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SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

PRELIMINARY FOUNDATION REPORT

Battery Tunnels
(Bridge No. 34-0161R and Bridge No. 34-0161L)

January 2009

Prepared By:

Caltrans and Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Preliminary Foundation Report

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January 2009

ARUP PB joint venture

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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1 Introduction

This preliminary foundation report provides preliminary foundation recommendations for the Battery Tunnel structures, cut-and-cover tunnels located in San Francisco, California. The proposed structures are part of the Doyle Drive Replacement Project which will replace the freeway that stretches from the west end of Lombard Street, through the Presidio of San Francisco, ending at the Golden Gate Bridge toll plaza. The cut-and-cover tunnel will be landscaped above to restore some of the natural beauty of the Presidio, which is now part of the U.S. National Park System. The Battery Tunnels will be located in the west portion of the project in a bluff adjacent to a reclaimed tidal marsh as shown on Figure 1.

The Battery Tunnels are proposed to replace the existing at-grade portion of Doyle Drive in approximately the same location. The underground structures are comprised of an approximately 56-foot-wide, 760-foot-long Northbound (NB) Tunnel and an approximately 66-foot-wide, 860-foot-long Southbound (SB) Tunnel. The two tunnels will be constructed separately in different stages in order to maintain normal traffic flow during construction. The structures are considered shallow tunnels and will be constructed with conventional cut-and-cover methods.

A draft of the preliminary foundation report dated April 15, 2008 was submitted to the Caltrans office of Geotechnical Design – West for their review and comments. We received comments back from Caltrans via email on May 13, 2008. A copy of the Review Comment Summary and Resolution is presented in Appendix A. Resolutions presented in the Appendix have been incorporated into the preliminary foundation report.

2 Site Exploration Program

The site exploration program for the Battery Tunnels included the following: 1) exploratory soil and rock boreholes; 2) in-situ geophysical tests; 3) oriented rock coring; 4) in-situ permeability (packer) testing; and 5) installation of standpipe piezometers in permeable soil and rock strata at selected locations to monitor groundwater levels and periodic readings of groundwater levels in the piezometers.

2.1 Boreholes

Arup/PB drilled boreholes in 18 locations in the vicinity of the Battery Tunnels. Boreholes were drilled in 10 locations for the foundation design of the Battery Tunnels. Boreholes were drilled in 5 locations for the design of adjacent retaining walls and were used for this report. Boreholes were drilled in 3 locations by hand auger at the base of the Battery bluff for the purpose of monitoring groundwater. The logs of these boreholes are presented in Appendix B.

Caltrans drilled 3 boreholes for the adjacent structures that were used as part of this report (RW8-R2, 34-0157NB-A1-PZ, and 34-0157SB-A1). These boreholes will be included in Caltrans Foundation Reports, but draft copies of the field logs are included in Appendix B of this report.

Two adjacent boreholes that were drilled as part of a previous investigation are also included in Appendix B.

Arup/PB drilled 2 boreholes (M-10 and M-11) east of the Battery Tunnels in the reclaimed tidal marsh. These boreholes were not used as part of this report, but are included in Appendix B for information.

The locations of boreholes used for this report are shown on Figure 2 and summarized on Table 1 including installation and survey data.

2.2 Geophysical Testing

Suspension P-S velocity logging was performed in boreholes BTNB-R4-PZ, BTNB-R5-PZ-D, BTNB-R7-PZ-D, BTSB-R2, BTSB-R3-PZ-D, RW6-R1-PZ, RW6-R2-PZ-D, and RW8-R1-PZ to obtain information about the stiffness characteristics of the soil and rock. The velocity results for these boreholes are presented in Appendix C of this preliminary foundation report.

The measured shear wave velocity of the Fill ranged from 450 feet per second (fps) to 820 fps. The shear wave velocity of the Colma Sand ranged from 950 fps to 1,750 fps. The shear wave velocity of the serpentinite ranged from 1,780 fps to 4,860 fps. The shear wave velocity of the sandstone typically ranged from 1,470 fps to 7,020 fps however, the shear wave velocity of the sandstone in BTSB-R3-PZ-D was as high as 8,750 fps indicating a block of very hard sandstone.

Acoustic televiewer testing was performed in boreholes BTNB-R4-PZ, BTNB-R5-PZ-D, BTNB-R7-PZ-D, BTSB-R3-PZ-D, RW6-R2-PZ-D, and RW8-R1-PZ.

The purpose of the acoustic televiewer tests was to determine if predominant fracture sets exist and if groundwater could be conveyed from the south side of the tunnels into the corresponding bedrock fractures on the north side of the tunnels recreating the groundwater flow as if the tunnel structures were not present. The acoustic televiewer results were very good in locations of harder rock, such as sandstone, but degraded in sections of Mélange Matrix or soft serpentinite.

Several average fracture sets are present in each borehole and are summarized on Table 2. No average fracture sets are presented for borehole BTNB-R4-PZ because only a limited number of fractures were observed. No consistent fracture sets were obtained in borehole RW8-R1-PZ.

2.3 Oriented Rock Coring

Oriented rock coring was performed in boreholes BTNB-R5-PZ-D, BTNB-R6-PZ-D, BTNB-R7-PZ-D, BTSB-R3-PZ-D, and RW6-R2-PZ-D to supplement the acoustic televiewer results and attempt to determine predominant fracture sets that could convey groundwater.

The oriented core was obtained using the EZY-MARK Core Orientation System. The EZY-MARK system works by drilling the borehole at a slight incline (approximately 5°) and inserting the EZY-MARK tool into the core barrel. The tool will mark the top of the core stub in the ground with a pencil and a series of pins as well as orienting itself with the “downside” of the inclined borehole. After completion of the core run, the top of the obtained core and the tool are aligned and the relation of the obtained core to the borehole orientation is determined.

The average fracture sets determined from the oriented rock coring are summarized on Table 3. The raw data is presented on the borehole logs.

2.4 Packer Testing

Packer tests were performed at 6 locations to measure the hydraulic conductivity of the bedrock below the Battery Tunnels. The hydraulic conductivity in the serpentinite bedrock ranged from $1.3x10^{-7}$ cm/s to $1.5x10^{-4}$ cm/s and in the sandstone ranged from very small (test interval did not take any water) to $1.6x10^{-4}$ cm/s. The results of the packer tests are summarized on Table 4 and presented in detail in Appendix D.

2.5 Piezometer Installation and Groundwater Readings

All piezometers were developed by Gregg Drilling and Testing, typically by pumping 10 times the well volume of water out of the well and measuring the turbidity of the pumped water. The results of our well development program are summarized on Table 5. The results of our groundwater monitoring, including piezometer screen intervals, and screened materials, are presented on Table 6.

3 Site Geology and Subsurface Conditions

3.1 General Site Geology

The regional topography of the San Francisco peninsula is characterized by relatively rugged hills formed by Jurassic- to Cretaceous-aged Bedrock surrounded by low flat-lying areas which are underlain by Quaternary sedimentary deposits. Bedrock consists of highly deformed and fractured sedimentary rocks of the Franciscan assemblage. Locally, Franciscan Bedrock contains large through-going shear zones such as the City College and Fort Point-Potrero Hill-Hunters Point shear zones. The Fort Point-Potrero Hill-Hunters Point shear zone traverses the study area as may be seen on Figure 3. It should therefore be expected that the Franciscan Bedrock would be highly fractured, containing highly to completely weathered (soil-like) inclusions.

In the Peninsula area, Quaternary sediments lie unconformably on the eroded Bedrock surface and consist of an alternating sequence of terrestrial and estuarine deposits that reflect major sea level fluctuations during the Pleistocene and Holocene epochs. Low stands of sea level are recorded by the deposition of terrestrial sediments, whereas estuarine sediments such as the Yerba Buena Mud (also known locally as Old Bay Clay) and Bay Mud were deposited during high sea-level stands (Sloan, 1992). The Yerba Buena Mud was deposited in an estuarine environment similar to that which presently exists in San Francisco Bay, and therefore has a lateral distribution similar to that of the younger estuarine Bay Mud. Historical development of the San Francisco Bay area has resulted in placement of artificial fill material over substantial portions of modern estuaries, marshlands and creek beds in an effort to reclaim land.

The Battery Tunnels are located in the western portion of the project where younger estuarine Bay Mud and marshland deposits do not exist.

3.2 Site Specific Subsurface Conditions

Figure 4 presents a generalized subsurface cross section, showing the soils encountered underneath the Northbound Tunnel. Figure 5 presents a generalized subsurface cross section along the Southbound Tunnel. Transverse cross sections at Stations 78+00, 81+00, and 85+00 are presented on Figures 6, 7, and 8,

respectively. A summary of the soil and rock properties determined from laboratory testing are presented in Tables 7 and 8, respectively.

The depth of the bedrock changes along the alignment of the tunnels. At the east end of the tunnels, about 59 feet of soils exist over bedrock whereas, near the west end, about 12 feet of soils exist above bedrock.

The surficial soil unit is a medium dense sandy Fill that is present along the entire alignment. The Fill is related to site grading performed while the Presidio was used for military activities and ranges between 3 and 23 feet thick. Much of the Fill may be derived from Dune Sand. Verification of large amounts of Fill was given by overlaying ground surface elevations from 1871 and 2000 which indicate that the ground surface has risen due to site grading and filling (Barnaal, The Presidio Trust, 2008). Figure 9 presents changes in the site grading in the area of the Battery Tunnels.

The Fill is often underlain by a thin Buried Soil Horizon. When present, this unit ranges from 1 to 5 feet thick and is characterized by soft, dark brown silts with some sand and a strong organic odor.

At the east end, below the Buried Soil Horizon is a layer of medium stiff Sandy Silts and Sandy Clays ranging up to 12 feet thick. The Sandy Silt and Sandy Clay layer is underlain by up to 32 feet of dense Colma Sand. The Colma Sand is dense to very dense with typically a trace of fines (about 5 percent) to about 20 percent fines. A second layer of Sandy Clay exists below the Colma Sand, which in turn is underlain by Colluvium or Residual Soil over bedrock, although Colluvium or Residual Soil was not encountered in all boreholes.

At the west end, the sandy Fill is underlain by Residual Soil over bedrock.

Bedrock beneath the Battery Tunnels is generally of the Franciscan Formation. This formation consists of a variety of heavily folded and sheared assemblages of Greywacke sandstone, siltstone, chert, serpentinite, and Mélange Matrix (a plastic bedrock unit which is similar to a gravelly clay). The hardness of these bedrock units typically ranges from very soft to hard and may vary in short distances, but large blocks (on the order of hundreds of feet) of harder rock may be encountered. Photographs of typical geologic features within the bedrock are shown on Figure 10. The types of bedrock encountered can also change rapidly within the Franciscan Formation. In the east portion, bedrock was typically comprised of serpentinite and some greenstone, whereas to towards the west portion, a large block of sandstone was encountered. Mélange Matrix was encountered between the serpentinite and sandstone.

3.3 Groundwater

Groundwater varies across the tunnel alignments, increasing in elevation from east to west. At the east portion, groundwater was encountered in the Colma Sand between elevations 40 feet and 50 feet. To the west, as the bedrock surface rises in elevation, a seasonal groundwater layer is typically perched on the soil-rock interface.

Groundwater measured within the rock stabilized near the top of the rock surface. Average groundwater readings and piezometer screen intervals are shown on the longitudinal and transverse Cross Sections (Figures 4 through 8) and Table 6.

The results of the acoustic televiewer tests and the oriented rock coring are compared on Figure 11. The results are inconclusive that predominant fracture sets exist through which groundwater is conveyed from south to north towards the face of the bluff.

4 Scour

Scour will not be a concern on this portion of the project. However, surface runoff will cause erosion if engineered fill and native soils are not covered with vegetation.

5 Corrosivity

Six soil samples were collected for corrosion testing. Sampling and testing of the site soils were in conformance with the Corrosion Guidelines for Foundation Investigations (Caltrans, 2003). The results of the corrosion testing are presented on Table 9.

Caltrans (2003) considers a site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

- Chloride concentration is greater than or equal to 500 ppm;
- Sulfate concentration is greater than or equal to 2,000 ppm; or
- The pH is 5.5 or less.

Based on the results of the corrosion analyses and the Caltrans criteria, the site is considered non-corrosive.

6 Seismicity/Liquefaction

Structural design criteria has been proposed in the report titled *Structural Design Criteria: Cut-and-Cover Tunnels and Non-Standard Retaining Walls, Draft-Revision 3a,* dated April 30, 2008. This document summarizes the seismic demand placed on the structure. In addition, Amec Geomatrix in conjunction with Dr. Norm Abrahamson has been retained to provide the following services:

- Perform a site-specific seismic hazard assessment and develop rock response spectra for Functional Evaluation Earthquake (FEE) and Safety Evaluation Earthquake (SEE) events;
- Develop three independent sets of spectrum-compatible rock motions for each of the FEE and SEE events; and
- Perform site response analyses using SHAKE for both fault-normal and fault-parallel components and for all three sets of time histories.

Potential liquefaction conditions do not exist in the Battery Tunnels area because of the low water table and stiff soil profile. The medium dense sandy Fill is typically not saturated because the water table is located just above or at the top of the bedrock. In areas where the water table is located within the overburden soils, it is typically found within the dense Colma Sand layer.

For the purposes of the seismic considerations of this preliminary foundation report, the project was characterized by a single coordinate at the midpoint of the project as latitude and longitude. The chosen midpoint was Aerial Survey Mark V-117,

located near the intersection of Lincoln Boulevard and Sheridan Street at latitude 37 48' 4.22577" and longitude -122 27' 41.60799".

Final design values for moment magnitude and peak ground acceleration are to be determined using a 1,000 year return period. These values are currently being developed by AMEC-Geomatrix and will be incorporated into the final design. For the purposes of this preliminary liquefaction assessment, values of moment magnitude and peak rock acceleration were obtained from the U.S. Geological Survey website. The liquefaction analysis was performed assuming an earthquake with moment magnitude of 7.5. The analysis was performed for an assumed peak ground acceleration of 0.65g which corresponds to the peak ground acceleration estimated from the probabilistic hazard analysis for an earthquake having 5% probability of exceedance in 50 years (or a return period of 975 years).

A liquefaction analysis was performed following the procedure proposed by Seed, et al. (2003) using the results of standard penetration tests. Blowcounts from the Modified California (MC) sampler were converted to equivalent Standard Penetration Test (SPT) blowcounts by multiplying by 0.75 for sandy soils, 0.71 for silts, and 0.52 for clays. The correlations were determined from approximately 150 sets of consecutively driven MC and SPT samplers that were conducted during the geotechnical exploration program for the Doyle Drive Replacement Project.

Figures 12 and 13 show the probability of liquefaction triggering in the Fill and Colma Sand from the SPT correlations, respectively. The analyses indicate that liquefaction triggering is unlikely below the Battery Tunnels.

7 Foundation Type Recommendations

7.1 Tunnel Foundations

The Battery Tunnel structures should be founded on a reinforced mat foundation. For preliminary design a spring constant approach may be used.

Spring constants in the Draft Preliminary Foundation Report were estimated based on maximum loads and these values have been revised for the Preliminary Foundation Report. The spring constants for the Northbound alignment have been separated into two portions; from the East Portal to Station 78+50 where bedrock will not be exposed when excavating for the structure and from Station 78+50 to the West Portal where the mat is expected to be located within serpentinite, Mélange Matrix, and average strength sandstone bedrock. The spring constants for the Southbound alignment have been separated into three portions; from the East Portal to Station 78+50 where bedrock will not be exposed when excavating for the structure, from Station 78+50 to Station 81+50 where hard sandstone is expected to be encountered and from Station 81+50 to the West Portal where average strength sandstone is expected to be encountered.

The spring constants for this preliminary foundation report were estimated using a pseudo-coupled analysis. In a pseudo-coupled analysis, varying spring constants are applied to the mat such that the value in the center of the mat is less than those computed for the perimeter of the mat while maintaining that the weighted average of the spring constants by area is equal to the average spring constant for the entire mat. The perimeter values are equal to two times the central values and one intermediate spring constant is applied each with equal area.

The estimated spring constants are shown on Figure 14 and detailed below:

- From the NB East Portal to NB Station 78+50 the spring constant for the outer zone of the tunnel is k_s = 55 ksf/ft. For the intermediate zone k_s = 41 ksf/ft and for the inner zone k_s = 28 ksf/ft.
- From NB Station 78+50 to the NB West Portal to the spring constant for the outer zone of the tunnel is k_s = 62 ksf/ft. For the intermediate zone k_s = 42 ksf/ft and for the inner zone k_s = 31 ksf/ft.
- From the SB East Portal to SB Station 78+50 the spring constant for the outer zone of the tunnel is k_s = 52 ksf/ft. For the intermediate zone k_s = 39 ksf/ft and for the inner zone k_s = 26 ksf/ft.
- From SB Station 78+50 to SB Station 81+50 the spring constant for the outer zone of the tunnel is k_s = 205 ksf/ft. For the intermediate zone k_s = 154 ksf/ft and for the inner zone k_s = 103 ksf/ft.
- From SB Station 81+50 to the SB West Portal the spring constant for the outer zone of the tunnel is k_s = 91 ksf/ft. For the intermediate zone k_s = 68 ksf/ft and for the inner zone k_s = 45 ksf/ft.

These spring constants assume that all soft or loose materials are removed prior to the construction of the mat foundation. If soft materials, especially clays, are encountered below the base of the mat, these materials will need to be excavated and replaced with structural backfill.

Because of the excavation depths required to reach the final grade of the Battery Tunnels, the net load on the supporting soil and rock is minimal and in many locations negative. The small to negative final loading conditions and the lack of compressible soils anticipated beneath the Battery Tunnels indicate that total and differential settlements are expected to be negligible.

7.2 Portal Foundations

The East and West Portals for the Northbound and Southbound Tunnels may be supported at grade. The East Portals for both the Northbound and Southbound Tunnels are expected to be supported on Colma Sand. The Southbound West Portal is anticipated to be supported on sandstone bedrock and the Northbound West Portal is anticipated to be supported on Mélange Matrix.

For preliminary design a spring constant approach may be used. For this preliminary report, an average spring constant was calculated for the portal structures. The East Portals, which are supported on Colma Sand, may be designed using an average spring constant of $k_{s,avg}$ = 30 ksf/ft. The West Portals, which are supported on bedrock, may be designed using an average spring constant of $k_{s,avg}$ = 225 ksf/ft.

8 Earth Pressures

8.1 Vertical Earth Pressures

Landscaping over the top of the tunnel structures will exert a distributed vertical load on the roof of the structures. This dead load pressure from landscaping fill will be equal to 140 pcf times the depth of the fill. For example, if there is 5 feet of fill

material placed over the structures, the applied distributed load from this material will be 700 psf.

There will be other vertical loads imposed on the structures from other sources such as traffic, however these loads are not considered in the scope of this preliminary foundation report.

8.2 Lateral Earth Pressures

At-rest lateral earth pressures will develop on the side walls of the tunnels with the placement of the backfill. For preliminary estimation of the at-rest earth pressure at a particular depth z, in feet, the following equations can be used:

- For the southern wall of the Southbound Tunnel: $p_{at\text{-}rest} = 80 * z$ in psf; and
- For the northern wall of the Northbound Tunnel: $p_{at\text{-}rest} = 60 * z$ in psf.

The soil and rock parameters that were used to develop these equations are presented on Table 10.

It is assumed that drainage behind retaining walls and tunnel sidewalls will be provided to relieve hydrostatic pressure. Surcharges from other loadings should be added where appropriate.

Final seismic lateral earth pressures will be developed as part of a detailed seismic analysis. For preliminary design, we recommend a lateral seismic earth pressure in psf equal to 19 times the height of the wall in feet.

The equations to determine preliminary pressures are given for an individual point. Over the side of the tunnel walls, the earth pressure will be a triangular distributed force. Resultants may be easily determined using standard methods.

Lateral earth pressures will develop on the retaining walls at the ends of the tunnels. Retaining Walls RW-5 and RW-6 are located at the west end of the Battery Tunnels while RW-7 and RW-8 are located at the east end. For preliminary estimation of the earth pressures at Retaining Walls RW-5, RW-6, RW-7, and RW-8, the recommendation presented in the Caltrans memorandum, dated February 5, 2008, should be used. A copy of the memorandum prepared for the Doyle Drive Replacement Retaining Structures is presented in Appendix E.

9 Construction Concerns

9.1 Retaining Structures

Construction of the Battery Tunnels will require excavations up to approximately 40 feet deep. In order to support these excavation depths, temporary retaining structures will need to be constructed. We recommend temporary retaining structures such as soldier pile and lagging or secant pile walls be constructed. Although the soldier piles will be taken at least 5 feet beyond the excavation depth, lagging will be only taken down to the top of the bedrock. The rock formation would be shored with rock bolts, fencing and shotcrete as necessary. Secant piles will be taken below the bottom of the excavation, including into the bedrock. Soldier pile and lagging walls are typically less expensive to install than secant pile walls, however the use of a soldier pile and lagging wall requires wells be installed to dewater to the top of the bedrock or the bottom of the excavation, whichever is shallower. Dewatering is not necessary for secant pile walls. However,

penetrations will need to be opened in the secant pile walls after construction in order to maintain groundwater flow to the face of the bluff.

Tiebacks will not be allowed below the National Cemetery. Therefore, the retaining structures would require internal bracing to limit deflections. Short portions of the excavation may be able to be cut at a 2:1 (H:V) slope and will not require retaining structures.

A soil nail wall may be used to support the excavation along portions of the north side of the Northbound Tunnel. Soil nail walls are typically inexpensive; however, they cannot be used along the entire north side because the existing historic batteries are located very close to the alignment. Additionally, the transition from a soil nail wall to a different wall type will require special design considerations for the tunnel walls.

Active lateral earth pressures will develop on the side walls of the temporary retaining structures. For preliminary estimation of the active earth pressure at a particular depth, z in feet, the following equations can be used:

- For the southern wall of the Southbound Tunnel: $p_{active} = 30 * z$ (lbs/ft^2);
- For the northern wall of the Southbound Tunnel: $p_{active} = 65 * z$ (lbs/ft^2); and
- For the northern wall of the Northbound Tunnel: $p_{active} = 65 * z$ (lbs/ft^2).

If internal bracing is used, apparent earth pressures will develop on the side walls of the retaining walls. For preliminary estimation of the apparent earth pressures (A.P.) the following values can be used as based on Terzaghi and Peck, 1969 method as presented in Fang (1991):

- For the southern wall of the Southbound Tunnel: A.P. = 1,000 (lbs/ft^2);
- For the northern wall of the Southbound Tunnel: A.P. = 1,200 (lbs/ft^2); and
- For the northern wall of the Northbound Tunnel: A.P. = 1,700 (lbs/ft^2).

The soil and rock parameters that were used to develop these equations are presented on Table 10.

It is assumed that drainage behind retaining walls will be provided to relieve hydrostatic pressure. Surcharges from other loadings should be added where appropriate.

For final design, consideration should be given to designing temporary retaining structures for a Construction Earthquake Event.

The equations to determine preliminary pressures are given for an individual point. Over the side of the tunnel walls, the earth pressure will be a triangular distributed force. Resultants may be easily determined using standard methods.

Construction of a slurry/diaphragm wall may be used as part of the permanent design forming the walls of the tunnel structure. However, the connection between the slurry/ diaphragm wall and the mat of the new structure is difficult and costly to construct and traditionally does not perform well in seismic events.

9.2 Excavatability

In order to reach final grade, approximately 17,000 yd^3 of rock will need to be excavated for the Battery Tunnels. Much of the rock to be excavated is rippable to

marginally rippable sandstone. However, it should be anticipated that there will be blocks of very hard sandstone that must be excavated, particularly in the vicinity of borehole BTSB-R3-PZ-D. Drilling and blasting will not be allowed within the Presidio; therefore, a hoe-ram may be required. Serpentinite bedrock will be encountered in small volumes, and is expected to be rippable.

Figure 15 shows empirical correlations of excavatability with compression wave velocity and point load strength. Recordings of compression wave velocities can be altered by the presence of groundwater. Compression waves travel through water at a speed of approximately 6,000 ft/sec which can obscure the effect the rock structure. For this reason, compression wave velocities measured below the groundwater table, such as those shown on Figure 12, must be interpreted as approximate.

9.3 Excavation of Serpentinite

Excavation to the final grade for the Battery Tunnels will require excavation of serpentinite bedrock. Serpentinite bedrock may contain naturally occurring asbestos, which presents a worker health and safety hazard. Testing to determine the presents of asbestos will occur during the environmental investigation and if asbestos is present proper procedures must be followed as detailed in the Design Documents.

9.4 Groundwater Control

The invert of the Southbound Battery Tunnel will be constructed from 30 to 40 feet below the existing grade. High groundwater conditions will be encountered at the Battery Tunnels that will require installation of a drainage panel along the southbound south wall to collect water adjacent to the wall. The collected water will be conveyed under the tunnel slabs by a subdrain system and allowed to flow north along the top of the bedrock and into the rock fractures maintaining seepage at the face of the Battery bluff.

9.5 Slope Stability

Two slope failures occurred in 1998 at the east end of Battery Bluff, adjacent to the proposed location of the East Portals. The slope was repaired with compacted benches and underdrains. As part of the new construction, a berm will be built over the repaired slope to facilitate hiking trails. Figure 16 presents the results of stability analysis of the new berm. Analyses were performed using SLOPE/W 2007 version software. As currently detailed, the berm, and the underlying repaired slope, should not pose a stability concern and should not be expected to undermine the adjacent east portal of the Northbound Battery Tunnel.

10 Additional Required Analyses

The site exploration and laboratory testing program is complete as of the issuing of this preliminary foundation report. As a result of the exploration and testing program, we recommend that numerical analyses be performed to evaluate the effects of the subsurface conditions on the tunnel structures. Specifically, analyses are required to determine the effect of the tunnel structures bearing partly on rock and partly on soils.

The recommendations contained in this preliminary foundation report are not final. Any questions regarding the above preliminary recommendations should be directed to the attention of Francis R. Greguras at 415-946-0255.

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STATE OF CALIFORNIA

11 References

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TABLES

TABLE 1 SUMMARY OF SURVEYED BOREHOLE LOCATIONS			
Borehole ID	**Northing**	**Easting**	**Elevation**
34-0157NB-A1-PZ	2120509.438	5993931.703	80.911
34-0157SB-A1	2120481.342	5993926.250	81.209
BTNB-R1	2120470.078	5994297.737	91.378
BTNB-R2	2120407.628	5994505.431	89.420
BTNB-R3	2120351.985	5994725.980	86.286
BTNB-R4-PZ	2120366.979	5994998.299	70.422
BTNB-R5A-PZ-S	2120582.620	5994169.980	79.370
BTNB-R5-PZ-D	2120581.324	5994178.193	79.635
BTNB-R6A-PZ-S	2120558.479	5994527.552	83.531
BTNB-R6-PZ-D	2120559.949	5994521.542	83.591
BTNB-R7A-PZ-S	2120461.975	5994829.468	78.961
BTNB-R7-PZ-D	2120459.851	5994825.735	79.353
BTSB-R1-PZ	2120323.729	5994396.263	101.030
BTSB-R2	2120218.262	5994858.344	92.121
BTSB-R3A-PZ-S	2120227.544	5994550.875	98.049
BTSB-R3-PZ-D	2120225.975	5994556.115	97.900
M-9/RW7-A1A	2120378.671	5995179.887	17.928
M-10	2120511.047	5995523.129	11.908
M-11	2120559.565	5995764.236	12.472
RW5-R1	2120520.291	5994131.737	93.094
RW6-R1-PZ	2120380.700	5994104.938	108.507
RW6-R2A-PZ-S	2120266.257	5993963.449	108.315
RW6-R2-PZ-D	2120270.083	5993967.843	108.659
RW8-R1A-PZ	2120199.669	5995008.466	90.616
RW8-R1-PZ	2120199.669	5995008.466	90.616
RW8-R2	2120192.938	5995167.458	82.348
HA-1-PZ	2120752.489	5994220.945	27.802
HA-2-PZ	2120690.897	5994579.932	25.348
HA-3-PZ	2120613.038	5994884.724	22.315

TABLE 2 SUMMARY OF ACOUSTIC TELEVIEWER TEST RESULTS		
Borehole ID	**Average Strike**	**Average Dip**
BTNB-R5-PZ-D	147	51
	71	54
	220	39
	290	47
BTNB-R7-PZ-D	252	15
	22	32
	181	57
BTSB-R3-PZ-D	209	38
	323	31
	324	65
	4	64
	93	46
RW6-R1-PZ	286	65
	154	64
	87	50
RW6-R2-PZ-D	221	75
	249	79
	315	74
	284	41
	358	34
	76	62
	117	47

TABLE 3 SUMMARY OF ORIENTED ROCK CORING RESULTS		
Borehole ID	**Average Strike**	**Average Dip**
BTNB-R5-PZ-D	186	55
	255	44
	36	53
	336	17
BTNB-R7-PZ-D	128	52
	209	29
	320	40
	358	12
BTSB-R3-PZ-D	1	38
	270	79
	172	50
	107	37
RW6-R2-PZ-D	120	44
	38	53
	217	89
	349	25
	244	22
BTNB-R6-PZ-D	299	29
	208	25

TABLE 4
SUMMARY OF PACKER TEST RESULTS

Borehole ID	Depth Interval (ft)	Elevation Interval (NAVD88) (ft)	Rock Type(s)	Hydraulic Conductivity	
				Royle [1] (cm/s)	Bureau of Reclamation [2] (cm/s)
BTNB-R4-PZ	55 to 66	15 to 26	Serpentinite	1.31E-07	1.37E-07
	63 to 74	7 to 18	Serpentinite	1.15E-06	1.05E-06
	73 to 84	-3 to 8.4	Serpentinite	2.06E-04	2.15E-04
	83 to 94	-13 to -2	Serpentinite	1.50E-04	1.62E-04
BTNB-R5-PZ-D	89 to 100	-9 to 1.6	Sandstone	2.05E-04	2.14E-04
	99 to 110	-19 to -8	Sandstone	1.66E-04	1.73E-04
BTNB-R7-PZ-D	53 to 64	26 to 37	Greenstone	4.84E-04	3.87E-04
	67 to 78	12 to 23	Greenstone	8.30E-05	8.64E-05
	77 to 88	2 to 13	Greenstone, Gabbro	8.23E-06	8.58E-06
	87 to 98	-8 to 3.4	Gabbro, Serpentinite	6.04E-05	6.29E-05
BTSB-R3-PZ-D	24 to 35	74 to 85	Sandstone	No Take	No Take
	35 to 46	63 to 74	Sandstone	8.36E-05	8.71E-05
	46 to 57	52 to 63	Sandstone	1.56E-04	1.63E-04
	57 to 68	41 to 52	Sandstone	4.61E-04	4.79E-04
	68 to 79	30 to 41	Sandstone, Shale	2.71E-05	2.83E-05
	82 to 93	16 to 27	Sandstone, Shale	9.49E-06	9.89E-06
RW6-R1-PZ	30 to 41	79 to 90	Sandstone	1.17E-05	1.21E-05
	40 to 51	69 to 80	Sandstone	9.27E-04	9.98E-04
RW6-R2-PZ-D	32 to 43	77 to 88	Sandstone	2.31E-04	2.42E-04
	41 to 52	68 to 79	Sandstone	2.99E-04	3.12E-04
	54 to 65	55 to 66	Sandstone	7.16E-06	7.46E-06
	65 to 76	44 to 55	Sandstone	9.47E-06	9.86E-06
	76 to 87	33 to 44	Sandstone	2.98E-06	3.11E-06
	87 to 98	22 to 33	Sandstone, Shale	2.85E-06	3.00E-06

[1] Royle, Michael (October, 2006) Standard Operating Procedures for Borehole Packer Testing, SRK Consulting

[2] United States Department of the Interior, Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes, USBR 7310-89

TABLE 5
SUMMARY OF WELL DEVELOPMENT DATA

Piezometer ID	Installed By	Date of Installation	Northing (ft)	Easting (ft)	Elevation (NAVD88) (ft)	Slotted Interval Depth (ft)	Sand Interval Depth (ft)	Date of Development	Time Start	Time Completed	Duration of Development (min)	Initial Water Depth from Ground Surface (ft)	Pumped (Y/N)	Surged (Y/N)	Pumping Rate (gpm)	Average Water Depth from Ground Surface During Pumping (ft)	Water Collected (gal)	Water Quality at Last Reading				Remarks
																		pH	Electrical Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°C)	
34-0157NB-A1-PZ	Caltrans	2/26/2008	2120509.438	5993931.703	80.911	15.0 to 25.0	14.0 to 25.0	6/11/2008	14:05	14:40	35	Dry	N	N	N/A	N/A	0.5	N/A	N/A	N/A	N/A	1.5" diameter well
BTNB-R4-PZ	Pitcher Drilling	2/18/2008	2120366.979	5994998.299	70.422	49.5 to 69.5	47.0 to 69.5	6/9/2008	15:55	18:19	144	25.15	Y	Y	1 to 0.5	Varied	50	6.99	0.456	5	17.4	Well pumped dry. Pumping continued after allowing it to recharge.
BTNB-R5A-PZ-S	Pitcher Drilling	4/11/2008	2120582.620	5994169.980	79.370	15.0 to 35.0	14.0 to 36.0	6/13/2008	10:05	11:55	110	3.07	Y	Y	1.0	5.17	55	7.31	1.03	-5	15.2	
BTNB-R5-PZ-D	Pitcher Drilling	4/10/2008	2120581.324	5994178.193	79.635	78.0 to 98.0	77.0 to 99.0	6/13/2008	7:40	10:00	140	53.84	Y	Y	1.0	Not Measured	75	7.31	1.01	-5	15.2	Unable to measure water level during pumping because well is inclined.
BTNB-R6A-PZ-S	Pitcher Drilling	3/27/2008	2120558.479	5994527.552	83.531	17.0 to 32.0	15.0 to 32.0	6/13/2008	14:25	15:30	65	27.46	N	N	N/A	N/A	2	N/A	N/A	N/A	N/A	After bailing, well was dry and did not recharge.
BTNB-R6-PZ-D	Pitcher Drilling	3/28/2008	2120559.949	5994521.542	83.591	60.0 to 80.0	58.5 to 80.5	6/13/2008	12:05	14:10	125	26.78	Y	Y	1.0	Not Measured	91	8.27	6.97	10	16.5	Unable to measure water level during pumping because well is inclined.
BTNB-R7A-PZ-S	Pitcher Drilling	4/1/2008	2120461.975	5994829.468	78.961	28.5 to 43.5	26.5 to 43.5	6/10/2008	8:20	10:25	125	28.45	Y	Y	0.5	Not Measured	25	6.60	0.586	1	18.7	
BTNB-R7-PZ-D	Pitcher Drilling	4/3/2008	2120459.851	5994825.735	79.353	50.0 to 70.0	47.0 to 70.0	6/10/2008	10:30	15:50	320	11.84	Y	Y	0.5	Not Measured	100	8.51	0.687	140	19.7	Unable to measure water level during pumping because well is inclined.
BTSB-R1-PZ	Pitcher Drilling	1/23/2008	2120323.729	5994396.263	101.030	23.5 to 33.5	21.5 to 33.5	6/12/2008	8:25	10:45	140	18.48	Y	Y	<0.01	Varied	26	6.89	0.599	94	20.7	Well pumped dry. Pumping continued after allowing it to recharge.
BTSB-R3A-PZ-S	Pitcher Drilling	4/23/2008	2120227.544	5994550.875	98.049	9.0 to 18.0	7.0 to 19.3	6/12/2008	11:00	11:35	35	15.00	N	N	N/A	N/A	1	N/A	N/A	N/A	N/A	After bailing, well was dry and did not recharge.
BTSB-R3-PZ-D	Pitcher Drilling	4/23/2008	2120225.975	5994556.115	97.900	50.0 to 70.0	48.5 to 71.0	6/12/2008	11:45	14:55	190	11.85	Y	Y	1.0	33.30	100	7.19	0.617	10	19.1	
RW6-R1-PZ	Pitcher Drilling	2/28/2008	2120380.700	5994104.938	108.507	12.0 to 22.0	10.0 to 22.0	6/9/2008	9:00	9:45	45	19.87	N	N	N/A	N/A	0.25	N/A	N/A	N/A	N/A	After bailing, well was dry and did not recharge.
RW6-R2A-PZ-S	Pitcher Drilling	4/17/2008	2120266.257	5993963.449	108.315	12.0 to 29.0	13.0 to 28.0	6/9/2008	9:50	10:15	25	Dry	N	N	N/A	N/A	0.25	N/A	N/A	N/A	N/A	Well was dry prior to bailing.
RW6-R2-PZ-D	Pitcher Drilling	4/17/2008	2120270.083	5993967.843	108.659	76.0 to 98.0	77.0 to 97.0	6/9/2008	10:20	15:05	285	41.70	Y	Y	1	Varied	94	7.35	1.37	209	17.9	Well pumped dry. Pumping continued after allowing it to recharge.
RW8-R1-PZ	Pitcher Drilling	1/17/2008	2120199.669	5995008.466	90.616	25.0 to 45.0	20.0 to 46.0	6/11/2008	12:30	13:30	60	39.45	N	Y	N/A	N/A	5	N/A	N/A	N/A	N/A	

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TABLE 6
SUMMARY OF GROUNDWATER MONITORING RESULTS

Borehole ID	34-0157NB-A1-PZ	BTNB-R4-PZ	BTNB-R5-PZ-D	BTNB-R5A-PZ-S	BTNB-R6-PZ-D	BTNB-R6A-PZ-S	BTNB-R7-PZ-D	BTNB-R7A-PZ-S	BTSB-R1-PZ	BTSB-R3-PZ-D	BTSB-R3A-PZ-S	RW6-R1-PZ	RW6-R2-PZ-D	RW6-R2A-PZ-S	RW8-R1A-PZ
Piezometer ID			Deep	Shallow	Deep	Shallow	Deep	Shallow		Deep	Shallow		Deep	Shallow	
Elevation, NAVD88 (ft)	80.911	70.422	79.635	79.37	83.591	83.531	79.353	78.961	101.03	97.9	98.049	108.507	108.659	108.315	90.616
Screen Depth Inverval (ft)	15.0 to 25.0	49.5 to 69.5	78.0 to 98.0	15.0 to 35.0	60.0 to 80.0	17.0 to 32.0	50.0 to 70.0	28.5 to 43.5	23.5 to 33.5	50.0 to 70.0	8.0 to 18.0	12.0 to 22.0	76.0 to 98.0	12.0 to 29.0	25.0 to 45.0
Screened Material	Colma Sand	Colma Sand	Mélange Matrix, Sandstone	Sandstone	Greenstone, Sandstone, Serpentinite	Sandy Silt, Colma Sand	Greenstone	Colma Sand, Greenstone	Buried Soil Horizon, Sandstone	Sandstone	Fill, Buried Soil Horizon, Sandy Clay, Sandstone	Colma Sand, Sandstone	Sandstone, Shale	Colma Sand, Sandstone	Colma Sand, Sandy Clay, Residual Soil
Pipe Inside Diameter (in)	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Date Installed	2/28/2008	2/18/2008	4/10/2008	4/11/2008	3/28/2008	3/27/2008	4/3/2008	4/1/2008	1/23/2008	4/23/2008	4/23/2008	2/28/2008	4/17/2008	4/17/2008	1/17/2008
Date Developed	6/11/2008	6/9/2008	6/13/2008	6/13/2008	6/13/2008	6/13/2008	6/10/2008	6/10/2008	6/12/2008	6/12/2008	6/12/2008	6/9/2008	6/9/2008	6/9/2008	6/11/2008
Date Read															
03/04/08															
03/28/08									17.15						
06/09/08		25.15										19.87	41.70	Dry	
06/10/08							11.84	28.45							
06/11/08	Dry														39.45
06/12/08									18.48	11.85	15.00				
06/13/08			53.84	3.07	26.78	27.46									
07/18/08	24.03	29.69	51.64	3.37	27.58	29.04	30.31	29.81	20.20	17.18	17.79	20.21	50.41	28.20	38.73
08/29/08	24.46	30.02	51.44	4.01	27.68	29.58	30.43	30.04	21.48	17.42	14.80	20.60	52.20	28.55	38.80
Average	24.2	29.9	51.5	3.7	27.6	29.3	30.4	29.9	20.8	17.3	16.3	20.4	51.3	28.4	38.8

Reading taken before piezometer was developed.

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TABLE 7
SUMMARY OF LABORATORY TEST RESULTS ON SOIL

Borehole ID	Depth (ft)	Elevation (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)	Type of Test	Normal or Confining Stress (psf)	Shear Strength[1] (psf)	Friction Angle at 10% Strain[2] (degrees)	Over Consolidation Ratio, OCR	Compression/ Recompression Ratio, CR/RR
BTNB-R3	11.6	74.7	Sandy Clay	18.9	130.0	41	17	24	0.08	109.4							
BTNB-R3	18.3	68.0	Colma Sand	18.2													
BTNB-R3	31.7	54.6	Colma Sand	23.1	125.6					102.1							
BTNB-R4-PZ	8.3	62.2	Sandy Clay	13.7	130.7	32	16	16	-0.14	114.9	81.1						
BTNB-R4-PZ	13.4	57.1	Sandy Silt	14.1	136.8					119.8	54.4						
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.5	131.9					110.4	14.3	DS	2,700	2,640			
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.4	129.0					108.0		DS	3,300	3,336			
BTNB-R4-PZ	23.5	47.0	Colma Sand	18.8	127.8					107.6		DS	4,000	4,020			
BTNB-R4-PZ	33.1	37.4	Colma Sand	20.1	132.9					110.7	9.5						
BTNB-R4-PZ	48.1	22.4	Colma Sand	21.2	134.2					110.8	14.2						
BTNB-R6-PZ-D	8.2	75.4	Fill	14.7	124.3					108.3	9.5						
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	34	17	17	0.21	107.3		TXUU	2,250	2,442			
BTNB-R6-PZ-D	18.3	65.3	Sandy Silt	18.0	134.0					113.5	59.1						
BTNB-R6-PZ-D	23.6	60.0	Colma Sand	15.7	136.3					117.8	17.9						
BTNB-R6-PZ-D	27.6	56.0	Colma Sand	14.9	124.4					108.3	10.9	TXICU	4,650		39.0		
BTNB-R7A-PZ-S	9.8	69.2	Buried Soil Horizon	20.4		30	15	15	0.36								
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1					107.7	52.5	TXUU	3,100	1,240			
BTNB-R7A-PZ-S	19.8	59.2	Sandy Clay	23.6		30	14	16	0.60								
BTNB-R7A-PZ-S	23.1	55.9	Colma Sand	19.9	133.6					111.5	17.6						
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand	20.9	132.1					109.3	18.2	TXICU	5,800		38.4		
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	23	15	8	0.23	115.1		TXUU	2,250	1,740			
BTSB-R1-PZ	13.3	87.8	Fill	15.0	121.7					105.8	3.3						
BTSB-R1-PZ	22.8	78.3	Fill	26.4	127.0					100.5	2.1	DS	2,650	2,208			
BTSB-R1-PZ	22.8	78.3	Fill	25.3	126.2					100.7		DS	3,300	2,508			
BTSB-R1-PZ	22.8	78.3	Fill	30.8	125.4					95.9		DS	4,000	3,012			
BTSB-R1-PZ	27.5	73.5	Sandy Clay	22.0	129.9					106.5		TXUU	5,200	1,480			
BTSB-R1-PZ	28.8	72.3	Sandy Clay	22.8	123.5					100.6						4.1	0.124/ 0.006
BTSB-R1-PZ	28.8	72.3	Sandy Clay			37	16	21									
BTSB-R1-PZ	28.8	72.3	Sandy Clay			39	18	21									
BTSB-R2	3.3	88.9	Fill	5.3	118.8					112.9							
BTSB-R2	12.8	79.3	Sandy Clay	22.5	128.2	38	18	20	0.23	104.6		TXUU	2,250	1,854			
BTSB-R2	17.8	74.3	Colma Sand	19.1	135.8					114.0	48.3	TXUU	3,100	1,854			
BTSB-R2	28.3	63.9	Colma Sand	21.8	130.1					106.8	11.4	DS	3,200	3,120			
BTSB-R2	28.3	63.9	Colma Sand	20.7	129.9					107.6		DS	4,000	3,744			
BTSB-R2	28.3	63.9	Colma Sand	20.6	130.0					107.8		DS	4,800	4,404			
BTSB-R2	33.6	58.6	Colma Sand	21.2	128.5					106.0	13.0	TXICU	5,700		37.1		
BTSB-R2	37.8	54.3	Sandy Clay	20.7	130.4	30	17	13	0.28	108.1		TXUU	6,550	2,296			
BTSB-R2	38.3	53.8	Sandy Clay	22.3	127.6	45	21	24	0.05	104.3		TXUU	6,550	3,675			
BTSB-R2	42.8	49.3	Sandy Clay	19.4	132.4	40	20	20	-0.03	110.9		TXUU	7,400	6,274			
BTSB-R3A-PZ-S	3.1	95.0	Fill	6.7	115.6					108.4	1.8						
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.2	109.1					99.9	1.4	DS	1,000	936			
BTSB-R3A-PZ-S	9.3	88.8	Fill	10.4	112.9					102.3		DS	1,300	1,044			
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.3	109.7					100.4		DS	1,600	1,500			
BTSB-R3A-PZ-S	12.8	85.2	Buried Soil Horizon	18.6	131.8	23	16	7	0.37	111.2		TXUU	2,250	775			

TABLE 7
SUMMARY OF LABORATORY TEST RESULTS ON SOIL

Borehole ID	Depth	Elevation (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines	Type of Test	Normal or Confining Stress	Shear Strength[1]	Friction Angle at 10% Strain[2]	Over Consolidation Ratio, OCR	Compression/ Recompression Ratio, CR/RR
M-10	4.8	7.2	Hydraulic Fill	22.7							4.0						
M-10	10.8	1.2	Hydraulic Fill	28.3	121.4					94.6	4.2	DS	1,275	1,152			
M-10	10.8	1.2	Hydraulic Fill	26.5	123.1					97.3		DS	1,600	1,248			
M-10	10.8	1.2	Hydraulic Fill	27.2	124.5					97.9		DS	1,900	1,452			
M-10	14.6	-2.6	Colma Sand	19.3	133.9					112.2							
M-10	24.6	-12.6	Colma Sand	23.7	130.6					105.5	7.6						
M-10	41.3	-29.3	Colma Sand	20.6							15.3						
M-11	16.1	-3.6	Hydraulic Fill	23.9	129.4					104.4	1.4	DS	1,850	1,860			
M-11	16.1	-3.6	Hydraulic Fill	26.6	130.3					102.9		DS	2,300	2,040			
M-11	16.1	-3.6	Hydraulic Fill	24.9	127.9					102.4		DS	2,800	2,112			
M-11	21.2	-8.7	Hydraulic Fill	19.6	132.2					110.6	2.8						
M-9/RW7-A1A	6.3	11.7	Hydraulic Fill	39.7	113.5					81.3	31.2						
M-9/RW7-A1A	12.8	5.2	Hydraulic Fill	22.0							25.5						
M-9/RW7-A1A	17.3	0.7	Marine Sand	24.8							44.9						
M-9/RW7-A1A	26.1	-8.1	Colluvium								50.9						
M-9/RW7-A1A	30.8	-12.8	Colluvium								58.4						
M-9/RW7-A1A	35.3	-17.3	Colluvium								24.1						
RW5-R1	3.3	89.8	Colma Sand	13.8	134.0					117.7							
RW6-R1-PZ	3.1	105.5	Fill	15.4	124.3					107.7	49.5						
RW6-R1-PZ	7.9	100.7	Sandy Clay	15.7		28	15	13	0.05		75.6						
RW6-R1-PZ	12.9	95.7	Colma Sand	16.6	128.7					110.4	21.5	DS	1,000	1,236			
RW6-R1-PZ	12.9	95.7	Colma Sand	16.8	127.2					108.9		DS	1,200	1,320			
RW6-R1-PZ	12.9	95.7	Colma Sand	16.3	129.1					111.0		DS	1,400	1,764			
RW6-R1-PZ	17.3	91.3	Colma Sand	21.2	131.1					108.2	27.4	DS	2,000	1,884			
RW6-R1-PZ	17.3	91.3	Colma Sand	22.1	131.0					107.3		DS	2,500	2,100			
RW6-R1-PZ	17.3	91.3	Colma Sand	18.7	134.1					113.0		DS	3,000	2,652			
RW6-R2A-PZ-S	3.8	104.6	Fill	4.5	104.2					99.7	4.5						
RW6-R2A-PZ-S	8.1	100.3	Fill	24.3	126.3					101.6	2.7	DS	1,000	972			
RW6-R2A-PZ-S	8.1	100.3	Fill	21.7	131.2					107.8		DS	1,200	1,092			
RW6-R2A-PZ-S	8.1	100.3	Fill	18.2	124.7					105.5		DS	1,400	1,200			
RW6-R2A-PZ-S	18.6	89.8	Colma Sand	13.2	129.6					114.5	16.4						

[1]Shear strength values represent peak or undrained shear strength
[2]Friction angle at 10% strain calculated assuming c = 0

TABLE 8
SUMMARY OF LABORATORY TEST RESULTS ON ROCK

Borehole ID	Depth (ft)	Elevation (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)	Type of Test	Confining Stress (psf)	Shear Strength (psf)	Compressive Strength (psi)	Other Tests
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	22	15	7	-0.67	135.6		TXUU	9,500	935		
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	Non-Plastic	Non-Plastic	Non-Plastic		119.7		TXUU	10,500	729		
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.2												Slake Durability Index = 94.2
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.03												Slake Durability Index = 65.2
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	Non-Plastic	Non-Plastic	Non-Plastic		118.6		TXUU	16,000	832		
BTNB-R4-PZ	96.48	-26.1	Serpentinite		142.4										1,280	
BTNB-R5A-PZ-S	25.1	54.3	Sandstone		167.5											Splitting Tensile Strength = 690 psi
BTNB-R5A-PZ-S	25.1	54.3	Sandstone													Cerchar Abrasivity Index = 1.2
BTNB-R5A-PZ-S	25.45	53.9	Sandstone		165.6										9,800	
BTNB-R5-PZ-D	54.5	25.1	Mélange Matrix	9.3	158.6	27	16	11	-0.61	145.1						
BTNB-R5-PZ-D	88.35	-8.7	Sandstone		163.8										8,810	
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8					73.1	31.8	TXUU	4,850	1,487		
BTNB-R6-PZ-D	47.7	35.9	Serpentinite		132.1										400	
BTNB-R6-PZ-D	83.8	-0.2	Serpentinite		151.1										3,650	
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	39	33	6	-3.02	122.2		TXUU	17,000	875		
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	30	28	2	-6.60	122.2		TXUU	16,000	570		
BTSB-R1-PZ	36.25	64.8	Sandstone		164.6										10,840	
BTSB-R1-PZ	36.625	64.4	Sandstone		165.3											Splitting Tensile Strength = 610 psi
BTSB-R1-PZ	45.175	55.9	Sandstone, Shale		166.4										12,610	
BTSB-R3A-PZ-S	17.8	80.2	Sandstone	10.5	142.2					128.7	33.1	TXUU	3,100	2,561		
BTSB-R3-PZ-D	24.775	73.1	Sandstone													Cerchar Abrasivity Index = 1.0
BTSB-R3-PZ-D	25.075	72.8	Sandstone		158.2										4,870	
BTSB-R3-PZ-D	25.45	72.5	Sandstone													Peak Slope (Punch Test) = 61 kips/in
BTSB-R3-PZ-D	30.2	67.7	Sandstone		159.5										3,350	
BTSB-R3-PZ-D	44.45	53.5	Sandstone		161.3										9,430	
BTSB-R3-PZ-D	44.85	53.1	Sandstone		166.7											Splitting Tensile Strength = 790 psi
BTSB-R3-PZ-D	50.4	47.5	Sandstone		164.9										16,800	
BTSB-R3-PZ-D	81.65	16.3	Sandstone		166.2										3,510	
M-9/RW7-A1A	41.1	-23.1	Serpentinite			44	23	21								
M-9/RW7-A1A	46.925	-29.0	Gabbro		162.9										7,850	
M-9/RW7-A1A	47.275	-29.3	Gabbro		160											Splitting Tensile Strength = 630 psi
RW6-R1-PZ	26.575	81.9	Sandstone													Cerchar Abrasivity Index = 0.4
RW6-R1-PZ	26.9	81.6	Sandstone		152.6										3,090	
RW6-R1-PZ	45.325	63.2	Sandstone		163.4										14,480	
RW6-R1-PZ	49.85	58.7	Sandstone		166.5											Splitting Tensile Strength = 1,090 psi
RW6-R2-PZ-D	30.95	77.7	Sandstone		160.5										3,770	
RW8-R1-PZ	76.475	14.1	Serpentinite	7.69												Slake Durability Index = 61.8
RW8-R1-PZ	121.9	-31.3	Serpentinite		150.5										1,770	

TABLE 9
SUMMARY OF CORROSIVITY ANALYSIS

Borehole ID	Depth (ft)	Soil Unit	pH*	Resistivity (ohms-cm)	Chloride** (mg/kg)	Sulfate*** (mg/kg)
BTNB-R4-PZ	17.8 - 19.0	Colma Sand	7.4	3,900	--	23
BTSB-R2	22.8 - 24.0	Colma Sand	7.2	5,500	--	15
BTSB-R3A-PZ-S	0 - 2.5	Fill	7.2	5,100	--	--
BTSB-R3A-PZ-S	0 - 2.5	Fill	7.1	25,000	--	--
BTSB-R1-PZ	8.0 - 9.0	Fill	7.0	6,100	--	19
M-9/RW7-A1A	20.0 - 22.5	Marine Sand	7.9	5,300	20	15
		Method:	CT 532/643	CT 532/643	CT 422/ASTM D4327	CT 417/ASTM D4327

* The pH of the soils range from 7.0 to 7.9 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

** The chloride iron concentrations range from zero to 20 mg/kg. Since these concentrations are below 300 mg/kg, they are determined to be insufficient to attack embedded steel in a concrete mortar coating.

***The sulfate ion concentrations range from zero to 23 mg/kg. Since these concentrations are below 2,000 mg/kg, they are determined to be insufficient to be potentially deterimental to reinforced concrete structures and cement mortar-coated steel.

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TABLE 10 Design Parameters Used for Earth Pressure Calculations							
Soil Unit	**Total Unit Weight (pcf)**	**ϕ (°)**	**c (psf)**	**Ka**	**Ko**	**OCR**	**PI (%)**
Fill[1]	120	35	0	0.27	0.43	1	Non-Plastic
Sandy Silts and Sandy Clays	120	35	0	0.27	0.43	1	Non-Plastic
Colma Sand	130	38	0	0.24	0.38	1	Non-Plastic
Sandstone (ss)	165	55	0	0.10	0.18	1	Non-Plastic
Serpentinite (srp)	150	0	1,000	1.00	0.46	1	5

[1]Buried Soil Horizon was assumed to have the same properties as Fill

FIGURES

Source: USGS, San Francisco North Quadrangle, California, 7.5-Minute Series (Topographic), 1996

SCALE: 1:24,000
Contour Interval 25 feet
(National Geographic Vertical Datum of 1929)

N

SITE VICINITY MAP

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Q:\131558\4a Arup Internal Project Data\4a-15 Geotech\4a-015-006 Drawings\Site Vicinity Map.ai

FIGURE 1

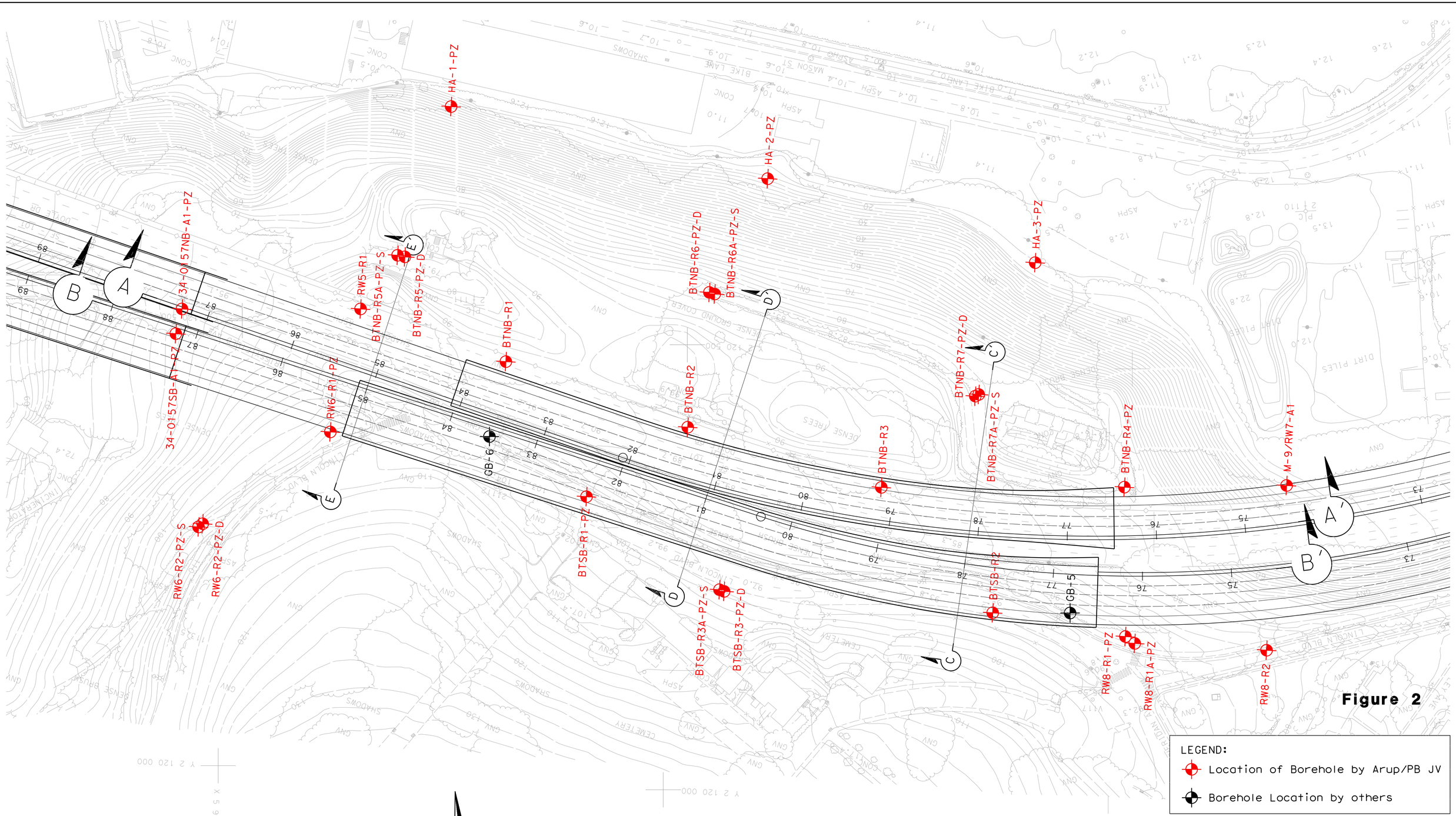
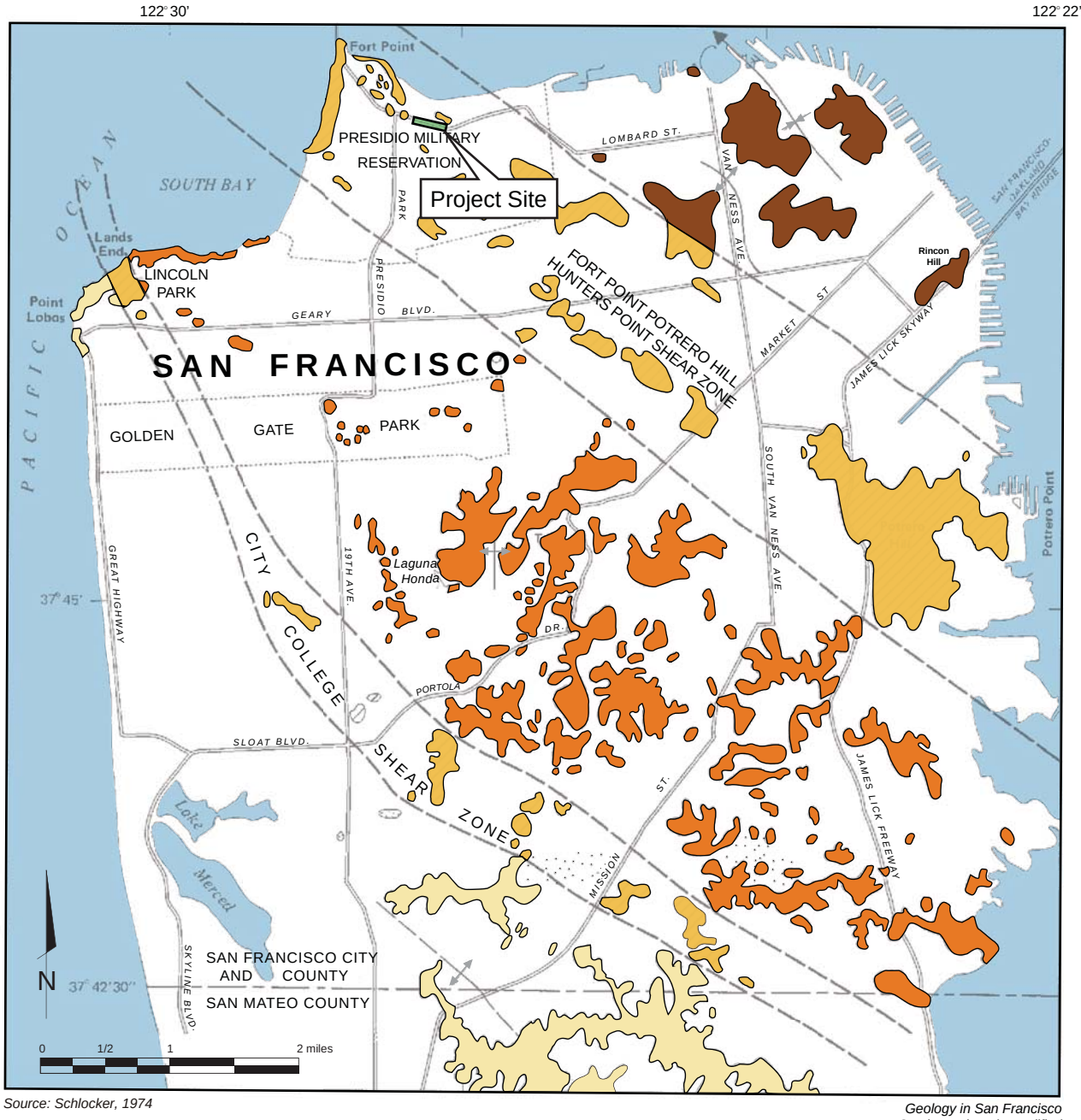


Figure 2

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations
Battery Tunnels



Source: Schlocker, 1974

Geology in San Francisco South quadrangle modified after Bonilla (1965)

QUATERNARY

Surficial deposits

CRETACEOUS AND JURASSIC (?)

Great Valley Sequence

Sandstone and shale Rocks in the Point Lobos area, west at the City College shear zone are tentatively assigned to the Great Valley sequence

Franciscan Formation

Radiolarian Chert, greenstone, and some sandstone and shale

Sandstone and shale

Sheared rocks Includes fragments of Franciscan Formation, Great Valley sequence, and serpentine

Contact

Anticline

Syncline

GENERALIZED GEOLOGY OF SAN FRANCISCO

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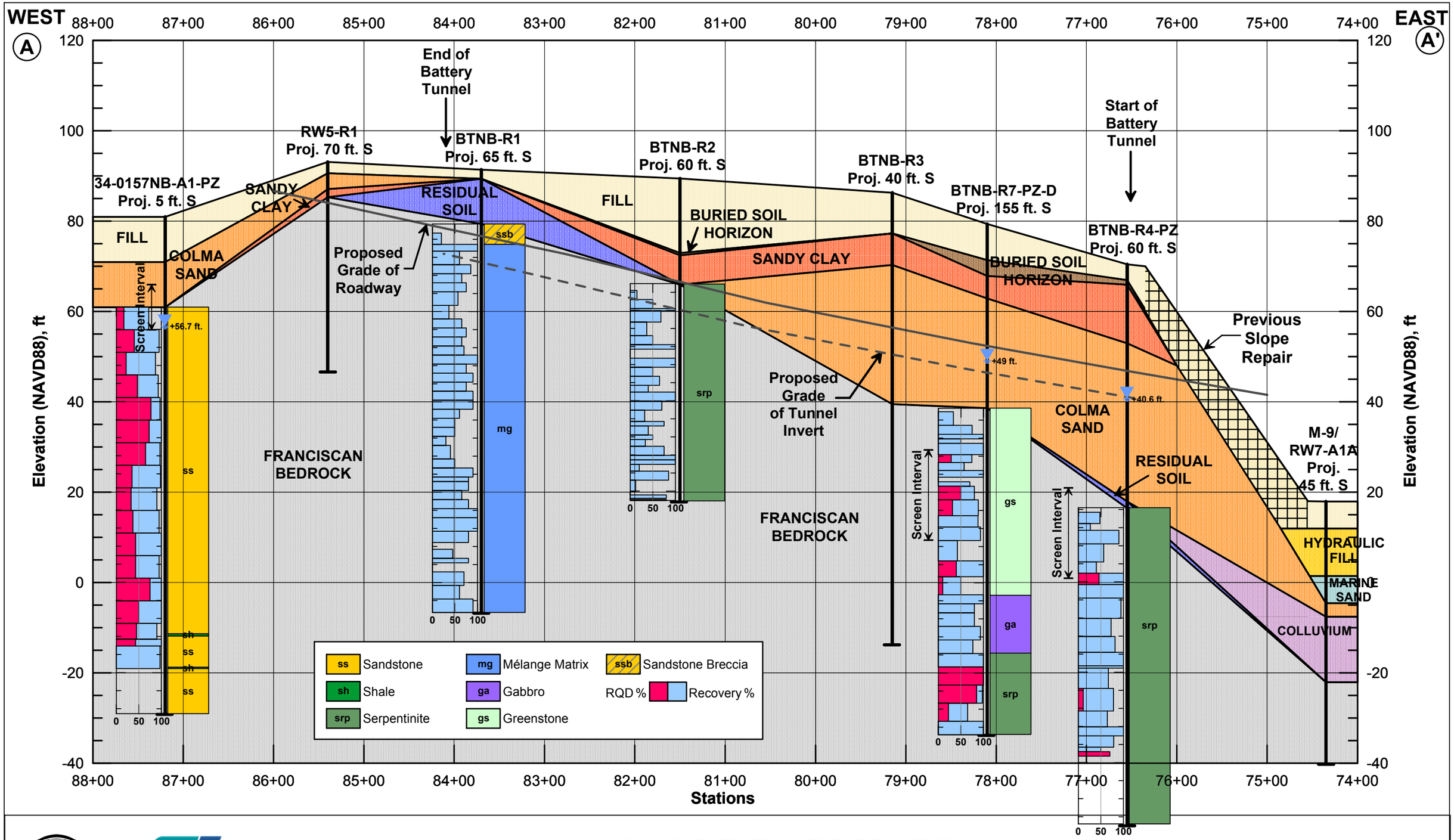
Q:\131558\4a Arup Internal Project Data\4a-15 Geotech\4a-015-006 Drawings\Generalized Geology.ai

FIGURE 3



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section A-A'
Along Northbound Battery Tunnel (Bridge No. 34-0161R)

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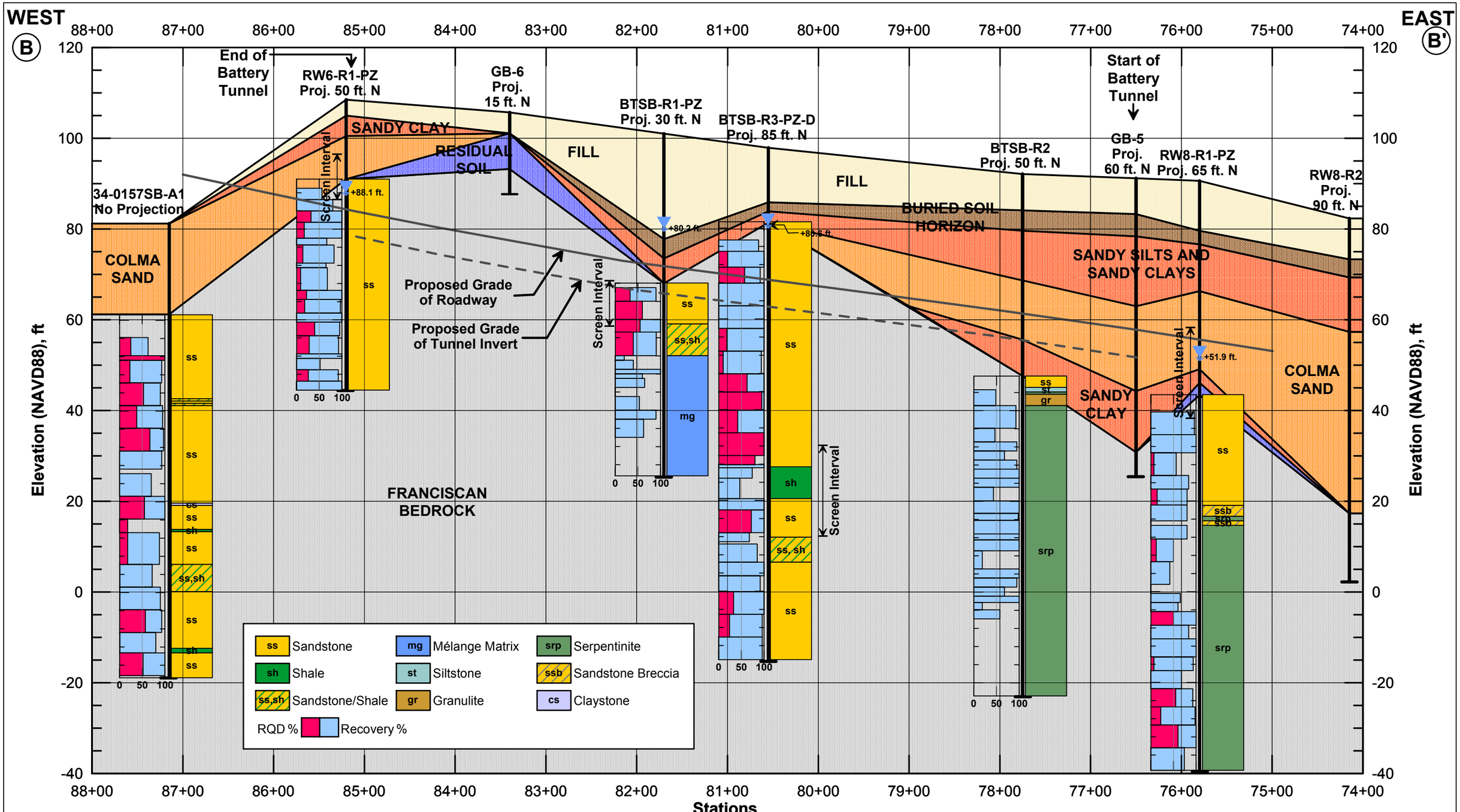
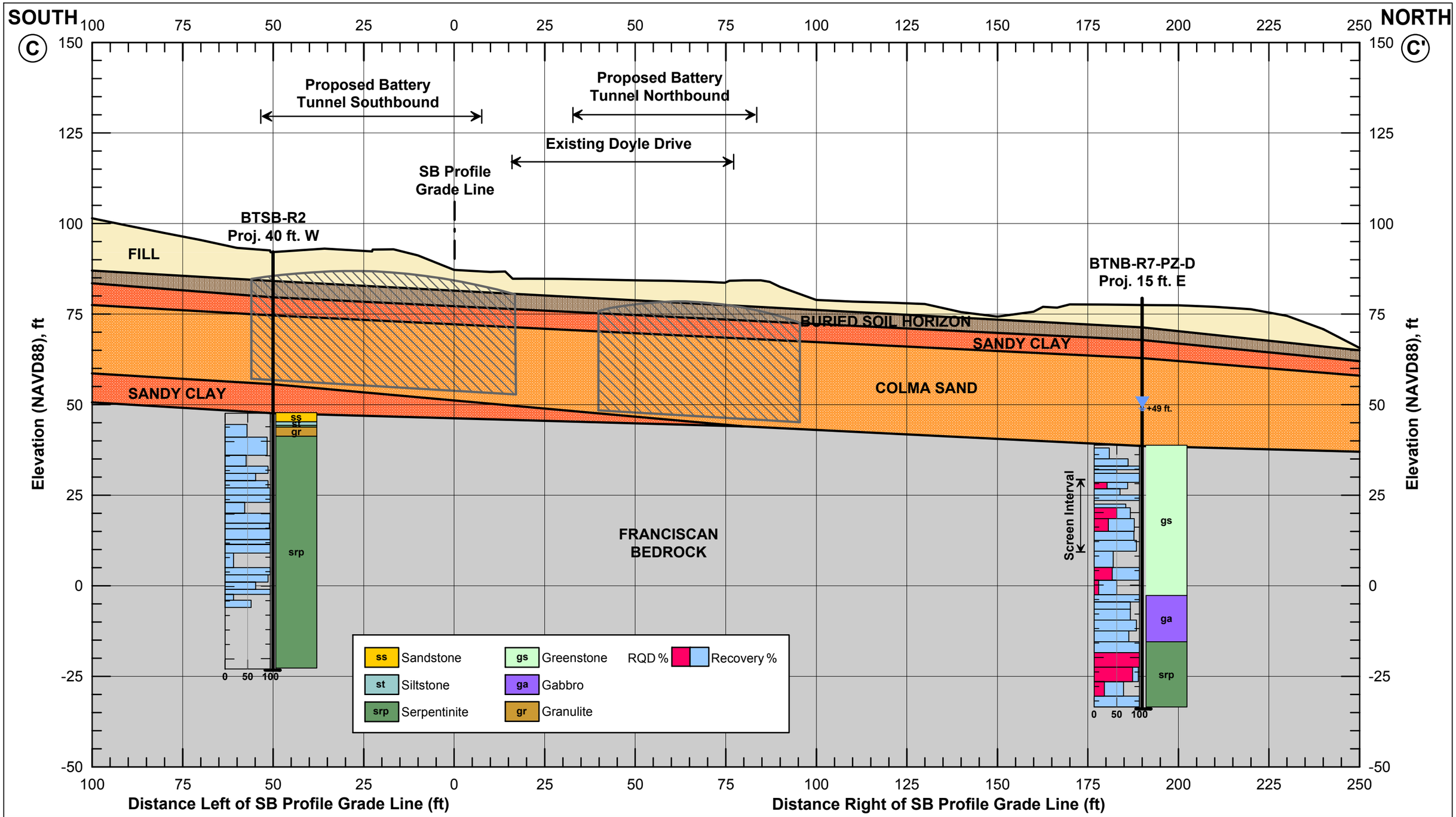
Figure 4



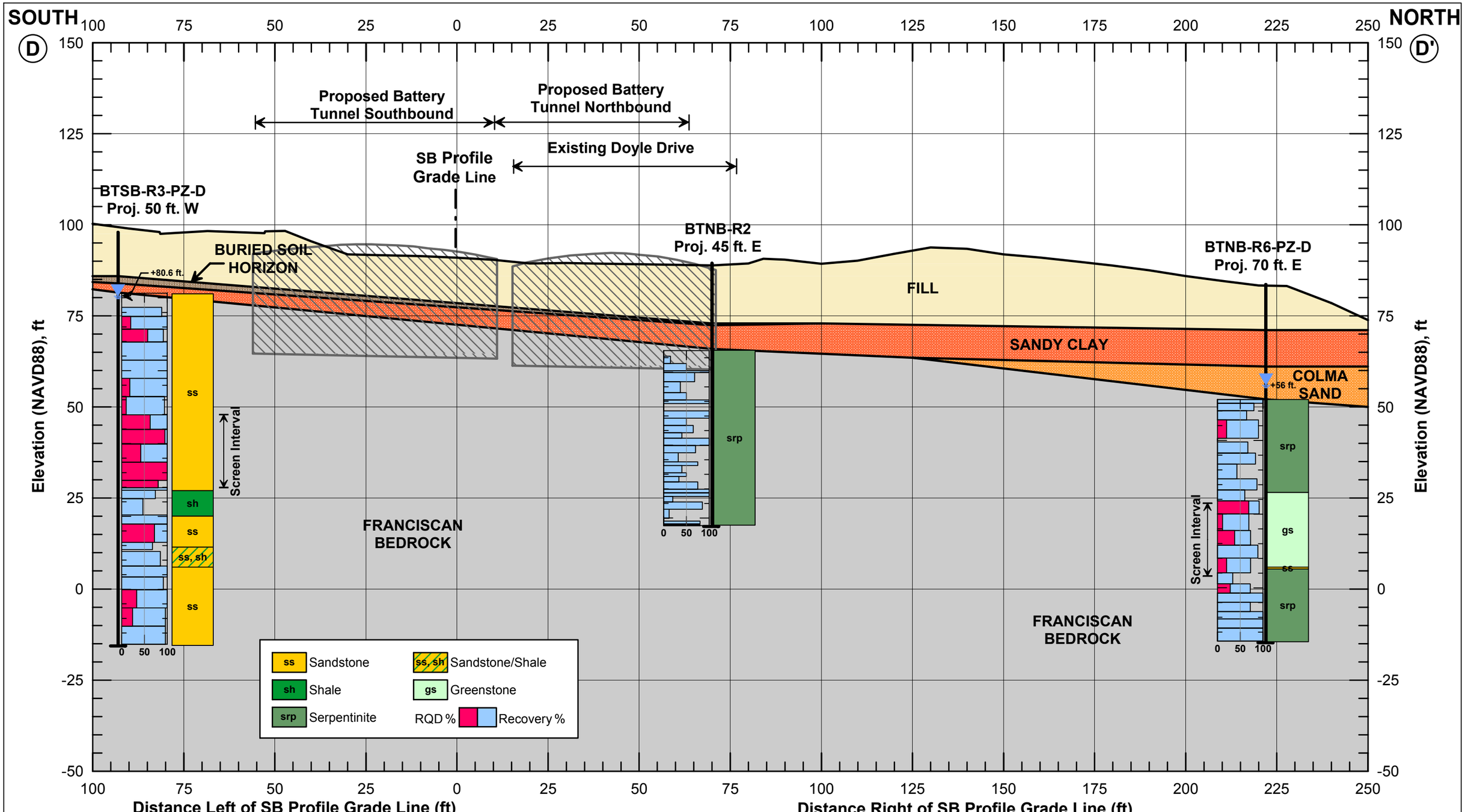
DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section B-B'
Along Southbound Battery Tunnel (Bridge No. 34-0161L)

Figure 5



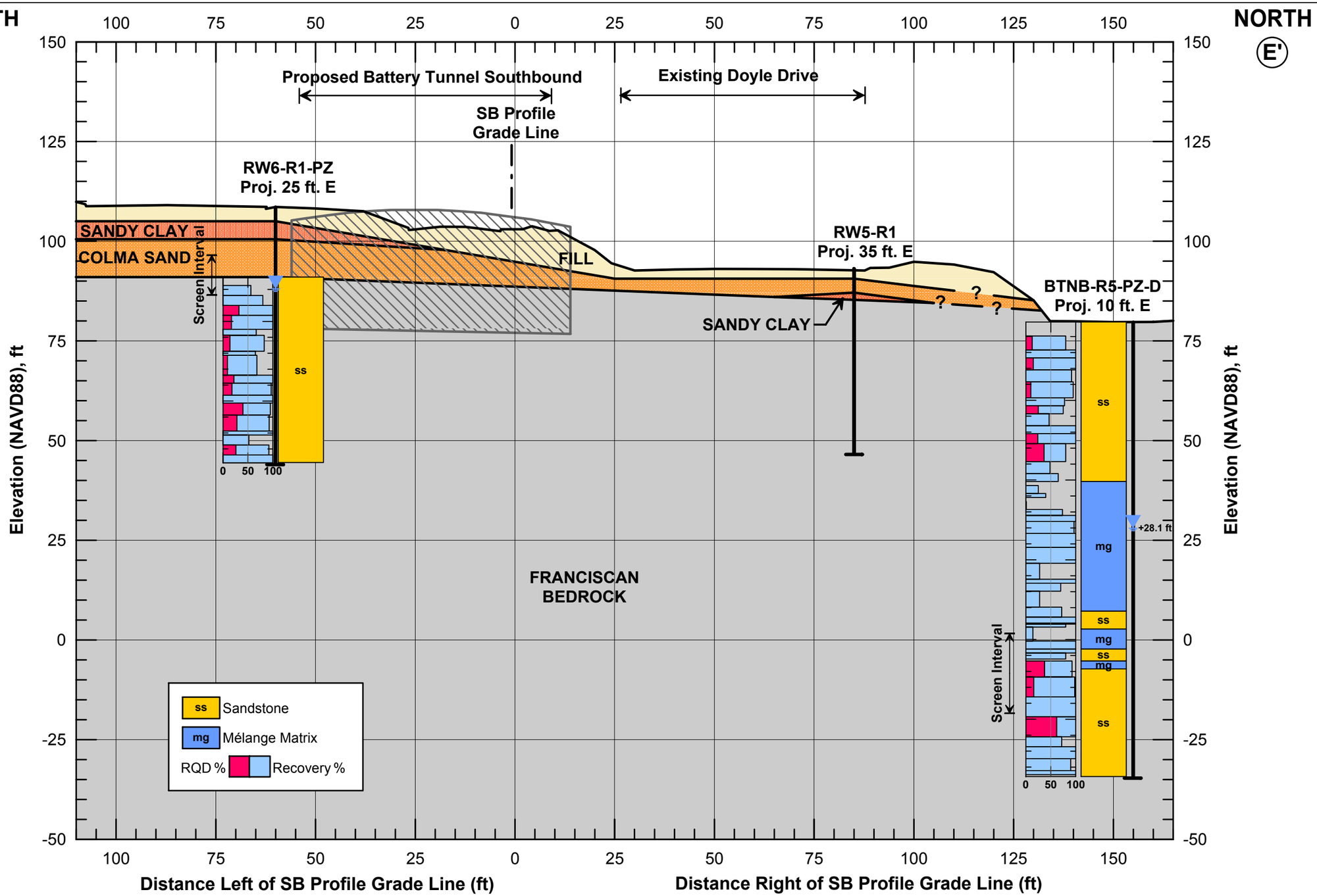
DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Cross Section C-C'
Transverse Cross Section at Station 78+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 6



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section D-D'
Transverse Cross Section at Station 81+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 7



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy, Section E-E'
Transverse Cross Section at Station 85+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 8

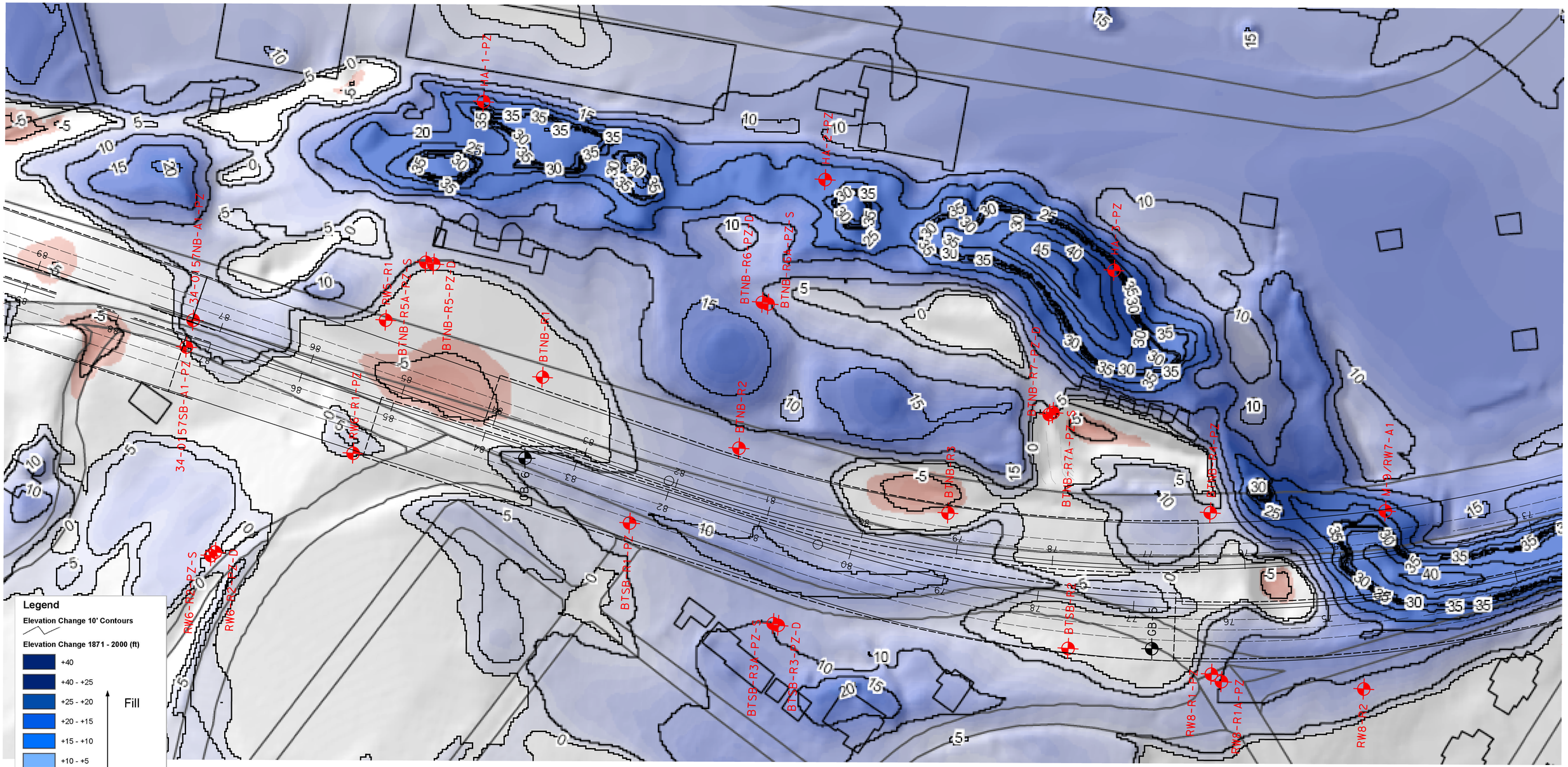


Figure 9

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

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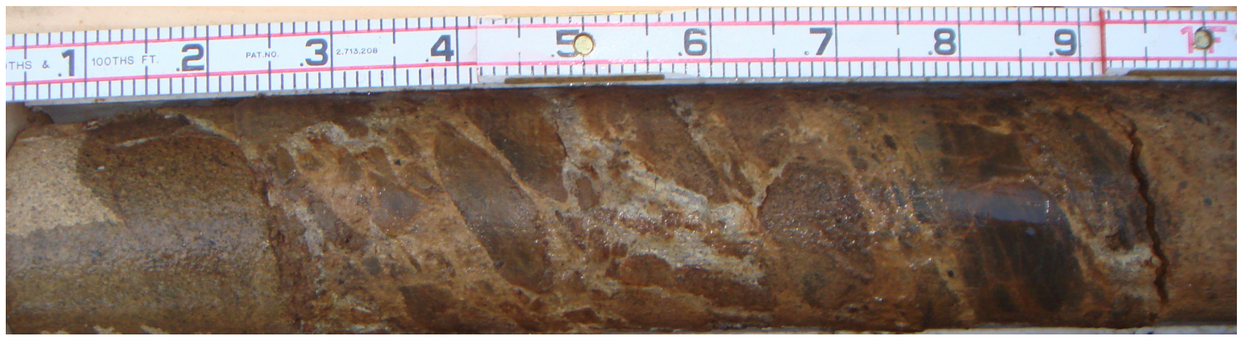
DOYLE DRIVE REPLACEMENT PROJECT
Map of Presidio Showing Comparison Between 1871- and 2000-year Contours



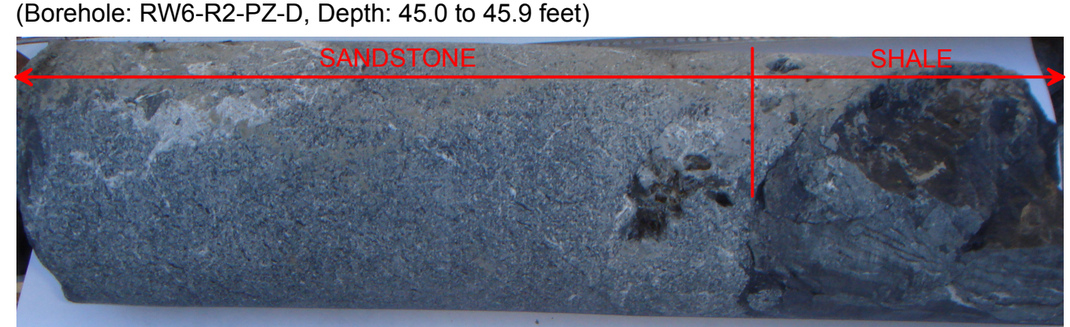
Brecciated Sandstone: Small blocks of sandstone filled around by soft white clay.
(Borehole: RW8-R1-PZ, Depth: 51.2 to 51.95 feet)

Mélange Matrix: Sandstone blocks within a Sheared Shale Matrix.
(Borehole: BTNB-R5-PZ-D, Depth: 49.5 to 50.5 feet)

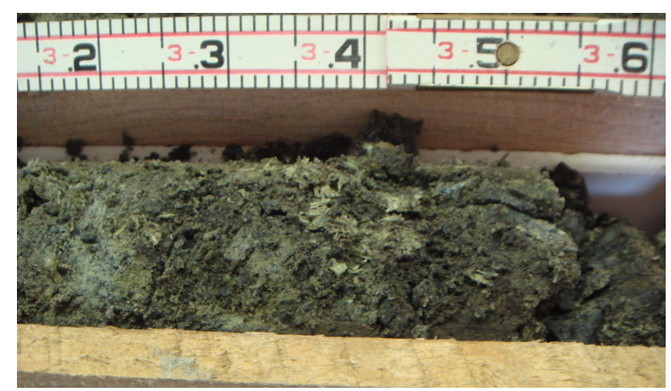
Slickensides: Evidence of shearing on fracture surface in sandstone.
(Borehole: BTSB-R1, Depth: 35.9 feet)

Slickensides: Evidence of shearing on fracture surface in serpentinite. Secondary white mineral deposit on fracture surface.
(Borehole: BTNB-R2, Depth: 61.8 feet)

Mylonized Sandstone: Very intensely weathered and sheared. Comprised of up to 50% clay.
(Borehole: RW6-R2-PZ-D, Depth: 45.0 to 45.9 feet)



Sandstone and Shale: Bedding distorted by soft sediment deformation and micro-faulting. Surface of core is pitted.
(Borehole: BTSB-R1, Depth: 45.5 to 46.3 feet)



Fibrous Texture: Fibers (asbestos?) present in serpentinite.
(Borehole: BTNB-R2, Depth: 37.5 to 37.9 feet)

PHOTOGRAPHS OF TYPICAL GEOLOGIC FEATURES

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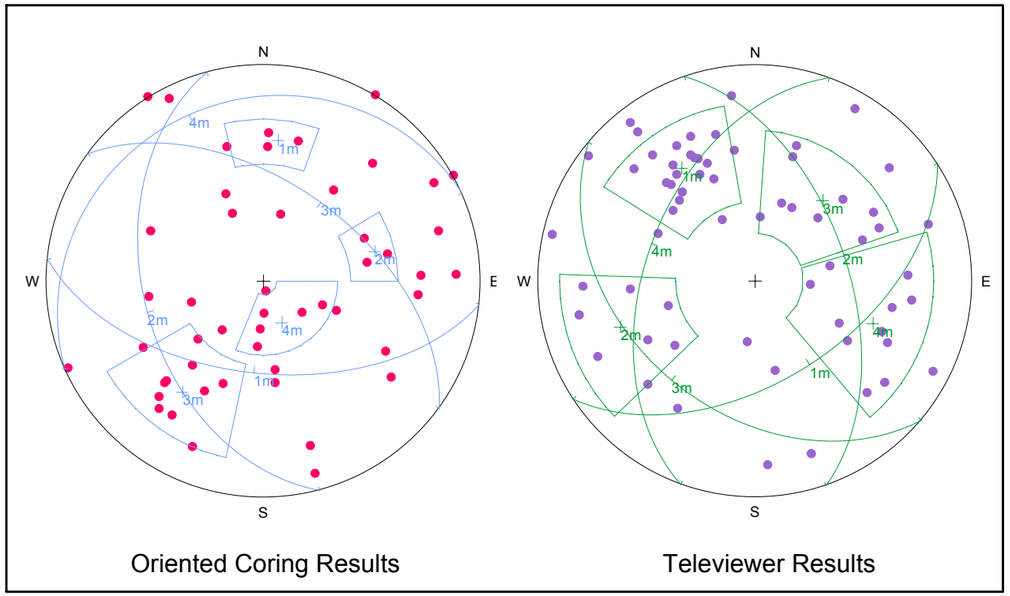
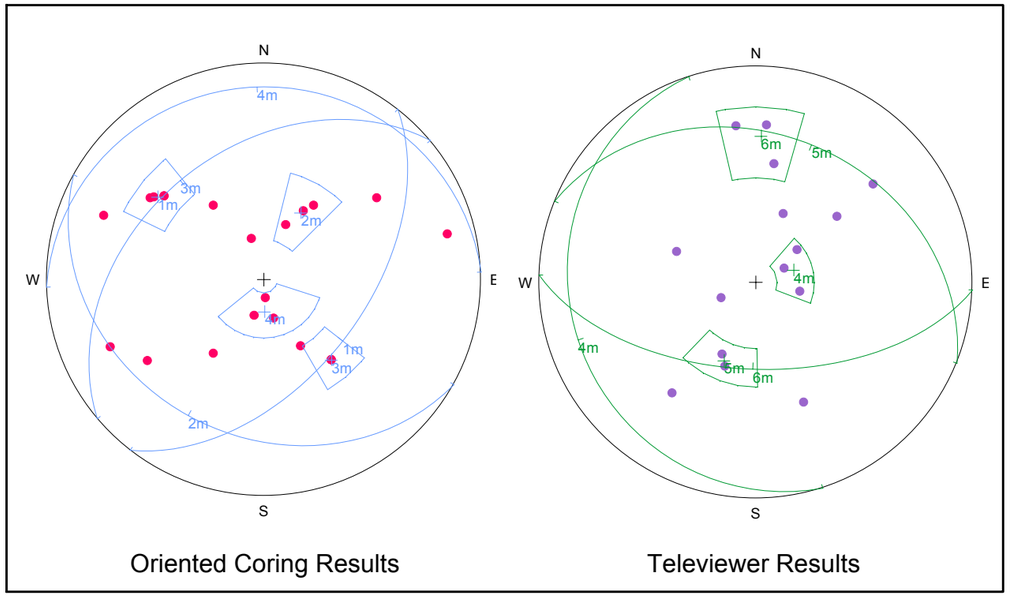
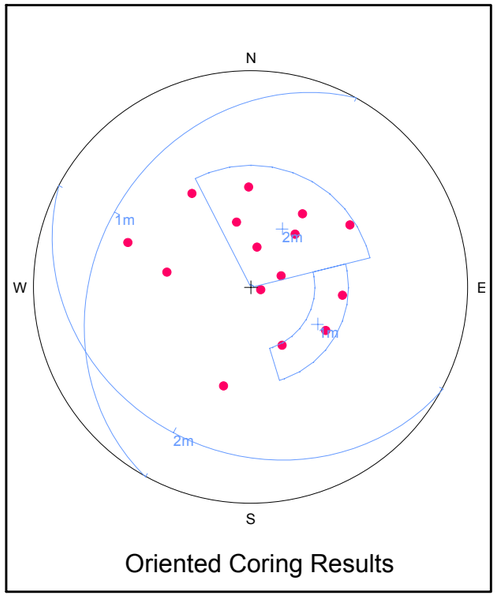
FIGURE 10



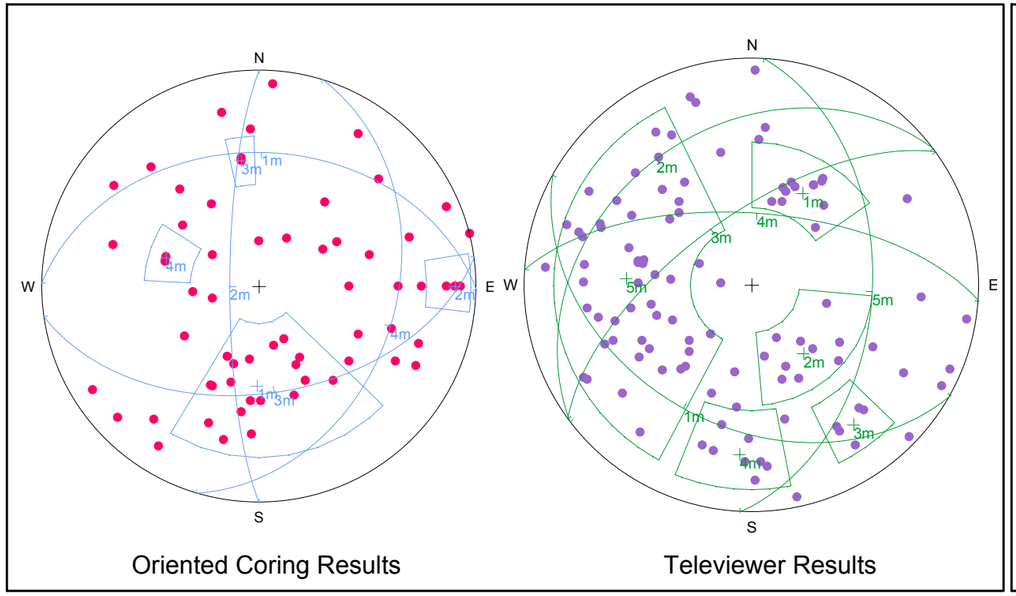
Borehole: BTNB-R5-PZ-D



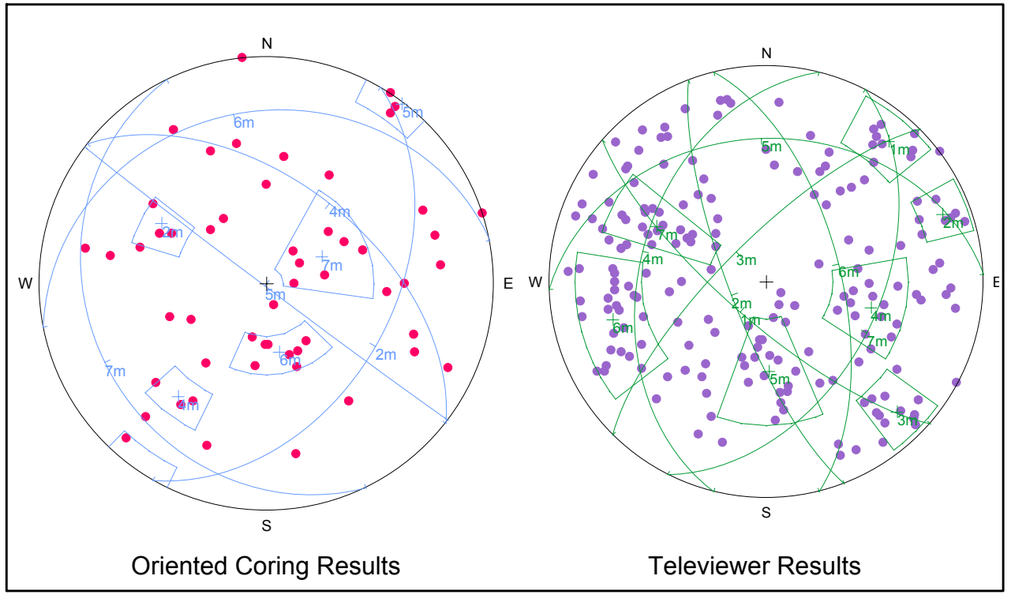
Borehole: BTNB-R7-PZ-D



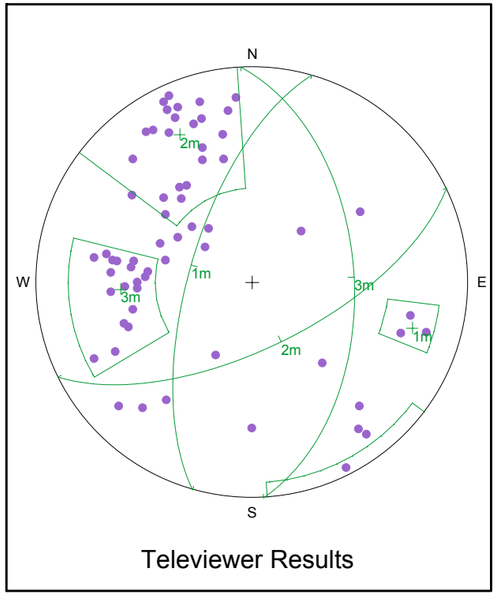
Borehole: BTNB-R6-PZ-D



Borehole: BTSB-R3-PZ-D



Borehole: RW6-R2-PZ-D



Borehole: RW6-R1-PZ

Notes:
1.) Stereonet plots are equal area, lower hemisphere projections.
2.) Groupings of similar rock orientations are shown on each plot along with the corresponding pole location.
3.) An acoustic televiewer test was not performed in Borehole BTNB-R6-PZ-D. Oriented Coring was not performed in borehole RW6-R1-PZ

COMPARISON OF RESULTS FROM ACOUSTIC TELEVIEWER TESTS AND ORIENTED ROCK CORING TESTS PLOTTED ON STEREONETS

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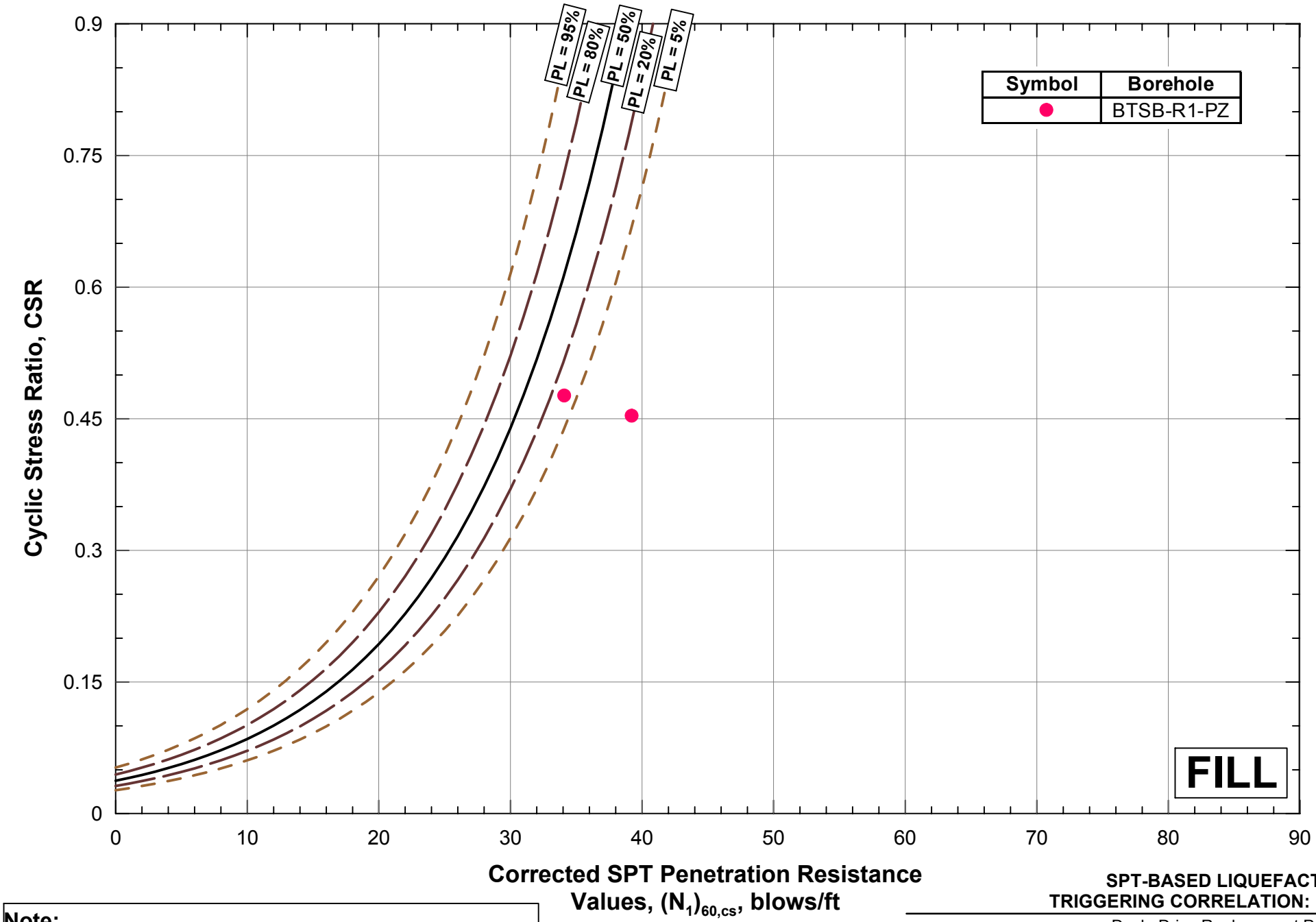
FIGURE 11



Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: FILL

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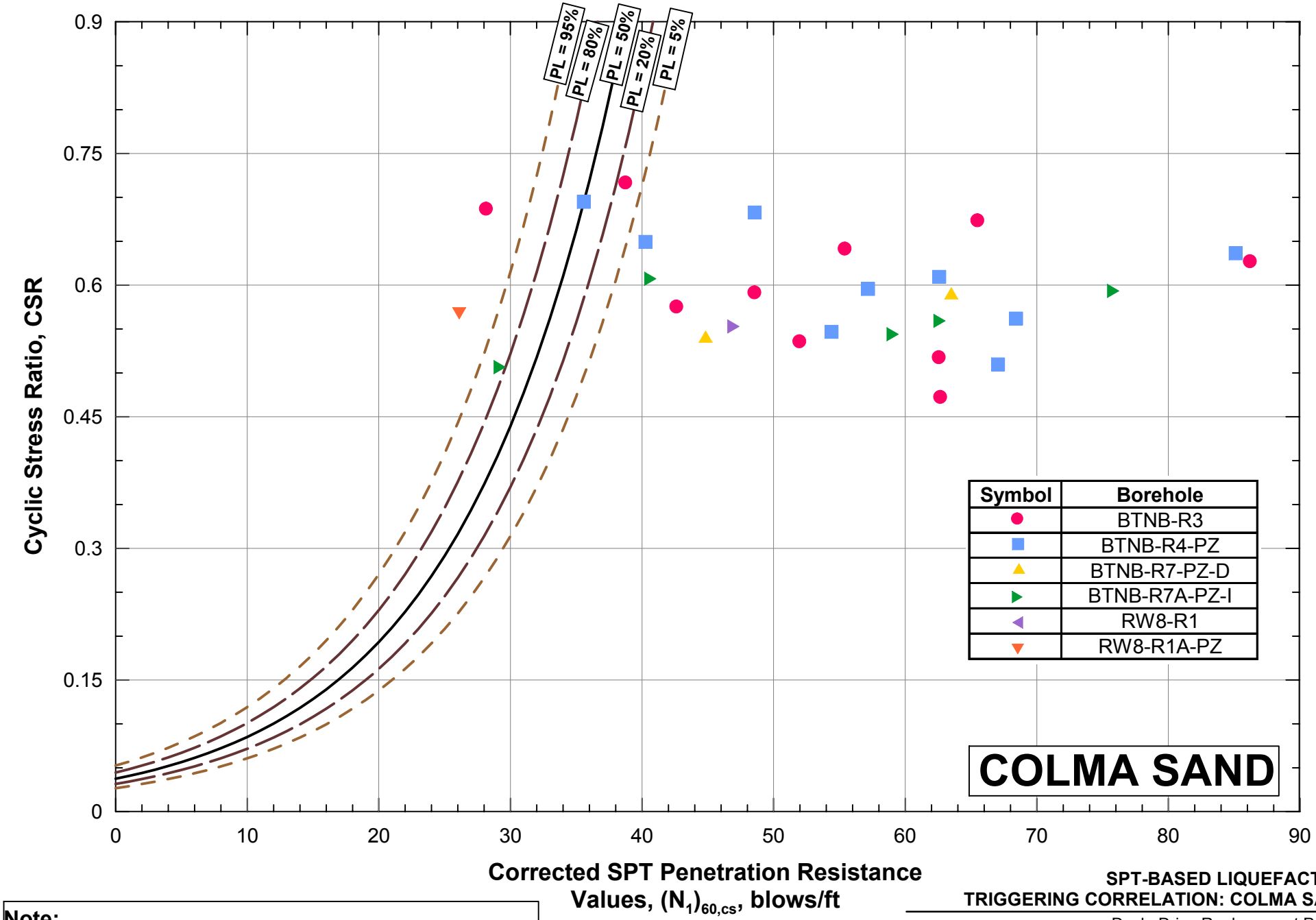
FIGURE 12

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationFILL Battery.grf



Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: COLMA SAND

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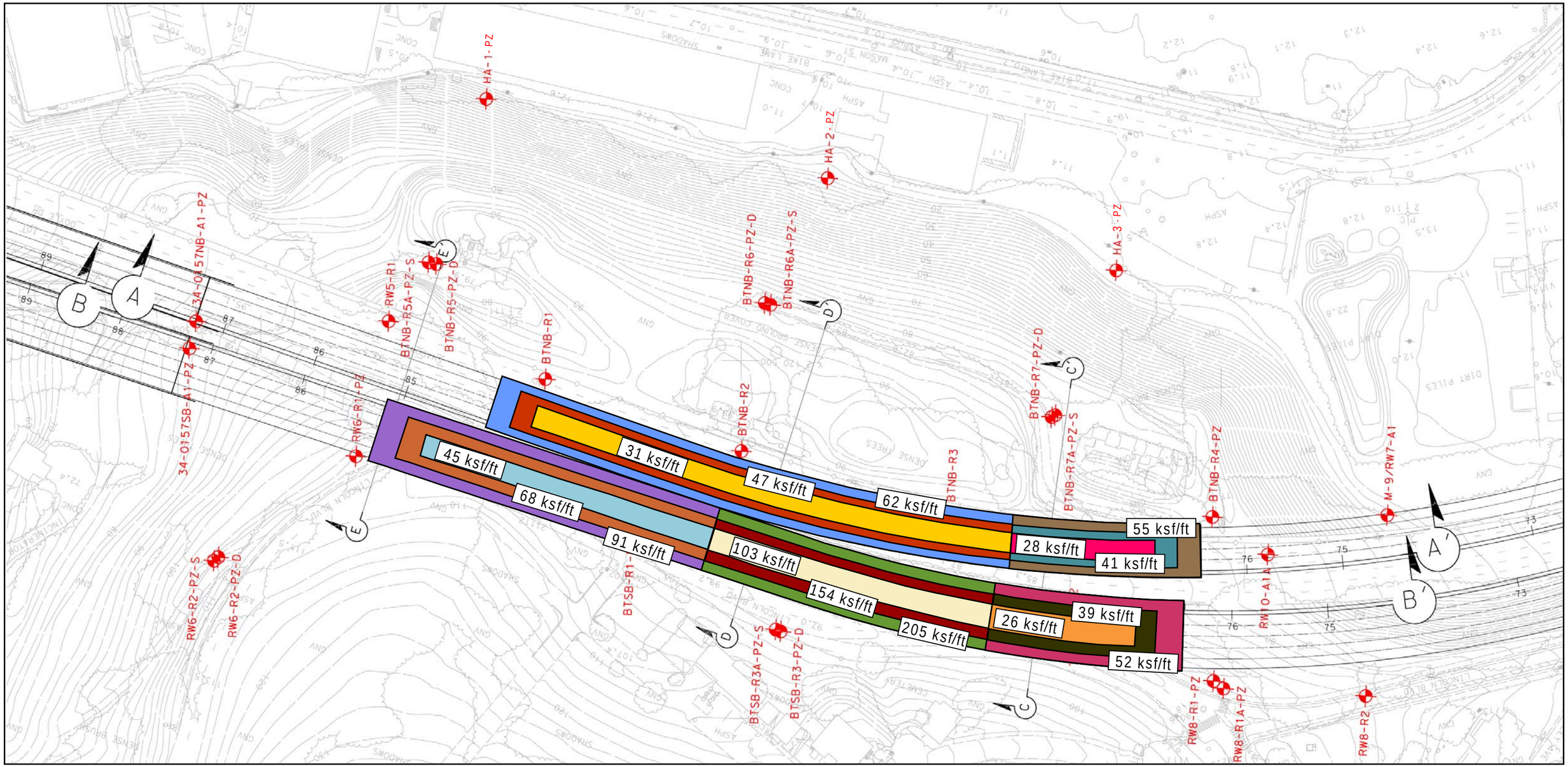
FIGURE 13

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationCOLMA Battery.grf



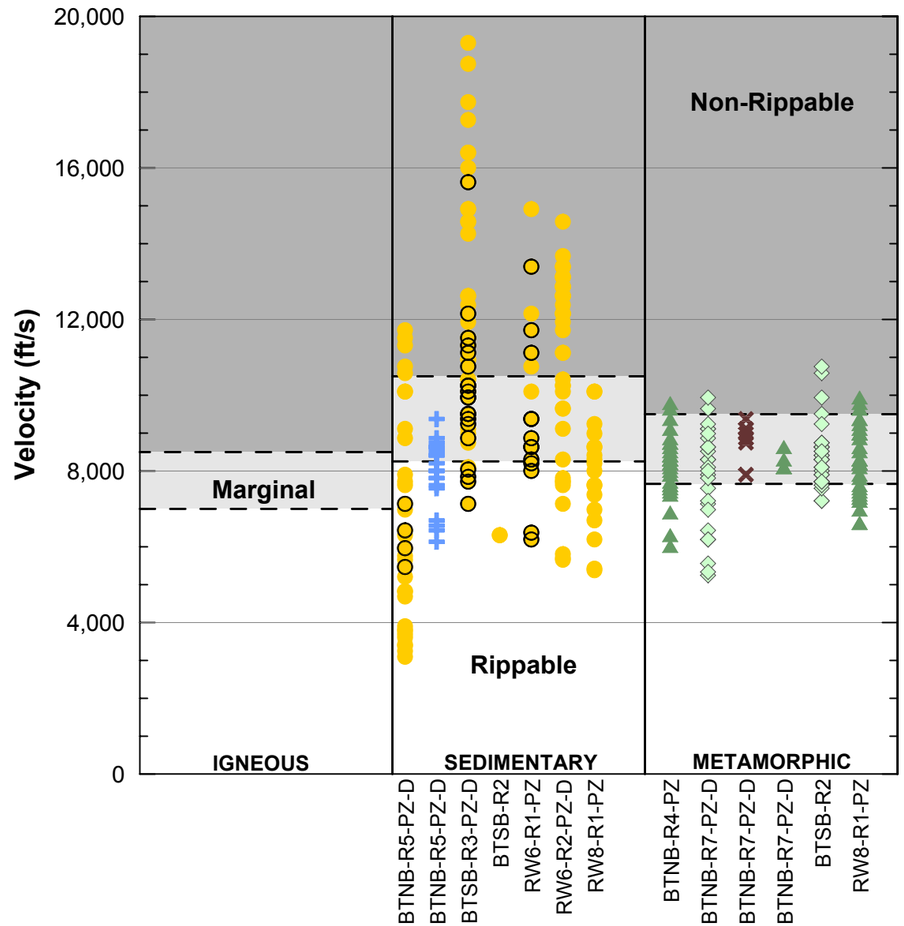
k_S = 62 ksf/ft	k_S = 28 ksf/ft	k_S = 154 ksf/ft
k_S = 47 ksf/ft	k_S = 91 ksf/ft	k_S = 103 ksf/ft
k_S = 31 ksf/ft	k_S = 68 ksf/ft	k_S = 52 ksf/ft
k_S = 55 ksf/ft	k_S = 45 ksf/ft	k_S = 39 ksf/ft
k_S = 41 ksf/ft	k_S = 205 ksf/ft	k_S = 26 ksf/ft

ESTIMATED VERTICAL SPRING CONSTANTS BELOW THE BATTERY TUNNELS

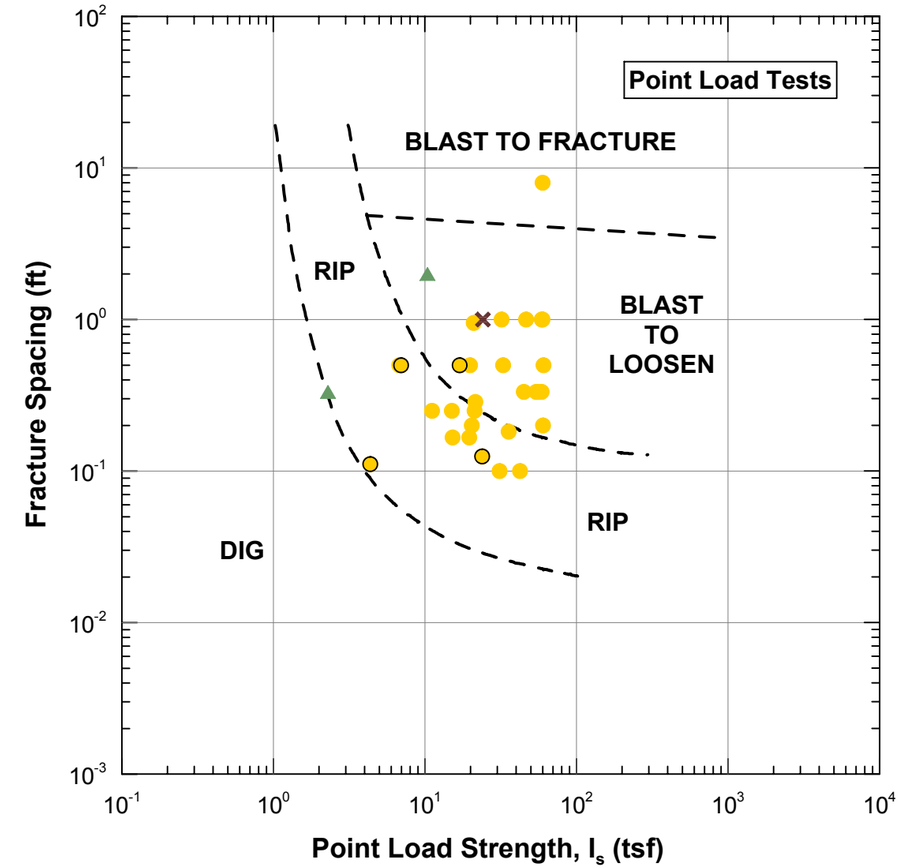
Doyle Drive Replacement Project
Battery Tunnels Preliminary Foundation Report
San Francisco County Transportation Authority
January 2009 San Francisco, California

ARUP PB joint venture

FIGURE 14



Symbol	Rock Identification
●	Sandstone Within 10' Of Excavation
●	Sandstone >10' Below Excavation
×	Gabbro Below Excavation
+	Melange Matrix Below Excavation
▲	Serpentinite Below Excavation
◇	Greenstone Below Excavation



Symbol	Rock Type
×	Gabbro
●	Sandstone At or Above Foundation
●	Sandstone Below Foundation
▲	Serpentinite

Notes:

1.) Excavatability of rock based on criteria as shown in Fig. 8 of Naval Facilities Engineering Command, Design Manual 7.02 (1986).
2.) Blasting criteria are as shown in Fig. 9 of Naval Facilities Engineering Command, Design Manual 7.02 (1986).
3.) Velocity data presented is from P-wave results obtained from suspension velocity logging.

EMPIRICAL ESTIMATES OF EXCAVATABILITY OF ROCK BASED ON THE RESULTS OF POINT LOAD AND SUSPENSION VELOCITY TESTS

Doyle Drive Replacement Project
Battery Tunnels Preliminary Foundation Report
San Francisco County Transportation Authority
January 2009 San Francisco, California

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FIGURE 15

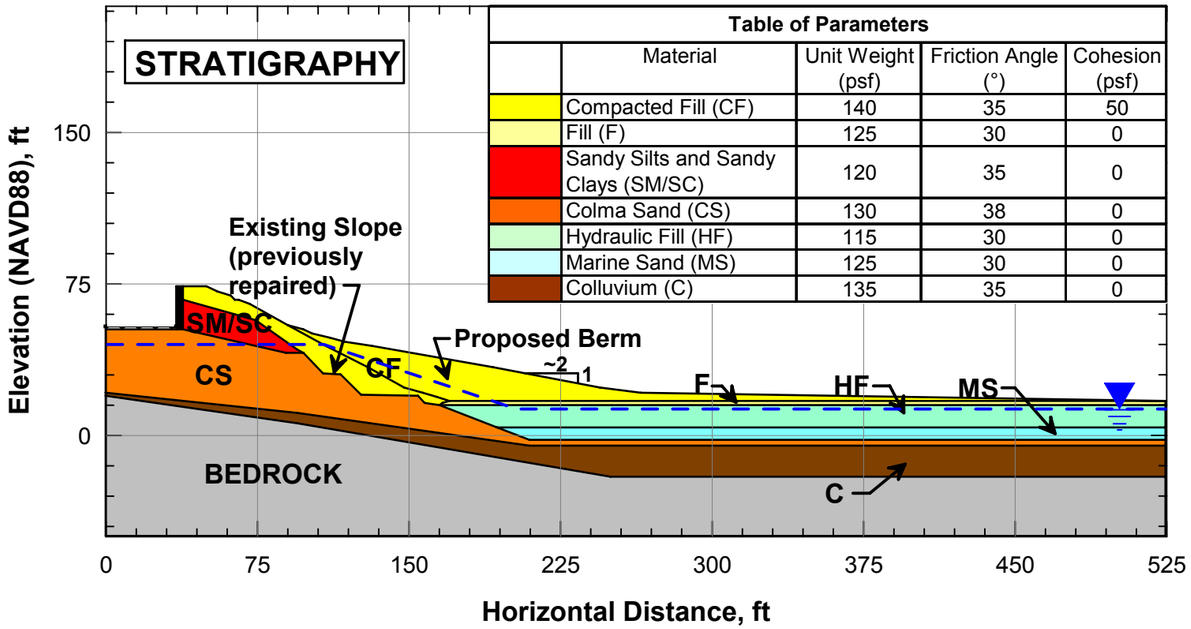
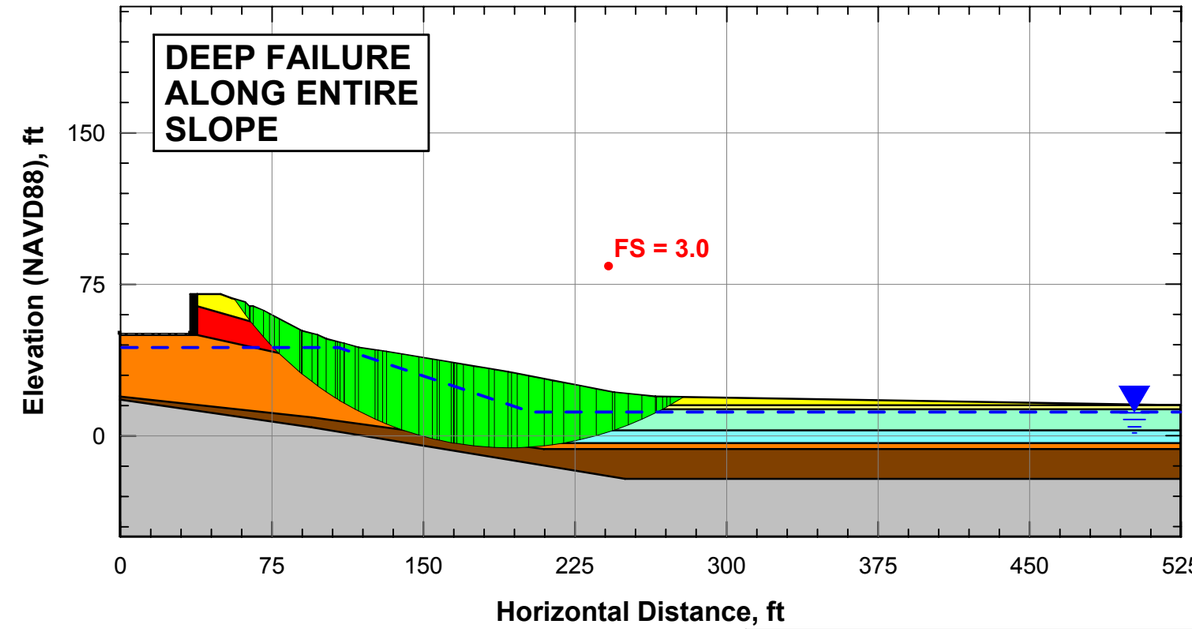
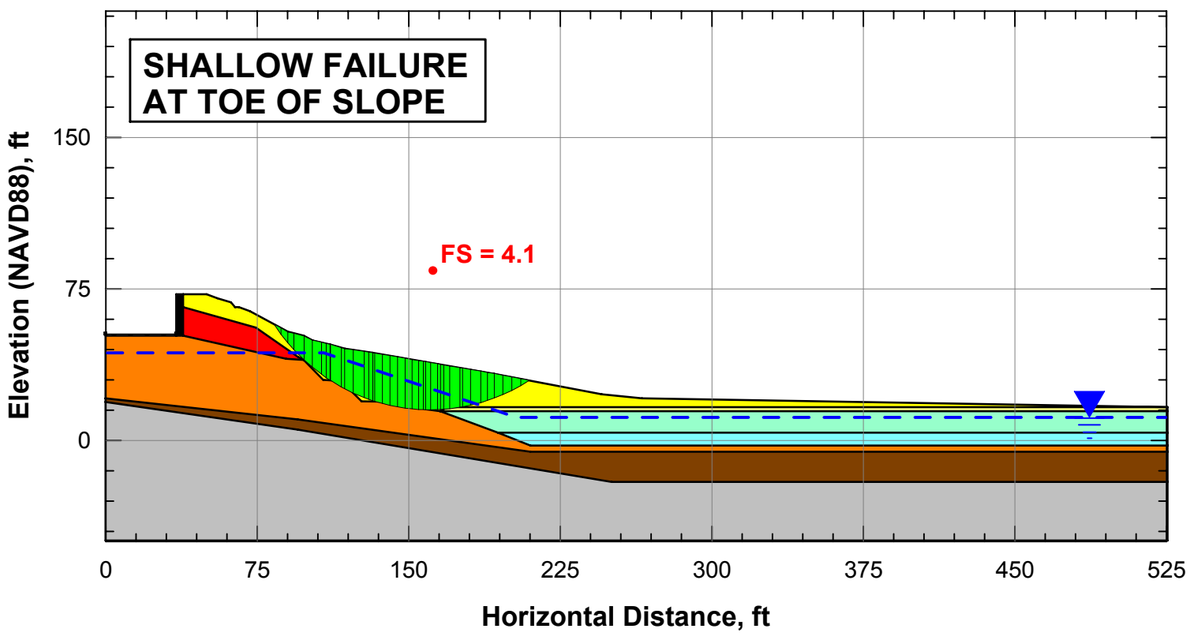
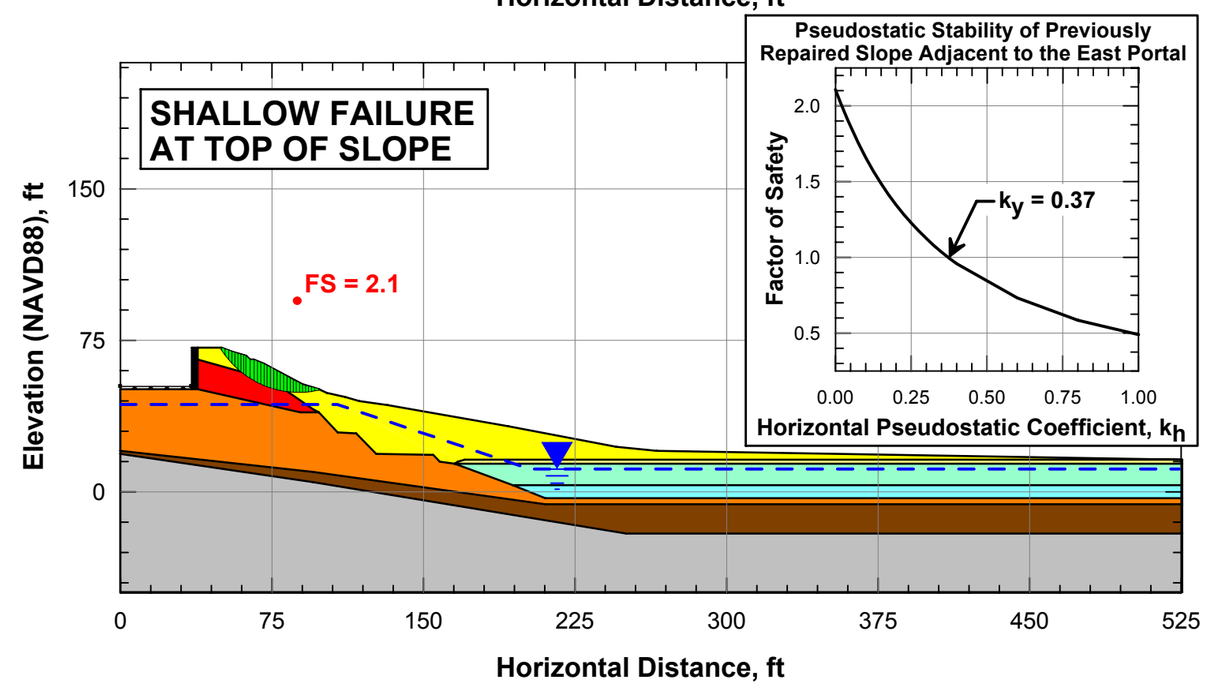


Table of Parameters			
Material	Unit Weight (psf)	Friction Angle (°)	Cohesion (psf)
Compacted Fill (CF)	140	35	50
Fill (F)	125	30	0
Sandy Silts and Sandy Clays (SM/SC)	120	35	0
Colma Sand (CS)	130	38	0
Hydraulic Fill (HF)	115	30	0
Marine Sand (MS)	125	30	0
Colluvium (C)	135	35	0







Notes:
1.) Factors of Safety calculated using Spencer Method.

STABILITY ANALYSIS OF THE PROPOSED BERM AT THE EAST PORTAL OF THE NORTHBOUND BATTERY TUNNEL

Doyle Drive Replacement Project
Battery Tunnels Preliminary Foundation Report
San Francisco County Transportation Authority
January 2009 San Francisco, California

ARUP PB joint venture

FIGURE 16

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stability Calcs\Battery Tunnel\East_Portal_Cut_2.grf

Appendix A

Review Comment Summary and Resolution

REVIEW COMMENT SUMMARY AND RESOLUTION

Submittal: Draft Preliminary Foundation Report for Battery Tunnels - NB & SB (Bridge No 34-0161 L/R), Doyle Drive Replacement Project		CODE	**A** - Accept Comment (correct, add, clarify) **B -** Will not incorporate **C** - Resolution of comment in next submittal
Circulated by: ARUP PB Joint Venture	Date:4/15/2008		

Comment No.	Dwg or Page No. (1)	Reviewer/Entity (2)	Reviewer's Comments (3)	RESPONSE			Final Disposition (5)		
				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
1	1	T.Nguyen/ M.Momezadeh, CT	Section 2.2 Site Specific Subsurface Conditions: Figure 2 shows subsurface cross section from only borings located along southbound SR 101. Subsurface cross section for northbound SR 101 should also be developed to describe subsurface condition for Br. No 34-0161R. Add Stations along the subsurface stratigraphy figures. For ease of design, define geological units, significant strength and deformation parameters in a table form or place these below each of the geological units. Please describe soil/rock material characteristics along the tunnel foundation grade. Include information such as, unit	A	F. Greguras, Arup PB JV	A subsurface cross section has been developed along the Northbound Tunnel (Bridge No. 34-0161R), Figure 4, in the finalized Preliminary Foundation Report. The southbound subsurface cross section has been relabeled Figure 5. Also, transverse subsurface sections have been added (Figures 6 through 8). Stations have been placed on the subsurface sections. Rock recoveries and RQD values have been added to the subsurface cross sections. Preliminary characteristics for the soil and rock are presented in Tables 7 and 8 of the finalized Preliminary Foundation Report.			

(1) Indicate Drawing No. or Page No. or use "G" for General Comment

(2) Example: J. Smith, CT

Entity: CCTA = Authority; CT = Caltrans; P = Parsons & Subconsultants

(3) If no comment, write "NO COMMENT"

(4) To be filled out by Design Manager <or should this be Discipline Manager> or designee

(5) To be determined at Review Meeting or in subsequent meeting/discussion

REVIEW COMMENT SUMMARY AND RESOLUTION

Submittal: Draft Preliminary Foundation Report for Battery Tunnels - NB & SB (Bridge No 34-0161 L/R), Doyle Drive Replacement Project		CODE	**A** - Accept Comment (correct, add, clarify) **B -** Will not incorporate **C** - Resolution of comment in next submittal
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Comment No.	Dwg or Page No. (1)	Reviewer/Entity (2)	Reviewer's Comments (3)	RESPONSE			Final Disposition (5)		
				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
			weights, shear strength, settlements, and modulus parameters. Additional information such as swelling index/EI index/activity for cohesive soils, unconfined compressive strength and slake durability (for fine grain rock) for rock zones, etc. should be also identified based on laboratory and/or in-situ testing. Please address dune sand and effects of the disturbance on its strength characteristics as well.			Slake durability results for the soft, fine-grained rock are presented in Table 8. Also, the excavatability of the harder rock is shown on Figure 15 and is discussed in Section 9.2 of the Preliminary Foundation Report. A review of the borehole logs and recovered samples indicate that the extent of dune sand is limited near the Battery Tunnels. Discussion of subsurface conditions is presented in Section 3.2 of the Preliminary Foundation Report.			
2	G	T.Nguyen/ M.Momezadeh, CT	Boring logs should be included in the report. Also, groundwater records from piezometers should be included in the report.	A	F. Greguras, Arup PB JV	Boring logs are included in Appendix B of finalized Preliminary Foundation Report. Groundwater data from piezometers is presented in Table 6.			

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Comment No.	Dwg or Page No. (1)	Reviewer/Entity (2)	Reviewer's Comments (3)	RESPONSE			Final Disposition (5)		
				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
3	3	T.Nguyen/ M.Momezadeh, CT	Section 5.0 Seismic/Liquefaction: This section presents P-S velocity data in four boreholes. However, preliminary characteristics or conclusion were not included in the report.	A	F. Greguras, Arup PB JV	The suspension velocity test results are summarized in Section 2.2 and the summaries are plotted in Appendix C. Also, Appendix C presents a discussion on how the tests were performed.			
4	3	T.Nguyen/ M.Momezadeh, CT	Section 6.0 Foundation Type Recommendations: Settlement and differential settlement should be discussed for tunnels which are supported by mat foundations.	A	F. Greguras, Arup PB JV	Settlement and differential settlement discussion is presented in Section 7.1 for the grade supported tunnel foundations.			
5	3	T.Nguyen/ M.Momezadeh, CT	Section 6.0 Foundation Type Recommendations: Please check a consistency of the term "spring constant" with kip/ft^3 unit. Before lateral earth pressures section, please discuss the wall type options and selecting	A	F. Greguras, Arup PB JV	Modulus of subgrade reaction "spring constant" unit is revised to kips/ft^2/ft in Sections 7.1 and 7.2. Wall type options and selection criteria are added to finalized Preliminary Foundation Report Sections 8			

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Comment No.	Dwg or Page No. (1)	Reviewer/Entity (2)	Reviewer's Comments (3)	RESPONSE			Final Disposition (5)		
				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
			criteria. The scheme of the retaining walls for cut and cover support, tunnel structure and its foundation are not clear in the report.			and 9.			
6	4	T.Nguyen/ M.Momezadeh, CT	Section 7.2 Lateral Earth Pressures: At-rest lateral earth pressures of 65z psf were preliminarily estimated and proposed for tunnels. Please clarify geotechnical engineering properties of backfill for this pressure estimation. Please clarify the shape of the assumed pressure distribution with depth. Are the retaining walls for this tunnel temporary or they will be long term integrated in the tunnel structure? If they are temporary, address the lateral pressure criteria on the tunnel structures.	A	F. Greguras, Arup PB JV	Design parameters for lateral earth pressures are presented in Table 10 and recommended earth pressure values are discussed and presented in Sections 8 and 9. Discussion is presented in Section 9.3 for temporary and diaphragm retaining walls.			

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				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
			Similar to Main Post Tunnel, stress and deformation of the retaining and tunnel structures plus foundation should be analyzed for design seismic loading.			For preliminary design, we recommend using a seismic pressure of 19H (Section 8.2). Final design will be based on site specific seismic hazard analysis.			
7	4	T.Nguyen/ M.Momezadeh, CT	Section 8.0 Construction Concerns: Groundwater issue should be discussed in this section. Include constructability and issues related to the preferred retaining wall system.	A	F. Greguras, Arup PB JV	Construction dewatering requirements for temporary soldier pile walls is discussed in Section 9.1 and groundwater control measures for the tunnels are discussed in Section 9.4.			
8	5	T.Nguyen/ M.Momezadeh, CT	Section 9.0 Additional Field Work and Laboratory Testing: The report states that "The program will consist of laboratory tests that will determine the geotechnical engineering properties of the major soil units". Does this program plan for rock samples? Please clarify.	A	F. Greguras, Arup PB JV	Testing of the rock was performed and results are summarized in Table 8.			

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				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
9	1	RNashed/ GWilcox CT	Section 2.1 General Geology – The phrase of "with Bay Mud at the surface underlain" should be omitted, since no Bay Mud present in the western part of the project including the Battery Tunnel section).	A	F. Greguras, Arup PB JV	Clarification that no Bay Mud is present in western part of project is presented in Section 3.1 of the finalized Preliminary Foundation Report.			
10	1	GWilcox CT	Section 2.2 Site Specific Subsurface Condition – What is the evidence to support artificial fill at this location? The topography doesn't lend itself to that interpretation. Is there other evidence or only the soil description from the boring?	A	F. Greguras, Arup PB JV	Based on a GIS map produced by Presidio Archaeologist comparing 1871 and 2000 topography contours, there is evidence of filling in the area of Battery Tunnels. This discussion is presented in Section 3.2 and shown on Figure 9.			

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				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
11	2	GWilcox CT	Section 2.2 Site Specific Subsurface Condition – The lower portion of the tunnel has lower stiff clay not upper stiff clay (as shown on subsurface stratigraphy, section A-A')/ with no stiff clay at the extreme Western end of the Battery tunnel.	A	F. Greguras, Arup PB JV	Confusing terms "lower" and "upper" have been removed from subsurface condition descriptions in our Site Geology and Subsurface Conditions (Section 3.0). Since issuing the draft Preliminary Foundation Report, samples have been reviewed and logs have been edited.			
12	2	GWilcox CT	Section 2.2 Site Specific Subsurface Condition – Should mention that these boulders of sandstone contained within the Franciscan Formation can be extremely large (over 200' across in some cases)	A	F. Greguras, Arup PB JV	Section 3.2 presents discussion that sandstone encountered is likely a large block within the Franciscan Formation.			
13	2	GWilcox CT	Section 2.3 Groundwater- when refer to "deep" stiff clay unit, it is assumed that you mean "lower" stiff clay unit? Please be consistent.	A	F. Greguras, Arup PB JV	Reference to "deep" and "lower" were removed from finalized Preliminary Foundation Report.			

(1) Indicate Drawing No. or Page No. or use "G" for General Comment

(2) Example: J. Smith, CT

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				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
14	2	GWilcox CT	Section 2.3 Groundwater- What do the other borings show for groundwater levels. Groundwater issues for the Battery Tunnels are very important and more details should be provided for this discussion. How are ground water issues to be dealt with? Is this to be handled in a separate report?	A	F. Greguras, Arup PB JV	Additional discussion regarding groundwater issues related to excavations and groundwater data is presented in the finalized Preliminary Foundation Report. Data was not available when the draft Preliminary Foundation Report was issued.			
15	3	GWilcox CT	Section 5.0 Seismicity / Liquefaction – Briefly explain why liquefaction conditions do not exist at the Battery Tunnels area. The x-sections shows dune sand (described as "free of fines" i.e. clean?) with ground water over bedrock. The fill is also described as a clean sand (loose) and sand with clay. Why would neither of these conditions not be susceptible to liquefaction? To	A	F. Greguras, Arup PB JV	Discussion presented in Section 6.0 explains why loose clean sands (fill) are not liquefiable above groundwater level and analyses are presented on Figure 12.			

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				Response Code (4)	By Whom/Entity (2)	Response Text (4)	"√"	By Whom/ Entity (2)	Date
			the average person these conditions might suggest this area would be a candidate for liquefaction.						

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Appendix B

Geotechnical Exploration Program and Logs by Others

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	5-31-08	6-1-08	N2120470.078 / E5994297.737 (NAD83)	BTNB-R1
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 77ft R Sta 83+61 NB Alignment	91.378 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Bulk, 101-Sampler			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill				98 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	3.75" ASPHALT CONCRETE, 7.5" UNREINFORCED CONCRETE.		S1										Bulk sample collected from 0 to 5'
	1	SILTY SAND with GRAVEL (SM), light brown, dry, SAND is fine to medium, GRAVEL is fine, angular to subangular. [FILL]												
89.38	2	SILT with SAND (ML), hard, brown and yellowish brown, dry, trace GRAVEL, GRAVEL is angular to subangular, with reddish brown mottling, rock-like structure (defined fracture planes). [RESIDUAL SOIL]												
	3			S2	13 24 40	64	100							
87.38	4			S3	14 28 36	64	50							
	5													
85.38	6	SILTY SAND (SM), very dense, brown to reddish brown, moist, trace GRAVEL, GRAVEL is fine to coarse, highly weathered sandstone fragments.												
	7													
83.38	8			S4	19 36 46	82	94							
	9			S5	32 50/ 5.5"	50/ 5.5"	70							
81.38	10													
	11													
79.38	12	SEDIMENTARY ROCK (Sandstone Breccia), reddish brown. [BEDROCK]												Rig chatter at 12'; switch to rock coring (101 system)
	13			S6	18 41 50/3"	91/9"	53							
77.38	14	Fine grained, yellowish brown, moderately weathered, core is broken, contains CLAY and SILT, SANDSTONE pieces are hard, with soft CLAYEY, thinly weathered portions.		C7			20	0						
	15													
75.38	16													
	17			C8			100	0						
73.38	18	SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C9			60	0						
	19													
71.38	20													
	21			C10			85	0						
69.38	22													
	23	23.0' - 23.4', SANDSTONE piece.		C11			65	0						
67.38	24													
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C12			75	0						
65.38	26														
	27		25.0' - 25.3', hard SILTSTONE piece. Grades with SANDSTONE, SILTSTONE, and SHALE fragments.		C13			57	0						
63.38	28														
	29														
61.38	30		30.0' - 30.8', slightly serpentinized or chloritized interval.		C14			37	0						
	31														
59.38	32														
	33		33.0', slightly weathered.		C15			65	0						
57.38	34														
	35		Grades with SHALE fragments.		C16			75	0						Begin Box 2 at 35'
55.38	36														
	37				C17			65	0						
53.38	38		37.5' - 38.3', moderately hard SILTSTONE fragments with some SERPENTINITE.												
	39				C18			70	0						
51.38	40														
	41				C19			100	0						
49.38	42		41.5' - 41.65', reddish brown (CHERT?) fragment. 42.0', SHALE fragments, moderately soft.												Losing circulation
	43		43.0', SILTSTONE and fine grained SANDSTONE fragments (up to 0.1 thick) in sheared SHALE matrix.		C20			75	0						
47.38	44														
	45				C21			90	0						
45.38	46														
	47		46.5', 1.5" greenish gray, serpentinized interval.		C22			75	0						
43.38	48														
	49				C23			90	0						
41.38	50		49.8', light gray, completely sheared throughout.												
	51				C24			90	0						Begin Box 3 at 51'
39.38	52									10.3	135.6				PI
	53		Fragments are up to 0.02' thick.		C25			60	0						
37.38	54														
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C26			50	0						
35.38	56													
	57	55.4' - 56.0', fragments are meta-SANDSTONE (up to 0.25' thick).		C27			50	0						
33.38	58													
	59			C28			30	0						
31.38	60													
	61	61.0', moderately weathered, with slight iron-oxide staining throughout.		C29			40	0						
29.38	62													
	63	63.0', slightly weathered.												
27.38	64			C30			50	0						
	65													
25.38	66	CLAY matrix is dark greenish gray, serpentinized.		C31			90	0						
	67													Losing circulation
23.38	68			C32			80	0						
	69	68.5', white secondary mineral deposit. Grades slightly more gray than green and with increase in SILTSTONE content.		C33			80	0						
21.38	70	69.0' - 69.8', crushed granular interval.												
	71			C34			65	0						
19.38	72													
	73	White secondary mineral is more common.		C35			80	0						Begin Box 4 at 73'
17.38	74	74.0', sheared SHALE matrix commonly has sandy intervals.												
	75			C36			100	0						
15.38	76													
	77			C37			100	0						
13.38	78													
	79													
11.38	80			C38			80	0						
	81													
9.38	82													
	83													Drill with tricone through hard material from 82.5' to 84'
7.38	84			C39			45	0						
	85													

(continued)

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.												
5.38	86				C40			80	0						
	87														Drill with tricone through hard material from 87' to 89'
3.38	88														
	89				C41			70	0						
1.38	90														
	91														
-0.62	92				C42			60	0						Begin Box 5 at 92'
	93														
-2.62	94														
	95				C43			90	0						
-4.62	96														
	97														
-6.62	98		Borehole terminated at a depth of 98 feet on 6/1/2008.												
	99		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-8.62	100														
	101														
-10.62	102														
	103														
-12.62	104														
	105														
-14.62	106														
	107														
-16.62	108														
	109														
-18.62	110														
	111														
-20.62	112														
	113														
-22.62	114														
	115														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	5-31-08	6-1-08	N2120407.628 / E5994505.431 (NAD83)	BTNB-R2
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 70ft R Sta 81+44 NB Alignment	89.420 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Bulk, Shelby (2.87"), 101-Sampler			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill				71.5 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	4" ASPHALT CONCRETE. 7-8" UNREINFORCED CONCRETE.												
	1	3" Poorly graded SAND (SP), yellowish brown, dry to moist, fine, clean, frequent roots up to 1/4" diameter. [FILL]		B1										
87.42	2	SILTY SAND (SM), poorly compacted, yellowish brown, moist, fine, GRAVEL is fine to coarse, slight horizontal laminations (from compaction?).												
	3			S2	4 7 9	16	83							
85.42	4	SANDY SILT (ML), moderately compacted, yellowish brown, moist, SAND is fine to medium, piece of coarse GRAVEL.		S3	3 4 16	20	78				PP = 1.5			
	5													
83.42	6	CLAYEY GRAVEL (GC), loose, yellowish brown and green, moist, GRAVEL is coarse, rounded, serpentinite fragment (up to 3" diameter in shoe at 8.5'), CLAY is stiff.												
	7													
81.42	8			S4	4 5 10	15	67							
	9	CLAYEY SAND (SC), loose to medium dense, yellowish brown, fine with coarse SAND, fine GRAVEL (subrounded to rounded, serpentinite fragments in CLAYEY SAND matrix).		S5	4 4 6	10	44							
79.42	10													
	11													
77.42	12													
	13	Lean CLAY with GRAVEL and SAND (CL), soft, brown and greenish gray, moist to wet, GRAVEL is angular serpentinite fragments, GRAVEL is fine to coarse, SAND is fine to coarse.		S6	4 8 7	15	47							Modified California sample at 12.5' was unlined
75.42	14			S7	3 2 4	6	44							
	15													
73.42	16	16.5', rig chatter.												
	17	SILTY SAND (SM), loose, very dark brown, wet, fine, very strong hydrocarbon/oily odor. [BURIED SOIL HORIZON]		S8	3 3 3	6	72							
71.42	18	Fat CLAY with SAND, medium stiff to stiff, very dark brown, wet, SAND is fine, with rootlets, very strong hydrocarbon odor. [COLMA FORMATION]		U9		500 psi, last 18"	67				PP = 1.63, 1.63, 1.75			
	19													
69.42	20													
	21	20.5', grades grayish brown, stiff, without odor, without organics.												
67.42	22													
	23			U10		1000 psi	100							
65.42	24	METAMORPHIC ROCK (Serpentinite), very soft, yellowish brown, greenish gray and dark gray, moist, decomposed, very intensely fractured (SANDY SILT (ML), medium stiff,		S11	9 19 42	61	67							
	25													

(continued)

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		sand is fine - moist). [BEDROCK]		C12			15	0						101-Coring System
63.42	26		METAMORPHIC ROCK (Serpentinite), dark greenish gray and dark gray, moderately to intensely weathered, very soft, very intensely fractured, common iron-oxide staining (localized), occasional small moderately soft zones.												
	27				C13			50	N/A						
61.42	28														
	29		29.0', grades soft, intensely sheared throughout, fibrous texture common throughout (ML - SANDY SILT, SAND is fine, moist).		C14			100	N/A						C14, shoe plugged, replaced with smaller shoe
59.42	30				C15			68	N/A						
	31														
57.42	32		32.0', slight iron-oxide staining, slightly weathered, harder fragments (angular) of SERPENTINITE with softer material washed away, fragments are moderately hard, up to 0.1' in diameter (SM - SILTY SAND, fine to coarse, angular, with fine GRAVEL fragments, angular to subangular, moist).		C16			37	N/A					
	33														
55.42	34														
	35				C17			50	N/A						
53.42	36														
	37				C18			100	N/A						
51.42	38		37.4', soft to moderately soft, faint iron-oxide staining on fracture surfaces.		C19			100	N/A						Slower drilling at 38'
	39		37.7', fibrous texture noted as long as 0.02'. 37.9', moderately soft, bluish gray. 38.0', soft. 38.0', dark bluish gray with infilling of light greenish gray.												
49.42	40		38.65', fibrous texture noted as long as 0.02'. 39.15', thin (0.01' thick) white mineral (talc?) vein dipping 50°.		C20			100	N/A						
	41		40.0', moderately weathered with common iron-oxide staining. 41.3', slightly weathered, very soft.												
47.42	42				C21			50	N/A						End Box #1 at 42'
	43														
45.42	44		44.35', angular fragments up to 0.1' diameter.		C22			65	N/A						
	45														
43.42	46				C23			40	N/A						
	47														
41.42	48		47.9' - 48.6', moderately hard, very intensely fractured, fragments of harder rock, dark gray.		C24			100	N/A						
	49														
39.42	50		50.0', soft to moderately soft.		C25			70	N/A						
	51														
37.42	52		51.5', very soft.		C26			32	N/A						
	53														
35.42	54		54.2', very intensely fractured zone, fragments are moderately hard, dark bluish gray, overall matrix is very soft		C27			75	N/A						
	55														

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Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		54.7', fibrous texture noted.		C28			40	N/A						
33.42	56		METAMORPHIC ROCK (Serpentinite), dark greenish gray and dark gray, moderately to intensely weathered, very soft, very intensely fractured, common iron-oxide staining (localized), occasional small moderately soft zones.												
	57		55.7', concentration of white mineral.		C29			50	0						
31.42	58		57.5' - 59.5', recovery is light gray meta-sandstone and gabbro, moderately weathered, hard, 0.1' to 0.2' fragments, significant iron-oxide staining, hard to moderately hard.		C30			33	0						
	59														
29.42	60		59.5', moderately weathered, soft, light greenish gray and orangish brown, heavy iron-oxide staining. 59.7', concentrated iron-oxide weathering along shear planes.		C31			75	N/A						
	61														
27.42	62		61.5', moderately soft, slightly weathered, greenish gray to olive gray, with moderately hard, white and dark gray minerals (white mineral has very fine, fibrous texture developed along planar surfaces, asbestos? White mineral also common with powdery texture disseminated thorught rock mass).		C32			100	0						
	63				C33			100	N/A						
25.42	64		61.8', horizontal buff sheared seam (0.01' thick), fibrous texture noted.		C34			20	N/A						
	65		62.5', bluish gray, clayey, with green chlorite? minerals, moderately to slightly weathered, very soft.		C35			89	N/A						
23.42	66														
	67		67.0', moderately weathered, increase in iron-oxide staining. 67.4' - 67.7', moderately hard rock fragments (gabbro?).		C36			54	N/A						
21.42	68														
	69														
19.42	70				C37			43	N/A						
			70.2', moderately to slightly weathered, increase in white mineral (talc) disseminated throughout.		C38			75	N/A						
	71		71.5', hard rock fragments.		C39			0	N/A						Switch to HQ at 71'
17.42	72		Borehole terminated at a depth of 71.5 feet on 6/1/2008.		C40			100							
	73		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
15.42	74														
	75														
13.42	76														
	77														
11.42	78														
	79														
9.42	80														
	81														
7.42	82														
	83														
5.42	84														
	85														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
B. Kluzniak	7-26-08	7-26-08	N2120351.985 / E5994725.98 (NAD83)	BTNB-R3
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 67ft R Sta 79+10 NB Alignment	86.286 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Bulk, 101-Sampler			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill			21.6	100 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	4.5" ASPHALT CONCRETE; 6" UNREINFORCED CONCRETE.												
	1	SILTY SAND (SM), yellowish brown, moist, SAND is fine to medium, with trace subangular serpentinite fragments, with dark brown oxidized nodules. [FILL]		B1										
84.29	2	2.0', serpentinite cobble up to 1/8" diameter.												Augering slow at 2'
	3	SANDY SILT (ML), medium stiff, dark yellowish brown, moist, SAND is fine, with black specks.		S2	9 12 14	26	83				PP = 2.0			
82.29	4	4.0', block of serpentinite, yellowish brown and greenish brown, fine-grained, decomposed (SILT (ML), stiff, dry to moist).		S3	4 8 9	17	83							
	5													
80.29	6													Driller reports easier drilling/harder zone alternating from 6' to 7.5'
	7													
78.29	8	Poorly graded SAND (SP), poorly to moderately compacted, dark brown, moist, trace SILT, fine to medium, with occasional rootlets up to 1/16" diameter.		S4	6 8 10	18	50							
	9	SANDY Lean CLAY (CL), very stiff, yellowish brown to dark yellowish brown, moist, SAND is fine, with dark brown specks, with thin gray seams.		S5	4 6 9	15	0							
76.29	10	Cuttings are yellowish brown SANDY CLAY (COLMA FORMATION?).												
	11			S6	9 13 18	31	100							
74.29	12								18.9	109.4	PP = 2.125, 2.125			PI
	13	12.5', increased SAND content, increased plasticity.		S7	5 7 7	14	50							Drills faster at 12.5'
72.29	14													
	15													
70.29	16	CLAYEY SAND (SC), medium dense, yellowish brown, moist, fine to medium, with black specks, slightly cemented. [COLMA SAND]		S8	8 11 15	26	83							
	17													
68.29	18	Grades with increased SAND content.		S9	7 11 13	24	100		18.2					
	19													
66.29	20	Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine to medium, with black specks												
	21			S10	17 23 34	57	94							
64.29	22													
	23	Grades dense.		S11	16 21 22	43	67							
62.29	24													
	25													Slight bouncing of drill rods at 24.5'

(continued)

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine to medium, with black specks												
60.29	26	Grades with iron-oxide mottling, with moderate cementation, with decrease in CLAY content.		S12	19 25 33	58	94							
	27													
58.29	28			S13	13 17 20	37	89							
	29													
56.29	30	Grades light yellowish brown and olive gray, mottled, without iron-oxide staining, with decrease in CLAY content.												
	31			S14	15 19 22	41	94							
54.29	32								23.1	102.1				
	33			S15	10 15 21	36	100							
52.29	34													
	35													
50.29	36	Poorly graded SAND (SP), dense, yellowish brown to grayish brown, moist, SAND is fine to medium.		S16	20 36 55	91	83							
	37													
48.29	38			S17	11 15 30	45	89							
	39													
46.29	40													
	41	Grades grayish brown with iron-oxide mottling, SAND is fine.		S18	23 36 36	72	83							
44.29	42													
	43	Poorly graded SAND with CLAY, medium dense, yellowish brown, moist, SAND is fine, with very dark brown mottling.		S19	9 11 12	23	89							
42.29	44													
	45													
40.29	46	Lean CLAY with SAND and GRAVEL (CL), medium stiff to stiff, yellowish brown, moist, GRAVEL is fine to coarse, subangular serpentinite fragments. [RESIDUAL SOIL (COLLUVIUM?)]		S20	9 15 27	42	61							Run #3 dropped from barrel, unable to recover
	47	METAMORPHIC ROCK (Serpentinite), fine-grained, yellow and greenish gray, decomposed, very soft (SILT (ML), stiff, horizontally laminated, dry). [BEDROCK]												
38.29	48			S21	30 50/ 5.5"	50/ 5.5"	52							
	49	Grades greenish gray, light gray and reddish brown, intensely weathered, very soft, very intensely fractured, internally crushed and sheared (SILT (ML), medium stiff, moist to wet, trace fine to medium SAND), pervasively sheared, iron-oxide staining throughout rock mass.		C22			100	N/A						
36.29	50	50.25', white clay seam infilling.												
	51	51.5', 0.2' thick zone, horizontally fissured, soft, dark mineral fragments up to 0.01' in diameter.												
34.29	52	52.0' - 52.6', moderately hard, gabbroic with localized shearing.		C23			77	N/A						
	53													
32.29	54													
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Grades greenish gray, light gray and reddish brown, intensely weathered, very soft, very intensely fractured, internally crushed and sheared (SILT (ML), medium stiff, moist to wet, trace fine to medium SAND), pervasively sheared, iron-oxide staining throughout rock mass.		C24			0							
30.29	56														
	57														
28.29	58		58.0', moderately hard, with localized shearing.		C25			100	0						
	59		58.5' - 58.7', white minerals common with tan CLAY infilling.												
26.29	60														
	61		60.5', intensely weathered, very soft, heavy iron-oxide staining.		C26			95	0						
24.29	62		61.6' - 62.0' and 62.4' - 62.6', 45° dipping fractures. 62.05', 62.5', and 62.65', black staining on fracture surfaces (manganese-oxide?).												
	63		62.7', moderately weathered, moderately hard, iron-oxide staining limited to fracture planes.												
22.29	64		63.3', 63.65', and 63.8', light yellowish brown CLAY infilling.												
	65		65.0' - 65.3' and 65.55' - 65.8', zones of very soft serpentinite.		C27			28							
20.29	66		Heavy iron-oxide staining throughout run.												
	67														
18.29	68														
	69		69.1', white secondary mineral deposit on fracture plane, moderately to intensely weathered, moderately hard.		C28			100	N/A						
16.29	70		69.6', sub-horizontal shearing planes with heavy iron-oxide staining.		C29			95							
	71														
14.29	72				C30			100	N/A						
	73		72.4', light orangish brown staining. 72.9' - 73.7', intensely weathered, very soft serpentinite.												
12.29	74		IGNEOUS ROCK (Gabbro), aphanitic, very dark gray to black, moderately to slightly weathered, moderately hard to hard, very intensely fractured.		C31			90	N/A						
	75		74.4', thin light gray secondary mineral deposit, localized shearing on through fractures, color change to very dark gray/black.												
10.29	76		76.0', very intensely fractured (entire run).		C32			100	N/A						
	77		76.4' - 77.2', heavy iron-oxide staining.												
8.29	78		78.3', METAMORPHIC ROCK (Serpentinite), intensely weathered, moderately soft, light greenish gray.		C33			88	N/A						
	79		78.5' - 78.7', very soft.												
6.29	80		79.5' - 79.6', very soft (CLAY-like). 79.7' - 80.3', reduced diameter.												
	81		81.0', color change to dark bluish gray.		C34			83	N/A						
4.29	82		82.2', very light gray.												
	83														
2.29	84				C35			67	0.3/ 3'						
	85														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		84.7', very soft (CLAY-like), bluish gray (gabbroic), secondary white mineral on shearing planes.												
0.29	86		IGNEOUS ROCK (Gabbro), aphanitic, very dark gray to black, moderately to slightly weathered, moderately hard to hard, very intensely fractured.												
	87				C36			100	0.25/ 2.5'						
-1.71	88		87.4' - 87.6', 88.0' - 88.2', and 88.5' - 88.7', severely weathered, very soft. 88.2' - 88.5', reduced diameter.												
	89		88.8', moderately weathered, intensely fractured, moderately hard, dark to very dark gray, predominantly gabbroic.												
-3.71	90		89.5' - 89.8', mechanical breaks. 89.9' - 90.5', very soft (CLAY-like), light bluish gray.		C37			100	0.5/ 2.5'						
	91		90.5' - 91.5', variable softness (very soft to moderately hard).												
-5.71	92		92.0' - 93.7', moderately hard, with horizontal markings from drill bit.		C38			100	N/A						
	93														
-7.71	94		94.2' - 94.6', slightly weathered, very soft.												
	95				C39			100	0.5/ 2.5'						
-9.71	96														
	97		96.5' - 96.8', secondary white mineral on predominant fracture plane, dipping approximately 70°.		C40			60	N/A						
-11.71	98		97.5' - 97.8', intensely fractured, slightly weathered to fresh, very soft.												
	99		97.8' - 100.0', moderately hard, with very soft to soft zones at 98.0', 98.4', and 98.6'.												
-13.71	100		Borehole terminated at a depth of 100 feet on 7/26/2008.												
	101		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-15.71	102														
	103														
-17.71	104														
	105														
-19.71	106														
	107														
-21.71	108														
	109														
-23.71	110														
	111														
-25.71	112														
	113														
-27.71	114														
	115														

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-18-08	2-19-08	N2120366.979 / E5994998.299 (NAD83)	BTNB-R4-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 100ft R Sta 76+22 NB Alignment	70.422 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 49.5 to 69.5 ft				124 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY GRAVEL (GC), reddish brown, moderately compacted, gravel is fine, angular, with fine to coarse sand, with black organic mottling - dry to moist. [FILL]												
68.42	2													
	3	2.5', piece of plastic.		S1	17 9 8	17	100							
66.42	4	SANDY ORGANIC SOIL (OL), soft to medium stiff, with fine SAND, very dark brown, moist, with decayed vegetation up to 1.5" diameter, slight organic odor detected. [BURIED SOIL HORIZON]		S2	4 8 13	21	83							
64.42	6	SILT with SAND (ML), medium stiff, yellowish brown, dry to moist, with light yellowish brown mottling and black specks, strongly cemented, with piece of decayed vegetation. [SANDY SILT]												
62.42	8	Grades without decayed vegetation. Grades with iron-oxide staining, increase in SAND content, dense.		S3	19 22 31	53	100		13.7	130.7				PI, PA
60.42	10			S4	12 17 22	39	67							
58.42	12													
56.42	13–14	SANDY Lean CLAY (CL), stiff, yellowish to reddish brown, dry to moist, SAND is fine, with light yellowish brown mottling, with black specks. [SANDY CLAY]		S5	12 23 29	52	72		14.1	136.8				PA
	15			S6	10 15 19	34	67							
54.42	16–17													
52.42	18–19	Poorly graded SAND (SP), dense, fine, reddish brown, moist, trace fines. [COLMA SAND] Black carbon nodule up to 1/4" diameter.		S7	19 32 49	81	83							CR
50.42	20	Grades dark yellowish brown.		S8	14 19 25	44	83							
48.42	22													
	23	Poorly graded SAND with CLAY (SP-SC), very dense, reddish brown, moist, fine.		S9	27 47 50/ 5.5"	97/ 11.5"	86		19.5	131.9	DS = 1.32			PA
46.42	24–25	Grades yellowish brown.		S10		48	100		19.4 18.8	129.0 127.0	DS =			

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND with CLAY (SP-SC), very dense, reddish brown, moist, fine.			16 23 25						1.67 DS = 2.01			
44.42	26													
	27													
42.42	28	Grades reddish brown with yellowish brown layer, with occasional black specks.		S11	18 33 43	76	89							
	29			S12	17 23 30	53	83							
40.42	30	Grades yellowish brown, very dense.												
	31													
38.42	32													
	33	Grades fine to medium, with frequent pockets of slight cementation, with occasional black specks and iron-oxide staining.		S13	20 27 31	58	83		20.1	132.9				PA
36.42	34			S14	17 23 33	56	83							
	35													
34.42	36													
	37													
32.42	38	Grades without black specks, without iron-oxide staining. SAND grades fine.		S15	21 27 36	63	94							
	39			S16	11 22 31	53	67							
30.42	40													
	41													
28.42	42													
	43	Grades dense, dark yellowish brown and light yellowish brown, with pockets of slight cementation, trace fines, SAND grades fine to medium.		S17	30 43 50/ 5.5"	93/ 11.5"	86							
26.42	44			S18	11 19 16	35	100							Appears to be a water bearing layer at 44'
	45	45.0', grades clayey.												
24.42	46	Poorly graded SAND with CLAY (SP-SC), dense, fine, yellowish brown, moist, horizontally laminated, with iron-oxide mottling.												
	47													
22.42	48	Poorly graded SAND (SP), medium dense, fine to medium, dark yellowish brown, wet, with iron-oxide mottling, with crushable black carbon nodules.		S19	15 22 34	56	83		21.2	134.2				PA
	49	Poorly graded SAND with CLAY (SP-SC), dense, fine to very fine, dark yellowish brown, moist, with iron-oxide mottling.		S20	11 11 21	32	100							
20.42	50													
	51													
18.42	52													
	53	Lean CLAY with SAND (CL), very stiff, grayish and yellowish brown, moist, pockets of cemented SAND up to 1/8" diameter, occasional piece of angular fine GRAVEL. [RESIDUAL SOIL]		S21	7 12 18	30	83				PP = 1.875			
16.42	54	METAMORPHIC ROCK (Serpentinite), greenish gray, very		S22	12 50/6"	50/6"	83							
	55													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	intensely weathered, soft, very intensely fractured (Lean CLAY with SAND (CL), very stiff, moist). [BEDROCK]		C23			48	0						HQ-3 syntek bit
14.42	56	54.5', grades moderately strong and moderately weathered.												
	57	METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
12.42	58			C24			27	0						
	59	Greenish gray non-gabbroic, pervasively sheared, slightly weathered to fresh, soft.		C25			90	0						59', switch to diamond bit
10.42	60													
	61								16.5	119.7	UU = 0.36			PI
		61.5', reddish brown slightly oxidized zone.												
8.42	62			C26			56	N/A						
	63													
6.42	64													
	65													
4.42	66	Recovery is dark gray gabbroic blocks only.		C27			40	0						
	67													
2.42	68													
	69	68.5', green and dark gray, moderately fractured, moderately soft. Break at 68.95' is mechanical.		C28			100	46						
0.42	70	69.0' - 70.5', surface of core is slightly pitted.												
		70.5', 0.15' thick diagonal white mineral vein, moderate							7.2					
	71	iron-oxide staining on fracture surfaces at 69.4' and 70.6'. 71.0' - 71.5', light green mineral vein infilling (chlorite?).		C29			100	0						
-1.58	72	71.6', white minearl vein (0.08' thick) with fibrous texture. 72.1', white mineral vein (0.08' thick).												
	73	73.0', green and greenish gray, very soft, slightly weathered.												
-3.58	74	74.0', surface pitted.		C30			94	0						Increase in drill rate at 73.4', stopped run at 74'
	75	75.0', very soft.												
-5.58	76								6.03					
	77	Dark purple blocks of harder serpentinite (gabbroic) at 76.5', 77.5', and 77.0' (each 0.2' thick).												
-7.58	78													
	79	78.5' - 78.8', dark purple block of harder serpentinite (gabbroic).		C31			73	N/A						
-9.58	80													
	81	80.5', 0.3' block of greenish gray harder serpentinite (grabbroic).												
-11.58	82													
	83	82.5' - 83.3', dark greenish gray, intensely fractured, moderately hard, moderately strong, slightly weathered. 83.3', light greenish gray, very soft to soft.		C32			81	0						
-13.58	84													
		84.3' - 84.7', harder blocks.												
	85													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85	METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
-15.58	86			C33			100	N/A						
	87													PI
-17.58	88								16.8	118.6	UU = 0.42			Lost circulation at 88' to 88.5'
	89			C34			100	N/A						
-19.58	90			C35			67	N/A						
	91	90.5', iron-oxide staining.												
-21.58	92	91.5', diagonal white secondary mineral vein filliing.												
	93													
-23.58	94	94.0', soft, secondary white mineral disceminated throughout.		C36			78	11						
	95													
-25.58	96	95.8' - 97.0', dark greenish gray, moderately hard, intensely to moderately fractured (no secondary, not internally sheared), fibrous mineralization noted along fractures.												
	97										UC = 92			
-27.58	98													
	99			C37			64	N/A						
-29.58	100													
	101													
-31.58	102													
	103			C38			100	N/A						
-33.58	104													
	105	104.7' - 105.6' and 107.0' - 108.0', recovery is broken, moderately hard, dark gray and green gabbroic serpentinite up to 2.5" in length.		C39			78	N/A						
-35.58	106	105.0' - 105.4', recovery is only loose, moderately strong, moderately hard, fresh blocks of dark gray and green serpentinite up to 1" in length.												
	107			C40			50							
-37.58	108			C41			100	70						
	109													Harder drilling 115' - 116' Harder drilling 123' - 124'
-39.58	110													Straight drill to 124'
	111													
-41.58	112													
	113													
-43.58	114													
	115													

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Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
-45.58	116														
	117														
-47.58	118														
	119														
-49.58	120														
	121														
-51.58	122														
	123														
-53.58	124		Borehole terminated at a depth of 124 feet on 2/19/2008.												
	125		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-55.58	126														
	127														
-57.58	128														
	129														
-59.58	130														
	131														
-61.58	132														
	133														
-63.58	134														
	135														
-65.58	136														
	137														
-67.58	138														
	139														
-69.58	140														
	141														
-71.58	142														
	143														
-73.58	144														
	145														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-5-08	4-8-08	N2120581.324 / E5994178.193 (NAD83)	BTNB-R5-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 154ft R Sta 85+5 NB Alignment	79.635 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 78.0 to 98.0 ft				114 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	1/2" ASPHALT CONCRETE.												
	1	SEDIMENTARY ROCK (Sandstone), medium grained to fine grained, no indication of bedding, dark grayish brown, moderately weathered, moderately hard, moderately fractured, heavy iron-oxide staining on fracture surfaces, light staining within rock mass at 4.5', vein infilling up to 0.02' thick (calcite?), grades very thinly bedded, intensely fractured, fracture dipping ranges from 20° to 70°, fractures are typically intensely weathered. Grains are angular to subangular, uniform, numerous insipient fractures, very dense/lithified. [BEDROCK]												
77.64	2													
	3			S1		50/3"	78							
75.64	4			C2			80	13						
	5													
73.64	6													
	7	6.8', finer grained with decrease in medium grained, darker minerals, moderately to slightly weathered.		C3			100	0						
71.64	8													
	9			C4			100	15						
69.64	10	10.01', clayey sand sheared filling, entire interval appears massive (no indication of bedding).												
	11													PL
67.64	12	12.0', fracture orientation and spacings remain consistent with above.		C5			92	0						
	13													
65.64	14													
	15			C6			95	10						
63.64	16	15.9', seam infilling with clay.												
	17	16.5', slickensides parallel to dip.												
61.64	18	~17.9' to 19.0", near vertical fracture, undulating surface intersecting fractures average orientation is 345/81E.												
	19	19.0', slightly weathered (slight iron-oxide staining).		C7			78	0						
59.64	20													
	21	21.0', very intensely to intensely fractured with one length from 21.5' to 22.0' intact.		C8			75	25						
57.64	22													
	23	23.0', hard, fresh to slightly weathered (absence of iron-oxide stains).		C9			47	0						Hole taking a little fluid at 23'
55.64	24	23.0', multiple vertical fractures entire length of core with additional sub-horizontal fractures.												
	25													

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Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		23.4', white mineral, vein, hard (non-quartz). 23.6', CLAY seam infilling.												
53.64	26		SEDIMENTARY ROCK (Sandstone), medium grained to fine grained, no indication of bedding, dark grayish brown, moderately weathered, moderately hard, moderately fractured, heavy iron-oxide staining on fracture surfaces, light staining within rock mass at 4.5', vein infilling up to 0.02' thick (calcite?), grades very thinly bedded, intensely fractured, fracture dipping ranges from 20° to 70°, fractures are typically intensely weathered. Grains are angular to subangular, uniform, numerous insipient fractures, very dense/lithified. [BEDROCK]		C10			100	0						
	27														
51.64	28				C11			100	24						
	29														
49.64	30		27.0' - 28.0', white mineral vein fillings (unrelated to fracturing) pervasively fractured (from fragments to 0.2').												PL
	31		28.0', intensely fractured, fractures dipping commonly 60° to 70°, continued localized white mineral vein fillings.		C12			80	37						
47.64	32		30.9', 0.08' thick shear zone (light gray, silty, fine sand). 31.0', contact to fine grained SAND (medium grained above).												Lost circulation 31.5' to 32.5'
	33														PL Taking a little water at 33'
45.64	34		33.4', fine to medium grained (core broken with silty fine SAND fragments <0.01' to 0.2').												Apparent bedding caused by coring (typical 31.9' to 32.2)
	35				C13			48	0						
43.64	36														
	37		36.4', very intensely fractured (crushed) (silty, fine SAND shear zone).												
41.64	38		38.0', 0.3' intact fragment (laminated showing soft sediment deformation), no visible sand grains.		C14			65	0						
	39		38.3', 0.05' quartz vein.												
39.64	40		SEDIMENTARY ROCK (Mélange Matrix), dark gray (consisting of fine grained SANDSTONE, very hard SILTSTONE, and fragmented hard SHALE), very intensely fractured (crushed), slightly weathered to fresh.												40' to 41', straight drill At 40' rock contact gradual based on drilling change Recovery is broken fragments of core, not representative of zone.
	41				C15			25	0						
37.64	42														
	43				C16			40	0						
35.64	44														Straight drill 44' to 45'
	45				C17			1	N/A						
33.64	46														
	47		Very soft to hard.		C18			73	N/A						
31.64	48														
	49		48.5', fresh, fragments are fine grained, lithic SANDSTONE, occasional quartz? veins, fragments range from <0.01' to core diameter.		C19			127	N/A						Switch to 101 sampler at 48.5'
29.64	50		50.0' - 51.1', crushed, very fine grained.		C20			97	N/A						
	51		51.1' - 52.1', clayey (primarily clay with hard fragments).												
27.64	52		52.1' - 52.4', crushed, very fine grained. 52.4' - 52.9', clayey.												
	53		Scattered green mineral filling within small cavities (up to 0.08" diameter)(chlorite?).		C21			100	N/A						
25.64	54		53.0', highly sheared shale with internal slickensided shear planes within rock mass and very fine grained sandstone fragments.							9.3	145.1				PI
	55														

(continued)

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), dark gray (consisting of fine grained SANDSTONE, very hard SILTSTONE, and fragmented hard SHALE), very intensely fractured (crushed), slightly weathered to fresh.												
23.64	56														
	57		56.5', less clayey (more intact shale). 56.8' and 60.4', 0.15' hard resistant rock fragments, core breaks are irregular sub-horizontal to 10°dip.		C22			100	N/A						
21.64	58														
	59		59.2', crushed/sheared zone without clay.												
19.64	60		Iron-oxide staining common on fracture faces, moderately weathered.												
	61				C23			28	N/A						
17.64	62														
	63														
15.64	64														
	65		64.5', very minor local staining on surfaces (chlorite?), iron-oxide staining throughout, primarily sheared fragments with sub-horizontal fissillity.		C24			100							
13.64	66		65.5', interval ranges from pervasively sheared shale (clayey) to hard gray sandstone fragments (up to 0.25').		C25			70	N/A						
	67		65.75', dipping 35°.												
11.64	68		67.5', continued highly sheared shale. 67.5' - 68.2', scattered quartz vein filling. 68.2', subangular sandstone fragments (up to 0.05') in olive brown clay matrix.		C26			28	N/A						
	69														
9.64	70														
	71														
7.64	72				C27			72	N/A						
	73		SEDIMENTARY ROCK (Sandstone), fine grained, hard, very intensely fractured, moderately weathered with heavy iron-oxide staining on fracture surfaces and extending slightly into the rock mass.												
5.64	74		72.5', iron-oxide staining on some surfaces, but not all, suggesting mechanical breaks.		C28			100	O						
	75		74.0', continued mechanical breaks, multiple fracture orientations, quartz vein (20° dip) at 74.7' (0.02' thick).												
3.64	76		75.7', horizontal to 10° fractures, clay filled sheared fracture at 76.3'.		C29			100	0						
					C30			75	0						
	77		SEDIMENTARY ROCK (Mélange Matrix), dark gray, fresh, very soft.		C31			14	0						Contact based on drilling change.
1.64	78														
	79														
-0.36	80				C32			100	N/A						
	81		81.1', chlorite? vein (1/4" thick).												
-2.37	82		81.6', quartz vein (1/4" thick), sheared shale with hard sandstone pieces (up to 1/4"diameter).		C33			100	N/A						
	83		SEDIMENTARY ROCK (Sandstone), dark gray, fine grained, moderately hard, very intensely fractured, fresh, not clayey. 82.3' - 82.6', crushed zone.		C34			80	N/A						
-4.37	84														
	85														84.5' to 85', straight drill

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		SEDIMENTARY ROCK (Mélange Matrix), dark gray, slightly weathered to fresh, soft, very intensely fractured (crushed), mylonized (CLAY-like) with subangular sandstone fragments, variably oriented contacts dipping up to 30°. SANDSTONE fragments up to 0.2' thick localized shearing along thin fractures.		C35			93	1.5/4'						Switch to HQ core barrel at 85'
-6.36	86														
	87														
-8.36	88		METAMORPHIC ROCK (Meta-Sandstone), steeply dipping, laminated relic bedding offset by healed micro-faults, dark gray, fresh, hard, moderately to slightly fractured, milky white vein filling.												PL PL
	89		89.0', clayey infilling common, very intensely fractured (crushed), random quartzitic vein filling, locally associated with fractures and planes of weakness, harder pieces within mylonized zone are moderately hard overall matrixes soft.		C36			98	1.6			UC = 634			
-10.37	90														
	91		89.6' - 91.0', fractured mylonized zones. 91.0', hard, moderately fractured.												
-12.37	92		92.0', mylonized seam (0.02' thick).												
	93														
-14.37	94				C37			100	0						
	95		94.4', intensely to moderately fractured, mylonized zone. 95.0, crushed zone.												
-16.37	96														
	97		96.4', mylonized clay zone with quartz vein filling.												
-18.37	98														
	99		99.0', continued quartz vein filling, parallel and not parallel to fractures, moderately fractured.		C38			100	62						
-20.37	100														
	101														
-22.37	102														
	103		103.2', sheared/mylonized, dark gray and yellowish brown, iron-oxide staining throughout fractures, very intensely fractured (crushed), slickensides of fractures at 103.2' parallel to dip.												
-24.37	104				C39			72	N/A						At 104', fluid color change from light gray to yellow brown
	105		104.0', pervasively fractured, mylonized, with pervasive secondary clay formation, remanant intersecting fracture planes at 30° to 40° dip, moderately weathered.												
-26.37	106														
	107		106.5', predominantly moderately hard, intensely weathered, clay smearing and iron-oxide staining on fractures at 109.0'.		C40			100	0						
-28.37	108		106.5' - 106.9' and 108.5' and 108.8', clayey mylonized zones (with subangular sandstone fragments in clay matrix).												
	109		108.3' - 109.5', additional sub-vertical fractures. 109.0', gray clay along predominant fracture. Quartz? veins continued, primarily unrelated to fracures. Multiple fracture sets primarily between 50° - 30°.												
-30.37	110				C41			90	0						
	111		110.7' - 102.2', pervasively sheared with a substantial portion mylonized, random fracture orientations.												
-32.37	112														
	113		112.5', pervasively oxidized, intensely fractured, variably oriented fractures.		C42			100	O						
-34.37	114				C43			0	0						
	115														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115														
-36.37	116														
	117														
-38.37	118														
	119														
-40.37	120		Borehole terminated at a depth of 114 feet on 4/8/2008.												
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-42.37	122														
	123														
-44.37	124														
	125														
-46.37	126														
	127														
-48.37	128														
	129														
-50.37	130														
	131														
-52.37	132														
	133														
-54.37	134														
	135														
-56.37	136														
	137														
-58.37	138														
	139														
-60.37	140														
	141														
-62.37	142														
	143														
-64.37	144														
	145														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-9-08	4-10-08	N2120582.62 / E5994169.98 (NAD83)	BTNB-R5A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 154ft R Sta 85+13 NB Alignment	79.370 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	4 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
HQ Core			N/A	
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 15.0 to 35.0 ft				76 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Recovery (%)	RQD (%)	Remarks
	0	SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured. [BEDROCK]					0' to 1' straight drill to set casing
	1			C1	95	0	
77.37	2	1.85', moderately hard, moderately weathered.					
	3	2.8' and 5.4', heavy iron-oxide staining on fracture surfaces, sheared/mylonized clay filled fractures, slight iron-oxide staining throughout rock mass, randomly oriented fracture surfaces.					
75.37	4						
	5						PL
73.37	6						
	7	Iron-oxide staining reduced to fracture surfaces only.		C2	88	20	
71.37	8						
	9	9.0', very intensely to intensely fractured zone (0.5' thick).					
69.37	10						
	11	10.7', crushed/mylonized zone (0.3' thick).					
67.37	12	12.0', very thinly bedded (alternating light gray and gray), slightly weathered, moderately to slightly fractured, slight weathering on fracture planes, intact rock mass is unstained, hard.		C3	96	39	
	13						PL
65.37	14	14.0', intensely fractured.					
	15						
63.37	16						
	17	16.5', sheared/crushed/clay-filled zone (0.3' thick). 17.0', very intensely fractured, less iron-oxide staining, no indication of bedding, fine-grained.		C4	80	0	
61.37	18						
	19	18.5', intensely fractured, with mylonized/clay-filled zones at 19.0' and 20.0' up to 0.1' thick.		C5	88	0	At 18.5' switch from face discharge bit to side discharge/ impregnated bit
59.37	20						
	21	21.0', slightly weathered to fresh. 21.3' - 22.1', very intensely fractured.		C6	95	30	
57.37	22	22.1', intensely to moderately fractured.					
	23	23.0', intensely to moderately fractured with very intensely fractured zone from 24.1' to 24.9'.		C7	82	26	PL
55.37	24						
	25						

Drilling Method: Casing Depth

Blows per 6 In / Blows per Foot / Moisture Content (%) / Dry Unit Weight (pcf) / Shear Strength (tsf): not recorded

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured. [BEDROCK] 25.0', occasional thin white vein infilling (quartz?).									UC = 706			
53.37	26														
	27														
51.37	28		28.0', very intensely to intensely fractured, slight clay infilling of fractures.		C8			92	0						
	29														
49.37	30														
	31														Straight drill at 30.5' to 70.6' for PS-logging
47.37	32														
	33														
45.37	34														
	35														
43.37	36														
	37														
41.37	38														
	39														
39.37	40														
	41														
37.37	42														
	43														
35.37	44														
	45														
33.37	46														
	47														
31.37	48														
	49														
29.37	50														
	51														
27.37	52														
	53														
25.37	54														
	55														

(continued)

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured. [BEDROCK]												
23.37	56														
	57														
21.37	58														
	59														
19.37	60														
	61														
17.37	62														
	63														
15.37	64														
	65														
13.37	66														
	67														
11.37	68														
	69														
9.37	70														
	71														
7.37	72														
	73														
5.37	74														
	75														
3.37	76		Borehole terminated at a depth of 76 feet on 4/10/2008.												
	77		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
1.37	78														
	79														
-0.63	80														
	81														
-2.63	82														
	83														
-4.63	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-26-08	3-28-08	N2120559.949 / E5994521.542 (NAD83)	BTNB-R6-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 222ft R Sta 81+67 NB Alignment	83.591 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, HQ-Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 60' to 80'				98 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY GRAVEL (GC), poorly compacted, reddish brown, moist, gravel is subangular, trace roots (1/4" diameter). [FILL]												
	1	Poorly graded SAND (SP), poorly compacted, yellowish brown, moist, fine, trace fines, trace medium sand.												
81.59	2													
	3			S1	7 9 9	18	61							
79.59	4	Grades dark brown, grades without medium SAND, with increase in fines content, with pockets of black organic material (up to 1/8" diameter).		S2	4 2 3	5	44							
	5													
77.59	6													
	7													
75.59	8	Poorly graded SAND with CLAY (SP-SC), moderately compacted, reddish brown, moist, fine, with shell fragments.		S3	7 6 7	13	61		14.7	108.4				PA
	9	9.1', grades with yellowish brown mottling.		S4	3 7 7	14	50							
73.59	10	9.7', 1/4" diameter root.												
	11													
71.59	12													
	13	Lean CLAY (CL), stiff, yellowish brown and grayish brown, moist, mottled, trace fine to medium sand, with black oxidized nodules (up to 1/8" diameter). [SANDY CLAY]		S5	7 11 16	27	83		20.5	107.3	PP = 1.5, 1.4 UU = 1.2			PI
69.59	14	Grades to CLAY with SAND, with black specks, rootlets.		S6	14 16 20	36	94							
	15													
67.59	16													
	17													
65.59	18	SANDY SILT (ML), stiff, light yellowish brown, moist, with thin horizontal laminations. [SANDY SILT]		S7	13 18 23	41	100		18.0	113.6	PP = 1.4, 1.8, 2.1, 1.9			PA
	19	19.0', grades with slight iron-oxide mottling, without rootlets.		S8	7 11 12	23	94							
63.59	20													
	21													
61.59	22													
	23	SILTY SAND (SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE, with SANDY CLAY partings, with black specks. [COLMA SAND]		S9	17 27 41	68	83		15.7	117.8				PA
59.59	24			S10		59	67							
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	SILTY SAND (SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE, with SANDY CLAY partings, with black specks. [COLMA SAND]			17 27 32									
57.59	26													
	27													
55.59	28	Poorly graded SAND with SILT (SP-SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE.		S11	40 50/5"	50/5"	73		14.9	108.3				PA CU
	29			S12	29 32 34	66	83							
53.59	30													
	31													
51.59	32	METAMORPHIC ROCK (Serpentinite), dark greenish gray and very dark bluish gray, moderately weathered, very soft, moderately fractured (intensely crushed), fractures are planar to sub-planar 20° from horizontal, highly sheared throughout, with micro-slickensided surfaces throughout, light brown iron-oxide staining throughout, local sub-horizontal folliation. [BEDROCK]		S13										Rig chatter at 31.5'
	33			C14			100	N/A						
49.59	34	33.5', grades soft, decreased iron-oxide staining.		C15			80	N/A						
	35													
47.59	36	36.2' and 36.6', 40° dip highly polished.		C16			64	N/A						
	37	36.2' - 36.6', dark greenish gray, moderately hard, slightly weathered.												
45.59	38	38.0', sub-horizontal fracture, moderately hard.		C17			90	20						
	39													
43.59	40	39.6' to 40.2' near vertical (80°) 1/8" thick mylonized zone along fracture.												
	41	40.0', soft to very soft, abundant very light green mineral (talc?).												
41.59	42	41.0', sub-horizontal fracture surfaces typically polished and sheared.												
	43			C18			0							Lost circulation at 43'
		Straight drill from 43.5' to 44.0'.		C19										
39.59	44	Talc? is non-fibrous.		C20			67	N/A						
	45	Grades soft, very dark greenish gray, with chlorite and talc? vein fillings variably oriented throughout mass, no indication of fibrous texture, fractures are irregular (sub-horizontal).												Lost fluid at 44.5', thickened mud, full circulation at 45.5'
37.59	46	Core breaks along preferred orientation (strike N/S dip 45° west), platey appearance parallel to joints.												
	47			C21			83	N/A						
35.59	48	47.2', additional random fractures (1/16" thick) with talc? infilling.									UC = 29			
	49													
33.59	50	With less talc?		C22			43	N/A						
	51	Preferential fracture planes parallel to platey structure, alternately zones of very soft to moderately soft.												
31.59	52													
	53													
29.59	54	54.0', very soft to soft.		C23			87	N/A						
	55													

(continued)

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		55.3', mechanized fracture dips ~45°.												
27.59	56		55.8', grades with abundant iron-oxide staining, indirect fractures are sub-horizontal, continued internally sheared polished surfaces.												
	57		METAMORPHIC ROCK (Greenstone), dark greenish gray, slightly weathered, moderately hard to hard, intensely fractured with very intensely to intensely fractured zones, fractures franging from horizontal to 20° dip. Open and healed fractures with filling and staining of black magnesium oxide. Subrounded vitreous crystals predominant throughout mass (pyroxene/olivine?), localized black vugular zones (maximum 0.2' thick).		C24			60						
25.59	58														
	59														
23.59	60				C25			91	2.4/3.5'						
	61		60.0' - 60.8', intensely fractured (open and closed, internal shearing characterized by microstriations on plane surfaces). 60.4', dip 40°.												
21.59	62		60.8, intensely fractured, moderately hard. Grades less crystalline (micro crystalline). 62.4', dip 70°.												
	63		62.9', dip 70°.												
19.59	64		63.4' - 65.6', very intensely fractured, very soft (with hard pieces, crumbles to 1/16" to 1" pieces, moderately weathered, with abundant iron-oxide staining).		C26			69	0.5/4.5'						
	65														
17.59	66		65.6', moderately weathered.												
	67														
15.59	68		68.0', intensely fractured, moderately hard, moderately weathered, fractures horizontal to 45°, filled (vertical at 70.5'), fracture with similar appearance to rest of rock, scattered fibrous minerals at random orientations (asbestos?), few appararent unique crystals. 69.6' - 70.4', very intensely fractured.		C27			73	1.5/4'					
	69														PL
13.59	70														
	71														
11.59	72		72.0', fractures infilled with fibrous mineral (asbestos?) 72.3', moderately weathered with abundant iron-oxide staining throughout, very soft, very intensely fractured. 73.0', moderately to slightly fractured, hard, moderately weathered.		C28			89	0						
	73														
9.59	74														
	75														
7.59	76		76.0' - 77.4' and 78.0' - 78.4', crushed zones (very soft, severely weathered, with abundant iron-oxide staining).		C29			73	0.8/4'						
	77														
5.59	78		SEDIMENTARY ROCK (Greywacke), fine grained to aphanitic, yellowish brown, slightly weathered, hard, healed very thin fractures.												
	79		METAMORPHIC ROCK (Serpentinite), green and yellowish brown, moderately weathered, soft.												
3.59	80		Recovery is dark greenish gray and dark gray pieces of serpentine and greenstone, moderately hard - not representative of rock layer.		C30			33	N/A						
	81														
1.59	82														
	83		Very dark gray, intensely fractured, moderately hard, severely weathered, talc/chlorite in fractures.		C31			72	0.7/2.5'						
-0.41	84		83.5' - 84.3', slightly fractured, veinlettes of fibrous minerals.									UC = 263			
	85														

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		METAMORPHIC ROCK (Serpentinite), green and yellowish brown, moderately weathered, soft.		C32			100	N/A						
-2.41	86		85.0', very intensely fractured and sheared (crushed), soft to very soft, moderately weathered.												
	87														
-4.41	88				C33			72	N/A						
	89														
			89.1', very soft with zones of moderately hard, common green vitreous appearance (chlorite?).												
-6.41	90				C34			100	0						
	91														PI
			91.1', moderately fractured, moderately hard, slightly weathered at 90.0', platey secondary mineral formation (chlorite?) pervasively throughout.												
-8.41	92				C35			100	0						
	93		91.2', fibrous, light green, translucent minerals oriented parallel to dip.												
			92.3', internally sheared/crushed, very soft to soft, moderately weathered, platey secondary mineral formation pervasively throughout (chlorite?) portions of core - one locally micro-fractured with chlorite? filling.												
-10.41	94														
	95		94.5', very dark gray, intensely fractured, moderately hard, slightly weathered.		C36			100	0						
			95.0', internally sheared/crushed.												
-12.41	96														
	97		97.0' - 97.5', very intensely to intensely fractured.												
-14.41	98														
	99		Borehole terminated at a depth of 98 feet on 3/28/2008.												
			See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-16.41	100		Additional Notes:												
	101		1. Oriented rock coring performed.												
-18.41	102														
	103														
-20.41	104														
	105														
-22.41	106														
	107														
-24.41	108														
	109														
-26.41	110														
	111														
-28.41	112														
	113														
-30.41	114														
	115														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-27-08	3-27-08	N2120558.479 / E5994527.552 (NAD83)	BTNB-R6A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 222ft R Sta 81+61 NB Alignment	83.531 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 17.0 to 32.0 ft				32 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	1/2" ASPHALT CONCRETE												
	1	GRAVELLY CLAY (GC), poorly compacted, reddish brown, moist, gravel is subangular, trace roots (1/4"). [FILL]												
81.53	2	Poorly graded SAND (SP), poorly compacted, fine, dark yellowish brown, moist, trace medium SAND, trace fines.												
	3			S1	4 6 8	14	50							
79.53	4			S2	2 3 3	6	50							
	5													
77.53	6													
	7													
75.53	8	Grades with yellowish brown and reddish brown mottling, abundant rootlets (up to 1/16" diameter). 8.0', 1/2" diameter angular chert fragment.		S3	5 7 10	17	67							
	9			S4	4 8 10	18	50							
73.53	10													
	11													
71.53	12													
	13	SILT (ML), very stiff, yellowish brown and grayish brown, mottled, moist, trace fine to medium SAND, with black oxidized nodules (up to 1/8" diameter), occasional rootlet, with pockets of SANDY CLAY (up to 1/8" diameter). [SANDY SILT] 14.0', grades to SILT with SAND.		S5	7 13 17	30	83				PP = 2.0			
69.53	14			S6	4 6 11	17	89							
	15													Drilling slowed at 15.5'
67.53	16													
	17													
65.53	18			S7	10 18 24	42	83							
	19	19.0', grades to SANDY SILT, without rootlets, horizontally fissured (up to 1/4").		S8	7 11 12	23	89							
63.53	20													
	21													
61.53	22													
	23	Poorly graded SAND with SILT (SP-SM), dense, yellowish brown to dark yellowish brown, moist, fine to medium, frequent dark reddish brown oxidized nodules (up to 1/4" diameter). [COLMA SAND]		S9	13 19 23	42	83							
59.53	24			S10		38	89							
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25				15 18 20									
57.53	26													
	27	Poorly graded SAND with CLAY (SP-SC), very dense, light yellowish brown, fine to medium, with black specks, with serpentinite rock fragments (up to 1/4" diameter).												
55.53	28	METAMORPHIC ROCK (Serpentinite), no indication of bedding, yellowish green and very dark gray, very intensely weathered, soft, very intensely fractured, with occasional iron-oxide staining. [BEDROCK] (clayey SAND (SC) very dense, moist)		S11	13 22 47	69	83		48.8	108.8	UU = 0.74			PA
	29			S12	41 50/5.5"	50/5.5"	70							
53.53	30													Straight drill to 32'
	31													
51.53	32	Borehole terminated at a depth of 32 feet on 3/27/2008.												
	33	See Boring Record Legend for soil classification chart and key to test data and sampler type.												
49.53	34													
	35													
47.53	36													
	37													
45.53	38													
	39													
43.53	40													
	41													
41.53	42													
	43													
39.53	44													
	45													
37.53	46													
	47													
35.53	48													
	49													
33.53	50													
	51													
31.53	52													
	53													
29.53	54													
	55													

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-28-08	4-3-08	N2120459.851 / E5994825.735 (NAD83)	BTNB-R7-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 188ft R Sta 78+17 NB Alignment	79.353 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ-Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 50' to 70'				113 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	GRAVEL with SAND (GP), dark gray and brown, moist, gravel is angular, sand is fine. [BASEROCK]												
	1	Poorly graded SAND (SP), poorly compacted, dark yellowish brown, moist, fine. [FILL]												
77.35	2													
	3			S1	3 3 4	7	50							
75.35	4													
	5													
73.35	6	SILTY SAND (SM), poorly compacted, dark brown, wet, fine to very fine.												
	7													
71.35	8	SILT (ML), soft, dark brown, wet, trace fine SAND, with crushable iron-oxide nodules. [BURIED SOIL HORIZON]		S2	0 1 2	3	89							
	9													
69.35	10													
	11													Drilling slowed at 10.5' Clay in cuttings
67.35	12	Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, SAND is fine, with pockets of dark brown iron-oxide staining up to 1/4" diameter. [SANDY CLAY] 12.0', black vertical seam of organic filling.												
	13			S3	9 14 19	33	89		16.8	115.1	UU = 0.87			PI
65.35	14													
	15													
63.35	16													
	17	SILTY SAND (SM), loose to medium dense, yellowish brown to reddish brown, moist, with crushable iron-oxide nodules, fine. [COLMA SAND]												
61.35	18			S4	7 7 11	18	83							
	19													
59.35	20													
	21	Poorly graded SAND with SILT (SM), dense, dark yellowish to reddish brown, moist, fine.												
57.35	22													
	23			S5	7 13 20	33	100							
55.35	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND with SILT (SM), dense, dark yellowish to reddish brown, moist, fine.												
53.35	26													
	27													
51.35	28	Grades yellowish brown, with iron-oxide mottling, with black nodules (up to 1/8" diameter).		S6	10 12 13	25	100							
	29													
49.35	30													
	31													
47.35	32													
	33	Grades without iron-oxide staining.		S7	10 16 20	36	94							
45.35	34													
	35													
43.35	36													
	37	37.0', harder drilling.												
41.35	38	Grades very dense, with iron-oxide mottling.		S8	14 26 27	53	94							
	39													
39.35	40													
	41	METAMORPHIC ROCK (Greenstone), dark greenish gray, intensely fractured, moderately hard, moderately weathered, iron-manganese rich mineral composition, internally folliated with elongated crystals, iron-oxide staining throughout, prominent healed fractures filled with white mineral dipping 68°. [BEDROCK]												
37.35	42			C9			33	0						
	43													
35.35	44													
	45	~44.5', soft, moderately weathered, with moderately soft zones. 45.1' - 45.2' and 45.3' - 45.5', soft, 0.1' to 0.2' thick intensely sheared zones, locally very intensely weathered, thin mineral filled fractures in soft zones, predominantly sub-horizontal very soft zones with intersecting 45° fractures, manganese-oxide coating on fracture planes.		C10			75	N/A						
33.35	46													
	47			C11			100	0						
31.35	48	47.0', abrupt color change to purplish brown, moderately soft, moderately strong, moderately to slightly weathered. Orthogonal filled fractures up to 45° dip.		C12			50	0						
	49	47.5', greenish gray, core broken into fragments ranging from 0.05' to 0.2'. 48.5', intensely fractured.		C13			91	0						
29.35	50	Crushed zones at 49.0', 49.3', and 49.8'. Common manganese-oxide coating on fracture planes.												Hole is steadily taking water
	51	50.2', very intensely fractured (clayey), intensely sheared, moderately weathered.												
27.35	52	51.25', intensely fractured, moderately hard, slightly weathered, orthogonal fracture planes.		C14			74	29						
	53	53.0', sub-horizontal and dipping 30° fractures.		C15			67	0						
25.35	54													
	55			C16			100	N/A						

(continued)

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		54.5', moderately fractured, very soft to soft, intensely to moderately weathered.												
23.35	56		METAMORPHIC ROCK (Greenstone), dark greenish gray, intensely fractured, moderately hard, moderately weathered, iron-manganese rich mineral composition, internally folliated with elongated crystals, iron-oxide staining throughout, prominent healed fractures filled with white mineral dipping 68°. [BEDROCK]		C17			0	N/A						
	57				C18			70	N/A						
21.35	58		55.6', 1/4" thick mylonized clayey fracture filling.		C19			80	50						
	59		55.8', internally crushed, very soft, intensely to moderately weathered.												
19.35	60		57.3' - 57.5', intensely fractured zone. 58.0', intensely fractured, soft to moderately soft, moderately weathered, iron-oxide staining on micro-fractures.												
	61		58.0', medium fractured, moderately hard, moderately strong, moderately weathered.		C20			89	31						
17.35	62		58.2', white preciptate on fracture face (calcite?), 1/16" thick precipitate filling on additional micro-fractures throughout.												
	63		59.7', intensely fractured, friable, very weak, severe to moderate weathering. Highly sheared zone.												
15.35	64		61.0', slightly fractured, moderately hard, slightly weathered, variably oriented fractures, commonly filled with tan to light brown (calcite?) filling. Fractures are commonly closed (intensely spaced internally), localized iron-oxide staining.												
	65		62.0', intensely fractured, soft, locally internally sheared, moderately to slightly weathered, up to 1/4" thick tan to very light brown (calcite?) filling.		C21			88	N/A						
13.35	66		62.1', serpentinized zone (0.2').												
	67		64.5', moderately weathered, locally intensely sheared/crushed.												
11.35	68		67.0', slightly fractured, moderately hard.		C22			93	0						
	69		69.0', variably oriented fractures, grades green, with anastomozing veins of (clear) gray mineral filling (translucent).												
9.35	70		70.0', intensely fractured, localized iron-oxide staining, translucent vein fillings up to 0.08' thick, variably oriented (healed shear zones), commonly fractured.		C23			42	0						
	71														
7.35	72														
	73														PL
5.35	74														
	75		74.5', slightly fractured (internally intensely sheared), serpentinitic, soft (locally plastic), moderately to slightly weathered, continued translucent vein filling.		C24			100	40						
3.35	76		76.0', moderately hard, slightly weathered, abundant closed fractures, abundant fine to medium sand-sized particles along fractues, ferro-magnesium minerals predominate, localized iron-oxide staining (minor).												
	77														
1.35	78		78.0', minor localized iron-oxide staining. 78.4', horizontal contact.		C25			50	10						
	79		78.9', intensely fractured, very soft, moderately weathered (internally crushed), predominantly comprised of talc.												
-0.65	80		Remnant rock fabric with serpentinite appearance, highly sheared.												
	81														
-2.65	82		IGNEOUS ROCK (Gabbro), dark gray and bluish gray, moderately fractured (internally sheared and crushed), very soft to moderately hard, moderately to slightly weathered. Serpentinite appearance with platey mineral structure common.		C26			100	N/A						
	83														
-4.65	84		84.0', very intensely to intensely fractured, moderately soft,		C27			80	N/A						
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		slightly weathered. Highly weathered (40° to 90°), intensely sheared planes/fractures. Locally phyllitic in appearance, secondary mineralization along micro-fractures, locally serpentinized appearance (chlorite?). 84.2' - 84.4', approximately 40° dipping shistosity. IGNEOUS ROCK (Gabbro), dark gray and bluish gray, moderately fractured (internally sheared and crushed), very soft to moderately hard, moderately to slightly weathered. Serpentinite appearance with platey mineral structure common.												
-6.65	86				C28			80	N/A	14.8	122.2	UU = 0.29			PI
	87														
-8.65	88														
	89		86.0', intensely fractured, intensely sheared with folliated appearance, alternating light green and dark gray. Green mineral (chlorite?) fibrous, perpendicular to veins. Locally crushed, friable, plastic. Primary orientation of folliation is vertical. 89.0', with irregular sub-horizontal surfaces.		C29			93	N/A						
-10.65	90														
	91														
-12.65	92		92.0', intensely to moderately fractured (internally sheared/crushed).		C30			77	N/A						
	93														
-14.65	94														
	95		METAMORPHIC ROCK (Serpentinite), bluish gray, very slightly fractured, slightly weathered (internally highly sheared), with "platey" texture (talc?) on internal fracture planes.		C31			100	N/A						
-16.65	96														
	97														
-18.65	98		98.4', slightly weathered to fresh.		C32			100	89						
	99		99.0', dipping 70°.												PL
-20.65	100														
	101														
-22.65	102		Grades to shaley serpentinite, moderately fractured, soft to moderately hard, with soft intervals (up to 0.4' at 102.1'), slightly weathered to fresh. 102.1', sub-horizontal fracture.		C33			98	85						
	103														
-24.65	104														
	105		104.7', healed fractures with secondary mineral formation, vein fillings.												
-26.65	106		106.0', intensely fractured to crushed (internally sheared), slightly weathered to fresh, abundant chlorite? fracture and vein filling up to 1/8" wide (healed fractures). 106.9', moderately fractured, moderately hard, fresh. 106.9' and 107.25', dipping 40°. 106.9' to 107.8', gabbroic. 107.8', intensely fractured (internally sheared), soft, slightly weathered.		C34			65	23						
	107														
-28.65	108														
	109														
-30.65	110		110.0', very slightly fractured (very intensely micro-fractured), fresh (much of core has appearance of highly sheared shale with secondary (chlorite?) mineral formation along weak zones).		C35			100	N/A						
	111														
-32.65	112														
	113														
-34.65	114														
	115														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		.												
-36.65	116														
	117														
-38.65	118														
	119														
-40.65	120		Borehole terminated at a depth of 113 feet on 4/3/2008.												
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-42.65	122		Additional Notes:												
	123		1. Oriented rock coring performed.												
-44.65	124		2. On 4/2/2008 downhole geophysical (suspension) logging was performed by GEOVision, Inc. Acoustic televiewer peformed on 4/2/2008. Packer tests performed on 4/2/2008.												
	125														
-46.65	126														
	127														
-48.65	128														
	129														
-50.65	130														
	131														
-52.65	132														
	133														
-54.65	134														
	135														
-56.65	136														
	137														
-58.65	138														
	139														
-60.65	140														
	141														
-62.65	142														
	143														
-64.65	144														
	145														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-1-08	4-1-08	N2120461.975 / E5994829.468 (NAD83)	BTNB-R7A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 190ft R Sta 78+13 NB Alignment	78.961 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 28.5' to 43.5'				45 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Poorly graded SAND (SP), poorly compacted, dark yellowish to reddish brown, moist, fine, with fine roots in upper 3" (root mat). [FILL]												
	1													
76.96	2													
	3	Grades with occasional angular coarse GRAVEL and pocket of yellowish brown SANDY CLAY. Grades yellowish brown.		S1	6 9 16	25	94							
74.96	4	Grades with occasional clumps of dark brown SANDY CLAY.		S2	4 3 4	7	94							
	5													
72.96	6													
	7	SILTY SAND (SM), poorly compacted, dark brown, wet, fine to very fine, SAND is fine.												
70.96	8	SILT with SAND (ML), soft, dark brown, wet, with yellowish brown mottling, with crushable iron-oxide nodules. [BURIED SOIL HORIZON]		S3	2 2 2	4	67							
	9	Lean CLAY (CL), soft, dark brown, moist, trace fine SAND.		S4	2 4 7	11	67							
68.96	10								20.4					PI
	11													
66.96	12	SILT with SAND (ML), medium stiff, yellowish brown, moist, SAND is fine, with vertical vein of black organic filling and black mottling. [SANDY SILT]												
	13			S5	8 13 19	32	83							
64.96	14	Grades to SANDY SILT without organic vein.		S6	4 5 7	12	100							
	15													
62.96	16													
	17	SILTY SAND (SM), yellowish brown, moist, fine. [COLMA SAND]												
60.96	18			S7	6 7 8	15	83							
	19	SANDY lean CLAY (CL), medium stiff, yellowish brown, moist, SAND is fine, with veins of black CLAY. [SANDY CLAY]							20.8	107.7	UU = 0.62			PA
58.96	20			S8	3 3 4	7	83		23.6					PI
	21													
56.96	22	Poorly graded SAND with SILT (SP-SM), dark yellowish brown to dark reddish brown, moist, fine to very fine. [COLMA SAND]												
	23			S9	15 20 24	44	83		19.9	111.4				PA
54.96	24	Grades dense, with iron-oxide staining.		S10		38	83							
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-7-09	1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND with SILT (SP-SM), dark yellowish brown to dark reddish brown, moist, fine to very fine. [COLMA SAND]			18 18 20									
52.96	26													
	27													
50.96	28	Grades yellowish brown, medium dense, fine, with iron-oxide mottling, with pockets of iron-oxide nodules (up to 1/2" diameter).		S11	13 19 22	41	83							
	29			S12	9 10 13	23	89							
48.96	30													
	31													
46.96	32	SILTY SAND (SM), dense, yellowish brown, moist, very fine to fine, with dark gray mottling.												
	33			S13	20 28 32	60	100		20.9	109.3				CU PA
44.96	34	Grades very dense, with iron-oxide mottling.		S14	16 23 29	52	89							
	35													
42.96	36													
	37													
40.96	38	Grades without iron-oxide mottling, SAND grades fine to medium.		S15	28 32 50/5.5"	82/11.5"	84							Indication of water flow in S15 at 37.5'
	39	Poorly graded SAND with CLAY (SP-SC), dense, yellowish brown, moist, fine, with angular rock fragments up to 3/4" diameter.		S16	13 15 19	34	89							
38.96	40													
	41													
36.96	42	METAMORPHIC ROCK (Greenstone), yellowish brown and green, decomposed, very soft, very intensely fractured (poorly graded SAND with SILT (SP-SM), moist). [BEDROCK]												Rig chatter at 41.5'
	43													
34.96	44			S17	24 33 31	64	89							
	45	Borehole terminated at a depth of 45 feet on 4/1/2008.												
32.96	46	See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	47													
30.96	48													
	49													
28.96	50													
	51													
26.96	52													
	53													
24.96	54													
	55													

Material Graphics

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161R	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	1-17-08	1-22-08	N2120323.729 / E5994396.263 (NAD83)	BTSB-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.				101.030 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Failing 1500	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Shelby (2.87"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.8%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 23.5 to 33.5 ft				75.5 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY SAND (SC), loose, dark brown, dry, fine, with GRAVEL. [FILL]												
	1													
99.03	2	Grades dry to moist. Grades no GRAVEL, grades with pockets of yellowish brown CLAY.		S1	4 6 7	13	100							
	3	Poorly graded SAND, loose, reddish brown, dry to moist, fine.												
97.03	4	Grades dark yellowish brown.		S2	2 2 5	7	78							
	5													
95.03	6													
	7	Grades yellowish brown to light yellowish brown, medium dense.												
93.03	8	SAND grades fine to medium.		S3	5 10 14	24	100							
	9	SAND grades fine.		S4	4 9 11	20	100							CR
91.03	10													
	11													
89.03	12													
	13			S5	9 13 27	40	100		15.0	105.8				PA
87.03	14			S6	6 11 14	25	44							
	15													
85.03	16													
	17													
83.03	18	Grades moist.		S7	8 14 19	33	67							
	19			S8	5 9 13	22	56							
81.03	20													
	21													
79.03	22													
	23			S9	10 6 6	12	33		26.4 25.3	100.5 100.7	DS = 1.1			PA
77.03	24	Lean CLAY with SAND (CL), soft, very dark gray to black, wet, with brown mottling, occasional small decayed vegetation. [BURIED SOIL HORIZON]		S10		3	67		30.8	95.9	DS = 12.5 DS =			
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161L	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Lean CLAY with SAND (CL), soft, very dark gray to black, wet, with brown mottling, occasional small decayed vegetation. [BURIED SOIL HORIZON]			0 1 2						1.51			
75.03	26													
	27	Lean CLAY with SAND (CL), soft, brown, wet. [SANDY CLAY]												
73.03	28			U11		225 psi	97		22.0	106.5	PP = 1.25 UU = 0.74			
	29								22.8	100.6				C PI PI
71.03	30	Grades yellowish brown with gray clay lenses and pocket of very stiff gray CLAYEY SAND.												
	31													
69.03	32													
	33	Grades with black organic mottling, medium stiff to stiff.		S12	8 50/2"	50/2"	100				PP = 0.5			
		SEDIMENTARY ROCK (Sandstone), fine to medium grained, massive, gray to dark gray, moderately weathered, moderately hard, intensely fractured, anastomizing white secondary mineral vein infilling. [BEDROCK]												
67.03	34			C13			90	33						
	35	35.2', slightly weathered, moderately to intensely fractured.												
65.03	36													PL
	37			C14			100	60			UC = 780			
63.03	38	37.6' - 37.9', intensely fractured.												
	39													PL
61.03	40													
	41			C15			100	55						
59.03	42	41.8', slightly weathered to fresh.												
	43	SEDIMENTARY ROCK (Sandstone and Shale), sandstone is medium to fine grained, laminated to moderately bedded (distorted by soft sediment deformation and micro faulting white secondary mineral vein infilling occurs along faults), gray to dark gray, slightly weathered to fresh, moderately hard, moderately fractured, surface of core is occasionally pitted, ractures are commonly polished and slickensided.												
57.03	44			C16			90	40						
	45										UC = 908			
55.03	46													PL
	47	47.3' - 47.6', surface of core is commonly pitted.												
53.03	48													
	49	SEDIMENTARY ROCK (Mélange Matrix), very dark gray gravel, slightly weathered to fresh, very soft, very intensely fractured (hard meta-sandstone fragments in sheared shale matrix)(lean clay with gravel (CL), soft, gravel is fine to coarse, angular, moist to wet).		C17			20	0						End of Box 1 at 49.0' Lost circulation at 49.0' on Run C17, recovered core consists primarily of harder fragments with occasional intervals of intact core consisting of sheared/brecciated meta-sandstone and shale. We install 4' casing to 52'.
51.03	50			C18			40	0						
	51													
49.03	52			C19			100	0						
	53			C20			60	0						
47.03	54			C21			65	0						
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll		DATE 1-7-09	SHEET 2 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), very dark gray gravel, slightly weathered to fresh, very soft, very intensely fractured (hard meta-sandstone fragments in sheared shale matrix)(lean clay with gravel (CL), soft, gravel is fine to coarse, angular, moist to wet).												
45.03	56														Hole is consistently caving to about 54'; we drill with tricone to 58' and install 4" casing to 58'
	57														
43.03	58				C22			53	0						
	59		59.3', hard piece of meta-sandstone (0.3' diameter).												
41.03	60														Hole caved to 60' after drilling to 67', switch to 101-system.
	61				C23			90	0						
39.03	62														
	63				C24			63	0						
37.03	64														
	65														
35.03	66														
	67														Straight drill to 75.5' and monitor cuttings - all melange matrix; the aggregate is mostly siltstone
33.03	68														
	69														
31.03	70														
	71														
29.03	72														
	73														
27.03	74														
	75														
25.03	76		Borehole terminated at a depth of 75.5 feet on 1/22/2008.												
	77		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
23.03	78														
	79														
21.03	80														
	81														
19.03	82														
	83														
17.03	84														
	85														

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-25-08	2-29-08	N2120218.262 / E5994858.344 (NAD83)	BTSB-R2
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.				92.121 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), 101-Sampler			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill			7	115 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	6" ASPHALT CONCRETE.												
	1	10" UNREINFORCED CONCRETE.												
90.12	2	GRAVELLY fat CLAY (CH), poorly compacted, dark brown, moist, GRAVEL is angular, with SAND. [FILL]												
	3	Poorly graded SAND (SP), loose, dark yellowish brown, dry to moist, fine, trace fines.		S1	4 4 5	9	100		5.3	112.8				
88.12	4			S2	4 5 6	11	100							
	5													
86.12	6													
	7	Grades dark brown.												
84.12	8	Lean CLAY (CL), soft, dark brown, moist, trace fine SAND. [BURIED SOIL HORIZON]		S3	7 7 7	14	50				PP = 0.875			
	9			S4	3 3 4	7	89							
82.12	10													
	11													
80.12	12													
	13	Lean CLAY (CL), medium stiff, yellowish brown, moist, trace fine sand, frequent dark brown oxidized nodules (up to 1/2" diameter). [SANDY CLAY]		S5	5 9 13	22	83		22.5	104.6	PP = 1.0 UU = 0.93			PI
78.12	14			S6	5 7 8	7	89							
	15													
76.12	16													
	17													
74.12	18	SILTY SAND (SM), medium dense, yellowish brown, moist to wet, fine, with root hairs (up to 1/16" diameter), with black oxidized nodules (up to 1/16" diameter). [COLMA SAND]		S7	6 9 11	20	83		19.1	114.0	UU = 0.93			PA
	19	Poorly graded SAND with SILT (SP-SM), medium dense, yellowish brown, moist to wet, fine to medium.		S8	6 7 7	14	83							
72.12	20													
	21													
70.12	22													
	23	Poorly graded SAND (SP), dense, yellowish brown, moist, fine, trace fines.		S9	20 30 40	70	83							CR
68.12	24			S10		60	89							
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161L	T. Carroll	1-7-09	1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND (SP), dense, yellowish brown, moist, fine, trace fines.			20 30 30									
66.12	26													
	27													
64.12	28	Grades to reddish brown with black oxidized nodules (up to 1/4" diameter).		S11	24 41 50	91	72		20.7 21.8	107.6 106.8	DS = 1.87			PA
	29			S12	12 19 26	45	100		20.6	107.8	DS = 1.56			
62.12	30	Grades with increase in fines content.									DS = 2.20			
	31													
60.12	32													
	33	Grades yellowish brown.		S13	26 34 35	69	83							
58.12	34	33.8', grades weakly cemented.		S14	12 14 23	37	89		21.2	106.0				PA, CU
	35	35.0', occasional fine GRAVEL (up to 1/2" diameter), subrounded, reddish brown (chert fragment).												
56.12	36	Grades with occasional pockets of SANDY CLAY (up to 1/8" diameter).												
	37	Lean CLAY (CL), very stiff, yellowish brown and reddish brown, moist, trace fine SAND, with black specks. [SANDY CLAY]												
54.12	38			S15	9 13 17	30	83		20.7	108.1	UU = 1.15			
	39	Fat CLAY (CH), very stiff, yellowish brown and grayish brown, dry to moist, trace fines, trace SAND, with black specks, mottled.		S16	10 12 15	27	89		22.3	104.3	PP = 1.63 UU = 1.84			PI PI
52.12	40													
	41													
50.12	42													
	43	Lean CLAY (CL), hard, yellowish brown and light gray, trace fine SAND, mottled, with iron-oxide staining, with black specks		S17	15 32 50	82	50		19.4	110.9	PP = >2.0 UU = 3.14			PI
48.12	44			S18	15 33 39	72	67							
	45	SEDIMENTARY ROCK (Sandstone), fine to coarse grained, light yellowish brown, decomposed, very soft, very intensely fractured. (CLAYEY SAND (SC), very dense, light yellowish brown, dry, fine to coarse, faint dark reddish brown predefined fracture planes, slight rock structure, with frequent manganese-oxide staining.) [BEDROCK]												
46.12	46													
	47	SEDIMENTARY ROCK (Siltstone), dark brown, intensely weathered, moderately hard, very intensely fractured.												
44.12	48	METAMORPHIC ROCK (Serpentinite), greenish gray and yellowish brown, very intensely weathered, moderately soft, very intensely fractured.		S19	28 50/5.5"	50/5.5"	70							
	49			C20			68	N/A						
42.12	50	METAMORPHIC ROCK (Granulite), medium to coarse SAND and fine GRAVEL-sized, yellowish brown and light greenish gray, intensely weathered, soft, very intensely fractured (crushed), intensely mylonized, localized sheared surfaces on more competent 0.1' to 0.2' thick blocks.												
	51			C21			93	N/A						
40.12	52	METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
	53													
38.12	54													
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
36.12	56				C22			47	N/A						
	57														
34.12	58														
	59				C23			95	N/A						
32.12	60														
	61				C24			68	N/A						
30.12	62														
	63				C25			95	N/A						
28.12	64														
	65				C26			100	N/A						
26.12	66														
	67				C27			100	N/A						
24.12	68														
	69		68.4', white secondary mineralization forming a banding effect.		C28			43	0						
22.12	70		69.0', dark olive gray and very dark gray, moderately weathered, moderately hard to locally soft, intensely fractured, fractures dipping 15° to 25°, common secondary mineralization along closely spaced fractured/sheared surfaces throughout interval, commonly breaks 0.1' to 0.2' fragments (hard).												
	71														
20.12	72				C29			100	0						
	73														
18.12	74														
	75				C30			100	N/A						
16.12	76		75.8', greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured.												
	77				C31			100	N/A						
14.12	78														
	79														
12.12	80		Bluish gray and very dark gray.		C32			100	N/A						
	81				C33			100	N/A						
10.12	82														
	83				C34			19	N/A						
8.12	84														
	85														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
6.12	86														
	87				C35			100	N/A						
4.12	88														
	89				C36			95	N/A						
2.12	90														
	91				C37			68	N/A						
0.12	92														
	93				C38			100	N/A						
-1.88	94														
	95				C39			19	N/A						
-3.88	96		96.3' - 96.8', sand-like texture.		C40			58	N/A						
	97														
-5.88	98														Straight drill from 98' to 115' done with CME 550
	99														
-7.88	100														
	101														
-9.88	102														
	103														
-11.88	104														
	105														
-13.88	106														
	107														
-15.88	108														
	109														
-17.88	110														
	111														
-19.88	112														
	113														
-21.88	114														
	115														

(continued)

Department of Transportation
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Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		.												
-23.88	116														
	117														
-25.88	118														
	119														
-27.88	120		Borehole terminated at a depth of 115 feet on 2/29/2008.												
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-29.88	122		Additional Notes:												
	123		1. On 2/29/2008 downhole geophysical (suspension) logging was performed by GEOVision, Inc.												
-31.88	124														
	125														
-33.88	126														
	127														
-35.88	128														
	129														
-37.88	130														
	131														
-39.88	132														
	133														
-41.88	134														
	135														
-43.88	136														
	137														
-45.88	138														
	139														
-47.88	140														
	141														
-49.88	142														
	143														
-51.88	144														
	145														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-18-08	4-22-08	N2120225.975 / E5994556.115 (NAD83)	BTSB-R3-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 93ft L Sta 80+49 SB Alignment	97.900 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 50.0 to 70.0 ft				113 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND (SM), poorly compacted, very dark brown, moist, fine, occasional fine gravel and coarse sand, slight organic odor, trace fine roots. [FILL]												Very wet at ground surface due to lawn watering
95.90	2	Poorly graded SAND (SP), poorly compacted, dark yellowish brown, moist, fine to very fine, occasional roots (up to 1/8" thick).		S1	2 2 2	4	83							
93.90	4													
91.90	6													
89.90	8	Grades with dark gray to black laminations (horizontal), with occasional dark brown CLAY.		S2	7 12 14	26	50							
87.90	10													
85.90	12	Lean CLAY with SAND (CL), medium stiff, dark brown, moist, SAND is fine. [BURIED SOIL HORIZON]		S3	3 4 4	8	100							
83.90	14	Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, with iron-oxide nodules and mottling. [SANDY CLAY]												
81.90	16													
79.90	18	SEDIMENTARY ROCK (Sandstone), fine to medium grained, yellowish brown, very soft, decomposed, intensely fractured, with vertical and sub-horizontal partings, with manganese-oxide staining on vertical fracture planes, angular to subangular gravels, individual grains commonly altered around perimeter (poorly graded SAND with CLAY (SP-SC), moist, with iron-oxide mottling and nodules). [BEDROCK]		S4	30 50/ 3.5"	50/3.5"	63							Drilling slowed at 16.5'
77.90	20			S5	50/5"	50/5"	80							
75.90	22	SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes. 21.1', approximately 1/2 face manganese-oxide stained separated by fracture from thin clay filling.		C6			88	0						21.1', 330/31E 21.2', 38/67S 21.65', 48/63N 21.8', 90/79S 22.0', 305/70W
73.90	24	23.0', fine to coarse grained, pitted texture, continued manganese-oxide staining of fractures at 23.3', 23,5', and 24.3'; clay filling on fractures (up to 0.01' thick), fracture dips range from sub-horizontal to 30° with occasional up to 80°.		C7			100	19						22.25', 200/61E 22.6', 76/90

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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161L	T. Carroll	1-7-09	1 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes.									UC = 351			
71.90	26														PL
	27		26.5', increase in darker minerals, fracture dips range from horizontal to 45°.		C8			91	86						
69.90	28														
	29														
67.90	30		30.0', intensely fractured.		C9			100	0			UC = 241			
	31														30.5', 38/41W 30.65', 296/42N 30.9', 310/45N
65.90	32														31.2', 60/28N 31.5', 285W/375 31.9', 20/57E and 309/37S
	33		33.0', bluish gray, moderately weathered.												32.1', 285W/37S PL
63.90	34														32.9', 60/34W 33.2', 26/42E 34.0', 32/76E
	35				C10			100	0						34.8', 288/37S
61.90	36														
	37														
59.90	38		38.0' - 38.8', very intensely fractured (crushed), with localized mylonization (variably oriented fractures with clay filling), minor pitting along some fractures, most fractures dip 20° to 40° with occasional vertical fractures.												PL
	39														
57.90	40		Common near vertical fractures, continued localized pitting, grain size is variable and mixed suggesting soft sediment deposition.		C11			100	18						40.2', 357/62W From 40.3' to 41.4' fracture is curvilinear
	41														40.3' to 40.8', 58/79S 40.8' to 41.4', 67/83N
55.90	42		42.4' - 43.0', irregular fracture not measured (sub-vertical).												41.6', 47/78S 41.7', 334/40N
	43														42.95', 56/34S 43.2', 85/25S
53.90	44														43.4', 30/21N
	45		Iron-oxide staining only, limited to fracture planes, very intensely fractured zones 45.6' to 45.8' and 47.2' to 47.6'.		C12			94	10			UC = 679			45.2', 24E/29E 45.4', 8/49E
51.90	46		46.2' - 46.8', sub-vertical.												45.7', 90/82S 46.0', 290/67N
	47														46.1', 359/44E 46.2' - 46.8', sub-vertical fracture
49.90	48		48.0', occasional white (quartz?) veins, aphinitic dark rock fragments (fine grained sized) within fine to medium matrix, slightly weathered.												46.8', 33/73W 47.1', 90/75N (shearing along plane) 47.4', 352/49W
	49														
47.90	50		50.0', elongated rock fragments (aphinitic) are sub-parallel, dark minerals predominate, moderately fractured, hard.		C13			100	60			UC = 1210			PL
	51		Increased iron-oxide staining at 51.0'.												
45.90	52														
	53														PL
43.90	54		Very slight iron-oxide staining, moderately to slightly fractured.		C14			100	93						
	55														

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Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes.												54.85', 16/38E 54.95', 72/63N 55.1', 0/17E PL 56.0', 75/18S
41.90	56														
	57														
39.90	58				C15			100	40						PL
	59		Very intensely fractured zones at 59.4' to 59.8' and 61.6' to 62.1'.												
37.90	60		Localized banding appearance of dark mineral fragments.												PL
	61														
35.90	62														
	63														PL
33.90	64		Unfractured, continued <0.02' thick quartz veins, continued localized dark mineral "banding", strong, fresh to slightly weathered.		C16			100	100						
	65		64.9', mechanical break.												PL
31.90	66														
	67														
29.90	68		One core break is mechanical.		C17			80	80						PL
	69														
27.90	70		SEDIMENTARY ROCK (Shale), aphanitic, no indication of bedding, dark gray, fresh, moderately hard where intact otherwise sheared, very intensely to intensely fractured, weak to moderately strong.		C18			100							
	71				C19			74	N/A						
25.90	72		71.7' - 72.3', crushed. 71.8', 0.1' thick clay zone <50°.												
	73		73.0' - 73.2', hard.		C20			47	N/A						
23.90	74		73.2' - 75.1', crushed/sheared, highly variable orientation to shears, minor green serpentine fragments.												
	75														
21.90	76														
	77														
19.90	78		SEDIMENTARY ROCK (Sandstone), fine to medium grained, dark gray, slightly weathered, moderately hard, intensely fractured, slight iron-oxide staining on some fractures, fractures ~45-90°.		C21			100	0						
	79														
17.90	80		80.0', fresh, continued quartz veins, with dark mineral veins, localized soft sediment deposition.		C22			100	72						
	81														
15.90	82											UC = 253			81.4', 330/36W
	83		82.5' - 87.9', sheared zone (clayey).												82.7', 7/28E
13.90	84		83.9', slickensides parallel to strike, rake is 18° down to SE.												83.5', 346/23E 83.9', 322/46E 84.3', 335/22E
	85														

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Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		85.15', dip ~18° with slickensides on fracture surface. 85.5', dip ~37°.		C23			70	0						84.5', 288/54N 84.8', 4/44E
11.90	86		SEDIMENTARY ROCK (Sandstone and Shale), commonly crushed to fragments up to 0.1' diameter, SANDSTONE is fine grained, variably oriented quartz veins within SANDSTONE intervals, light green mineral (chlorite?) within SHALE intervals, soft, moderately weathered. 86.1', 0.2' clay zone. 88.1' - 88.6', crushed (not clayey). 88.8' - 89.3', sheared zone (clayey).											
	87				C24			0							
9.90	88				C25			85	0						
	89														
7.90	90														
	91		Iron-oxide along fracture planes.												
5.90	92		SEDIMENTARY ROCK (Sandstone), fine to medium grained, laminated to thinly bedded (contact between fine to medium grained and very fine gravel at 91.9' ~60° to 80° dip), dark gray, moderately to slightly weathered, moderately hard to moderately soft, intensely fractured, numerous closed fractures, fractures are randomly oriented, numerous healed micro faults.		C26			100	0						PL
	93														
3.90	94														
	95		94.5', moderately fractured with localized very intensely fractured (crushed) zones along fractures, limited to fracture planes.		C27			91	0						
1.90	96														
	97		97.0', contact to medium to fine grained, moderately hard, dipping ~45°.												
-0.10	98		98.0', slightly to moderately weathered. From 99.0' to 99.8', fracture with localized crushing and slickensides. Increase in iron-oxide staining.		C28			100	33						98.4', 3/58E and 321/40W
	99														PL
-2.10	100														99.4', 297/70N and 348/71W 99.6', 74/44W 99.9', 286/59S
	101		101.0' - 102.2', fine to very fine grained, moderately soft, indicating soft sediment disposition.												100.1', 352/50W 100.8', 25/42E 101.2', 335/33E
-4.10	102		102.4' - 102.9', very intensely fractured (crushed), moderately weathered, with evidence of shearing.												102.0', (contact) 4/83W 102.4', N42W/63SW
	103				C29			96	24						
-6.10	104		104.1', quartz vein infilling.												
	105		105.0' - 105.5', contact to fine grained.												
-8.10	106		105.5', frequent closed/healed fractures, ruggy, (occasional iron-oxide stained openings in the core that are not, through fractures up to 0.2' in length and 0.03' wide oriented near vertical to dipping ~80°).												105.5', 304/21S 106.25', (parallel to bedding) 90/54S
	107														106.75', 13/62E and 342/44E 106.9', 90/34S
-10.10	108		108.0', near parallel, sub-vertical fractures (to 110.5'), fine to medium grained from 109.2' to 110.0' and 111.0' to 111.2'. 108.0' - 109.2', very thinly bedded.		C30			96	0						
	109														
-12.10	110														
	111		111.0' to 112.8', frequent randomly oriented whie mineral veins (calcite?).												
-14.10	112														
	113		Borehole terminated at a depth of 113 feet on 4/22/2008.												
-16.10	114		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	115														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 4	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-23-08	4-23-08	N2120227.544 / E5994550.875 (NAD83)	BTSB-R3A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 92ft L Sta 80+54 SB Alignment	98.049 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Bulk			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 9.0 to 18.0 ft				19.3 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Remarks
	0	SILTY SAND (SM), poorly compacted, dark brown, moist to wet, fine, slight organic odor, trace fine roots. [FILL]	B1							
	1	CLAY with GRAVEL (CL), poorly compacted, dark brown, moist, gravel is subangular, with chert fragments, with veins of yellowish brown clay and roots.								
96.05	2		S2							CR
	3	Poorly compacted, dark yellowish brown, moist.	S3	2 3 4	7	83	6.7	115.6		PA
94.05	4		S4	2 3 6	9	100				
	5									
92.05	6		S5							
	7									
90.05	8	Grades medium dense, yellowish brown.	S6	9 13 16	29	100				
	9		S7	3 4 7	11	83	9.2 10.4 9.3	109.7 112.9 109.7	DS = 0.47 DS = 0.52 DS = 0.75	PA
88.05	10									
	11									
86.05	12	Lean CLAY with SAND (CL), medium stiff, dark brown, moist, SAND is fine to medium with dark yellowish brown mottling. [BURIED SOIL HORIZON]								
	13		S8	5 6 8	14	83	18.6	131.8	UU = 0.39	PI
84.05	14	Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, with iron-oxide nodules and mottling. [SANDY CLAY]	S9	2 4 5	9	100				
	15									
82.05	16									
	17	SEDIMENTARY ROCK (Sandstone), very soft, fine to medium grained, decomposed, intensely fractured, with light yellowish brown clay infilling (Poorly graded SAND with CLAY (SP-SC), moist, with iron-oxide mottling and nodules). [BEDROCK]	S10	28 50/4"	50/4"	80				Rods bouncing at 16.5'
80.05	18		S11	65 50/6"	50/6"	17	10.5	142.2	UU = 1.28	PA
	19									
78.05	20	Borehole terminated at a depth of 19.3 feet on 4/23/2008.								
	21	See Boring Record Legend for soil classification chart and key to test data and sampler type.								
76.05	22									
	23									
74.05	24									
	25									

Drilling Method: Casing Depth

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER 34-0161L	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 1 of 1	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-29-08	4-29-08	N2120752.489 / E5994220.945 (NAD83)	HA-1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 331ft R Sta 85+7 NB Alignment	27.802 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Hand Auger				5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Grab			N/A	N/A
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 6.5 to 11.5 ft				11.3 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY GRAVEL (GC), yellowish brown, damp, gravel is fine to coarse, with frequent cobbles up to 8" diameter. [FILL]												
	1			S1										
25.80	2													
	3													
23.80	4	CLAYEY SAND (SC), light yellowish brown, moist, trace fine gravel, gravel is subrounded.		S2										
	5													
21.80	6			S3										
	7	METAMORPHIC ROCK (Serpentinite), greenish gray, damp, intensely weathered, soft to moderately soft (friable), very intensely fractured.		S4										
19.80	8													
	9	Grades with some larger rock fragments (up to 1" diameter).		S5										
17.80	10	10.0', soft, with CLAY infilling.		S6										Easier drilling 9.7' to 11.3'
	11													
15.80	12	Borehole terminated at a depth of 11.3 feet on 4/29/2008.												
	13	See Boring Record Legend for soil classification chart and key to test data and sampler type.												
13.80	14													
	15													
11.80	16													
	17													
9.80	18													
	19													
7.80	20													
	21													
5.80	22													
	23													
3.80	24													
	25													

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				HA-1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-9-09	1 of 1	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-29-08	4-29-08	N2120690.897 / E5994579.932 (NAD83)	HA-2-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 363ft R Sta 81+44 NB Alignment	25.348 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Hand Auger				5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Grab			N/A	N/A
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 6.5 to 11.5 ft				11.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		SILTY SAND (SM), dark brown, damp, fine, trace fine roots, slight organic odor. [FILL]												
	1														
23.35	2		Poorly graded SAND (SP), dark yellowish brown, damp, fine, trace fines.												
	3				S1										
21.35	4														
	5		Grades moist, trace roots.												
19.35	6				S2										
	7				S3										
17.35	8		Grades moist to wet.		S4										
	9				S5										
15.35	10														
	11														
13.35	12		Borehole terminated at a depth of 11.5 feet on 4/29/2008.												
	13		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
11.35	14														
	15														
9.35	16														
	17														
7.35	18														
	19														
5.35	20														
	21														
3.35	22														
	23														
1.35	24														
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				HA-2-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-9-09	1 of 1	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-29-08	4-30-08	N2120613.038 / E599484.724 (NAD83)	HA-3-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 345ft R Sta 77+60 NB Alignment	22.315 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Hand Auger				5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Grab			N/A	N/A
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 3.0 to 6.5 ft				6.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		CLAYEY SAND with GRAVEL (SC), dark brown, moist, with occasional COBBLES up to 6" diameter, with pieces of wood and roots (up to 1/8" diameter), GRAVEL and COBBLES are CHERT and SERPENTINITE fragments. [FILL]												
	1														
20.32	2														
	3				S1										
18.32	4														
	5		METAMORPHIC ROCK (Serpentinite), greenish gray and yellowish green, moderately weathered, moderately hard, recovery may not be indicative of in-situ condition due to augering technique.		S2 S3										Sample at 4.5' is mixed with sand from above Harder drilling at 4.5'; we used water to help clean the hole
16.32	6		6.1', grades to slightly weathered, hard.		S4										
	7		Borehole terminated at a depth of 6.5 feet on 4/30/2008.												
14.32	8		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	9														
12.32	10														
	11														
10.32	12														
	13														
8.32	14														
	15														
6.32	16														
	17														
4.32	18														
	19														
2.32	20														
	21														
0.32	22														
	23														
-1.69	24														
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				HA-3-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161R	T. Carroll	1-9-09	1 of 1	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-4-08	3-4-08	N2120378.671 / E5995179.887 (NAD83)	M-9/RW7-A1
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.				17.928 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
				6 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND with GRAVEL (SM), poorly compacted, dark brown, moist, fine, occasional clumps of CLAY, with clastes up to 1/16" diameter, piece of brick at 1', GRAVEL is sub-rounded to sub-angular, GRAVEL is fine. [FILL]												
15.93	2													
	3			S1	1 2 12	14	67							
13.93	4	4.0', grades gray, wet.		S2	1 2 1	3	33							
	5													
11.93	6	Borehole terminated at a depth of 6 feet on 3/4/2008.												
	7	See Boring Record Legend for soil classification chart and key to test data and sampler type.												
9.93	8													
	9													
7.93	10													
	11													
5.93	12													
	13													
3.93	14													
	15													
1.93	16													
	17													
-0.07	18													
	19													
-2.07	20													
	21													
-4.07	22													
	23													
-6.07	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				M-9/RW7-A1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 1	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-4-08	3-4-08	N2120378.671 / E5995179.887 (NAD83)	M-9/RW7-A1A
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 91ft R Sta 74+26 NB Alignment	17.928 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Shelby (2.87"), HQ Core, 101-Sampler			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill				59 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND with GRAVEL (SM), poorly compacted, dark brown, moist, fine, occasional clumps of CLAY, with casts up to 1/16" diameter, piece of brick at 1', GRAVEL is sub-rounded to sub-angular, GRAVEL is fine. [FILL]												Lithology and samples above 5.5' taken from M-9/RW7-A1
	1													
15.93	2													
	3			S1	1 2 12	14	67							
13.93	4	4.0', grades gray, wet.		S2	1 2 1	3	33							
	5													
11.93	6	CLAYEY SAND (SC), very loose, dark gray, wet, fine to very fine, slight organic odor, frequent decomposed wood. [HYDRAULIC FILL]		S3	0 2 2	4	100		39.7	113.5				PA
	7	SAND with CLAY (SP-SC), loose, dark gray, wet, fine to very fine.		S4	0 0 0	0	78							
9.93	8	CLAYEY SAND (SC), loose, dark brown, wet, fine to very fine, occasional pieces of wood/twigs (up to 1/16" diameter).												
	9													
7.93	10			U5		50 psi	0							
	11													
5.93	12	Grades yellowish brown and reddish brown, fine, with occasional pockets of SANDY CLAY (up to 1/4" diameter).		S6	0 1 2	3	100		22.0					PA
	13													
3.93	14													
	15			S7	1 2 2	4	0							
1.93	16													
	17	CLAYEY SAND (SC), bluish gray, moist to wet, with occasional roots (up to 1/16" diameter), with greenish gray mottling, pieces of decayed vegetation, with pockets of CLAYEY SAND. [MARINE SAND]		S8	0 1 2	3	100		24.8					PA
-0.07	18													
	19	19.0', cuttings are fine sand.												
-2.07	20	Poorly graded SAND (SP-SC), medium dense, yellowish brown, fine to medium, with pieces of GRAVEL, GRAVEL is rounded.		S9	10 15 19	34	67							MC sample at 20' run with catchers
	21													CR
-4.07	22			S10	7 25 40	65	100							
	23	Poorly graded SAND (SP), dense, yellowish to reddish brown, moist, fine, trace fines. [COLMA SAND]												
-6.07	24													
	25													

(continued)

Department of Transportation
Division of Engineering Services
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REPORT TITLE				HOLE ID
BORING RECORD				M-9/RW7-A1A
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	SANDY lean CLAY (CL), medium stiff, brown and dark reddish brown, moist, SAND is fine to coarse, mottled. [COLLUVIUM]		S11	15 28 14	42	83							
-8.07	26								20.4	135.7				PA
	27	Grades brown to yellowish brown, with chert fragments up to 3/4" diameter (angular).		S12	6 9 14	23	89							
-10.07	28	Grades hard, greenish gray, trace SILT, with grayish brown mottling, SAND is fine.												
	29													
-12.07	30	Grades grayish brown, moist, trace GRAVEL, GRAVEL is fine, subangular (up to 3/4" diameter), SAND is fine to coarse, with reddish brown mottling, with black specks.		S13	10 20 26	46	67							
	31								24.3	129.4				PA
-14.07	32	32.0', grades very stiff, SAND is fine, with frequent reddish brown oxidized nodules (up to 1/4" diameter).		S14	8 7 14	21	50							
	33													
-16.07	34													
	35	CLAYEY GRAVEL with SAND (GC), dense, greenish gray and brown, moist, GRAVEL is angular to subangular, SAND is fine, with reddish brown oxidation.		S15	25 43 34	77	33							
-18.07	36								12.1	142.2				PA
	37	GRAVELLY lean CLAY with SAND (CL), mediuim stiff, dark gray, moist, GRAVEL is subangular, SAND is fine to coarse, with pockets of greenish gray SANDY CLAY up to 1/8" diameter.		S16	14 16 24	40	67							
-20.07	38	37.0' - 37.3', red to dark red CHERT fragments.												Rig chatter at 37.5'
	39													
-22.07	40	METAMORPHIC ROCK (Serpentinite), yellowish green and green, completely weathered, moderately soft, very intensely fractured (SANDY lean CLAY (CL), very stiff to hard, moist, trace fine GRAVEL). [BEDROCK]		S17	13 31 50/5"	81/11"	100							
	41								14.0	124.2				PI
-24.07	42			S18	50/6"	50/6"	67							
	43	IGNEOUS ROCK (Gabbro), aphanitic, very dark gray, slightly weathered, hard, moderately to slightly fractured, secondary mineralization throughout (blebs).		C19			25	0						Common mechanical breaks
-26.07	44													
	45			C20			0	N/A						
-28.07	46			C21			85	45						46', unable to advance 101, switch to HQ
	47										UC = 565			
-30.07	48	47.4', white mineral vein filling along fracture (dipping 48°).												PL
	49	METAMORPHIC ROCK (Serpentinite), green, intensely weathered, soft, intensely fractured.												
-32.07	50	SEDIMENTARY ROCK (Mélange Matrix), dark gray, crushed, slightly weathered to fresh, very soft, very intensely fractured (moderately hard SILTSTONE fragments in sheared SHALE matrix, CLAY with GRAVEL (CL), soft GRAVEL is fine to angular, moist to wet, coarse.		C22			20	N/A						
	51													
-34.07	52													
	53													
-36.07	54													
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-9/RW7-A1A
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), dark gray, crushed, slightly weathered to fresh, very soft, very intensely fractured (moderately hard SILTSTONE fragments in sheared SHALE matrix, CLAY with GRAVEL (CL), soft GRAVEL is fine to angular, moist to wet, coarse.		C23			32	N/A						Swith to mud rotary at 55.5'
-38.07	56														
	57														
-40.07	58				C24			0	N/A						
	59				S25	50/5"	50/5"	80							
-42.07	60		Borehole terminated at a depth of 59 feet on 3/4/2008. See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	61														
-44.07	62														
	63														
-46.07	64														
	65														
-48.07	66														
	67														
-50.07	68														
	69														
-52.07	70														
	71														
-54.07	72														
	73														
-56.07	74														
	75														
-58.07	76														
	77														
-60.07	78														
	79														
-62.07	80														
	81														
-64.07	82														
	83														
-66.07	84														
	85														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				M-9/RW7-A1A
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-5-08	3-7-08	N2120511.047 / E5995523.129 (NAD83)	M-10
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 112ft R Sta 70+39 NB Alignment	11.908 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill			3.5	55 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND (SM), poorly compacted, dark brown, moist, fine, with frequent angular GRAVEL pieces. [FILL]												
	1	10.0", piece of asphalt (3" diameter).												
9.91	2	CLAYEY GRAVEL (GC), moderately compacted, greenish gray, moist, angular, with fine to coarse SAND												
	3	2.8', piece of decomposed wood.		S1	16 12 14	26	83							
7.91	4	SILTY SAND (SM), poorly compacted, dark gray, moist, SAND is fine to very fine. [HYDRAULIC FILL]												
	5	Poorly graded SAND (SP), loose, dark gray, wet, fine, trace medium to coarse SAND, trace fines, occasional shell fragments.		S2	4 2 6	8	83		22.7					PA
5.91	6	5.0', grades yellowish brown. 5.5', 2.5" nail. 6.0', occasional piece of rounded GRAVEL, SAND grades fine to medium.		S3	1 2 1	3	100							
	7	6.5', grades dark gray.		S4	0 3 4	7	100							
3.91	8													
	9	8.5', piece of ceramic.												
1.91	10	Slight increase in fines content, with pockets of dark gray, poorly graded SAND with SILT, and pockets of dark gray fat CLAY.												
	11	Grades grayish brown with frequent pieces of decomposed vegetation (up to 1/2" diameter), a piece of angular fine GRAVEL up to 1/4" diameter.		S5	4 9 10	19	67		26.5 27.2	123.1 124.5	DS = 0.58			PA
-0.09	12	Grades without decayed vegetation, without GRAVEL, without pockets of CLAY.		S6	4 12 18	30	39		28.3	121.4	DS = 0.62 DS = 0.73			
	13	Poorly graded SAND (SP), medium dense, yellowish brown, wet, fine to medium, trace fines, with iron-oxide staining. [COLMA SAND]												
-2.09	14	14.3', trace of coarse SAND.		S7	6 14 27	41	50		19.3	133.9				
	15	14.8', dark gray, very fine SAND; grades without iron-oxide staining.												
-4.09	16	Grades loose.		S8	2 4 6	10	94							
	17													
-6.09	18													
	19	Grades medium dense.		S9	9 14 15	29	67							
-8.09	20													
	21	Poorly graded SAND with CLAY (SP-SC), loose, yellowish brown, wet, fine to medium, with pieces of subangular to subrounded GRAVEL, GRAVEL is fine to coarse.		S10	3 4 6	10	100							
-10.09	22													
	23													
-12.09	24			S11		56	83		23.7	130.6				PA
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-10
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND with SILT (SP-SM), dense, yellowish brown, wet, very fine to fine, with iron-oxide mottling, occasional pockets of weak cementation (up to 1/4" diameter). 25.5', occasional piece of coarse SAND, grades very dense.			9									
-14.09	26			S12	21 35	56	100							
	27				10 20 36									
-16.09	28													
	29	Poorly graded SAND, very dense, yellowish brown, wet, fine to very fine, trace fines, with iron-oxide mottling.		S13	17 37 50	87	89							
-18.09	30													
	31	31.0', piece of GRAVEL (serpentine, 1/2" diameter.		S14	4 20 36	56	100							
-20.09	32													
	33													Slight rig chatter at 33'
-22.09	34	Pockets of moderate cementation (up to 1/4" diameter).		S15	23 38 50	88	83							
	35													
-24.09	36			S16	15 21 30	51	89							
	37													
-26.09	38													
	39	Grades without pockets of cementation, grades dense.		S17	9 26 40	66	83							
-28.09	40													
	41	SILTY SAND (SM), very dense, light yellowish brown, wet, fine, with iron-oxide staining.		S18	14 26 45	71	89		20.6					PA
-30.09	42													
	43													
-32.09	44	Grades medium dense.		S19	8 12 18	30	94							
	45													
-34.09	46													
	47													
-36.09	48													
	49	Poorly graded SAND (SP), dense, brown, wet, coarse.		S20	7 21 34	55	89							
-38.09	50	Lean CLAY with SAND (CL), stiff, yellowish brown, moist, trace of subrounded to subangular fine GRAVEL, with pockets of lean CLAY. [COLLUVIUM]												
	51													
-40.09	52													
	53													Slower drilling, no rig chatter
-42.09	54	SEDIMENTARY ROCK (Sandstone), dark gray, fine to medium grained, slightly weathered, moderately strong, very		S21	23 50/6"	50/6"	25							
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-10
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		intensely fractured, with yellowish brown CLAY infillings. [BEDROCK]												
-44.09	56														
	57														
-46.09	58														
	59														
-48.09	60		Borehole terminated at a depth of 55 feet on 3/7/2008.												
	61		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-50.09	62														
	63														
-52.09	64														
	65														
-54.09	66														
	67														
-56.09	68														
	69														
-58.09	70														
	71														
-60.09	72														
	73														
-62.09	74														
	75														
-64.09	76														
	77														
-66.09	78														
	79														
-68.09	80														
	81														
-70.09	82														
	83														
-72.09	84														
	85														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-10
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-7-08	3-7-08	N2120559.565 / E5995764.236 (NAD83)	M-11
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 68ft R Sta 67+97 NB Alignment	12.472 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Bulk			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill				36.5 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	GRAVELLY lean CLAY with SAND (CL), soft, dark brown, moist, GRAVEL is subangular, slight organic odor. [FILL]												
	1			S1										
10.47	2	3" ASPHALT CONCRETE.												
		Poorly graded GRAVEL with CLAY and SAND (GP-GC), poorly compacted, dark gray, moist, subangular, slight hydrocarbon odor, with brick fragments. [FILL]		S2										
	3			B3										
8.47	4			B4										
	5			S5	1 2 1	3	28							
6.47	6													
	7			S6	0 1 2	3	67							
4.47	8	CLAYEY SAND (SC), poorly compacted, dark gray, wet, fine, with pieces of angular GRAVEL, GRAVEL is fine to coarse, with pockets of dark gray CLAY, with roots. [HYDRAULIC FILL]												8', hole caving, switch to mud rotary
	9													
2.47	10	Fat CLAY with SAND and GRAVEL (CH), very soft, dark gray, wet, SAND is fine to coarse, GRAVEL is fine, strong organic odor, with frequent pieces of decomposed wood - wet.		S7	0 0 0	0	0							
	11													
0.47	12	Poorly graded SAND (SP), very loose, grayish brown, wet, fine, trace fines, occasional piece of coarse to medium SAND, with occasional fine to coarse GRAVEL and pockets of CLAY.		S8	0 1 2	3	67							
	13													
-1.53	14													
	15	Grades with occasional pockets of CLAY up to 3" diameter.		S9	2 1 2	3	83							
-3.53	16								23.9	129.4	DS = 0.93			PA
	17	17.0', concrete fragments (up to 1" diameter), grades medium dense.		S10	3 12 14	26	100		26.6 / 24.9	130.3 / 127.9	DS = 1.02			
-5.53	18	17.5', grades yellowish brown.									DS = 1.06			
	19													
-7.53	20	A piece of glass up to 1/4" diameter, SAND grades fine to medium with occasional coarse SAND.		S11	4 6 14	20	94							
	21	21.5', white ceramic fragment.							19.6	132.2				PA
-9.53	22	Poorly graded SAND (SP), medium dense, yellowish brown, wet, fine to medium, trace fines. [COLMA SAND]		S12	3 7 5	12	67							
	23	22.5', heavy zone of iron-oxide staining.												
-11.53	24													
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-11
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Poorly graded SAND (SP), medium dense, yellowish brown, wet, fine to medium, trace fines. [COLMA SAND]		S13	21 30 40	70	67							MC sample at 25' unlined
-13.53	26		Grades dark yellowish brown, dense.												
	27														
-15.53	28														
	29														
-17.53	30		Grades yellowish brown, medium dense.		S14	14 20 23	43	89							
	31		SAND grades fine to very fine. Grades with iron-oxide mottling.												
-19.53	32		Poorly graded SAND with CLAY, (SP-SC), medium dense, yellowish brown, moist, fine to very fine, with iron-oxide mottling.		S15	11 13 16	29	83							Cuttings changed color from grayish brown to reddish brown at 34'
	33														
-21.53	34														
	35		Poorly graded SAND (SP), dense, dark yellowish brown, moist, fine, with iron-oxide staining.		S16	16 19 20	39	100							
-23.53	36														
	37		Borehole terminated at a depth of 36.5 feet on 3/7/2008.												
-25.53	38		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	39														
-27.53	40														
	41														
-29.53	42														
	43														
-31.53	44														
	45														
-33.53	46														
	47														
-35.53	48														
	49														
-37.53	50														
	51														
-39.53	52														
	53														
-41.53	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				M-11
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
P. Ryan	7-26-08	7-27-08	N2120520.291 / E5994131.737 (NAD83)	RW5-R1
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 84ft R Sta 85+34 NB Alignment	93.094 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill			11.1	46.2 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	4" ASPHALT CONCRETE, 6" UNREINFORCED CONCRETE, 3/4" BITUMENOUS LAYER.												
	1	SANDY lean CLAY (CL), stiff, reddish brown, moist, SAND is fine. [SANDY CLAY]												
91.09	2													
	3	SILTY SAND (SM), medium dense, dark yellowish brown, dry to moist, fine, soil appears to have been compacted. [COLMA SAND]		S1	20 26 30	56	100		13.8	117.7				
89.09	4													
	5			S2	7 8 10	18	89							
87.09	6	SANDY lean CLAY (CL), stiff, dark yellowish brown, moist, SAND is fine to medium. [SANDY CLAY]												
	7													
85.09	8	SEDIMENTARY ROCK (Sandstone), fine grained, intensely weathered, yellowish brown, very soft, very intensely fractured. [BEDROCK]		S3	41 50/ 3.5"	50/ 3.5"	89							
	9	Moderately hard, intensely fractured, some fractures infilled with lean clay dipping ~45° up to 0.03' thick.		C4			94	33						
83.09	10	10.0', moderately fractured.												PL
	11			C5			86	50						
81.09	12	SEDIMENTARY ROCK (Sandstone Breccia), mylonized, pegmatic, with moderately soft fragments (gravel-size pieces of SANDSTONE), yellowish brown, moderately to slightly weathered, matrix is very soft, intensely fractured.												
	13	SEDIMENTARY ROCK (Shale), 2-3" seam, moderately soft, intensely weathered, slickensides on fracture plane not parallel to shale bedding.												
79.09	14													
	15	SEDIMENTARY ROCK (Sandstone), fine to medium grained, moderately weathered, light grayish brown, moderately hard, moderately fractured, thin white vein fillings locally open.		C6			100	88						
77.09	16													PL
	17													
75.09	18	17.8', slickensides on fracture plane.												
	19			C7			93	0						
73.09	20	20.2', intensely fractured and broken.												
	21	METAMORPHIC ROCK (Meta-Siltstone), dark gray, moderately weathered, moderately hard, intensely fractured and broken.												
71.09	22	METAMORPHIC ROCK (Meta-Graywacke Sandstone), fine to medium grained, moderately weathered, light grayish brown, moderately hard, very intensely fractured.		C8			82	0						End Box #1 at 21.8'
	23													
69.09	24	SEDIMENTARY ROCK (Sandstone Breccia), moderately weathered, moderately hard, pegmatic fragments in soft matrix.												
	25			C9			90							

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Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW5-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-8-09	1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/8/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Mylonized from 23.65' to 26.1'.						22						
67.09	26		SEDIMENTARY ROCK (Sandstone), fine grained, moderately weathered, light grayish brown, moderately hard, intensely to moderately fractured.												
	27														PL
65.09	28														
	29		Core run is broken into fragments up to 0.1' in diameter with occasional intact core lengths up to 0.4' long.		C10			100	0						Loss of fluid circulation; added drilling polymer
63.09	30														
	31														
61.09	32		32.0', occasionally vuggy, with gray lean CLAY on fracture surfaces, slightly weathered.		C11			100	0						
	33														
59.09	34				C12			92	0						
	35		35.0' - 35.5', steeply dipping fractures, slightly weathered to fresh, light grayish brown, continued white vein infilling.												
57.09	36														
	37				C13			87	0						
55.09	38		38.0', gold colored disseminated minerals noted (pyrite?)												
	39		38.6', moderately fractured, hard to moderately hard. Calcite vein dipping at 45°.												Mechanical break at 39'
53.09	40		39.9', fracture dipping ~75° white vein infilling, intensely to moderately fractured.		C14			100	0						
	41				C15			79	0						
51.09	42				C16			53	0						Continued circulation loss
	43				C17			100	0						
49.09	44		43.8' - 43.9', very fine grained. 44.0', mylonized zone.												
	45				C18			100							
47.09	46		Borehole terminated at a depth of 46.2 feet on 7/27/2008.												
	47		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
45.09	48														
	49														
43.09	50														
	51														
41.09	52														
	53														
39.09	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW5-R1
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-8-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/8/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-27-08	2-28-08	N2120380.7 / E5994104.938 (NAD83)	RW6-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 58ft L Sta 85+24 SB Alignment	108.507 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 12.0 to 22.0 ft				64 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY SAND (SC), loose, dark brown, dry to moist, fine, with occasional roots, with pieces of crushable black nodules, strong organic odor. [FILL]												
106.51	2													
	3	Lean CLAY with SAND (CL), stiff, yellowish brown, dry to moist, with iron-oxide staining, SAND is very fine, with black organic mottling and pieces of decayed vegetation. [SANDY CLAY]		S1	3 3 7	10	83		15.4	124.3				PA
104.51	4			S2	3 5 7	12	67							
102.51	6													
	7			S3	11 19 30	49	72							
100.51	8	SILTY SAND (SM), medium dense, yellowish brown, dry to moist, very fine, with frequent black specks and piece of decayed vegetation up to 1/8" diameter. [COLMA SAND]							15.7					PI, PA
	9			S4	14 22 20	42	56							
98.51	10	Grades dense.												
96.51	12	Grades reddish brown, moist, fine, with slight black carbon mottling.		S5	14 21 26	47	78							
	13								16.6	128.7	DS = 0.62			PA
94.51	14			S6	13 20 25	45	67		16.8 16.3	127.2 129.1	DS = 0.66			
	15										DS = 0.88			
92.51	16													
	17	Grades yellowish brown, medium dense, with iron-oxide mottling, and seams of light yellowish brown CLAY.		S7	8 12 42	54	67		21.2 22.1	131.1 131.0	DS = 0.94			Did not clean hole prior to coring (began coring at 17'; new hole at 19')
90.51	18	SEDIMENTARY ROCK (Sandstone), yellowish brown, decomposed, soft (poorly graded SAND with CLAY (SP-SC), very dense, moist, SAND is fine with light gray CLAY infilling and black organic mottling).		S8	34 50/1"	50/1"	71		18.7	134.1	DS = 1.05			PA
	19			C9			47	0			DS = 1.33			
88.51	20	SEDIMENTARY ROCK (Sandstone), fine to medium grained, massive, yellowish brown and grayish brown, moderately weathered, moderately hard, heavy mechanical breaks (at 0.1' to 0.2'), obscure in-situ fractures with some evidence of variably oriented natural fractures ranging from 50° to 80°.												Core has reduced diameter (0.15') at 20' due to heavy chatter.
86.51	22			C10			80	0						
84.51	24	Core at full diameter (~2.5").												
	25			C11			100	32						

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW6-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		24.5', intensely fractured, moderate oxidation staining on fractured planes.												
82.51	26		SEDIMENTARY ROCK (Sandstone), fine to medium grained, massive, yellowish brown and grayish brown, moderately weathered, moderately hard, heavy mechanical breaks (at 0.1' to 0.2'), obscure in-situ fractures with some evidence of variably oriented natural fractures ranging from 50° to 80°. Crushed zones (0.05' thick) at 25.2', 25.5', and 26.1'. 26.2', medium fractured, variably oriented dark gray lamination due to soft sediment deformation. 29.0' - 33.3', crushed zone with clay.												
	27				C12			100	17			UC = 222			Decreased rotation rate to keep core from rattling
80.51	28														
	29														
78.51	30														
	31				C13			67	0						
76.51	32				C14			83	14						
	33		33.2', dark gray.												
74.51	34														
	35														PL
72.51	36				C15			65	0						
	37		37.0', slightly weathered.		C16			68	9						PL
70.51	38														
	39														Mechanical breaks at 38.75' and 38.85'
68.51	40														PL
	41														
66.51	42		Healed and open fractures ranging from 30° to sub-vertical.		C17			100	22						
	43														
64.51	44				C18			97	18						
	45														
62.51	46											UC = 1043			
	47				C19			100	0						
60.51	48		47.7' - 48.8', multiple near vertical fractures.												
	49				C20			75	40						
58.51	50														PL
	51		50.3' - 51.2', crushed zone. 50.75', fresh, moderately hard to hard, with mineral precipitate infilling of fractures (no evidence of shearing).												
56.51	52				C21			93	28						
	53		53.0', white mineral veins aligned at 45° occasionally correspond to fractures, additional fractures not aligned with veins.												PL
54.51	54														
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW6-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), fine to medium grained, massive, yellowish brown and grayish brown, moderately weathered, moderately hard, heavy mechanical breaks (at 0.1' to 0.2'), obscure in-situ fractures with some evidence of variably oriented natural fractures ranging from 50° to 80°.												
52.51	56				C22			100	0						
	57		56.0', crushed (mechanical?) 57.0' - 58.3', vertical fracture.		C23			52	0						
50.51	58														
	59														
48.51	60		59.5', mineral precipitate on naturally occuring fracture planes.		C24			92	26						
	61														PL
46.51	62		62.0', crushed (primarily mechanical?) 62.5' - 63.1', very closely fractured (mechanical).		C25			100	0						
	63		63.1', crushed (primarily mechanical?).												
44.51	64		Borehole terminated at a depth of 64 feet on 2/28/2008.												
	65		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
42.51	66														
	67														
40.51	68														
	69														
38.51	70														
	71														
36.51	72														
	73														
34.51	74														
	75														
32.51	76														
	77														
30.51	78														
	79														
28.51	80														
	81														
26.51	82														
	83														
24.51	84														
	85														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW6-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 3	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-14-08	4-15-08	N2120270.083 / E5993967.843 (NAD83)	RW6-R2-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 200ft L Sta 86+29 SB Alignment	108.659 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 76.0 to 98.0 ft				114.7 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	0.5" ASPHALT CONCRETE.												
	1	8" Poorly graded GRAVEL with SAND (GP), light gray, dry, GRAVEL is coarse to fine. [BASEROCK]												
106.66	2	Poorly graded SAND (SP), poorly compacted, dark brown, dry, trace SILT, trace fine GRAVEL, SAND is fine, occasional twigs and roots (up to 1/8" diameter). [FILL]												
	3			S1	2 4 4	8	100							
104.66	4													
	5													
102.66	6													
	7													
100.66	8	Grades medium dense.		S2	6 7 10	17	33							
	9													
98.66	10													
	11	SILTY SAND (SM), very dense, light reddish brown, dry to moist, fine, weakly cemented, with gray horizontal laminations, trace of decayed vegetation. [COLMA SAND]												Driller reports change at 11'
96.66	12													
	13			S3	13 27 37	64	83							
94.66	14													
	15													
92.66	16													
	17													
90.66	18	Grades dense, reddish brown, moist, fine to medium, weakly cemented.		S4	15 20 23	43	89							
	19													
88.66	20													
	21													
86.66	22													
	23	Grades fine.		S5	17 23 26	49	94							
84.66	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25													
82.66	26	SEDIMENTARY ROCK (Sandstone), very soft, yellowish brown, no indication of bedding, decomposed, with fragments of moderately hard rock, very intensely fractured (poorly graded SAND (SP), very dense, SAND is fine to medium). [BEDROCK]												Harder drilling at 26', Easier drilling 27' - 27.5'
	27													
80.66	28			S6	25 50/6"	50/6"	83							
	29	SEDIMENTARY ROCK (Sandstone), fine to medium grained, very thickly bedded (possibly massively), grayish brown, slightly weathered, hard, intensely to moderately fractured.		C7			100	34						
78.66	30													PL
	31										UC = 271			
76.66	32													PL
	33													
74.66	34			C8			100	9						
	35													
72.66	36	35.3', clay on fracture.												
	37													
70.66	38	37.6' and 38.5', laminated light-dark coloring, shaley.												PL
	39	38.6', heavily mylonized manganese-oxide staining.		C9			90	0						
68.66	40													
	41	40.5', intensely fractured.												
66.66	42													
	43	42.3', very intensely fractured. 42.7', apparent bedding interrupted by movement along fracture at 39', medium to coarse grained. 43.5', very intensely fractured, moderately weathered.		C10			80	0						Loss of water at 43'
64.66	44													
	45	45.0' - 45.9', very intensely weathered, mylonized/sheared with up to 50% clay.		C11			95	0						
62.66	46	45.9', intensely fractured, fine to medium grained; vertical fractures along core from 45.9' to 48.8'.												
	47													
60.66	48													
	49			C12			100	0						
58.66	50													
	51													
56.66	52													
	53													
54.66	54	53.6' fractures are incipient. 54.0', darker minerals appear to be oriented sub-parallel to horizontal localized grain size irregularities suggest		C13			100	0						
	55													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		soft-sediment disposition, continued iron-oxide staining restricted to fracture planes, localized manganese-oxide staining throughout, very hard, minor pitting throughout run, minor clay coating on many fractures. SEDIMENTARY ROCK (Sandstone), fine to medium grained, very thickly bedded (possibly massive), grayish brown, slightly weathered, hard, intensely to moderately fractured. 57.6', primarily fine grained.												
52.66	56														
	57														
50.66	58														
	59				C14			100	32						
48.66	60		59.6', clay seam filling (0.03' thick) at 59', pervasive iron-oxide staining, vertical fracture from 50.8' to 53.0'. Grain size varies along core becoming fine to medium.												
	61														
46.66	62														
	63														
44.66	64		64.0' - 65.9', variably oriented mineral filled closed fractures, continued pitting, massive no indication of bedding since 38.5', near vertical fractures (70° to 80° dip).		C15			100	14						
	65														
42.66	66														
	67														
40.66	68														
	69				C16			100	48						
38.66	70		Iron-oxide staining restricted to fracture surfaces, continued pitting, variably oriented fractures at 73.0' and 73.5', and 0.1' bluish discoloration on surface of core, fracture spacing is highly variable (from 0.7' to 0.02'), slightly weathered.												
	71														
36.66	72														
	73														PL
34.66	74		Pitting oriented parallel to predominate fracture orientation (45°), continued iron-oxide and manganese-oxide staining on fracture planes, many fractures are insipient, very intensely fractured zone 0.8' to 0.9' continued bluish discoloration at 76.0'.		C17			100	68						
	75														
32.66	76														
	77														
30.66	78														
	79		79.0' - 79.2', very intensely fractured zone.		C18			100	70						PL
28.66	80		Bluish coloring is more prominent, with increasing prominence with depth, continued but less frequent pitting. Continued variable fracture orientations, some continued insipient fractures.												
	81														
26.66	82		82.2', thin white vein filling (quartzitic?).												PL
	83														
24.66	84				C19			100	34						
	85														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		SEDIMENTARY ROCK (Sandstone), fine to medium grained, very thickly bedded (possibly massive), grayish brown, slightly weathered, hard, intensely to moderately fractured.												
22.66	86		85.35' - 85.55', very intensely fractured zone.												
	87														
20.66	88		87.5', approximately 0.15' thick tan colored, silty clay with quartz vein filling above and below, ranging from 0.01' to 0.06' thick, no obvious mylonization on shearing.												
	89		87.7', distorted thinly bedded (from 0.01' to 0.2' thick). 88.0' - 88.7', very intensely bedded zone. 85.35' - 85.55', very intensely fractured.		C20			90	0						
18.66	90		SEDIMENTARY ROCK (Shale), no indication of bedding, dark gray, very intensely to intensely fractured, moderately hard, primarily fresh with slight weathering between 89.0' to 90.1', variably oriented 0.01' thick quartz veins, no obvious indication of bedding.												
	91														
16.66	92														
	93				C21			100	0						
14.66	94		Contact between SHALE and SANDSTONE at 93.35' dipping ~5°.												
	95		SEDIMENTARY ROCK (Sandstone), fine to medium grained (coarse grained minerals are darker), bluish gray with localized oxidation along and eminating from fractures, fresh to slightly weathered, hard, intensely to moderately fractured, fractures are primarily 45° dip or vertical with additional random orientations.												
12.66	96														
	97														
10.66	98		98.0', moderately fractured, fine grained, with random quartz veins (veins offset by micro faults).		C22			98	52						
	99														PL
8.66	100		100.3', very fine-grained, localized slickensides or fracture planes, laminated at 100.7' (laminate are offset by micro faults).												
	101		101.5' - 101.7', fine sandy CLAY filling along open fractures.												
6.66	102														
	103		102.4' to end of run, crushed/sheared/mylonized zone (primarily shale).		C23			84	20						
4.66	104		SEDIMENTARY ROCK (Shale), no indication of bedding, very dark gray, slightly weathered, hard, fine to medium grained, intensely fractured.												
	105		Oxidation along fractures (open and closed) commonly extending outwards (0.02' to 0.05') perpendicular to the fractures, closed and green quartz filled veins, locally superimposed fractures.												
2.66	106														
	107		SEDIMENTARY ROCK (Sandstone), no indication of bedding, bluish gray, slightly weathered, hard, fine to medium grained, intensely fracured.												
0.66	108		103.9' and 105.5', clay seam infilling, up to 0.01' thick.		C24			96	0						
	109		109.1' - 111.6', near vertical fracture coincided with quartz vein, continues massive (no bedding).												
-1.34	110		110.0', very intensely fractured, random orientation, crushing observed along fractures.												
	111														
-3.34	112		112.0', gray clay fracture infilling.												
	113		SEDIMENTARY ROCK (Shale), no indication of bedding, very dark gray, slightly weathered to fresh, moderately hard, very intensely fractured.		C25			100	0						
-5.34	114		SEDIMENTARY ROCK (Sandstone), no indication of bedding, bluish gray, slightly weathered, hard, fine to medium												
	115														

(continued)

Department of Transportation
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Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		grained, intensely fractured, with sheared and mylonized shale, continued minor quartz veins throughout both rock types. Iron-oxide staining in sandstone limited to fracture planes, common near vertical fractures.												
-7.34	116														
	117														
-9.34	118														
	119														
-11.34	120		Borehole terminated at a depth of 114.7 feet on 4/15/2008.												
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-13.34	122														
	123														
-15.34	124														
	125														
-17.34	126														
	127														
-19.34	128														
	129														
-21.34	130														
	131														
-23.34	132														
	133														
-25.34	134														
	135														
-27.34	136														
	137														
-29.34	138														
	139														
-31.34	140														
	141														
-33.34	142														
	143														
-35.34	144														
	145														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2-PZ-D
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-17-08	4-17-08	N2120266.257 / E5993963.449 (NAD83)	RW6-R2A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 205ft L Sta 86+32 SB Alignment	108.315 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 12.0 to 29.0 ft				29 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	1/2" ASPHALT CONCRETE												
	1	12" poorly graded GRAVEL with SAND (GP), light gray, dry, GRAVEL is coarse to fine, subangular to subrounded. [BASEROCK]												
106.32	2	Poorly graded SAND (SP), poorly compacted, dark brown, dry, fine, trace silt, with roots (up to 1/8" diameter). [FILL]												
	3			S1	2 3 3	6	100							
104.32	4	Grades with interbedded dark brown SANDY SILT and yellowish brown SILT with coarse SAND.		S2	3 2 1	3	67		4.5	104.2				PA
	5													
102.32	6													
	7	Grades medium dense, moist to wet.												
100.32	8			S3	6 12 17	29	50		24.3	126.3	DS = 0.49			PA
	9			S4	5 7 10	17	50		21.7 / 18.2	131.2 / 124.7	DS = 0.55			
98.32	10	SILT (ML), medium stiff, dark yellowish brown, damp to moist, trace fine sand, trace decayed vegetation. [SANDY SILT]									DS = 0.60			
	11													
96.32	12	SILTY SAND (SM), very dense, reddish brown, damp, fine, weakly cemented. [COLMA SAND]												
	13			S5	21 41 50/5.5"	91/11.5"	100							
94.32	14			S6	17 25 31	56	67							
	15													
92.32	16													
	17													
90.32	18			S7	24 40 50/5.5"	90/11.5"	83							
	19	18.3', light gray vertical seam (1/16" thick) with pieces of decayed vegetation.		S8	19 33 48	81	67		13.2	129.6				PA
88.32	20													
	21													Drilling slightly easier at 20.5'
86.32	22													
	23	Grades with less SILT.		S9	8 11 18	29	83							
84.32	24	Lean CLAY with SAND (CL), medium stiff, light yellowish brown and light gray, damp, mottled with occasional black specks, with fragments of moderately soft rock with heavy manganese oxide staining on the fracture planes. [SANDY		S10		66	67				PP = 1.75, 2.25,			
	25													

(continued)

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAY]			14						2.0			
82.32	26		SEDIMENTARY ROCK (Sandstone and Shale), dark grayish brown, fine-grained, no indication of bedding, intensely weathered, moderately soft, very intensely fractured. [BEDROCK]		S11	30 36	52/6"	75							
	27				S12	20 52/6" 50/2"	50/2"	50							26.6' - 29.0', straight drill
80.32	28														Losing water 27.5' to 29'
	29		Borehole terminated at a depth of 29 feet on 4/17/2008.												
78.32	30		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	31														
76.32	32														
	33														
74.32	34														
	35														
72.32	36														
	37														
70.32	38														
	39														
68.32	40														
	41														
66.32	42														
	43														
64.32	44														
	45														
62.32	46														
	47														
60.32	48														
	49														
58.32	50														
	51														
56.32	52														
	53														
54.32	54														
	55														

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R2A-PZ-S
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	1-10-08	1-17-08	N2120199.669 / E5995008.466 (NAD83)	RW8-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 68ft L Sta 76+18 SB Alignment	90.616 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Failing 1500	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Shelby (2.87"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.8%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout backfill				130 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND (SM), dark brown, moist, SAND is fine, with fine angular GRAVEL, with roots and plant debris, earthy odor detected. [FILL]												No driven samples in top 5', because of potential underground utilities
	1			S1										
88.62	2	2.0' - 2.5', remnant BRICK structure.												
	3	Poorly graded SAND with SILT (SP-SM), loose, fine, yellowish brown, moist, with wood pieces, earthy odor detected. [FILL]		S2										
86.62	4													
	5													
84.62	6	Grades brown.												
	7													
82.62	8	Poorly graded SAND (SP), loose, yellowish brown, moist, SAND is very fine, trace of fines.		S3	1 2 2	4	100							
	9	Grades dark brown with slight increase in fines content.		S4	0 2 3	5	100							
80.62	10													
	11	Lean CLAY (CL), medium stiff, dark brown, moist, trace of fine SAND, earthy odor detected. [BURIED SOIL HORIZON]												
78.62	12													
	13			S5	0 0 0	0	100							
76.62	14	Lean CLAY (CL), yellowish brown, with black specks and dark gray mottling, trace of very fine SAND. [SANDY CLAY]		S6	1 3 3	6	100				PP = 0.375			
	15													
74.62	16													
	17													
72.62	18	Grades very stiff.		S7	8 12 16	28	100				PP = 1.85			
	19			S8	5 7 10	17	100							
70.62	20	Increase in SAND content, SAND is fine.												
	21													
68.62	22													
	23	Grades with trace of fine SAND.		U9		100 psi	100							
66.62	24					200 psi								
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
N/A	T. Carroll	1-7-09	1 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Poorly graded SAND with CLAY (SP-SC), medium dense, fine to medium, reddish brown, moist, with occasional coarse SAND. [COLMA SAND]												
64.62	26														Black organic pieces in drill cuttings
	27														
62.62	28				S10	9 16 20	36	100							
	29		Grades dense, with black specks.		S11	9 16 16	32	100							
60.62	30														
	31														
58.62	32														
	33		Grades yellowish brown with black mottling and iron-oxide staining.		S12	10 20 26	46	100							
56.62	34				S13	7 15 23	38	100							
	35														Thin interbedded olive brown layer noted in shoe
54.62	36														
	37														
52.62	38		Grades without iron-oxide staining and without black mottling.		S14	25 29 40	69	100							
	39				S15	13 23 19	42	100							
50.62	40														
	41														
48.62	42		Lean CLAY (CL), stiff to very stiff, reddish brown, moist, with trace SAND, with frequent black specks and crushable nodules. [SANDY CLAY]												
	43				S16	8 9 11	20	100							
46.62	44				S17	7 7 9	16	100				PP = 1.0			
	45		Lean CLAY (CL), reddish brown, with crushed nodules, with white veins, slight rock structure, completely weathered rock. [RESIDUAL SOIL]												
44.62	46														
	47														
42.62	48		SEDIMENTARY ROCK (Sandstone), fine to medium, reddish brown, decomposed, very soft (poorly graded SAND (SP), very dense, SAND is fine to medium, moist). [BEDROCK]		S18	50/4"	50/4"	100							
					S19	50/5"	50/5"	100							
	49														
40.62	50														
	51		Grades to yellowish brown, moderately weathered, moderately soft to soft, moderately fractured, numerous incipiant fractures, fractures are filled with white precipate (soft). 51.3' - 52.2', brecciated zone.		C20			96	NA						Begin HQ system coring at 51.0'
38.62	52														
	53														
36.62	54														
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	SEDIMENTARY ROCK (Sandstone), fine to medium, reddish brown, decomposed, very soft (poorly graded SAND (SP), very dense, SAND is fine to medium, moist). [BEDROCK]												PL
34.62	56			C21			100	NA						
	57													
32.62	58													
	59	59.2' - 60.0', interbedded siltstone lenses (0.1 to 0.3' thick) with soft sediment deformation.												
30.62	60			C22			56	7						
	61	61.4' - 62.8', very intensely fractured (fragments of sandstone and siltstone mylonized)												
28.62	62													
	63													
26.62	64													
	65	Fractures are variably oriented, heavy iron-oxide staining on fracture surfaces.		C23			83	0						
24.62	66													
	67													
22.62	68			C24			80	14						PL
	69													
20.62	70	69.8' - 70.6', interbedded siltstone lenses (soft sediment deformation?).												
	71													
18.62	72	SEDIMENTARY ROCK (Sandstone Breccia), fine grained, dark brown and yellowish brown, moderately weathered, soft with harder inclusions, moderately fractured.		C25			88	0						
	73													
16.62	74	METAMORPHIC ROCK (Serpentinite), dark greenish gray, intensely weathered, very soft, very intensely fractured, pervasively sheared.												At 74.5' we began to lose fluid and the hole began caving
	75	SEDIMENTARY ROCK (Sandstone Breccia), fine to medium grained, dark yellowish brown, moderately weathered, soft (with 0.05' to 0.1' thick fragments of siltstone and sandstone).		C26			100	0						SPT from 74' to 75.5'; blowcount 4, 13, 26
14.62	76	METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.		C27			80	0						
	77													
12.62	78													
	79	79.5' - 79.8' and 80.3' - 80.6', white apparent decomposition to talc?		C28			50	3						After drilling to 79', hole caved to 75'
10.62	80													
	81													
8.62	82													
	83													
6.62	84			C29			42	0						
	85													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 3 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		84.9' - 85.8', white apparent decomposition to talc?												
4.62	86		METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.												
	87														
2.62	88														
	89				C30			0							
0.62	90														
	91				C31			65	0						
-1.38	92														
	93		93.0', white secondary mineral "blocks" and vein fillings common throughout interval (up to 0.05' thick).		C32			60	0						
-3.38	94														
	95				C33			100	50						
-5.38	96														
	97														
-7.38	98				C34			83	0						
	99														
-9.38	100														
	101				C35			100	0						
-11.38	102														
	103														
-13.38	104														
	105				C36			93	7						
-15.38	106														
	107														
-17.38	108		108.0' - 110.7', intensely fractured (mechanical).		C37			68	0						
	109														
-19.38	110														
	111														
-21.38	112				C38			93	55						
	113														
-23.38	114		Healed white anastomized fractures.												
	115														

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Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 4 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.												
-25.38	116				C39			98	22						
	117		116.9' - 119.9', polished surfaces on fractures.												
-27.38	118		117.8' - 120.0', brecciated zone.												
	119		119.3', fibrous texture noted.												
-29.38	120				C40			100	60						
	121		120.6' - 123.1', very dark gray, gabbroic, dense, moderately hard, moderately fractured. 121.5', fibrous secondary mineral deposit on fracture.												
-31.38	122		122.15' - 123.0', white mineral vein infilling.									UC = 127			PL
	123		123.1', light greenish gray, soft, intensely fractured (non-gabbroic).												
-33.38	124		124.35', 0.01' thick fibrous secondary mineral deposit on fracture-oriented perpendicular to fracture.												
	125				C41			74	0						
-35.38	126		126.3', gabbroic.												
	127														
-37.38	128														
	129														
-39.38	130		Borehole terminated at a depth of 130 feet on 1/17/2008.												
	131		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-41.38	132														
	133														
-43.38	134														
	135														
-45.38	136														
	137														
-47.38	138														
	139														
-49.38	140														
	141														
-51.38	142														
	143														
-53.38	144														
	145														

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REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 5 of 5	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
K. Karina	6-5-08	6-5-08	N / E (NAD83)	RW8-R1A-PZ
DRILLING CONTRACTOR: Gregg Drilling and Testing, Inc.			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION: 90.000 ft (NAVD88)
DRILLING METHOD: Hollow Stem Auger			DRILL RIG: Mobile B53	BOREHOLE DIAMETER: 8 in.
SAMPLER TYPE(S) AND SIZE(S) (ID): MC (2.4"), SPT (1.4"), Bulk			SPT HAMMER TYPE: Automatic, 140 lbs., 30-inch drop	HAMMER EFFICIENCY, ERi
BOREHOLE BACKFILL AND COMPLETION: 2" dia. Standpipe Piezo Screened 25.0 to 45.0 ft			GROUNDWATER READINGS: DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING: 46.5 ft

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Poorly-graded SAND (SP), brown, dry to moist, SAND is fine, trace of roots. [FILL]		B1										
	1													
88.00	2	Grades with fragments of concrete and brick up to 1.5" diameter.												
	3													
86.00	4													
	5	SAND is very loose to loose.		S2	6 6 4	10	56							
84.00	6			S3	2 2 2	4	81							
	7													
82.00	8	Poorly-graded SAND (SP), loose, dark brown, moist, SAND is fine, trace SILT.												
	9													
80.00	10			S4	3 4 6	10	100							
	11													
78.00	12	SANDY SILT (ML), soft, brown, moist, SAND is fine. [BURIED SOIL HORIZON]		S5	1 1/12"	1/12"	100							
	13	Lean CLAY with SAND (CL), soft, dark brown, wet, SAND is fine.												
76.00	14													
	15	Lean CLAY (CL), very stiff, orangish brown, moist, with grayish brown mottling and black specks, trace of fine SAND. [SANDY CLAY]		S6	5 6 10	16	100				PP = 1.5			
74.00	16													
	17			S7	4 6 10	16	100							
72.00	18	Decayed root (1/8" diameter, 10" long).												
	19													
70.00	20	Lean CLAY with SAND (CL), very stiff, yellowish brown, moist, SAND is fine to medium.		S8	6 12 14	26	100				PP = 1.75, 1.875			
	21													
68.00	22	Grades with increase in moisture content.		S9	5 5 6	11	100							
	23													
66.00	24													
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1A-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 1 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND (SC), medium dense, yellowish brown, moist to wet, fine to medium. [COLMA SAND]												
64.00	26				S10	4 5 7	12	100							
	27														
62.00	28														
	29		Poorly-graded SAND with CLAY (SP-SC), dense, dark yellowish brown to reddish brown, moist, SAND is fine to medium, with black stains.												
60.00	30				S11	11 13 18	31	100							
	31														
58.00	32														
	33														
56.00	34														
	35		Grades very dense, with iron-oxide staining.		S12	17 23 31	54	100							
54.00	36														
	37														
52.00	38														
	39														
50.00	40		Grades medium dense, moist. 40.4', piece of crushable iron-oxide nodule, seam of dark gray staining.		S13	8 12 13	25	100							
	41														
48.00	42														
	43														
46.00	44		Lean CLAY (CL), stiff, yellowish brown, moist, with black specks, trace of fine SAND. [SANDY CLAY]												
	45				S14	3 5 7	12	100							
44.00	46		Fat CLAY (CH), medium stiff, yellowish brown, moist, with light grayish brown mottling, with rock-like structure, with black staining and vein of iron-oxide staining. [RESIDUAL SOIL]												
	47														
42.00	48														
	49														
40.00	50														
	51														
38.00	52														
	53														
36.00	54														
	55														

Borehole terminated at a depth of 46.5 feet on 6/5/2008.

See Boring Record Legend for soil classification chart and key to test data and sampler type.

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Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1A-PZ
DIST. 4	COUNTY S.F.	ROUTE 101	POSTMILE 8.3/9.4	EA 163701
PROJECT OR BRIDGE NAME Doyle Drive Replacement Project				
BRIDGE NUMBER N/A	PREPARED BY T. Carroll	DATE 1-7-09	SHEET 2 of 2	

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY CALTRANS FORMAT.GLB 1/7/09

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic / Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

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

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE				
BORING RECORD LEGEND				
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
34-0161	T. Carroll	1-7-09	1 of 3	

CONSISTENCY OF COHESIVE SOILS

Descriptor	Unconfined Compressive Strength (tsf)	Pocket Penetrometer (tsf)	Torvane (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	0.25 - 0.50	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	0.50 - 1.0	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	1.0 - 2.0	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	2.0 - 4.0	1.0 - 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60} - Value (blows / foot)
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Descriptor	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE

Descriptor		Size
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	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.
High	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.

CEMENTATION

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

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.

ROCK GRAPHIC SYMBOLS

IGNEOUS ROCK

SEDIMENTARY ROCK

METAMORPHIC ROCK

BEDDING SPACING

Descriptor	Thickness or Spacing
Massive	> 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8 inches to 1 ft
Thinly bedded	1-1/4 to 3-5/8 inches
Very thinly bedded	3/8 inch to 1-1/4 inches
Laminated	< 3/8 inch

WEATHERING DESCRIPTORS FOR INTACT ROCK

	Diagnostic Features					
	Chemical Weathering-Discoloration-Oxidation		Mechanical Weathering and Grain Boundary Conditions	Texture and Solutioning		
Descriptor	Body of Rock	Fracture Surfaces		Texture	Solutioning	General Characteristics
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy"	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation (refer to grain boundary conditions)	All fracture surfaces are discolored or oxidized; surfaces are friable	Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated	Altered by chemical disintegration such as via hydration or argillation	Leaching of soluble minerals may be complete	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened.
Decomposed	Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay		Complete separation of grain boundaries (disaggregated)	Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes".

Note: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

RELATIVE STRENGTH OF INTACT ROCK

Descriptor	Uniaxial Compressive Strength (psi)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

ROCK HARDNESS

Descriptor	Criteria
Extremely Hard	Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows
Very hard	Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows
Hard	Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows
Moderately Soft	Specimen can be grooved 1/6 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure
Soft	Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure
Very Soft	Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light hand pressure

CORE RECOVERY CALCULATION (%)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

RQD CALCULATION (%)

$$\frac{\Sigma \text{ Length of intact core pieces > 4 in.}}{\text{Total length of core run (in.)}} \times 100$$

FRACTURE DENSITY

Descriptor	Criteria
Unfractured	No fractures
Very Slightly Fractured	Lengths greater 3 ft
Slightly Fractured	Lengths from 1 to 3 ft, few lengths outside that range
Moderately Fractured	Lengths mostly in range of 4 in. to 1 ft, with most lengths about 8 in.
Intensely Fractured	Lengths average from 1 in. to 4 in. with scattered fragmented intervals with lengths less than 4 in.
Very Intensely Fractured	Mostly chips and fragments with few scattered short core lengths

LOGS BY OTHERS

34-0157 NB-A1

EXPLORATION BORING FIELD LOG

Date 2/26/08 | Boring No.

Location Doyle Drive, Hig Viaduct, Crissy Field | Alt. No. | EA No. 163701 | Page 1 of 3

Dist. 04 Co. SF Rt. 101 P.M. Br. No. Purpose of Work

Rt. Ft. Lt. Line. Sta. Northings. Eastings. Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Javed, Randy

Drill rig: CME-750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary Wash - Coring | Casing: N/A

Hole Completion: 2/28/08

Depth	Sample Interval	Blows	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
1								
2								
3							Sand (SP), v. loose, brown, slightly moist, medium grained	
4								
5								
		3						
6	1	1						
		3						
7								
8							Silty sand (SW), medium dense, reddish brown, medium to fine grained	
9								
10								
		3						
11	2	9						
		13						
12								
13							Sand (SP), dense, yellowish brown, medium grained	
14								
15								
		12						
16	3	18						
		16						
17								
18								
19		2B						Brass tube sampled
20		2A					Sandstone, coarse to medium grained, massive, yellowish brown to dark brown, hard, intensely weathered, intensely fractured and jointed	
	RQD							
21	117		172					From 20.0 to 25.00
22								30 min
23								
24								
25								
26	140		195				Sandstone, coarse grained, massive, reddish brown, v. hard, moderately weathered, moderately fractured and jointed	29 min
27								
28								
29								
30								
31	124		187				The same as above	24 min
32								

34-015748-A

Caltrans EXPLORATION BORING FIELD LOG

Date 2/26/03 | Boring No.

Location Doyle Drive - High Viaduct - Crissy Field Ave | Proj No. | EA No. 163701 | Page 2 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Rt. Ft. Lt. Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Javod, Randy

Drill rig: CME-750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary Wash - Coring | Casing: N/A

Hole Completion: 2/28/08

Depth	Sample Interval	Tool Blows	Rod	Sample I.D.	% Rec.	Strength	Graphic Log	Description			Remarks
33											
34	3"										
35								The same as above			
36		1/47		1/97							22 min
37											
38	7"										
39								Sandstone, massive, coarse			
40								grained gray, hard, slightly			cont. on 2/27/08
41		1/77		1/97				weathered, slightly fractured,			
42								moderately jointed			27 min
43	5"										
44								Sandstone, massive, coarse			
45								grained, dark brown to gray, hard			
46		1/73		1/100				moderately weathered, slightly			
47								fractured, and moderately jointed			22 min
48	6"										
49								Sandstone as above, but			
50								gray			
51		1/65		1/97							
52											22 min
53	7"							Sandstone, massive, coarse			
54								grained, gray, hard, moderately			
55								weathered, intensely fractured			
56		1/35		1/98				and intensely jointed			19 min
57											
58	8"										
59								The same as above			
60											
61		1/33		1/90							
62											26 min
63	9"							Sandstone, massive, coarse			
64								grained, dark gray, moderately			
65								to slightly weathered, moderately			
66		1/37		1/95				fractured, intensely jointed			33 min
67											
68	10"										
69								Sandstone, massive, coarse			
70								grained, gray to yellowish gray,			
71		1/43		1/100				hard, intensely weathered,			
72								intensely fractured and slightly jointed			30 min

0603

34-0157NR-A1

Caltrans EXPLORATION BORING FIELD LOG

Date 2/27/08 | Boring No.

Location Doyle Drive, high Viaduct, Crissy field | Loc No. | EA No. 163701 | Page 3 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Rt. Ft. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Javed, Randy

Drill rig: CME 750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary wash / Coring | Casing: N/A

Hole Completion: 2/28/08

Depth	Sample Interval	Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
73	11								
74								Sandstone, massive, coarse grained	
75								gray, hard, intesely to moderately	
76		1/43		1/95				weathered, intensely fractured and	
77								jointed	
78	12								27 min
79								Sandstone, massive, coarse	
80								grained, gray, hard, slightly	
81		1/75		1/100				weathered, moderately fractured	22 min
82								slightly jointed	
83	13								
84								Sandstone, massive, coarse	
85								grained, gray to yellowish gray,	
86		1/50		1/100				moderately weathered, intensely	21 min
87								fractured and intensely jointed	
88	14								
89								Sandstone as above	
90									Continue on 2/28/08
91		1/45		1/90				Shale, thinly bedded, fine grained	
92	15							black, soft, intensely weathered	
93									21 min
94		1/42		1/100				Sandstone as above / shear zone	
95								Sandstone as above	7 min
96				1/97				Shaley Sandstone (melange)	
97								massive, coarse grained, dark gray	
98	17							v. hard, slightly weathered, intact	30 min
99								rock, few joints, calcic veinlets	
100								Shale, thinly bedded, moderate	
								grained, black, intensely weathered	
								extensive fractured	
								Graywake massive, coarse	
								grained black, moderately	
								hard to moderately soft,	
								intensely weathered, intensely	
								fractured	
								The Bottom of the hole	
								@ 110 ft	

34-0675B-A

Caltrans EXPLORATION BORING FIELD LOG

Date 2/20/08 | Boring No.

Location Doyle Drive - High Viduct, Crissy Field Ave | Loc No. | EA No. 163701 | Page 1 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Ft. Rt. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Cerle, Andy

Drill rig: CME-750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary wash - Coring | Casing: N/A

Hole Completion: 2/21/08

Depth	Sample Interval Total Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description			Remarks
1										
2										
3										
4							Sand (SP), Colma formation			
5							Vidence, brownish yellow, slightly moist, medium grained			
		20								
6	1	20								
		28								
7										
8										
9										
10							The same as above			
		12								
11	2	19								
		23								
12										
13										
14										
15							The same as above			
		12								
16	3	20								
		25								
17										
18										
19							Sand stone, coarse grained			Bed rock @ depth
20							brownish yellow, soft, intensely			20.0 ft
	Refusal						weathered, massive, calac			
21	4						veinlets.			
22										
23										
24										
25							Sand stone, coarse grained			
	5	Refusal					yellowish brown, hard,			
26	1/25	1/63					moderately weathered,			from 25 to 29
										18 min
27							The same but moderately			
							soft and moderately			
28							fractured			
29										
30	2/00	1/00					The same, but moderately hard, slightly weathered, intact rock wit a joint			from 29 to 30
										5 min

34-015 TSB-A1

Caltrans EXPLORATION BORING FIELD LOG

Date 2/20/08 | Boring No.

Location Doyle Drive, High Viduct, Crissy Field Ave | Job No. | EA No. 163701 | Page 2 of 3

Dist. 04 Co. SF Rt. 101 P.M. Br. No. Purpose of Bark

Rt. Ft., Lt. Line, Sta. Northings. Eastings. Elev.

Ground Water Data	Date / Time	Water Level	Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Cerle, Andy

Drill rig: CME - 750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary Wash, Coring | Casing: N/A

Hole Completion: 2/21/08

Depth	Sample Interval	Total Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
31		%23			%93			Sandstone, massive, coarse grained	
32								yellowish brown to olive, moderately hard,	28 min
33	3							slightly weathered, intensely jointed	
34								and fractured.	
35									
36		%53			%96			The same as above.	
37								Shaley Sandston, thinly bedded,	
38	4							fine to medium grained, yellowish brown	27 min
39								v. soft, decomposed	
40								Sandstone as above	
41		%38			%95				
42								Shaley Sandstone as above	
43	5								21 min
44								Sandstone, massive, coarse grained,	
45								yellowish brown, moderately hard,	
46		%67			%97			moderately weathered, intensely	
47								fractured and sheared.	
48	6							Sandstone as above, but less	19 min
49								fractured and jointed.	
50								Sandstone, massive, coarse grained,	
51					%93			gray, moderately to v. hard, slightly	From 50.0 to 54 ft
52	7							weathed, few fractures and joints	18 min
53									
54								The same as above	
55	8							Sandstone gravel (rock fragments)	To be continue in 2/21
56		%0			%70			sub-rounded to size 2".	(From 54.0 to 55.0 ft = 7 min)
57								Sandstone, massive, coarse grained	
58	9							gray, slightly weathered, v. intensely	(From 55.0 to 59'3")
59								fractured and jointed (mostly rock fragment)	28 min
60								The same as above	(from 59'3" to 60.0 ft)
61		%55			%100			Claystone, thinly bedded, fine grained	4 min
62								olive gray, v. soft, v. intensely weathered,	
63	10							Sandstone, massive, coarse grained	25 min
64								gray, v. hard, slightly weathered	
65								moderately fractured and jointed	
66		%18						Shale, fissile, medium grained,	
67								black, soft, intensely weathed, organic	19 min
68								(carbon closures)	
69								Sandstone as above	
70									

34-0575B-A

Caltrans EXPLORATION BORING FIELD LOG

Date 2/21/08 | Boring No.

Location Doyle Drive, High Viaduct, Crissy field | Log No. | EA No. 163701 | Page 3 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Ft., Rt. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data

Date / Time	Water Level	Bot. of Boring

Logged By: R Nashed | Drill Crew:

Drill rig: CME 750 | Hammer Type and Weight:

Drilling Method: Rotary Wash - Coring | Casing:

Hole Completion: 2/21/08

Depth	Sample Interval	Total Blows	Recovery RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
71			1.18		1.88			sandstone, massive, coarse grained, gray, v. hard, slightly weathered	
72									
73	12							intensely fractured and jointed	19 min
74									
75									
76			1.1		1.72			shaly sandstone, thinly bedded, coarse grained, gray, intensely weathered, intensely fractured and sheared	
77									
78	13								27 min
79									
80									
81			1.1		1.90			Sandstone, massive, coarse grained, gray to yellowish gray, v. hard, sheared slightly to intensely weathered, intensely fractured and completely cracked	
82									
83	14								23 min
84									
85									
86			1.57		1.93			Sandstone, massive, coarse grained, dark gray, hard, slightly weathered, moderately fractured and jointed	
87									
88	15								13 min
89									
90									
91			1.1		1.80			Sandstone, massive, coarse grained, yellowish gray, moderately hard, sheared, intensely weather, intensely fractured	
92									15 min
93									
94									
95			1.52		1.69			shale, thinly bedded, medium grained, black, v. soft, intensely weathered and sheared	
96									
97	16								12 min
98									
99									
100								Sandstone, massive, coarse grained, gray, v. hard, slightly weathered, moderately fractured and jointed	

Caltrans EXPLORATION BORING FIELD LOG

Date 4/17/03 | Boring No. RWB-R2

Location Doyle Drive - Lincoln Blvd | Job No. | EA No. 163704 | Page 1 of 3

Dist. 04 Co. SF Rt. | P.M. | Br. No. | Purpose of Work

Ft. Rt. Lt. Line. Sta. Northings. Eastings. Elev.

Ground Water Data

Date / Time	Water Level	Bot. of Boring

Logged By : R Nashed | Drill Crew : Brad Jared, Joe

Drill rig : CME 75 | Hammer Type and Weight : Automatic

Drilling Method : Rotary - Coring | Casing :

Hole Completion :

Depth	Sample Interval Tool	Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description			Remarks
1								on Asphalt @ Freq line			
2											
3											
4								Sand (SP) - Dune Sand; Very			
5								loose, yellowish brown, dry,			
	1	1						fine grained			
6		2									
		2									
7											
8											
9											
10								Sandy silt (ML), stiff to			
	2	5						soft, brownish gray, fined			
11		7						grained sand > 15% (fill)			
		8						roots (organic)			
12											
13											
14								Sandy silt (ML), stiff,			
15								brownish yellow, fined			
	3	5						grained sand > 25%			
16		9									
		11									
17											
18											
19											
20											
		4						The same as above, but			
21	4	5						soft			
		7									
22											
23											
24											
25											
		7						Sand (SP) - Colma Formation,			
26	5	20						very dense, brown, medium			
		28						grained			
27											
28											
29											
30											

Caltrans

EXPLORATION BORING FIELD LOG

Date 1/17/08 | Boring No. R-8-R2

Location Doyle Drive - Lincoln Blvd | Lab No. | EA No. 163701 | Page 2 of 3

Dist. 04 Co. SF Rt. 101 P.M. Br. No. Purpose of Work

Ft. Rt. Lt. Line. Sta. Northings. Eastings. Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By: R Nashed | Drill Crew: Brad, Jarod, Joe

Drill rig: CME 750 | Hammer Type and Weight: Automatic

Drilling Method: Rotary Wash/Coring | Casing: N/A

Hole Completion: 1/17/08

Depth	Sample Interval Tool	Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description			Remarks
		15						Sand (SP), Colma Formation, very			
31	6	32						dense, brown, medium grained			
		40									
32											
33											
34											
35											
		10						The same as above			
36	7	16									
		20									
37											
38											
39											
40											
		10						The same as above			
41	8	17									
		23									
42											
43											
44											
45											
		16						The same as above			
46	9	23									
		25									
47											
48											
49											
50											
		23						The same as above			
51	10	43									
		34									
52											
53											
54											
								The same as above			
		14									
		26									
		27									

Caltrans EXPLORATION BORING FIELD LOG

Date 1/17/08 | Boring No. ~~R-2~~ R2

Location Doyle Drive - Lincoln Blvd | Job No. | EA No. 163701 | Page 3 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Rt. Ft. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

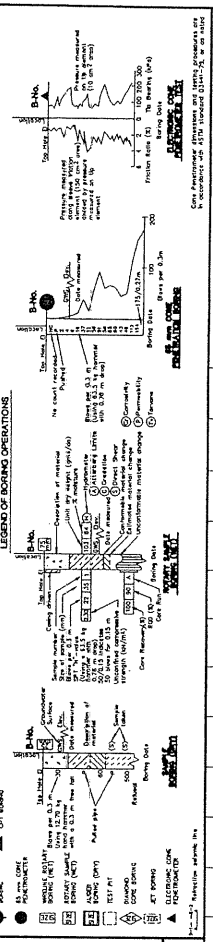
Logged By: R Nashed | Drill Crew: Brad, Javad, Joe

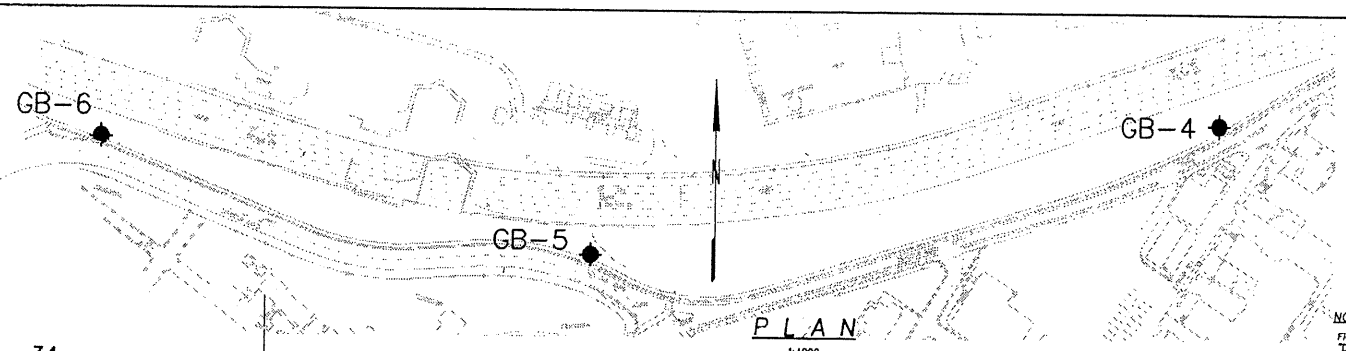
Drill rig: CME-75b | Hammer Type and Weight: Automatic

Drilling Method: Rotary Wash/Coring | Casing: N/A

Hole Completion: 1/17/08

Depth	Sample Interval	Total Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description			Remarks
59											
60								The same as above			
		11									
61	12	21									
		22									
62											
63											
64											
65								Sandy Shale, fissile, coarse to medium grained, yellowish black, v. soft, intensely weathered			
		8									
66	13	15									
		21									
67		9/25		1/57				The same as above, intensely fractured			
68											
69											
70											
		9/20		9/25				The same as above			5.5 min
71											
72											
73											
74											
75											
		9/20		9/62				The same as above, but more sand content			5.0 min
76											
77											
78											
79											
80											





PLAN

1:1000

Caltrans Metric

NOTES

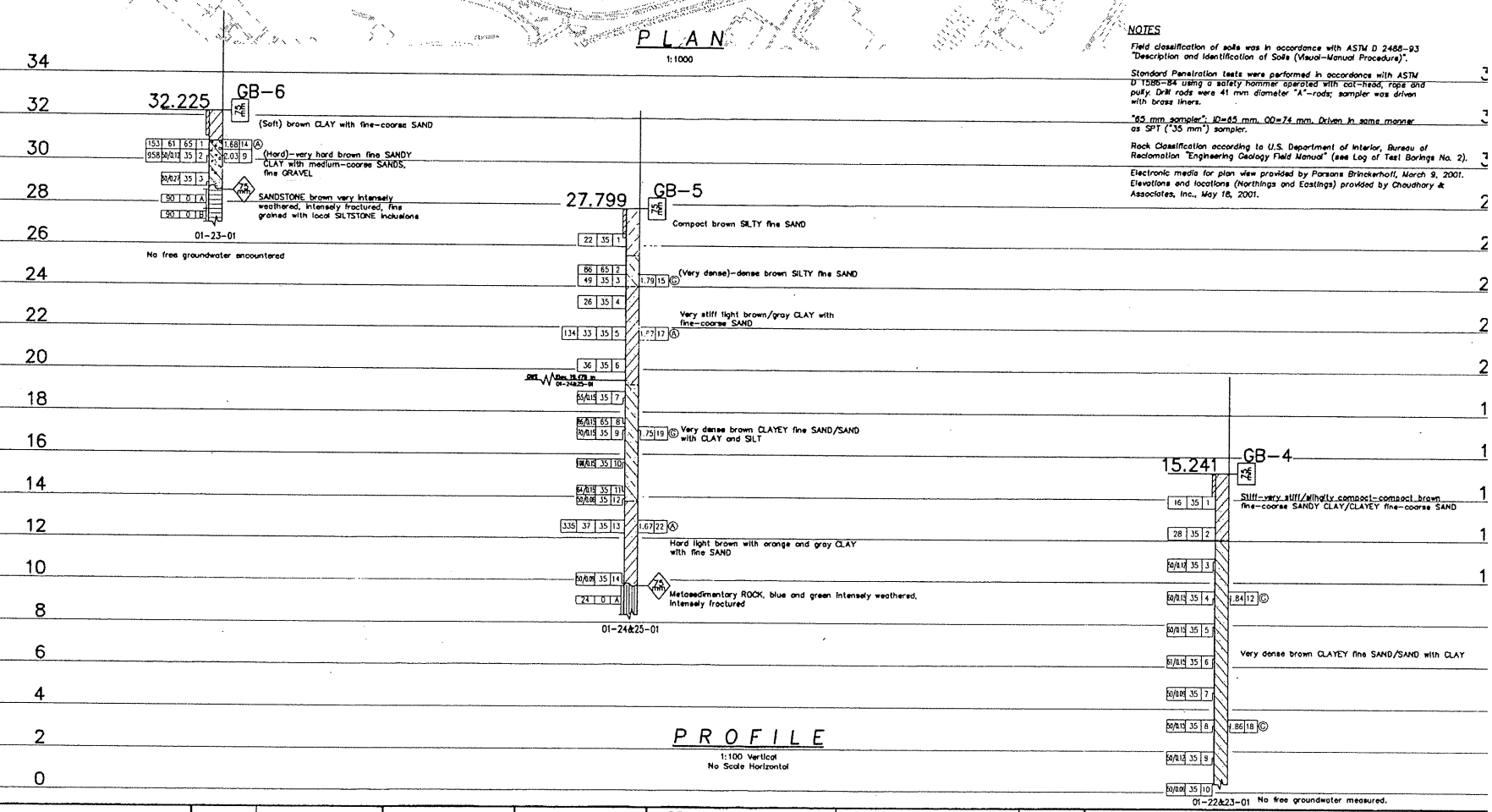
Field classification of soils was in accordance with ASTM D 2488-93 "Description and Identification of Soils (Visual-Manual Procedure)".

Standard Penetration tests were performed in accordance with ASTM D 1586-84 using a safety hammer operated with cat-head, rope and pully. Drill rods were 41 mm diameter "A"-rods; sampler was driven with brass liners.

"65 mm sampler": ID=65 mm, OD=74 mm. Driven in same manner as SPT ("35 mm") sampler.

Rock Classification according to U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual" (see Log of Test Borings No. 2).

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Choudhary & Associates, Inc., May 18, 2001.



PROFILE

1:100 Vertical
No Scale Horizontal

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001			

KP

DOYLE DRIVE RECONSTRUCTION PROJEC

LOG OF TEST BORINGS No. 3

Tabor Consultants Job No. 202/300/133 file id: 202300133a.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

CU EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)

SHEET

Appendix C

Shear Wave Velocity Testing

C1 Suspension Velocity Tests

This appendix presents the results of the geophysical tests performed as part of the exploration program for the Battery Tunnels of the Doyle Drive Replacement Project. The tests were performed using the suspension velocity method, which allows measurements of shear wave and compression wave velocities of soils and rocks.

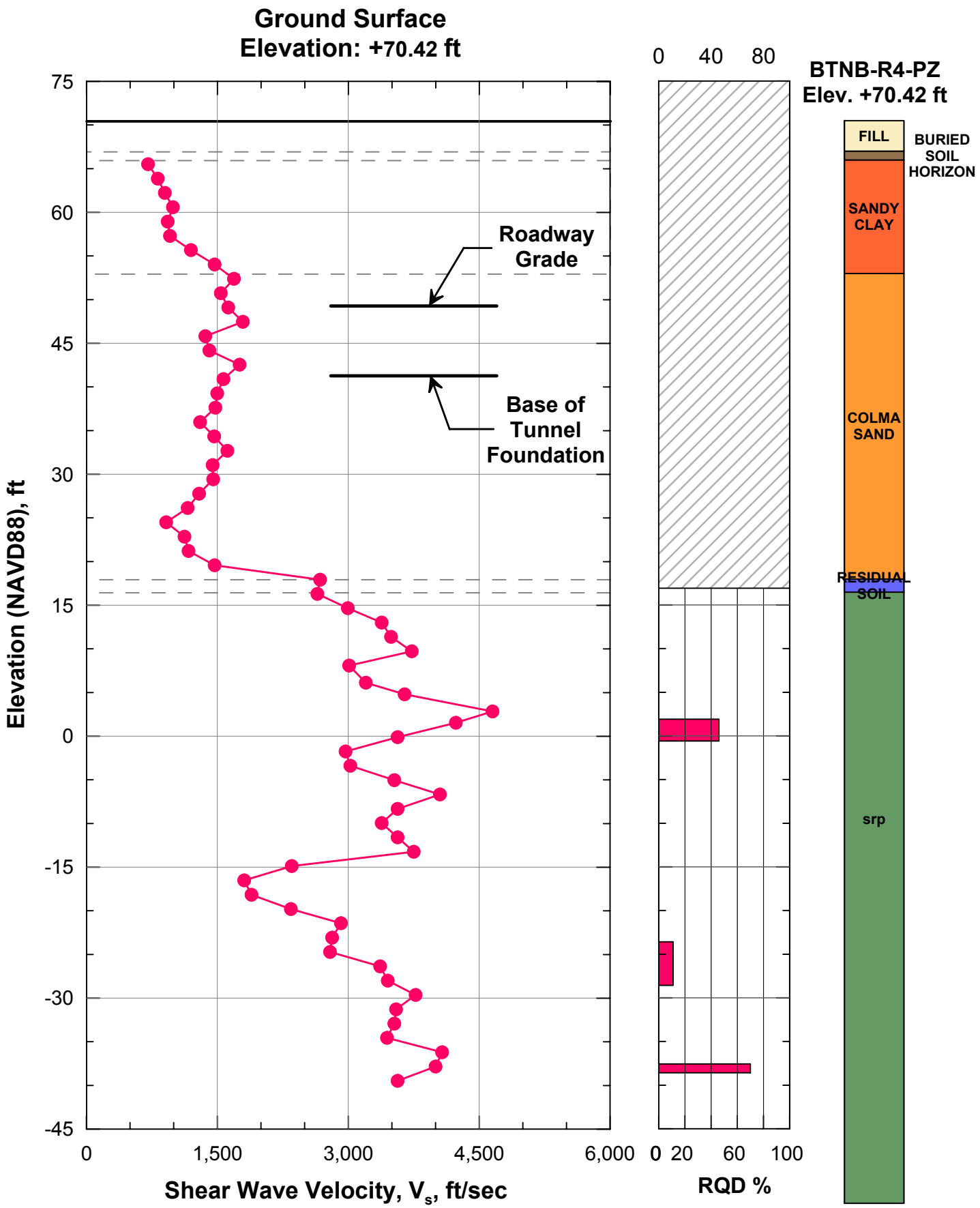
The suspension velocity tests are performed in the borehole drilled as part of the geotechnical investigation program. The suspension velocity tests are performed after the drilling and sampling is completed. The suspension velocity test apparatus is lowered to the bottom of the hole to begin the test. It is raised in short depth intervals and the test repeated, until measurements are obtained over the full depth of the borehole providing information on shear and compression wave velocities approximately at 1.5-foot depth intervals. The results of the test are used to develop profiles of the variations of shear wave and compression velocity with depth. The detailed information obtained from the suspension velocity tests allows characterization of the various strata in terms of their stiffness (shear and Young's modulus), but also provides information of the variations of the velocities within each stratum.

The velocity profiles also offer an indirect way of obtaining detailed information regarding stratigraphic changes, by correlating major changes in velocity values to changes in stratigraphy. This is particularly important in cases where soft or weathered, relatively thin rock layers, may be embedded within stronger rock, or where soft soil deposits may be present within stiffer or denser soils. More important however, is that the suspension velocity tests provide information to quantify the variability of the rock conditions not only with depth but also from location to location. One of the difficulties with rock coring is that often recovery may be poor, which means that it is not possible to identify or characterize the rock within the depth interval of low or no recovery. The suspension velocity tests provide information from which the characteristics of the rock in the areas of low or no recovery can be evaluated. The shear wave velocity measurements with the suspension velocity tests provide a basis for estimating the characteristics of the rock and, equally important, to quantify the potential variability of the rock conditions along the tunnel.

The shear wave velocity measurements can be used also to calculate the small strain shear modulus of the soil deposits and rock formation. The small strain shear modulus is an important parameter that is required to evaluate the seismic site response in the event of an earthquake and, in numerical analyses to evaluate stresses and deformations that would develop around the tunnel as excavation progresses.

The suspension velocity measurements were performed by GEOVision Geophysical Services (GEOVision) of Corona, California, between January 9 and April 22, 2008. Prior to the velocity measurements, the boreholes were sampled and drilled under supervision of an Arup/PB engineer or geologist who maintained records of the field activities, classified the soils and rock types encountered and developed a log for the borehole. A total of eight suspension velocity tests were performed in exploratory boreholes drilled for the Battery Tunnels.

Figures C-1 through C-8 present the variation of the shear wave velocity measurements with depth for the performed tests. The compression velocity profiles are omitted from these figures because compression velocity measurements may not be meaningful below groundwater.



SHEAR WAVE VELOCITY PROFILE: BTNB-R4-PZ

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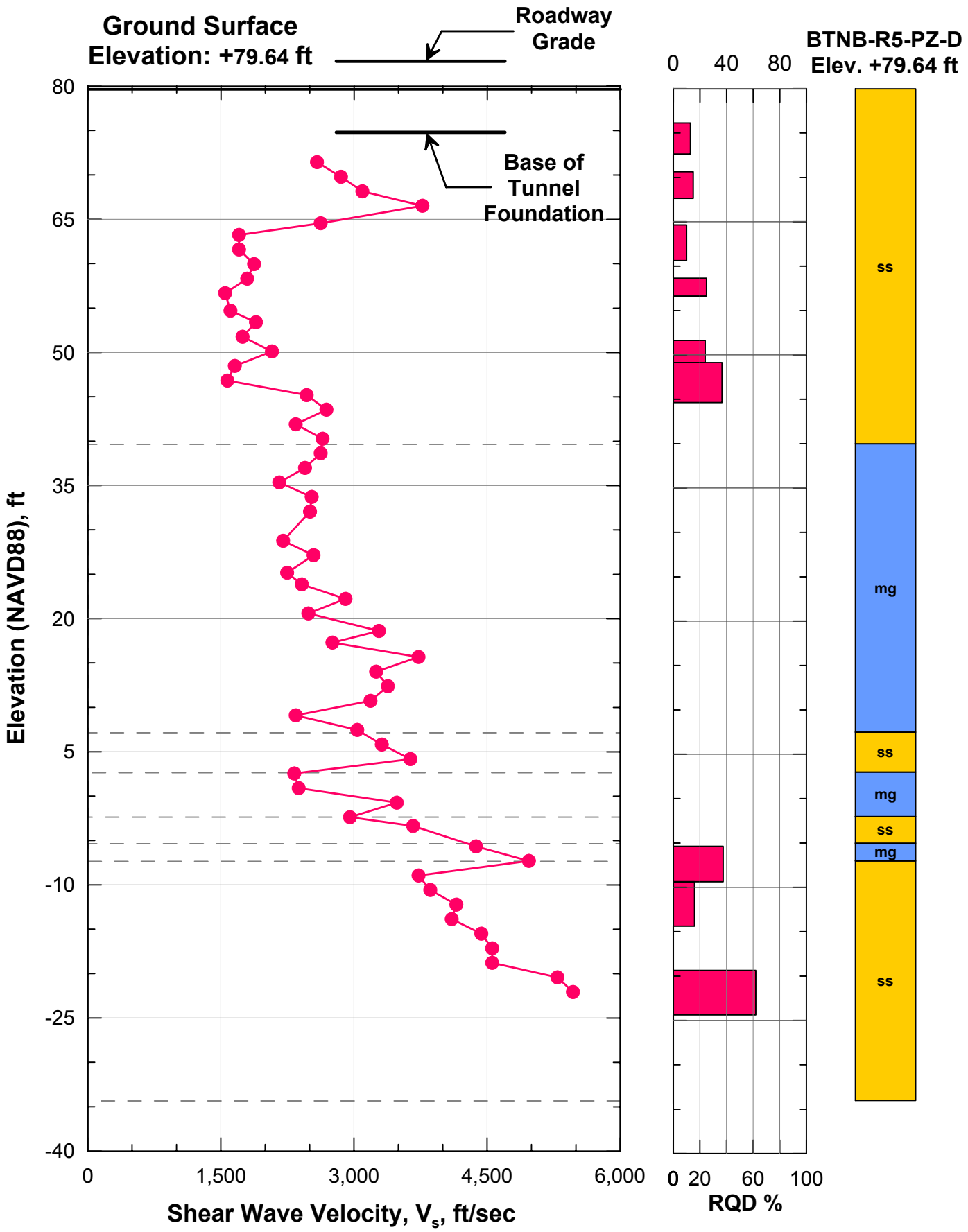
Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\PS Logging\SWV BTNB-R4.grf

FIGURE C-1



SHEAR WAVE VELOCITY PROFILE: BTNB-R5-PZ-D

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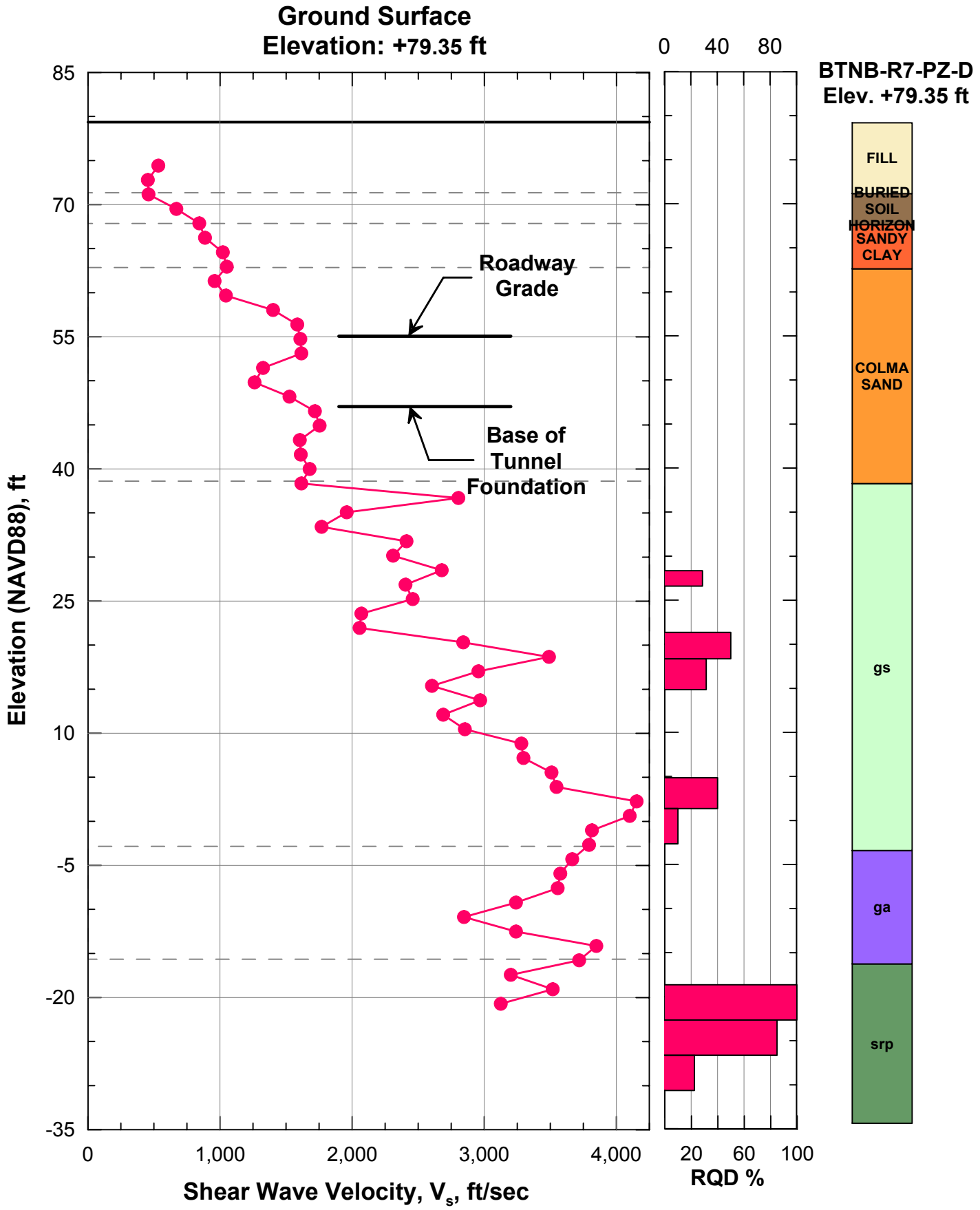
FIGURE C-2



SHEAR WAVE VELOCITY PROFILE: BTNB-R7-PZ-D

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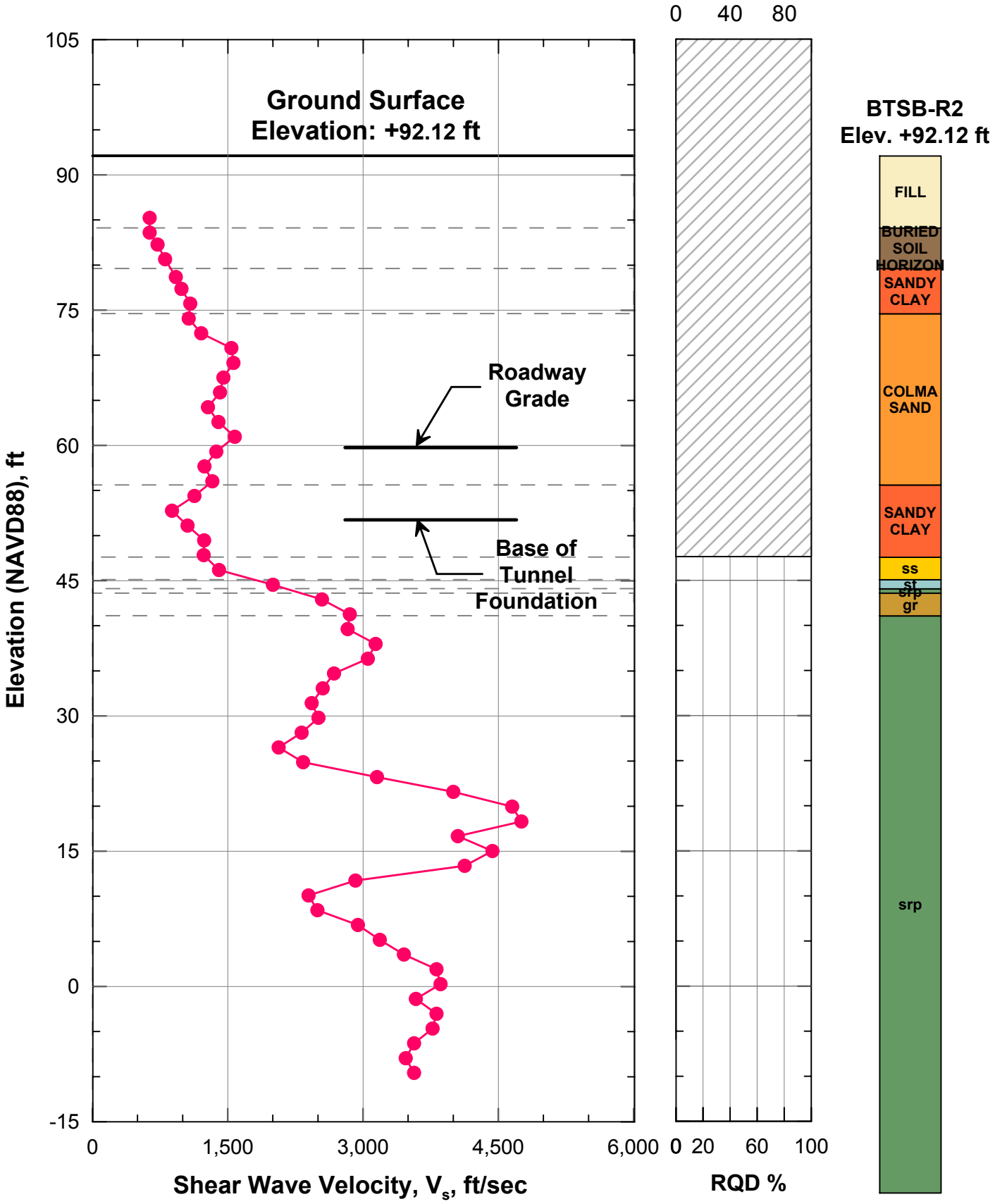
FIGURE C-3



SHEAR WAVE VELOCITY PROFILE: BTSB-R2

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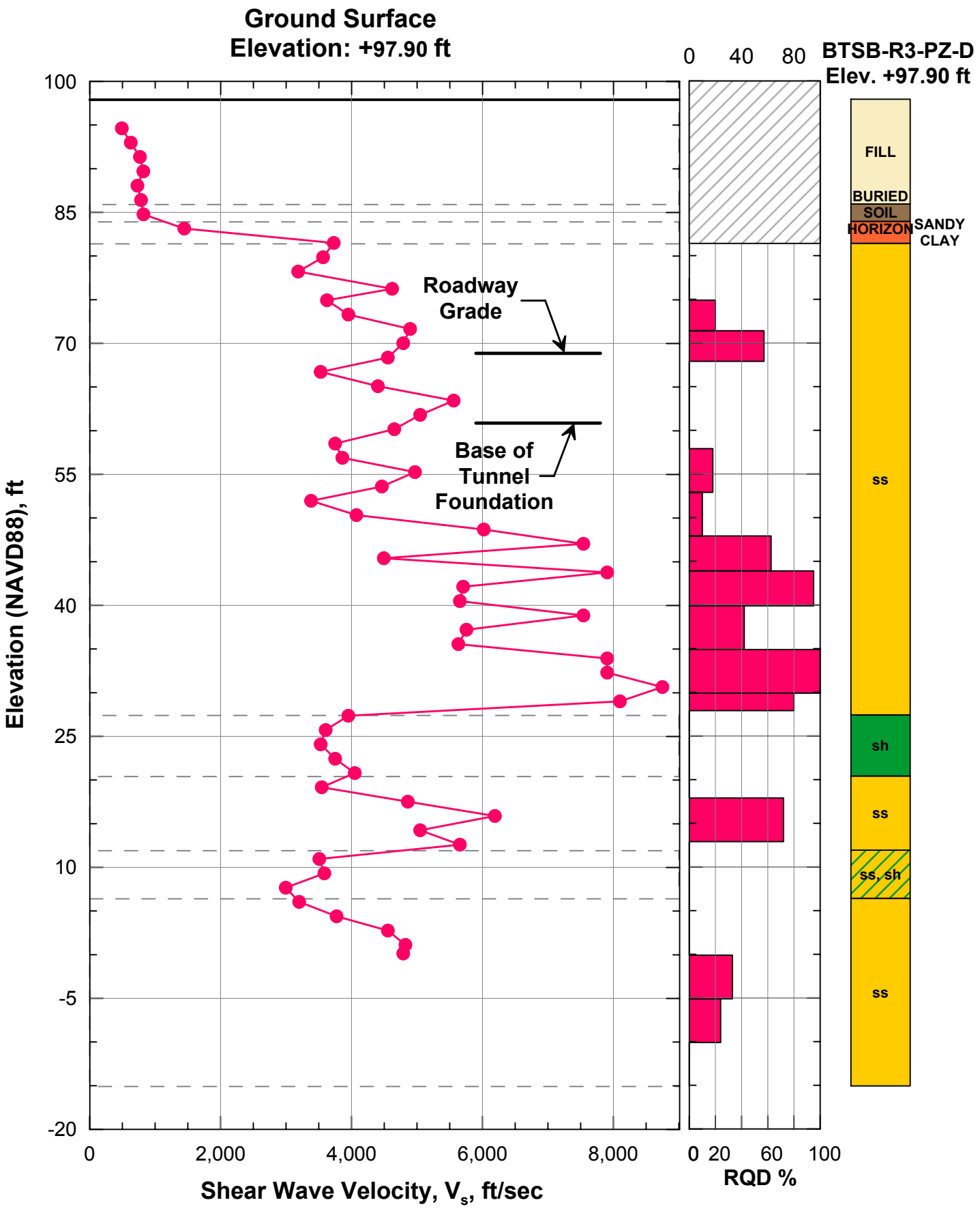
Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\PS Logging\SWV BTSB-R2.grf

FIGURE C-4



SHEAR WAVE VELOCITY PROFILE: BTSB-R3-PZ-D

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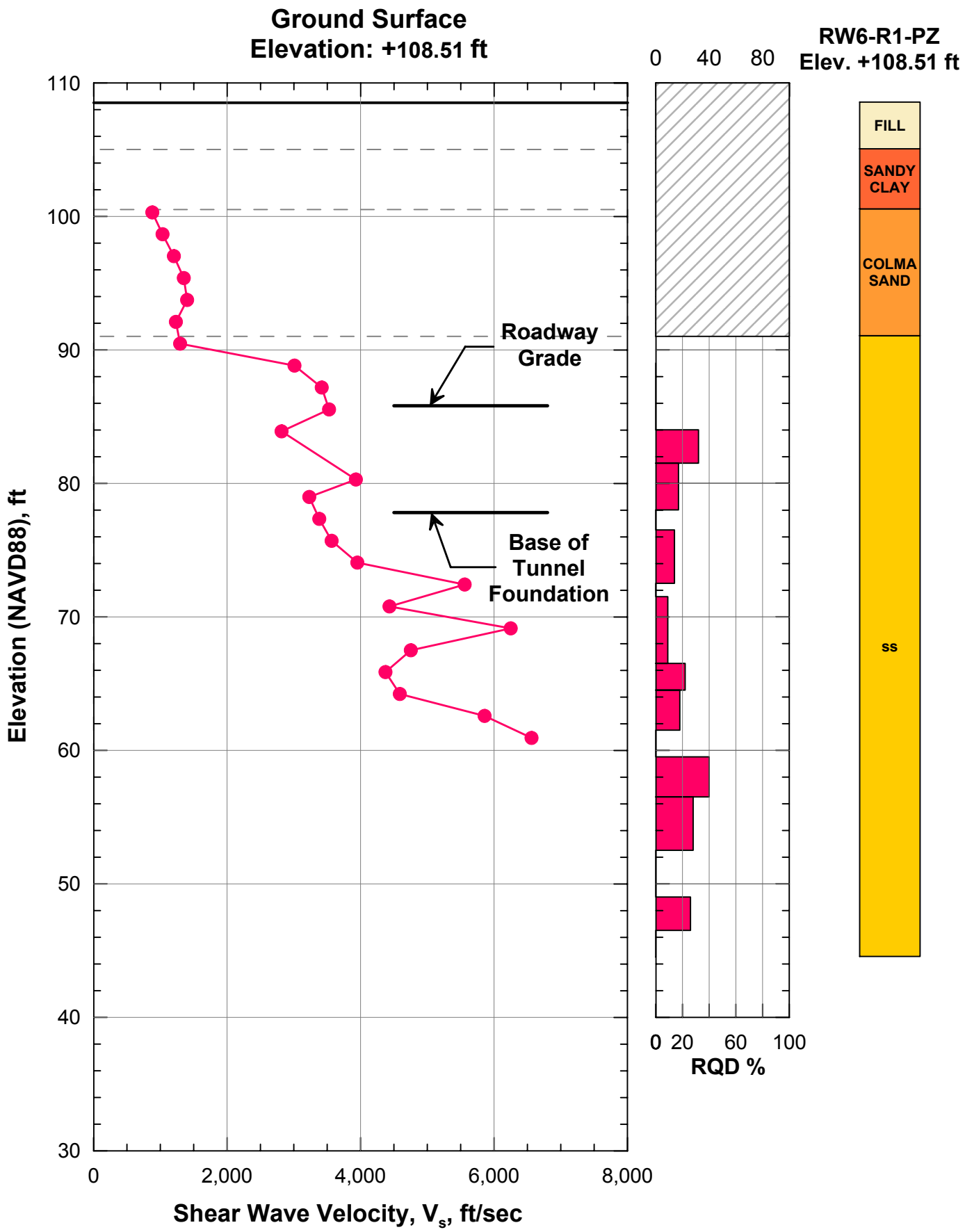
FIGURE C-5



SHEAR WAVE VELOCITY PROFILE: RW6-R1-PZ

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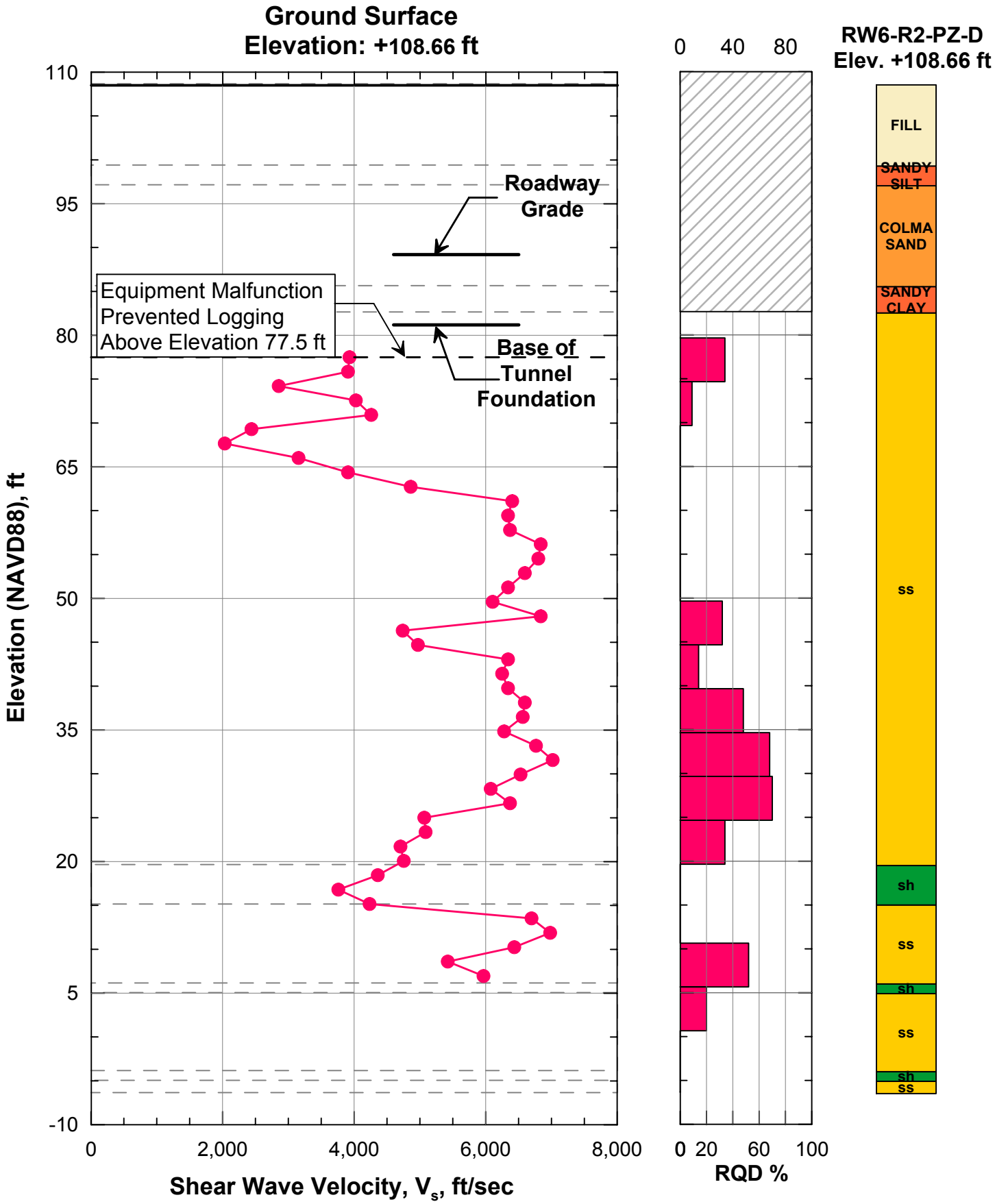
FIGURE C-6



SHEAR WAVE VELOCITY PROFILE: RW6-R2-PZ-D

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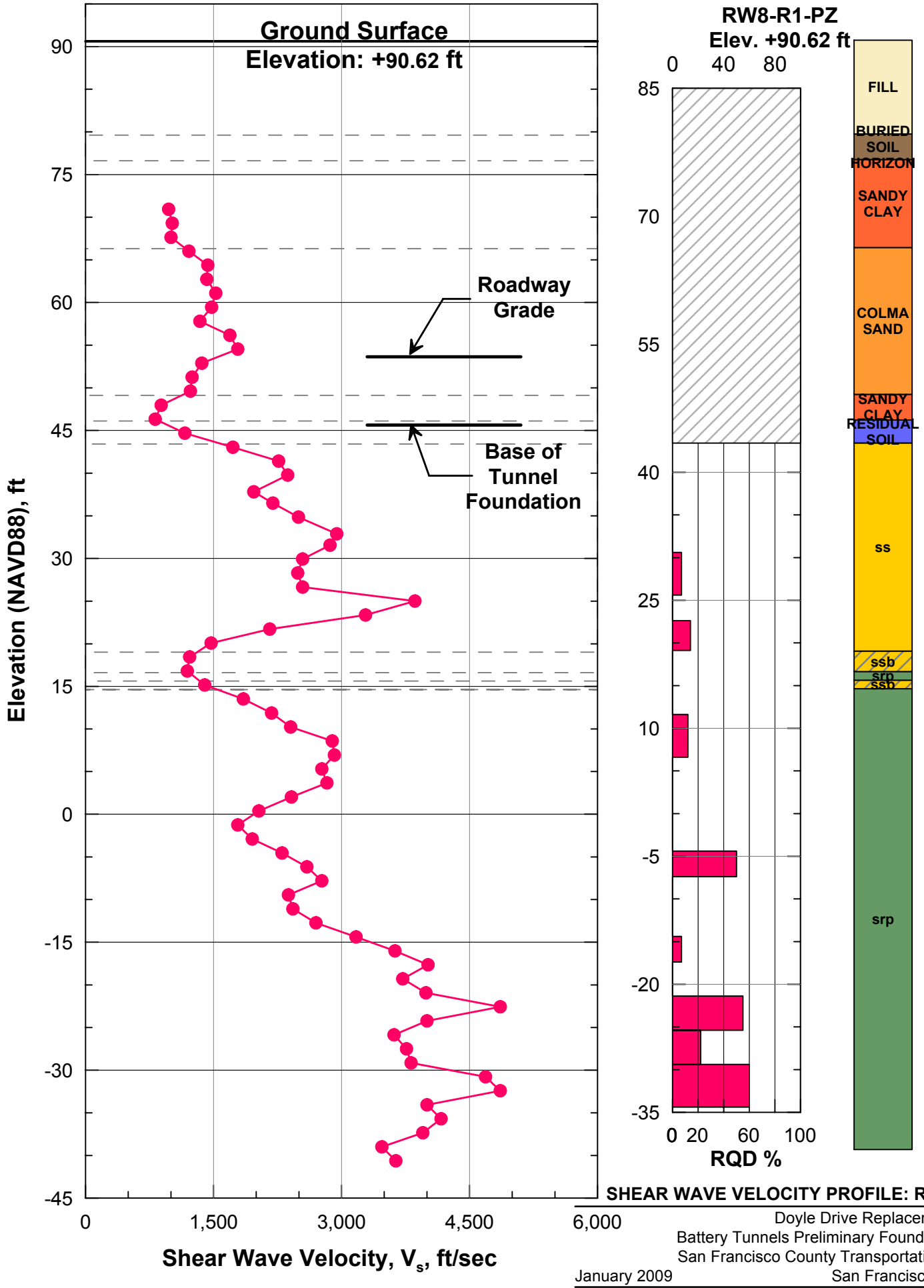
FIGURE C-7



SHEAR WAVE VELOCITY PROFILE: RW8-R1-PZ

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FIGURE C-8

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\PS Logging\SWV RW8-R1.grf

Appendix D

In-situ Permeability Testing (Packer Tests)

D1 Introduction

This appendix presents the results of the packer tests performed as part of the exploration program for the Battery Tunnels of the Doyle Drive Replacement Project. The tests were performed using a Double Packer System.

The packer test consists of isolating a section of the rock in a predrilled borehole, pumping water under sustained pressure, and measuring the rate of water flow into the rock formation. The test apparatus consists of a segment of pipe with a packer at each end. The apparatus is lowered down to the designated test depth, the packers are inflated to create a seal, and then water is pumped through the central pipe and allowed to flow through into the sealed section of the borehole into the rock.

The test procedure is illustrated on Figure D-1. Initially, the packer arrangement is lowered down to the lowest zone that is to be tested, and the tests performed. Then the packer assembly is lifted to the next highest level and the test repeated. This procedure is repeated as many times as deemed necessary, progressively raising the packer test apparatus in short length increments.

The permeability values for the packer test were estimated following the procedures outlined in a manual issued by the U.S. Department of Interior, Bureau of Reclamation (USBR 7310-89), entitled: "Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes" and also in "Standard Operating Procedures for Borehole Packer Testing," by Michael Royle, M.A.Sc.

Packer tests were performed at six borehole locations drilled in rock along the Battery Tunnels alignment. The packer tests were performed between February 21 and April 22, 2008.

D2 Packer Tests Field Procedures

The data recorded during the test consists of the flow rate and the corresponding pressure when steady-state conditions have been achieved. These data are recorded over a number of increasing and decreasing (recovery) pressure steps. The range of pressures for the pressures steps are selected based on the anticipated permeability of the rock within the test interval. The test scheduled used for this project consisted of three increasing pressure steps followed by two decrements of pressure that matched the pressures during the increasing phase of the test. The procedures for the injections tests consisted of the following steps:

1. The borehole is cleared by pumping and circulating water from the bottom up to remove all drilling mud and drill cuttings from the hole.
2. The static water level in the borehole is measured before the test is started.
3. The packer assembly is lowered inside the borehole to the depth of the lowest test interval. The selection of the test intervals is based on the stratigraphy information obtained from the exploratory borehole previously drilled at that same location.
4. The glands of the packers are inflated to the working pressure. The working pressure should be such that it ensures a proper seal of the tests section and it should include the necessary pressure to overcome the hydrostatic pressure at that depth.

5. Water injection starts for the first pressure step and observations of flow are made every minute until three consistent reading are taken. This should represent steady-state flow. The steady-state flow rate and the corresponding pressure are recorded. The injection pressure at the test interval is recorded with a vibrating wire piezometer.
6. The water injection pressure is then increased to the second pressure step and the flow rate and the corresponding pressure are recorded when the steady-state condition is reached at that pressure step.
7. The same procedure is repeated for the third pressure step and the two recovery pressure steps. At this point the test is completed for the first test interval.
8. The packer assembly is deflated and lifted to the depth of the next test interval and steps 4 through 7 are repeated.

D3 Calculation of Permeability from Double Packer Tests

The permeability of the rock unit(s) within each test interval were calculated using two methods. One of the methods used the following equation, presented in the USBR 7310-89 manual; Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes:

$$k = \frac{q}{(C_s + 4)rH}$$

Where:

k = Permeability of the tested interval

q = Constant rate of flow in the test interval

C_s = Conductivity coefficient

H = Differential head of water exerted at the test interval

r = Radius of the borehole

The differential head of water, H, is calculated as the combined pressure head exerted at the test interval as follows:

$$H = P_p - (h_z - h_s)$$

Where:

P_p = Injection Pressure measured by a vibrating wire piezometer

h_z = Depth to the test interval

h_s = Depth to the static water level

The permeability of the rock unit(s) within each test interval were also calculated using the following equation, presented in the “Standard Operating Procedures for Borehole Packer Testing,” by Michael Royle, M.A.Sc.:

$$k = \frac{q}{(2\pi L P_i)} \ln\left(\frac{L}{r}\right)$$

Where:

k = Permeability of the tested interval

q = Constant rate of flow in the test interval

L = Length of the test interval

P_i = Net injection pressure

r = Radius of the borehole

The net injection pressure P_i, is calculated as the combined pressure head exerted at the test interval as follows:

$$P_i = P_p - (h_z - h_s)$$

Where:

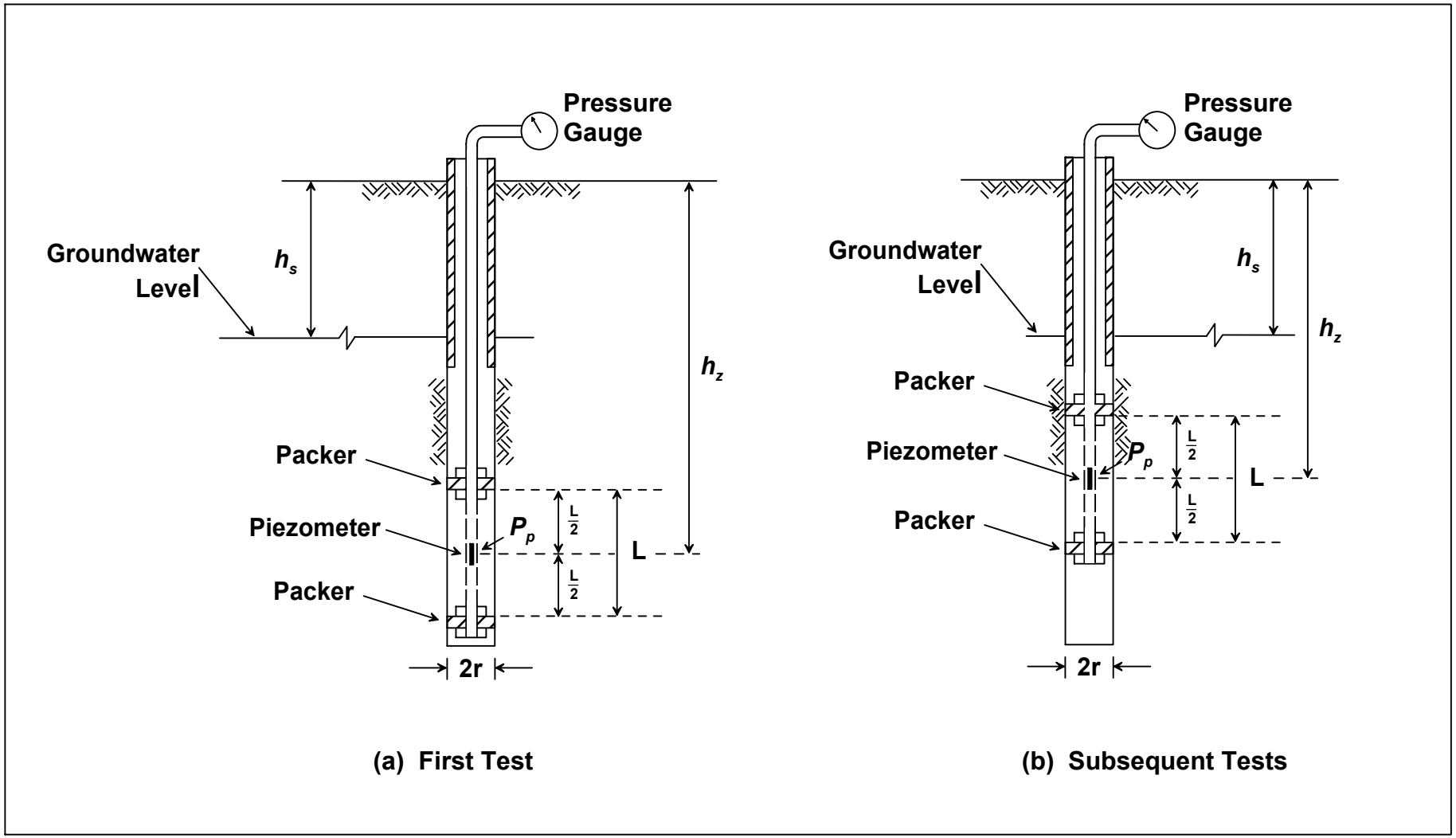
P_p = Injection Pressure measured by a vibrating wire piezometer

h_z = Depth to the test interval

h_s = Depth to the static water level

D4 Double Packer Permeability Test Results

All packer test intervals were in the Franciscan rock. Flow versus pressure curves for the six packer tests are presented on Figures D-2 through D-7.



TYPICAL DOUBLE PACKER TEST SETUP

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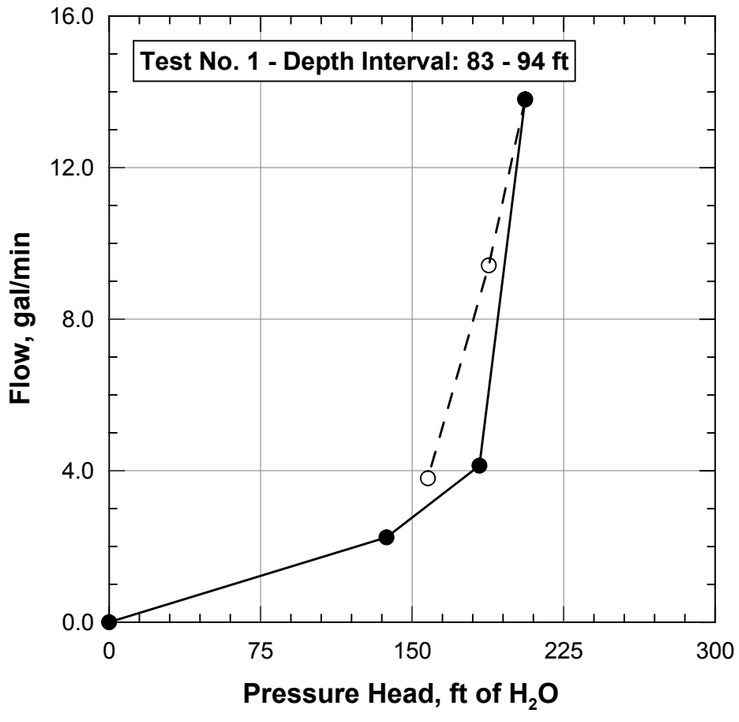
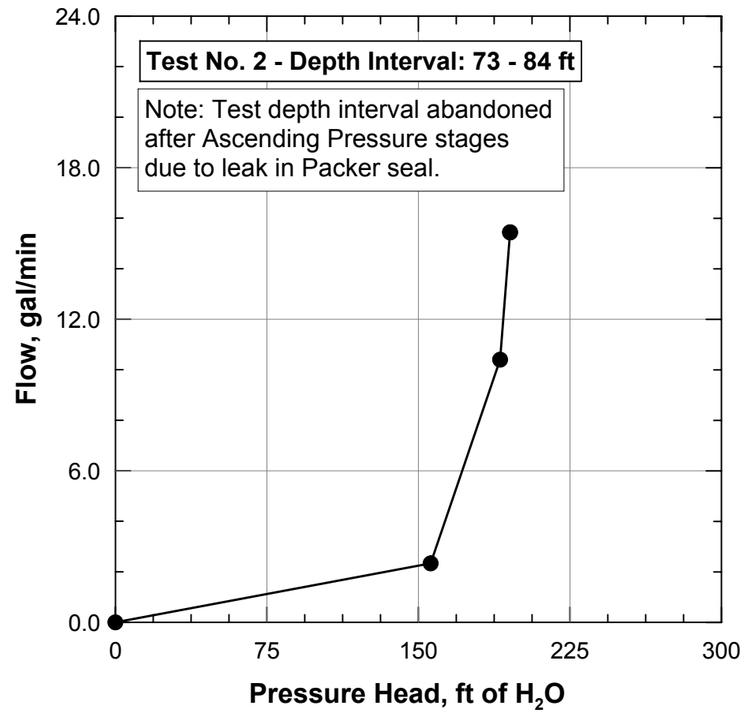
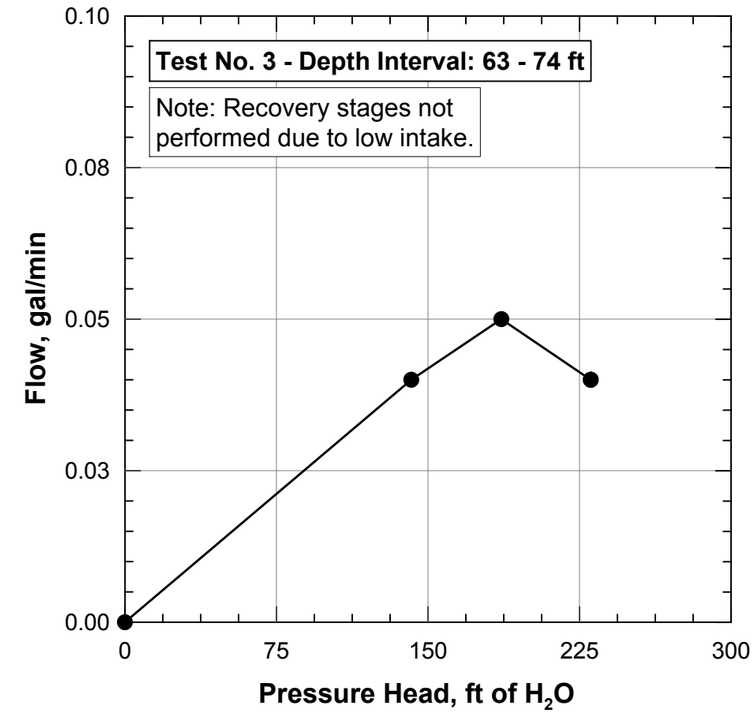
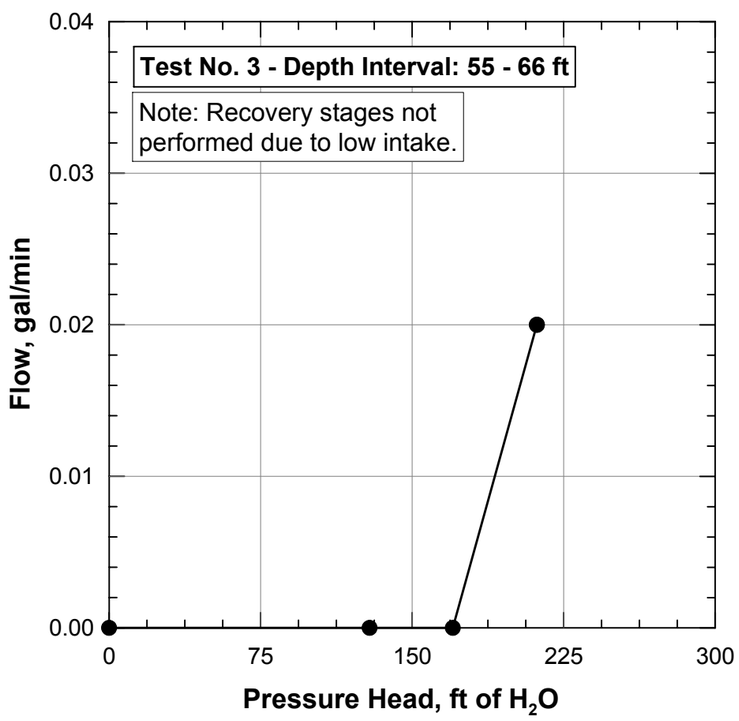
FIGURE D-1

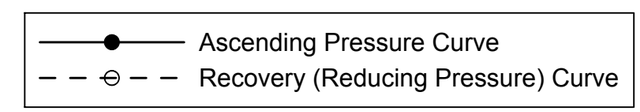
Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\Packer Test Setup.grf











FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R4-PZ

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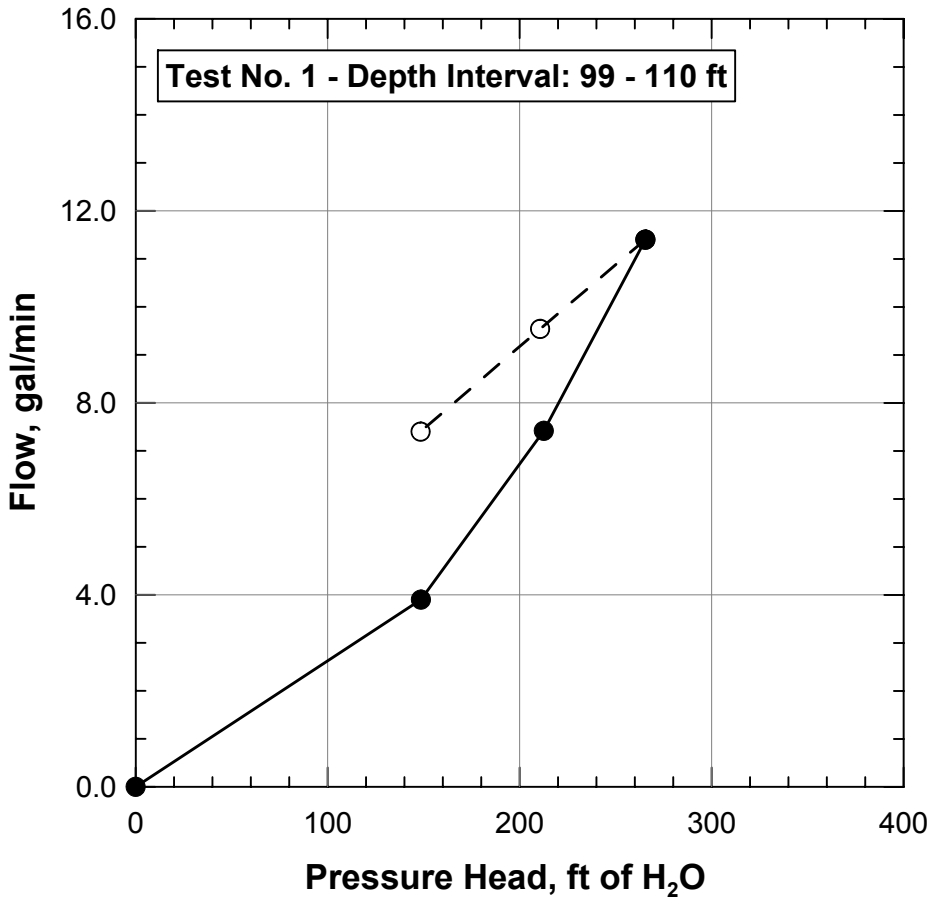
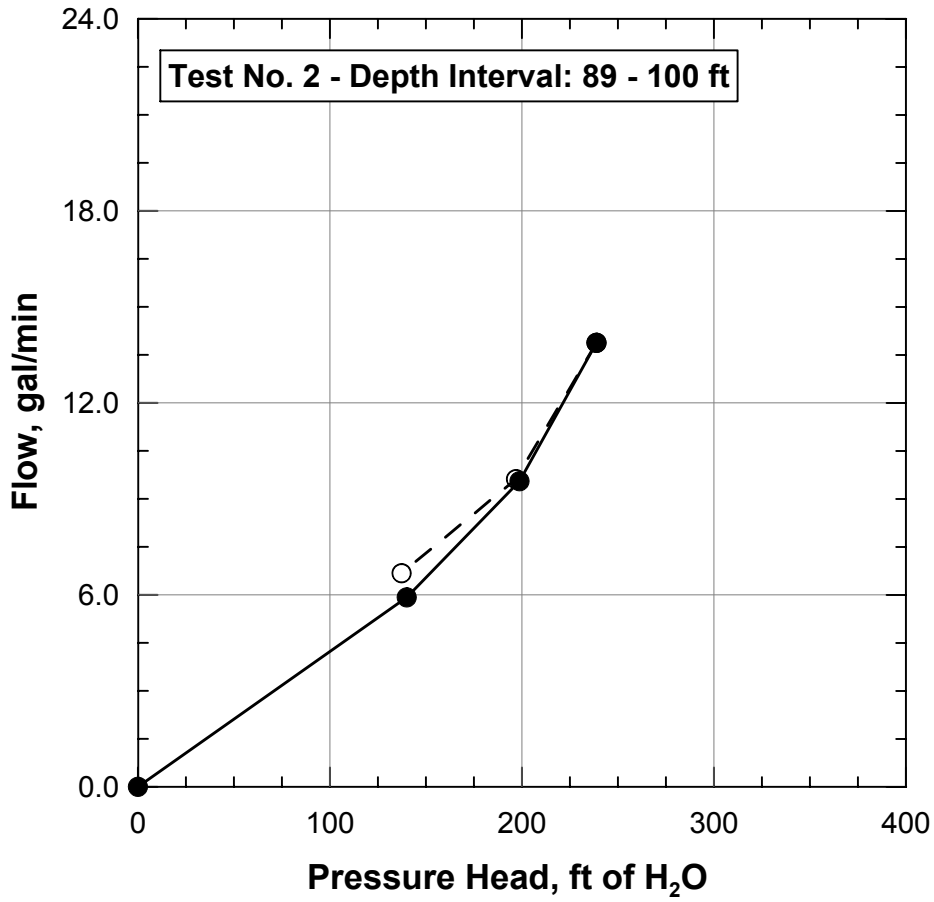
FIGURE D-2

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\BTNB-R4.grf





Ascending Pressure Curve
Recovery (Reducing Pressure) Curve

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R5-PZ-D

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FIGURE D-3

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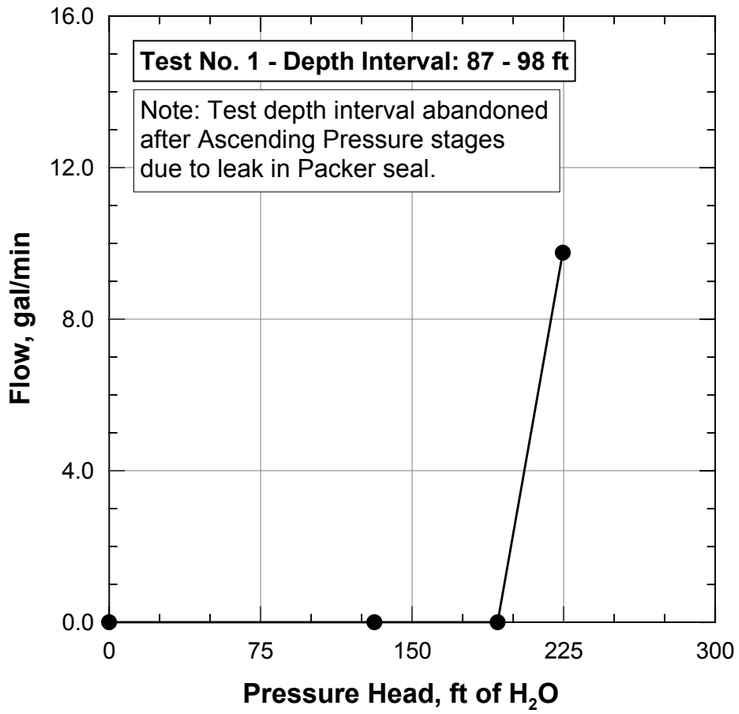

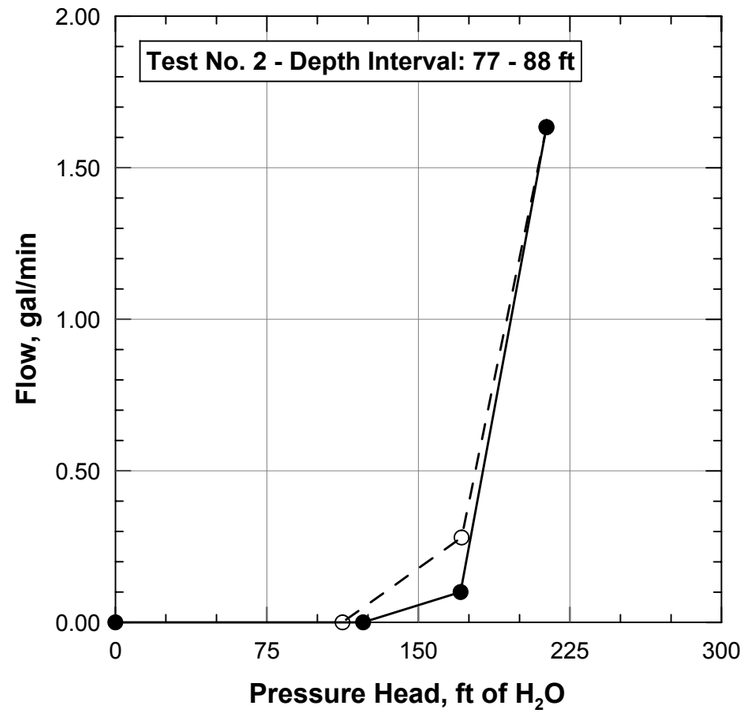

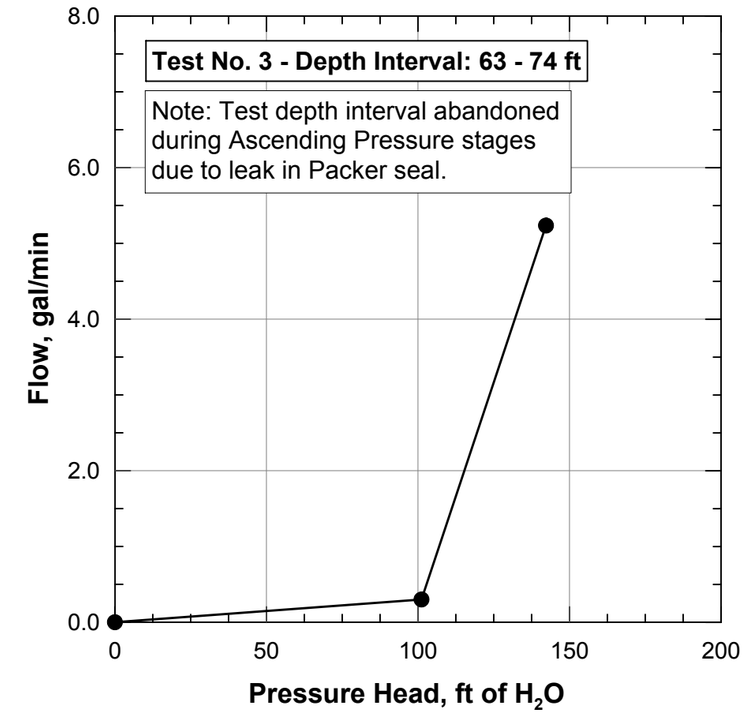

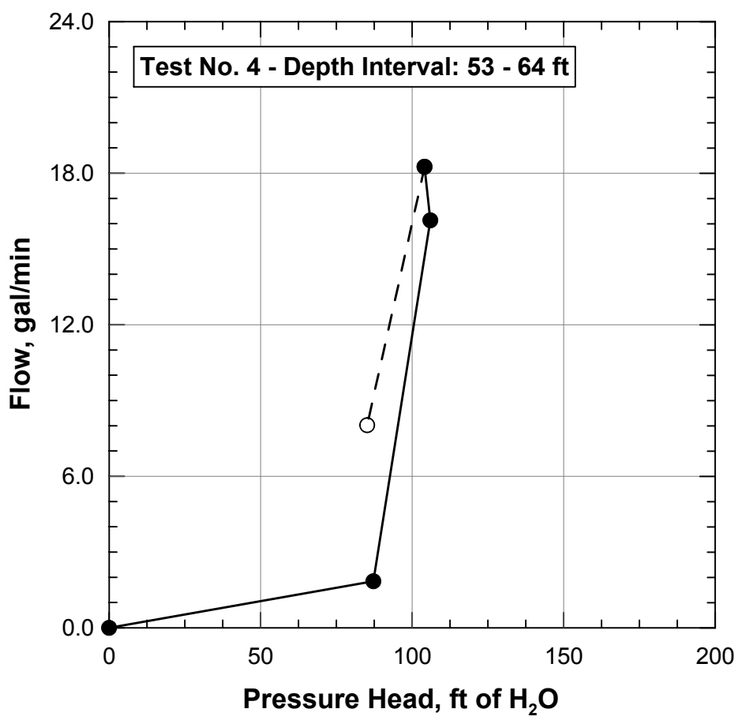

Ascending Pressure Curve
Recovery (Reducing Pressure) Curve

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R7-PZ-D

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FIGURE D-4

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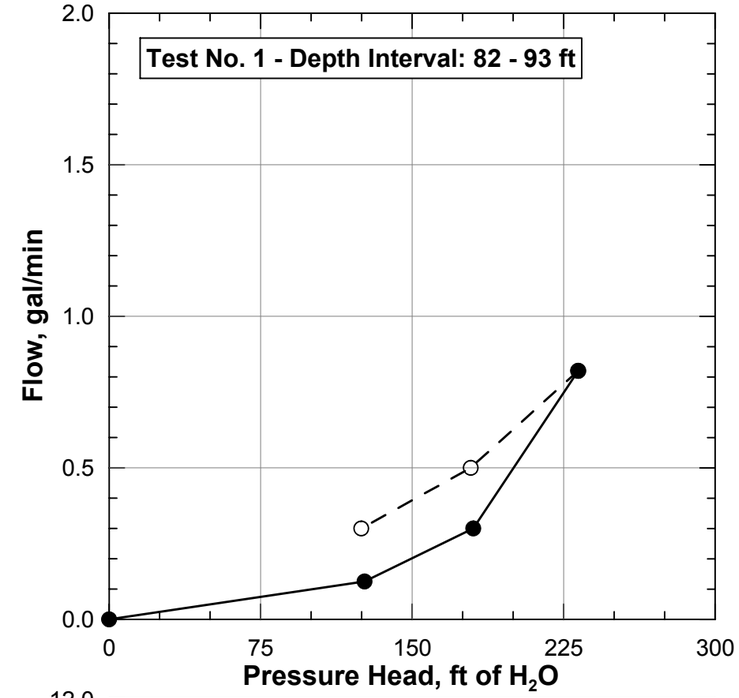

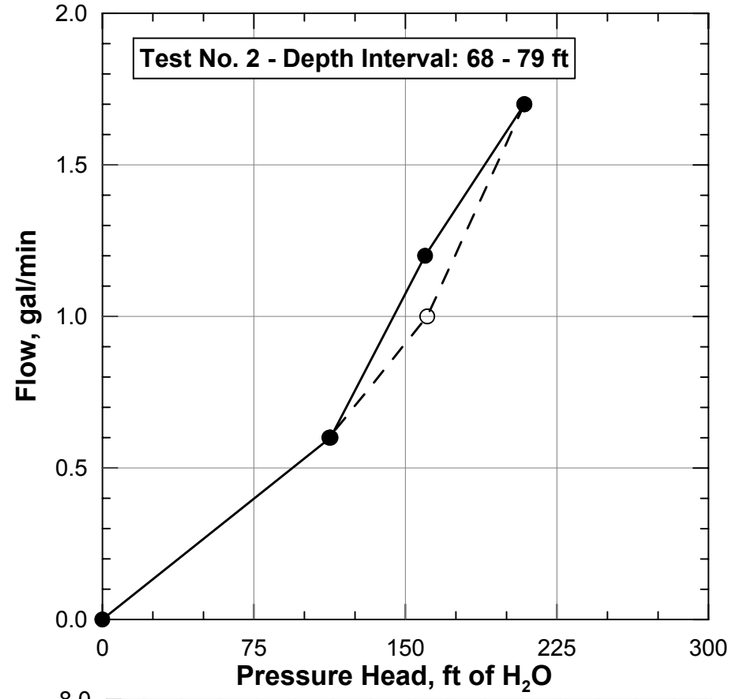

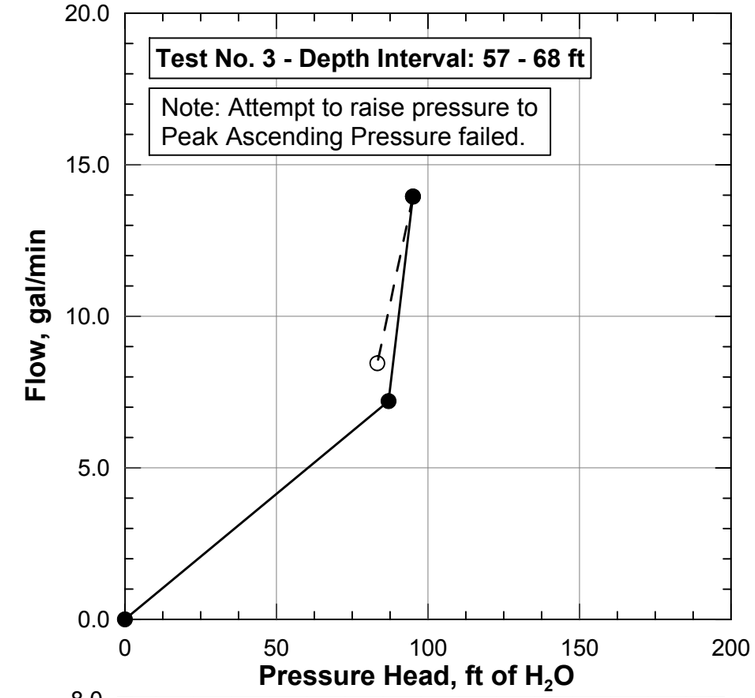

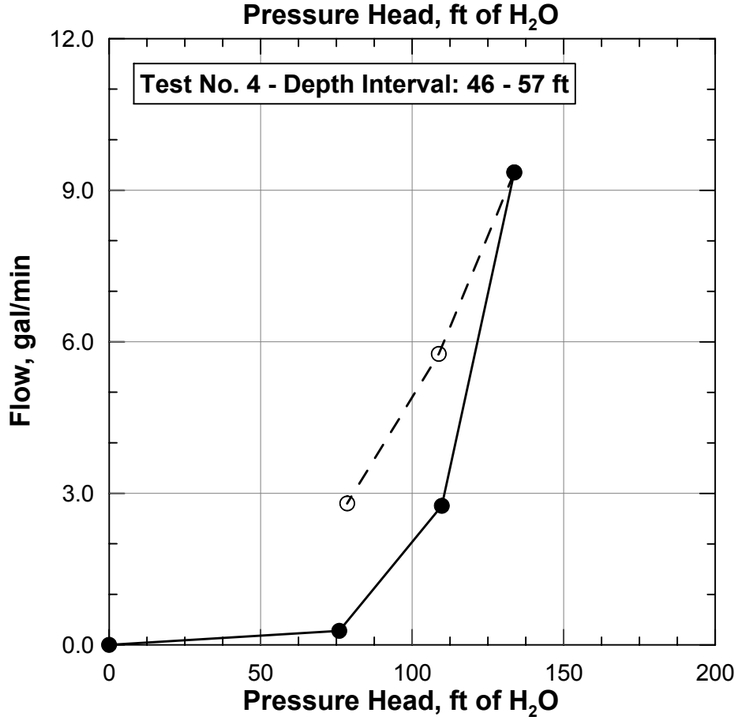

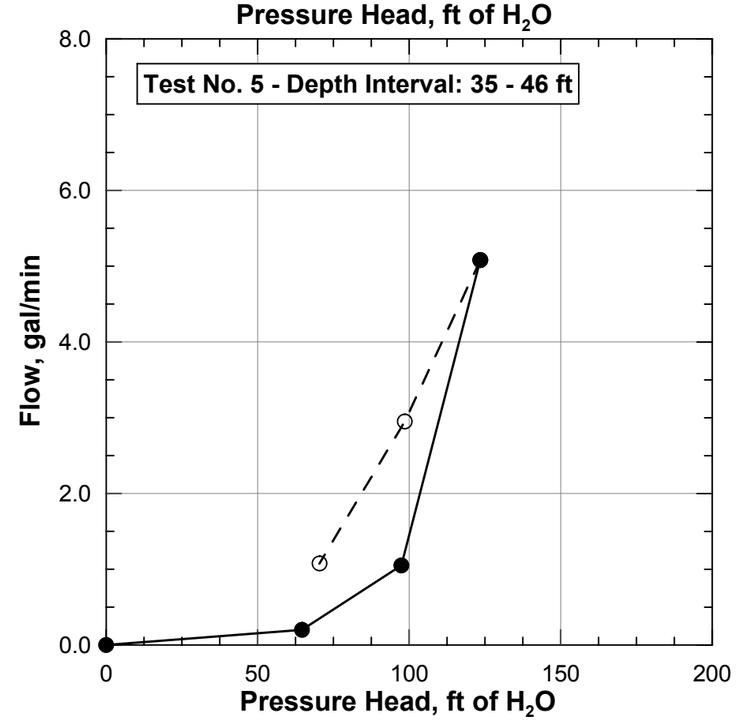

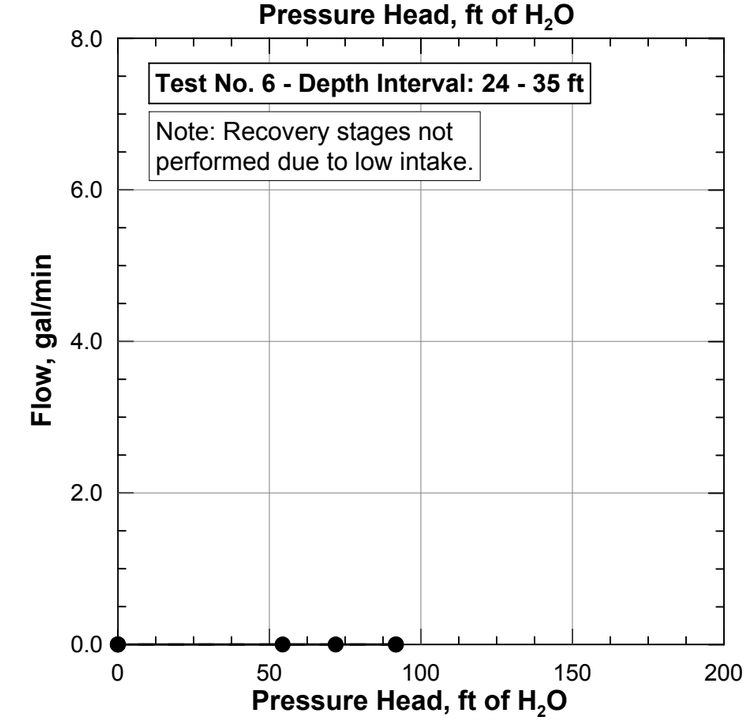

Ascending Pressure Curve
Recovery (Reducing Pressure) Curve

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTSB-R3-PZ-D

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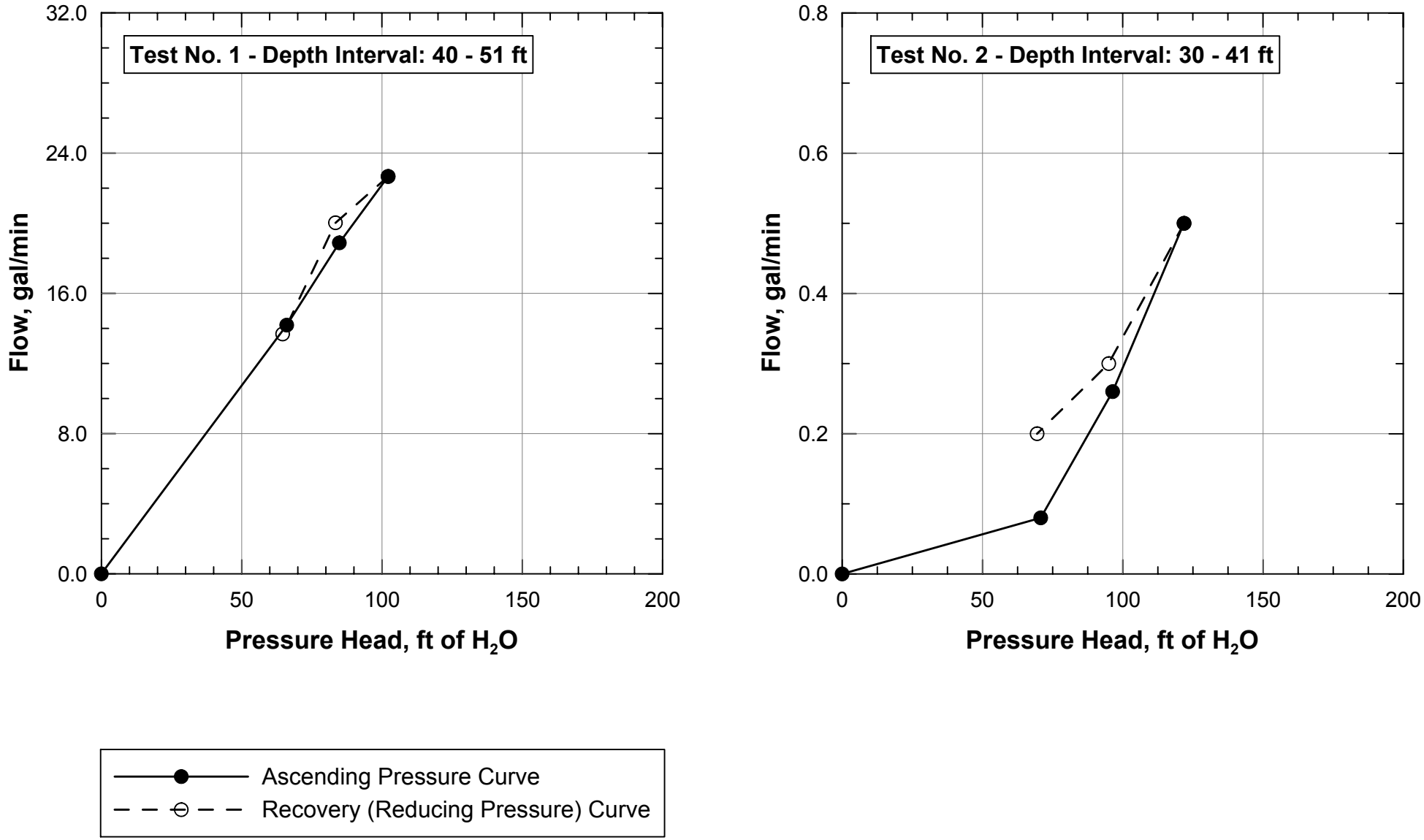
FIGURE D-5

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\BTSB-R3.grf



FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE RW6-R1-PZ

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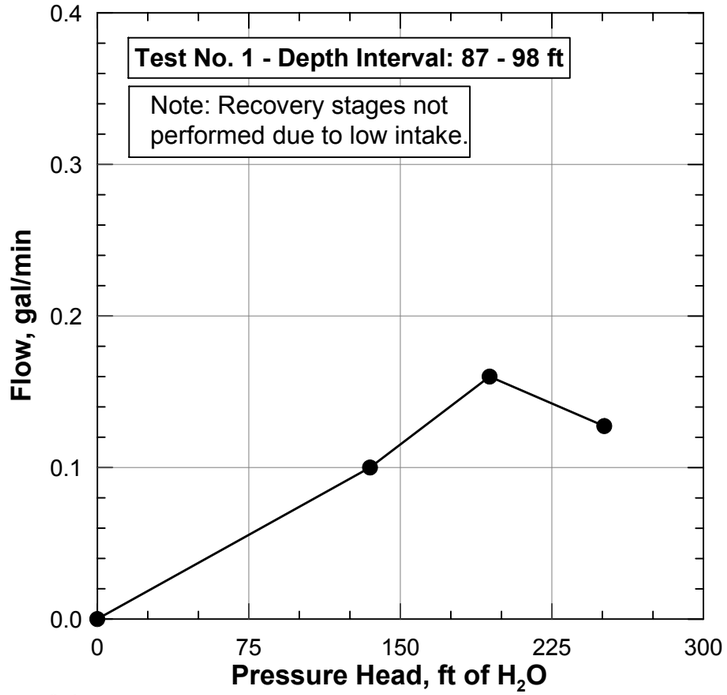
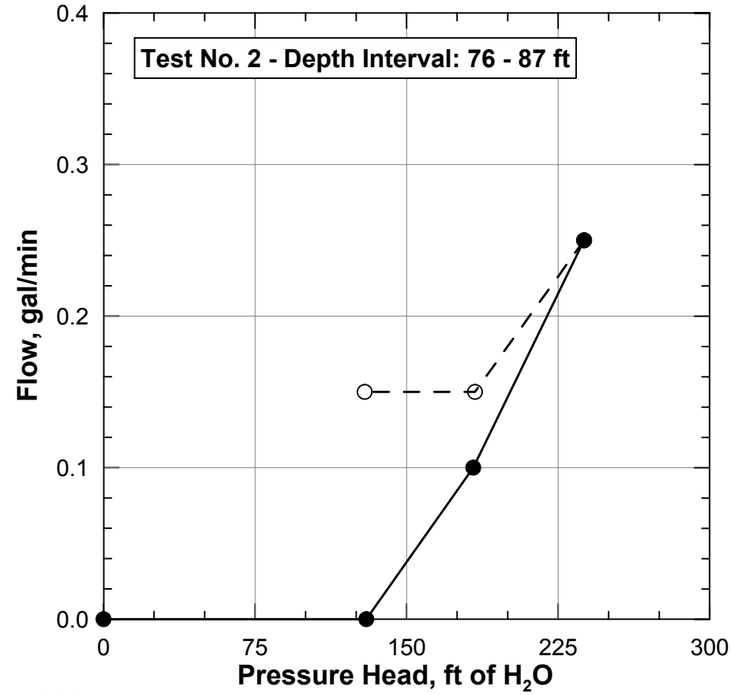
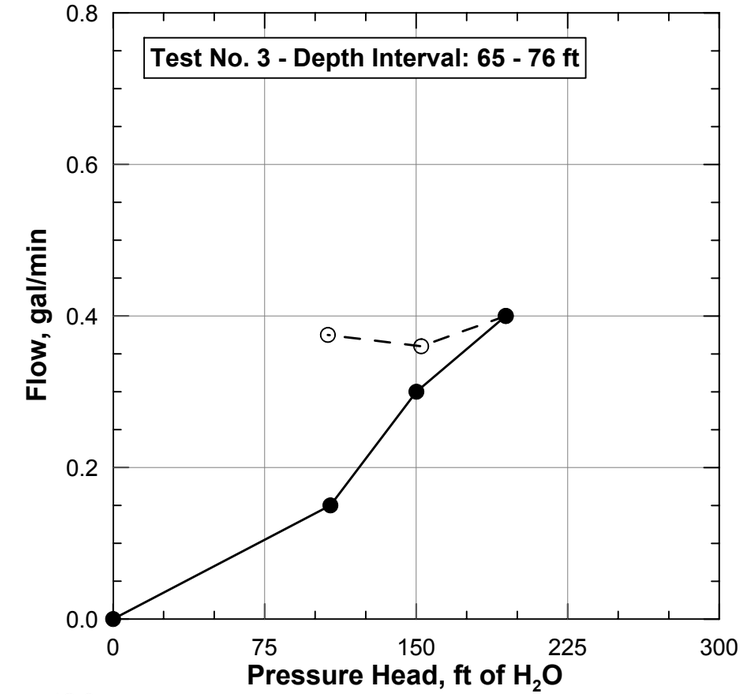
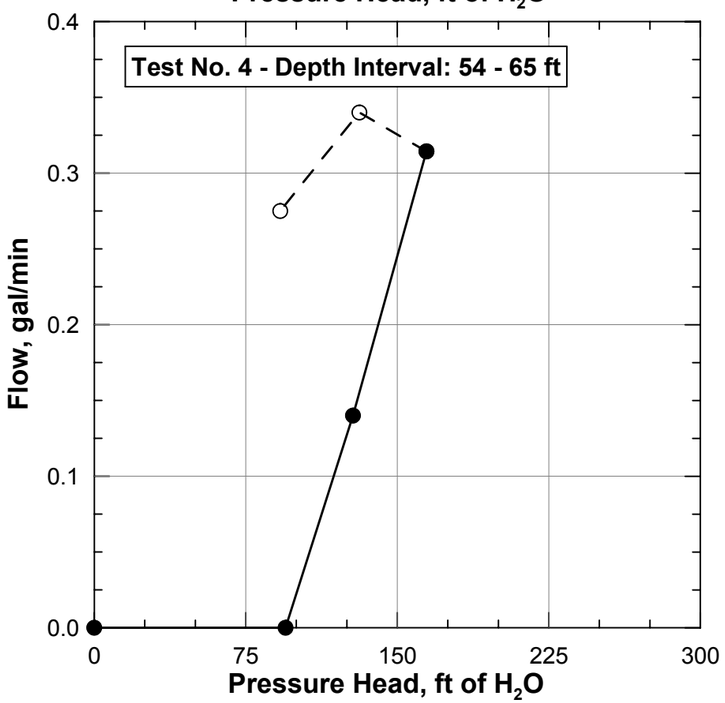
FIGURE D-6

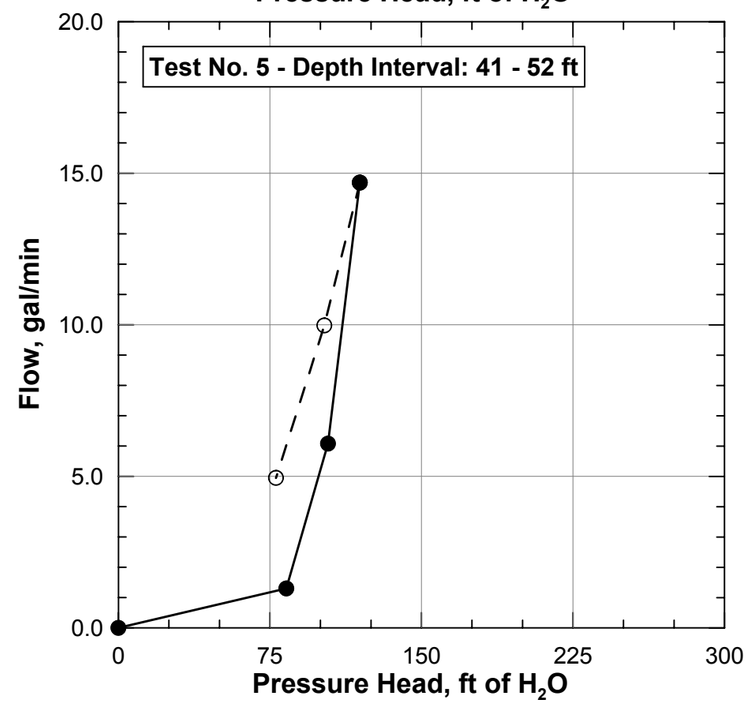
Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\RW6-R1.grf

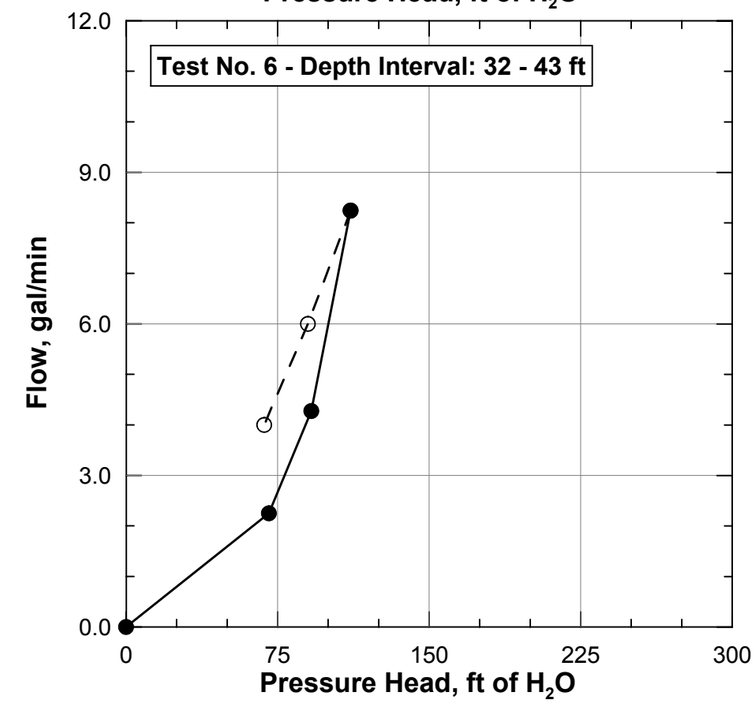












Ascending Pressure Curve

Recovery (Reducing Pressure) Curve

FLOW VERSUS PRESSURE CURVES: PACKER TESTS AT BOREHOLE RW6-R2-PZ-D

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FIGURE D-7

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\RW6-R2.grf

Appendix E

Caltrans Memorandum, Dated February 5, 2008, Doyle Drive Replacement Retaining Structures Preliminary Foundation Report

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. ABBAS TOURZANI
Senior Bridge Engineer
Office of Bridge Design-West
Division of Engineering Services

Date: February 05, 2008

Attention: Phil Lutz

File: 04-SF-101-KP 13.4/15.1
(PM 8.3/9.4)
04-163701
Doyle Drive Replacement
Retaining Structures
Structure # 34-0155L/R,
34-0162M, 34-0166 & Other
Retaining Walls

From: TUNG NGUYEN
Transportation Engineer
Office of Geotechnical Design – West
Geotechnical Services
Division of Engineering Services

WAJAHAT NYAZ
Chief, Branch C
Office of Geotechnical Design-West
Geotechnical Services
Division of Engineering Services

Subject: Preliminary Foundation Report (PFR) for Hook Under-Crossing (SB and NB) - Structure No. 34-0155L/R, Lincoln – Retaining Wall Structure 34-0162M, Girard Road Depressed – Retaining Wall Structure No. 34-0166 and Other Retaining Walls

PROJECT LOCATION

This Preliminary Foundation Report (PFR) addresses all of the retaining walls for the Doyle Drive Replacement project (Advance Planning Study (APS) Alternative 5). The report is based on the APS plans and the most recent project plans, dated January 19, 2008 provided by the Office of Structure Design. The control line stationing and some structure names and numbering have been revised in the most recent project plans. For clarity, this report addresses the proposed structure using both the new and old structure names and numbers where appropriate. The old structure names and numbers are in shown in parenthesis. The stations referenced in this report are based on the most recent project plans.

The project proposes to replace existing Doyle Drive from Marina Boulevard and Lombard Streets to the southern approach of the Golden Gate Bridge on State Route (SR) 101 from Post Mile (PM) 8.3 to PM 9.4 (or KP 13.4 to KP 15.1).

The Advance Planning Study (APS) plans prepared by consulting firm Parsons Brinckerhoff and the post recent project plans, dated January 19, 2008, show that Nineteen (19) new retaining walls (RW 1 to RW 19) are proposed in this project. RW 1 to RW 4, are located in the vicinity of the Presidio Parkway (SR 101/SR 1) Interchange. RW 9 to RW 19, are located in the proposed Tennessee Hollow and Girard Road depression area. RW 5 and RW 6 are located on the outside shoulders of northbound and southbound Doyle Drive (SR 101) immediately east of the proposed Battery Tunnel. RW 7 and Lincoln Retaining Wall (RW 8) – Structure No 34-0162M are located on the outside shoulders of northbound and southbound Doyle Drive (SR 101) between the Main Post and Battery Tunnels. Retaining wall RW 8 is the largest retaining wall in this project and it spans the entire distance between the Main Post and Battery Tunnels.

Retaining walls RW 11 to RW 19 are located at the proposed Girard Road Depressed Section and they are all part of a below ground reinforced concrete slab "boat" section structure. These retaining walls are part of one single structure that will consist of a depressed section and related on-off ramps. These walls are located at:

- Southbound Doyle Drive off-ramp to Girard Road
- Girard Road on-ramp to northbound Doyle Drive
- Girard Road
- Gorgas Road

In this report RW 11 to RW 19 will be treated together as Girard Road Depressed – Retaining Wall Structure No 34-0166. Similarly, portion of RW 1 and RW 2 are part of the northbound and southbound Hook Under-Crossings – Structures No 34-0155 L/R (PPI UC), which consists of a cast-in-place box structures. These walls will be treated as part of the northbound and southbound Hook Under-Crossing (PPI UC) structures.

Since the retaining walls plans have not been developed at this stage of the project design, we have estimated the retaining wall heights from the typical sections, roadway profile and project topographic map. These wall heights are not final and are meant only for the preliminary foundation recommendations. For retaining walls locations (layout), refer to the most recent project plans dated January 19, 2008.

SITE GEOLOGY AND SITE SUBSURFACE CONDITIONS

Site Geology

Shallow bedrock of the Franciscan Formation generally underlies the more elevated western areas of the project site. This Formation consists of heavily folded and sheared assemblage of Greywacke Shale Sandstone, Chert, and Serpentinite. The overburden soil consist of artificial fill, slope debris, ravine fill and/or the Colma Formation, which is an unconsolidated fine to medium-grained sand unit with clay beds. The lower elevations on the eastern side of the project site reflect an estuarine deposition environment where the bedrock is located at a significant depth. The surficial soil in the eastern side of the project site consists of dune and beach sands and soft clayey silt layers. These soils are generally underlain by Colma Formation, which overlies the Franciscan bedrock. The bedrock is exclusively serpentinite west of Station 90+00±, and Sandstone/Shale is found east of Stations 90+00±.

In the past, the project site consisted of an extensive tidal marsh separated from the Bay by a beach and dunes. The area that extends from the Crissy Field in a southerly direction towards Lombard Street and underlies Doyle Drive east of the Post Commissary Building was filled with hydraulic fill in 1912. The hydraulic fill consists of loose sands with variable amount of silt and clay. The specific subsurface conditions at each structure (retaining wall) location are discussed in the following section.

Site Specific Subsurface Conditions

The subsurface conditions described herein are based on the preliminary subsurface investigations performed for this project by Taber Consultants and review of pertinent available reports, and boring logs of projects performed at, or in the vicinity of, the project site. For simplicity, the soil/rock and groundwater conditions described in this report have been subdivided based on structure (retaining wall) locations and site geologic similarity.

Northbound and Southbound Hook Under-Crossings (PPI UC) - Retaining Walls RW 1 & RW 2 and Retaining Walls RW 3 & RW 4

The subsurface condition at these locations is characterized by the information obtained from nearby exploration borings No. 22, 29, and 30 conducted for the original Presidio

Road construction in 1933. These borings were drilled to the depths of 19 ft, 15 ft, and 15 ft, respectively. The boring locations map and boring logs are included in the Doyle Drive Preliminary Geotechnical Report (PGR).

The existing boring logs show that the site is underlain by a maximum of 10 ft of Quaternary clayey and sandy deposits, which are classified as slope debris and ravine fill. The slope debris and ravine fill are underlain by serpentine bedrock. Groundwater information at this location could not be determined from the available information.

Please note that the subsurface information in the above mentioned boring logs is limited. The boring logs lack quantitative and qualitative material descriptions and they have limited or no soil consistency, density, strength, and rock hardness information. These boring logs also lack groundwater information.

Retaining Walls RW 5 and RW 6

Borings No. 17 and 18 drilled for the Presidio Road construction in 1933 and boring GB-6 drilled, in January 2001, for this project are located in the vicinity of RW 5 and RW 6. Borings No. 17, 18, and GB-6 were drilled to depths of 26 ft, 15 ft, and 17 ft, respectively. The boring locations map and boring logs are included in the Doyle Drive Preliminary Geotechnical Report (PGR).

Borings No. 17 and 18 show that the site is underlain by 11 to 20 ft of surficial soils consisting of sandy loam, sandy, silty clay, and clay with fine to coarse sand and gravel. The clay materials are soft to very hard with low plasticity and unconfined compressive strength ranging from 3 ksf to 20 ksf. Published geologic map show that the dominant surficial soils at this location are dune sand in contact with Colma Formation. Dune sand are generally poorly sorted, well rounded, medium to coarse sand. Colma Formation is described as Pleistocene light brown to orange, fine to medium grained sand with minor clay material. Sandstone (bedrock) was encountered in the borings below the surficial soils. The sandstone encountered is generally very intensely weathered and fractured with Rock Quality Designation (RQD) of zero. Results of point load tests performed on samples from depths of 13 ft and 16 ft show that the uniaxial compressive strength of sandstone rock varies from 4.20 ksi to 5.35 ksi.

We anticipate that the cut for the RW 5 will be entirely in surficial soils and cut for the RW 6 may encounter weathered and fractured sandstone (rock) at lower elevations.

Groundwater condition was not described in Borings No. 17 and 18 and groundwater was not encountered in Boring GB-6. At this time, it is our assessment that groundwater will not be encountered in the cuts for RW 5 and RW 6.

Retaining Wall RW 7

The most relevant information for this wall can be obtained from the 1998 PC Exploration/Woodward-Clyde boring, B-1, drilled for a slope (storm damage) repair project (at PM 9.0). This boring was drilled on a slope, to the depth of about 37 ft, immediately north of the existing Doyle Drive (SR 101) and behind the proposed RW 7. The slope at this location failed and it was subsequently repaired.

The boring B-1 encountered loose sand, silty sand, sandy silt, and clayey sand to a depth of 7.2 ft. Below these deposits, are loose to medium dense sand and sandy clay/clayey sand that extend to a depth of 33.5 ft and overlay 2-ft thick very stiff gravelly clay. Under this layer to the maximum depth of exploration, is dark green to black, hard and highly sheared Serpentine. Results of consolidated undrained triaxial tests on samples taken at depths 10 ft and 16 ft show that sand deposits has an effective friction angle of 35 degree. The Standard Penetration Test (SPT) blow count (N) in this material ranges from 8 to 15. Since the slope has been repaired, the proposed cut for RW 7 will likely be in compacted fill and surficial soils described above and bedrock will not be encountered.

According to the PC Exploration/Woodward-Clyde Report, groundwater was encountered at the depth of 15 ft in boring B-1 at the time of drilling. However, the groundwater elevation was not shown in the boring log of B-1.

Lincoln Retaining Wall (RW 8)

Borings GB-5 and GB-4 and Cone Penetration Test (CPT) sounding CPT-8, performed during the preliminary investigation to a depth of 50 ft in January 2001, describe the material likely to be encountered at RW 8 location. Based on the borings and the CPT, the cut in the western portion of RW 8 is likely to encounter 0 to 12 ft of medium to very dense (N of 16 to 28) silty fine sand underlain by very dense (N > 50) clayey sand. The middle portion of the cut is likely to encounter very stiff clay with fine sand and very dense (N > 50) clayey fine sand. The grain size analyses showed that the percentage of fines (clay materials) in the sandy deposits is about 14 %. The cut in the eastern portion of RW 8 is likely to be in stiff to very stiff clay, silty clay, and sandy clay. The bedrock

was encountered in borings GB-5 at the depth of 59 ft (elevation 32 ft) and bedrock is not likely to be encountered in the proposed cut for retaining wall RW8.

Groundwater was encountered in GB-5 at elevation 64 ft in January of 2001. We anticipate that groundwater will be encountered in the western portion of the proposed wall cut. Groundwater was not measured in boring GB-4 and CPT-8 during the investigation. We also anticipate that a perched groundwater table develops at this site during the rainy season.

Girard Street Depressed Section (Location of Retaining Walls 9 to 19)

The Girard Street location has been studied extensively in the past. Many borings and CPT soundings have been performed and several monitoring wells have been installed at the site. However, most of the available information was generated for environmental and hydrogeology studies and it is of limited use for this study. We used a variety of existing information to characterize the subsurface and groundwater condition at the Girard Depressed Section site. The previous investigations used for site characterization include:

- The 1997 International Technology Corporation site investigation in the vicinity of Buildings 207 and 231 on the south sides of the Highway 101 ramps. Four CPT soundings 231-HP15, 231-HP16, 231-HP18, and 231-HP31, performed for the (1997) investigation were used in this study.

- The 2003 hydrological investigation by Taber Consultants for this (Doyle Drive) project. Two CPT soundings, CPT-3 and CPT-4, performed to the depths of 35 and 49 ft, respectively and 3 boring, HGB-1, HGB-2 and HGB-3, drilled to the depths of about 90 ft were used for this study. Borings HGB-1, HGB-2, and HGB-3 were converted to piezometers (monitoring wells) to monitor groundwater level at different depths. The historical groundwater monitoring data of these piezometers are not available.

- The 2007 MACTEC Correction Action Plan (CAP) investigations for Buildings 207/231 and 1065. This investigation was performed for the environmental remediation of Buildings 207/231 and 1065 sites. Numerous borings were drilled for this investigation. This CAP investigation reports included geologic cross-sections for a portion of the Girard Depressed Section site. Several of the borings were converted

to piezometers (monitoring wells) to monitor groundwater level at different depths. The historical groundwater monitoring data of these piezometers are included in the CAP reports.

Based on the results of the investigations mentioned above, the subsurface and groundwater condition at the Girard Depressed Section can be characterized as follows:

The Girard Depressed Section site consists of zero to 10 ft (maximum) thick artificial fill, which generally consists of loose (N of 7) silty sand, sandy silt, and very soft to soft sandy clay with gravel. The fill is underlain by a thin layer of very soft to soft (N of 0 to 4) dark gray clay with peat, silty clay, and clayey silt. The thickness of this layer varies considerable and ranges from 2 ft to 10 ft. These clayey deposits have low to medium plasticity index and undrained shear strength of 400 psf or higher. The soft clayey deposits are underlain by a 5 to 15 ft thick layer of loose to very dense (N of 7 to 65) silty/clayey fine sand with about 22% fines. The loose to dense silty/clayey fine sands are underlain by a layer of very soft to stiff silty clay (N of 0 to 16). All of these deposits mentioned above overlay medium to very dense silty and clayey sand with thickness up to 44 ft (N of 16 to refusal). These sandy deposits have 5 to 41% fines. Under the sand layer, to the maximum depth of exploration, is a layer of very stiff to hard (N of 16 to refusal) sandy clay, silty clay, and clay with sand and very dense silty sand. The clayey materials have medium to high plasticity index and undrained shear strength of 3800 psf or higher.

Groundwater was encountered in the borings at the depth of about 5 ft below the ground surface. The project final Hydrology Report and the 2007 CAP reports indicate that the site of the Girard Depressed Section has a shallow unconfined aquifer and deeper confined aquifer. The Hydrology Report states that the potentiometric head was found to be above the ground surface. However, this report does not provide the quantitative potentiometric head or include the groundwater monitoring data. The CAP Report (for the area of Building1065/1027) also show that the groundwater head in the lower aquifer is higher than the water level of the upper aquifer in the northeastern portion of the site and at some locations it is higher than the existing ground surface. At this time, we do not have quantitative information to determine the actual potentiometric head. The upper and lower aquifers are generally separated by an aquitard consisting 2 to 3 feet thick layer of stiff silty clay. The data obtained from the above referenced investigation indicate that the permeability of the deeper confined aquifer is low to medium.

SCOUR EVALUATION

Scour evaluation will be addressed in the final hydraulic report. This report is being prepared by consulting firm, Parsons Brinkhoff.

CORROSION EVALUATION

The site is anticipated to be corrosive due to its proximity to the San Francisco Bay and the past existence of a tidal marsh. Soil/rock and groundwater samples will be collected from this site during the geotechnical investigation and tested for corrosion potential. Sampling and testing of site soils and groundwater shall be in conformance with the Corrosion Guidelines for Foundation Investigations (Caltrans, 2003).

PRELIMINARY SEISMIC STUDY

Hossain Salimi of the Office of Geotechnical Design-West will provide preliminary seismic recommendations including preliminary liquefaction analysis for this project.

PRELIMINARY FOUNDATION RECOMMENDATIONS

Northbound and Southbound Hook Under-Crossing (PPI) - Retaining Walls RW 1 & 2

A portion of RW 1 and RW 2 will be the earth retaining sidewalls of the box structures that will serve as under-crossings and the remaining portions of these walls will be cantilever walls that will retain cut leading up to the under-crossings. The maximum retained height of these walls is anticipated to be ±14 ft. We recommend that the box structure and cantilever potions of retaining walls RW 1 and RW 2 be treated as separate and independent structures.

Box Structure

We do not anticipate settlement or bearing capacity issues at this location and therefore, shallow foundation will be adequate. The sidewalls of the box structure should be designed as restrained retaining structures using at-rest earth pressure. The preliminary loading and allowable bearing pressure for the box structure are provided in Table 1.

Table 1: Earth Pressure for the Northbound and Southbound PPI Box Structures

Equivalent At-Rest Earth Pressure (pcf)	Equivalent Passive Earth Pressure (pcf)	Seismic Earth Pressure (psf)	Allowable Bearing Pressure (psf)
55	442	19H	5000

H is the design height

The loading assumes that the drainage of box structure sidewalls (to relief hydrostatic pressure) will be provided. If drainage cannot be provided, assume a hydrostatic pressure for the 2/3 of the wall design height. Traffic loading should be added where appropriate.

Cantilever Walls

Since we do not anticipate settlement or bearing capacity issues at this location and the retaining wall heights are anticipated to be less than 14 ft, Standard Retaining Wall (Type I) on spread footing will be appropriate at this location. A joint should be provided between the cantilever walls and the box structure to accommodate relative movement.

Retaining Walls RW 3 & RW 4

Based on the available information, it is our assessment that retaining wall RW 3 will retain fill and cut and retaining wall RW 4 will retain only fill. RW 3 and RW 4 are generally medium to small size walls with maximum heights of ±12 ft and ±21 ft, respectively. Based on the site and subsurface conditions, it is our preliminary assessment that Standard Retaining Wall (Type I) on spread footing will be appropriate for these walls.

Retaining Walls RW 5 and RW 6

Retaining walls RW 5 and RW 6 are predominantly cut walls with maximum heights of 15 ft and 26 ft, respectively. These walls are located immediately west of the proposed cut-and-cover Battery Tunnel and will conform to the tunnel sidewalls. The cut portion of the walls should be constructed in conjunction with the tunnel. According to the APS, the temporary shoring system for the tunnel excavation will consist of soldier pile earth retaining system.

CIDH pile wall with tiebacks, secant/tangent pile wall, stressed anchor wall or conventional gravity retaining wall are possible alternatives for these walls. However, it is our understanding that the issue of temporary/permanent easement behind the wall is still unresolved. Availability of easement will play a big part on the selection of the retaining system at this location. Depending on the easement situation, we recommend three alternatives for these walls. The preliminary design parameters for these alternatives are listed in Table 2.

Option 1- permanent easement is available. In this scenario, we recommend a stresses anchor wall with whaler beams. We anticipate a maximum of two rows of anchors inclined at 10 to 15 degrees to the horizontal. These anchors will be about 50 ft (maximum) long. Requiring a permanent easement of at least 50 ft at all locations where the wall height exceeds 12 ft. We do not recommend soil-nail wall at this time because soil nails anchors will require drilling hole at 5 ft on-center (or less), both horizontally and vertically. Because of the sandy nature of the subsurface material, there is a high potential that the drilled holes will not stay open and casing will be required making installation of a large number of soil nails very time consuming and expensive. Caltrans do not have an approved self-drilled anchor system for permanent applications. We anticipate instability of the cut face during construction. Temporary measures such as installation of vertical nails (micropiles) will likely be needed to temporarily stabilize the cut face.

Alternatively, CIDH pile wall or Secant Pile wall with tie-backs can be used. Tiebacks will be needed at locations where the wall height exceeds 12 ft. The number of tiebacks rows and requirement for permanent easement will be the same as mentioned above.

Option 2- easement is not available – In this scenario, we recommend a tangent/secant pile wall. The tangent/secant pile wall will consist of 2 to 3 ft diameter overlapping or adjoining drilled piles with "I" beam in every (or every other) pile. At locations where the wall height exceeds 15 ft, large diameter (3 ft) CIDH piles with large size double "I" beams will be needed to provide the needed stiffness and to limit deflection to an acceptable level. Because of the sandy nature of the subsurface soils and presence of groundwater, the installation of CIDH piles is likely to be difficult. We anticipate that that this alternative will be significantly more expensive than other options discussed in this report.

Option 3 - only temporary easement is available. In this scenario, a temporary soil-nail can be constructed at a distance of 0.9 x H (where H is the wall design height) behind the proposed RW 6 face to make room for construction of a gravity retaining wall. Once the gravity retaining walls is constructed, the space between the temporary soil-nail wall and the permanent gravity retaining wall can be backfilled. The permanent gravity wall can be Standard Retaining Wall (Type 1) on spread footing.

To address the constructability concerns associated with temporary soil-nail installation mentioned above, we recommend using self-drilled anchor for the temporary soil-nail wall. The self-drilled anchors can be abandoned in place.

Even though the existing borings do not show presence of groundwater, it is our opinion that groundwater should be anticipated, at the lower elevation when the cut is made at this locations. The walls must be designed with a drainage system to prevent build-up of hydrostatic pressure behind the wall. Some dewatering may be needed, if conventional gravity wall option is used.

Please note that RW 5 and RW 6 are essentially extension of the proposed Battery Tunnel, and their construction operations are likely to be contagious with the tunnel. The design of these walls should be performed in coordination with the tunnel temporary shoring design. Using similar system for both walls and tunnel shoring is likely to be more economical.

Retaining Wall RW 7

Retaining wall RW 7 is a cut wall with maximum height of 36 ft. This wall is located immediately east of the proposed cut-and-cover Battery Tunnel (on the north side of proposed Doyle Drive) and like RW 5 and RW 6, it will conform to the tunnel sidewalls. The existing slope at this location has had instability (storm damage) in the past and a repair was performed at this location in 2000. The slope failure was entirely in the surficial soil above the bedrock. A back-analysis of the failed slope at this location was performed in 1998. The back-analysis indicated that the surficial material of this slope has an overall effective friction angle of 35 degrees and effective cohesion of zero.

The alternatives recommended for RW 5 and RW 6 are also applicable to RW 7 except that the Option 2 cannot be fully implemented. It is our preliminary opinion that it will not be possible to construct the secant/tangent pile wall without anchors for wall heights

in excess of 25 ft at this location and therefore, some temporary or permanent easement will be needed. We anticipate permanent easement of at least 50 ft or a temporary easement as discussed in RW 5 and RW 6 (Option 3) section. The preliminary design parameters for these alternatives are listed in Table 2.

Lincoln Retaining Wall (RW 8)

Lincoln Retaining Wall, RW 8, is a cut wall with maximum height of about 30 ft and a 10 ft high slope on top of the wall. The APS plans show that this wall is battered at an inclination of 4:1 (vertical to horizontal). RW 8 wall is located on south side of the proposed Doyle Drive and it spans the entire distance between the two cut-and-cover tunnels and it will conform to the tunnel sidewalls. We anticipate that this wall will be constructed in conjunction with the cut for the tunnels. A portion of the RW 8 will be located immediately (within a distance of few feet) in front of Building 106. It is our understanding that Building 106 will be under pinned.

CIDH pile wall with tie-backs, secant/tangent pile wall, stressed anchor wall or gravity conventional retaining wall are possible alternatives for this wall. However, it is our understanding that the issue of temporary/permanent easement behind the wall is still unresolved. Availability of easement will play a big part on the selection of the retaining system at this location. Depending on the easement situation, we recommend three alternatives for this wall. The preliminary design parameters for the design of these alternatives are listed in Table 2.

Option 1 - permanent easement is available. In this scenario, we recommend a stresses anchor wall with whaler beams. We anticipate a maximum of two rows of anchors inclined at 10 to 15 degrees to the horizontal. These anchors will be about 50 ft (maximum) long. Requiring a permanent easement of at least 50 ft at all locations where the wall height exceeds 12 ft. We do not recommend soil-nail wall at this time because soil nails anchors will require drilling a large number of holes (at 5 ft on-center or less), both horizontally and vertically. There is a high potential that the drilled hole will not stay open and casing will be required making installation of the anchors (nails) very time consuming and expensive. Caltrans do not have approved self-drilled anchor system for permanent applications. This option should be able to accommodate the proposed wall batter.

Alternatively, CIDH pile wall or tangent/secant pile wall with tie-backs can be used. Tiebacks will be needed at locations where the wall height exceeds 12 ft. The requirement for permanent easement should be the same as mentioned above. It will be very difficult to accommodate the proposed wall batter if CIDH pile wall or tangent/secant pile wall with tie-backs system is used. We anticipate that if any of these systems are selected, the wall batter will have to be eliminated.

Option 2 - easement is not available – It is our preliminary opinion that it will not be possible to construct this wall as planned without permanent and or temporary easement. Our analysis indicate that, for all practical purpose, secant/tangent pile wall system cannot be constructed without anchors for heights in excess of 25 ft and at locations around Building 106 where wall deflection has to be minimal. At these locations, the wall will require anchors and consequently permanent easement will be needed. Based on the APS plans, these locations are from Stations ±76+15 to ± 76+45 and ±65+70 to ±66+60.

At all other locations, secant/tangent pile retaining can be constructed. The tangent/secant pile wall will consist of 2 to 3 ft diameter overlapping or adjoining drilled piles with "I" beam in every (or every other) pile. At location where wall height exceeds 15 ft, large diameter (3 ft) CIDH piles with large size double "I" beams will be needed to provide the needed stiffness and to limit deflection to an acceptable level. It will be very difficult to batter the wall at 4:1 (vertical to horizontal) using this system. If this option is selected, the wall batter should be eliminated. Because of the sandy nature of the subsurface soils at some locations and presence of groundwater, the installation of the CIDH piles is likely to be difficult and casing may be needed. We anticipate that construction of secant/tangent pile retaining system is likely to be significantly more expensive than other options discussed in this report.

At location where anchors are needed, CIDH pile wall with tie-backs can be viable alternatives for this wall. The anchor spacing and easement requirement will be similar to Option 1 above. At this time, we do not recommend soil-nail wall or stressed anchor wall with a whaler.

Option 3 - only temporary easement is available. Again, the portion of proposed wall in the vicinity of Building 106 (±65+70 to ±66+60) cannot be constructed as planned without permanent easement. The rest of the wall can be constructed as described below.

Construct a temporary soil-nail at a distance of 0.9 x H (where H is the wall design height) behind the proposed RW 8 face to make room for construction of a gravity retaining wall. Once the gravity retaining walls is constructed, the space between the temporary soil-nail wall and the permanent gravity retaining wall can be backfilled. The permanent gravity wall can be modified form of Standard Retaining Wall (Type 1 or Type 3). This option should be able to accommodate the proposed wall batter.

To address the constructability concerns associated with soil-nail installation mentioned earlier, we recommend using self-drilled anchor for the temporary soil-nail wall. The self-drilled anchors can be abandoned in place.

It is not possible to construct the temporary wall between Stations ±65+70 and ±66+60 due to the proximity of Building 106. This section of RW 8 will require tiebacks anchors as described earlier.

At this time, we do not have the as-built foundation plans of Building 106 and the need and scope of the underpinning work cannot be estimated. The underpinning and impact of excavation on Building 106 will be evaluated in detail in the final Foundation Report.

Table 2: Preliminary Design Soil Parameters and Pressures for Retaining Walls RW 5 to RW 8

Wall #	Internal Friction Angle ϕ (degrees)	Internal Cohesion c (psf)	Unit Weight (pcf)	Seismic Pressure (psf)	Hydrostatic Pressure
5	35	0	125	19H	
6	35	0	125	19H	
7	32	0	125	19H	Below Elev. 33 ft
8	35	0	125	19H	Lower 1/3of design height

Where H is the design height

Girard Street Depressed Section (Retaining Walls 11 to 15 and 18 to 19)

The Girard Street Depressed Section will require cuts of up to ±22 ft in height. The sides of the proposed depression will be retained by a series of retaining walls and the bottom slab will be on pile foundation. Most of the Girard Depression area is underlain by a pressurized confined aquifer. The deepest portion of the proposed cut will extend into the pressurized confined aquifer. Effective dewatering, stabilization of the excavation bottom, and controlling settlement of the nearby structures/utilities due to dewatering are major concerns in the design and construction Girard Street Depressed Section. Furthermore, the site has high potential for liquefaction.

Based on the information available we recommend the following:

- Minimize the area (footprint) of the excavation. The plans call for a 122 ft (max) wide excavation of which approximately 50 ft will be backfilled with soil to create landscaped slope. We recommend that the excavation width be reduced to the amount needed to accommodate the roadway and the landscape is eliminated. The sidewalls can be stepped to allow for planting.

- Create a cut-off system (walls) to isolate the depressed area. The cut-off system must be watertight and it should extend deep into the confined aquifer to minimize the effect of dewatering (settlement) on the nearby structures. Alternatively, the cut off wall can be restricted to the shallow aquifer if a continuous aquitard can be constructed to isolate the confined aquifer.

- The cut off wall can be either temporary structure or part of the permanent structure. Please note that the cut-off system is temporary and the permanent section should be designed as a watertight section.

  Interlocking sheet piles, soil-cement mix columns and jet grout columns are possible options for the cut-off system. If the cut-off system will be a temporary structure and noise/vibration generated due to the sheet pile installation is not an issue, sheet pile option will be the most appropriate option. If the cut-off system is designed as a part of the permanent structure or there are noise restrictions to preclude pile driving, a soldier beam and soil-cement/jet grout column will be appropriate. At location where deflection of the cut-off system has to be controlled to minimize impact to the

adjacent structure(s), tie-back anchors may be necessary. For preliminary design purpose, we recommend the following:

- If the cut-off system is a temporary structure, create a cofferdam of interlocking sheet piles to isolate the excavation area. The water retaining capability of the sheet pile can be increased by using a sealant system. The tip of the sheet pile is estimated at elevation –52 ft.

- If the cut-off system is a part of the permanent structure, install a soldier beam and soil-cement/jet grout columns wall. For preliminary purpose, we recommend 27 inch primary grout piles with W24 I-beam insert at 4 ft on-center and grout in between the piles to form a water tight barrier. The pile grout tip should be at elevation –52 ft. The W24 I-beam need not extend to grout tip and can be terminated at elevation –35 ft. The construction of the cut-off wall should be the first order of work at this site.

The choice of the appropriate cut-off wall will depend on many factors and cost analysis and this issue will be discussed in detail at a later stage when the detailed subsurface investigation is completed.

- There is a high potential that the excavation bottom will blow out due to artesian pressure as the excavation progresses. Our calculations show that a blow-out should be anticipated due to the excavation of the overburden soils below elevation 1.65 ft. This blow-out will create unstable condition for slab and pile installation. To prevent the blow-out, create a 5 ft thick water tight grout certain (aquitard) at the top of the confined aquifer in the entire depressed area within the confines of the cutoff walls. The top elevation of the curtain (aquitard) should be at elevation +1 ft. The curtain should be created after the cut-off walls are installed but prior to any excavation at the site. The grout curtain by itself may not be sufficient to prevent blowout at all locations and additional measure may be needed. It is our opinion that in addition to measures recommended above, it will be necessary to install bleeder wells through the natural and artificial aquitards (to relief pressure) and dewatering the site. The spacing and diameter of the bleeder wells will depend on the permeability and water head in the deeper aquifer. Dewatering of the shallow aquifer should be performed prior to installation of bleeder wells.

The bottom slab must be designed to resist hydrostatic pressure from water head in excess 24 ft above the bottom of the slab. It is our opinion that tie-downs or pile foundation will be needed to prevent uplift of the bottom slab. Please note that bleeder wells are affective only as long as dewatering is ongoing. In the long-term, the bleeder wells will become ineffective. The piles should derive uplift resistance from soil below the liquefiable zone.

The site is underlain by loose sandy deposits that can liquefy during a seismic event. The anticipated zone of liquefiable soil is located between elevation –10 ft and – 20 ft. Refer to the Preliminary Seismic Report for more detailed discussion on liquefaction. We also anticipate poor soil/pile cap contact due to the artesian pressure. Based on the site conditions, the best option will be to install pipe piles at this location. If pipe piles are no feasible due to noise/vibration restrictions, CIDH pile can be used. However difficult CIDH pile installation should be anticipated due to the presence of pressurized aquifer, and loose sandy soil. Temporary and/or permanent casing will be needed and the piles have to be installed in wet condition with slurry head that can equalize the artesian water pressure. It is possible that permanent casing will be needed in the upper zone of the piles. Another option will be install soil-cement columns and insert H beams in lieu of CIDH piles. In this scenario, we recommend that uplift capacity be computed based only of H-pile section since it will be difficult to verify the soil-cement pile quality. Alternatively, a pile test can be performed to verify the uplift capacity.

The preliminary pile tension (uplift) will be derived from soil below elevation –23 ft. For preliminary purpose, assume unit soil friction along the pile shaft is shown in Table 3. The earth retaining sidewalls of the Girard Depressed Section should be designed using earth pressure loading provided in Table 3. The depressed section will likely be required a mechanical pump system to remove surface water.

Table 3: Preliminary Earth Pressure and Bearing Pressure for Girard Depressed Section Boat Section

Equivalent active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Loading (psf)	Pile Unit Friction Resistance (Tension) (psf)
80	250	19H	45H* (900 max)

** Triangular distribution from Elev. –23 ft to –43; Below Elev. –43 ft, use a constant value of 900 psf*

Retaining Walls RW 9, RW 10, RW 16 and RW 17

Retaining walls RW 9 and RW 10 are cut walls, retaining walls RW 16 and RW 17 are fill walls which will retain the approach fill to the Girard Road under-crossing. Based on our preliminary assessment, these walls can be standard retaining wall (Type 1) on pile foundation. Again, because of the anticipated noise vibration restrictions, the piles for these walls will have to be CIDH piles. The piles design criteria should be the same as that of the Girard Depressed Section, except that the ultimate pile vertical compression capacity should be twice the tension capacity stated in Table 3. Please note that the artesian conditions exist at these wall locations.

Construction Concerns

- Difficult CIDH installation should be anticipated. The anticipated difficulties have been addressed at each wall locations in the Recommendation Section of this report. Strict noise and vibration restriction are anticipated, this will likely preclude driven piles/sheet-piles at the site.

- Soil-mixing or grouting to construct the aquitard and/or cut-off walls can problematic under artesian pressure head that is above the ground surface. There is a possibility of continuous leakage of water at the grout/soil interface, which can result in voids due the migration of fines. To prevent this scenario, the head of the pressurized aquifer has to be reduced by at least 7 ft. A pumping test should be conducted (during the geotechnical investigation) to determine what how the artesian head can be reduce temporarily to facilitate the construction of the artificial aquitard and cut off walls. An additionally significant amount of water will likely be generated during the

pumping test and dewatering confined aquifer to lower the artesian head during construction. Proper estimate of the water to be removed is needed.

- Historical building that are located close to the proposed retaining walls (especially Building 106) and those building that are located in the vicinity of Girard Depressed Section will require monitoring. This will include establishment of baseline for measurement prior to construction and periodic monitoring during construction. Specific items can include video survey, monitoring (survey) of control points for vertical and horizontal deformations, and crack monitors.

- Because of the granular (sandy) nature of the material at some locations, we anticipate zones of instability in the cut face for retaining wall during construction. Vertical micropiles or similar system may be needed to temporarily stabilize the cut face.

- Soft and unstable sub-grade conditions will likely be encountered and may require stabilization to operate construction equipment.

- Regulation pertaining to cross contamination of the aquifers during drilling operation has to be considered when constructing CIDH piles. Use of casing to isolate zones within the drilled hole may be required. Control of groundwater flow due to the artesian pressure will also be required.

Additional Field Work and Laboratory Testing

Our Office in cooperation with ARUP developed a program of subsurface investigation including boring and CPT soundings. Our additional recommendations for this program are:

1. Extend boring RW7-A1 to the depth of 82.5 ft (25 m) or at least 10 ft into the good bedrock which ever is lesser.
2. Extend boring RW11-R1, RW18-A1 to 50 ft (15 m).
3. Extend boring RW14-R1, RW17-A1, and RW15-R1 to 100 ft (30 m).
4. Convert borings RW14-A1, RW17-A1, ENB-R1, and RW15-R1 into multistage piezometers to monitor groundwater levels of different aquifers.

At Girard depression area, the upper part of 35 ft shall be continuously sampling samples for laboratory testing including grain size analysis and plasticity index. Consolidation and

triaxial tests shall be conducted for retaining wall design. Moreover, pumping tests should also be conducted in this area to characterize hydrogeologic conditions for effective dewatering the site during construction of the Girard Depressed Section, cut and cover tunnels and bride footings.

The recommendations contained in this report are not final. A request for final recommendations should be made during final project design phase, and sent to the Office of Geotechnical Design – West. Final report can only be prepared after the general plans are furnished for each structure. Any questions regarding the above recommendations should be directed to the attention of Tung Nguyen, 510-622-1775 or Wajahat Nyaz, 510-622-1777 at the Office of Geotechnical Design-West, Branch C.

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