REVISED FINAL GEOTECHNICAL DESIGN REPORT FOR RETAINING WALLS AT ROUTE 99/ARCH ROAD INTERCHANGE FOR SAN JOAQUIN COUNCIL OF GOVERNMENTS

Arch Road/State Route 99 Ramp Improvements
San Joaquin County, California
EA 10-1C4214; 10-SJ-99; PM 14.3/14.9

Prepared by:

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September 2016

Prepared for:

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File No. 1201.X
September 21, 2016

Martha M. Dadala, P.E.
HDR, Inc.
2379 Gateway Oaks Drive, Suite 200
Sacramento, California 95833

Subject: **REVISED FINAL GEOTECHNICAL DESIGN REPORT FOR RETAINING WALLS AT ROUTE 99/ARCH ROAD INTERCHANGE FOR SAN JOAQUIN COUNCIL OF GOVERNMENTS (SJCOG)**
Arch Road/State Route 99 Ramp Improvements
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Dear Ms. Dadala,

Blackburn Consulting (BCI) prepared this Geotechnical Design Report for the proposed Retaining Walls RW1-RW4 associated with the Arch Road/State Route 99 Ramp Improvements in San Joaquin County, California. BCI prepared this report in accordance with Amendment 1 to our June 4, 2013 Subconsultant Agreement between BCI and HDR, Inc. Thank you for the opportunity to be part of your design team. Please call us if you have questions or require additional information.

Sincerely;
BLACKBURN CONSULTING

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
DAVID J. MORRELL
No. GE 2843
GEOTECHNICAL
STATE OF CALIFORNIA

David J. Morrell, P.E., G.E.
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Principal

Copies: 2 to Addressee (Hard Copies and PDF)

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1. INTRODUCTION

1.1 Purpose

HDR, Inc. (HDR) retained Blackburn Consulting (BCI) to prepare this Revised Final Geotechnical Design Report (SPGR) for design and construction of Retaining Walls RW1-RW4 associated with the overall Arch Road/State Route 99 (SR 99) Ramp Improvements Project in San Joaquin County, California.

This report documents subsurface geotechnical conditions, provides analyses of the anticipated site conditions as they pertain to the retaining walls described herein, and recommends geotechnical design and construction criteria for Retaining Walls RW1-RW4. This report also establishes a geotechnical "baseline" to assess the existence and scope of possible changed site conditions with respect to construction of the retaining walls. BCI's scope of services did not include preparation of a Geotechnical Design Report or Materials Report for other aspects of the overall ramp improvement project.

1.2 Scope of Services

To prepare this report, BCI:

- Discussed the project with HDR.
- Reviewed preliminary layout and typical cross section plans for the walls prepared by HDR.
- Reviewed published maps and literature related to site soil and geologic conditions.
- Drilled, logged and sampled a total of 5 borings adjacent to the proposed retaining wall locations.
- Performed laboratory tests on soil samples retrieved from the borings.
- Performed engineering analysis and calculations to develop our conclusions and recommendations.

1.3 Project Location and Description

The project is located at Arch Road/SR 99 about 2 miles south of the E. Mariposa Road Overcrossing and about 3 miles north of the French Camp Road Undercrossing in San Joaquin County, California. Figure 1 presents a site Vicinity Map.

The project will widen the existing SR 99 southbound on-ramp ("AL1" Line) and northbound on-ramp ("AR3" Line) to provide maintenance vehicle pullouts and California Highway Patrol (CHP) enforcement area pullouts along the outside shoulder of the ramps. Retaining Walls RW1 to RW3 will be constructed on the southbound on-ramp and Retaining Wall RW4 will be constructed on the northbound on-ramp. The walls will be Type 1 Retaining Walls (Case 1) designed in accordance with Caltrans Revised Standard Plan RSP B3-1A (2010). Refer to the Log of Test Borings in Appendix A for the proposed wall layouts.

We describe the proposed walls in Table 1 based on information provided by HDR:

Table 1: Type 1 Retaining Wall Descriptions			
Retaining Wall No.	**Approximate Limits**	**Wall Height (ft.)**	**Notes**
RW1	**"AL1" Line Sta. 756+26 to 756+91**	**6**	Spread footing will be founded entirely within the existing 2:1 (horizontal to vertical) embankment fill slope without a level bench in front of the wall. Although wall will be designed for a 6-foot height, the actual height of new approach fill retained will be about 2 feet. The closest top edge of the footing will be at least 4 feet (horizontally) away from the finish slope face
RW2	**"AL1" Line Sta. 759+06 to 760+38**	**10-12**	Spread footing will be founded within the planned 2:1 embankment fill slope, partially on existing and new embankment fill. A level bench (2½ to 4 feet wide) will be constructed in front of the wall.
RW3	**"AL1" Line Sta. 762+49 to 763+26**	**12-14**	Spread footing will be founded within the planned 2:1 embankment fill slope, partially on existing and new embankment fill. A level bench (2½ to 4 feet wide) will be constructed in front of the wall.
RW4	**"AR3" Line Sta. 778+60 to 779+50**	**6-8**	Spread footing will be founded near the toe of the new 2:1 embankment fill slope, partially on existing and on new embankment fill. A level bench (2½ to 4 feet wide) will be constructed in front of the wall.

2. SUBSURFACE EXPLORATION PROGRAM

To characterize the site subsurface conditions, BCI retained Taber Drilling to drill and sample 5 borings (A-15-001 through A-15-005) to depths ranging from 21.5 to 26.5 feet within the existing paved shoulder areas near the proposed retaining walls. The Log of Test Borings in Appendix A show the approximate boring locations with respect to the proposed retaining wall layouts.

Taber Drilling used a CME 55 track rig to drill Borings A-15-001 through A-15-002, and a CME 75 truck rig to drill Borings A-15-003 through A-15-005. Taber Drilling used 4-inch solid stem augers to advance the borings. BCI obtained soil samples at various intervals using both a 3.0-inch O.D. Modified California (MC) sampler (equipped with 2.4-inch diameter brass liners) and a 2–inch O.D. Standard Penetration (SPT) sampler. Samples were driven with an automatic hammer, weighing 140-pounds and falling approximately 30-inches per blow. We also collected bulk composite samples from the upper 1.5 to 5 feet of the borings. Upon completion of drilling, Taber Drilling backfilled the borings with neat cement grout and patched the surface with concrete.

Kristy Chapman, our project engineer, logged the borings generally consistent with the Caltrans "Soil and Rock Logging, Classification and Presentation Manual" (2010 edition) and retained the samples for laboratory testing.

3. SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 General Project Area Geology

Literature published by the California Geological Survey (CGS) indicates that the site is located in the San Joaquin Valley within the central portion of the Great Valley Geomorphic Province. This province encompasses the San Joaquin Valley in the south and the Sacramento Valley in the north. The province is bound by the Sierra Nevada to the east, the Coast Ranges to the west, the Klamath Mountains and Cascade Range to the north.

The Great Valley is a broad, elongated, northwest trending, structural trough that has been filled with a thick sequence of sediments. The eastern margin of the valley is formed by the west sloping Sierran bedrock surface that extends westward beneath the alluvium and older sedimentary bedrock within the valley. The western border is underlain by east dipping rock of the Coast Ranges that form a deeply buried trough.

During the late Mesozoic and through most of Tertiary time (approximately 100 million to 20 million years ago), deposition of thousands of feet of marine sediments occurred within the Great Valley. Continental deposits (generally alluvium) of late Tertiary and Quaternary age (approximately 20 million years ago to the present) overlie these marine deposits. Both the continental deposits and the underlying marine sediments form a wedge of sediments that generally thickens from east to west. The accumulated thickness of the marine and continental sediments is at least several thousand feet at the site.

Mapping by the California Geologic Survey[1] shows the site is underlain by sediments of the Pleistocene-age Modesto Formation. These sediments are alluvium comprised mostly of sand, silt and clay.

[1] Geologic Map of the San Francisco-San Jose Quadrangle, 1:250,000, California Division of Mines and Geology, 1990.

3.2 Subsurface Soil Conditions

Within the southbound on-ramp borings, the existing pavement section consists of 6.5 to 7 inches of hot mix asphalt concrete, over 5 to 6 inches of aggregate base, over a layer of clayey to silty sand with gravel (possible subbase material) that extends to depths of 2 to 2.5 feet below existing grade. Beneath the pavement sections, we generally observed fill that consists of very stiff to hard, lean to fat clay to depths of 15 to 19 feet below existing grade (Elevations 29.0 to 30.0 ft., NAVD 83). Beneath the fill, we observed very stiff to hard, lean to fat clay to the maximum depths explored in these borings.

Within the northbound on-ramp borings, the existing pavement section consisted of 8 to 8.5 inches of hot mix asphalt concrete, over 6 to 7.5 inches of aggregate base, over clayey sand with gravel (possible subbase material) that extends to a depth of about 2 feet below existing grade. Beneath the pavement sections, we generally observed fill that consists of hard, lean to fat clay and dense silty sand to depths of about 8½ feet below existing grade (Elev. 28.0 ft., NAVD 83). Beneath the fill, we observed interlayered, hard fat clay, hard lean clay and medium dense silty sand to the maximum depths explored in these borings.

Appendix A includes the Log of Test Borings which contain more detailed descriptions of the subsurface conditions encountered in the borings.

3.3 Groundwater

We did not observe groundwater in any of the borings during drilling. BCI reviewed groundwater level data for nearby wells available at the California Department of Water Resources website (http://www.water.ca.gov/waterdatalibrary/). Based on this information, we estimate that the groundwater level at the site fluctuates between about Elev. -25.0 ft. to -35.0 ft., which is at least 50 feet below the existing ground surface at the site. However, relatively shallow perched water may occur within the near-surface soils during the winter and spring months.

Groundwater and perched water levels can fluctuate due to changes in precipitation, irrigation, pumping of wells, and other factors.

4. FIELD AND LABORATORY TESTING

We completed the following laboratory tests on representative soil samples obtained from the exploratory borings:

- Moisture content and dry density (ASTM D2216 / D2937)
- Plasticity Index (ASTM D4318)
- Direct Shear (ASTM D3080)
- Sulfate content (CTM 417), chloride content (CTM 422), pH (CTM 643) and resistivity testing (CTM 643)

During drilling, we performed field pocket penetrometer testing on selected samples of cohesive soil retrieved from the borings. Appendix B contains both the laboratory test results and the field pocket penetrometer test results.

5. SEISMIC DATA AND EVALUATION

5.1 Seismic Data and Geologic Hazards

5.1.1 *Ground Motion*

BCI used Caltrans ARS Online (Version 2.3.06) to evaluate seismic ground motions at the site. Based on the soil conditions encountered in the borings, and our local experience, we used a Soil Profile Type D with a V_{S30} (Small Strain Shear Wave Velocity) of 270 m/s for the analysis. Our analysis yielded a Peak Ground Acceleration (PGA) of 0.31g, which is controlled by the probabilistic spectrum (probability of exceedance equal to 5% in 50 years, a 975-year return period). A horizontal seismic acceleration coefficient (K_h) of 0.16 (half of the PGA) is appropriate for seismic wall design provided the walls can tolerate seismic movements of 1-inch or more.

5.1.2 *Liquefaction*

Liquefaction can occur when saturated, loose to medium dense, granular soils (generally within 50 feet of the surface), or specifically defined cohesive soils, are subjected to ground shaking. We consider the potential for detrimental liquefaction to be very low at the site based on the deep groundwater level, the soil encountered in our borings and the relatively low site PGA.

5.1.3 *Fault Rupture*

Based on the Caltrans ARS Online (V2.3.06) output, the closest seismic source is a portion of the Great Valley 07 (Orestimba) fault located approximately 20.4 miles (32.8 km) to the west. We consider the potential for fault rupture within the project area to be very low.

5.1.4 *Seismic Settlement*

During a seismic event, ground shaking can cause densification of granular soil above the water table that can result in settlement of the ground surface. We consider the potential for detrimental seismic settlement within the project area to be low for the native soil and properly compacted engineered fill.

5.1.5 *Seismic Slope Instability*

Based on the relatively low PGA and the soil conditions encountered in the borings, we consider the potential for seismic slope instability of engineered fill slopes constructed at typical allowable gradients of 2H:1V or flatter to be very low.

6. TYPE 1 RETAINING WALL CONCLUSIONS AND RECOMMENDATIONS

BCI evaluated Retaining Walls RW1-RW4 to determine if Caltrans Revised Standard Plan RSP B3-1A (2010) for Type 1 Retaining Walls (Case 1) is suitable for design of the walls. We present our evaluation and global stability analysis results below.

6.1 Evaluation and Suitability of Standard Plan Wall Design

Retaining Wall RW1

Based on information provided by HDR, the spread footing for Retaining Wall RW1 will be founded entirely within the existing 2:1 (horizontal to vertical) embankment fill slope without a bench in front of the wall. Although the wall will be designed for a 6-foot height, the actual height of new embankment fill retained will only be about 2 feet based on a preliminary cross section provided by HDR. In addition, HDR indicated that the closest top edge of the footing will be at least 4 feet (horizontally) away from the finish slope face.

Based on the subsurface conditions encountered in Borings A-15-003 through A-15-005 drilled within the same ramp approach fill, we anticipate that the spread footing foundation material will consist of very stiff to hard lean to fat clay (fill). We anticipate that the unconfined compressive strength of the fill is about 3 tsf or greater based on our pocket penetometer test results (see Appendix B), which exceeds the shear strength developed using the granular soil properties (friction angle of 34 degrees and unit weight of 120 pcf) used for the standard plan wall design.

In our opinion, Caltrans Revised Standard Plan RSP B3-1A (2010) can be used for Retaining Wall RW1 based on limited retained fill height, planned 4-foot distance from the footing to slope face, and the very stiff to hard soil conditions anticipated at foundation level.

Retaining Walls RW2-RW3

Based on information provided by HDR, the spread footings for Retaining Walls RW2 and RW3 will be founded within the planned 2:1 embankment fill slope, partially on existing and new embankment fill. A level bench (2½ to 4 feet wide) will be constructed in front of the walls.

We anticipate that the unconfined compressive strength of the existing fill and native clay soil is about 3 tsf or greater based on our pocket penetometer test results (see Appendix B), which exceeds the shear strength developed using the granular soil properties (friction angle of 34 degrees and unit weight of 120 pcf) used for the standard plan wall design. Considering that new fill will be placed, we used the more conservative standard plan soil properties to evaluate foundation bearing and lateral capacity for footings embedded in sloping ground.

To develop the necessary passive resistance (passive wedge) against the face of the footing toe, we recommend that the minimum footing embedment be increased to 3 feet below finish grade in front of the walls, with the top edge of the footing located no closer than 6 feet (horizontally) away from the finish slope face.

BCI evaluated spread footing bearing resistance for the Strength and Extreme Limits States using methods outlined in Section 10 (Foundations) of the AASHTO LRFD Bridge Design Specifications, 6th edition and associated January 2014 California Amendments to these specifications. For our analysis, we used the following:

- Standard plan soil properties (friction angle of 34 degrees and unit weight of 120 pcf).
- Modified bearing capacity factor for footings in cohesionless soil on sloping ground per Figure 10.6.3.1.2c-2 of the above bridge design specifications.
- Effective footing dimensions and loading conditions for standard plan wall heights of 10 and 14 feet, respectively, to capture the variation in proposed wall heights.
- BCI's above recommended minimum footing embedment and footing distance from the slope face to develop the necessary passive resistance.
- A geotechnical resistance factor of 0.45 for strength limit bearing resistance analysis, and a geotechnical resistance factor of 1.0 for the extreme limit case.

Our analysis indicates that the bearing resistance for the proposed walls exceeds the Strength and Extreme Limit State wall loads shown on the standard plan for wall heights of 14 feet or less. We evaluated wall settlement[2] for the 10-foot and 14-foot high wall case under standard plan service limit state loads and effective footing dimensions, indicating wall settlements will be nominal (less than ¼-inch) at the service limit state. Per Section 5.1.1 of this report, a horizontal seismic acceleration coefficient (Kh) of 0.16 is applicable for the site, which is less than the 0.20 value used for standard plan wall design.

We present the results of our bearing and settlement analysis in Appendix C.

Based on the above analysis, Caltrans Revised Standard Plan RSP B3-1A (2010) can be used for Retaining Walls RW2 and RW3 for heights up to 14 feet, provided our recommended footing embedment and footing distance from the slope face are incorporated into the design. In addition, all new embankment fill placed for slope construction within the retaining wall limits (and 5 feet beyond the ends of the walls) shall be structure backfill meeting the requirements of Section 8.1 of this report.

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[2] Schmertmann's Modified Method for Calculation of Immediate Settlements (1978), Soils and Foundations - Volume II, FHWA NHI-06-089, December 2006.

Retaining Wall RW4

Based on information provided by HDR, the spread footing for Retaining Wall RW4 will be founded near the toe of the new 2:1 embankment fill slope, partially on existing and new embankment fill. A level bench (2½ to 4 feet wide) will be constructed in front of the wall.

Based on our pocket penetrometer results (see Appendix B) for the cohesive soils, and the field blow counts recorded in Borings A-15-001 and A-15-002 for the silty sands, we anticipate that the insitu soil shear strength exceeds the shear strength developed using the granular soil properties (friction angle of 34 degrees and unit weight of 120 pcf) used for the standard plan wall design.

To develop the necessary passive resistance (passive wedge) against the face of the footing toe, we recommend that the minimum footing embedment be increased to 3 feet below finish grade in front of the walls, with the top of the footing located no closer than 6 feet (horizontally) away from the finish slope face.

Based on analysis performed for the taller Retaining Walls RW2 and RW3, Caltrans Revised Standard Plan RSP B3-1A (2010) can be used for Retaining Wall RW4 for heights up to 14 feet, provided our recommended footing embedment and footing distance from the slope face are incorporated into the design. In addition, all new embankment fill placed for slope construction within the retaining wall limits (and 5 feet beyond the ends of the walls) shall be structure backfill meeting the requirements of Section 8.1 of this report.

6.2 Global Stability Analysis

BCI evaluated global stability (static and pseudo-static) of Retaining Wall RW2 (12-foot wall height case) since this represents the tallest (most critical) finish slope with respect to the proposed retaining wall locations. We used the slope stability limit equilibrium program Slide 5.0 by Rocscience Inc. for our analysis. We modeled the existing clayey embankment fill with a unit weight of 125 pcf, cohesion of 2,500 psf and friction angle of zero. We modeled new embankment fill (structure backfill) with a unit weight of 120 pcf, cohesion of zero, and friction angle of 34 degrees. For pseudo-static (seismic analysis), we used a conservative horizontal seismic acceleration coefficient of 0.2g.

Our global stability analysis yielded a static safety factor of 3.7 and pseudo-static safety factor of 2.8, which are above the minimum acceptable safety factors of 1.5 (static) and 1.1 (pseudo-static). The results indicate that Retaining Walls RW1-RW4 should be globally stable.

We present our global stability analysis output in Appendix C.

6.3 Soil Corrosivity

Table 2 presents our soil corrosivity test results.

Table 2: Soil Corrosion Test Summary

Boring	Sample No.	Depth (ft)	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
A-15-002	3	10.5-11.0	380	7.97	125	308
A-15-003	3	6.5-8.0	830	8.11	49	31

Caltrans considers soils corrosive to foundation elements if one or more of the following conditions exist:

- Chloride concentration is 500 parts per million (ppm) or greater,
- Sulfate concentration is 2000 ppm or greater,
- pH is 5.5 or less.

Based on the laboratory test results, the site soils are classified as "non-corrosive" to structural wall elements according Caltrans Corrosion Guidelines (Version 2.0, November 2012).

7. CONSTRUCTION CONSIDERATIONS

7.1 Embankment Settlement Waiting Period

Based on the generally very stiff to hard clay and/or medium dense to dense silty sand encountered in the borings, a settlement waiting period is not required from the end of embankment fill placement to the beginning of retaining wall foundation construction.

7.2 Temporary Excavation and Shoring

The contractor is responsible for design and construction of excavation sloping and shoring in accordance with CalOSHA Standards.

7.3 Perched Water and Over-Optimum Soil Moisture

During the rainy season, infiltrating rain water can pond upon less permeable underlying soil creating a perched water condition. This perched water condition may extend into the late spring or early summer season. If perched groundwater or surface water is encountered, sump pumps may be required to facilitate construction.

Excessively over-optimum (wet) soil conditions can make proper compaction difficult or impossible. Wet soil is commonly encountered during the winter and spring months, or in excavations where groundwater or perched groundwater is encountered.

In general, wet soil can be mitigated by:

- Discing the soil during prolonged periods of warm, dry weather (late spring to early fall months)
- Overexcavation and replacement with drier material
- Lime treatment or stabilization using aggregate and or stabilization fabric

We anticipate that over-optimum (wet) soil conditions, and resulting unstable soil, will exist at the site from late October through late April during normal years. To avoid delays and additional costs to dry and/or stabilize subgrade and fill, we recommend scheduling grading during the drier late spring to early fall months.

If wet, unstable soil is encountered, BCI can observe the conditions and provide more specific mitigation recommendations.

7.4 Erosion

Embankment slopes and areas disrupted by grading are susceptible to erosion from surface runoff. Fill slopes will require erosion control, such as vegetation, and control of surface runoff.

8. EARTHWORK RECOMMENDATIONS AND SPECIFICATIONS

In this section, we present our recommended geotechnical specifications, and special provisions to be used in design and construction of the retaining wall portions of the project. If designers have questions or issues with any of these recommendations, or if conditions are found to be different during construction, contact BCI to determine if additional fieldwork, analysis, or recommendations are required.

Where referenced below, Standard Specifications and Standard Plans refer to the 2010 California Department of Transportation (Caltrans) Standard Specifications and Standard Plans.

Earthwork shall be performed in accordance with Section 19 of the Standard Specifications. Structural Backfill shall conform to Section 19-3 of the Standard Specifications. Clearing and Grubbing shall be performed as described and within the limits provided in Section 16 of the Standard Specifications. In addition, earthwork and structural backfill shall be in accordance with the following special provisions. If a conflict exists between the Standard Specifications and special provisions below, the special provisions govern.

8.1 Special Provision for New Embankment Fill

All new embankment fill placed for slope construction within the retaining wall limits (and 5 feet beyond the ends of the walls) shall be compacted to at least 95 percent, have a Sand Equivalent of not less than 20, and comply with the gradation requirements below:

- 100 percent passing the 3-inch Sieve.
- 90-100 percent passing the 1-inch Sieve.
- 50-100 percent passing the No. 4 Sieve.
- 15-40 percent passing the No. 200 Sieve.

The requirement of Section 19-6.03A of the Standard Specifications for cutting into the existing embankment slope at least 6 feet horizontally as each layer of new embankment fill is placed shall not be waived.

8.2 Special Provision for Footing Excavation Observation

Prior to placing reinforcing steel, all retaining wall spread footing excavations must be observed by a BCI engineer to verify that expected bearing materials have been exposed.

9. RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risks of costly design, construction, and maintenance problems can be significantly lowered by retaining the geotechnical engineer of record to provide additional services during design and construction. For this project, BCI should be retained to:

- Review and provide comments on the civil plans and specifications prior to construction.
- Monitor construction to check and document our report assumptions. At a minimum, BCI should monitor grading within retaining wall areas, retaining wall footing excavations and retaining wall backfill compaction.
- Update this report if design changes occur, 2 years or more lapses between this report and construction, and/or site conditions have changed.

If we are not retained to perform the above applicable services, we are not responsible for any other party’s interpretation of our report, and subsequent addendums, letters, and discussions

10. DIFFERING SITE CONDITIONS AND GDR LIMITATIONS

BCI based this report on the observed site conditions. We assume the soil and groundwater conditions encountered in our borings are representative of the subsurface conditions across the site. Actual conditions between boring locations can be different. If differing site conditions are encountered, contact BCI immediately to provide additional recommendations.

BCI performed services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. We do not warranty our services.

Our scope did not include evaluation of flood potential or biological pollutants. Contact BCI if you would like an evaluation of one or more of these issues.

The Log of Test Borings are presented in Appendix A. The lines designating the interface between soil types are approximate. The transition between material types may be abrupt or gradual. Our recommendations are based on the final logs, which represent our interpretation of the field logs, general knowledge of the site, and geological conditions.

Modern design and construction are complex, with many regulatory sources/restrictions, involved parties, construction alternatives, etc. It is common to experience changes and delays. The owner should set aside a reasonable contingency fund based on complexities and cost estimates to cover changes and delays.

GEOTECHNICAL DESIGN REPORT
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Arch Road/State Route 99 Ramp Improvements
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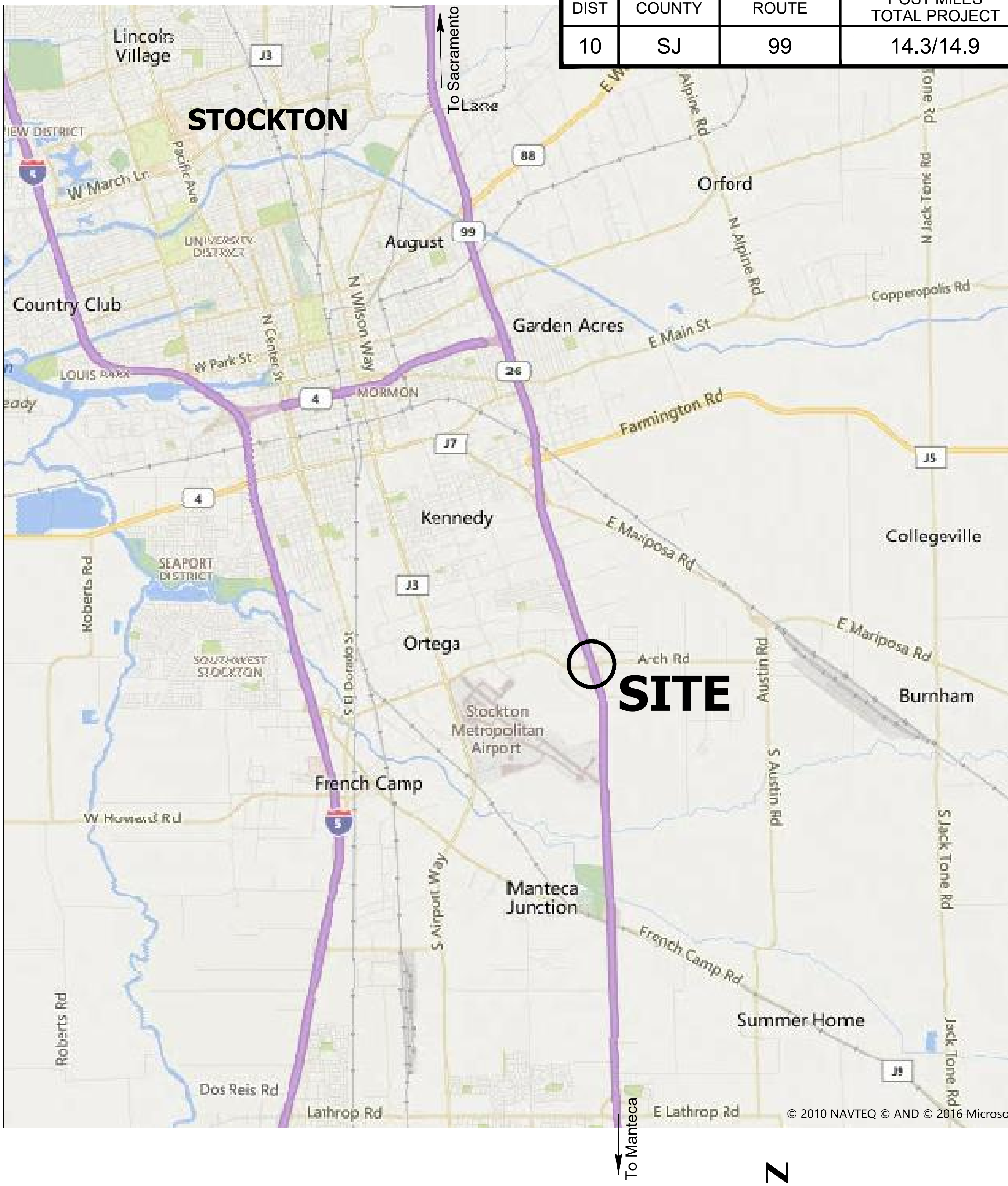
APPENDIX A

Figure 1 – Vicinity Map

Log of Test Borings-Sheets 1-2

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT
10	SJ	99	14.3/14.9



N

NO SCALE

3/28/2016 1201.x Fig1 Arch Road SR-99 Ramp Imrpovements.dwg

blackburn consulting

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VICINITY MAP

Retaining Walls at Route 99/Arch Road Interchange, EA 10-1C4214
San Joaquin County, California

File No. 1201.x

March 2016

Figure 1

NOTES:

1. Field classification of soils was in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual 2010.
2. Legends sheets are not included in plan set. See Caltrans Standard Plans, 2015 Edition, sheets A10F, A10G (soil legends), and A10H (rock legend). Sample ID is shown on the boring log as:

   Sample ID; Sample Size (in.); Blow Count — | 16 | 2.4 | 1 |

3. Standard Penetration Tests were performed in accordance with ASTM D 1586 using an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
4. Where indicated by an asterisk (*) the number of blows shown is for only that fraction of the initial 0.5 ft. "seating drive" interval penetrated.
5. If laboratory tests are not shown as being performed, the soil descriptions presented in the LOTB are based solely on the visual practices described in the before mentioned Manual.
6. The length of each sampled interval is shown graphically on the boring log.
7. Consistency of soils shown in ( ) where estimated.
8. Groundwater surface (GWS) reflect the fluid level in the borings on the specified date. Groundwater surface is subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
9. Boring elevations are approximate and based on "Topography" shown on Layout sheets referenced in note 10 below.
10. Plan view developed from Layout Sheets L-1 and L-2, dated 1/8/2016, by HDR Engineering, Inc.

BENCHMARK
BENCHMARK# 502 ELEV. 30.59 NAVD 83
DESCRIPTION: KSNCONTROLRBRC,
NORTHING 2152719.97, EASTING 6353714.81.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
10	SJ	99	14.3/14.9	38	52

REGISTERED CIVIL ENGINEER — DATE 3/28/16

REGISTERED PROFESSIONAL ENGINEER — David J. Morrell — No. 60578 — Exp. 12/31/16 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

BLACKBURN CONSULTING
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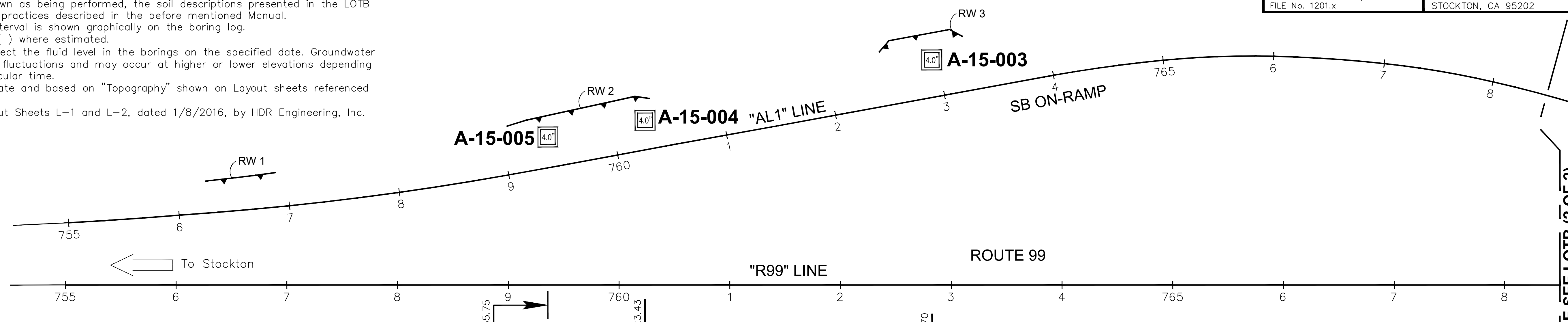
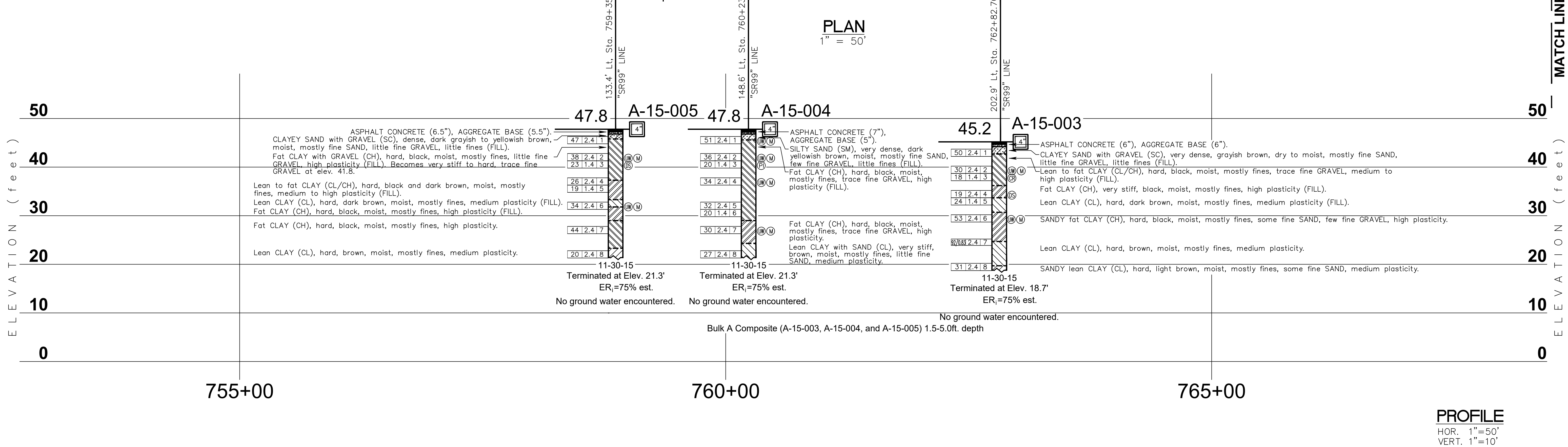
SAN JOAQUIN COUNCIL
OF GOVERNMENTS
555 E. WEBER AVE.
STOCKTON, CA 95202





SHEIKH ALAM — DESIGN OVERSIGHT — SIGN OFF DATE	DRAWN BY: M. ROBERTSON	K. A. CHAPMAN — FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	HENRY LUU — PROJECT ENGINEER
	CHECKED BY: M. WRIGHT	DATE: NOVEMBER 2015		

BRIDGE NO. — POST MILE 14.3/14.9

RETAINING WALLS NO. 1, 2, AND 3
LOG OF TEST BORINGS (1 OF 2)

GS CIVIL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 1454
PROJECT NUMBER & PHASE: 1015000131
CONTRACT NO.: 10-1C4214

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES — SHEET 38 OF 52

FILE => $REQUEST

3/28/2016 1201.x Arch Road SR-99 Ramp Improvements LOTB.dwg

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

NOTES:

1. Field classification of soils was in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual 2010.
2. Legends sheets are not included in plan set. See Caltrans Standard Plans, 2015 Edition, sheets A10F, A10G (soil legends), and A10H (rock legend). Sample ID is shown on the boring log as;

   Sample ID — Sample Size (in.) — Blow Count: | 16 | 2.4 | 1 |

3. Standard Penetration Tests were performed in accordance with ASTM D 1586 using an automated drop system. Drill rods were 1 5/8–inch diameter "A"–rods; sampler was driven with brass liners.
4. Where indicated by an asterisk (*) the number of blows shown is for only that fraction of the initial 0.5 ft. "seating drive" interval penetrated.
5. If laboratory tests are not shown as being performed, the soil descriptions presented in the LOTB are based solely on the visual practices described in the before mentioned Manual.
6. The length of each sampled interval is shown graphically on the boring log.
7. Consistency of soils shown in ( ) where estimated.
8. Groundwater surface (GWS) reflect the fluid level in the borings on the specified date. Groundwater surface is subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
9. Boring elevations are approximate and based on "Topography" shown on Layout sheets referenced in note 10 below.
10. Plan view developed from Layout Sheets L–1 and L–2, dated 1/8/2016, by HDR Engineering, Inc.

BENCHMARK
BENCHMARK# 502 ELEV. 30.59 NAVD 83
DESCRIPTION: KSNCONTROLRBRC,
NORTHING 2152719.97, EASTING 6353714.81.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
10	SJ	99	14.3/14.9	39	52

REGISTERED CIVIL ENGINEER — DATE 3/28/16

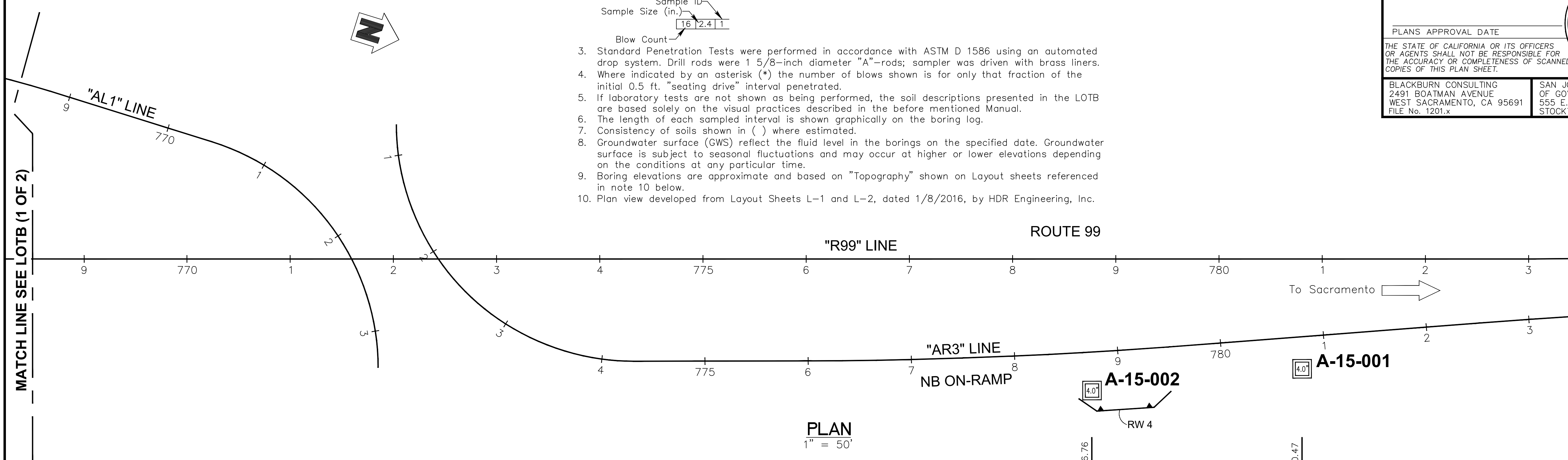
REGISTERED PROFESSIONAL ENGINEER — David J. Morrell — No. 60578 — Exp. 12/31/16 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

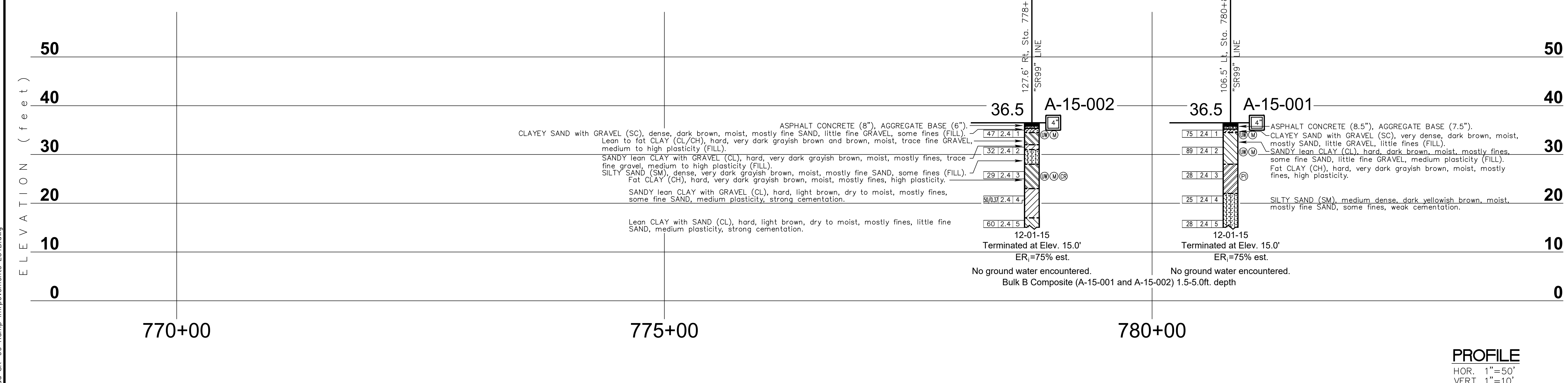
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

BLACKBURN CONSULTING
2491 BOATMAN AVENUE
WEST SACRAMENTO, CA 95691
FILE No. 1201.x

SAN JOAQUIN COUNCIL OF GOVERNMENTS
555 E. WEBER AVE.
STOCKTON, CA 95202



PLAN
1" = 50'



PROFILE
HOR. 1"=50'
VERT. 1"=10'

SHEIKH ALAM DESIGN OVERSIGHT SIGN OFF DATE	DRAWN BY: M. ROBERTSON CHECKED BY: M. WRIGHT	K. A. CHAPMAN FIELD INVESTIGATION BY: DATE: DECEMBER 2015	PREPARED FOR THE **STATE OF CALIFORNIA** DEPARTMENT OF TRANSPORTATION	HENRY LUU PROJECT ENGINEER	BRIDGE NO. POST MILE 14.3/14.9

RETAINING WALL NO. 4

LOG OF TEST BORINGS (2 OF 2)

GS CIVIL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 1454
PROJECT NUMBER & PHASE: 1015000131
CONTRACT NO.: 10–1C4214

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES — SHEET 39 OF 52

FILE => $REQUEST

3/28/2016 1201.x Arch Road SR-99 Ramp Imrpovements LOTB.dwg

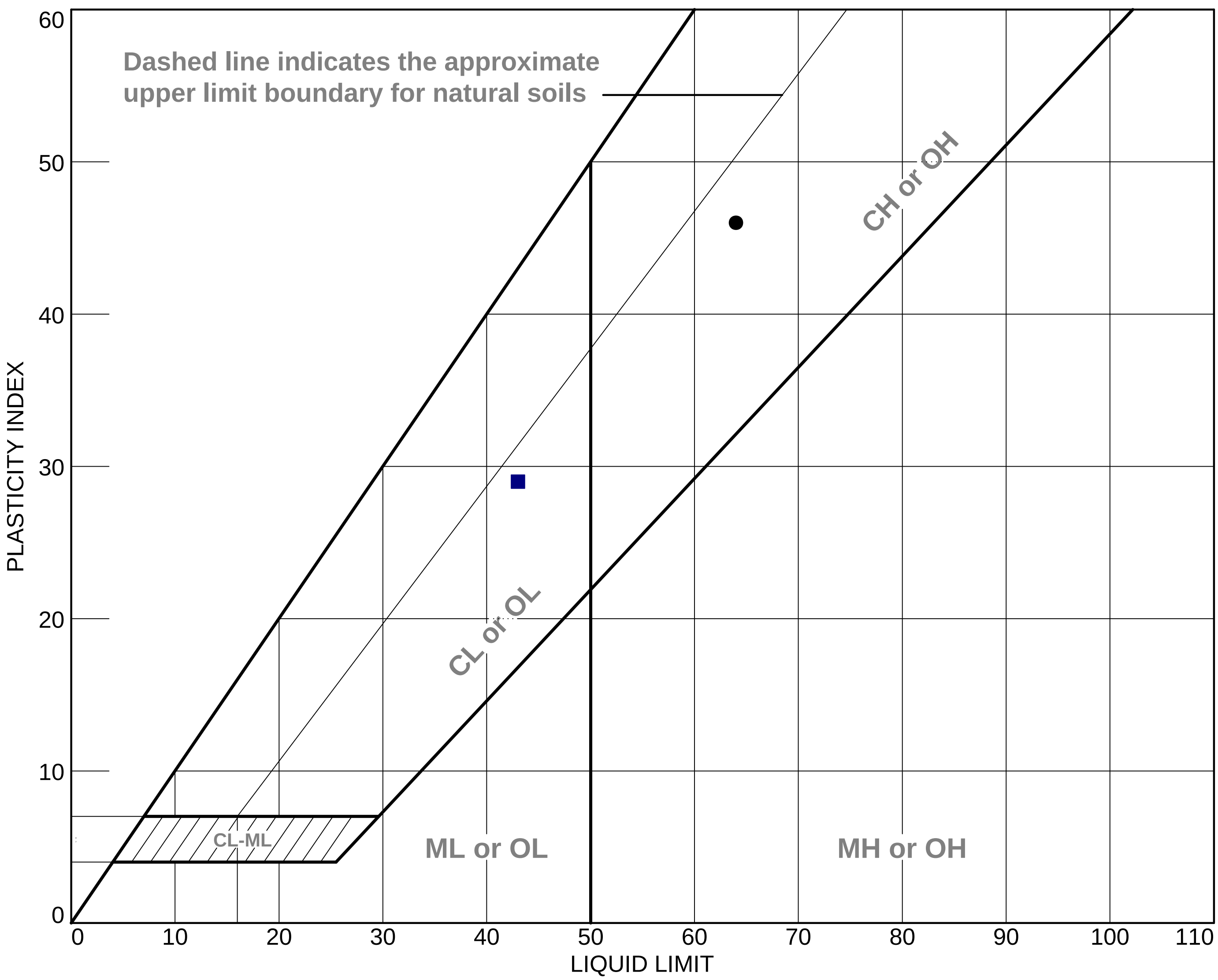
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

GEOTECHNICAL DESIGN REPORT
FOR RETAINING WALLS AT ROUTE 99/ARCH ROAD INTERCHANGE
FOR SAN JOAQUIN COUNCIL OF GOVERNMENTS
Arch Road/State Route 99 Ramp Improvements
San Joaquin County, California
EA 10-1C4214; 10-SJ-99; PM 14.3/14.9

APPENDIX B

Laboratory Results

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

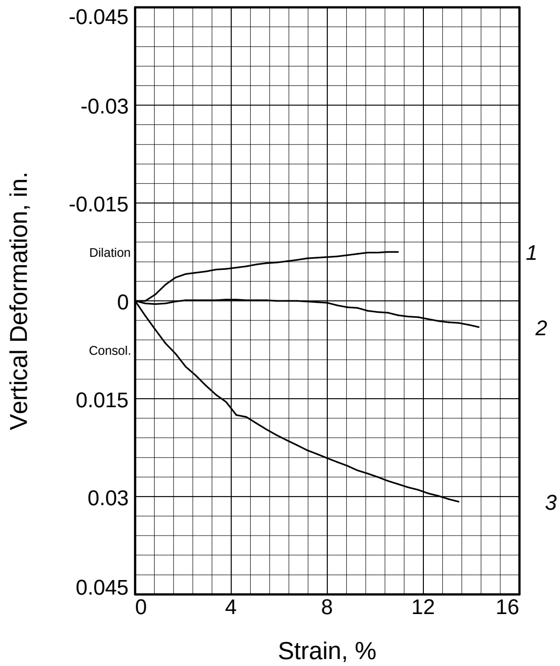
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	A-15-001	3B	10.5-11.0'		18	64	46	CH
■	A-15-004	3	6.5-8.0'		14	43	29	CL

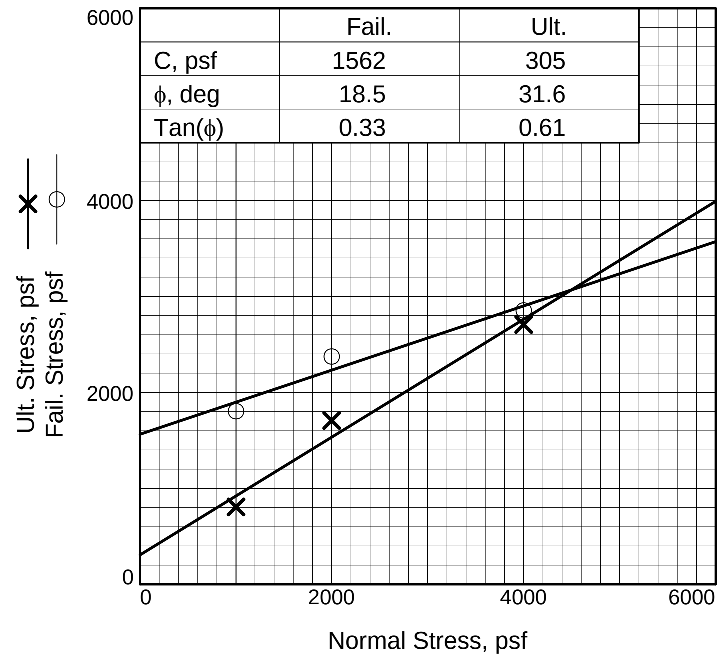
Blackburn Consulting

W. Sacramento, CA

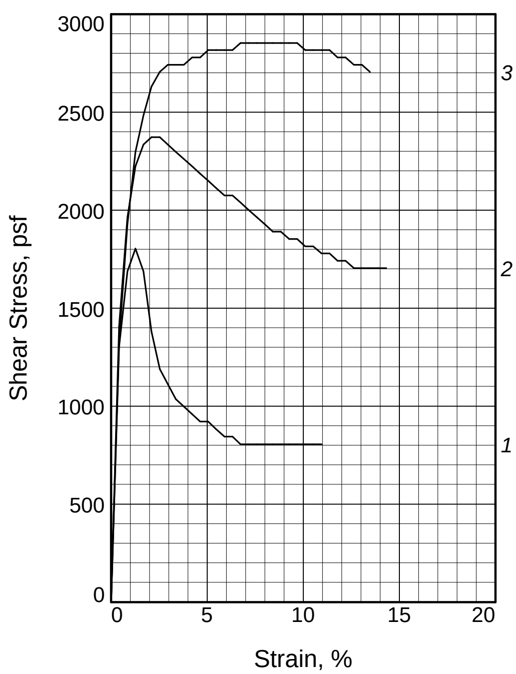
Client: HDR Inc.
Project: Arch Rd./SR99 NB and SB Diagonal On-Ramp Widening

Project No.: 1201.x **Figure**





	Fail.	Ult.
C, psf	1562	305
ϕ, deg	18.5	31.6
Tan(ϕ)	0.33	0.61



	Sample No.	1	2	3
Initial	Water Content, %	17.0	17.0	18.9
	Dry Density, pcf	108.8	108.6	105.8
	Saturation, %	83.5	83.0	86.2
	Void Ratio	0.5486	0.5519	0.5930
	Diameter, in.	2.38	2.38	2.38
	Height, in.	0.94	0.94	0.94
At Test	Water Content, %	20.5	20.0	20.5
	Dry Density, pcf	108.5	109.5	108.5
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.5530	0.5394	0.5539
	Diameter, in.	2.38	2.38	2.38
	Height, in.	0.95	0.94	0.92
	Normal Stress, psf	1000	2000	4000
	Fail. Stress, psf	1803	2372	2853
	Strain, %	1.3	2.1	6.7
	Ult. Stress, psf	805	1705	2705
	Strain, %	6.7	12.6	13.5
	Strain rate, %/min.	0.05	0.05	0.05

Sample Type: Undisturbed

Description: Fat CLAY, dark yellowish brown

Assumed Specific Gravity= 2.70

Remarks: ASTM D3080

3rd Point sampled from 4b

Figure ________

Client: HDR Inc.

Project: Arch Rd./SR99 NB and SB Diagonal On-Ramp Widening

Source of Sample: A-15-003 **Depth:** 11.0-11.5'

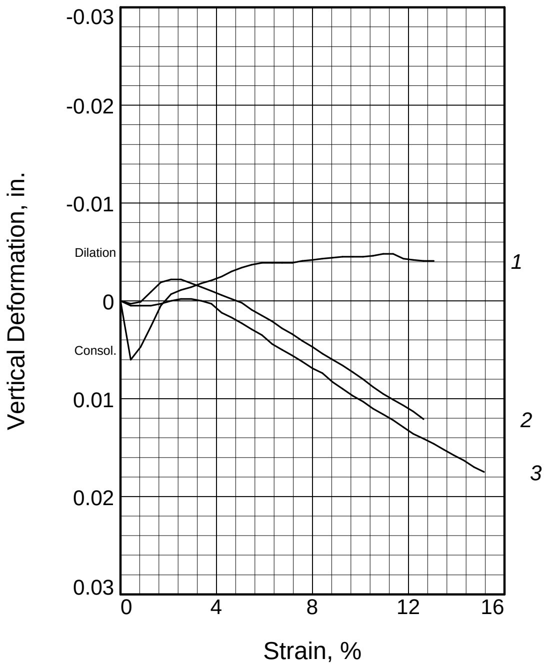
Sample Number: 4b,c

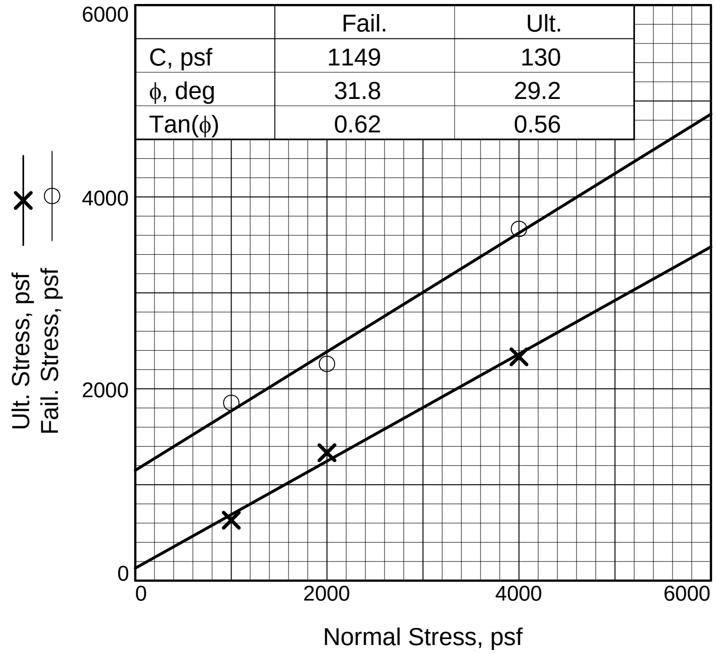
Proj. No.: 1201.x **Date Sampled:** 11/30/2015

DIRECT SHEAR TEST REPORT

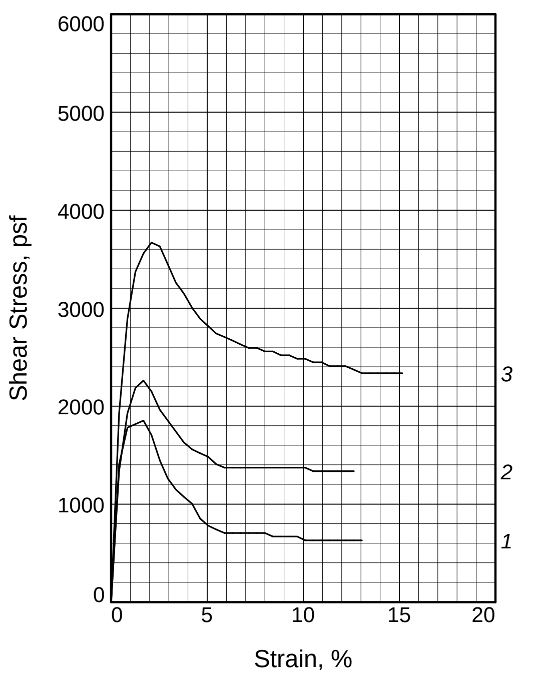
Blackburn Consulting

W. Sacramento, CA





	Fail.	Ult.
C, psf	1149	130
φ, deg	31.8	29.2
Tan(φ)	0.62	0.56



	Sample No.	1	2	3
Initial	Water Content, %	17.5	17.5	17.5
	Dry Density, pcf	107.7	105.4	108.6
	Saturation, %	83.4	78.7	85.4
	Void Ratio	0.5652	0.5986	0.5518
	Diameter, in.	2.38	2.38	2.38
	Height, in.	0.94	0.94	0.94
At Test	Water Content, %	20.9	21.8	19.7
	Dry Density, pcf	107.7	106.0	110.0
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.5652	0.5899	0.5318
	Diameter, in.	2.38	2.38	2.38
	Height, in.	0.94	0.94	0.93
	Normal Stress, psf	1000	2000	4000
	Fail. Stress, psf	1853	2260	3668
	Strain, %	1.7	1.7	2.1
	Ult. Stress, psf	630	1334	2334
	Strain, %	10.1	10.5	13.1
	Strain rate, %/min.	0.05	0.05	0.05

Sample Type: Undisturbed

Description: Lean CLAY, dark yellowish brown

Assumed Specific Gravity= 2.70

Remarks: ASTM D3080

Figure ________

Client: HDR Inc.

Project: Arch Rd./SR99 NB and SB Diagonal On-Ramp Widening

Source of Sample: A-15-005 **Depth:** 11.0-11.5'

Sample Number: 4C

Proj. No.: 1201.x **Date Sampled:** 11/30/2015

DIRECT SHEAR TEST REPORT

Blackburn Consulting
W. Sacramento, CA

Sunland Analytical
11419 Sunrise Gold Cir.#10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 12/16/15
Date Submitted 12/09/15

To: David Morrell
Blackburn Consulting
2491 Boatman Ave
West Sacramento, 95691

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

The reported analysis was requested for the following:
Location : 1201.X A-15-002 Site ID: 3B
Thank you for your business.

* For future reference to this analysis please use SUN # 70958 - 148036

EVALUATION FOR SOIL CORROSION

Soil pH	7.97		
Minimum Resistivity	0.38	ohm-cm (x1000)	
Chloride	124.5 ppm	0.0125	%
Sulfate-S	307.9 ppm	0.0308	%

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

Sunland Analytical
11419 Sunrise Gold Cir.#10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 12/16/15
Date Submitted 12/09/15

To: David Morrell
Blackburn Consulting
2491 Boatman Ave
West Sacramento, 95691

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

The reported analysis was requested for the following:
Location : 1201.X A-15-003 Site ID: 3
Thank you for your business.

* For future reference to this analysis please use SUN # 70958 - 148037

EVALUATION FOR SOIL CORROSION

Soil pH	8.11		
Minimum Resistivity	0.83	ohm-cm (x1000)	
Chloride	49.2 ppm	0.0049	%
Sulfate-S	30.9 ppm	0.0031	%

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

blackburn consulting

Project Name: SR99/Arch Road Ramp Widening
BCI File No: 1201.X
Date: 12/18/2015
Technician: RMS

MOISTURE-DENSITY TESTS

ASTM D 2216 / D 2937

Sample No.	A-15-001-1C	A-15-001-2C	A-15-002-1C	A-15-002-3C	A-15-003-2C	A-15-003-6C
Depth (ft.)	2.5-3.0	6.0-6.5	2.5-3.0	11.0-11.5	6.0-6.5	16.0-16.5
Moisture (%)	**9.5**	**8.7**	**15.2**	**21.0**	**20.9**	**5.3**
Wet Density (pcf)	**141.6**	**143.6**	**138.3**	**126.1**	**132.4**	**126.5**
Dry Density (pcf)	**129.3**	**132.1**	**120.1**	**104.2**	**109.5**	**120.2**
Pocket Pen (tsf)	**>>4.5**	**>>4.5**	**>4.5**	**4.4**	**4.0**	**4.3**

Sample: A-15-001-1C — Description: Sandy Lean Clay
Moisture (Appearance): moist — Consistency/Cementation:

Sample: A-15-001-2C — Description: Sandy Lean Clay
Moisture (Appearance): moist — Consistency/Cementation:

Sample: A-15-002-1C — Description: Lean to Fat Clay
Moisture (Appearance): moist — Consistency/Cementation:

Sample: A-15-002-3C — Description: Fat CLAY
Moisture (Appearance): moist — Consistency/Cementation:

Sample: A-15-003-2C — Description: Lean to Fat Clay
Moisture (Appearance): moist — Consistency/Cementation:

Sample: A-15-003-6C — Description: Sandy Fat Clay
Moisture (Appearance): dry — Consistency/Cementation:

Diameter = 1.44" for 1.5-inch Tubes
Diameter = 1.938" for 2-inch Tubes
Diameter = 2.43" for 2.5-inch Brass / 2.40" for SS
Diameter= 2.850" for 3.0-inch Shelby Tubes

blackburn consulting

Project Name: SR99/Arch Road Ramp Widening
BCI File No: 1201.X
Date: 12/18/2015
Technician: RMS

MOISTURE-DENSITY TESTS

ASTM D 2216 / D 2937

Sample No.	A-15-004-1C	A-15-004-2C	A-15-004-4C	A-15-004-7C	A-15-005-2C	A-15-005-6C
Depth (ft.)	2.5-3.0	6.0-6.5	11.0-11.5	21.0-21.5	6.0-6.5	16.0-16.5
Moisture (%)	**5.6**	**14.3**	**19.8**	**14.3**	**12.8**	**21.8**
Wet Density (pcf)	**130.2**	**133.4**	**129.8**	**132.8**	**130.1**	**125.6**
Dry Density (pcf)	**123.3**	**116.7**	**108.4**	**116.2**	**115.4**	**103.1**
Pocket Pen (tsf)	**2.6**	**2.3**	**3.8**	**>4.5**	**3.2**	**3.9**

Sample: A-15-004-1C Description: Fat CLAY

Moisture (Appearance): dry Consistency/Cementation:

Sample: A-15-004-2C Description: Fat CLAY

Moisture (Appearance): moist Consistency/Cementation:

Sample: A-15-004-4C Description: Fat CLAY

Moisture (Appearance): moist Consistency/Cementation: Lensing

Sample: A-15-004-7C Description: Fat CLAY

Moisture (Appearance): moist Consistency/Cementation:

Sample: A-15-005-2C Description: Fat CLAY with Gravel

Moisture (Appearance): moist Consistency/Cementation:

Sample: A-15-005-6C Description: Fat CLAY

Moisture (Appearance): moist Consistency/Cementation:

Diameter = 1.44" for 1.5-inch Tubes
Diameter = 1.938" for 2-inch Tubes

Diameter = 2.43" for 2.5-inch Brass / 2.40" for SS
Diameter= 2.850" for 3.0-inch Shelby Tubes

blackburn consulting

Project Name: Arch Road/SR 99 Ramp Improvements
Project No: 1201.X

FIELD POCKET PENETROMETER TEST RESULTS

Boring Number	Date Tested	Depth (ft.)	Unconfined Compressive Strength (TSF)
A-15-001	12/1/2015	2.5	>4.5
		6.0	>4.5
		11.0	4.0
A-15-002	12/1/2015	2.5	>4.5
		11.0	>4.5
		15.5	>4.5
		21.0	>4.5
A-15-003	11/30/2015	3.0	4.25
		6.0	>4.5
		11.0	3.25
		16.0	>4.5
		21.0	>4.5
		26.0	>4.5
A-15-004	11/30/2015	3.0	>4.5
		6.0	>4.5
		8.0	>4.5
		11.0	4.5
		16.0	3.5
		21.0	>4.5
		26.0	2.5
A-15-005	11/30/2015	3.0	>4.5
		6.5	4.0
		8.0	>4.5
		11.5	>4.5
		13.0	>4.5
		16.0	>4.5
		21.0	>4.5
		26.0	>4.5

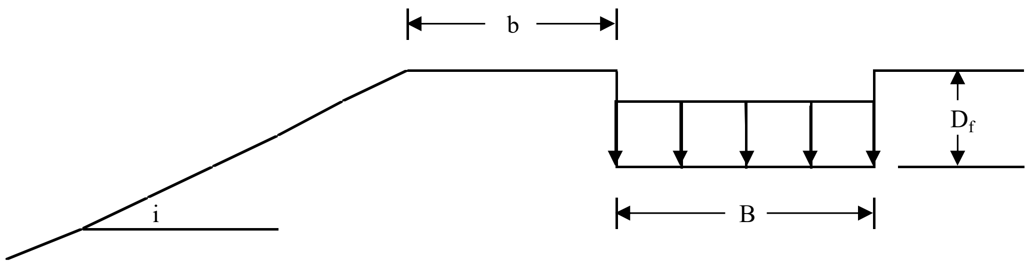
GEOTECHNICAL DESIGN REPORT
FOR RETAINING WALLS AT ROUTE 99/ARCH ROAD INTERCHANGE
FOR SAN JOAQUIN COUNCIL OF GOVERNMENTS
Arch Road/State Route 99 Ramp Improvements
San Joaquin County, California
EA 10-1C4214; 10-SJ-99; PM 14.3/14.9

APPENDIX C

Engineering Analysis Results

Modified Bearing Capacity Factor for Footing Adjacent to Sloping Ground after Meyerhof (1957)

Date:	1/21/2016
Project:	Arch Rd/SR99 Ramp Widening
Support:	RETAINING WALLS RW2 AND RW3 (10' Height Case)
Boring:	A-15-004 and A-15-005
BCI No.:	1201.X
By:	DJM



Input Parameters:

Depth to Bottom of Footing, D_f = 3.00 feet

Footing Width, B = 3.00 feet

Footing to Slope Distance, b = 2.00 feet

Slope Inclination, i = 26.6 degrees

D_f/B = 1.00 ($D/B \leq 1$)

b/B = 0.67

Soil Unit Weight, γ = 120 (pcf)

Friction Angle, ϕ = 34 ($\phi \geq 30°$)

Cohesion, c = 0 (psf)

By Interpolation:

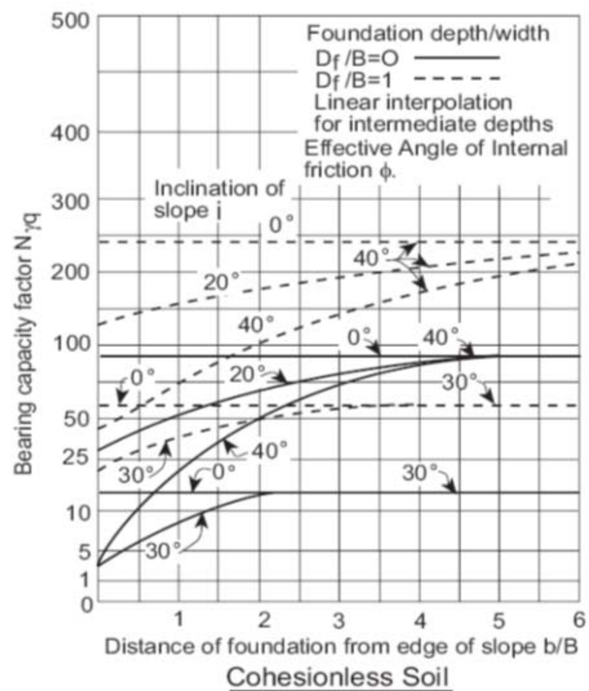
At $D_f/B = 0$

ϕ	$N\gamma q$
30	8.9
34	20.8
40	38.6

At $D_f/B = 1$

ϕ	$N\gamma q$
30	36.6
34	69.5
40	118.8

D_f/B	$N\gamma q$
0.00	20.8
1.00	**69.5**
1.00	69.5



Modified Bearing Capacity Factor:

$N\gamma q$ = **69.5**

Reference: AASHTO LRFD Bridge Design Specifications, 6th Edition (2012).

Figure 10.6.3.1.2c-2 Modified Bearing Capacity Factors for Footing in Cohesionless Soils and Adjacent to Sloping Ground after Meyerhof (1957).

Nominal Bearing Resistance and Immediate Settlement Worksheet (LRFD)

Date:	**1/21/2016**	*Support:*	**RETAINING WALLS RW2 AND RW3 (10' Height Case)**
Project:	**Arch Rd/SR99 Ramp Widening**	*Boring:*	**A-15-004 and A-15-005**
BCI No:	**1201.X**	*By:*	**DJM**
		Check by:	**PFF**
		Date:	**1/28/16**

		Effective Footing Width, B_f (feet)	Effective Footing Length, L_f (feet)
LRFD Service Limit State I Vertical Load (kips):	1286	6.0	134.0
LRFD Strength Limit State Load (kips):	1327	3.0	134.0
LRFD Extreme Event Limit State Load (kips):	1412	3.1	134.0

Ground Surface Elevation (feet):	40.0	(equal to footing bottom for a footing in fill above ex. grnd. surface)
Ground Water Elevation (feet):	-25.0	
Depth to Ground Water (feet):	65.0	(for settlement analysis)
Depth of footing (feet):	3.5	
Time to Settlement (t):	0.1	

Bottom Footing Elevation (feet):	36.5

Finished Grade (feet):	40.0	
Depth to Ground Water (feet):	65.0	(for bearing resistance analysis)
Depth of footing (feet):	3.5	
γ (pcf) =	120	Soil Parameters at base of footing
ϕ (degrees) =	34	
c (psf) =	0	
Resistance Factor (φ_b)=	0.45	

Permissible Settlement: 1.0 inch

Layer	Soil Description	Depth Bottom Layer (feet)	Layer Thickness (feet)	Top Elev. (feet)	Bottom Elev. (feet)	Soil Unit Weight (pcf)	Soil Type (1, 2, 3, or 4)	$N1_{60}$	Es (tsf)	or	Estimated Es (tsf)
1	CL/CH	25	25	40.0	15.0	125					500
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

Soil Types

1) Silts, sandy silts, slightly cohesive mixtures
2) Clean fine to medium sands and slightly silty sands
3) Coarse sands and sands with little gravel
4) Sandy gravel and gravels

Gross Nominal Bearing Resistance q_n (ksf)	Factored Gross Nominal Bearing Resistance q_R (ksf)
12.51	5.63

Gross Uniform Bearing Stress (Service Limit) q_o (ksf)	Net Bearing Stress q'o (ksf)	Gross Uniform Bearing Stress (Strength Limit) q_o (ksf)	Gross Uniform Bearing Stress (Extreme Limit) q_o (ksf)
1.60	1.16	3.30	3.40

Sevice Limit State Settlement Check 1 inch		
q'_o (ksf)	<	q_{pn} (ksf)
1.16		14.90
OKAY		

Permissible Net Contact Stress q_{pn} (ksf)	Permissible Gross Contact Stress q_{pg} (ksf)	Immediate Settlement S_i (inches)
14.90	15.34	1.00

Immediate Settlement under Net Bearing Stress due to Service Limit I State Load Combination S_i, (inches)
0.05

The Net Bearing Stress (q'_o) due to LRFD Service I load combination is used to evaluate footing settlement.

Strength Limit State Bearing Capacity Check		
q_o (ksf)	<	q_R (ksf)
3.30		5.63
OKAY		

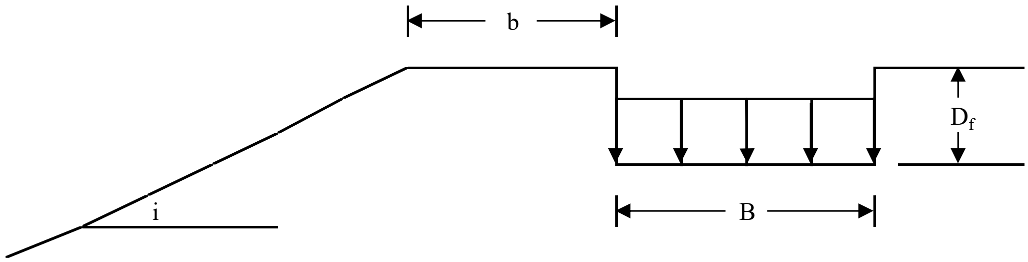
Extreme Limit State Bearing Capacity Check		
q_o (ksf)	<	q_R (ksf)
3.40		5.63
OKAY		

References
1) Caltrans, Memo To Designers 4-1 Spread Footings, April 2008.
2) Nominal Bearing Resistance Equation (10.6.3.1.2a-1)
AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012.
3) Schmertmann's Modified Method for Calculation of Immediate Settlements (1978),
Soils and Foundations - Volume II, FHWA NHI-06-089, December 2006.
4) Elastic Constants of Various Soils (Table C10.4.6.3-1)
AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012.

The Gross Uniform Bearing Stress is equivalent to the Design Load.

Modified Bearing Capacity Factor for Footing Adjacent to Sloping Ground after Meyerhof (1957)

Date:	1/21/2016
Project:	Arch Rd/SR99 Ramp Widening
Support:	RETAINING WALLS RW2 AND RW3 (14' Height Case)
Boring:	A-15-003
BCI No.:	1201.X
By:	DJM



Input Parameters:

Depth to Bottom of Footing, D_f = 3.50 feet

Footing Width, B = 4.30 feet

Footing to Slope Distance, b = 2.00 feet

Slope Inclination, i = 26.6 degrees

D_f/B = 0.81 (D/B ≤ 1)

b/B = 0.47

Soil Unit Weight, γ = 120 (pcf)

Friction Angle, ϕ = 34 (ϕ ≥ 30°)

Cohesion, c = 0 (psf)

By Interpolation:

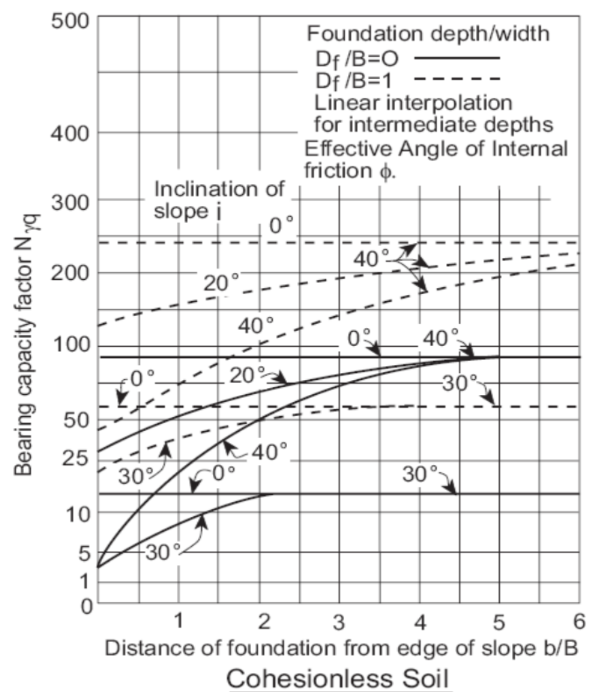
At D_f/B = 0

ϕ	Nγq
30	7.1
34	17.7
40	33.5

At D_f/B = 1

ϕ	Nγq
30	34.3
34	65.4
40	112.0

D_f/B	**Nγq**
0.00	17.7
0.81	**56.5**
1.00	65.4



Modified Bearing Capacity Factor:

Nγq = **56.5**

Reference: AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012.

Figure 10.6.3.1.2c-2 Modified Bearing Capacity Factors for Footing in Cohesionless Soils and Adjacent to Sloping Ground after Meyerhof (1957).

Nominal Bearing Resistance and Immediate Settlement Worksheet (LRFD)

Date: **1/21/2016**
Project: **Arch Rd/SR99 Ramp Widening**
BCI No: **1201.X**

Support: **RETAINING WALLS RW2 AND RW3 (14' Height Case)**
Boring: **A-15-003**
By: **DJM**
Check by: **PFF** *Date:* **1/28/16**

	Load (kips)	Effective Footing Width, B'_f (feet)	Effective Footing Length, L'_f (feet)
LRFD Service Limit State I Vertical Load (kips):	1213	7.5	77.0
LRFD Strength Limit State Load (kips):	1258	4.3	77.0
LRFD Extreme Event Limit State Load (kips):	1306	3.2	77.0

Ground Surface Elevation (feet): 35.0 (equal to footing bottom for a footing in fill above ex. grnd. surface)
Ground Water Elevation (feet): -25.0

(for settlement analysis)
Depth to Ground Water (feet): 60.0
Depth of footing (feet): 3.5
Time to Settlement (t): 0.1

Bottom Footing Elevation (feet): 31.5

(for bearing resistance analysis)
Finished Grade (feet): 35.0
Depth to Ground Water (feet): 60.0
Depth of footing (feet): 3.5

Soil Parameters at base of footing
γ (pcf) = 120
ϕ (degrees) = 34
c (psf) = 0
Resistance Factor (φ_b)= 0.45

Permissible Settlement: 1.0 inch

Layer	Soil Description	Depth Bottom Layer (feet)	Layer Thickness (feet)	Top Elev. (feet)	Bottom Elev. (feet)	Soil Unit Weight (pcf)	Soil Type (1, 2, 3, or 4)	$N1_{60}$	Es (tsf)	or	Estimated Es (tsf)
1	CL/CH	25	25	35.0	10.0	125					500
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

Soil Types
1) Silts, sandy silts, slightly cohesive mixtures
2) Clean fine to medium sands and slightly silty sands
3) Coarse sands and sands with little gravel
4) Sandy gravel and gravels

Gross Nominal Bearing Resistance q_n (ksf)	Factored Gross Nominal Bearing Resistance q_R (ksf)
14.58	6.56

Gross Uniform Bearing Stress (Service Limit) q_o (ksf)	Net Bearing Stress q'o (ksf)	Gross Uniform Bearing Stress (Strength Limit) q_o (ksf)	Gross Uniform Bearing Stress (Extreme Limit) q_o (ksf)
2.10	1.66	3.80	5.30

Sevice Limit State Settlement Check 1 inch

q'_o (ksf)	<	q_{pn} (ksf)
1.66		11.50

OKAY

Permissible Net Contact Stress q_{pn} (ksf)	Permissible Gross Contact Stress q_{pg} (ksf)	Immediate Settlement S_i (inches)
11.50	11.94	0.99

Immediate Settlement under Net Bearing Stress due to Service Limit I State Load Combination S_i, (inches)
0.10

The Net Bearing Stress (q'_o) due to LRFD Service I load combination is used to evaluate footing settlement.

Strength Limit State Bearing Capacity Check

q_o (ksf)	<	q_R (ksf)
3.80		6.56

OKAY

Extreme Limit State Bearing Capacity Check

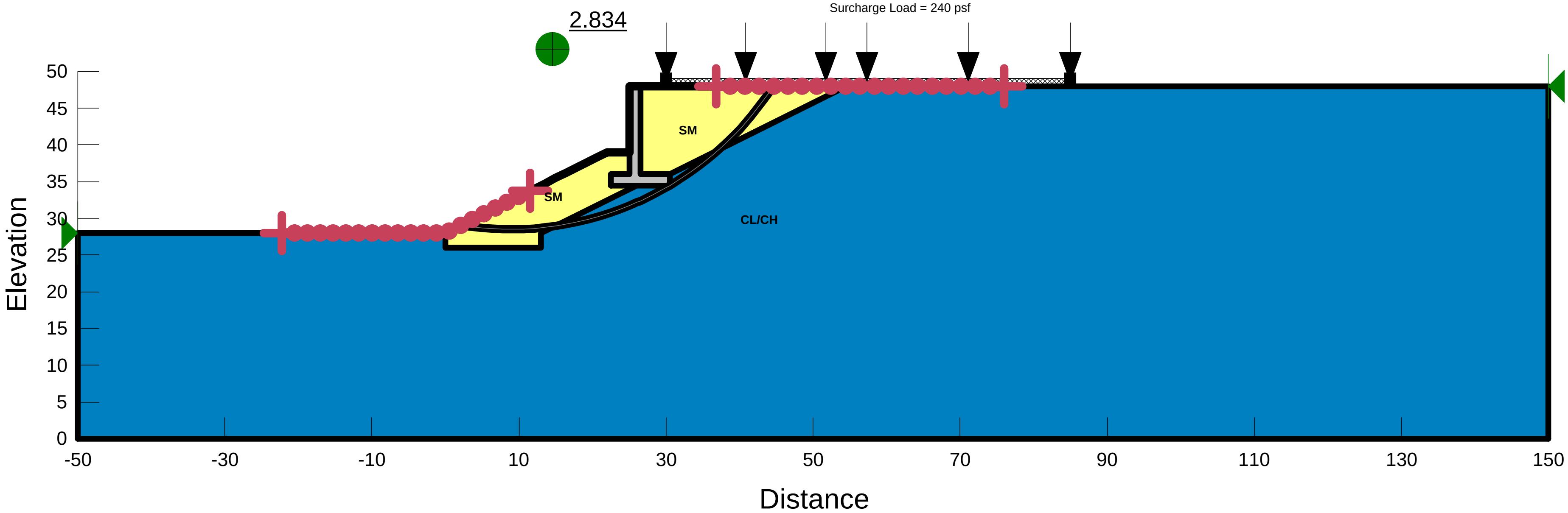
q_o (ksf)	<	q_R (ksf)
5.30		6.56

OKAY

References
1) Caltrans, Memo To Designers 4-1 Spread Footings, April 2008.
2) Nominal Bearing Resistance Equation (10.6.3.1.2a-1)
AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012.
3) Schmertmann's Modified Method for Calculation of Immediate Settlements (1978),
Soils and Foundations - Volume II, FHWA NHI-06-089, December 2006.
4) Elastic Constants of Various Soils (Table C10.4.6.3-1)
AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012.

The Gross Uniform Bearing Stress is equivalent to the Design Load.

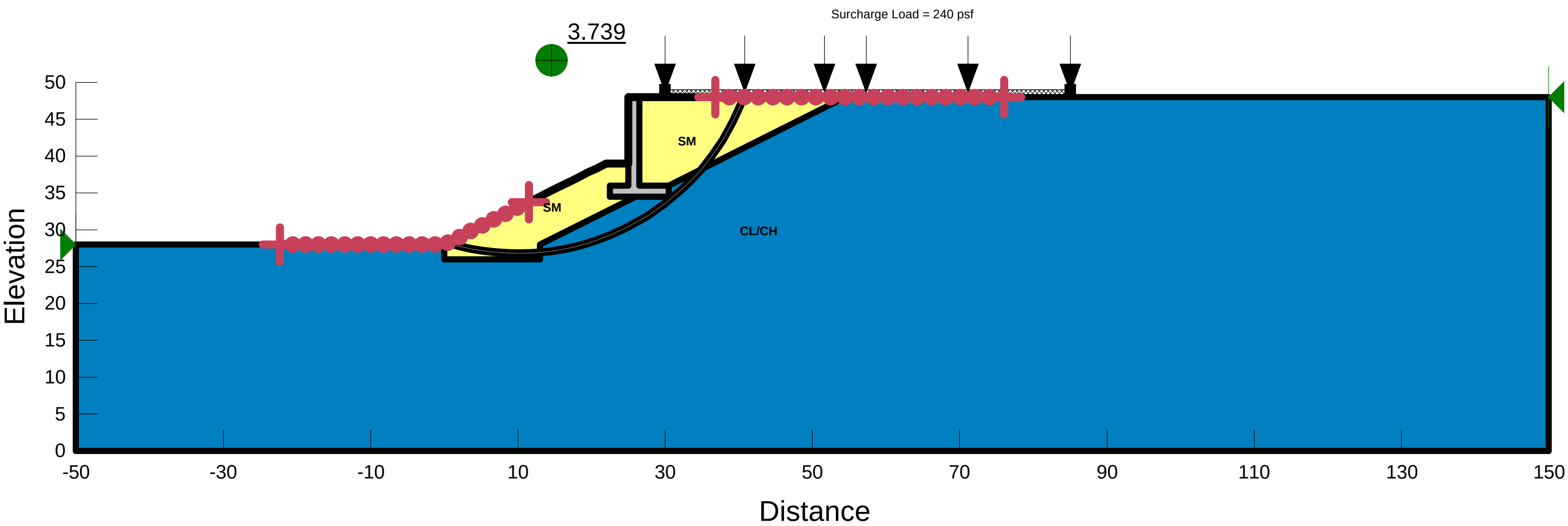
1201.X Arch Rd/SR99 Ramp Widening
Retaining WAll No. 2 Global Stability Analysis
Pseudo-Static Slope Stability Kh = 0.2g



Material Name, Unit Weight, Effective Cohesion, Effective Friction Angle

Concrete Footing	**150 pcf**	**35000 psf**	**30 °**
New Embankment Fill, Silty Sand	**120 pcf**	**0 psf**	**34 °**
Lean Clay/Fat Clay	**125 pcf**	**2500 psf**	**0 °**

1201.X Arch Rd/SR99 Ramp Widening
Retaining WAll No. 2 Global Stability Analysis
Static Slope Stability



Material Name, Unit Weight, Effective Cohesion, Effective Friction Angle

Concrete Footing	**150 pcf**	**35000 psf**	**30 °**
New Embankment Fill, Silty Sand	**120 pcf**	**0 psf**	**34 °**
Lean Clay/Fat Clay	**125 pcf**	**2500 psf**	**0 °**