

Appendix E.1



Project No. T2881-22-02

October 14, 2019

REVISED June 5, 2024

Eric Hays
Albert A. Webb Associates
3788 McCray Street
Riverside, California 92506

Subject: GEOTECHNICAL PAVEMENT INVESTIGATION
 SUN LAKES BOULEVARD REALIGNMENT
 SOUTH HIGHLAND HOME ROAD TO SUNSET AVENUE
 BANNING, CALIFORNIA

Mr. Hays,

In accordance with the *Subconsultant Agreement*, dated August 29, 2019, between Albert A. Webb Associates and Geocon West, Inc. (Geocon), we have prepared this report of our geotechnical investigation for the Sun Lakes Boulevard realignment circulation element update project, located in the City of Banning, California. The approximate limits of the project are depicted on the attached *Vicinity Map* (Figure 1). This report presents a summary of the methods used to explore the subsurface geologic conditions, results of our laboratory testing, and geotechnical recommendations for design and construction of the proposed improvements. Based on the results of this study, it is our opinion that the site is suitable for the proposed roadway improvements, provided the recommendations of this report are followed.

Geocon should be afforded the opportunity to review the final project design and plans, and to revise this report and provide additional geotechnical recommendations as needed.

PROJECT UNDERSTANDING

We understand that Sun Lakes Boulevard will be realigned from South Highland Home Road to Sunset Avenue, along a section of road that currently exists as Westward Avenue, from Sun Lakes Boulevard's current planned S-curve alignment that extends from South Highland Home Road to West Lincoln Street. The City of Banning will update their General Plan Circulation Element to reflect the proposed alignment change. The site currently exists as a dirt roadway in most areas with a few utility substations along the south side of the road. Multiple utilities are located within and adjacent to the roadway. A locked gate was observed at the South Highland Home Road intersection with Sunset Avenue. Smith Creek crosses the western portion of the road near a utility substation and Montgomery Creek crosses the eastern portion of the road. Corrugated steel pipe culverts exist at the creek crossings and are buried in cemented riprap consisting of boulders and demolished construction debris. The creek crossings are paved over the culverts and riprap. Two white pipes were observed daylighting through the western and eastern hillsides on the south side of the road at the Smith Creek crossing.

Project plans were not available for our review at the time of our field investigation; project information provided in May 2024 indicates the proposed improvements will consist of a new conventional asphalt concrete paved roadway and new box culverts at three drainage crossings. Additional site improvements are expected to include concrete flatwork and storm water catch basins and piping. We expect site earthwork to consist of cuts and fills of up to 10 feet to meet finish grade elevations, with approximately 10 feet of fill placed over the proposed box culverts. The proposed roadway alignment will be immediately north of the dirt road extending through the site.

Based on project -specific topographic information, the elevation at the west end of the proposed roadway is approximately 2,499 feet and at the east end approximately 2,436 feet. Low elevations at the proposed culvert locations are approximately 2,451 feet at the I Line, 2,452 feet at the J Line, and 2,412 feet at the K Line. Site topography at the culvert locations is shown on Figures 2-1 and 2-2, Site Maps.

The recommendations presented herein are based on analysis of the data obtained during this investigation and our experience with similar soil and geologic conditions. If project details vary significantly from those described herein, Geocon should be contacted to determine the necessity for review and possible revision of this report.

SCOPE OF SERVICES

The general purpose of this investigation was to drill eight geotechnical borings to observe and document the subsurface geologic conditions, collect soil samples for laboratory testing, and provide geotechnical recommendations for construction of the proposed improvements. Our scope of services included the following:

- Marking the proposed boring locations and notifying Underground Service Alert (USA) to locate and mark utilities within the proposed investigation area.
- Acquiring an encroachment permit from the City of Banning.
- Drilling eight geotechnical borings to observe the subsurface geologic conditions, collect relatively undisturbed in-situ and disturbed bulk samples for laboratory testing.
- Performing laboratory testing of select soils samples which included maximum dry density and optimum moisture content, soil resistance value (R-value), grain size distribution, in-situ direct shear, and in-situ density and moisture content.
- Preparing this geotechnical pavement report presenting our findings, conclusions and recommendations as it pertains to the proposed improvements.

FIELD EXPLORATION AND LABORATORY TESTING

Our subsurface investigation was conducted on September 17, 2019 by drilling eight 8-inch diameter geotechnical borings utilizing a truck mounted CME-75 drilling machine. The borings were drilled to depths of 6½ and 26½ feet below the existing ground surface in areas of the planned improvements to observe the subsurface geologic conditions, and to collect relatively undisturbed in-situ and disturbed bulk samples for laboratory testing. The approximate locations of the exploratory borings are depicted on the *Geologic Map* (Figure 2).

Laboratory tests were performed on selected soil samples obtained during the investigation in accordance with current, generally accepted test methods of ASTM International (ASTM). We analyzed selected soil samples for maximum dry density and optimum moisture content, soil resistance value (R-value), grain size distribution, in-situ direct shear, and in-situ density and moisture content. The results of the laboratory tests are presented on Figures B-1 through B-8 in Appendix B.

GEOLOGIC SETTING

The project site is located in the San Gorgonio Pass at the northern margin of the Peninsular Ranges Geomorphic Province. The Peninsular Ranges are bounded on the north by the Transverse Ranges (San Gabriel and San Bernardino Mountains) and on the east by the San Andreas fault. The Peninsular Ranges Province extends southward into Mexico and westward past the Channel Islands. Geologic units within the Peninsular Ranges consist of granitic and metamorphic bedrock highlands and deep and broad alluvial valleys.

Locally, the site lies within the valley between the San Jacinto and San Bernardino Mountains, west of the San Gorgonio River. Active drainages such as Smith Creek and Montgomery Creek flow southeast from the north, through the site, before merging along the base of the San Jacinto Mountains, and continuing east to join the San Gorgonio River. This broad valley is filled with older alluvial fan materials consisting of sand, gravel and granitic detritus shed from the San Jacinto Mountains dissected by active stream channels with sand and gravel deposits.

GEOLOGIC MATERIALS

Geologic units encountered during our investigation include undocumented fill (afu), Holocene-age alluvium (Qa), and Pleistocene-age Alluvial fan of the San Gorgonio Pass (Qf) deposits. The descriptions of the soil and geologic conditions are shown on the boring logs located in Appendix A and described below in order of increasing age. Geologic nomenclature of this report follows that of Dibblee (2003).

Undocumented Fill (afu)

Undocumented fill was encountered within borings B-7 and B-8 below the surface and asphalt concrete pavement to depths of approximately 5 feet. This unit generally consists of locally derived silty sand and poorly-graded sand with silt that is loose to medium dense, dry to moist, and yellowish brown and olive brown. Rusty metal debris were encountered within B-8 at approximately 4½ of depth.

Alluvium (Qa)

Alluvium was encountered at the surface and below the undocumented fill, near and within the active channel areas where borings B-2 and B-7 were drilled. The alluvium was encountered to depths of approximately 15 feet below the ground surface. The soils consist of silty sand, poorly-graded sand, and poorly-graded sand with silt that is loose to dense, damp to moist, and brown with hues of red, yellow, and olive.

Alluvial Fan of the San Gorgonio Pass (Qf)

Alluvial fan deposits were encountered at the ground surface in the areas of higher elevation outside, and below the alluvium and undocumented fill to the maximum depths explored within the borings. This unit consists of clayey sand, silty sand, poorly-graded sand, poorly-graded sand with silt, well-graded sand, and to a lesser extent sandy clay that is loose to very dense or stiff, dry to wet, and yellowish to reddish brown.

GROUNDWATER

Groundwater was not encountered during this investigation. Historic well data acquired from the California Department of Water Resources Water Data Library indicates the shallowest groundwater levels were measured at depths ranging between 243 and 271 feet below the ground surface within observation wells in the immediate vicinity of the site. During the wet weather season, localized perched water conditions may develop above less permeable units that may require special consideration during grading operations. Groundwater elevations and seepage are dependent on seasonal precipitation, irrigation, and land use, among other factors, and vary as a result.

SCOUR EVALUATION

Foundations should be properly protected against the potential scour or extended below the zone affected by scour. We obtained samples at various depths and performed grain size distribution analysis on the samples to provide information for a future scour analysis. The particle size at which 30, 50, and 90 percent is passing (D_{30} , D_{50} , D_{90}) is presented in Table 1 below. Geocon should be contacted for additional parameters if needed.

TABLE 1
SOIL GRAIN SIZE DISTRIBUTION D_{50} TEST RESULTS

Sample ID (Boring Number & Sample Depth)	D_{90} (mm)	D_{50} (mm)	D_{30} (mm)
B-2 @ 7.5'	1.2	0.14	
B-2 @ 15'	0.95	0.76	0.34
B-7 @ 10'	1.3	0.31	0.18
B-7 @ 20'	2.1	0.17	0.092

SEISMIC EVALUATION

Ground Motion Evaluation

The design response spectrum for the Safety Evaluation Earthquake (SEE), as specified in Caltrans *Seismic Design Criteria* with October 2019 interim revisions (v2.0), is the probabilistic response spectrum representing the horizontal ground motion at the site with a 5% probability of exceedance in 50 years (return period of 975 years). The United States Geological Survey (USGS) *2014 National Seismic Hazard Map* is used as the basis to determine the design Acceleration Response Spectrum (ARS). The ARS for the site was estimated using Caltrans' *ARS Online* web tool (V3.1.0, accessed May 29, 2024). Table 2 summarizes the site-specific information used for the analysis and the *ARS Online* results.

TABLE 2
ARS ONLINE SUMMARY

Approx. Latitude, °	Approx. Longitude, °	Estimated Shear Wave Velocity (V_{S30}) ¹ , feet/second	Design Peak Ground Acceleration (PGA) ² , g	Deaggregated Mean Earthquake Moment Magnitude (M)	Mean Site-to-Source Distance (R) ³ , miles	Site Soils Class ⁴
33.9179	-116.9197	656	0.69	6.84	7.3	S2
Notes: - Estimated time-average shear wave velocity for the upper 100 feet of soil at the site. - Where "g" represents the acceleration due to gravity. - Mean site-to-source distance for 1.0 second period spectral acceleration. - Based on the subsurface soil conditions encountered within the foundation's zone of influence and Caltrans <i>Seismic Design Criteria</i> Sections 6.1 and 6.2.3						

The culverts are not located within a deep sedimentary basin per Caltrans *ARS Online*. Based on the subsurface materials encountered during our investigation, the site is generally underlain by loose to very dense relatively clean to silty/clayey sand and stiff sandy clay alluvial soils, which most closely reflects a Caltrans Soil Profile Type D. The shear wave velocity, V_{s30} , was calculated from the average shear wave velocity of the four deeper borings along the project alignment using the shear wave correlations provided in Caltrans' *Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations*.

The recommended design response spectrum is presented as Figure 4 (Recommended Design Response Spectrum).

Fault Rupture

The site is not located within an Alquist-Priolo Earthquake Fault Zone as established by the State Geologist around known active faults or within a Riverside County Fault Hazard Zone. Local field reconnaissance revealed no indications of an active fault trace at the site. Review of available literature indicates there are no active fault traces within 1,000 feet of the project location. The USGS Quaternary Fault and Fold Database maps the nearest active ("Historical" and "Latest Quaternary") fault as the San Geronio Pass Fault Zone located over 1 mile miles northeast of the project location. Given the above, no fault rupture hazard analysis is required for this project per Caltrans' *Memo to Designers 20-10, Fault Rupture*.

Embankment Slope Stability

Assuming that new fill slopes and embankments are designed and properly constructed in accordance with Caltrans guidelines, typical slope inclinations 2:1 (horizontal:vertical) or flatter, and with appropriate slope protection installed, global slope instability should not be a hazard for new embankments on the project.

CONCLUSIONS AND RECOMMENDATIONS

We did not encounter soil or geologic conditions that would preclude the construction of the proposed improvements, provided the recommendations presented herein are followed and implemented during construction.

New Pavements – Conventional Pavement

The final pavement design should be based on R-value testing of soils at the subgrade following grading at the site. Paved areas at the site should be designed in accordance with the City of Banning *Street Standards* when final Traffic Indices and R-Value test results of subgrade soil are completed. Roadway classifications and traffic indices are based on the County of Riverside *Ordinance 461*. The civil engineer should evaluate the final traffic indices for the pavements and determine their applicability to the site. Based on laboratory testing, we used an R-value of 25 for the preliminary pavement design recommendations. Preliminary flexible pavement sections are presented in Table 3 based on the County of Riverside *Ordinance 461* and the Caltrans *Highway Design Manual*.

TABLE 3
PRELIMINARY FLEXIBLE PAVEMENT SECTIONS

Road Classification/Use	Traffic Index	Subgrade R-Value	Asphalt Concrete (Inches)	Aggregate Base Materials (Inches)
Local Street	5.5	25	4	7
Enhanced Local Street	6.5		4	9
Collector	7.0		5	10
Industrial Collector	8.0		6	11
Secondary Highway	8.5		6	12

The upper 12 inches of the subgrade soil should be compacted to a dry density of at least 95 percent of the laboratory maximum dry density at 0 to 2 percent above optimum moisture content.

The aggregate base materials and asphalt concrete materials should conform to Section 200-2.2 and Section 203-6, respectively, of the Greenbook. Base materials should be compacted to a dry density of at least 95 percent of the laboratory maximum dry density near to slightly above optimum moisture content. Asphalt concrete should be compacted to a density of 95 percent of the laboratory Hveem density in accordance with ASTM D 2726.

A rigid Portland cement concrete (PCC) pavement section should be placed in driveway aprons and cross gutters. We calculated the rigid pavement section in general conformance with the procedure recommended by the American Concrete Institute report ACI 330R *Guide for Design and Construction of Concrete Parking Lots* using the parameters presented in Table 4.

TABLE 4
RIGID PAVEMENT DESIGN PARAMETERS

Design Parameter	Design Value
Modulus of subgrade reaction, k	120 pci
Modulus of rupture for concrete, M_R	500 psi
Traffic Category, TC	B, C, and D
Average daily truck traffic, ADTT	25, 300, and 700

Based on the criteria presented herein, the PCC pavement sections should have a minimum thickness as presented in Table 5.

TABLE 5
RIGID PAVEMENT RECOMMENDATIONS

Location	Portland Cement Concrete (inches)
Light Truck Traffic (TC = C)	6.0
Entrance / Driveway Aprons; Moderate Truck Traffic (TC = C)	7.5
Entrance / Driveway Aprons; Heavy Truck Traffic (TC = D)	8.0

The PCC pavement should be placed over subgrade soil that is compacted to a dry density of at least 95 percent of the laboratory maximum dry density at 0 to 2 percent above optimum moisture. This pavement section is based on a minimum concrete compressive strength of approximately 3,000 psi (pounds per square inch). Base material will not be required beneath concrete improvements.

A thickened edge or integral curb should be constructed on the outside of concrete slabs subjected to wheel loads. The thickened edge should be 1.2 times the slab thickness or a minimum thickness of 2 inches, whichever results in a thicker edge, and taper back to the recommended slab thickness 4 feet behind the face of the slab (e.g., a 9-inch-thick slab would have an 11-inch-thick edge). Reinforcing steel will not be necessary within the concrete for geotechnical purposes except for dowels at construction joints as discussed herein.

In order to control the location and spread of concrete shrinkage cracks, crack-control joints (weakened plane joints) should be included in the design of the concrete pavement slab in accordance with the referenced ACI report.

Performance of the pavements is highly dependent on providing positive surface drainage away from the edge of the pavement. Ponding of water on or adjacent to the pavement surfaces will likely result in pavement distress and subgrade failure. Drainage from landscaped areas should be directed to controlled drainage structures. Landscape areas adjacent to the edge of asphalt pavements are not recommended due to the potential for surface or irrigation water to infiltrate the underlying permeable aggregate base and cause distress. Where such a condition cannot be avoided, consideration should be given to incorporating measures that will significantly reduce the potential for subsurface water migration into the aggregate base. If planter islands are planned, the perimeter curb should extend at least 6 inches below the level of the base materials.

Earthwork

Earthwork for the proposed improvements should be performed in accordance with Caltrans guidelines, the grading ordinances of the City of Banning, and the recommended grading specifications attached.

Prior to commencing earthwork, a preconstruction conference should be held at the site with the City inspector, City engineer, earthwork contractor, civil engineer, and geotechnical engineer in attendance. Special soil handling and/or the improvement plans can be discussed at that time.

Site preparation should begin with the removal of deleterious material, debris and vegetation. The depth of removal should be such that material exposed in cut areas or soil to be used as fill is relatively free of organic matter. Material generated during stripping and/or site demolition should be exported from the site.

For grading of new roadways in areas outside of the creek channels, the previously placed undocumented fill (where encountered) and upper portion of alluvial fan material should be removed to expose competent alluvial fan material. Removals within creek channels is addressed in the section titled "Foundation Recommendations for Culverts." Areas of loose, dry, or compressible soils, if encountered, will require deeper excavation and processing prior to fill placement. Removals should extend at least 3 feet below subgrade and into competent alluvial soils. The engineering geologist should evaluate the actual depth of removal during grading operations. The bottom of excavations should be proof-rolled with heavy equipment to observe yielding of the excavation bottom. The firm, unyielding bottom of the over excavation should then scarified to a depth of at least 1 foot, moisture conditioned at 0 to 2 percent above optimum moisture content, and compacted to 90 percent of the maximum dry density as determined by ASTM D1557.

The site should be brought to finish grade elevations with fill compacted in layers. Layers of fill should be no thicker than will allow for adequate bonding and compaction. Fill, including backfill and scarified ground surfaces, should be compacted to a dry density of at least 90 percent of the laboratory maximum dry density, at 0 to 2 percent above optimum moisture content, as determined by ASTM D1557. The upper 12 inches of subgrade in areas of vehicular traffic should be compacted to a dry density of at least 95 percent of the laboratory maximum dry density, at 0 to 2 percent above optimum moisture content, as determined by ASTM D1557. Fill materials placed below the recommended moisture content may require additional moisture conditioning prior to placing additional fill.

If perched groundwater, wet, or saturated materials are encountered, extensive drying and mixing with dryer soil will be required. The excavated materials should then be moisture conditioned as necessary to the recommended optimum moisture content prior to placement as compacted fill.

Where relatively loose, soft, or wet soils are encountered in the site excavations, subgrade stabilization may be required prior to placing fill or installing utilities. Where required, subgrade stabilization can be achieved by over excavating the loose or soft materials and replacing with compacted fill, placing 3-inch diameter rock in the soft bottom and working it into soil until it is stabilized, use of aggregate base fill with geogrid interlayers, or placing gravel wrapped in filter fabric at the bottom of the excavation. Recommendations for stabilizing excavation bottoms should be based on an evaluation in the field by Geocon at the time of construction.

If needed, import fill should consist of granular materials with “low” expansion potential (EI of 50 or less), should not be corrosive, generally free of deleterious material and rock fragments larger than 6 inches, and should be compacted as recommended herein. Geocon should be notified of the import soil source and should perform laboratory testing of import soil prior to its arrival at the site to evaluate its suitability as fill material.

Utility Trench Backfill

Utility trenches should be properly backfilled in accordance with the requirements of the City of Banning and the latest edition of the *Standard Specifications for Public Works Construction* (Greenbook). The pipes should be bedded with well-graded crushed rock or clean sand (Sand Equivalent greater than 30) to a depth of at least one foot over the pipe. The use of well-graded crushed rock is only acceptable if used in conjunction with filter fabric to prevent the gravel from having direct contact with soil. The remainder of the trench backfill may be derived from onsite soil or approved import soil. Backfill of utility trenches should not contain rocks greater than 3 inches in diameter. The use of 2-sack slurry and controlled low strength material (CLSM) are also acceptable as backfill. However, consideration should be given to the possibility of differential settlement where the slurry ends and earthen backfill begins. These transitions should be minimized, and additional stabilization should be considered at these transitions.

Trench excavation bottoms must be observed and approved in writing by the Geotechnical Engineer, prior to placing bedding materials, fill, gravel, or concrete.

Utility trench backfill should be placed in layers no thicker than will allow for adequate bonding and compaction. Utility backfill should be compacted to a dry density of at least 90 percent of the laboratory maximum dry density and moisture conditioned at 0 to 2 percent above optimum moisture content as determined by ASTM D 1557. Backfill at the finish subgrade elevation of new pavements should be compacted to at least 95 percent of the maximum dry density. Backfill materials placed below the recommended moisture content may require additional moisture conditioning prior to placing additional fill.

FOUNDATION RECOMMENDATIONS FOR CULVERTS

The following foundation recommendations for culverts are based on the encountered subsurface conditions and our experience with similar projects/structures in similar geotechnical and geological conditions.

The proposed structures are expected to consist of cast-in-place (CIP) reinforced concrete box (RCB) culverts with structure details and loading conditions per Caltrans *2023 Standard Plan D81*. Box culvert details are provided in Table 6. Box culvert alignments are shown in Figures 2-2 and 2-3, Site Map.

TABLE 6
BOX CULVERT INFORMATION

Culvert ID	Culvert Type	Culvert Location (Sun Lakes Blvd Stationing)	Culvert Length, ft	Culvert Normal Width, ft	Culvert Bottom Average Elevation, ft
I Line	7 cell, 10' high by 14' span, CIP RCB	69+60.23	140.1	104.3	2,448.8
J Line	6 cell, 10' high by 14' span, CIP RCB	66+12.83	269.0	89.6	2,451.3
K Line	7 cell, 10' high by 14' span, CIP RCB	97+90.11	119.6	104.3	2,409.6

Some remedial grading in the form of removal and re-compaction below the culvert bottoms should be anticipated to achieve competent and consistent bearing conditions. Previously placed undocumented fill (where encountered) and upper portion of alluvium material should be removed to expose competent alluvium. We anticipate that such remedial grading below the culverts would be on the order of at least 5 feet, and extend laterally 5 feet beyond the foundation footprint, or for a lateral distance equal to the depth of removal, whichever is greater. The engineering geologist will evaluate the limits of remedial grading in the field during grading operations.

Foundation excavations should be observed by the engineering geologist prior to the placement of reinforcing steel and concrete to verify that the excavations and exposed soil conditions are consistent with those anticipated.

Special subgrade presaturation is not deemed necessary prior to placing concrete; however, the exposed foundation subgrade soil should be moisturized to maintain a moist condition prior to placement of concrete.

Our analysis indicates that the soil conditions are suitable to support the proposed box culverts using the provided *Standard Plan* bearing pressures for a 10-foot earth cover with estimated total settlements ranging from approximately ½ inch to 2 inches. Table 7 summarizes the estimated total settlement for each box culvert structure.

TABLE 7
ESTIMATED BOX CULVERT TOTAL SETTLEMENT

Culvert ID	Culvert Type	Estimated Total Settlement, in.
I Line	7 cell, 10' high by 14' span, CIP RCB	1/2 inch
J Line	6 cell, 10' high by 14' span, CIP RCB	2/3 inch
K Line	7 cell, 10' high by 14' span, CIP RCB	2 1/4 inches

Differential settlement is generally assumed to be approximately ½ the estimated total settlement. Given the generally granular soil conditions, settlement should be generally realized during the construction period. A one-week waiting period should be observed after final fill placement prior to pavement construction.

Headwalls

This section provides geotechnical recommendations for proposed headwalls up to 24 feet in height. Associated ramp walls that are proposed at Culverts J (southeast headwall) and I (southwest headwall) are governed in design by their respective headwalls.

Retaining walls not restrained at the top and having a level backfill surface should be designed for an active soil pressure equivalent to the pressure exerted by a fluid density of 30 pounds per cubic foot (pcf). Where the backfill will be inclined at no steeper than 2:1 (horizontal to vertical), an active soil pressure of 50 pcf is recommended. These soil pressures assume that the backfill materials within an area bounded by the wall and a 1:1 plane extending upward from the base of the wall possess an EI of 50 or less. For walls where backfill materials do not conform to the criteria herein, Geocon should be consulted for additional recommendations.

Unrestrained walls are those that are allowed to rotate more than 0.001H (where H equals the height of the retaining portion of the wall in feet) at the top of the wall. Where walls are restrained from movement at the top, the walls should be designed for a soil pressure equivalent to the pressure exerted by a fluid density of 50 pcf.

Unrestrained walls will move laterally when backfilled and loading is applied. The amount of lateral deflection is dependent on the wall height, the type of soil used for backfill, and loads acting on the wall. The retaining walls and improvements above the retaining walls should be designed to incorporate an appropriate amount of lateral deflection as determined by the structural engineer.

Retaining walls should be provided with a drainage system adequate to prevent the buildup of hydrostatic forces and waterproofed as required by the project architect. The soil immediately adjacent to the backfilled retaining wall should be composed of free draining material completely wrapped in Mirafi 140N (or equivalent) filter fabric for a lateral distance of 1 foot for the bottom two-thirds of the height of the retaining wall. The upper one-third should be backfilled with less permeable compacted fill to reduce water infiltration. Alternatively, a drainage panel, such as a Miradrain 6000 or equivalent, can be placed along the back of the wall. The use of drainage openings through the base of the wall (weep holes) is not recommended where the seepage could be a nuisance or otherwise adversely affect the property adjacent to the base of the wall. The recommendations herein assume a properly compacted backfill (EI of 50 or less) with no hydrostatic forces or imposed surcharge load. If conditions different than those described are expected or if specific drainage details are desired, Geocon should be contacted for additional recommendations.

We understand the CIP RCB culverts will have headwalls per Caltrans *2023 Standard Plan B3-1A*. Table 8 summarizes the proposed headwall details.

TABLE 8
SUMMARY OF PROPOSED HEADWALLS

Structure	Wall Type	Foundation Type	Bottom of Footing Elevation (feet)	Length (feet)	Maximum Design Height (feet)
I Line NE	Type 1	Spread Footing	2,448.8	23	16
I Line NW				29	16
I Line SE				32	16
I Line SW				33	16
J Line NE			2,451.3	54	16
J Line NW				59	16
J Line SE				18	16
J Line SW				56	16
K Line NE			2,409.6	83	20
K Line NW				45	20
K Line SE				24	24
K Line SW				22	24
Notes: Type 1 = Retaining Wall Type 1 (Case 1), Caltrans 2023 Standard Plan Sheet B3-1A					

Tables 9 through 12 summarize the Service, Strength, and Extreme Limit State analysis results for the headwall structures.

TABLE 9
SERVICE LIMIT STATE FOUNDATION DATA

Structure	Design Height (feet)	Bottom of Footing Elevation (feet)	Footing Width (feet)	Minimum Footing Embedment Depth (feet)	Effective Footing Width for Service Limit State (feet)	Service Limit State Net Bearing Stress (ksf)	Calculated Settlement at Net Bearing Pressure (inches)	Total Permissible Settlement (inches)
I Line NE	16	2,448.8	9.75	3.2	7.1	0.7	< 0.25	1.0
I Line NW								
I Line SE								
I Line SW								
J Line NE		2,451.3				1.0		
J Line NW								
J Line SE								
J Line SW								
K Line NE	20	2,409.6	11.67	3.3	8.4	2.2	0.3	
K Line NW								
K Line SE	24		13.75	3.7	9.7	2.9	0.4	
K Line SW								

Note: 1) Calculated Net Uniform Bearing Stresses are negative due to overburden soil removed given the existing ground surface elevation, proposed bottom of footing elevations, and the design net bearing stresses provided in the project plans.

TABLE 10
STRENGTH LIMIT STATE FOUNDATION DATA

Structure	Design Height (feet)	Bottom of Footing Elevation (feet)	Footing Width (feet)	Minimum Footing Embedment Depth (feet)	Effective Footing Width for Strength Ia Limit State (feet)	Strength Limit State Gross Uniform Bearing Stress (ksf)	Strength Limit State Factored Bearing Resistance (ksf) $\phi_b (q_n)$ $\phi_b = 0.45$	
I Line NE	16	2,448.8	9.75	3.2	3.5	5.2	16.4	
I Line NW								
I Line SE								
I Line SW								
J Line NE		2,451.3					7.1	
J Line NW								
J Line SE								
J Line SW								
K Line NE	20	2,409.6	11.67	3.3	4.4	5.8		9.2
K Line NW								
K Line SE	24		13.75	3.7	5.2	7.0		10.8
K Line SW								10.9

TABLE 11
EXTREME LIMIT STATE FOUNDATION DATA

Structure	Design Height (feet)	Bottom of Footing Elevation (feet)	Footing Width (feet)	Minimum Footing Embedment Depth (feet)	Effective Footing Width for Extreme I Limit State (feet)	Extreme I Limit State Gross Uniform Bearing Stress (ksf)	Extreme I Limit State Factored Bearing Resistance (ksf) ϕ_b (q_n) $\phi_b = 1.0$	Effective Footing Width for Extreme II Limit State (feet)	Extreme II Limit State Gross Uniform Bearing Stress (ksf)	Extreme II Limit State Factored Bearing Resistance (ksf) ϕ_b (q_n) $\phi_b = 0.8$
I Line NE	16	2,448.8	9.75	3.2	4.8	5.6	44.2	7.2	3.8	55.0
I Line NW							42.9			54.9
I Line SE										
I Line SW										
J Line NE		2,451.3					18.3			22.8
J Line NW							18.9			23.0
J Line SE										
J Line SW							18.3			22.8
K Line NE	20	2,409.6	11.67	3.3	5.6	6.8	23.0	9.8	4.0	32.3
K Line NW			13.75							31.9
K Line SE	24		13.75	3.7	6.3	8.7	26.5	12.4	4.5	37.7
K Line SW										37.6

TABLE 12
SPREAD FOOTING DATA

Structure	Design Height (feet)	Service Limit State Permissible Net Contact Stress (ksf)	Strength Factored Gross Nominal Bearing Resistance for Controlling Load Case $\phi_b = 0.45$ (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance for Controlling Load Case $\phi_b = 0.8$ (ksf)
I Line NE	16	20.4	16.4	44.2
I Line NW		18.3		42.9
I Line SE		17.4		
I Line SW		17.1		
J Line NE		12.9	7.1	18.3
J Line NW		14.6		18.9
J Line SE		12.9		18.3
J Line SW				
K Line NE	20	6.6	9.2	23.0
K Line NW				
K Line SE	24	7.4	10.8	26.5
K Line SW		7.5	10.9	

Based on the results of our analyses and assuming that wall foundations are founded in compacted engineered fill founded on undisturbed native soils as recommended in this report, the spread footing details shown in the project plans are considered appropriate for the support of the proposed headwalls.

Miscellaneous Structures

Within the creek channel areas, foundations for structures such as landscape or retaining walls may be supported on conventional foundations following remedial grading and bearing on a minimum of 4 feet of newly placed engineered fill that extend laterally 4 feet beyond the foundation footprint, or for a lateral distance equal to the depth of removal, whichever is greater. For separate structures outside of creek channel areas, the foundations should bear on a minimum of 2 feet of newly placed engineered fill that extend laterally 2 feet beyond the foundation footprint, or for a lateral distance equal to the depth of removal, whichever is greater. Where excavation and compaction cannot be performed or is undesirable, such as adjacent to utilities or property lines, foundations may derive support in the undisturbed alluvium or alluvial fan material found at or below a depth of 5 feet and 3 feet, respectively, and should be deepened as necessary to maintain a minimum 12-inch embedment into undisturbed alluvium or alluvial fan material. Foundation excavations must be observed and approved by a Geocon representative.

Miscellaneous foundations deriving support in newly placed engineered fill may be designed for a bearing value of 2,500 pounds per square foot (psf) and should be a minimum of 18 inches in width, a minimum of 12 inches in depth below the lowest adjacent grade, and a minimum of 12 inches into the recommended bearing material. The allowable bearing pressure may be increased by up to one-third for transient loads due to wind or seismic forces. Steel reinforcement for the spread footings should be designed by the project structural engineer.

Lateral Design

Resistance to lateral loading may be provided by friction acting at the base of foundations, slabs and by passive earth pressure. A passive pressure exerted by an equivalent fluid weight of 300 pcf with a maximum earth pressure of 3,000 psf should be used for the design of footings or shear keys poured neat against newly compacted fill. The allowable passive pressure assumes a horizontal surface extending at least 5 feet, or three times the surface generating the passive pressure, whichever is greater. The upper 12 inches of material in areas not protected by floor slabs or pavement should not be included in design for passive resistance.

If friction is to be used to resist lateral loads, an allowable coefficient of friction between newly compacted fill soil and concrete of 0.35 should be used for design. When combining passive pressure and friction for lateral resistance, the passive component should be reduced by one-third.

Concrete Flatwork

Exterior concrete flatwork not subject to vehicular traffic should be constructed in accordance with the recommendations herein assuming the subgrade materials possess an Expansion Index of 50 or less. Subgrade soils should be compacted to 90 percent relative compaction at a moisture content 0 to 2 percent above optimum as determined by ASTM D1557. Slab panels should be a minimum of 4 inches thick and when in excess of 8 feet square should be reinforced with No. 3 reinforcing bars spaced 24 inches on in both directions to reduce the potential for cracking. In addition, concrete flatwork should be provided with crack control joints to reduce and/or control shrinkage cracking. Crack control spacing should be determined by the project structural engineer based upon the slab thickness and intended usage. Criteria of the American Concrete Institute (ACI) should be taken into consideration when establishing crack control spacing. Subgrade soil for exterior slabs not subjected to vehicle loads should be compacted in accordance with criteria presented in the earthwork section prior to concrete placement. Subgrade soil should be properly compacted and the moisture content of subgrade soil should be verified prior to placing concrete. Base materials will not be required below concrete improvements.

Even with the incorporation of the recommendations of this report, the exterior concrete flatwork has a potential to experience some uplift due to expansive soil beneath grade or differential settlement.

The steel reinforcement should overlap continuously in flatwork to reduce the potential for vertical offsets within flatwork.

The recommendations presented herein are intended to reduce the potential for cracking of exterior slabs as a result of differential movement. However, even with the incorporation of the recommendations presented herein, concrete slabs will still crack. The occurrence of concrete shrinkage cracks is independent of the soil supporting characteristics. Their occurrence may be reduced and/or controlled by limiting the slump of the concrete, the use of crack control joints and proper concrete placement and curing. Crack control joints should be spaced at intervals no greater than 12 feet. Literature provided by the Portland Concrete Association (PCA) and American Concrete Institute (ACI) present recommendations for proper concrete mix, construction, and curing practices, and should be incorporated into project construction.

Temporary Excavations

The recommendations included herein are provided for stable excavations. It is the responsibility of the contractor to provide a safe excavation during the construction of the proposed project.

Temporary excavations should be made in conformance with OSHA requirements and as directed by the assigned competent person in the field (contractor). In general, special shoring requirements may not be necessary if temporary excavations will be less than 4 feet in height. Temporary excavations greater than 4 feet in height, however, should be sloped back at an appropriate inclination based on the material type, and as determined by the contractor during construction. These excavations should not be allowed to become saturated or to dry out. Surcharge loads should not be permitted to a distance equal to the height of the excavation from the top of the excavation. The top of the excavation should be a minimum of 15 feet from the edge of existing improvements. Excavations steeper than those recommended or closer than 15 feet from an existing surface improvement should be shored in accordance with applicable OSHA codes and regulations.

Where there is insufficient space for sloped excavations, shoring or trench shields should be used to support excavations. Shoring may also be necessary where sloped excavation could remove vertical or lateral support of existing improvements, including existing utilities and adjacent structures.

Where sloped embankments are utilized, the top of the slope should be barricaded to prevent vehicles and storage loads at the top of the slope within a horizontal distance equal to the height of the slope. If the temporary construction embankments are to be maintained during the rainy season, berms are suggested along the tops of the slopes where necessary to prevent runoff water from entering the excavation and eroding the slope faces. The contractor's competent person should inspect the soils exposed in the cut slopes during excavation in accordance with OSHA regulations so that modifications of the slopes can be made if variations in the soil conditions occur.

Site Drainage and Moisture Protection

Proper site drainage is critical to reduce the potential for differential soil movement, erosion and subsurface seepage. The site should be graded and maintained such that surface drainage is directed away from structures in accordance with 2016 CBC 1804.4 and the Caltrans *Highway Design Manual*. In addition, surface drainage should be directed away from the top of slopes into swales or other controlled drainage devices.

Underground utilities should be leak free. Utility and irrigation lines should be checked periodically for leaks, and detected leaks should be repaired promptly. Detrimental soil movement could occur if water is allowed to infiltrate the soil for prolonged periods of time.

Landscaping planters adjacent to paved areas have the potential for surface or irrigation water to infiltrate the pavement's subgrade and base course. Where landscaping is planned adjacent to the pavement, we recommend construction of a cutoff wall along the edge of the pavement that extends at least 6 inches below the bottom of the base material.

If not properly constructed, there is a potential for distress to improvements and properties located hydrologically down gradient or adjacent to infiltration areas. Factors such as the amount of water to be detained, its residence time, and soil permeability have an important effect on seepage transmission and the potential adverse impacts that may occur if the storm water management features are not properly designed and constructed. We have not performed a hydrogeology study at the site. Down-gradient and adjacent structures may be subjected to seeps, movement of foundations and slabs, or other impacts as a result of water infiltration.

Plan Review

Geocon should be afforded the opportunity review the improvement plans for the project prior to final submittal, to verify that the plans have been prepared in substantial conformance with the recommendations of this report. Additional analyses may be required after review of the project plans.

Should you have any questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Very truly yours,

GEOCON WEST, INC.


Andrew Shoashekan
PE 93940




Ronald E. Loutzenhiser
GE 2865




Lisa A. Battiato
CEG 2316



ATS:LAB:REL:hd

Attachments: LIMITATIONS AND UNIFORMITY OF CONDITIONS
LIST OF REFERENCES

FIGURES

- Figure 1, Vicinity Map
- Figures 2-1 through 2-3, Site Map
- Figure 3, Geologic Map
- Figure 4, Recommended Design Response Spectrum

APPENDIX A

Figures A-1 through A-8, Logs of Borings

APPENDIX B

- Figures B-1 & B-2, Modified Compaction Test of Soils
- Figures B-3 & B-4, Direct Shear Test
- Figures B-5 through B-8, Grain Size Distribution

APPENDIX C

Recommended Grading Specifications

Distribution: Addressee (Email)

LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Geocon West, Inc. should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous or corrosive materials was not part of the scope of services provided by Geocon West, Inc.

This report is issued with the understanding that it is the responsibility of the owner, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the engineer and contractor for the project and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

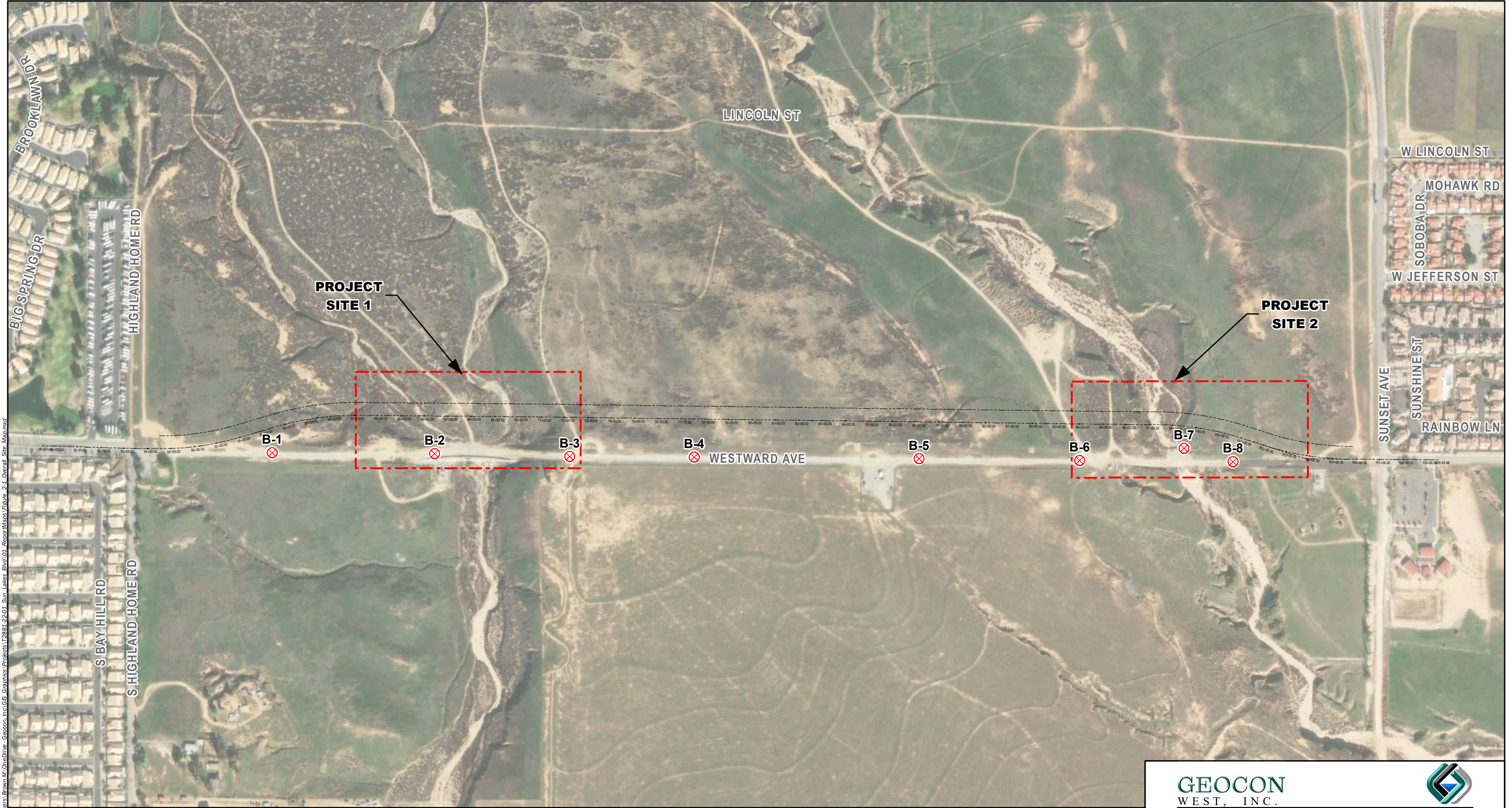
The findings of this report are valid as of the date of this report. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.

The firm that performed the geotechnical investigation for the project should be retained to provide testing and observation services during construction to provide continuity of geotechnical interpretation and to check that the recommendations presented for geotechnical aspects of site development are incorporated during site grading, construction of improvements, and excavation of foundations. If another geotechnical firm is selected to perform the testing and observation services during construction operations, that firm should prepare a letter indicating their intent to assume the responsibilities of project geotechnical engineer of record. A copy of the letter should be provided to the regulatory agency for their records. In addition, that firm should provide revised recommendations concerning the geotechnical aspects of the proposed development, or a written acknowledgement of their concurrence with the recommendations presented in our report. They should also perform additional analyses deemed necessary to assume the role of Geotechnical Engineer of Record.

REFERENCES

1. Albert A. Webb Associates, 2024, *Sun Lakes Boulevard Extension*, WO 2020-0126, dated May 29.
2. American Concrete Institute, 2008, Report 330R-08, *Guide for the Design and Construction of Concrete Parking Lots*, undated.
3. California Department of Transportation, Geotechnical Services Design Manual, latest versions of the individual modules.
4. California Department of Transportation, 2023, Standard Specifications, undated.
5. California Department of Transportation (Caltrans), 2023, *Standard Plan B3-1A and D81*.
6. California Department of Transportation (Caltrans), 2020, *Highway Design Manual*.
7. California Department of Transportation, 2017, Foundation Reports for ERS, month of February.
8. California Department of Transportation, ARS Online (Version 3.1.0), accessed May 29, 2024.
9. Dibblee, Thomas W. Jr., 2003, *Geologic Map of the Beaumont 7.5' Quadrangle, Riverside County, California*, Dibblee Foundation Report DF-114.
10. Dokken Engineering, 2024, *Storm Drain Improvement*, WO 2020-0126, dated March 11.
11. Public Works Standards, Inc., 2015, *"Greenbook" Standard Specifications for Public Works Construction*, Published by BNI Building News.



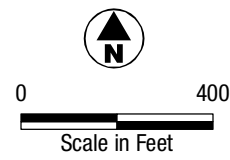


GEOCON 6/21/2024 USER Brown M PATH C:\Users\Brown M\OneDrive - Geocon, Inc\GIS Graphics\Projects\T2881-22-02\Sun Lakes Blvd 02 Report Maps\Figure 2-1 Overall Site Map.mxd

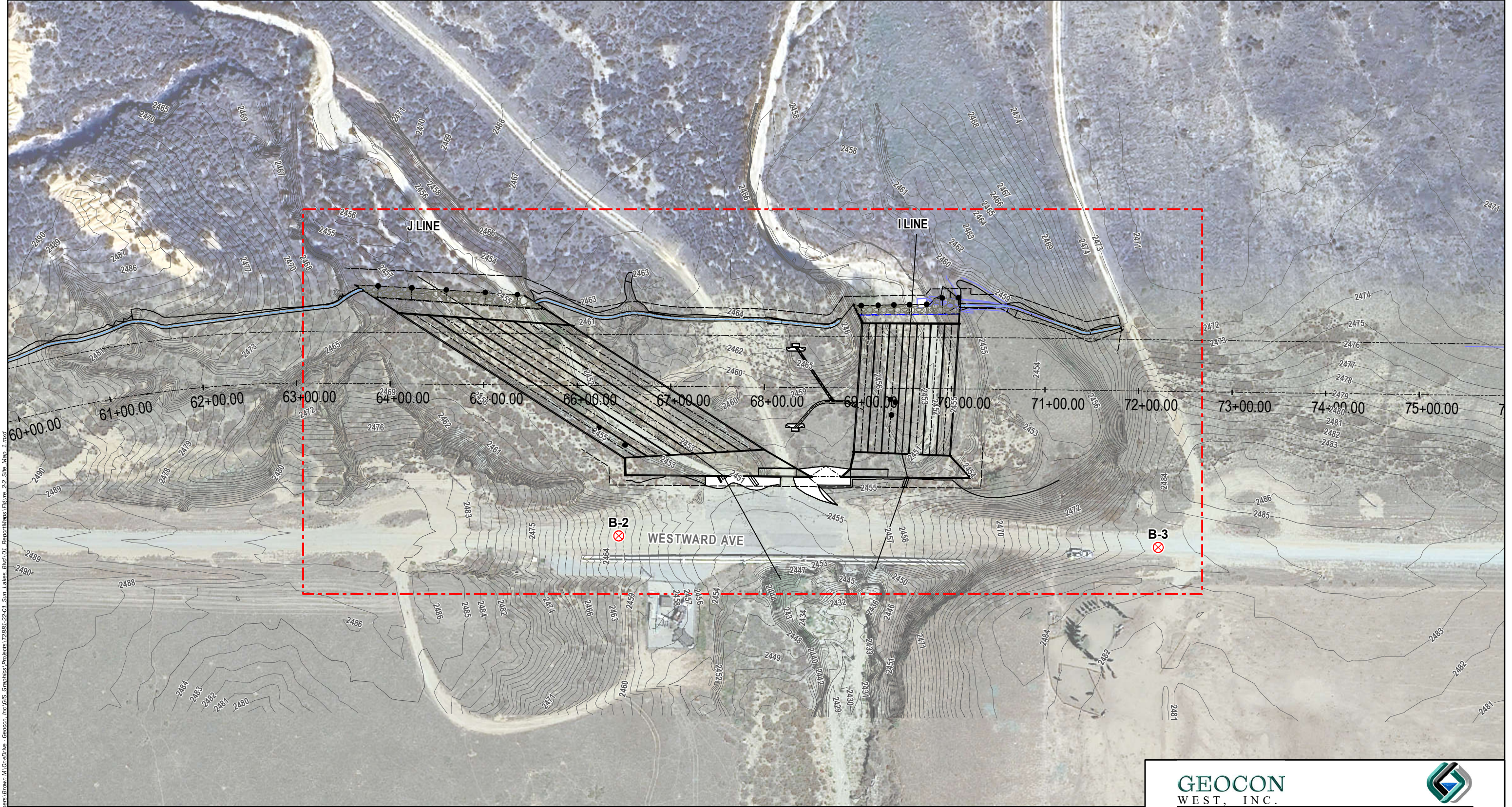
Legend

B-8 Approximate Boring Location

Approximate Site Boundary

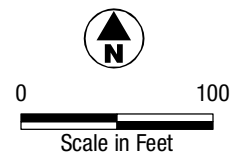


 GEOCON WEST, INC. GEOTECHNICAL ENVIRONMENTAL MATERIALS 4157 CORNING PLACE - SUITE 101 - MURRIETA, CA 92562 PHONE 951.304.2300 - FAX 651.304.2392		
Sun Lakes Boulevard Realignment		
South Highland Home Road to Sunset Avenue Banning, California		
OVERALL SITE MAP		
T2881-22-02	JUNE 2024	Figure 2-1



GEOCON 6/29/2024 USER Brown M PATH C:\Users\Brown M\OneDrive - Geocon, Inc\GIS Graphics\Projects\T2881-22-02\Sun Lakes Blvd 01 Report\Draws\Figure 2-2 Site Map 1.mxd

- Legend**
- B-3 Approximate Boring Location
 - 1-Foot Elevation Contours
 - Approximate Site Boundary



GEOCON
WEST, INC.

GEOTECHNICAL ENVIRONMNETAL MATERIALS
4157 CORNING PLACE - SUITE 101 - MURRIETA, CA 92562
PHONE 951.304.2300 - FAX 651.304.2392

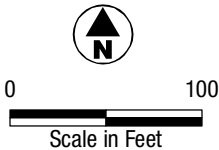


Sun Lakes Boulevard Realignment		
South Highland Home Road to Sunset Avenue Banning, California		
SITE MAP - AREA 1		
T2881-22-02	JUNE 2024	Figure 2-2

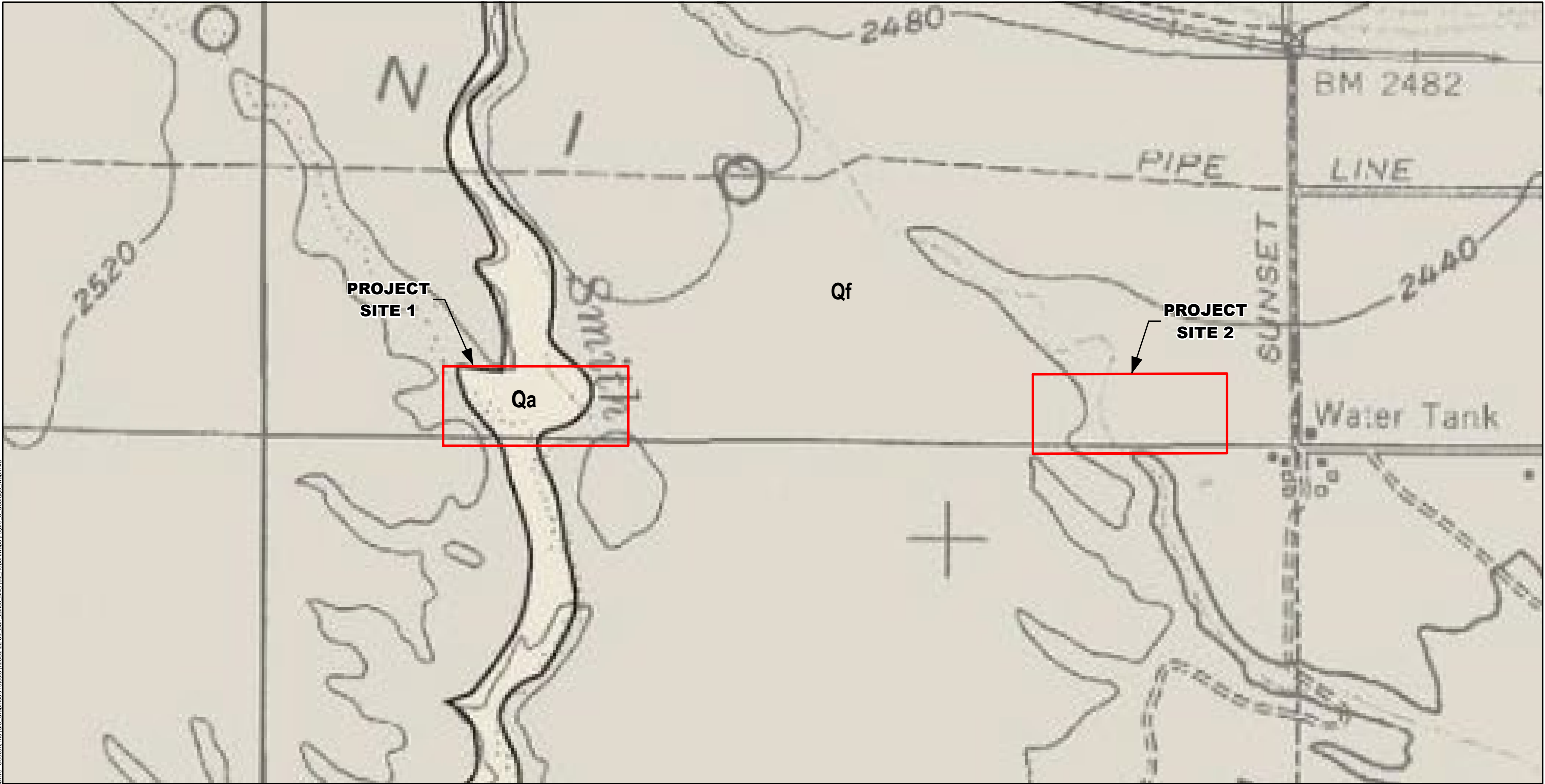


GEOCON 6/29/2024 USER Brown M PATH C:\Users\Brown M\OneDrive - Geocon, Inc\GIS Graphics\Projects\T2881-22-02\Sun Lakes Blvd 01 Report\Drawings\Figure 2-3 Site Map 2.mxd

- Legend**
-  B-8 Approximate Boring Location
 -  1-Foot Elevation Contours
 -  Approximate Site Boundary

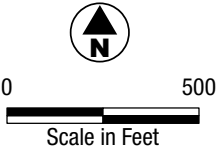


GEOCON WEST, INC. GEOTECHNICAL ENVIRONMENTAL MATERIALS 4157 CORNING PLACE - SUITE 101 - MURRIETA, CA 92562 PHONE 951.304.2300 - FAX 651.304.2392		
Sun Lakes Boulevard Realignment		
South Highland Home Road to Sunset Avenue Banning, California		
SITE MAP - AREA 2		
T2881-22-02	JUNE 2024	Figure 2-3



Geologic Map of the Barumont Quadrangle, Riverside County, California; Thomas W. Dibblee, Jr. and John A. Minch; 2003

- Unit Explanntion**
- Qa** Surficial Sediments
 - Qf** Alluvial fan San Gorgonio Pass



GEOCON
WEST, INC.

GEOTECHNICAL ENVIRONMNETAL MATERIALS
4157 CORNING PLACE - SUITE 101 - MURRIETA, CA 92562
PHONE 951.304.2300 - FAX 651.304.2392

Sun Lakes Boulevard Realignment

South Highland Home Road to Sunset Avenue
Banning, California

GEOLOGIC MAP

T2881-22-01

May 2024

Figure 3

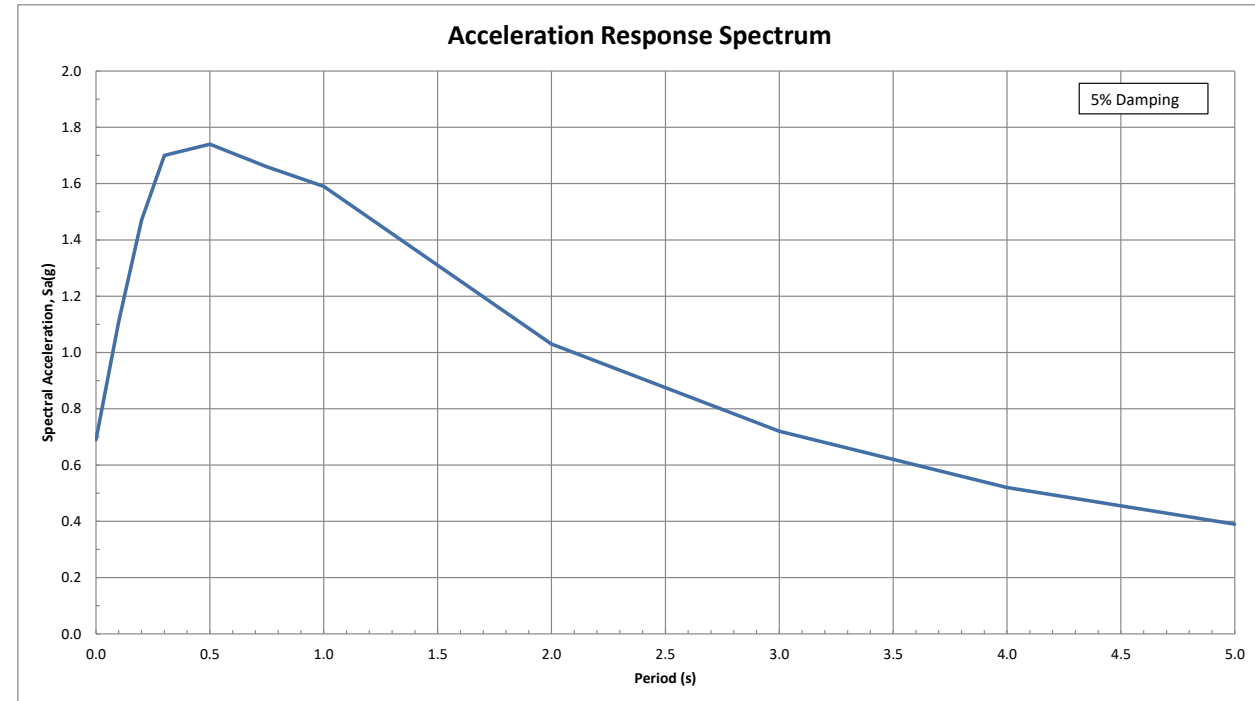
ARS Data for:

Sun Lakes Boulevard Realignment

Period, T (s)	Spectral Acceleration, S _a (g)
0.00	0.69
0.10	1.11
0.20	1.47
0.30	1.70
0.50	1.74
0.75	1.66
1.00	1.59
2.00	1.03
3.00	0.72
4.00	0.52
5.00	0.39

<u>Latitude, degrees</u>
33.917900
<u>Longitude, degrees</u>
-116.919700

<u>Seismic Loading Table</u>		
Soil Profile (V _{s30}):	200	m/s
or:	656	ft/s
PGA Mean Moment Magnitude (M) for PGA:	6.84	
Rupture Distance: R:	11.8	km
or:	7.3	mi
PGA (HPGA):	0.69	g



The ARS curve was developed based on the USGS 2014 national Seismic Hazard Map for a 975 year return period (Hazard Model/Edition Dynamic Continuous U.S. 2014 (Update) (V4.2.0) hazard data obtained by using ARS Online v3.1.0). Modifications for basin effects and/or near fault effects were applied, where applicable, per Appendix B of SDC v2.0 with October 2019 Interim Revisions.



GEOCON
CONSULTANTS, INC.

3160 GOLD VALLEY DR - SUITE 800 - RANCHO CORDOVA, CA 95742
PHONE 916.852.9118 - FAX 916.852.9132

Sun Lakes Boulevard Realignment

Banning,
California

RECOMMENDED DESIGN RESPONSE SPECTRUM

T2881-22-01

May 2024

Figure 4

SEE Design - Ground Motion Data Sheet

APPENDIX

A

APPENDIX A

EXPLORATORY EXCAVATIONS

We performed the field investigation on September 17, 2019. Our subsurface exploration consisted of excavating eight geotechnical borings utilizing a truck-mounted, hollow-stem auger drill rig. The borings were drilled to depths of 6½ and 26½ feet below the existing ground surface in areas of the planned improvements. We collected bulk and relatively undisturbed samples from the borings by driving a 3-inch O. D., California Modified Sampler into the “undisturbed” soil mass with blows from a 140-pound hammer falling 30 inches or a slide hammer. The California Modified Sampler was equipped with 1-inch high by 2³/₈-inch inside diameter brass sampler rings to facilitate removal and testing. Bulk and relatively undisturbed samples of soils were transported to our laboratory for testing.

The soil conditions encountered in the borings were visually examined, classified and logged in general accordance with the Unified Soil Classification System (USCS). Logs of the borings are presented on Figures A-1 through A-8. The logs depict the soil and geologic conditions encountered and the depth at which samples were obtained. The approximate locations of the borings are indicated the *Geologic Map* (Figure 2).

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-1			PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.)	2490.5	DATE COMPLETED				
					ENG./GEO.	A.Shoashekan	DRILLER	2R Drilling			
					EQUIPMENT	HOLLOW STEM AUGER	HAMMER TYPE	Autohammer			
MATERIAL DESCRIPTION											
0	B-1@0-5			SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf) Silty SAND, dense, damp, reddish brown; fine to medium sand with few coarse sand						
1											
2											
3	B-1@2.5			SC	Clayey SAND, dense, moist, light reddish brown; fine to medium sand; calcium carbonate deposits; porous			75		9.3	
4											
5	B-1@5				- becomes very dense			96		8.5	
6					Total Depth = 6'-6" Groundwater not encountered Backfilled with cuttings 9/17/2019						

Figure A1, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▨ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-2 ELEV. (MSL.) <u>2463</u> ENG./GEO. <u>A.Shoashekan</u> EQUIPMENT <u>HOLLOW STEM AUGER</u> DATE COMPLETED <u>9/17/19</u> DRILLER <u>2R Drilling</u> HAMMER TYPE <u>Autohammer</u>	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
0					MATERIAL DESCRIPTION				
1				SP-SM	UNDOCUMENTED FILL (afu) Poorly-graded SAND with silt and some gravel, dense, damp, reddish brown; fine to medium sand with few coarse sand				
2									
3	B-2@2.5			SM	ALLUVIUM (Qa) Silty SAND, medium dense, moist, brown; fine sand; porous	24			
4									
5	B-2@5			SP-SM	Poorly-graded SAND with silt, medium dense, moist, yellowish brown; fine to medium sand	17			
6									
7	B-2@7.5			SM	Silty SAND, medium dense, moist, yellowish brown; fine sand; porous	17			
8									
9									
10	B-2@10				-becomes damp; porous; increase in sand content	25		6.9	
11	B-2@10-15								
12									
13									
14									
15	B-2@15			SP-SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf) Poorly-graded SAND with silt and little gravel, dense, wet, yellowish brown; fine to coarse sand	73			
16									
17									
18									
19									
20	B-2@20					66		7.5	
21									
22									
23									
24									
25	B-2@25				-becomes medium dense	36			
26				CL	Sandy CLAY, stiff, moist, red; fine to coarse sand; porous; manganese staining				
Total Depth = 26'-6" Groundwater not encountered Backfilled with cuttings 9/17/2019									

Figure A2, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▨ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-3			PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.)	2483.5	DATE COMPLETED	9/17/19			
					ENG./GEO.	A.Shoashekan	DRILLER	2R Drilling			
					EQUIPMENT	HOLLOW STEM AUGER	HAMMER TYPE	Autohammer			
MATERIAL DESCRIPTION											
0				SC	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf)						
1					Clayey SAND, very dense, damp, reddish brown; fine to medium sand						
2											
3	B-3@2.5				-becomes moist			50/5"		10.3	
4											
5	B-3@5			SP	Poorly-graded SAND, very dense, moist, olive; fine to medium sand; manganese staining, granitic clast			50/6"		6.8	
6											
7											
8	B-3@7.5			SP-SM	Poorly-graded SAND with silt, very dense, moist, light olive brown; fine to medium sand; granitic clast			98/11"			
9											
10	B-3@10			SM	Silty SAND, dense, moist, reddish brown; fine sand			64			
11											
12											
13											
14											
15	B-3@15			SP	Poorly-graded SAND, very dense, moist, yellowish brown; medium sand; granitic clast			88/10"			
16											
17											
18											
19											
20	B-3@20				- fine to coarse sand; granitic clast			50/6"			
21											
22											
23											
24											
25	B-3@25				- becomes olive yellow			95			
26											
					Total Depth = 26'-6"						
					Groundwater not encountered						
					Backfilled with cuttings 9/17/2019						

Figure A3, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▨ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-4			PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.) 2480	DATE COMPLETED 9/17/19	ENG./GEO. A.Shoashekan				
MATERIAL DESCRIPTION											
0	B-4@0-5			SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf) Silty SAND with few gravel, medium dense, damp, reddish brown; fine to medium sand						
1											
2											
3	B-4@2.5				SC	Clayey SAND, medium dense, damp, reddish brown; fine to medium sand; calcium carbonate stringers	26		6.8		
4											
5	B-4@5					-becomes moist	28		8.5		
6					Total Depth = 6'-6" Groundwater not encountered Backfilled with cuttings 9/17/2019						

Figure A4, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

... SAMPLING UNSUCCESSFUL

... DISTURBED OR BAG SAMPLE

... STANDARD PENETRATION TEST

... CHUNK SAMPLE

... DRIVE SAMPLE (UNDISTURBED)

... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-5			PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.) 2465	DATE COMPLETED 9/17/19	ENG./GEO. A.Shoashekan				
MATERIAL DESCRIPTION											
0	B-5@0-5			SC	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf)			38	8.0		
1					Clayey SAND, dense, damp, brown; fine to medium sand with few coarse sand						
2											
3	B-5@2.5				-becomes medium dense, moist; calcium carbonate stringers; porous						
4											
5	B-5@5			SM	Silty SAND, dense, moist, yellowish brown; fine to medium sand; porous; trace calcium carbonate stringers			50	10.3		
6											
Total Depth = 6'-6" Groundwater not encountered Backfilled with cuttings 9/17/2019											

Figure A5, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▨ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-6			PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.)	2437	DATE COMPLETED	9/17/19			
					ENG./GEO.	A.Shoashekan	DRILLER	2R Drilling			
					EQUIPMENT	HOLLOW STEM AUGER	HAMMER TYPE	Autohammer			
MATERIAL DESCRIPTION											
0				SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf)						
1					Silty SAND, loose, dry, light brownish gray; fine sand						
2											
3	B-6@2.5				-becomes damp; trace porosity			15		6.0	
4											
5	B-6@5				-increase in porosity			14		6.6	
6											
7											
8	B-6@7.5							16			
9											
10	B-6@10				-becomes medium dense			20			
11											
12											
13											
14											
15	B-6@15			SP	Poorly-graded SAND, medium dense, moist, light yellowish brown; fine to coarse sand			18			
16											
17											
18											
19											
20	B-6@20			SW	Well-graded SAND, medium dense, moist, light yellowish brown; fine to coarse sand			43			
21											
22											
23											
24											
25	B-6@25			SP-SM	Poorly-graded SAND with silt, medium dense, moist, yellowish brown; fine sand; trace calcium carbonate stringers			29			
26											
					Total Depth = 26'-6"						
					Groundwater not encountered						
					Backfilled with cuttings 9/17/2019						

Figure A6, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▣ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-7		PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
					ELEV. (MSL.) <u>2416</u>	DATE COMPLETED <u>9/17/19</u>				
					ENG./GEO. <u>A.Shoashekan</u>	DRILLER <u>2R Drilling</u>				
					EQUIPMENT <u>HOLLOW STEM AUGER</u>	HAMMER TYPE <u>Autohammer</u>				
					MATERIAL DESCRIPTION					
0					PAVEMENT					
1				SP-SM	4" asphalt concrete section					
2					UNDOCUMENTED FILL (afu)					
3	B-7@2.5			SM	Poorly-graded SAND with silt, loose, dry, yellowish brown; fine to coarse sand					12
4					Silty SAND, loose, moist, olive brown; fine sand					
5	B-7@5			SP-SM	ALLUVIUM (Qa)					14
6					Poorly-graded SAND with silt, loose, moist, olive brown; fine sand					
7										
8	B-7@7.5 B-7@8-13			SM	Silty SAND, medium dense, moist, yellowish brown; fine to medium sand with few coarse; trace calcium carbonate stringers					28
9				SP						
10	B-7@10			SP-SM	Poorly-graded SAND, medium dense, moist, yellowish brown; fine to coarse sand					12
11					Poorly-graded SAND with silt, loose, damp, yellowish brown; fine to medium sand; trace calcium carbonate stringers; trace porosity					
12										
13										
14										
15	B-7@15			SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf)					35
16					Silty SAND, medium dense, moist, olive brown; fine to medium sand; trace calcium carbonate stringers; trace porosity					
17										
18										
19										
20	B-7@20				-becomes yellowish brown; fine to coarse sand					31
21										
22										
23										
24										
25	B-7@25				-fine to medium sand					34
26										
					Total Depth = 26'-6"					
					Groundwater not encountered					
					Backfilled with cuttings 9/17/2019					

Figure A7, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▣ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

▤ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE INTERVAL & RECOVERY	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-8 ELEV. (MSL.) <u>2422</u> ENG./GEO. <u>A.Shoashekan</u> EQUIPMENT <u>HOLLOW STEM AUGER</u> DATE COMPLETED <u>9/17/19</u> DRILLER <u>2R Drilling</u> HAMMER TYPE <u>Autohammer</u>	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)	ADDITIONAL TESTS
0	B-8@0-5			SM	MATERIAL DESCRIPTION				
1					UNDOCUMENTED FILL (afu)				
2					Silty SAND, medium dense, dry, light yellowish brown; fine sand with few medium and coarse sand				
3	B-8@2.5				- becomes damp	39		6.0	
4					- debris				
5	B-8@5			SM	ALLUVIAL FAN OF THE SAN GORGONIO PASS (Qf)	12		5.3	
6					Silty SAND, loose, damp, light yellowish brown; fine to medium sand				
7									
8	B-8@7.5				- becomes medium dense; porous; calcium carbonate stringers	22			
9									
10	B-8@10					27			
11									
12									
13									
14									
15	B-8@15					31			
16									
17									
18									
19									
20	B-8@20					46			
21									
22									
23									
24									
25	B-8@25			SW	Well-graded SAND, very dense, moist, light yellowish brown; fine to coarse sand	90			
26					Total Depth = 26' -6" Groundwater not encountered Backfilled with cuttings 9/17/2019				

Figure A8, Log of Boring, page 1 of 1

IN PROGRESS T2881-22-01 BORING LOGS.GPJ 05/29/24



SAMPLE SYMBOLS

□ ... SAMPLING UNSUCCESSFUL

▨ ... DISTURBED OR BAG SAMPLE

■ ... STANDARD PENETRATION TEST

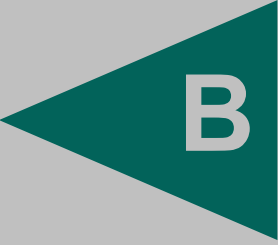
■ ... CHUNK SAMPLE

■ ... DRIVE SAMPLE (UNDISTURBED)

▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

APPENDIX

**B**

APPENDIX B

LABORATORY TESTING

We performed laboratory tests in accordance with current generally accepted test methods of ASTM International (ASTM) or other suggested procedures. We analyzed selected soil samples for maximum dry density and optimum moisture content, grain size distribution, soil resistance value (R-value), and direct shear strength. The results of the laboratory tests are presented on Figures B-1 through B-8. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

Sample No:

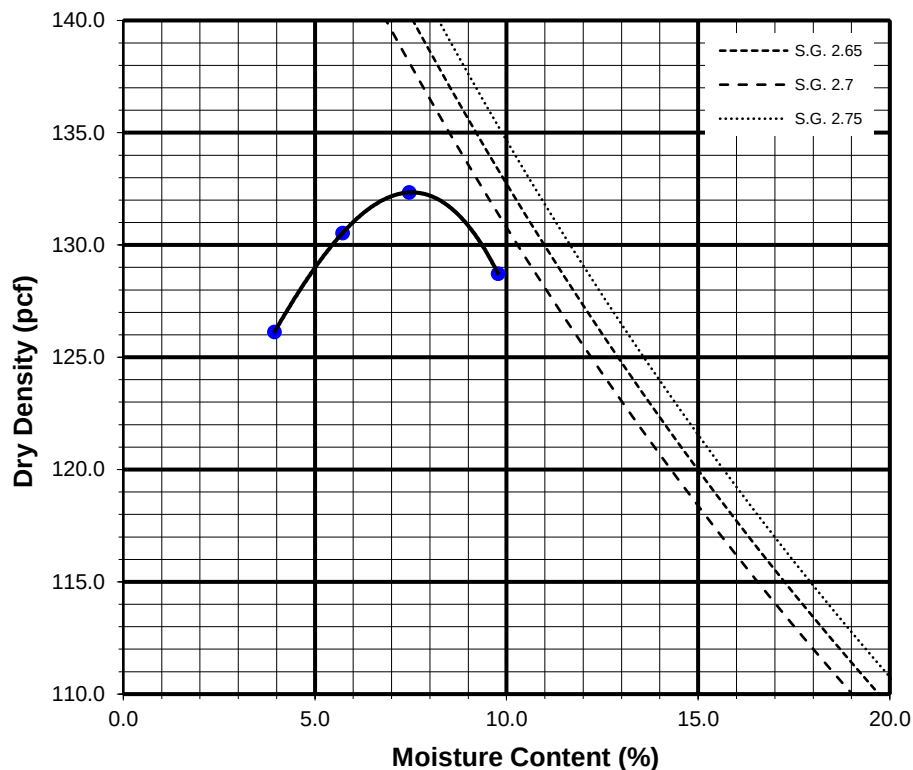
B-7@8-13'

silty SAND (SM), yellowish brown

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6367	6430	6417	6262		
Weight of Mold	(g)	4282	4282	4282	4282		
Net Weight of Soil	(g)	2085	2148	2135	1980		
Wet Weight of Soil + Cont.	(g)	760.7	790.2	788.5	763.9		
Dry Weight of Soil + Cont.	(g)	733.5	753.1	741.3	744.7		
Weight of Container	(g)	258.2	255.5	258.5	258.1		
Moisture Content	(%)	5.7	7.5	9.8	3.9		
Wet Density	(pcf)	138.0	142.2	141.3	131.1		
Dry Density	(pcf)	130.5	132.3	128.7	126.1		

Maximum Dry Density (pcf) 132.5

Optimum Moisture Content (%) 8.0



Preparation Method: B



MODIFIED COMPACTION TEST OF SOILS

ASTM D-1557

Checked by: ATS

Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-1

Sample No:

B-4 & B-5 @0-5' MIX

clayey SAND (SC), reddish brown

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6287	6396	6394	6169		
Weight of Mold	(g)	4282	4282	4282	4282		
Net Weight of Soil	(g)	2005	2114	2112	1887		
Wet Weight of Soil + Cont.	(g)	755.4	773.1	757.2	752.7		
Dry Weight of Soil + Cont.	(g)	730.7	738.0	713.9	736.3		
Weight of Container	(g)	256.9	256.7	255.2	257.6		
Moisture Content	(%)	5.2	7.3	9.4	3.4		
Wet Density	(pcf)	133.1	140.4	140.3	125.3		
Dry Density	(pcf)	126.5	130.9	128.2	121.2		

Maximum Dry Density (pcf) 131.5

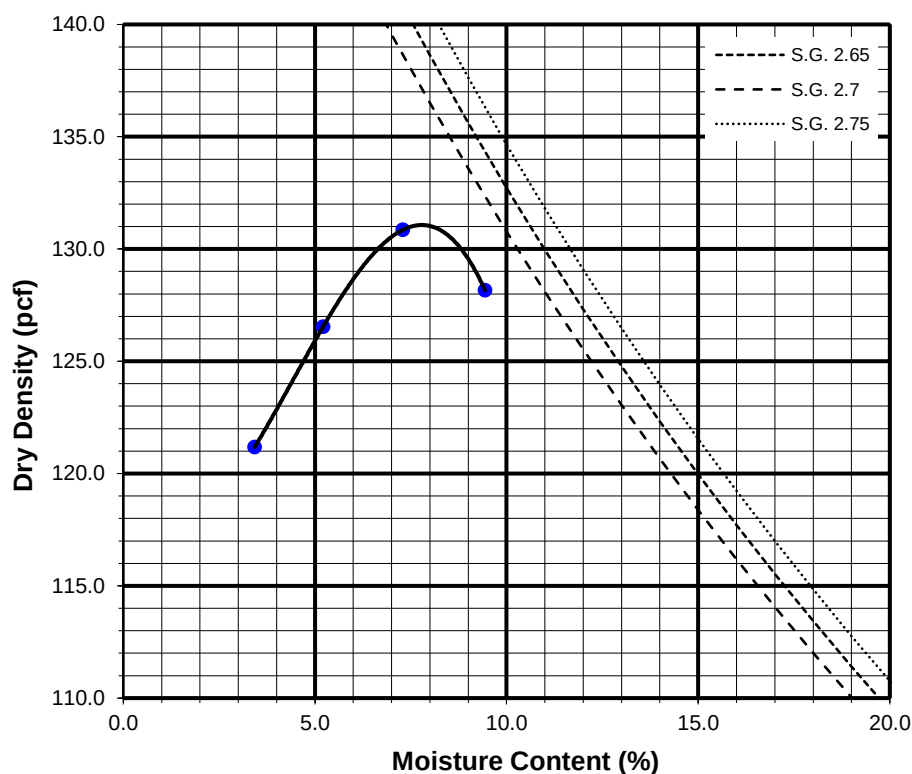
Bulk Specific Gravity (dry) 2.62

Corrected Maximum Dry Density (pcf) 133.5

Optimum Moisture Content (%) 8.0

Oversized Fraction (%) 7.0

Corrected Moisture Content (%) 7.5



Preparation Method: A



MODIFIED COMPACTION TEST OF SOILS

ASTM D-1557

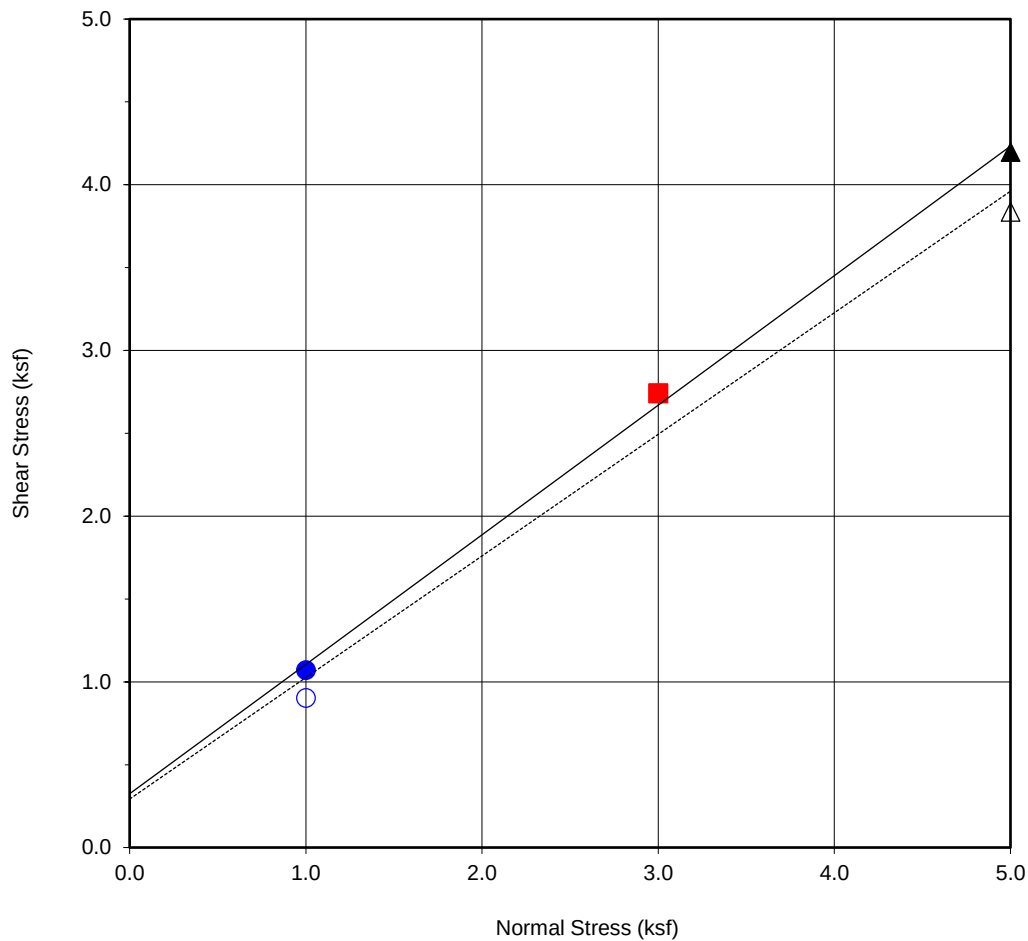
Checked by: ATS

Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-2



Boring No.	B-2
Sample No.	B-2@10'
Depth (ft)	10
<u>Sample Type:</u>	Ring

<u>Soil Identification:</u>		
silty SAND (SM), yellowish brown		
<u>Strength Parameters</u>		
	C (psf)	ϕ ($^{\circ}$)
Peak	324	38.0
Ultimate	292	36.3

Normal Stress (kip/ft ²)	1	3	5
Peak Shear Stress (kip/ft ²)	● 1.07	■ 2.74	▲ 4.20
Shear Stress @ End of Test (ksf)	○ 0.90	□ 2.74	△ 3.84
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	10.2	11.5	9.9
Initial Dry Density (pcf)	114.3	99.3	115.2
Initial Degree of Saturation (%)	58.0	44.7	57.8
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	15.5	14.3	20.3



DIRECT SHEAR TEST RESULTS

Consolidated Drained ASTM D-3080

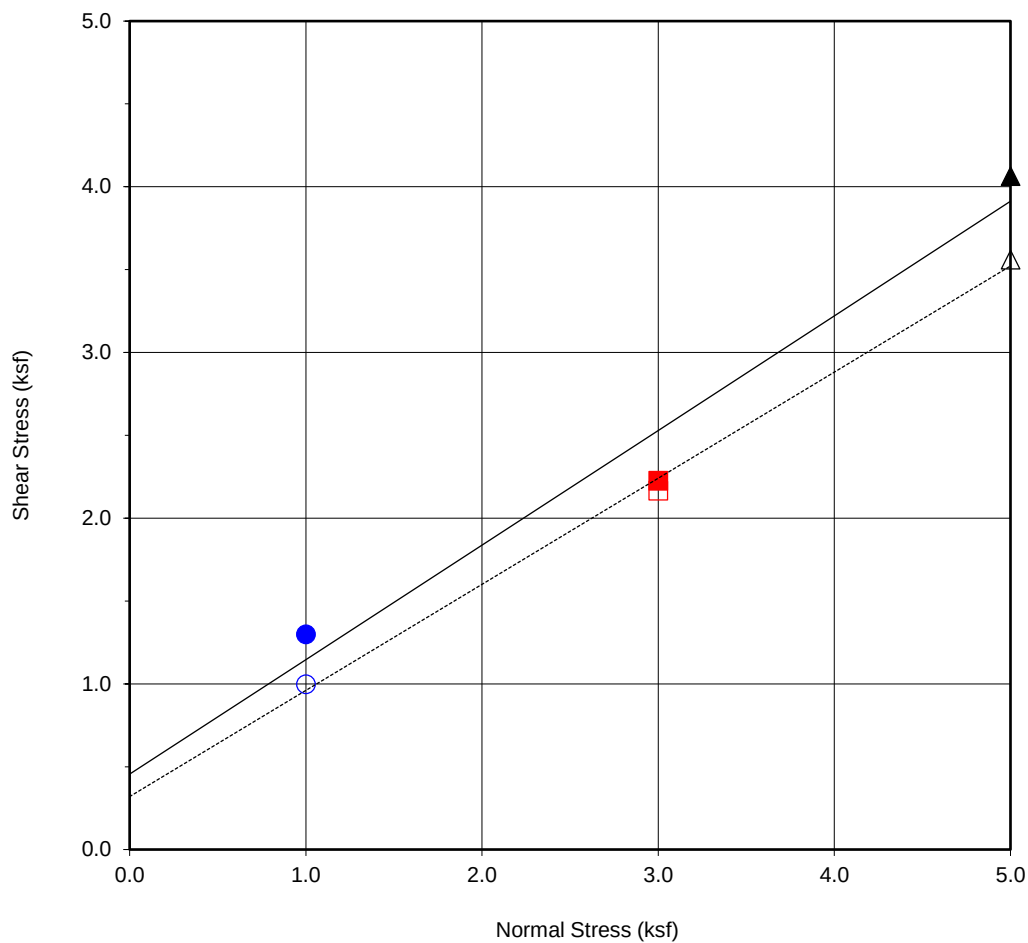
Checked by: ATS

Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-3



Boring No.	B-7
Sample No.	B-7@7.5
Depth (ft)	7.5
<u>Sample Type:</u>	Ring

<u>Soil Identification:</u>		
Silty SAND (SM), yellowish brown		
<u>Strength Parameters</u>		
	C (psf)	ϕ ($^{\circ}$)
Peak	455	34.7
Ultimate	320	32.6

Normal Stress (kip/ft ²)	1	3	5
Peak Shear Stress (kip/ft ²)	● 1.30	■ 2.23	▲ 4.07
Shear Stress @ End of Test (ksf)	○ 1.00	□ 2.17	△ 3.56
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	13.0	13.2	10.3
Initial Dry Density (pcf)	115.3	109.8	115.4
Initial Degree of Saturation (%)	76.2	66.3	60.4
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	16.7	16.9	15.6



DIRECT SHEAR TEST RESULTS

Consolidated Drained ASTM D-3080

Checked by: ATS

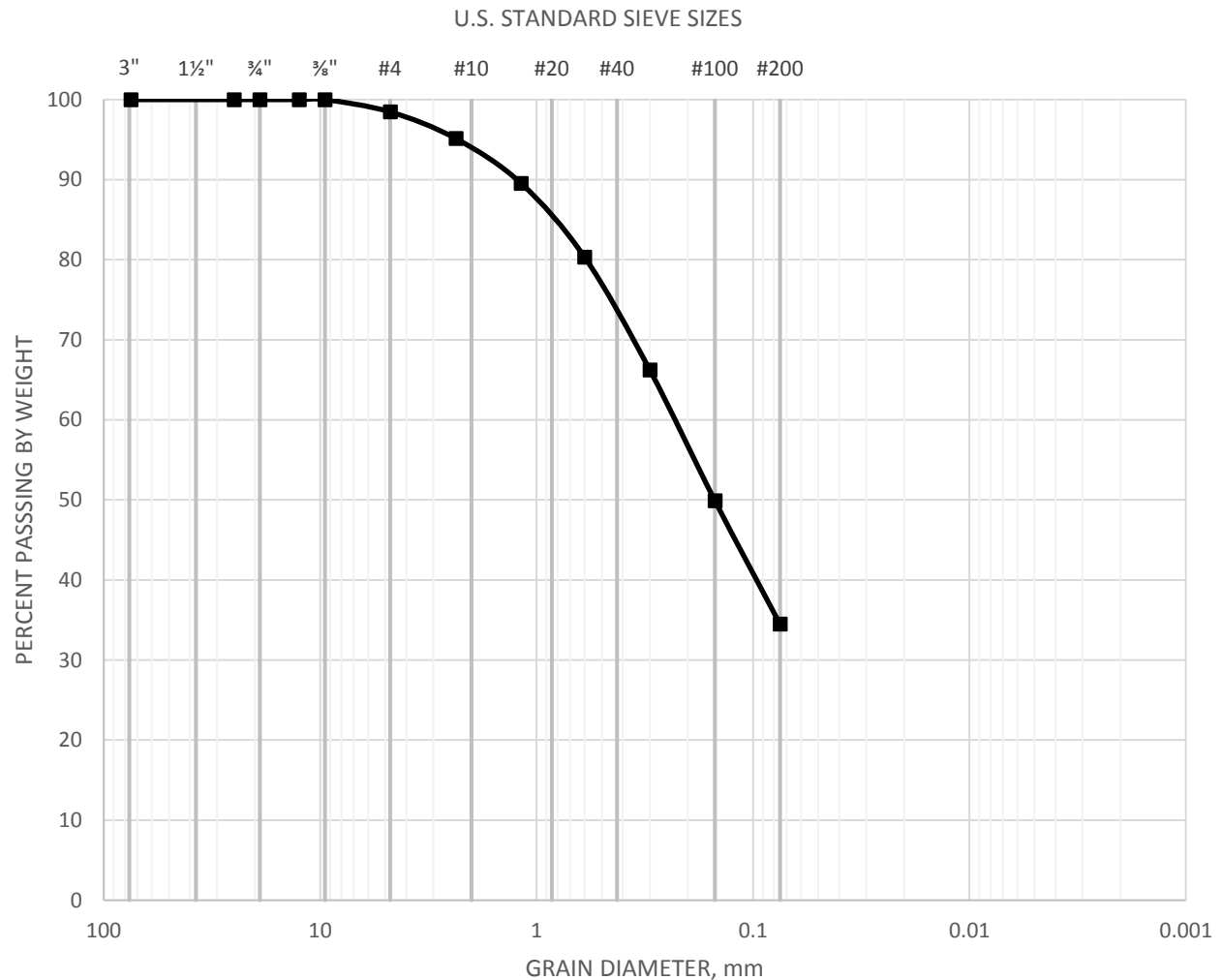
Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-4

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B-2 @ 7.5	silty SAND (SM), yellowish brown	0.22		



GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

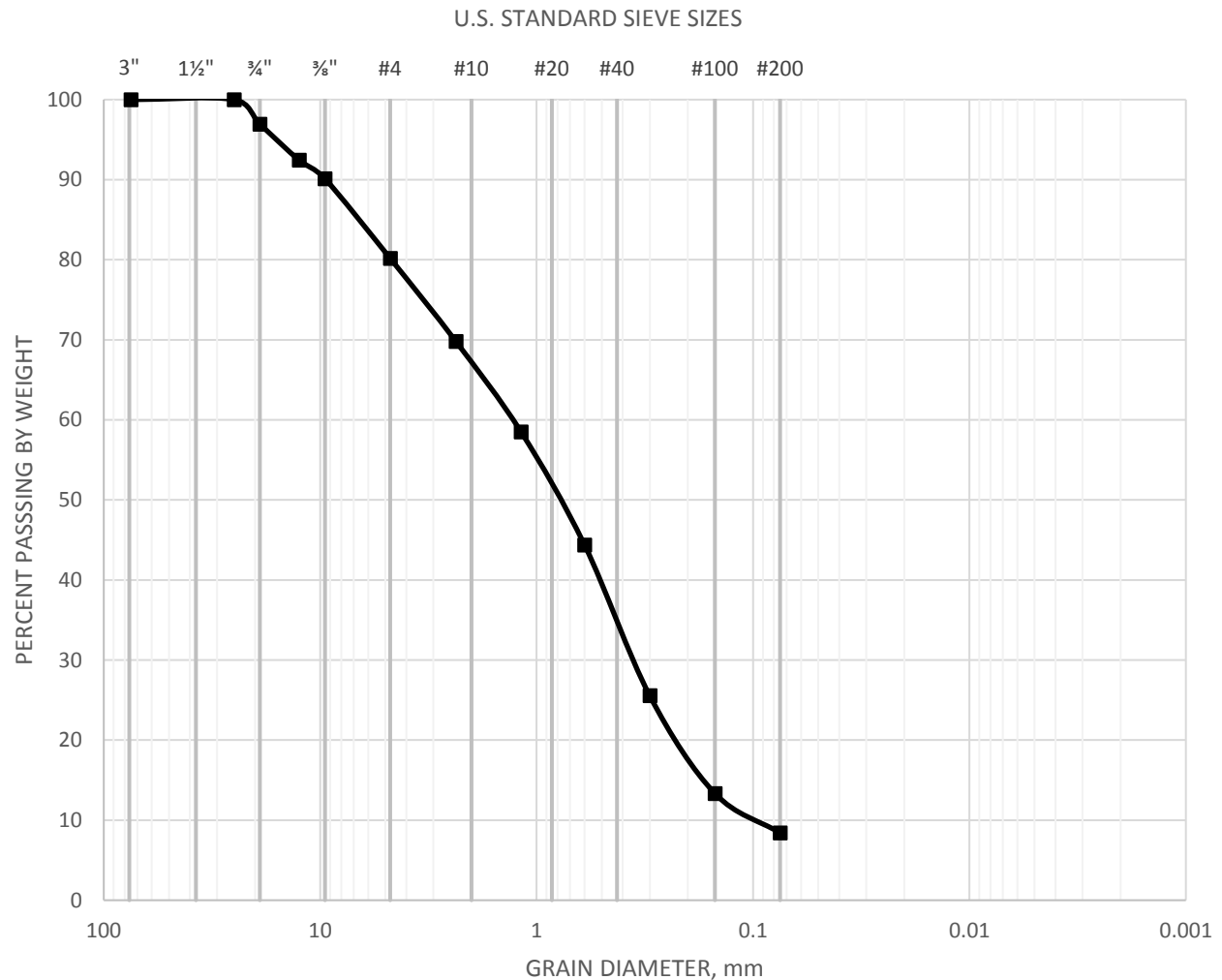
Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-5

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B-2 @ 15'	poorly-graded SAND with silt and little gravel (SP-SM), yellowish brown	1.2	0.34	0.097



GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

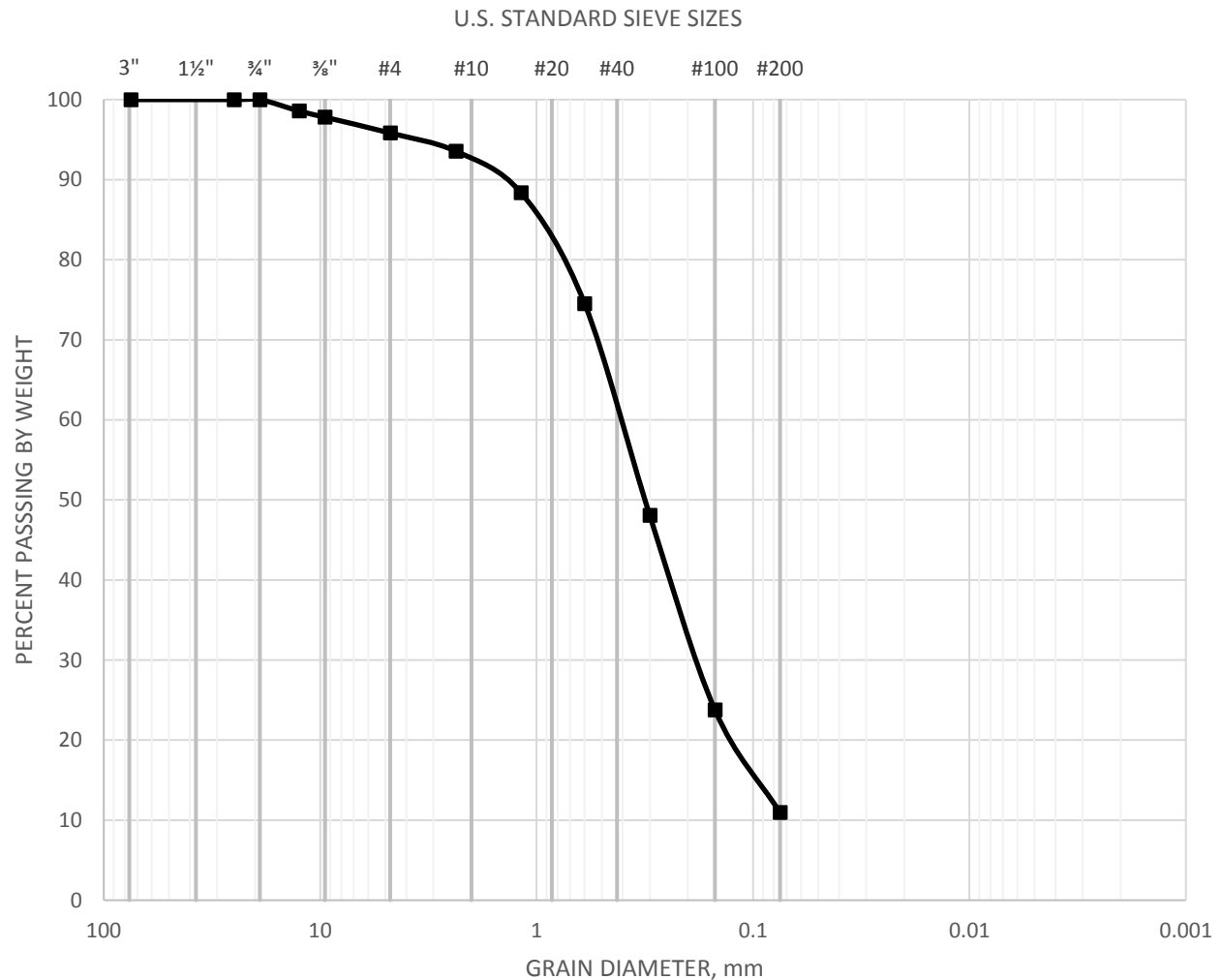
Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-6

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B-7 @ 10'	poorly-graded SAND with silt (SP-SM), yellowish brown	0.41	0.18	0.12



GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

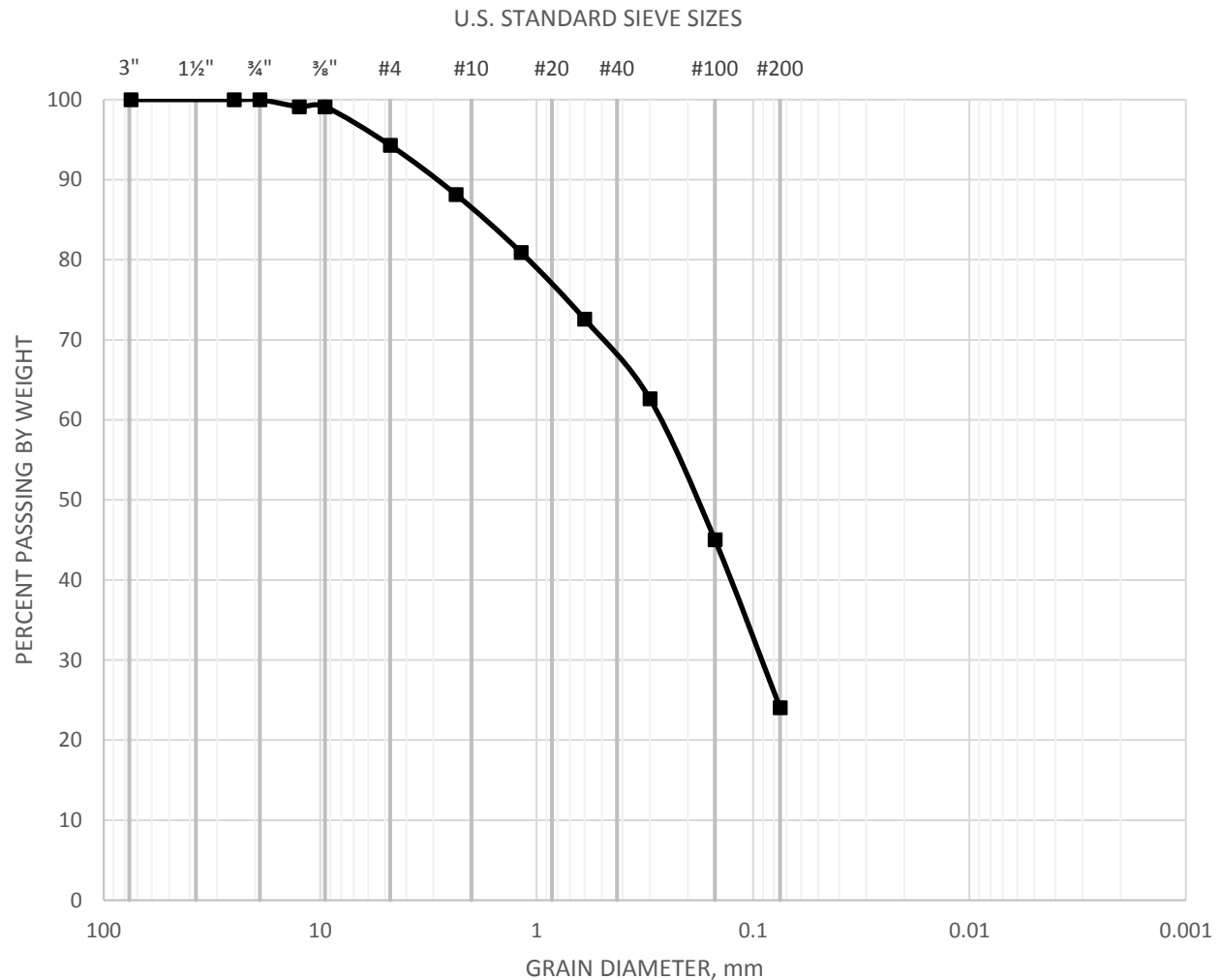
Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-7

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B-7 @ 20'	silty SAND (SM), yellowish brown	0.25	0.092	



GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

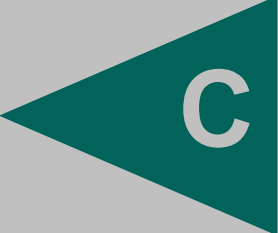
Project No.: T2881-22-01

Sun Lakes Boulevard Realignment
South Highland Home Road to Sunset Avenue
Banning, California

October 2019

Figure B-8

APPENDIX



C

APPENDIX C

RECOMMENDED GRADING SPECIFICATIONS

FOR

SUN LAKES BOULEVARD REALIGNMENT
SOUTH HIGHLAND HOME ROAD TO SUNSET AVENUE
BANNING, CALIFORNIA

PROJECT NO. T2881-22-02

RECOMMENDED GRADING SPECIFICATIONS

1. GENERAL

- 1.1 These Recommended Grading Specifications shall be used in conjunction with the Geotechnical Report for the project prepared by Geocon. The recommendations contained in the text of the Geotechnical Report are a part of the earthwork and grading specifications and shall supersede the provisions contained hereinafter in the case of conflict.
- 1.2 Prior to the commencement of grading, a geotechnical consultant (Consultant) shall be employed for the purpose of observing earthwork procedures and testing the fills for substantial conformance with the recommendations of the Geotechnical Report and these specifications. The Consultant should provide adequate testing and observation services so that they may assess whether, in their opinion, the work was performed in substantial conformance with these specifications. It shall be the responsibility of the Contractor to assist the Consultant and keep them apprised of work schedules and changes so that personnel may be scheduled accordingly.
- 1.3 It shall be the sole responsibility of the Contractor to provide adequate equipment and methods to accomplish the work in accordance with applicable grading codes or agency ordinances, these specifications and the approved grading plans. If, in the opinion of the Consultant, unsatisfactory conditions such as questionable soil materials, poor moisture condition, inadequate compaction, and/or adverse weather result in a quality of work not in conformance with these specifications, the Consultant will be empowered to reject the work and recommend to the Owner that grading be stopped until the unacceptable conditions are corrected.

2. DEFINITIONS

- 2.1 **Owner** shall refer to the owner of the property or the entity on whose behalf the grading work is being performed and who has contracted with the Contractor to have grading performed.
- 2.2 **Contractor** shall refer to the Contractor performing the site grading work.
- 2.3 **Civil Engineer** or **Engineer of Work** shall refer to the California licensed Civil Engineer or consulting firm responsible for preparation of the grading plans, surveying and verifying as-graded topography.
- 2.4 **Consultant** shall refer to the soil engineering and engineering geology consulting firm retained to provide geotechnical services for the project.

- 2.5 **Soil Engineer** shall refer to a California licensed Civil Engineer retained by the Owner, who is experienced in the practice of geotechnical engineering. The Soil Engineer shall be responsible for having qualified representatives on-site to observe and test the Contractor's work for conformance with these specifications.
- 2.6 **Engineering Geologist** shall refer to a California licensed Engineering Geologist retained by the Owner to provide geologic observations and recommendations during the site grading.
- 2.7 **Geotechnical Report** shall refer to a soil report (including all addenda) which may include a geologic reconnaissance or geologic investigation that was prepared specifically for the development of the project for which these Recommended Grading Specifications are intended to apply.

3. MATERIALS

- 3.1 Materials for compacted fill shall consist of any soil excavated from the cut areas or imported to the site that, in the opinion of the Consultant, is suitable for use in construction of fills. In general, fill materials can be classified as *soil* fills, *soil-rock* fills or *rock* fills, as defined below.
- 3.1.1 **Soil fills** are defined as fills containing no rocks or hard lumps greater than 12 inches in maximum dimension and containing at least 40 percent by weight of material smaller than $\frac{3}{4}$ inch in size.
- 3.1.2 **Soil-rock fills** are defined as fills containing no rocks or hard lumps larger than 4 feet in maximum dimension and containing a sufficient matrix of soil fill to allow for proper compaction of soil fill around the rock fragments or hard lumps as specified in Paragraph 6.2. **Oversize rock** is defined as material greater than 12 inches.
- 3.1.3 **Rock fills** are defined as fills containing no rocks or hard lumps larger than 3 feet in maximum dimension and containing little or no fines. Fines are defined as material smaller than $\frac{3}{4}$ inch in maximum dimension. The quantity of fines shall be less than approximately 20 percent of the rock fill quantity.
- 3.2 Material of a perishable, spongy, or otherwise unsuitable nature as determined by the Consultant shall not be used in fills.
- 3.3 Materials used for fill, either imported or on-site, shall not contain hazardous materials as defined by the California Code of Regulations, Title 22, Division 4, Chapter 30, Articles 9

and 10; 40CFR; and any other applicable local, state or federal laws. The Consultant shall not be responsible for the identification or analysis of the potential presence of hazardous materials. However, if observations, odors or soil discoloration cause Consultant to suspect the presence of hazardous materials, the Consultant may request from the Owner the termination of grading operations within the affected area. Prior to resuming grading operations, the Owner shall provide a written report to the Consultant indicating that the suspected materials are not hazardous as defined by applicable laws and regulations.

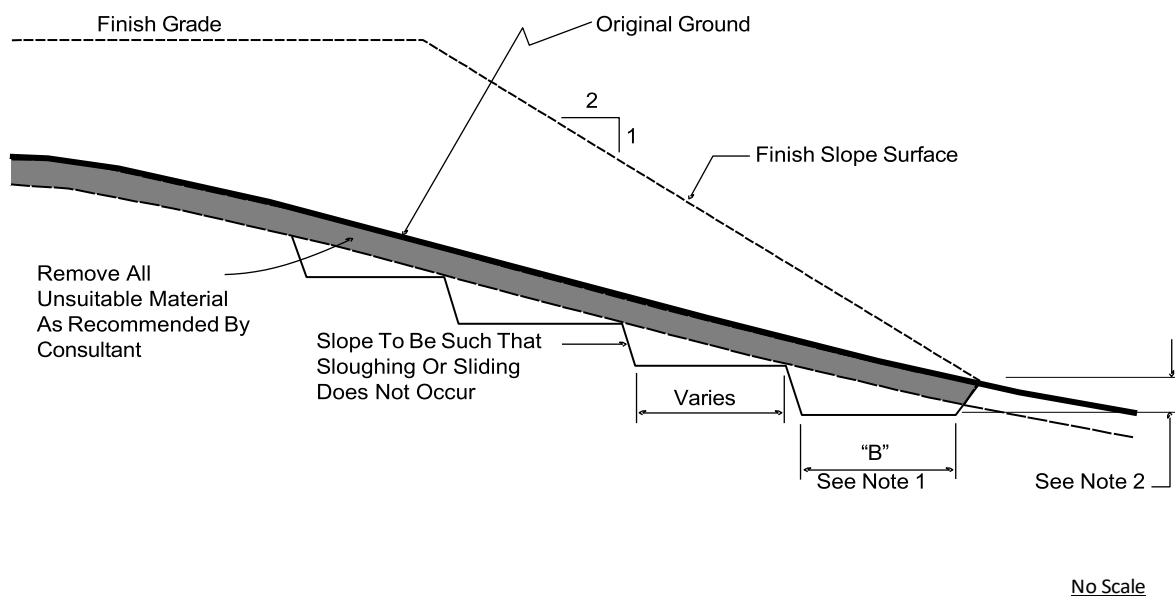
- 3.4 The outer 15 feet of *soil-rock* fill slopes, measured horizontally, should be composed of properly compacted *soil* fill materials approved by the Consultant. *Rock* fill may extend to the slope face, provided that the slope is not steeper than 2:1 (horizontal:vertical) and a soil layer no thicker than 12 inches is track-walked onto the face for landscaping purposes. This procedure may be utilized provided it is acceptable to the governing agency, Owner and Consultant.
- 3.5 Samples of soil materials to be used for fill should be tested in the laboratory by the Consultant to determine the maximum density, optimum moisture content, and, where appropriate, shear strength, expansion, and gradation characteristics of the soil.
- 3.6 During grading, soil or groundwater conditions other than those identified in the Geotechnical Report may be encountered by the Contractor. The Consultant shall be notified immediately to evaluate the significance of the unanticipated condition

4. CLEARING AND PREPARING AREAS TO BE FILLED

- 4.1 Areas to be excavated and filled shall be cleared and grubbed. Clearing shall consist of complete removal above the ground surface of trees, stumps, brush, vegetation, man-made structures, and similar debris. Grubbing shall consist of removal of stumps, roots, buried logs and other unsuitable material and shall be performed in areas to be graded. Roots and other projections exceeding 1½ inches in diameter shall be removed to a depth of 3 feet below the surface of the ground. Borrow areas shall be grubbed to the extent necessary to provide suitable fill materials.
- 4.2 Asphalt pavement material removed during clearing operations should be properly disposed at an approved off-site facility or in an acceptable area of the project evaluated by Geocon and the property owner. Concrete fragments that are free of reinforcing steel may be placed in fills, provided they are placed in accordance with Section 6.2 or 6.3 of this document.

- 4.3 After clearing and grubbing of organic matter and other unsuitable material, loose or porous soils shall be removed to the depth recommended in the Geotechnical Report. The depth of removal and compaction should be observed and approved by a representative of the Consultant. The exposed surface shall then be plowed or scarified to a minimum depth of 6 inches and until the surface is free from uneven features that would tend to prevent uniform compaction by the equipment to be used.
- 4.4 Where the slope ratio of the original ground is steeper than 5:1 (horizontal:vertical), or where recommended by the Consultant, the original ground should be benched in accordance with the following illustration.

TYPICAL BENCHING DETAIL



DETAIL NOTES: (1) Key width "B" should be a minimum of 10 feet, or sufficiently wide to permit complete coverage with the compaction equipment used. The base of the key should be graded horizontal, or inclined slightly into the natural slope.

(2) The outside of the key should be below the topsoil or unsuitable surficial material and at least 2 feet into dense formational material. Where hard rock is exposed in the bottom of the key, the depth and configuration of the key may be modified as approved by the Consultant.

- 4.5 After areas to receive fill have been cleared and scarified, the surface should be moisture conditioned to achieve the proper moisture content, and compacted as recommended in Section 6 of these specifications.

5. COMPACTION EQUIPMENT

- 5.1 Compaction of *soil* or *soil-rock* fill shall be accomplished by sheepfoot or segmented-steel wheeled rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers, or other types of acceptable compaction equipment. Equipment shall be of such a design that it will be capable of compacting the *soil* or *soil-rock* fill to the specified relative compaction at the specified moisture content.
- 5.2 Compaction of *rock* fills shall be performed in accordance with Section 6.3.

6. PLACING, SPREADING AND COMPACTION OF FILL MATERIAL

- 6.1 *Soil* fill, as defined in Paragraph 3.1.1, shall be placed by the Contractor in accordance with the following recommendations:
 - 6.1.1 *Soil* fill shall be placed by the Contractor in layers that, when compacted, should generally not exceed 8 inches. Each layer shall be spread evenly and shall be thoroughly mixed during spreading to obtain uniformity of material and moisture in each layer. The entire fill shall be constructed as a unit in nearly level lifts. Rock materials greater than 12 inches in maximum dimension shall be placed in accordance with Section 6.2 or 6.3 of these specifications.
 - 6.1.2 In general, the *soil* fill shall be compacted at a moisture content at or above the optimum moisture content as determined by ASTM D 1557.
 - 6.1.3 When the moisture content of *soil* fill is below that specified by the Consultant, water shall be added by the Contractor until the moisture content is in the range specified.
 - 6.1.4 When the moisture content of the *soil* fill is above the range specified by the Consultant or too wet to achieve proper compaction, the *soil* fill shall be aerated by the Contractor by blading/mixing, or other satisfactory methods until the moisture content is within the range specified.
 - 6.1.5 After each layer has been placed, mixed, and spread evenly, it shall be thoroughly compacted by the Contractor to a relative compaction of at least 90 percent. Relative compaction is defined as the ratio (expressed in percent) of the in-place dry density of the compacted fill to the maximum laboratory dry density as determined in accordance with ASTM D 1557. Compaction shall be continuous over the entire area, and compaction equipment shall make sufficient passes so that the specified minimum relative compaction has been achieved throughout the entire fill.

- 6.1.6 Where practical, soils having an Expansion Index greater than 50 should be placed at least 3 feet below finish pad grade and should be compacted at a moisture content generally 2 to 4 percent greater than the optimum moisture content for the material.
 - 6.1.7 Properly compacted *soil* fill shall extend to the design surface of fill slopes. To achieve proper compaction, it is recommended that fill slopes be over-built by at least 3 feet and then cut to the design grade. This procedure is considered preferable to track-walking of slopes, as described in the following paragraph.
 - 6.1.8 As an alternative to over-building of slopes, slope faces may be back-rolled with a heavy-duty loaded sheepsfoot or vibratory roller at maximum 4-foot fill height intervals. Upon completion, slopes should then be track-walked with a D-8 dozer or similar equipment, such that a dozer track covers all slope surfaces at least twice.
- 6.2 *Soil-rock* fill, as defined in Paragraph 3.1.2, shall be placed by the Contractor in accordance with the following recommendations:
- 6.2.1 Rocks larger than 12 inches but less than 4 feet in maximum dimension may be incorporated into the compacted *soil* fill, but shall be limited to the area measured 15 feet minimum horizontally from the slope face and 5 feet below finish grade or 3 feet below the deepest utility, whichever is deeper.
 - 6.2.2 Rocks or rock fragments up to 4 feet in maximum dimension may either be individually placed or placed in windrows. Under certain conditions, rocks or rock fragments up to 10 feet in maximum dimension may be placed using similar methods. The acceptability of placing rock materials greater than 4 feet in maximum dimension shall be evaluated during grading as specific cases arise and shall be approved by the Consultant prior to placement.
 - 6.2.3 For individual placement, sufficient space shall be provided between rocks to allow for passage of compaction equipment.
 - 6.2.4 For windrow placement, the rocks should be placed in trenches excavated in properly compacted *soil* fill. Trenches should be approximately 5 feet wide and 4 feet deep in maximum dimension. The voids around and beneath rocks should be filled with approved granular soil having a Sand Equivalent of 30 or greater and should be compacted by flooding. Windrows may also be placed utilizing an "open-face" method in lieu of the trench procedure, however, this method should first be approved by the Consultant.

- 6.2.5 Windrows should generally be parallel to each other and may be placed either parallel to or perpendicular to the face of the slope depending on the site geometry. The minimum horizontal spacing for windrows shall be 12 feet center-to-center with a 5-foot stagger or offset from lower courses to next overlying course. The minimum vertical spacing between windrow courses shall be 2 feet from the top of a lower windrow to the bottom of the next higher windrow.
- 6.2.6 Rock placement, fill placement and flooding of approved granular soil in the windrows should be continuously observed by the Consultant.
- 6.3 *Rock* fills, as defined in Section 3.1.3, shall be placed by the Contractor in accordance with the following recommendations:
- 6.3.1 The base of the *rock* fill shall be placed on a sloping surface (minimum slope of 2 percent). The surface shall slope toward suitable subdrainage outlet facilities. The *rock* fills shall be provided with subdrains during construction so that a hydrostatic pressure buildup does not develop. The subdrains shall be permanently connected to controlled drainage facilities to control post-construction infiltration of water.
- 6.3.2 *Rock* fills shall be placed in lifts not exceeding 3 feet. Placement shall be by rock trucks traversing previously placed lifts and dumping at the edge of the currently placed lift. Spreading of the *rock* fill shall be by dozer to facilitate *seating* of the rock. The *rock* fill shall be watered heavily during placement. Watering shall consist of water trucks traversing in front of the current rock lift face and spraying water continuously during rock placement. Compaction equipment with compactive energy comparable to or greater than that of a 20-ton steel vibratory roller or other compaction equipment providing suitable energy to achieve the required compaction or deflection as recommended in Paragraph 6.3.3 shall be utilized. The number of passes to be made should be determined as described in Paragraph 6.3.3. Once a *rock* fill lift has been covered with *soil* fill, no additional *rock* fill lifts will be permitted over the *soil* fill.
- 6.3.3 Plate bearing tests, in accordance with ASTM D 1196, may be performed in both the compacted *soil* fill and in the *rock* fill to aid in determining the required minimum number of passes of the compaction equipment. If performed, a minimum of three plate bearing tests should be performed in the properly compacted *soil* fill (minimum relative compaction of 90 percent). Plate bearing tests shall then be performed on areas of *rock* fill having two passes, four passes and six passes of the compaction equipment, respectively. The number of passes required for the *rock* fill shall be determined by comparing the results of the plate bearing tests for the *soil* fill and the *rock* fill and by evaluating the deflection

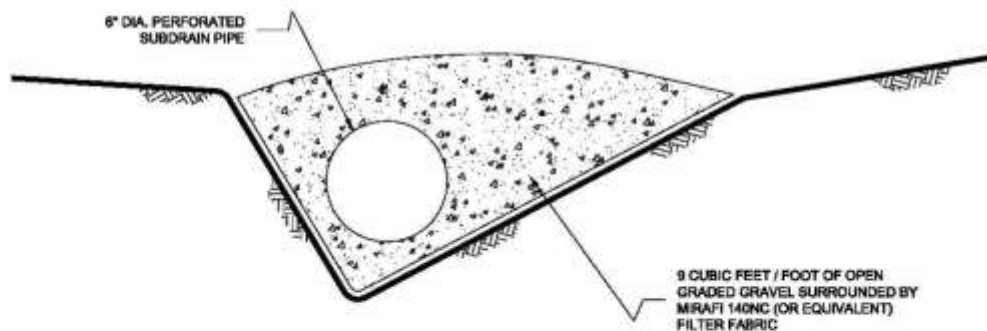
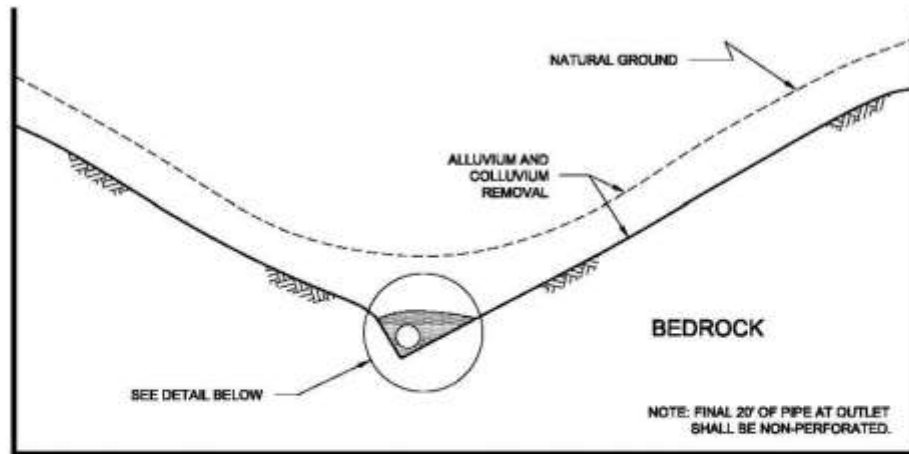
variation with number of passes. The required number of passes of the compaction equipment will be performed as necessary until the plate bearing deflections are equal to or less than that determined for the properly compacted *soil* fill. In no case will the required number of passes be less than two.

- 6.3.4 A representative of the Consultant should be present during *rock* fill operations to observe that the minimum number of “passes” have been obtained, that water is being properly applied and that specified procedures are being followed. The actual number of plate bearing tests will be determined by the Consultant during grading.
- 6.3.5 Test pits shall be excavated by the Contractor so that the Consultant can state that, in their opinion, sufficient water is present and that voids between large rocks are properly filled with smaller rock material. In-place density testing will not be required in the *rock* fills.
- 6.3.6 To reduce the potential for “piping” of fines into the *rock* fill from overlying *soil* fill material, a 2-foot layer of graded filter material shall be placed above the uppermost lift of *rock* fill. The need to place graded filter material below the *rock* should be determined by the Consultant prior to commencing grading. The gradation of the graded filter material will be determined at the time the *rock* fill is being excavated. Materials typical of the *rock* fill should be submitted to the Consultant in a timely manner, to allow design of the graded filter prior to the commencement of *rock* fill placement.
- 6.3.7 *Rock* fill placement should be continuously observed during placement by the Consultant.

7. SUBDRAINS

- 7.1 The geologic units on the site may have permeability characteristics and/or fracture systems that could be susceptible under certain conditions to seepage. The use of canyon subdrains may be necessary to mitigate the potential for adverse impacts associated with seepage conditions. Canyon subdrains with lengths in excess of 500 feet or extensions of existing offsite subdrains should use 8-inch-diameter pipes. Canyon subdrains less than 500 feet in length should use 6-inch-diameter pipes.

TYPICAL CANYON DRAIN DETAIL



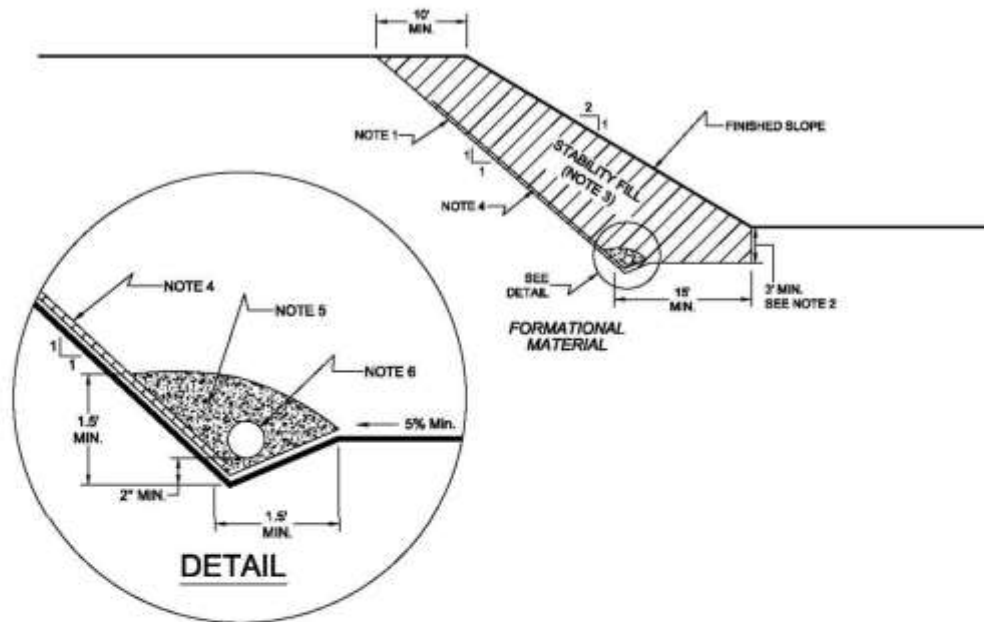
NOTES:

- 1.....8-INCH DIAMETER, SCHEDULE 80 PVC PERFORATED PIPE FOR FILLS IN EXCESS OF 100-FEET IN DEPTH OR A PIPE LENGTH OF LONGER THAN 500 FEET.
- 2.....6-INCH DIAMETER, SCHEDULE 40 PVC PERFORATED PIPE FOR FILLS LESS THAN 100-FEET IN DEPTH OR A PIPE LENGTH SHORTER THAN 500 FEET.

NO SCALE

7.2 Slope drains within stability fill keyways should use 4-inch-diameter (or larger) pipes.

TYPICAL STABILITY FILL DETAIL



NOTES:

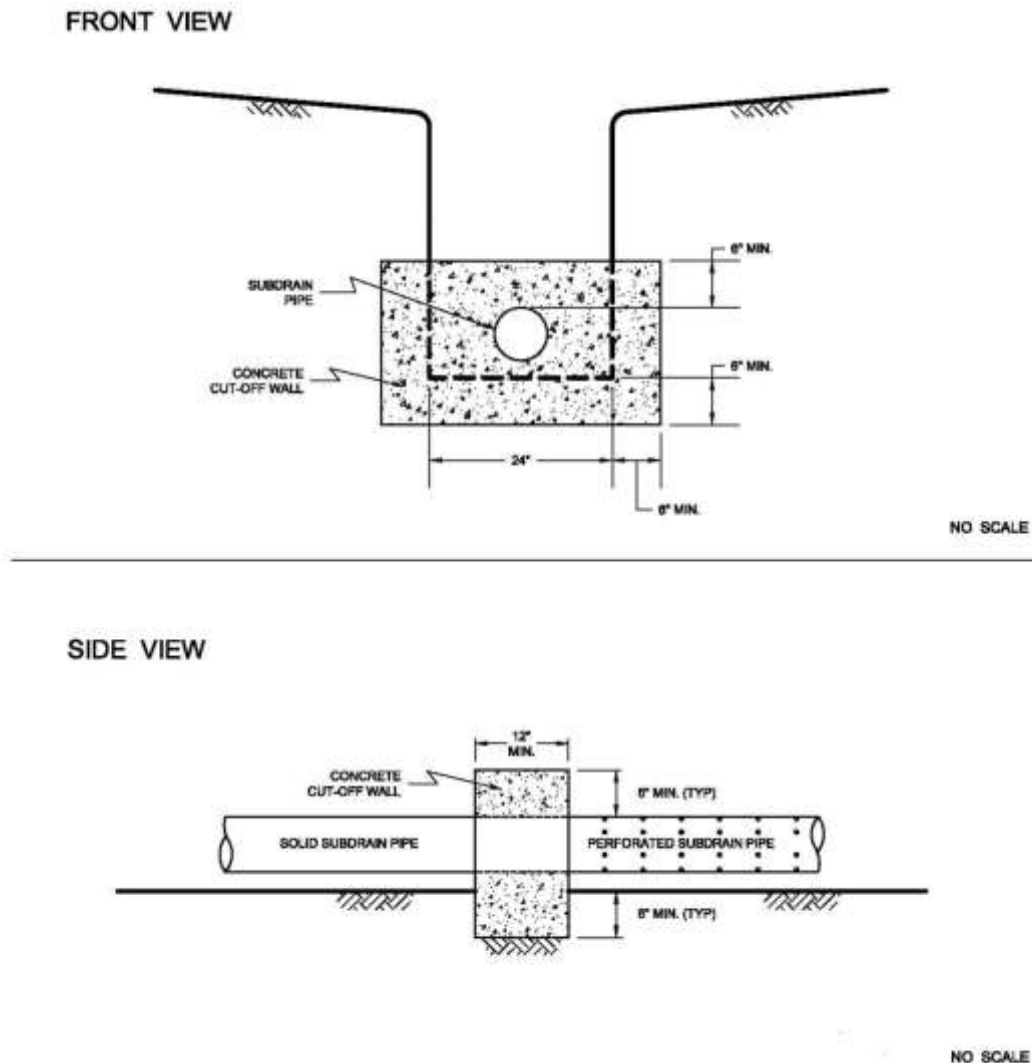
- 1.....EXCAVATE BACKCUT AT 1:1 INCLINATION (UNLESS OTHERWISE NOTED).
- 2.....BASE OF STABILITY FILL TO BE 3 FEET INTO FORMATIONAL MATERIAL, SLOPING A MINIMUM 5% INTO SLOPE.
- 3.....STABILITY FILL TO BE COMPOSED OF PROPERLY COMPACTED GRANULAR SOIL.
- 4.....CHIMNEY DRAINS TO BE APPROVED PREFABRICATED CHIMNEY DRAIN PANELS (MIRADRAIN G200N OR EQUIVALENT) SPACED APPROXIMATELY 20 FEET CENTER TO CENTER AND 4 FEET WIDE. CLOSER SPACING MAY BE REQUIRED IF SEEPAGE IS ENCOUNTERED.
- 5.....FILTER MATERIAL TO BE 3/4-INCH, OPEN-GRADED CRUSHED ROCK ENCLOSED IN APPROVED FILTER FABRIC (MIRAFI 140NC).
- 6.....COLLECTOR PIPE TO BE 4-INCH MINIMUM DIAMETER, PERFORATED, THICK-WALLED PVC SCHEDULE 40 OR EQUIVALENT, AND SLOPED TO DRAIN AT 1 PERCENT MINIMUM TO APPROVED OUTLET.

NO SCALE

- 7.3 The actual subdrain locations will be evaluated in the field during the remedial grading operations. Additional drains may be necessary depending on the conditions observed and the requirements of the local regulatory agencies. Appropriate subdrain outlets should be evaluated prior to finalizing 40-scale grading plans.
- 7.4 *Rock fill or soil-rock fill areas may require subdrains along their down-slope perimeters to mitigate the potential for buildup of water from construction or landscape irrigation. The subdrains should be at least 6-inch-diameter pipes encapsulated in gravel and filter fabric. Rock fill drains should be constructed using the same requirements as canyon subdrains.*

- 7.5 Prior to outletting, the final 20-foot segment of a subdrain that will not be extended during future development should consist of non-perforated drainpipe. At the non-perforated/perforated interface, a seepage cutoff wall should be constructed on the downslope side of the pipe.

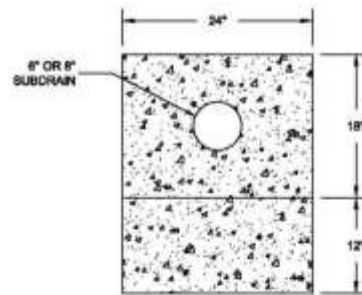
TYPICAL CUT OFF WALL DETAIL



- 7.6 Subdrains that discharge into a natural drainage course or open space area should be provided with a permanent headwall structure.

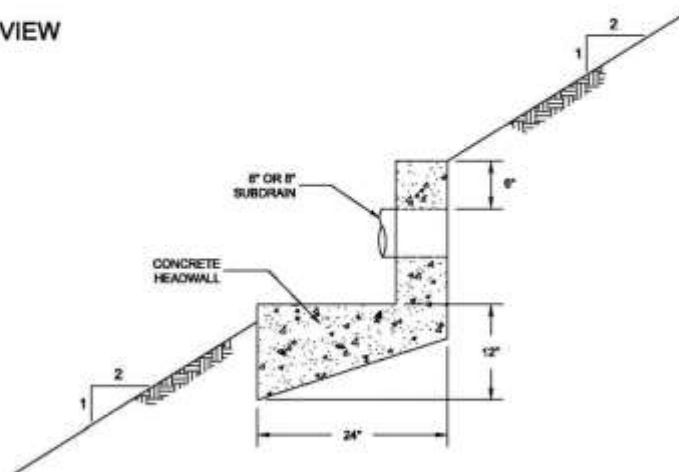
TYPICAL HEADWALL DETAIL

FRONT VIEW



NO SCALE

SIDE VIEW



NOTE: HEADWALL SHOULD OUTLET AT TOE OF FILL SLOPE
OR INTO CONTROLLED SURFACE DRAINAGE

NO SCALE

- 7.7 The final grading plans should show the location of the proposed subdrains. After completion of remedial excavations and subdrain installation, the project civil engineer should survey the drain locations and prepare an "as-built" map showing the drain locations. The final outlet and connection locations should be determined during grading operations. Subdrains that will be extended on adjacent projects after grading can be placed on formational material and a vertical riser should be placed at the end of the subdrain. The grading contractor should consider videoing the subdrains shortly after burial to check proper installation and functionality. The contractor is responsible for the performance of the drains.

8. OBSERVATION AND TESTING

- 8.1 The Consultant shall be the Owner's representative to observe and perform tests during clearing, grubbing, filling, and compaction operations. In general, no more than 2 feet in vertical elevation of *soil* or *soil-rock* fill should be placed without at least one field density test being performed within that interval. In addition, a minimum of one field density test should be performed for every 2,000 cubic yards of *soil* or *soil-rock* fill placed and compacted.
- 8.2 The Consultant should perform a sufficient distribution of field density tests of the compacted *soil* or *soil-rock* fill to provide a basis for expressing an opinion whether the fill material is compacted as specified. Density tests shall be performed in the compacted materials below any disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below that specified, the particular layer or areas represented by the test shall be reworked until the specified density has been achieved.
- 8.3 During placement of *rock* fill, the Consultant should observe that the minimum number of passes have been obtained per the criteria discussed in Section 6.3.3. The Consultant should request the excavation of observation pits and may perform plate bearing tests on the placed *rock* fills. The observation pits will be excavated to provide a basis for expressing an opinion as to whether the *rock* fill is properly seated and sufficient moisture has been applied to the material. When observations indicate that a layer of *rock* fill or any portion thereof is below that specified, the affected layer or area shall be reworked until the *rock* fill has been adequately seated and sufficient moisture applied.
- 8.4 A settlement monitoring program designed by the Consultant may be conducted in areas of *rock* fill placement. The specific design of the monitoring program shall be as recommended in the Conclusions and Recommendations section of the project Geotechnical Report or in the final report of testing and observation services performed during grading.
- 8.5 We should observe the placement of subdrains, to check that the drainage devices have been placed and constructed in substantial conformance with project specifications.
- 8.6 Testing procedures shall conform to the following Standards as appropriate:

8.6.1 Soil and Soil-Rock Fills:

- 8.6.1.1 Field Density Test, ASTM D 1556, *Density of Soil In-Place By the Sand-Cone Method*.

- 8.6.1.2 Field Density Test, Nuclear Method, ASTM D 6938, *Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)*.
- 8.6.1.3 Laboratory Compaction Test, ASTM D 1557, *Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Pound Hammer and 18-Inch Drop*.
- 8.6.1.4 Expansion Index Test, ASTM D 4829, *Expansion Index Test*.

9. PROTECTION OF WORK

- 9.1 During construction, the Contractor shall properly grade all excavated surfaces to provide positive drainage and prevent ponding of water. Drainage of surface water shall be controlled to avoid damage to adjoining properties or to finished work on the site. The Contractor shall take remedial measures to prevent erosion of freshly graded areas until such time as permanent drainage and erosion control features have been installed. Areas subjected to erosion or sedimentation shall be properly prepared in accordance with the Specifications prior to placing additional fill or structures.
- 9.2 After completion of grading as observed and tested by the Consultant, no further excavation or filling shall be conducted except in conjunction with the services of the Consultant.

10. CERTIFICATIONS AND FINAL REPORTS

- 10.1 Upon completion of the work, Contractor shall furnish Owner a certification by the Civil Engineer stating that the lots and/or building pads are graded to within 0.1 foot vertically of elevations shown on the grading plan and that all tops and toes of slopes are within 0.5 foot horizontally of the positions shown on the grading plans. After installation of a section of subdrain, the project Civil Engineer should survey its location and prepare an *as-built* plan of the subdrain location. The project Civil Engineer should verify the proper outlet for the subdrains and the Contractor should ensure that the drain system is free of obstructions.
- 10.2 The Owner is responsible for furnishing a final as-graded soil and geologic report satisfactory to the appropriate governing or accepting agencies. The as-graded report should be prepared and signed by a California licensed Civil Engineer experienced in geotechnical engineering and by a California Certified Engineering Geologist, indicating that the geotechnical aspects of the grading were performed in substantial conformance with the Specifications or approved changes to the Specifications.