TECHNICAL MEMORANDUM NO. 1
SUPPLEMENTAL BASIS OF DESIGN - RESPONSE TO ECRB COMMENTS

TO: **Cleve Livingston, Terminal One Development, LLC**

FROM **Pedro Espinosa, GE; Jeff Fippin, GE; Todd Bradford, PE**

DATE: **September 29, 2017**
Revised October 12, 2017

SUBJECT: **Terminal 1, Latitude Project – Response to ECRB Comments**

Reference: ENGEO; Existing Geotechnical Conditions and Seismic Slope Stability, Terminal One, Richmond, California; July 24, 2017; Project No. 5931.000.000

This Technical Memorandum No. 1 provides supplemental design criteria and clarifications regarding the engineering assumptions employed in our analysis of the existing geotechnical conditions and seismic slope stability at the Terminal One site in Richmond, California. The supplemental information set forth below has been prepared in response to comments and inquiries received from the San Francisco Bay Conservation and Development Commission (BCDC) Engineering Criteria Review Board (ECRB), on August 8, 2017, during a meeting on the Latitude Project. The "ECRB Comments" listed below have been excerpted from the draft August 8, 2017 Meeting Minutes.

ECRB Comment #1:

Look at the amount of information gathered on the western part of the site to see if additional work and exploration is warranted to better characterize the materials below the Bay mud.

ENGEO Response #1:

As requested by the ECRB, we reviewed the site exploration data for the western portion of the Terminal One site. Based on this review, we performed an additional subsurface exploration in the vicinity of the southwest corner of the site, shown on Figure 1, denoted as 3-EB-1 (Attachment C). The boring log for this boring is attached. Figure 3 shows the locations of three cross-sections along the existing shoreline that illustrate the relative consistency in subsurface conditions. We discuss our findings in our response to ECRB Comment #5 below.

ECRB Comment #2:

Questions were raised regarding the strength parameters used in evaluating the stability of the sand and clayey sand using phi of 30 degrees and a c of 730 psf.

ENGEO Response #2:

We performed supplemental analysis supporting soil classifications and strength parameters within the sand, clayey sand, and potentially liquefiable sand layers underlying the wharf structure.

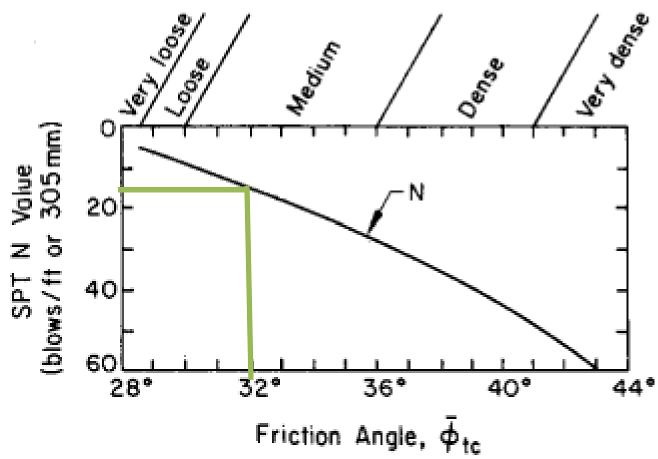
As requested by the ECRB, we revisited the laboratory data and soil classifications indicated on our boring logs and revised accordingly. Specifically, we reclassified a previously designated *clayey sand* layer in boring 2-EB-3 as a *sand with clay* per the Unified Soil Classification System based on grain size distribution analysis. Table 1 below summarizes the soil layers in question, their location, uncorrected and corrected blow counts, evaluated strength parameter, and cited source of the strength evaluation.

Our boring logs present uncorrected blow counts. Our subcontractor used an automatic-trip hammer when sampling during drilling. To evaluate the potential for liquefaction of these layers, we corrected our field blow counts to sixty percent energy and overburden ($(N_1)_{60}$) using methodologies discussed by Seed et al. (2003) and other researchers. We specifically incorporated corrections for overburden, rod length, and hammer energy. The drilling subcontractor provided us relatively recent records of field energy delivery by the hammer system, which indicate an approximate average energy of 78 percent; our experience and publications indicates this energy transfer efficiency is reasonable for this type of hammer system. We applied this energy rating to our blow counts using the equation shown in Exhibit 2. We did not apply the corrections for bore hole size and irregular sampler as they were not appropriate.

We determined that the shallower *sand with clay* layer at approximately 32 feet below soil surface **is unlikely** to liquefy based on a factor of safety against liquefaction of approximately 1.3 (Attachment D). Our liquefaction analysis is based on the methodologies by both Youd et al. (2001) and Seed et al. (2003). This analysis is included in Appendix B.

Based on correlations between N_{60} and friction angle by Peck, Hanson, and Thornburn, we conservatively assigned the *sand with clay* layer a friction angle of 30 degrees. As shown below, based on a blow count of 16, a higher friction angle would be reasonable.

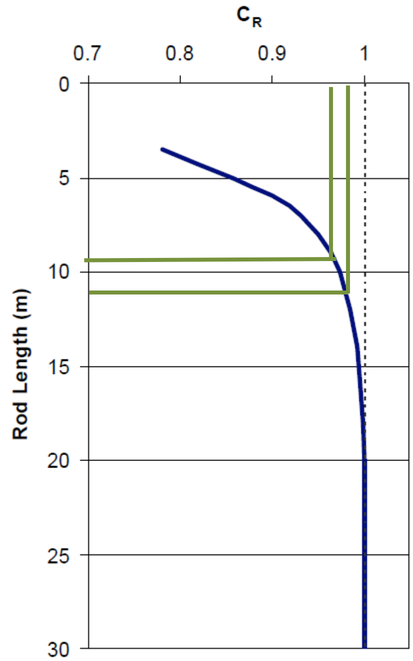
Exhibit 1: N versus Phi (Peck, Hanson, and Thornburn)



Our liquefaction analysis indicate the layer of *clayey sand* at approximately 37 feet below soil surface **is** potentially liquefiable. We analyzed the potentially liquefiable *clayey sand* layer by correcting the $(N_1)_{60}$ for fines content and established a residual shear strength value using methodology by Seed and Harder (1990). Our input, methods, and results are shown in Exhibit 2, Table 1, and Exhibit 3, below.

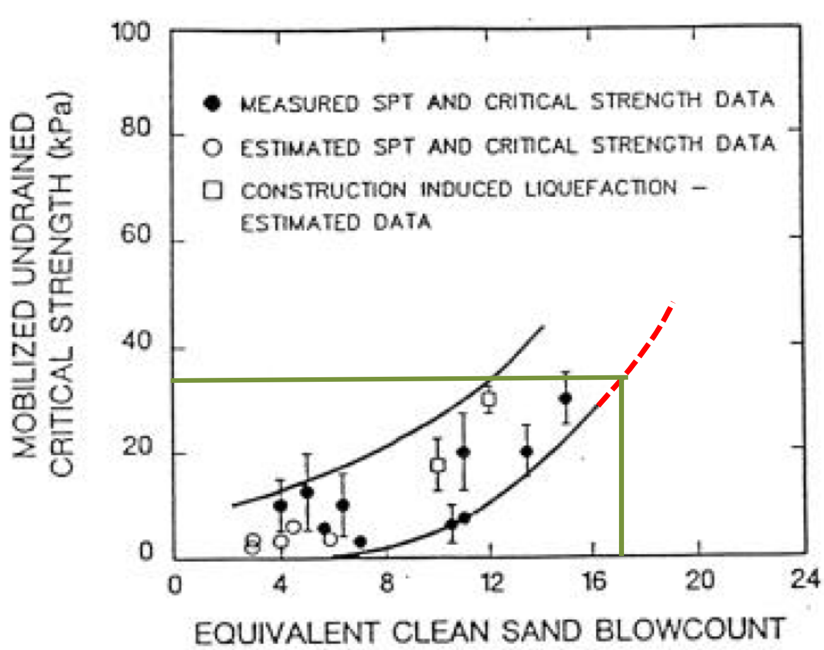
Exhibit 2: Overburden, Rod length, and Energy Ratio corrections (Seed, 2003)

$$C_N = \left(\frac{1}{\sigma'_v}\right)^{0.5}$$



$$C_E = \frac{ER}{60\%}$$

Exhibit 3: Recommended Relationship Between Su_r and N_{160cs} (Seed and Harder, 1990)



As illustrated in Exhibit 3, we previously used an extrapolated lower bound Sur value of 730 psf (35 kPa) corresponding to the corrected blow count of 17. Lastly, as recommended in Seed (2003) and given the relatively higher value of residual shear strength, we checked that in general, drained strengths did not govern when compared to the shear strength calculated with a friction angle of 28 degrees.

The following table summarizes our analyses of the soil layers and our interpreted soil parameters used in analysis.

TABLE 1

Boring	Depth below wharf (ft)	Depth below soil (ft)	Depth below soil (m)	Soil Classification	N_{60}	C_N	C_R	C_E	$(N_1)_{60}$	Fines Content (%)	C_{FINES}	$N_{160cs-Sr}$	Phi / Su_r (psf)	Cited Source
2-EB-2	60	47	14.3	Clayey Sand	-	-	-	-	-		-	-	**- / 730**	Extrapolated from 2-EB-3
2-EB-3	61	32	9.8	Sand with clay	16	1.43	0.96	1.28	28	12	1.06	30	**30 / -**	Peck, Hanson, and Thornburn via EPRI Manual, pp 4-15
2-EB-3	66	37	11.3	Clayey Sand	8	1.31	0.98	1.28	13	33	1.26	17	**- / 730**	Seed (1987) & Seed and Harder (1990)
2-EB-3	73	44	13.4	Old Alluvium (Lean Sandy Clay)	-	-	-	-	-		-	-	**- / 3100***	Laboratory UUTx
3-EB-1	-	55	16.8	Clayey Sand	21	0.82	0.99	1.28	22	14	1.09	24		Seed (1987) & Seed and Harder (1990)

*value represents undrained shear strength

ECRB Comment #3:

Reexamine the deflections for the piles during an event and the configuration and depth of the DSM buttress.

ENGEO Response #3:

Based on input from the ECRB Board as discussed in our Response #2 above, we revisited and revised our interpreted soil profile for the slope stability analysis of the wharf and shoreline. The presumed potentially liquefiable layer now extends beneath the wharf structure (Figure 3). We present the results of the analysis in Attachment A, which still achieve satisfactory performance based on the analysis criteria outlined in Reference 1.

ECRB Comment #4:

Justify why the site is classified as E and not F.

ENGEO Response #4:

The wharf area of the site is classified as Site Soil Class F. Our report erroneously categorized the site as Class E. Based on the determination of a Site Soil Class F, and pursuant to criteria in ASCE 7-10, Section 11.4.7, we performed a site response analysis in accordance with ASCE 7-10, Section 21.1. We provide a detail of our analysis in our response to comment #6, below, and show the analysis results in Attachment B.

ECRB Comment #5:

Provide information gathered regarding subsurface profiles in other parts of the site, including longitudinally.

ENGEO Response #5:

While the majority of our slope stability study presented in the reviewed report related to the southern shoreline underlying the wharf, we also considered the stability along the western edge of the site as well as east of the wharf. Improvements along the western shoreline and east of the wharf include a section of the Bay Shore Trail and a portion of Dornan Drive. Figures 1 and 2 illustrate the locations of the other cross sections we considered. All of the cross-sections are shown on Figure 3.

Given the similar soil types and thicknesses within the various sections, we anticipate similar seismic performance across the shoreline. Based on the seismic slope stability analysis we performed on Section 2-2' beneath the wharf and by inspection of the other cross-sections, we recommended the DSM buttress as a mitigation along the entire perimeter of the site. The DSM will abut the back of the rock dike and likely have a 1:1 depth to width ratio, and terminate a minimum of 5 feet below the bottom of the Young Bay Mud.

The silty sand shown on Section 1-1' is fill material within an historic swale which we have identified as potentially liquefiable. As such, we recommended that a closed grid of deep soil mixing (DSM) elements be constructed along the western shoreline.

Figure 2 shows geologic contours of the approximate bottom elevation of the YBM across the site. Using these contours as a starting reference, we will work with the DSM contractor to develop a DSM design that provides appropriate displacement of the buttress and soil retained by the buttress as described in our referenced report. The design criteria will include the requirement that the DSM penetrates the entire thickness of YBM and is embedded in either the Old Alluvium or Bedrock. The DSM layout is currently being analyzed and designed but is shown conceptually in Figure 2.

Section 4-4', following Figure 3, illustrates a cross-section east of the limits of the proposed DSM. In this area, the buildings are set back 185 feet from the shoreline. Using the same slope stability and deformation analysis we used in Reference 1, and outlined in NCHRP 611, we determined that the yield coefficient for a critical failure surface extending back through the project boundary and into the proposed structural area corresponds with a deformation of 6 inches or less. As discussed in the California Geological Survey's "Guidelines for Evaluating and Mitigating Seismic Hazards in California", Special Publication 117A, dated 2008, displacements less than 6 inches, "are unlikely to correspond to serious landslide movement and damage." We recommend in this area of the project that the building be designed considering this potential 6 inches of lateral ground deformation and associated stretch of the building. Between the building area and the shoreline, the displacement will be incrementally larger closer to the water. The majority of potential displacement would occur within the parking lot of the adjacent marina off the project limits.

ECRB Comment #6:

Reexamine the results and provide a narrative of the seismic hazard staging.

ENGEO Response #6:

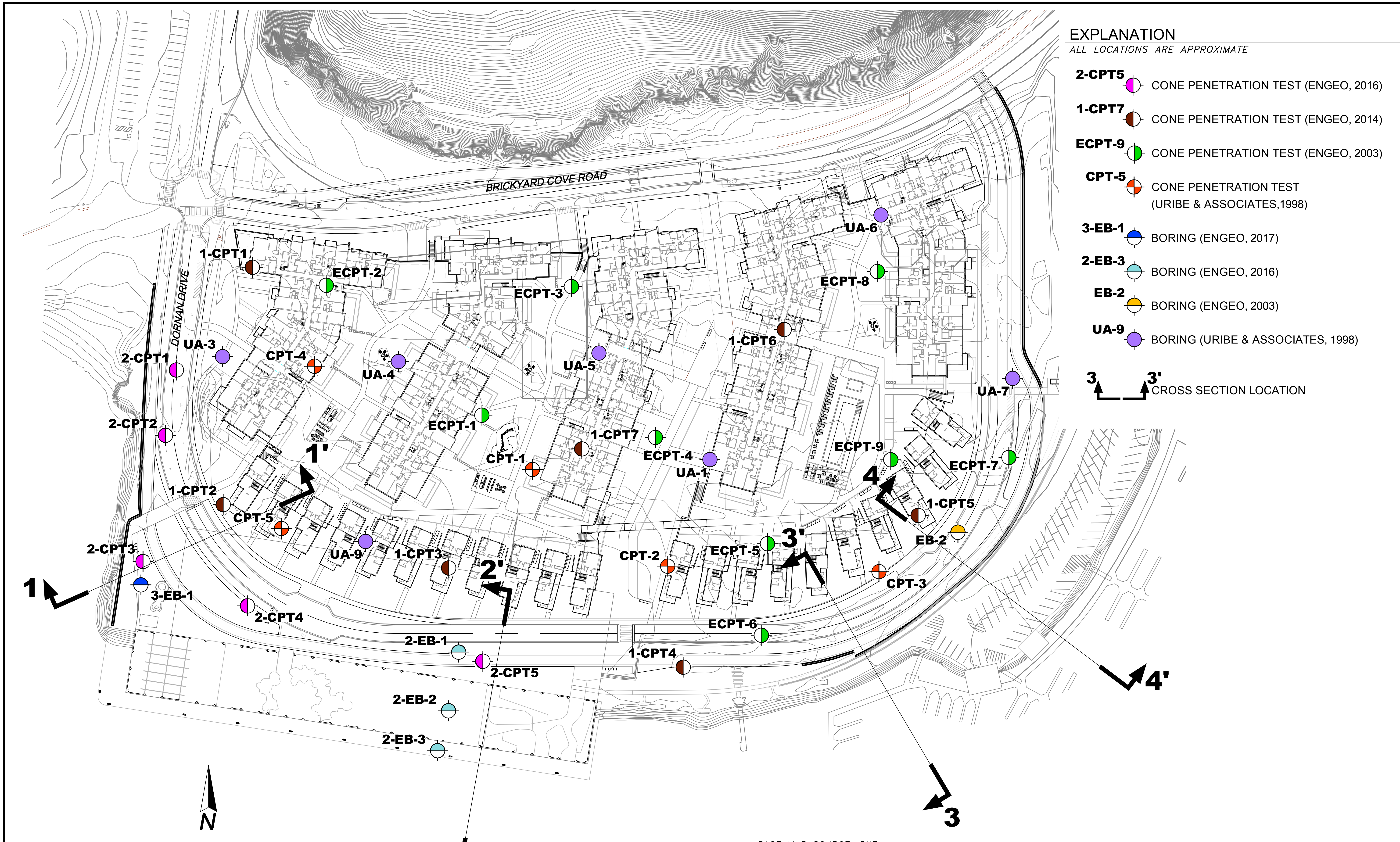
We prepared the following narrative describing the analysis methodologies, reasoning, and assumptions for the site-specific ground response analysis. Specifically, we have addressed the decision making process for choosing the target base rock spectra (mapped MCE_R versus site-specific MCE_R) and selection of appropriate input rock ground motions to supplement the information in our referenced report.

We used the mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) spectra corresponding with a Site Soil Class B to scale our input ground motions in our site-specific ground response analysis. ASCE 7-10, Section 21.1 states that the mapped MCE_R for a Site Soil Class B may be used as the target spectra when developing input rock motions for a ground response analysis. Furthermore, our experience indicates that in this area the mapped spectra is typically very similar to the spectra developed through site-specific seismic hazard analysis performed in accordance with ASCE 7-10, for Site Class B. To evaluate this effect and answer this question, we performed a site-specific seismic hazard analysis and provide our results compared with the mapped Site Soil Class B MCE_R spectra in Attachment B. As illustrated, the code specified deterministic lower limit governs the analysis and either matches or is less than the mapped Site Class B spectra at all periods except near a period of 0.2 seconds where the maximum rotated 84th-percentile deterministic seismic hazard results govern. Since the structural period of interest is 0.74 seconds, use of the mapped MCE_R for Site Soil Class B adequately captures the governing site response.

To perform our analysis, we selected time histories for five historic earthquakes in strict conformance with the requirements of ASCE 7-10 Chapter 21.1.1 which indicates, “At least five recorded or simulated horizontal ground motion acceleration time histories shall be selected from events having magnitudes and fault distances that are consistent with those that control the MCE_R ground motion.” Based on our site-specific analysis, the spectra is controlled by the 84th-percentile deterministic seismic hazard from the Hayward-Rogers Creek Fault.

In developing the input rock motions for our site-response analysis, we chose five earthquake time histories that will reflect the potential ground motions at the site. The NEHRP report titled “Selecting and Scaling Earthquake Ground Motions for Performing Response-History Analysis”, dated November of 2011, suggests that the most important factors affecting an analysis using recorded ground motions, is the spectral shape, and the existence of a velocity pulse. In addition, the effective duration, magnitudes and peak ground acceleration are also of importance. As shown in our report, we selected three ground motions with a velocity pulse (indication of near-site effects), and all ground motions have an effective duration of at least 12 seconds, which is in the range of the expected duration for the design event at the Hayward Fault. Another factor affecting earthquake records is fault type. It is of note that the main rupture mode of the Hayward Fault is a strike slip, but oblique faulting from the main trace of the Hayward fault is also possible. As an example, the 1989 Loma Prieta earthquake was on a reverse-oblique fault off the San Andreas main trace. We believe that by selecting 3 motions that represent a strike-slip fault, and 2 that represent reverse/normal faulting, we are encapsulating the ranges of potential faulting events at the site.

FIGURES



BASE MAP SOURCE: BKF

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SITE PLAN
TERMINAL ONE
POINT RICHMOND, CALIFORNIA

PROJECT NO.: 5931.000.000	FIGURE NO. 1
SCALE: AS SHOWN	
DRAWN BY: JCS	CHECKED BY: JAF

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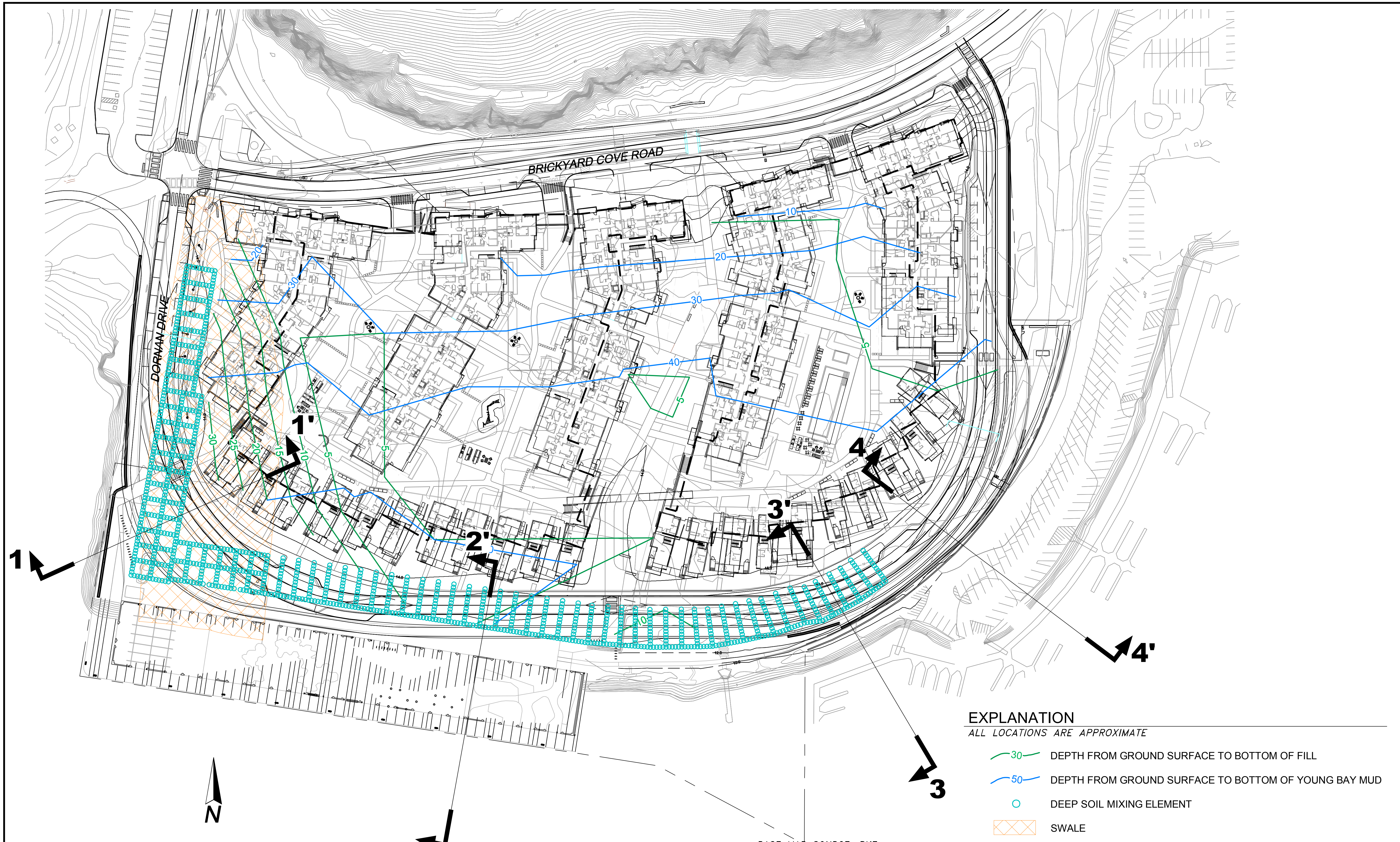
ORIGINAL FIGURE PRINTED IN COLOR



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DEEP SOIL MIXING AREA AND GEOLOGIC CONTOURS
TERMINAL ONE
POINT RICHMOND, CALIFORNIA

PROJECT NO.: 5931.000.000		FIGURE NO.
SCALE: AS SHOWN		2
DRAWN BY: JCS	CHECKED BY: JAF	

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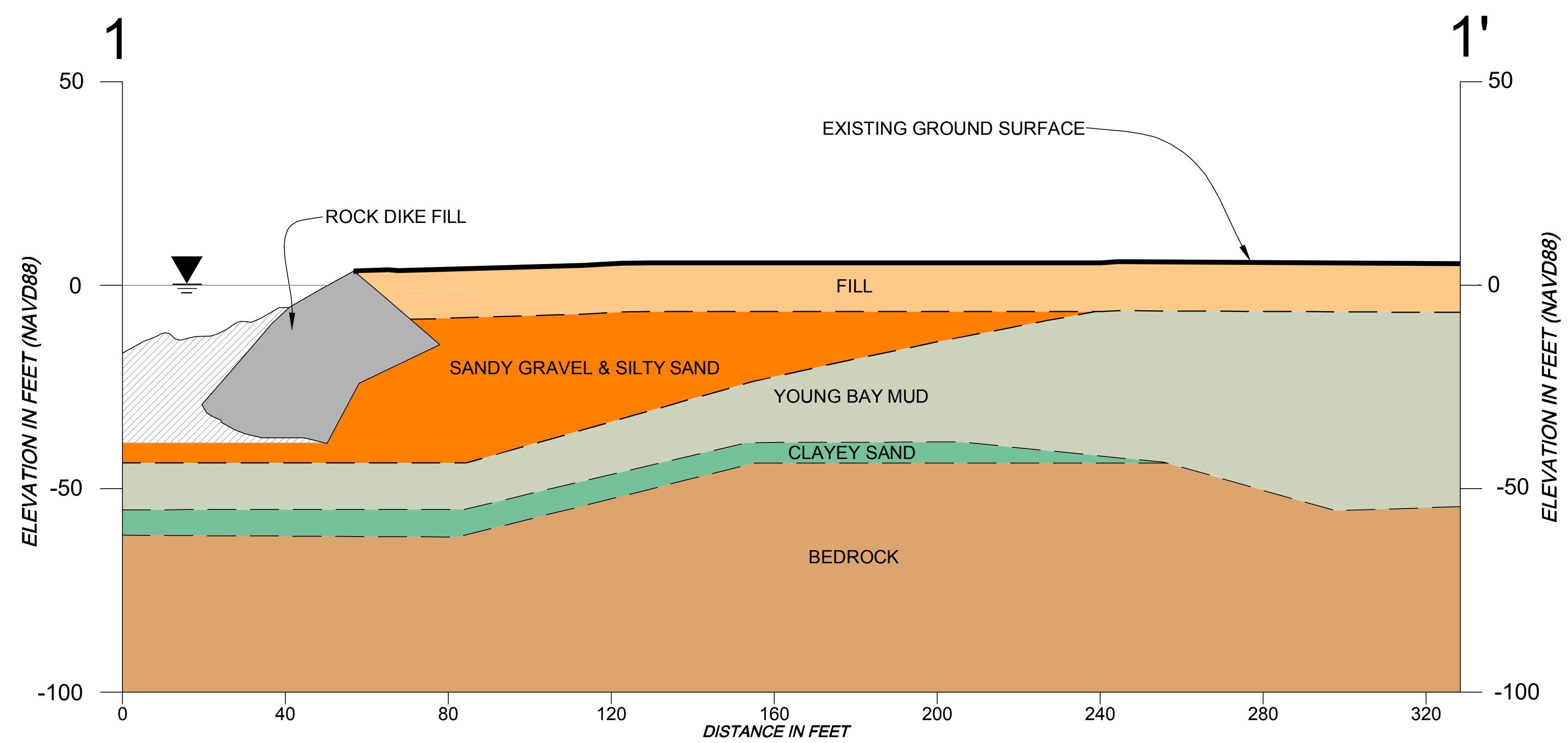

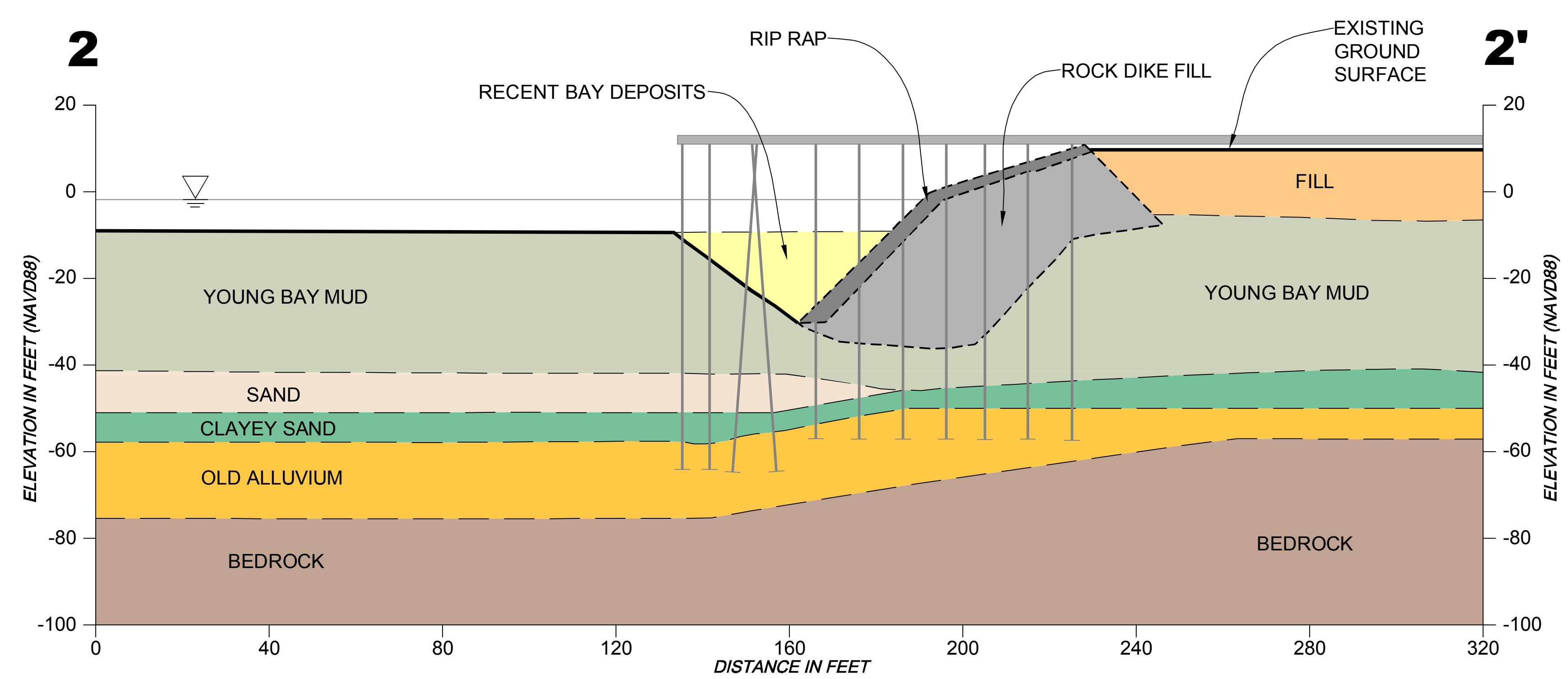

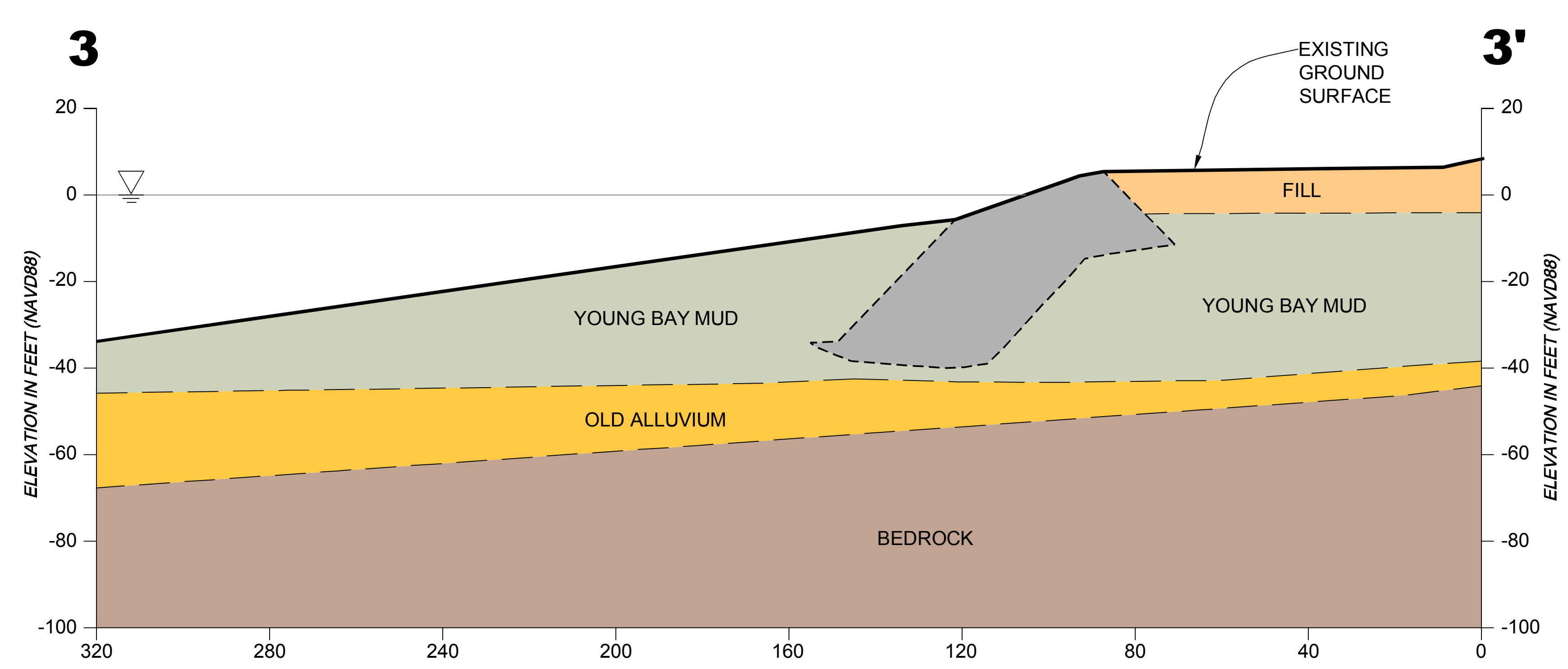

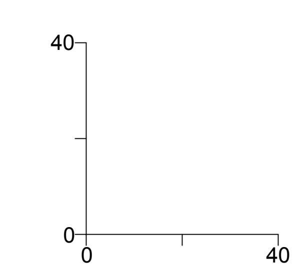

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CROSS SECTIONS
TERMINAL ONE
POINT RICHMOND, CALIFORNIA

PROJECT NO.: 5931.000.000
SCALE: AS SHOWN
DRAWN BY: JCS
CHECKED BY: JAF
FIGURE NO. 3

ORIGINAL FIGURE PRINTED IN COLOR

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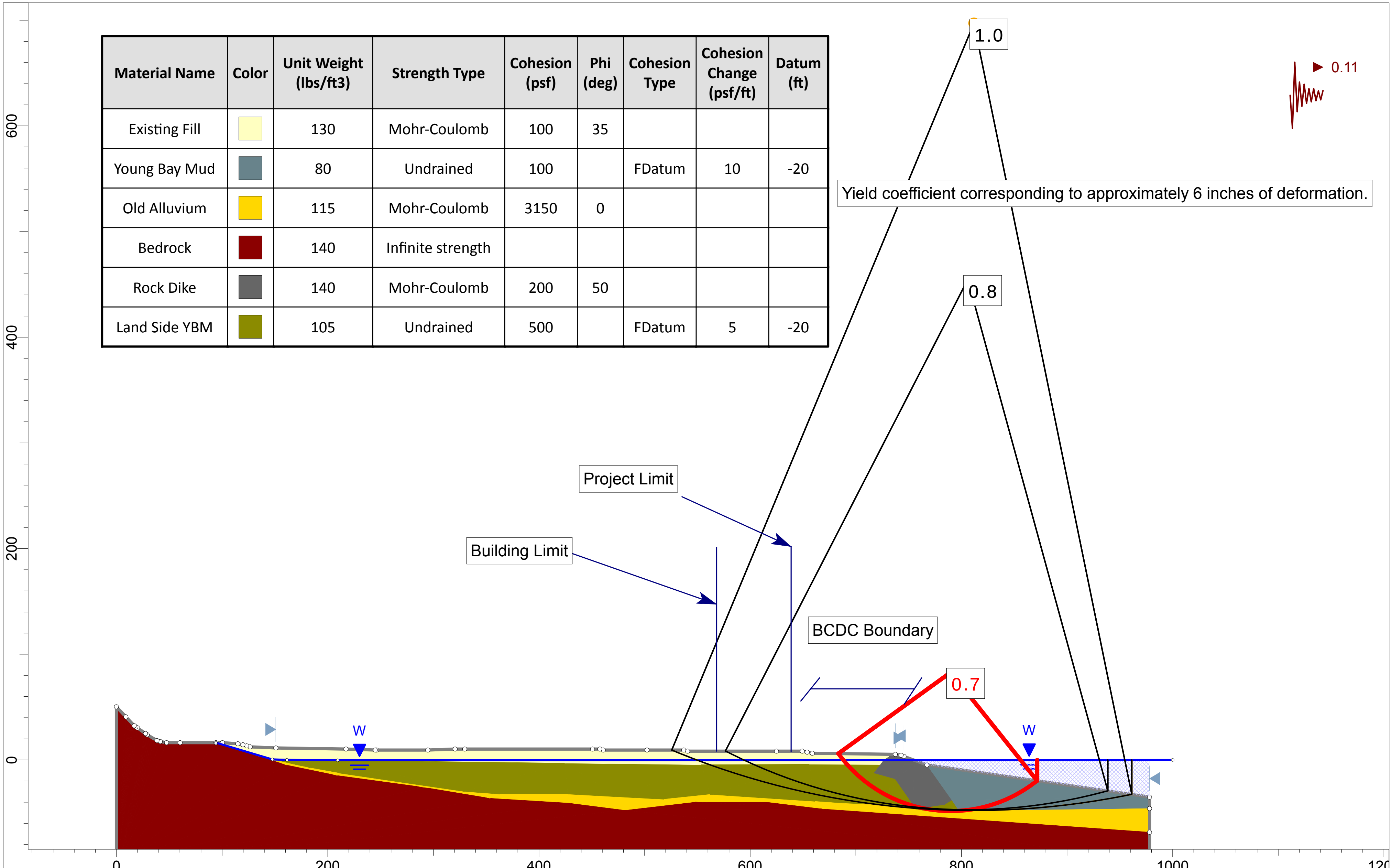
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Existing Fill		130	Mohr-Coulomb	100	35			
Young Bay Mud		80	Undrained	100		FDatum	10	-20
Old Alluvium		115	Mohr-Coulomb	3150	0			
Bedrock		140	Infinite strength					
Rock Dike		140	Mohr-Coulomb	200	50			
Land Side YBM		105	Undrained	500		FDatum	5	-20



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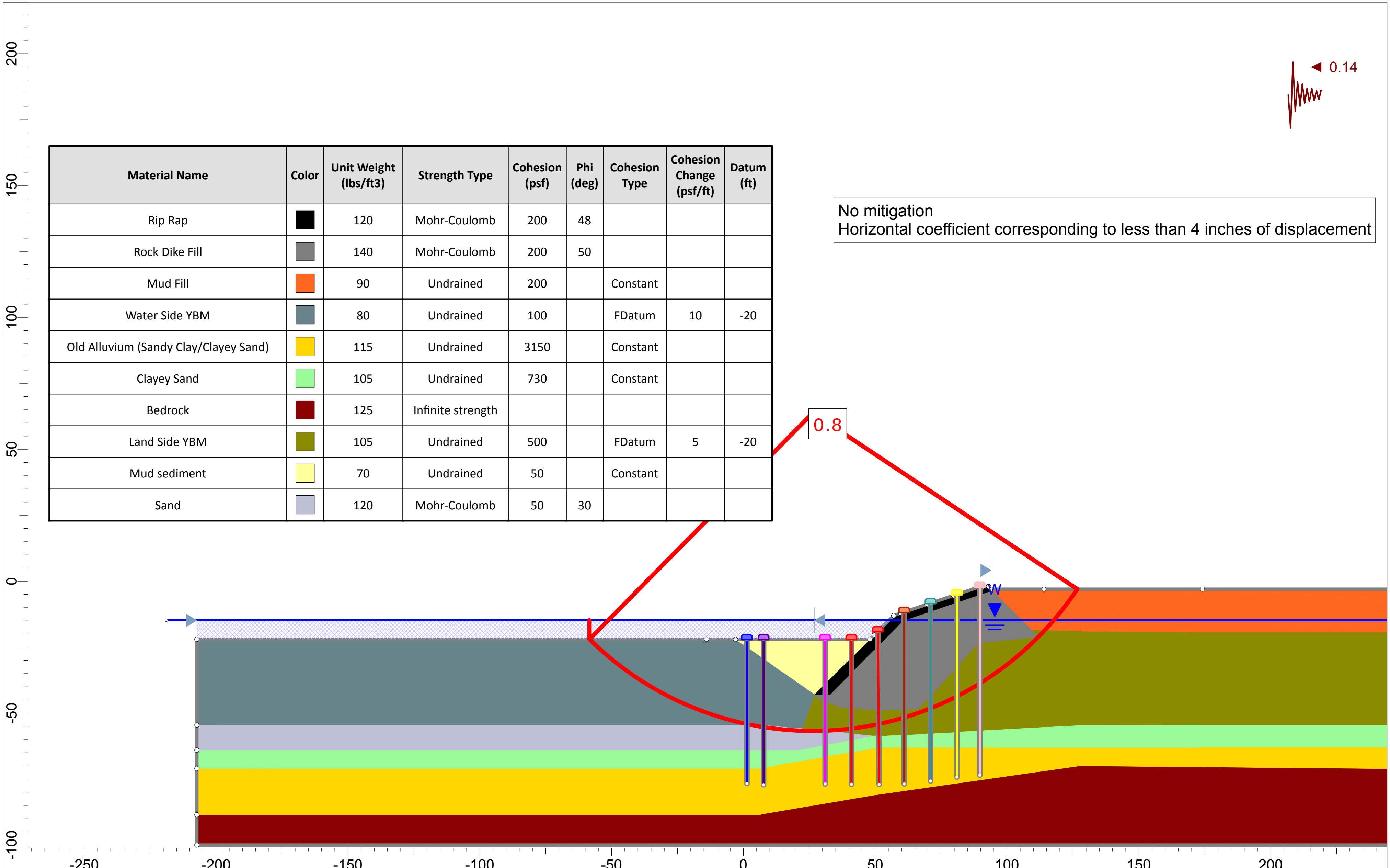
SLIDEINTERPRET 7.023

Project	Terminal One - Section 4-4'		
Scale 1:1500	*Author* T. Bradford	*Project No.* 5931.000.000	
Date 9/29/2017	*Condition* Psuedo-Static		

ATTACHMENT A

Slope Stability

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Rip Rap		120	Mohr-Coulomb	200	48			
Rock Dike Fill		140	Mohr-Coulomb	200	50			
Mud Fill		90	Undrained	200		Constant		
Water Side YBM		80	Undrained	100		FDatum	10	-20
Old Alluvium (Sandy Clay/Clayey Sand)		115	Undrained	3150		Constant		
Clayey Sand		105	Undrained	730		Constant		
Bedrock		125	Infinite strength					
Land Side YBM		105	Undrained	500		FDatum	5	-20
Mud sediment		70	Undrained	50		Constant		
Sand		120	Mohr-Coulomb	50	30			



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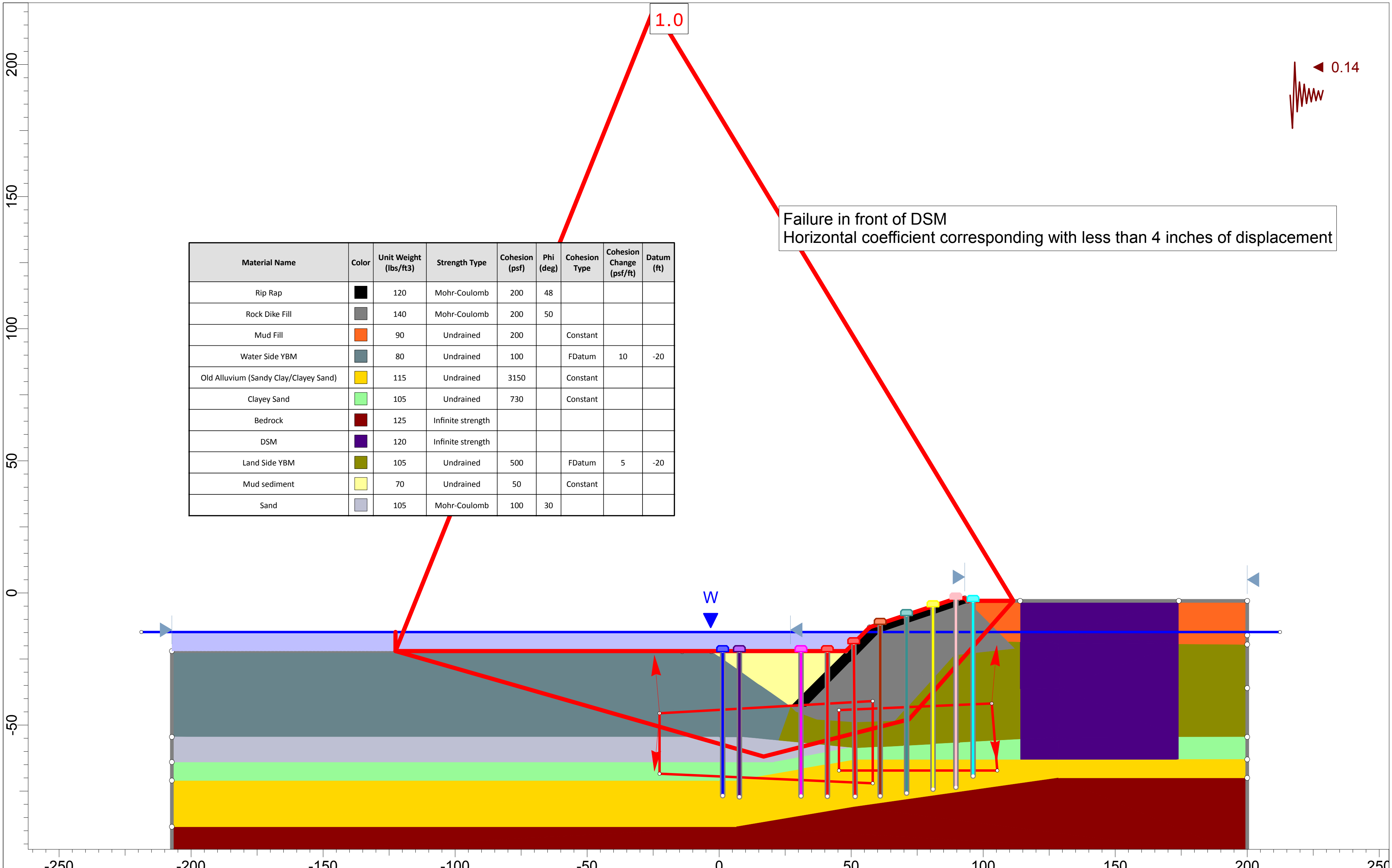
SLIDEINTERPRET 7.023

Project	Terminal One - Section 2-2'		
Scale 1:600	*Author* T. Bradford	*Project No.*	
Date October 4, 2017	*Condition* Wedge-Type Failure		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Rip Rap		120	Mohr-Coulomb	200	48			
Rock Dike Fill		140	Mohr-Coulomb	200	50			
Mud Fill		90	Undrained	200		Constant		
Water Side YBM		80	Undrained	100		FDatum	10	-20
Old Alluvium (Sandy Clay/Clayey Sand)		115	Undrained	3150		Constant		
Clayey Sand		105	Undrained	730		Constant		
Bedrock		125	Infinite strength					
DSM		120	Infinite strength					
Land Side YBM		105	Undrained	500		FDatum	5	-20
Mud sediment		70	Undrained	50		Constant		
Sand		105	Mohr-Coulomb	100	30			

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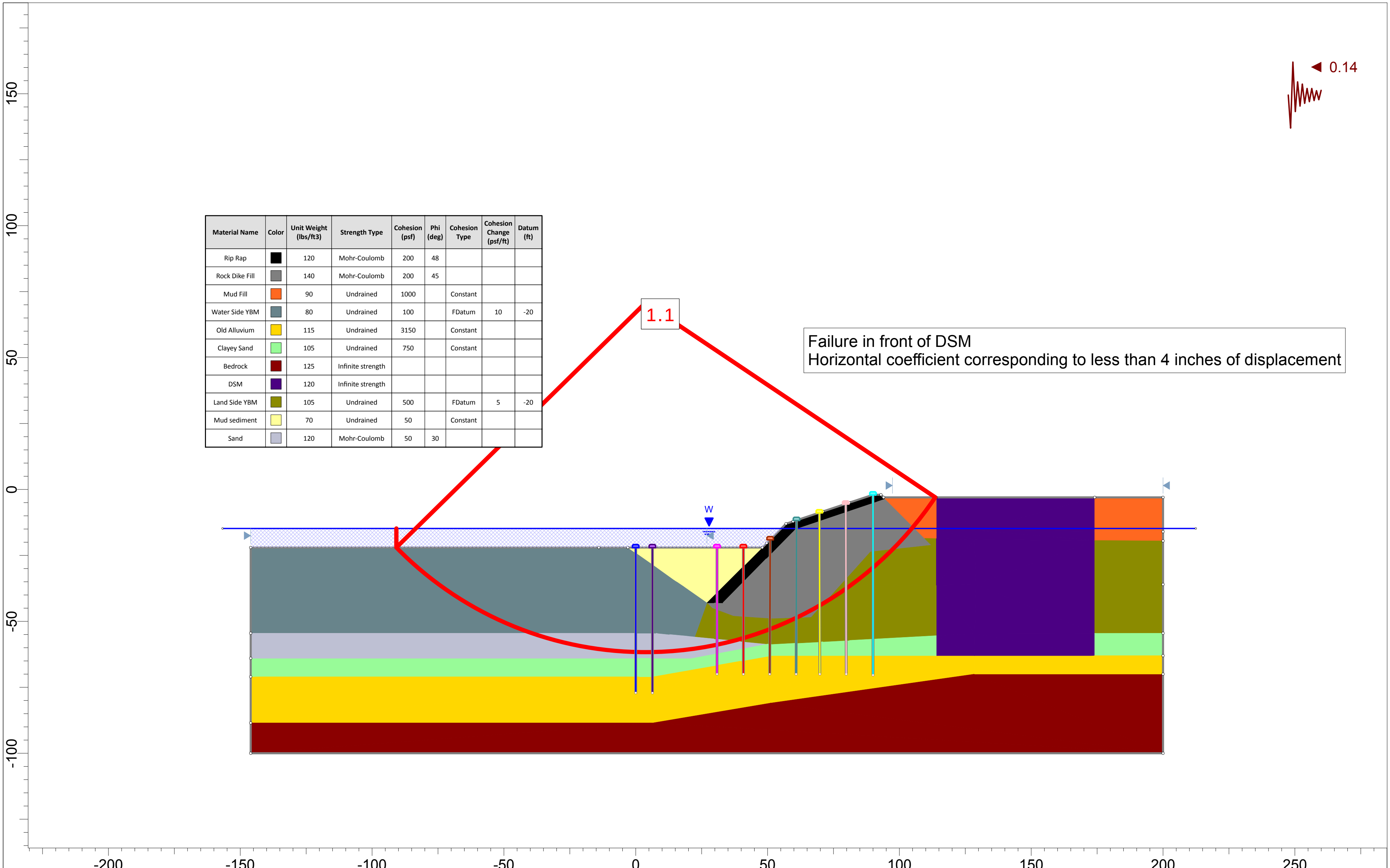
Project	Terminal One - Section 2-2'		
Scale 1:600	*Author* T. Bradford	*Project No.*	
Date October 4, 2017	*Condition* Wedge-Type Failure		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Rip Rap		120	Mohr-Coulomb	200	48			
Rock Dike Fill		140	Mohr-Coulomb	200	45			
Mud Fill		90	Undrained	1000		Constant		
Water Side YBM		80	Undrained	100		FDatum	10	-20
Old Alluvium		115	Undrained	3150		Constant		
Clayey Sand		105	Undrained	750		Constant		
Bedrock		125	Infinite strength					
DSM		120	Infinite strength					
Land Side YBM		105	Undrained	500		FDatum	5	-20
Mud sediment		70	Undrained	50		Constant		
Sand		120	Mohr-Coulomb	50	30			

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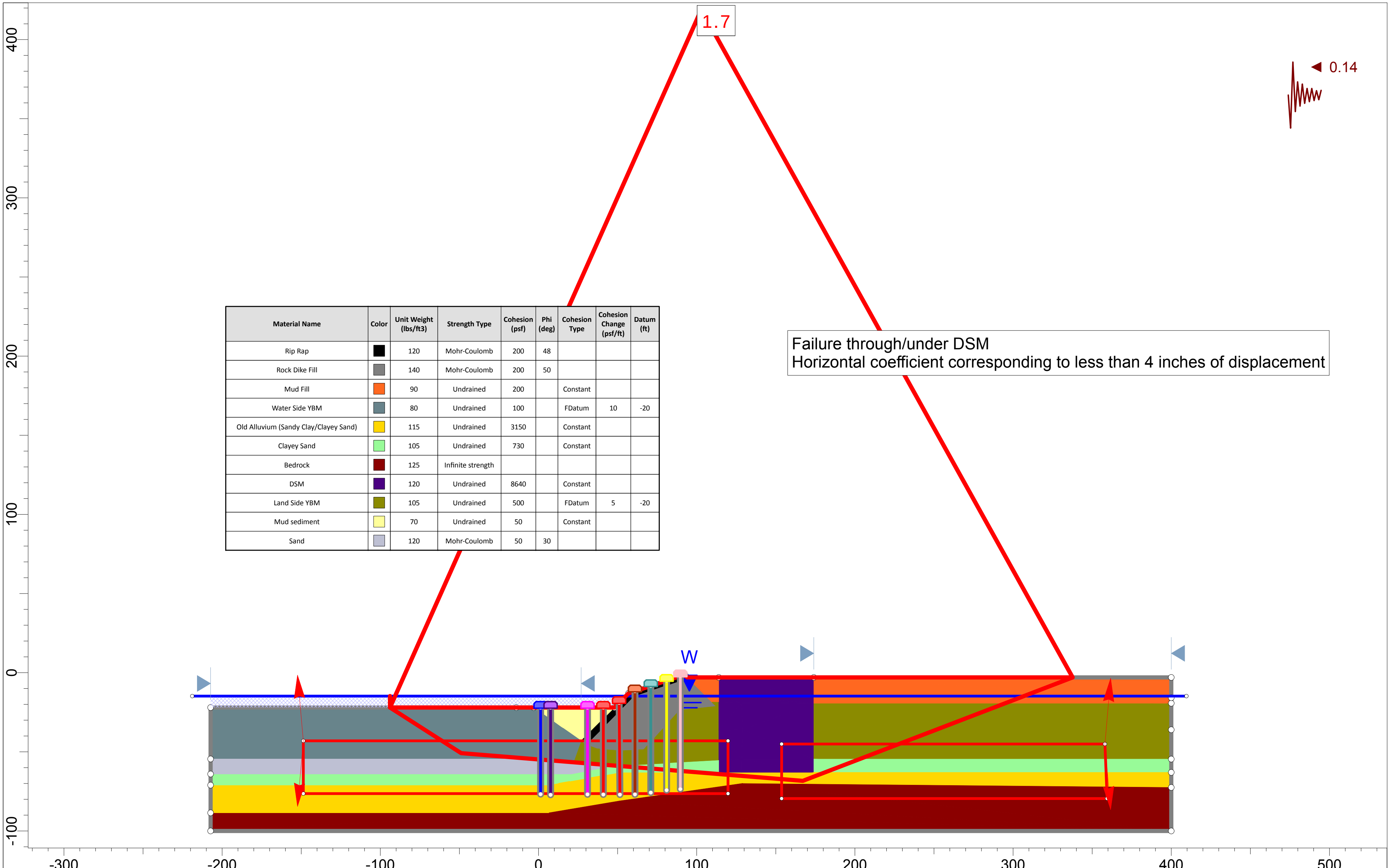
Project Terminal One - Section 2-2'			
Scale 1:600	*Author* T. Bradford	*Project No.*	
Date October 4, 2017	*Condition* Circular Failure		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Rip Rap		120	Mohr-Coulomb	200	48			
Rock Dike Fill		140	Mohr-Coulomb	200	50			
Mud Fill		90	Undrained	200		Constant		
Water Side YBM		80	Undrained	100		FDatum	10	-20
Old Alluvium (Sandy Clay/Clayey Sand)		115	Undrained	3150		Constant		
Clayey Sand		105	Undrained	730		Constant		
Bedrock		125	Infinite strength					
DSM		120	Undrained	8640		Constant		
Land Side YBM		105	Undrained	500		FDatum	5	-20
Mud sediment		70	Undrained	50		Constant		
Sand		120	Mohr-Coulomb	50	30			

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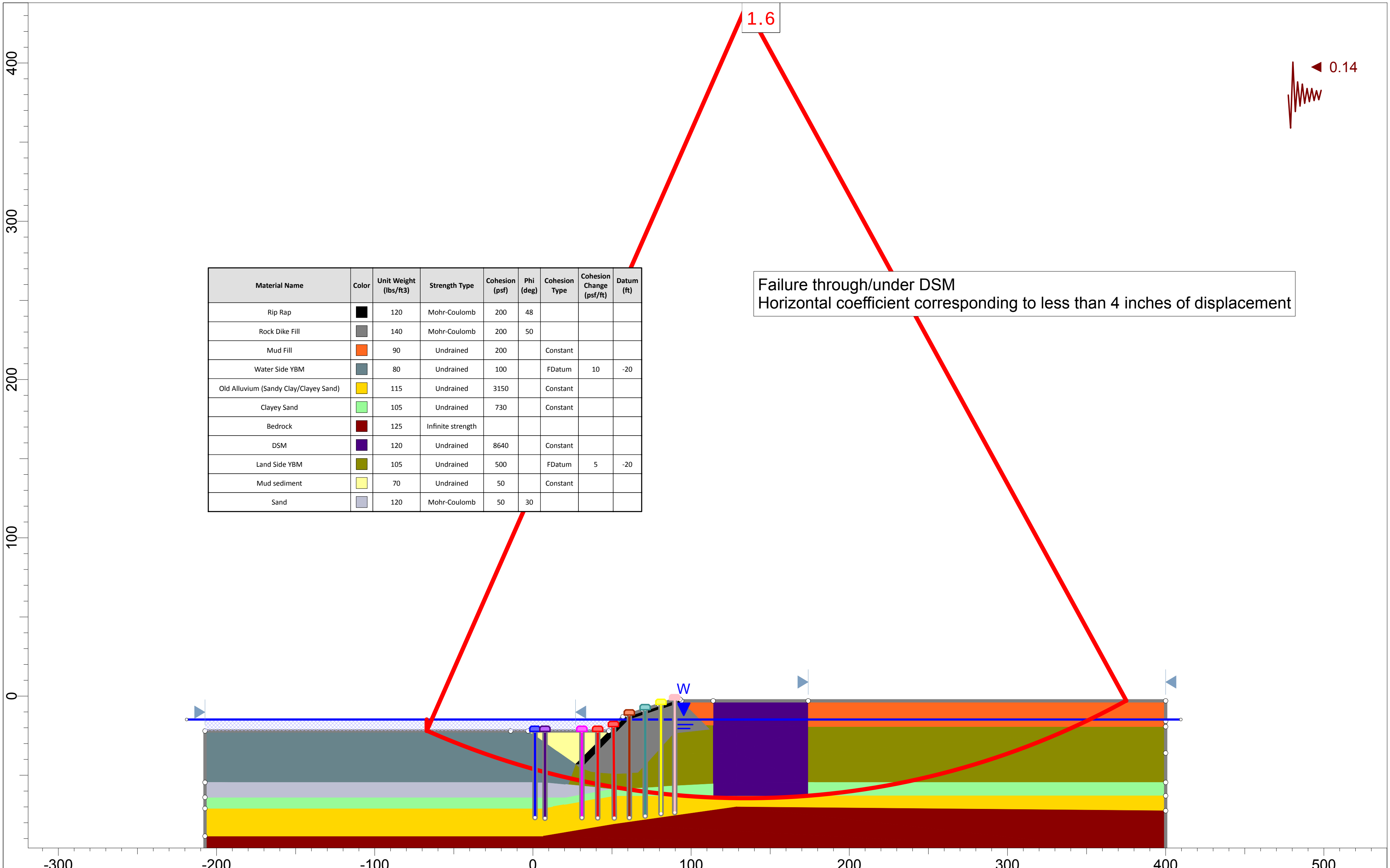
Project	Terminal One - Section 2-2'
Scale 1:1000	*Author* T. Bradford
Date October 4, 2017	*Condition* Wedge-Type Failure
Project No.	

SLIDEINTERPRET 7.023



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Cohesion Change (psf/ft)	Datum (ft)
Rip Rap		120	Mohr-Coulomb	200	48			
Rock Dike Fill		140	Mohr-Coulomb	200	50			
Mud Fill		90	Undrained	200		Constant		
Water Side YBM		80	Undrained	100		FDatum	10	-20
Old Alluvium (Sandy Clay/Clayey Sand)		115	Undrained	3150		Constant		
Clayey Sand		105	Undrained	730		Constant		
Bedrock		125	Infinite strength					
DSM		120	Undrained	8640		Constant		
Land Side YBM		105	Undrained	500		FDatum	5	-20
Mud sediment		70	Undrained	50		Constant		
Sand		120	Mohr-Coulomb	50	30			

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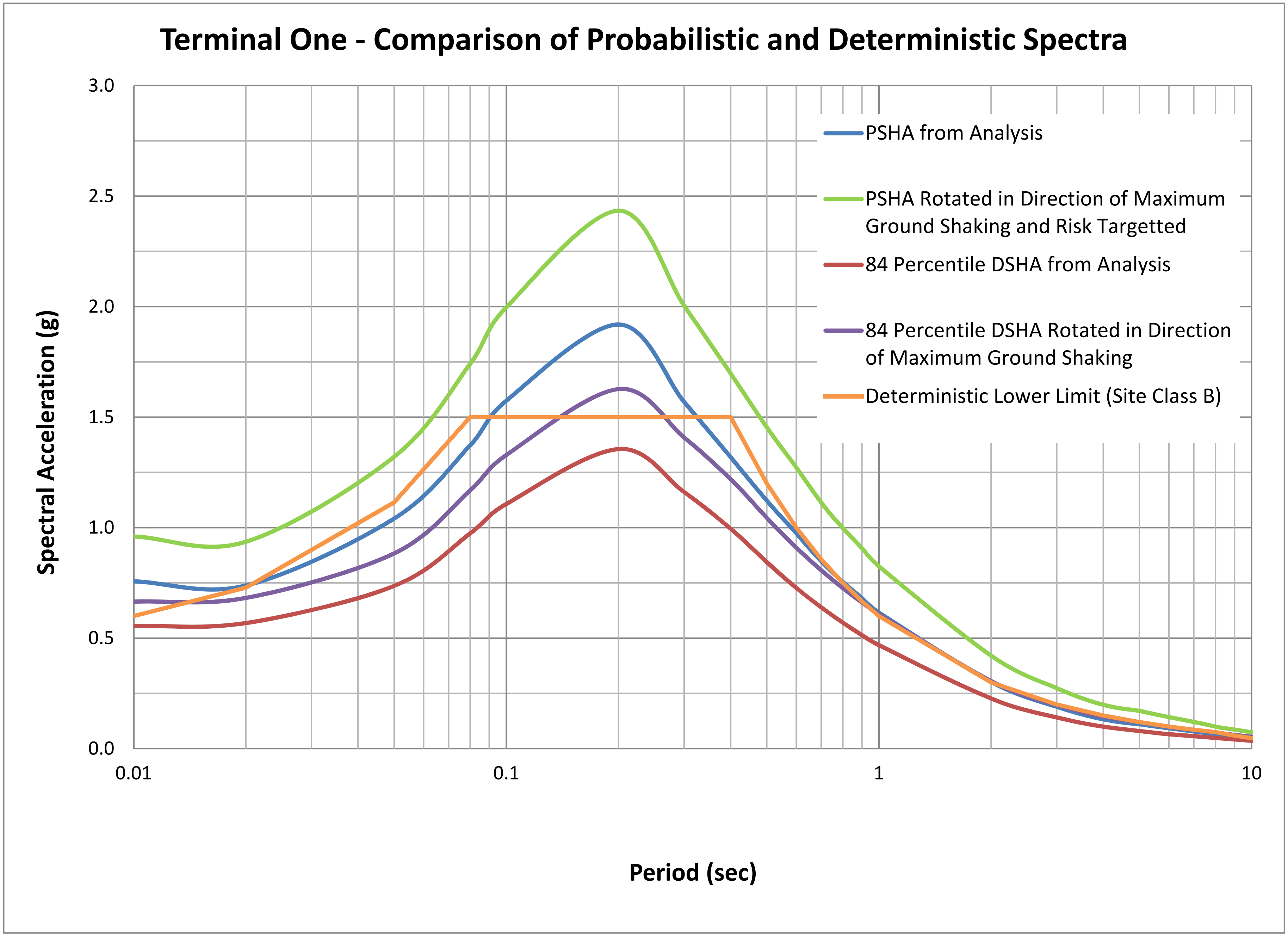
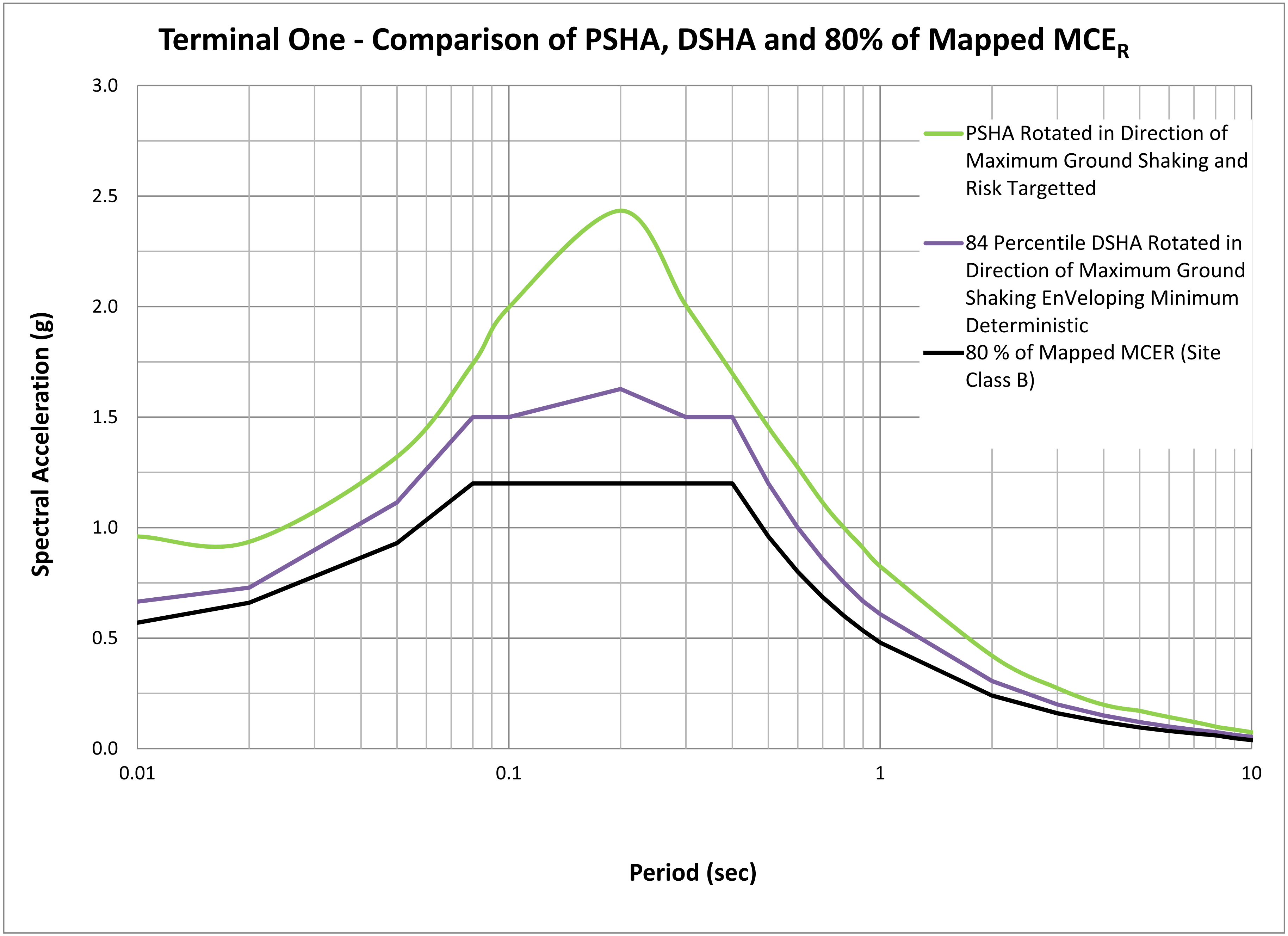
Project	Terminal One - Section 2-2'		
Scale 1:1000	Author T. Bradford	Project No.	
Date October 4, 2017	Condition Circular Failure		

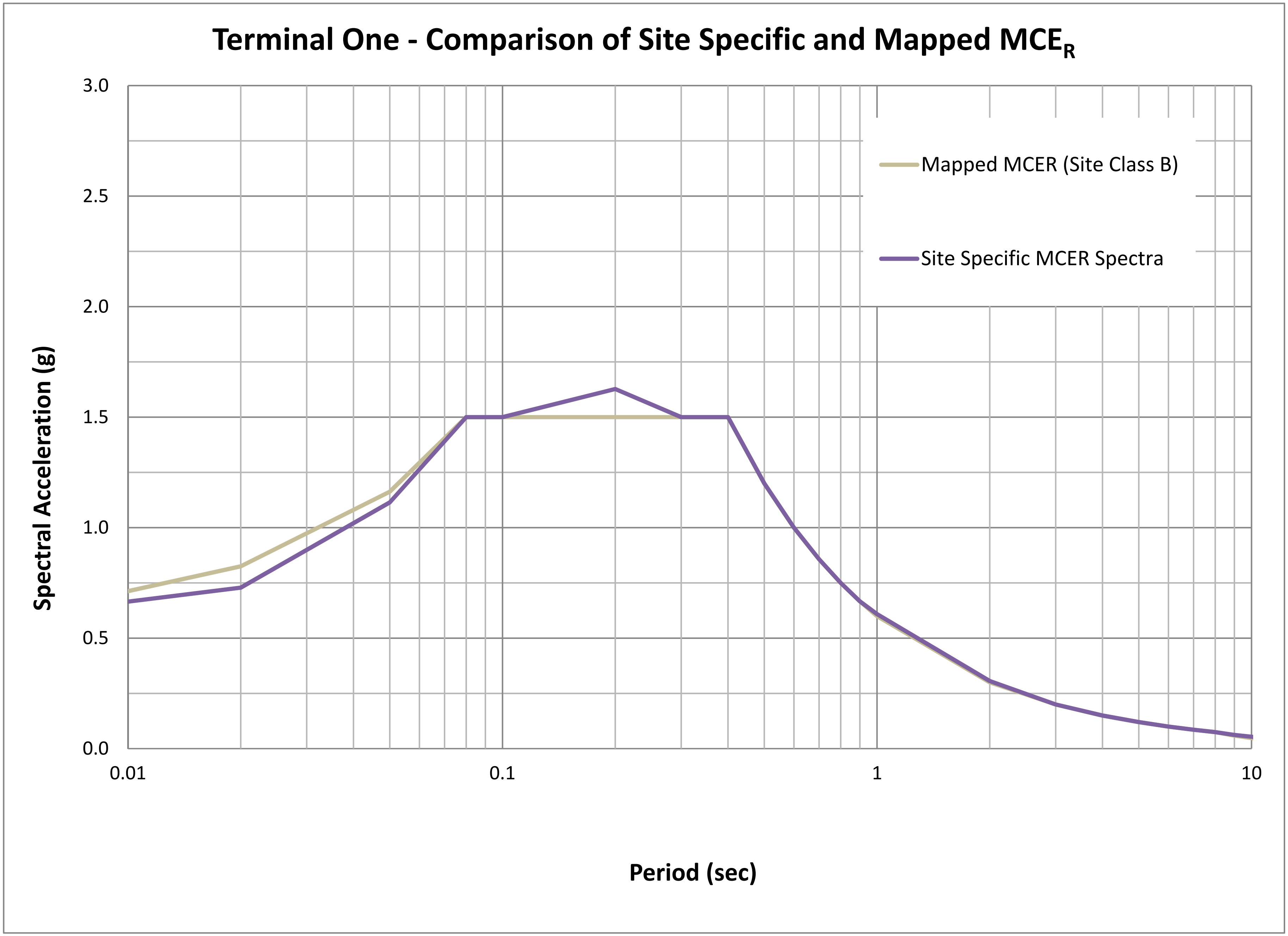
ATTACHMENT B

Site-Specific GM Analysis Plots


Terminal One - Comparison of Probabilistic and Deterministic Spectra
Spectral Acceleration (g)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.01
0.1
1
10
Period (sec)
PSHA from Analysis
PSHA Rotated in Direction of Maximum Ground Shaking and Risk Targetted
84 Percentile DSHA from Analysis
84 Percentile DSHA Rotated in Direction of Maximum Ground Shaking
Deterministic Lower Limit (Site Class B)



Terminal One - Comparison of PSHA, DSHA and 80% of Mapped MCE_R
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.01
0.1
1
10
Spectral Acceleration (g)
Period (sec)
PSHA Rotated in Direction of Maximum Ground Shaking and Risk Targetted
84 Percentile DSHA Rotated in Direction of Maximum Ground Shaking EnVeloping Minimum Deterministic
80 % of Mapped MCER (Site Class B)



Terminal One - Comparison of Site Specific and Mapped MCE_R
Mapped MCER (Site Class B)
Site Specific MCER Spectra
Spectral Acceleration (g)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.01
0.1
1
10
Period (sec)

ATTACHMENT C

Boring Logs

LOG OF BORING 2-EB-1

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Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED: 12/23/2016
HOLE DEPTH: Approx. 73¾ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		Concrete, 8" [FOUNDATION SLAB]										
		Air Void										
		Concrete Rubble										
		FAT CLAY (CH), yellowish brown mottled with gray, moist, contains some construction debris [FILL]										
	10											
		FAT CLAY (CH), dark gray, soft to medium stiff, moist, some silt [FILL]										
5			12							1000*		PP
		Asphalt debris										
	5											
10												
	0	grades very soft to soft, wet, with shell fragments								400*		PP
15												
		grades very soft	11							250*		PP
		SANDSTONE, yellowish brown, strong (R4), moderately weathered (WM) to slightly weathered (WS), fine- to medium-grained [FILL]										
	-5											
20		FAT CLAY (CH), yellowish brown mottled with gray, medium stiff, wet, contains fine-grained sand [YBM]										
	-10											
25			14									

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LOG OF BORING 2-EB-1

Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED: 12/23/2016
HOLE DEPTH: Approx. 73¾ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			FAT CLAY (CH), yellowish brown mottled with gray, medium stiff, wet, contains fine-grained sand [YBM]												
	-15														
30			grades dark gray, no sand			22									
	-20														
35						7							600*		PP
			grades soft, shell fragments												
	-25														
40															
	-30														
45							78	32	46		55.3	66	709		UU
											68.7	59.4	900*		PP
			grades soft to medium stiff, trace shell fragments												
	-35														
50															

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LOG OF BORING 2-EB-1

Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED: 12/23/2016
HOLE DEPTH: Approx. 73¾ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		FAT CLAY (CH), yellowish brown mottled with gray, medium stiff, wet, contains fine-grained sand [YBM]										
	-40	Wood debris (potentially a pile)										
55			12									
	-45	CLAYEY SAND (SC), dark gray, loose to medium dense, wet, fine-grained sand										
60			11	NP	NP	NP	13	34.1				
	-50	CLAYEY SAND (SC), yellowish brown, medium dense to dense, wet, fine- to coarse- grained sand, trace fine gravel										
65			37				29			700*		PP
	-55											
70		SANDSTONE, dark gray, strong (R4), massive, slightly weathered (WS) to freshly weathered (F), fine- to medium-grained	50/3"									
	-60		50/2"									

Boring terminated at a depth of 73.75 feet below top of wharf deck. Depth to groundwater was not measured due to drilling method.

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LOG OF BORING 2-EB-2

Geotechnical Exploration
Terminal One
Richmond, CA
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DATE DRILLED:	12/21/2016	LOGGED / REVIEWED BY:	N. Serra / JAF
HOLE DEPTH:	Approx. 90¼ ft.	DRILLING CONTRACTOR:	Pitcher Drilling
HOLE DIAMETER:	4.0 in.	DRILLING METHOD:	Mud Rotary
SURF ELEV (NAVD 88):	Approx. 13 ft.	HAMMER TYPE:	140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			Concrete, 12" [FOUNDATION SLAB]												
	10		Void												
5															
	5														
10															
	0		SANDSTONE, dark greenish gray, strong (R4), freshly weathered (F) to slightly weathered (WS), fine- to medium-grained [RIPRAP]												
15															
						11									
	-5														
20															
			SANDSTONE-SHALE, dark gray, freshly weathered (F) to slightly weathered (WS), fine to coarse angular fragments [ROCK DIKE FILL]												
	-10														
25															

LOG OF BORING 2-EB-2

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Geotechnical Exploration
Terminal One
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DATE DRILLED: 12/21/2016
HOLE DEPTH: Approx. 90¼ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SANDSTONE-SHALE, dark gray, freshly weathered (F) to slightly weathered (WS), fine to coarse angular fragments [ROCK DIKE FILL]			9									
	-15														
30															
	-20														
35			trace sand			10									
	-25														
40															
	-30														
45						18									
	-35														
			FAT CLAY (CH), dark gray, soft to medium stiff, wet, contains silt, trace organics [YBM]												
50															

LOG OF BORING 2-EB-2

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Geotechnical Exploration
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Richmond, CA
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DATE DRILLED: 12/21/2016
HOLE DEPTH: Approx. 90¼ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			FAT CLAY (CH), dark gray, soft to medium stiff, wet, contains silt, trace organics [YBM]				61	25	36		53.6	70.2	760		UU
	-40														
55															
	-45														
			CLAYEY SAND (SC), dark gray, wet, fine-grained sand												
60															
	-50		LEAN CLAY WITH SAND (CL), pale olive mottled with orange gray, stiff to very stiff, wet, iron oxide staining, fine-grained sand												
65						21									
	-55														
70															
	-60					32							2500*		PP
75															

LOG OF BORING 2-EB-2

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DATE DRILLED: 12/21/2016
HOLE DEPTH: Approx. 90¼ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			LEAN CLAY WITH SAND (CL), pale olive mottled with orange gray, stiff to very stiff, wet, iron oxide staining, fine-grained sand												
	-65		CLAYEY SAND (SC), yellowish brown, dense, wet, fine- to coarse- grained sand, trace fine gravel												
80						44									
	-70		SANDSTONE, yellowish brown, very weak (R1), very closely fractured, highly weathered (WH) to completely weathered (WC), iron oxide staining, some interbedded shale												
85															
	-75		SHALE, dark gray, weak (R2), crushed, laminated, slightly weathered (WS) to moderately weathered (WM)												
90						50/3"									
			Boring terminated at a depth of 90.25 feet below top of wharf deck. Depth to groundwater was not measured due to drilling method.												

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LOG OF BORING 2-EB-3

Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED:	12/22/2016	LOGGED / REVIEWED BY:	N. Serra / JAF
HOLE DEPTH:	Approx. 94½ ft.	DRILLING CONTRACTOR:	Pitcher Drilling
HOLE DIAMETER:	4.0 in.	DRILLING METHOD:	Mud Rotary
SURF ELEV (NAVD 88):	Approx. 13 ft.	HAMMER TYPE:	140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			Asphaltic Concrete, 6"												
			Aggregate Base, 6"												
			Concrete, 6" [FOUNDATION SLAB]												
			Void												
	10														
5															
	5														
10															
					▽										
	0														
15															
	-5														
20															
	-10														
25															

LOG OF BORING 2-EB-3

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Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED: 12/22/2016
HOLE DEPTH: Approx. 94½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			Void												
	-15														
			FAT CLAY (CH), dark gray, very soft, wet [YBM]												
30															
	-20												97		LVS
35															
	-25														
40															
			grades with shell fragments										269		LVS
	-30														
45															
	-35														
50															

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LOG OF BORING 2-EB-3

Geotechnical Exploration
Terminal One
Richmond, CA
5931.000.000

DATE DRILLED: 12/22/2016
HOLE DEPTH: Approx. 94½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			FAT CLAY (CH), dark gray, very soft, wet [YBM]												
	-40														
										42	40.3	83.1			
			SAND WITH CLAY (SP), dark gray, medium dense, wet, fine- grained sand												
55															
	-45														
60															
						16	NP	NP	NP	12	29.1				
	-50														
			CLAYEY SAND (SC), dark gray, loose, wet, fine- grained sand												
65															
						8				33					
	-55														
70															
			SANDY LEAN CLAY (CL), yellowish brown, very stiff, wet, iron oxide staining, fine- grained sand												
	-60					45	44	18	26		21.6	106.7	3757	3.75	UU
75															

LOG OF BORING 2-EB-3

ENGEO
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Geotechnical Exploration
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DATE DRILLED: 12/22/2016
HOLE DEPTH: Approx. 94½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: N. Serra / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	-65		SANDY LEAN CLAY (CL), yellowish brown, very stiff, wet, iron oxide staining, fine- grained sand												
80	-70														
85			increasing sand content			34								3.25*	TV
	-75		CLAYEY SAND (SC), yellowish brown, medium dense to dense, wet, fine- grained sand												
90			SHALE, dark brown, weak (R2), crushed, laminated, moderately weathered (WM) to slightly weathered (WS)			50/4"									
	-80					50/6"									
			Boring terminated at a depth of 94.5 feet below top of wharf deck. Depth to groundwater was measured at 11.75 feet below top of wharf deck.												

LOG OF BORING 3-EB-1

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Geotechnical Exploration
Terminal One
Richmond, CA
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DATE DRILLED:	9/22/2017	LOGGED / REVIEWED BY:	J. Allen / JAF
HOLE DEPTH:	Approx. 82 ft.	DRILLING CONTRACTOR:	Pitcher Drilling
HOLE DIAMETER:	4.0 in.	DRILLING METHOD:	Mud Rotary
SURF ELEV (NAVD 88):	Approx. 13 ft.	HAMMER TYPE:	140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			Asphalt												
			WELL GRADED SAND WITH GRAVEL (SW), dark grayish brown, loose, moist, 1 to 1 1/2-inch angular gravel (FILL)												
	10														
5						9									
	5														
			WELL GRADED GRAVEL WITH SAND (GW), very dark grayish olive, medium dense, wet, 1-inch angular gravel, very strong hydrocarbon odor (FILL)												
10						15									
	0														
15						12									
	-5														
20						39									
						11									
	-10														
			CLAYEY GRAVEL (GC), greenish gray, medium dense, wet, angular pea gravel (FILL)												
25															

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LOG OF BORING 3-EB-1

Geotechnical Exploration
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5931.000.000

DATE DRILLED: 9/22/2017
HOLE DEPTH: Approx. 82 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: J. Allen / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	DESCRIPTION	Blow Count/Foot	Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		CLAYEY GRAVEL (GC), greenish gray, medium dense, wet, angular pea gravel (FILL)	15									
	-15											
30		Material is predominately angular pea gravel, trace 1-inch angular gravel	13									
	-20											
35		Loose to medium dense	10									
	-25											
40		Sandstone cobble	22									
	-30											
		FAT CLAY (CH), grayish green, soft, wet, contains shells and some decomposed organics (YOUNG BAY MUD)										
45			9									
	-35											
								34.2	89.4	1323		UU
50												

Columns also include Sample Type, Log Symbol, Water Level.

LOG OF BORING 3-EB-1

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Richmond, CA
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DATE DRILLED: 9/22/2017
HOLE DEPTH: Approx. 82 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: J. Allen / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	-40		FAT CLAY (CH), grayish green, soft, wet, contains shells and some decomposed organics (YOUNG BAY MUD)												
55			CLAYEY SAND (SC), very dark bluish gray mottled with brown, medium dense, wet, some angular pea gravel			21				14	12.3				
60	-45		Residual soil			50/4"									
			SANDSTONE, yellowish brown, strong (R4), slightly weathered (WS)			50/2"									
	-50		RQD = 27%**												
65			RQD = 30%**												
70	-55		RQD = 27%**												
75	-60		RQD = 33%**												

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LOG OF BORING 3-EB-1

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DATE DRILLED: 9/22/2017
HOLE DEPTH: Approx. 82 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (NAVD 88): Approx. 13 ft.

LOGGED / REVIEWED BY: J. Allen / JAF
DRILLING CONTRACTOR: Pitcher Drilling
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet - NAVD88	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SANDSTONE, yellowish brown, strong (R4), slightly weathered (WS)												
			RQD = 10%**												
	-65		RQD = 10%**												
80															
			Bottom of exploration at approximately 82 feet below ground surface. Groundwater not measured due to drilling method. **NOTE: RQD shown is artificiallly low due to mechanical breaks												

ATTACHMENT D

Liquefaction and Settlement

Terminal 1

Liquefaction Evaluation - Youd 2001, Seed 2003

Note, if sloping ground and non-zero statis shear stress exist, user may chose to change value of kalpha

Input

Yellow cells are calculated

Green cells require user input - reference respective papers for details
Corrdction factors on "Driving Force" and "Resisting Force" sheets require user input

Water Table depth at time of Exploration	Water Table depth at time of Liquefaction	amax/g	Mw	Estimated Unit Weight
0	0	0.41	8.1	96.0

						At time of Exploration		At time of Liquefaction	
Boring Designation	Depth [ft]	Layer Thickness [ft]	Soil Type	N_m [Blows/ft]	FC	Total Stress [psf]	Effective Stress [psf]	Total Stress [psf]	Effective Stress [psf]
2-EB-3	32	7	SP	16	12	3072	1075.2	3072	1075.2
2-EB-3	37	7	SP	8	33	3552	1243.2	3552	1243.2
3-EB-1	55	7	SP	21	14	5865	3182	5865	3182

N_m = Measured SPT Blow Count

YOUD 2001 Methodology Results

Boring Designation	Depth	CRR	CSR	FS
2-EB-3	32	TDL	0.69	TDL
2-EB-3	37	0.18	0.66	0.26
3-EB-1	55	0.23	0.34	0.66

TDL = Too Dense to Liquefy based on blowcount criteria

SEED 2003 Methodology Results

			CSR			Calculated FS		
Boring Designation	Depth	CRR	mean rd	rd + sigma	rd - sigma	mean rd	rd + sigma	rd - sigma
2-EB-3	32	0.31	0.24	0.34	0.14	1.31	0.93	2.21
2-EB-3	37	0.11	0.23	0.34	0.12	0.48	0.32	0.92
3-EB-1	55	0.15	0.19	0.29	0.09	0.78	0.50	1.71

THC = CRR capped at 4, in high seismicity cases, verify