAVEL with CLAY (or SILTY CLAY) | SANDY SILTY CLAY with GRAVEL
GP-GC | Poorly graded GRAVEL with clay and SAND (or SILTY CLAY and SAND) | GRAVELLY SILTY CLAY WITH SAND
GM | SILTY GRAVEL | Silt with SAND
GM | SILTY GRAVEL with SAND | Silt with GRAVEL
GM | CLAYEY GRAVEL | SANDY SILT
GM | CLAYEY GRAVEL with SAND | GRAVELLY SILT WITH SAND
GC-GM | SILTY, CLAYEY GRAVEL | ORGANIC lean CLAY
GC-GM | SILTY, CLAYEY GRAVEL with SAND | ORGANIC lean CLAY with SAND
GC-GM | SILTY, CLAYEY GRAVEL with SAND | ORGANIC lean CLAY with GRAVEL
SW | Well-graded SAND | SANDY ORGANIC lean CLAY
SW | Well-graded SAND with GRAVEL | GRAVELLY ORGANIC lean CLAY WITH SAND
SP | Poorly graded SAND | Silt with SAND
SP | Poorly graded SAND with GRAVEL | Silt with GRAVEL
SW-SM | Well-graded SAND with SILT | SANDY SLT
SW-SM | Well-graded SAND with SILT and GRAVEL | GRAVELLY SLT WITH SAND
SW-SC | Well-graded SAND with CLAY (or SILTY CLAY) | GRAVELLY SLT WITH SAND
SW-SC | Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) | GRAVELLY SLT WITH SAND
SP-SM | Poorly graded SAND with SILT | SANDY SLT
SP-SM | Poorly graded SAND with SILT and GRAVEL | GRAVELLY SLT WITH SAND
SM | SILTY SAND | SANDY ORGANIC fat CLAY
SM | SILTY SAND with GRAVEL | SANDY ORGANIC fat CLAY with GRAVEL
SC | CLAYEY SAND | GRAVELLY ORGANIC fat CLAY
SC | CLAYEY SAND with GRAVEL | GRAVELLY ORGANIC fat CLAY WITH SAND
SC-SM | SILTY, CLAYEY SAND | ORGANIC fat CLAY
SC-SM | SILTY, CLAYEY SAND with GRAVEL | ORGANIC fat CLAY WITH GRAVEL
PT | PEAT | GRAVELLY ORGANIC fat CLAY
PT | Modified California Sampler
PT | Other (see remarks)

WATER LEVEL SYMBOLS

* First Water Level Reading (during drilling)
* Static Water Level Reading (short-term)
* Static Water Level Reading (long-term)

FIELD AND LABORATORY TESTS

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Consolidation (ASTM D 2435-04)</td>
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<tr>
<td>CL</td>
<td>Collapse Potential (ASTM D 5333-03)</td>
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<tr>
<td>CP</td>
<td>Compaction Curve (CTM 216 - 06)</td>
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<tr>
<td>CR</td>
<td>Corrosion, Sulfates, Chlorides (CTM 643 - 99; CMT 417 - 06; CMT 422 - 06)</td>
</tr>
<tr>
<td>CU</td>
<td>Consolidated Undrained Triaxial (ASTM D 4767-02)</td>
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<td>DS</td>
<td>Direct Shear (ASTM D 3080-04)</td>
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<td>EI</td>
<td>Expansion Index (ASTM D 4829-03)</td>
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<td>Moisture Content (ASTM D 2216-05)</td>
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<td>OC</td>
<td>Organic Content (ASTM D 2974-07)</td>
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<td>P</td>
<td>Permeability (CTM 220 - 05)</td>
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<td>PA</td>
<td>Particle Size Analysis (ASTM D 422-63 [2002])</td>
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<td>PI</td>
<td>Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)</td>
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<td>PL</td>
<td>Point Load Index (ASTM D 5731-05)</td>
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<td>Specific Gravity (AASHTO T 100-06)</td>
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<td>Torvane Temperature</td>
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<td>Unconfined Compression - Rock (ASTM D 2938-95)</td>
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<td>UU</td>
<td>Unconsolidated Undrained Triaxial (ASTM D 2850-03)</td>
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<tr>
<td>UW</td>
<td>Unit Weight (ASTM D 4677-04)</td>
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<tr>
<td>VS</td>
<td>Vane Shear (AASHTO T 223-96 [2004])</td>
</tr>
</tbody>
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SAMPLER GRAPHIC SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>2.0&quot; O.D. Standard Penetration Test (SPT)</td>
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<tr>
<td>Modified California Sampler</td>
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<tr>
<td>3.0&quot; O.D. Modified California Sampler</td>
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<td>Shelby Tube</td>
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<tr>
<td>Piston Sampler</td>
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<td>NX Rock Core</td>
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<tr>
<td>Bulk Sample</td>
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<tr>
<td>Other (see remarks)</td>
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</table>

SIERRA GEOTECH
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Rocklin, CA 95677
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Email: info@sierrageotech.com

REPORT TITLE
BORING RECORD LEGEND
DIST. 03 ED 50 POSTMILE EA 03-CIP#41918
PROJECT OR BRIDGE NAME
Western Placerville Interchanges - Phases 2.2
BRIDGE NUMBER N/A PREPARED BY DATE SHEET 1 of 2

DRILLING METHOD SYMBOLS

Auger Drilling   Rotary Drilling   Dynamic Cone or Hand Driven   Diamond Core

GROUP SYMBOLS AND NAMES

Graphic / Symbol | Group Names | Graphic / Symbol | Group Names
--- | --- | --- | ---
GW | Well-graded GRAVEL | CL | Lean CLAY
GW | Well-graded GRAVEL with SAND | Lean CLAY with SAND
GW | Poorly graded GRAVEL | SANDY lean CLAY
SW-GM | Well-graded GRAVEL with SILT | SANDY lean CLAY with GRAVEL
SW-GM | Well-graded GRAVEL with SILT and SAND | GRAVELLY lean CLAY with SAND
GW-GC | Well-graded GRAVEL with CLAY (or SILTY CLAY) | SILTY CLAY
GW-GC | Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND) | SILTY CLAY with SAND
GP-GM | Poorly graded GRAVEL with SILT | SILTY CLAY with GRAVEL
GP-GM | Poorly graded GRAVEL with SILT and SAND | SANDY SILTY CLAY
GP-GC | Poorly graded GRAVEL with CLAY (or SILTY CLAY) | SANDY SILTY CLAY with GRAVEL
GP-GC | Poorly graded GRAVEL with clay and SAND (or SILTY CLAY and SAND) | GRAVELLY SILTY CLAY WITH SAND
GM | SILTY GRAVEL | Silt with SAND
GM | SILTY GRAVEL with SAND | Silt with GRAVEL
GM | CLAYEY GRAVEL | SANDY SLT
GM | CLAYEY GRAVEL with SAND | GRAVELLY SLT WITH SAND
GC-GM | SILTY, CLAYEY GRAVEL | ORGANIC lean CLAY
GC-GM | SILTY, CLAYEY GRAVEL with SAND | ORGANIC lean CLAY with SAND
GC-GM | SILTY, CLAYEY GRAVEL with SAND | ORGANIC lean CLAY with GRAVEL
SW | Well-graded SAND | SANDY ORGANIC lean CLAY
SW | Well-graded SAND with GRAVEL | GRAVELLY ORGANIC lean CLAY WITH SAND
SP | Poorly graded SAND | Silt with SAND
SP | Poorly graded SAND with GRAVEL | Silt with GRAVEL
SW-SM | Well-graded SAND with SILT | SANDY SLT
SW-SM | Well-graded SAND with SILT and GRAVEL | GRAVELLY SLT WITH SAND
SW-SC | Well-graded SAND with CLAY (or SILTY CLAY) | GRAVELLY SLT WITH SAND
SW-SC | Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) | GRAVELLY SLT WITH SAND
SP-SM | Poorly graded SAND with SILT | SANDY SLT
SP-SM | Poorly graded SAND with SILT and GRAVEL | GRAVELLY SLT WITH SAND
SM | SILTY SAND | SANDY ORGANIC fat CLAY
SM | SILTY SAND with GRAVEL | SANDY ORGANIC fat CLAY WITH GRAVEL
SC | CLAYEY SAND | GRAVELLY ORGANIC fat CLAY
SC | CLAYEY SAND with GRAVEL | GRAVELLY ORGANIC fat CLAY WITH SAND
SC-SM | SILTY, CLAYEY SAND | ORGANIC fat CLAY
SC-SM | SILTY, CLAYEY SAND with GRAVEL | ORGANIC fat CLAY WITH GRAVEL
PT | PEAT | GRAVELLY ORGANIC fat CLAY
PT | Modified California Sampler
PT | Other (see remarks)

WATER LEVEL SYMBOLS

* First Water Level Reading (during drilling)
* Static Water Level Reading (short-term)
* Static Water Level Reading (long-term)
**CONSISTENCY OF COHESIVE SOILS**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Unconfined Compressive Strength (tsf)</th>
<th>Pocket Penetrometer (tsf)</th>
<th>Torvane (tsf)</th>
<th>Field Approximation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>&lt; 0.25</td>
<td>&lt; 0.25</td>
<td>&lt; 0.12</td>
<td>Easily penetrated several inches by fist</td>
</tr>
<tr>
<td>Soft</td>
<td>0.25 - 0.50</td>
<td>0.25 - 0.50</td>
<td>0.12 - 0.25</td>
<td>Easily penetrated several inches by thumb</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>0.50 - 1.0</td>
<td>0.50 - 1.0</td>
<td>0.25 - 0.50</td>
<td>Can be penetrated several inches by thumb</td>
</tr>
<tr>
<td>Stiff</td>
<td>1.0 - 2.0</td>
<td>1.0 - 2.0</td>
<td>0.50 - 1.0</td>
<td>Readily indented by thumb but penetrated only with great effort</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>2.0 - 4.0</td>
<td>2.0 - 4.0</td>
<td>1.0 - 2.0</td>
<td>Readily indented by thumbnail</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 2.0</td>
<td>Indented by thumbnail with difficulty</td>
</tr>
</tbody>
</table>

**APPARENT DENSITY OF COHESIONLESS SOILS**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>SPT N60 - Value (blows / foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Loose</td>
<td>5 - 10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>11 - 30</td>
</tr>
<tr>
<td>Dense</td>
<td>31 - 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>

**MOISTURE**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Absence of moisture, dusty, dry to the touch</td>
</tr>
<tr>
<td>Moist</td>
<td>Damp but no visible water</td>
</tr>
<tr>
<td>Wet</td>
<td>Visible free water, usually soil is below water table</td>
</tr>
</tbody>
</table>

**PERCENT OR PROPORTION OF SOILS**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>Particles are present but estimated to be less than 5%</td>
</tr>
<tr>
<td>Few</td>
<td>5 to 10%</td>
</tr>
<tr>
<td>Little</td>
<td>15 to 25%</td>
</tr>
<tr>
<td>Some</td>
<td>30 to 45%</td>
</tr>
<tr>
<td>Mostly</td>
<td>50 to 100%</td>
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</tbody>
</table>

**SOIL PARTICLE SIZE**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>&gt; 12 inches</td>
</tr>
<tr>
<td>Cobble</td>
<td>3 to 12 inches</td>
</tr>
<tr>
<td>Gravel</td>
<td>Coarse 3/4 inch to 3 inches</td>
</tr>
<tr>
<td></td>
<td>Fine No. 4 Sieve to 3/4 inch</td>
</tr>
<tr>
<td>Sand</td>
<td>Coarse No. 10 Sieve to No. 4 Sieve</td>
</tr>
<tr>
<td></td>
<td>Medium No. 40 Sieve to No. 10 Sieve</td>
</tr>
<tr>
<td></td>
<td>Fine No. 200 Sieve to No. 40 Sieve</td>
</tr>
<tr>
<td>Silt and Clay</td>
<td>Passing No. 200 Sieve</td>
</tr>
</tbody>
</table>

**PLASTICITY OF FINE-GRAINED SOILS**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonplastic</td>
<td>A 1/8-inch thread cannot be rolled at any water content.</td>
</tr>
<tr>
<td>Low</td>
<td>The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.</td>
</tr>
<tr>
<td>Medium</td>
<td>The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.</td>
</tr>
<tr>
<td>High</td>
<td>It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.</td>
</tr>
</tbody>
</table>

**CEMENTATION**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>Crumbles or breaks with handling or little finger pressure.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Crumbles or breaks with considerable finger pressure.</td>
</tr>
<tr>
<td>Strong</td>
<td>Will not crumble or break with finger pressure.</td>
</tr>
</tbody>
</table>

**NOTE:** This legend sheet provides descriptors and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (July 2007), Section 2, for tables of additional soil description components and discussion of soil description and identification.
CLAYEY GRAVEL with SAND (GC); loose to medium dense; brown; moist to wet; intermixed with rock fragments; RANDOM FILL (STOCK PILE).

METAVOLCANIC ROCK fragments in sandy silty soil matrix; dark grayish green to dark brown; decomposed to intensely weathered; thinly foliated, soft to moderately soft; dry to moist; cobble and boulder sized fragments noted intermittently.

100 86 92 75 82 87 79 90 95 77 81 92 74 90 99 87

Rain soaked prior to drilling
Intermittent Cobbles and Boulders noted

metavolcanic rock in sandy silty soil matrix

perched water

metavolcanic rock in sandy silty soil matrix

perched water noted
CLAYEY GRAVEL with SAND (GC) (continued).

- **Intermittent Cobbles and Boulders noted**
- **Perched water noted**

Groundwater was not encountered.

---

**REPORT TITLE**
BORING RECORD

**HOLE ID**
A-19-101

**DIST.**
03

**COUNTY**
ED

**ROUTE**
50

**POSTMILE**

**EA**
03-CIP#41918

**PROJECT OR BRIDGE NAME**
Western Placerville Interchanges - Phase 2.2

**BRIDGE NUMBER**
N/A

**PREPARED BY**
MT

**DATE**
5-17-19

**SHEET**
2 of 2
**CLAYEY GRAVEL with SAND (GC); loose to medium dense; brown; moist to wet; intermixed with rock fragments; RANDOM FILL (STOCK PILE).**

**META VOLCANIC ROCK fragments in sandy silty soil matrix; dark grayish green to dark brown; decomposed to intensely weathered; thinly foliated, soft to moderately soft; dry to moist; cobble and boulder sized fragments noted intermittently.**

**Rain soaked prior to drilling**

**metavolcanic rock in sandy silty soil matrix**

**perched water**

**Intermittent Cobbles and Boulders noted**

**metavolcanic rock in sandy silty soil matrix**

**perched water**

**Intermittent Cobbles and Boulders**
Bottom of borehole at 51.5 ft bgs
Groundwater was not encountered.

### BORING RECORD

<table>
<thead>
<tr>
<th>HOLES</th>
<th>HOLE ID</th>
<th>EA</th>
<th>Casing Depth</th>
<th>Sample Location</th>
<th>Remarks</th>
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<td>03-A-19-102</td>
<td>A-19-102</td>
<td>03-CIP#41918</td>
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### MATERIALS

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Moisture Content (%)</th>
<th>Blows per 6 in.</th>
<th>Blows per foot</th>
<th>RQD (%)</th>
<th>Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>101</td>
<td>21</td>
<td>99</td>
<td></td>
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<tr>
<td>26</td>
<td>104</td>
<td>27</td>
<td>105</td>
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</tbody>
</table>

**Description:**
- Perched water noted
- Intermittent Cobbles and Boulders noted
- Perched water

**Drilling Method:**
- Perched water
<table>
<thead>
<tr>
<th>ELEVATION (ft)</th>
<th>DESCRIPTION</th>
<th>Sample Location</th>
<th>Bore per 6 in</th>
<th>Bore per foot</th>
<th>RQD (%)</th>
<th>Moisture Content (%)</th>
<th>Unit Weight (pcf)</th>
<th>Shear Strength (tsf)</th>
<th>Blows per foot</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>1882.00</td>
<td>CLAYEY GRAVEL with SAND (GC/GC); loose to medium dense; brown; moist to wet; intermixed with rock fragments.</td>
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<tr>
<td>1880.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, moderate brown to light olive brown, intensely weathered, very intensively fractured, very thinly bedded; soft to very soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>1</td>
<td>45</td>
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<tr>
<td>1878.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, light olive gray to grayish brown, intensely weathered, moderately fractured, thinly bedded; moderately soft to soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>2</td>
<td>35</td>
<td></td>
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<td>1876.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to brownish gray, slightly weathered, moderately fractured, thinly bedded; moderately hard to moderately soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>3</td>
<td>25</td>
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<td>1874.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to moderate brown, intensely weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>4</td>
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<tr>
<td>1872.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to moderate brown, intensely weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to brownish gray, slightly weathered, moderately fractured, thinly bedded; moderately hard to moderately soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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<td>1868.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to moderate brown, intensely weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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<td>1864.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to moderate brown, intensely weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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<td>1860.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to moderate brown, intensely weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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</tr>
<tr>
<td>1858.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, grayish brown to brownish gray, slightly weathered, moderately fractured, thinly bedded; moderately hard to moderately soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
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</tr>
<tr>
<td>ELEVATION (ft)</td>
<td>DESCRIPTION</td>
<td>Sample Location</td>
<td>Blows per 6 in.</td>
<td>Blows per foot</td>
<td>Recovery (%)</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
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<td></td>
</tr>
<tr>
<td>1858.00</td>
<td>brownish gray to light olive gray, moderately weathered, intensely fractured, thinly bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>Sample Number 5</td>
<td>30</td>
<td>13</td>
<td>30</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
<td></td>
</tr>
<tr>
<td>1856.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, moderate brown to light olive gray, moderately weathered, moderately fractured, thinly bedded; moderately soft to soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>Sample Number 6</td>
<td>40</td>
<td>17</td>
<td>40</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
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<tr>
<td>1854.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, dusky brown to grayish brown, slightly weathered, moderately fractured, thinly bedded; soft to very soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>Sample Number 7</td>
<td>30</td>
<td>15</td>
<td>30</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
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<tr>
<td>1852.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, light olive gray to olive gray, intensely weathered, very slightly fractured, thinly bedded; moderately hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>Sample Number 8</td>
<td>35</td>
<td>18</td>
<td>35</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
<td></td>
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<tr>
<td>1850.00</td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK, moderate brown to grayish brown, slightly weathered, slightly fractured, thinly bedded; very hard to moderately hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>Sample Number 9</td>
<td>40</td>
<td>19</td>
<td>40</td>
<td>Moisture Content (%)</td>
<td>Unit Weight (pcf)</td>
<td>Shear Strength (tsf)</td>
<td>Remarks</td>
<td></td>
</tr>
</tbody>
</table>

Bottom of borehole at 49.5 ft bgs
Groundwater was not encountered.
<table>
<thead>
<tr>
<th>ELEVATION (ft)</th>
<th>DESCRIPTION</th>
<th>Sample Location</th>
<th>Bore per 6 in.</th>
<th>Bore per foot</th>
<th>RQD (%)</th>
<th>Moisture (%)</th>
<th>Unit Weight (pcf)</th>
<th>Shear Strength (tsf)</th>
<th>Blows per 6 in.</th>
<th>Blows per foot</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885.00</td>
<td>CLAYEY GRAVEL with SAND (GC/GC); loose to medium dense; brown; moist to wet; intermixed with rock fragments.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1883.00</td>
<td>METAMORPHIC ROCK, META-VOLCANIC ROCK moderately brown to dusky brown, moderately weathered, very intensely fractured, laminated; soft to very soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>20</td>
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<tr>
<td>1881.00</td>
<td>METAMORPHIC ROCK, META-VOLCANIC ROCK grayish brown to light olive brown, moderately weathered, very intensely fractured, very thinly bedded; moderately soft to soft; moist; Logtown Ridge Formation of Mariposa Formation.</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>35</td>
</tr>
<tr>
<td>1879.00</td>
<td>METAMORPHIC ROCK, META-VOLCANIC ROCK grayish brown to olive gray, intensely weathered, very intensely fractured, very thinly bedded; moderately soft to soft; moist; Logtown Ridge Formation of Mariposa Formation.</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>1877.00</td>
<td>METAMORPHIC ROCK, META-VOLCANIC ROCK moderately yellowish brown to moderately brown, slightly weathered, very intensely fractured, moderately bedded; hard to moderately hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>1869.00</td>
<td>METAMORPHIC ROCK, META-VOLCANIC ROCK brownish gray to grayish brown, intensely weathered, moderately bedded; moderately soft to soft; moist; Logtown Ridge Formation or Mariposa formation.</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>
**METAMORPHIC ROCK (continued).**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material/Graphic</th>
<th>Description</th>
<th>Sample Location</th>
<th>Blows per 6 in.</th>
<th>Blows per foot</th>
<th>Recovery (%)</th>
<th>Moisture Content (%)</th>
<th>Unit Weight (pcf)</th>
<th>Shear Strength (tsf)</th>
<th>Drilling Method</th>
<th>Casing Method</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1851.00</td>
<td></td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK,</td>
<td>5</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1853.00</td>
<td></td>
<td>dusky brown to light olive brown, moderately weathered, intensely fractured, thinly bedded; soft to very soft; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>6</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1855.00</td>
<td></td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK,</td>
<td>7</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1857.00</td>
<td></td>
<td>moderate brown to moderate yellowish brown, slightly weathered, slightly fractured, moderately bedded; moderately hard to hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td>8</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1859.00</td>
<td></td>
<td>METAMORPHIC ROCK, METAVOLCANIC ROCK,</td>
<td>9</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1861.00</td>
<td></td>
<td>light olive gray to grayish brown, intensely weathered, intensely fractured, moderately bedded; hard to very hard; moist; Logtown Ridge Formation or Mariposa Formation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bottom of borehole at 48.0 ft bgs

Groundwater was not encountered.

---

**SIERRA GEOTECH**
2250 Sierra Meadows Drive, Suite A
Rocklin, CA 95677
Phone: 916.934.2167
Email: info@sierrageotech.com

---

**REPORT TITLE**
BORING RECORD

**HOLE ID**
A-20-102

**DIST.**
03
**COUNTY**
ED
**ROUTE**
50
**POSTMILE**
EA 03-CIP#41918

**PROJECT OR BRIDGE NAME**
Western Placerville Interchanges - Phase 2.2

**BRIDGE NUMBER**
N/A
**PREPARED BY**
MT
**DATE**
1-15-20
**SHEET**
2 of 2
Appendix A
Laboratory Testing

Sierra Geotech completed the following laboratory tests on representative soil samples from exploratory borings:

- California Test Method 226 – Moisture Content
- California Test Method 212 – Unit Weight
- California Test Method 204 – Plasticity Index
- California Test Method 202 – Gradation
- California Test Method 301 – R-Value
- California Test Method 643 – pH
- California Test Method 417 – Sulfates
- California Test Method 422 – Chlorides

### Table A-1 - Summary of R-Value Test Results ASTM D 2844

<table>
<thead>
<tr>
<th>Boring No. (sample depth)</th>
<th>Soil Type (USCS Classification)</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-19-101 (0.5 – 2.0 feet)</td>
<td>Clayey Gravel with Sand (GC)</td>
<td>16</td>
</tr>
<tr>
<td>A-19-102 (0.5 – 2.0 feet)</td>
<td>Clayey Gravel with Sand (GC)</td>
<td>24</td>
</tr>
</tbody>
</table>

### Table A-2 - Summary of Soil Corrosion Parameters (CTM 643, CTM 417, CTM 422)

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Soil Type (USCS Classification)</th>
<th>Resistivity (ohm-cm)</th>
<th>pH</th>
<th>Chloride (ppm)</th>
<th>Sulfate (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-19-101 (10.0 feet)</td>
<td>Clayey Gravel with Sand (GC)</td>
<td>1.45</td>
<td>7.59</td>
<td>15.1</td>
<td>36.4</td>
</tr>
<tr>
<td>A-19-102 (10.0 feet)</td>
<td>Clayey Gravel with Sand (GC)</td>
<td>1.31</td>
<td>7.64</td>
<td>23.4</td>
<td>26.9</td>
</tr>
</tbody>
</table>
**SOIL DATA**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SAMPLE NO.</th>
<th>DEPTH</th>
<th>NATURAL WATER CONTENT (%)</th>
<th>PLASTIC LIMIT (%)</th>
<th>LIQUID LIMIT (%)</th>
<th>PLASTICITY INDEX (%)</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-19-101</td>
<td>S 2</td>
<td>3.5-5.0</td>
<td>24.0</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>GC</td>
</tr>
<tr>
<td>▲ A-19-101</td>
<td>S 6</td>
<td>9.5-11.0</td>
<td>22.0</td>
<td>37</td>
<td>23</td>
<td>14</td>
<td>CL</td>
</tr>
<tr>
<td>▲ A-19-102</td>
<td>S 8</td>
<td>11.0-12.5</td>
<td>8.0</td>
<td>45</td>
<td>35</td>
<td>10</td>
<td>ML</td>
</tr>
<tr>
<td>A-19-102</td>
<td>S 16</td>
<td>23.0-24.5</td>
<td>11.0</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>GC</td>
</tr>
</tbody>
</table>

**ATTERBERG LIMITS (ASTM D4318)**

- CH or OH
- ML or OL
- MH or OH
MATERIAL DESCRIPTION: CLAYEY GRAVEL (GC); brown; moist to wet; intermixed with rock fragments;

DEPTH: Bulk Bag 0.5' to 2.0'

BORING NO.: A-19-101

USCS CLASSIFICATION: GC

PLASTICITY INDEX:

**We are a disabled veteran business enterprise and certified small business (micro)**
### GRAIN SIZE DISTRIBUTION (ASTM D422, ASTM D6913)

<table>
<thead>
<tr>
<th>US Standard Sieve Size</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>100.00%</td>
</tr>
<tr>
<td>1.5”</td>
<td>89.00%</td>
</tr>
<tr>
<td>1”</td>
<td>82.00%</td>
</tr>
<tr>
<td>3/4”</td>
<td>71.00%</td>
</tr>
<tr>
<td>1/2” (12.65 mm)</td>
<td>60.00%</td>
</tr>
<tr>
<td>3/8” (9.5 mm)</td>
<td>52.00%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>US Standard Sieve Size</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.4 (4.75 mm)</td>
<td>30%</td>
</tr>
<tr>
<td>No. 10 (2 mm)</td>
<td>22%</td>
</tr>
<tr>
<td>No. 40 (425 μm)</td>
<td>17%</td>
</tr>
<tr>
<td>No. 200 (75 μm)</td>
<td>14%</td>
</tr>
</tbody>
</table>

---

**Material Description:** CLAYEY GRAVEL with SAND (GC); brown; moist to wet; intermixed with rock fragments;

**Depth:** Composite

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>USCS Classification</th>
<th>Liquid Limit</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-19-101</td>
<td>GC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**We are a disabled veteran business enterprise and certified small business (micro)**
**Silty, CLAYEY GRAVEL with SAND (GC); brown; moist to wet; intermixed rock fragments:**

<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>% Finer</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.65</td>
<td>63.64%</td>
</tr>
<tr>
<td>9.5</td>
<td>50.00%</td>
</tr>
<tr>
<td>75 µm</td>
<td>14%</td>
</tr>
<tr>
<td>425 µm</td>
<td>19%</td>
</tr>
<tr>
<td>2 mm</td>
<td>22%</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>30%</td>
</tr>
<tr>
<td>100%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

**USCS Classification:** GC-GM

**Boring No.** A-19-102

**Material Description:** Silty, CLAYEY GRAVEL with SAND (GC); brown; moist to wet; intermixed rock fragments; Bulk Bag 0.5' to 2.0'

**We are a disabled veteran business enterprise and certified small business (micro)**
**Material Description:** CLAYEY GRAVEL (GC); brown; moist to wet; intermixed with rock fragments;

*Material Description: CLAYEY GRAVEL (GC); brown; moist to wet; intermixed with rock fragments;*

**Depth:** Bulk Bag 0.5' to 2.0'

**Boring No.** A-19-102

**US Standard Sieve Size** | **% Finer**
---|---
2" | 100.00%
1.5" | 90.91%
1" | 81.82%
3/4" | 72.73%
1/2" (12.65 mm) | 63.64%
3/8" (9.5 mm) | 54.55%

**US Standard Sieve Size** | **% Finer**
---|---
No. 4 (4.75 mm) | 23%
No. 10 (2 mm) | 20%
No. 40 (425 μm) | 19%
No. 200 (75 μm) | 16%
To:       Frank Knight  
Sierra Geotech  
2250  Sierra Meadows Dr.  
Rocklin, CA,  95677  

From:  Gene Oliphant, Ph.D. \  Randy Horney  
General Manager \  Lab Manager  

The reported analysis was requested for the following:  
Location : BORROW   Site ID:  TP-3  
Thank you for your business.  

* For future reference to this analysis please use SUN # 79888 - 166894  

<table>
<thead>
<tr>
<th>EVALUATION FOR SOIL CORROSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
</tr>
<tr>
<td>Minimum Resistivity</td>
</tr>
<tr>
<td>Chloride</td>
</tr>
<tr>
<td>Sulfate-S</td>
</tr>
</tbody>
</table>

METHODS:  
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)  
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
To: Frank Knight  
Sierra Geotech  
2250 Sierra Meadows Dr.  
Rocklin, CA, 95677

From: Gene Oliphant, Ph.D.  \  Randy Horney  
General Manager  \  Lab Manager

The reported analysis was requested for the following:
Location: BORROW  Site ID: TP-1
Thank you for your business.

* For future reference to this analysis please use SUN # 79888 - 166893

---------------------------------------------
EVALUATION FOR SOIL CORROSION
---------------------------------------------

Soil pH  7.59
Minimum Resistivity  1.45 ohm-cm (x1000)
Chloride  15.1 ppm  0.0015 %
Sulfate-S  36.4 ppm  0.0036 %

METHODS:
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
APPENDIX B

Refraction Seismic Investigation at the WPI Phase 2.2 East Bound On-Ramp Project Site in Placerville, El Dorado County, California

GGSI Project No. 2020-06.01

Prepared by:
Gasch Geophysical Services, Inc.
Rancho Cordova, California 95742-6576

Submitted to:
Mr. Shaun Vemuri
Sierra Geotech
2250 Sierra Meadows Drive, Suite A
Rocklin, California 95677

January, 2020
January 17, 2020

Mr. Shaun Vemuri  
Sierra Geotech  
2250 Sierra Meadows Drive, Suite A  
Rocklin, California 95677

Re: Refraction Seismic Investigation at the WPI Phase 2.2 Eastbound On-ramp Project Site in Placerville, El Dorado County, California.  
GGSI Project No. 2020-06.01

Dear Mr. Vemuri:

At your request and authorization, Gasch Geophysical Services, Inc. (GGSI) has completed a refraction seismic investigation at the WPI Phase 2.2 Eastbound On-ramp Project Site in Placerville, El Dorado County, California (Figure 1).

Purpose

It was our understanding that the purpose of this investigation was to define the rippability (excavatability) characteristics of the sub-surface materials at the WPI Phase 2.2 Eastbound On-ramp Project Site.

Method, Instrumentation and Software

The refraction seismic (RS) method was used to evaluate the rock velocities on site, as seismic primary-wave travel times are used to quantify the rock velocities and, as a result, can determine the general competency/rippability in areas of various rock types.

The RS method measures the velocity at which a seismic wave propagates through a soil or rock medium. In this case, the primary seismic wave (p-wave or compression wave) was measured. Higher seismic p-wave velocities (measured in feet per second, ft/s) indicate material of higher density, thus quantifying the competency, or strength, of the soil or rock medium and providing an estimation of the rippability and/or excavatability of the sub-surface materials.

The seismic data acquisition system used by GGSI was a Seistronix EX-6 Explorer, which is a distributed, 24-bit digital instrument with data output to electronic media for subsequent processing. Geophones were single, 28-Hz, digital grade units manufactured by OYO Geospace Corporation. Spread cables were manufactured by Pro-Seismic Services. The energy source for this project was a 16-pound sledgehammer with a hardwired link for system triggering. All data were processed in house on our data reduction and plotting workstation.
Refraction seismic data processing was carried out using Rayfract® version 3.36. This refraction seismic processing software utilizes Wavepath Eikonal Traveltime (WET) tomography, which models multiple signal propagation paths contributing to one first break (the Fresnel volume approach). Conventional ray tracing tomography is limited to the modeling of just one ray path per first break. The WET inversion method is founded upon a back-projection formula for inverting velocities from travel times computed by a finite-difference solution to the Eikonal equation (Qin, et al. 1992). An Eikonal solver is used for traveltime field computation, which models diffraction in addition to refraction and transmission of acoustic waves. As a result, the velocity anomaly imaging capability is enhanced with the WET tomographic inversion method compared to conventional ray tomography. This software is developed by Intelligent Resources, Inc. of Vancouver, British Colombia, Canada.

A color-coded seismic velocity cross-section of the subsurface has been generated for each RS line, where cool colors (blues) indicate lower seismic velocities and warm colors (reds, purple) indicate higher velocities. Color scaling of these seismic velocity sections is based on the range of seismic velocity values calculated. Velocity scaling has been normalized on all RS velocity sections.

**Data Acquisition Parameters**

A total of 2 RS lines were acquired during this investigation. RS Line locations were suggested by Sierra Geotech personnel and slightly adjusted in the field to allow for safe and efficient data acquisition. Geophone stations were spaced at 10-foot intervals with energy source points located between every other geophone station as well as off the ends of each line. Both RS Lines were acquired with 17 active geophone stations for a total line length of 180 feet each. A total of 360 lineal feet of data collected for this investigation. Field data acquisition was carried out on January 15th, 2020 by a field crew consisting of Professional Geophysicist Kent Gasch and geophysical technician Keith Peschel. The location of the RS lines are presented on Figure 2.

**Rippability**

Rippability is dependent on the physical condition of the rock masses to be excavated. In addition to rock type and degree of weathering, structural features in the rock such as bedding planes, cleavage planes, joints, fractures, consolidation, and shear zones also influence rippability. Rock masses tend to be more easily ripped if they have well defined, fractures, joints, or other planes of weakness. Massive rock bodies which lack discontinuities may allow for slow and difficult ripping or refusal, even where partially weathered, and may require blasting to break the rock for efficient removal.

The association between the seismic velocity of any given earth material and its rippability varies greatly from one type of earth-moving equipment to another. For example, a large track laying dozer with a single ripper tooth can sometimes rip material with seismic velocities in excess of 10,000 ft/s however, if the ripper tooth cannot
penetrate the rock, inefficient excavation performance may be encountered. GGSI has experienced a limiting (refusal) velocity for large excavators ranging from 3,500 ft/s to 4,500 ft/s, and a standard backhoe may meet refusal at seismic velocities as low as 2,000 ft/s. Ultimately, the relationship between seismic velocity and rippability is dependent on a combination of site conditions, equipment used, and operator ability.

Seismic p-wave velocities are related to both rock hardness and fracture density. Rippability has been empirically correlated to refraction seismic velocities by Caterpillar Inc., as displayed on Figure 5 for a CAT D8R/D8T (Caterpillar Performance Handbook, Edition 47, January 2017). According to this chart, metamorphic rock becomes marginally rippable around 6,300 ft/s and non-rippable at about 8,200 ft/s for a D8R/D8T dozer. These estimations are based on the published values for metamorphic rocks on the CAT chart; however, site geology and topography may cause some variations of these values.

The Caterpillar Chart of Ripper Performance should be considered as being only one indicator of rippability. Ripper tooth penetration is the key to successful ripping, regardless of seismic velocity. This is particularly true in finer-grained, homogeneous materials and in tightly cemented formations. Ripping success may ultimately be determined by the operator finding the proper combination of factors, such as: number of shanks used, length and depth of shank, tooth angle, direction of travel, and use of throttle. Although low seismic velocities in any rock type indicate probable rippability; if the fractures, bedding and/or joints do not allow tooth penetration, the material still may not be ripped efficiently, and, in some cases, drilling and blasting may be required to induce sufficient fracturing to allow for excavation.

Seismic Velocities

Generally, seismic p-wave velocities less than 3,000 ft/s indicate native soil, fill material, or highly weathered and/or decomposed rock, while velocities in excess of 10,000 ft/s indicate fresh (essentially non-weathered) rock. Seismic velocities between these two values typically indicate rock with varying degrees of weathering and/or fracturing. Consolidation and cementation, as well as fracture spacing and density, also affect the measured seismic velocities. Moderate velocities may indicate compacted soil, moderately weathered rock, or loosely consolidated sediment such as gravel, sand, and silt. Saturated sediment below the water table characteristically displays seismic velocities near or slightly above 5,000 ft/s which can effect measured velocities in this type of environment.

Extremes in seismic velocities may range from below 1,000 ft/s to over 20,000 ft/s. Very low seismic velocities usually indicate highly weathered or poorly compacted material, either natural or man-made. Extremely high velocities are rare in the near-surface, and only possible in certain types of rock. Rock velocities are dependent on the physical condition of the rock masses evaluated, as a result, seismic p-wave velocities
are related to rock hardness, fracture density and sediment consolidation, saturation, and cementation.

Findings

The results of this refraction seismic investigation are summarized by Figures 3 and 4. These seismic velocity sections, which were created through the inversion process, have very low error and provide a high degree of lateral definition of the seismic velocity horizons found beneath each line. The seismic velocity sections have been scaled from 1,500 ft/s to 10,000 ft/s for the velocity window. Spatial axes have been scaled to 20 feet per inch in both the horizontal and vertical.

RS Line 1 (Figure 3)

RS Line 1 is located at the top of the planned cut area for the retaining wall and spans a total length of 180 feet. This Line is oriented approximately southwest to northeast (see Figure 2). This Line crosses RS Line 2 at distance station 110 feet in the northeast portion of the line. Measured seismic velocities at this location show a moderate gradation from low to moderate velocities (1,500 to 5,000 ft/s) at the surface to depths ranging from approximately 33 feet to 45 feet below ground surface (bgs). This low to moderate velocity horizon extends to the maximum depth of exploration below this Line. Based on the measured seismic velocities and the CAT Performance Handbook for a D8R/D8T dozer or equivalent, excavation with this type of equipment should not be problematic in the area of RS Line 1, at least to the depths noted above.

RS Line 2 (Figure 4)

RS Line 2 is also located at the top of the planned cut area for the retaining wall and crosses RS Line 1 at distance station 26 feet. This Line is oriented approximately west-southwest to east-northeast and is 180 feet in length (see Figure 2). Measured seismic velocities at this location show low to moderate velocities (1,500 to 5,000 ft/s) across the length of the line at approximate depths of 37 to 50 feet bgs. These measured low to moderate velocities extend to the maximum depth of exploration below this Line and suggest that excavation with a D8R/D8T dozer or equivalent should not be problematic in the area of RS Line 2 to approximately 50 feet bgs.

Summary

This refraction seismic investigation was designed to provide a good sampling of the subsurface conditions along a portion of the WPI Phase 2.2 Eastbound On-ramp retaining wall area. This investigation revealed a moderate degree of variation in the calculated seismic velocities of the subsurface materials, with the highest seismic velocity of greater than 5,000 ft/s measured at the maximum depth of exploration on both RS Lines. Low velocity material was encountered in the near surface on both lines, which suggests highly weathered/fractured rock and soil or fill. The moderate velocity
range of 3,000 ft/s to approximately 5,000 ft/s, suggests soil/fill to weathered/fractured rock. Both RS Lines show this low to moderate velocity section of material from surface to the maximum depth of exploration.

In general, rippability with a D8R/D8T dozer (or equivalent) should not be problematic to the depths noted above for each RS Line; however, depending on the maximum depth of excavation, progress may be slower if zones of higher velocity material are encountered at depths greater than the maximum depth of exploration beneath these two lines. In such instances, alternative means of excavation, such as drilling and blasting, may be necessary.

Warranty and Limitations

Gasch Geophysical Services, Inc. has performed these services in a manner which is consistent with standards of the profession. Site conditions can cause some variations of the calculated seismic velocities. Refraction seismic velocities assume that velocities increase with depth; therefore, a lower seismic velocity layer beneath a higher seismic velocity layer will not be resolved. No guarantee, with respect to the results and performance of services or products delivered for this project, is implied or expressed by Gasch Geophysical Services, Inc.

We trust that this is the information you require; however, should you have comments or questions, please contact our Rancho Cordova office at your convenience. Thank you for this opportunity to be of service.

Sincerely,

GASCH GEOPHYSICAL SERVICES, INC.

[Signature]

Kent L. Gasch
Professional Geophysicist #1061

Expires 12/31/2021
Figure 1

Refraction Seismic Investigation: WPI Phase 2.2 On-ramp Project

Prepared for: Sierra Geotech

Project Number: 2020-06.01 Date: January, 2020
Legend

- Geophone Station

- Energy

- Source Locations

Scale:
Horizontal: 1" = 20'
Vertical: 1" = 20'

Figure 3

Refraction Seismic Investigation:
WPI Phase 2.2 On-ramp Project

Prepared for: Sierra Geotech

Project Number: 2020-06.01 Date: January, 2020
Seismic Velocity Section • RS Line 2

West-southwest

East-northeast

Scale:
Horizontal: 1” = 20'
Vertical: 1” = 20'

Legend:
- Geophone Station
- Source Locations

Refraction Seismic Investigation: WPI Phase 2.2 On-ramp Project
Prepared for: Sierra Geotech
Project Number: 2020-06.01 Date: January, 2020

Figure 4
### Caterpillar D8R/D8T Ripper Performance Chart*

**D8R/D8T**

Multi or Single Shank No. 8 Ripper
Estimated by Seismic Wave Velocities

<table>
<thead>
<tr>
<th>Seismic Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meters Per Second x 1000</td>
</tr>
<tr>
<td>Feet Per Second x 1000</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

- **TOPSOIL**
- **CLAY**
- **GLACIAL TILL**
- **IGNEOUS ROCKS**
  - **GRANITE**
  - **BASALT**
  - **TRAP ROCK**
- **SEDIMENTARY**
  - **SANDSTONE**
  - **SILTSTONE**
  - **CLAYSTONE**
  - **CONGLOMERATE**
  - **BRECCIA**
  - **CALICHE**
  - **LIMESTONE**
- **METAMORPHIC**
  - **SCHIST**
  - **SLATE**
- **MINERALS & ORES**
  - **COAL**
  - **IRON ORE**

- **RIPPABLE**
- **MARGINAL**
- **NON-RIPPABLE**

* Based on the Caterpillar Performance Handbook
Edition 47 - January, 2017

---

**Figure 5**

Refraction Seismic Investigation:
WPI Phase 2.2 On-ramp Project

Prepared for: **Sierra Geotech**

Project Number: 2020-06.01 Date: January, 2020
APPENDIX C

SLOPE STABILITY ANALYSES RESULTS
Factor of Safety = 1.3

Unit Weight: 120 pcf
Cohesion': 0 psf
\( \Phi' \): 31°
K_x = 0.076g
PGA = 0.227g

Factor of Safety = 1.1

Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 31 °
Factor of Safety = 1.25

Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 31°
Factor of Safety = 1.05

Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 31°
Factor of Safety = 1.3

Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 31°
Factor of Safety = 1.1

Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 31°

$K_h = 0.076g$
$PGA = 0.227g$
Factor of Safety = 1.6

Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 31°
Factor of Safety = 1.3

Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 31°

$K_v = 0.076g$
$PGA = 0.227g$
Factor of Safety = 1.5

Unit Weight: 120 pcf
Cohesion': 0 psf
\( \Phi' = 31^\circ \)
Unit Weight: 120 pcf
Cohesion': 0 psf
\( \Phi' = 31^\circ \)

Factor of Safety = 1.3

\( K_n = 0.076g \)
\( PGA = 0.227g \)
Factor of Safety = 1.5

Unit Weight: 120 pcf
Cohesion': 0 psf
\( \Phi' = 31^\circ \)
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 31 °

Factor of Safety = 1.2

K_s = 0.076g
PGA = 0.227g
APPENDIX D

PAVEMENT CALCULATIONS
Empirical Method for Multiple Layered Flexible Pavement
Caltrans Highway Design Manual Sixth Edition
Chapter 630 Flexible Pavement Topic 633 - Engineering Procedures for New Construction and Reconstruction

### HMA on Class 2 AB Flexible Pavement Design

<table>
<thead>
<tr>
<th>TI (5.0 - 12.0)</th>
<th>Class 2 AB R-Value</th>
<th>Subgrade R-Value</th>
<th>GEHMA (ft)</th>
<th>Factor of Safety</th>
<th>Design GEHMA (ft)</th>
<th>HMA Thickness (ft)</th>
<th>HMA Thickness (in)</th>
<th>Design GEHMA (ft)</th>
<th>HMA Thickness (ft)</th>
<th>HMA Thickness (in)</th>
<th>Design AB (ft)</th>
<th>AB Thickness (ft)</th>
<th>AB Thickness (in)</th>
<th>Design AB (ft)</th>
<th>Design AB Thickness (ft)</th>
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<td>0.62</td>
<td>2.31</td>
<td>0.27</td>
<td>3.2</td>
<td>0.30</td>
<td>3.6</td>
<td>1.54</td>
<td>0.91</td>
<td>1.1</td>
<td>0.83</td>
<td>10.0</td>
<td>0.85</td>
<td>10.2</td>
<td>1.15</td>
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<td>0.32</td>
<td>3.9</td>
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<td>4.2</td>
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<td>1.1</td>
<td>1.00</td>
<td>12.0</td>
<td>1.00</td>
<td>12.0</td>
<td>1.35</td>
</tr>
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<td>2.00</td>
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<td>4.8</td>
<td>2.05</td>
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<td>1.1</td>
<td>1.17</td>
<td>14.0</td>
<td>1.20</td>
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<td>22.2</td>
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</tr>
</tbody>
</table>

**Legend**

- **User Input**
- **Calculated Cell**

| Text  | HMA thickness greater than 0.50-ft, use Table 633.1
| Text  | HMA thinner than 0.125-ft (1.5-in) or AB thinner than 0.35-ft |