FOUNDATION REPORT
RETAINING WALLS
RICHMOND-SAN RAFAEL BRIDGE ACCESS
IMPROVEMENT PROJECT
EA NO. 04-2J6800

For

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1.0 SCOPE OF WORK

The scope of work performed for this investigation included a review of the readily available soils and geologic literature pertaining to the project site; engineering analysis of the available field and laboratory data; and preparation of this report.

The purpose of this report is to evaluate the general subsurface soil conditions at the project site, to evaluate their engineering properties, and to provide foundation design recommendations for the proposed project. The approximate location of the project site is shown on the Plate No. 1A "Project Location Plan".

2.0 PROJECT DESCRIPTION

The Richmond-San Rafael Bridge Access Improvement Project ("project") proposes to convert the existing shoulders on the Richmond-San Rafael ("RSR") Bridge to accommodate bicycle and pedestrian access on the upper bridge deck (westbound), and a new vehicular travel lane on the lower deck (eastbound). Bicycle and pedestrian access on the upper deck of the RSR Bridge would be provided by installing a barrier to separate bicyclists and pedestrians from motorists.

The total length of the project is approximately 6 miles [Contra Costa County post mile (PM) R4.98 to Marin County PM 3.30]. Within the project limits there are six existing structures; San Quentin Undercrossing (Main Street) (Br. No. 27-0070), the RSR Bridge (Br. No. 28-0100), Western Drive Undercrossing (Stenmark Drive) (Br. No. 28-0141R), Scofield Avenue Undercrossing (Br. No. 28-0140 L/R), Marine Street Undercrossing (Br. No. 28-0139), and the Castro Street Undercrossing (Br. No. 28-0290 L/R/S). All proposed improvements are anticipated to be within existing highway and local street rights-of-way, except as noted below in Project Element 3. The project location is shown in Plate 1 and proposed improvements for all project elements are shown in Plate 2, Site Plan.

The project consists of three major components that are interrelated:

- Element 1: Eastbound I-580 travel lane between Marin County and Contra Costa County.
- Element 2: Bicycle/Pedestrian Path in Contra Costa County.
- Element 3: Bicycle/Pedestrian Path on the RSR Bridge and connections to the RSR Bridge.

The details of Element 1 through Element 3 of the improvements are briefly described below:

Project Element 1 – Eastbound I-580 Peak Period Use Lane (Pilot Project)

Project Element 1 of the proposed project would construct a new third travel lane by converting the existing shoulder of the eastbound lower deck of the RSR Bridge to a travel lane. The new lane will begin immediately downstream from the Main Street EB off-ramp in Marin County and terminate on the Contra Costa County side of the RSR Bridge, slightly downstream of the Marine Street/East Standard Avenue EB off-ramp in Richmond. The Bridge portion of the third lane on the lower deck will operate during peak hours only (as part of the pilot project). The exact hours of operation of the lane will be outlined in the Project Report. The off-Bridge portion of the third lane will operate 24 hours a day, 7 days per week. Electronic and static signs will be used to operate and manage the lane during the hours of operations and are included in the project description below. The third travel lane on the RSR Bridge is part of a pilot project with Project Element 3, which will run for the duration of four years and is intended to test and evaluate the performance and use of the third travel lane. After four years, the third lane on the RSR Bridge will be evaluated to determine if it is to remain a peak period use lane (PPUL), be converted to a full-time use lane, or return to function as a shoulder. All other constructed components of Project Element 1 would be permanent. The EB I-580 third lane would include the following work elements:

1) Modify roadside post mounted signage on EB I-580 and install new roadside signs.

2) Install new electronic signs on the bridge to communicate to drivers when the third travel lane may be used. Electronic Changeable Message Signs (CMS) will indicate whether the lane is open or closed.
3) Modify striping on the EB Main Street/San Quentin off-ramp to extend the existing Sir Francis Drake auxiliary lane beyond the Main Street interchange. The extension of the auxiliary lane necessitates shifting of the median barrier approximately 10 feet northerly to improve stopping sight distance for mainline eastbound traffic, at the approach to the RSR Bridge.
4) Widen Main Street between the eastbound and westbound ramps to accommodate two 5-foot Class II bike lanes, maintaining the 5-foot sidewalk. A Type 7 (L-shaped) retaining wall will be constructed on the west side (southbound side) of Main Street under I-580 (Retaining Wall No.1). This element will be a permanent feature and is not part of the pilot test.
5) Realign the EB Main Street on-ramp to merge with the proposed travel lane. A Type 7 (L-shaped) retaining wall will be constructed along the left side of the ramp (Retaining Wall No.3). Standard construction methods will be used.
6) Reconstruct the southeast corner of the Main Street/WB off-ramp intersection and the northeast corner of the Main Street/EB on-ramp intersection and construct a new sidewalk on the southeast corner of the Main Street/EB on-ramp. A new Type 7 (L-shaped) wall will be constructed at the foot of the embankment slope at the San Quentin Undercrossing. The wall will curve around the corner behind the northeast Main Street sidewalk, onto the north side of the Main Street on-ramp (Retaining Wall No.2). The southeast sidewalk will be constructed along the east side of Main Street, from the sidewalk constructed by Marin Public Works prior to this project (approximately 25 feet south of the EB on-ramp) where it will conform to the right-of-way line. The sidewalk will continue around the southeast corner of the EB on-ramp intersection and along the south side of the EB on-ramp, where a new Golden Gate Transit bus shelter will be constructed. A new Type 5 retaining wall will be constructed along the south side of the Main Street on-ramp to preserve access to the electrical substation at the Caltrans Maintenance Yard (Retaining Wall No.6).
7) Reconstruct the right shoulder in the eastbound direction to create a travel lane from the RSR Bridge to the Marine Street off-ramp (CC PM R5.43).

8) Remove the existing 362.5-foot retaining wall along EB I-580, immediately downstream of the Scofield Avenue Undercrossing. A new soil nail retaining wall will be constructed approximately 15 feet south of the existing edge of pavement (Retaining Wall No.4). The new wall will improve the stopping sight distance along mainline EB I-580. An additional soil nail retaining wall will be constructed 30 feet east of Retaining Wall No. 4, providing additional shoulder and lane width (Retaining Wall No. 7). The new wall will require the removal of 85 feet of the existing retaining wall along EB I-580. Additional shoulder and lane width requires that the 8-foot by 7-foot tunnel utility running under EB I-580 be extended by 17 feet. This includes 8 feet of tunnel extension and 9 feet of access structure. This utility tunnel is located between Retaining Walls No. 4 and No. 7.
9) Reconfigure the Marine Street off-ramp exit nose to accommodate continuation of the eastbound travel lane and widen the inside of the existing off-ramp to provide additional storage for vehicle queuing.
10) Reconfigure East Standard Avenue between Marine Street and Castro Street to change one of the two westbound lanes to an eastbound lane by reconstructing the existing median barrier approximately 12 feet northerly. A permanent, Type 60 series concrete barrier will also be installed to separate the bicycle and pedestrian path from vehicular traffic. The barrier will extend along the south side of East Standard Avenue between Marine Street and Castro Street to the existing bicycle and pedestrian paths, linking the bicycle facilities on Tewksbury Avenue and Marine Street. Minor sliver widening will be required along East Standard Avenue to accommodate the full street configuration including shoulders.
11) Modify traffic signal and intersection operations, including upgrading, replacing, or adding new controller cabinets, traffic signal posts, and other intersection control equipment at three locations: EB I-580/Marine Street off-ramp, EB East Standard Avenue/Castro Street and WB I-580/Castro Street off-ramp. It is anticipated that any controller cabinets or traffic signal poles would be installed within the existing operational transportation right-of-way.
12) Install standard loop traffic monitoring stations in the pavement of the upper and lower bridge decks.

13) Mount CCTV cameras with eastbound and westbound views along the Bridge. CCTV cameras with eastbound views will begin on I-580 East in Marin County and end at the Marine Street interchange in Contra Costa County. CCTV cameras with westbound views will begin on the westbound RSR Bridge, westerly of the Toll Plaza, and end near the Main Street off-ramp.
14) Install ramp metering at two on-ramp locations: the eastbound Main Street single-lane on-ramp and the eastbound Standard Avenue two-lane on-ramp.

All improvements for Project Element 1 will be within existing local and state right-of-way.

Element 2 – Bicycle/Pedestrian Path in Contra Costa County

The proposed Class I bi-directional bicycle and pedestrian path in Contra Costa County would be constructed along the north side of westbound (WB) I-580 from the Marine Street interchange in Contra Costa County to Stenmark Drive (formerly Western Drive) and the Toll Plaza where it would then connect to Project Element 3. The Class I bi-directional bicycle and pedestrian path would be implemented along the existing WB I-580 and Stenmark Drive shoulders and would replace the existing one-way Class III bicycle lanes on both EB and WB I-580 between Marine Street and the Toll Plaza. The proposed bi-directional bicycle and pedestrian path would be separated from vehicle traffic by a continuous concrete barrier. Implementation of the path would include the following work elements:

1) Install a Class I bi-directional path for bicycles and pedestrians separated from automobile traffic by a permanent concrete barrier. The path will begin at the existing bike lane and sidewalk on the Marine Street EB off-ramp and continue parallel with WB I-580 to the Stenmark Drive off-ramp.
2) Widen the north side of the existing Stenmark Drive off-ramp to provide an inside shoulder, a vehicle lane, an outside shoulder, a concrete barrier, and a 12-foot bi-directional bicycle/pedestrian path. A new retaining wall will be constructed along the north side of the bi-directional bicycle and pedestrian path (Retaining Wall No.5). The new wall will be set back 14 feet from the existing edge of the travel way.

Bicycle/pedestrian path improvements along Stenmark Drive between stations 1 and 3 will be no more than 3 feet deep. Standard construction methods will be used.

3) A gabion wall 8.5 feet high and approximately 54 feet long will be installed on the slope between WB 580 and the curve of the bicycle/pedestrian path, just west of Marine Street. The gabion wall will be embedded 2 feet into the ground, with a 12 degree batter.
4) Install a crosswalk at Stenmark Drive to continue the Class I bi-directional bicycle and pedestrian path further west on the south side of Stenmark Drive, where it will connect to the existing bicycle trail and to the Point Molate path being constructed by East Bay Regional Parks (separate project).
5) Replace existing railings on the Scofield Avenue Undercrossing with a Transportation Security Administration (TSA) approved visual screen (similar to a chain-link fence) or wall to physically and visually block access to the adjacent Chevron fuel pipelines. The visual screen or wall will be designed to prevent the general public from dropping objects onto Chevron's petroleum facilities below.
6) PG&E will relocate utility poles and overhead wires along Stenmark Drive to a location of their choice, within local and state right-of-way (may be underground). Currently the poles are within the footprint of the multi-use path.
7) Project Element 2 is expected to require installation of new roadside signs and relocation or removal of existing signs.

All improvements for Project Element 2 will be within existing local and state right-of-way.

Element 3 – Bicycle/Pedestrian Path on RSR Bridge and Related Connections to RSR bridge (Pilot Project)

Project Element 3 includes the continuation of the proposed Class I bi-directional bicycle and pedestrian path from the Stenmark Drive off-ramp to East Francisco Boulevard at Grange Avenue. The portion of the bi-directional bicycle and pedestrian path from Stenmark Drive to the Main Street off-ramp would be part of the pilot project that would run for four years, intended to evaluate the performance and use of a bicycle and pedestrian path on the RSR Bridge. After four years, the bi-directional bicycle and pedestrian path on the RSR Bridge may be made permanent, or may return to functioning as a shoulder. All other portions of the bike path would be permanent. Bicycle and pedestrian access improvements are also included in this project element to improve multimodal circulation and connections to the RSR Bridge. Implementation of Project Element 3 would include the following work elements:

1) Install a 10-foot wide Class I bi-directional bicycle and pedestrian path from Stenmark Drive west of the Toll Plaza Maintenance Buildings on an easement through Chevron property, connecting to the bicycle and pedestrian path on the RSR Bridge.
2) Install a 10-foot wide Class I bi-directional bicycle/pedestrian path on the westbound upper deck of the RSR Bridge, separated from motor vehicle traffic by a 42-inch moveable concrete barrier. The 18-inch wide moveable barrier would start near the end of the maintenance facility and continue across the RSR Bridge to the Marin County side of WB I-580. The barrier would be movable to provide emergency access, access for RSR Bridge maintenance, and other safety considerations.
3) Raise the outside bridge railing to approximately 48 inches above the utility tray (approximately 60 inches above the RSR Bridge deck) to provide additional fall protection for bicyclists and pedestrians. Install necessary signage to properly guide pedestrian and bicycle traffic onto and off the bike path.
4) Realign the Main Street off-ramp to continue the Class I bicycle/pedestrian path onto Francisco Boulevard between Main Street and Grange Avenue. From Grange Avenue, bicyclists and pedestrians can connect to other existing off-street and on-street routes, including the Class I San Francisco Bay Trail.
5) Install bike detection systems on the westbound upper deck of the Bridge. The bike detection system for the bicycle/pedestrian path on the Bridge will be located at the Marin side approach to the Bridge at the East Francisco Boulevard off-ramp. The bike detection system for the bicycle/pedestrian path in Contra Costa County will be located near the Toll Plaza.
6) Project Element 3 is expected to require installation of new roadside signage, and relocation or removal of existing signs.

With the exception of the segment of the bicycle/pedestrian path adjacent to the maintenance facility located on an easement to be provided by Chevron, all improvements for Project Element 3 will be located within local and state right-of-way.

This preliminary foundation report is for the retaining walls, located at Western Dr Off-Ramp and east of Scofield Avenue in Contra Costa County and located at east and west of Main St on-ramp and southbound of Main St under San Quentin Undercrossing in Marin County, California.

2.1 Existing Retaining Wall

Based on the as-built plans, we understand that existing tieback retaining wall (Bridge No. 28-0000), located east of Scofield Avenue, between approx. Sta.1021+00 ("CC-E" Line) and 1025+00 ("CC-M" Line), is approximately 362.5 feet in length. Top of the wall elevation varies from 82.3 feet to 102.0 feet. It is a tieback wall consisting of 30-inch diameter CIDH piles with a single row of tieback. The design force per tieback ranges from 65 to 120 kip according to the as-built plans (9/4/1987, Contract No. 04-118774). There are 37 CIDH piles and spacing between piles varies between 8 feet and 15.6 feet. Tip elevations of the CIDH piles vary between 50 feet and 60 feet.

2.2 Proposed Retaining Walls

Based on the plans provided by HNTB Corporation, dated March 2015, following retaining walls are proposed under the RSR Bridge Access Improvement Project. Proposed retaining wall locations are shown in Plate No. 1B "Site Map".

- Retaining wall No. 1: Northwest of Main St Undercrossing, approximately 4'-2½" from existing overcrossing bent face, between "MAIN04" Sta 4+40.66 and 6+11.11 in Marin County. Approximate length of the wall is 170'-5¾" feet and the wall height varies between 8 and 10 feet.

- Retaining wall No. 2: East corner of the intersection of Main St and Eastbound on-ramp (along the curb return), between "MAIN02" Sta 241+68.54 and 242+09.74 in Marin County. Approximate length of the wall is 68' and the height varies between 8 feet and 10 feet.

- Retaining wall No. 3: Main St/San Quentin on-ramp, between “MAIN02” Sta 242+64.00 and 243+96.91 in Marin County. This wall is located north of I-580 on-ramp. Approximate length of the wall is 132'-11" feet and the height varies between 6 and 8 feet. This wall will be constructed to realign the eastbound Main Street on-ramp to merge with the proposed travel lane and to accommodate continuation of the existing auxiliary lane beyond the interchange.

- Retaining wall No. 4: East of Scofield Ave undercrossing, between “CC-E” Sta. 1021+22.49 and “CC-M” Sta. 1026+71.51 in Contra Costa County. This wall is located south of eastbound I-580. Approximate length of the wall is 531'-8 3/8" feet and the height varies between 14 and 50 feet. We understand that existing tieback wall, which is approximately 362.5 feet, will be removed and replaced with new soil nail retaining wall. This new wall will be constructed approximately 15 feet offset from the existing wall to the south (further from existing edge of pavement) to improve the stopping sight distance along mainline eastbound I-580.

- Retaining wall No. 5: Western Dr off-ramp, between “WST” approx. Sta. 1005+60.21 and 1010+60.96 in Contra Costa County. This wall is located north of Western Dr off-ramp. Approximate length of the wall is 507'-8 5/8" and the height varies between 12 and 30 feet. This wall will be constructed to widen the right side of the existing Western Drive off-ramp to provide a 2-foot inside shoulder, a 12-foot vehicle lane, an 8-foot outside shoulder, a concrete barrier, and a 10-foot bi-directional bicycle and pedestrian path.

- Retaining wall No. 6: Main St/San Quentin on-ramp, between “MAIN02” Sta 242+04.21 and 245+42.00 in Marin County. This wall is located south of I-580 on-ramp. Approximate length of the wall is 339'-4 7/8" feet and the height varies between 6 and 12 feet. This wall will be constructed along the south side of the Main Street on-ramp to preserve access to the electrical substation at the Caltrans Maintenance Yard.

- Retaining wall No. 7: East of Scofield Ave undercrossing, between “CC-M” Sta. 1026+93.56 and Sta. 1028+25.08 in Contra Costa County. This wall is located south of eastbound I-580 and approximately 30 feet east of Retaining Wall No. 4, providing additional shoulder and lane width. The new wall will require the removal of 85 feet of the existing retaining wall along EB I-580. Approximate length of the wall is 125 feet and the height varies between 16 and 26 feet.

- Retaining wall No. 8: Based on the plans provided, we understand that new gabion wall is planned on the slope between WB 580 and the curve of the bicycle/pedestrian path, just west of Marine Street. Approximate length of the wall is 54 feet and approximate height is 8.5 feet. We also understand that earth gabion wall is considered for landscaping purpose. The proposed gabion earth wall will be on the abutment embankment.

3.0 EXCEPTION TO POLICY

For design, normal procedures were assumed for construction of the retaining walls throughout our analyses and represent one of the bases of recommendations presented herein. The recommendation of the proposed foundations has followed Caltrans policy.

4.0 FIELD INVESTIGATION AND TESTING PROGRAM

Based on the plans and discussions with the design team, 7 borings were drilled at selected locations to depths ranging from 13.5 feet to 84 feet below the existing ground surface for the proposed retaining walls.

The test borings were advanced with a truck-mounted drill rigs with energy ratio of 77% and 84%, by Geo-Ex Subsurface Exploration of Dixon, CA. The bore holes were advanced by hollow stem and solid stem auger drilling method. Selected samples were obtained from 2.5-inch I.D. (Modified California, MC) and 1.4-inch I.D. (Standard Penetration Test, SPT) samplers at various depths. The samplers were driven into subsurface soils under the impact of a 140-pound hammer having a free fall of 30 inches. In-situ testing consists of recording blow counts during sampling (using both Modified California sampler and Standard Penetration Test sampler). Based on our previous experience, when correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler may be converted equivalent SPT blow counts by multiplying a conversion factor of 0.65. The in-situ test results are presented on the LOTB attached in Appendix A. Bulk samples were collected from the soil cuttings. Pictures of core samples from boring A-16-580-012 are also attached in Appendix A.

The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation. The overall boring program is summarized in the following tables.

TABLE 1 – EXPLORATION PROGRAM

Boring No.	Approx. Location(*)	Approx. Offset(*)	Elevation (ft)	Approx. Boring Depth (ft)
A-15-580-001	"MAINO2" Line 243+00±	30± ft Lt.	32.0±	41.5
A-15-580-010	"BP1" Line 1006+25±	4± ft Lt.	50.0±	13.5
A-15-580-011	"BP1" Line 1009+35±	5± ft Lt.	40.0±	16.5
A-16-580-012	"CC-M" Line 1023+15±	158± ft Rt.	160.0±	84.0
A-15-580-013	"MAINO4" Line 4+30±	48± ft Lt.	15.0±	25.0
A-15-580-016	"MAINO2" Line 243+16±	44± ft Rt.	18.0±	45.8
A-15-580-017	"MAINO2" Line 245+08±	29± ft Rt.	22.0±	45.8

* The boring locations and elevations were not surveyed and are approximate based on the plans provided by the designer.

The approximate locations of these explorations are shown on the attached Site Plans, Plates 2A, 2B & 2C.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Geophysical Investigation

A geophysical investigation (seismic refraction) for seismic wave velocity measurement was performed for the soilnail wall relocation (RW 4) to provide data for information relevant for rippability, excavation and drilling in rock. NORCAL Geophysical Consultants, Inc performed the geophysical work. Because of the steep slope and existing small trees and bushes, the survey line was selected on the flat area located on top of the slope. The geophysical investigation results are attached in Appendix C.

5.0 LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected samples in the laboratory to evaluate the physical and engineering properties of the subsoils. The tests performed for the study include the following: Laboratory determination of Moisture (California Test Method 226), Atterberg Limits (California Test Method 204), Grain Size Analysis (California Test Method 202), Unconfined Compression Test (California Test Method 221), Compressive Strength Test for Rock Core Samples (ASTM C 42), Resistivity and pH Test (California Test Method 643), Sulfate Content (California Test Method 417), Chloride Content (California Test Method 422), and R-value Tests (California Test Method 301). The laboratory test results are attached in Appendix B.

6.0 SITE GEOLOGY AND SUBSURFACE SOIL CONDITIONS

6.1 Site Geology

General geologic features pertaining to the site were evaluated with reference to " Blake, M.C.; Graymer, R.W.; and Jones, D.L.; 2000; Geologic Map and Map Database of Parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California; U.S. Geological Survey Miscellaneous Field Studies MF 2337, Online Version 1.0 (Digital Database by Soule, A., and Graymer, R.W.) http://pubs.usgs.gov/mf/2000/2337/". Based on the geologic map, project site is mapped as artificial fill over Bay Mud (Qmf) and Late Cretaceous-age Franciscan sandstone (Kfs).

Qaf - **Artificial fill** (Quaternary): Human-placed mixture of varying character, consisting of clay, silt, sand, rock fragments, organic material, and (or) man-made debris that may be engineered or non-engineered.

Qmf - **Artificial fill over Marine and Marsh Deposits** (Quaternary): Mud, including much organic material, silty mud, silt, and sand (very soft to soft where wet) overlain by artificial fill.

Kfs – **Franciscan Sandstone and Shale** (Cretaceous): Sandstone and interbedded shale, with minor conglomerate; crops out in alternating sequence of largely medium-thick to very thick sandstone beds with generally minor interbedded shale and predominantly shale with interbedded thin to medium-thick sandstone beds; rock is locally severely sheared or brecciated but lacks tectonic inclusions of other rock types such as greenstone and chert which are common in unit fsr; thicker sandstone beds are medium- to coarse-grained arkosic wacke containing 2 to 25 percent detrital potassium feldspar, but commonly 2 to 5 percent, whereas thinner sandstone beds are fine grained, quartz rich wacke, and contain 0 to 2 percent detrital potassium feldspar; sandstone is light gray where fresh, weathering to buff colors, and shale is commonly dark gray; laumontite veins, calcite veins, and microscopic secondary prehnite and (or) pumpellyite are common in sandstone. Rocks of this unit typically form resistant topography. Bedding may be indistinct to prominent. The cut slope along the north side of the west-bound off-ramp located north of the toll plaza at the east end of the Richmond-San Rafael Bridge exposes bedding planes in Franciscan sandstone that dip steeply (60 to 70 degrees below horizontal) toward the southwest as depicted on the published map.

fsr – **Melange**: A tectonic mixture of variably sheared shale and sandstone containing (1) hard tectonic inclusions largely of greenstone, chert, graywacke, and their metamorphosed equivalents, plus exotic high-grade metamorphic rocks and serpentinite and (2) variably resistant masses of graywacke, greenstone, and serpentinite up to several miles in longest dimension, and including minor discrete masses of limestone too small to be shown. Blocks and resistant masses have survived the extensive shearing evident in the mélange's matrix, and range in abundance from less than 1 to 50 percent or more of the rock mass. The degree of shearing in the unit ranges from gouge to unsheared rock, with resistant masses relatively unsheared and matrix sheared. Severely sheared shale is abundant in areas where blocks are abundant. Fresh, relatively unsheared rock is hard, the larger resistant masses are pervasively fractured, and blocks are commonly tough and relatively unfractured. Sandstone is graywacke, grayish green where fresh, weathering to brown, commonly medium to coarse grained, containing abundant angular lithic grains and no detrital potassium feldspar, except rarely as much as 5 percent. Graywacke is locally veined with quartz and carbonate, and usually contains microscopic secondary pumpellyite. Topography of coherent masses resembles that of unit Kfs, whereas highly sheared matrix typically yields subdued, gently-rounded topography.

The general geology of the project area is shown on the Geologic Map, Plate 3A & 3B.

6.2 Subsurface Soil Conditions

The subsurface soil conditions are summarized in the following paragraphs.

– *Retaining Wall No. 1 (RW 1), approx. "MAINO4" Line Sta. 4+40.66 to 6+11.11*

Based on the boring data of Boring A-15-580-013, the subsurface soil consists of moderately to slightly weathered sandstone to the maximum explored depth of 25 feet below the existing grade (approximate elevation of -10 feet). Based on the boring data of Boring A-15-580-001, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium stiff sandy lean clay with gravel to the maximum explored depth of 41.5 feet below the existing grade (approximate elevation of -9.5 feet). As shown on Site Plan, Boring A-15-580-013 was drilled at the southern corner of Main Street off-ramp and Main Street, which is at the beginning of the proposed retaining wall. Boring A-15-

580-001 was drilled at the eastbound I-580, which is southeast of Main Street and at the top of the embankment. Based on the Geologic Map (Plate 3A), RW 1 is located in the border of artificial fill and bedrock geologic units. Therefore, based on the boring logs and geologic map, artificial fill and bedrock are anticipated at RW 1 location.

– *Retaining Wall No. 2 (RW 2), approx. "MAINO2" Line Sta. 241+68.54 to 242+09.74 & Retaining Wall No. 3 (RW 3), approx. "MAINO2" Line Sta. 242+64 to 243+96.91*

  Based on the boring data of Boring A-15-580-001, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium stiff sandy lean clay with gravel to the maximum explored depth of 41.5 feet below the existing grade (approximate elevation of -9.5 feet). RW 3 is located in existing roadway embankment. As shown on Site Plan, Boring A-15-580-001 was drilled at the eastbound I-580, at the top of the embankment.

– *Retaining Wall No. 4 (RW 4), approx. "CC-E" Line Sta. 1021+22.90 to "CC-M" Line Sta. 1026+71.51 & Retaining Wall No. 7 (RW 7), approx. "CC-M" Line Sta. 1026+93.56 to 1028+25.08*

  Based on the as-built boring data of Retaining Wall No. 317, the subsurface soil consists of fractured greywacke (weathered sandstone with prominent to dominant clay particles) was encountered to the maximum explored depth of 3 feet and 9 feet below the existing grade (approximate elevation 67 feet and 63 feet). Based on the as-built boring data of Retaining Wall at PM 5.6, the upper part of the material is primarily exhibiting the nature of sandy soil. Based on the as-built plans, we understand that as-built borings at PM 5.6 were drilled on top of the slope close to Marine Street off-ramp.

  One boring, R-15-580-012, was drilled during our current investigation at the top of the hill inside Chevron property. Based on the boring data, the subsurface soil consist of lean clay with some weathered claystone/sandstone severely fragile to the depth of 8 feet (approximate elevation 152 feet) underlain by highly weathered sandstone to slightly weathered sandstone to the depth of 84 feet (approximate elevation 76 feet).

The geophysical investigation performed on top of the office hill confirmed the rocky material at the location.

– *Retaining Wall No. 5 (RW 5), approx. "WST" Line Sta. 1005+60.21 to 1010+60.96*

  Based on the boring data of Boring A-15-580-010 and A-15-580-011, the subsurface soil consists of intensely to slightly weathered sandstone to the maximum explored depth of 13.5 feet and 16.5 feet below the existing grade (approximate elevation of 36.5 feet and 24.8 feet).

– *Retaining Wall No. 6 (RW 6), approx. "MAIN02" Line Sta. 242+04.21 to 245+42.00*

  Based on the boring data of Boring A-15-580-015 and A-15-580-016, the subsurface soil consists of loose to very dense silty sand with gravel, silty gravel with sand and poorly graded gravel with silt and sand interbedded with soft lean clay and fat clay to the depth of 23 to 40 feet below the existing grade (approximate elevation of -5 to -16 feet). Weathered sandstone was encountered below the sand and gravel layers.

– *Retaining Wall No. 8 (RW 8) on the slope between WB 580 and the curve of the bicycle/pedestrian path, just west of Marine Street*

  Based on the as-built boring data of Marine Street undercrossing, the subsurface soil, below undercrossing elevation, consists of medium stiff clays at shallow depths overlying stiff to hard clay and silty clay, and compact to dense silt and clayey silt with scattered weathered gravel and coarse sand up to the elevation between -10 feet and -28 feet, underlain by weathered sandstone and clayey shale. As noted above these borings were drilled at the underpass elevation (boring elevations are between 11 feet and 20 feet). The proposed gabion earth wall will be on the abutment embankment. The embankment should be a compacted fill embankment of Route 580 construction. Therefore compacted fill properties can be assumed for embankment fill for the gabion wall design.

Detailed descriptions of the materials encountered in the exploratory borings are presented in the LOTB in Appendix A "Log of Test Borings". It should be noted that these descriptions and related information depict subsurface conditions only at the locations indicated and on the particular date noted on the LOTB. Because of the variability from place to place within soil/rock in general, subsurface soil conditions at other locations may differ from conditions occurring at the locations explored. The abrupt stratum changes shown on the logs may be gradational and relatively minor changes in soil types within a stratum may not be noted due to field limitations. Also, the passage of time may result in a change in the soil conditions at the locations due to environmental changes.

Based on the as-built Log of Test Borings, the groundwater was encountered between approximate elevations of +90.8 feet and +93.4 feet (As-built Borings of Retaining Wall at P.M. 5.6) and approximate depths between 7 feet and 18 feet below the existing ground during drilling. That appeared to be a location on the hill side. Near the bay, the natural groundwater level is expected to be close to Elev. ~0. Groundwater was not encountered in the remaining LOTBs within the project limit.

Groundwater was encountered at elevation 7.0, -1 and 6 feet in Borings A-15-580-001, A-15-580-015 and A-15-580-016, respectively, in Marin County. Near the bay, the natural groundwater level is expected to be close to Elev. ~0.

The groundwater level is anticipated to vary with the passage of time due to seasonal groundwater fluctuations, variations in yearly rainfall, water elevations in the nearby creeks, surface and subsurface flows, ground surface run-off, and other environmental factors that may not be present at the time of the investigation. We have assumed a groundwater level at Elev. 10 feet for engineering design purposes for the walls located in Marin County.

Note that the explorations were performed during the worst drought period that California has experienced. Ground water elevation could significantly vary in the event of a ‘normal’ rainfall period or following an El Nino period. Also, since groundwater may take time to recharge or react to such changes, the potential fluctuations due the extreme conditions as noted above may or may not be observed during construction.

Therefore, for the proposed underground construction (of the trench/excavation/CIDH, etc.), it is imperative that the contractor is aware of such potential change in groundwater level and should not solely rely on such transient measurements from the boring/CPT data. It may be prudent to make conservative assumptions in the construction program to account for the potential variation.

7.0 SCOUR EVALUATION

Scour is not a concern of the proposed retaining walls.

8.0 CORROSION EVALUATION

The corrosion investigation for this project was performed in general accordance with the provisions of California Test Method 643. Chemical tests were performed on selected samples to evaluate the corrosion potential of the subsurface soil. The corrosion test results are summarized in the following table.

TABLE 2 – SUMMARY OF CORROSION TEST RESULTS

Location	Sample No.	Depth (ft)	Minimum Resistivity (ohms-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
A-15-580-001	3	11	1390	7.73	18.2	18.7
A-15-580-011	1	3	1540	6.94	22.1	34.1
A-15-580-013	1	3	2220	7.41	11.6	26.1
A-15-580-014	1	5	4560	8.05	5.1	9.0
A-15-580-015	2	6	2090	7.65	12.9	47.6
A-15-580-016	3	16	350	7.56	485.4	360.8

Note: Please refer to “Boring Program” (Table 1) or the Site Plans for the boring locations.

According to Caltrans Corrosion Guidelines, November 2012 (Version 2.0), Caltrans considers a site to be corrosive to foundation element if one of the following conditions exists for the representative soil samples taken at the site:

- Chloride concentration is greater than or equal to 500 ppm,
- Sulfate concentration is greater than or equal to 2000 ppm,
- pH is 5.5 or less.

Based on the test results, the on-site soils are classified as non-corrosive per Caltrans corrosion guidelines. Standard Type II modified or Type I-P (MS) modified cement may be used for the concrete substructures. The minimum cement factor and cover thickness should be per Caltrans Bridge Design Specifications (Section 8.22).

9.0 SEISMIC RECOMMENDATIONS

The project is located in a seismically active part of northern California. Many faults exist in the regional area. These faults are capable of producing earthquakes and may cause strong ground shaking at the site.

Maximum moment magnitudes (M_{max}) of some of the closest faults in the area are based on the 2012 ARS Online Report. These maximum moment magnitudes represent the largest earthquake a fault is capable of generating and is related to the seismic moment. The earthquake data of the active faults in the project vicinity are summarized in the table below.

TABLE 3 – EARTHQUAKE DATA

Fault (Caltrans Fault ID)	Maximum Moment Magnitude of Fault, M_{Max}	Fault Type	Approximate Rupture Distance* & Horizontal Distance* to the Surface Projection from Site, Rrup/Rx (km)
Hayward (North) (123)	7.3	Strike-Slip	7.9/0.6
San Andreas (North Coast) 2011 CFM (80)	8	Strike-Slip	19.2/19.2
San Andreas (Peninsula) 2011 CFM (134)	8	Strike-Slip	19.4/18.3
San Gregorio fault (San Gregorio section) (127)	7.4	Strike-Slip	21.6/21.6
Rodgers Creek (103)	7.3	Strike-Slip	25.9/18.6
Hayward (South) (137)	7.3	Strike-Slip	34.4/7.7

*Scofield Ave UC was taken as reference point to estimate the distances.

9.1 Seismic Design Criteria

The design spectrum was developed in accordance with the 2012 Caltrans Fault Database (Version 2b) and the Acceleration Response Spectrum (ARS) Online web tool (Version 2.3.06). The development of the design ARS curve is based on several input parameters, including site location (longitude/latitude), average shear wave velocity for the top 30m/100 feet (Vs_{30m}), and other site parameters, such as fault characteristics, site-to-fault distances. The attached Fault Map, Plate 4, presents the locations of the fault systems relative to the project site.

The current design methods incorporate both “Deterministic and Probabilistic Seismic Hazards” to produce the “Design Response Spectrum”. According to the recent Caltrans methodology, the Caltrans probabilistic response spectrum to be used for design of bridge structures is verified with the spectrum from “2008 USGS National Seismic Hazard Map” for the 5% in 50 years probability of exceedance (or 975 year return period) at periods of 0, 0.3, 1 and 3 seconds.

Average shear wave velocities (V_s) for the top 30m (100 feet) were estimated by using established correlations and the procedure provided in the “Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (November 2012)”.

<u>Retaining Wall Nos. 1, 2, 3& 6 (Located at northwest of Main St Undercrossing, East corner of the intersection of Main St and Eastbound on-ramp, north of Main St Eastbound on-ramp and south of Main St Eastbound on-ramp)</u>

Borings A-15-580-001, A-15-580-013, A-15-580-015 & A-15-580-016 data were used to calculate average shear wave velocities.

- Site Location: 37.9434ºN/ 122.4805ºW
- Estimated V_{S30m} = 450 m/s
- Anticipated Peak Ground Acceleration = 0.628g
- The recommended ARS curve is governed by Caltrans online probabilistic ARS.

The recommended design curve is presented on Plates 5A & 5B.

<u>Retaining Wall Nos. 4, 5 & 7 (located East of Scofield Ave UC and at Western Ave Off-Ramp)</u>

Borings A-15-580-010 & A-15-580-011 and as-built boring data were used to calculate average shear wave velocities.

- Site Location: 37.9321ºN/ 122.3991ºW
- Estimated V_{S30m} = 510 m/s
- Anticipated Peak Ground Acceleration = 0.677g
- The recommended ARS curve is governed by Caltrans online probabilistic ARS.

The recommended design curve is presented on Plates 6A & 6B.

<u>Retaining Wall No. 8 (located at Marine St Undercrossing)</u>

As-built boring data were used to calculate average shear wave velocities.

- Site Location: 37.9315ºN/ 122.3917ºW
- Estimated V_{S30m} = 275 m/s
- Anticipated Peak Ground Acceleration = 0.698g

- The recommended ARS curve is governed by Caltrans online probabilistic ARS.

The recommended design curve is presented on Plates 7A & 7B.

9.2 Seismic Hazards/Liquefaction Potential

9.2.1 Seismic Hazards

Potential seismic hazards may arise from three sources: surface fault rupture, ground shaking and liquefaction.

9.2.2 Seismic Ground Shaking

Based on available geological and seismic data, the possibility of the project site to experience strong ground shaking may be considered high.

9.2.3 Surface Fault Rupture

Since no active fault passes through the project site, the potential for fault rupture is relatively low.

9.2.4 Liquefaction Potential

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment for liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). As indicated by advances in soil liquefaction engineering (Bray, 2006), for soils with sufficient fines content so as to separate the coarser particles and control behavior, liquefaction appears to occur in soils where these fines are either non-plastic or are low plasticity silts and/or silty clays (PI<12%, and LL<37%), and with high water content relative to their liquid limit (w> 0.85LL).

We have evaluated the liquefaction potential along the project limit based on the boring data. The detail discussions of each segment are summarized in the following paragraphs.

– *Retaining Wall No. 1 (RW 1), approx. "MAINO4" Line Sta. 4+40.66 to 6+11.11*

  As discussed in Section 7.3, RW 1 is located in the border of artificial fill and bedrock geologic units. Therefore, based on the boring logs and geologic map, both artificial fill and bedrock are anticipated along the RW 1 location. Based on the analysis of A-15-580-001 data, potential liquefiable poorly graded gravel with clay and sand, and clayey gravel layers were identified between elevations 8 and -0.5 feet, and -5 and -8.5 feet. The estimated post-liquefaction settlement is up to 2.5 inches.

– *Retaining Wall No. 2 (RW 2), approx. "MAINO2" Line Sta. 241+68.54 to 242+09.74 & Retaining Wall No. 3 (RW 3), approx. "MAINO2" Line Sta. 242+64 to 243+96.91*

  Based on the boring data of A-14-580-001, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium still sandy lean clay with gravel. Based on the analysis of A-15-580-001 data, potential liquefiable poorly graded gravel with clay and sand, and clayey gravel layers were identified between elevations 8 and -0.5 feet, and -5 and -8.5 feet. The estimated post-liquefaction settlement is up to 2.5 inches.

– *Retaining Wall No. 4 (RW 4), approx. “CC-E” Line Sta. 1021+22.49 to “CC-M” Line Sta. 1026+71.51 & Retaining Wall No. 7 (RW 7), approx. “CC-M” Line Sta. 1026+93.56 to 1028+25.08*

Based on the as-built boring data and boring A-16-580-012, the subsurface consists of fractured greywacke (weathered sandstone with prominent to dominant clay particles), and weathered sandstone and based on our analysis, the liquefaction potential is relatively low.

– *Retaining Wall No. 5 (RW 5), approx. “WST” Line Sta. 1005+60.21 to 1010+60.96*

Based on the boring data of A-14-580-010 and A-14-580-011, the subsurface consists of intensely to slightly sandstone and based on our analysis, the liquefaction potential is relatively low.

– *Retaining Wall No. 6 (RW 6), approx. “MAIN02” Line Sta. 242+04.21 to 245+42.00*

Based on the boring data of Boring A-15-580-015 and A-15-580-016, the subsurface soil consists of loose to very dense silty sand with gravel, silty gravel with sand and poorly graded gravel with silt and sand interbedded with soft lean clay and fat clay to the depth of 23 to 40 feet below the existing grade (approximate elevation of -5 to -16 feet). The underlying rock formation appears to slope towards the east. Based on the analysis, potential liquefiable silty sand with gravel and silty gravel with sand layers were identified between elevations 16 and 5 feet, and 1 and -16 feet. The estimated post-liquefaction settlement is up to 6 inches.

– *Retaining Wall No. 8 (RW 8) on the slope between WB 580 and the curve of the bicycle/pedestrian path, just west of Marine Street*

Based on the as-built boring data of Marine Street undercrossing, the subsurface soil, below undercrossing elevation, consists of medium stiff clays at shallow depths overlying stiff to hard clay and silty clay, and compact to dense silt and clayey silt with scattered weathered gravel and coarse sand up to the elevation between -10 feet and -28 feet, underlain by weathered sandstone and clayey shale. Based on our analysis, the liquefaction potential is relatively low.

10.0 AS-BUILT DATA

<u>As-Built Foundation Data</u>

According to the as-built plans, the existing tieback wall located east of Scofield Ave undercrossing is supported on 30-inch diameter CIDH piles with a single row of tieback. There are 37 CIDH piles and spacing between piles varies between 8 feet and 15.6 feet. Tip elevations of the CIDH piles vary between 50 feet and 60 feet.

According to the as-built plans, the existing San Quentin undercrossing bridge is supported on shallow spread footing and the bottom of the footing is at elevation +6 feet. As-built plans are attached in Appendix D.

<u>As-Built Boring Data</u>

We have reviewed following as-built LOTBs of the relevant existing structures within the project limits.

a) Caltrans, LOTBs for Construction on State Highway in Contra Costa County in Richmond at 0.1 Mile East of Scofield Avenue- Retaining Wall No. 317 (Br. No. 28-0000).

b) Caltrans, LOTBs for Construction on I-580 in Richmond from Marine Street Undercrossing to 0.1 Mile South of Scofield Avenue Undercrossing - Retaining Wall at P.M. 5.6 (Br. No. 28-302M).

c) Caltrans, LOTBs for Scofield Avenue Undercrossing (Widen) (Br. No. 28-140R/L).

d) Caltrans, LOTB for Marine Street Undercrossing, (Br. No. 28-139).

As-built LOTB’s are attached in Appendix D.

11.0 FOUNDATION RECOMMENDATIONS

Foundation recommendations for the proposed retaining walls are discussed in the following sections.

Retaining Wall No. 1 (RW 1), approx. "MAINO4" Line Sta. 4+40.66 to 6+11.11

As discussed in Section 2.2, RW 1 is proposed at northwest of Main St Undercrossing, approximately 4'-2½" from existing overcrossing bent face, between "MAIN04" Sta 4+40.66 and 6+11.11 in Marin County. Approximate length of the wall is 170.5 feet and the height varies between 8 feet and 10 feet. Based on the retaining wall plans, we understand that a Type 7 retaining wall is proposed at this location.

As discussed in section 6.2, RW 1 is located in the border of artificial fill and bedrock geologic units. Based on the boring data of Boring A-15-580-001, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium stiff sandy lean clay with gravel. Based on the boring data of Boring A-15-580-013, the subsurface soil consists of moderately to slightly weathered sandstone As discussed in section 9.2, potential liquefiable layers were identified between elevations 8 and -0.5 feet, and -5 and -8.5 feet. The estimated post-liquefaction settlement is up to 2.5 inches. The existing bridge structure is supported on spread footing foundations. The existing Main Street OC is supported on shallow foundation. Based on the subsurface soil data, shallow foundation, matching the as-built foundation type may be used for the retaining wall support, but will require foundation subgrade improvement. Additional construction joints may be considered for wall construction. We recommend removing 2 feet of soil below the bottom of the footing and replacing with lean concrete base to reduce the impact of liquefaction settlement on the foundation. Lean concrete base will act as a bridging layer between liquefiable layer and the footing. Since the planned wall foundation is in close proximity of existing bent foundation, the construction may need to adopt slot construction, so that the foundation construction may be done in stages.

Per Caltrans memo, Seismic Design and Selection of Standard Retaining Walls, dated June 13, 2013, at sites with PGA greater than 0.6g, the standard plans are not applicable and the structural design should design the walls as special design walls. The wall needs to be designed as special design wall since the anticipated PGA at this wall location is more than 0.6 g.

TABLE 4 – RW 1 SPREAD FOOTING DATA TABLE

Location	Design Height (ft)	Service Limit State Permissible Net Contact Stress (ksf)	Strength Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 0.5 (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 1.00 (ksf)
"MAIN04" 4+40.66 to 6+11.11	8 to 10	2	3	6

For the wall design, other relevant parameters for wall design are summarized in the following table.

TABLE 5 – GEOTECHNICAL DESIGN PARAMETERS FOR RW 1

Design Parameters	
Design Soil Conditions & Strength Parameters	Lean Clay to Weathered Sandstone Backfill, ϕ=34° Foundation, c=1250 psf
Active Pressure EFP (pcf)	52 (2H:1V Backslope)
Passive Resistance EFP (pcf) (factored per AASHTO when combined with bottom friction)	265
Footing Bottom Friction Coefficient	0.35
Seismic Incremental Lateral Earth Pressure EFP(pcf) (regular triangular)	50

<u>Retaining Wall No. 2 (RW 2), approx. "MAINO2" Line Sta. 241+68.54 to 242+09.74</u>

As discussed in Section 2.2, RW 2 is proposed at the east corner of the intersection of Main St and Eastbound on-ramp (along the curb return), between "MAIN02" Sta 241+68.54 and 242+09.74 in Marin County. Approximate length of the wall is 68 feet and the height varies between 8 feet and 10 feet. Based on the retaining wall plans, we understand that a Type 7 retaining wall is proposed at this location.

As discussed in sections 6.2, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium stiff sandy lean clay with gravel. As discussed in section 9.2, potential liquefiable layers were identified between elevations 8 and -0.5 feet, and -5 and -8.5 feet. The estimated post-liquefaction settlement is up to 2.5 inches. The existing bridge structure is supported on spread footing foundations. Based on the subsurface soil data, shallow foundation, matching the as-built foundation type may be used for the retaining wall support, but will require foundation subgrade improvement. Additional construction joints may be considered for wall construction. We recommend removing 2 feet of soil below the bottom of the footing and replacing with lean concrete base to reduce the impact of liquefaction settlement on the foundation. Lean concrete base will act as a bridging layer between liquefiable layer and the footing.

As discussed above, at sites with PGA greater than 0.6g, the standard plans are not applicable and the structural design should design the walls as special design walls. The wall needs to be designed as special design wall since the anticipated PGA at this wall location is more than 0.6 g.

TABLE 6 – RW 2 SPREAD FOOTING DATA TABLE

Location	Design Height (ft)	Service Limit State Permissible Net Contact Stress (ksf)	Strength Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 0.5 (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 1.00 (ksf)
"MAIN02" 241+68.54 to 242+09.74	8 to 10	2	3	6

For the wall design, other relevant parameters for wall design are summarized in the following table.

TABLE 7 – GEOTECHNICAL DESIGN PARAMETERS FOR RW 2

Design Parameters	
Design Soil Conditions & Strength Parameters	Lean Clay, Backfill, ϕ=34° Foundation, c=1250 psf
Active Pressure EFP (pcf)	52 (2H:1V Backslope)
Passive Resistance EFP (pcf) (factored per AASHTO when combined with bottom friction)	265
Footing Bottom Friction Coefficient	0.35
Seismic Incremental Lateral Earth Pressure EFP(pcf) (regular triangular)	50

Retaining Wall No. 3 (RW 3), approx. "MAINO2" Line Sta. 242+64 to 243+96.91

As discussed in Section 2.2, RW 3 is proposed at Main St/San Quentin on-ramp, between "MAIN02" Sta 242+64 and 243+96.91 in Marin County. This wall is located north of I-580 on-ramp. Approximate length of the wall is 132.9 feet and the height varies between 6 and 8 feet. This wall will be constructed to realign the eastbound Main Street on-ramp to merge with the proposed travel lane and to accommodate continuation of the existing auxiliary lane beyond the interchange. Based on the retaining wall plans, we understand that Type 7 retaining wall is proposed at this location.

As discussed in sections 6.2, the subsurface soil consists of medium dense to dense clayey gravel and poorly graded gravel with clay and sand interbedded with medium stiff sandy lean clay with gravel. As discussed in section 9.2, potential liquefiable layers were identified between elevations 8 and -0.5 feet, and -5 and -8.5 feet. The estimated post-liquefaction settlement is up to 2.5 inches in the general area. Since RW 3 footing will be on the existing embankment, there will be enough bridging layer between liquefiable layers and the footing. Therefore, shallow footing may be used for support of RW 3. Additional construction joints may be considered for wall construction.

As discussed above, at sites with PGA greater than 0.6g, the standard plans are not applicable and the structural design should design the walls as special design walls. The wall needs to be designed as special design wall since the anticipated PGA at this wall location is more than 0.6 g.

TABLE 8 – RW 3 SPREAD FOOTING DATA TABLE

Location	Design Height (ft)	Service Limit State Permissible Net Contact Stress (ksf)	Strength Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 0.5 (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 1.00 (ksf)
"MAIN02" 242+64 to 243+96.91	6 to 8	4	5	10

For the wall design, other relevant parameters for wall design are summarized in the following table.

TABLE 9 – GEOTECHNICAL DESIGN PARAMETERS FOR RW 3

Design Parameters	
Design Soil Conditions & Strength Parameters	Poorly graded gravel with clay and sand (Embankment) Backfill, ϕ=34˚ Foundation, ϕ=34˚
Active Pressure EFP (pcf)	75 (1.7H:1V Backslope)
Passive Resistance EFP (pcf) (factored per AASHTO when combined with bottom friction)	325
Footing Bottom Friction Coefficient	0.35
Seismic Incremental Lateral Earth Pressure EFP(pcf) (regular triangular)	70

<u>Retaining Wall No. 4 (RW 4), approx. "CC-E" Line Sta. 1021+22.49 to "CC-M" Line Sta.1026+71.51</u>

The existing tieback wall consists of 30-inch diameter CIDH piles with a single row of tieback. In order to improve the sight distance for the traffic of Route 580 EB, the planned new wall will be in similar alignment of the existing wall but relocated approx. 15 feet to the south (further to the hillside). The maximum height of the existing wall is about 30 feet above Route 580 grade, and the wall height tapers down at the beginning and end of the wall. The terrain ascends at about 1.5H:1V slope gradient above the wall to Elev. 159 feet by Chevron property. The existing slope is covered with vegetation and many trees. Geological data, as-built LOTB and field observation indicate that the subsurface consists of fractured greywacke, and weathered sandstone and shale (Kfs).

As discussed in Section 2.2, RW 4 is proposed at east of Scofield Ave undercrossing, between "CC-E" Sta. 1021+22.49 and "CC-M" Sta. 1026+71.51 in Contra Costa County. This wall is located south of eastbound I-580. Approximate length of the wall is 531.7 feet and the height varies between 14 and 50 feet. As mentioned above, the existing tieback wall is about 362.5 feet. This new wall will be constructed approximately 15 feet offset from the existing wall to the south (further from existing edge of pavement) to improve the stopping sight distance along mainline eastbound I-580.

Due to the existing steep terrain on the south side and busy traffic of Route 580 on the north side, constructability and access appear to be challenging for the new construction. From a geotechnical standpoint, we have summarized the considerations in the following:

- We have consulted with a specialty contractor and the designer regarding the wall type for the project. Due to the site constraints and limitations (steep slope on the hillside and Route 580 on the other side), the only access for construction is from the shoulder of Route 580. The available physical clearance for construction does not permit the use of equipment that is capable of installing CIDH soldier piles into the native rocky material. As the native material consists of primarily sandy soil (either highly weathered rock or man-made fill from previous Chevron development) on the upper part overlying native sandstone / siltstone material, base stability is not a design concern. After many discussions with the designer and specialty contractor, it was concluded that a soil nail wall designed in sandy soil is feasible at the site.

- Traffic impact / lane closure of existing Route 580 is expected if the construction has to be from the existing wall face.

- We anticipate that the new wall construction and removing of the existing wall will be "top down" and in stages. A portion of the new wall should be installed first prior to dismantling the existing wall in the front. Since the existing wall has only one row of tieback on top, the most critical stage could be that when the existing tiebacks are de-tensioned and only portion of the new wall system is installed. The temporary construction stage with the existing 30-inch diameter CIDH piles to support the hillside in cantilever condition should be verified.

- The existing terrain above the wall is too steep (1:5H:1V) for construction equipment. Access to the wall top may have to come from the shoulder of Route 580. Grading is anticipated above the wall, and cut for a bench will be required so that construction operation can proceed. For temporary cut during construction, a gradient of 1H:1V may be assumed for the weathered rock.

- The as-built drawings indicate 2” diameter perforated iron pipes extending into the hillside. These appear to be for drainage of the hillside. These 2” diameter iron pipes should not be blocked during new construction, and drainage should be provided. There could be other existing buried facilities (by Chevron or others) that need to be evaluated if they will impact the new construction.

Geotechnical design parameters are provided below.

TABLE 10 – SOIL NAIL DESIGN PARAMETERS FOR RW 4

Station Limit	Depth* (ft)	Soil Type	Unit Weight (pcf)	Friction Angle	Cohesion (psf)	Ultimate Bond Strength, qu (psi)
“CC-E” Line Sta. 1021+22 to “CC-M” Line Sta. 1024+50	0-20	Silty Sand	130	36	150	10
	20-40	Moderately Weathered Sandstone (Model as dense sand)	130	40	300	13
“CC-M” Line Sta. 1024+50 to 1026+72	Full Depth	Silty Sand	125	32	150	10

*Note: The depth is the distance from the top of the wall.

Seismic Design: The proposed wall design under seismic loading condition should be analyzed per Caltrans guidelines (Guidelines for Structures Foundation report manual, Ver. 2.0, 2006, updated December 2009), which recommend that the seismic factor equal to one third of the horizontal peak acceleration and not exceeding 0.2g. Based on our analysis PGA at this wall location is 0.677g. Therefore, the seismic factor of 0.2g is recommended. Sites with pseudo-static factor of safety equal to or greater than 1.1 shall be considered to have adequate stability.

We understand that Temporary soil nails are considered to install in the existing wall to support it after the tiebacks are cut. Above recommendations are valid for temporary soil nail design.

HNTB designed soil nail walls using Caltrans SNAIL program. Output files of critical case (seismic), which were provided by HNTB, are attached in Appendix F. Soil nail schedule, provided by HNTB, also attached in Appendix F.

Retaining Wall No. 5 (RW 5), approx. "WST" Line Sta. 1005+60.21 to 1010+70.07

As discussed in Section 2.2, RW 5 is proposed at Western Dr off-ramp, between "WST" approx. Sta. 1005+60.21 and 1010+70.07 in Contra Costa County. This wall is located north of Western Dr off-ramp. Approximate length of the wall is 507.7 feet and the height varies between 12 and 30 feet. This wall will be constructed to widen the right side of the existing Western Drive off-ramp to provide a 2-foot inside shoulder, a 12-foot vehicle lane, an 8-foot outside shoulder, a concrete barrier, and a 10-foot bi-directional bicycle and pedestrian path. Based on the retaining wall plans, we understand that soil nail wall is considered at this location.

Based on available as-built LOTB of Scofield Ave undercrossing, field observation of existing cut, geology map and current investigation data, the wall appears to be in weathered rock formation and soil nail wall is feasible for the retaining wall support. Recently completed field borings confirmed the weathered rock condition. Geotechnical design parameters are provided below.

TABLE 11 – SOIL NAIL DESIGN PARAMETERS FOR RW 5

Depth* (ft)	Soil Type	Unit Weight (pcf)	Friction Angle	Cohesion (psf)	Ultimate Bond Strength, qu (psi)
0-5	Highly Weathered Sandstone	130	40	300	10
Below 5	Moderately Weathered Sandstone	130	40	300	15

*Note: The depth is the distance from the top of the wall.

Seismic Design: The proposed wall design under seismic loading condition should be analyzed per Caltrans guidelines (Guidelines for Structures Foundation report manual, Ver. 2.0, 2006, updated December 2009), which recommend that the seismic factor equal to one third of the horizontal peak acceleration and not exceeding 0.2g. Based on our analysis PGA at this wall location is 0.677g. Therefore, the seismic factor of 0.2g is recommended. Sites with pseudo-static factor of safety equal to or greater than 1.1 shall be considered to have adequate stability.

HNTB designed soil nail walls using Caltrans SNAIL program. Output files of critical case (seismic), which were provided by HNTB, are attached in Appendix F. Soil nail schedule, provided by HNTB, also attached in Appendix F.

Retaining Wall No. 6 (RW 6), approx. "MAINO2" Line Sta. 242+04.21 to 245+42.00

As discussed in Section 2.2, RW 3 is proposed at Main St/San Quentin on-ramp, between "MAIN02" Sta 242+04.21 and 245+42.00 in Marin County. This wall is located south of I-580 on-ramp. Approximate length of the wall is 339.4 feet and the height varies between 6 and 12 feet. This wall will be constructed along the south side of the Main Street on-ramp to preserve access to the electrical substation at the Caltrans Maintenance Yard. Based on the retaining wall plans, we understand that Type 5 retaining wall is proposed at this location.

As discussed in sections 6.2, the subsurface soil consists of loose to very dense silty sand with gravel, silty gravel with sand and poorly graded gravel with silt and sand interbedded with soft lean clay and fat clay to the depth of 23 to 40 feet below the existing grade (approximate elevation of -5 to -16 feet). The underlying rock formation slopes towards the east. As discussed in section 9.2, potential liquefiable layers were identified between elevations 16 and 5 feet, and 1 and -16 feet. The estimated post-liquefaction settlement is up to 6 inches. Since continuous potential liquefiable layers are encountered, we recommend pile foundation support for RW 6. Based on the discussion with designer, Class 200 (Caltrans Standard Alt "W") piles are considered for the foundation. Pile drivabilty analysis is attached in Appendix E.

TABLE 12 – RETAINING WALLS GEOTECHNICAL DESIGN PARAMETERS

Design Parameters	Retaining Wall 6
Design Soil Conditions & Strength Parameters	Sand Backfill, ϕ=34°
Active Pressure EFP (pcf)	36 (level backfill)
Passive Resistance EFP (pcf) (factored per AASHTO when combined with bottom friction)	265
Seismic Incremental Lateral Earth Pressure EFP(pcf) (regular triangular)	30

TABLE 13 – PILE DATA TABLE

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elev. (ft)	Specified Tip Elev. (ft)	Nominal Driving Resistance Required. (kips)
		Compression	Tension			
"MAIN02" 242+04 to "MAIN02" 242+50	Class 200 Alt "W"	180	0	-5 (a) -2 (b)	-5	250
"MAIN02" 242+50 to "MAIN02" 243+00	Class 200 Alt "W"	180	0	-10 (a) -7 (b)	-10	280
"MAIN02" 243+00 to "MAIN02" 243+50	Class 200 Alt "W"	180	0	-14 (a) -11 (b)	-14	315
"MAIN02" 243+50 to "MAIN02" 244+00	Class 200 Alt "W"	180	0	-17 (a) -14 (b)	-17	340
"MAIN02" 244+00 to "MAIN02" 244+75	Class 200 Alt "W"	180	0	-20 (a) -17 (b)	-20	385
"MAIN02" 244+75 to "MAIN02" 245+42	Class 200 Alt "W"	180	0	-24 (a) -21 (b)	-24	420

Notes:
1. Design tip elevations are controlled by (a) Compression, and (b) lateral, respectively.
2. Shallow bedrock is anticipated between "MAIN02" Station 242+04 and 242+50. If excessive blow counts or high driving stresses during pile driving, center relief drilling can be used to achieve specified tip elevation. In this case piles should be driven up to at least lateral tip elevation.

As discussed above, at sites with PGA greater than 0.6g, the standard plans are not applicable and the structural design should design the walls as special design walls. The wall needs to be designed as special design wall since the anticipated PGA at this wall location is more than 0.6 g.

<u>Retaining Wall No. 7 (RW 7), approx. "CC-M" Line Sta. 1026+93.56 to 1028+25.08</u>

As discussed in Section 2.2, RW 7 is proposed at East of Scofield Ave undercrossing, between "CC-M" Sta. 1026+93.56 and Sta. 1028+25.08 in Contra Costa County. This wall is located south of eastbound I-580 and approximately 30 feet east of Retaining Wall No. 4, providing additional shoulder and lane width. Approximate length of the wall is 125 feet and the height varies between 16 and 26 feet. Based on the as-built plans, we understand that there is an existing tieback wall, similar to the existing tieback wall at RW 4 location, at the proposed RW 7 location. The new wall will require the removal of 85 feet of the existing retaining wall along EB I-580.

Based on available as-built LOTB of Scofield Ave undercrossing and existing retaining walls, field observation of existing cut, geology map and current investigation data, the wall appears to be in weathered rock formation and soil nail wall is feasible for the retaining wall support. The upper part of the material is primarily exhibiting the nature of the sandy soils. Geotechnical design parameters are provided below.

TABLE 14 – SOIL NAIL DESIGN PARAMETERS FOR RW 7

Station Limit	Depth* (ft)	Soil Type	Unit Weight (pcf)	Friction Angle	Cohesion (psf)	Ultimate Bond Strength, qu (psi)
"CC-M" Line Sta. 1026+93 to 1027+25	Full Depth	Silty Sand	125	32	150	10
"CC-M" Line Sta. 1027+25 to 1028+25	0-20	Silty Sand	130	36	150	10
	20-40	Moderately Weathered Sandstone (model as dense sand)	130	40	300	13

*Note: The depth is the distance from the top of the wall.

Seismic Design: The proposed wall design under seismic loading condition should be analyzed per Caltrans guidelines (Guidelines for Structures Foundation report manual, Ver. 2.0, 2006, updated December 2009), which recommend that the seismic factor equal to one third of the horizontal peak acceleration and not exceeding 0.2g. Based on our analysis PGA at this wall location is 0.677g. Therefore, the seismic factor of 0.2g is recommended. Sites with pseudo-static factor of safety equal to or greater than 1.1 shall be considered to have adequate stability.

We understand that Temporary soil nails are considered to install in the existing wall to support it after the tiebacks are cut. Above recommendations are valid for temporary soil nail design.

HNTB designed soil nail walls using Caltrans SNAIL program. Output files of critical case (seismic), which were provided by HNTB, are attached in Appendix F. Soil nail schedule, provided by HNTB, also attached in Appendix F.

<u>Retaining Wall No. 8 (RW 8) on the slope between WB 580 and the curve of the bicycle/pedestrian path, just west of Marine Street</u>

As discussed in Section 2.2, RW 8 is planned at Marine St undercrossing, between existing bike path and I-580 westbound to increase the eye sight along the bike path. Approximate length of the wall is 54 feet and the approximate height is 8.5 feet. We also understand that earth gabion wall is also considered for landscaping purpose.

As discussed in section 6.2, the proposed gabion earth wall will be on the abutment embankment. The embankment should be a compacted fill embankment of Route 580 construction. Therefore compacted fill properties can be assumed for embankment fill for the gabion wall design. Cohesion of 100 psf and friction angle of 30 degrees were considered for the foundation design and slope stability analysis.

As discussed above, at sites with PGA greater than 0.6g, the standard plans are not applicable and the structural design should design the walls as special design walls. The wall needs to be designed as special design wall since the anticipated PGA at this wall location is more than 0.6g.

TABLE 15 – RW 8 SPREAD FOOTING DATA TABLE

Location	Design Height (ft)	Service Limit State Permissible Net Contact Stress (ksf)	Strength Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 0.65 (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance for Controlling Load Case ϕ_b= 0.9 (ksf)
Marine St Undercrossing	5 to 8.5	2	3.9	5.4

For the wall design, other relevant parameters for wall design are summarized in the following table.

TABLE 16 – GEOTECHNICAL DESIGN PARAMETERS FOR RW 8

Design Parameters	
Design Soil Conditions & Strength Parameters	Backfill, Granular Backfill, ϕ=34˚ Foundation, Compacted Embankment Fill, ϕ=30˚, c=100 psf
Active Pressure EFP (pcf)	52 (2H:1V Backslope)
Footing Bottom Friction Coefficient	0.35
Seismic Incremental Lateral Earth Pressure EFP(pcf) (regular triangular)	60

Slope Stability: Slope stability analysis was performed on existing slope and the proposed slope configuration after earth gabion wall construction. Based on our analysis, the stability appears to be satisfactory for both static condition (F.S greater than 1.5) and seismic condition (F.S. greater than 1.1) before and after construction of earth gabion wall. Slope stability analysis outputs are attached in Appendix E.

Earth Gabion Installation: Earth gabion mesh can be selected based on availability in the market. Surface irregularities, loose material, and vegetation shall be removed during the preparation of the foundation. The erosion control blanket should be placed around the meshes. Backfill in to the meshes shall be made of a good quality, free draining, granular and/or selected fill. Structural backfill should be Caltrans standard backfill per Section 19-3 of Standard Specifications. It is recommended to place soil fill in approximately 8 inch lifts and compact it to the required level. Soil compaction within 3 feet of the face should be carefully performed with a walk-behind compactor to prevent any distortion or building of the facing unit. Backfill should have minimum 95% compaction as per Caltrans Standard. Compacting is to precede parallel to the wall, ensuring that the compacting machine does not come in contact with the mesh.

<u>Preliminary Corrosion Considerations</u>

The planned retaining walls are all located within 1000 feet from the ocean and tidal water. Per Caltrans BDS Section 8.22, the walls should be designed for Marine environment.

12.0 CONSTRUCTION CONSIDERATIONS

12.1 Construction Advisories

These sections are written primarily for the engineer responsible for the preparation of plans and specifications. Since these sections identify potential construction issues related to the project, it may also be of use to the Agency's representatives involved in monitoring of construction activity. The field investigation performed by us primarily addresses design issues and was not planned specifically to identify construction issues.

The project site is located along the existing I-580. Traffic control is required to maintain traffic flow along I-580. Several underground utilities exist at the site. The contractor should verify the utility lines, be aware of the existing conditions and plan the construction activities accordingly.

Pipe pile foundation is recommended for RW 6. Since, highly weathered sandstone is encountered at this location, hard pile driving conditions are expected during RW 6 pile driving. Since weathered and un-weathered sandstone are encountered at RW 4, 5 and 7 locations, hard drilling conditions are expected during soil nail drilling. Caving conditions also anticipated during soil nail drilling.

In our opinion, conventional equipment may be used to excavate the on-site soil materials. The material to be excavated for RW 4, 5 & 7 may consist of weathered and un-weathered sandstone. Extracted pages from CATERPILLER "Handbook of Ripping" were attached in Appendix E to determine rippability. Localized subgrade pumping may be encountered during earthwork construction depending on the weather, moisture condition of the subsurface soils, and surface drainage conditions. Equipment mobility may also be difficult if the subgrade is wet. In which case, the subgrade soils may require reworking, aeration, or over-excavation and replacing with dry granular fill to facilitate earthwork construction. It is possible that unknown old buried utilities or abandoned structures, concrete rubble etc. are located along the alignment. It might require special equipment and additional efforts to remove these buried objects.

Prospective contractors for the project must evaluate construction-related issues on the basis of their own knowledge and experience in the local area, on the basis of similar projects in other localities, or on the basis of field investigation on the site performed by them, taking into account their proposed construction methods and procedures. In addition, construction activities related to excavation and lateral earth support must conform to safety requirements of OSHA and other applicable municipal and State regulatory agencies.

12.2 Construction Consideration that Influence Specifications

The contractor should verify the conditions of the existing utility lines. These locations should not be used for stockpiling of borrow or excavated materials. Any conflicts with proposed construction should also be reviewed prior to construction.

12.3 Hazardous Waste Considerations

The project environmental study report should be referred to for details about any potential hazardous materials within the project site.

12.4 Differing Site Conditions

The soil conditions described in this report are based on available boring data. It should be noted that these borings depict subsurface conditions only at the locations drilled. Because of the variability from place to place within soils in general, and the nature of geologic depositions, subsurface conditions could change between the explored locations.

Early communication should be made between the Resident Engineer, the Contractor, and the Geotechnical Engineer as soon as conditions that differ from those established in this report are recognized by any of the parties. Additional recommendations could be provided if such conditions arise.

13.0 INVESTIGATION LIMITATION

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,

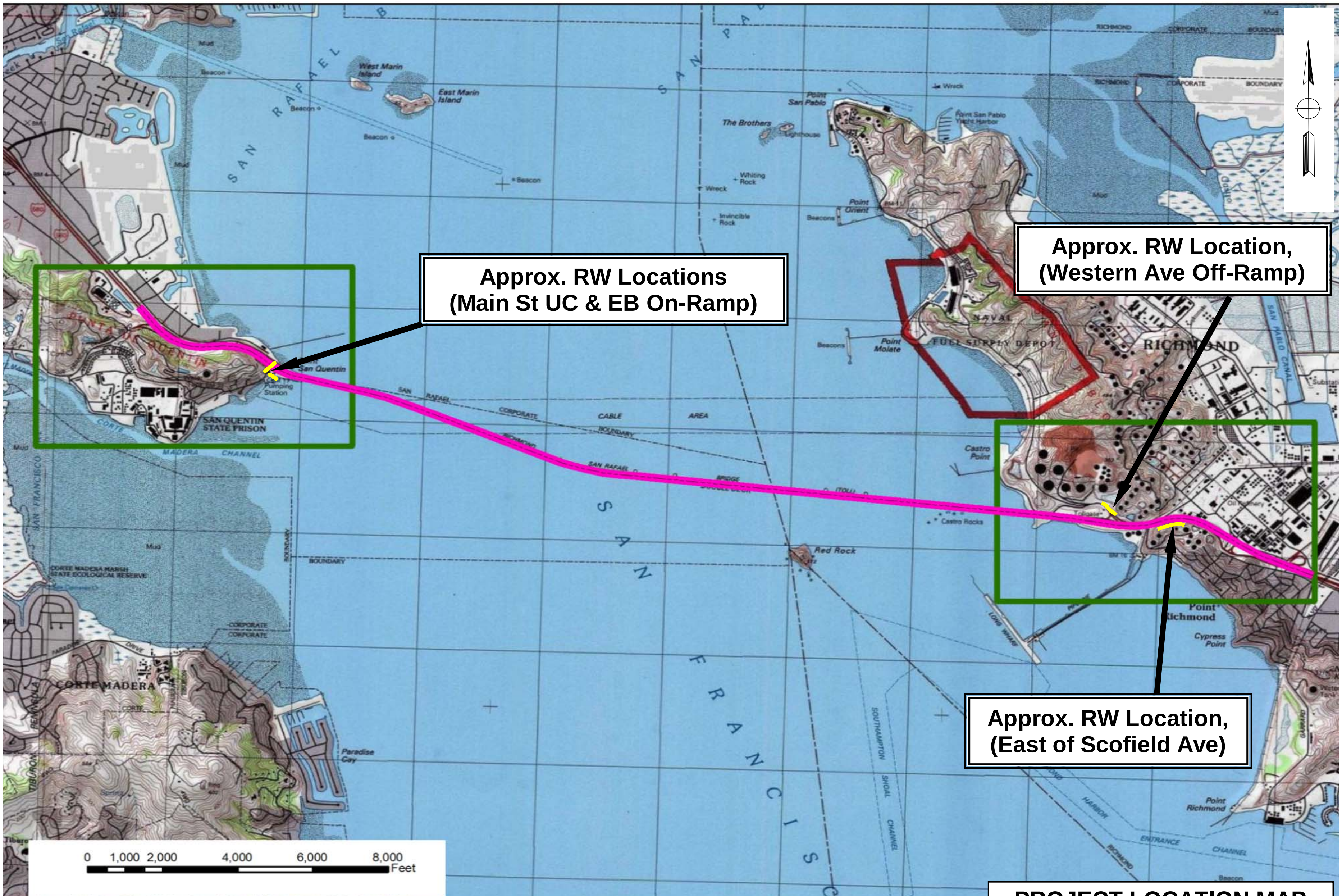
PARIKH CONSULTANTS, INC.

Y. David Wang

Kandeep Saravanapavan, P.E., G.E. 3040
Project Engineer

Y. David Wang, Ph.D., P.E. 52911
Senior Project Engineer

Gary Parikh, P.E., G.E. 666
Project Manager



PROJECT LOCATION MAP

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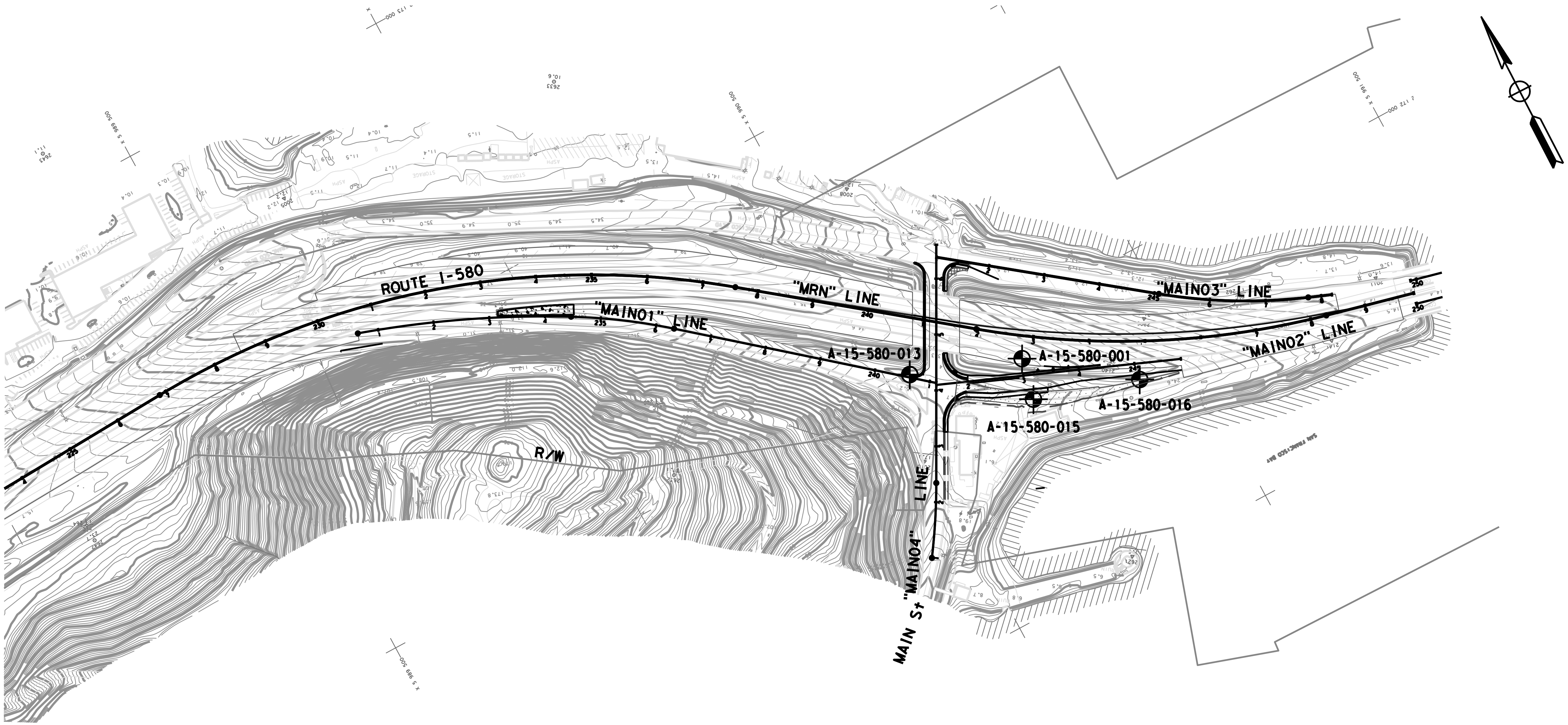
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
MARIN AND CONTRA COSTA COUNTIES, CALIFORNIA

JOB NO.: 2014-125-GDR	PLATE NO.: 1



SITE PLAN

LEGEND

A-15-580-001

Approx. Boring Location Drilled By Parikh Consultants, Inc. in 2015

SCALE: 1 inch = 200 feet

Note: All units are in feet unless otherwise specified

Reference Map was provided by HNTB, Inc.

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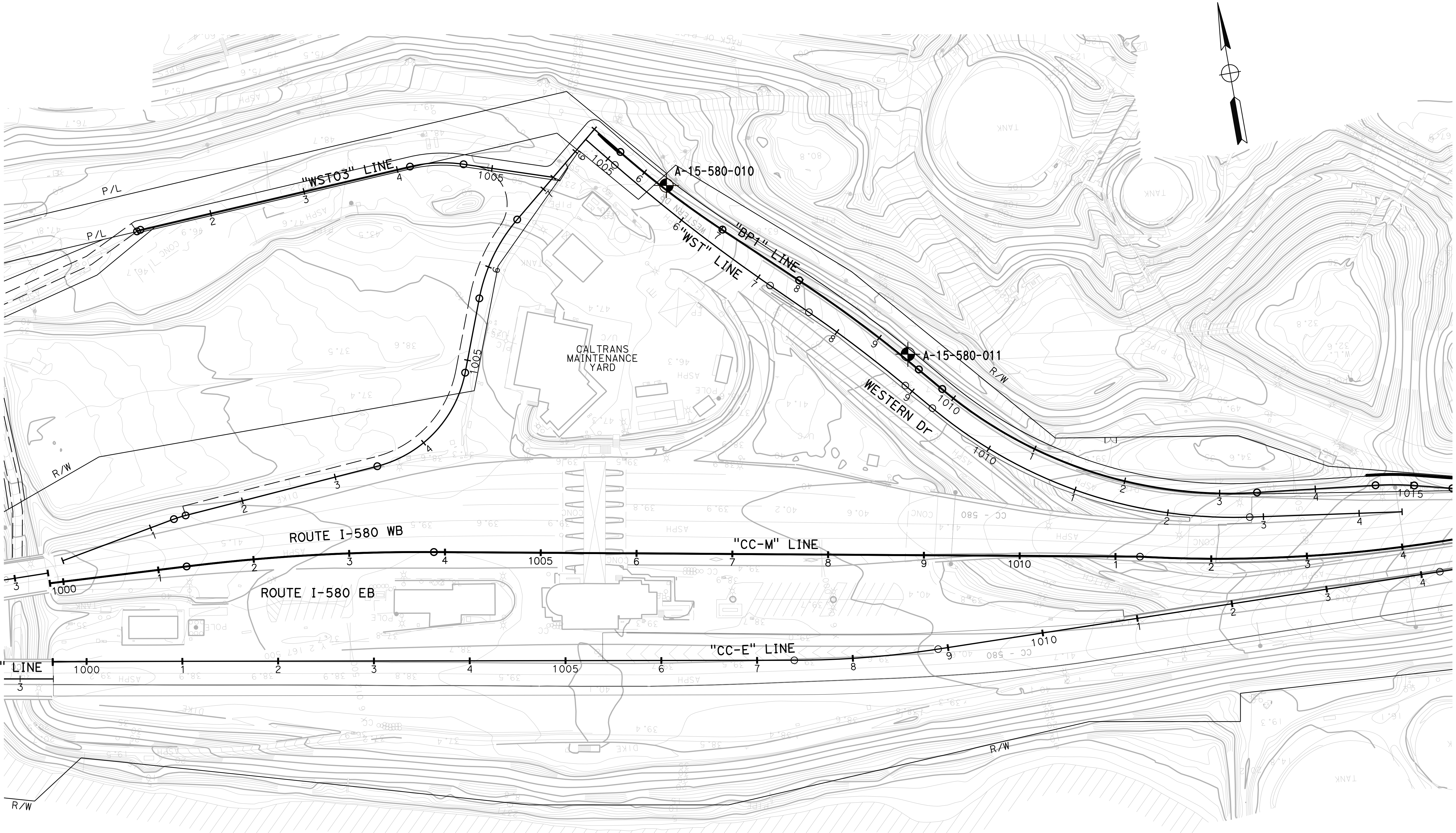
RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT	
RICHMOND CITY, CALIFORNIA	
PROJECT NO.:2014-125-GDR	PLATE NO: 2A



SITE PLAN

LEGEND

A-15-580-001

Approx. Boring Location Drilled By Parikh Consultants, Inc. in 2015

SCALE: 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by HNTB, Inc.

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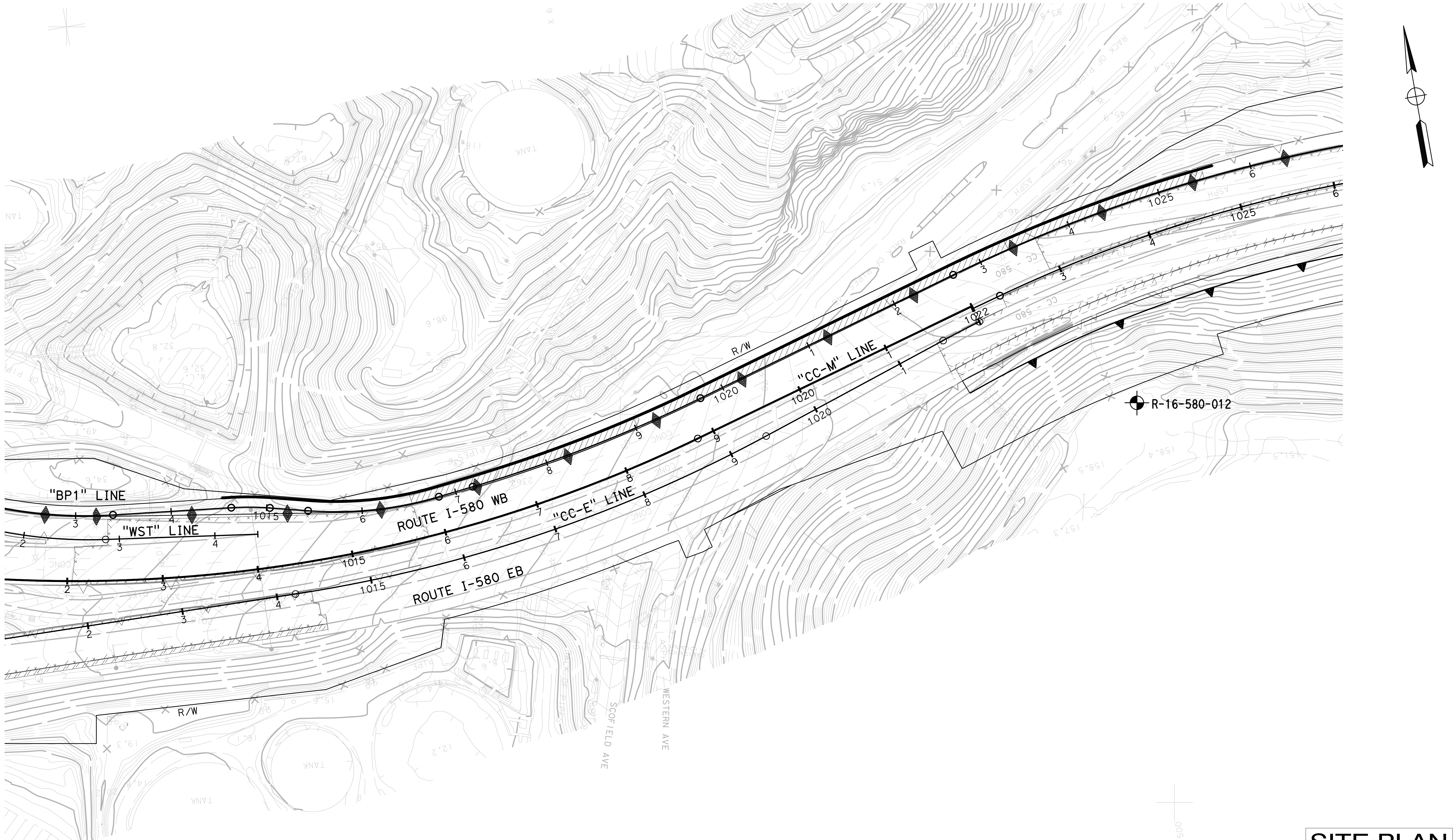
RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

RICHMOND CITY, CALIFORNIA

PROJECT NO.:2014-125-GDR | PLATE NO: 2B



SITE PLAN

LEGEND

A-15-580-001

Approx. Boring Location Drilled By Parikh Consultants, Inc.

SCALE: 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by HNTB, Inc.

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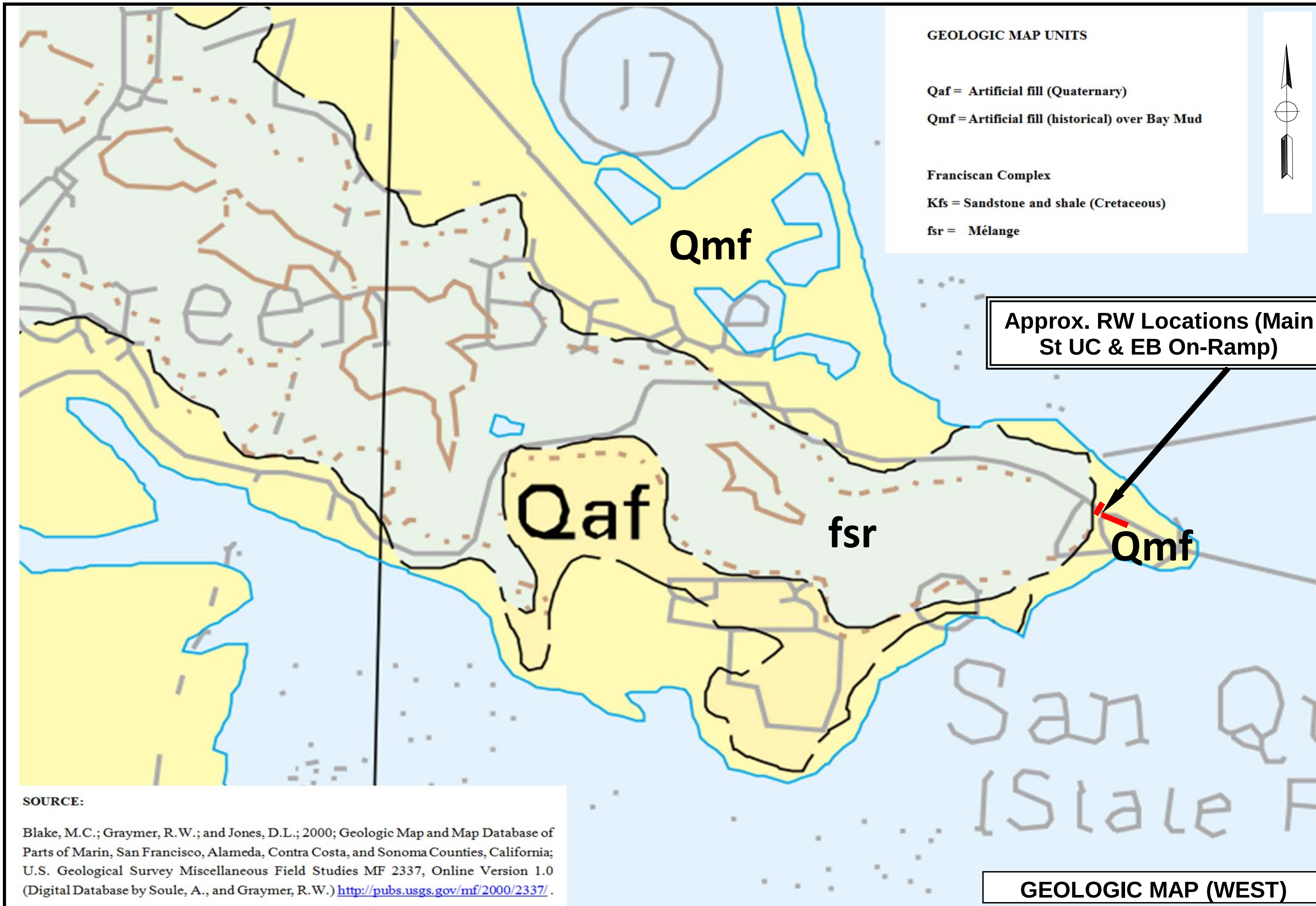
RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

RICHMOND CITY, CALIFORNIA

PROJECT NO.:2014-125-FDN

PLATE NO: 2C



SOURCE:

Blake, M.C.; Graymer, R.W.; and Jones, D.L.; 2000; Geologic Map and Map Database of Parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California; U.S. Geological Survey Miscellaneous Field Studies MF 2337, Online Version 1.0 (Digital Database by Soule, A., and Graymer, R.W.) http://pubs.usgs.gov/mf/2000/2337/ .

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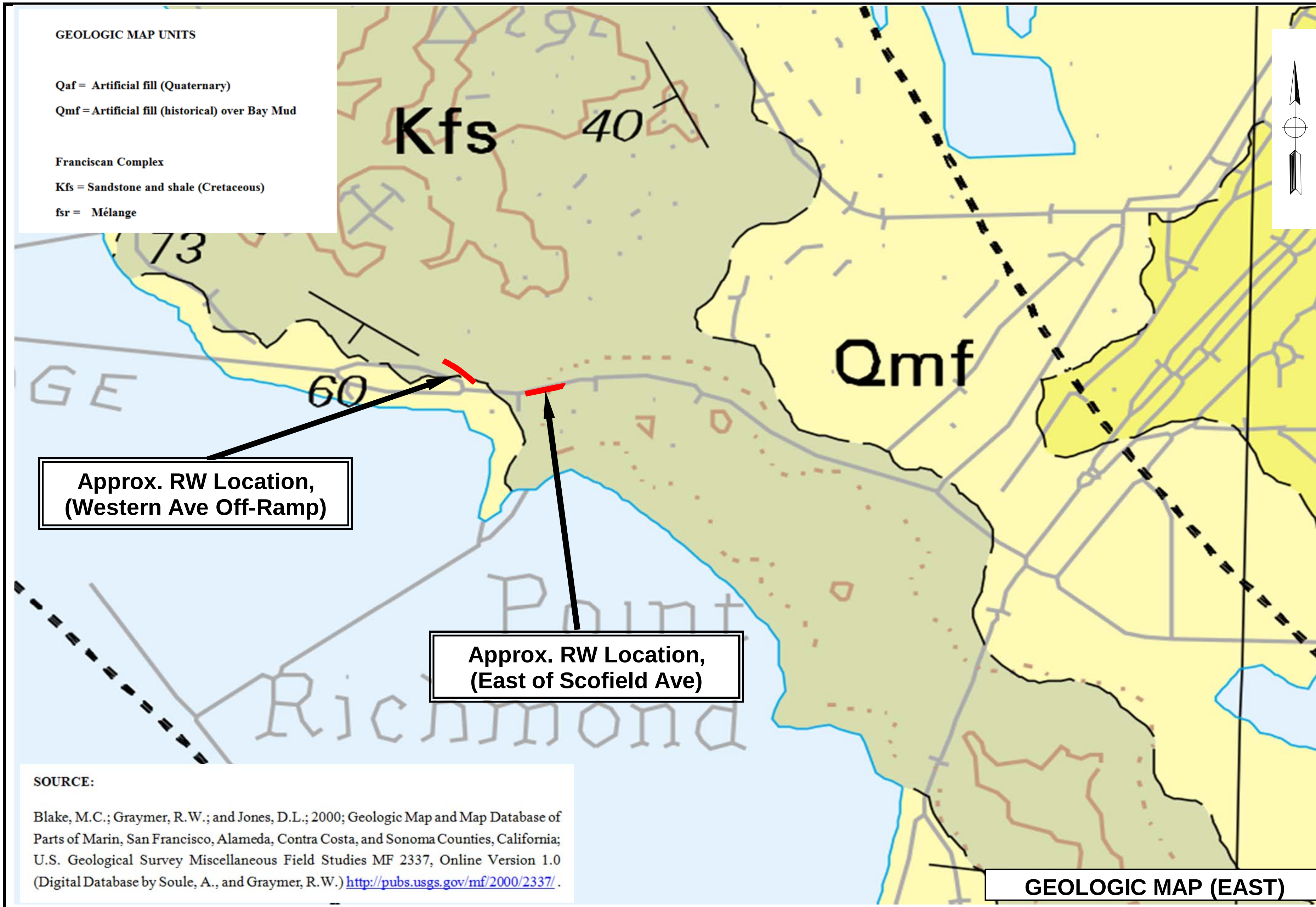
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
MARIN AND CONTRA COSTA COUNTIES, CALIFORNIA

JOB NO.: 2014-125-GDR | PLATE NO.: 3A



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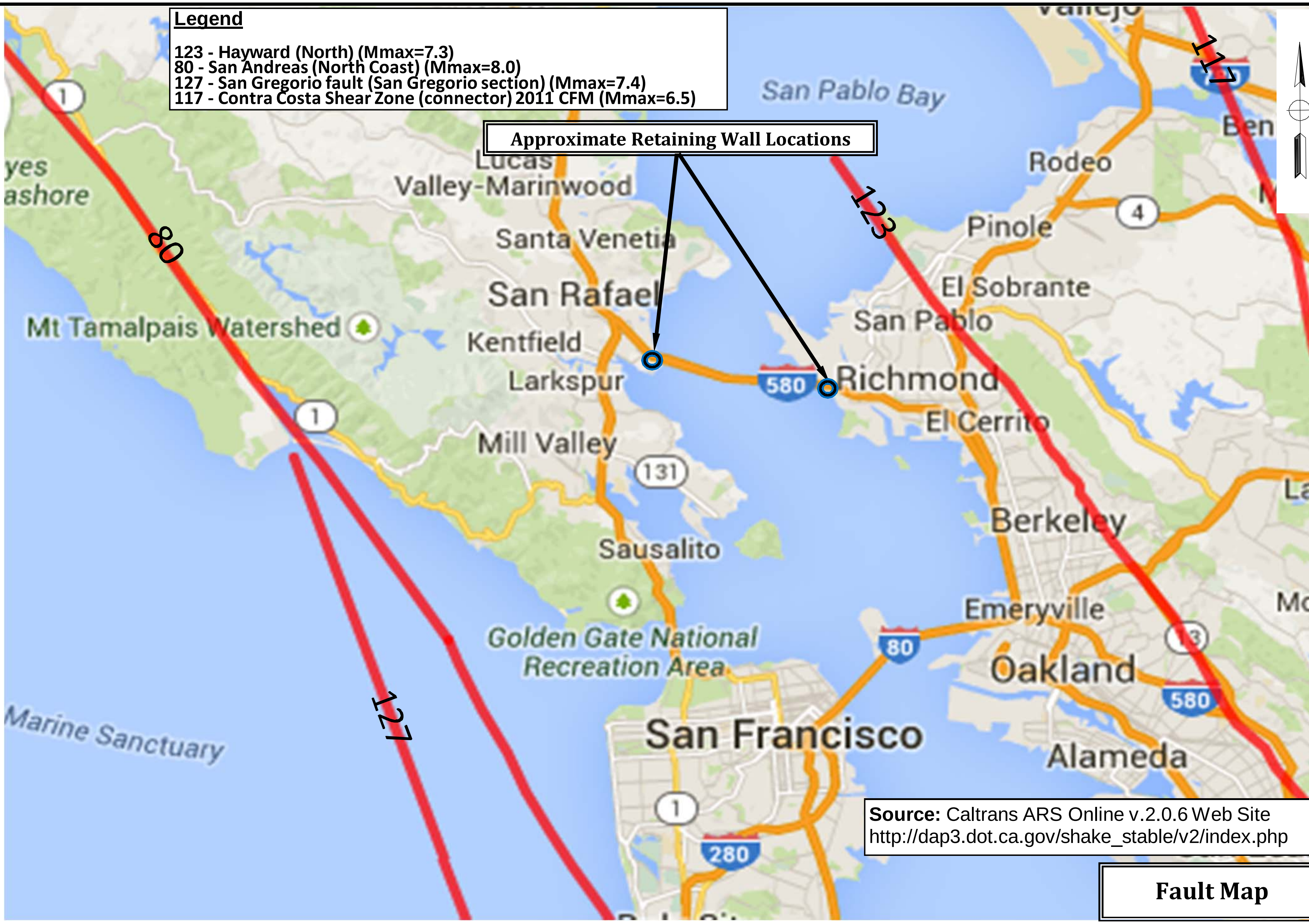
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
MARIN AND CONTRA COSTA COUNTIES, CALIFORNIA

JOB NO.: 2014-125-GDR	PLATE NO.: 3B



Fault Map

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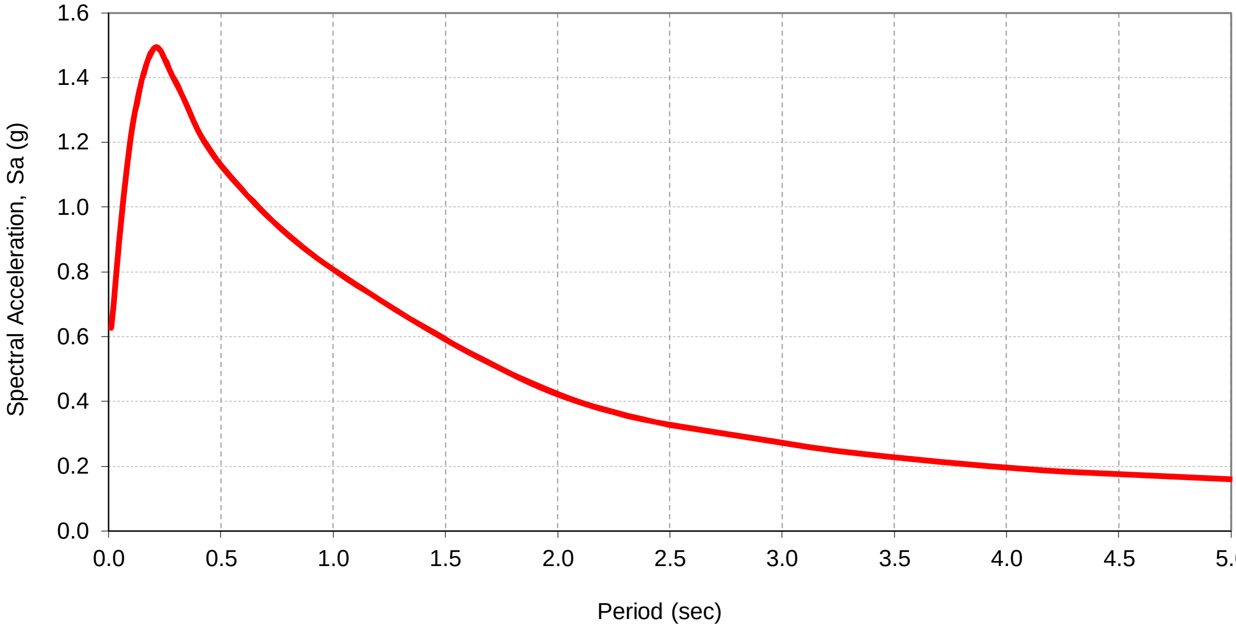
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
MARIN AND CONTRA COSTA COUNTIES, CALIFORNIA

JOB NO.: 2014-125-GDR | **PLATE NO.: 4**

RECOMMENDED ACCELERATION RESPONSE SPECTRUM

(5% Damping)



Site Information

Latitude:	37.9434
Longitude	-122.4805
V_{S30} (m/s) =	450
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	14.8

Governing Curve:

Caltrans Online Probabilistic ARS

Recommended Response Spectrum

Period (sec)	Caltrans Online Probabilistic Spectral Acceleration (g)	Adjusted for Near Fault Effect	Adjusted For Basin Effect	Final Adjusted Spectral Acceleration (g)
0.0	0.627	1	1	0.627
0.1	1.222	1	1	1.222
0.2	1.489	1	1	1.489
0.3	1.384	1	1	1.384
0.5	1.13	1	1	1.130
1.0	0.673	1.2	1	0.808
2.0	0.352	1.2	1	0.422
3.0	0.227	1.2	1	0.272
4.0	0.163	1.2	1	0.196
5.0	0.133	1.2	1	0.160

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)
2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)
3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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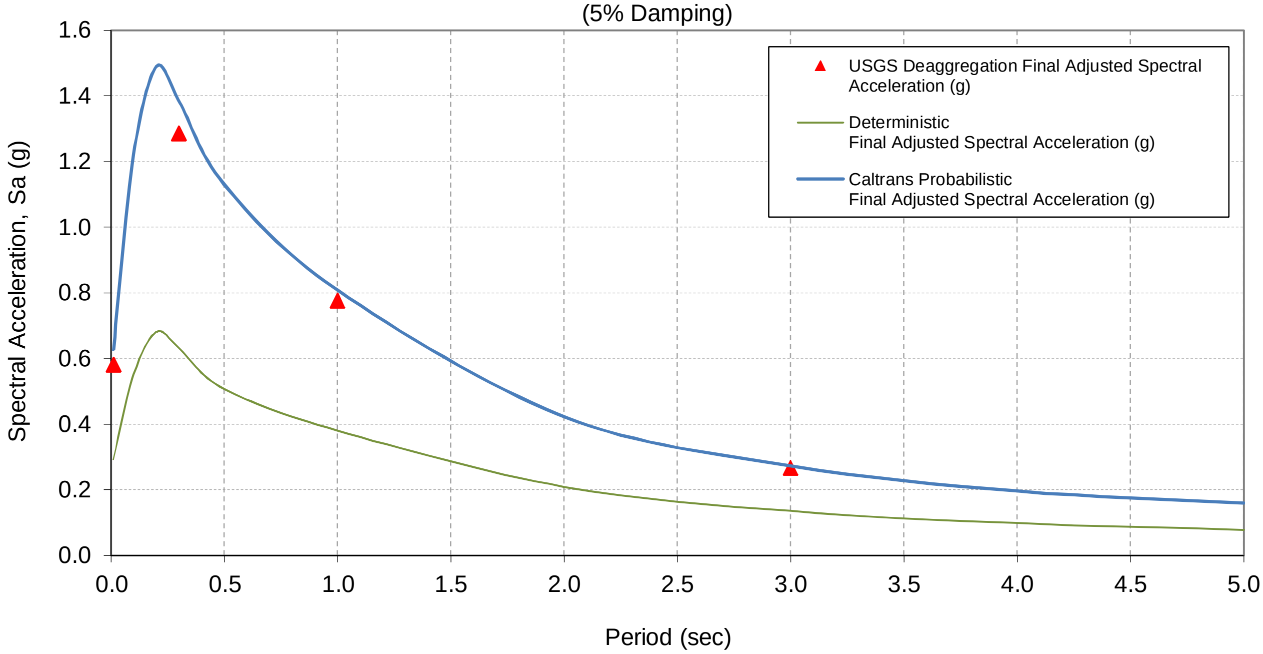
Richmond-San Rafael Bridge Access Improvement Project **Retaining Walls 1, 2, 3 & 6**	
Project No.: 2014-125-PGR	**Plate No.: 5A**

ACCELERATION RESPONSE SPECTRUM COMPARISON

(Deterministic & Probablistic Curves)
(5% Damping)



Site Information

Latitude:	37.9434
Longitude	-122.4805
V_{S30} (m/s) =	450
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	14.8

Period (sec)	Deterministic Final Adjusted Spectral Acceleration (g)	Caltrans Probabilistic Final Adjusted Spectral Acceleration (g)	USGS Deaggregation Final Adjusted Spectral Acceleration (g)
0.0	0.293	0.627	0.581
0.1	0.552	1.222	
0.2	0.681	1.489	
0.3	0.631	1.384	1.286
0.5	0.507	1.130	
1.0	0.380	0.808	0.776
2.0	0.209	0.422	
3.0	0.135	0.272	0.267
4.0	0.098	0.196	
5.0	0.078	0.160	

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)

2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)

3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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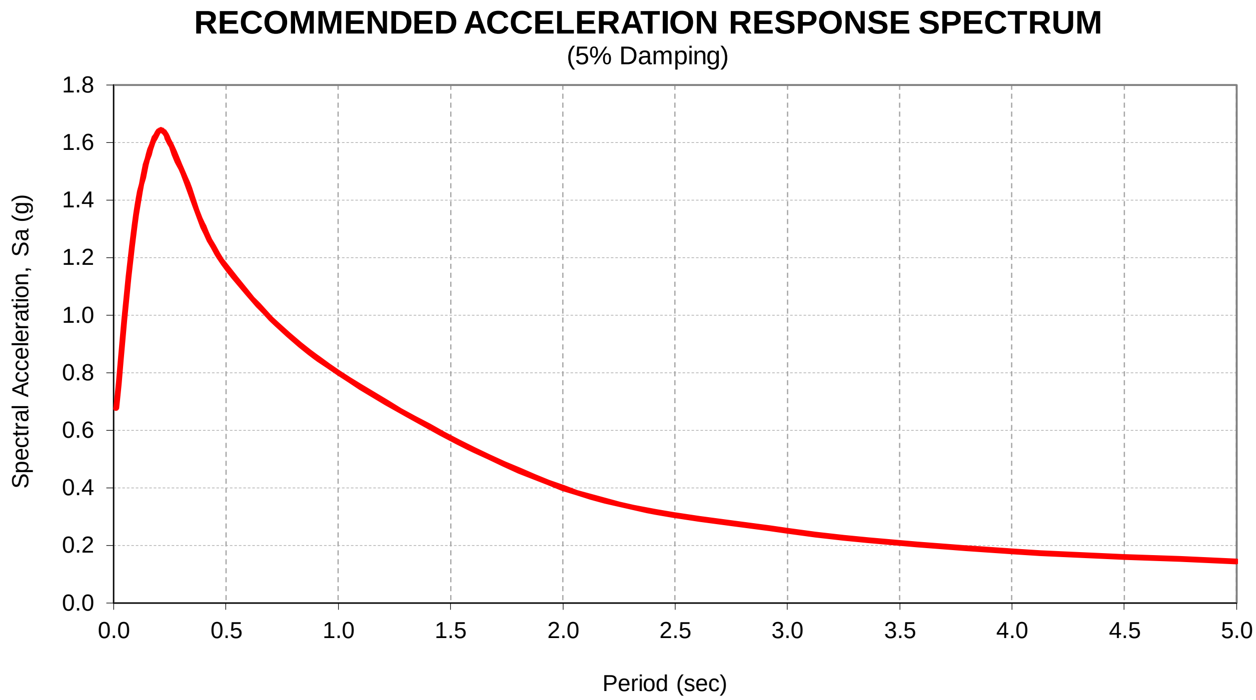
Richmond-San Rafael Bridge Access Improvement Project
Retaining Walls 1, 2, 3 & 6

Project No.: 2014-125-PGR	**Plate No.: 5B**



Site Information

Latitude:	37.9321
Longitude	-122.3991
V_{S30} (m/s) =	510
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	7.4

Governing Curve:
Caltrans Online Probabilistic ARS

Recommended Response Spectrum

Period (sec)	Caltrans Online Probabilistic Spectral Acceleration (g)	Adjusted for Near Fault Effect	Adjusted For Basin Effect	Final Adjusted Spectral Acceleration (g)
0.0	0.677	1	1	0.677
0.1	1.351	1	1	1.351
0.2	1.639	1	1	1.639
0.3	1.508	1	1	1.508
0.5	1.169	1	1	1.169
1.0	0.666	1.2	1	0.799
2.0	0.333	1.2	1	0.400
3.0	0.209	1.2	1	0.251
4.0	0.149	1.2	1	0.179
5.0	0.12	1.2	1	0.144

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)

2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)

3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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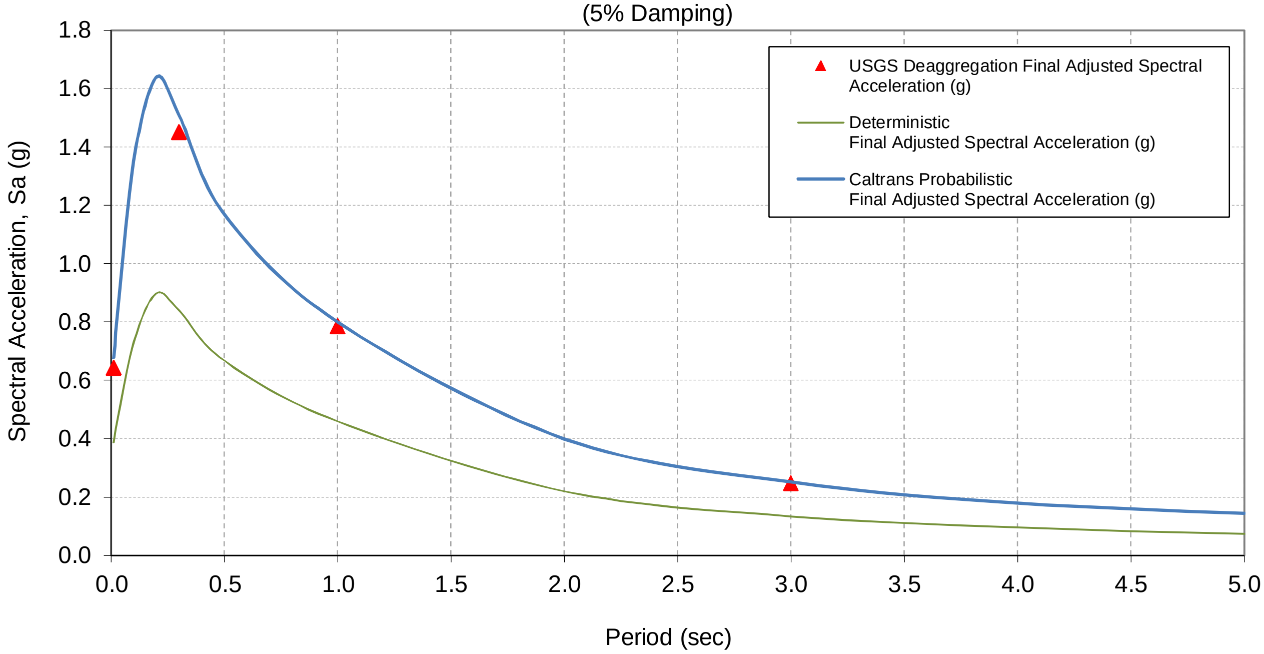
Richmond-San Rafael Bridge Access Improvement Project
Retaining Walls 4, 5 & 7

Project No.: 2014-125-PGR | **Plate No.: 6A**

ACCELERATION RESPONSE SPECTRUM COMPARISON

(Deterministic & Probablistic Curves)
(5% Damping)



Site Information

Latitude:	37.9321
Longitude	-122.3991
V_{S30} (m/s) =	510
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	7.4

Period (sec)	Deterministic Final Adjusted Spectral Acceleration (g)	Caltrans Probabilistic Final Adjusted Spectral Acceleration (g)	USGS Deaggregation Final Adjusted Spectral Acceleration (g)
0.0	0.388	0.677	0.642
0.1	0.730	1.351	
0.2	0.898	1.639	
0.3	0.839	1.508	1.451
0.5	0.667	1.169	
1.0	0.459	0.799	0.785
2.0	0.220	0.400	
3.0	0.134	0.251	0.247
4.0	0.095	0.179	
5.0	0.073	0.144	

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)
2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)
3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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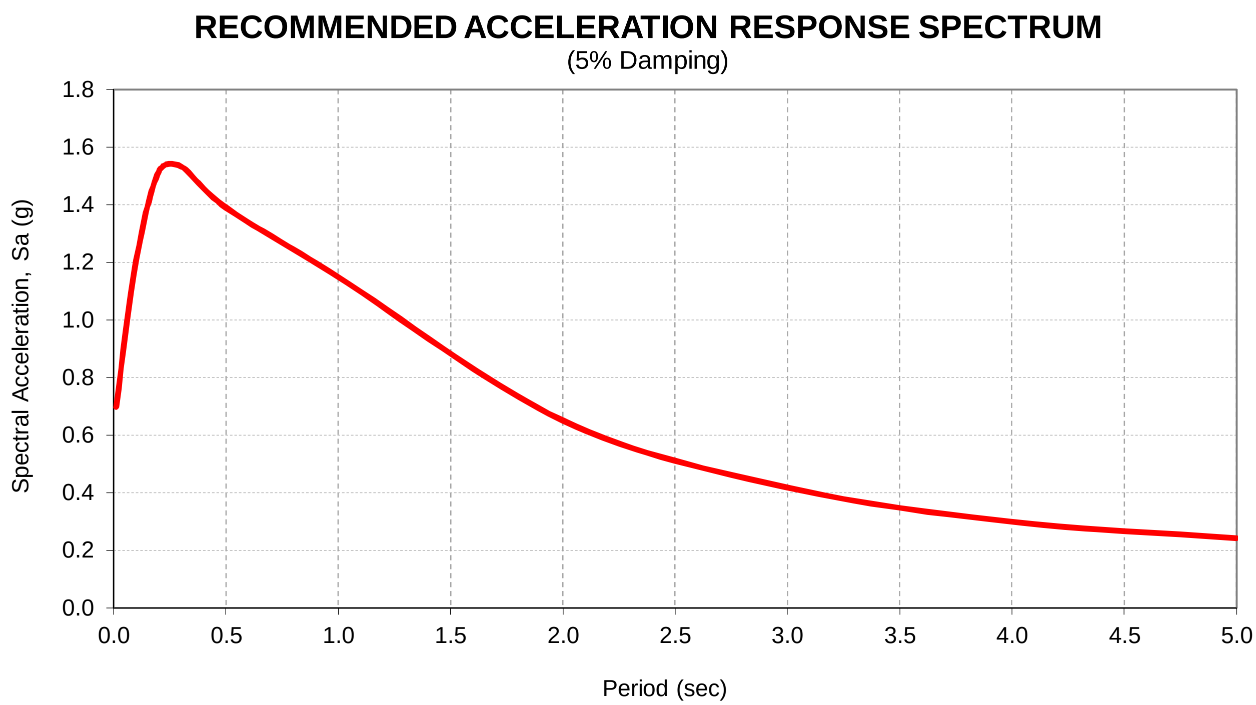
Richmond-San Rafael Bridge Access Improvement Project
Retaining Walls 4, 5 & 7

Project No.: 2014-125-PGR	**Plate No.: 6B**



Site Information

Latitude:	37.9315
Longitude	-122.3917
V_{S30} (m/s) =	275
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	6.9

Governing Curve:
Caltrans Online Probabilistic ARS

Recommended Response Spectrum				
Period (sec)	Caltrans Online Probabilistic Spectral Acceleration (g)	Adjusted for Near Fault Effect	Adjusted For Basin Effect	Final Adjusted Spectral Acceleration (g)
0.0	0.698	1	1	0.698
0.1	1.207	1	1	1.207
0.2	1.514	1	1	1.514
0.3	1.532	1	1	1.532
0.5	1.389	1	1	1.389
1.0	0.957	1.2	1	1.148
2.0	0.542	1.2	1	0.650
3.0	0.348	1.2	1	0.418
4.0	0.249	1.2	1	0.299
5.0	0.202	1.2	1	0.242

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)
2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)
3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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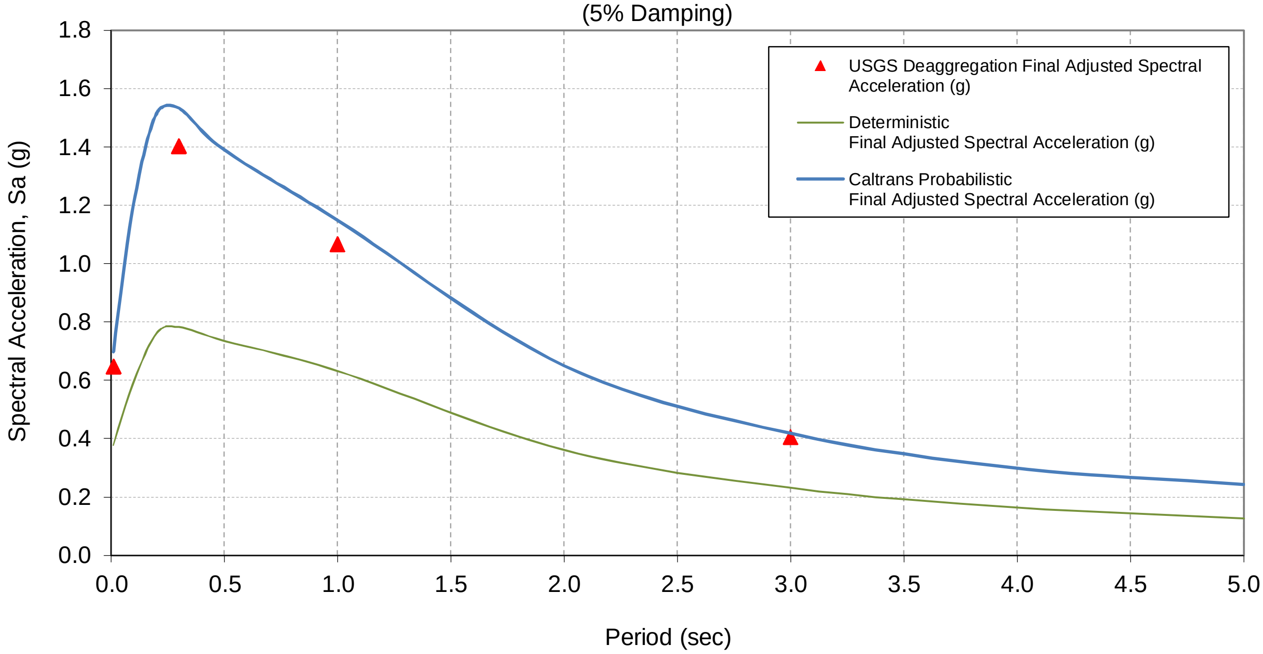
Richmond-San Rafael Bridge Access Improvement Project **Retaining Wall 8**	
Project No.: 2014-125-FDN	**Plate No.: 7A**

ACCELERATION RESPONSE SPECTRUM COMPARISON

(Deterministic & Probablistic Curves)
(5% Damping)



Site Information

Latitude:	37.9315
Longitude	-122.3917
V_{S30} (m/s) =	275
$Z_{1.0}$ (m) =	N/A
$Z_{2.5}$ (km) =	N/A
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	6.9

Period (sec)	Deterministic Final Adjusted Spectral Acceleration (g)	Caltrans Probabilistic Final Adjusted Spectral Acceleration (g)	USGS Deaggregation Final Adjusted Spectral Acceleration (g)
0.0	0.378	0.698	0.647
0.1	0.595	1.207	
0.2	0.760	1.514	
0.3	0.782	1.532	1.402
0.5	0.735	1.389	
1.0	0.632	1.148	1.067
2.0	0.361	0.650	
3.0	0.231	0.418	0.406
4.0	0.164	0.299	
5.0	0.126	0.242	

Source:

1. Caltrans ARS Online tool (V.2, http://dap3.dot.ca.gov/ARS_Online/)

2. USGS Deaggregation 2008 beta (http://eqint.cr.usgs.gov/deaggint/2008/index.php)

3. Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations, November 2012

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Richmond-San Rafael Bridge Access Improvement Project **Retaining Wall 8**	
Project No.: 2014-125-FDN	**Plate No.: 7B**

APPENDIX A

Log of Test Borings

NOTES:

Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2" Modified California Sampler: I.D. = 2.5"; O.D. = 3" Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)

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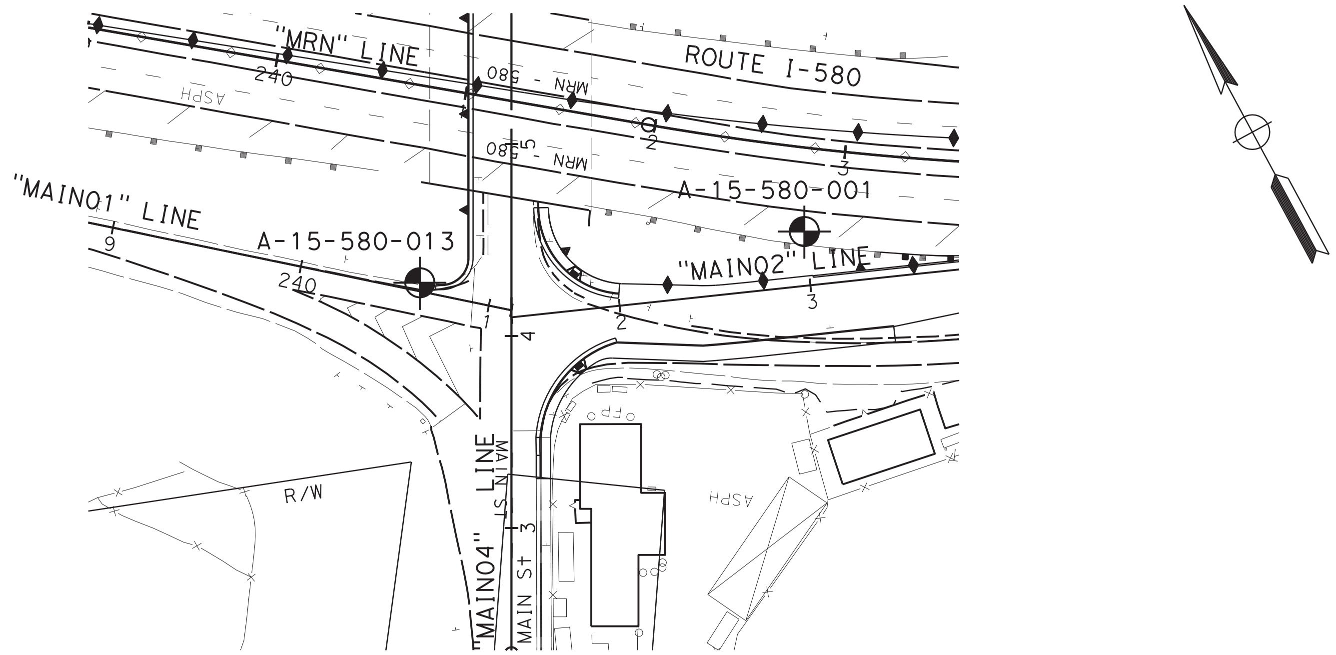
All dimensions are in feet unless otherwise shown



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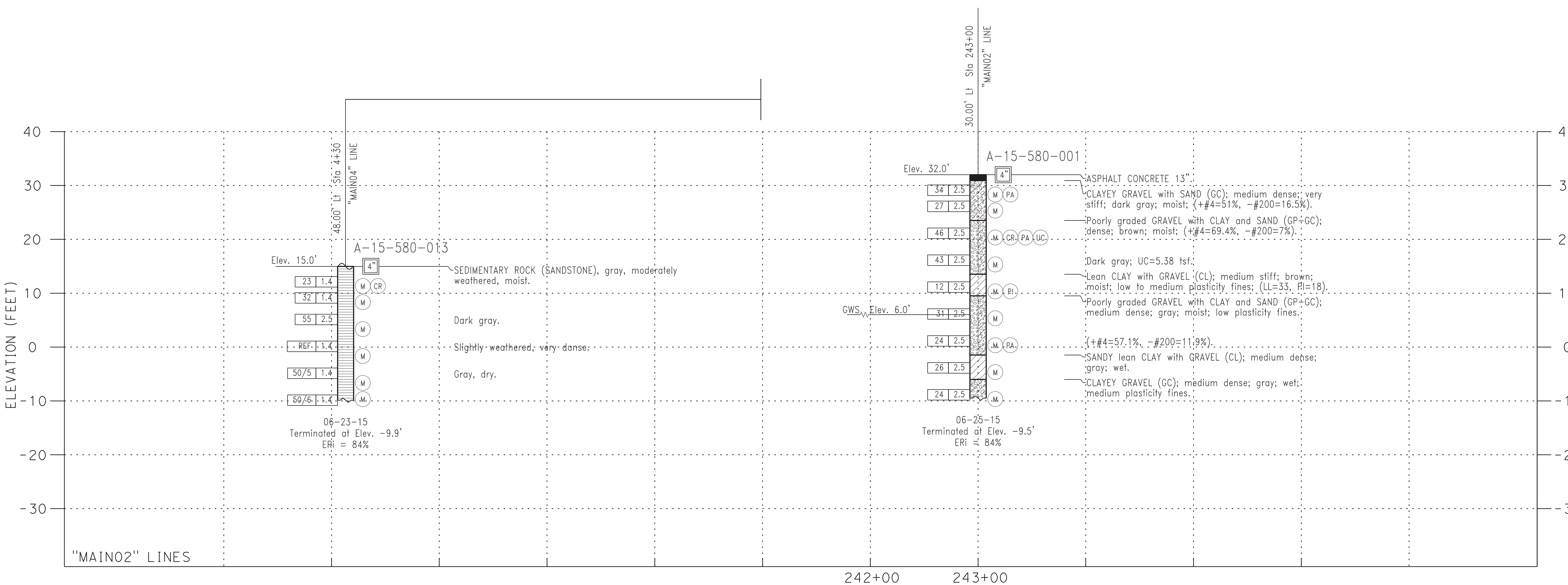

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

GEOTECHNICAL PROFESSIONAL — DATE 4/14/16

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. 666 Exp. 12/31/17 GEOTECHNICAL STATE OF CALIFORNIA

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PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

DRAWN BY: KIM OUYANG
CHECKED BY: KANDEEP SARAVANAPAVAN

L.S. BHANGOO
FIELD INVESTIGATION BY:
DATE: JUNE & DECEMBER 2015 TO MARCH 2016

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

KANDEEP SARAVANAPAVAN
PROJECT ENGINEER

BRIDGE NO.
POST MILES

RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

LOG OF TEST BORINGS 1 OF 4

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE:
CONTRACT NO.:

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

GEOTECHNICAL PROFESSIONAL 4/22/16 DATE

GARY PARIKH No. 666 Exp. 12/31/17 GEOTECHNICAL STATE OF CALIFORNIA REGISTERED PROFESSIONAL ENGINEER

PLANS APPROVAL DATE

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2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131

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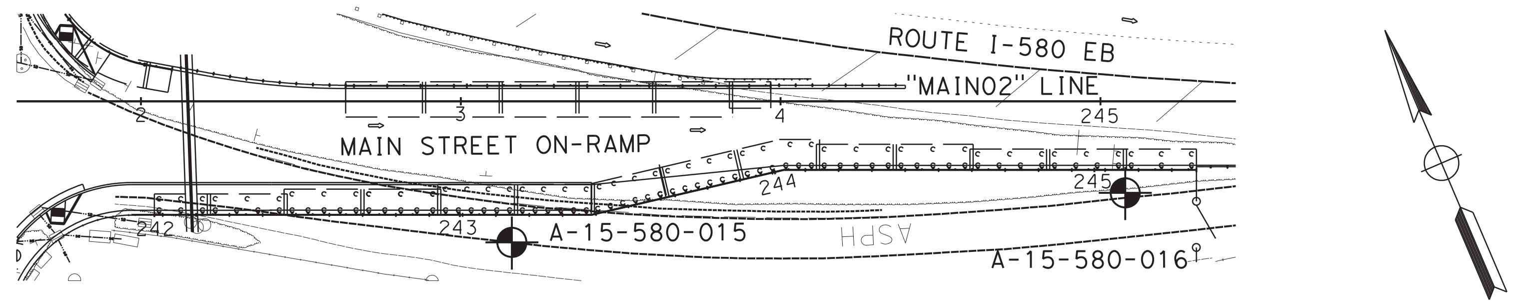
All dimensions are in feet unless otherwise shown



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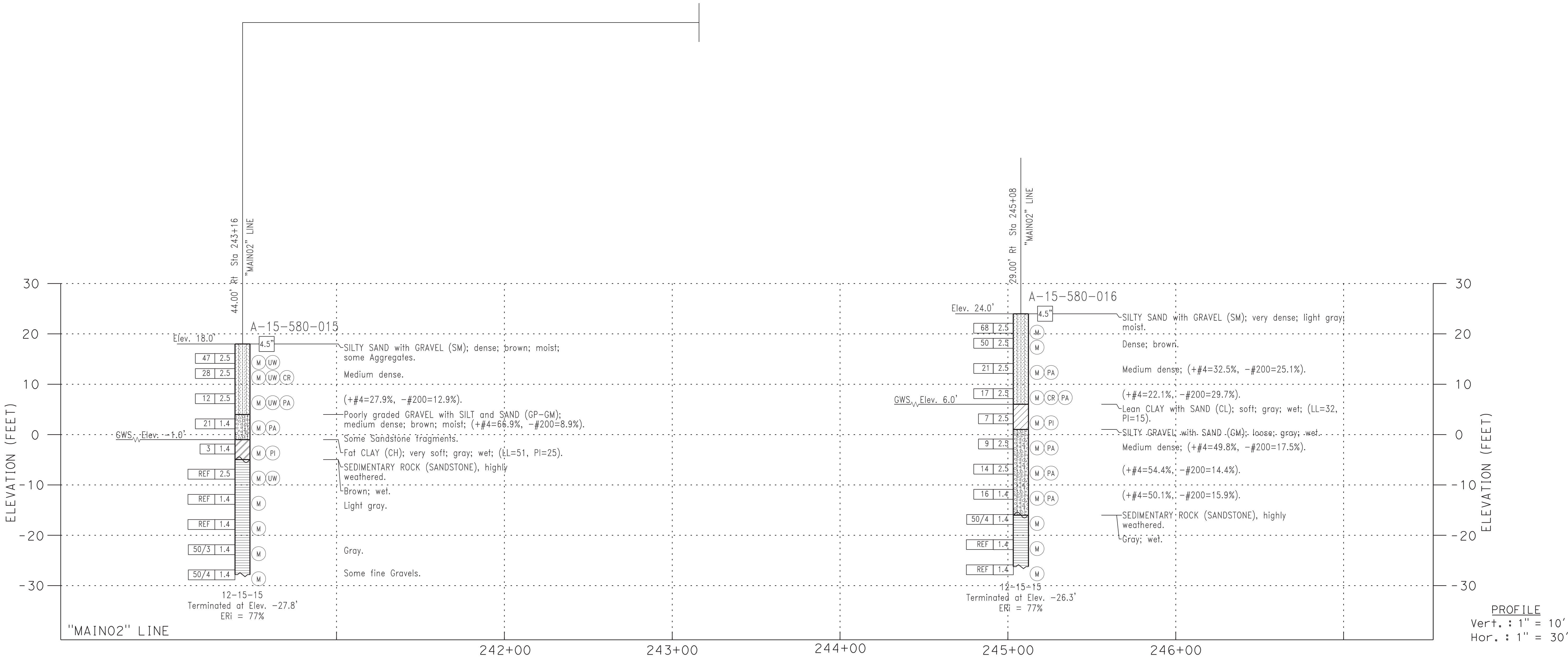

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 30'

X DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG	L.S. BHANGOO FIELD INVESTIGATION BY:
X SIGN OFF DATE	CHECKED BY	KANDEEP SARAVANAPAVAN	DATE: JUNE & DECEMBER 2015 TO MARCH 2016

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

KANDEEP SARAVANAPAVAN PROJECT ENGINEER

BRIDGE NO.

POST MILES

RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

LOG OF TEST BORINGS 2 OF 4

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE:

CONTRACT NO.:

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

GEOTECHNICAL PROFESSIONAL 4/14/16 DATE

PLANS APPROVAL DATE

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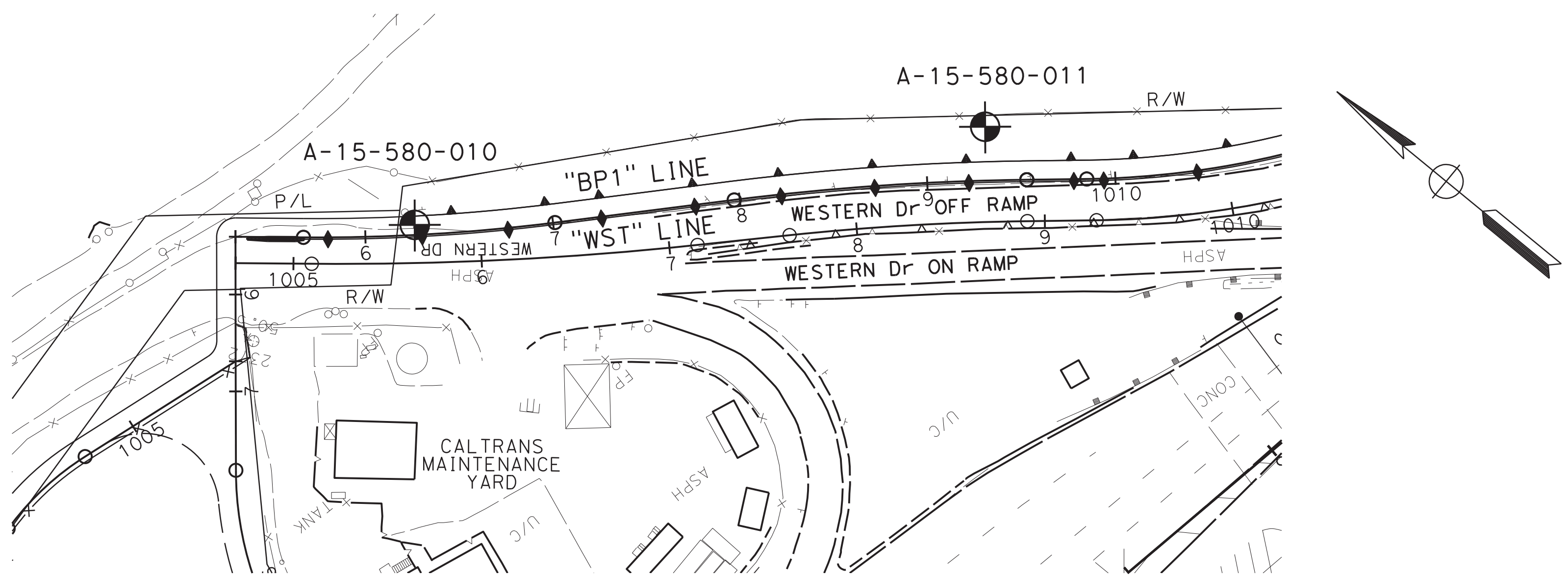

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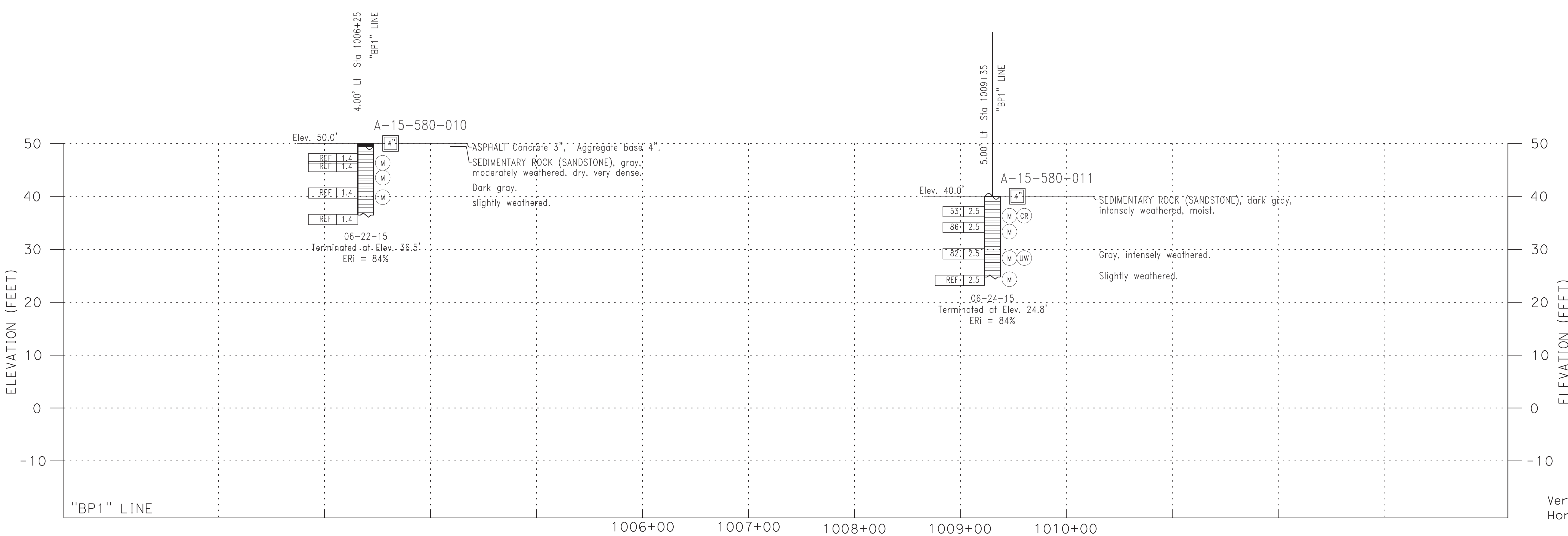

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

X DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG	L.S. BHANGOO FIELD INVESTIGATION BY:
X SIGN OFF DATE	CHECKED BY	KANDEEP SARAVANAPAVAN	DATE: JUNE & DECEMBER 2015 TO MARCH 2016

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

KANDEEP SARAVANAPAVAN
PROJECT ENGINEER

BRIDGE NO. POST MILES

RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

LOG OF TEST BORINGS 3 OF 4

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE:
CONTRACT NO.:

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

GEOTECHNICAL PROFESSIONAL 4/14/16 DATE

PLANS APPROVAL DATE

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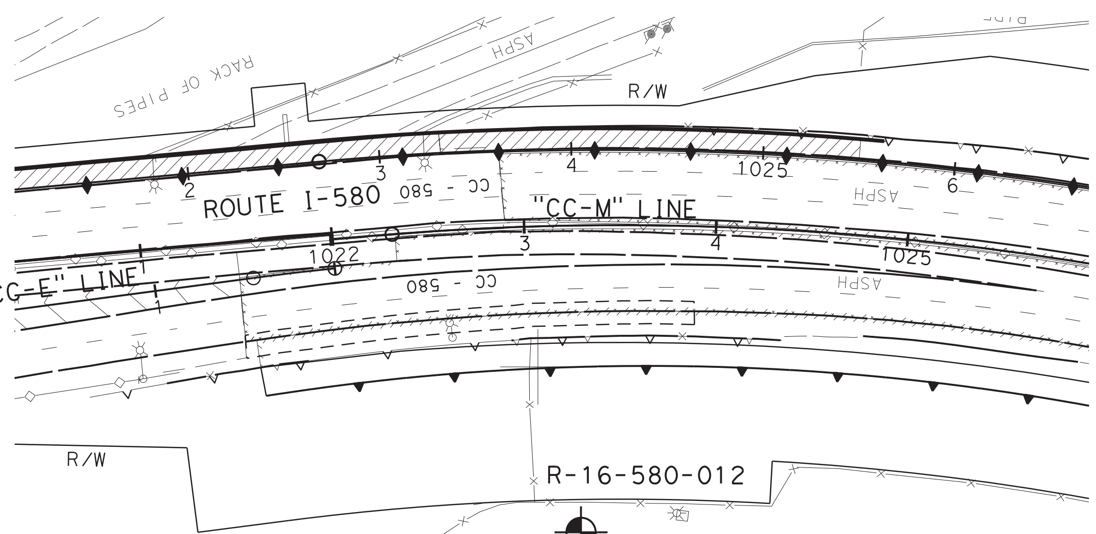

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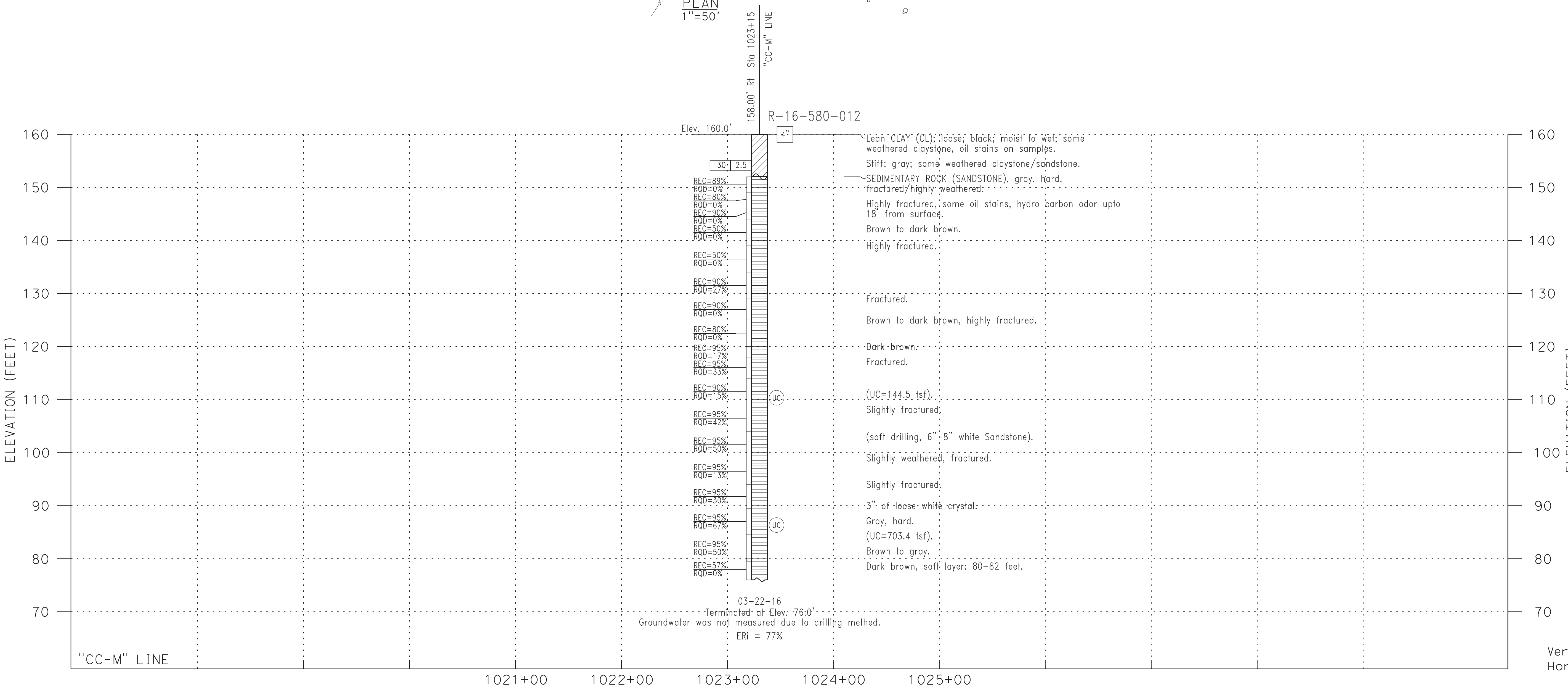

PROFILE
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Hor. : 1" = 50'

X DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG	L.S. BHANGOO FIELD INVESTIGATION BY:
X SIGN OFF DATE	CHECKED BY	KANDEEP SARAVANAPAVAN	DATE: JUNE & DECEMBER 2015 TO MARCH 2016

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

KANDEEP SARAVANAPAVAN
PROJECT ENGINEER

BRIDGE NO.
POST MILES

RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT

LOG OF TEST BORINGS 4 OF 4

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE:
CONTRACT NO.:

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

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Boring A-15-580-012, 8-21ft Core Sample

Boring A-15-580-012, 21-33ft Core Sample

Boring A-15-580-012, 33-40ft Core Sample

Boring A-15-580-012, 40-50ft Core Sample

Boring A-15-580-012, 50-60ft Core Sample

Boring A-15-580-012, 60-69ft Core Sample

Boring A-15-580-012, 69-80.5ft Core Sample

Boring A-15-580-012, 80-84ft Core Sample

APPENDIX B

Laboratory Test Data

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classifications of the samples were verified through visual examination in the laboratory and laboratory testing according to the Unified Soil Classification System (ASTM Test Method 2488). The results are presented on “Log of Test Borings”, Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the “Log of Test Borings”, Appendix A and Laboratory Summary Sheet, Plate No: B-2A & B-2B, “Laboratory Test Summary”.

Atterberg Limits

The Atterberg Limits were determined for selected samples that had been sieved through No. 40 sieve. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate No: B-3, “Plasticity Chart”.

Grain Size Classification

Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plate No: B-4A & B-4B, “Grain Size Distribution Curves”.

Corrosion Test

Corrosion tests were performed on selected samples to determine the corrosion potential of the soils. The pH and minimum resistively tests were performed according to California Test Method 643. The tests were performed by Sunland Analytical. The test results are presented on Plate No: B-5A through B-5E.

Borehole	Sample Number	Depth	Classi-fication	Water Content	Dry Density	Liquid Limit	Plastic Limit	Plasticity Index	% > Sieve 4	% < Sieve 200	Shear Strength (tsf)
A-15-580-001	1	3.0	GC	5.2	-				51.0	16.5	
A-15-580-001	2	6.0	GC	4.6	-						
A-15-580-001	3	11.0	GP-GC	2.6	-				69.4	7.0	
A-15-580-001	4	16.0	GP-GC	3.9	-						
A-15-580-001	5	21.0	CL	17.9	-	33	18	15			
A-15-580-001	6	26.0	GP-GC	5.9	-						
A-15-580-001	7	31.0	GP-GC	13.1	-				57.1	11.9	
A-15-580-001	8	36.0	CL	8.6	-						
A-15-580-001	9	41.0	GC	15.4	-						
A-15-580-010	1	3.0	-	1.3	-						
A-15-580-010	2	4.5	-	4.9	-						
A-15-580-010	3	9.5	-	1.9	-						
A-15-580-010	4	14.5	-	-	-						
A-15-580-011	1	3.0	-	7.8	-						
A-15-580-011	2	6.0	-	6.0	-						
A-15-580-011	3	11.0	-	15.2	116.0						
A-15-580-011	4	15.0	-	5.2	-						
A-15-580-013	1	3.0	-	5.5	-						
A-15-580-013	2	6.0	-	4.3	-						
A-15-580-013	3	11.0	-	9.4	-						
A-15-580-013	4	16.0	-	1.5	-						
A-15-580-013	5	21.0	-	2.6	-						
A-15-580-013	6	24.0	-	4.1	-						
A-15-580-014	1	5.0	-	6.2	-						
A-15-580-014	CORE 1	7.5	-	-	-						
A-15-580-014	CORE 2	10.0	-	-	-						
A-15-580-014	CORE 3	14.0	-	0.5	-						
A-15-580-014	CORE 4	19.0	-	-	-						
A-15-580-014	CORE 5	23.5	-	-	-						
A-15-580-015	1	3.0	SM	9.2	120.7						
A-15-580-015	2	6.0	SM	8.6	123.9						
A-15-580-015	3	11.0	SM	9.2	95.7				27.9	12.9	
A-15-580-015	4	16.0	GP-GM	8.6	-				66.9	8.9	
A-15-580-015	5	21.0	CH	30.5	-	51	26	25			
A-15-580-015	6	26.0	-	8.2	122.4						
A-15-580-015	7	31.0	-	6.5	-						
A-15-580-015	8	36.0	-	5.7	-						
A-15-580-015	9	41.0	-	8.3	-						
A-15-580-015	10	46.0	-	10.4	-						
A-15-580-016	1	3.0	SM	2.8	-						
A-15-580-016	2	6.0	SM	3.8	-						
A-15-580-016	3	11.0	SM	6.5	-				32.5	25.1	
A-15-580-016	4	16.0	SM	5.7	-				22.1	29.7	

Borehole	Sample Number	Depth	Classi-fication	Water Content	Dry Density	Liquid Limit	Plastic Limit	Plasticity Index	% > Sieve 4	% < Sieve 200	Shear Strength (tsf)
A-15-580-016	5	21.0	CL	12.1	-	32	17	15			
A-15-580-016	6	26.0	GM	13.1	-				49.8	17.5	
A-15-580-016	7	31.0	GM	9.2	-				54.4	14.4	
A-15-580-016	8	36.0	GM	9.1	-				50.1	15.9	
A-15-580-016	9	41.0	-	11.2	-						
A-15-580-016	10	46.0	-	9.9	-						
A-15-580-016	11	51.0	-	6.1	-						

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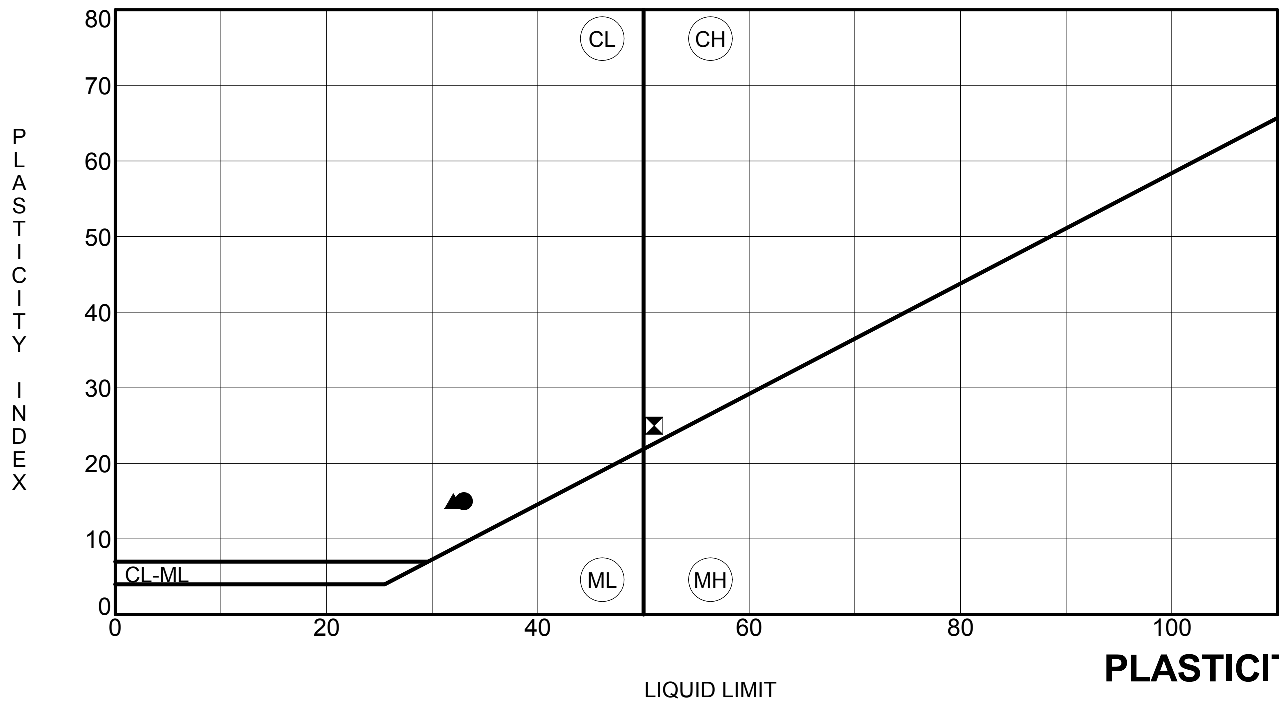
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMEMT PROJECT
RICHMOND & SAN RAFAEL, CALIFORNIA

JOB NO: 2014-125-GDR

PLATE NO: B-2B



PLASTICITY

	BOREHOLE	SAMPLE #	DEPTH	LL	PL	PI	Fines	Classification
●	**A-15-580-001**	**5**	**21.0**	**33**	**18**	**15**		**Lean CLAY with GRAVEL**
⧗	**A-15-580-015**	**5**	**21.0**	**51**	**26**	**25**		**Fat CLAY**
▲	**A-15-580-016**	**5**	**21.0**	**32**	**17**	**15**		**Lean CLAY with SAND**

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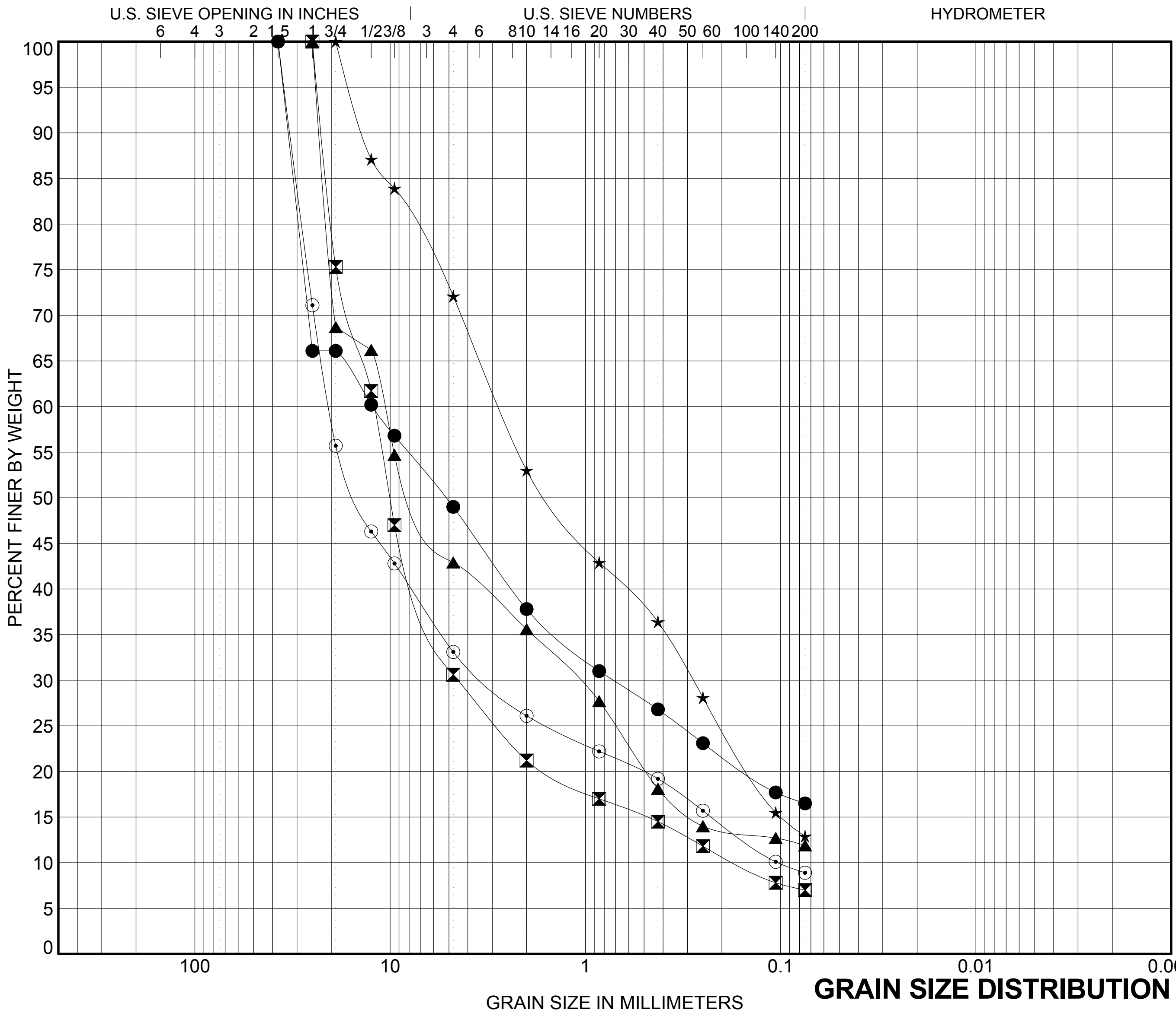
RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMEMT PROJECT
RICHMOND & SAN RAFAEL, CALIFORNIA

JOB NO: 2014-125-GDR | **PLATE NO: B-3**



GRAIN SIZE DISTRIBUTION

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING	SAMPLE #	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	A-15-580-001	1	3.0	**CLAYEY GRAVEL with SAND**					
⧗	A-15-580-001	3	11.0	**Poorly graded GRAVEL with CLAY and SAND**				9.82	71.26
▲	A-15-580-001	7	31.0	**Poorly graded GRAVEL with CLAY and SAND**				3.34	326.91
★	A-15-580-015	3	11.0	**SILTY SAND with GRAVEL**					
☉	A-15-580-015	4	16.0	**Poorly graded GRAVEL with SILT and SAND**				4.96	199.18

	BORING	SAMPLE #	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	A-15-580-001	1	3.0	37.5	12.3	0.721		51.0	32.5	16.5	
⧗	A-15-580-001	3	11.0	25	12.11	4.495	0.17	69.4	23.6	7.0	
▲	A-15-580-001	7	31.0	25	10.781	1.09		57.1	31.0	11.9	
★	A-15-580-015	3	11.0	19	2.746	0.282		27.9	59.2	12.9	
☉	A-15-580-015	4	16.0	37.5	20.513	3.238	0.103	66.9	24.2	8.9	

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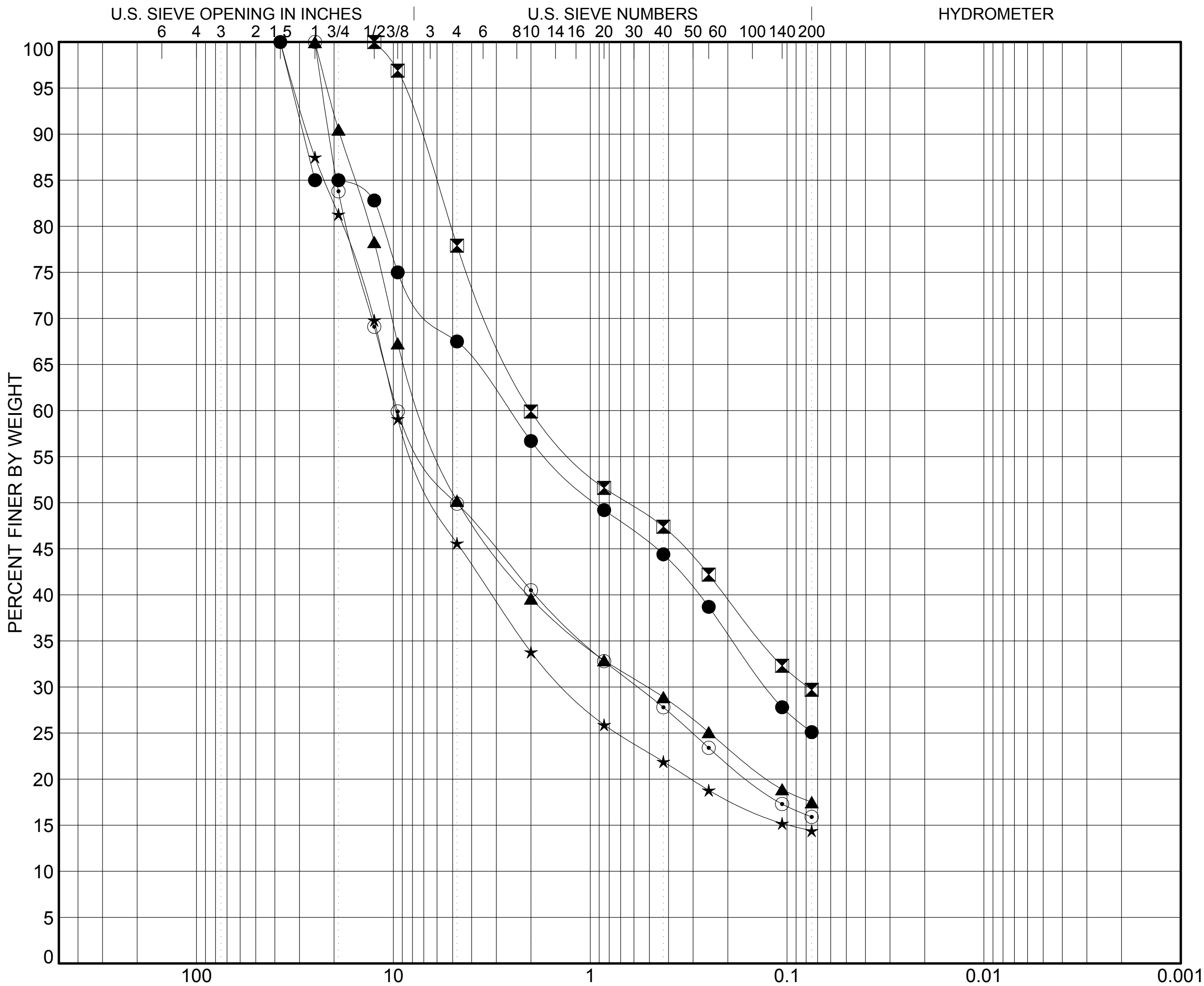
RICHMOND & SAN RAFAEL, CALIFORNIA

JOB NO: 2014-125-GDR | PLATE NO: B-4A



GRAIN SIZE DISTRIBUTION

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING	SAMPLE #	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**A-15-580-016**	**3**	**11.0**	**SILTY SAND with GRAVEL**					
⧗	**A-15-580-016**	**4**	**16.0**	**SILTY SAND with GRAVEL**					
▲	**A-15-580-016**	**6**	**26.0**	**SILTY GRAVEL with SAND**					
★	**A-15-580-016**	**7**	**31.0**	**SILTY GRAVEL with SAND**					
⊙	**A-15-580-016**	**8**	**36.0**	**SILTY GRAVEL with SAND**					

	BORING	SAMPLE #	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**A-15-580-016**	**3**	**11.0**	**37.5**	**2.605**	**0.126**		**32.5**	**42.4**	**25.1**	
⧗	**A-15-580-016**	**4**	**16.0**	**12.5**	**2.01**	**0.078**		**22.1**	**48.2**	**29.7**	
▲	**A-15-580-016**	**6**	**26.0**	**25**	**7.067**	**0.514**		**49.8**	**32.7**	**17.5**	
★	**A-15-580-016**	**7**	**31.0**	**37.5**	**9.722**	**1.325**		**54.4**	**31.2**	**14.4**	
⊙	**A-15-580-016**	**8**	**36.0**	**25**	**9.528**	**0.577**		**50.1**	**34.0**	**15.9**	

PARIKH
Practicing in the Geosciences

RICHMOND-SAN RAFAEL BRIDGE ACCESS IMPROVEMEMT PROJECT
RICHMOND & SAN RAFAEL, CALIFORNIA

JOB NO: 2014-125-GDR | **PLATE NO: B-4B**

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 08/05/2015
Date Submitted 07/31/2015

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite A
San Jose, CA 95131

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

The reported analysis was requested for the following location:
Location : 2014-125-GDR Site ID : A15-001-3@11 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 70149-146243.

EVALUATION FOR SOIL CORROSION

Soil pH	7.73		
Minimum Resistivity	1.39 ohm-cm (x1000)		
Chloride	18.2 ppm	00.00182	%
Sulfate	18.7 ppm	00.00187	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Plate No: B-5A

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 08/05/2015
Date Submitted 07/31/2015

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite A
San Jose, CA 95131

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

The reported analysis was requested for the following location:
Location : 2014-125-GDR Site ID : A15-011-1@3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 70149-146244.

EVALUATION FOR SOIL CORROSION

Soil pH	6.94	
Minimum Resistivity	1.54 ohm-cm (x1000)	
Chloride	22.1 ppm	00.00221 %
Sulfate	34.1 ppm	00.00341 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Plate No: B-5B

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 08/05/2015
Date Submitted 07/31/2015

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite A
San Jose, CA 95131

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

The reported analysis was requested for the following location:
Location : 2014-125-GDR Site ID : A15-013-1@3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 70149-146245.

EVALUATION FOR SOIL CORROSION

Soil pH	7.41	
Minimum Resistivity	2.22 ohm-cm (x1000)	
Chloride	11.6 ppm	00.00116 %
Sulfate	26.1 ppm	00.00261 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Plate No: B-5C

K

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 01/20/2016
Date Submitted 01/15/2016

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite A
San Jose, CA 95131

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

The reported analysis was requested for the following location:
Location : 2014-125-FDN Site ID : A15-580-015
Thank you for your business.

* For future reference to this analysis please use SUN # 71111-148298.

EVALUATION FOR SOIL CORROSION

Soil pH	7.65		
Minimum Resistivity	2.09	ohm-cm (x1000)	
Chloride	12.9 ppm	00.00129	%
Sulfate	47.6 ppm	00.00476	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Plate No: B-5D

K

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 01/20/2016
Date Submitted 01/15/2016

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite A
San Jose, CA 95131

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

The reported analysis was requested for the following location:
Location : 2014-125-FDN Site ID : A15-580-016.
Thank you for your business.

* For future reference to this analysis please use SUN # 71111-148299.

EVALUATION FOR SOIL CORROSION

Soil pH	7.56		
Minimum Resistivity	0.35	ohm-cm (x1000)	
Chloride	485.4 ppm	00.04854	%
Sulfate	360.8 ppm	00.03608	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Plate No: B-5E

COMPRESSIVE STRENGTH TEST FOR ROCK CORE SAMPLES (ASTM C 42)

Project Name: Richmond San Rafael Bridge Improvement
Project Number: 2014-125-FDN
Boring Number: A-15-580-012
Core Run Number: 10
Approx. Depth of Core Sample (ft): 49
Rock Type: Meta-Sandstone
Test Date: 4/5/16

Average Length (in)	Average Diameter (in)	Core Weight (gms)	Calculated Density (pcf)	Correction Factor	Max. Load (lbs)	Compressive Strength (psi)	Corrected Strength (psi)
5.0	2.39	984.5	166.8	1	9255	2064	2064

COMPRESSIVE STRENGTH TEST FOR ROCK CORE SAMPLES (ASTM C 42)

Project Name: Richmond San Rafael Bridge Improvement
Project Number: 2014-125-FDN
Boring Number: A-16-580-012
Core Run Number: 15
Approx. Depth of Core Sample (ft): 73
Rock Type: Meta-Sandstone
Test Date: 4/5/16

Average Length (in)	Average Diameter (in)	Core Weight (gms)	Calculated Density (pcf)	Correction Factor	Max. Load (lbs)	Compressive Strength (psi)	Corrected Strength (psi)
4.9	2.4	949	163.3	1	45438	10049	10049

APPENDIX C

Geophysical Study Report by NORCAL

July 30, 2015

Parikh Consultants, Inc.
2360 Qume Drive, Suite A
San Jose, California 95131

Subject: Seismic Refraction Investigation
Interstate 580 Retaining Wall
Richmond, California

NORCAL Job No: 15-426.22

Attention: Mr. Kandeep Saravanapavan

This report presents the findings of a seismic refraction (SR) investigation performed by NORCAL Geophysical Consultants as part of the retaining wall improvement project on eastbound Interstate 580 approximately 2,000 feet east of the Richmond Bridge Toll Plaza. The scope of the project includes widening the freeway and replacing the retaining wall with one approximately 15 feet further into the slope on the south side of the roadway. The survey was performed on June 29th, 2015 by NORCAL Professional Geophysicist David T. Hagin PGp 1033 and Senior Geophysical Technician Travis W. Black. Access to the site was via the Chevron Richmond Refinery. Logistical support was provided onsite by Mr. Robert Vanderlaan of Chevron.

1.0 SITE DESCRIPTION

The site consists of a steep cut slope above the existing retaining wall on the southern side of Interstate 580. The seismic survey was initially proposed to be conducted on the slope; however after field evaluation of the steepness of the slope, due to safety considerations it was determined jointly by Parikh and NORCAL personnel that the seismic survey would be conducted at the top of the slope adjacent to a chain link fence (Plate 1). In order to properly engineer the construction of the new retaining wall, it is desired to know the thickness of overburden and the depth to more competent material. Additionally, it is desired to estimate the excavatibility (rippability) of the rock.

The purpose of this investigation was to evaluate the shallow sub-surface conditions near the location of the planned excavation by measuring the seismic p-wave velocity values. These data will be used to evaluate the thickness of overburden and rock hardness with respect to rippability.

2.0 METHODOLOGY

The SR method is used to determine the compressional acoustic primary wave velocity (seismic velocity) of subsurface materials. The seismic velocity of fill, sediments, and rock are dependent on physical properties such as compaction, density, hardness, and induration. However, other factors such as bedding, fracturing, and saturation also affect seismic velocity. Typically, low velocities are indicative of loose, dry soils, poorly compacted fill material, poorly to semi-consolidated sediments, or alternatively, deeply weathered and/or highly fractured rock. Moderate velocities usually indicate dense and highly compacted or saturated sedimentary deposits or fill, and/or moderately weathered and fractured rock. High velocities typically represent slightly weathered to unweathered (fresh) rock with little fracturing. A more detailed description of the SR methodology is provided in Appendix A.

3.0 FIELD SURVEY AND DATA PROCESSING

3.1 Data Acquisition

The geophysical survey entailed the acquisition of a single SR line extending along the top of the slope above the existing retaining wall, as shown on Plate 1. The placement of the line was determined jointly by Parikh and NORCAL personnel, and based on the planned area of excavation. The seismic line consisted of two geophone spreads overlapping by 12 geophone stations. Each spread was comprised of 24 geophones coupled to the ground surface at eight foot intervals and seven shot points distributed in a collinear array. The two end shot points were located four stations beyond each end of the geophone spreads in order to assure adequate depth of investigation. Two additional shot points were located two stations beyond each end of the spreads and the remaining shot points were evenly spaced within the spread, yielding a total line length of 344 feet.

3.2 Instrumentation

The SR data were recorded using a ***Geometrics Geode***, 24-bit digital seismic recording system and ***Oyo Geospace*** digital-grade geophones with a natural frequency of 10 Hz. We produced seismic energy at each shot point by striking an aluminum plate placed on the ground surface with a 16-pound sledge hammer. An accelerometer attached to the hammer transmitted a triggering pulse to the seismograph to begin recording each time the plate was struck. Several strikes were performed and stacked at each shot point to ensure an acceptable signal to noise ratio. The locations and elevations of the geophones and shot-points were determined using field mapping techniques, stadia rod and hand level and a ***Trimble Geo 7X*** GPS receiver.

3.3 Data Processing

The refraction data were processed in-house using ***SeisImager***, specialized software developed by Geometrics, Inc. of San Jose, California. We then used the program ***Surfer 12*** by Golden Software to graphically illustrate the subsurface distribution of seismic velocities. This consisted of generating a color-contoured seismic velocity cross-section (profile).

4.0 RESULTS AND INTERPRETATIONS

The results of the seismic refraction survey are illustrated by the seismic velocity profile shown on Plate 2. The vertical axis represents elevation (above mean sea level) and the horizontal axis represents survey stationing (distance along the line). The profile shows the ground surface and color contours representing the distribution of seismic velocity values according to the color scale shown at the bottom of the plate.

4.1 Seismic Velocities

Low seismic velocity values of less than about 4,500 feet per second (ft/s) are interpreted to represent soil or fill "overburden" or possibly intensely weathered rock (tan, yellow and green). Moderate seismic velocity values ranging from 4,500 to 6,000 ft/s are interpreted to likely represent moderately weathered and/or fractured rock (blue). The highest seismic velocity values vary between 6,000 and slightly greater than 7,000 ft/s; they are interpreted to represent less weathered and/or fractured rock (magenta).

4.2 Seismic Refraction Profile - Line 1

The seismic profile indicates that a continuous surficial layer of low to moderate velocity material approximately ten feet thick extends across the entire line. This layer thickens slightly between stations 100 and 170 to a maximum of approximately 15 feet. Below this layer we note a rapid transition to higher seismic velocity values. The underlying material appears very uniform and extends to the bottom of the profile, with seismic velocity values that vary between 6,000 and 7,200 ft/s. The maximum depth of exploration is approximately 50 feet and the maximum seismic velocity values measured were approximately 7,200 ft/s.

4.3 Rippability

Seismic velocity charts relating seismic velocity to excavation characteristics have been developed from field tests by others. These charts list the seismic velocity of various types of rock and their relative ease of excavation using different types of rippers. Caterpillar Tractor Company publishes a performance manual that lists ripper performance charts for the D8R, D9R, D10T and D11T tractors. The following information in Table A was obtained from a performance chart for a D8R ripper (Caterpillar Performance Handbook, Edition 36, April 2006). We present the velocity range for metamorphic rock, as the California Geological Survey (CGS) 2010 geologic map indicates that local bedrock is the Franciscan Formation.

Table A: CAT D8R Ripper Performance in Metamorphic Rock

PERFORMANCE	VELOCITY RANGE (FT/S)
Rippable	Less than 6,300
Marginally Rippable	6,300 to 8,200
Non-Rippable	Greater than 8,200

We compared the measured seismic velocity values to the various ranges listed in the Caterpillar Performance Handbook. All of the measured seismic velocity values fall within the rippable or marginally rippable ranges for the selected equipment. Although the actual equipment used during excavation may vary from the referenced equipment, this chart may serve as a relative guideline to site rippability conditions.

5.0 LIMITATIONS

This information should only be used as a general guide to rippability as many other factors also contribute to the evaluation of rock rippability. These factors include rock jointing and fracture patterns, the experience of the equipment operator, and the equipment and excavation methods selected. Also, the computed velocities measured along each line are an average; therefore, there may be localized zones where the velocities may be higher or lower than indicated. Since the accuracy of our findings is subject to these limitations, it should be noted that subsurface conditions may vary from those depicted in the final results. A more detailed discussion of the limitations with regard to the seismic refraction method is presented in Appendix A.

It should also be noted that the seismic refraction technique is based on the assumption that seismic velocity increases with depth. Any layers representing a decrease in velocity with depth, otherwise known as a velocity inversion, will not be defined and will result in the over-estimation of the depth of deeper, higher velocity layers. In addition, relatively thin layers might not be individually resolved and might, instead, be lumped together with other layers. Hard and soft zones within a given seismic layer will tend to be averaged into the velocity of that layer. Finally, there is not necessarily a one-to-one relationship between lithologic layers and seismic layers. It is entirely possible that two different types of material could have the same seismic velocity. Alternatively, a change in velocity can occur within a single lithologic unit.

6.0 STANDARD OF CARE

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

Thank you for the opportunity to participate on this project.

Sincerely,

NORCAL Geophysical Consultants, Inc.

David T. Hagin tt.

David T. Hagin
Professional Geophysicist PGp 1033

DTH/KGB/tt
Enclosures: Plates 1 and 2
Appendix A - Seismic Refraction Survey

Appendix A

SEISMIC REFRACTION SURVEY

Appendix A

SEISMIC REFRACTION (SR)

METHODOLOGY

The seismic refraction method provides information regarding the seismic velocity structure of the subsurface. An impulsive (mechanical or explosive) source is used to produce compressional (P) wave seismic energy. The P-waves propagate into the earth and are refracted along interfaces caused by an increase in velocity. A portion of the P-wave energy is refracted back to the surface where it is detected by sensors (geophones) that are coupled to the ground surface in a collinear array (spread). The detected signals are recorded on a multi-channel seismograph and are analyzed to determine the shot point-to-geophone travel times. These data can be used along with the corresponding shot point-to-geophone distances to determine the depth, thickness, and velocity of subsurface seismic layers.

The seismic refraction technique is based on several assumptions. Paramount among these are:

- seismic velocity increases with depth, and,
- the velocity of each seismic layer is uniform over the length of the given spread.

In cases where these assumptions do not hold, the accuracy of the technique decreases. For example, if a low velocity layer occurs between two layers of higher velocity, the low velocity layer will not be detected and the depth to the underlying high velocity layer will be erroneously large. Also, if the velocity of a seismic layer varies laterally within a spread, those variations will be interpreted as fluctuations in the elevation of the underlying seismic layer.

It should be noted that apparent velocities can be affected by the orientation of bedding planes with respect to the direction of the seismic profile. Apparent velocities of rock are typically slower when measured along lines oriented perpendicular to bedding planes of steeply dipping rock than those measured along lines oriented parallel.

INSTRUMENTATION

Data acquisition is initiated along each SR line by producing seismic energy using a mechanical source. Mechanical sources produce energy by impacting a metal strike plate on the ground surface with either a 12-16 pound sledge hammer or an elastic-band driven weight drop. The resulting seismic wave forms are recorded using a Geometrics 24-channel engineering seismograph and Mark Products geophones with a natural frequency of 10 Hz. The data are recorded on hard copy records (seismograms) as well as on computer disks for future processing. The seismograms display the amount of time it takes for a compression (P) wave to travel from a given shot point to each geophone in a spread.

DATA ANALYSIS

The seismic data are downloaded to a computer and processed using the software ***Seisimager*** by Geometrics, Inc. This is an interactive program that is used to determine the shot point to geophone travel times, and to compute a 2D model based on those times. Once the travel times for a given line are determined, the programs time-term algorithm is used to compute a preliminary 2D seismic model. This model is then used as input for the programs tomographic routine. Using this procedure, the program divides the starting model into a network of cells and assigns velocities to those cells based on the starting model. The program then traces the refracted seismic travel paths through those cells and computes the associated travel times. It then compares the computed travel times with the measured times and adjusts the velocities of the appropriate cells to improve the fit. The software is programmed to continue this procedure for twenty iterations. Typically, at the end of the twenty iterations the travel times associated with the computed model match the observed travel times to an accuracy of one milli-second (mS) or better. Once a satisfactory model is computed, the software contours the model velocities to produce seismic velocity vs. depth and distance cross-sections (profiles).

LIMITATIONS

In general, there are limitations unique to the SR method. These limitations are primarily based on assumptions that are made by the data analysis routine. First, the data analysis routine assumes that the velocities along the length of each spread are uniform. If there are localized zones within each layer where the velocities are higher or lower than indicated, the analysis routine will interpret these zones as changes in the surface topography of the underlying layer. A zone of higher velocity material would be interpreted as a low in the surface of the underlying layer. Zones of lower velocity material would be interpreted as a high in the underlying layer.

Second, the data analysis routine assumes that the velocity of subsurface materials increase with depth. Therefore, if a layer exhibits velocities that are slower than those of the material above it, the slower layer will not be resolved. Also, a velocity layer may simply be too thin to be detected. Due to these and other limitations inherent to the SR method, the results of the SR survey should be considered only as approximations of the subsurface conditions. The actual conditions may vary locally.

VICINITY MAP

SCALE
0 60 120
(1 inch = 60 feet)

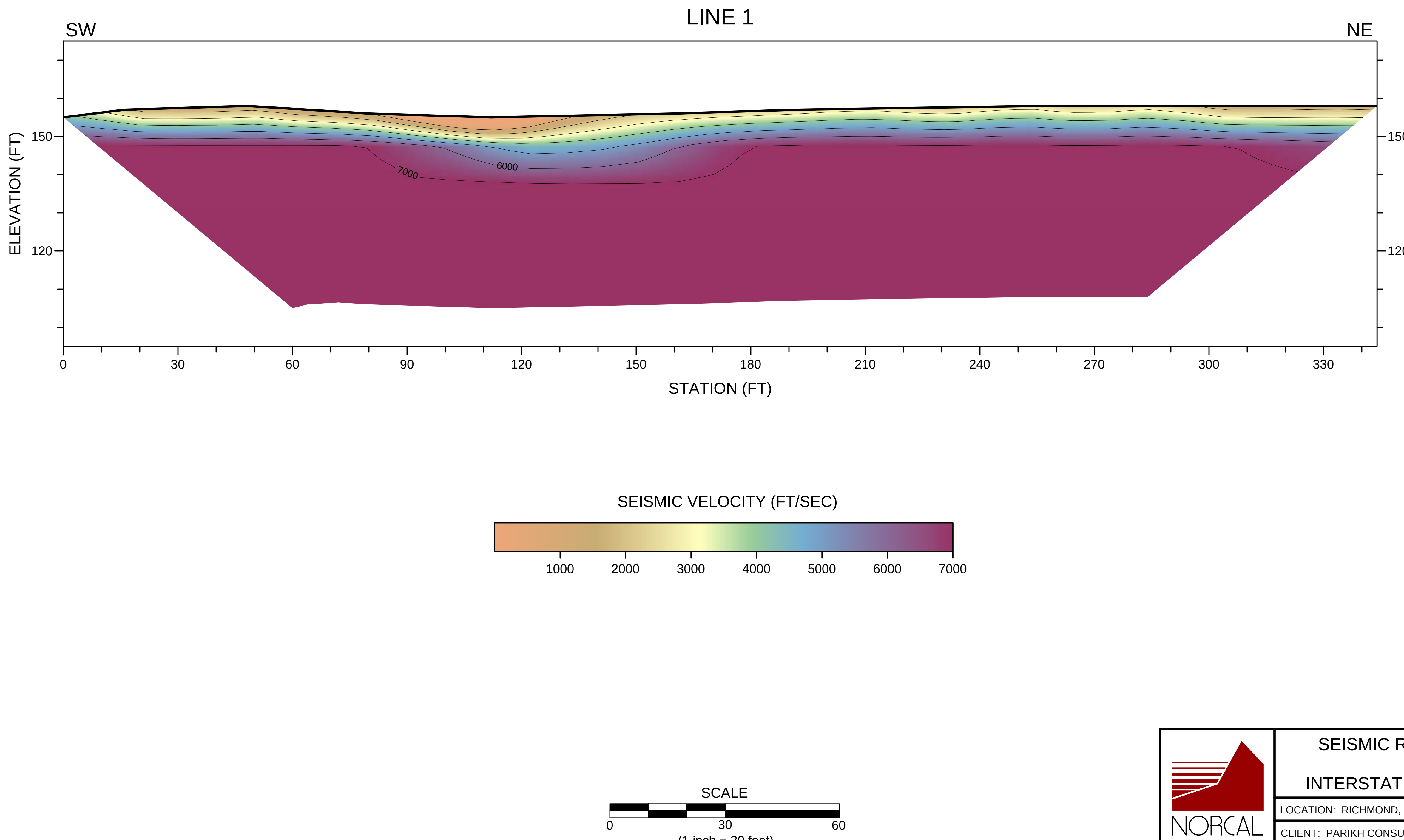
LEGEND

(red line)	SEISMIC REFRACTION LINE

NORCAL

SITE LOCATION MAP
SEISMIC REFRACTION SURVEY
INTERSTATE 580 RETAINING WALL

LOCATION: RICHMOND, CALIFORNIA
CLIENT: PARIKH CONSULTANTS
NORCAL GEOPHYSICAL CONSULTANTS INC.
JOB #: 15-426.22
DATE: JUL. 2015
DRAWN BY: G.RANDALL
APPROVED BY: DTH
PLATE 1



NORCAL

SEISMIC REFRACTION PROFILE
LINE 1
INTERSTATE 580 RETAINING WALL

LOCATION: RICHMOND, CALIFORNIA		
CLIENT: PARIKH CONSULTANTS		PLATE 2
JOB #: 15-426.22	NORCAL GEOPHYSICAL CONSULTANTS INC.	
DATE: JUL. 2015	DRAWN BY: G.RANDALL	APPROVED BY: DTH

APPENDIX D

As-Built Plan & LOTB

As-Built Plans

DIST	COUNTY	ROUTE	POST MILE—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	17	5.7	1	14

INDEX OF SHEETS

- Sheet No. 1 Title Sheet and Location Map
- " " 2 Typical Cross Sections
- " " 3 Standard Plan List
- " " 4 Layout
- " " 5 General Cross Section

STRUCTURE PLANS

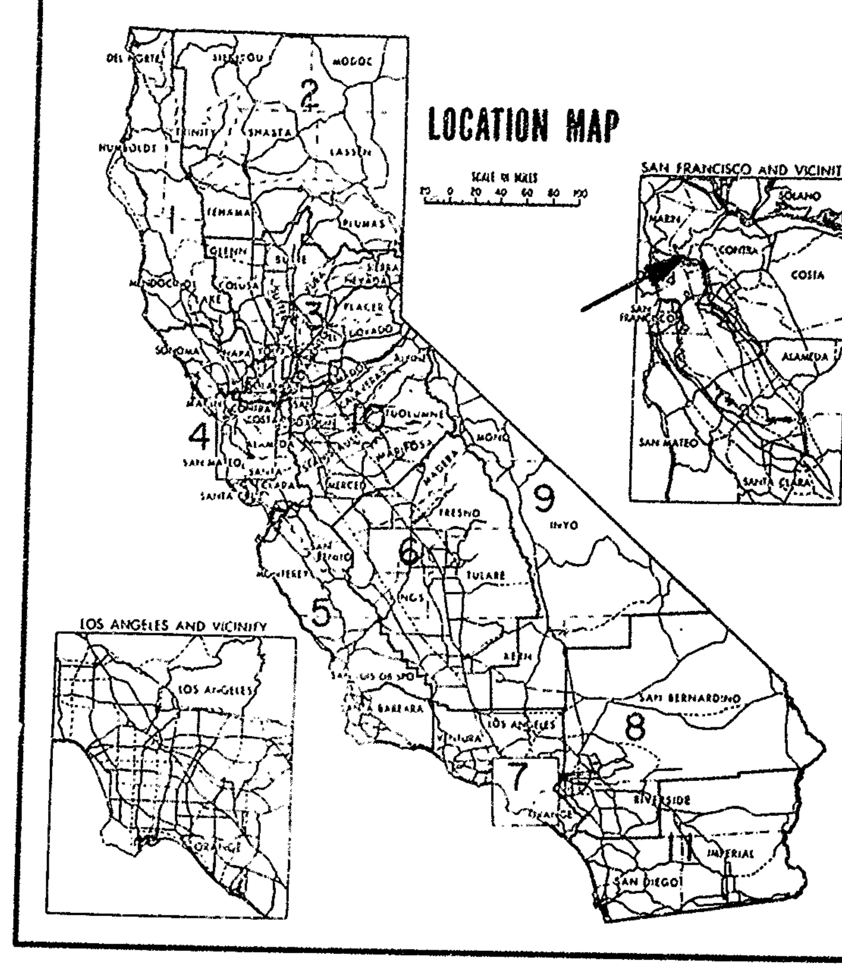
- " " 6 - 14 Retaining Wall Plans

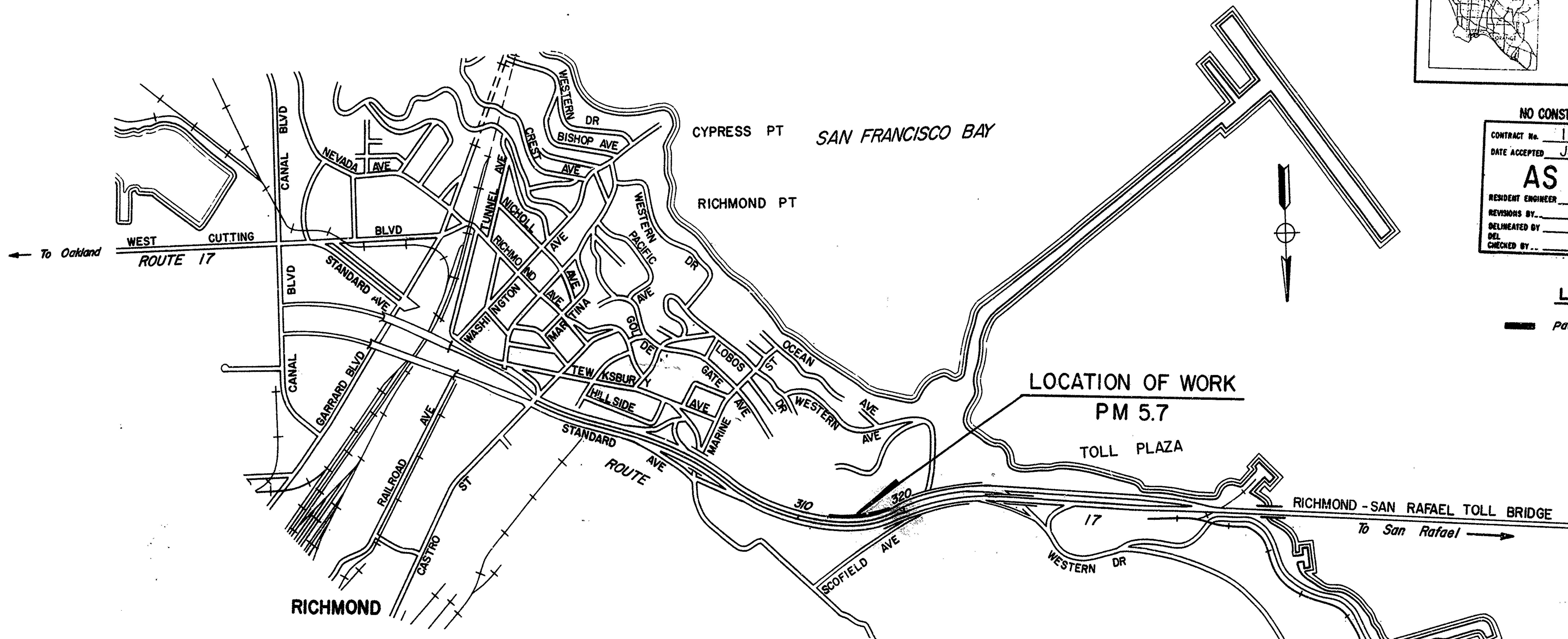
STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN CONTRA COSTA COUNTY IN RICHMOND AT 0.1 MILE EAST OF SCOFIELD AVENUE UNDERCROSSING

To be supplemented by Standard Plans dated July, 1984





NO CONSTRUCTION CHANGES

CONTRACT No. 118774

DATE ACCEPTED Jun. 2, 1986

AS BUILT

RESIDENT ENGINEER D. Ashe

REVISIONS BY ____ DATE ____

DELINEATED BY ____ DATE ____

CHECKED BY ____ DATE ____

LEGEND

Paving and Retaining Wall

Deputy District Director of Transportation
Registered Civil Engineer No. 10679

Approved November 26, 1984

Chief, Office of Office Engineer
Registered Civil Engineer No. 8854

Project Engineer	Date	Design Engineer	Date	Approval Recommended by	Date
A. IVERSEN	1/84	E. A. SATOW	1/84	L. CHU	1/84

×1

Drawn by	Date
Checked by	Date

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

Contract No. 04 – 118774

04210 118771

AS BUILT PLANS
Contract No. 04-118774
Date Completed 6-2-86
Document No.

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

DATE 8-12-88 SIGNATURE TITLE SUPERVISOR OF MICROFILM SERVICES

Dist.	County	Route	Post Miles Total Project	Sheet No.	Total Sheets
04	CC	17	5.7	2	14

A. Iversen
PROJECT ENGINEER
REGISTERED CIVIL ENGINEER NO. 11375
DATE APPROVED November 26, 1984

DRAINAGE STRUCTURE LIST

Item	Location	Quantity
Abandon Culvert	Lt L318 + 55	1 Ea
Cap Inlet	Lt L318 + 48	1 Ea
G2 Inlet - Minor Concrete (Minor Structure)	Lt L318 + 41	1.5CY(F)
18" Bit Ct Corrugated Steel Pipe. (.079" Thick)	Lt L318 + 43 - L318 + 63	20 LF
Frame and Grate (Type 24 - 13)	Lt L318 + 41	188 Lb(F)

(F) The quantity shown in this column for each individual portion of work is a final pay quantity.

PLACE ASPHALT CONCRETE DIKE(TYPE A)

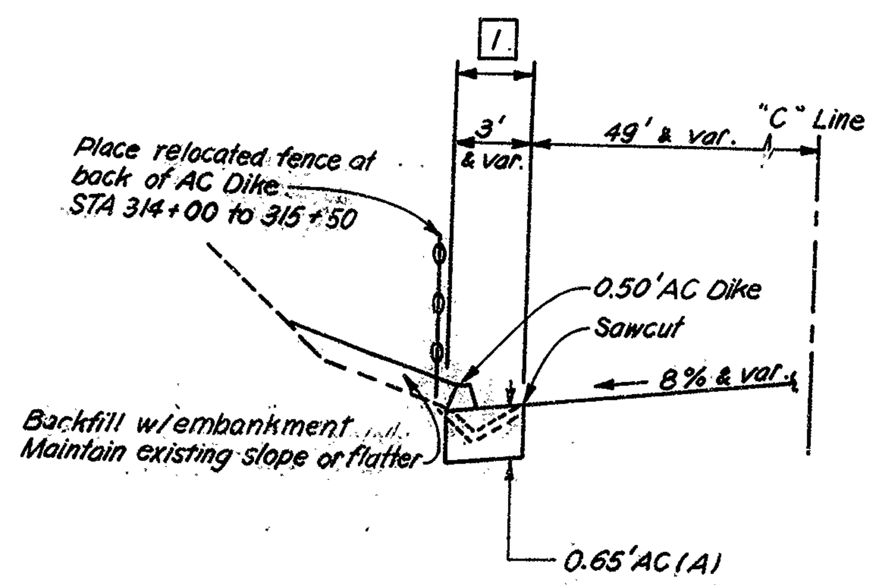
Station Limits	Location	LF
C 313 + 06 - L 315 + 50	Lt	244
	Total	244

CONSTRUCTION AREA SIGNS

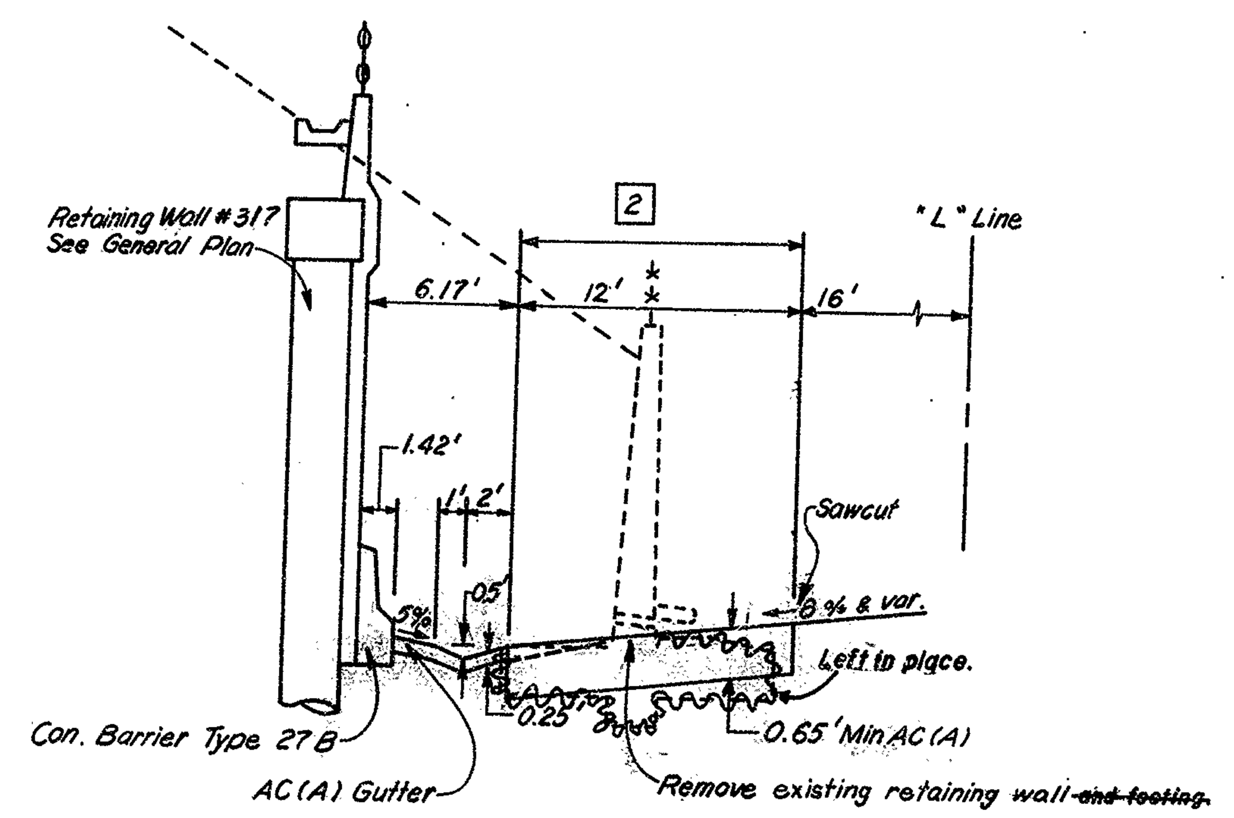
Code	Message	Quantity	Post Size (wood)	Panel Size
C 18	Road Construction Ahead	1	2-6" x 6" x 18'	72" x 72"
C 13	End Road Construction	1	2-4" x 4" x 12'-6"	60" x 24"

RECONSTRUCT CHAIN LINK FENCE

Station Limits	Location	LF
C 314 + 00 - L 315 + 50	Lt	150
	Total	150



STA C 313 + 06 To L 315 + 50



STA L 315 + 50 To L 318 + 61

Note :

Dimensions of the structural sections are subject to the tolerances specified in the Standard Specifications .

Abbreviations :

AC (A) .... Asphalt Concrete (Type A)
AB (2) .... Aggregate Base (class 2)
PSP .... Perforated Steel Pipe

CONSTRUCTION CHANGES
CONTRACT No. 118774
DATE ACCEPTED Jun. 2, 1986
AS BUILT
RESIDENT ENGINEER D Ashe
REVISIONS BY D Ashe DATE 6-30-86
DELINEATED BY S Combs DATE 4-14-88
CHECKED BY L Morita DATE 4-25-88

AS BUILT PLANS
Contract No. 04-118774
Date Completed 6-2-86
Document No.

Project Engineer	Date	Design Engineer	Date	Approval Recommended by	Date
A. IVERSEN	7/84	E.A. SATOW	7/84	L. CHU	7/84

2

TYPICAL CROSS SECTIONS
NO SCALE

TYPICAL CROSS SECTIONS

FORM DC-OS-F3-M (REV. 11/78)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

04210 118771

DISTRICT	COUNTY	ROUTE	POST MILES	SHEET NO.	TOTAL SHEETS
04	CC	17	5.7	3	14

To accompany plans dated NOVEMBER 26,1984

GENERAL ROAD WORK

- ☒ A-10 Symbols and Abbreviations
- ☐ A-20A Pavement Markers and Traffic Lines, Typical Details
- ☐ A-20B Pavement Markers and Traffic Lines, Typical Details
- ☐ A35-A P.C.C. Paving Details
- ☐ A35-B Approach Slab
- ☒ A62-A Excavation and Backfill Miscellaneous-Limits of Payment
- ☒ A62-B Excavation and Backfill Bridge Surcharge and Wall-Limits of Payment
- ☐ A62-C Excavation and Backfill Bridge - Limits of Payment
- ☐ A62-D Excavation and Backfill Details Concrete and Asbestos-Cement Pipe Culverts
- ☐ A62-E Excavation and Backfill Details Reinforced Concrete Box and Arch Culverts
- ☒ A62-F Excavation and Backfill Details Metal Culverts
- ☒ A73 Type III Barricade, Dikes and Road Intersections
- ☐ A74-A Markers and Delineators
- ☐ A74-B Survey Monuments
- ☐ A75-A Concrete Barrier Type 50
- ☐ A75-B Concrete Barrier Type 50
- ☐ A77-A Metal Beam Barrier
- ☐ A77-B Metal Beam Barrier
- ☐ A77C-1 Metal Beam Guard Railing-Standard Hardware
- ☐ A77C-2 Metal Beam Guard Railing
- ☐ A77-D Barrier and Guard Rail Anchors
- ☐ A77-E Cable Anchor Assembly (Breakaway)
- ☐ A77-F Thrie Beam Barrier
- ☐ A77G Thrie Beam Barrier
- ☐ A79-A Guard Rail Flares
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- ☐ A79-D Guard Rail Connections to Bridge Sidewalks and Curbs
- ☐ A80 Emergency Passageways
- ☐ A81 Barrier Transitions
- ☐ A83 Portable Scale
- ☐ C7-A Reinforced Concrete Crib Wall Types A, B, C and D-Construction Details
- ☐ C7-B Reinforced Concrete Crib Wall Types A, B, C and D-Design Data
- ☐ C7-C Reinforced Concrete Crib Wall Types I, II, III, IV, V, VI, VII, VIII and IX
- ☐ C7-D Reinforced Concrete Crib Wall Types X, XI & XII
- ☐ C7-E Reinforced Conrete Crib Wall Header & Stretcher Details
- ☐ C7-F Reinforced Concrete Crib Wall Design Data - Types I thru XII
- ☐ C8-A Steel Crib Wall-Construction Details
- ☐ C8-B Steel Crib Wall-Design Data
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- ☐ C9-B Timber Crib Wall Types A, B, C and D-Design Data
- ☐ D72 Drainage Inlets - OS, OL, GOL
- ☒ D73 Drainage Inlets - G1, G2, G3, G4, G5, G6
- ☐ D74 Drainage Inlets - GT1, GT2, GT3, GT4, G0, GDO
- ☐ D75 Pipe Inlets
- ☒ D77-A Grate Details
- ☒ D77-B Bicycle Proof Grate Details
- ☐ D78 Gutter Depressions
- ☐ D80 Single Box Culvert
- ☐ D81 Double Box Culvert
- ☐ D83 Box Culvert Miscellaneous
- ☐ D84 Box Culvert Wingwall, Types "A" "B" & "C"
- ☐ D85 Box Culvert Wingwall, Types "D" & "E"
- ☐ D86-A Box Culvert Warped Wingwalls
- ☐ D86-B Pipe Culvert Headwalls, Endwalls & Warped Wingwalls
- ☐ D86-C Arch Culvert Headwalls, Endwalls & Warped Wingwalls
- ☐ D87-A Overside Drains
- ☐ D87-B Overside Drains and Underdrains
- ☐ D88 Construction Loads on Culverts
- ☐ D89 Pipe Headwalls and Strut Details
- ☐ D90 Pipe Culvert Headwalls, Endwalls & Wingwalls Types "A" "B" & "C"
- ☐ D93 Drainage Inlet Riser Connections
- ☐ D94 Flared End Sections
- ☐ D95 Concrete Arch Culverts
- ☐ D96 Pipe Riser with Debris Rock Cage
- ☒ D97A CMP Coupling Band Details No. 1, Flanged End CSP Channel Coupling Band Details-Downdrains, Standard and Positive Joints
- ☒ D97B-1 CMP Coupling Band Details No. 2, Annular, Reformed End, and Helical Coupling Bands-Downdrains, Standard and Positive Joints
- ☒ D97B-2 CMP Coupling Band Details No. 3, Flanged End CSP Channel Coupling Band Details-Downdrains, Standard and Positive Joints
- ☒ D97C-1 CMP Coupling Band Details No. 4, Universal Coupling Bands Standard and Positive Joints
- ☒ D97C-2 CMP Coupling Band Details No. 5, Universal Coupling Bands Standard and Positive Joints
- ☒ D97D CMP Coupling Details No. 6-Standard Joint
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- ☐ D98-A Standard Inlet Structure Shoulder Installation Details and Details of Slotted Drain Connections
- ☐ D98-B 12" Thru 24" Slotted C.S.P. Drain Details
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- ☒ F-10 Chain Link Fence
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- ☐ N8-A Curbs and Driveways
- ☐ N8-B Wheelchair Ramp Details No. 1
- ☐ N8-C Wheelchair Ramp Details No. 2
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- ☐ T-11 Traffic Control System for Lane Closure on Multilane Conventional Highways, Miscellaneous Details
- ☐ T-12 Traffic Control System for Lane Closure on Multilane Conventional Highways, Miscellaneous Details
- ☐ T-13 Traffic Control System for Lane Closure on Two Lane Conventional Highways
- ☐ T-14 Details for Ramp Closures, Miscellaneous Details

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- ☐ B0-1 Bridge Details
- ☒ B0-3 Bridge Details
- ☐ B0-5 Bridge Details
- ☐ B0-13 Bridge Details
- ☐ B1-11 Closure Wall Details-Box Girder
- ☐ B2-3 16" Cast-in-Drilled-Hole Concrete Pile
- ☐ B2-5 Pile Details-Class 45 and Class 70
- ☐ B2-8 Pile Details-Class 45C and Class 70C
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- ☐ B3-1 Retaining Wall-Type I H=4'-30'
- ☐ B3-2 Retaining Wall-Type I H=32'-36'
- ☐ B3-3 Retaining Wall-Type I A
- ☐ B3-4 Retaining Wall-Type 2
- ☐ B3-5 Counterfort Retaining Wall - Type 3
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- ☐ B3-8 Retaining Wall Details No. 1
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- ☐ B3-11 Retaining Wall Type 6 - 6' Max.
- ☐ B6-1 T-Beam Details
- ☐ B6-10 Utility Openings - T-Beam
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- ☐ B7-11 Utilities Details
- ☐ B8-5 Cast-in-Place Prestressed Girder Details
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- ☐ B11-30 Temporary Railing (Type K)
- ☐ B11-47 Cable Railing
- ☐ B11-51 Tubular Hand Railing
- ☐ B11-52 Chain Link Railing Type 7
- ☐ B11-53 Concrete Barrier Type 25
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- ☐ B13-1 Slope Protection Detail No. 1
- ☐ B13-2 Slope Protection Detail No. 2
- ☐ B14-1 Structural Steel Plate Vehicular Undercrossing
- ☐ B14-2 Structural Steel Plate Arches
- ☐ B14-3 Supply Line & Communication & Sprinkler Control Conduit

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- ☐ S2-11 Overhead Signs, Truss, Single Post Type, Post Type II thru VIII
- ☐ S3-11 Overhead Signs, Truss, Two Post Type, Post Type 1-S thru VII-S
- ☐ S4-8 Overhead Signs, Truss, Single Post Type, Structural Frame Members
- ☐ S5-6 Overhead Signs, Truss, Two Post Type, Structural Frame Members
- ☐ S6-8 Overhead Signs, Truss, Structural Frame Details
- ☐ S7-8 Overhead Signs, Truss, Frame Juncture Details
- ☐ S8B Overhead Signs, Steel Frame Removable Sign Panel Frames
- ☐ S8-BA Overhead Formed Panel Details for Mounting on Removable Sign Panel Frames
- ☐ S8C Overhead Signs, Truss, Sign Panel Mounting Details Laminated Panel, Type A
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- ☐ S9-12 Overhead Signs, Walkway Details No. 1
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- ☐ S15-8 Overhead Signs, Lightweight, Type A, Connection Details
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- ☐ S18B-7 Overhead Signs, Lightweight, Light Fixture Mounting Details
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- ☐ S22-2 Overhead Signs, Box Beam, Two Post Type Frame Members
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- ☐ S40A-1 Overhead Signs, Box Beam, Closed Truss Alternative, Two Post Type Frame Members
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- ☐ S40C-1 Overhead Signs, Box Beam, Closed Truss Alternative, Ribbed Sheet Metal Details
- ☐ S40D-1 Overhead Signs, Box Beam, Closed Truss Alternative, Two Post Type Frame Details
- ☐ S40E-1 Overhead Signs, Box Beam, Closed Truss Alternative, Two Post Type Frame Juncture Details
- ☐ S40F-1 Overhead Signs, Box Beam, Closed Truss Alternative, Two Post Type Post Details
- ☐ S40G-1 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Type Frame Members
- ☐ S40H-1 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Cantilever Frame Details
- ☐ S40I-1 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Cantilever Frame Juncture Details
- ☐ S40J-1 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Cantilever Post Details
- ☐ S40K-1 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Butterfly Frame Details
- ☐ S40L-3 Overhead Signs, Box Beam, Closed Truss Alternative, Single Post Butterfly Frame Juncture Details
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- ☐ S40P Overhead Signs, Tubular, Single Post Type Layout and Pipe Selection
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- ☐ S40R Overhead Signs, Tubular, Structural Frame Details No. 1
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- ☐ S43-A Roadside Signs, Laminated Wood Box Posts, Typical Installation Details No. 3
- ☐ S43-B Roadside Signs, Steel Post, Typical Installation Details
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- ☐ ES-1A Traffic Signal and Highway Lighting Details, Symbols and Abbreviations
- ☐ ES-1B Traffic Signal and Highway Lighting Details, Symbols and Abbreviations
- ☐ ES-2A Traffic Signal and Highway Lighting Details, Service Equipment
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- ☐ ES-3A Traffic Signal and Highway Lighting Details, Signal Heads and Mountings
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- ☐ ES-4A Traffic Signal and Highway Lighting Details, Controller Cabinet Details
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- ☐ ES-5A Traffic Signal and Highway Lighting Details, Detectors
- ☐ ES-5B Traffic Signal and Highway Lighting Details, Detectors
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- ☐ ES-6A Traffic Signal and Lighting Standards, Type I Standards and Pushbutton Posts
- ☐ ES-6B Lighting Standards, Types 15 and 21
- ☐ ES-6D Lighting Standards, Types 30 and 31
- ☐ ES-6DA Lighting Standards, Type 32
- ☐ ES-6E Lighting Standards Types 30 and 31, Base Plate Details
- ☐ ES-6F 10 Degree Lighting Standards
- ☐ ES-6H 10 Degree Lighting Standards Details
- ☐ ES-6J Traffic Signal and Lighting Standards Case 1 Arm Loading, Wind Velocity=70 MPH Arm Lengths 15' to 30'
- ☐ ES-6K Traffic Signal and Lighting Standards Case 2 Arm Loading, Wind Velocity=70 MPH Arm Lengths 20' to 30'
- ☐ ES-6L Traffic Signal and Lighting Standards Case 3 Arm Loading, Wind Velocity=70 MPH Arm Lengths 20' to 30'
- ☐ ES-6M Traffic Signal and Lighting Standards Case 4 Arm Loading, Wind Velocity=70 MPH Arm Lengths 25' to 45'
- ☐ ES-6N Traffic Signal and Lighting Standards Type 40-0-80
- ☐ ES-6O Traffic Signal and Lighting Standards Case 1 Arm Loading, Wind Velocity=80 MPH Arm Lengths 25' to 30'
- ☐ ES-6P Traffic Signal and Lighting Standards Case 2 Arm Loading, Wind Velocity=80 MPH Arm Lengths 20' to 30'
- ☐ ES-6Q Traffic Signal and Lighting Standards Case 3 Arm Loading, Wind Velocity=80 MPH Arm Lengths 20' to 30'
- ☐ ES-6R Traffic Signal and Lighting Standards Case 4 Arm Loading, Wind Velocity=80 MPH Arm Lengths 25' to 45'
- ☐ ES-6S Traffic Signal and Lighting Standards Details No. 1
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- ☐ ES-6U Slip Base Insert for Type 10 & 15 Lighting Standards
- ☐ ES-6V Left Turn Signal and Sign Standard Type 33
- ☐ ES-7A Traffic Signal and Highway Lighting Details, Electrical Details Structure Installations
- ☐ ES-7B Traffic Signal and Highway Lighting Details, Electrical Details Structure Installations
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- ☐ ES-7F Traffic Signal and Highway Lighting Details, Electrical Details Structure Installations
- ☐ ES-8 Traffic Signal and Highway Lighting Details, Pull Box Details
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- ☐ ES-12 Pedestrian Undercrossing Fluorescent Lighting Fixture
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- ☐ ES-27A Extinguishable Message Sign, 10" Letters
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- ☐ ES-29 Mercury Sign Lighting Equipment
- ☐ ES-30 36" Fluorescent Sign Lighting Equipment
- ☐ ES-31 72" Fluorescent Sign Lighting Equipment
- ☐ ES-32 Sign Lighting Equipment
- ☐ ES-33 Internally Illuminated Street Name Sign

NO CONSTRUCTION CHANGES

CONTRACT No. 118774
DATE ACCEPTED Jun.2,1986

AS BUILT

RESIDENT ENGINEER D Ashe
REVISIONS BY ____ DATE ____
DELINEATED BY ____ DATE ____
CHECKED BY ____ DATE ____

STANDARD PLANS LIST

(July,1984 Edition)

3

The Standard Plan sheets indicated by a marked box are applicable to this CONTRACT NO.04-118774

04-118774

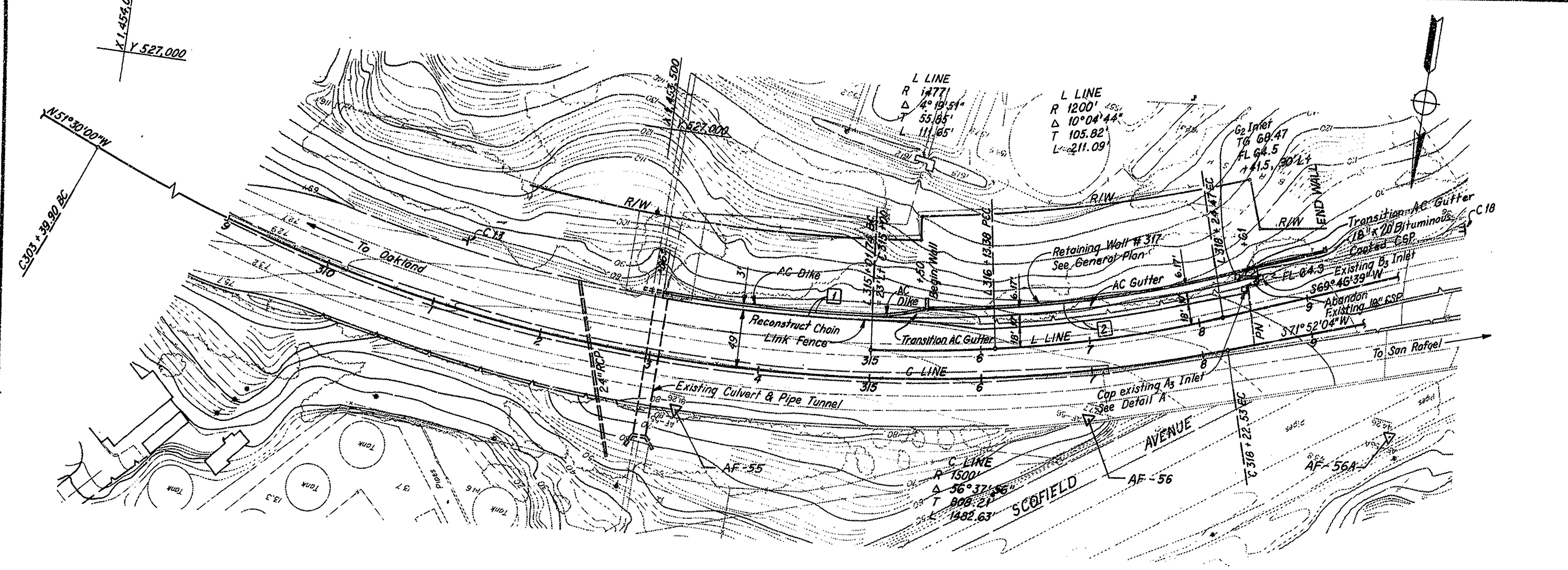
AS BUILT PLANS
Contract No. 04-118774
Date Completed 6-2-86
Document No. ____

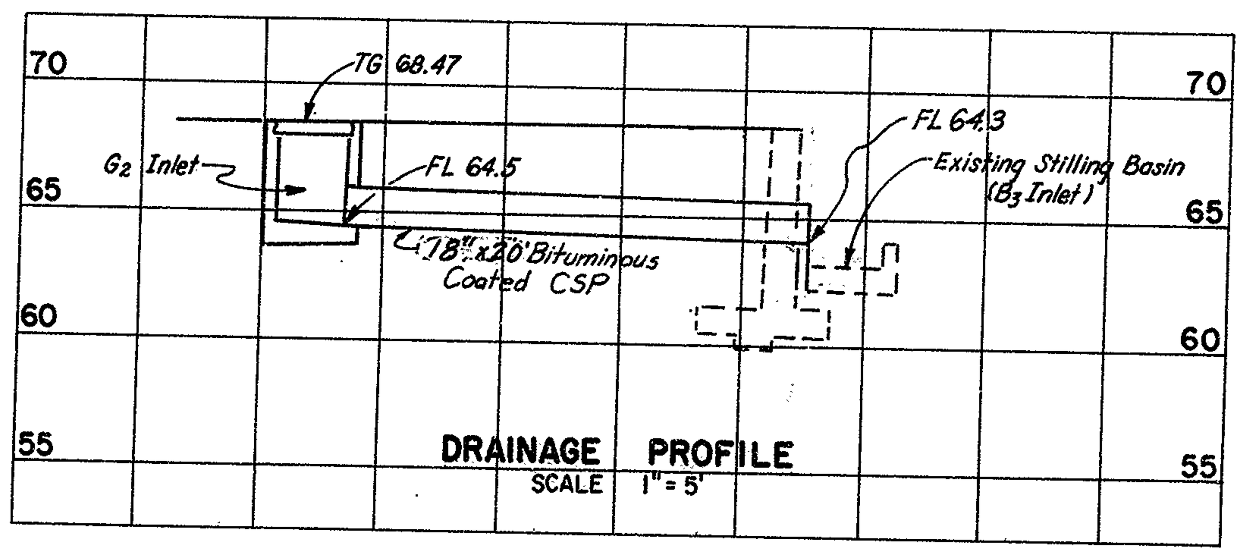
I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 8-12-88 SIGNATURE Donald Blackford TITLE SUPERVISOR OF MICROFILM SERVICES

Dist.	County	Route	Post Miles Total Project	Sheet No.	Total Sheets
04	CC	17	5.7	4	14

A. Iversen
PROJECT ENGINEER
REGISTERED CIVIL ENGINEER NO. 11375
DATE APPROVED November 26, 1984

DATUM IS NATIONAL GEODETIC VERTICAL DATUM OF 1929





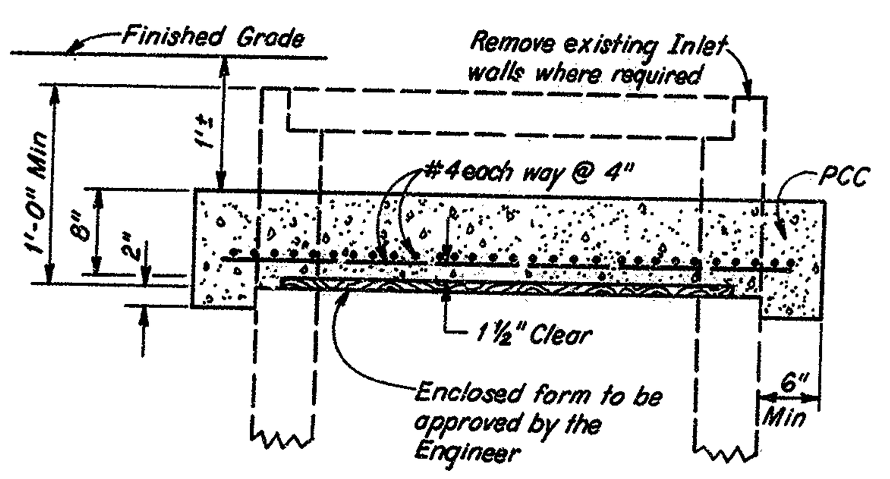
DRAINAGE PROFILE
SCALE 1" = 5'

NOTES:

1. Existing topography for orientation only.
2. Structural section type is indicated by $\boxed{No}$
3. All pipe joints shall be standard.
4. All ties are to the center of drainage structure unless otherwise noted.
5. Exact location and position of Construction Area Signs to be determined by the Engineer.

ABBREVIATIONS

AC	Asphalt Concrete
CSP	Corrugated Steel Pipe
FL	Flowline
PCC	Portland Cement Concrete
TG	Top of Grate



DETAIL "A"
CAP EXISTING A_3 INLET
LT STA 318+48
NO SCALE

AS BUILT PLANS
Contract No. 04-118774
Date Completed 6-2-86
Document No.

CONSTRUCTION SURVEY DATA			
DESCRIPTION	COORDINATES N.	COORDINATES E.	ELEVATION
C 303+ 39.90 B.C.	526870.05	1454377.90	
C 318 + 22.53 E.C.	527121.65	1452977.31	
L 315 + 01.74 B.C.	527165.55	1453294.55	
L 316 + 13.39 P.C.C.	527150.06	1453184.01	
L 318 + 24.47 E.C.	527094.84	1452980.53	
AF-55 L.P. & T. in P.C.C. curbing	527239.019	1453461.612	81.26
AF-56 L.P. & T. in P.C.C. curbing, 27' ±E. of B.B. 28-140R	527197.829	1453090.751	77.77
AF-56A R.R. Spike in ground on Chevron Refinery property	527175.934	1452817.629	44.26

NO CONSTRUCTION CHANGES
CONTRACT No. 118774
DATE ACCEPTED Jun. 2, 1986
AS BUILT
RESIDENT ENGINEER D Ashe
REVISIONS BY ______ DATE ______
DELINEATED BY ______ DATE ______
CHECKED BY ______ DATE ______

LAYOUT

Topography for orientation only

CONSTRUCTION DETAILS
SCALE: 1" = 50'
C-1

Project Engineer	Date	Design Engineer	Date	Approval Recommended by	Date
A. IVERSEN	7/84	E.A. SATOW	7/84	L. CHU	7/84

4

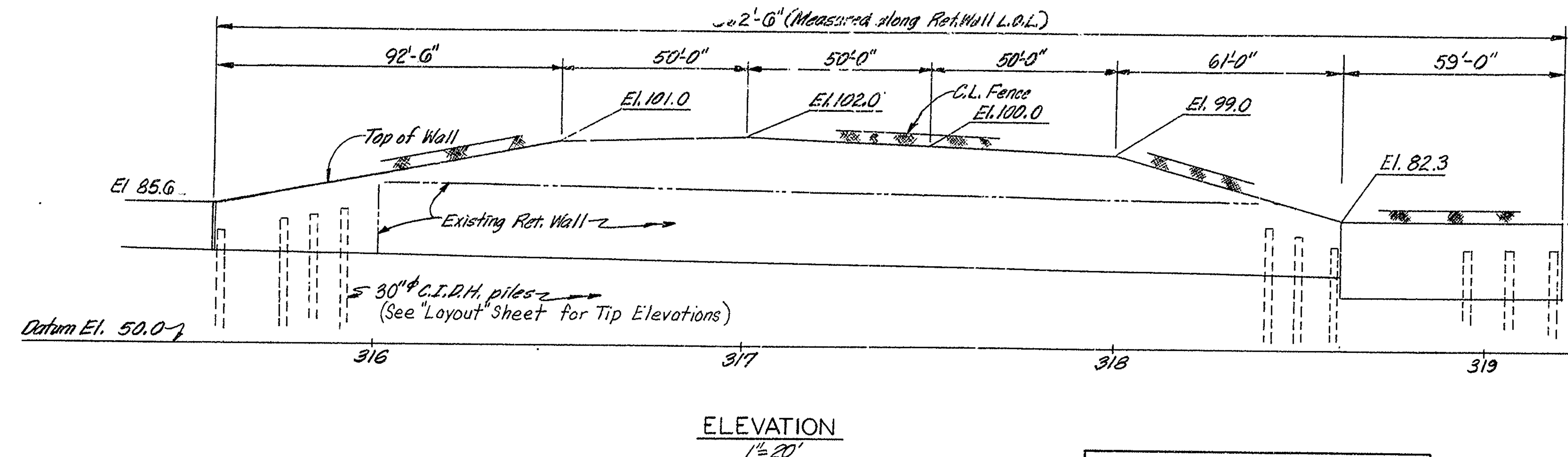
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

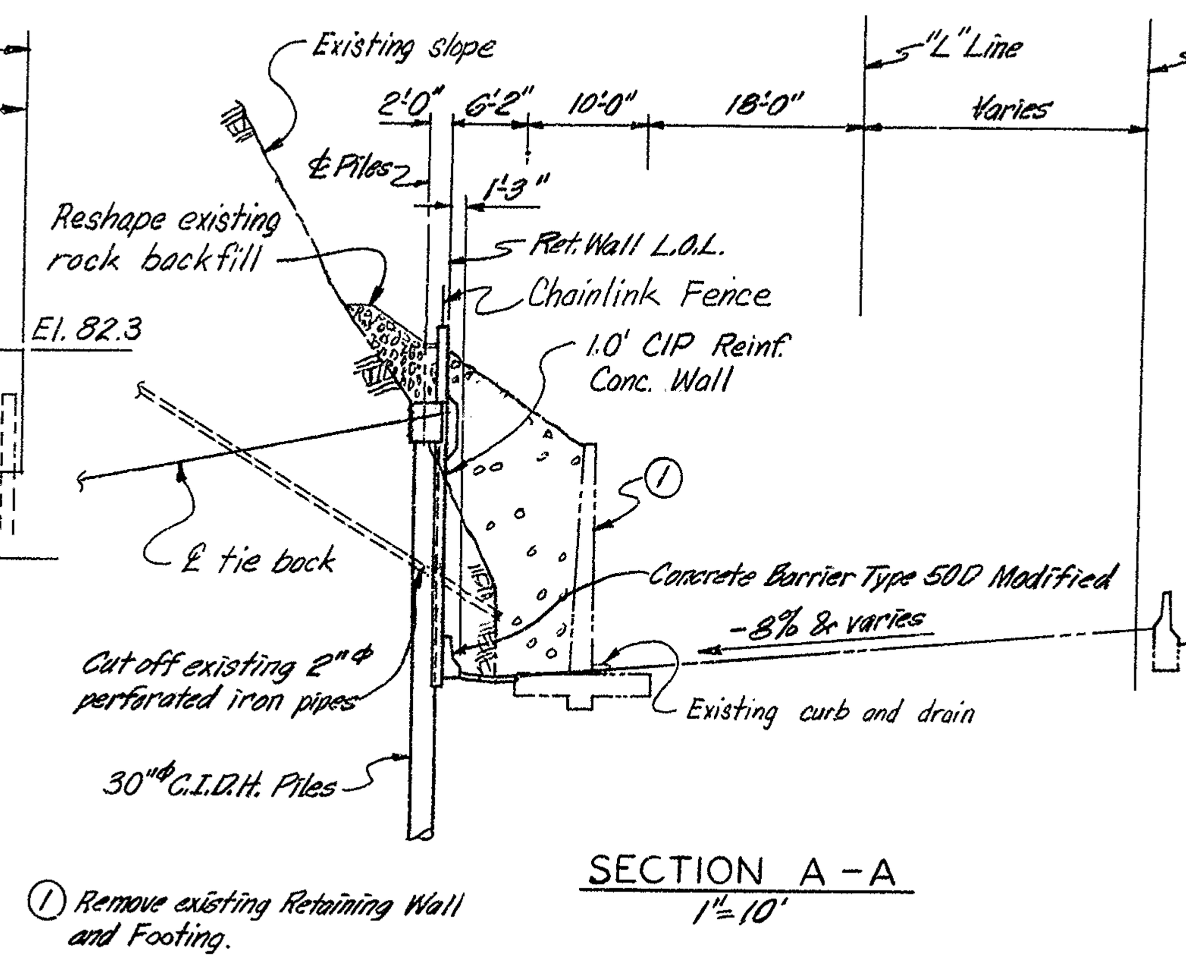
04210
118771

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 8-12-88 SIGNATURE Donald D Blackford TITLE SUPERVISOR OF MICROFILM SERVICES

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	17	5.7	6	14

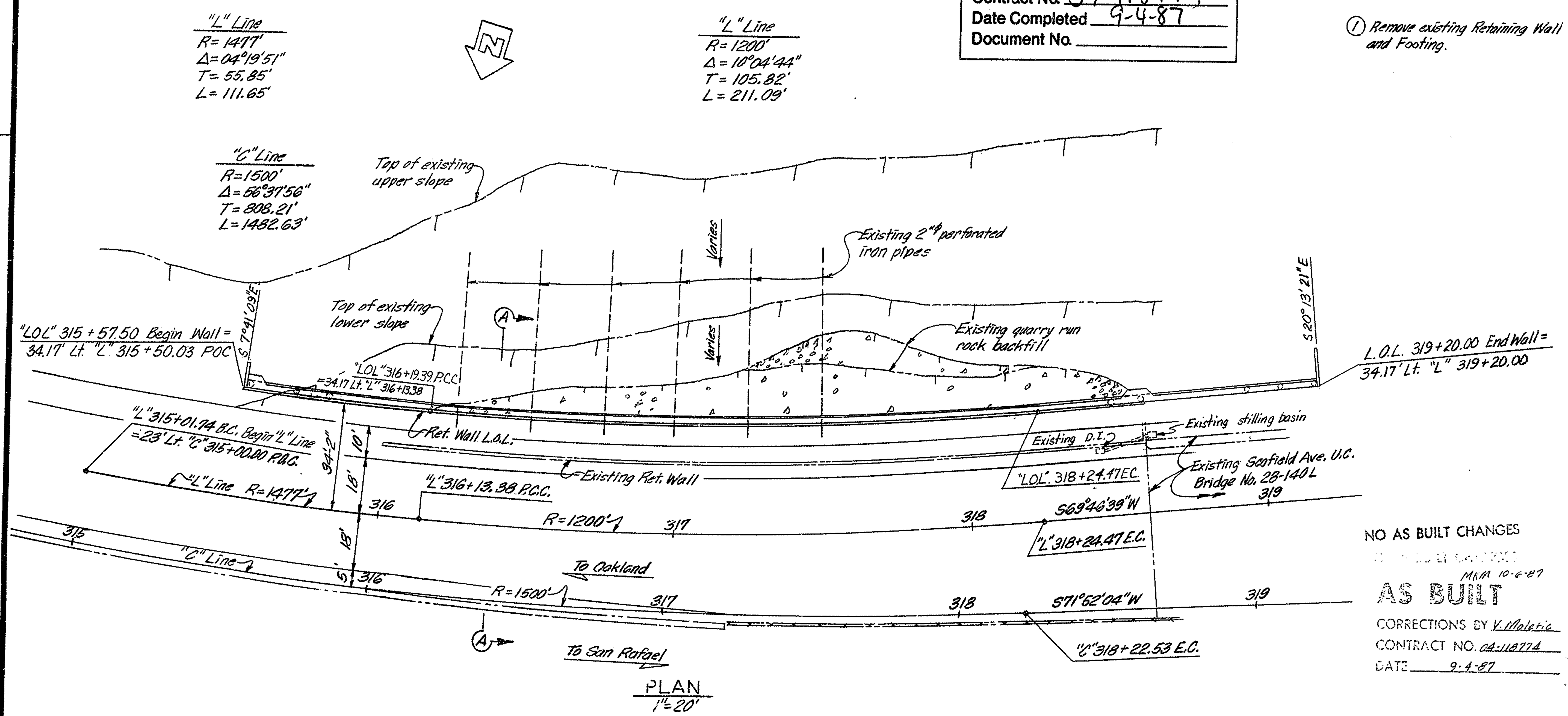
R.C. Cassano 9013
CHIEF, OFFICE OF STRUCTURES DESIGN — REGISTERED CIVIL ENGINEER NUMBER
DATE APPROVED November 26, 1984





① Remove existing Retaining Wall and Footing.

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No. ______



NO AS BUILT CHANGES

MKM 10-6-87

AS BUILT
CORRECTIONS BY V. Maletic
CONTRACT NO. 04-118774
DATE 9-4-87

INDEX TO PLANS

SHEET NO.	TITLE
1	GENERAL PLAN
2	PILE LAYOUT NO. 1
3	PILE LAYOUT No. 2
4	WALL DETAILS NO. 1
5	WALL DETAILS NO. 2
6	WALL DETAILS NO. 3
7	DRAINAGE DETAILS
8	CHAIN LINK FENCE DETAILS
9	LOG OF TEST BORINGS

STANDARD PLANS DATED JULY 1984

BO-3	BRIDGE DETAILS
B3-9	RETAINING WALL DETAILS NO. 2

Standard Plan Sheet No.
Detail No.

APPROXIMATE QUANTITIES

REMOVE RETAINING WALL	LUMP SUM
30 "CAST-IN-DRILLED-HOLE CONCRETE PILING	1,234 LF
TIEBACK ANCHOR	37 EA
AIR-BLOWN MORTAR	13 CY
4" ASBESTOS-CEMENT PIPE (CLASS II)	35 LF
6" PLASTIC PIPE	291 LF
ADJUST HORIZOTAL DRAIN	6 EA
MINOR CONCRETE (GUTTER)	12 CY
CHAIN LINX FENCE (TYPE CL-3, VINYL CLAD)	362 LF
CONCRETE BARRIER (TYPE 50D MODIFIED)	304 LF

FINAL PAY QUANTITIES

STRUCTURE EXCAVATION (RETAINING WALL)	3,240 CY
STRUCTURE BACKFILL (RETAINING WALL)	623 CY
STRUCTURAL CONCRETE, RETAINING WALL	496 CY
BAR REINFORCING STEEL (RETAINING WALL)	195,200 LB

Submitted by R.O. [signature] 1/84 17729
DESIGN ENGINEER — REGISTERED CIVIL ENGINEER NUMBER
Approval Recommended By [signature] 13523
DESIGN SUPERVISOR — REGISTERED CIVIL ENGINEER NUMBER

	By	Checked			
DESIGN	A.T. Dubovik II 11/83	K. Seifert 4/84	LOAD FACTOR DESIGN	LOAD FACTOR & SERVICE LOAD DESIGN	LIVE LOADING-NONE
DETAILS	T.A. Hanson 11/83	K. Seifert 4/84	LAYOUT	By A.T. Dubovik II 11/83	Checked K. Seifert 6/84
QUANTITIES	M. Moreno 6/84	T.A. Hanson 6/84	SPECIFICATIONS	By L.C. Stid C12227	Plans and Specs Compared L.C. Stid 11/84

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
A.T. Dubovik II 6/84 36372
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

BRIDGE NO. 28-0000 (~~28-MRW1~~)
POST MILE 5.6

RETAINING WALL NO. 317
GENERAL PLAN

DS D138

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04210
WO 118771

Disregard prints bearing earlier revision dates →

REVISION DATES (PRELIMINARY STAGE ONLY): 1/11/84, 4/25/84, 6/20/84, 7/18/84, 8/21/84, 9/10/84, 11/19/84, 11/27/84

SHEET 1 OF 9

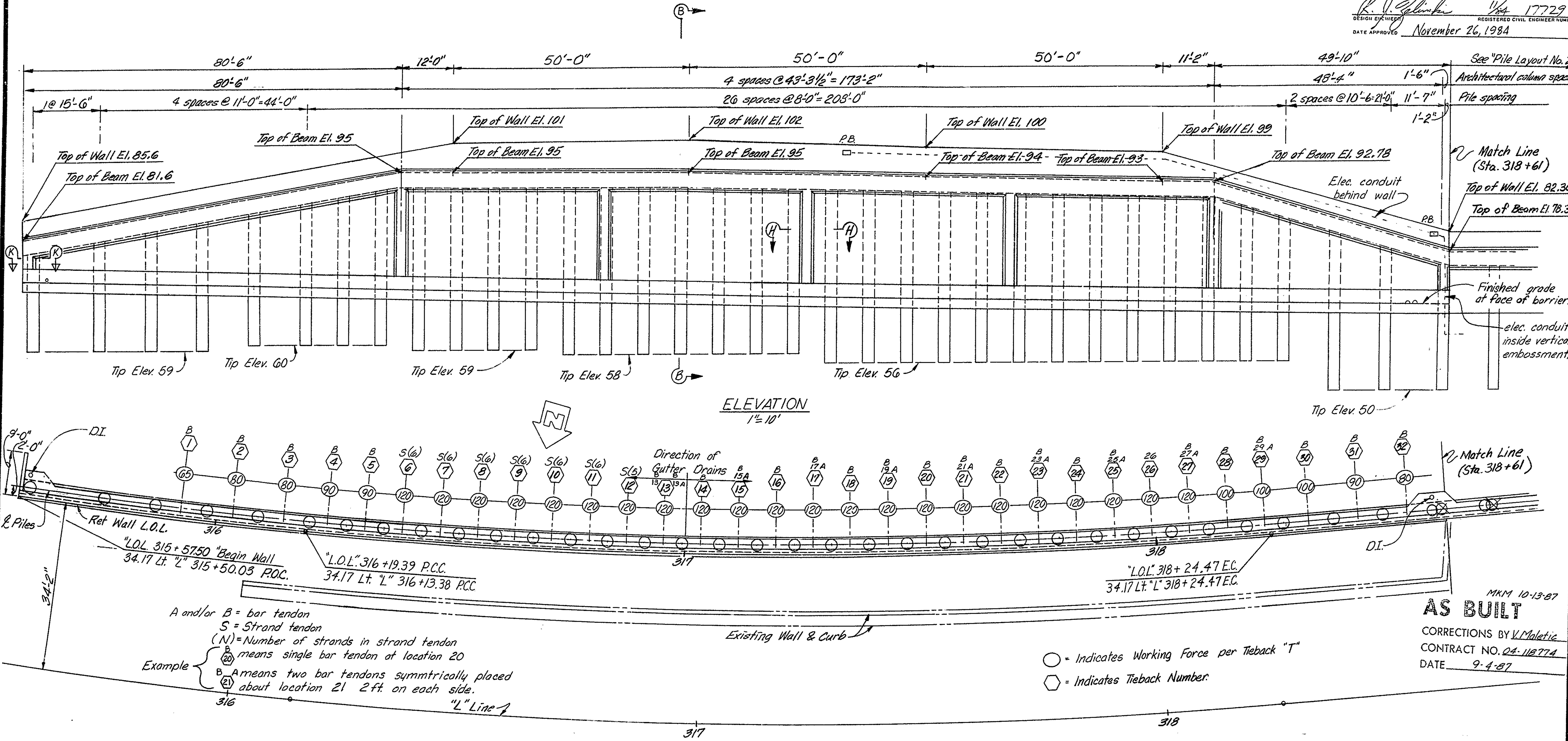
6

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 5/12/88 SIGNATURE Donald Blackford TITLE SUPERVISOR OF MICROFILM SERVICES

SCALE 1"= 50' — MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM
SCALE 1"= 10' or 1"= 100'
SCALE 1"= 20'
SCALE 1"= 40'

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	17	5.7	7	14

R. V. Zelinski 1/84 17729
DESIGN ENGINEER — REGISTERED CIVIL ENGINEER NUMBER
DATE APPROVED November 26, 1984



A and/or B = bar tendon
S = Strand tendon
(N) = Number of strands in strand tendon

Example: B (20) means single bar tendon at location 20; B (21) means two bar tendons symmtrically placed about location 21 2 ft. on each side.

○ = Indicates Working Force per Tieback "T"
⬡ = Indicates Tieback Number.

MKM 10-13-87
AS BUILT
CORRECTIONS BY V. Maletic
CONTRACT NO. 04-118774
DATE 9-4-87

PLAN
1" = 10'

BENCH MARK

Datum is National Geodetic Vertical Datum of 1929

Monument AF-55 Lead & Track
43' Rt. Sta. 313 + 30.83 "C" Line
Elev. 81.26

Monument AF-56 Lead & Track
42.71' Rt. Sta. 316 + 94.50 "C" Line
Elev. 77.77

Note:

For Section B-B see "Wall Details No. 1" sheet.
For Section H-H and K-K see "Wall Details No. 2" sheet.

Note:
Actual pile and tiebacks stations are indicated on the top of barrier rail or on the gunnited face of wall.
X = Bar tieback station.
✱ = Strand tieback station.
○ = Pile station

PRESTRESSING (TIEBACKS)

PRESTRESSING STEEL

BARS - ASTM DESIGNATION: A722 TYPE II

STRANDS - ASTM DESIGNATION: A416

T = WORKING FORCE PER TIEBACK (IN KIPS) =

SEE PLAN ON "PILE LAYOUT" SHEET.

f_{pu} = MINIMUM TENSILE STRENGTH OF PRESTRESSING STEEL (KIPS PER SQUARE INCH)

A_s (MIN) = MINIMUM CROSS SECTIONAL AREA OF PRESTRESSING STEEL IN TIEBACK (SQUARE INCHES)

$A_s \text{ (MIN)} = \frac{2\,T}{0.75\,f_{pu}}$

GENERAL NOTES

DESIGN: AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES DATED 1977 WITH INTERIM SPECIFICATIONS BRIDGES AND AS SUPPLEMENTED BY BRIDGE DESIGN SPECIFICATION INSERTS.

REINFORCED CONCRETE:

30" Ø PILE

fc' = 3,250 PSI
fy = 60,000 PSI

12" CIP CONCRETE WALL

fc = 1,300 PSI
fs = 24,000 PSI
n = 9

SOIL PARAMETERS: (FOR DETERMINATION OF DESIGN LATERAL EARTH PRESSURE ON WALL)

Ø = 45°
γ = 120 PCF

28-0000

DESIGN	By A.T. Dubovik II 6/84	Checked K. Seifert 6/84		
DETAILS	By T.A. Hanson 3/84	Checked K. Seifert 6/84		
QUANTITIES	By M. Moreno 6/84	Checked T.A. Hanson 6/84		

State of CALIFORNIA DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
A.T. Dubovik II 6/84 36372
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

BRIDGE NO. ~~28-MRWT~~
POST MILE 5.6

RETAINING WALL NO. 317
PILE LAYOUT NO. 1

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04210
WO 118771

Disregard prints bearing earlier revision dates →

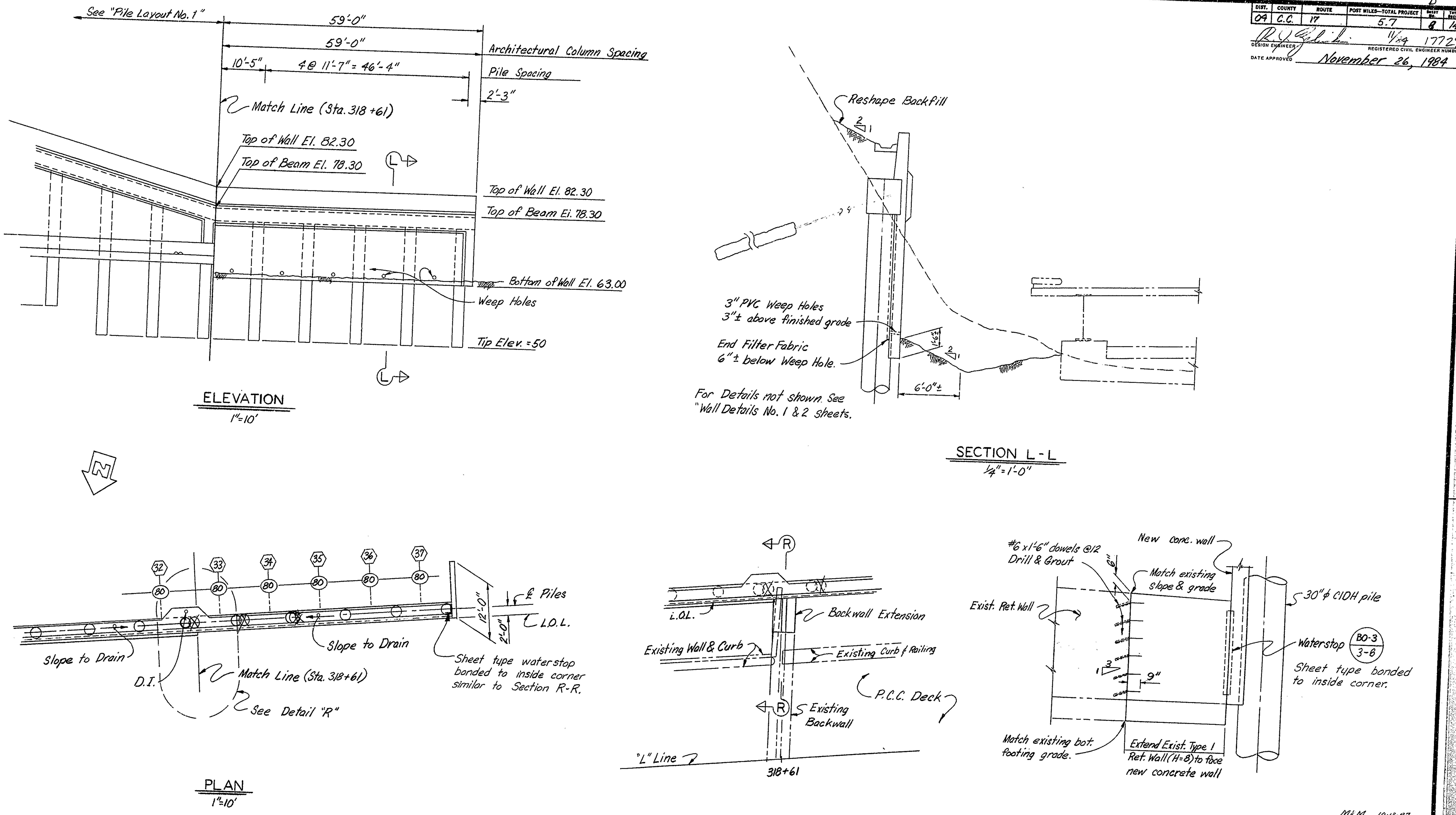
SHEET 2 OF 9

7

DS 8138

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No. ______

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 5/12/88 SIGNATURE Donald Blackford TITLE SUPERVISOR OF MICROFILM SERVICES



DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	C.C.	17	5.7	8	14

DESIGN ENGINEER — 11/84 — 17729 REGISTERED CIVIL ENGINEER NUMBER

DATE APPROVED November 26, 1984

M&M 10-13-87

AS BUILT

CORRECTIONS BY V. Maletic
CONTRACT NO. 04-118774
DATE 9-4-87

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No.

8

DESIGN	By A.T. Dubovik	11/84	Checked J. Seifert	11/84
DETAILS	By J. Thorne	11/84	Checked J. Seifert	11/84
QUANTITIES	By A.T. Dubovik	11/84	Checked J. Thorne	11/84

State of CALIFORNIA DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN
A.T. Dubovik 11/84 36312
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

CU 04210
WO 118771

28-0000
BRIDGE NO. 28-MRW1
POST MILE 5.6

RETAINING WALL NO. 317
PILE LAYOUT NO. 2

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

Disregard prints bearing earlier revision dates

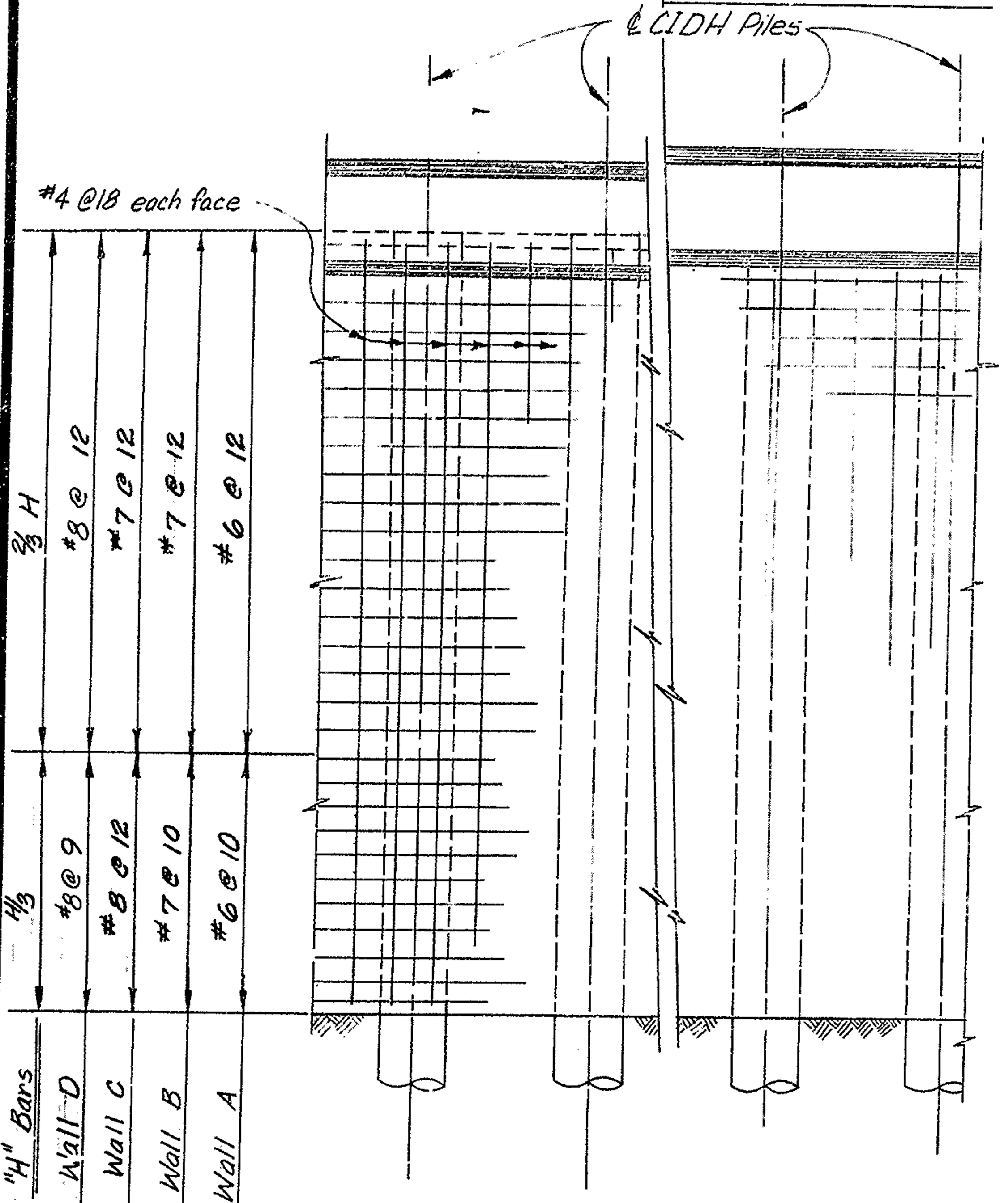
REVISION DATES (PRELIMINARY STAGE ONLY) 11/2/84 11/21/84

SHEET 3 OF 9

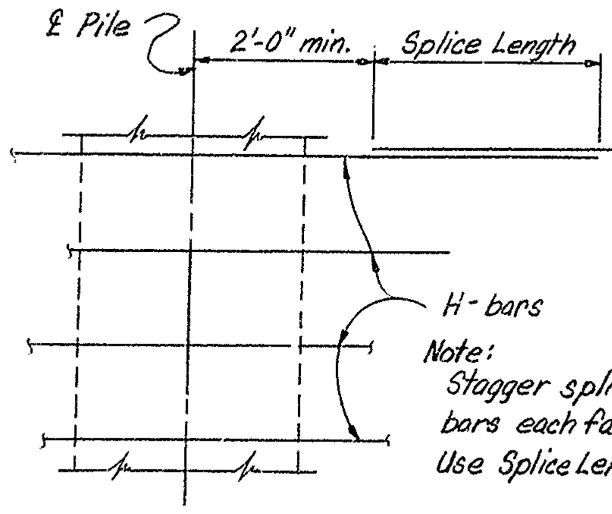
DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	17	5.7	9	14

REGISTERED CIVIL ENGINEER NUMBER 17729 — DESIGN ENGINEER — 11/84

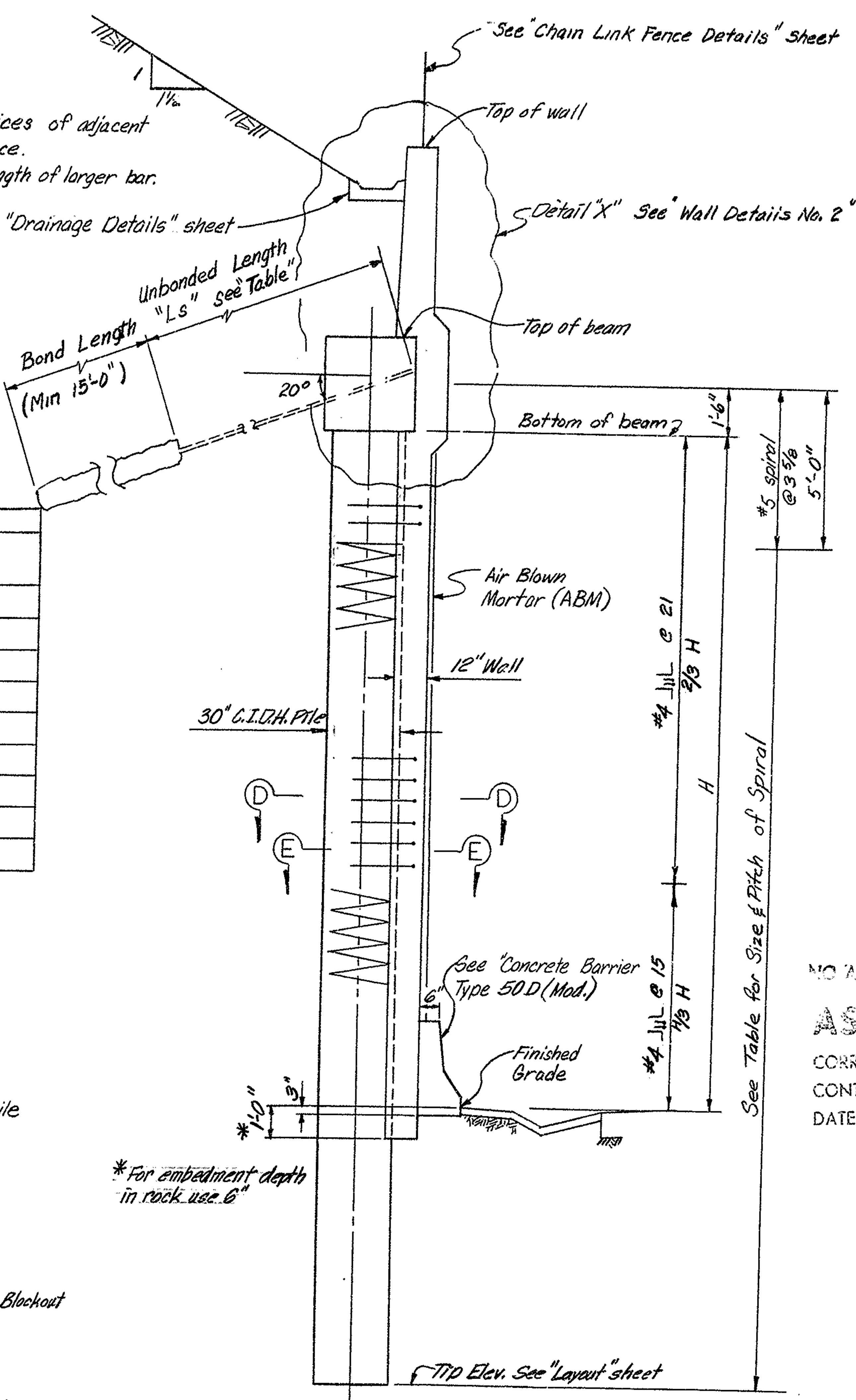
DATE APPROVED November 26, 1984



PART ELEVATION
No scale



H-BAR SPLICE DETAIL
No Scale

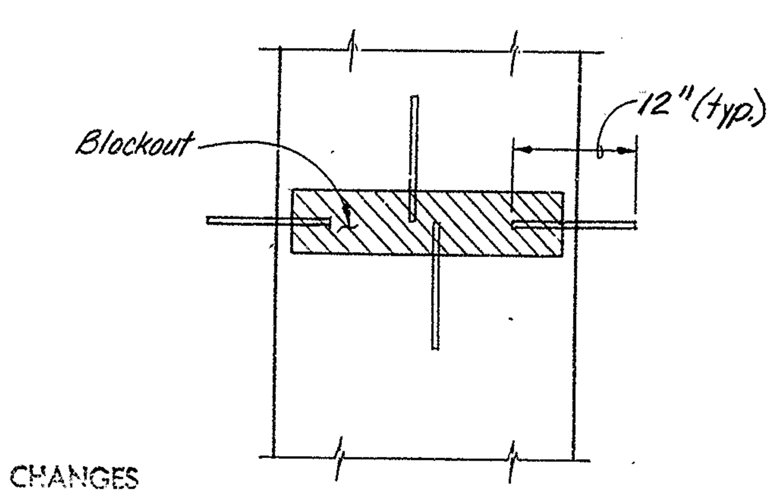


SECTION B-B
3/8" = 1'-0"

TABLE	
Station on "LOL"	Finish Grade at Barrier Face
315 + 50	73.59
315 + 73	73.43
316 + 00	73.11
316 + 50	72.42
317 + 00	71.59
317 + 50	70.75
318 + 00	70.07
318 + 50	69.41
318 + 61	69.24

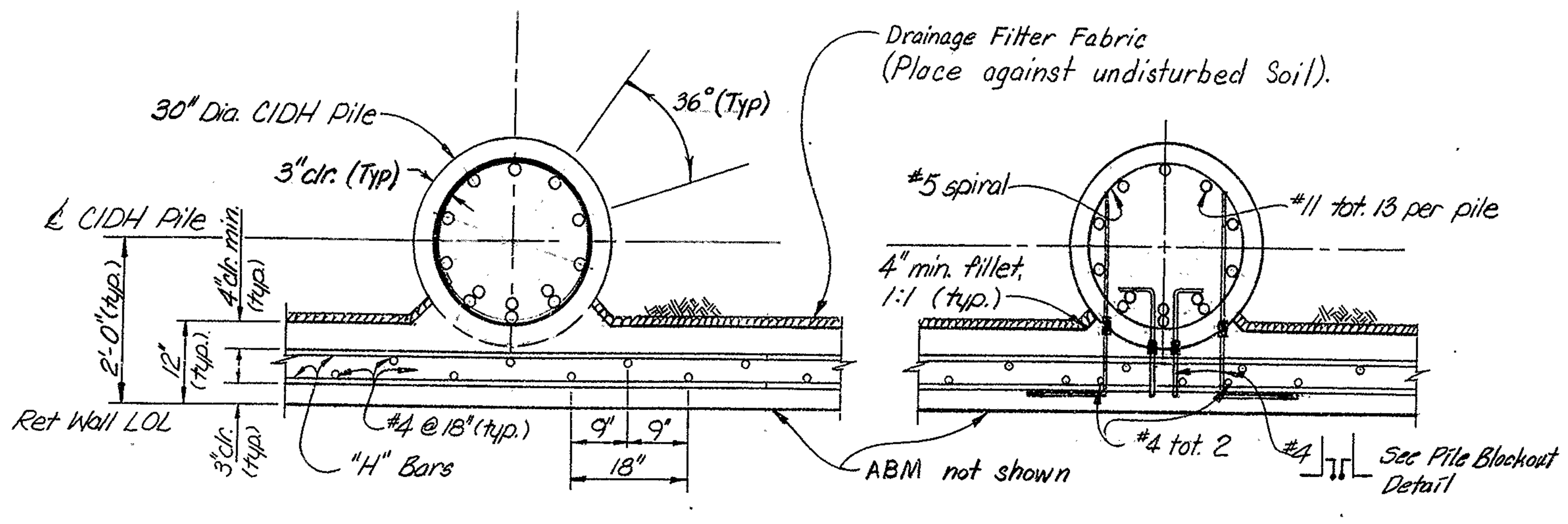
TABLE			
Location * LOL Sta. to LOL Sta.	Wall Type	Ls	Spiral Size & Pitch
315 + 57.5 to 315 + 75	Type D	20	#5 @ 6
315 + 75 to 315 + 97.25	Type B	20	#5 @ 6
315 + 97.25 to 316 + 19.25	Type C	20	#5 @ 5
316 + 19.25 to 316 + 35.25	Type C	20	#5 @ 5
316 + 35.25 to 318 + 11.25	Type A	20	#5 @ 4
318 + 11.25 to 318 + 27.25	Type A	20	#5 @ 4
318 + 27.25 to 318 + 37.75	Type C	20	#5 @ 4
318 + 37.75 to 319 + 20	Type C	20	#5 @ 5

* - Piles located at beginning or ending stations shall use smaller pitch



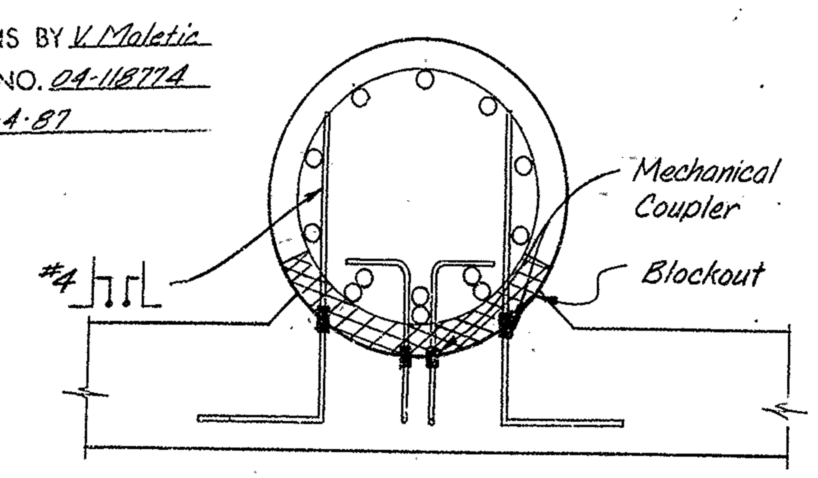
ELEVATION

NO AS BUILT CHANGES
AS BUILT M.K.M. 10-13-87
CORRECTIONS BY V. Moletic
CONTRACT NO. 04-118774
DATE 9-4-87



SECTION E-E
3/4" = 1'-0"

SECTION D-D (THRU CONNECTOR)
3/4" = 1'-0"



PLAN

PILE BLOCKOUT DETAIL
1" = 1'-0"

DESIGN	By A.T. Dubovik II 1/84	Checked K. Seifert 6/84
DETAILS	By A. Onodera	Checked K. Seifert 6/84
QUANTITIES	By M. Moreno 6/84	Checked T.A. Hanson 6/84

State of CALIFORNIA DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

A.T. Dubovik II 6/84 36372 — PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

BRIDGE NO. 28-0000 ~~28-MRWL~~

POST MILE 5.6

CU 04210
WO 118771

RETAINING WALL NO. 317

WALL DETAILS NO. 1

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

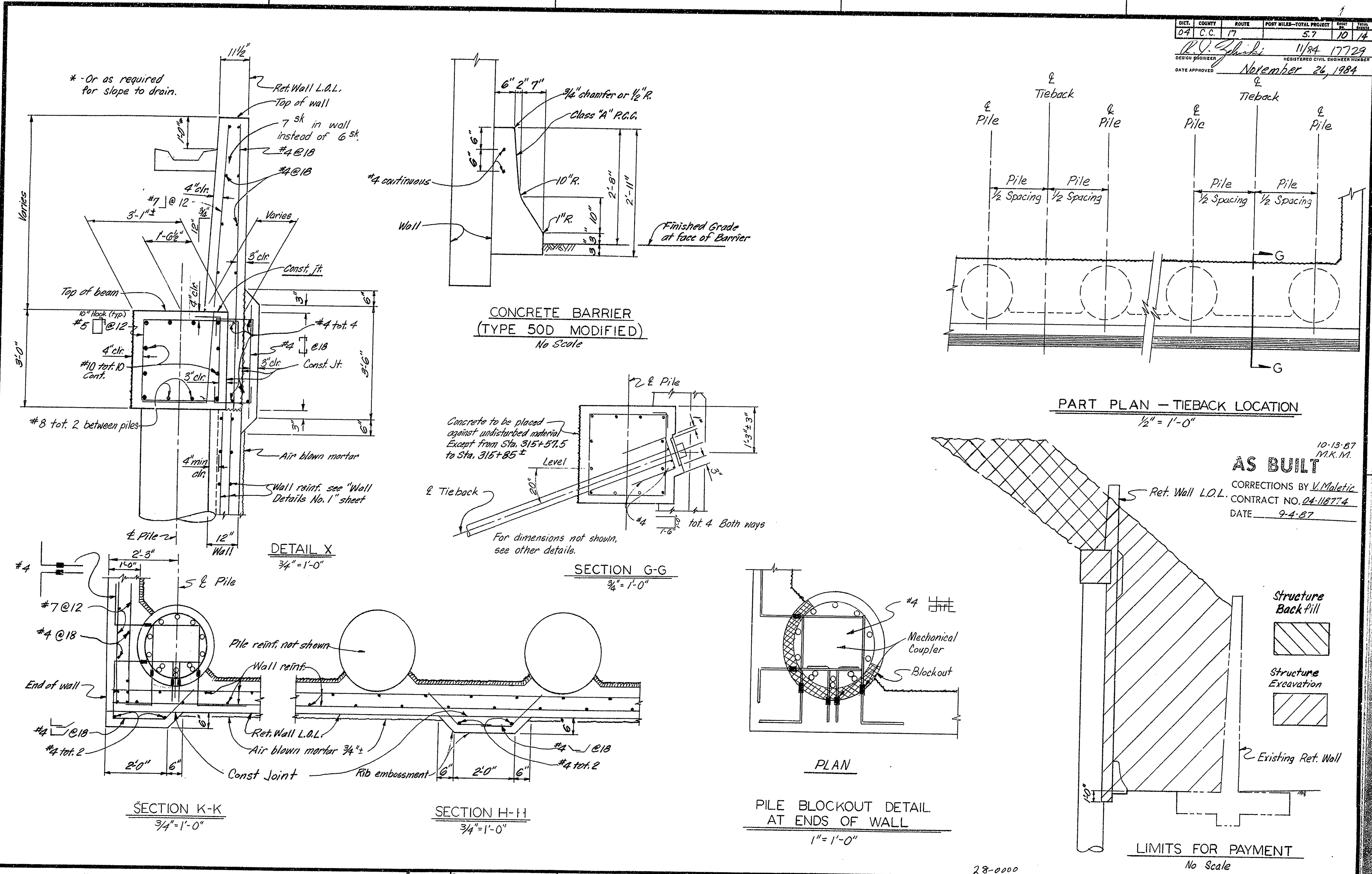
Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)

SHEET 4 OF 9

9

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No.



DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	C.C.	17	5.7	10	14

DESIGN ENGINEER: R.V. Zelinski 11/84 — REGISTERED CIVIL ENGINEER NUMBER 17729
DATE APPROVED: November 26, 1984

	By	Checked
DESIGN	A.T. Dubovik II 2/84	K. Seifert 6/84
DETAILS	J.D. Thorne 4/84	K. Seifert 6/84
QUANTITIES	M. Moreno 6/84	T.A. Hanson 6/84

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
A.T. Dubovik II 9/84 36372
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

BRIDGE NO. 28-0000 (~~28-MRWL~~)
POST MILE 5.6

RETAINING WALL NO. 317
WALL DETAILS NO. 2

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3
CU 04210
WO 118771
Disregard prints bearing earlier revision dates
SHEET 5 OF 9

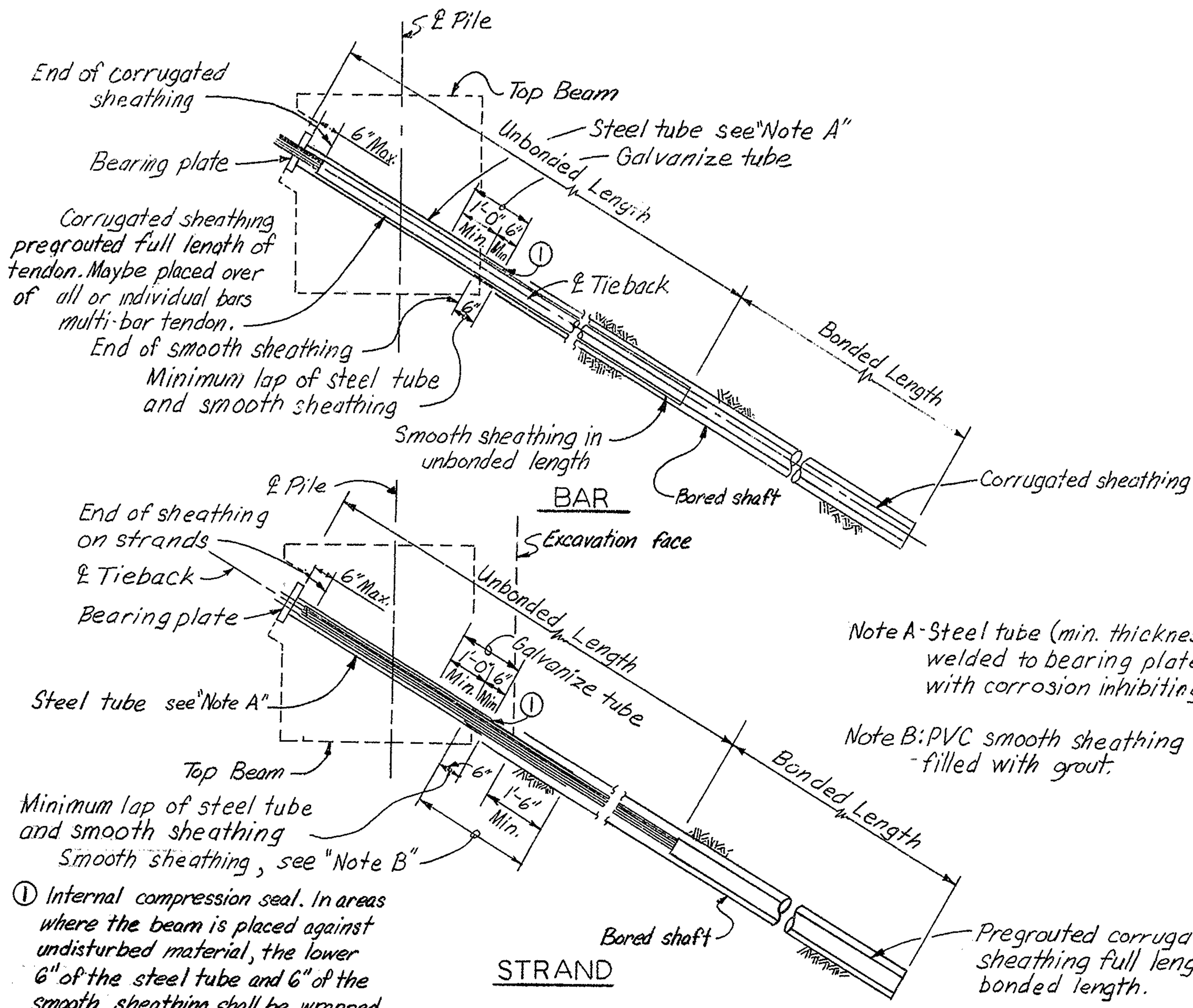
10

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No.

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	C.C.	17	5.7	11	14

DESIGN ENGINEER — 11/84 17729 — REGISTERED CIVIL ENGINEER NUMBER

DATE APPROVED November 26, 1984



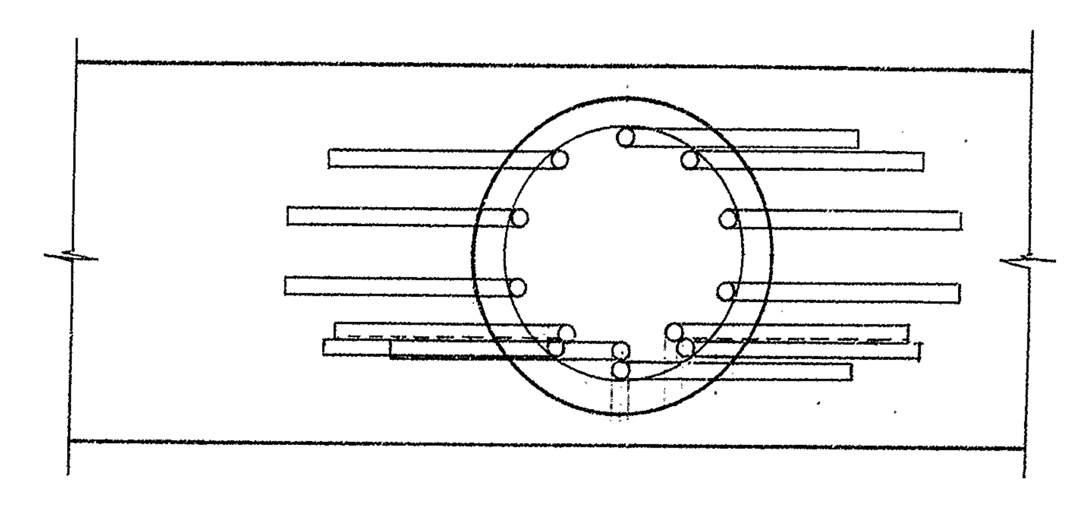
Note A - Steel tube (min. thickness = 0.20) welded to bearing plate Fill tube with corrosion inhibiting mastic.

Note B: PVC smooth sheathing to be filled with grout.

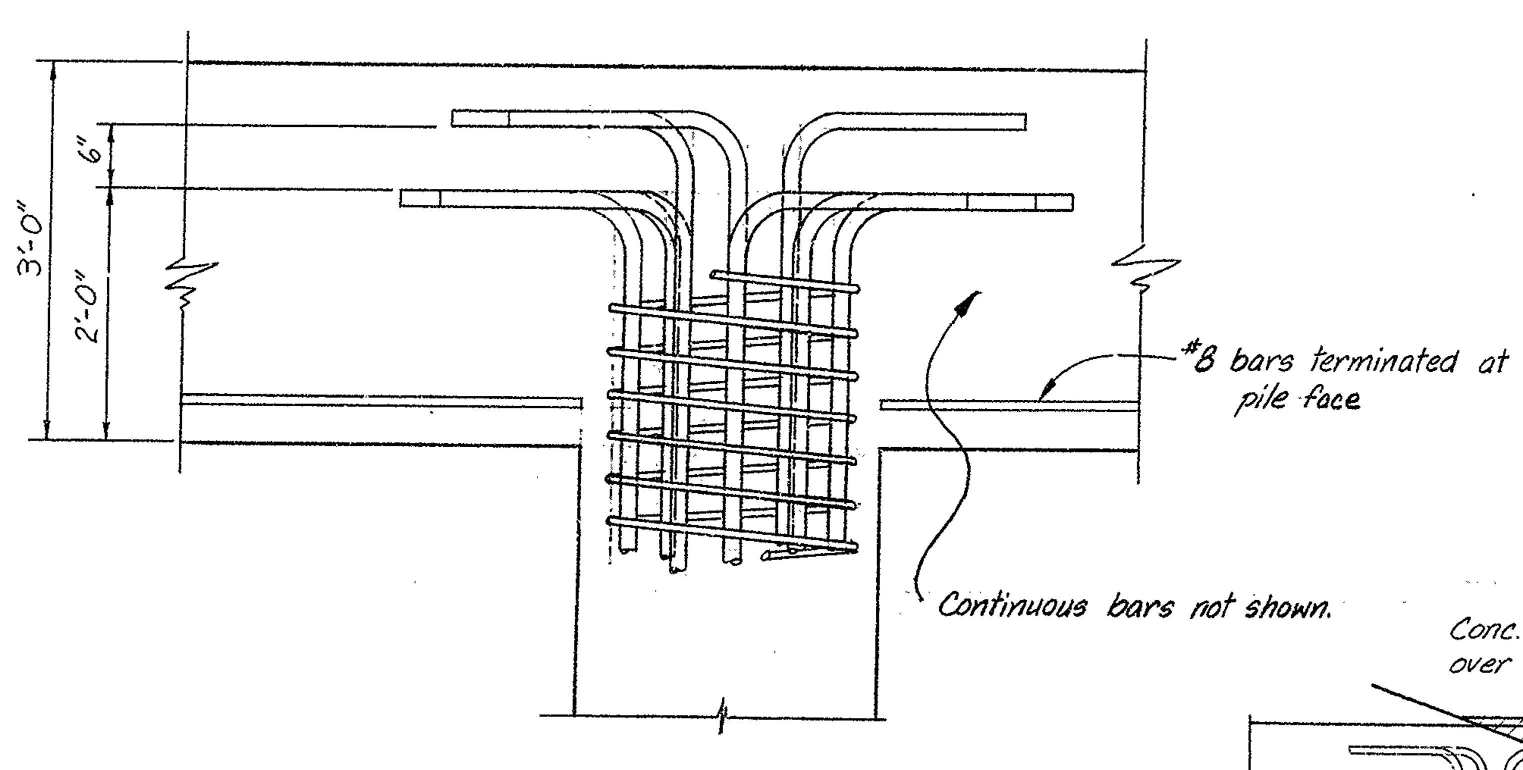
① Internal compression seal. In areas where the beam is placed against undisturbed material, the lower 6" of the steel tube and 6" of the smooth sheathing shall be wrapped with two thicknesses of 1-foot wide building paper.

TIEBACK TENDON DETAILS

No Scale



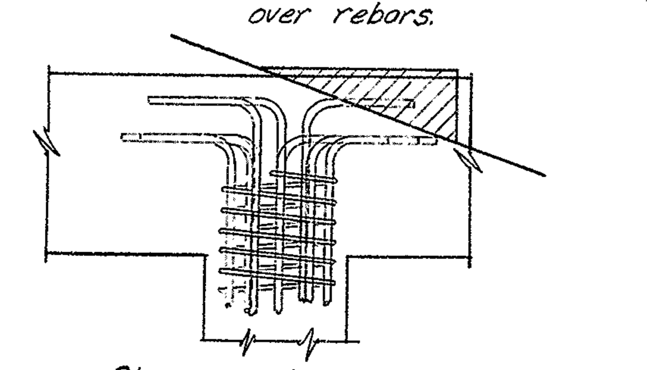
PLAN



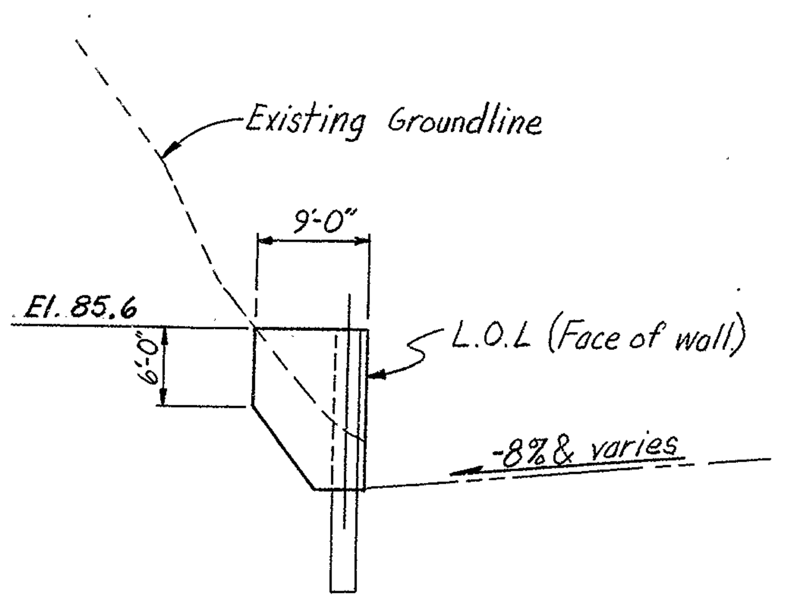
SECTION

DETAIL OF COLUMN STEEL IN TOP BEAM

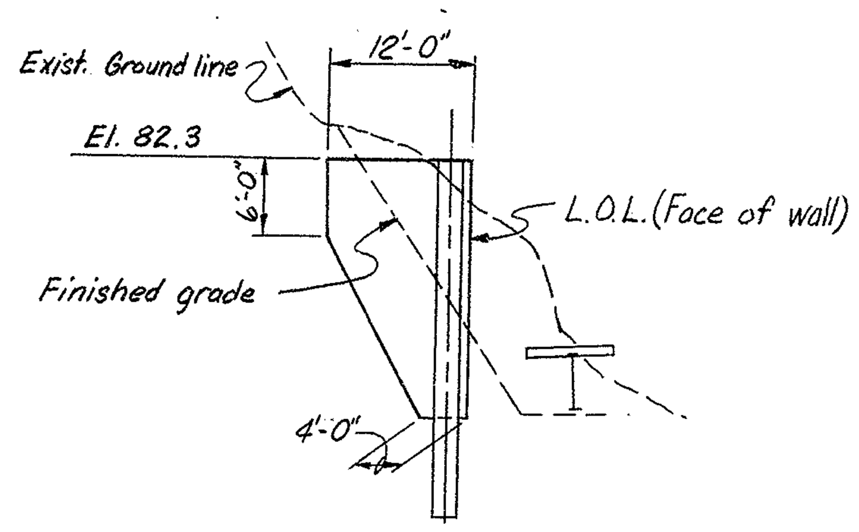
No Scale



Slope portion of Cap Beam near sta. 318+50



Sta. 315 + 57.5



Sta. 319 + 20

CROSS-SECTION
RETAINING WALL END RETURNS

AS BUILT MKM 10-13-87
CORRECTIONS BY V. Maletic
CONTRACT NO. 04-118774
DATE 9-4-87

DESIGN	By A.T. Dubovik II 4/84	Checked K. Seifert 6/84	
DETAILS	By J.D. Thorne 4/84	Checked K. Seifert 6/84	
QUANTITIES	By M. Moreno 6/84	Checked T.A. Hanson 6/84	

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
A.T. Dubovik II 6/84 36512
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

28-0000
BRIDGE NO. ~~28-MRWL~~
POST MILE 5.6

RETAINING WALL NO. 317
WALL DETAILS NO. 3

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04210
WO 118771

Disregard prints bearing earlier revision dates → 1

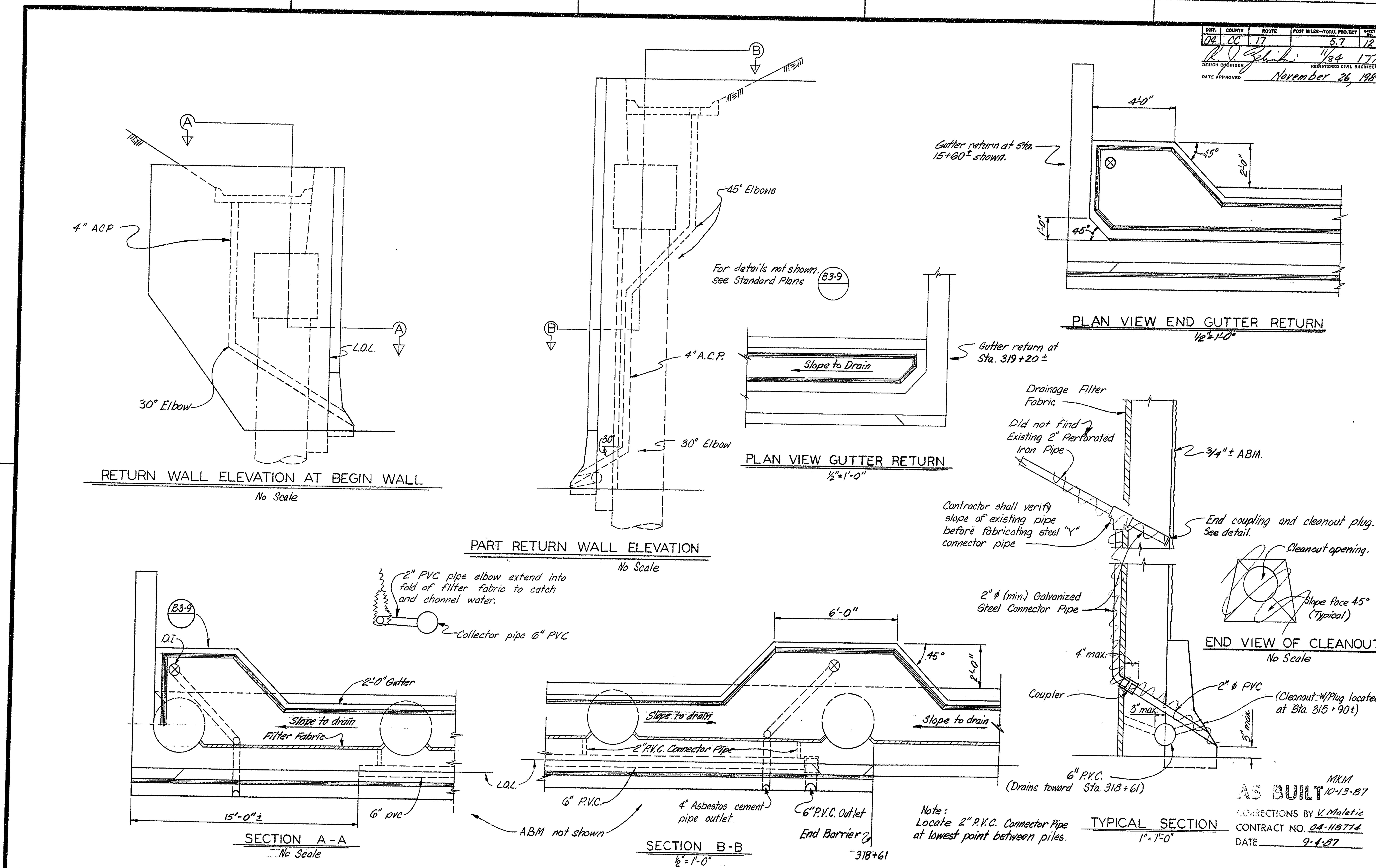
REVISION DATES (PRELIMINARY STAGE ONLY): 6/5/84, 7/16/84, 11/20/84

SHEET 6 OF 9

11

DS 0130

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No. ______



DESIGN	By A.T. Dubovik II 5/84	Checked K. Seifert 6/84	
DETAILS	By G. Fujii 5/84	Checked K. Seifert 6/84	
QUANTITIES	By M. Moreno 6/84	Checked T.A. Hanson 6/84	

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN
A.T. Dubovik II 6/84 36372
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

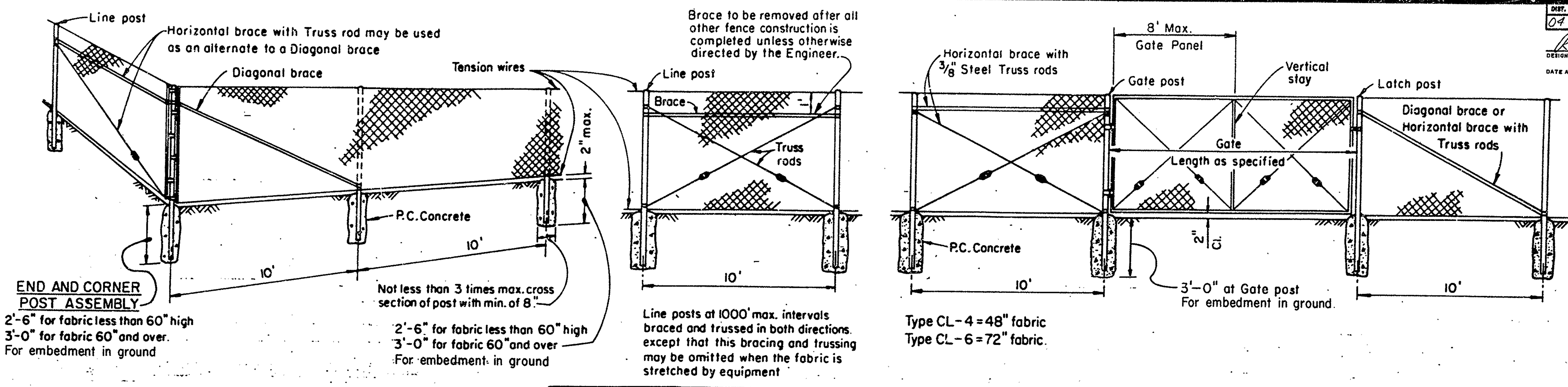
BRIDGE NO. 28-MRWL (28-0000)
POST MILE 5.6

RETAINING WALL NO. 317
DRAINAGE DETAILS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3
CU 04210
WO 118771
Disregard prints bearing earlier revision dates
REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET 7 OF 9

12

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No. ____



TYPICAL MEMBER DIMENSIONS

HEIGHT	LINE POSTS ROUND (I.D.)	LINE POSTS H	LINE POSTS ROLL FORMED	END, LATCH & CORNER POSTS ROUND (I.D.)	END, LATCH & CORNER POSTS ROLL FORMED	END, LATCH & CORNER POSTS ROLL FORMED	BRACES ROUND (I.D.)	BRACES H	BRACES ROLL FORMED	BRACES ROLL FORMED
6' and Less	1 1/2"	1 7/8" x 1 5/8"	2" x 1 3/4"	2"	3 1/2" x 3 1/2"	2" x 1 3/4"	1 1/4"	1 1/2" x 1 5/16"	1 5/8" x 1 1/4"	1 3/4" x 1 1/4"
Over 6'	2"	2 1/4" x 2"	2" x 1 3/4"	2 1/2"	3 1/2" x 3 1/2"	2 1/2" x 2 1/2"	1 1/4"	1 1/2" x 1 5/16"	1 5/8" x 1 1/4"	1 3/4" x 1 1/4"

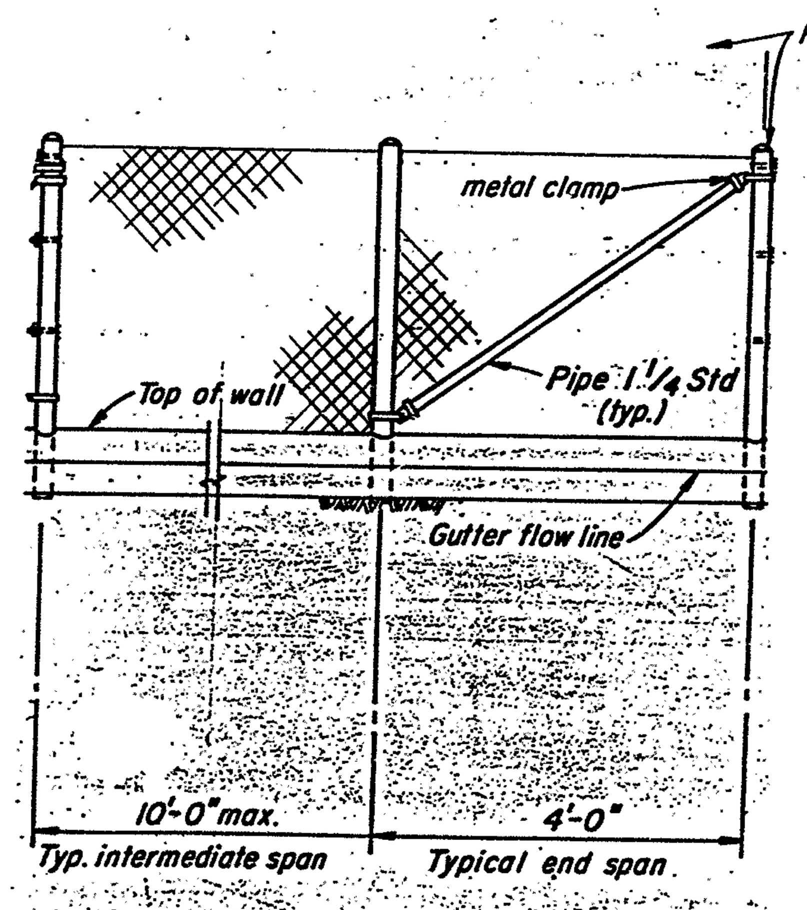
NOTES:

1. The above table shows examples of post and brace sections which may comply with the Specifications.
2. Sections shown in the tables must also comply with the strength requirements and other provisions of the Specifications.
3. Other sections which comply with the strength requirements and other provisions of the Specifications may be used on approval of the Engineer.
4. Options exercised shall be uniform on any one project.
5. Dimensions shown are nominal.

GATE POST

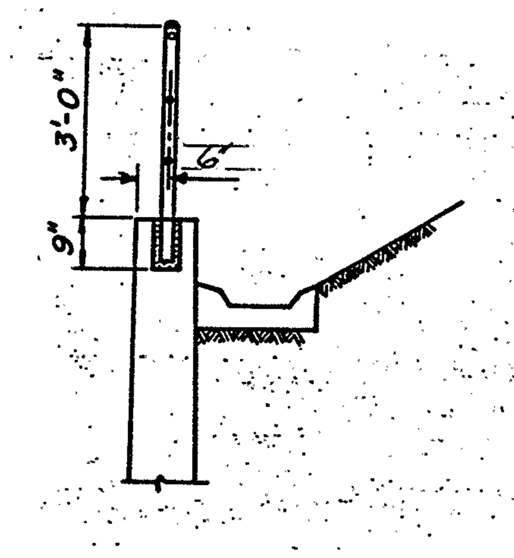
FENCE HEIGHT	GATE WIDTHS	NOMINAL I.D.	WEIGHT PER FOOT
6'-0" and Less	Up thru 6'	2 1/2"	4.95
	Over 6' thru 12'	4"	10.79
	Over 12' thru 18'	5"	14.62
	Over 18' to 24' Max.	6"	18.97
Over 6'	Up thru 6'	3"	7.58
	Over 6' thru 12'	5"	14.62
	Over 12' thru 18'	6"	18.97
	Over 18' to 24' Max.	8"	28.55

NOTE:
Above post dimensions and weights are minimums. Larger sizes may be used on approval of Engineer.

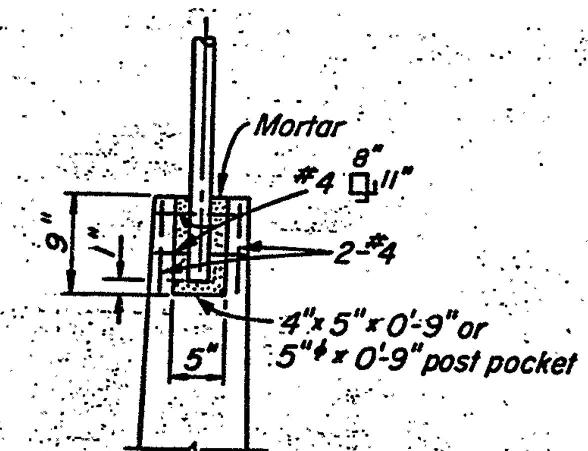


RETAINING WALL (With Gutter)

AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No.



SECTION
THRU PARAPET WALL



POST POCKET

NO AS BUILT CHANGES
AS BUILT M.K.M. 10-13-87
CORRECTIONS BY V. Moletic
CONTRACT NO. 04-118774
DATE 9-4-87

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	C.C.	17	5.7	13	14

DESIGN ENGINEER R. V. Zelinski 11/84 17729 REGISTERED CIVIL ENGINEER NUMBER
DATE APPROVED November 26, 1984

	By	Checked
DESIGN	A.T. Dubovik II 4/84	K. Seifert 6/84
DETAILS	J.D. Thorne 4/84	K. Seifert 6/84
QUANTITIES	M. Moreno 6/84	T.A. Hanson 6/84

State of CALIFORNIA DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
A.T. Dubovik II 4/84 36372
PROJECT ENGINEER REGISTERED CIVIL ENGINEER NO.

28-0000
BRIDGE NO. 28-MRWL
POST MILE 5.6

RETAINING WALL NO. 317
CHAIN LINK FENCE DETAILS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04210
WO 118771

Disregard prints bearing earlier revision dates →
REVISION DATES (PRELIMINARY STAGE ONLY) 9/14/84
SHEET 8 OF 9

13

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 5/17/88 SIGNATURE Donald Blackford TITLE SUPERVISOR OF MICROFILM

AS BUILT PLANS
Contract No. 04-003214
Date Completed 2-6-89
Document No. ______

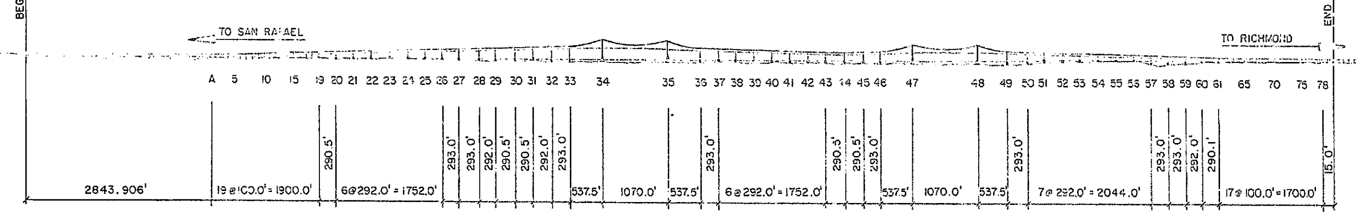
DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET	TOTAL SHEETS
04	CC, Mrn	580(Old 17)	6.2/7.8, L0.0/L2.5	1	44

CE 11428
January 6, 1986

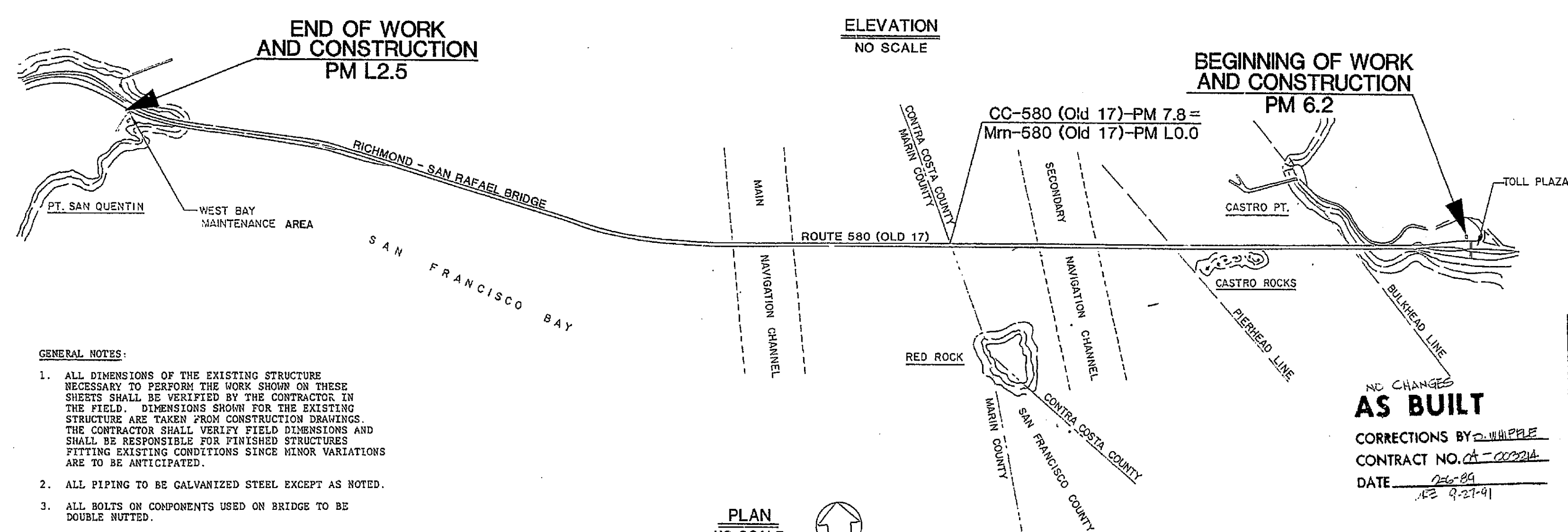
INDEX TO PLANS

APPLICABLE STANDARD PLANS

A-10	S41-3	ES-8
T-10	S42-15	ES-13

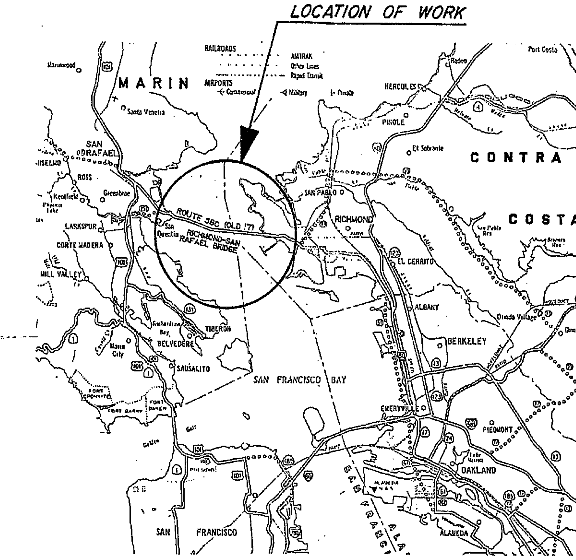


ELEVATION
NO SCALE



PLAN
NO SCALE

LOCATION OF WORK



LOCATION MAP
NO SCALE

APPROXIMATE QUANTITIES

CONCRETE BLOCK BUILDING	2 EA
ELECTRICAL WORK	LUMP SUM
MECHANICAL WORK	LUMP SUM

GENERAL NOTES:

1. ALL DIMENSIONS OF THE EXISTING STRUCTURE NECESSARY TO PERFORM THE WORK SHOWN ON THESE SHEETS SHALL BE VERIFIED BY THE CONTRACTOR IN THE FIELD. DIMENSIONS SHOWN FOR THE EXISTING STRUCTURE ARE TAKEN FROM CONSTRUCTION DRAWINGS. THE CONTRACTOR SHALL VERIFY FIELD DIMENSIONS AND SHALL BE RESPONSIBLE FOR FINISHED STRUCTURES FITTING EXISTING CONDITIONS SINCE MINOR VARIATIONS ARE TO BE ANTICIPATED.
2. ALL PIPING TO BE GALVANIZED STEEL EXCEPT AS NOTED.
3. ALL BOLTS ON COMPONENTS USED ON BRIDGE TO BE DOUBLE NUTTED.

NO CHANGES
AS BUILT
CORRECTIONS BY ______
CONTRACT NO. 04-003214
DATE 2-6-89
9-27-91

The Contractor shall possess either a Class A license or the following Class C licenses at the time this contract is awarded: Class C-8, C-32, C-34

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
PROJECT PLANS FOR
CONSTRUCTION ON STATE HIGHWAY

IN CONTRA COSTA AND MARIN COUNTIES IN RICHMOND AND SAN RAFAEL ON THE RICHMOND-SAN RAFAEL BRIDGE

to be supplemented by Standard Plans dated July, 1984

Contract No. 04-003214

Submitted by M20269
Approval Recommended by M17007
DESIGN | Checked
DETAILS | Kathi Schenk | Checked
QUANTITIES | Checked
LAYOUT | Checked
SPECIFICATIONS | Plans and Specs Compared 1-86

State of
CALIFORNIA
DEPARTMENT OF TRANSPORTATION

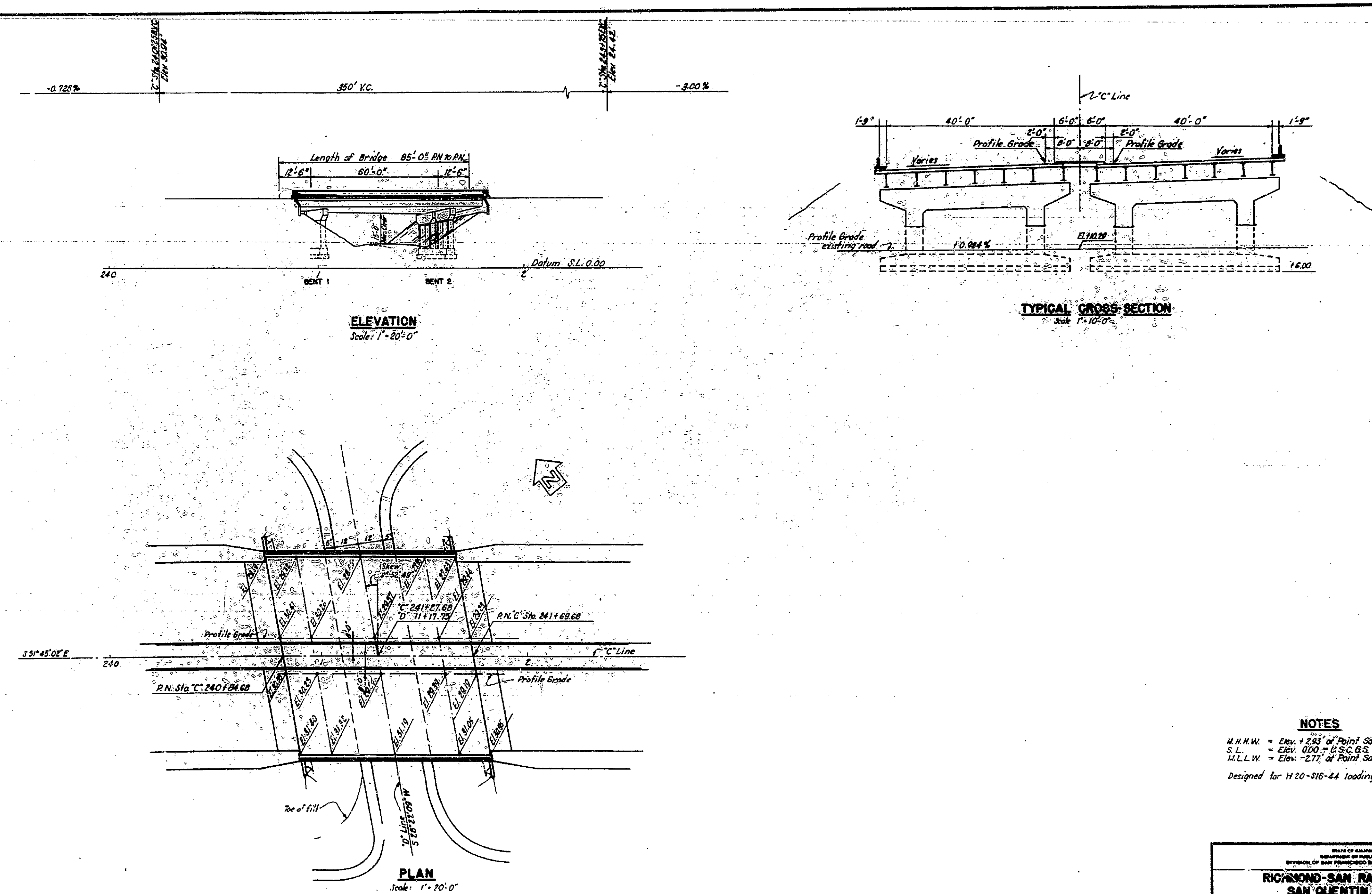
MECHANICAL-ELECTRICAL
STRUCTURES - DESIGN
M21648
PROJECT ENGINEER | REGISTERED ENGINEER NO

BRIDGE NO. 28-100
POST MILE

RICHMOND-SAN RAFAEL BRIDGE
WATER/AIR SYSTEMS UPGRADE

GENERAL PLAN ME-1

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3
CU 04205
WO 003211



NOTES

M.H.H.W. = Elev. +2.93' at Point San Quentin
S.L. = Elev. 0.00 = U.S.C.&G.S. Sea Level Datum of 1929
M.L.L.W. = Elev. -2.77' at Point San Quentin

Designed for H20-S16-44 loading.

MARK	DATE	DESCRIPTION	BY	CH'K
1	9-57	Built without revisions	G.F.	S.A.C.
		REVISION		

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RICHMOND-SAN RAFAEL BRIDGE
SAN QUENTIN APPROACH
SAN QUENTIN UNDERCROSSING

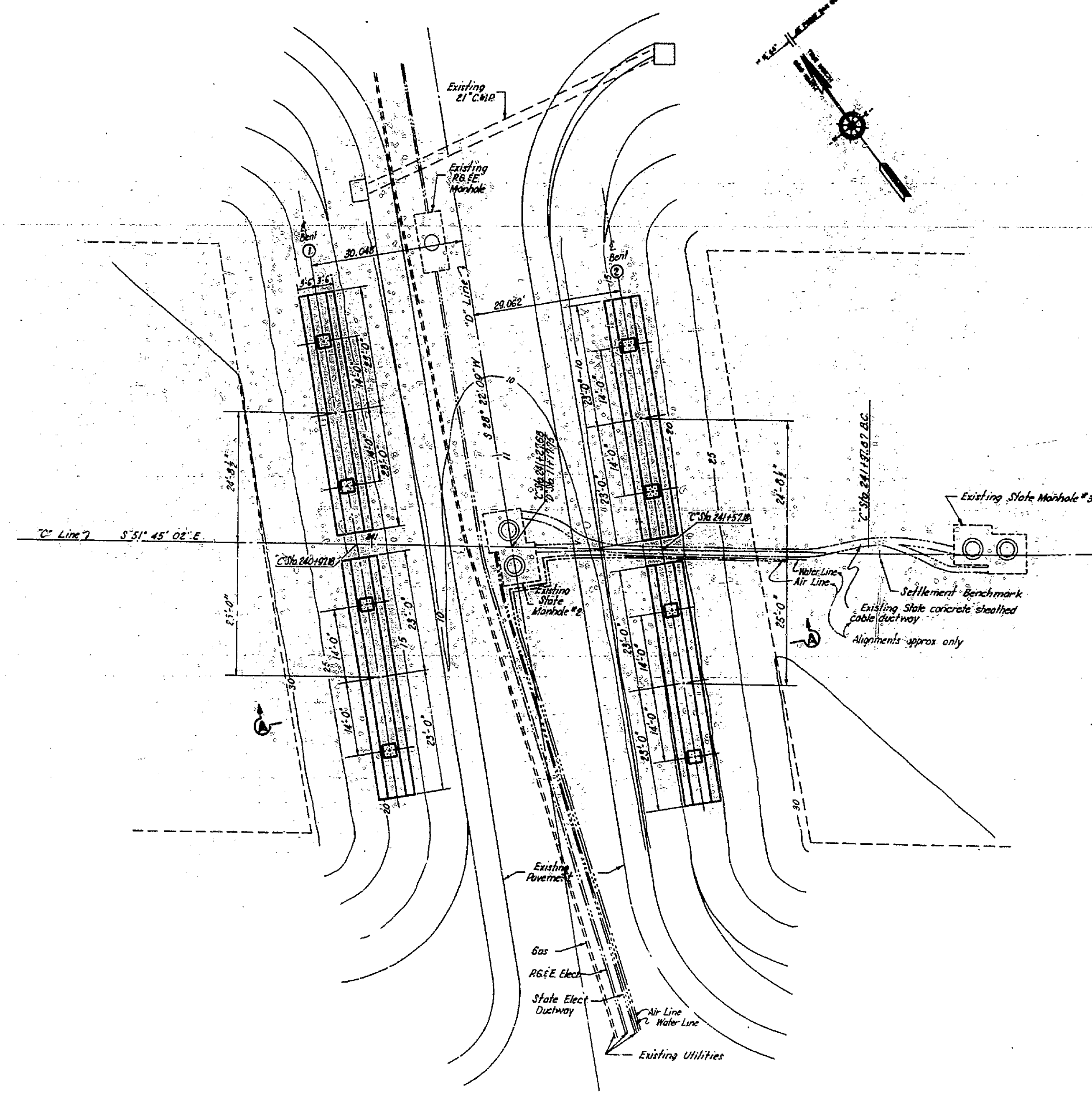
PLAN AND ELEVATION

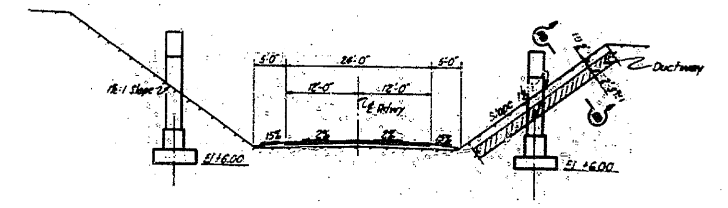
SCALE As Shown | BRIDGE 27-70 | SHEET No. 18 | DRAWING E-1017-18R

AS BUILT PLANS
Contract No. 04-UNKNOWN
Date Completed
Document No. 40008426

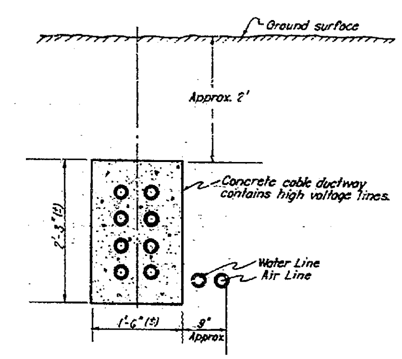
I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM





SECTION A-A



SECTION B-B

Scale 1" = 1'-0"
Existing Facilities

NOTE

For details of footings see Sheet 20.
Bottom of footing elevation may be varied by the Engineer after foundation is excavated.

MARK	DATE	DESCRIPTION	BY	CH'K
1	9-57	*Built without revisions*	G.F.	S.A.C.
		REVISION		

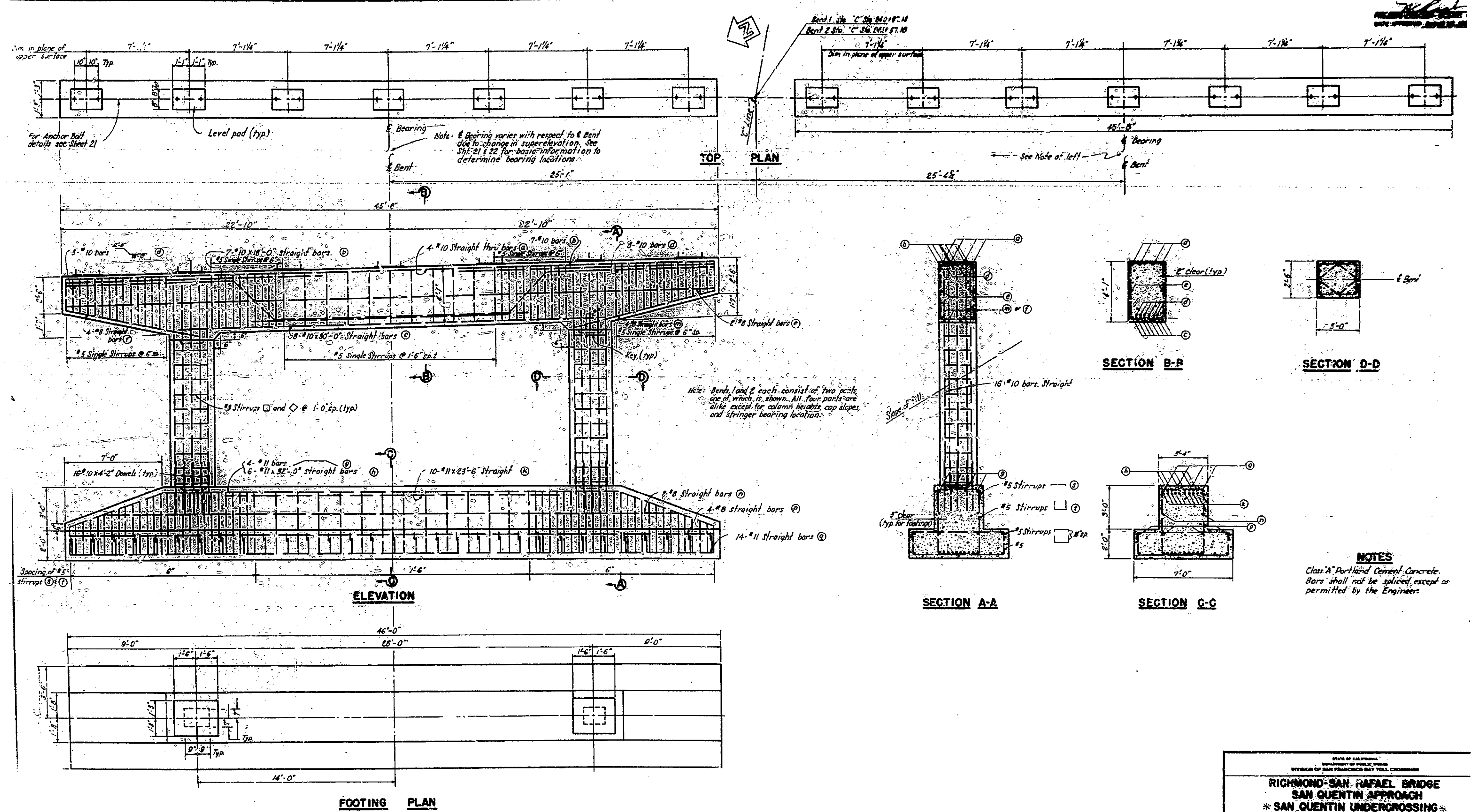
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RICHMOND - SAN RAFAEL BRIDGE
SAN QUENTIN APPROACH
*** SAN QUENTIN UNDERCROSSING ***

FOUNDATION PLAN AND TOPOGRAPHY

SCALE 1" = 10' | BRIDGE 27-70 | SHEET No. 19 | DRAWING C-1017-19R

AS BUILT PLANS
Contract No. 04-UNKNOWN
Date Completed
Document No. 40008426



MARK	DATE	DESCRIPTION	BY	CH'K
1	9-57	Built without revisions	G.F.	S.A.G.
REVISION				

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RICHMOND-SAN RAFAEL BRIDGE
SAN QUENTIN APPROACH
✳ SAN QUENTIN UNDERCROSSING ✳

BENT DETAILS

SCALE 3/8" = 1'-0" | BRIDGE 27-70 | SHEET No. 20 | DRAWING C-101

AS BUILT PLANS
Contract No. 04-UNKNOWN
Date Completed ______
Document No. 40008426

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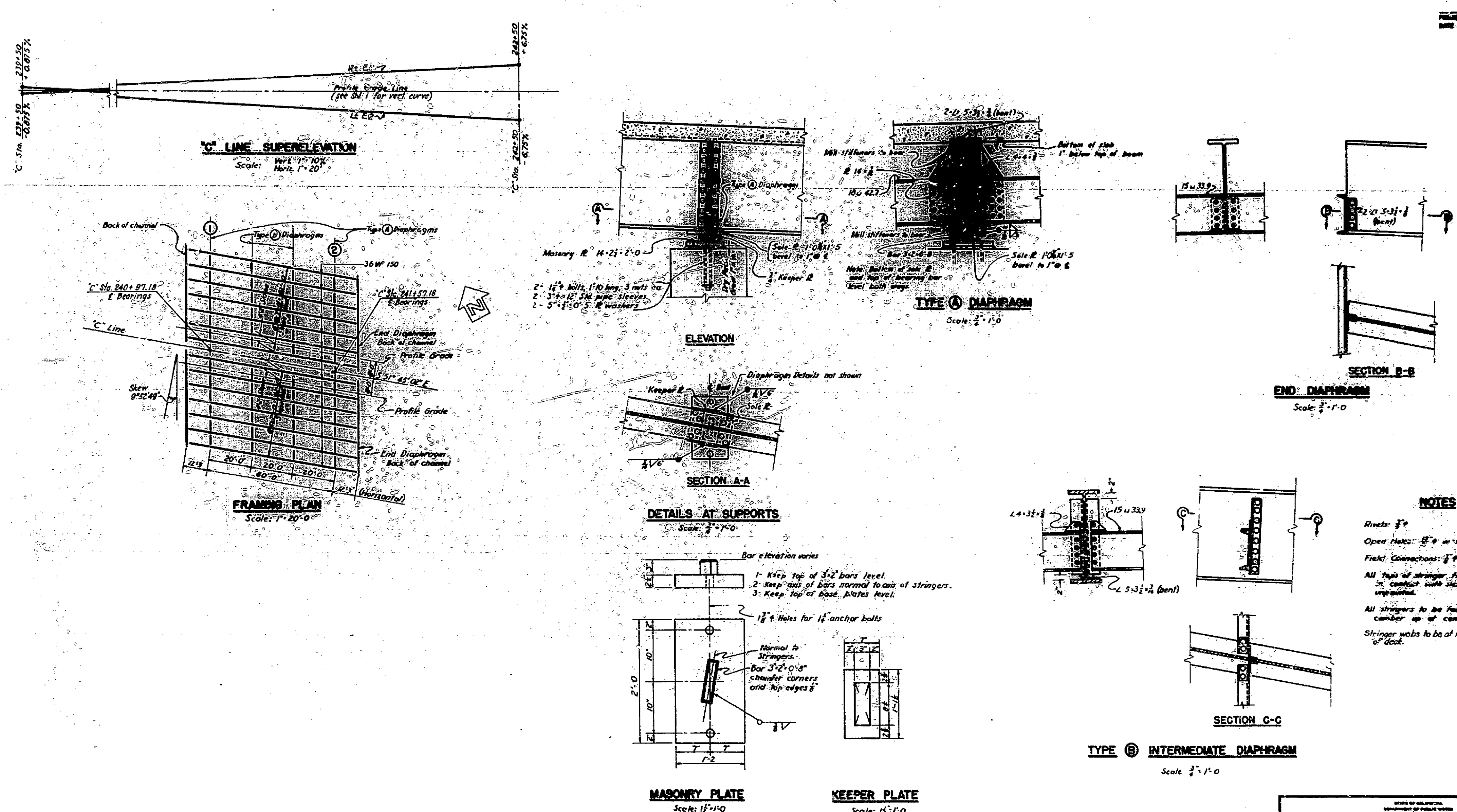


NOTES

Rivets: $\frac{3}{4}$"φ

Open Holes: $\frac{13}{16}$"φ or as noted.

Field Connections: $\frac{3}{4}$"φ H.T. bolts.

All tops of stringer flanges and tie plates in contact with slab concrete to be unpainted.

All stringers to be fabricated with natural camber up at center of span.

Stringer webs to be at right angles to surface of deck.

MARK	DATE	DESCRIPTION	BY	CH'K
1	9-57	Built without revisions	G.F.	S.A.G.
REVISION				

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RICHMOND - SAN RAFAEL BRIDGE
SAN QUENTIN APPROACH
✳ SAN QUENTIN UNDERCROSSING ✳

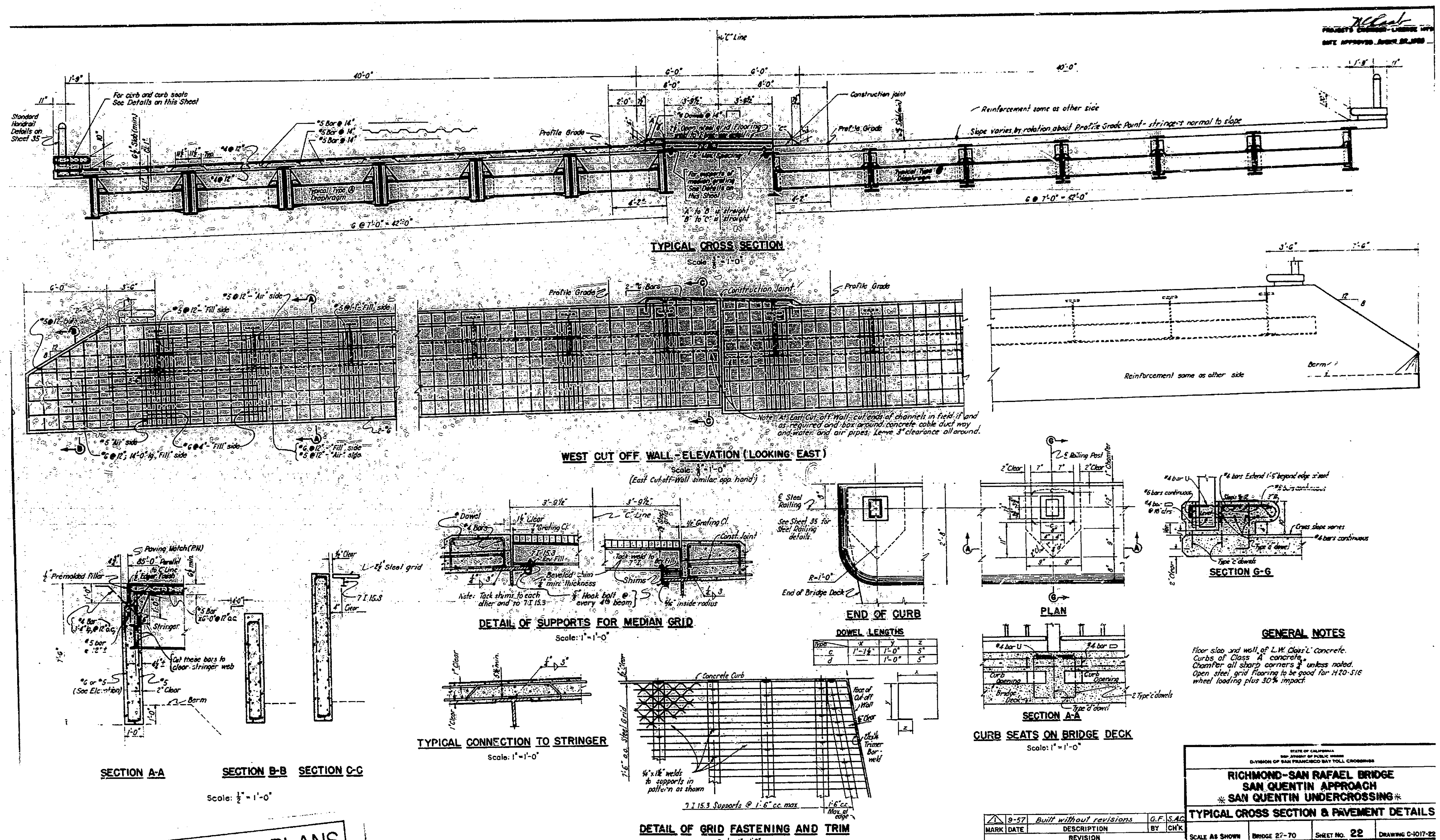
FRAMING PLAN AND STEEL DETAILS

SCALE As shown | BRIDGE 27-70 | SHEET NO. 21 | DRAWING C-1017-21

AS BUILT PLANS
Contract No. 04-UNKNOWN
Date Completed ____
Document No. 40008426

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM



GENERAL NOTES

Floor slab and wall of L.W. Class 'L' Concrete.
Curbs of Class 'A' concrete.
Chamfer all sharp corners ¾" unless noted.
Open steel grid flooring to be good for H20-S16 wheel loading plus 30% impact.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RICHMOND-SAN RAFAEL BRIDGE
SAN QUENTIN APPROACH
✳ SAN QUENTIN UNDERCROSSING ✳

TYPICAL CROSS SECTION & PAVEMENT DETAILS

MARK	DATE	DESCRIPTION	BY	CH'K
1	9-57	Built without revisions	G.F.	S.A.C.
		REVISION		

SCALE AS SHOWN | BRIDGE 27-70 | SHEET NO. 22 | DRAWING C-1017-22

As-Built LOTBs

INDEX OF SHEETS

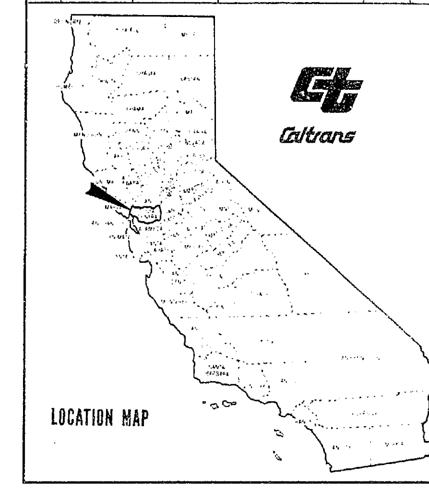
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

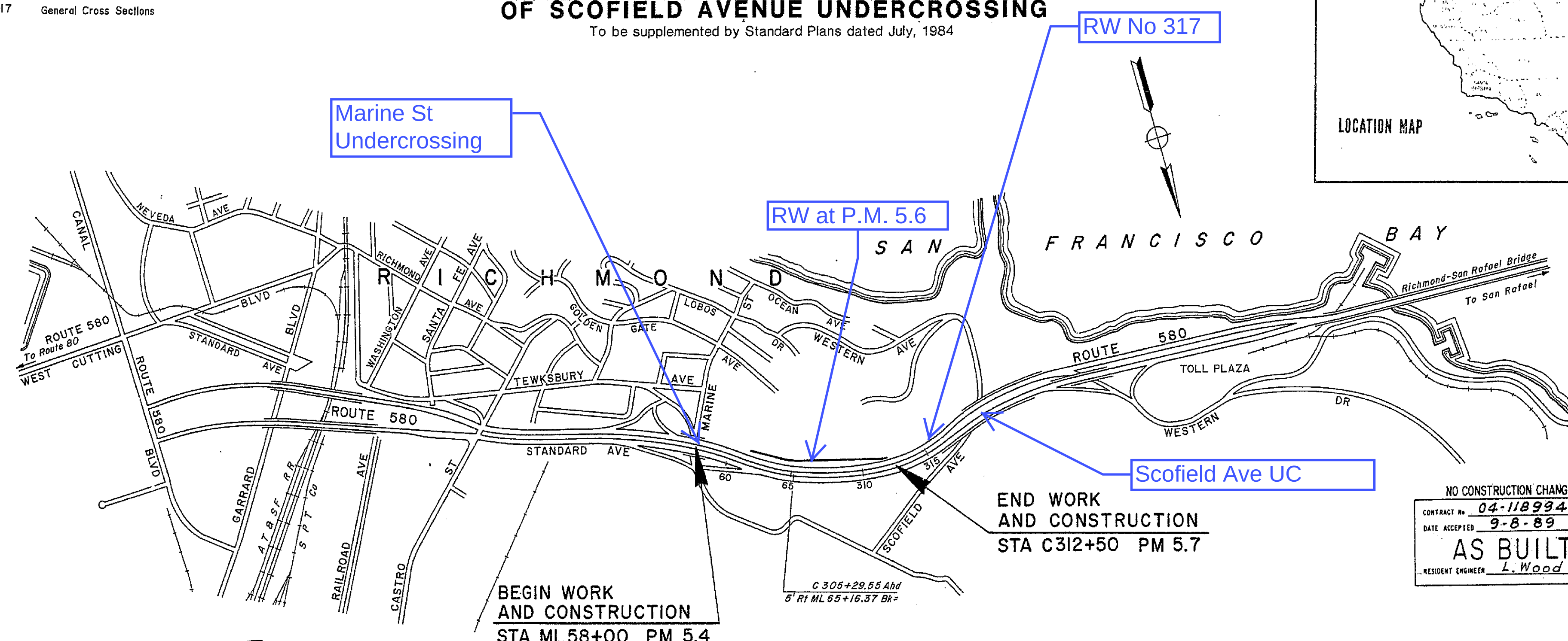
I-580-2(276)8

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN CONTRA COSTA COUNTY IN RICHMOND FROM MARINE STREET UNDERCROSSING TO 0.1 MILE SOUTH OF SCOFIELD AVENUE UNDERCROSSING

To be supplemented by Standard Plans dated July, 1984

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	580	5.4/5.7	1	38





NO CONSTRUCTION CHANGES
CONTRACT No. 04-118994
DATE ACCEPTED 9-8-89
AS BUILT
RESIDENT ENGINEER L. Wood

AS BUILT PLANS
Contract No. 04-118994
Date Completed 9-8-89
Document No.

NO SCALE

Robert H Jahrling
Deputy District Director of Transportation
Registered Civil Engineer
R H Jahrling No. 10679 Exp. 12/31/88 CIVIL

November 2, 1987
Plans Approval Date

V. Paul
Chief, Office of Office Engineer
Registered Civil Engineer
V. Paul No. 9567 Exp. 12-31-88 CIVIL

L G Wood — PROJECT ENGINEER — 4/87
R E Giegling — DESIGN ENGINEER — 4/87
L Chu — APPROVAL RECOMMENDED BY — 4/87

The Contractor shall possess the Class (or Classes) of license as specified in the "Notice to Contractors" on page 1 of the Special Provisions.

LOTB LOCATION PLAN (Base Plan from Contract No: 04-118994)

Contract No. 04-118994

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

CU 04209 EA 118991

FORM DC-OT-25-PF (REV. 1/86)

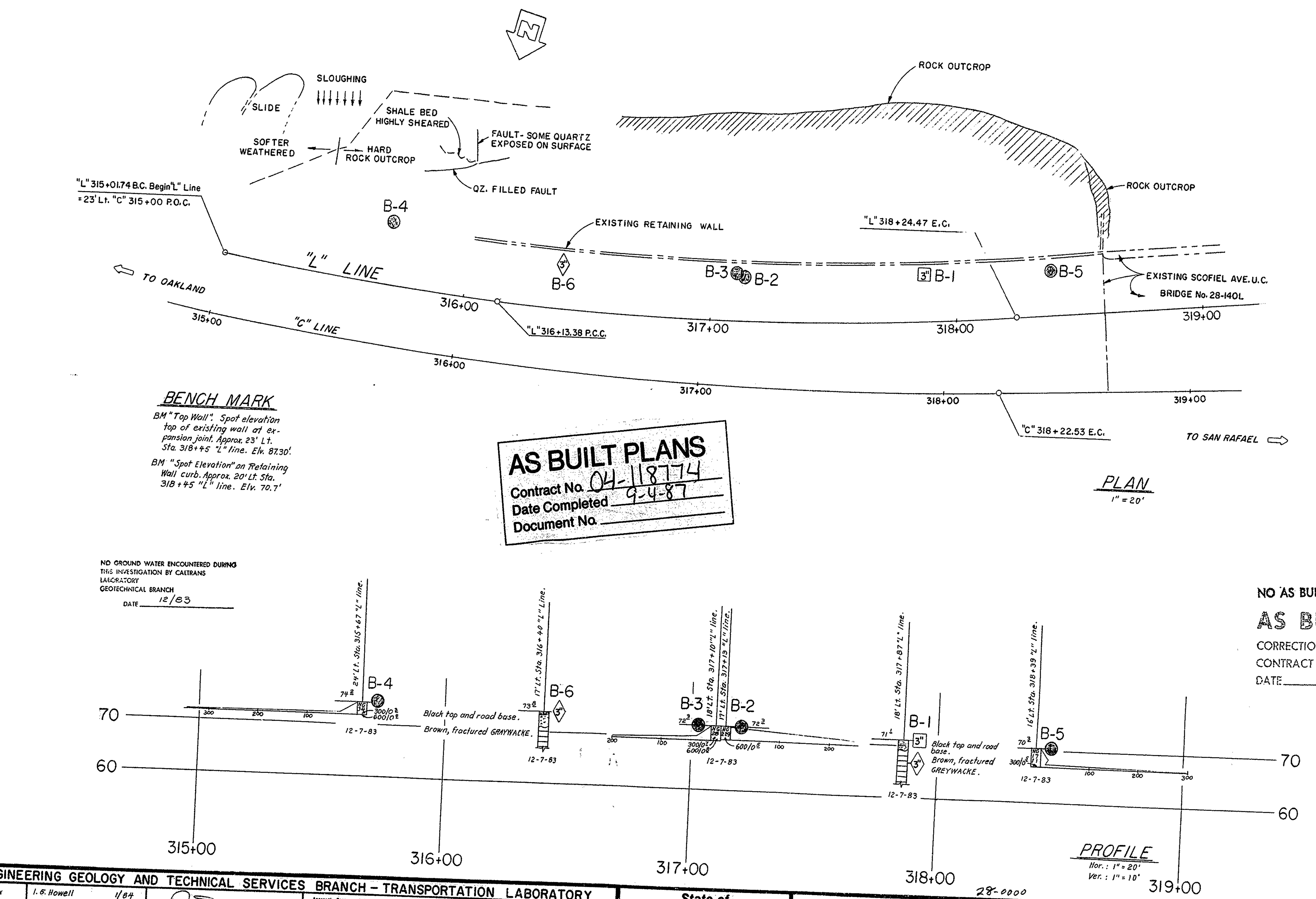
CERTIFICATE OF ACCURATE MICROFILM IMAGE
I hereby certify that this is a true and accurate image of the above document taken under my direction and control on this date in Sacramento, California pursuant to authorization by the Director of Transportation.
1.3.94

TAMERAN

30X

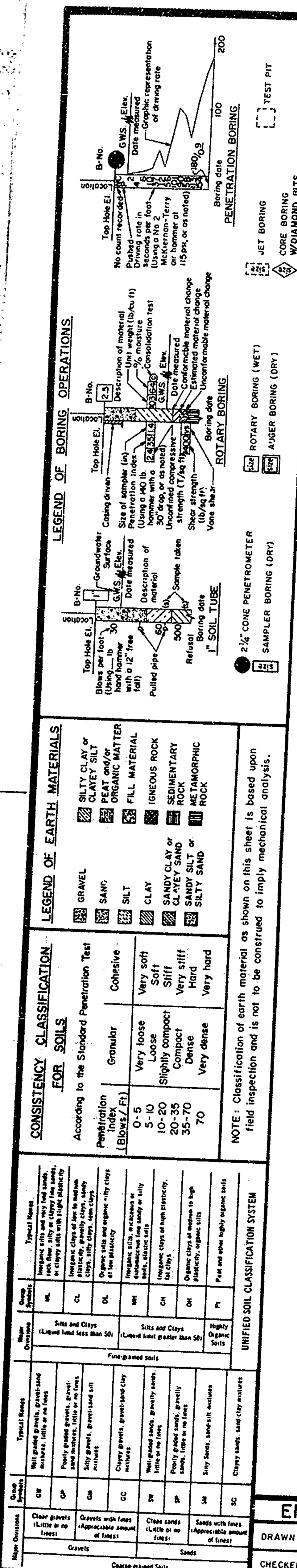
DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	17	5.7	14	14

Robert W. Reynolds #165
ENGINEERING GEOLOGIST — CERTIFIED ENGINEERING GEOLOGIST NUMBER
DATE APPROVED November 26, 1984



AS BUILT PLANS
Contract No. 04-118774
Date Completed 9-4-87
Document No. ____

NO AS BUILT CHANGES
AS BUILT M.K.M. 10-13-87
CORRECTIONS BY V. Moletic
CONTRACT NO. 04-118774
DATE 9-4-87



ENGINEERING GEOLOGY AND TECHNICAL SERVICES BRANCH – TRANSPORTATION LABORATORY

DRAWN BY	I. S. Howell	1/84
CHECKED BY	R. Fox	12/83

PROJECT GEOLOGIST — C.E.G. NO. 78 — ENGINEERING GEOLOGIST — C.E.G. NO. 271

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER NO.

BRIDGE NO. 28-0000
POST MILE 5.6

RETAINING WALL NO. 317
LOG OF TEST BORINGS

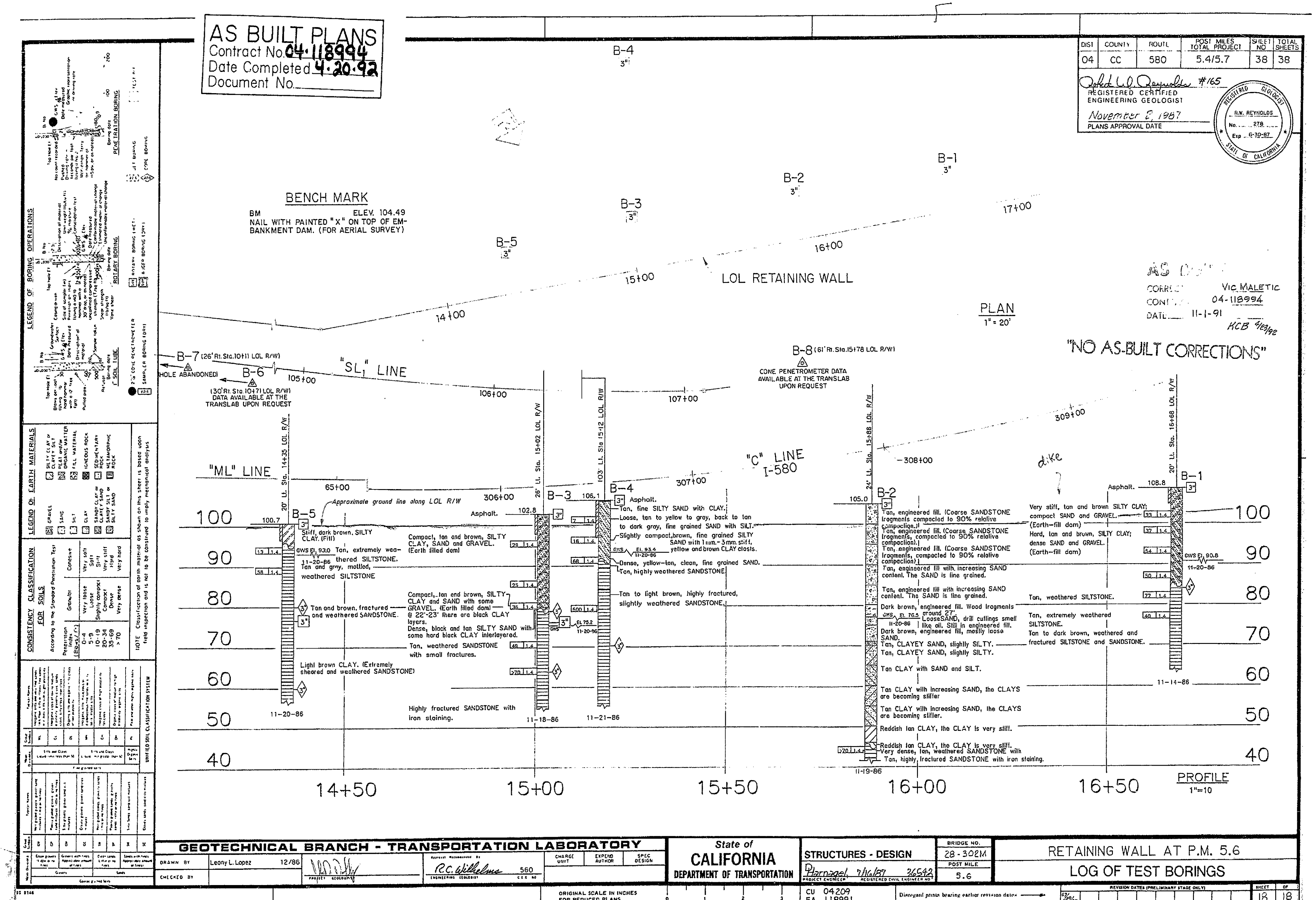
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

CU 04210
WO 118771

Disregard prints bearing earlier revision dates

SHEET 9 OF 9

14



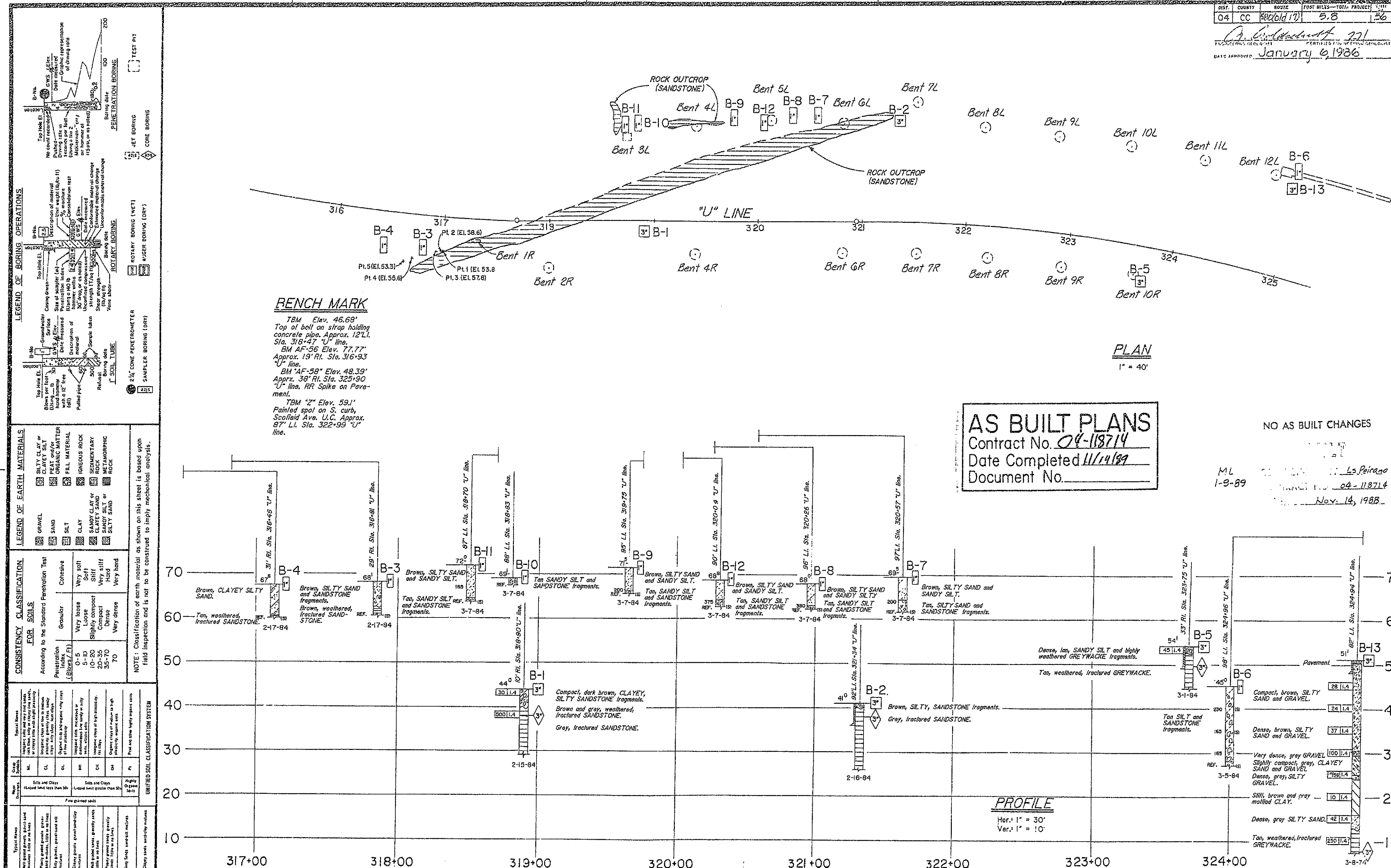
CERTIFICATE OF ACCURATE MICROFILM IMAGE

I hereby certify that this is a true and accurate image of the above document taken under my direction and control on this date in Sacramento, California pursuant to authorization by the Director of Transportation.

DATE 9-19-94

30X

Poor Quality



04 CC 680(old 17) 5.8 56 56

January 9, 1986

ENGINEERING GEOLOGY AND TECHNICAL SERVICES BRANCH – TRANSPORTATION LABORATORY

DRAWN BY IRMA HOWELL 3/84

CHECKED BY R. Fox 4/84

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

BRIDGE NO. 28-140R/L

POST MILE 5.8

SCOFIELD AVENUE U.C.

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

CU 04210
WO 118711

Disregard prints bearing earlier revision dates

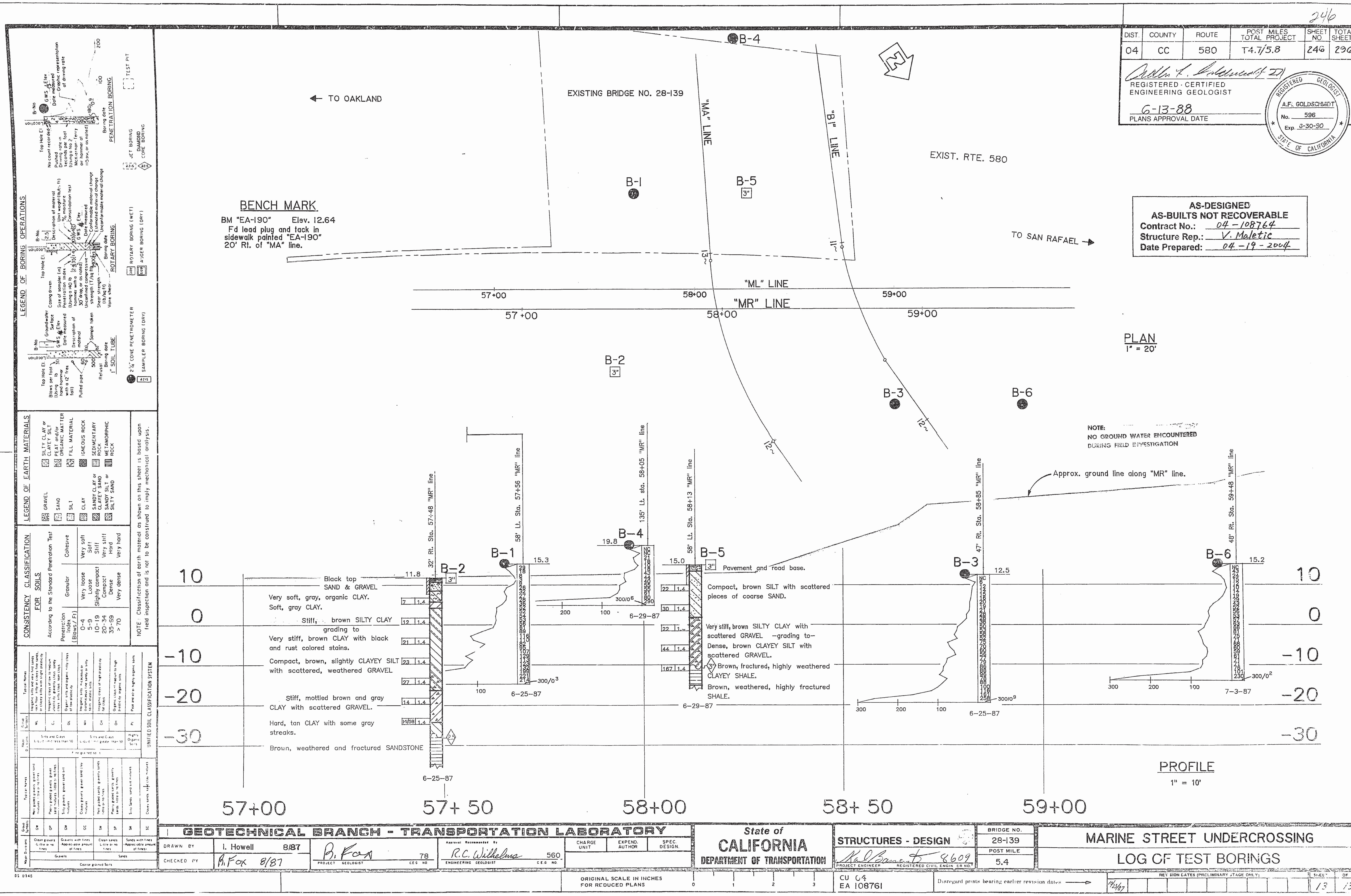
SHEET 41 OF 41

56

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

DATE 2/7/89 SUPERVISOR OF MICROFILM SERVICES

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM



DIST. 04 | COUNTY CC | ROUTE 580 | POST MILES TOTAL PROJECT T4.7/5.8 | SHEET NO. 246 | TOTAL SHEETS 296
REGISTERED · CERTIFIED ENGINEERING GEOLOGIST
6-13-88
PLANS APPROVAL DATE
REGISTERED GEOLOGIST A.F. GOLDSCHMIDT No. 596 Exp. 3-30-90 STATE OF CALIFORNIA
AS-DESIGNED
AS-BUILTS NOT RECOVERABLE
Contract No.: 04-108764
Structure Rep.: V. Maletic
Date Prepared: 04-19-2004
TO OAKLAND
EXISTING BRIDGE NO. 28-139
"MA" LINE
"B1" LINE
EXIST. RTE. 580
TO SAN RAFAEL
BENCH MARK
BM "EA-190" Elev. 12.64
Fd lead plug and tack in sidewalk painted "EA-190" 20' Rt. of "MA" line.
"ML" LINE
"MR" LINE
PLAN
1" = 20'
NOTE:
NO GROUND WATER ENCOUNTERED DURING FIELD INVESTIGATION
Approx. ground line along "MR" line.
LEGEND OF BORING OPERATIONS
LEGEND OF EARTH MATERIALS
CONSISTENCY CLASSIFICATION FOR SOILS
UNIFIED SOIL CLASSIFICATION SYSTEM
NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.
Black top SAND & GRAVEL
Very soft, gray, organic CLAY.
Soft, gray CLAY.
Stiff, brown SILTY CLAY grading to
Very stiff, brown CLAY with black and rust colored stains.
Compact, brown, slightly CLAYEY SILT with scattered, weathered GRAVEL
Stiff, mottled brown and gray CLAY with scattered GRAVEL.
Hard, tan CLAY with some gray streaks.
Brown, weathered and fractured SANDSTONE
Pavement and road base.
Compact, brown SILT with scattered pieces of coarse SAND.
Very stiff, brown SILTY CLAY with scattered GRAVEL —grading to— Dense, brown CLAYEY SILT with scattered GRAVEL.
Brown, fractured, highly weathered CLAYEY SHALE.
Brown, weathered, highly fractured SHALE.
B-1 B-2 B-3 B-4 B-5 B-6
PROFILE
1" = 10'
57+00 57+50 58+00 58+50 59+00
GEOTECHNICAL BRANCH - TRANSPORTATION LABORATORY
DRAWN BY I. Howell 8/87
CHECKED BY B. Fox 8/87
State of CALIFORNIA DEPARTMENT OF TRANSPORTATION
STRUCTURES - DESIGN
BRIDGE NO. 28-139
POST MILE 5.4
MARINE STREET UNDERCROSSING
LOG OF TEST BORINGS
CU 04
EA 108761

APPENDIX E

Liquefaction Analysis

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME ***Richmond San Rafael Bridge Access Improvement Project***
PROJECT NO. ***2014-125-GDR***
BORING NO. ***A-15-580-001***

SOIL GROUPS
1. GRAVELS, SANDS AND NONPLASTIC SILTS
2. CLAYS AND PLASTIC SILTS

FAULT INFO
Hayward (North)
a_{max} (g)= 0.63
FAULT M_w = 7.3

GW DEPTH (ft)= 26

BOREHOLE DIA (in)= 4
HAMMER ENERGY = 84%

CUT(-)/FILL(+) (ft) = 0
DESIGN GW DEPTH (ft)= 26 *(below OG)*

MSF = 1.07

SOIL STRATA							LIQUEFACTION RESISTANCE ($CRR_{7.5}$)								CYCLIC STRESS RATIO (CSR)				F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka			POST-LIQ. SETTLEMENT	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	4.0	1	3.0	1	34	MC	22.1	23.2	375.0	1.7	39.4	17%	44.6		375.0	375.0	1.0	0.4	1.0	1.0			
4.0	8.5	2	6.0	1	27	MC	17.6	19.7	750.0	1.6	32.1		32.1		750.0	750.0	1.0	0.4	1.0	1.0			
8.5	13.0	3	11.0	1	46	MC	29.9	35.6	1375.0	1.2	42.9	7%	43.4		1375.0	1375.0	1.0	0.4	1.0	1.0			
13.0	18.0	4	16.0	1	43	MC	28.0	37.2	2000.0	1.0	37.2		37.2		2000.0	2000.0	1.0	0.4	1.0	1.0			
18.0	22.5	5	21.0	2	12	MC	7.8	10.4	2625.0	0.9	9.1												
22.5	28.0	6	26.0	1	31	MC	20.2	28.2	3250.0	0.8	22.1		22.1	0.2	3250.0	3250.0	0.9	0.4	0.8	1.0	(0.57)	1.30%	0.86
28.0	33.5	7	31.0	1	24	MC	15.6	21.8	3563.0	0.7	16.4	12%	18.4	0.2	3875.0	3563.0	0.9	0.4	0.8	1.0	(0.43)	1.49%	0.98
33.5	38.0	8	36.0	2	26	MC	16.9	23.7	3876.0	0.7	17.0											-	-
38.0	41.5	9	41.0	1	24	MC	15.6	21.8	4189.0	0.7	15.1		15.1	0.2	5125.0	4189.0	0.8	0.4	0.8	1.0	(0.33)	1.73%	0.73

Total = 2.57

Notes:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   for FC $\leq$ 5% a = 0, b = 1.0
   for 5% < FC < 35% a = $\exp(1.76-(190/FC^2))$, b = $(0.99+(FC^{1.5}/1000))$
   for FC $\geq$ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:
Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME	***Richmond San Rafael Bridge Access Improvement Project***	*SOIL GROUPS*	*FAULT INFO*	
PROJECT NO.	***2014-125-GDR***	1. GRAVELS, SANDS AND NONPLASTIC SILTS	*Hayward (North)*	
BORING NO.	***A-15-580-010***	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=*	0.68
			FAULT M_w =	7.3

GW DEPTH (ft)=	14	*BOREHOLE DIA (in)=*	4	*CUT(-)/FILL(+) (ft) =*	0		*MSF =* 1.07
		HAMMER ENERGY =	84%	*DESIGN GW DEPTH (ft)=*	14	*(below OG)*	

SOIL STRATA							*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*								*CYCLIC STRESS RATIO (CSR)*				*F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka*			*POST-LIQ. SETTLEMENT*	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	3.0	1	3.0	1	100	SPT	100.0	126.0	375.0	1.7	214.2	17%	229.3		375.0	375.0	1.0	0.4	1.0	1.0			
3.0	7.0	2	6.0	1	100	SPT	100.0	134.4	750.0	1.6	219.5		219.5		750.0	750.0	1.0	0.4	1.0	1.0			
7.0	10.0	3	11.0	1	100	SPT	100.0	142.8	1375.0	1.2	172.2	7%	173.8		1375.0	1375.0	1.0	0.4	1.0	1.0			
10.0	13.5	4	16.0	1	100	SPT	100.0	159.6	1875.2	1.0	164.8		164.8		2000.0	1875.2	1.0	0.5	1.0	1.0	NON-LIQ.		

Total = 0.00

Notes:

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   - for FC $\leq$ 5%   a = 0,   b = 1.0
   - for 5% < FC < 35%   a = exp(1.76-(190/FC^2)),   b = (0.99+(FC$^{1.5}$/1000))
   - for FC $\geq$ 35%   a = 5.0,   b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:

Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME ***Richmond San Rafael Bridge Access Improvement Project***
PROJECT NO. ***2014-125-GDR***
BORING NO. ***A-15-580-011***

SOIL GROUPS
1. GRAVELS, SANDS AND NONPLASTIC SILTS
2. CLAYS AND PLASTIC SILTS

FAULT INFO
Hayward (North)
a_{max} (g)= 0.68
FAULT M_w = 7.3

GW DEPTH (ft)= 16

BOREHOLE DIA (in)= 4
HAMMER ENERGY = 84%

CUT(-)/FILL(+) (ft) = 0
DESIGN GW DEPTH (ft)= 16 *(below OG)*

MSF = 1.07

SOIL STRATA							*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*								*CYCLIC STRESS RATIO (CSR)*				*F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka*			*POST-LIQ. SETTLEMENT*	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	3.0	1	3.0	1	63	MC	41.0	43.0	375.0	1.7	73.1	17%	80.2		375.0	375.0	1.0	0.4	1.0	1.0			
3.0	8.0	2	6.0	1	86	MC	55.9	62.6	750.0	1.6	102.2		102.2		750.0	750.0	1.0	0.4	1.0	1.0			
8.0	12.0	3	11.0	1	82	MC	53.3	63.4	1375.0	1.2	76.5	7%	77.3		1375.0	1375.0	1.0	0.4	1.0	1.0			
12.0	15.3	4	16.0	1	100	MC	65.0	86.5	2000.0	1.0	86.5		86.5		2000.0	2000.0	1.0	0.4	1.0	1.0	NON-LIQ.		

Total = 0.00

Notes:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\ (N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   for FC $\leq$ 5% a = 0, b = 1.0
   for 5% < FC < 35% a = $\exp(1.76-(190/FC^2))$, b = $(0.99+(FC^{1.5}/1000))$
   for FC $\geq$ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:
Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME ***Richmond San Rafael Bridge Access Improvement Project***
PROJECT NO. ***2014-125-GDR***
BORING NO. ***A-15-580-013***

SOIL GROUPS
1. GRAVELS, SANDS AND NONPLASTIC SILTS
2. CLAYS AND PLASTIC SILTS

FAULT INFO
Hayward (North)
a_{max} (g)= 0.63
FAULT M_w = 7.3
MSF = 1.07

GW DEPTH (ft)= 26

BOREHOLE DIA (in)= 4
HAMMER ENERGY = 84%

CUT(-)/FILL(+) (ft) = 0
DESIGN GW DEPTH (ft)= 26 *(below OG)*

SOIL STRATA							LIQUEFACTION RESISTANCE ($CRR_{7.5}$)								CYCLIC STRESS RATIO (CSR)				F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka			POST-LIQ. SETTLEMENT	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	4.0	1	3.0	1	23	SPT	23.0	29.0	375.0	1.7	49.3	17%	55.0		375.0	375.0	1.0	0.4	1.0	1.0			
4.0	8.0	2	6.0	1	32	SPT	32.0	43.0	750.0	1.6	70.2		70.2		750.0	750.0	1.0	0.4	1.0	1.0			
8.0	13.0	3	11.0	1	55	MC	35.8	42.5	1375.0	1.2	51.3	7%	51.9		1375.0	1375.0	1.0	0.4	1.0	1.0			
13.0	17.0	4	16.0	1	100	SPT	100.0	159.6	2000.0	1.0	159.6		159.6		2000.0	2000.0	1.0	0.4	1.0	1.0			
17.0	22.0	5	21.0	1	100	SPT	100.0	159.6	2625.0	0.9	139.3		139.3		2625.0	2625.0	1.0	0.4	0.9	1.0			
22.0	25.0	6	26.0	1	100	SPT	100.0	168.0	3250.0	0.8	131.8		131.8		3250.0	3250.0	0.9	0.4	0.8	1.0	NON-LIQ.		

Total = 0.00

Notes:
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   for FC $\leq$ 5% a = 0, b = 1.0
   for 5% < FC < 35% a = exp(1.76-(190/FC^2)), b = (0.99+($FC^{1.5}$/1000))
   for FC $\geq$ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:
Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME ***Richmond San Rafael Bridge Access Improvement Project***
PROJECT NO. ***2014-125-GDR***
BORING NO. ***A-15-580-014***

SOIL GROUPS
1. GRAVELS, SANDS AND NONPLASTIC SILTS
2. CLAYS AND PLASTIC SILTS

FAULT INFO
Hayward (North)
a_{max} (g)= 0.63
FAULT M_w = 7.3

GW DEPTH (ft)= 26
BOREHOLE DIA (in)= 4
HAMMER ENERGY = 84%
CUT(-)/FILL(+) (ft) = 0
DESIGN GW DEPTH (ft)= 26 *(below OG)*
MSF = 1.07

SOIL STRATA							*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*								*CYCLIC STRESS RATIO (CSR)*				*F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka*			*POST-LIQ. SETTLEMENT*	
Layer Thickness from	Layer Thickness to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	4.0	1	3.0	1	43	MC	28.0	29.3	375.0	1.7	49.9	17%	55.6		375.0	375.0	1.0	0.4	1.0	1.0			
4.0	8.0	2	6.0	1	100	SPT	100.0	134.4	750.0	1.6	219.5		219.5		750.0	750.0	1.0	0.4	1.0	1.0			
8.0	13.0	3	11.0	1	100	SPT	100.0	142.8	1375.0	1.2	172.2	7%	173.8		1375.0	1375.0	1.0	0.4	1.0	1.0			
13.0	17.0	4	16.0	1	100	SPT	100.0	159.6	2000.0	1.0	159.6		159.6		2000.0	2000.0	1.0	0.4	1.0	1.0			
17.0	22.0	5	21.0	1	100	SPT	100.0	159.6	2625.0	0.9	139.3		139.3		2625.0	2625.0	1.0	0.4	0.9	1.0			
22.0	25.0	6	26.0	1	100	SPT	100.0	168.0	3250.0	0.8	131.8		131.8		3250.0	3250.0	0.9	0.4	0.8	1.0	NON-LIQ.		

Total = 0.00

Notes:

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   for FC $\leq$ 5% a = 0, b = 1.0
   for 5% < FC < 35% a = exp(1.76-(190/FC^2)), b = (0.99+($FC^{1.5}$/1000))
   for FC $\geq$ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:

Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME	***RSR Bridge Access Improvement***	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	***2014-125-GDR***	1. GRAVELS, SANDS AND NONPLASTIC SILTS	*Hayward (North)*
BORING NO.	***A-15-580-015***	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.63
			FAULT M_w = 7.3

GW DEPTH (ft)=	19	*BOREHOLE DIA (in)=*	4	*CUT(-)/FILL(+) (ft) =*	0	*MSF =*	1.07
		HAMMER ENERGY =	77%	*DESIGN GW DEPTH (ft)=*	8 *(below OG)*		

SOIL STRATA							*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*								*CYCLIC STRESS RATIO (CSR)*				*F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka*			*POST-LIQ. SETTLEMENT*	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	$SPT\text{-}N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	4.0	1	3.0	1	47	MC	30.6	29.4	375.0	1.7	50.0		50.0		375.0	375.0	1.0	0.4	1.0	1.0			
4.0	8.0	2	6.0	1	28	MC	18.2	18.7	750.0	1.6	30.5		30.5		750.0	750.0	1.0	0.4	1.0	1.0			
8.0	13.0	3	11.0	1	12	MC	7.8	8.5	1375.0	1.2	10.3		10.3	0.1	1375.0	1187.8	1.0	0.5	1.0	1.0	(0.27)	2.31%	1.39
13.0	19.0	4	16.0	1	21	SPT	21.0	30.7	2000.0	1.0	30.7		30.7		2000.0	1500.8	1.0	0.5	1.0	1.0	NON-LIQ.		
19.0	23.0	5	21.0	2	3	SPT	3.0	4.4	2500.2	0.9	3.9												
23.0	28.0	6	25.0	1	100	MC	65.0	83.4	2750.6	0.9	71.1		71.1		3125.0	2064.2	0.9	0.6	0.9	1.0	NON-LIQ.		
28.0	33.0	7	30.0	1	100	SPT	100.0	154.0	3063.6	0.8	124.4		124.4		3750.0	2377.2	0.9	0.6	0.8	1.0	NON-LIQ.		
33.0	38.0	8	35.0	1	100	SPT	100.0	154.0	3378.6	0.8	118.5		118.5		4377.0	2692.2	0.9	0.6	0.8	1.0	NON-LIQ.		
38.0	43.0	9	40.5	1	100	SPT	100.0	154.0	3730.9	0.7	112.8		112.8		5072.5	3044.5	0.8	0.6	0.8	1.0	NON-LIQ.		
43.0	45.8	10	45.5	1	100	SPT	100.0	154.0	4056.4	0.7	108.1		108.1		5710.0	3370.0	0.8	0.6	0.8	1.0	NON-LIQ.		
																						Total =	1.39

Notes:

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   for FC ≤ 5% a = 0, b = 1.0
   for 5% < FC < 35% $a = \exp(1.76-(190/FC^2))$, $b = (0.99+(FC^{1.5}/1000))$
   for FC ≥ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:

Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS (SPT procedures per Youd et al, 2001)

PROJECT NAME	***RSR Bridge Access Improvement***	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	***2014-125-GDR***	1. GRAVELS, SANDS AND NONPLASTIC SILTS	*Hayward (North)*
BORING NO.	***A-15-580-016***	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.63
			FAULT M_w = 7.3

GW DEPTH (ft)=	18	*BOREHOLE DIA (in)=*	4	*CUT(-)/FILL(+) (ft) =*	0		*MSF =* 1.07
		HAMMER ENERGY =	77%	*DESIGN GW DEPTH (ft)=*	14	*(below OG)*	

SOIL STRATA							*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*								*CYCLIC STRESS RATIO (CSR)*				*F.S.=($CRR_{7.5}$/CSR)*MSF*Ks*Ka*			*POST-LIQ. SETTLEMENT*	
Layer Thickness from	to	Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	SPT-$N_{eq.}$	N_{60}	σ_v' (psf)	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60,CS}$	$CRR_{7.5}$	σ_v (psf)	σ_v' (psf)	r_d	CSR	Ks	Ka	F.S.	Vol. Strain (%)	ΔD (in)
0.0	4.0	1	3.0	1	68	MC	44.2	42.5	375.0	1.7	72.3		72.3		375.0	375.0	1.0	0.4	1.0	1.0			
4.0	8.0	2	6.0	1	50	MC	32.5	33.4	750.0	1.6	54.5		54.5		750.0	750.0	1.0	0.4	1.0	1.0			
8.0	13.0	3	11.0	1	21	MC	13.7	14.9	1375.0	1.2	18.0		18.0		1375.0	1375.0	1.0	0.4	1.0	1.0			
13.0	18.0	4	16.0	1	17	MC	11.1	13.5	2000.0	1.0	13.5		13.5	0.1	2000.0	1875.2	1.0	0.4	1.0	1.0	(0.37)	1.88%	1.13
18.0	23.0	5	21.0	2	7	MC	4.6	5.5	2437.8	0.9	5.0												
23.0	28.0	6	26.0	1	9	MC	5.9	7.5	2750.8	0.9	6.4		6.4	0.1	3250.0	2501.2	0.9	0.5	0.9	1.0	(0.16)	3.29%	1.97
28.0	33.0	7	31.0	1	14	MC	9.1	11.7	3063.8	0.8	9.4		9.4	0.1	3875.0	2814.2	0.9	0.5	0.9	1.0	(0.20)	2.46%	1.48
33.0	40.0	8	36.0	1	16	SPT	16.0	24.6	3379.8	0.8	19.0		19.0	0.2	4503.0	3130.2	0.9	0.5	0.8	1.0	(0.35)	1.46%	1.22
40.0	44.0	9	40.5	1	100	SPT	100.0	154.0	3666.5	0.7	113.7		113.7		5070.5	3416.9	0.8	0.5	0.8	1.0	NON-LIQ.		
44.0	47.0	10	45.0	1	100	SPT	100.0	154.0	3958.2	0.7	109.5		109.5		5643.0	3708.6	0.8	0.5	0.8	1.0	NON-LIQ.		
47.0	50.3	11	50	1	100	SPT	100.0	154.0	4289.2	0.7	105.2		105.2		6286.0	4039.6	0.8	0.5	0.7	1.0	NON-LIQ.		

Total = 5.80

Notes:

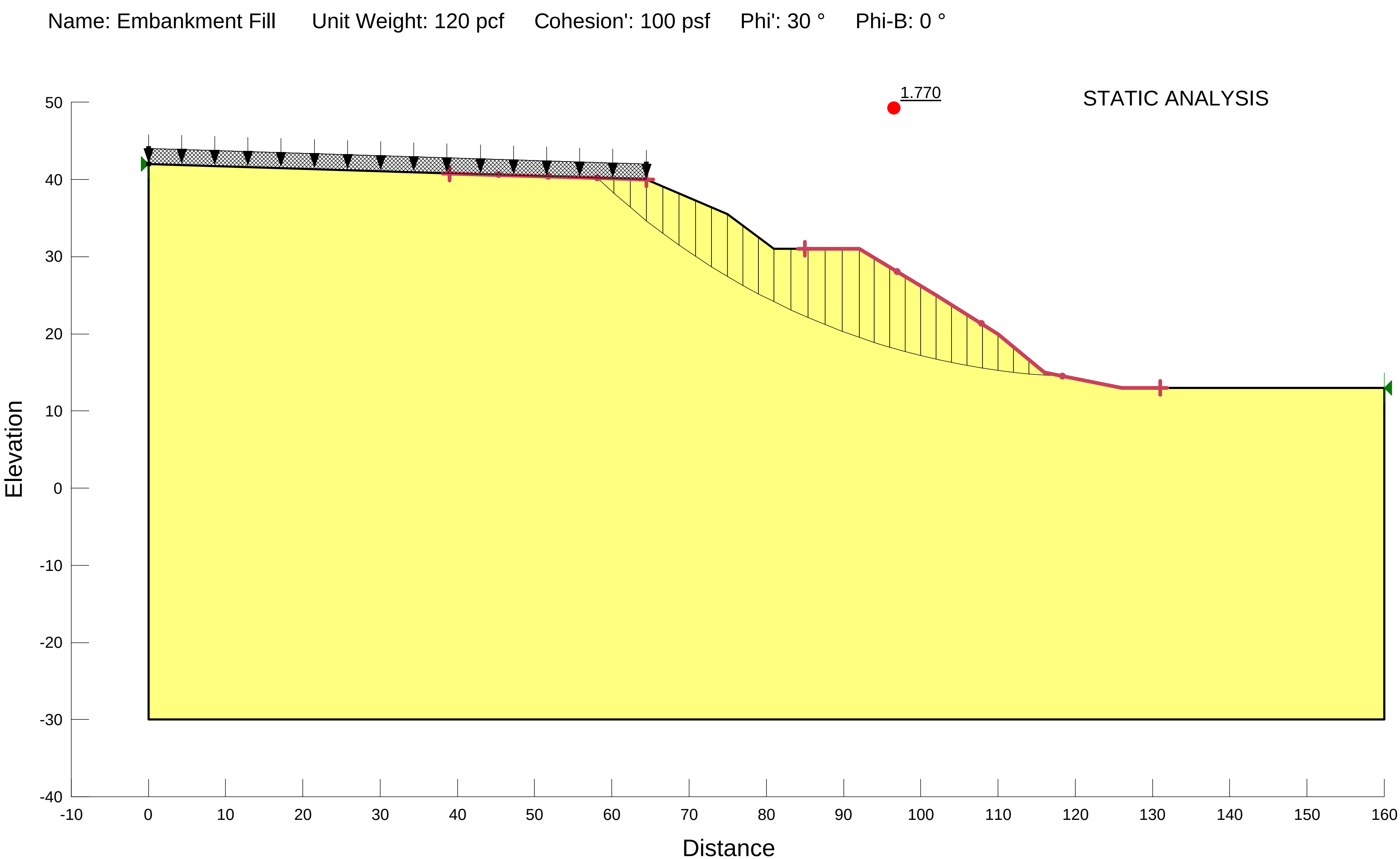
1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = (1/\sigma_v')^{0.5}$ with a maximum value of 1.7.
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = a + b\,(N_1)_{60}$
   where a and b = coefficients determined from the following relationships
   - for FC $\leq$ 5% a = 0, b = 1.0
   - for 5% < FC < 35% $a = \exp(1.76-(190/FC^2))$, $b = (0.99+(FC^{1.5}/1000))$
   - for FC $\geq$ 35% a = 5.0, b = 1.2
4. For $(N_1)_{60,cs}$ greater than 30, clean granular soils are too dense to liquefy and are classed as non-liquefiable.
5. Post-liquefaction settlement is estimated per Tokimatsu and Seed (1987).

Reference:

Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

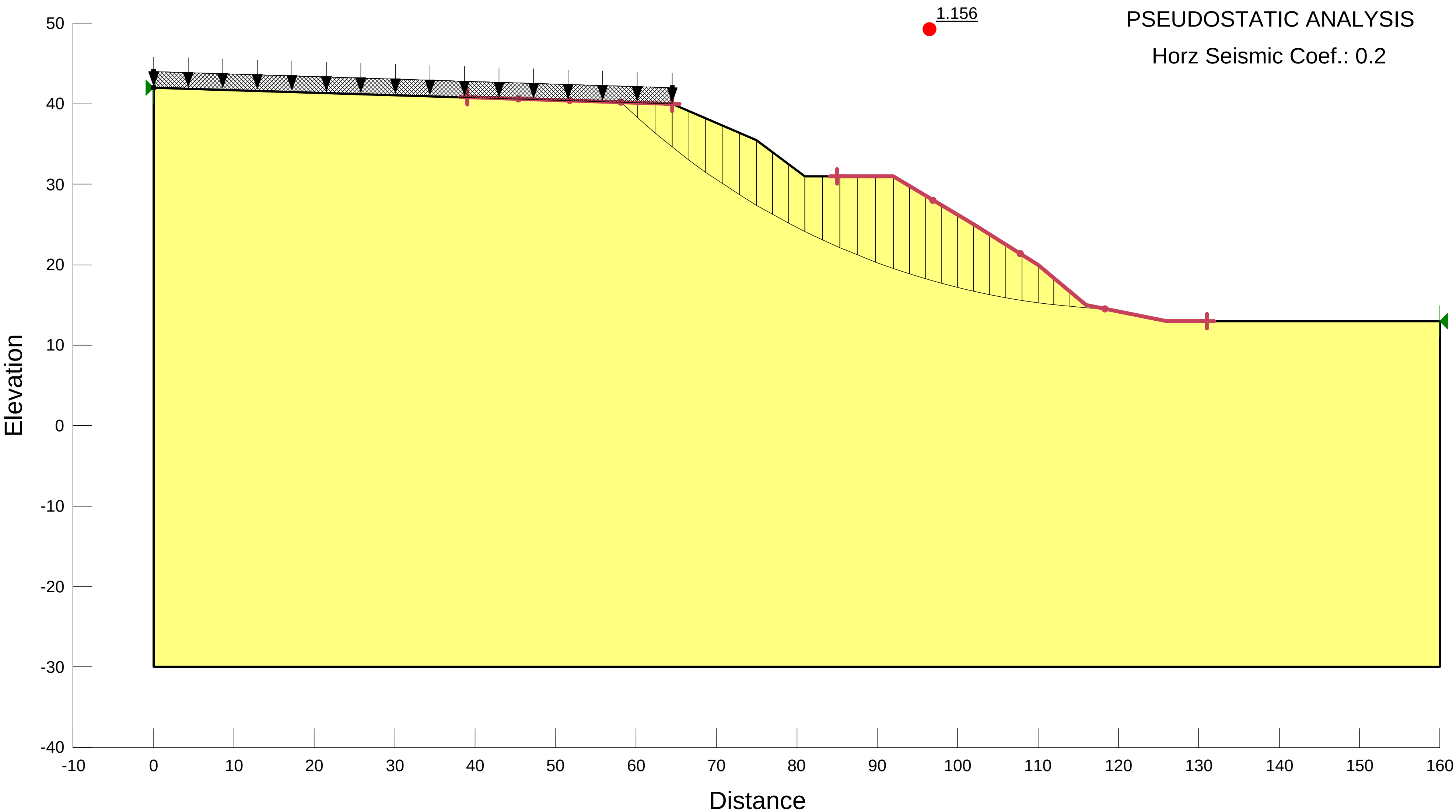
Slope Stability Analysis

RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
EA NO. 04-2J6800
RETAINING WALL NO. 8 (EXISTING CONDITION)



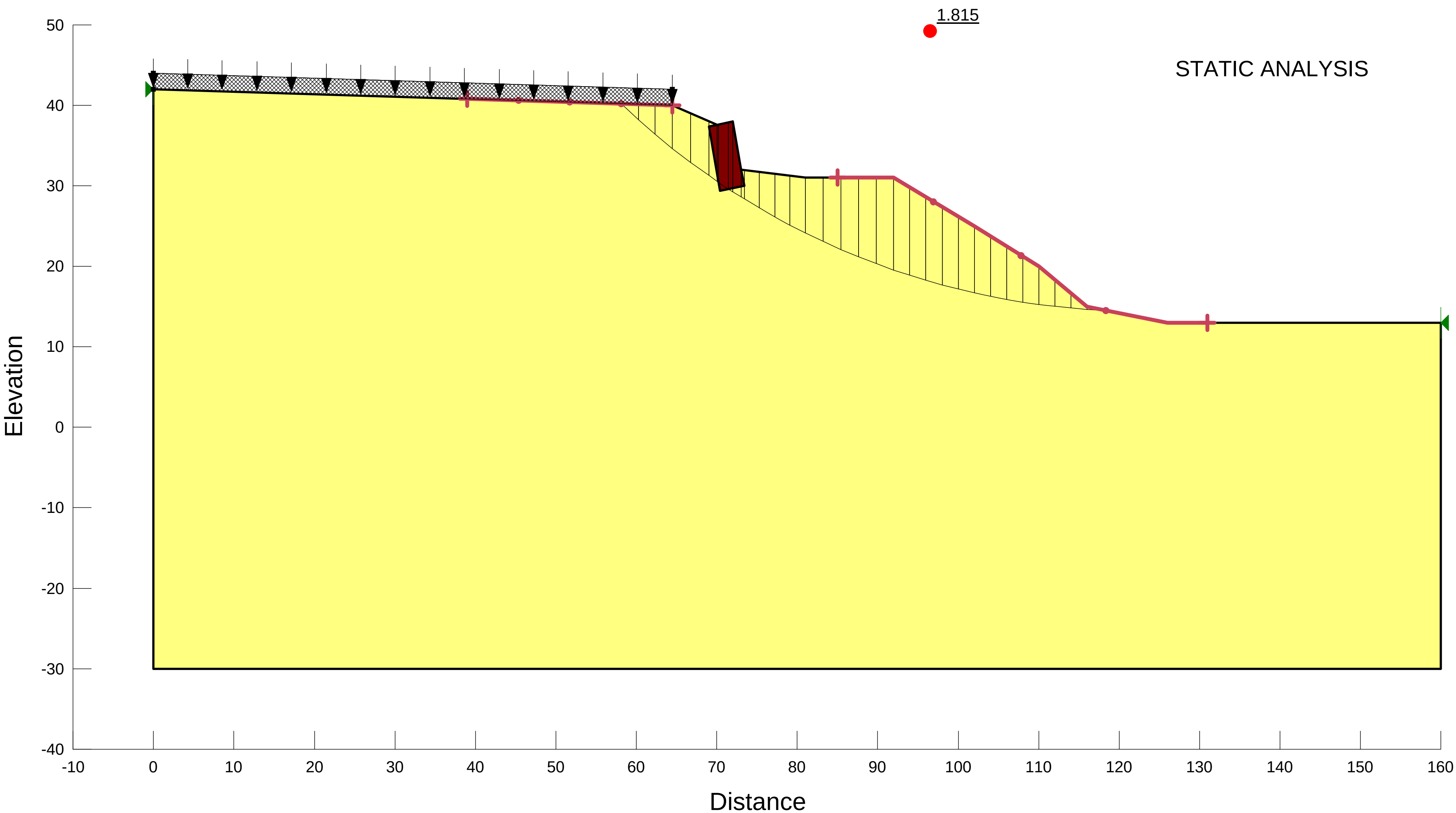
RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
EA NO. 04-2J6800
RETAINING WALL NO. 8 (EXISTING CONDITION)

Name: Embankment Fill Unit Weight: 120 pcf Cohesion': 100 psf Phi': 30 ° Phi-B: 0 °



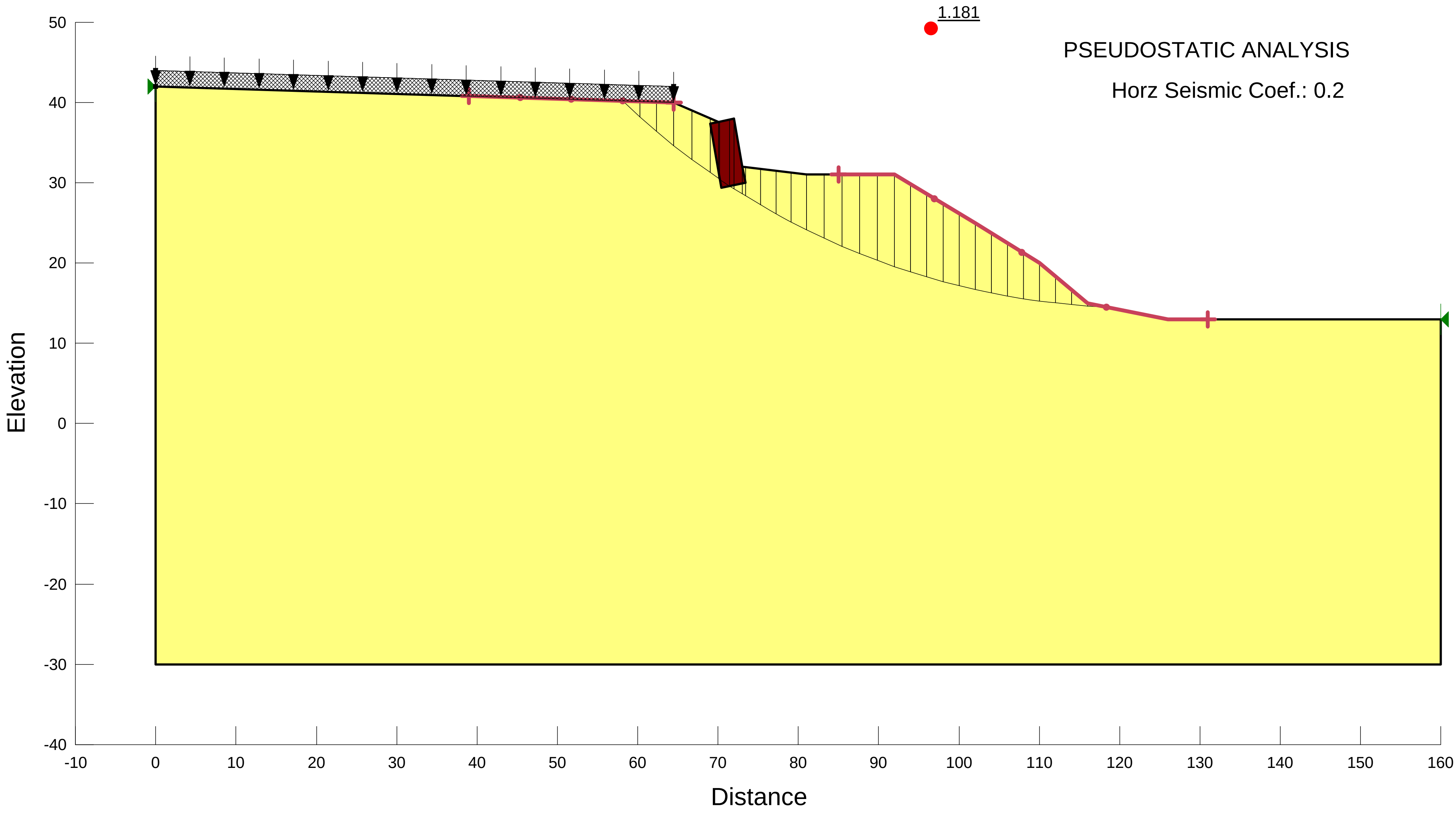
RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
EA NO. 04-2J6800
RETAINING WALL NO. 8 (GABIAN WALL)

Name: Embankment Fill   Unit Weight: 120 pcf   Cohesion': 100 psf   Phi': 30 °   Phi-B: 0 °
Name: Earth Gabion   Unit Weight: 125 pcf   Cohesion': 100 psf   Phi': 30 °   Phi-B: 0 °



RICHMOND - SAN RAFAEL BRIDGE ACCESS IMPROVEMENT PROJECT
EA NO. 04-2J6800
RETAINING WALL NO. 8 (GABIAN WALL)

Name: Embankment Fill   Unit Weight: 120 pcf   Cohesion': 100 psf   Phi': 30 °   Phi-B: 0 °
Name: Earth Gabion   Unit Weight: 125 pcf   Cohesion': 100 psf   Phi': 30 °   Phi-B: 0 °

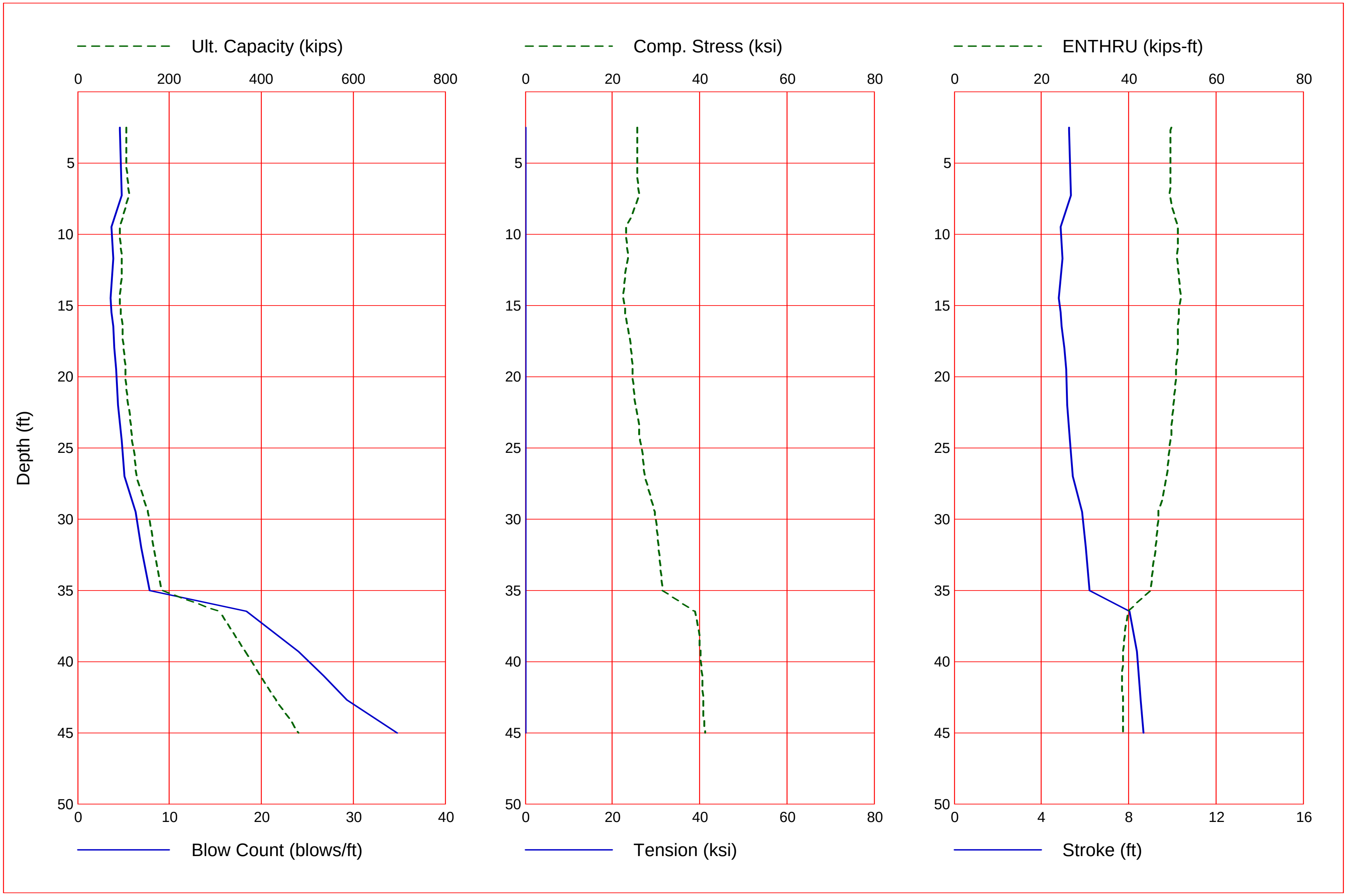


Pile Drivability Analysis

Parikh Consultants Inc
35 ft Soil Underlain by Rock

Jun 22 2016
GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000



Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.5	105.5	0.8	104.7	4.6	25.700	0.000	5.28	49.8
2.7	105.6	0.9	104.7	4.6	25.687	0.000	5.29	49.7
7.3	111.6	6.6	105.0	4.8	26.027	0.000	5.36	49.3
9.5	92.3	10.7	81.7	3.7	23.220	0.000	4.89	51.4
11.7	97.2	15.5	81.7	3.9	23.662	0.000	4.96	51.1
14.5	92.5	22.7	69.8	3.6	22.612	0.000	4.80	51.9
15.5	95.0	25.2	69.8	3.7	23.036	0.000	4.87	51.5
16.5	97.3	27.5	69.8	3.9	23.496	0.000	4.93	51.2
18.0	100.5	30.7	69.8	4.0	24.274	0.000	5.06	51.2
19.5	103.3	33.5	69.8	4.2	24.680	0.000	5.12	50.8
22.0	109.6	39.8	69.8	4.4	25.314	0.000	5.20	50.2
24.5	118.6	48.6	70.0	4.8	26.306	0.000	5.32	49.5
27.0	128.4	58.4	70.0	5.1	27.329	0.000	5.45	48.8
29.5	152.4	68.6	83.8	6.3	29.706	0.000	5.86	46.9
32.0	164.8	81.0	83.8	6.9	30.559	0.000	6.02	46.2
35.0	182.6	98.8	83.8	7.8	31.551	0.000	6.22	45.1
36.5	309.1	108.8	200.4	18.4	38.932	0.000	8.03	39.7
39.3	364.6	128.7	235.9	24.1	40.209	0.000	8.39	38.8
41.0	398.1	141.1	256.9	26.8	40.587	0.000	8.48	38.4
42.7	432.0	154.1	277.9	29.3	40.948	0.000	8.57	38.8
45.0	480.3	173.1	307.2	34.8	41.386	0.000	8.70	38.7

Total Continuous Driving Time 9.00 minutes; Total Number of Blows 408

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile

installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

```
 Input  File: S:\ONGOING\DAVID WANG\2014-125 I-580 IMPROVEMENT
PROJECT\FR\CAL\DRIVABILITY\DRIVABILITY-DEEP ROCK-RUN 2.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource
\HAMMER2003.GW
 Hammer File Version:  2003 (8/11/2011)

                        Input File Contents
     35 ft Soil Underlain by Rock
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-
D MXT     DEx
-100   0  22   0   1   0  0   0   0   0   0   0  0   0   0   0
0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.185    32.185   201.060    16.000                Pipe
      W Cp      A Cp      E Cp      T Cp       CoR      ROut
StCp
     1.700   227.000     530.0     2.000     0.800     0.010
0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri        CI
CoR      ROut
    45.000     24.34   30457.9   493.356     4.188         0
0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 46           1        5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
     10.14    137.80     19.61     10.57     10.56      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      1.95     27.95     19.61     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff
VolCStart  Vol CEnd
     22.75    304.30    690.80     0.001     0.002     1.250
0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70    975.00    877.50    790.00    711.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff
Eps-Str  Total-AW
   10.5600    0.8000  975.0000    0.0000    0.0000    0.0000
0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx
Rati      Dept
     0.100     0.115     0.080     0.150     0.000     0.000
0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
     0.000     0.000     0.000     0.000
  Res. Distribution
    Dpth    Rskn      Rtoe      Qs      Qt      Js      Jt   SU F
LimD   SU T
```



```
    0.00    0.00    104.72    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    5.00    0.30    104.72    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    5.00    0.30    104.98    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    9.00    0.48    104.98    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    9.00    0.48     81.65    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   14.00    0.64     81.65    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   14.00    0.64     69.81    0.10    0.23    0.20    0.15   2.00
6.56    1.0
   19.00    0.43     69.81    0.10    0.23    0.20    0.15   2.00
6.56    1.0
   19.00    0.43     69.81    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   24.00    0.93     69.81    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   24.00    0.93     69.99    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   28.00    0.94     69.99    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   28.00    0.94     83.78    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   35.00    1.55     83.78    0.10    0.23    0.05    0.15   1.20
6.56    1.0
   35.00    1.55    181.51    0.10    0.12    0.20    0.15   2.00
6.56  168.0
   45.00    2.00    307.17    0.10    0.12    0.20    0.15   2.00
6.56  168.0
  Gain/Loss factors: shaft and toe
   1.00000   0.00000   0.00000   0.00000   0.00000
   1.00000   0.00000   0.00000   0.00000   0.00000
      Dpth         L      Wait      Strk      Pmx%      Eff.
Stff       CoR
      2.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      2.67      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      7.33      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      9.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     11.67      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     14.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     15.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     16.50      0.00      0.00     0.000     0.000     0.000
```

```
0.000     0.000
     18.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     19.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     22.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     24.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     27.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     29.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     32.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     35.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     36.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     39.33      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     41.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     42.67      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     45.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      0.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
          1           0   10.56000       10.57000
```



```
            GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
                                 Version 2010
                                English Units

                   35 ft Soil Underlain by Rock
                   ________________________________________

            Hammer Model:   D 46                Made by:
DELMAG

            No.    Weight    Stiffn       CoR     C-Slk     Dampg
                     kips    k/inch                  ft    k/ft/s
              1     2.028
              2     2.028  317807.3     1.000    0.0100
              3     2.028  317807.3     1.000    0.0100
              4     2.028  317807.3     1.000    0.0100
              5     2.028  317807.3     1.000    0.0100
      Imp Block     1.950  157787.2     0.900    0.0100
      Helmet        1.700   60155.0     0.800    0.0098      13.8
      Combined Pile Top     19220.1

HAMMER OPTIONS:
  Hammer File ID No.                22  Hammer Type
OE Diesel
  Stroke Option              FxdP-VarS  Stroke Convergence Crit.
0.010
  Fuel Pump Setting            Maximum

HAMMER DATA:
  Ram Weight          (kips)     10.14  Ram Length
(inch)    137.80
  Maximum Stroke        (ft)     10.57
  Rated Stroke          (ft)     10.56  Efficiency
0.800

  Maximum Pressure     (psi)    975.00  Actual Pressure
(psi)    975.00
  Compression Exponent           1.350  Expansion Exponent
1.250
  Ram Diameter        (inch)     19.61
  Combustion Delay       (s)   0.00100  Ignition Duration
(s)   0.00200

          The Hammer Data Includes Estimated (NON-MEASURED)
Quantities

____________________________________________________________


  HAMMER CUSHION                        PILE CUSHION
  Cross Sect. Area     (in2)    227.00  Cross Sect. Area
```

```
(in2)      0.00
  Elastic-Modulus      (ksi)     530.0  Elastic-Modulus
(ksi)       0.0
  Thickness           (inch)      2.00  Thickness
(inch)      0.00
  Coeff of Restitution             0.8  Coeff of Restitution
1.0
  RoundOut             (ft)        0.0  RoundOut
(ft)       0.0
  Stiffness        (kips/in)   60155.0  Stiffness
(kips/in)       0.0
```



```
 35 ft Soil Underlain by Rock
06/22/2016
 Parikh Consultants Inc                                        GRLWEAP
Version 2010

  Depth                 (ft)       2.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     105.5
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     0.8   0.050 0.100
45.00   4.2    24.3
 Toe                                    104.7   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)

  PILE, SOIL, ANALYSIS OPTIONS:
  Uniform pile                          Pile Segments: Automatic
  No. of Slacks/Splices              0  Pile Damping
(%)         1
                                        Pile Damping Fact.
(k/ft/s)     0.877
  Driveability Analysis
  Soil Damping Option            Smith
  Max No Analysis Iterations         0  Time Increment/Critical
```

```
160
  Output Time Interval               1  Analysis Time-Input
(ms)         0
  Output Level: Normal
  Gravity Mass, Pile, Hammer:   32.170    32.185    32.185
  Output Segment Generation: Automatic

     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      2.50     10.56      1.00     0.800
```



```
 35 ft Soil Underlain by Rock
06/22/2016
 Parikh Consultants Inc                                            GRLWEAP
Version 2010

     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   105.5     4.6   5.28   5.26    0.00   1   0    25.70   9   3
49.8    50.5
           1           0   10.56000       10.57000
```

```
  Depth                 (ft)       2.7
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     105.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     0.9   0.050 0.100
45.00   4.2    24.3
 Toe                                    104.7   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      2.67     10.56      1.00     0.800
```



```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   105.6     4.6   5.29   5.27    0.00   1   0    25.69  10   4
49.7    50.5
           1           0   10.56000       10.57000
```

```
  Depth                 (ft)       7.3
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     111.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     0.1   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     2.0   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     4.5   0.050 0.100
45.00   4.2    24.3
 Toe                                    105.0   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      7.33     10.56      1.00     0.800
```



```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   111.6     4.8   5.36   5.34    0.00   1   0    26.03   9   3
49.3    50.1
          1           0   10.56000       10.57000
```

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                  (ft)       9.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)      92.3
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     1.2   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     3.7   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     5.8   0.050 0.100
45.00   4.2    24.3
 Toe                                     81.7   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      9.50     10.56      1.00     0.800
```



```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
    92.3     3.7   4.89   4.91    0.00   1   0    23.22  10   4
51.4    52.4
           1           0   10.56000       10.57000
```

11.67 10.56 1.00 0.800

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      11.7
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)      97.2
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     0.5   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     2.9   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     5.2   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     6.9   0.050 0.100
45.00   4.2    24.3
 Toe                                    81.7   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
    97.2     3.9   4.96   4.97    0.00   1   0    23.66  10   4
51.1    52.0
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      14.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model           Total Capacity Rut
(kips)      92.5
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     0.3   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     2.6   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     4.9   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     6.7   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     8.1   0.074 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)
```

Depth ft	Stroke ft	Pressure Ratio	Efficy
14.50	10.56	1.00	0.800

35 ft Soil Underlain by Rock
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Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
92.5	3.6	4.80	4.83	0.00	1	0	22.61	10	4	51.9	52.9

1 0 10.56000 10.57000

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      15.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)      95.0
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     0.9   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     3.4   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     5.5   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     7.2   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     8.2   0.120 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)
```


Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
15.50	10.56	1.00	0.800

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
    95.0     3.7   4.87   4.89    0.00   1   0    23.04   9   3
51.5    52.5
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      16.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model           Total Capacity Rut
(kips)      97.3
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     0.0   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     1.6   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     4.1   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     6.1   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     7.6   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     8.0   0.165 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)
```

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
16.50	10.56	1.00	0.800

35 ft Soil Underlain by Rock
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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
97.3	3.9	4.93	4.95	0.00	1	0	23.50	10	4	51.2	52.2

1 0 10.56000 10.57000

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      18.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     100.5
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     0.5   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     2.9   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     5.1   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     6.9   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     8.2   0.088 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     7.2   0.200 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)
```


Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
18.00	10.56	1.00	0.800

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   100.5     4.0   5.06   5.02    0.00   1   0    24.27   9   3
51.2    51.7
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      19.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model           Total Capacity Rut
(kips)     103.3
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     0.0   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     1.5   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     4.0   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     6.0   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     7.5   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     8.1   0.155 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     6.4   0.178 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232
```

3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
3.754 kips total reduced pile weight (g= 32.19 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
19.50	10.56	1.00	0.800

35 ft Soil Underlain by Rock
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Version 2010

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
103.3	4.2	5.12	5.07	0.00	1	0	24.68	9	3	50.8	51.3

1 0 10.56000 10.57000

```
 35 ft Soil Underlain by Rock
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 Parikh Consultants Inc                                   GRLWEAP
Version 2010

  Depth                 (ft)      22.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     109.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     0.9   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     3.5   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     5.6   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     7.2   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     8.2   0.123 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     6.8   0.200 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00     7.6   0.058 0.100
45.00   4.2    24.3
 Toe                                     69.8   0.150 0.232
```



```
 3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
 3.754 kips total reduced pile weight   (g= 32.19 ft/s2)

Depth    Stroke  Pressure    Efficy
   ft        ft     Ratio
22.00     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   109.6     4.4   5.20   5.17    0.00   1   0    25.31   7   3
50.2    50.9
           1           0   10.56000       10.57000
```


35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      24.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     118.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     0.5   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     2.9   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     5.1   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     6.9   0.050 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     8.2   0.091 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     7.2   0.200 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00     6.9   0.088 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    10.9   0.050 0.100
45.00   4.2    24.3
```

```
Toe                                       70.0   0.150 0.232

     3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    24.50     10.56      1.00     0.800
```



```
 35 ft Soil Underlain by Rock
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 Parikh Consultants Inc                                           GRLWEAP
Version 2010

     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   118.6     4.8   5.32   5.29    0.00   1   0    26.31   6   3
49.5    50.3
           1           0   10.56000       10.57000
```

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      27.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     128.4
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     0.2   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     2.3   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     4.7   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     6.6   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     8.0   0.057 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     7.6   0.200 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     6.5   0.123 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    10.0   0.050 0.100
41.79   4.2    24.3
```



```
  14  0.268    19220 0.000 0.000 1.00    12.5   0.050 0.100
45.00   4.2    24.3
 Toe                                     70.0   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     27.00     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   128.4     5.1   5.45   5.44    0.00   1   0    27.33   4   2
48.8    49.7
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      29.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     152.4
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     0.0   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     1.8   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     4.2   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     6.2   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     7.7   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     8.0   0.172 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     6.4   0.160 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00     9.0   0.050 0.100
38.57   4.2    24.3
```

```
  13  0.268    19220 0.000 0.000 1.00    12.3   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    13.0   0.050 0.100
45.00   4.2    24.3
 Toe                                     83.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     29.50     10.56      1.00     0.800
```



```
 35 ft Soil Underlain by Rock
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     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   152.4     6.3   5.86   5.84    0.00   1   0    29.71   6   3
46.9    48.0
           1           0   10.56000       10.57000
```

```
 35 ft Soil Underlain by Rock
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 Parikh Consultants Inc                                        GRLWEAP
Version 2010

  Depth                 (ft)      32.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     164.8
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     1.2   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     3.7   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     5.8   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     7.4   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     8.2   0.139 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     6.6   0.194 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00     8.1   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    11.9   0.050 0.100
38.57   4.2    24.3
```



```
  13  0.268    19220 0.000 0.000 1.00    12.7   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    15.5   0.050 0.100
45.00   4.2    24.3
 Toe                                     83.8   0.150 0.232

     3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    32.00     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   164.8     6.9   6.02   5.97    0.00   1   0    30.56   6   3
46.2    47.4
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      35.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     182.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     1.0   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     3.6   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     5.7   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     7.3   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     8.2   0.129 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     6.7   0.200 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     7.8   0.052 0.100
32.14   4.2    24.3
  11  0.268    19220 0.000 0.000 1.00    11.7   0.050 0.100
35.36   4.2    24.3
```

```
  12  0.268    19220 0.000 0.000 1.00    12.7   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    15.2   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    19.0   0.050 0.100
45.00   4.2    24.3
 Toe                                     83.8   0.150 0.232

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     35.00     10.56      1.00     0.800
```



```
 35 ft Soil Underlain by Rock
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     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   182.6     7.8   6.22   6.19    0.00   1   0    31.55   5   2
45.1    46.7
           1           0   10.56000       10.57000
```

```
 35 ft Soil Underlain by Rock
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Version 2010

  Depth                  (ft)      36.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     309.1
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.0   0.000 0.100
6.43   4.2    24.3
   3  0.268    19220 0.000 0.000 1.00     0.2   0.050 0.100
9.64   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     2.2   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     4.6   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     6.5   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     7.9   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     7.7   0.200 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     6.4   0.131 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00     9.8   0.050 0.100
32.14   4.2    24.3
```



```
  11  0.268    19220 0.000 0.000 1.00    12.5   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    13.4   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    17.0   0.050 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    20.5   0.123 0.100
45.00   4.2    24.3
 Toe                                    200.4   0.150 0.116

     3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     36.50     10.56      1.00     0.800
```

```
 35 ft Soil Underlain by Rock
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     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   309.1    18.4   8.03   8.02    0.00   1   0    38.93   4   2
39.7    41.3
           1           0   10.56000       10.57000
```



```
 35 ft Soil Underlain by Rock
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  Depth                 (ft)      39.3
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model           Total Capacity Rut
(kips)     364.6
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.1   0.050 0.100
6.43   4.2    24.3
   3  0.268    19220 0.000 0.000 1.00     1.9   0.050 0.100
9.64   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     4.4   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     6.3   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     7.8   0.050 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     7.9   0.181 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     6.4   0.151 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00     9.3   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00    12.4   0.050 0.100
32.14   4.2    24.3
```

```
  11  0.268    19220 0.000 0.000 1.00    13.2   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    16.5   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    20.2   0.105 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    22.5   0.200 0.100
45.00   4.2    24.3
 Toe                                   235.9   0.150 0.116

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     39.33     10.56      1.00     0.800
```



```
 35 ft Soil Underlain by Rock
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     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   364.6    24.1   8.39   8.41    0.00   1   0    40.21   3   2
38.8    40.4
           1           0   10.56000       10.57000
```

35 ft Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      41.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     398.1
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.0   0.000 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     0.7   0.050 0.100
6.43   4.2    24.3
   3  0.268    19220 0.000 0.000 1.00     3.2   0.050 0.100
9.64   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     5.4   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     7.1   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     8.2   0.110 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     6.9   0.200 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     7.3   0.069 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00    11.4   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00    12.6   0.050 0.100
32.14   4.2    24.3
```



```
  11  0.268    19220 0.000 0.000 1.00    14.7   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    18.5   0.050 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    21.6   0.181 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    23.5   0.200 0.100
45.00   4.2    24.3
 Toe                                  256.9   0.150 0.116

     3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    41.00     10.56      1.00     0.800
```

```
 35 ft Soil Underlain by Rock
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Version 2010

     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   398.1    26.8   8.48   8.53    0.00   1   0    40.59   3   2
38.4    40.2
           1           0   10.56000       10.57000
```



```
 35 ft Soil Underlain by Rock
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  Depth                 (ft)      42.7
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model           Total Capacity Rut
(kips)     432.0
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     0.1   0.050 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     2.0   0.050 0.100
6.43   4.2    24.3
   3  0.268    19220 0.000 0.000 1.00     4.4   0.050 0.100
9.64   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     6.3   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     7.8   0.050 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     7.8   0.187 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     6.4   0.144 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00     9.5   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00    12.4   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00    13.2   0.050 0.100
32.14   4.2    24.3
```

```
  11  0.268    19220 0.000 0.000 1.00    16.7   0.050 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    20.3   0.111 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    22.6   0.200 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    24.5   0.200 0.100
45.00   4.2    24.3
 Toe                                    277.9   0.150 0.116

      3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
      3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     42.67     10.56      1.00     0.800
```



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     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   432.0    29.3   8.57   8.60    0.00   1   0    40.95   3   2
38.8    40.0
           1           0   10.56000       10.57000
```

```
 35 ft Soil Underlain by Rock
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Version 2010

  Depth                 (ft)      45.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      45.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     5.322

         Pile and Soil Model            Total Capacity Rut
(kips)     480.3
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.268    19220 0.010 0.000 0.85     1.3   0.050 0.100
3.21   4.2    24.3
   2  0.268    19220 0.000 0.000 1.00     3.8   0.050 0.100
6.43   4.2    24.3
   3  0.268    19220 0.000 0.000 1.00     5.9   0.050 0.100
9.64   4.2    24.3
   4  0.268    19220 0.000 0.000 1.00     7.4   0.050 0.100
12.86   4.2    24.3
   5  0.268    19220 0.000 0.000 1.00     8.1   0.145 0.100
16.07   4.2    24.3
   6  0.268    19220 0.000 0.000 1.00     6.5   0.188 0.100
19.29   4.2    24.3
   7  0.268    19220 0.000 0.000 1.00     8.3   0.050 0.100
22.50   4.2    24.3
   8  0.268    19220 0.000 0.000 1.00    12.0   0.050 0.100
25.71   4.2    24.3
   9  0.268    19220 0.000 0.000 1.00    12.8   0.050 0.100
28.93   4.2    24.3
  10  0.268    19220 0.000 0.000 1.00    15.6   0.050 0.100
32.14   4.2    24.3
```



```
  11  0.268    19220 0.000 0.000 1.00    19.4   0.068 0.100
35.36   4.2    24.3
  12  0.268    19220 0.000 0.000 1.00    22.1   0.200 0.100
38.57   4.2    24.3
  13  0.268    19220 0.000 0.000 1.00    24.0   0.200 0.100
41.79   4.2    24.3
  14  0.268    19220 0.000 0.000 1.00    25.9   0.200 0.100
45.00   4.2    24.3
 Toe                                    307.2   0.150 0.116

     3.753 kips total unreduced pile weight (g= 32.17 ft/s2)
     3.754 kips total reduced pile weight   (g= 32.19 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
    45.00     10.56      1.00     0.800
```

Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft			ksi			ksi			kip-ft	b/min
480.3	34.8	8.70	8.72	0.00	1	0	41.39	3	2	38.7	39.8

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
2.5	105.5	0.8	104.7	4.6	25.700	0.000	5.28	49.8
2.7	105.6	0.9	104.7	4.6	25.687	0.000	5.29	49.7
7.3	111.6	6.6	105.0	4.8	26.027	0.000	5.36	49.3
9.5	92.3	10.7	81.7	3.7	23.220	0.000	4.89	51.4
11.7	97.2	15.5	81.7	3.9	23.662	0.000	4.96	51.1
14.5	92.5	22.7	69.8	3.6	22.612	0.000	4.80	51.9
15.5	95.0	25.2	69.8	3.7	23.036	0.000	4.87	51.5
16.5	97.3	27.5	69.8	3.9	23.496	0.000	4.93	51.2
18.0	100.5	30.7	69.8	4.0	24.274	0.000	5.06	51.2
19.5	103.3	33.5	69.8	4.2	24.680	0.000	5.12	50.8
22.0	109.6	39.8	69.8	4.4	25.314	0.000	5.20	50.2
24.5	118.6	48.6	70.0	4.8	26.306	0.000	5.32	49.5
27.0	128.4	58.4	70.0	5.1	27.329	0.000	5.45	48.8
29.5	152.4	68.6	83.8	6.3	29.706	0.000	5.86	46.9
32.0	164.8	81.0	83.8	6.9	30.559	0.000	6.02	46.2
35.0	182.6	98.8	83.8	7.8	31.551	0.000	6.22	45.1
36.5	309.1	108.8	200.4	18.4	38.932	0.000	8.03	39.7
39.3	364.6	128.7	235.9	24.1	40.209	0.000	8.39	38.8
41.0	398.1	141.1	256.9	26.8	40.587	0.000	8.48	38.4
42.7	432.0	154.1	277.9	29.3	40.948	0.000		

8.57   38.8
     45.0   480.3   173.1   307.2   34.8 41.386   0.000
8.70   38.7

Total Driving Time   9 minutes;   Total No. of Blows
408

Table of Depths Analyzed with Driving System Modifiers

Depth	Temp. Length	Wait Time	Equivalent Stroke	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
ft	ft	hr	ft				
2.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
2.67	45.00	0.00	10.56	1.00	0.80	1.00	1.00
7.33	45.00	0.00	10.56	1.00	0.80	1.00	1.00
9.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
11.67	45.00	0.00	10.56	1.00	0.80	1.00	1.00
14.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
15.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
16.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
18.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00
19.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
22.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00
24.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
27.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00
29.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
32.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00
35.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00
36.50	45.00	0.00	10.56	1.00	0.80	1.00	1.00
39.33	45.00	0.00	10.56	1.00	0.80	1.00	1.00
41.00	45.00	0.00	10.56	1.00	0.80		

						1.00	1.00
42.67	45.00	0.00	10.56	1.00	0.80	1.00	1.00
45.00	45.00	0.00	10.56	1.00	0.80	1.00	1.00

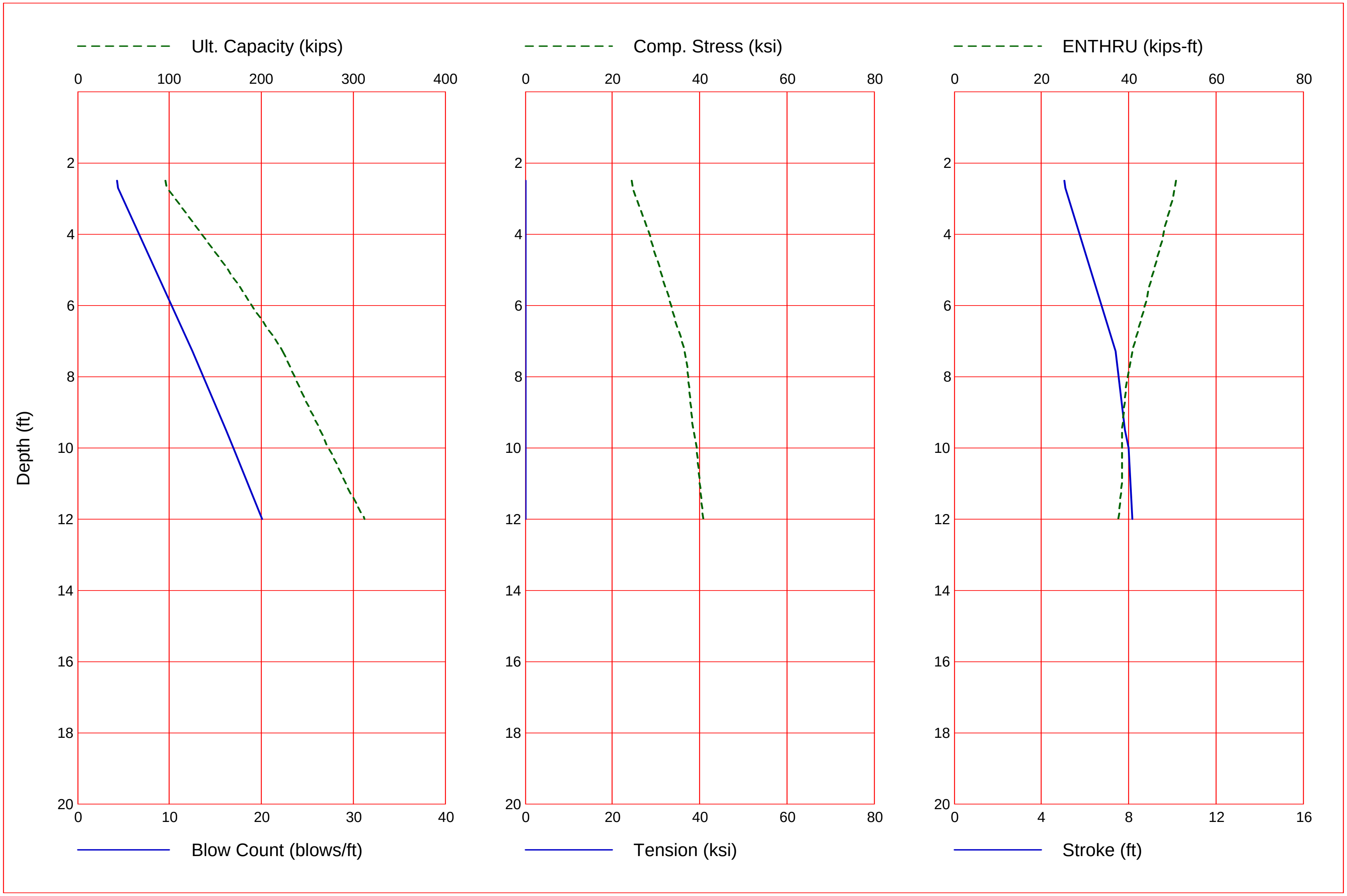
Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.00	0.00	104.72	0.100	0.232	0.050	0.150	0.333	6.560	1.000
5.00	0.30	104.72	0.100	0.232	0.050	0.150	0.333	6.560	1.000
5.00	0.30	104.98	0.100	0.232	0.050	0.150	0.333	6.560	1.000
9.00	0.48	104.98	0.100	0.232	0.050	0.150	0.333	6.560	1.000
9.00	0.48	81.65	0.100	0.232	0.050	0.150	0.333	6.560	1.000
14.00	0.64	81.65	0.100	0.232	0.050	0.150	0.333	6.560	1.000
14.00	0.64	69.81	0.100	0.232	0.200	0.150	1.000	6.560	1.000
19.00	0.43	69.81	0.100	0.232	0.200	0.150	1.000	6.560	1.000
19.00	0.43	69.81	0.100	0.232	0.050	0.150	0.333	6.560	1.000
24.00	0.93	69.81	0.100	0.232	0.050	0.150	0.333	6.560	1.000
24.00	0.93	69.99	0.100	0.232	0.050	0.150	0.333	6.560	1.000
28.00	0.94	69.99	0.100	0.232	0.050	0.150	0.333	6.560	1.000
28.00	0.94	83.78	0.100	0.232	0.050	0.150	0.333	6.560	1.000
35.00	1.55	83.78	0.100	0.232	0.050	0.150	0.333	6.560	1.000
35.00	1.55	181.51	0.100	0.116	0.200	0.150	1.000	6.560	168.000
45.00	2.00	307.17	0.100	0.116	0.200	0.150	1.000	6.560	168.000

Parikh Consultants Inc
7 ft Granular Soil Underlain by Rock

Jun 22 2016
GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000



Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.5	95.7	0.9	94.7	4.3	24.432	0.000	5.04	50.9
2.7	97.5	1.1	96.4	4.4	24.657	0.000	5.09	50.6
7.3	222.8	9.7	213.1	12.5	36.591	0.000	7.40	40.8
9.5	263.5	26.2	237.4	16.2	38.450	0.000	7.82	38.5
10.0	273.1	30.2	242.9	17.0	39.386	0.000	8.00	38.6
12.0	312.4	47.1	265.3	20.1	40.956	0.000	8.19	37.6

Total Continuous Driving Time 3.00 minutes; Total Number of Blows 121

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile

installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

```
 Input  File: S:\ONGOING\DAVID WANG\2014-125 I-580 IMPROVEMENT
PROJECT\FR\CAL\DRIVABILITY\DRIVABILITY-DEEP ROCK-RUN 1.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource
\HAMMER2003.GW
 Hammer File Version:  2003 (8/11/2011)

                        Input File Contents
     7 ft Granular Soil Underlain by Rock
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-
D MXT     DEx
-100   0  22   0   1   0  0   0   0   0   0   0  0   0   0   0
0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.185    32.185   201.060    16.000                Pipe
      W Cp      A Cp      E Cp      T Cp       CoR      ROut
StCp
     1.700   227.000     530.0     2.000     0.800     0.010
0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri        CI
CoR      ROut
    12.000     24.34   30457.9   493.356     4.188         0
0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 46           1        5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
     10.14    137.80     19.61     10.57     10.56      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      1.95     27.95     19.61     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff
VolCStart  Vol CEnd
     22.75    304.30    690.80     0.001     0.002     1.250
0.00      0.00
     P atm        P1        P2        P3        P4       P5
     14.70    975.00    877.50    790.00    711.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff
Eps-Str  Total-AW
   10.5600    0.8000  975.0000    0.0000    0.0000    0.0000
0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx
Rati      Dept
     0.100     0.100     0.050     0.150     0.000     0.000
0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
     0.000     0.000     0.000     0.000
  Res. Distribution
    Dpth    Rskn      Rtoe      Qs      Qt      Js      Jt   SU F
LimD   SU T
```



```
    0.00    0.00     69.81    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    7.00    0.50    139.63    0.10    0.23    0.05    0.15   1.20
6.56    1.0
    7.00    1.70    209.44    0.10    0.12    0.05    0.15   1.20
6.56    1.0
   12.00    2.10    265.28    0.10    0.12    0.05    0.15   1.20
6.56    1.0
  Gain/Loss factors: shaft and toe
   1.00000   0.00000   0.00000   0.00000   0.00000
   1.00000   0.00000   0.00000   0.00000   0.00000
      Dpth         L      Wait      Strk      Pmx%      Eff.
Stff       CoR
      2.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      2.67      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      7.33      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      9.50      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     10.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
     12.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
      0.00      0.00      0.00     0.000     0.000     0.000
0.000     0.000
         1           0   10.56000       10.57000
```

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

7 ft Granular Soil Underlain by Rock

Hammer Model: D 46 Made by:
DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.028				
2	2.028	317807.3	1.000	0.0100	
3	2.028	317807.3	1.000	0.0100	
4	2.028	317807.3	1.000	0.0100	
5	2.028	317807.3	1.000	0.0100	
Imp Block	1.950	157787.2	0.900	0.0100	
Helmet	1.700	60155.0	0.800	0.0098	13.8
Combined Pile Top		20592.9			

HAMMER OPTIONS:
Hammer File ID No. 22 Hammer Type
OE Diesel
Stroke Option FxdP-VarS Stroke Convergence Crit.
0.010
Fuel Pump Setting Maximum

HAMMER DATA:
Ram Weight (kips) 10.14 Ram Length
(inch) 137.80
Maximum Stroke (ft) 10.57
Rated Stroke (ft) 10.56 Efficiency
0.800

Maximum Pressure (psi) 975.00 Actual Pressure
(psi) 975.00
Compression Exponent 1.350 Expansion Exponent
1.250
Ram Diameter (inch) 19.61
Combustion Delay (s) 0.00100 Ignition Duration
(s) 0.00200

The Hammer Data Includes Estimated (NON-MEASURED)
Quantities

HAMMER CUSHION PILE CUSHION
Cross Sect. Area (in2) 227.00 Cross Sect. Area

(in2) 0.00
Elastic-Modulus (ksi) 530.0 Elastic-Modulus
(ksi) 0.0
Thickness (inch) 2.00 Thickness
(inch) 0.00
Coeff of Restitution 0.8 Coeff of Restitution
1.0
RoundOut (ft) 0.0 RoundOut
(ft) 0.0
Stiffness (kips/in) 60155.0 Stiffness
(kips/in) 0.0

```
 7 ft Granular Soil Underlain by Rock
06/22/2016
 Parikh Consultants Inc                                   GRLWEAP
Version 2010

  Depth                 (ft)       2.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model            Total Capacity Rut
(kips)      95.7
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
      kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     0.0   0.000 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     0.0   0.000 0.100
6.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00     0.9   0.050 0.100
12.00   4.2    24.3
 Toe                                     94.7   0.150 0.232

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)

  PILE, SOIL, ANALYSIS OPTIONS:
  Uniform pile                          Pile Segments: Automatic
  No. of Slacks/Splices              0  Pile Damping
(%)         1
                                        Pile Damping Fact.
(k/ft/s)     0.877
  Driveability Analysis
  Soil Damping Option            Smith
  Max No Analysis Iterations         0  Time Increment/Critical
```



```
160
  Output Time Interval               1  Analysis Time-Input
(ms)         0
  Output Level: Normal
  Gravity Mass, Pile, Hammer:   32.170    32.185    32.185
  Output Segment Generation: Automatic

     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      2.50     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
    95.7     4.3   5.04   5.01    0.00   1   0    24.43   1   2
50.9    51.6
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)       2.7
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model            Total Capacity Rut
(kips)      97.5
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     0.0   0.000 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     0.0   0.000 0.100
6.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00     1.1   0.050 0.100
12.00   4.2    24.3
 Toe                                     96.4   0.150 0.232

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      2.67     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
    97.5     4.4   5.09   5.06    0.00   1   0    24.66   1   2
50.6    51.3
           1           0   10.56000       10.57000
```


7 ft Granular Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)       7.3
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model            Total Capacity Rut
(kips)     222.8
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     0.0   0.000 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     0.3   0.050 0.100
6.00   4.2    24.3
   3  0.250    20593 0.000 0.000 1.00     2.5   0.050 0.100
9.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00     6.9   0.050 0.100
12.00   4.2    24.3
 Toe                                    213.1   0.150 0.116

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      7.33     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   222.8    12.5   7.40   7.33    0.00   1   0    36.59   2   2
40.8    43.0
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)       9.5
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
      0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
     12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model            Total Capacity Rut
(kips)     263.5
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     0.0   0.050 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     1.8   0.050 0.100
6.00   4.2    24.3
   3  0.250    20593 0.000 0.000 1.00     4.5   0.050 0.100
9.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00    19.9   0.050 0.100
12.00   4.2    24.3
 Toe                                    237.4   0.150 0.116

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
      9.50     10.56      1.00     0.800
```

7 ft Granular Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   263.5    16.2   7.82   7.82    0.00   1   0    38.45   4   2
38.5    41.8
           1           0   10.56000       10.57000
```


7 ft Granular Soil Underlain by Rock
06/22/2016
Parikh Consultants Inc GRLWEAP
Version 2010

```
  Depth                 (ft)      10.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
        ft      in2      ksi   lb/ft3       ft             ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model           Total Capacity Rut
(kips)     273.1
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     0.1   0.050 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     2.2   0.050 0.100
6.00   4.2    24.3
   3  0.250    20593 0.000 0.000 1.00     4.9   0.050 0.100
9.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00    22.9   0.050 0.100
12.00   4.2    24.3
 Toe                                    242.9   0.150 0.116

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     10.00     10.56      1.00     0.800
```

```
     Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t
ENTHRU   Bl Rt
    kips    b/ft   down     up     ksi              ksi
kip-ft   b/min
   273.1    17.0   8.00   7.93    0.00   1   0    39.39   4   2
38.6    41.4
           1           0   10.56000       10.57000
```



```
  Depth                 (ft)      12.0
  Shaft Gain/Loss Factor         1.000  Toe Gain/Loss Factor
1.000

  PILE PROFILE:
  Toe Area             (in2)   201.060  Pile Type
Pipe
  Pile Size           (inch)    16.000

   L b Top     Area    E-Mod  Spec Wt    Perim  C Index  Wave Sp
EA/c
       ft      in2      ksi   lb/ft3       ft              ft/s
k/ft/s
       0.0    24.34   30458.    493.4      4.2        0    16911.
43.8
      12.0    24.34   30458.    493.4      4.2        0    16911.
43.8

  Wave Travel Time 2L/c (ms)     1.419

         Pile and Soil Model           Total Capacity Rut
(kips)     312.4
 No. Weight   Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake
LbTop Perim    Area
       kips     k/in    ft    ft         kips    s/ft  inch
ft    ft     in2
   1  0.250    20593 0.010 0.000 0.85     1.3   0.050 0.100
3.00   4.2    24.3
   2  0.250    20593 0.000 0.000 1.00     4.0   0.050 0.100
6.00   4.2    24.3
   3  0.250    20593 0.000 0.000 1.00    16.9   0.050 0.100
9.00   4.2    24.3
   4  0.250    20593 0.000 0.000 1.00    24.9   0.050 0.100
12.00   4.2    24.3
 Toe                                    265.3   0.150 0.116

      1.001 kips total unreduced pile weight (g= 32.17 ft/s2)
      1.001 kips total reduced pile weight   (g= 32.19 ft/s2)


     Depth    Stroke  Pressure    Efficy
        ft        ft     Ratio
     12.00     10.56      1.00     0.800
```

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
312.4	20.1	8.19	8.18	0.00	1	0	40.96	4	2	37.6	40.9

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
2.5	95.7	0.9	94.7	4.3	24.432	0.000	5.04	50.9
2.7	97.5	1.1	96.4	4.4	24.657	0.000	5.09	50.6
7.3	222.8	9.7	213.1	12.5	36.591	0.000	7.40	40.8
9.5	263.5	26.2	237.4	16.2	38.450	0.000	7.82	38.5
10.0	273.1	30.2	242.9	17.0	39.386	0.000	8.00	38.6
12.0	312.4	47.1	265.3	20.1	40.956	0.000	8.19	37.6

Total Driving Time 3 minutes; Total No. of Blows 121

Table of Depths Analyzed with Driving System Modifiers

Depth	Temp. Length	Wait Time	Equivalent Stroke	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
ft	ft	hr	ft				
2.50	12.00	0.00	10.56	1.00	0.80	1.00	1.00
2.67	12.00	0.00	10.56	1.00	0.80	1.00	1.00
7.33	12.00	0.00	10.56	1.00	0.80	1.00	1.00
9.50	12.00	0.00	10.56	1.00	0.80	1.00	1.00
10.00	12.00	0.00	10.56	1.00	0.80	1.00	1.00
12.00	12.00	0.00	10.56	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth	Shaft Res.	End Bearing	Shaft Quake	Toe Quake	Shaft Damping	Toe Damping	Soil Setup	Limit Distance	Setup Time
ft	k/ft2	kips	inch	inch	s/ft	s/ft	Normlzd	ft	hrs
0.00	0.00	69.81	0.100	0.232	0.050	0.150	1.000	6.560	1.000
7.00	0.50	139.63	0.100	0.232	0.050	0.150	1.000	6.560	1.000
7.00	1.70	209.44	0.100	0.116	0.050	0.150	1.000	6.560	1.000
12.00	2.10	265.28	0.100	0.116	0.050	0.150	1.000	6.560	1.000

APPENDIX F

Soil Nail Schedule and SNAIL Output Files (Critical Seismic Case) of RW 4, 5 & 7 by HNTB

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER E. OKADA No. S4415 Exp. 6-30-16 STRUCTURAL STATE OF CALIFORNIA

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HNTB CORPORATION
1111 BROADWAY
9TH FLOOR
OAKLAND, CA 94607

BAY AREA TOLL AUTHORITY
101 EIGHTH STREET
3RD FLOOR
OAKLAND, CA 94607

SOIL NAIL SCHEDULE

WALL ZONE	ROW	Le	Deg	S	BAR #	Pn	DESCRIPTION
1	R1-R2	30	15	5	9	2.26	HIGHLY WEATHERED SANDSTONE
	R3-R4	25	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
	R5-R6	20	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
2	R1-R3	40	15	5	9	2.26	HIGHLY WEATHERED SANDSTONE
	R4-R6	30	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
	R7-R8	25	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
3	R1-R4	45	15	5	9	2.26	HIGHLY WEATHERED SANDSTONE
	R5-R7	35	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
	R8-R9	25	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
4	R1-R2	30	15	5	9	2.26	HIGHLY WEATHERED SANDSTONE
	R3-R4	25	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
	R5-R6	20	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE
5	R1-R2	40	15	5	9	3.02	SILTY SAND
	R3-R5	30	15	5	9	3.02	SILTY SAND

LEGEND:

- ⪤ INDICATES EXIST TIE-BACK ANCHOR
- + INDICATES PRODUCTION NAIL
- ⊕ INDICATES TEST NAIL
- —··—··— INDICATES EXIST STRUCTURE
- —·—·— INDICATES NAIL ROW DESIGNATION LINE

Le: EMBEDMENT LENGTH (Ft)

Deg°: NAIL DECLINATION (Deg)

S: HORIZONTAL SPACING (Ft)

BAR#: MINIMUM SOIL NAIL BAR SIZE

Pn: NOMINAL PULLOUT RESISTANCE (KLF)

NOTES:

1. Expansion joint in CIP concrete facing only.

MIRRORED WALL ELEVATION

1"=10'-0"

DESIGN	BY G. Yu	CHECKED M. Vargas		
DETAILS	BY H. Paige	CHECKED M. Vargas		
QUANTITIES	BY M. Vargas	CHECKED		

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Erik Okada
PROJECT ENGINEER

BRIDGE NO. 28E0215
POST MILES 5.92

RETAINING WALL NO. 4
SOIL NAIL LAYOUT 2

DESIGN DETAIL SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE: 0414000552 CONTRACT NO.: X

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => 008-28-0100r-g-rwdt02.dgn

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

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER E. OKADA No. S4415 Exp. 6-30-16 STRUCTURAL STATE OF CALIFORNIA

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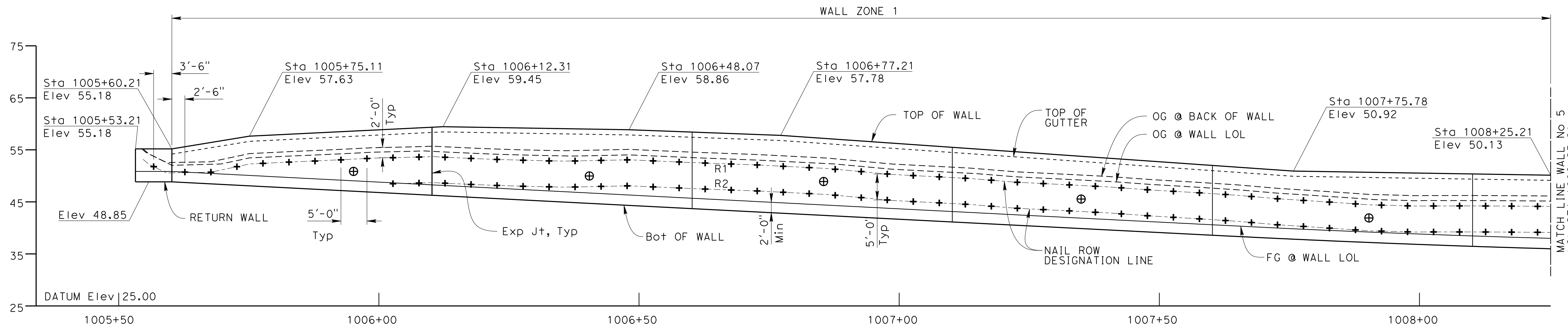
HNTB CORPORATION
1111 BROADWAY
9TH FLOOR
OAKLAND, CA 94607

BAY AREA TOLL AUTHORITY
101 EIGHTH STREET
3RD FLOOR
OAKLAND, CA 94607



DEVELOPED ELEVATION

1"=10'-0"

WALL ZONE	ROW	Le	Deg°	S	BAR #	Pn	DESCRIPTION
1	R1	15	15	5	8	2.26	HIGHLY WEATHERED SANDSTONE
	R2	15	15	5	8	3.39	MODERATELY WEATHERED SANDSTONE

Le: EMBEDMENT LENGTH (FT)
Deg°: NAIL DECLINATION (Deg.)
S: HORIZONTAL SPACING OF NAILS (FT)
BAR#: MINIMUM SOIL NAIL BAR SIZE
Pn: NOMINAL PULLOUT RESISTANCE (KLF)

LEGEND:

- - - - - INDICATES NAIL ROW DEGINATION LINE
+ PRODUCTION SOIL NAILS
⊕ PROOF TEST NAILS

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

DESIGN	BY G. Yu	CHECKED C. Chen
DETAILS	BY H. Li	CHECKED G. Yu
QUANTITIES	BY G. Yu	CHECKED C. Chen

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Erik Okada
PROJECT ENGINEER

BRIDGE NO. 28E0216
POST MILES 6.00

RETAINING WALL NO. 5
SOIL NAIL LAYOUT 1

DESIGN DETAIL SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE: 0414000552 CONTRACT NO.: X

DISRIGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => 015-28-0100l-g-rwdt11.dgn

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

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER E. OKADA No. S4415 Exp. 6-30-16 STRUCTURAL STATE OF CALIFORNIA

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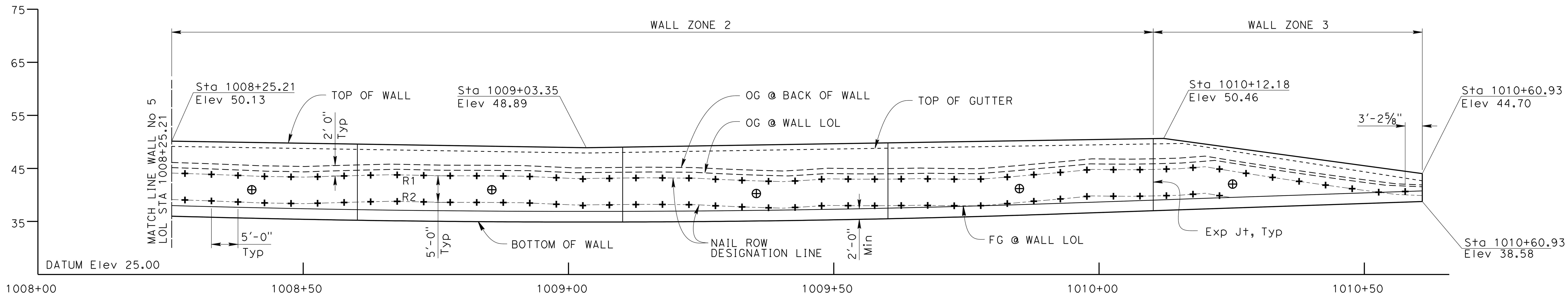
9TH FLOOR
OAKLAND, CA 94607

BAY AREA TOLL AUTHORITY
101 EIGHTH STREET
3RD FLOOR
OAKLAND, CA 94607



DEVELOPED ELEVATION

1"=10'-0"

WALL ZONE	ROW	Le	Deg°	S	BAR #	Pn	DESCRIPTION
2	R1	15	15	5	8	2.26	HIGHLY WEATHERED SANDSTONE
	R2	15	15	5	8	3.39	MODERATELY WEATHERED SANDSTONE
3	R1	10	15	5	8	2.26	HIGHLY WEATHERED SANDSTONE
	R2	10	15	5	8	3.39	MODERATELY WEATHERED SANDSTONE

Le: EMBEDMENT LENGTH (FT)
Deg°: NAIL DECLINATION (Deg.)
S: HORIZONTAL SPACING OF NAILS (FT)
BAR#: MINIMUM SOIL NAIL BAR SIZE
Pn: NOMINAL PULLOUT RESISTANCE (KLF)

LEGEND:

- - - - - INDICATES NAIL ROW DEGINATION LINE
+ PRODUCTION SOIL NAILS
⊕ PROOF TEST NAILS

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	G. Yu	C. Chen
DETAILS	H. Li	G. Yu
QUANTITIES	G. Yu	C. Chen

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Erik Okada
PROJECT ENGINEER

BRIDGE NO. 28E0216
POST MILES 6.00

RETAINING WALL NO. 5
SOIL NAIL LAYOUT 2

DESIGN DETAIL SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE: 0414000552 CONTRACT NO.: X

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => 016-28-01001-g-rwdt12.dgn

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

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	CC/Mrn	580	5.0/7.8, 0.0/3.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER E. OKADA No. S4415 Exp. 6-30-16 STRUCTURAL STATE OF CALIFORNIA

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.

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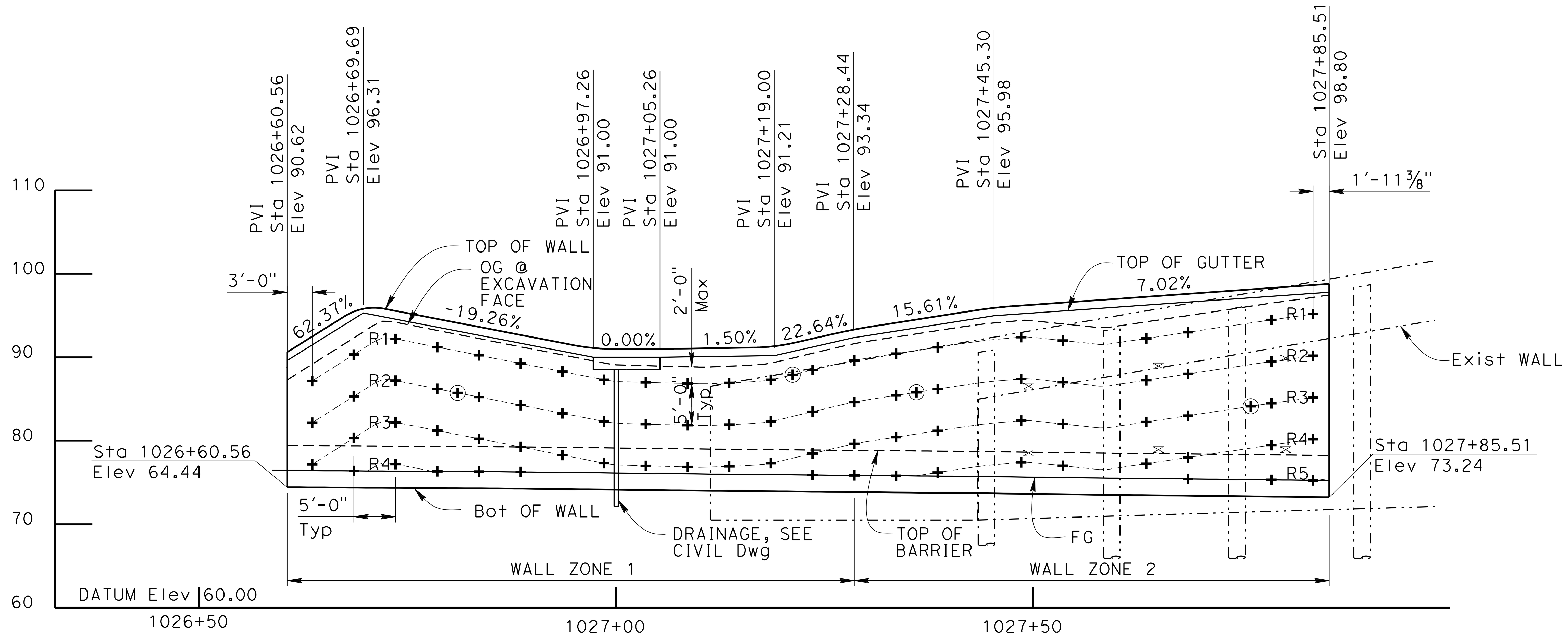
1111 BROADWAY
9TH FLOOR
OAKLAND, CA 94607

BAY AREA TOLL AUTHORITY
101 EIGHTH STREET
3RD FLOOR
OAKLAND, CA 94607



MIRRORED ELEVATION

1"=10'-0"

SOIL NAIL SCHEDULE

WALL ZONE	ROW	Le	Deg	S	BAR #	Pn	DESCRIPTION
1	R1-R2	35	15	5	9	3.02	SILTY SAND
	R3-R4	25	15	5	9	3.02	SILTY SAND
2	R1-R2	30	15	5	9	2.26	HIGHLY WEATHERED SANDSTONE
	R3-R5	20	15	5	9	2.94	MODERATELY WEATHERED SANDSTONE

NOTES:

1. The contractor shall verify all controlling field dimensions before ordering of fabrication any material.
2. The dimension on the plans are approximate. Prior to installing soil nails, contractor shall verify the existing wall and pile locations.
3. Install soil nail normal to retaining wall LOL.
4. Max 5'-0" Excavation lift.

LEGEND:

- ⌅ INDICATES EXIST TIE-BACK ANCHOR
- + INDICATES PRODUCTION NAIL
- ⊕ INDICATES TEST NAIL
- —··—··— INDICATES EXIST STRUCTURE
- —·—·— INDICATES NAIL ROW DESIGNATION LINE

Le: EMBEDMENT LENGTH (Ft)

Deg°: NAIL DECLINATION (Deg)

S: HORIZONTAL SPACING (Ft)

BAR#: MINIMUM SOIL NAIL BAR SIZE

Pn: NOMINAL PULLOUT RESISTANCE (KLF)

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	G. Yu	M. Vargas
DETAILS	H. Li	M. Vargas
QUANTITIES	G. Yu	M. Vargas

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Erik Okada
PROJECT ENGINEER

BRIDGE NO. 28E0217
POST MILES 5.92

RETAINING WALL NO. 7
SOIL NAIL LAYOUT

DESIGN DETAIL SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT:
PROJECT NUMBER & PHASE: 0414000552 CONTRACT NO.: X

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X SHEET X OF X

FILE => 025-28-0100r-g-rwdt18.dgn

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

Richmond-San Rafael
Access Improvement Project

04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79
(Sir Francis Drake EB On-Ramp to Marine Street Off-Ramp)
EA# 04-2J6804

Design Calculations

Retaining Wall No. 4
Soil Nail Wall (28E0215)

Prepared for

State of California
Department of Transportation

BATA
Bay Area Toll Authority

By

HNTB

HNTB Corporation
1111 Broadway, 9th Floor
Oakland, CA 94607

January 28, 2016

DESIGN CALCULATIONS

FOR STRUCTURES

PROJECT EA. NO.: 04-2J6804

DISTRICT-COUNTY-ROUTE-KP: 04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79

DESCRIPTION: Richmond-San Rafael Access Improvement Project

KEY STRUCTURE NAME: Retaining Wall No. 4 (28E0215)

DESIGN CALCULATIONS: HNTB Corporation

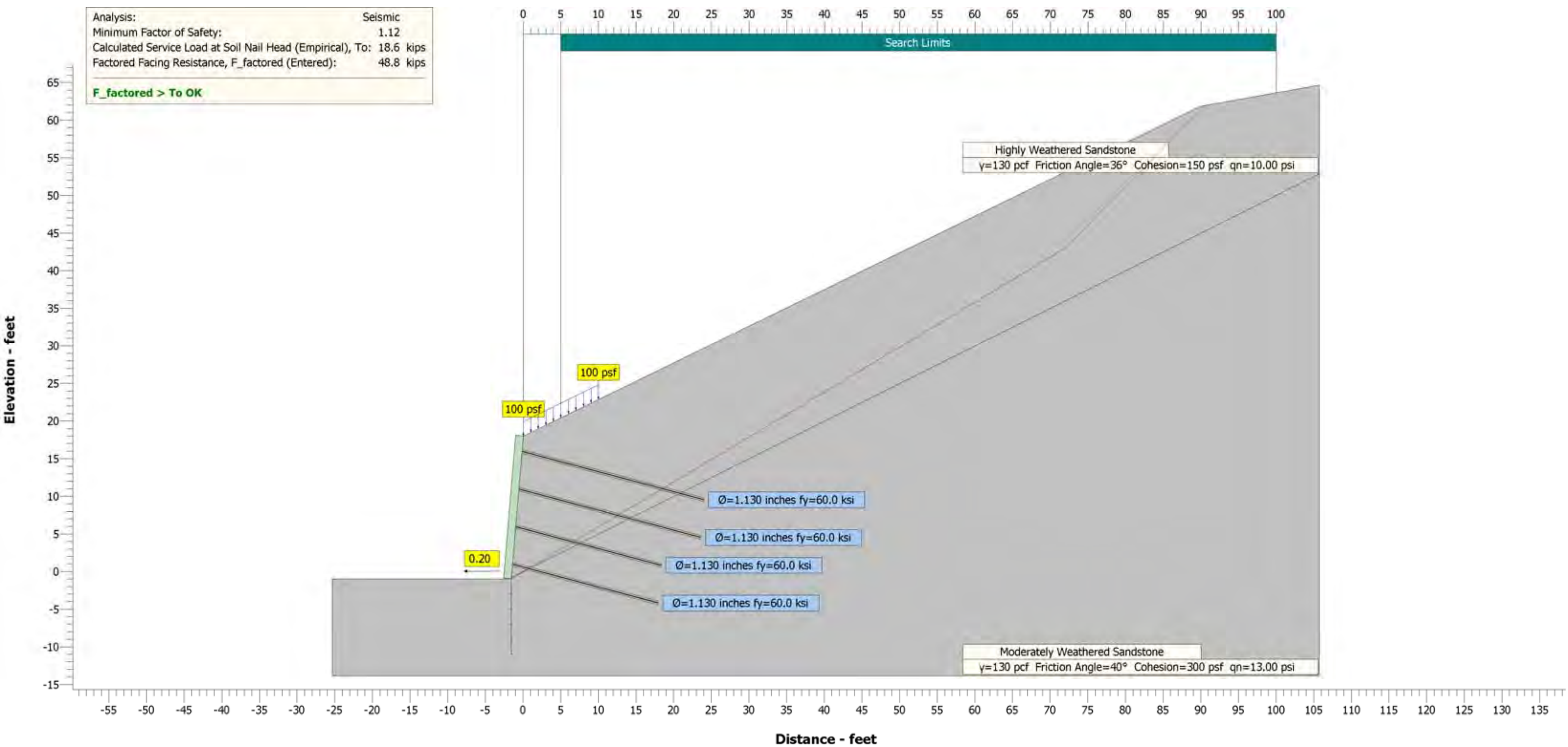
PHONE: (510) 208-4599

The attached calculations are forwarded for your use in preparing or coordinating the contract documents for the above project.

CONTRACT NO. 0414000552

SOIL NAIL WALLS

(SEISMIC DESIGN)


Analysis: Seismic
Minimum Factor of Safety: 1.12
Calculated Service Load at Soil Nail Head (Empirical), To: 18.6 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
0.20
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

Snail

Version: 1.3

File Information

File Name: RW4_1021+00_4 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:22:56

Project Information

Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 4 row - seismic

Station: Sta. 1021+20

Engineer: GHY

Designer

Comments:

Geometry

Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 18.00 feet

Wall Dimensions:

Wall Height: 19.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	100.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	0.00	100.00	50.00

Ground Water:

Include Ground Water: No

Soil Nails

Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 4

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	25.00	15	2.00	1.130	60.0
2	25.00	15	5.00	1.130	60.0
3	20.00	15	5.00	1.130	60.0
4	20.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

Loads

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.12

Found at Search Level: Toe of the wall

Found at Search Point: 10

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 18.6 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				Controlling
	Factor of	From Toe of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.52	6.58	63.84	11.94	83.00	10.80	1	24.1	Pullout
							2	26.5	Pullout
							3	23.4	Pullout
							4	27.7	Pullout
2	1.66	16.08	48.61	24.33	90.00	7.82	1	16.5	Pullout
							2	22.5	Pullout
							3	21.1	Pullout
							4	27.0	Pullout
3	1.34	25.58	43.84	35.47	90.00	6.14	1	14.4	Pullout
							2	21.0	Pullout
							3	20.2	Pullout
							4	26.8	Pullout
4	1.23	35.08	38.86	45.06	90.00	7.07	1	12.1	Pullout

							2	19.3	Pullout
							3	19.3	Pullout
							4	26.5	Pullout
5	1.18	44.58	35.65	54.86	-90.00	7.99	1	10.4	Pullout
							2	18.1	Pullout
							3	18.6	Pullout
							4	26.3	Pullout
6	1.16	54.08	36.59	67.35	90.00	4.46	1	10.9	Pullout
							2	18.5	Pullout
							3	18.8	Pullout
							4	26.4	Pullout
7	1.14	63.58	34.88	77.50	90.00	4.92	1	9.9	Pullout
							2	17.8	Pullout
							3	18.4	Pullout
							4	26.3	Pullout
8	1.13	73.08	33.56	87.70	-90.00	5.39	1	9.2	Pullout
							2	17.3	Pullout
							3	18.1	Pullout
							4	26.2	Pullout
9	1.13	82.58	31.80	77.73	46.74	24.10	1	8.1	Pullout
							2	16.5	Pullout
							3	17.6	Pullout

							4	26.0	Pullout
** 10	1.12	92.08	30.89	85.84	45.72	26.38	1	7.5	Pullout
							2	16.1	Pullout
							3	17.4	Pullout
							4	26.0	Pullout
11	1.12	101.58	29.10	93.01	43.66	28.08	1	6.4	Pullout
							2	15.3	Pullout
							3	16.9	Pullout
							4	25.8	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 16.3 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor of	From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.47	6.58	63.19	13.13	86.79	11.74	1	23.7	Pullout
							2	25.7	Pullout
							3	22.3	Pullout
							4	26.6	Pullout
2	1.71	16.08	44.93	15.90	74.02	17.52	1	16.2	Pullout
							2	19.5	Pullout
							3	18.6	Pullout
							4	24.7	Pullout

3	1.41	25.58	45.65	36.59	90.00	6.54	1	13.4	Pullout
							2	19.8	Pullout
							3	18.8	Pullout
							4	24.8	Pullout
4	1.29	35.08	40.41	46.08	90.00	7.47	1	10.8	Pullout
							2	17.8	Pullout
							3	17.5	Pullout
							4	24.1	Pullout
5	1.24	44.58	36.99	55.81	-90.00	8.39	1	8.8	Pullout
							2	16.4	Pullout
							3	16.6	Pullout
							4	23.6	Pullout
6	1.21	54.08	37.80	68.44	90.00	4.66	1	9.3	Pullout
							2	16.7	Pullout
							3	16.8	Pullout
							4	23.7	Pullout
7	1.19	63.58	35.95	78.55	90.00	5.12	1	8.2	Pullout
							2	15.9	Pullout
							3	16.2	Pullout
							4	23.4	Pullout
8	1.18	73.08	34.53	88.71	-90.00	5.59	1	7.3	Pullout
							2	15.2	Pullout
							3	15.7	Pullout

							4	23.2	Pullout
9	1.17	82.58	33.40	98.92	-90.00	6.05	1	6.6	Pullout
							2	14.7	Pullout
							3	15.2	Pullout
							4	23.0	Pullout
10	1.17	92.08	32.41	109.07	90.00	6.49	1	5.9	Pullout
							2	14.2	Pullout
							3	14.8	Pullout
							4	22.8	Pullout
11	1.18	101.58	33.26	121.48	0.00	0.00	1	6.5	Pullout
							2	14.6	Pullout
							3	15.2	Pullout
							4	22.9	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 14.1 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
Node									
1	2.67	6.58	65.03	14.03	87.04	12.74	1	23.6	Pullout
							2	25.6	Pullout
							3	21.6	Pullout
							4	25.8	Pullout

2	1.84	16.08	52.62	26.49	90.00	9.02	1	15.1	Pullout
							2	20.6	Pullout
							3	18.8	Pullout
							4	23.8	Pullout
3	1.52	25.58	47.34	37.75	90.00	6.94	1	12.5	Pullout
							2	18.6	Pullout
							3	17.4	Pullout
							4	22.8	Pullout
4	1.39	35.08	41.90	47.13	90.00	7.87	1	9.5	Pullout
							2	16.4	Pullout
							3	15.7	Pullout
							4	21.7	Pullout
5	1.32	44.58	38.28	56.79	-90.00	8.79	1	7.4	Pullout
							2	14.7	Pullout
							3	14.2	Pullout
							4	20.9	Pullout
6	1.28	54.08	38.97	69.56	90.00	4.86	1	7.8	Pullout
							2	15.0	Pullout
							3	14.5	Pullout
							4	21.1	Pullout
7	1.25	63.58	37.00	79.62	90.00	5.32	1	6.5	Pullout
							2	14.0	Pullout

							3	13.6	Pullout
							4	20.6	Pullout
8	1.23	73.08	35.48	89.74	-90.00	5.79	1	5.5	Pullout
							2	13.0	Pullout
							3	12.9	Pullout
							4	20.2	Pullout
9	1.22	82.58	34.26	99.92	-90.00	6.25	1	4.6	Pullout
							2	12.2	Pullout
							3	12.4	Pullout
							4	19.9	Pullout
10	1.21	92.08	33.20	110.04	90.00	6.69	1	3.6	Pullout
							2	11.4	Pullout
							3	11.8	Pullout
							4	19.6	Pullout
11	1.22	101.58	34.04	122.59	0.00	0.00	1	4.4	Pullout
							2	12.0	Pullout
							3	12.3	Pullout
							4	19.8	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 11.9 kips (Clouterre)

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-----------------------------------------------------------------------------------------------------
|       |         |          |            Failure Planes            |        Reinforcement         |
|       |         |          |--------------------------------------|------------------------------|
|       | Minimum | Distance |       Lower       |       Upper      |       |        |             |
|       | Factor  | From Toe |--------------------------------------|       |        | Controlling |
|       |   of    | of Wall  |  Angle  | Length  |  Angle  | Length |       | Stress | Resistance  |
```



```
| Node  | Safety  |   feet   | degrees |  feet   | degrees |  feet  | Level |  ksi   | Failure Mode |
-----------------------------------------------------------------------------------------------------
```

1	2.76	6.58	61.64	12.47	87.71	16.48	1	23.6	Pullout
							2	25.5	Pullout
							3	20.1	Pullout
							4	23.8	Pullout
2	2.01	16.08	53.05	24.08	82.86	12.93	1	14.0	Pullout
							2	19.3	Pullout
							3	17.4	Pullout
							4	21.9	Pullout
3	1.65	25.58	45.13	36.26	90.00	11.01	1	9.5	Pullout
							2	15.9	Pullout
							3	14.5	Pullout
							4	20.0	Pullout
4	1.49	35.08	43.31	48.21	90.00	8.27	1	8.4	Pullout
							2	15.1	Pullout
							3	13.7	Pullout
							4	19.5	Pullout
5	1.41	44.58	39.52	57.79	-90.00	9.19	1	6.0	Pullout
							2	12.8	Pullout
							3	11.9	Pullout
							4	18.4	Pullout
6	1.36	54.08	36.82	67.56	90.00	10.12	1	3.9	Pullout

							2	10.9	Pullout
							3	10.6	Pullout
							4	17.6	Pullout
7	1.32	63.58	38.02	80.71	90.00	5.52	1	5.0	Pullout
							2	11.8	Pullout
							3	11.2	Pullout
							4	17.9	Pullout
8	1.30	73.08	36.40	90.80	-90.00	5.99	1	3.5	Pullout
							2	10.6	Pullout
							3	10.3	Pullout
							4	17.4	Pullout
9	1.28	82.58	35.11	100.95	-90.00	6.45	1	2.3	Pullout
							2	9.6	Pullout
							3	9.6	Pullout
							4	17.0	Pullout
10	1.26	92.08	33.98	111.04	90.00	6.89	1	1.1	Pullout
							2	8.7	Pullout
							3	9.0	Pullout
							4	16.6	Pullout
11	1.27	101.58	34.81	123.72	0.00	0.00	1	2.0	Pullout
							2	9.4	Pullout
							3	9.5	Pullout
							4	16.9	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 9.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of	Distance From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.20	6.58	69.56	9.42	80.93	20.87	1	24.3	Pullout
							2	26.9	Pullout
							3	22.2	Pullout
							4	24.5	Pullout
2	2.17	16.08	54.70	25.05	83.27	13.72	1	13.9	Pullout
							2	18.6	Pullout
							3	16.5	Pullout
							4	20.5	Pullout
3	1.82	25.58	47.22	26.37	68.37	20.82	1	9.5	Pullout
							2	15.1	Pullout
							3	13.1	Pullout
							4	18.3	Pullout
4	1.61	35.08	40.85	46.38	90.00	13.00	1	4.8	Pullout
							2	11.0	Pullout
							3	9.9	Pullout
							4	16.1	Pullout
5	1.50	44.58	40.72	58.83	-90.00	9.59	1	4.7	Pullout

							2	10.9	Pullout
							3	9.8	Pullout
							4	16.1	Pullout
6	1.44	54.08	37.89	68.53	90.00	10.52	1	2.0	Pullout
							2	8.8	Pullout
							3	8.2	Pullout
							4	15.0	Pullout
7	1.40	63.58	35.76	78.36	90.00	11.45	1	0.0	Pullout
							2	7.0	Pullout
							3	6.9	Pullout
							4	14.1	Pullout
8	1.37	73.08	37.31	91.88	-90.00	6.19	1	1.4	Pullout
							2	8.3	Pullout
							3	7.9	Pullout
							4	14.8	Pullout
9	1.34	82.58	35.94	101.99	-90.00	6.65	1	0.0	Pullout
							2	7.2	Pullout
							3	7.0	Pullout
							4	14.2	Pullout
10	1.32	92.08	34.74	112.05	90.00	7.09	1	0.0	Pullout
							2	6.2	Pullout
							3	6.3	Pullout

							4	13.7	Pullout
11	1.33	101.58	32.76	120.79	90.00	7.26	1	0.0	Pullout
							2	4.4	Pullout
							3	5.0	Pullout
							4	12.8	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 7.1 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	909.00	6.58	43.69	9.10	90.00	25.15	1	23.3	Pullout
							2	25.0	Pullout
							3	19.4	Pullout
							4	19.6	Pullout
2	2.36	16.08	52.04	18.30	77.43	22.17	1	15.4	Pullout
							2	18.3	Pullout
							3	13.4	Pullout
							4	17.8	Pullout
3	1.96	25.58	44.84	28.86	75.89	20.99	1	6.7	Pullout
							2	11.4	Pullout
							3	9.6	Pullout
							4	15.1	Pullout

4	1.74	35.08	45.15	44.77	75.54	14.05	1	5.9	Pullout
							2	11.6	Pullout
							3	9.8	Pullout
							4	15.2	Pullout
5	1.62	44.58	38.12	56.67	-90.00	14.99	1	0.0	Pullout
							2	6.1	Pullout
							3	5.5	Pullout
							4	12.2	Pullout
6	1.52	54.08	38.93	69.52	90.00	10.92	1	0.2	Pullout
							2	6.7	Pullout
							3	6.0	Pullout
							4	12.6	Pullout
7	1.48	63.58	36.70	79.30	90.00	11.85	1	0.0	Pullout
							2	4.8	Pullout
							3	4.5	Pullout
							4	11.5	Pullout
8	1.44	73.08	38.19	92.98	-90.00	6.39	1	0.0	Pullout
							2	6.1	Pullout
							3	5.5	Pullout
							4	12.2	Pullout
9	1.41	82.58	36.75	103.06	-90.00	6.85	1	0.0	Pullout
							2	4.9	Pullout
							3	4.5	Pullout

							4	11.6	Pullout
10	1.39	92.08	35.49	113.09	90.00	7.29	1	0.0	Pullout
							2	3.7	Pullout
							3	3.7	Pullout
							4	10.9	Pullout
11	1.38	101.58	33.47	121.78	90.00	7.46	1	0.0	Pullout
							2	1.8	Pullout
							3	2.2	Pullout
							4	9.9	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

==

END OF REPORT

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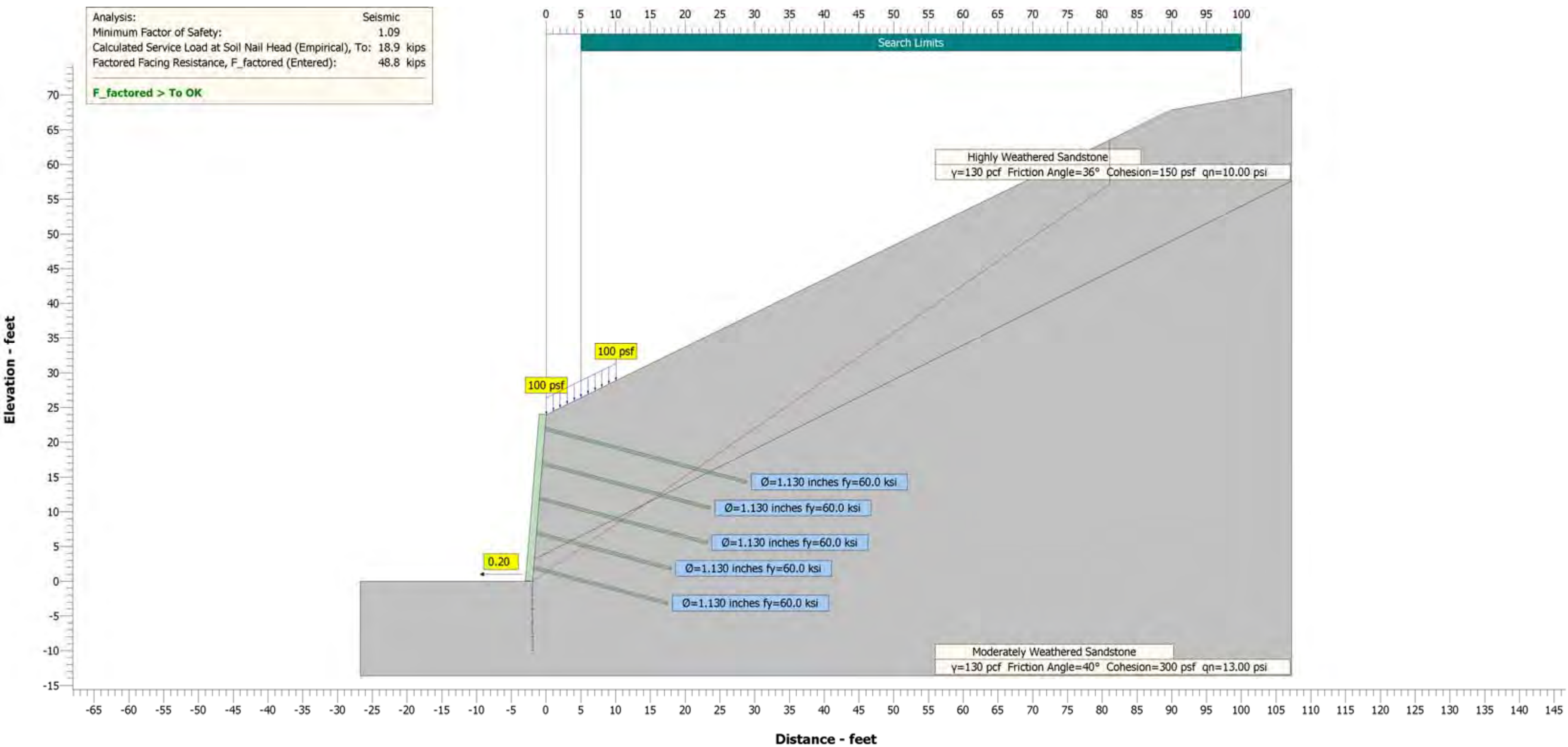

Analysis: Seismic
Minimum Factor of Safety: 1.09
Calculated Service Load at Soil Nail Head (Empirical), To: 18.9 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

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File Information

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File Name: RW4_1021+30_5 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:19:02

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Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 5 row -seismic

Station: Sta. 1021+30

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 24.00 feet

Wall Dimensions:

Wall Height: 24.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	100.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	4.00	100.00	54.00

Ground Water:

Include Ground Water: No

==

Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 5

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	30.00	15	2.00	1.130	60.0
2	25.00	15	5.00	1.130	60.0
3	25.00	15	5.00	1.130	60.0
4	20.00	15	5.00	1.130	60.0
5	20.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

==

Soil Properties

==

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

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Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

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Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.09

Found at Search Level: Toe of the wall

Found at Search Point: 9

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 18.9 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.32	7.00	62.10	11.97	84.96	15.92	1	30.3	Pullout
							2	25.2	Pullout
							3	27.4	Pullout
							4	24.4	Pullout
							5	28.1	Pullout
2	1.57	16.50	52.82	27.30	90.00	9.32	1	21.3	Pullout
							2	19.5	Pullout
							3	24.9	Pullout
							4	23.0	Pullout
							5	27.6	Pullout
3	1.27	26.00	47.69	38.62	-90.00	7.14	1	18.7	Pullout
							2	17.4	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
							3	23.5	Pullout
							4	22.2	Pullout
							5	27.3	Pullout
4	1.17	35.50	42.27	47.97	90.00	8.07	1	15.6	Pullout
							2	15.0	Pullout
							3	21.8	Pullout
							4	21.0	Pullout
							5	26.9	Pullout
5	1.13	45.00	41.97	60.52	90.00	4.50	1	15.4	Pullout
							2	14.9	Pullout
							3	21.7	Pullout
							4	20.9	Pullout
							5	26.9	Pullout
6	1.10	54.50	39.33	70.45	-90.00	4.96	1	13.7	Pullout
							2	13.6	Pullout
							3	20.8	Pullout
							4	20.2	Pullout
							5	26.7	Pullout
7	1.09	64.00	37.34	80.49	90.00	5.42	1	12.4	Pullout
							2	12.6	Pullout
							3	20.0	Pullout
							4	19.7	Pullout
							5	26.6	Pullout

8	1.09	73.50	35.79	90.61	90.00	5.89	1	11.3	Pullout
							2	11.7	Pullout
							3	19.3	Pullout
							4	19.2	Pullout
							5	26.4	Pullout
** 9	1.09	83.00	34.55	100.77	90.00	6.35	1	10.4	Pullout
							2	11.0	Pullout
							3	18.7	Pullout
							4	18.9	Pullout
							5	26.3	Pullout
10	1.10	92.50	33.47	110.89	90.00	6.79	1	9.6	Pullout
							2	10.4	Pullout
							3	18.1	Pullout
							4	18.5	Pullout
							5	26.2	Pullout
11	1.10	102.00	34.32	123.49	0.00	0.00	1	10.2	Pullout
							2	10.9	Pullout
							3	18.6	Pullout
							4	18.8	Pullout
							5	26.3	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 16.7 kips (Clouterre)

RW4_1021+30_5 row_seismic.txt

			Failure Planes				Reinforcement		
	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet			Controlling Resistance Failure Mode
Node							Level	Stress ksi	
1	2.36	7.00	61.03	13.00	87.65	17.08	1	30.0	Pullout
							2	24.6	Pullout
							3	26.5	Pullout
							4	23.2	Pullout
							5	26.6	Pullout
2	1.64	16.50	53.19	24.78	82.89	13.33	1	20.4	Pullout
							2	18.1	Pullout
							3	23.6	Pullout
							4	21.5	Pullout
							5	25.7	Pullout
3	1.34	26.00	45.43	37.05	-90.00	11.31	1	15.6	Pullout
							2	14.6	Pullout
							3	21.0	Pullout
							4	19.4	Pullout
							5	24.8	Pullout
4	1.22	35.50	43.66	49.07	90.00	8.47	1	14.5	Pullout
							2	13.7	Pullout
							3	20.3	Pullout
							4	18.8	Pullout
							5	24.6	Pullout

5	1.17	45.00	43.21	61.74	90.00	4.70	1	14.2	Pullout
							2	13.5	Pullout
							3	20.1	Pullout
							4	18.7	Pullout
							5	24.5	Pullout
6	1.14	54.50	40.44	71.60	-90.00	5.16	1	12.3	Pullout
							2	12.0	Pullout
							3	18.8	Pullout
							4	17.8	Pullout
							5	24.1	Pullout
7	1.13	64.00	38.34	81.59	90.00	5.62	1	10.9	Pullout
							2	10.9	Pullout
							3	17.7	Pullout
							4	17.1	Pullout
							5	23.8	Pullout
8	1.12	73.50	36.70	91.67	90.00	6.09	1	9.7	Pullout
							2	9.8	Pullout
							3	16.8	Pullout
							4	16.5	Pullout
							5	23.5	Pullout
9	1.12	83.00	35.39	101.81	90.00	6.55	1	8.6	Pullout
							2	8.7	Pullout
							3	16.0	Pullout

							4	16.0	Pullout
							5	23.3	Pullout
10	1.12	92.50	34.24	111.89	90.00	6.99	1	7.6	Pullout
							2	7.8	Pullout
							3	15.3	Pullout
							4	15.6	Pullout
							5	23.1	Pullout
11	1.12	102.00	35.08	124.63	0.00	0.00	1	8.4	Pullout
							2	8.5	Pullout
							3	15.8	Pullout
							4	15.9	Pullout
							5	23.2	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 14.4 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.50	7.00	62.65	13.71	87.81	18.28	1	30.0	Pullout
							2	24.6	Pullout
							3	26.5	Pullout
							4	22.4	Pullout
							5	25.4	Pullout

2	1.72	16.50	53.03	21.95	79.34	17.84	1	21.3	Pullout
							2	16.8	Pullout
							3	22.0	Pullout
							4	19.6	Pullout
							5	23.8	Pullout
3	1.43	26.00	46.91	38.06	-90.00	11.91	1	14.7	Pullout
							2	13.6	Pullout
							3	19.7	Pullout
							4	17.5	Pullout
							5	22.7	Pullout
4	1.29	35.50	44.98	50.18	90.00	8.87	1	13.5	Pullout
							2	12.5	Pullout
							3	18.7	Pullout
							4	16.8	Pullout
							5	22.3	Pullout
5	1.23	45.00	41.05	59.66	90.00	9.79	1	10.7	Pullout
							2	10.3	Pullout
							3	16.5	Pullout
							4	15.3	Pullout
							5	21.5	Pullout
6	1.19	54.50	41.52	72.79	-90.00	5.36	1	11.1	Pullout
							2	10.6	Pullout
							3	16.8	Pullout

							4	15.5	Pullout
							5	21.6	Pullout
7	1.17	64.00	39.32	82.72	90.00	5.82	1	9.4	Pullout
							2	8.9	Pullout
							3	15.5	Pullout
							4	14.6	Pullout
							5	21.1	Pullout
8	1.16	73.50	37.59	92.76	90.00	6.29	1	8.0	Pullout
							2	7.5	Pullout
							3	14.4	Pullout
							4	13.9	Pullout
							5	20.7	Pullout
9	1.15	83.00	36.21	102.86	90.00	6.75	1	6.6	Pullout
							2	6.3	Pullout
							3	13.5	Pullout
							4	13.3	Pullout
							5	20.4	Pullout
10	1.14	92.50	34.99	112.91	90.00	7.19	1	5.2	Pullout
							2	5.3	Pullout
							3	12.7	Pullout
							4	12.7	Pullout
							5	20.1	Pullout
11	1.14	102.00	35.82	125.79	0.00	0.00	1	6.1	Pullout

							2	6.0	Pullout
							3	13.2	Pullout
							4	13.1	Pullout
							5	20.3	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 12.3 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.59	7.00	68.78	17.40	87.53	16.23	1	30.0	Pullout
							2	24.6	Pullout
							3	26.6	Pullout
							4	22.9	Pullout
							5	25.3	Pullout
2	1.86	16.50	52.09	18.80	77.46	22.79	1	21.8	Pullout
							2	17.4	Pullout
							3	20.4	Pullout
							4	17.3	Pullout
							5	21.7	Pullout
3	1.53	26.00	48.31	39.09	-90.00	12.51	1	14.0	Pullout
							2	12.6	Pullout
							3	18.2	Pullout

							4	15.8	Pullout
							5	20.8	Pullout
4	1.38	35.50	46.24	51.33	90.00	9.27	1	12.5	Pullout
							2	11.4	Pullout
							3	17.0	Pullout
							4	15.0	Pullout
							5	20.3	Pullout
5	1.30	45.00	42.18	60.73	90.00	10.19	1	9.5	Pullout
							2	8.6	Pullout
							3	14.6	Pullout
							4	13.2	Pullout
							5	19.2	Pullout
6	1.26	54.50	39.22	70.35	-90.00	11.12	1	6.9	Pullout
							2	6.1	Pullout
							3	12.6	Pullout
							4	11.8	Pullout
							5	18.3	Pullout
7	1.23	64.00	40.27	83.88	90.00	6.02	1	8.0	Pullout
							2	7.0	Pullout
							3	13.3	Pullout
							4	12.3	Pullout
							5	18.6	Pullout
8	1.21	73.50	38.46	93.87	90.00	6.49	1	6.1	Pullout

							2	5.4	Pullout
							3	12.1	Pullout
							4	11.4	Pullout
							5	18.1	Pullout
9	1.19	83.00	37.01	103.93	90.00	6.95	1	4.4	Pullout
							2	4.1	Pullout
							3	11.0	Pullout
							4	10.7	Pullout
							5	17.6	Pullout
10	1.18	92.50	35.74	113.95	90.00	7.39	1	3.0	Pullout
							2	2.9	Pullout
							3	10.1	Pullout
							4	10.0	Pullout
							5	17.2	Pullout
11	1.18	102.00	36.55	126.97	0.00	0.00	1	3.9	Pullout
							2	3.6	Pullout
							3	10.7	Pullout
							4	10.4	Pullout
							5	17.5	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 10.3 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.88	7.00	70.42	14.62	84.20	20.77	1	30.4	Pullout
							2	25.3	Pullout
							3	27.6	Pullout
							4	22.6	Pullout
							5	24.6	Pullout
2	2.00	16.50	55.96	23.58	80.41	19.81	1	21.1	Pullout
							2	16.4	Pullout
							3	20.4	Pullout
							4	17.0	Pullout
							5	20.9	Pullout
3	1.66	26.00	45.25	36.93	-90.00	17.48	1	10.0	Pullout
							2	8.6	Pullout
							3	14.1	Pullout
							4	12.2	Pullout
							5	17.6	Pullout
4	1.48	35.50	43.63	49.04	90.00	14.50	1	8.7	Pullout
							2	7.3	Pullout
							3	13.0	Pullout
							4	11.4	Pullout
							5	17.1	Pullout
5	1.39	45.00	43.28	61.81	90.00	10.59	1	8.4	Pullout

							2	7.0	Pullout
							3	12.7	Pullout
							4	11.2	Pullout
							5	17.0	Pullout
6	1.33	54.50	40.22	71.37	-90.00	11.52	1	5.2	Pullout
							2	4.2	Pullout
							3	10.5	Pullout
							4	9.5	Pullout
							5	15.9	Pullout
7	1.30	64.00	37.88	81.09	90.00	12.45	1	2.5	Pullout
							2	2.0	Pullout
							3	8.8	Pullout
							4	8.2	Pullout
							5	15.0	Pullout
8	1.27	73.50	39.31	95.00	90.00	6.69	1	4.2	Pullout
							2	3.4	Pullout
							3	9.9	Pullout
							4	9.0	Pullout
							5	15.5	Pullout
9	1.24	83.00	37.79	105.03	90.00	7.15	1	2.4	Pullout
							2	1.9	Pullout
							3	8.7	Pullout
							4	8.2	Pullout

							5	15.0	Pullout
10	1.23	92.50	36.46	115.01	90.00	7.59	1	0.8	Pullout
							2	0.5	Pullout
							3	7.6	Pullout
							4	7.4	Pullout
							5	14.4	Pullout
11	1.23	102.00	37.27	128.17	0.00	0.00	1	1.8	Pullout
							2	1.4	Pullout
							3	8.3	Pullout
							4	7.8	Pullout
							5	14.8	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 7.7 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	3.20	7.00	72.25	11.48	82.19	25.75	1	30.6	Pullout
							2	25.8	Pullout
							3	28.2	Pullout
							4	23.4	Pullout
							5	24.2	Pullout
2	2.16	16.50	51.22	21.07	82.37	24.86	1	20.6	Pullout

							2	15.7	Pullout
							3	17.7	Pullout
							4	13.0	Pullout
							5	17.5	Pullout
3	1.80	26.00	47.69	30.90	77.18	23.44	1	12.6	Pullout
							2	8.4	Pullout
							3	13.4	Pullout
							4	11.2	Pullout
							5	16.2	Pullout
4	1.61	35.50	47.80	47.56	76.77	15.51	1	10.2	Pullout
							2	8.5	Pullout
							3	13.5	Pullout
							4	11.2	Pullout
							5	16.2	Pullout
5	1.48	45.00	40.54	59.21	90.00	16.49	1	2.9	Pullout
							2	1.8	Pullout
							3	8.1	Pullout
							4	7.0	Pullout
							5	13.3	Pullout
6	1.41	54.50	41.19	72.41	-90.00	11.92	1	3.6	Pullout
							2	2.4	Pullout
							3	8.6	Pullout
							4	7.4	Pullout

							5	13.6	Pullout
7	1.36	64.00	38.77	82.08	90.00	12.85	1	0.7	Pullout
							2	0.0	Pullout
							3	6.6	Pullout
							4	5.9	Pullout
							5	12.5	Pullout
8	1.33	73.50	40.14	96.15	90.00	6.89	1	2.4	Pullout
							2	1.4	Pullout
							3	7.8	Pullout
							4	6.8	Pullout
							5	13.1	Pullout
9	1.30	83.00	38.56	106.14	90.00	7.35	1	0.5	Pullout
							2	0.0	Pullout
							3	6.4	Pullout
							4	5.8	Pullout
							5	12.4	Pullout
10	1.29	92.50	37.18	116.09	90.00	7.79	1	0.0	Pullout
							2	0.0	Pullout
							3	5.2	Pullout
							4	4.8	Pullout
							5	11.8	Pullout
11	1.29	102.00	35.09	124.65	-90.00	7.96	1	0.0	Pullout

2	0.0	Pullout
3	3.3	Pullout
4	3.4	Pullout
5	10.7	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

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END OF REPORT

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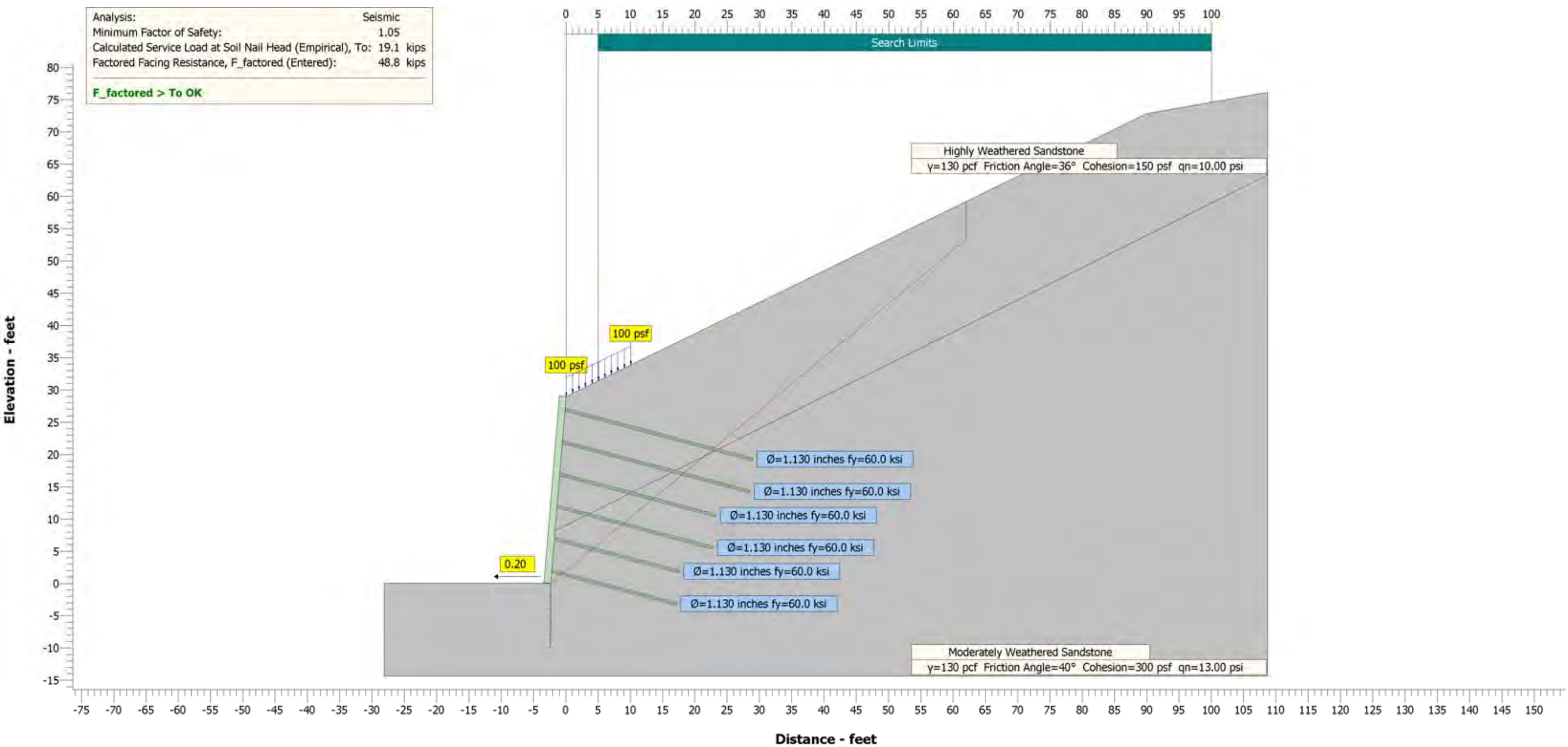

Analysis: Seismic
Minimum Factor of Safety: 1.05
Calculated Service Load at Soil Nail Head (Empirical), To: 19.1 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

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File Information

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File Name: RW4_1021+40_6 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:15:33

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 6 row -seismic

Station: Sta. 1021+40

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 29.00 feet

Wall Dimensions:

Wall Height: 29.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	100.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	9.00	100.00	59.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 6

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	30.00	15	2.00	1.130	60.0
2	30.00	15	5.00	1.130	60.0
3	25.00	15	5.00	1.130	60.0
4	25.00	15	5.00	1.130	60.0
5	20.00	15	5.00	1.130	60.0
6	20.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

Loads

Applied Loads:

Seismic:

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Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.05

Found at Search Level: Toe of the wall

Found at Search Point: 7

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 19.1 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.37	7.41	57.83	11.14	86.15	22.06	1	30.2	Pullout
							2	32.2	Pullout
							3	27.0	Pullout
							4	29.0	Pullout
							5	24.4	Pullout
							6	27.9	Pullout
2	1.51	16.91	53.12	22.55	79.38	18.35	1	21.3	Pullout
							2	24.1	Pullout
							3	21.8	Pullout
							4	26.5	Pullout
							5	23.4	Pullout
							6	27.6	Pullout

3	1.23	26.41	50.95	41.93	90.00	8.14	1	16.9	Pullout
							2	22.6	Pullout
							3	20.9	Pullout
							4	25.8	Pullout
							5	23.0	Pullout
							6	27.5	Pullout
4	1.12	35.91	45.28	51.04	90.00	9.07	1	13.1	Pullout
							2	19.5	Pullout
							3	18.2	Pullout
							4	23.6	Pullout
							5	21.7	Pullout
							6	27.1	Pullout
5	1.08	45.41	44.72	63.92	90.00	5.00	1	12.7	Pullout
							2	19.2	Pullout
							3	17.8	Pullout
							4	23.4	Pullout
							5	21.6	Pullout
							6	27.1	Pullout
6	1.06	54.91	41.83	73.69	-90.00	5.46	1	10.6	Pullout
							2	17.4	Pullout
							3	16.1	Pullout
							4	22.2	Pullout
							5	20.9	Pullout

							6	26.9	Pullout
** 7	1.05	64.41	39.61	83.62	90.00	5.92	1	8.9	Pullout
							2	15.6	Pullout
							3	14.7	Pullout
							4	21.2	Pullout
							5	20.3	Pullout
							6	26.7	Pullout
8	1.05	73.91	37.87	93.64	90.00	6.39	1	7.3	Pullout
							2	14.1	Pullout
							3	13.6	Pullout
							4	20.4	Pullout
							5	19.8	Pullout
							6	26.6	Pullout
9	1.05	83.41	36.47	103.73	-90.00	6.85	1	5.8	Pullout
							2	12.9	Pullout
							3	12.6	Pullout
							4	19.7	Pullout
							5	19.4	Pullout
							6	26.5	Pullout
10	1.06	92.91	38.14	118.13	0.00	0.00	1	7.6	Pullout
							2	14.3	Pullout
							3	13.8	Pullout
							4	20.5	Pullout

							5	19.9	Pullout
							6	26.6	Pullout
11	1.06	102.41	36.08	126.72	0.00	0.00	1	5.4	Pullout
							2	12.5	Pullout
							3	12.3	Pullout
							4	19.5	Pullout
							5	19.3	Pullout
							6	26.5	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 16.9 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.32	7.41	68.24	18.00	87.46	16.74	1	30.0	Pullout
							2	32.0	Pullout
							3	26.6	Pullout
							4	30.1	Pullout
							5	25.2	Pullout
							6	27.4	Pullout
2	1.57	16.91	54.59	23.36	79.92	19.33	1	21.2	Pullout
							2	23.9	Pullout
							3	20.9	Pullout

RW4_1021+40_6 row_seismic.txt

							4	25.2	Pullout
							5	21.9	Pullout
							6	25.9	Pullout
3	1.28	26.41	48.54	39.89	90.00	12.81	1	13.7	Pullout
							2	19.6	Pullout
							3	17.8	Pullout
							4	22.7	Pullout
							5	20.3	Pullout
							6	25.2	Pullout
4	1.16	35.91	46.52	52.19	90.00	9.47	1	12.2	Pullout
							2	18.4	Pullout
							3	16.6	Pullout
							4	21.8	Pullout
							5	19.7	Pullout
							6	24.9	Pullout
5	1.11	45.41	45.85	65.20	90.00	5.20	1	11.7	Pullout
							2	18.0	Pullout
							3	16.1	Pullout
							4	21.5	Pullout
							5	19.5	Pullout
							6	24.8	Pullout
6	1.08	54.91	42.85	74.91	-90.00	5.66	1	9.5	Pullout
							2	15.7	Pullout

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RW4_1021+40_6 row_seismic.txt

							3	14.2	Pullout
							4	20.1	Pullout
							5	18.6	Pullout
							6	24.4	Pullout
7	1.07	64.41	40.55	84.78	90.00	6.12	1	7.4	Pullout
							2	13.7	Pullout
							3	12.6	Pullout
							4	18.9	Pullout
							5	17.8	Pullout
							6	24.1	Pullout
8	1.06	73.91	38.73	94.75	90.00	6.59	1	5.4	Pullout
							2	12.0	Pullout
							3	11.3	Pullout
							4	17.9	Pullout
							5	17.2	Pullout
							6	23.8	Pullout
9	1.06	83.41	37.26	104.81	-90.00	7.05	1	3.7	Pullout
							2	10.6	Pullout
							3	10.2	Pullout
							4	17.1	Pullout
							5	16.7	Pullout
							6	23.6	Pullout
10	1.07	92.91	35.98	114.82	-90.00	7.49	1	2.2	Pullout

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							2	9.4	Pullout
							3	9.2	Pullout
							4	16.4	Pullout
							5	16.2	Pullout
							6	23.4	Pullout
11	1.06	102.41	36.80	127.90	0.00	0.00	1	3.2	Pullout
							2	10.2	Pullout
							3	9.9	Pullout
							4	16.9	Pullout
							5	16.5	Pullout
							6	23.5	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 14.8 kips (Clouterre)

	Minimum	Distance	Failure Planes				Reinforcement		
	Factor	From Toe	Lower		Upper				Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.44	7.41	67.29	15.37	86.01	21.31	1	30.2	Pullout
							2	32.3	Pullout
							3	27.1	Pullout
							4	29.1	Pullout
							5	23.8	Pullout
							6	26.1	Pullout
2	1.68	16.91	52.77	25.16	85.18	20.11	1	19.9	Pullout

							2	22.1	Pullout
							3	18.3	Pullout
							4	22.6	Pullout
							5	19.5	Pullout
							6	23.8	Pullout
3	1.36	26.41	49.83	40.95	90.00	13.41	1	13.0	Pullout
							2	18.8	Pullout
							3	16.5	Pullout
							4	21.2	Pullout
							5	18.5	Pullout
							6	23.3	Pullout
4	1.24	35.91	47.70	53.37	90.00	9.87	1	11.4	Pullout
							2	17.3	Pullout
							3	15.1	Pullout
							4	20.1	Pullout
							5	17.8	Pullout
							6	22.9	Pullout
5	1.17	45.41	43.55	62.66	90.00	10.79	1	8.0	Pullout
							2	13.8	Pullout
							3	12.2	Pullout
							4	17.9	Pullout
							5	16.3	Pullout
							6	22.0	Pullout

6	1.14	54.91	43.85	76.14	-90.00	5.86	1	8.3	Pullout
							2	14.0	Pullout
							3	12.4	Pullout
							4	18.1	Pullout
							5	16.4	Pullout
							6	22.1	Pullout
7	1.11	64.41	41.46	85.96	90.00	6.32	1	5.7	Pullout
							2	11.8	Pullout
							3	10.6	Pullout
							4	16.7	Pullout
							5	15.5	Pullout
							6	21.6	Pullout
8	1.10	73.91	39.57	95.89	90.00	6.79	1	3.6	Pullout
							2	10.0	Pullout
							3	9.1	Pullout
							4	15.6	Pullout
							5	14.7	Pullout
							6	21.2	Pullout
9	1.09	83.41	38.04	105.91	-90.00	7.25	1	1.7	Pullout
							2	8.5	Pullout
							3	7.9	Pullout
							4	14.7	Pullout
							5	14.1	Pullout

							6	20.8	Pullout
10	1.09	92.91	36.70	115.88	-90.00	7.69	1	0.1	Pullout
							2	7.1	Pullout
							3	6.8	Pullout
							4	13.8	Pullout
							5	13.5	Pullout
							6	20.5	Pullout
11	1.09	102.41	37.51	129.11	0.00	0.00	1	1.1	Pullout
							2	7.9	Pullout
							3	7.5	Pullout
							4	14.3	Pullout
							5	13.9	Pullout
							6	20.7	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 12.9 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.59	7.41	65.20	12.37	85.15	26.30	1	30.3	Pullout
							2	32.5	Pullout
							3	27.3	Pullout
							4	29.5	Pullout

							5	22.3	Pullout
							6	24.6	Pullout
2	1.79	16.91	54.11	25.97	85.40	21.10	1	19.8	Pullout
							2	22.0	Pullout
							3	17.3	Pullout
							4	21.4	Pullout
							5	18.1	Pullout
							6	22.2	Pullout
3	1.46	26.41	51.06	42.03	90.00	14.01	1	12.3	Pullout
							2	18.0	Pullout
							3	15.2	Pullout
							4	19.8	Pullout
							5	16.9	Pullout
							6	21.5	Pullout
4	1.32	35.91	48.83	54.56	90.00	10.27	1	10.6	Pullout
							2	16.1	Pullout
							3	13.7	Pullout
							4	18.5	Pullout
							5	16.1	Pullout
							6	20.9	Pullout
5	1.24	45.41	44.60	63.78	90.00	11.19	1	6.7	Pullout
							2	12.3	Pullout
							3	10.5	Pullout

							4	16.1	Pullout
							5	14.3	Pullout
							6	19.8	Pullout
6	1.19	54.91	41.44	73.26	-90.00	12.12	1	3.1	Pullout
							2	9.2	Pullout
							3	8.0	Pullout
							4	14.1	Pullout
							5	12.9	Pullout
							6	19.0	Pullout
7	1.16	64.41	42.35	87.16	90.00	6.52	1	4.2	Pullout
							2	10.1	Pullout
							3	8.7	Pullout
							4	14.7	Pullout
							5	13.3	Pullout
							6	19.2	Pullout
8	1.14	73.91	40.39	97.05	90.00	6.99	1	1.8	Pullout
							2	8.1	Pullout
							3	7.1	Pullout
							4	13.4	Pullout
							5	12.4	Pullout
							6	18.7	Pullout
9	1.13	83.41	38.80	107.03	-90.00	7.45	1	0.0	Pullout
							2	6.4	Pullout

							3	5.7	Pullout
							4	12.3	Pullout
							5	11.6	Pullout
							6	18.2	Pullout
10	1.13	92.91	37.41	116.97	-90.00	7.89	1	0.0	Pullout
							2	4.9	Pullout
							3	4.4	Pullout
							4	11.3	Pullout
							5	10.9	Pullout
							6	17.7	Pullout
11	1.13	102.41	38.21	130.34	0.00	0.00	1	0.0	Pullout
							2	5.8	Pullout
							3	5.2	Pullout
							4	11.9	Pullout
							5	11.3	Pullout
							6	18.0	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 11.0 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.76	7.41	66.31	12.92	85.39	27.70	1	30.2	Pullout
							2	32.4	Pullout

							3	27.2	Pullout
							4	29.4	Pullout
							5	22.1	Pullout
							6	23.6	Pullout
2	1.91	16.91	55.36	26.78	85.61	22.10	1	19.8	Pullout
							2	21.9	Pullout
							3	16.3	Pullout
							4	20.2	Pullout
							5	16.8	Pullout
							6	20.7	Pullout
3	1.56	26.41	52.23	43.13	90.00	14.61	1	11.7	Pullout
							2	17.1	Pullout
							3	14.1	Pullout
							4	18.4	Pullout
							5	15.4	Pullout
							6	19.8	Pullout
4	1.40	35.91	46.11	51.81	90.00	16.00	1	6.1	Pullout
							2	11.4	Pullout
							3	9.3	Pullout
							4	14.6	Pullout
							5	12.6	Pullout
							6	17.9	Pullout
5	1.31	45.41	45.60	64.91	90.00	11.59	1	5.5	Pullout

							2	10.9	Pullout
							3	8.9	Pullout
							4	14.3	Pullout
							5	12.4	Pullout
							6	17.7	Pullout
6	1.25	54.91	42.37	74.32	-90.00	12.52	1	1.6	Pullout
							2	7.5	Pullout
							3	6.2	Pullout
							4	12.1	Pullout
							5	10.7	Pullout
							6	16.7	Pullout
7	1.22	64.41	43.21	88.38	90.00	6.72	1	2.6	Pullout
							2	8.4	Pullout
							3	6.9	Pullout
							4	12.7	Pullout
							5	11.2	Pullout
							6	16.9	Pullout
8	1.20	73.91	41.19	98.22	90.00	7.19	1	0.1	Pullout
							2	6.3	Pullout
							3	5.1	Pullout
							4	11.3	Pullout
							5	10.1	Pullout
							6	16.2	Pullout

9	1.18	83.41	39.54	108.16	-90.00	7.65	1	0.0	Pullout
							2	4.4	Pullout
							3	3.6	Pullout
							4	10.0	Pullout
							5	9.2	Pullout
							6	15.6	Pullout
10	1.17	92.91	38.10	118.07	-90.00	8.09	1	0.0	Pullout
							2	2.8	Pullout
							3	2.2	Pullout
							4	8.9	Pullout
							5	8.3	Pullout
							6	15.1	Pullout
11	1.17	102.41	38.89	131.59	0.00	0.00	1	0.0	Pullout
							2	3.7	Pullout
							3	3.0	Pullout
							4	9.5	Pullout
							5	8.8	Pullout
							6	15.4	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 9.0 kips (Clouterre)

	Minimum Factor of	Distance From Toe of Wall	Failure Planes: Lower Angle	Failure Planes: Lower Length	Failure Planes: Upper Angle	Failure Planes: Upper Length	Reinforcement	Reinforcement: Stress	Reinforcement: Controlling Resistance

Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.00	7.41	61.77	9.41	84.89	33.28	1	30.3	Pullout
							2	32.5	Pullout
							3	27.4	Pullout
							4	29.6	Pullout
							5	22.4	Pullout
							6	22.5	Pullout
2	2.02	16.91	53.71	22.86	83.02	27.85	1	20.4	Pullout
							2	22.8	Pullout
							3	17.3	Pullout
							4	17.6	Pullout
							5	14.2	Pullout
							6	18.4	Pullout
3	1.68	26.41	50.19	33.00	78.23	25.90	1	12.2	Pullout
							2	14.2	Pullout
							3	10.5	Pullout
							4	15.1	Pullout
							5	12.5	Pullout
							6	17.1	Pullout
4	1.51	35.91	43.92	39.89	75.45	28.59	1	3.0	Pullout
							2	6.7	Pullout
							3	5.0	Pullout
							4	10.7	Pullout

							5	9.1	Pullout
							6	14.7	Pullout
5	1.39	45.41	46.57	66.06	90.00	11.99	1	4.3	Pullout
							2	9.5	Pullout
							3	7.4	Pullout
							4	12.6	Pullout
							5	10.5	Pullout
							6	15.8	Pullout
6	1.32	54.91	43.27	75.41	-90.00	12.92	1	0.2	Pullout
							2	6.0	Pullout
							3	4.4	Pullout
							4	10.2	Pullout
							5	8.7	Pullout
							6	14.5	Pullout
7	1.29	64.41	40.69	84.96	90.00	13.85	1	0.0	Pullout
							2	3.0	Pullout
							3	2.0	Pullout
							4	8.2	Pullout
							5	7.1	Pullout
							6	13.4	Pullout
8	1.26	73.91	41.97	99.42	90.00	7.39	1	0.0	Pullout
							2	4.5	Pullout
							3	3.2	Pullout

							4	9.2	Pullout
							5	7.9	Pullout
							6	13.9	Pullout
9	1.24	83.41	40.27	109.32	-90.00	7.85	1	0.0	Pullout
							2	2.5	Pullout
							3	1.5	Pullout
							4	7.9	Pullout
							5	6.9	Pullout
							6	13.2	Pullout
10	1.22	92.91	38.78	119.19	-90.00	8.29	1	0.0	Pullout
							2	0.7	Pullout
							3	0.0	Pullout
							4	6.6	Pullout
							5	5.9	Pullout
							6	12.5	Pullout
11	1.22	102.41	39.57	132.85	0.00	0.00	1	0.0	Pullout
							2	1.7	Pullout
							3	0.8	Pullout
							4	7.3	Pullout
							5	6.4	Pullout
							6	12.9	Pullout

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Nominal Pullout Resistance

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Nominal Pullout Resistance

Layer	Description	klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

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END OF REPORT

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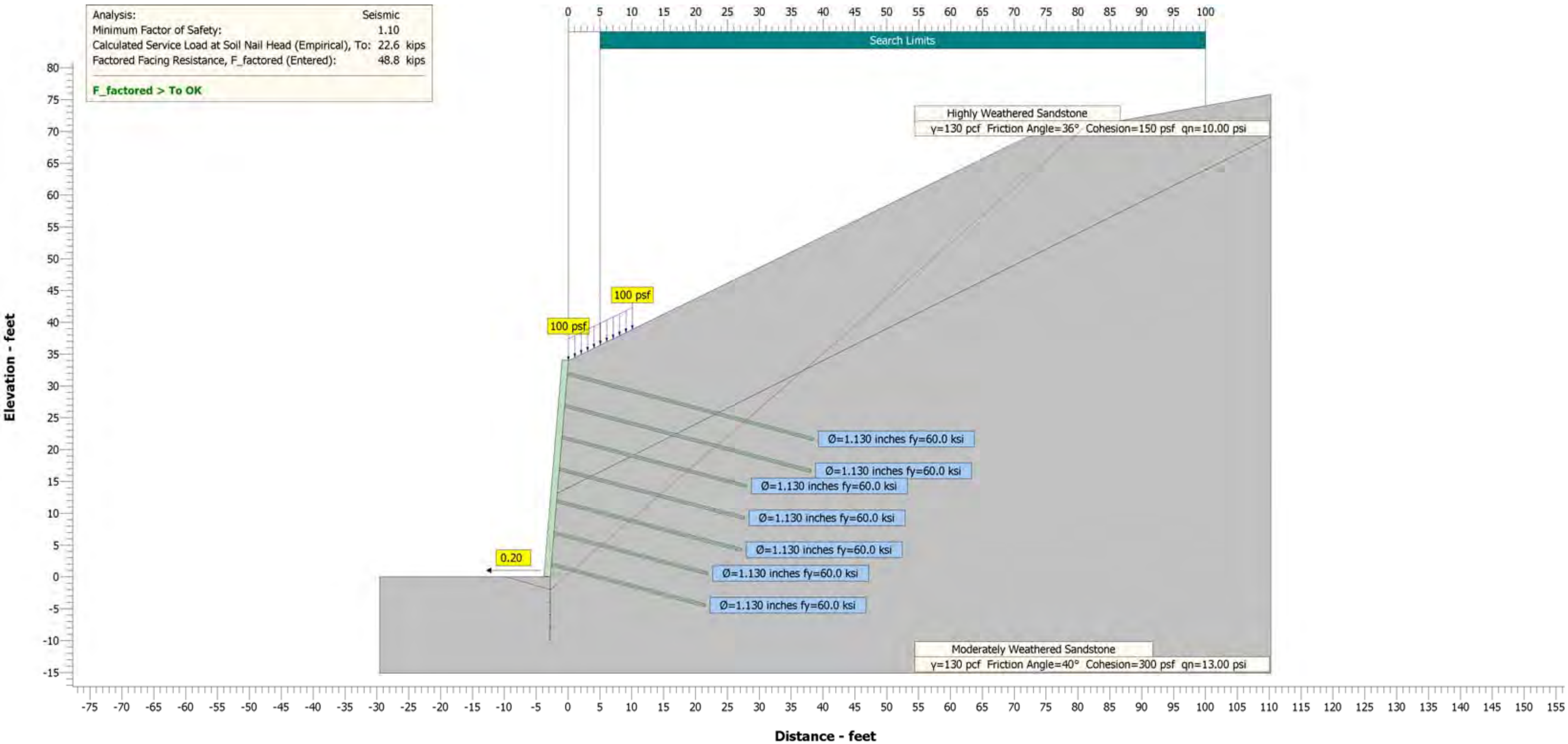
Analysis: Seismic
Minimum Factor of Safety: 1.10
Calculated Service Load at Soil Nail Head (Empirical), To: 22.6 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

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Snail

Version: 1.3

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File Information

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File Name: RW4_1021+60_7 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:10:09

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Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 7 row - Seismic

Station: Sta. 1021+60

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 34.00 feet

Wall Dimensions:

Wall Height: 34.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	80.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	14.00	100.00	64.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 7

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	40.00	15	2.00	1.130	60.0
2	40.00	15	5.00	1.130	60.0
3	30.00	15	5.00	1.130	60.0
4	30.00	15	5.00	1.130	60.0
5	30.00	15	5.00	1.130	60.0
6	25.00	15	5.00	1.130	60.0
7	25.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

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Soil Properties

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Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

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Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.10

Found at Search Level: 2.00 feet below the toe of the wall

Found at Search Point: 9

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 24.4 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	2.64	7.83	66.74	15.86	85.90	21.92	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.4	Pullout
							4	36.5	Pullout
							5	38.3	Pullout
							6	33.3	Pullout
							7	35.7	Pullout
2	1.80	17.33	52.78	25.79	85.18	20.61	1	34.5	Pullout
							2	36.7	Pullout
							3	25.2	Pullout
							4	29.5	Pullout

							5	33.7	Pullout
							6	30.7	Pullout
							7	34.9	Pullout
3	1.45	26.83	45.63	19.18	67.25	34.69	1	31.1	Pullout
							2	35.0	Pullout
							3	23.4	Pullout
							4	25.7	Pullout
							5	31.1	Pullout
							6	29.1	Pullout
							7	34.5	Pullout
4	1.27	36.33	47.95	54.24	-90.00	10.07	1	25.8	Pullout
							2	31.6	Pullout
							3	22.0	Pullout
							4	27.0	Pullout
							5	32.0	Pullout
							6	29.6	Pullout
							7	34.6	Pullout
5	1.19	45.83	43.82	63.52	90.00	10.99	1	22.2	Pullout
							2	27.9	Pullout
							3	19.0	Pullout
							4	24.6	Pullout
							5	30.3	Pullout
							6	28.7	Pullout
							7	34.4	Pullout

6	1.15	55.33	44.11	77.07	90.00	5.96	1	22.6	Pullout
							2	28.2	Pullout
							3	19.2	Pullout
							4	24.8	Pullout
							5	30.5	Pullout
							6	28.8	Pullout
							7	34.4	Pullout
7	1.12	64.83	41.73	86.87	-90.00	6.42	1	19.9	Pullout
							2	25.9	Pullout
							3	17.3	Pullout
							4	23.4	Pullout
							5	29.4	Pullout
							6	28.2	Pullout
							7	34.2	Pullout
8	1.10	74.33	39.83	96.79	90.00	6.89	1	17.6	Pullout
							2	24.0	Pullout
							3	15.8	Pullout
							4	22.2	Pullout
							5	28.6	Pullout
							6	27.7	Pullout
							7	34.1	Pullout
9	1.10	83.83	40.13	109.65	0.00	0.00	1	18.0	Pullout
							2	24.3	Pullout

							3	16.0	Pullout
							4	22.4	Pullout
							5	28.7	Pullout
							6	27.8	Pullout
							7	34.1	Pullout
10	1.10	93.33	37.78	118.09	0.00	0.00	1	15.1	Pullout
							2	21.9	Pullout
							3	14.0	Pullout
							4	20.8	Pullout
							5	27.6	Pullout
							6	27.1	Pullout
							7	33.9	Pullout
11	1.13	102.83	35.75	126.70	0.00	0.00	1	12.4	Pullout
							2	19.6	Pullout
							3	12.2	Pullout
							4	19.4	Pullout
							5	26.6	Pullout
							6	26.5	Pullout
							7	33.8	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 22.6 kips (Clouterre)

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---------------------------------------------------------------------------------------------------
|       |         |          |            Failure Planes            |        Reinforcement          |
|       |         |          |--------------------------------------|-------------------------------|
|       | Minimum | Distance |       Lower       |       Upper       |       |         |             |
|       | Factor  | From Toe |--------------------------------------|       |         | Controlling |
```

Node	of Safety	of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Resistance Failure Mode
1	2.52	7.83	61.49	13.12	86.67	26.95	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.2	Pullout
							4	36.1	Pullout
							5	35.9	Pullout
							6	30.9	Pullout
							7	34.0	Pullout
2	1.77	17.33	54.09	26.59	85.40	21.61	1	34.5	Pullout
							2	36.6	Pullout
							3	24.2	Pullout
							4	28.3	Pullout
							5	32.4	Pullout
							6	29.1	Pullout
							7	33.2	Pullout
3	1.43	26.83	45.46	26.77	74.29	29.73	1	28.3	Pullout
							2	31.4	Pullout
							3	18.1	Pullout
							4	23.2	Pullout
							5	28.6	Pullout
							6	26.7	Pullout
							7	32.1	Pullout

4	1.27	36.33	49.05	55.44	-90.00	10.47	1	25.0	Pullout
							2	30.4	Pullout
							3	20.6	Pullout
							4	25.4	Pullout
							5	30.3	Pullout
							6	27.8	Pullout
							7	32.6	Pullout
5	1.19	45.83	44.84	64.64	90.00	11.39	1	21.0	Pullout
							2	26.5	Pullout
							3	17.3	Pullout
							4	22.8	Pullout
							5	28.3	Pullout
							6	26.5	Pullout
							7	32.0	Pullout
6	1.14	55.33	45.06	78.33	90.00	6.16	1	21.2	Pullout
							2	26.7	Pullout
							3	17.5	Pullout
							4	23.0	Pullout
							5	28.4	Pullout
							6	26.6	Pullout
							7	32.1	Pullout
7	1.11	64.83	42.60	88.07	-90.00	6.62	1	18.3	Pullout
							2	24.2	Pullout
							3	15.5	Pullout

							4	21.4	Pullout
							5	27.3	Pullout
							6	25.8	Pullout
							7	31.7	Pullout
8	1.10	74.33	40.63	97.95	90.00	7.09	1	15.9	Pullout
							2	22.2	Pullout
							3	13.8	Pullout
							4	20.0	Pullout
							5	26.3	Pullout
							6	25.2	Pullout
							7	31.5	Pullout
** 9	1.10	83.83	40.92	110.95	0.00	0.00	1	16.3	Pullout
							2	22.5	Pullout
							3	14.0	Pullout
							4	20.2	Pullout
							5	26.4	Pullout
							6	25.3	Pullout
							7	31.5	Pullout
10	1.10	93.33	38.54	119.32	0.00	0.00	1	13.2	Pullout
							2	19.8	Pullout
							3	11.8	Pullout
							4	18.5	Pullout
							5	25.2	Pullout

							6	24.5	Pullout
							7	31.1	Pullout
11	1.11	102.83	36.48	127.88	0.00	0.00	1	10.4	Pullout
							2	17.4	Pullout
							3	9.9	Pullout
							4	16.9	Pullout
							5	24.0	Pullout
							6	23.7	Pullout
							7	30.8	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 19.4 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.59	7.83	62.69	13.65	86.83	28.35	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.1	Pullout
							4	36.0	Pullout
							5	35.8	Pullout
							6	29.9	Pullout
							7	32.7	Pullout
2	1.77	17.33	56.06	21.73	79.12	27.54	1	36.0	Pullout

							2	38.8	Pullout
							3	26.9	Pullout
							4	27.7	Pullout
							5	31.4	Pullout
							6	27.9	Pullout
							7	31.7	Pullout
3	1.47	26.83	49.18	32.84	77.82	25.43	1	27.0	Pullout
							2	29.2	Pullout
							3	18.6	Pullout
							4	23.4	Pullout
							5	28.2	Pullout
							6	25.7	Pullout
							7	30.5	Pullout
4	1.31	36.33	50.11	56.65	-90.00	10.87	1	24.2	Pullout
							2	29.3	Pullout
							3	19.3	Pullout
							4	24.0	Pullout
							5	28.6	Pullout
							6	26.0	Pullout
							7	30.6	Pullout
5	1.22	45.83	45.83	65.77	90.00	11.79	1	19.7	Pullout
							2	25.1	Pullout
							3	15.8	Pullout
							4	21.1	Pullout

							5	26.5	Pullout
							6	24.5	Pullout
							7	29.8	Pullout
6	1.17	55.33	42.60	75.17	90.00	12.72	1	15.8	Pullout
							2	21.7	Pullout
							3	12.9	Pullout
							4	18.8	Pullout
							5	24.7	Pullout
							6	23.3	Pullout
							7	29.2	Pullout
7	1.14	64.83	43.45	89.30	-90.00	6.82	1	16.8	Pullout
							2	22.6	Pullout
							3	13.7	Pullout
							4	19.4	Pullout
							5	25.2	Pullout
							6	23.6	Pullout
							7	29.4	Pullout
8	1.12	74.33	41.42	99.13	90.00	7.29	1	14.2	Pullout
							2	20.4	Pullout
							3	11.8	Pullout
							4	17.9	Pullout
							5	24.0	Pullout
							6	22.8	Pullout

							7	28.9	Pullout
9	1.10	83.83	33.75	40.33	46.10	72.54	1	5.6	Pullout
							2	10.9	Pullout
							3	3.8	Pullout
							4	11.5	Pullout
							5	19.1	Pullout
							6	19.4	Pullout
							7	27.1	Pullout
10	1.11	93.33	39.29	120.58	0.00	0.00	1	11.4	Pullout
							2	17.9	Pullout
							3	9.7	Pullout
							4	16.3	Pullout
							5	22.8	Pullout
							6	21.9	Pullout
							7	28.5	Pullout
11	1.12	102.83	37.19	129.08	0.00	0.00	1	8.4	Pullout
							2	15.3	Pullout
							3	7.6	Pullout
							4	14.5	Pullout
							5	21.4	Pullout
							6	21.0	Pullout
							7	28.0	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 16.7 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.73	7.83	66.71	13.86	85.48	29.80	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.6	Pullout
							4	36.7	Pullout
							5	36.7	Pullout
							6	29.8	Pullout
							7	32.2	Pullout
2	1.83	17.33	56.47	28.24	85.79	23.60	1	34.4	Pullout
							2	36.5	Pullout
							3	23.0	Pullout
							4	26.2	Pullout
							5	29.9	Pullout
							6	26.3	Pullout
							7	30.0	Pullout
3	1.54	26.83	50.30	33.60	78.27	26.40	1	26.8	Pullout
							2	28.9	Pullout
							3	17.4	Pullout
							4	22.0	Pullout
							5	26.7	Pullout

							6	24.0	Pullout
							7	28.6	Pullout
4	1.37	36.33	47.35	53.62	-90.00	16.90	1	19.3	Pullout
							2	24.4	Pullout
							3	14.8	Pullout
							4	19.9	Pullout
							5	25.0	Pullout
							6	22.8	Pullout
							7	27.9	Pullout
5	1.27	45.83	46.78	66.93	90.00	12.19	1	18.6	Pullout
							2	23.8	Pullout
							3	14.3	Pullout
							4	19.5	Pullout
							5	24.7	Pullout
							6	22.5	Pullout
							7	27.7	Pullout
6	1.22	55.33	43.49	76.26	90.00	13.12	1	14.4	Pullout
							2	20.1	Pullout
							3	11.2	Pullout
							4	17.0	Pullout
							5	22.7	Pullout
							6	21.1	Pullout
							7	26.9	Pullout

7	1.18	64.83	44.28	90.55	-90.00	7.02	1	15.4	Pullout
							2	21.0	Pullout
							3	12.0	Pullout
							4	17.6	Pullout
							5	23.2	Pullout
							6	21.5	Pullout
							7	27.1	Pullout
8	1.16	74.33	42.19	100.33	90.00	7.49	1	12.7	Pullout
							2	18.6	Pullout
							3	9.9	Pullout
							4	15.9	Pullout
							5	21.9	Pullout
							6	20.5	Pullout
							7	26.5	Pullout
9	1.13	83.83	34.45	40.66	46.86	73.56	1	4.1	Pullout
							2	9.3	Pullout
							3	1.4	Pullout
							4	8.9	Pullout
							5	16.4	Pullout
							6	16.6	Pullout
							7	24.1	Pullout
10	1.13	93.33	32.20	44.12	44.40	78.38	1	0.0	Pullout
							2	5.3	Pullout

							3	0.0	Pullout
							4	6.6	Pullout
							5	14.6	Pullout
							6	15.3	Pullout
							7	23.3	Pullout
11	1.15	102.83	37.89	130.30	0.00	0.00	1	6.5	Pullout
							2	13.3	Pullout
							3	5.4	Pullout
							4	12.2	Pullout
							5	19.0	Pullout
							6	18.4	Pullout
							7	25.2	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 15.0 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.78	7.83	67.65	14.41	85.68	31.20	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.5	Pullout
							4	36.6	Pullout
							5	36.6	Pullout
							6	29.2	Pullout

							7	31.3	Pullout
2	1.88	17.33	58.28	23.08	79.99	29.90	1	35.8	Pullout
							2	38.5	Pullout
							3	26.4	Pullout
							4	27.1	Pullout
							5	29.2	Pullout
							6	25.3	Pullout
							7	28.8	Pullout
3	1.63	26.83	48.04	36.11	84.30	26.99	1	24.5	Pullout
							2	25.1	Pullout
							3	13.2	Pullout
							4	18.2	Pullout
							5	23.2	Pullout
							6	20.9	Pullout
							7	25.9	Pullout
4	1.44	36.33	48.34	54.66	-90.00	17.50	1	18.3	Pullout
							2	23.2	Pullout
							3	13.5	Pullout
							4	18.5	Pullout
							5	23.4	Pullout
							6	21.0	Pullout
							7	26.0	Pullout
5	1.34	45.83	47.71	68.11	90.00	12.59	1	17.5	Pullout

							2	22.5	Pullout
							3	12.9	Pullout
							4	18.0	Pullout
							5	23.0	Pullout
							6	20.7	Pullout
							7	25.8	Pullout
6	1.27	55.33	44.35	77.37	90.00	13.52	1	13.1	Pullout
							2	18.7	Pullout
							3	9.6	Pullout
							4	15.2	Pullout
							5	20.8	Pullout
							6	19.1	Pullout
							7	24.7	Pullout
7	1.23	64.83	41.71	86.85	-90.00	14.45	1	9.4	Pullout
							2	15.4	Pullout
							3	6.8	Pullout
							4	12.9	Pullout
							5	19.0	Pullout
							6	17.7	Pullout
							7	23.8	Pullout
8	1.20	74.33	42.95	101.55	90.00	7.69	1	11.1	Pullout
							2	17.0	Pullout
							3	8.2	Pullout

							4	14.0	Pullout
							5	19.8	Pullout
							6	18.3	Pullout
							7	24.2	Pullout
9	1.17	83.83	35.14	41.01	47.59	74.58	1	2.7	Pullout
							2	7.8	Pullout
							3	0.0	Pullout
							4	6.5	Pullout
							5	13.8	Pullout
							6	13.9	Pullout
							7	21.2	Pullout
10	1.17	93.33	34.56	56.66	45.93	67.10	1	0.0	Pullout
							2	5.6	Pullout
							3	0.0	Pullout
							4	5.9	Pullout
							5	13.3	Pullout
							6	13.5	Pullout
							7	21.0	Pullout
11	1.18	102.83	38.58	131.54	0.00	0.00	1	4.7	Pullout
							2	11.3	Pullout
							3	3.3	Pullout
							4	10.0	Pullout
							5	16.6	Pullout

Level	Stress ksi	Controlling Resistance Failure Mode
6	15.9	Pullout
7	22.6	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 13.0 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
1	2.93	7.83	68.52	14.97	85.87	32.59	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	34.4	Pullout
							4	36.5	Pullout
							5	36.4	Pullout
							6	29.0	Pullout
							7	30.4	Pullout
2	2.07	17.33	55.84	24.69	83.55	30.84	1	34.9	Pullout
							2	37.3	Pullout
							3	24.3	Pullout
							4	24.5	Pullout
							5	26.1	Pullout
							6	22.6	Pullout
							7	26.4	Pullout
3	1.71	26.83	49.08	36.86	84.50	27.98	1	24.4	Pullout
							2	24.9	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
							3	12.1	Pullout
							4	16.9	Pullout
							5	21.7	Pullout
							6	19.2	Pullout
							7	24.0	Pullout
4	1.51	36.33	44.90	51.29	-90.00	24.14	1	11.4	Pullout
							2	16.9	Pullout
							3	7.8	Pullout
							4	13.3	Pullout
							5	18.8	Pullout
							6	16.9	Pullout
							7	22.4	Pullout
5	1.40	45.83	44.78	64.57	90.00	19.49	1	11.2	Pullout
							2	16.8	Pullout
							3	7.6	Pullout
							4	13.2	Pullout
							5	18.7	Pullout
							6	16.9	Pullout
							7	22.4	Pullout
6	1.33	55.33	45.18	78.50	90.00	13.92	1	11.8	Pullout
							2	17.3	Pullout
							3	8.1	Pullout
							4	13.5	Pullout

							5	19.0	Pullout
							6	17.1	Pullout
							7	22.6	Pullout
7	1.28	64.83	42.49	87.92	-90.00	14.85	1	7.9	Pullout
							2	13.9	Pullout
							3	5.1	Pullout
							4	11.0	Pullout
							5	17.0	Pullout
							6	15.5	Pullout
							7	21.5	Pullout
8	1.25	74.33	40.33	97.50	90.00	15.77	1	4.6	Pullout
							2	11.0	Pullout
							3	2.6	Pullout
							4	8.9	Pullout
							5	15.2	Pullout
							6	14.2	Pullout
							7	20.5	Pullout
9	1.22	83.83	37.59	52.90	49.11	64.03	1	0.2	Pullout
							2	7.1	Pullout
							3	0.0	Pullout
							4	6.1	Pullout
							5	12.9	Pullout
							6	12.4	Pullout

							7	19.3	Pullout
10	1.21	93.33	35.22	57.12	46.64	67.96	1	0.0	Pullout
							2	3.4	Pullout
							3	0.0	Pullout
							4	3.5	Pullout
							5	10.8	Pullout
							6	10.8	Pullout
							7	18.1	Pullout
11	1.21	102.83	33.17	61.43	44.44	72.01	1	0.0	Pullout
							2	0.1	Pullout
							3	0.0	Pullout
							4	1.0	Pullout
							5	8.8	Pullout
							6	9.3	Pullout
							7	17.1	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

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END OF REPORT

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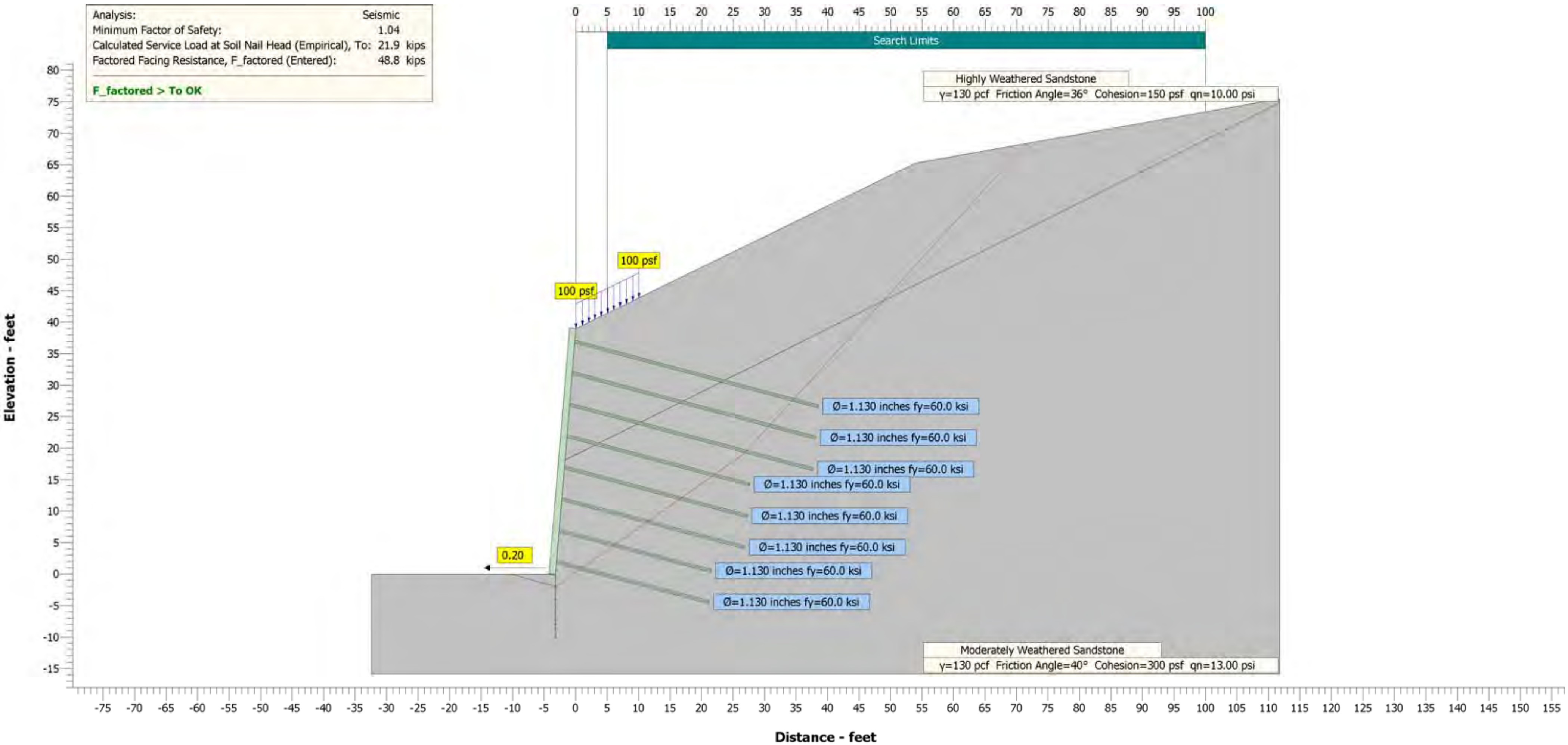

Analysis: Seismic
Minimum Factor of Safety: 1.04
Calculated Service Load at Soil Nail Head (Empirical), To: 21.9 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: RW4_1022+00_8 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:05:56

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 8 row - seismic

Station: Sta. 1022+00

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 39.00 feet

Wall Dimensions:

Wall Height: 39.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	60.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	19.00	100.00	69.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 8

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	40.00	15	2.00	1.130	60.0
2	40.00	15	5.00	1.130	60.0
3	40.00	15	5.00	1.130	60.0
4	30.00	15	5.00	1.130	60.0
5	30.00	15	5.00	1.130	60.0
6	30.00	15	5.00	1.130	60.0
7	25.00	15	5.00	1.130	60.0
8	25.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

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Soil Properties

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Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

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Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.04

Found at Search Level: 2.00 feet below the toe of the wall

Found at Search Point: 8

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 24.3 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	2.59	8.25	62.04	14.07	86.75	29.05	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	36.0	Pullout
							5	35.8	Pullout
							6	36.8	Pullout
							7	32.5	Pullout
							8	35.5	Pullout
2	1.64	17.75	55.26	28.03	85.60	23.10	1	34.4	Pullout
							2	36.6	Pullout
							3	37.8	Pullout

							4	26.8	Pullout
							5	30.7	Pullout
							6	34.6	Pullout
							7	31.2	Pullout
							8	35.1	Pullout
3	1.37	27.25	46.76	27.84	74.96	31.50	1	28.1	Pullout
							2	31.0	Pullout
							3	32.3	Pullout
							4	21.1	Pullout
							5	26.3	Pullout
							6	31.5	Pullout
							7	29.4	Pullout
							8	34.6	Pullout
4	1.20	36.75	50.31	57.54	90.00	11.07	1	24.0	Pullout
							2	29.0	Pullout
							3	33.6	Pullout
							4	23.6	Pullout
							5	28.2	Pullout
							6	32.9	Pullout
							7	30.2	Pullout
							8	34.8	Pullout
5	1.12	46.25	46.05	66.64	-90.00	11.99	1	19.3	Pullout
							2	24.6	Pullout

							3	30.0	Pullout
							4	20.6	Pullout
							5	25.9	Pullout
							6	31.2	Pullout
							7	29.2	Pullout
							8	34.5	Pullout
6	1.08	55.75	46.21	80.55	90.00	6.46	1	19.5	Pullout
							2	24.8	Pullout
							3	30.1	Pullout
							4	20.7	Pullout
							5	26.0	Pullout
							6	31.3	Pullout
							7	29.3	Pullout
							8	34.5	Pullout
7	1.05	65.25	37.49	32.89	50.03	60.94	1	12.5	Pullout
							2	17.1	Pullout
							3	21.8	Pullout
							4	13.8	Pullout
							5	20.6	Pullout
							6	27.5	Pullout
							7	27.0	Pullout
							8	33.9	Pullout
8	1.06	74.75	42.46	101.32	0.00	0.00	1	14.8	Pullout

							2	20.7	Pullout
							3	26.6	Pullout
							4	17.9	Pullout
							5	23.8	Pullout
							6	29.8	Pullout
							7	28.4	Pullout
							8	34.3	Pullout
9	1.07	84.25	39.75	109.58	0.00	0.00	1	11.1	Pullout
							2	17.5	Pullout
							3	24.0	Pullout
							4	15.7	Pullout
							5	22.1	Pullout
							6	28.6	Pullout
							7	27.7	Pullout
							8	34.1	Pullout
10	1.10	93.75	37.43	118.05	0.00	0.00	1	7.8	Pullout
							2	14.6	Pullout
							3	21.5	Pullout
							4	13.7	Pullout
							5	20.6	Pullout
							6	27.5	Pullout
							7	27.0	Pullout
							8	33.9	Pullout
11	1.13	103.25	35.42	126.69	0.00	0.00	1	4.7	Pullout

2	12.0	Pullout
3	19.3	Pullout
4	11.9	Pullout
5	19.2	Pullout
6	26.5	Pullout
7	26.4	Pullout
8	33.7	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 21.9 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.46	8.25	71.13	22.95	87.83	21.73	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	35.5	Pullout
							5	36.9	Pullout
							6	38.7	Pullout
							7	33.2	Pullout
							8	35.0	Pullout
2	1.63	17.75	56.40	28.86	85.78	24.10	1	34.4	Pullout
							2	36.5	Pullout

							3	37.7	Pullout
							4	25.8	Pullout
							5	29.5	Pullout
							6	33.3	Pullout
							7	29.7	Pullout
							8	33.4	Pullout
3	1.36	27.25	47.86	28.43	75.51	32.66	1	27.9	Pullout
							2	30.6	Pullout
							3	31.9	Pullout
							4	19.7	Pullout
							5	24.7	Pullout
							6	29.7	Pullout
							7	27.4	Pullout
							8	32.4	Pullout
4	1.20	36.75	46.13	31.81	66.87	37.41	1	23.3	Pullout
							2	25.8	Pullout
							3	28.1	Pullout
							4	18.3	Pullout
							5	23.6	Pullout
							6	28.9	Pullout
							7	26.9	Pullout
							8	32.2	Pullout
5	1.12	46.25	46.99	67.80	-90.00	12.39	1	18.2	Pullout
							2	23.4	Pullout

							3	28.5	Pullout
							4	19.0	Pullout
							5	24.2	Pullout
							6	29.3	Pullout
							7	27.2	Pullout
							8	32.3	Pullout
6	1.08	55.75	47.08	81.86	90.00	6.66	1	18.3	Pullout
							2	23.5	Pullout
							3	28.6	Pullout
							4	19.1	Pullout
							5	24.2	Pullout
							6	29.4	Pullout
							7	27.2	Pullout
							8	32.3	Pullout
7	1.05	65.25	38.31	33.26	50.86	62.02	1	11.3	Pullout
							2	15.9	Pullout
							3	20.4	Pullout
							4	11.6	Pullout
							5	18.3	Pullout
							6	25.0	Pullout
							7	24.4	Pullout
							8	31.1	Pullout
** 8	1.04	74.75	35.24	36.61	47.70	66.63	1	6.1	Pullout

							2	11.1	Pullout
							3	16.2	Pullout
							4	8.6	Pullout
							5	15.9	Pullout
							6	23.3	Pullout
							7	23.3	Pullout
							8	30.6	Pullout
9	1.06	84.25	40.55	110.87	0.00	0.00	1	9.5	Pullout
							2	15.8	Pullout
							3	22.1	Pullout
							4	13.7	Pullout
							5	19.9	Pullout
							6	26.2	Pullout
							7	25.2	Pullout
							8	31.4	Pullout
10	1.08	93.75	38.19	119.28	0.00	0.00	1	6.0	Pullout
							2	12.7	Pullout
							3	19.5	Pullout
							4	11.5	Pullout
							5	18.2	Pullout
							6	25.0	Pullout
							7	24.4	Pullout
							8	31.1	Pullout

11	1.11	103.25	36.15	127.86	0.00	0.00	1	2.8	Pullout
							2	9.9	Pullout
							3	17.1	Pullout
							4	9.5	Pullout
							5	16.7	Pullout
							6	23.8	Pullout
							7	23.6	Pullout
							8	30.8	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 19.8 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.40	8.25	61.43	15.52	88.52	31.82	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	35.1	Pullout
							5	34.6	Pullout
							6	34.2	Pullout
							7	29.5	Pullout
							8	32.5	Pullout
2	1.68	17.75	57.46	29.70	85.95	25.10	1	34.3	Pullout
							2	36.4	Pullout

							3	37.6	Pullout
							4	24.9	Pullout
							5	28.5	Pullout
							6	32.0	Pullout
							7	28.3	Pullout
							8	31.9	Pullout
3	1.40	27.25	48.92	29.03	76.02	33.83	1	27.7	Pullout
							2	30.3	Pullout
							3	31.5	Pullout
							4	18.4	Pullout
							5	23.2	Pullout
							6	28.1	Pullout
							7	25.6	Pullout
							8	30.4	Pullout
4	1.24	36.75	48.50	55.46	90.00	17.80	1	17.9	Pullout
							2	22.8	Pullout
							3	27.8	Pullout
							4	18.0	Pullout
							5	22.9	Pullout
							6	27.8	Pullout
							7	25.4	Pullout
							8	30.3	Pullout
5	1.15	46.25	47.90	68.98	-90.00	12.79	1	17.1	Pullout

							2	22.1	Pullout
							3	27.2	Pullout
							4	17.5	Pullout
							5	22.5	Pullout
							6	27.5	Pullout
							7	25.2	Pullout
							8	30.2	Pullout
6	1.10	55.75	44.55	78.23	90.00	13.72	1	12.6	Pullout
							2	18.2	Pullout
							3	23.8	Pullout
							4	14.7	Pullout
							5	20.2	Pullout
							6	25.8	Pullout
							7	24.0	Pullout
							8	29.6	Pullout
7	1.07	65.25	39.11	33.64	51.67	63.12	1	10.2	Pullout
							2	14.7	Pullout
							3	19.1	Pullout
							4	9.6	Pullout
							5	16.1	Pullout
							6	22.7	Pullout
							7	21.9	Pullout
							8	28.4	Pullout
8	1.06	74.75	36.00	36.96	48.49	67.67	1	4.8	Pullout

							2	9.7	Pullout
							3	14.6	Pullout
							4	6.3	Pullout
							5	13.5	Pullout
							6	20.7	Pullout
							7	20.5	Pullout
							8	27.7	Pullout
9	1.07	84.25	33.40	40.37	45.73	72.41	1	0.0	Pullout
							2	5.1	Pullout
							3	10.5	Pullout
							4	3.4	Pullout
							5	11.1	Pullout
							6	18.9	Pullout
							7	19.3	Pullout
							8	27.0	Pullout
10	1.09	93.75	38.94	120.53	0.00	0.00	1	4.3	Pullout
							2	10.9	Pullout
							3	17.5	Pullout
							4	9.4	Pullout
							5	16.0	Pullout
							6	22.6	Pullout
							7	21.8	Pullout
							8	28.4	Pullout

11	1.11	103.25	36.87	129.05	0.00	0.00	1	1.0	Pullout
							2	7.9	Pullout
							3	14.9	Pullout
							4	7.3	Pullout
							5	14.3	Pullout
							6	21.2	Pullout
							7	20.9	Pullout
							8	27.9	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 18.2 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	2.61	8.25	70.83	20.09	86.68	28.51	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	36.1	Pullout
							5	35.9	Pullout
							6	36.7	Pullout
							7	31.2	Pullout
							8	33.0	Pullout
2	1.76	17.75	58.47	30.55	86.10	26.10	1	34.3	Pullout
							2	36.4	Pullout

							3	37.5	Pullout
							4	24.0	Pullout
							5	27.4	Pullout
							6	30.9	Pullout
							7	27.0	Pullout
							8	30.5	Pullout
3	1.46	27.25	49.94	29.64	76.49	34.99	1	27.5	Pullout
							2	30.0	Pullout
							3	31.1	Pullout
							4	17.6	Pullout
							5	21.8	Pullout
							6	26.5	Pullout
							7	23.8	Pullout
							8	28.5	Pullout
4	1.29	36.75	45.04	52.01	90.00	24.54	1	10.9	Pullout
							2	16.4	Pullout
							3	21.9	Pullout
							4	12.7	Pullout
							5	18.2	Pullout
							6	23.7	Pullout
							7	21.8	Pullout
							8	27.3	Pullout
5	1.20	46.25	48.77	70.17	-90.00	13.19	1	16.1	Pullout

							2	21.0	Pullout
							3	25.9	Pullout
							4	16.1	Pullout
							5	20.9	Pullout
							6	25.8	Pullout
							7	23.4	Pullout
							8	28.2	Pullout
6	1.15	55.75	45.38	79.36	90.00	14.12	1	11.4	Pullout
							2	16.8	Pullout
							3	22.2	Pullout
							4	13.0	Pullout
							5	18.4	Pullout
							6	23.9	Pullout
							7	22.0	Pullout
							8	27.4	Pullout
7	1.11	65.25	41.72	43.71	53.22	54.48	1	8.1	Pullout
							2	12.3	Pullout
							3	18.1	Pullout
							4	9.5	Pullout
							5	15.5	Pullout
							6	21.6	Pullout
							7	20.3	Pullout
							8	26.4	Pullout

8	1.09	74.75	38.53	47.78	50.06	58.22	1	2.4	Pullout
							2	7.5	Pullout
							3	14.1	Pullout
							4	6.1	Pullout
							5	12.8	Pullout
							6	19.4	Pullout
							7	18.8	Pullout
							8	25.4	Pullout
9	1.09	84.25	34.11	40.70	46.49	73.42	1	0.0	Pullout
							2	3.7	Pullout
							3	8.9	Pullout
							4	1.0	Pullout
							5	8.6	Pullout
							6	16.2	Pullout
							7	16.4	Pullout
							8	24.0	Pullout
10	1.11	93.75	39.67	121.79	0.00	0.00	1	2.7	Pullout
							2	9.1	Pullout
							3	15.6	Pullout
							4	7.4	Pullout
							5	13.8	Pullout
							6	20.2	Pullout
							7	19.3	Pullout
							8	25.8	Pullout

11	1.13	103.25	37.57	130.26	0.00	0.00	1	0.0	Pullout
							2	6.0	Pullout
							3	12.9	Pullout
							4	5.1	Pullout
							5	11.9	Pullout
							6	18.8	Pullout
							7	18.3	Pullout
							8	25.1	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 15.6 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.74	8.25	68.73	15.92	85.91	34.70	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	36.5	Pullout
							5	36.4	Pullout
							6	36.3	Pullout
							7	29.4	Pullout
							8	31.5	Pullout
2	1.89	17.75	56.72	25.87	83.76	32.64	1	34.9	Pullout

							2	37.2	Pullout
							3	38.9	Pullout
							4	24.4	Pullout
							5	24.6	Pullout
							6	28.3	Pullout
							7	24.7	Pullout
							8	28.4	Pullout
3	1.53	27.25	53.40	36.56	79.48	29.85	1	26.3	Pullout
							2	28.1	Pullout
							3	28.9	Pullout
							4	18.1	Pullout
							5	22.3	Pullout
							6	26.4	Pullout
							7	23.3	Pullout
							8	27.5	Pullout
4	1.35	36.75	45.96	52.86	90.00	25.34	1	9.9	Pullout
							2	15.2	Pullout
							3	20.6	Pullout
							4	11.2	Pullout
							5	16.5	Pullout
							6	21.9	Pullout
							7	19.9	Pullout
							8	25.2	Pullout
5	1.26	46.25	45.81	66.35	-90.00	20.39	1	9.7	Pullout

							2	15.0	Pullout
							3	20.4	Pullout
							4	11.1	Pullout
							5	16.4	Pullout
							6	21.8	Pullout
							7	19.8	Pullout
							8	25.1	Pullout
6	1.20	55.75	46.18	80.51	90.00	14.52	1	10.2	Pullout
							2	15.5	Pullout
							3	20.8	Pullout
							4	11.4	Pullout
							5	16.7	Pullout
							6	22.0	Pullout
							7	20.0	Pullout
							8	25.3	Pullout
7	1.16	65.25	42.50	44.25	53.96	55.45	1	7.2	Pullout
							2	11.2	Pullout
							3	16.4	Pullout
							4	7.7	Pullout
							5	13.6	Pullout
							6	19.5	Pullout
							7	18.1	Pullout
							8	24.0	Pullout

8	1.13	74.75	39.27	48.28	50.81	59.15	1	1.3	Pullout
							2	5.8	Pullout
							3	12.3	Pullout
							4	4.1	Pullout
							5	10.6	Pullout
							6	17.2	Pullout
							7	16.3	Pullout
							8	22.9	Pullout
9	1.13	84.25	36.55	52.44	48.04	63.00	1	0.0	Pullout
							2	1.5	Pullout
							3	8.5	Pullout
							4	0.9	Pullout
							5	8.0	Pullout
							6	15.0	Pullout
							7	14.7	Pullout
							8	21.8	Pullout
10	1.14	93.75	34.24	56.70	45.59	66.98	1	0.0	Pullout
							2	0.0	Pullout
							3	5.1	Pullout
							4	0.0	Pullout
							5	5.5	Pullout
							6	13.1	Pullout
							7	13.3	Pullout
							8	20.8	Pullout

11	1.16	103.25	38.26	131.49	0.00	0.00	1	0.0	Pullout
							2	4.2	Pullout
							3	10.9	Pullout
							4	3.0	Pullout
							5	9.7	Pullout
							6	16.4	Pullout
							7	15.8	Pullout
							8	22.5	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 13.7 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.79	8.25	69.49	16.48	86.07	36.09	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	36.4	Pullout
							5	36.3	Pullout
							6	36.2	Pullout
							7	28.8	Pullout
							8	30.7	Pullout
2	1.96	17.75	57.67	26.55	83.98	33.83	1	34.8	Pullout

							2	37.1	Pullout
							3	38.7	Pullout
							4	24.2	Pullout
							5	24.4	Pullout
							6	27.2	Pullout
							7	23.4	Pullout
							8	27.0	Pullout
3	1.61	27.25	51.07	39.02	84.87	30.47	1	24.2	Pullout
							2	24.7	Pullout
							3	24.7	Pullout
							4	14.0	Pullout
							5	18.5	Pullout
							6	23.1	Pullout
							7	20.2	Pullout
							8	24.8	Pullout
4	1.42	36.75	46.85	53.73	90.00	26.14	1	8.9	Pullout
							2	14.1	Pullout
							3	19.3	Pullout
							4	9.8	Pullout
							5	15.0	Pullout
							6	20.2	Pullout
							7	18.0	Pullout
							8	23.2	Pullout

5	1.33	46.25	42.23	62.46	-90.00	27.99	1	1.6	Pullout
							2	7.5	Pullout
							3	13.5	Pullout
							4	4.8	Pullout
							5	10.8	Pullout
							6	16.8	Pullout
							7	15.4	Pullout
							8	21.4	Pullout
6	1.26	55.75	43.13	76.39	90.00	22.38	1	3.1	Pullout
							2	8.9	Pullout
							3	14.7	Pullout
							4	5.8	Pullout
							5	11.6	Pullout
							6	17.4	Pullout
							7	15.9	Pullout
							8	21.7	Pullout
7	1.22	65.25	40.03	59.65	62.97	43.07	1	0.0	Pullout
							2	4.2	Pullout
							3	10.5	Pullout
							4	2.3	Pullout
							5	8.6	Pullout
							6	15.0	Pullout
							7	14.0	Pullout
							8	20.4	Pullout

8	1.18	74.75	40.00	48.79	51.53	60.08	1	0.2	Pullout
							2	4.6	Pullout
							3	10.5	Pullout
							4	2.2	Pullout
							5	8.6	Pullout
							6	15.0	Pullout
							7	14.0	Pullout
							8	20.4	Pullout
9	1.18	84.25	37.25	52.92	48.76	63.90	1	0.0	Pullout
							2	0.0	Pullout
							3	6.6	Pullout
							4	0.0	Pullout
							5	5.7	Pullout
							6	12.6	Pullout
							7	12.2	Pullout
							8	19.1	Pullout
10	1.18	93.75	34.90	57.15	46.30	67.85	1	0.0	Pullout
							2	0.0	Pullout
							3	2.9	Pullout
							4	0.0	Pullout
							5	3.1	Pullout
							6	10.5	Pullout
							7	10.6	Pullout

							8	18.0	Pullout
11	1.19	103.25	38.94	132.74	0.00	0.00	1	0.0	Pullout
							2	2.4	Pullout
							3	9.0	Pullout
							4	0.9	Pullout
							5	7.5	Pullout
							6	14.1	Pullout
							7	13.3	Pullout
							8	19.9	Pullout

==

Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

==

END OF REPORT

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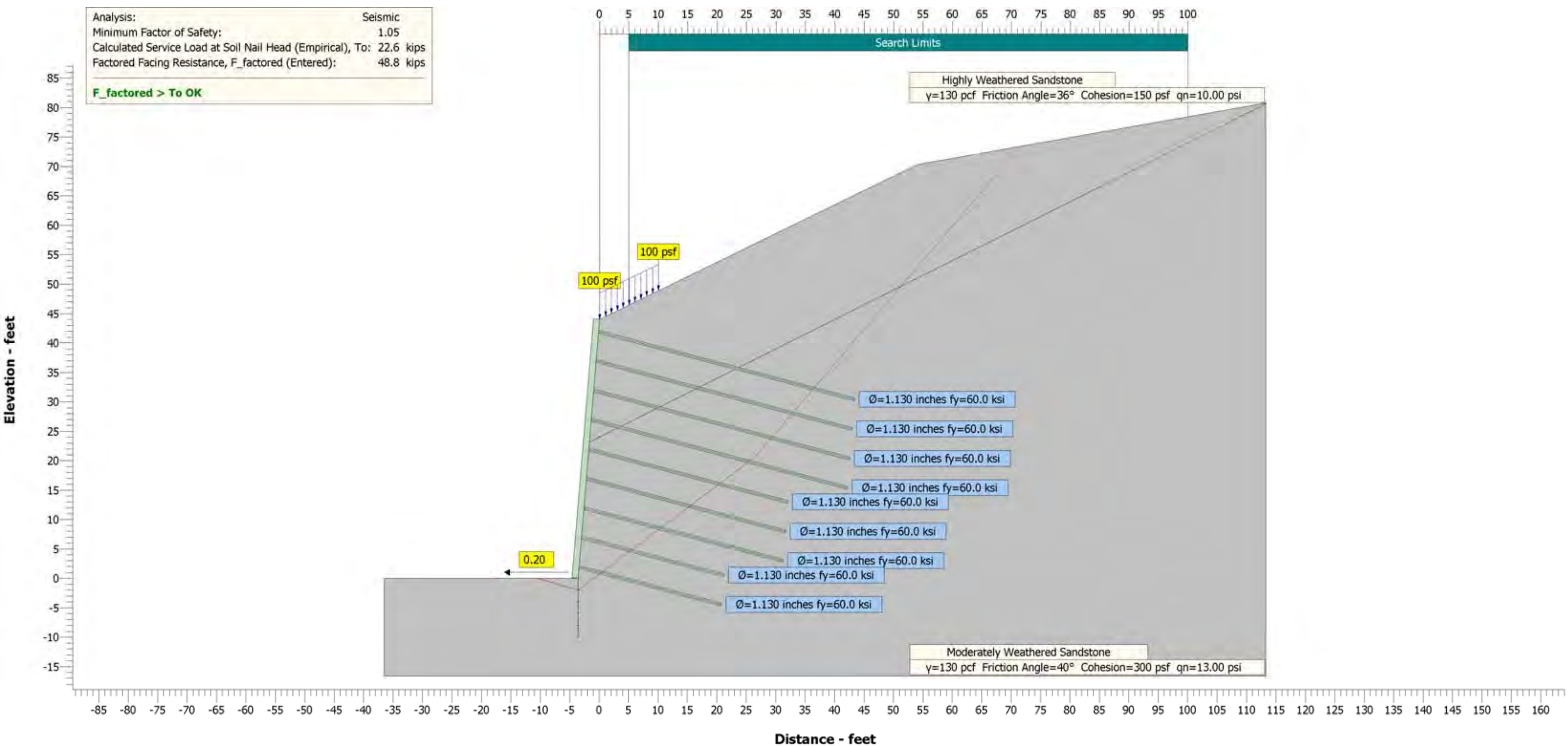
Analysis: Seismic
Minimum Factor of Safety: 1.05
Calculated Service Load at Soil Nail Head (Empirical), To: 22.6 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: RW4_1022+80_9 row_seismic.snz

Run Date: 01/27/16

Run Time: 15:59:45

==

Project Information

==

Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.:   Wall No. 4

Structure No.: 9 row - seismic

Station: Sta. 1022+80

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 44.00 feet

Wall Dimensions:

Wall Height: 44.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	60.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	24.00	100.00	74.00

Ground Water:

Include Ground Water: No

==

Soil Nails

==

Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 9

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	45.00	15	2.00	1.130	60.0
2	45.00	15	5.00	1.130	60.0
3	45.00	15	5.00	1.130	60.0
4	45.00	15	5.00	1.130	60.0
5	35.00	15	5.00	1.130	60.0
6	35.00	15	5.00	1.130	60.0
7	35.00	15	5.00	1.130	60.0
8	25.00	15	5.00	1.130	60.0
9	25.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

==========

Soil Properties

==========

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

==========

Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

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Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.05

Found at Search Level: 2.00 feet below the toe of the wall

Found at Search Point: 8

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 24.5 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.52	8.66	63.55	15.56	86.95	32.55	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	43.0	Pullout
							6	42.8	Pullout
							7	44.4	Bar Yield
							8	32.8	Pullout
							9	35.5	Pullout
2	1.79	18.16	54.58	25.07	83.24	30.86	1	42.3	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	33.7	Pullout
							6	37.7	Pullout
							7	41.7	Pullout
							8	31.0	Pullout
							9	35.1	Pullout
3	1.42	27.66	49.01	29.52	76.06	34.44	1	35.0	Pullout
							2	37.6	Pullout
							3	38.8	Pullout
							4	39.9	Pullout
							5	30.0	Pullout
							6	34.9	Pullout
							7	39.7	Pullout
							8	29.9	Pullout
							9	34.7	Pullout
4	1.27	37.16	47.27	32.86	67.68	39.14	1	30.2	Pullout
							2	32.5	Pullout
							3	34.7	Pullout
							4	38.4	Pullout
							5	28.8	Pullout
							6	33.9	Pullout
							7	39.0	Pullout

							8	29.5	Pullout
							9	34.6	Pullout
5	1.17	46.66	48.08	69.85	-90.00	12.99	1	24.1	Pullout
							2	29.1	Pullout
							3	34.1	Pullout
							4	39.1	Pullout
							5	29.4	Pullout
							6	34.4	Pullout
							7	39.4	Pullout
							8	29.7	Pullout
							9	34.7	Pullout
6	1.11	56.16	42.91	30.67	55.33	59.24	1	23.0	Pullout
							2	26.9	Pullout
							3	30.8	Pullout
							4	34.7	Pullout
							5	25.6	Pullout
							6	31.4	Pullout
							7	37.3	Pullout
							8	28.5	Pullout
							9	34.3	Pullout
7	1.07	65.66	41.15	43.60	52.66	54.13	1	16.2	Pullout
							2	20.5	Pullout
							3	26.5	Pullout

							4	32.7	Pullout
							5	24.2	Pullout
							6	30.4	Pullout
							7	36.5	Pullout
							8	28.0	Pullout
							9	34.2	Pullout
8	1.06	75.16	36.22	37.27	48.73	68.37	1	11.8	Pullout
							2	16.7	Pullout
							3	21.5	Pullout
							4	27.5	Pullout
							5	20.0	Pullout
							6	27.1	Pullout
							7	34.2	Pullout
							8	26.7	Pullout
							9	33.8	Pullout
9	1.07	84.66	33.63	40.67	45.97	73.09	1	6.7	Pullout
							2	12.0	Pullout
							3	17.3	Pullout
							4	24.5	Pullout
							5	17.5	Pullout
							6	25.2	Pullout
							7	32.9	Pullout
							8	25.9	Pullout
							9	33.6	Pullout

10	1.09	94.16	39.18	121.48	0.00	0.00	1	11.1	Pullout
							2	17.6	Pullout
							3	24.2	Pullout
							4	30.7	Pullout
							5	22.6	Pullout
							6	29.1	Pullout
							7	35.6	Pullout
							8	27.5	Pullout
							9	34.0	Pullout
11	1.12	103.66	37.11	129.99	0.00	0.00	1	7.7	Pullout
							2	14.6	Pullout
							3	21.6	Pullout
							4	28.5	Pullout
							5	20.8	Pullout
							6	27.7	Pullout
							7	34.7	Pullout
							8	26.9	Pullout
							9	33.9	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 22.6 kips (Clouterre)

	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.46	8.66	68.08	20.89	88.29	29.08	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	42.1	Pullout
							6	42.8	Pullout
							7	44.4	Bar Yield
							8	32.5	Pullout
							9	34.7	Pullout
2	1.72	18.16	51.39	20.38	81.66	37.55	1	42.7	Pullout
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	33.7	Pullout
							6	34.2	Pullout
							7	38.6	Pullout
							8	28.4	Pullout
							9	32.9	Pullout
3	1.40	27.66	46.21	31.98	80.92	35.06	1	33.1	Pullout
							2	34.5	Pullout
							3	35.1	Pullout
							4	35.7	Pullout
							5	25.7	Pullout

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							6	31.0	Pullout
							7	36.3	Pullout
							8	26.9	Pullout
							9	32.2	Pullout
4	1.25	37.16	45.18	26.36	66.94	47.43	1	30.6	Pullout
							2	33.1	Pullout
							3	35.4	Pullout
							4	37.7	Pullout
							5	25.4	Pullout
							6	30.4	Pullout
							7	35.8	Pullout
							8	26.6	Pullout
							9	32.1	Pullout
5	1.15	46.66	43.74	38.75	65.09	44.31	1	22.1	Pullout
							2	24.7	Pullout
							3	27.3	Pullout
							4	32.7	Pullout
							5	23.7	Pullout
							6	29.4	Pullout
							7	35.1	Pullout
							8	26.2	Pullout
							9	31.9	Pullout
6	1.10	56.16	45.57	80.22	90.00	14.32	1	18.3	Pullout

							2	23.7	Pullout
							3	29.1	Pullout
							4	34.5	Pullout
							5	25.2	Pullout
							6	30.6	Pullout
							7	36.0	Pullout
							8	26.7	Pullout
							9	32.1	Pullout
7	1.05	65.66	40.10	34.34	52.64	64.93	1	16.2	Pullout
							2	20.5	Pullout
							3	24.8	Pullout
							4	29.1	Pullout
							5	20.6	Pullout
							6	27.0	Pullout
							7	33.3	Pullout
							8	25.0	Pullout
							9	31.4	Pullout
** 8	1.05	75.16	36.96	37.62	49.49	69.42	1	10.6	Pullout
							2	15.4	Pullout
							3	20.1	Pullout
							4	25.3	Pullout
							5	17.7	Pullout
							6	24.6	Pullout
							7	31.6	Pullout

							8	23.9	Pullout
							9	30.9	Pullout
9	1.05	84.66	34.33	41.01	46.73	74.10	1	5.3	Pullout
							2	10.5	Pullout
							3	15.7	Pullout
							4	22.1	Pullout
							5	15.0	Pullout
							6	22.5	Pullout
							7	30.1	Pullout
							8	22.9	Pullout
							9	30.4	Pullout
10	1.07	94.16	32.10	44.46	44.30	78.94	1	0.4	Pullout
							2	6.0	Pullout
							3	11.6	Pullout
							4	19.2	Pullout
							5	12.6	Pullout
							6	20.6	Pullout
							7	28.6	Pullout
							8	22.0	Pullout
							9	30.0	Pullout
11	1.10	103.66	37.81	131.20	0.00	0.00	1	5.9	Pullout
							2	12.7	Pullout
							3	19.5	Pullout

							4	26.3	Pullout
							5	18.5	Pullout
							6	25.3	Pullout
							7	32.1	Pullout
							8	24.2	Pullout
							9	31.0	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 20.8 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.49	8.66	62.74	17.02	88.60	35.32	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	41.9	Pullout
							6	41.5	Pullout
							7	41.6	Pullout
							8	29.9	Pullout
							9	32.7	Pullout
2	1.72	18.16	56.59	26.39	83.73	33.24	1	42.2	Pullout
							2	44.4	Bar Yield
							3	44.4	Bar Yield

							4	44.4	Bar Yield
							5	31.9	Pullout
							6	35.3	Pullout
							7	39.0	Pullout
							8	28.0	Pullout
							9	31.8	Pullout
3	1.42	27.66	50.17	38.87	84.71	29.98	1	31.6	Pullout
							2	32.1	Pullout
							3	32.2	Pullout
							4	36.7	Pullout
							5	26.7	Pullout
							6	31.3	Pullout
							7	36.0	Pullout
							8	26.0	Pullout
							9	30.7	Pullout
4	1.27	37.16	46.09	53.59	90.00	25.74	1	16.8	Pullout
							2	22.1	Pullout
							3	27.4	Pullout
							4	32.7	Pullout
							5	23.3	Pullout
							6	28.6	Pullout
							7	33.9	Pullout
							8	24.6	Pullout

							9	29.9	Pullout
5	1.17	46.66	44.58	39.31	65.72	45.40	1	21.6	Pullout
							2	24.0	Pullout
							3	26.5	Pullout
							4	31.1	Pullout
							5	22.0	Pullout
							6	27.6	Pullout
							7	33.1	Pullout
							8	24.0	Pullout
							9	29.6	Pullout
6	1.11	56.16	46.36	81.37	90.00	14.72	1	17.2	Pullout
							2	22.4	Pullout
							3	27.7	Pullout
							4	32.9	Pullout
							5	23.5	Pullout
							6	28.8	Pullout
							7	34.1	Pullout
							8	24.7	Pullout
							9	29.9	Pullout
7	1.07	65.66	40.86	34.73	53.38	66.05	1	15.3	Pullout
							2	19.4	Pullout
							3	23.6	Pullout
							4	27.8	Pullout
							5	18.6	Pullout

							6	24.8	Pullout
							7	31.0	Pullout
							8	22.6	Pullout
							9	28.8	Pullout
8	1.05	75.16	37.68	37.99	50.23	70.49	1	9.5	Pullout
							2	14.1	Pullout
							3	18.8	Pullout
							4	23.4	Pullout
							5	15.4	Pullout
							6	22.3	Pullout
							7	29.1	Pullout
							8	21.3	Pullout
							9	28.1	Pullout
9	1.06	84.66	35.01	41.35	47.46	75.13	1	4.1	Pullout
							2	9.2	Pullout
							3	14.2	Pullout
							4	19.9	Pullout
							5	12.6	Pullout
							6	20.0	Pullout
							7	27.3	Pullout
							8	20.1	Pullout
							9	27.4	Pullout
10	1.07	94.16	32.75	44.78	45.01	79.92	1	0.0	Pullout

							2	4.5	Pullout
							3	10.0	Pullout
							4	16.7	Pullout
							5	10.0	Pullout
							6	17.8	Pullout
							7	25.7	Pullout
							8	19.0	Pullout
							9	26.8	Pullout
11	1.09	103.66	38.49	132.44	0.00	0.00	1	4.3	Pullout
							2	10.9	Pullout
							3	17.6	Pullout
							4	24.3	Pullout
							5	16.3	Pullout
							6	22.9	Pullout
							7	29.6	Pullout
							8	21.6	Pullout
							9	28.3	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 17.7 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of	Distance From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.55	8.66	71.72	22.09	86.85	31.51	1	44.4	Bar Yield

							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	43.1	Pullout
							6	42.9	Pullout
							7	44.4	Bar Yield
							8	31.5	Pullout
							9	33.2	Pullout
2	1.76	18.16	60.19	32.89	86.36	28.59	1	41.6	Pullout
							2	43.6	Pullout
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	32.6	Pullout
							6	35.8	Pullout
							7	39.1	Pullout
							8	27.6	Pullout
							9	30.8	Pullout
3	1.47	27.66	51.10	39.65	84.88	30.98	1	31.6	Pullout
							2	32.0	Pullout
							3	32.1	Pullout
							4	35.5	Pullout
							5	25.4	Pullout
							6	29.9	Pullout

							7	34.4	Pullout
							8	24.3	Pullout
							9	28.8	Pullout
4	1.30	37.16	45.57	37.16	74.35	41.34	1	25.7	Pullout
							2	27.1	Pullout
							3	28.5	Pullout
							4	29.9	Pullout
							5	20.5	Pullout
							6	25.9	Pullout
							7	31.3	Pullout
							8	22.0	Pullout
							9	27.4	Pullout
5	1.21	46.66	46.79	68.16	-90.00	21.29	1	15.5	Pullout
							2	20.7	Pullout
							3	25.9	Pullout
							4	31.1	Pullout
							5	21.6	Pullout
							6	26.8	Pullout
							7	32.0	Pullout
							8	22.6	Pullout
							9	27.7	Pullout
6	1.15	56.16	47.12	82.54	90.00	15.12	1	16.1	Pullout
							2	21.2	Pullout
							3	26.3	Pullout

							4	31.5	Pullout
							5	21.9	Pullout
							6	27.1	Pullout
							7	32.2	Pullout
							8	22.7	Pullout
							9	27.8	Pullout
7	1.11	65.66	41.60	35.12	54.09	67.17	1	14.3	Pullout
							2	18.4	Pullout
							3	22.5	Pullout
							4	26.5	Pullout
							5	16.7	Pullout
							6	22.8	Pullout
							7	28.8	Pullout
							8	20.3	Pullout
							9	26.3	Pullout
8	1.08	75.16	38.39	38.36	50.94	71.58	1	8.4	Pullout
							2	12.9	Pullout
							3	17.5	Pullout
							4	22.0	Pullout
							5	13.3	Pullout
							6	20.0	Pullout
							7	26.7	Pullout
							8	18.7	Pullout

							9	25.4	Pullout
9	1.08	84.66	35.69	41.69	48.17	76.17	1	2.9	Pullout
							2	7.8	Pullout
							3	12.8	Pullout
							4	17.8	Pullout
							5	10.2	Pullout
							6	17.5	Pullout
							7	24.7	Pullout
							8	17.3	Pullout
							9	24.5	Pullout
10	1.09	94.16	33.39	45.11	45.72	80.92	1	0.0	Pullout
							2	3.0	Pullout
							3	8.4	Pullout
							4	14.4	Pullout
							5	7.4	Pullout
							6	15.2	Pullout
							7	22.9	Pullout
							8	16.0	Pullout
							9	23.7	Pullout
11	1.11	103.66	31.42	48.59	43.54	85.80	1	0.0	Pullout
							2	0.0	Pullout
							3	4.2	Pullout
							4	11.3	Pullout
							5	4.9	Pullout

6	13.1	Pullout
7	21.3	Pullout
8	14.8	Pullout
9	23.0	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 16.9 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
1	2.66	8.66	69.63	17.42	86.10	38.20	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	43.6	Pullout
							6	43.5	Pullout
							7	43.4	Pullout
							8	29.8	Pullout
							9	31.8	Pullout
2	1.85	18.16	61.04	33.76	86.48	29.59	1	41.5	Pullout
							2	43.6	Pullout
							3	44.4	Bar Yield
							4	44.4	Bar Yield

							5	31.8	Pullout
							6	34.9	Pullout
							7	38.0	Pullout
							8	26.4	Pullout
							9	29.6	Pullout
3	1.54	27.66	51.99	40.43	85.04	31.97	1	31.5	Pullout
							2	31.9	Pullout
							3	31.9	Pullout
							4	34.5	Pullout
							5	24.2	Pullout
							6	28.6	Pullout
							7	32.9	Pullout
							8	22.7	Pullout
							9	27.1	Pullout
4	1.35	37.16	47.81	55.34	90.00	27.34	1	14.9	Pullout
							2	19.9	Pullout
							3	25.0	Pullout
							4	30.0	Pullout
							5	20.3	Pullout
							6	25.4	Pullout
							7	30.4	Pullout
							8	20.8	Pullout
							9	25.8	Pullout
5	1.26	46.66	47.59	69.19	-90.00	21.89	1	14.5	Pullout

							2	19.6	Pullout
							3	24.7	Pullout
							4	29.7	Pullout
							5	20.1	Pullout
							6	25.2	Pullout
							7	30.3	Pullout
							8	20.7	Pullout
							9	25.7	Pullout
6	1.19	56.16	42.65	45.82	64.24	51.70	1	13.1	Pullout
							2	15.8	Pullout
							3	18.5	Pullout
							4	23.9	Pullout
							5	15.2	Pullout
							6	21.1	Pullout
							7	27.0	Pullout
							8	18.2	Pullout
							9	24.1	Pullout
7	1.15	65.66	44.17	45.77	55.54	58.02	1	12.4	Pullout
							2	16.3	Pullout
							3	20.2	Pullout
							4	25.8	Pullout
							5	16.7	Pullout
							6	22.4	Pullout

							7	28.0	Pullout
							8	19.0	Pullout
							9	24.6	Pullout
8	1.12	75.16	40.91	49.72	52.42	61.63	1	6.2	Pullout
							2	10.5	Pullout
							3	15.5	Pullout
							4	21.7	Pullout
							5	13.3	Pullout
							6	19.5	Pullout
							7	25.7	Pullout
							8	17.3	Pullout
							9	23.5	Pullout
9	1.11	84.66	38.13	53.82	49.66	65.40	1	0.3	Pullout
							2	5.1	Pullout
							3	11.3	Pullout
							4	18.1	Pullout
							5	10.1	Pullout
							6	16.9	Pullout
							7	23.6	Pullout
							8	15.7	Pullout
							9	22.4	Pullout
10	1.11	94.16	34.02	45.44	46.40	81.92	1	0.0	Pullout
							2	1.6	Pullout
							3	6.9	Pullout

							4	12.1	Pullout
							5	5.0	Pullout
							6	12.6	Pullout
							7	20.2	Pullout
							8	13.1	Pullout
							9	20.7	Pullout
11	1.12	103.66	32.02	48.90	44.21	86.77	1	0.0	Pullout
							2	0.0	Pullout
							3	2.6	Pullout
							4	8.9	Pullout
							5	2.3	Pullout
							6	10.3	Pullout
							7	18.4	Pullout
							8	11.8	Pullout
							9	19.8	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 12.8 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower		Upper				Controlling Resistance Failure Mode
Node			Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	
1	2.77	8.66	70.29	17.98	86.24	39.59	1	44.4	Bar Yield
							2	44.4	Bar Yield

							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	43.5	Pullout
							6	43.4	Pullout
							7	43.3	Pullout
							8	29.0	Pullout
							9	30.9	Pullout
2	1.96	18.16	51.58	23.38	85.14	42.90	1	41.9	Pullout
							2	44.1	Pullout
							3	44.4	Bar Yield
							4	44.4	Bar Yield
							5	30.7	Pullout
							6	30.8	Pullout
							7	30.8	Pullout
							8	20.5	Pullout
							9	24.9	Pullout
3	1.61	27.66	49.90	34.36	82.01	39.81	1	32.7	Pullout
							2	33.9	Pullout
							3	34.3	Pullout
							4	34.7	Pullout
							5	20.4	Pullout
							6	24.9	Pullout
							7	29.6	Pullout
							8	19.6	Pullout

							9	24.3	Pullout
4	1.42	37.16	48.63	56.23	90.00	28.14	1	14.9	Pullout
							2	18.9	Pullout
							3	23.8	Pullout
							4	28.7	Pullout
							5	19.0	Pullout
							6	23.9	Pullout
							7	28.7	Pullout
							8	19.0	Pullout
							9	23.9	Pullout
5	1.31	46.66	43.95	64.82	-90.00	29.99	1	6.1	Pullout
							2	11.7	Pullout
							3	17.4	Pullout
							4	23.1	Pullout
							5	14.1	Pullout
							6	19.7	Pullout
							7	25.4	Pullout
							8	16.4	Pullout
							9	22.1	Pullout
6	1.24	56.16	44.78	79.12	90.00	23.88	1	7.5	Pullout
							2	13.0	Pullout
							3	18.6	Pullout
							4	24.1	Pullout

							5	15.0	Pullout
							6	20.5	Pullout
							7	26.0	Pullout
							8	16.9	Pullout
							9	22.4	Pullout
7	1.20	65.66	41.64	61.50	64.26	45.36	1	1.8	Pullout
							2	7.9	Pullout
							3	14.0	Pullout
							4	20.1	Pullout
							5	11.5	Pullout
							6	17.5	Pullout
							7	23.6	Pullout
							8	15.0	Pullout
							9	21.1	Pullout
8	1.17	75.16	41.60	50.25	53.09	62.58	1	5.2	Pullout
							2	9.4	Pullout
							3	13.9	Pullout
							4	20.0	Pullout
							5	11.4	Pullout
							6	17.5	Pullout
							7	23.6	Pullout
							8	15.0	Pullout
							9	21.1	Pullout
9	1.15	84.66	38.80	54.31	50.33	66.31	1	0.0	Pullout

							2	3.9	Pullout
							3	9.5	Pullout
							4	16.1	Pullout
							5	8.1	Pullout
							6	14.7	Pullout
							7	21.3	Pullout
							8	13.2	Pullout
							9	19.8	Pullout
10	1.15	94.16	34.64	45.78	47.07	82.94	1	0.0	Pullout
							2	0.2	Pullout
							3	5.4	Pullout
							4	10.5	Pullout
							5	2.7	Pullout
							6	10.1	Pullout
							7	17.6	Pullout
							8	10.4	Pullout
							9	17.8	Pullout
11	1.16	103.66	32.61	49.23	44.86	87.75	1	0.0	Pullout
							2	0.0	Pullout
							3	1.0	Pullout
							4	6.5	Pullout
							5	0.0	Pullout
							6	7.7	Pullout

7	15.6	Pullout
8	8.8	Pullout
9	16.8	Pullout

==

Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

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END OF REPORT

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Snail

Version: 1.3

Facing Analysis

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File Information

==

Draft Standard Drawing xs12-000-1 February 2013: Design Number 3

==

Analysis

==

Temporary Shoring Only: No

Check Bearing Plate Capacity: No

==

Soil Nails

==

Horizontal Spacing: 5.00 feet

Vertical Spacing: 5.00 feet

==

Facing

==

	Temporary	Permanent	
Facing Thickness:	4.000	8.000	inches
Vertical Reinforcement Area:	0.12	0.20	in²/foot
Horizontal Reinforcement Area:	0.12	0.20	in²/foot
No. of Vertical Waler Bars:	2	0	
No. of Horizontal Waler Bars:	2	0	
Waler Bar Area:	0.20	0.00	in²
Concrete Yield Strength:	3.6	3.6	ksi
Reinforcement Yield Strength:	65.0	60.0	ksi

Punching Correction Factor:	1.00	1.00
Flexural Correction Factor:	2.00	1.00

==

Bearing Plates

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Bearing Plate Width / Height: 10.000 inches

Bearing Plate Thickness: 1.000 inches

==

Studs

==

Number of Studs: 4

Stud Head Diameter: 1.250 inches

Head Thickness: 0.310 inches

Headed-Stud Length: 5.250 inches

Stud Shaft Diameter: 0.750 inches

Stud Spacing: 6.000 inches

Stud Tensile Strength: 60.0 ksi

==

Resistance Factors

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Facing Resistance Factors:

	Temporary	Permanent	Seismic
Punching:	0.74	0.67	0.91
Flexural:	0.74	0.67	0.91
Stud Tensile:		0.50	0.67

==

Results

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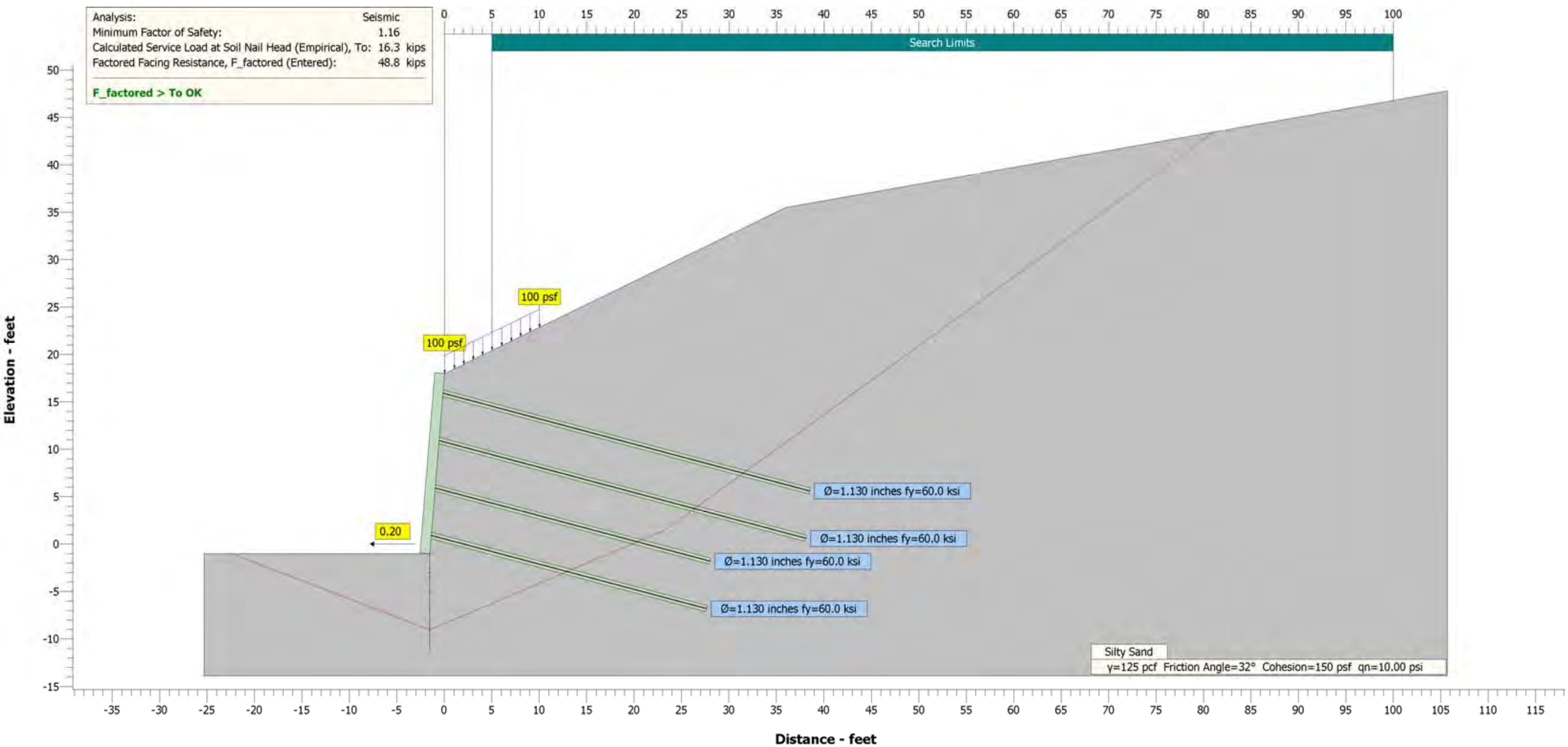
Facing:

	Factored Resistance	Capacity Ratio (Normalized by Control Mode

Analysis	Failure Mode	kips	Capacity)
Temporary:	Flexure:	39.0	1.24
	Punching Shear:	31.5	1.00
Permanent:	Flexure:	40.7	1.13
	Punching Shear:	35.9	1.00
	Stud Tensile:	53.0	1.48
Seismic:	Flexure:	55.3	1.13
	Punching Shear:	48.8	1.00
	Stud Tensile:	71.0	1.46

END OF REPORT


Analysis: Seismic
Minimum Factor of Safety: 1.16
Calculated Service Load at Soil Nail Head (Empirical), To: 16.3 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
100 psf
100 psf
0.20
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Silty Sand
γ=125 pcf Friction Angle=32° Cohesion=150 psf qn=10.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: RW4_1025+00_4 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:35:31

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 4 row - seismic

Station: Sta. 1025+00

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 18.00 feet

Wall Dimensions:

Wall Height: 19.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	40.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 1

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	0.00	100.00	50.00

Ground Water:

Include Ground Water: No

==

Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 8.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 4

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	40.00	15	2.00	1.130	60.0
2	40.00	15	5.00	1.130	60.0
3	30.00	15	5.00	1.130	60.0
4	30.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Silty Sand	125	32	150

Loads

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

RW4_1025+00_4 row_seismic.txt

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.16

Found at Search Level: 8.00 feet below the toe of the wall

Found at Search Point: 9

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 27.4 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	3.10	6.58	35.90	7.31	87.80	17.16	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.7	Pullout
							4	42.2	Pullout
2	2.81	16.08	31.30	15.06	80.01	18.53	1	40.7	Pullout
							2	41.4	Pullout
							3	33.3	Pullout
							4	41.7	Pullout
3	2.17	25.58	13.50	13.15	65.16	30.45	1	35.5	Pullout
							2	38.1	Pullout
							3	25.7	Pullout
							4	39.1	Pullout
4	1.73	35.08	21.95	18.91	58.18	33.27	1	30.4	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
							2	34.0	Pullout
							3	29.4	Pullout
							4	40.6	Pullout
5	1.54	44.58	26.95	25.01	49.87	34.59	1	27.6	Pullout
							2	37.1	Pullout
							3	31.7	Pullout
							4	41.3	Pullout
6	1.44	54.08	20.04	23.03	44.21	45.27	1	24.0	Pullout
							2	31.5	Pullout
							3	28.4	Pullout
							4	40.3	Pullout
7	1.38	63.58	17.92	26.73	40.78	50.38	1	19.5	Pullout
							2	29.4	Pullout
							3	27.2	Pullout
							4	40.0	Pullout
8	1.35	73.08	11.05	22.34	36.98	64.04	1	17.2	Pullout
							2	24.4	Pullout
							3	22.0	Pullout
							4	38.5	Pullout
9	1.34	82.58	10.18	25.17	34.70	70.31	1	13.6	Pullout
							2	21.2	Pullout
							3	21.1	Pullout
							4	38.3	Pullout

10	1.34	92.08	9.49	28.01	32.80	76.68	1	10.2	Pullout
							2	18.3	Pullout
							3	20.4	Pullout
							4	38.1	Pullout
11	1.35	101.58	13.25	20.87	27.91	91.96	1	16.8	Pullout
							2	26.1	Pullout
							3	23.9	Pullout
							4	39.0	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 24.3 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.53	6.58	49.89	9.19	87.70	16.42	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.8	Pullout
							4	41.0	Pullout
2	2.26	16.08	26.51	12.58	77.88	22.97	1	41.4	Pullout
							2	42.4	Pullout
							3	28.3	Pullout
							4	37.2	Pullout
3	1.76	25.58	32.59	18.22	65.92	25.08	1	35.1	Pullout

							2	37.6	Pullout
							3	30.3	Pullout
							4	38.4	Pullout
4	1.54	35.08	23.06	19.06	59.58	34.64	1	29.3	Pullout
							2	32.7	Pullout
							3	25.5	Pullout
							4	36.3	Pullout
5	1.36	44.58	19.64	23.67	54.99	38.85	1	22.6	Pullout
							2	26.7	Pullout
							3	23.2	Pullout
							4	35.3	Pullout
6	1.27	54.08	20.97	23.17	45.62	46.40	1	22.3	Pullout
							2	27.8	Pullout
							3	24.1	Pullout
							4	35.7	Pullout
7	1.25	63.58	24.33	20.93	37.78	56.31	1	24.2	Pullout
							2	31.2	Pullout
							3	26.2	Pullout
							4	36.6	Pullout
8	1.24	73.08	17.04	15.29	34.59	71.02	1	21.7	Pullout
							2	29.4	Pullout
							3	22.0	Pullout

							4	34.4	Pullout
9	1.24	82.58	15.72	17.16	32.34	78.19	1	18.8	Pullout
							2	27.0	Pullout
							3	20.2	Pullout
							4	33.9	Pullout
10	1.25	92.08	14.65	19.04	30.47	85.47	1	16.2	Pullout
							2	24.8	Pullout
							3	19.1	Pullout
							4	33.5	Pullout
11	1.26	101.58	13.78	20.92	28.89	92.82	1	13.7	Pullout
							2	22.8	Pullout
							3	18.2	Pullout
							4	33.1	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 22.8 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor of	From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.48	6.58	52.18	9.66	87.88	17.82	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.7	Pullout
							4	39.3	Pullout

2	1.96	16.08	39.73	18.82	84.91	18.11	1	39.1	Pullout
							2	39.1	Pullout
							3	30.2	Pullout
							4	36.8	Pullout
3	1.63	25.58	30.17	20.71	72.47	25.48	1	31.7	Pullout
							2	33.3	Pullout
							3	25.6	Pullout
							4	34.3	Pullout
4	1.45	35.08	38.13	44.60	90.00	11.80	1	30.7	Pullout
							2	37.6	Pullout
							3	29.5	Pullout
							4	36.4	Pullout
5	1.29	44.58	25.11	19.69	51.33	42.81	1	26.1	Pullout
							2	30.7	Pullout
							3	22.4	Pullout
							4	32.6	Pullout
6	1.22	54.08	21.89	23.31	46.97	47.55	1	20.7	Pullout
							2	26.0	Pullout
							3	20.1	Pullout
							4	31.3	Pullout
7	1.19	63.58	19.54	26.99	43.42	52.52	1	15.7	Pullout
							2	21.6	Pullout
							3	18.1	Pullout

							4	30.3	Pullout
8	1.19	73.08	23.12	23.84	36.20	63.40	1	18.7	Pullout
							2	26.0	Pullout
							3	21.0	Pullout
							4	31.8	Pullout
9	1.19	82.58	16.36	17.21	33.44	79.17	1	16.3	Pullout
							2	24.3	Pullout
							3	17.1	Pullout
							4	28.6	Pullout
10	1.20	92.08	15.23	19.09	31.50	86.39	1	13.5	Pullout
							2	21.9	Pullout
							3	15.2	Pullout
							4	28.0	Pullout
11	1.21	101.58	14.31	20.97	29.86	93.70	1	10.8	Pullout
							2	19.6	Pullout
							3	13.4	Pullout
							4	27.4	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 19.2 kips (Clouterre)

RW4_1025+00_4 row_seismic.txt

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.33	6.58	42.81	8.08	88.28	21.96	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.5	Pullout
							4	36.1	Pullout
2	1.88	16.08	36.79	16.07	81.85	22.68	1	40.1	Pullout
							2	40.6	Pullout
							3	26.0	Pullout
							4	33.0	Pullout
3	1.60	25.58	35.66	18.89	68.29	27.66	1	33.8	Pullout
							2	36.0	Pullout
							3	25.2	Pullout
							4	32.7	Pullout
4	1.37	35.08	30.51	24.43	64.13	32.16	1	26.0	Pullout
							2	28.8	Pullout
							3	22.1	Pullout
							4	30.8	Pullout
5	1.28	44.58	30.51	25.87	53.97	37.89	1	23.6	Pullout
							2	28.5	Pullout
							3	22.1	Pullout
							4	30.8	Pullout
6	1.21	54.08	26.76	30.28	49.64	41.76	1	17.6	Pullout
							2	24.9	Pullout

							3	19.5	Pullout
							4	29.2	Pullout
7	1.18	63.58	20.34	27.12	44.66	53.64	1	13.9	Pullout
							2	19.6	Pullout
							3	13.9	Pullout
							4	25.8	Pullout
8	1.17	73.08	24.00	24.00	37.35	64.35	1	16.5	Pullout
							2	23.6	Pullout
							3	17.3	Pullout
							4	27.8	Pullout
9	1.16	82.58	22.17	26.75	34.94	70.52	1	13.1	Pullout
							2	20.7	Pullout
							3	15.7	Pullout
							4	26.8	Pullout
10	1.17	92.08	20.69	29.53	32.91	76.78	1	9.9	Pullout
							2	18.0	Pullout
							3	14.3	Pullout
							4	26.0	Pullout
11	1.19	101.58	19.46	32.32	31.20	83.13	1	7.0	Pullout
							2	15.9	Pullout
							3	13.0	Pullout
							4	25.2	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 16.3 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.41	6.58	63.30	13.18	87.87	17.68	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.7	Pullout
							4	38.4	Pullout
2	1.92	16.08	35.23	11.81	76.72	28.01	1	41.8	Pullout
							2	42.9	Pullout
							3	29.0	Pullout
							4	30.1	Pullout
3	1.60	25.58	42.23	17.28	64.73	29.96	1	35.7	Pullout
							2	38.4	Pullout
							3	26.0	Pullout
							4	32.1	Pullout
4	1.39	35.08	31.70	24.74	65.18	33.43	1	25.3	Pullout
							2	27.9	Pullout
							3	19.4	Pullout
							4	27.7	Pullout
5	1.26	44.58	31.64	26.18	55.18	39.04	1	22.5	Pullout

							2	26.5	Pullout
							3	19.3	Pullout
							4	27.7	Pullout
6	1.22	54.08	27.77	30.56	50.85	42.83	1	16.2	Pullout
							2	22.0	Pullout
							3	16.3	Pullout
							4	25.7	Pullout
7	1.18	63.58	27.25	21.46	41.45	59.38	1	18.5	Pullout
							2	24.8	Pullout
							3	16.0	Pullout
							4	25.4	Pullout
8	1.17	73.08	24.86	24.16	38.47	65.34	1	14.5	Pullout
							2	21.4	Pullout
							3	13.8	Pullout
							4	24.0	Pullout
** 9	1.16	82.58	22.96	26.91	35.99	71.44	1	10.9	Pullout
							2	18.2	Pullout
							3	11.9	Pullout
							4	22.8	Pullout
10	1.17	92.08	21.41	29.67	33.91	77.66	1	7.5	Pullout
							2	15.3	Pullout
							3	10.3	Pullout
							4	21.7	Pullout

11	1.17	101.58	20.12	32.46	32.13	83.97	1	4.4	Pullout
							2	12.6	Pullout
							3	8.8	Pullout
							4	20.7	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 12.6 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.37	6.58	57.87	11.14	88.29	22.02	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.5	Pullout
							4	36.1	Pullout
2	1.89	16.08	51.25	23.13	84.91	18.11	1	39.1	Pullout
							2	39.1	Pullout
							3	28.4	Pullout
							4	33.0	Pullout
3	1.60	25.58	38.51	26.15	78.17	24.95	1	28.8	Pullout
							2	29.7	Pullout
							3	20.9	Pullout
							4	27.7	Pullout
4	1.43	35.08	42.13	47.31	90.00	13.60	1	26.0	Pullout

							2	32.1	Pullout
							3	23.2	Pullout
							4	29.4	Pullout
5	1.30	44.58	32.74	26.50	56.32	40.19	1	21.4	Pullout
							2	25.3	Pullout
							3	16.7	Pullout
							4	24.8	Pullout
6	1.23	54.08	28.75	30.84	52.01	43.93	1	14.9	Pullout
							2	19.4	Pullout
							3	13.3	Pullout
							4	22.4	Pullout
7	1.20	63.58	31.09	29.70	43.17	52.31	1	16.0	Pullout
							2	22.0	Pullout
							3	15.4	Pullout
							4	23.8	Pullout
8	1.19	73.08	25.72	24.34	39.55	66.34	1	12.6	Pullout
							2	19.3	Pullout
							3	10.9	Pullout
							4	20.4	Pullout
9	1.18	82.58	23.74	27.06	37.01	72.40	1	8.8	Pullout
							2	15.9	Pullout
							3	8.3	Pullout

							4	18.9	Pullout
10	1.18	92.08	22.12	29.82	34.87	78.57	1	5.2	Pullout
							2	12.8	Pullout
							3	6.4	Pullout
							4	17.6	Pullout
11	1.18	101.58	20.78	32.60	33.05	84.83	1	1.9	Pullout
							2	10.0	Pullout
							3	4.8	Pullout
							4	16.4	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Silty Sand	3.016

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END OF REPORT

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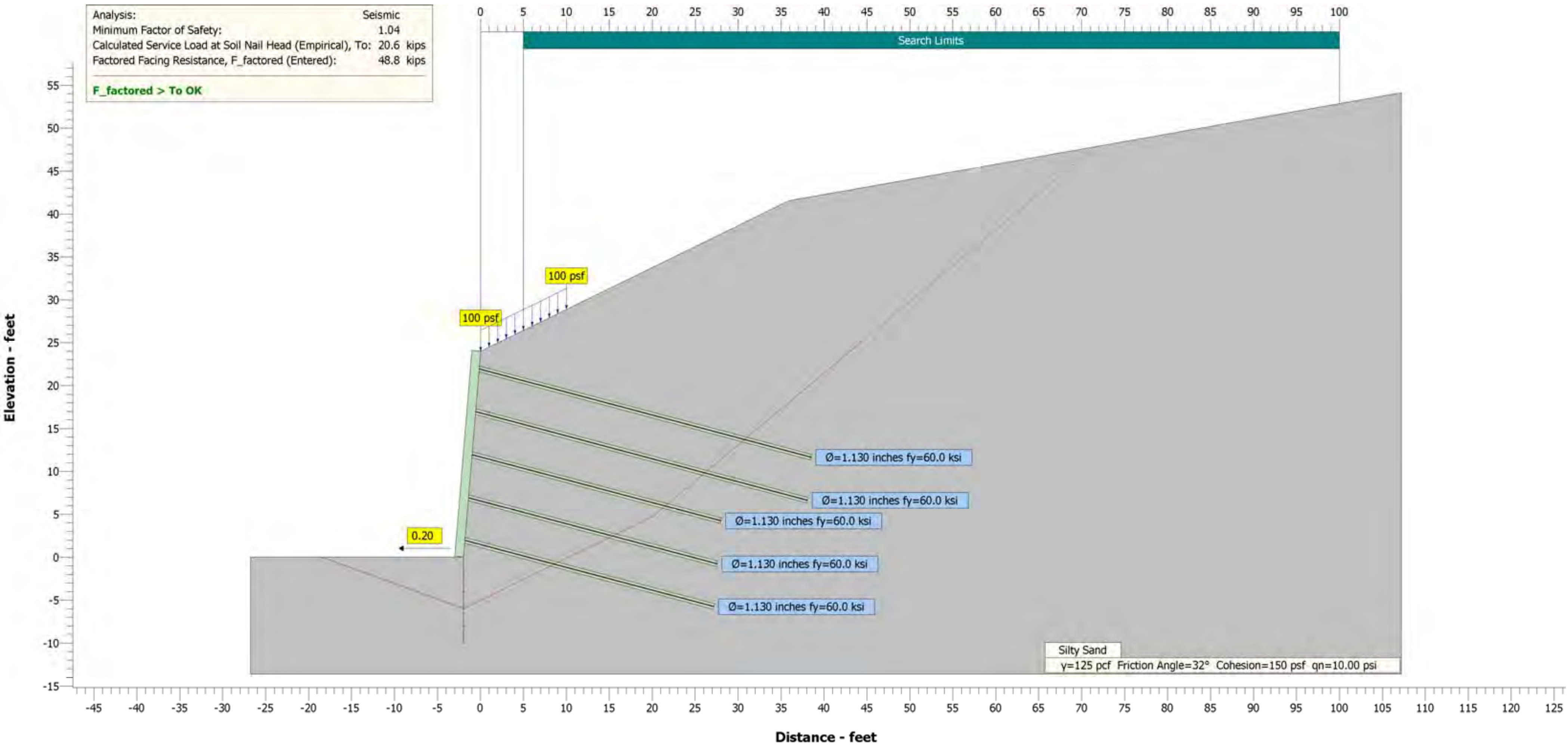

Analysis: Seismic
Minimum Factor of Safety: 1.04
Calculated Service Load at Soil Nail Head (Empirical), To: 20.6 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
100 psf
100 psf
0.20
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Silty Sand
γ=125 pcf Friction Angle=32° Cohesion=150 psf qn=10.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

==

File Name: RW4_1025+50_5 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:29:58

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Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 4

Structure No.: 5 row - seismic

Station: Sta. 1025+50

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 24.00 feet

Wall Dimensions:

Wall Height: 24.00 feet

Facing Angle: 85.24 degrees

Facing Batter: 0.999 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	40.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 1

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	0.00	100.00	50.00

Ground Water:

Include Ground Water: No

==

Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 8.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 5

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	40.00	15	2.00	1.130	60.0
2	40.00	15	5.00	1.130	60.0
3	30.00	15	5.00	1.130	60.0
4	30.00	15	5.00	1.130	60.0
5	30.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Silty Sand	125	32	150

Loads

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	Distance from Top of Wall End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.04

Found at Search Level: 6.00 feet below the toe of the wall

Found at Search Point: 8

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 29.2 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.62	7.00	40.01	8.22	88.11	21.16	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.6	Pullout
							4	36.2	Pullout
							5	42.5	Pullout
2	2.17	16.50	39.93	19.36	84.94	18.72	1	39.1	Pullout
							2	39.1	Pullout
							3	29.4	Pullout
							4	35.9	Pullout
							5	42.5	Pullout
3	1.71	26.00	30.48	21.12	72.67	26.18	1	31.6	Pullout
							2	33.2	Pullout
							3	24.4	Pullout
							4	33.0	Pullout
							5	41.7	Pullout
4	1.43	35.50	34.29	21.48	57.85	33.35	1	30.6	Pullout
							2	34.3	Pullout
							3	26.6	Pullout
							4	34.3	Pullout
							5	42.0	Pullout
5	1.29	45.00	29.70	25.90	53.08	37.46	1	24.4	Pullout
							2	30.1	Pullout
							3	23.9	Pullout
							4	32.7	Pullout
							5	41.6	Pullout
6	1.21	54.50	22.19	23.54	47.40	48.31	1	20.2	Pullout
							2	25.4	Pullout
							3	18.4	Pullout
							4	29.5	Pullout
							5	40.7	Pullout
7	1.18	64.00	19.82	27.21	43.86	53.26	1	15.0	Pullout
							2	20.9	Pullout
							3	16.3	Pullout
							4	28.3	Pullout
							5	40.3	Pullout
8	1.17	73.50	23.44	24.03	36.62	64.11	1	17.9	Pullout

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							2	25.1	Pullout
							3	19.4	Pullout
							4	30.1	Pullout
							5	40.8	Pullout
9	1.17	83.00	21.67	26.79	34.27	70.30	1	14.5	Pullout
							2	22.3	Pullout
							3	18.0	Pullout
							4	29.3	Pullout
							5	40.6	Pullout
10	1.18	92.50	20.24	29.58	32.29	76.60	1	11.5	Pullout
							2	19.9	Pullout
							3	16.7	Pullout
							4	28.5	Pullout
							5	40.4	Pullout
11	1.19	102.00	14.52	21.07	30.23	94.44	1	9.8	Pullout
							2	18.5	Pullout
							3	12.1	Pullout
							4	24.9	Pullout
							5	39.3	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 26.2 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	of Safety	of Wall feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.40	7.00	34.11	5.07	83.76	25.75	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	38.4	Pullout
							4	38.6	Pullout
							5	38.8	Pullout
2	1.88	16.50	36.93	16.51	81.89	23.38	1	40.1	Pullout
							2	40.5	Pullout
							3	25.9	Pullout
							4	32.0	Pullout
							5	39.2	Pullout
3	1.51	26.00	44.04	21.70	65.31	24.90	1	35.4	Pullout
							2	38.0	Pullout
							3	28.7	Pullout
							4	34.5	Pullout
							5	40.3	Pullout
4	1.28	35.50	30.81	24.80	64.40	32.86	1	25.8	Pullout
							2	28.6	Pullout
							3	21.0	Pullout
							4	29.5	Pullout
							5	38.1	Pullout
5	1.17	45.00	26.45	20.10	53.00	44.86	1	24.5	Pullout

							2	28.9	Pullout
							3	18.2	Pullout
							4	27.4	Pullout
							5	37.1	Pullout
6	1.12	54.50	29.61	18.80	44.25	53.26	1	24.0	Pullout
							2	29.7	Pullout
							3	20.5	Pullout
							4	29.0	Pullout
							5	37.8	Pullout
7	1.10	64.00	26.63	21.48	40.68	59.07	1	19.7	Pullout
							2	26.1	Pullout
							3	17.8	Pullout
							4	27.5	Pullout
							5	37.2	Pullout
8	1.09	73.50	24.31	24.19	37.75	65.07	1	15.8	Pullout
							2	22.8	Pullout
							3	15.8	Pullout
							4	26.2	Pullout
							5	36.6	Pullout
9	1.10	83.00	22.46	26.94	35.33	71.21	1	12.2	Pullout
							2	19.7	Pullout
							3	14.1	Pullout
							4	25.1	Pullout

							5	36.1	Pullout
10	1.11	92.50	20.96	29.72	33.29	77.46	1	9.0	Pullout
							2	16.9	Pullout
							3	12.5	Pullout
							4	24.1	Pullout
							5	35.7	Pullout
11	1.12	102.00	19.72	32.51	31.56	83.80	1	6.0	Pullout
							2	14.3	Pullout
							3	11.2	Pullout
							4	23.3	Pullout
							5	35.3	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 23.4 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.17	7.00	55.40	11.09	88.12	21.32	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.6	Pullout
							4	36.2	Pullout
							5	39.9	Pullout
2	1.73	16.50	53.03	21.95	79.34	17.84	1	40.9	Pullout

							2	41.7	Pullout
							3	30.8	Pullout
							4	35.1	Pullout
							5	39.5	Pullout
3	1.38	26.00	41.11	24.15	71.87	25.07	1	32.0	Pullout
							2	33.7	Pullout
							3	24.5	Pullout
							4	30.8	Pullout
							5	37.1	Pullout
4	1.23	35.50	41.16	47.15	90.00	13.30	1	26.9	Pullout
							2	33.2	Pullout
							3	24.5	Pullout
							4	30.8	Pullout
							5	37.1	Pullout
5	1.12	45.00	31.95	26.52	55.51	39.73	1	22.2	Pullout
							2	26.1	Pullout
							3	18.3	Pullout
							4	26.5	Pullout
							5	34.8	Pullout
6	1.08	54.50	33.70	26.20	46.05	47.11	1	21.8	Pullout
							2	27.2	Pullout
							3	19.6	Pullout
							4	27.4	Pullout

							5	35.3	Pullout
7	1.06	64.00	27.57	21.66	41.83	60.13	1	18.0	Pullout
							2	24.2	Pullout
							3	15.3	Pullout
							4	24.0	Pullout
							5	33.5	Pullout
8	1.05	73.50	25.17	24.36	38.85	66.06	1	13.8	Pullout
							2	20.6	Pullout
							3	12.3	Pullout
							4	22.5	Pullout
							5	32.6	Pullout
9	1.06	83.00	23.25	27.10	36.37	72.15	1	10.1	Pullout
							2	17.4	Pullout
							3	10.4	Pullout
							4	21.1	Pullout
							5	31.9	Pullout
10	1.07	92.50	21.68	29.86	34.27	78.35	1	6.6	Pullout
							2	14.4	Pullout
							3	8.6	Pullout
							4	19.9	Pullout
							5	31.2	Pullout
11	1.08	102.00	15.57	21.18	32.08	96.30	1	4.5	Pullout

							2	12.8	Pullout
							3	6.0	Pullout
							4	14.2	Pullout
							5	28.2	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 20.6 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
1	2.15	7.00	49.21	8.57	86.91	25.99	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	37.1	Pullout
							4	36.9	Pullout
							5	36.6	Pullout
2	1.65	16.50	51.30	23.75	84.91	18.61	1	39.1	Pullout
							2	39.1	Pullout
							3	27.9	Pullout
							4	32.5	Pullout
							5	37.1	Pullout
3	1.38	26.00	42.51	24.69	72.69	26.21	1	31.6	Pullout
							2	33.2	Pullout
							3	22.7	Pullout
							4	28.7	Pullout

							5	34.8	Pullout
4	1.22	35.50	42.42	48.09	90.00	13.90	1	25.5	Pullout
							2	31.6	Pullout
							3	22.6	Pullout
							4	28.7	Pullout
							5	34.8	Pullout
5	1.12	45.00	33.04	26.84	56.62	40.89	1	21.1	Pullout
							2	25.0	Pullout
							3	15.7	Pullout
							4	23.7	Pullout
							5	31.7	Pullout
6	1.07	54.50	29.05	31.17	52.35	44.61	1	14.6	Pullout
							2	19.0	Pullout
							3	12.1	Pullout
							4	21.1	Pullout
							5	30.2	Pullout
7	1.04	64.00	31.42	30.00	43.54	52.97	1	15.5	Pullout
							2	21.4	Pullout
							3	14.3	Pullout
							4	22.7	Pullout
							5	31.1	Pullout
** 8	1.04	73.50	26.01	24.54	39.92	67.08	1	12.0	Pullout

							2	18.6	Pullout
							3	10.1	Pullout
							4	18.9	Pullout
							5	28.8	Pullout
9	1.04	83.00	24.02	27.26	37.38	73.11	1	8.1	Pullout
							2	15.1	Pullout
							3	7.1	Pullout
							4	17.3	Pullout
							5	27.8	Pullout
10	1.05	92.50	22.39	30.01	35.23	79.27	1	4.4	Pullout
							2	11.9	Pullout
							3	4.8	Pullout
							4	15.9	Pullout
							5	26.9	Pullout
11	1.07	102.00	21.03	32.78	33.39	85.51	1	1.0	Pullout
							2	9.0	Pullout
							3	3.1	Pullout
							4	14.6	Pullout
							5	26.2	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 19.1 kips (Clouterre)

	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
Node									
1	2.26	7.00	47.56	9.33	88.55	27.56	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.4	Pullout
							4	36.0	Pullout
							5	35.5	Pullout
2	1.67	16.50	46.47	21.56	85.98	23.50	1	38.7	Pullout
							2	38.6	Pullout
							3	23.5	Pullout
							4	28.1	Pullout
							5	33.5	Pullout
3	1.40	26.00	40.05	27.17	78.79	26.73	1	28.4	Pullout
							2	29.3	Pullout
							3	18.2	Pullout
							4	24.7	Pullout
							5	31.3	Pullout
4	1.23	35.50	43.63	49.04	90.00	14.50	1	24.1	Pullout
							2	30.0	Pullout
							3	20.8	Pullout
							4	26.7	Pullout
							5	32.6	Pullout
5	1.14	45.00	36.95	33.79	59.43	35.39	1	18.6	Pullout

RW4_1025+50_5 row_seismic.txt

							2	23.6	Pullout
							3	15.7	Pullout
							4	22.9	Pullout
							5	30.0	Pullout
6	1.08	54.50	30.01	31.47	53.42	45.72	1	13.4	Pullout
							2	17.7	Pullout
							3	9.3	Pullout
							4	18.1	Pullout
							5	26.9	Pullout
7	1.06	64.00	32.39	30.32	44.62	53.95	1	14.0	Pullout
							2	19.7	Pullout
							3	11.7	Pullout
							4	19.9	Pullout
							5	28.0	Pullout
8	1.05	73.50	29.66	33.83	41.53	58.91	1	9.3	Pullout
							2	15.6	Pullout
							3	9.0	Pullout
							4	17.8	Pullout
							5	26.7	Pullout
9	1.05	83.00	27.45	37.41	38.94	64.02	1	5.0	Pullout
							2	12.2	Pullout
							3	6.6	Pullout
							4	16.1	Pullout

							5	25.5	Pullout
10	1.05	92.50	23.09	30.17	36.16	80.20	1	2.3	Pullout
							2	9.6	Pullout
							3	1.9	Pullout
							4	12.0	Pullout
							5	22.8	Pullout
11	1.07	102.00	21.68	32.93	34.28	86.41	1	0.0	Pullout
							2	6.5	Pullout
							3	0.0	Pullout
							4	10.6	Pullout
							5	21.9	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 15.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.26	7.00	66.63	15.88	88.17	21.87	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	36.6	Pullout
							4	36.2	Pullout
							5	38.1	Pullout
2	1.73	16.50	47.89	22.14	86.17	24.70	1	38.6	Pullout

							2	38.5	Pullout
							3	23.4	Pullout
							4	26.6	Pullout
							5	31.7	Pullout
3	1.45	26.00	41.32	27.69	79.26	27.91	1	28.2	Pullout
							2	29.0	Pullout
							3	16.4	Pullout
							4	22.7	Pullout
							5	29.0	Pullout
4	1.26	35.50	39.02	31.98	70.58	32.03	1	21.5	Pullout
							2	23.4	Pullout
							3	14.5	Pullout
							4	21.2	Pullout
							5	28.0	Pullout
5	1.17	45.00	39.39	58.22	90.00	15.83	1	16.6	Pullout
							2	23.2	Pullout
							3	14.8	Pullout
							4	21.5	Pullout
							5	28.2	Pullout
6	1.11	54.50	33.67	39.29	56.29	39.28	1	10.4	Pullout
							2	16.7	Pullout
							3	9.6	Pullout
							4	17.4	Pullout

							5	25.3	Pullout
7	1.08	64.00	33.34	30.64	45.66	54.94	1	12.5	Pullout
							2	18.1	Pullout
							3	9.2	Pullout
							4	17.2	Pullout
							5	25.1	Pullout
8	1.07	73.50	30.53	34.13	42.54	59.85	1	7.7	Pullout
							2	13.7	Pullout
							3	6.3	Pullout
							4	14.9	Pullout
							5	23.5	Pullout
9	1.06	83.00	28.26	37.69	39.90	64.91	1	3.2	Pullout
							2	9.8	Pullout
							3	3.6	Pullout
							4	12.9	Pullout
							5	22.1	Pullout
10	1.07	92.50	26.37	41.30	37.64	70.09	1	0.0	Pullout
							2	6.5	Pullout
							3	1.3	Pullout
							4	11.1	Pullout
							5	20.8	Pullout
11	1.08	102.00	24.80	44.94	35.70	75.36	1	0.0	Pullout
							2	4.0	Pullout

3	0.0	Pullout
4	9.4	Pullout
5	19.7	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Silty Sand	3.016

==

END OF REPORT

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Richmond-San Rafael
Access Improvement Project

04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79
(Sir Francis Drake EB On-Ramp to Marine Street Off-Ramp)
EA# 04-2J6804

Design Calculations
Retaining Wall No. 5

Prepared for

State of California
Department of Transportation

BATA
Bay Area Toll Authority

By

HNTB Corporation
1111 Broadway, 9th Floor
Oakland, CA 94607

December 15, 2015

DESIGN CALCULATIONS

FOR STRUCTURES

PROJECT EA. NO.: 04-2J6804

DISTRICT-COUNTY-ROUTE-KP: 04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79

DESCRIPTION: Richmond-San Rafael Access Improvement Project

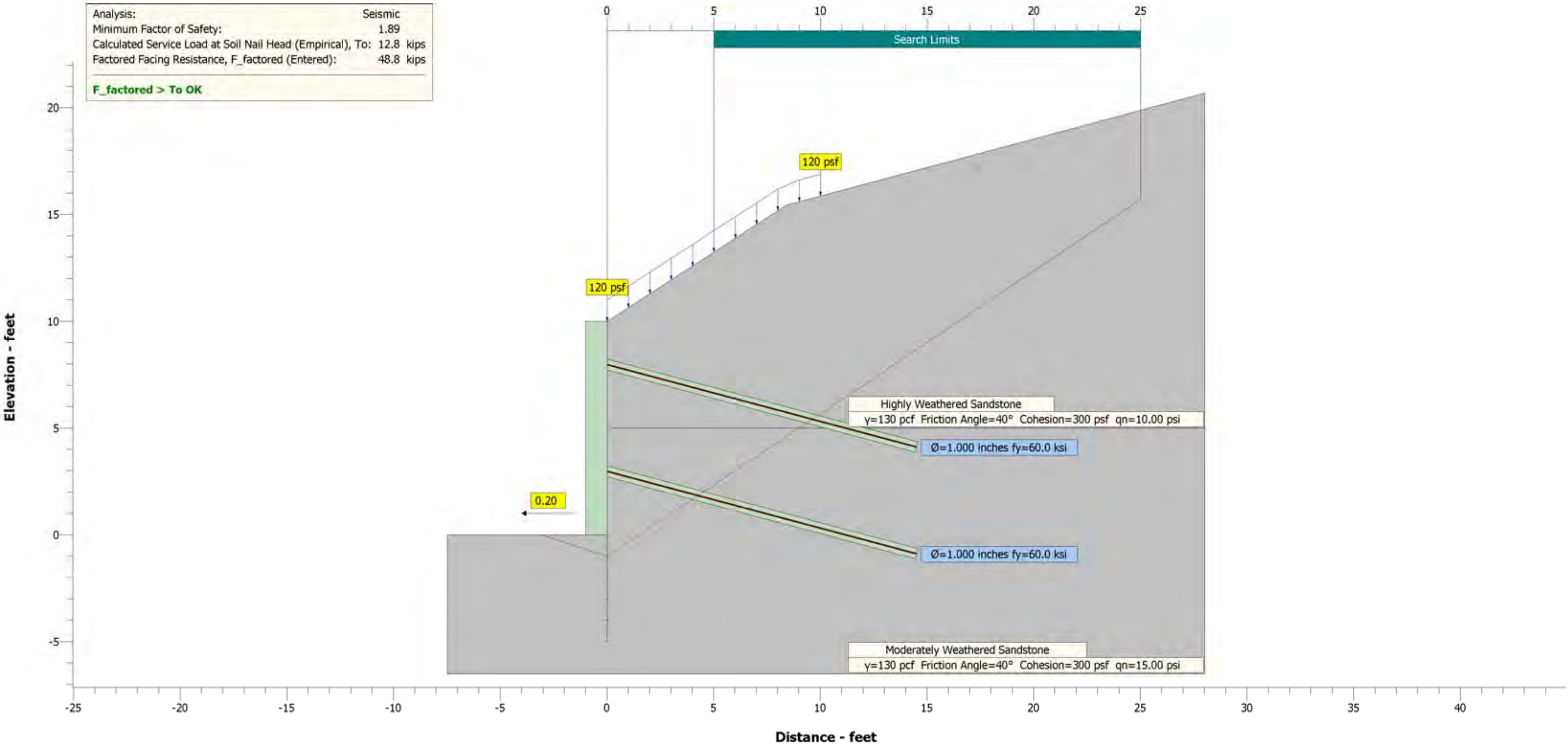
KEY STRUCTURE NAME: Retaining Wall No. 5

DESIGN CALCULATIONS: HNTB Corporation

PHONE: (510) 208-4599

The attached calculations are forwarded for your use in preparing or coordinating the contract documents for the above project.

CONTRACT NO. 0414000552



Analysis: Seismic
Minimum Factor of Safety: 1.89
Calculated Service Load at Soil Nail Head (Empirical), To: 12.8 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
120 psf
120 psf
0.20
Highly Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=10.00 psi
Ø=1.000 inches fy=60.0 ksi
Ø=1.000 inches fy=60.0 ksi
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=15.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: I-580_Soil Nail 2_Seismic.snz

Run Date: 12/03/15

Run Time: 11:13:02

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Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 5

Structure No.: 2 rows -Seismic

Station:

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 10.00 feet

Wall Dimensions:

Wall Height: 10.00 feet

Facing Angle: 90.00 degrees

Facing Batter: 0.000 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	33	10.00
2	15	

Number of lines that define the ground surface in front of the toe: 1

No.	Angle degrees	Distance feet
1	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	5.00	10.00	5.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes:	6.000 inches
Horizontal Spacing:	5.00 feet
Maximum Vertical Spacing:	5.00 feet
Number of Soil Nail Rows:	2
Soil Nail Design Parameters:	Uniform Throughout Cross-Section
Soil Nail Length:	15.00 feet
Inclination From Horizontal:	15 degrees
Vertical Distance from Top of Wall to First Row:	2.00 feet
Vertical Spacing:	5.00 feet
Nail Bar Diameter Ø:	1.000 inches
Nail Bar Yield Strength fy:	60.0 ksi

Resistance Factors:

	Temporary	Permanent	Seismic	
Factored Facing Resistance:	31.5	35.9	48.8	kips
Bond Resistance Factor:	0.50	0.50	0.50	
Nail Bar Resistance Factor:	0.56	0.56	0.74	

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Soil Properties

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Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		40	300
2	Moderately Weathered 130Sandstone		40	300

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Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

	Distance from Top of Wall		Load	Load
	Begin	End	Begin	End
No.	feet	feet	psf	psf
1	0.00	10.00	120	120

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 25.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 5.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

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Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.89

Found at Search Level: 1.00 feet below the toe of the wall

Found at Search Point: 11

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 14.0 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet		Stress	Controlling Resistance Failure Mode
Node							Level	ksi	
1	3.44	5.00	58.87	7.74	81.42	6.70	1	18.0	Pullout
							2	28.9	Pullout
2	2.88	7.00	55.49	12.36	90.00	4.36	1	17.1	Pullout
							2	28.5	Pullout
3	2.45	9.00	50.53	14.16	90.00	4.68	1	16.0	Pullout
							2	27.9	Pullout
4	2.22	11.00	45.78	15.77	90.00	4.84	1	14.8	Pullout
							2	27.2	Pullout
5	2.11	13.00	41.93	17.47	90.00	5.00	1	13.8	Pullout
							2	26.6	Pullout
6	2.03	15.00	42.56	20.37	-90.00	3.44	1	14.0	Pullout

							2	26.7	Pullout
7	1.99	17.00	39.88	22.15	90.00	3.55	1	13.2	Pullout
							2	26.3	Pullout
8	1.96	19.00	37.60	23.98	-90.00	3.66	1	12.6	Pullout
							2	25.9	Pullout
9	1.94	21.00	35.65	25.84	90.00	3.77	1	11.9	Pullout
							2	25.6	Pullout
10	1.93	23.00	33.96	27.73	90.00	3.87	1	11.4	Pullout
							2	25.3	Pullout
11	1.93	25.00	32.49	29.64	90.00	3.98	1	10.9	Pullout
							2	25.0	Pullout

Search Level: 1.00 feet below the toe of the wall Facing Design Force = 12.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of	Distance From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.26	5.00	48.74	3.79	77.63	11.67	1	18.6	Pullout
							2	26.6	Pullout
2	2.81	7.00	48.00	4.18	71.34	13.13	1	17.5	Pullout
							2	26.0	Pullout
3	2.46	9.00	52.26	14.70	90.00	4.98	1	15.5	Pullout

							2	26.7	Pullout
4	2.23	11.00	47.50	16.28	90.00	5.14	1	14.2	Pullout
							2	25.8	Pullout
5	2.11	13.00	43.60	17.95	90.00	5.30	1	13.1	Pullout
							2	25.1	Pullout
6	2.03	15.00	40.37	19.69	-90.00	5.47	1	12.1	Pullout
							2	24.4	Pullout
7	1.98	17.00	41.43	22.67	90.00	3.75	1	12.4	Pullout
							2	24.6	Pullout
8	1.94	19.00	39.08	24.48	-90.00	3.86	1	11.6	Pullout
							2	24.1	Pullout
9	1.92	21.00	37.06	26.32	90.00	3.97	1	10.9	Pullout
							2	23.7	Pullout
10	1.90	23.00	35.31	28.18	90.00	4.07	1	10.3	Pullout
							2	23.2	Pullout
** 11	1.89	25.00	33.77	30.07	90.00	4.18	1	9.7	Pullout
							2	22.9	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 11.7 kips (Clouterre)

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---------------------------------------------------------------------------------------------------------
|       |         |          |              Failure Planes            |        Reinforcement           |
|       |         |          |----------------------------------------|--------------------------------|
|       | Minimum | Distance |       Lower        |       Upper       |       |         |              |
|       | Factor  | From Toe |----------------------------------------|       |         | Controlling  |
```

	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.43	5.00	50.65	3.94	78.42	12.45	1	18.5	Pullout
							2	26.3	Pullout
2	2.91	7.00	58.85	13.53	90.00	4.96	1	16.3	Pullout
							2	26.6	Pullout
3	2.53	9.00	53.87	15.26	90.00	5.28	1	15.0	Pullout
							2	25.6	Pullout
4	2.30	11.00	49.11	16.80	90.00	5.44	1	13.6	Pullout
							2	24.5	Pullout
5	2.17	13.00	45.17	18.44	90.00	5.60	1	12.4	Pullout
							2	23.6	Pullout
6	2.08	15.00	41.89	20.15	-90.00	5.77	1	11.3	Pullout
							2	22.8	Pullout
7	2.02	17.00	39.13	21.91	90.00	5.93	1	10.3	Pullout
							2	22.1	Pullout
8	1.98	19.00	40.51	24.99	-90.00	4.06	1	10.8	Pullout
							2	22.4	Pullout
9	1.95	21.00	38.43	26.81	90.00	4.17	1	10.0	Pullout
							2	21.9	Pullout
10	1.92	23.00	36.61	28.65	90.00	4.27	1	9.3	Pullout
							2	21.3	Pullout

11	1.91	25.00	35.02	30.53	90.00	4.38	1	8.7	Pullout
							2	20.9	Pullout

Search Level: 3.00 feet below the toe of the wall Facing Design Force = 10.7 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	3.37	5.00	54.32	6.00	82.49	11.47	1	17.9	Pullout
							2	24.5	Pullout
2	3.02	7.00	60.32	14.14	90.00	5.26	1	15.9	Pullout
							2	25.8	Pullout
3	2.64	9.00	51.13	14.34	90.00	7.44	1	13.2	Pullout
							2	23.5	Pullout
4	2.40	11.00	50.62	17.34	90.00	5.74	1	13.0	Pullout
							2	23.4	Pullout
5	2.26	13.00	46.66	18.94	90.00	5.90	1	11.7	Pullout
							2	22.3	Pullout
6	2.16	15.00	43.34	20.62	-90.00	6.07	1	10.5	Pullout
							2	21.3	Pullout
7	2.09	17.00	40.52	22.36	90.00	6.23	1	9.4	Pullout

							2	20.4	Pullout
8	2.04	19.00	38.11	24.15	-90.00	6.39	1	8.5	Pullout
							2	19.6	Pullout
9	2.00	21.00	36.04	25.97	90.00	6.55	1	7.6	Pullout
							2	18.9	Pullout
10	1.97	23.00	37.88	29.14	90.00	4.47	1	8.4	Pullout
							2	19.6	Pullout
11	1.95	25.00	36.23	30.99	90.00	4.58	1	7.7	Pullout
							2	19.0	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 8.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	3.66	5.00	64.21	5.75	78.30	12.33	1	18.5	Pullout
							2	26.3	Pullout
2	3.11	7.00	52.95	6.97	77.83	13.28	1	16.2	Pullout
							2	22.9	Pullout
3	2.85	9.00	53.71	12.16	79.60	9.97	1	13.3	Pullout
							2	22.8	Pullout
4	2.64	11.00	50.68	10.42	70.00	12.86	1	13.1	Pullout

							2	21.9	Pullout
5	2.48	13.00	46.69	11.37	67.27	13.45	1	11.5	Pullout
							2	20.6	Pullout
6	2.31	15.00	35.27	18.37	-90.00	10.61	1	4.9	Pullout
							2	16.3	Pullout
7	2.17	17.00	41.85	22.82	90.00	6.53	1	8.7	Pullout
							2	18.9	Pullout
8	2.11	19.00	39.39	24.59	-90.00	6.69	1	7.6	Pullout
							2	18.0	Pullout
9	2.06	21.00	37.27	26.39	90.00	6.85	1	6.3	Pullout
							2	17.2	Pullout
10	2.03	23.00	35.41	28.22	90.00	7.01	1	5.0	Pullout
							2	16.4	Pullout
11	1.99	25.00	33.79	30.08	90.00	7.17	1	3.8	Pullout
							2	15.7	Pullout

Search Level: 5.00 feet below the toe of the wall Facing Design Force = 7.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	4.04	5.00	71.80	9.60	77.64	9.34	1	18.6	Pullout

							2	27.0	Pullout
2	3.44	7.00	64.48	6.50	72.94	14.31	1	17.2	Pullout
							2	25.3	Pullout
3	2.94	9.00	48.87	8.21	75.99	14.87	1	14.1	Pullout
							2	20.1	Pullout
4	2.74	11.00	53.94	13.08	72.67	11.08	1	12.4	Pullout
							2	21.5	Pullout
5	2.62	13.00	51.36	16.66	73.31	9.05	1	11.3	Pullout
							2	20.6	Pullout
6	2.48	15.00	48.01	17.94	71.35	9.38	1	10.0	Pullout
							2	19.4	Pullout
7	2.36	17.00	41.74	13.67	63.52	15.25	1	8.1	Pullout
							2	17.0	Pullout
8	2.27	19.00	39.26	14.72	61.46	15.91	1	6.2	Pullout
							2	15.9	Pullout
9	2.15	21.00	34.25	25.40	90.00	9.53	1	1.8	Pullout
							2	13.5	Pullout
10	2.09	23.00	36.56	28.63	90.00	7.31	1	3.6	Pullout
							2	14.7	Pullout
11	2.05	25.00	34.88	30.48	90.00	7.47	1	2.3	Pullout
							2	13.9	Pullout

===

Nominal Pullout Resistance

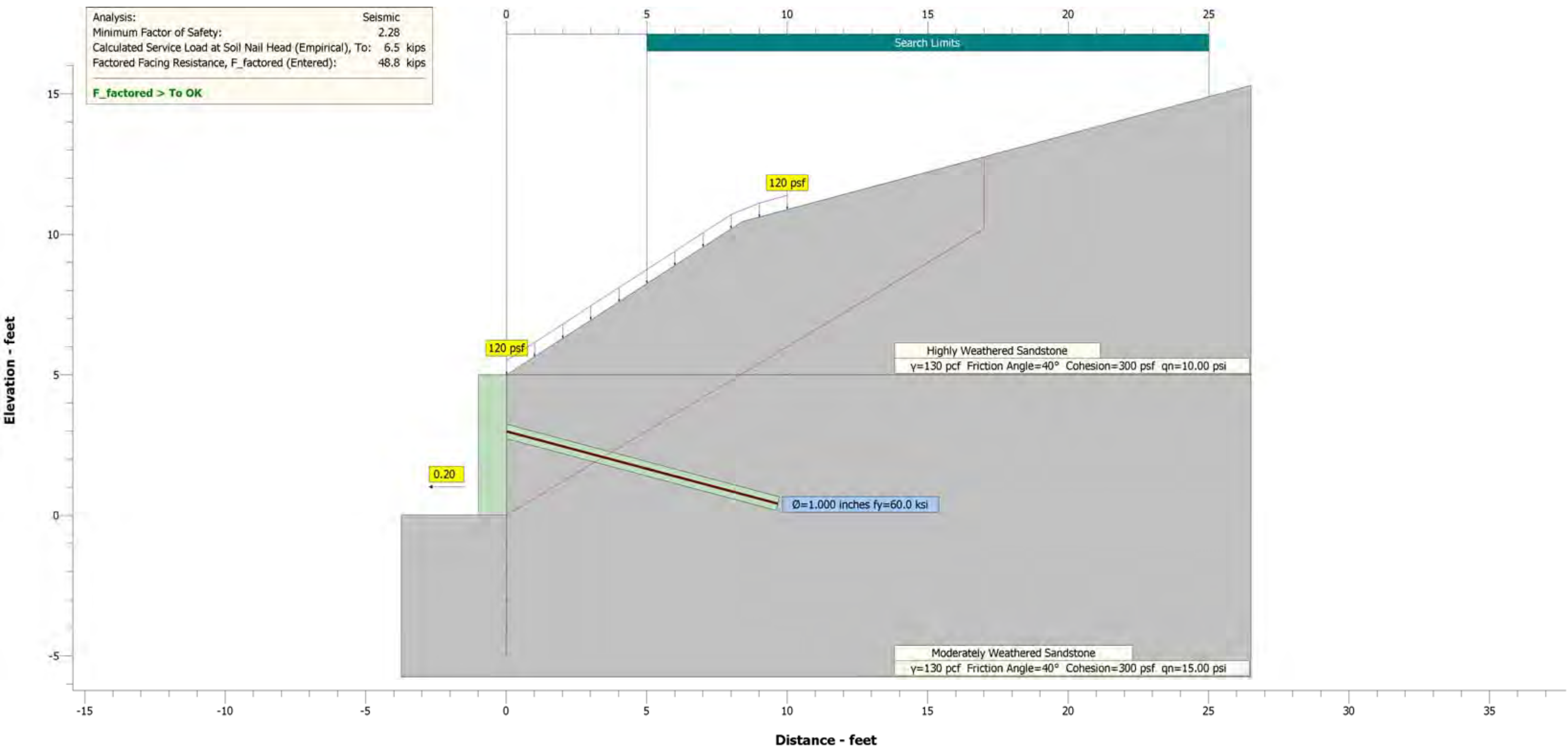
===

Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	3.393

===

END OF REPORT

===



Analysis: Seismic
Minimum Factor of Safety: 2.28
Calculated Service Load at Soil Nail Head (Empirical), To: 6.5 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
120 psf
120 psf
0.20
Highly Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=10.00 psi
Ø=1.000 inches fy=60.0 ksi
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=15.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: I-580_Soil Nail 1_Seismic.snz

Run Date: 12/03/15

Run Time: 10:52:44

==

Project Information

==

Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.:   Wall No. 5

Structure No.: 1 row -Seismic

Station:

Engineer: GHY

                Designer

Comments:

==

Geometry

==

Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 5.00 feet

Wall Dimensions:

Wall Height: 5.00 feet

Facing Angle: 90.00 degrees

Facing Batter: 0.000 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	33	10.00
2	15	

Number of lines that define the ground surface in front of the toe: 1

No.	Angle degrees	Distance feet
1	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	5.00	10.00	5.00

Ground Water:

Include Ground Water: No

==

Soil Nails

==

Dimensions and Properties:

Diameter of Drilled Holes:	6.000 inches
Horizontal Spacing:	5.00 feet
Maximum Vertical Spacing:	5.00 feet
Number of Soil Nail Rows:	1
Soil Nail Design Parameters:	Uniform Throughout Cross-Section
Soil Nail Length:	10.00 feet
Inclination From Horizontal:	15 degrees
Vertical Distance from Top of Wall to First Row:	2.00 feet
Vertical Spacing:	5.00 feet
Nail Bar Diameter Ø:	1.000 inches
Nail Bar Yield Strength fy:	60.0 ksi

Resistance Factors:

	Temporary	Permanent	Seismic	
Factored Facing Resistance:	31.5	35.9	48.8	kips
Bond Resistance Factor:	0.50	0.50	0.50	
Nail Bar Resistance Factor:	0.56	0.56	0.74	

==

Soil Properties

==

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		40	300
2	Moderately Weathered 130Sandstone		40	300

==

Loads

==

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

	Distance from Top of Wall		Load	Load
	Begin	End	Begin	End
No.	feet	feet	psf	psf
1	0.00	10.00	120	120

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

==

Search Options

==

Search Limits:

Begin: 5.00 feet

End: 25.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 5.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

==

Factors of Safety

==

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 2.28

Found at Search Level: Toe of the wall

Found at Search Point: 7

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 6.5 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet			Controlling
Node							Level	Stress ksi	Resistance Failure Mode
1	3.35	5.00	49.10	7.64	-90.00	2.47	1	13.6	Pullout
2	2.78	7.00	43.67	9.68	-90.00	2.86	1	13.0	Pullout
3	2.47	9.00	39.53	11.67	90.00	3.18	1	12.6	Pullout
4	2.34	11.00	35.35	13.49	-90.00	3.34	1	12.1	Pullout
5	2.30	13.00	35.71	16.01	90.00	2.34	1	12.2	Pullout
6	2.28	15.00	33.09	17.90	90.00	2.44	1	11.8	Pullout
** 7	2.28	17.00	30.97	19.83	90.00	2.55	1	11.6	Pullout
8	2.28	19.00	29.23	21.77	90.00	2.66	1	11.3	Pullout
9	2.29	21.00	27.78	23.73	-90.00	2.77	1	11.1	Pullout
10	2.30	23.00	26.54	25.71	90.00	2.87	1	10.9	Pullout

11	2.31	25.00	25.49	27.70	90.00	2.98	1	10.7	Pullout

Search Level: 1.00 feet below the toe of the wall Facing Design Force = 5.1 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	3.53	5.00	42.76	4.09	72.83	6.77	1	12.1	Pullout
2	2.97	7.00	46.52	10.17	-90.00	3.16	1	12.2	Pullout
3	2.64	9.00	42.08	12.13	90.00	3.48	1	11.6	Pullout
4	2.47	11.00	37.70	13.90	-90.00	3.64	1	11.0	Pullout
5	2.39	13.00	34.33	15.74	90.00	3.80	1	10.4	Pullout
6	2.35	15.00	35.18	18.35	90.00	2.64	1	10.6	Pullout
7	2.32	17.00	32.91	20.25	90.00	2.75	1	10.2	Pullout
8	2.30	19.00	31.04	22.17	90.00	2.86	1	9.8	Pullout
9	2.29	21.00	29.46	24.12	-90.00	2.97	1	9.5	Pullout
10	2.29	23.00	28.12	26.08	90.00	3.07	1	9.3	Pullout
11	2.29	25.00	26.96	28.05	90.00	3.18	1	9.0	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 4.2 kips (Clouterre)

				Failure Planes				Reinforcement	

Node	Lower / Upper: Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	3.76	5.00	53.80	5.08	71.98	6.47	1	12.2	Pullout
2	3.25	7.00	52.84	11.59	-90.00	2.31	1	12.0	Pullout
3	2.82	9.00	44.45	12.61	90.00	3.78	1	10.7	Pullout
4	2.62	11.00	39.92	14.34	-90.00	3.94	1	10.0	Pullout
5	2.52	13.00	36.38	16.15	90.00	4.10	1	9.3	Pullout
6	2.45	15.00	33.57	18.00	90.00	4.27	1	8.7	Pullout
7	2.41	17.00	31.28	19.89	90.00	4.43	1	8.2	Pullout
8	2.37	19.00	32.77	22.60	90.00	3.06	1	8.5	Pullout
9	2.35	21.00	31.09	24.52	-90.00	3.17	1	8.1	Pullout
10	2.33	23.00	29.65	26.46	90.00	3.27	1	7.8	Pullout
11	2.32	25.00	28.40	28.42	90.00	3.38	1	7.5	Pullout

Search Level: 3.00 feet below the toe of the wall Facing Design Force = 3.2 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode

1	4.35	5.00	62.59	7.60	71.56	4.74	1	12.6	Pullout
2	3.57	7.00	47.08	5.14	68.27	9.45	1	10.8	Pullout
3	3.14	9.00	42.22	6.08	64.72	10.54	1	9.5	Pullout
4	2.88	11.00	37.66	6.95	60.95	11.33	1	8.3	Pullout
5	2.76	13.00	29.45	14.93	90.00	7.34	1	5.5	Pullout
6	2.57	15.00	35.38	18.40	90.00	4.57	1	7.6	Pullout
7	2.51	17.00	32.97	20.26	90.00	4.73	1	6.9	Pullout
8	2.46	19.00	30.97	22.16	90.00	4.89	1	6.1	Pullout
9	2.42	21.00	29.29	24.08	-90.00	5.05	1	5.4	Pullout
10	2.39	23.00	27.85	26.01	90.00	5.21	1	4.8	Pullout
11	2.37	25.00	29.80	28.81	90.00	3.58	1	5.6	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 1.1 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	5.70	5.00	22.21	3.24	79.72	11.20	1	10.9	Pullout
2	4.79	7.00	17.88	4.41	77.07	12.51	1	9.0	Pullout
3	4.16	9.00	15.14	5.59	74.69	13.63	1	7.1	Pullout

4	3.33	11.00	24.65	7.26	70.04	12.89	1	5.2	Pullout
5	2.98	13.00	46.55	15.12	61.07	5.38	1	8.8	Pullout
6	2.83	15.00	37.68	13.27	60.97	9.27	1	6.6	Pullout
7	2.71	17.00	26.23	18.95	90.00	8.38	1	1.0	Pullout
8	2.58	19.00	28.64	21.65	90.00	6.92	1	2.4	Pullout
9	2.50	21.00	30.72	24.43	-90.00	5.35	1	3.4	Pullout
10	2.46	23.00	29.20	26.35	90.00	5.51	1	2.7	Pullout
11	2.43	25.00	27.89	28.28	90.00	5.67	1	2.0	Pullout

Search Level: 5.00 feet below the toe of the wall Facing Design Force = 0.1 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	6.60	5.00	20.73	3.74	82.83	12.02	1	10.4	Pullout
2	5.05	7.00	19.10	4.44	77.93	13.39	1	8.8	Pullout
3	4.82	9.00	13.92	6.49	79.12	14.31	1	5.6	Pullout
4	4.39	11.00	11.84	7.87	77.21	14.90	1	2.3	Pullout
5	4.16	13.00	10.39	9.25	75.44	15.51	1	0.0	Pullout

6	3.60	15.00	10.83	9.16	68.84	16.62	1	0.0	Pullout
7	3.01	17.00	24.11	13.04	67.69	13.43	1	0.0	Pullout
8	2.76	19.00	31.03	17.74	67.44	9.90	1	1.0	Pullout
9	2.66	21.00	33.92	20.24	60.85	8.62	1	2.6	Pullout
10	2.60	23.00	26.80	25.77	90.00	7.74	1	0.0	Pullout
11	2.54	25.00	29.62	20.13	52.99	12.46	1	0.2	Pullout

==

Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	3.393

==

END OF REPORT

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Richmond-San Rafael
Access Improvement Project

04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79
(Sir Francis Drake EB On-Ramp to Marine Street Off-Ramp)
EA# 04-2J6804

Design Calculations

Retaining Wall No. 7
Soil Nail Wall (28E0217)

Prepared for

State of California
Department of Transportation

BATA
Bay Area Toll Authority

By

HNTB

HNTB Corporation
1111 Broadway, 9th Floor
Oakland, CA 94607

January 28, 2016

DESIGN CALCULATIONS

FOR STRUCTURES

PROJECT EA. NO.: 04-2J6804

DISTRICT-COUNTY-ROUTE-KP: 04-MRN-580-PM 0.0/3.16, 04-CC-580-PM 4.98/7.79

DESCRIPTION: Richmond-San Rafael Access Improvement Project

KEY STRUCTURE NAME: Retaining Wall No. 7 (28E0217)

DESIGN CALCULATIONS: HNTB Corporation

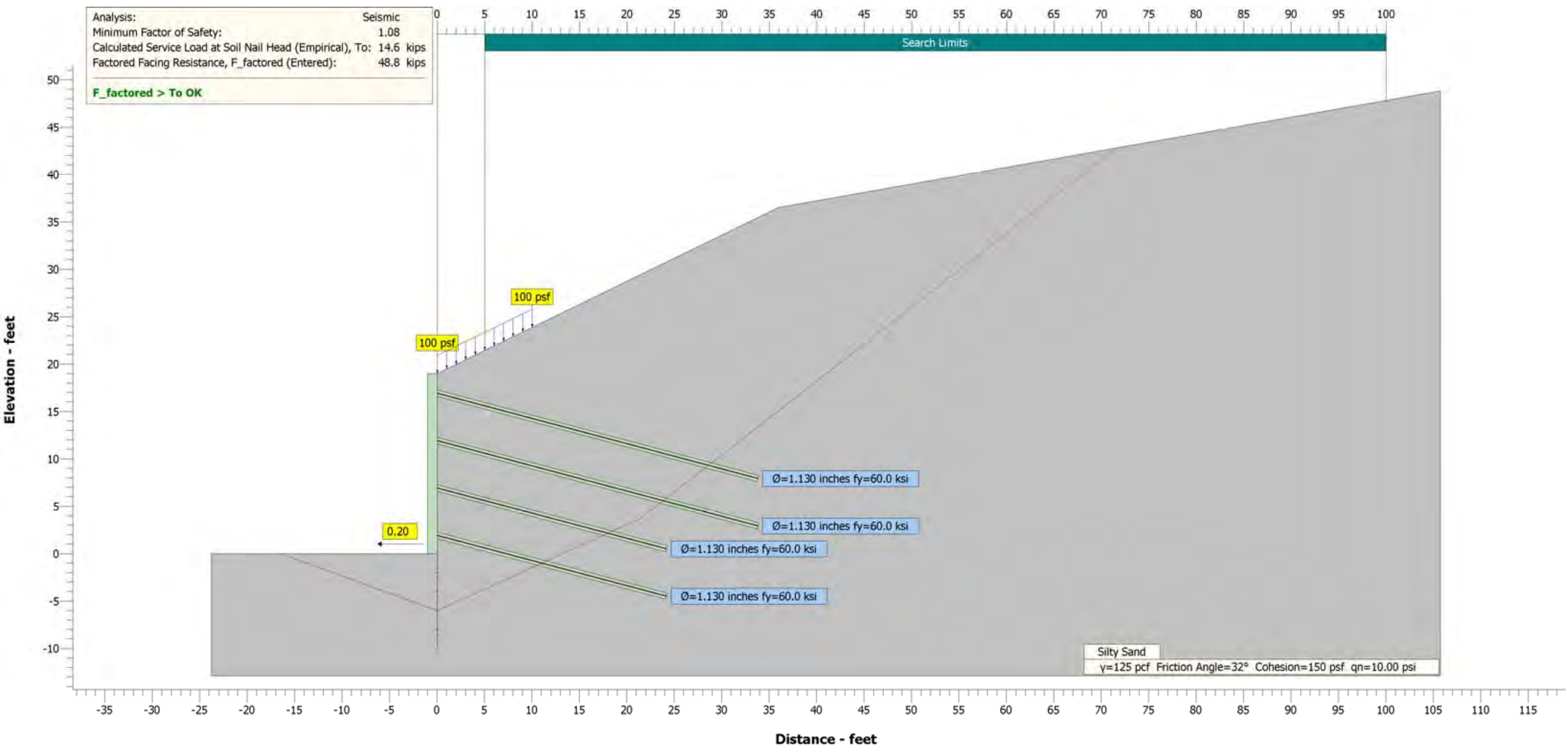
PHONE: (510) 208-4599

The attached calculations are forwarded for your use in preparing or coordinating the contract documents for the above project.

CONTRACT NO. 0414000552

<u>SOIL NAIL WALLS</u>

(SEISMIC DESIGN)



Analysis: Seismic
Minimum Factor of Safety: 1.08
Calculated Service Load at Soil Nail Head (Empirical), To: 14.6 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
100 psf
100 psf
0.20
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Silty Sand
γ=125 pcf Friction Angle=32° Cohesion=150 psf qn=10.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

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File Information

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File Name: RW7_1026+70_4 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:41:45

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:

Project ID: 60366

Wall No.: Wall No. 7

Structure No.: 4 row - seismic

Station: Sta. 1026+70

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 19.00 feet

Wall Dimensions:

Wall Height: 19.00 feet

Facing Angle: 90.00 degrees

Facing Batter: 0.000 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	26	40.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 1

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	0.00	100.00	50.00

Ground Water:

Include Ground Water: No

==

Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 8.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 4

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	35.00	15	2.00	1.130	60.0
2	35.00	15	5.00	1.130	60.0
3	25.00	15	5.00	1.130	60.0
4	25.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Silty Sand	125	32	150

Loads

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

RW7_1026+70_4 row_seismic.txt

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	Distance from Top of Wall End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.08

Found at Search Level: 6.00 feet below the toe of the wall

Found at Search Point: 8

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 23.6 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes Lower Angle degrees	Failure Planes Lower Length feet	Failure Planes Upper Angle degrees	Failure Planes Upper Length feet	Reinforcement Level	Reinforcement Stress ksi	Reinforcement Controlling Resistance Failure Mode
1	2.37	5.00	67.23	11.63	87.33	10.73	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	33.5	Pullout
							4	36.4	Pullout
2	2.11	14.50	37.62	12.81	76.59	18.76	1	34.6	Pullout
							2	36.3	Pullout
							3	27.1	Pullout
							4	34.6	Pullout
3	1.66	24.00	36.17	20.81	68.65	19.78	1	26.4	Pullout
							2	33.9	Pullout
							3	26.7	Pullout
							4	34.5	Pullout

4	1.41	33.50	36.44	41.64	90.00	10.60	1	26.3	Pullout
							2	34.1	Pullout
							3	26.8	Pullout
							4	34.5	Pullout
5	1.28	43.00	35.10	52.56	90.00	7.56	1	25.4	Pullout
							2	33.4	Pullout
							3	26.4	Pullout
							4	34.4	Pullout
6	1.23	52.50	20.59	11.22	40.21	55.00	1	22.0	Pullout
							2	29.0	Pullout
							3	20.9	Pullout
							4	32.8	Pullout
7	1.21	62.00	23.86	20.34	37.17	54.46	1	17.9	Pullout
							2	26.3	Pullout
							3	22.2	Pullout
							4	33.2	Pullout
8	1.21	71.50	21.76	23.10	34.38	60.64	1	14.8	Pullout
							2	24.6	Pullout
							3	21.3	Pullout
							4	32.9	Pullout
9	1.22	81.00	20.11	25.88	32.11	66.94	1	12.0	Pullout
							2	23.2	Pullout

							3	20.4	Pullout
							4	32.7	Pullout
10	1.23	90.50	14.31	18.68	29.84	83.47	1	10.5	Pullout
							2	19.8	Pullout
							3	16.8	Pullout
							4	31.6	Pullout
11	1.24	100.00	13.45	20.56	28.28	90.85	1	8.2	Pullout
							2	17.9	Pullout
							3	16.1	Pullout
							4	31.5	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 20.8 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.21	5.00	57.38	8.35	88.26	16.41	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	30.6	Pullout
							4	34.2	Pullout
2	1.73	14.50	47.89	15.14	75.52	17.40	1	34.9	Pullout
							2	36.8	Pullout
							3	27.4	Pullout

							4	33.1	Pullout
3	1.42	24.00	34.27	17.42	67.25	24.83	1	27.1	Pullout
							2	30.0	Pullout
							3	22.8	Pullout
							4	31.0	Pullout
4	1.26	33.50	37.96	42.49	90.00	11.20	1	24.4	Pullout
							2	31.8	Pullout
							3	24.2	Pullout
							4	31.7	Pullout
5	1.17	43.00	24.82	18.95	50.97	40.97	1	19.2	Pullout
							2	24.4	Pullout
							3	18.4	Pullout
							4	29.1	Pullout
6	1.12	52.50	27.76	17.80	42.06	49.50	1	19.5	Pullout
							2	26.1	Pullout
							3	20.0	Pullout
							4	29.8	Pullout
7	1.11	62.00	24.88	20.50	38.48	55.44	1	15.8	Pullout
							2	23.1	Pullout
							3	18.4	Pullout
							4	29.1	Pullout
8	1.13	71.50	17.40	14.99	35.18	69.98	1	13.3	Pullout

							2	21.3	Pullout
							3	14.2	Pullout
							4	26.9	Pullout
9	1.14	81.00	16.01	16.85	32.84	77.13	1	10.3	Pullout
							2	18.9	Pullout
							3	12.4	Pullout
							4	26.4	Pullout
10	1.16	90.50	19.53	28.81	31.30	74.14	1	6.6	Pullout
							2	17.6	Pullout
							3	15.1	Pullout
							4	27.6	Pullout
11	1.17	100.00	13.99	20.61	29.27	91.71	1	5.2	Pullout
							2	14.6	Pullout
							3	10.5	Pullout
							4	25.5	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 18.0 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor of	From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.23	5.00	59.47	5.91	84.39	20.45	1	44.4	Bar Yield
							2	44.4	Bar Yield

							3	32.2	Pullout
							4	32.9	Pullout
2	1.64	14.50	46.04	16.71	80.87	18.27	1	33.2	Pullout
							2	34.4	Pullout
							3	24.5	Pullout
							4	30.4	Pullout
3	1.38	24.00	35.87	17.77	68.44	26.12	1	26.5	Pullout
							2	29.2	Pullout
							3	20.3	Pullout
							4	28.2	Pullout
4	1.21	33.50	39.42	43.37	90.00	11.80	1	22.6	Pullout
							2	29.8	Pullout
							3	21.9	Pullout
							4	29.0	Pullout
5	1.13	43.00	37.86	54.46	90.00	8.36	1	21.4	Pullout
							2	28.8	Pullout
							3	21.2	Pullout
							4	28.7	Pullout
6	1.09	52.50	28.89	17.99	43.41	50.59	1	17.7	Pullout
							2	24.1	Pullout
							3	16.7	Pullout
							4	26.2	Pullout
7	1.08	62.00	25.89	20.67	39.76	56.45	1	13.8	Pullout

							2	20.9	Pullout
							3	14.9	Pullout
							4	25.2	Pullout
8	1.08	71.50	23.58	23.40	36.80	62.51	1	10.2	Pullout
							2	17.9	Pullout
							3	13.3	Pullout
							4	24.3	Pullout
9	1.10	81.00	21.75	26.16	34.37	68.69	1	7.0	Pullout
							2	15.3	Pullout
							3	11.9	Pullout
							4	23.6	Pullout
10	1.12	90.50	20.28	28.94	32.35	74.99	1	4.0	Pullout
							2	13.6	Pullout
							3	10.7	Pullout
							4	22.9	Pullout
11	1.13	100.00	14.53	20.66	30.25	92.61	1	2.4	Pullout
							2	11.5	Pullout
							3	5.6	Pullout
							4	19.9	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 14.6 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet		Stress ksi	Controlling Resistance Failure Mode
Node							Level		
1	2.18	5.00	67.71	11.86	88.26	16.47	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	30.5	Pullout
							4	33.0	Pullout
2	1.66	14.50	47.88	17.30	81.43	19.46	1	33.0	Pullout
							2	34.1	Pullout
							3	22.9	Pullout
							4	28.5	Pullout
3	1.38	24.00	46.95	35.16	-90.00	11.01	1	25.9	Pullout
							2	31.7	Pullout
							3	22.5	Pullout
							4	28.3	Pullout
4	1.21	33.50	40.82	44.27	90.00	12.40	1	21.0	Pullout
							2	27.9	Pullout
							3	19.7	Pullout
							4	26.6	Pullout
5	1.14	43.00	39.16	55.46	90.00	8.76	1	19.5	Pullout
							2	26.7	Pullout
							3	18.9	Pullout
							4	26.1	Pullout

6	1.10	52.50	33.00	25.04	45.29	44.77	1	15.4	Pullout
							2	22.1	Pullout
							3	15.5	Pullout
							4	24.0	Pullout
7	1.08	62.00	29.69	28.55	41.57	49.72	1	11.0	Pullout
							2	19.2	Pullout
							3	13.4	Pullout
							4	22.7	Pullout
** 8	1.08	71.50	24.47	23.57	37.96	63.48	1	8.1	Pullout
							2	15.5	Pullout
							3	9.6	Pullout
							4	20.4	Pullout
9	1.08	81.00	22.56	26.31	35.46	69.61	1	4.6	Pullout
							2	12.6	Pullout
							3	8.0	Pullout
							4	19.4	Pullout
10	1.10	90.50	21.02	29.08	33.37	75.86	1	1.5	Pullout
							2	9.9	Pullout
							3	6.6	Pullout
							4	18.5	Pullout
11	1.12	100.00	19.74	31.87	31.60	82.19	1	0.0	Pullout
							2	7.9	Pullout
							3	5.3	Pullout

							4	17.7	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 13.0 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.24	5.00	65.63	9.70	87.22	20.63	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	31.0	Pullout
							4	31.4	Pullout
2	1.72	14.50	49.60	17.90	81.93	20.65	1	32.8	Pullout
							2	33.9	Pullout
							3	21.4	Pullout
							4	26.8	Pullout
3	1.40	24.00	42.66	22.85	72.78	24.31	1	24.2	Pullout
							2	26.5	Pullout
							3	18.0	Pullout
							4	24.5	Pullout
4	1.24	33.50	42.16	45.20	90.00	13.00	1	19.5	Pullout
							2	26.1	Pullout
							3	17.7	Pullout
							4	24.3	Pullout

5	1.16	43.00	32.57	25.51	56.14	38.59	1	14.3	Pullout
							2	18.7	Pullout
							3	11.8	Pullout
							4	20.4	Pullout
6	1.11	52.50	34.13	25.37	46.52	45.78	1	13.9	Pullout
							2	19.8	Pullout
							3	12.9	Pullout
							4	21.1	Pullout
7	1.09	62.00	30.72	28.85	42.75	50.66	1	9.3	Pullout
							2	16.5	Pullout
							3	10.5	Pullout
							4	19.5	Pullout
8	1.09	71.50	28.05	32.41	39.66	55.72	1	5.1	Pullout
							2	13.8	Pullout
							3	8.4	Pullout
							4	18.2	Pullout
9	1.09	81.00	23.36	26.47	36.52	70.55	1	2.5	Pullout
							2	10.2	Pullout
							3	4.2	Pullout
							4	15.3	Pullout
10	1.10	90.50	21.75	29.23	34.37	76.75	1	0.0	Pullout
							2	7.3	Pullout

							3	2.6	Pullout
							4	14.2	Pullout
11	1.12	100.00	20.41	32.01	32.54	83.03	1	0.0	Pullout
							2	4.6	Pullout
							3	1.1	Pullout
							4	13.3	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 9.6 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.35	5.00	64.49	10.45	88.70	22.01	1	44.4	Bar Yield
							2	44.4	Bar Yield
							3	30.4	Pullout
							4	30.5	Pullout
2	1.73	14.50	54.11	22.26	85.40	18.09	1	31.6	Pullout
							2	32.3	Pullout
							3	21.6	Pullout
							4	26.3	Pullout
3	1.47	24.00	44.10	23.40	73.58	25.46	1	23.8	Pullout
							2	26.0	Pullout
							3	16.2	Pullout

							4	22.5	Pullout
4	1.29	33.50	43.45	46.15	90.00	13.60	1	18.0	Pullout
							2	24.4	Pullout
							3	15.8	Pullout
							4	22.2	Pullout
5	1.20	43.00	41.63	57.53	90.00	9.56	1	16.3	Pullout
							2	23.0	Pullout
							3	14.7	Pullout
							4	21.4	Pullout
6	1.15	52.50	29.47	30.15	52.83	43.44	1	6.7	Pullout
							2	11.6	Pullout
							3	5.8	Pullout
							4	15.2	Pullout
7	1.12	62.00	31.74	29.16	43.89	51.62	1	7.7	Pullout
							2	14.0	Pullout
							3	7.7	Pullout
							4	16.5	Pullout
8	1.11	71.50	28.98	32.69	40.75	56.63	1	3.3	Pullout
							2	11.0	Pullout
							3	5.4	Pullout
							4	14.9	Pullout
9	1.11	81.00	26.77	36.29	38.12	61.78	1	0.0	Pullout

							2	8.3	Pullout
							3	3.3	Pullout
							4	13.4	Pullout
10	1.12	90.50	24.96	39.93	35.90	67.03	1	0.0	Pullout
							2	5.9	Pullout
							3	1.5	Pullout
							4	12.1	Pullout
11	1.14	100.00	23.45	43.60	34.01	72.38	1	0.0	Pullout
							2	3.8	Pullout
							3	0.0	Pullout
							4	11.0	Pullout

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Nominal Pullout Resistance

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Layer	Description	Nominal Pullout Resistance klf
1	Silty Sand	3.016

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END OF REPORT

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Snail

Version: 1.3

Facing Analysis

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File Information

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Draft Standard Drawing xs12-000-1 February 2013: Design Number 1

===

Analysis

===

Temporary Shoring Only: No

Check Bearing Plate Capacity: No

===

Soil Nails

===

Horizontal Spacing: 5.00 feet

Vertical Spacing: 5.00 feet

===

Facing

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	Temporary	Permanent	
Facing Thickness:	4.000	8.000	inches
Vertical Reinforcement Area:	0.08	0.20	in²/foot
Horizontal Reinforcement Area:	0.08	0.20	in²/foot
No. of Vertical Waler Bars:	2	0	
No. of Horizontal Waler Bars:	2	0	
Waler Bar Area:	0.20	0.00	in²
Concrete Yield Strength:	3.6	3.6	ksi

Reinforcement Yield Strength:	65.0	60.0	ksi
Punching Correction Factor:	1.00	1.00	
Flexural Correction Factor:	2.00	1.00	

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Bearing Plates

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Bearing Plate Width / Height: 8.000 inches

Bearing Plate Thickness: 0.750 inches

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Studs

===

Number of Studs: 4

Stud Head Diameter: 1.250 inches

Head Thickness: 0.310 inches

Headed-Stud Length: 5.250 inches

Stud Shaft Diameter: 0.750 inches

Stud Spacing: 4.000 inches

Stud Tensile Strength: 60.0 ksi

===

Resistance Factors

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Facing Resistance Factors:

	Temporary	Permanent	Seismic
Punching:	0.74	0.67	0.91
Flexural:	0.74	0.67	0.91
Stud Tensile:		0.50	0.67

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Results

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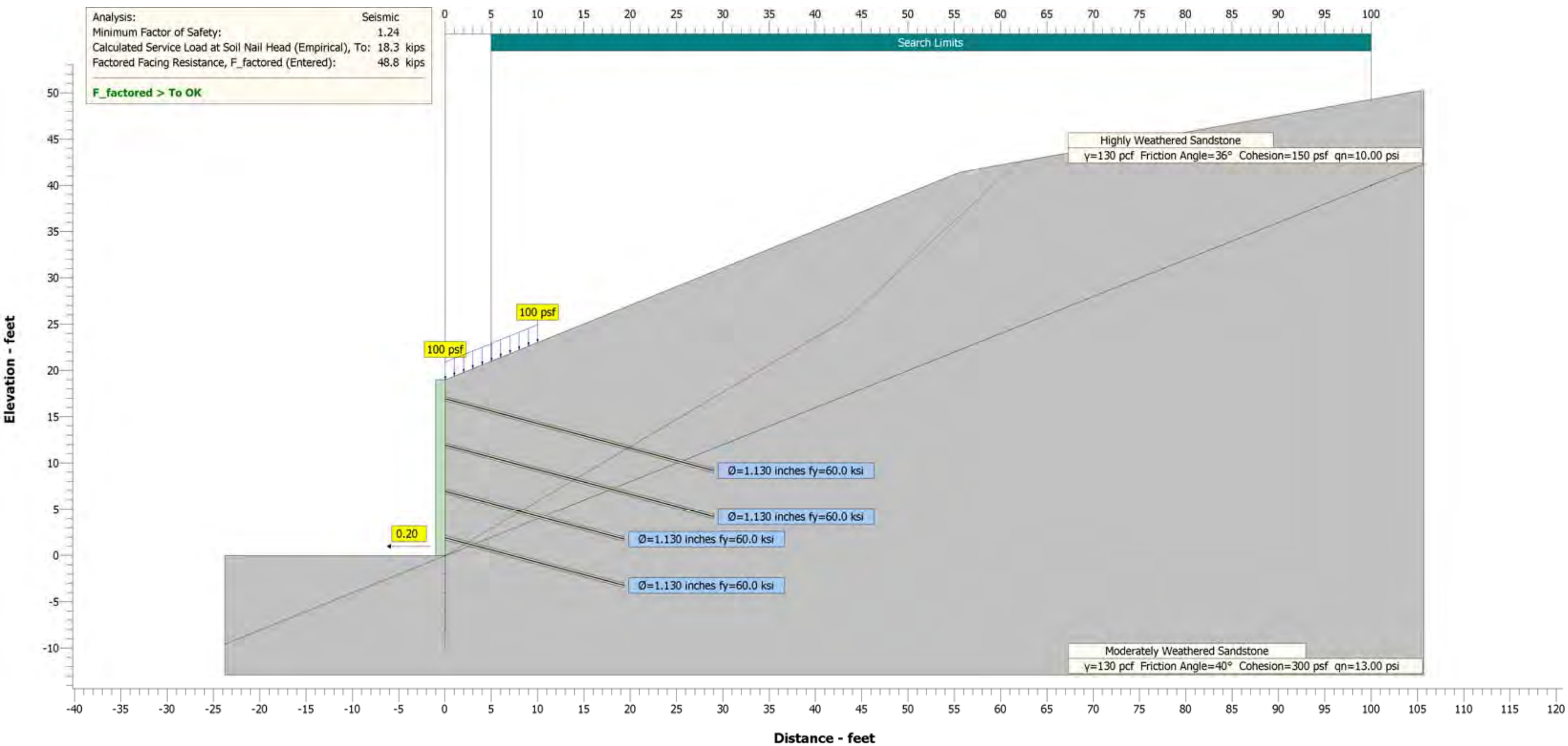
Facing:

Capacity Ratio

Factored (Normalized by

Analysis	Failure Mode	Resistance kips	Control Mode Capacity)
Temporary:	Flexure:	29.2	1.08
	Punching Shear:	27.0	1.00
Permanent:	Flexure:	40.7	1.45
	Punching Shear:	28.0	1.00
	Stud Tensile:	53.0	1.89
Seismic:	Flexure:	55.3	1.45
	Punching Shear:	38.1	1.00
	Stud Tensile:	71.0	1.86

END OF REPORT


Analysis: Seismic
Minimum Factor of Safety: 1.24
Calculated Service Load at Soil Nail Head (Empirical), To: 18.3 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
100 psf
100 psf
0.20
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

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File Information

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File Name: RW7_1027+50_4 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:53:31

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 7

Structure No.: 4 row - seismic

Station: Sta. 1027+50

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 19.00 feet

Wall Dimensions:

Wall Height: 19.00 feet

Facing Angle: 90.00 degrees

Facing Batter: 0.000 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	22	60.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	0.00	100.00	40.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 4

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	30.00	15	2.00	1.130	60.0
2	30.00	15	5.00	1.130	60.0
3	20.00	15	5.00	1.130	60.0
4	20.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

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Soil Properties

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Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

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Loads

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Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

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Search Options

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Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

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Factors of Safety

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Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.24

Found at Search Level: Toe of the wall

Found at Search Point: 7

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 18.3 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
1	2.16	5.00	66.82	11.43	87.28	10.52	1	29.5	Pullout
							2	32.4	Pullout
							3	22.5	Pullout
							4	27.4	Pullout
2	1.72	14.50	53.90	12.31	64.08	16.58	1	24.0	Pullout
							2	29.2	Pullout
							3	20.7	Pullout
							4	26.8	Pullout
3	1.42	24.00	43.73	33.21	-90.00	5.74	1	18.9	Pullout
							2	26.2	Pullout
							3	19.0	Pullout

							4	26.4	Pullout
4	1.31	33.50	37.85	42.42	90.00	6.51	1	16.1	Pullout
							2	24.3	Pullout
							3	17.8	Pullout
							4	26.0	Pullout
5	1.27	43.00	37.28	54.04	90.00	3.64	1	15.8	Pullout
							2	24.1	Pullout
							3	17.7	Pullout
							4	26.0	Pullout
6	1.25	52.50	34.58	63.77	-90.00	4.02	1	14.3	Pullout
							2	23.1	Pullout
							3	17.1	Pullout
							4	25.8	Pullout
** 7	1.24	62.00	30.50	50.37	42.49	25.23	1	11.9	Pullout
							2	21.3	Pullout
							3	16.1	Pullout
							4	25.5	Pullout
8	1.25	71.50	27.30	48.27	37.74	36.17	1	9.8	Pullout
							2	19.8	Pullout
							3	15.2	Pullout
							4	25.3	Pullout
9	1.26	81.00	23.05	35.21	33.50	58.28	1	6.4	Pullout

							2	17.5	Pullout
							3	13.9	Pullout
							4	24.9	Pullout
10	1.29	90.50	22.83	49.10	32.27	53.52	1	6.3	Pullout
							2	17.4	Pullout
							3	13.8	Pullout
							4	24.9	Pullout
11	1.32	100.00	26.24	111.49	0.00	0.00	1	9.0	Pullout
							2	19.3	Pullout
							3	14.9	Pullout
							4	25.2	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 16.2 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.33	5.00	68.65	12.36	87.51	11.52	1	29.5	Pullout
							2	32.4	Pullout
							3	21.9	Pullout
							4	26.6	Pullout
2	1.72	14.50	46.63	14.78	74.89	16.69	1	21.6	Pullout
							2	25.7	Pullout

							3	17.7	Pullout
							4	24.7	Pullout
3	1.48	24.00	45.66	34.34	-90.00	6.14	1	17.9	Pullout
							2	25.0	Pullout
							3	17.5	Pullout
							4	24.6	Pullout
4	1.36	33.50	39.51	43.42	90.00	6.91	1	14.8	Pullout
							2	22.7	Pullout
							3	16.0	Pullout
							4	23.8	Pullout
5	1.31	43.00	38.77	55.15	90.00	3.84	1	14.4	Pullout
							2	22.4	Pullout
							3	15.8	Pullout
							4	23.7	Pullout
6	1.28	52.50	35.89	64.80	-90.00	4.22	1	12.7	Pullout
							2	21.2	Pullout
							3	15.1	Pullout
							4	23.2	Pullout
7	1.27	62.00	32.92	73.86	90.00	4.46	1	10.8	Pullout
							2	19.8	Pullout
							3	14.2	Pullout
							4	22.7	Pullout
8	1.28	71.50	32.91	85.17	0.00	0.00	1	10.8	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
							2	19.8	Pullout
							3	14.2	Pullout
							4	22.7	Pullout
9	1.30	81.00	30.62	94.13	0.00	0.00	1	9.3	Pullout
							2	18.7	Pullout
							3	13.4	Pullout
							4	22.3	Pullout
10	1.32	90.50	28.74	103.21	0.00	0.00	1	7.9	Pullout
							2	17.7	Pullout
							3	12.6	Pullout
							4	21.9	Pullout
11	1.35	100.00	27.16	112.39	0.00	0.00	1	6.7	Pullout
							2	16.8	Pullout
							3	11.8	Pullout
							4	21.5	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 14.1 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.55	5.00	70.22	13.29	87.71	12.52	1	29.5	Pullout
							2	32.3	Pullout

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
							3	21.4	Pullout
							4	26.0	Pullout
2	1.87	14.50	53.00	21.68	82.84	11.63	1	19.8	Pullout
							2	26.0	Pullout
							3	17.6	Pullout
							4	23.6	Pullout
3	1.58	24.00	47.46	35.50	-90.00	6.54	1	17.0	Pullout
							2	23.9	Pullout
							3	16.2	Pullout
							4	22.6	Pullout
4	1.44	33.50	41.10	44.46	90.00	7.31	1	13.6	Pullout
							2	21.3	Pullout
							3	14.4	Pullout
							4	21.3	Pullout
5	1.38	43.00	36.91	53.78	90.00	8.07	1	11.0	Pullout
							2	19.4	Pullout
							3	12.9	Pullout
							4	20.4	Pullout
6	1.35	52.50	37.16	65.87	-90.00	4.42	1	11.2	Pullout
							2	19.5	Pullout
							3	13.0	Pullout
							4	20.4	Pullout

7	1.33	62.00	34.08	74.85	90.00	4.66	1	9.1	Pullout
							2	17.9	Pullout
							3	11.6	Pullout
							4	19.7	Pullout
8	1.33	71.50	34.03	86.27	0.00	0.00	1	9.1	Pullout
							2	17.9	Pullout
							3	11.6	Pullout
							4	19.7	Pullout
9	1.34	81.00	31.66	95.16	0.00	0.00	1	7.4	Pullout
							2	16.5	Pullout
							3	10.4	Pullout
							4	19.0	Pullout
10	1.36	90.50	29.70	104.19	0.00	0.00	1	5.8	Pullout
							2	15.0	Pullout
							3	9.4	Pullout
							4	18.5	Pullout
11	1.39	100.00	28.06	113.32	0.00	0.00	1	4.2	Pullout
							2	13.7	Pullout
							3	8.5	Pullout
							4	18.0	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 11.3 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Lower Length feet	Upper Angle degrees	Upper Length feet	Reinforcement: Level	Stress ksi	Controlling Resistance Failure Mode
1	2.72	5.00	67.40	11.71	88.23	16.22	1	29.4	Pullout
							2	32.2	Pullout
							3	20.4	Pullout
							4	24.8	Pullout
2	2.03	14.50	54.82	22.65	83.30	12.43	1	19.7	Pullout
							2	25.2	Pullout
							3	16.7	Pullout
							4	22.1	Pullout
3	1.70	24.00	45.34	34.15	-90.00	10.41	1	14.1	Pullout
							2	21.3	Pullout
							3	13.8	Pullout
							4	19.8	Pullout
4	1.55	33.50	42.62	45.53	90.00	7.71	1	12.5	Pullout
							2	20.0	Pullout
							3	12.7	Pullout
							4	19.1	Pullout
5	1.47	43.00	38.25	54.75	90.00	8.47	1	9.6	Pullout
							2	17.8	Pullout
							3	10.6	Pullout
							4	17.8	Pullout

6	1.42	52.50	38.39	66.98	-90.00	4.62	1	9.7	Pullout
							2	17.9	Pullout
							3	10.7	Pullout
							4	17.9	Pullout
7	1.39	62.00	35.20	75.88	90.00	4.86	1	7.5	Pullout
							2	15.9	Pullout
							3	9.1	Pullout
							4	16.8	Pullout
8	1.39	71.50	32.33	84.61	90.00	5.03	1	5.2	Pullout
							2	13.7	Pullout
							3	7.4	Pullout
							4	15.8	Pullout
9	1.39	81.00	32.67	96.23	0.00	0.00	1	5.5	Pullout
							2	13.9	Pullout
							3	7.6	Pullout
							4	16.0	Pullout
10	1.40	90.50	30.65	105.19	0.00	0.00	1	3.4	Pullout
							2	12.2	Pullout
							3	6.4	Pullout
							4	15.2	Pullout
11	1.42	100.00	28.94	114.27	0.00	0.00	1	1.5	Pullout
							2	10.7	Pullout

3	5.3	Pullout
4	14.5	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 9.3 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.09	5.00	70.99	9.21	84.38	20.41	1	29.8	Pullout
							2	33.0	Pullout
							3	21.5	Pullout
							4	24.7	Pullout
2	2.15	14.50	51.54	20.98	84.96	16.49	1	19.3	Pullout
							2	22.4	Pullout
							3	14.2	Pullout
							4	19.4	Pullout
3	1.87	24.00	47.52	24.88	68.58	19.71	1	14.6	Pullout
							2	20.5	Pullout
							3	12.6	Pullout
							4	18.2	Pullout
4	1.67	33.50	40.27	43.90	90.00	12.16	1	8.9	Pullout
							2	16.7	Pullout
							3	8.9	Pullout

							4	15.7	Pullout
5	1.56	43.00	39.54	55.76	90.00	8.87	1	8.4	Pullout
							2	16.2	Pullout
							3	8.5	Pullout
							4	15.4	Pullout
6	1.50	52.50	36.30	65.14	-90.00	9.64	1	6.0	Pullout
							2	13.7	Pullout
							3	6.6	Pullout
							4	14.2	Pullout
7	1.46	62.00	36.30	76.93	90.00	5.06	1	6.0	Pullout
							2	13.7	Pullout
							3	6.6	Pullout
							4	14.2	Pullout
8	1.45	71.50	33.35	85.59	90.00	5.23	1	3.0	Pullout
							2	11.2	Pullout
							3	4.7	Pullout
							4	12.9	Pullout
9	1.45	81.00	33.67	97.32	0.00	0.00	1	3.4	Pullout
							2	11.5	Pullout
							3	4.9	Pullout
							4	13.1	Pullout
10	1.45	90.50	31.58	106.23	0.00	0.00	1	1.0	Pullout

							2	9.6	Pullout
							3	3.5	Pullout
							4	12.1	Pullout
11	1.47	100.00	29.81	115.25	0.00	0.00	1	0.0	Pullout
							2	7.9	Pullout
							3	2.2	Pullout
							4	11.3	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 6.6 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	909.00	5.00	0.00	0.50	81.75	31.34	1	30.1	Pullout
							2	33.5	Pullout
							3	22.3	Pullout
							4	25.8	Pullout
2	2.36	14.50	53.95	17.25	78.25	21.36	1	20.8	Pullout
							2	24.6	Pullout
							3	13.7	Pullout
							4	18.2	Pullout
3	2.01	24.00	45.22	27.26	76.07	19.93	1	12.0	Pullout
							2	17.6	Pullout

							3	9.1	Pullout
							4	15.0	Pullout
4	1.80	33.50	44.64	42.37	75.29	13.19	1	10.0	Pullout
							2	17.2	Pullout
							3	8.8	Pullout
							4	14.8	Pullout
5	1.68	43.00	37.05	53.88	90.00	13.91	1	3.9	Pullout
							2	11.3	Pullout
							3	4.1	Pullout
							4	11.5	Pullout
6	1.59	52.50	37.42	66.10	-90.00	10.04	1	4.3	Pullout
							2	11.7	Pullout
							3	4.3	Pullout
							4	11.7	Pullout
7	1.55	62.00	37.36	78.01	90.00	5.26	1	4.3	Pullout
							2	11.6	Pullout
							3	4.3	Pullout
							4	11.7	Pullout
8	1.52	71.50	34.34	86.59	90.00	5.43	1	0.9	Pullout
							2	8.9	Pullout
							3	2.2	Pullout
							4	10.2	Pullout
9	1.51	81.00	34.63	98.44	0.00	0.00	1	1.2	Pullout

							2	9.2	Pullout
							3	2.4	Pullout
							4	10.3	Pullout
10	1.51	90.50	32.49	107.29	0.00	0.00	1	0.0	Pullout
							2	7.1	Pullout
							3	0.8	Pullout
							4	9.2	Pullout
11	1.53	100.00	30.67	116.26	0.00	0.00	1	0.0	Pullout
							2	5.2	Pullout
							3	0.0	Pullout
							4	8.2	Pullout

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Nominal Pullout Resistance

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Nominal Pullout Resistance

Layer	Description	klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

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END OF REPORT

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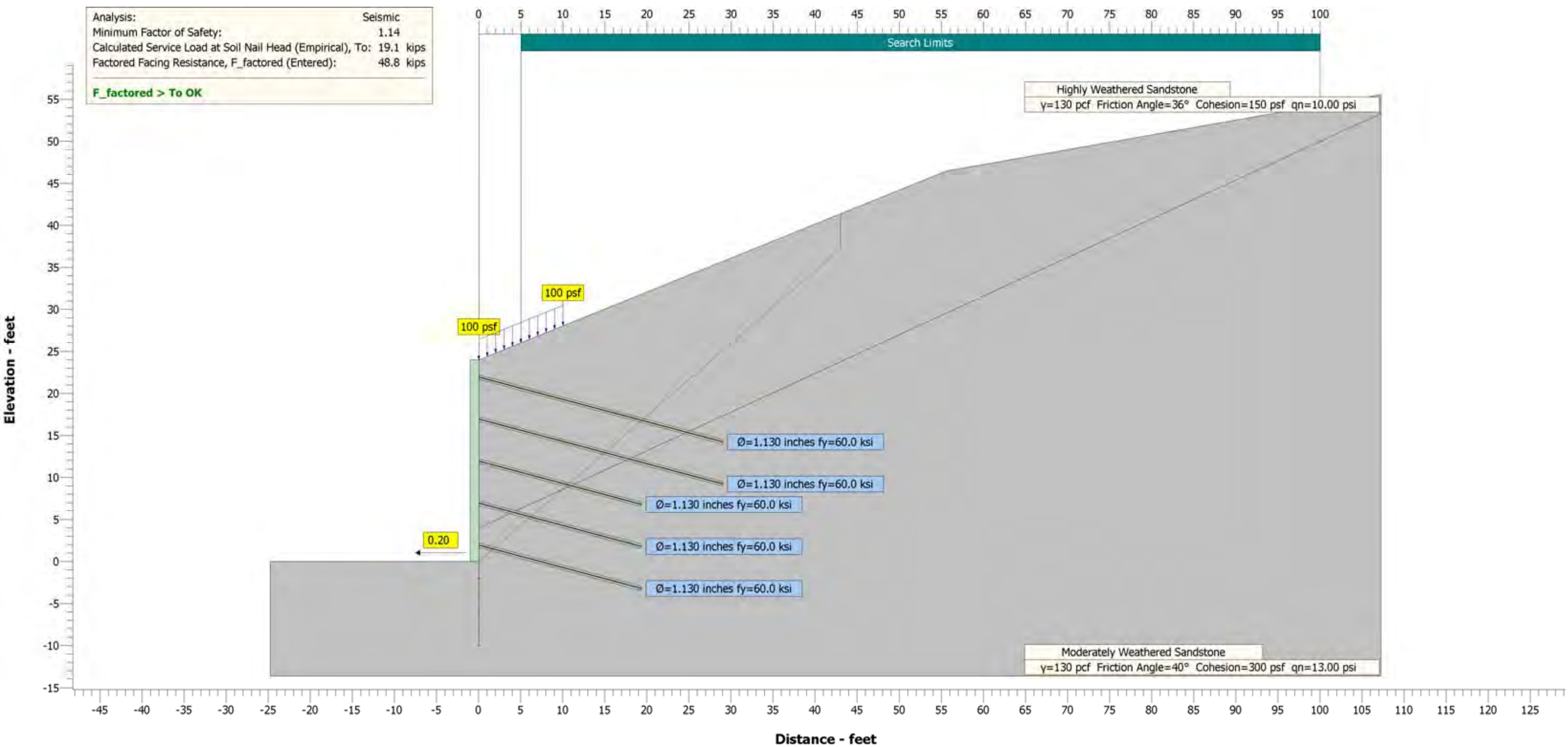
Analysis: Seismic
Minimum Factor of Safety: 1.14
Calculated Service Load at Soil Nail Head (Empirical), To: 19.1 kips
Factored Facing Resistance, F_factored (Entered): 48.8 kips
F_factored > To OK
Search Limits
Highly Weathered Sandstone
γ=130 pcf Friction Angle=36° Cohesion=150 psf qn=10.00 psi
100 psf
100 psf
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
Ø=1.130 inches fy=60.0 ksi
0.20
Moderately Weathered Sandstone
γ=130 pcf Friction Angle=40° Cohesion=300 psf qn=13.00 psi
Elevation - feet
Distance - feet

==

Snail

Version: 1.3

==

File Information

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File Name: RW7_1027+80_5 row_seismic.snz

Run Date: 01/27/16

Run Time: 16:48:31

==

Project Information

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Description: I-580

Location: RSR Off Ramp

EA:
Project ID: 60366

Wall No.: Wall No. 7

Structure No.: 5 row - seismic

Station: Sta. 1027+80

Engineer: GHY

Designer

Comments:

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Geometry

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Layout:

Reference Point:

At: Top of Wall

Distance From Origin: 0.00 feet

Elevation Above Origin: 24.00 feet

Wall Dimensions:

Wall Height: 24.00 feet

Facing Angle: 90.00 degrees

Facing Batter: 0.000 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 2

No.	Angle degrees	Distance feet
1	22	60.00
2	10	

Number of lines that define the ground surface in front of the toe: 2

No.	Angle degrees	Distance feet
1	0	20.00
2	0	

Soil Layers:

Number of Layers: 2

Layers Below the Top Layer:

Coordinates of the Top of the Layer feet

Layer	Point 1 Distance	Point 1 Elevation	Point 2 Distance	Point 2 Elevation
2	0.00	4.00	100.00	50.00

Ground Water:

Include Ground Water: No

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Soil Nails

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Dimensions and Properties:

Diameter of Drilled Holes: 6.000 inches

Horizontal Spacing: 5.00 feet

Maximum Vertical Spacing: 5.00 feet

Number of Soil Nail Rows: 5

Soil Nail Design Parameters: Varying

No.	Soil Nail Length feet	Inclination From Horizontal degrees	Vertical Spacing feet	Nail Bar Diameter Ø inches	Nail Bar Yield Strength fy ksi
1	30.00	15	2.00	1.130	60.0
2	30.00	15	5.00	1.130	60.0
3	20.00	15	5.00	1.130	60.0
4	20.00	15	5.00	1.130	60.0
5	20.00	15	5.00	1.130	60.0

Resistance Factors:

	Temporary	Permanent	Seismic
Factored Facing Resistance:	31.5	35.9	48.8 kips
Bond Resistance Factor:	0.50	0.50	0.50
Nail Bar Resistance Factor:	0.56	0.56	0.74

Soil Properties

Layer	Description	Unit Weight γ pcf	Friction Angle φ' degrees	Cohesion c' psf
1	Highly Weathered Sand130stone		36	150
2	Moderately Weathered 130Sandstone		40	300

Loads

Applied Loads:

Seismic:

Horizontal Seismic Coefficient: 0.20

External Load:

Apply external load: No

Surcharges:

Apply surcharges: Yes

No.	Distance from Top of Wall Begin feet	End feet	Load Begin psf	Load End psf
1	0.00	10.00	100	100

LRFD Load and Resistance Factors:

Apply Load and Resistance Factors: No

Search Options

Search Limits:

Begin: 5.00 feet

End: 100.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: Yes

Number of BTS Points: 5

BTS Depth: 10.00 feet

Interface Friction

Reduction Factor: 0.33

Advanced Search Options:

Use Advanced Search Options: No

Factors of Safety

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Analysis Scenario: Seismic

Summary:

Minimum Factor of Safety: 1.14

Found at Search Level: Toe of the wall

Found at Search Point: 5

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall Facing Design Force = 19.1 kips (Clouterre)

Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Failure Planes: Lower Angle degrees	Failure Planes: Lower Length feet	Failure Planes: Upper Angle degrees	Failure Planes: Upper Length feet	Reinforcement: Level	Reinforcement: Stress ksi	Reinforcement: Controlling Resistance Failure Mode
1	2.06	5.00	66.62	11.34	88.17	15.62	1	29.7	Pullout
							2	32.3	Pullout
							3	20.2	Pullout
							4	24.7	Pullout
							5	28.1	Pullout
2	1.45	14.50	55.25	25.44	-90.00	8.96	1	20.3	Pullout
							2	26.1	Pullout
							3	17.3	Pullout
							4	23.1	Pullout
							5	27.5	Pullout

3	1.23	24.00	48.32	36.09	-90.00	6.74	1	16.9	Pullout
							2	23.5	Pullout
							3	15.4	Pullout
							4	21.7	Pullout
							5	27.1	Pullout
4	1.16	33.50	45.24	47.58	90.00	3.75	1	15.2	Pullout
							2	22.2	Pullout
							3	14.5	Pullout
							4	21.0	Pullout
							5	26.9	Pullout
** 5	1.14	43.00	40.89	56.88	90.00	4.14	1	12.7	Pullout
							2	20.2	Pullout
							3	13.1	Pullout
							4	20.0	Pullout
							5	26.6	Pullout
6	1.14	52.50	37.78	66.42	-90.00	4.52	1	10.7	Pullout
							2	18.7	Pullout
							3	11.9	Pullout
							4	19.1	Pullout
							5	26.4	Pullout
7	1.15	62.00	37.52	78.16	0.00	0.00	1	10.5	Pullout
							2	18.6	Pullout
							3	11.7	Pullout

							4	19.1	Pullout
							5	26.4	Pullout
8	1.17	71.50	34.57	86.83	0.00	0.00	1	8.5	Pullout
							2	17.0	Pullout
							3	10.3	Pullout
							4	18.2	Pullout
							5	26.1	Pullout
9	1.21	81.00	32.17	95.69	0.00	0.00	1	6.7	Pullout
							2	15.2	Pullout
							3	9.0	Pullout
							4	17.5	Pullout
							5	25.9	Pullout
10	1.26	90.50	30.18	104.69	0.00	0.00	1	4.7	Pullout
							2	13.6	Pullout
							3	7.9	Pullout
							4	16.8	Pullout
							5	25.7	Pullout
11	1.32	100.00	28.50	113.79	0.00	0.00	1	2.8	Pullout
							2	12.2	Pullout
							3	6.9	Pullout
							4	16.2	Pullout
							5	25.6	Pullout

Search Level: 2.00 feet below the toe of the wall Facing Design Force = 17.0 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
	Minimum Factor of	Distance From Toe of Wall	Angle	Length	Angle	Length		Stress	Controlling Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.23	5.00	68.13	12.08	88.30	16.82	1	29.7	Pullout
							2	32.2	Pullout
							3	20.2	Pullout
							4	24.1	Pullout
							5	27.1	Pullout
2	1.55	14.50	57.50	18.89	74.73	16.51	1	21.9	Pullout
							2	25.8	Pullout
							3	16.6	Pullout
							4	21.9	Pullout
							5	26.0	Pullout
3	1.31	24.00	49.96	37.30	-90.00	7.14	1	16.1	Pullout
							2	22.5	Pullout
							3	14.3	Pullout
							4	20.0	Pullout
							5	25.2	Pullout
4	1.22	33.50	43.35	46.07	90.00	7.91	1	12.2	Pullout
							2	19.4	Pullout
							3	11.8	Pullout

							4	18.1	Pullout
							5	24.3	Pullout
5	1.19	43.00	42.23	58.08	90.00	4.34	1	11.5	Pullout
							2	18.9	Pullout
							3	11.2	Pullout
							4	17.7	Pullout
							5	24.2	Pullout
6	1.17	52.50	38.99	67.54	-90.00	4.72	1	9.3	Pullout
							2	17.1	Pullout
							3	9.6	Pullout
							4	16.6	Pullout
							5	23.7	Pullout
7	1.17	62.00	38.66	79.40	0.00	0.00	1	9.1	Pullout
							2	17.0	Pullout
							3	9.4	Pullout
							4	16.5	Pullout
							5	23.6	Pullout
8	1.19	71.50	35.65	87.98	0.00	0.00	1	6.9	Pullout
							2	14.7	Pullout
							3	7.8	Pullout
							4	15.5	Pullout
							5	23.2	Pullout
9	1.22	81.00	33.17	96.77	0.00	0.00	1	4.5	Pullout

							2	12.7	Pullout
							3	6.3	Pullout
							4	14.5	Pullout
							5	22.7	Pullout
10	1.26	90.50	31.12	105.71	0.00	0.00	1	2.2	Pullout
							2	10.9	Pullout
							3	4.9	Pullout
							4	13.6	Pullout
							5	22.4	Pullout
11	1.32	100.00	29.38	114.76	0.00	0.00	1	0.1	Pullout
							2	9.3	Pullout
							3	3.7	Pullout
							4	12.9	Pullout
							5	22.0	Pullout

Search Level: 4.00 feet below the toe of the wall Facing Design Force = 14.6 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.44	5.00	66.05	9.85	87.28	21.04	1	29.8	Pullout
							2	32.5	Pullout
							3	20.5	Pullout

							4	23.2	Pullout
							5	25.7	Pullout
2	1.65	14.50	57.28	24.15	83.89	13.62	1	19.8	Pullout
							2	24.3	Pullout
							3	15.2	Pullout
							4	20.2	Pullout
							5	24.3	Pullout
3	1.41	24.00	51.49	38.54	-90.00	7.54	1	15.4	Pullout
							2	21.6	Pullout
							3	13.2	Pullout
							4	18.4	Pullout
							5	23.3	Pullout
4	1.30	33.50	44.77	47.18	90.00	8.31	1	11.2	Pullout
							2	18.3	Pullout
							3	10.0	Pullout
							4	16.1	Pullout
							5	22.1	Pullout
5	1.25	43.00	43.52	59.30	90.00	4.54	1	10.4	Pullout
							2	17.6	Pullout
							3	9.4	Pullout
							4	15.6	Pullout
							5	21.8	Pullout
6	1.22	52.50	40.15	68.69	-90.00	4.92	1	8.0	Pullout

							2	15.3	Pullout
							3	7.5	Pullout
							4	14.3	Pullout
							5	21.1	Pullout
7	1.22	62.00	36.83	77.46	90.00	5.16	1	5.2	Pullout
							2	12.6	Pullout
							3	5.4	Pullout
							4	12.9	Pullout
							5	20.4	Pullout
8	1.22	71.50	36.69	89.17	0.00	0.00	1	5.0	Pullout
							2	12.5	Pullout
							3	5.3	Pullout
							4	12.8	Pullout
							5	20.3	Pullout
9	1.24	81.00	34.15	97.88	0.00	0.00	1	2.3	Pullout
							2	10.3	Pullout
							3	3.7	Pullout
							4	11.7	Pullout
							5	19.7	Pullout
10	1.27	90.50	32.03	106.75	0.00	0.00	1	0.0	Pullout
							2	8.3	Pullout
							3	2.1	Pullout
							4	10.6	Pullout

							5	19.1	Pullout
11	1.32	100.00	30.24	115.75	0.00	0.00	1	0.0	Pullout
							2	6.5	Pullout
							3	0.8	Pullout
							4	9.7	Pullout
							5	18.6	Pullout

Search Level: 6.00 feet below the toe of the wall Facing Design Force = 12.7 kips (Clouterre)

			Failure Planes				Reinforcement		
			Lower		Upper				
Node	Minimum Factor of Safety	Distance From Toe of Wall feet	Angle degrees	Length feet	Angle degrees	Length feet	Level	Stress ksi	Controlling Resistance Failure Mode
1	2.58	5.00	74.30	16.63	88.21	16.02	1	29.7	Pullout
							2	32.3	Pullout
							3	20.2	Pullout
							4	23.9	Pullout
							5	26.1	Pullout
2	1.82	14.50	53.95	22.18	85.38	17.99	1	19.5	Pullout
							2	22.3	Pullout
							3	12.7	Pullout
							4	17.3	Pullout
							5	21.9	Pullout
3	1.52	24.00	49.18	36.72	-90.00	11.91	1	12.4	Pullout

							2	18.9	Pullout
							3	10.2	Pullout
							4	15.5	Pullout
							5	20.8	Pullout
4	1.39	33.50	46.11	48.32	90.00	8.71	1	10.3	Pullout
							2	17.2	Pullout
							3	8.4	Pullout
							4	14.2	Pullout
							5	20.0	Pullout
5	1.33	43.00	41.39	57.32	90.00	9.47	1	6.9	Pullout
							2	13.6	Pullout
							3	5.6	Pullout
							4	12.2	Pullout
							5	18.8	Pullout
6	1.29	52.50	41.28	69.86	-90.00	5.12	1	6.8	Pullout
							2	13.5	Pullout
							3	5.5	Pullout
							4	12.1	Pullout
							5	18.7	Pullout
7	1.27	62.00	37.89	78.56	90.00	5.36	1	3.4	Pullout
							2	10.6	Pullout
							3	3.2	Pullout
							4	10.5	Pullout

							5	17.7	Pullout
8	1.27	71.50	37.71	90.37	0.00	0.00	1	3.2	Pullout
							2	10.4	Pullout
							3	3.1	Pullout
							4	10.4	Pullout
							5	17.7	Pullout
9	1.28	81.00	35.11	99.02	0.00	0.00	1	0.2	Pullout
							2	8.0	Pullout
							3	1.2	Pullout
							4	9.0	Pullout
							5	16.8	Pullout
10	1.31	90.50	32.94	107.83	0.00	0.00	1	0.0	Pullout
							2	5.9	Pullout
							3	0.0	Pullout
							4	7.8	Pullout
							5	16.1	Pullout
11	1.35	100.00	31.09	116.77	0.00	0.00	1	0.0	Pullout
							2	3.9	Pullout
							3	0.0	Pullout
							4	6.7	Pullout
							5	15.4	Pullout

Search Level: 8.00 feet below the toe of the wall Facing Design Force = 10.8 kips (Clouterre)

	Minimum	Distance	Failure Planes				Reinforcement		
	Factor	From Toe	Lower		Upper				Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	2.80	5.00	73.62	14.18	87.20	20.44	1	29.8	Pullout
							2	32.5	Pullout
							3	20.5	Pullout
							4	23.2	Pullout
							5	25.2	Pullout
2	1.98	14.50	55.42	22.99	85.62	18.98	1	19.4	Pullout
							2	22.3	Pullout
							3	11.7	Pullout
							4	16.1	Pullout
							5	20.5	Pullout
3	1.68	24.00	53.50	36.31	79.14	12.74	1	13.7	Pullout
							2	19.7	Pullout
							3	10.6	Pullout
							4	15.3	Pullout
							5	19.9	Pullout
4	1.49	33.50	47.40	49.49	90.00	9.11	1	9.5	Pullout
							2	16.0	Pullout
							3	6.9	Pullout
							4	12.5	Pullout

							5	18.1	Pullout
5	1.41	43.00	42.57	58.39	90.00	9.87	1	5.6	Pullout
							2	12.0	Pullout
							3	3.7	Pullout
							4	10.1	Pullout
							5	16.5	Pullout
6	1.36	52.50	39.04	67.59	-90.00	10.64	1	1.8	Pullout
							2	8.8	Pullout
							3	1.2	Pullout
							4	8.2	Pullout
							5	15.3	Pullout
7	1.33	62.00	38.91	79.67	90.00	5.56	1	1.6	Pullout
							2	8.7	Pullout
							3	1.1	Pullout
							4	8.1	Pullout
							5	15.2	Pullout
8	1.33	71.50	38.70	91.61	0.00	0.00	1	1.4	Pullout
							2	8.5	Pullout
							3	0.9	Pullout
							4	8.0	Pullout
							5	15.1	Pullout
9	1.33	81.00	36.05	100.18	0.00	0.00	1	0.0	Pullout
							2	5.9	Pullout

							3	0.0	Pullout
							4	6.5	Pullout
							5	14.1	Pullout
10	1.35	90.50	33.82	108.93	0.00	0.00	1	0.0	Pullout
							2	3.5	Pullout
							3	0.0	Pullout
							4	5.0	Pullout
							5	13.1	Pullout
11	1.39	100.00	31.92	117.82	0.00	0.00	1	0.0	Pullout
							2	1.4	Pullout
							3	0.0	Pullout
							4	3.8	Pullout
							5	12.3	Pullout

Search Level: 10.00 feet below the toe of the wall Facing Design Force = 8.2 kips (Clouterre)

			Failure Planes				Reinforcement		
	Minimum	Distance	Lower		Upper				
	Factor	From Toe							Controlling
	of	of Wall	Angle	Length	Angle	Length		Stress	Resistance
Node	Safety	feet	degrees	feet	degrees	feet	Level	ksi	Failure Mode
1	3.32	5.00	80.16	14.62	83.40	21.76	1	30.2	Pullout
							2	33.2	Pullout
							3	21.6	Pullout
							4	24.7	Pullout

							5	26.3	Pullout
2	2.15	14.50	59.80	23.06	81.72	20.14	1	20.3	Pullout
							2	23.5	Pullout
							3	12.5	Pullout
							4	16.3	Pullout
							5	20.2	Pullout
3	1.80	24.00	48.69	29.09	77.61	22.37	1	11.7	Pullout
							2	14.8	Pullout
							3	5.6	Pullout
							4	11.0	Pullout
							5	16.4	Pullout
4	1.62	33.50	47.82	44.90	76.78	14.65	1	8.1	Pullout
							2	14.1	Pullout
							3	5.0	Pullout
							4	10.5	Pullout
							5	16.0	Pullout
5	1.51	43.00	42.90	52.83	74.41	16.00	1	3.4	Pullout
							2	9.8	Pullout
							3	1.4	Pullout
							4	7.8	Pullout
							5	14.1	Pullout
6	1.44	52.50	40.08	68.61	-90.00	11.04	1	0.2	Pullout
							2	7.0	Pullout

							3	0.0	Pullout
							4	6.1	Pullout
							5	12.9	Pullout
7	1.40	62.00	39.90	80.82	90.00	5.76	1	0.0	Pullout
							2	6.9	Pullout
							3	0.0	Pullout
							4	6.0	Pullout
							5	12.8	Pullout
8	1.40	71.50	39.66	92.87	0.00	0.00	1	0.0	Pullout
							2	6.6	Pullout
							3	0.0	Pullout
							4	5.8	Pullout
							5	12.7	Pullout
9	1.40	81.00	36.96	101.37	0.00	0.00	1	0.0	Pullout
							2	3.8	Pullout
							3	0.0	Pullout
							4	4.0	Pullout
							5	11.5	Pullout
10	1.41	90.50	34.68	110.06	0.00	0.00	1	0.0	Pullout
							2	1.3	Pullout
							3	0.0	Pullout
							4	2.4	Pullout
							5	10.3	Pullout

11	1.43	100.00	32.74	118.89	0.00	0.00	1	0.0	Pullout
							2	0.0	Pullout
							3	0.0	Pullout
							4	1.0	Pullout
							5	9.3	Pullout

Nominal Pullout Resistance

Layer	Description	Nominal Pullout Resistance klf
1	Highly Weathered Sandstone	2.262
2	Moderately Weathered Sandstone	2.940

END OF REPORT

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Snail

Version: 1.3

Facing Analysis

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File Information

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Draft Standard Drawing xs12-000-1 February 2013: Design Number 3

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Analysis

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Temporary Shoring Only: No

Check Bearing Plate Capacity: No

===

Soil Nails

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Horizontal Spacing: 5.00 feet

Vertical Spacing: 5.00 feet

===

Facing

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	Temporary	Permanent	
Facing Thickness:	4.000	8.000	inches
Vertical Reinforcement Area:	0.12	0.20	in²/foot
Horizontal Reinforcement Area:	0.12	0.20	in²/foot
No. of Vertical Waler Bars:	2	0	
No. of Horizontal Waler Bars:	2	0	
Waler Bar Area:	0.20	0.00	in²
Concrete Yield Strength:	3.6	3.6	ksi

Reinforcement Yield Strength:	65.0	60.0	ksi
Punching Correction Factor:	1.00	1.00	
Flexural Correction Factor:	2.00	1.00	

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Bearing Plates

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Bearing Plate Width / Height: 10.000 inches

Bearing Plate Thickness: 1.000 inches

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Studs

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Number of Studs: 4

Stud Head Diameter: 1.250 inches

Head Thickness: 0.310 inches

Headed-Stud Length: 5.250 inches

Stud Shaft Diameter: 0.750 inches

Stud Spacing: 6.000 inches

Stud Tensile Strength: 60.0 ksi

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Resistance Factors

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Facing Resistance Factors:

	Temporary	Permanent	Seismic
Punching:	0.74	0.67	0.91
Flexural:	0.74	0.67	0.91
Stud Tensile:		0.50	0.67

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Results

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Facing:

Capacity Ratio

Factored (Normalized by

Analysis	Failure Mode	Resistance kips	Control Mode Capacity)
Temporary:	Flexure:	39.0	1.24
	Punching Shear:	31.5	1.00
Permanent:	Flexure:	40.7	1.13
	Punching Shear:	35.9	1.00
	Stud Tensile:	53.0	1.48
Seismic:	Flexure:	55.3	1.13
	Punching Shear:	48.8	1.00
	Stud Tensile:	71.0	1.46

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END OF REPORT

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APPENDIX G

Comments and Responses

Office of Special Funded Projects
Comment & Response Form

(Revised 08/2011)

General Project Information (OSFP Liaison to complete)		Review Phase (OSFP Liaison to complete)	Reviewer Information (Reviewer Liaison to complete)	
Dist:	**04**	☐ PSR/PDS (Review No.)	Reviewer Name:	**Sunny Yang**
Proj ID (Phase):	**0414000552**	☐ APS/PSR (Review No.)	Functional Unit:	**OGDW**
Project Name:	**RSR Access Improvement**	☐ APS/PR (Review No.)	Cost Center:	**59.3660**
OSFP Liaison:	**Emil Vergara**	☐ Type Selection	Phone Number:	**510-286-4808**
Phone:		☐ 65% PS&E Unchecked Details	e-mail:	**Sunny.yang@dot.ca.gov**
E-mail:		☑ PS&E (Review No. 1)	Date of Review:	**6/2/16**
		☐ Construction	Structure Name*:	**Richmond San Rafael Bridge**
		☐ Other:	Br No*:	**28- 0100**
			(*Use if necessary to when comment sheets are by individual structure)	

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	E-mail	Response Date
Kandeep Saravanapavan	**Parikh Consultants, Inc**	**408-452-9000**	**ksaravanapavan@parikhnet.com**	**06/22/2016**

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR	35	Table 13 should include lateral tips	Lateral tips are included.	
2	FR	35	Table 13: Required nominal driving resistance is much higher than nominal resistance. Pile driveability analysis should be performed. Proper pile thickness, driving shoes, and proper hammer should be determined to avoid damaging the piles during driving.	Since potential liquefiable layers were encountered above the bedrock, pile capacities were not considered along the liquefiable layer for the nominal resistance calculation. But pile capacities along the liquefiable layers were included in the driving resistance. That's why driving resistance is higher than nominal resistance. Pile drivability analysis were performed and attached in appendix for shallow bedrock and deeper bedrock cases. Pile type was changed to Class 200 Alt "W" to satisfy maximum driving compressive stress.	
3	FR	35	Notes of Table 13: If the piles reach bedrock with high enough blow counts and pile lengths exceed lateral tips, then the piles don't need to reach vertical tips. If lateral tips are below the bedrock, then center relief drilling can be	Agreed, revised the recommendations with center relief drilling. Revised the notes.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Submittal Data (Reviewer to complete)
Project ID: 06 0000 0484 Reviewer: Str Name*:
Date of Review: Functional Unit: Br No*. *=if applicable

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
			used.		
4	FR	35	Notes of Table 13: Pre-drilling as described in Note 1 should not be allowed. Center relief drilling is okay which is different than pre-drilling	Agreed, revised the recommendations with center drilling.	
5	RW Plans	Sheets 3/4	FR recommended 2' of lean concrete base under the footings of RW 1 and 2. This concrete base should be shown on RW plans.	Lean concrete base is called out on the typical section and notes.	
6	FR and RW Plans	Plan sheets 13 and 29	Temporary shoring for RW 4 and 7. These shorings are not mentioned in FR. Please provide recommendations in FR.	Temporary soil nails are considered to install in the existing wall to support it after the tiebacks are cut. RW 4 & 7 recommendations are valid for temporary soil nail design. It is mentioned in the updated foundation report.	
7					
8					
9					
10					
11					
12					

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

OSFP Rev Form 12/2010