Jacobs

Elkhorn Pumping Plant Replacement

Geotechnical Data Report

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Natomas Mutual Water Company

Elkhorn Pumping Plant Replacement

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Jacobs

2525 Airpark Drive
Redding, CA 96001-2443
United States
T +1.530.243.5831
F +1.530.243.1654
www.jacobs.com

Document History and Status

Revision	Date	Description	By	Review	Approved
Draft	6/16/23	Draft Geotechnical Data Report	ADM	MRT	BLM
Final	2/20/24	Geotechnical Data Report	ADM	MRT	BLM

Contents

Acronyms and Abbreviations

°	degree(s)
ASCE	American Society of Civil Engineers
ASTM	ASTM International
CBC	California Building Code
CPT	cone penetrometer test
g	acceleration of gravity
MCE_G	maximum considered earthquake geometric mean
MCE_R	risk targeted maximum considered earthquake
mm/yr	millimeter(s) per year
NAVD88	North American Vertical Datum of 1988
NLIP	Natomas Levee Improvement Program
NMWC	Natomas Mutual Water Company
PGA	peak ground acceleration
Project	Elkhorn Pumping Plant Replacement Project
SPT	Standard Penetration Test
USGS	U.S. Geological Survey

1. Introduction

This report presents a summary of existing geotechnical data for the Elkhorn Pumping Plant Replacement Project (Project), which includes replacement of the existing Elkhorn Pumping Plant. The pumping plant is owned and operated by the Natomas Mutual Water Company (NMWC) of Rio Linda, California.

Extensive geotechnical investigations have been completed along the levee protecting the Natomas Basin as part of the Natomas Levee Improvement Program (NLIP). The purpose of this geotechnical data report is to summarize subsurface soil conditions at the proposed structure foundations. To accomplish this, our scope of services included the following:

- Reviewing recent subsurface data from previous subsurface explorations near the existing pumping plant.
- Preparing this report summarizing the anticipated geotechnical conditions.

NMWC authorized Jacobs to perform the geotechnical services described in this report through Task Order 2.

2. Project Description

The Elkhorn Pumping Plant is located on the east bank of the Sacramento River approximately 500 feet north of the intersection of Reservoir Road and Garden Highway, as shown on Figure 1. The purpose of the Project is to replace the existing pumping plant to accommodate modified discharge piping associated with the NLIP and to prevent fish entrainment.

Project facilities include the following proposed structures and appurtenances:

- A pump support structure founded on steel pipe piles.
- An improved driveway and access road from Garden Highway to the pump support structure.
- A log boom and deflector boom to protect the pump support structure from floating debris.
- Discharge piping (including flow meters) extending from the new pumps to a connection point water side of the levee. Discharge piping up-and-over the levee is by others.
- Concrete equipment pads for vacuum priming system, switchgear, and transformer.

3. Field Exploration

Geotechnical explorations have been conducted along the Sacramento River levee as part of the NLIP to improve levee stability and seepage concerns. Subsurface explorations in the vicinity of the Project were conducted from 2002 to 2009 by various geotechnical firms, and the subsurface data are summarized in the *Geotechnical Basis of Design Report for the Sacramento River East Levee*, prepared by Kleinfelder (Kleinfelder 2010).

Three cone penetrometer test (CPT) soundings were advanced within 250 feet of the existing Elkhorn Pumping Plant, with two of them being within 100 feet of the existing pumping plant. Five soil borings were drilled within 250 feet of the existing pumping plant. Borings E-03-04 and E-03-02 were near the two closest CPT soundings and matched the CPT soil profiles reasonably well. The details of the soil borings and CPT soundings are summarized in Table 1.

Table 1. Summary of Geotechnical Exploration near the Elkhorn Pumping Plant

Soil Boring or Cone Penetrometer Name	Type	Elevation of Ground Surface (feet)	Depth (feet)	Elevation at Bottom of Exploration (feet)
CPT-09-35	CPT	43.0	99.5	-56.5
CPT-09-96	CPT	36.0	80.0	-44.0
CPT-09-98	CPT	33.0	80.1	-47.1
E-03-1	Soil Boring	40.5	81.5	-41.0
E-03-2	Soil Boring	27.0	71.5	-44.5
E-03-3	Soil Boring	38.0	71.5	-33.5
E-03-4	Soil Boring	29.0	73.0	-44.0
SRE-08-07	Soil Boring	43.0	116.5	-73.5

Note:

Elevation datum is the North American Vertical Datum of 1988 (NAVD88).

The location of explorations near the Project site is presented on Figure 2, along with a subsurface cross section of the CPT and soil boring data. The data are copied from the Kleinfelder 2010 report. The detailed soil boring logs and CPT sounding data were obtained from Kleinfelder. Jacobs processed the CPT data using the computer program CPeT-IT, and the results are presented in Appendix A.

In situ testing and soil sampling were performed in the soil borings using the Standard Penetration Test (SPT) at approximate 1.5- to 5-foot intervals. The SPT provides a disturbed sample of the soil and an empirical indication (N-value) of the soil density or consistency. A modified California 2.5-inch split-spoon sampler was also used for some sample locations. Some materials were also recovered using Shelby tubes for less disturbed soil specimens used in laboratory testing.

4. Soil Laboratory Testing

No laboratory testing has been performed as part of this Project. The boring data provided by Kleinfelder presents some test reports of the amount of material finer than the Number (No.) 200 sieve (ASTM International [ASTM] D1140 2017a), Atterberg limits (ASTM D4318 2017b), direct shear strength tests (ASTM D3080 2012), consolidation tests (ASTM D2435 2020), and density measurements (ASTM D2937 2017c).

5. Site Conditions

5.1 Local Geology

The Project site is underlain by levee fill materials and native alluvial soil.

5.2 Subsurface Soil Materials

The soil profiles in the CPTs and soil borings are somewhat consistent. A side-by-side comparison of the CPTs and the soil boring near the existing pumping plant is presented on Figure 3. Jacobs used data from CPT-09-96 and CPT-09-98 and E-03-2 and E-03-4 logs to develop a representative profile of the upper 80 feet of soil materials at the project site. Below 80 feet depth, the subsurface profile was considered to be represented by soil boring SRE-08-07.

The interpreted soil profile beneath the proposed facilities, beginning at the level of the existing pumping plant structure or elevation 35 feet, consists of five interpreted soil layers to a depth of 115 feet. The upper 15 feet consists of silt and clay soil. SPT N-values in this material ranged from 3 to 12 blows per foot, corresponding to a soft to stiff consistency. This is underlain by an approximate 90-foot-thick deposit of sand soil. The upper approximate 15 feet of sand appears to be loose to medium dense with lower SPT N- values and CPT tip resistance. The SPT-N values in the sand are variable throughout the layer, generally varying from medium dense to dense. However, the bottom 15 feet of the sand layer from depths of 90 to 105 feet are dense to very dense. This lower sand is underlain by clay, with SPT N-values between 14 to 37 blows per foot, corresponding to stiff to hard consistency.

5.3 Groundwater

Reported groundwater levels from a well located approximately 0.1 mile southwest of the Project site have ranged between elevation -13 and 6 feet (NAVD88) over the last 3 years. Groundwater levels were estimated to be between elevation 1 and 9 feet (NAVD88) at the time of the soil borings on the levee within 250 feet of the Elkhorn Pumping Plant.

The normal groundwater at the Elkhorn Pumping Plant is subject to elevated levels during flood stages in the Sacramento River because the pumping plant is located on the riverbank. The Project Design Report (Jacobs 2023) provides a summary of river stage and flow data. The flow and river stage are greatest in the winter months. The 200-year flood water surface elevation is 42.1 feet (NAVD88). The river flow has been less than 15,000 cubic feet per second over the last 10 years for 50 percent of the time in any given month. The corresponding water level at the Elkhorn pumping plant facility is approximately 12 feet (NAVD88).

6. Seismic Hazards

6.1 Seismic Setting

The Project site is in an area of moderate seismic activity. From a review of the Quaternary Fault and Fold Database of the United States (U.S. Geological Survey [USGS] 2021a), there are no known Quaternary faults passing through the Project site. The fault and fold database for the Project vicinity indicates that the nearest faults showing evidence of rupture during the last 130,000 years are at least 18 miles from the Project site. The nearest faults that have the most influence on potential ground motion at the Project site are listed in Table 2, along with the fault characteristics.

During the last 150 years, the area within approximately 60 miles of the Project site has had approximately 18 earthquakes greater than magnitude 5 (USGS 2021b). The nearest and largest earthquake, of estimated magnitude 6.2, occurred in 1892 approximately 21 miles southwest of the Project site. The most recent significant earthquake was a magnitude 6.0 earthquake that occurred approximately 50 miles southwest of the Project site in 2014.

Table 2. Summary of Quaternary Faults Most Significant to the Project and Rupture Scenarios

Fault Name or Zone	Type	Dip, Direction, and Slip Rate	Distance and Direction from Site (miles)	Characteristic Magnitude
Great Valley, Segments 3 and 4 (Dunnigan Hills Fault, Vaca Fault)	Reverse	15° west, 1.5 mm/yr	21 Southwest	6.8
Concord – Green Valley Faults	Strike slip	90°, 6 mm/yr	38 Southwest	6.9
Rodgers Creek Fault	Strike slip	90°, 9 mm/yr	58 Southwest	7.0
Foothill Fault System	Normal	65°, 0.05 mm/yr	31 Northeast	6.5

Notes:

Fault parameters obtained from USGS 2008 and USGS 1996

° = degree(s)

mm/yr = millimeter(s) per year

6.2 Seismic Design Parameters

Using the field-measured N-values from the nearest soil borings, soil Site Class D is applicable for the design of structures subject to seismic loads, per American Society of Civil Engineers (ASCE) 7-16 (ASCE 2016) and the *2019 California Building Code* (CBC) (California Building Standards Commission 2019).

For sites with significant ground motion risk, such as the Project site, a site-specific ground motion procedure is required by the 2019 CBC for Site Class D with a 1-second spectral acceleration greater than 0.2 acceleration of gravity (g) for the risk-targeted maximum considered earthquake. However, a site-specific ground motion hazard analysis is not required for structures if the seismic response coefficient Cs is determined in accordance with Section 11.4.8 of ASCE 7-16.

The CBC seismic design parameters for the Project are summarized in Table 3.

Table 3. Seismic Design Parameters According to ASCE 7-16

Parameter	ASCE 7-16 Values	Description
S_S	0.645	MCE_R ground motion. (for 0.2 second period)
S_1	0.272	MCE_R ground motion. (for 1.0 second period)
S_{MS}	0.828	Site-modified spectral acceleration value
S_{M1}	0.559	Site-modified spectral acceleration value
S_{DS}	0.552	Seismic design spectral acceleration value at 0.2 second period
S_{D1}	0.373	Seismic design spectral acceleration at 1.0 second period
Fa	1.284	Site amplification factor at 0.2 second period
Fv	2.056	Site amplification factor at 1.0 second period
PGA	0.272	MCE_G PGA
F_{PGA}	1.328	Site amplification factor at PGA
PGA_M	0.361	Site-modified PGA

Notes:

MCE_G = geometric mean maximum considered earthquake
MCE_R = risk targeted maximum considered earthquake
PGA = peak ground acceleration

The maximum considered earthquake geometric mean PGA for the Project site is 0.27 g, as mapped in ASCE 7-16. The PGA adjusted for Site Class D conditions is 0.36 g. The modal earthquake for this ground motion is a magnitude 6.1 event at approximately 9 miles from the Project site, in accordance with deaggregation of the earthquake motion with a return period of approximately 2,475 years, using the online Uniform Hazard Tool developed by USGS.

7. Limitations

This report has been prepared for the exclusive use of NMWC for specific application to the Elkhorn Pumping Plant Replacement Project in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

The data contained in this report are from CPTs and soil boring data available from geotechnical investigations performed for levee improvements along the Sacramento River levee, including the section where the Elkhorn Pumping Plant is located. Certain specific laboratory testing results were not available for the soil profile beneath the proposed structures.

Jacobs is not responsible for claims, damages, or liability associated with the interpretation of subsurface data or reuse of the subsurface data without the express written authorization of Jacobs.

8. References

American Society of Civil Engineers (ASCE). 2016. Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-16).

ASTM International (ASTM). 2012. *ASTM D3080-04, Standard Test Methods for Direct Shear Test of Soil Under Consolidated Drained Conditions.* West Conshohocken, PA. https://www.astm.org/d3080-04.html.

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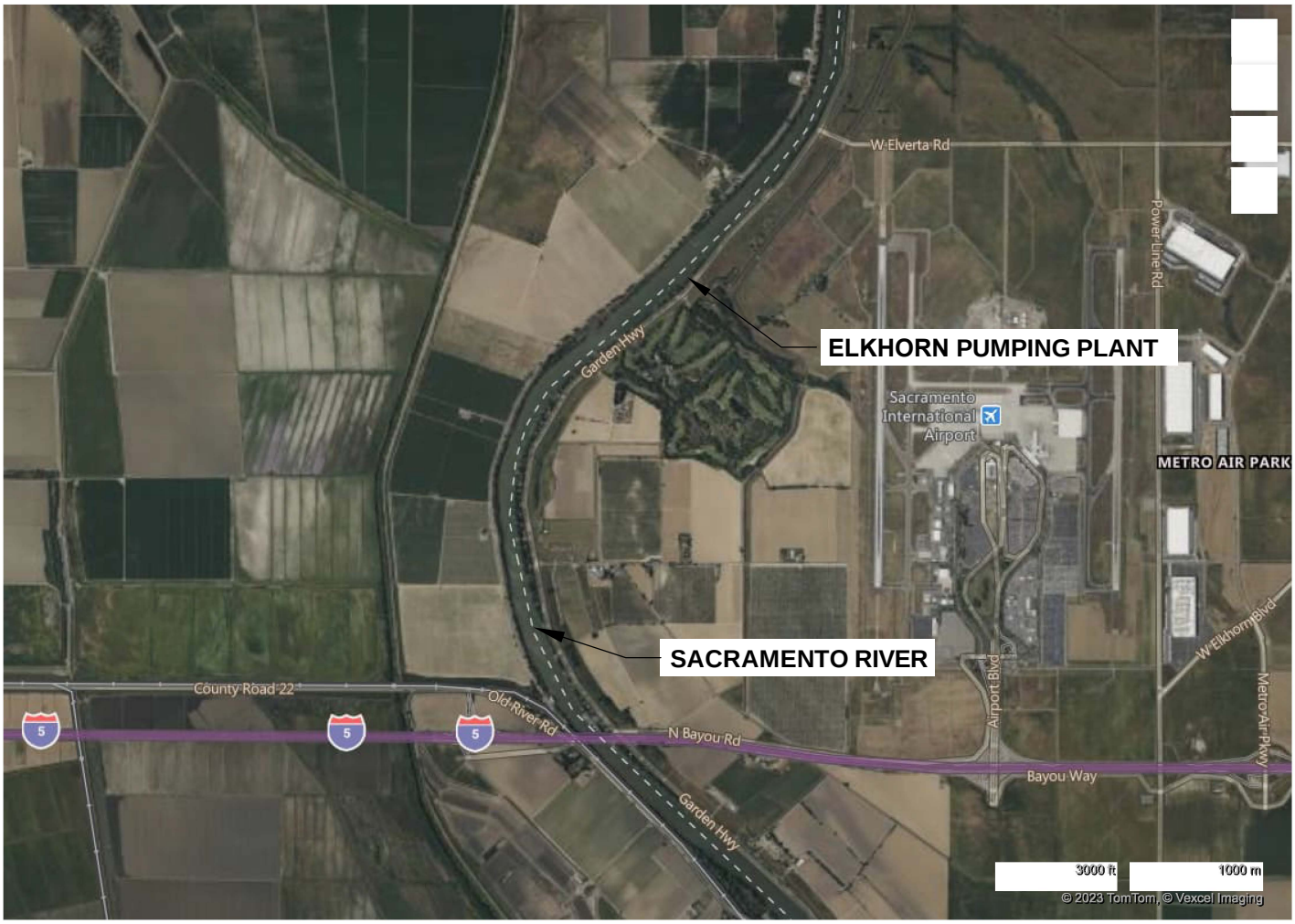
U.S. Geological Survey (USGS). 2021b. *Historic Earthquakes.* Accessed May 6, 2021. https://earthquake.usgs.gov/earthquakes/eventpage/usp000155j/impact.

Figures



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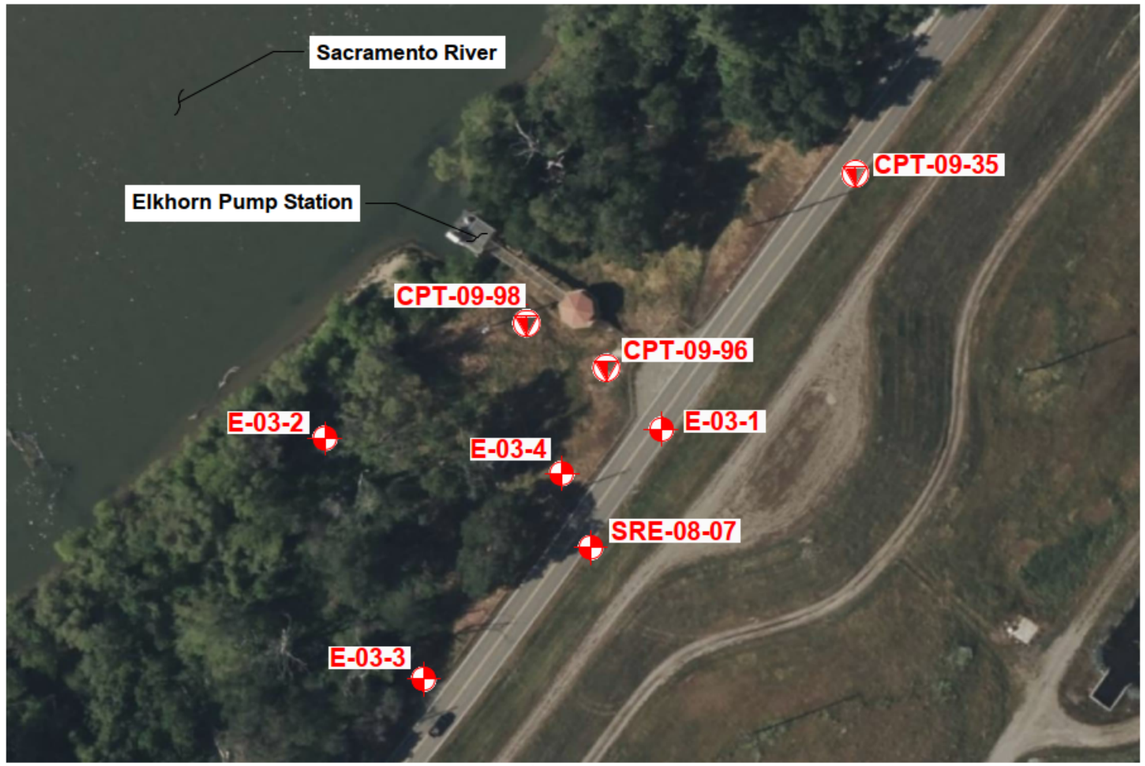
NOT TO SCALE

N

FIGURE 1
Project Location Map
Elkhorn Pumping Plant Replacement Project

Jacobs



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Modifications by Jacobs

LEGEND

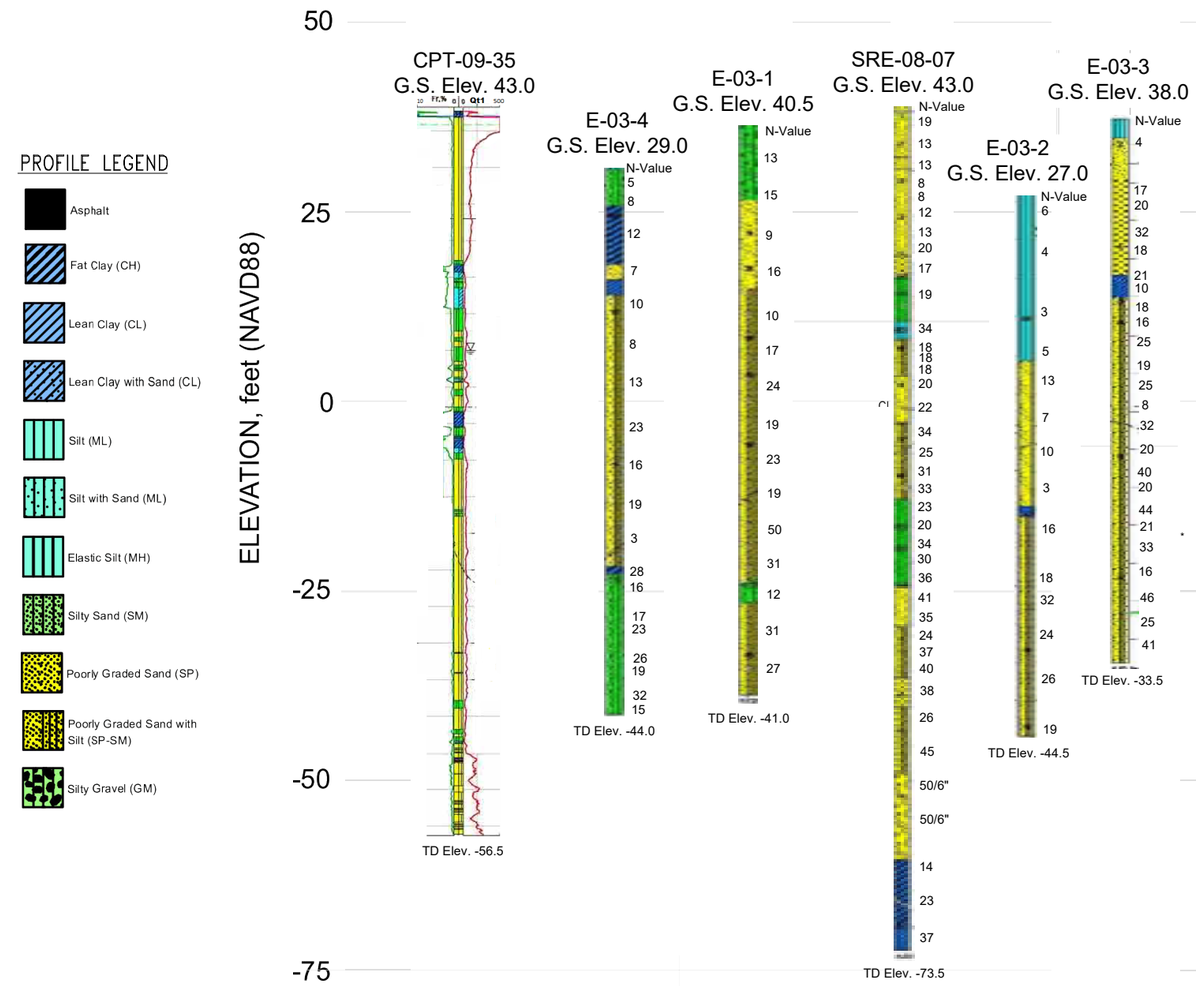
B# APPROXIMATE BOREHOLE LOCATIONS

CPT# APPROXIMATE CONE PENETROMETER TEST LOCATIONS

0 50 100 150

APPROXIMATE SCALE 1"=100'

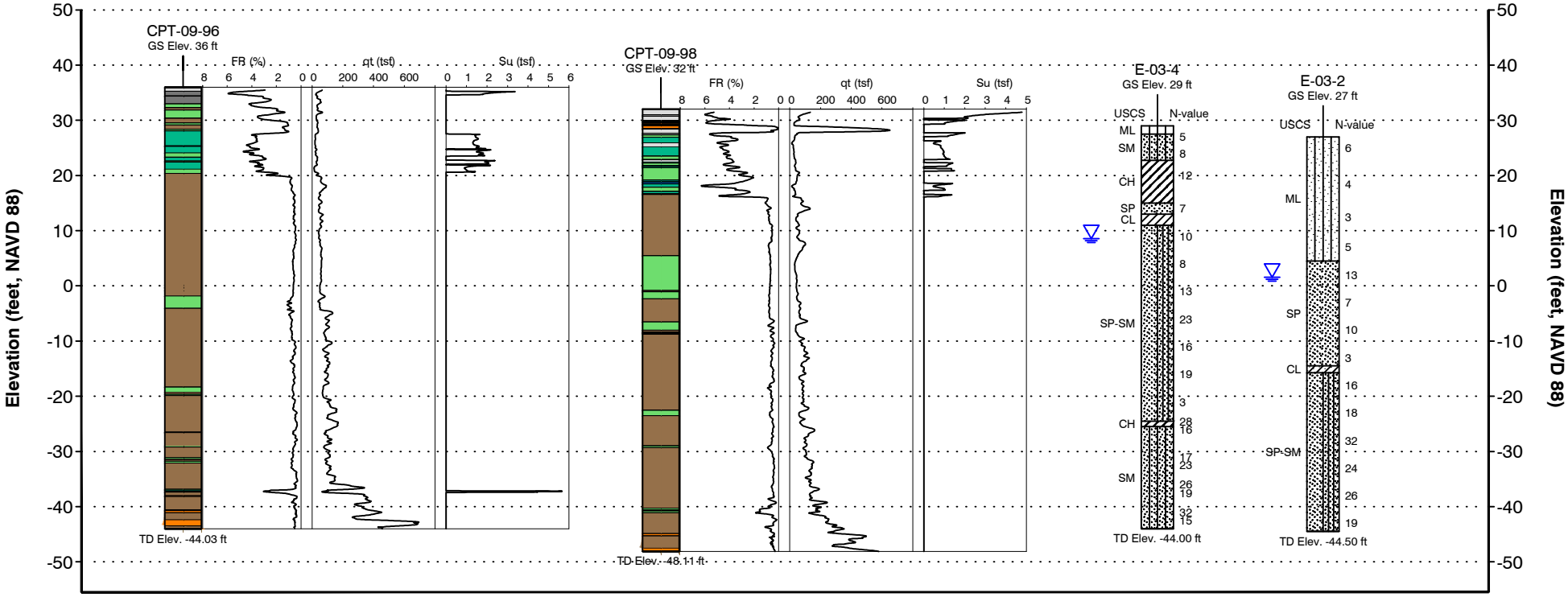
N



Copied Data from Kleinfelder, 2010, Modifications by Jacobs

FIGURE 2
Geotechnical Explorations Near Elkhorn Pumping Plant
Elkhorn Pumping Plant Replacement Project

Jacobs



Surface Profile

NORMALIZED CPT SOIL BEHAVIOR TYPE (SBTN)

- 1: Sensitive fine-grained
- 2: Organic material
- 3: Clay to silty clay
- 4: Clayey silt to silty clay
- 5: Silty sand to sandy silt
- 6: Clean sand to silty sand
- 7: Gravelly sand to sand
- 8: Very stiff sand to clayey sand
- 9: Very stiff fine-grained

USCS SOIL CLASSIFICATION

- Lean Clay (CL)
- Fat Clay (CH)
- Silt (ML)
- Silty Sand (SM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand with Silt (SP-SM)

NOTES:

1. Upper 5 feet at each CPT location was hand augered, no CPT data recorded.
2. Undrained shear strength values are an approximate interpretation based on empirical correlations for CPT results.

ABBREVIATIONS AND LETTER SYMBOLS

CPT	cone penetrometer test
FR	friction ratio, %
GS	ground surface
qt	tip resistance, tons per square foot
Su	undrained shear strength, tons per square foot
TD	total depth

FIGURE 3
Side by Side Comparison of CPT and Boring Logs
Elkhorn Pumping Plant Replacement Project

Jacobs

Date: 3/30/2023 Time: 19:04 User: TRANAJ

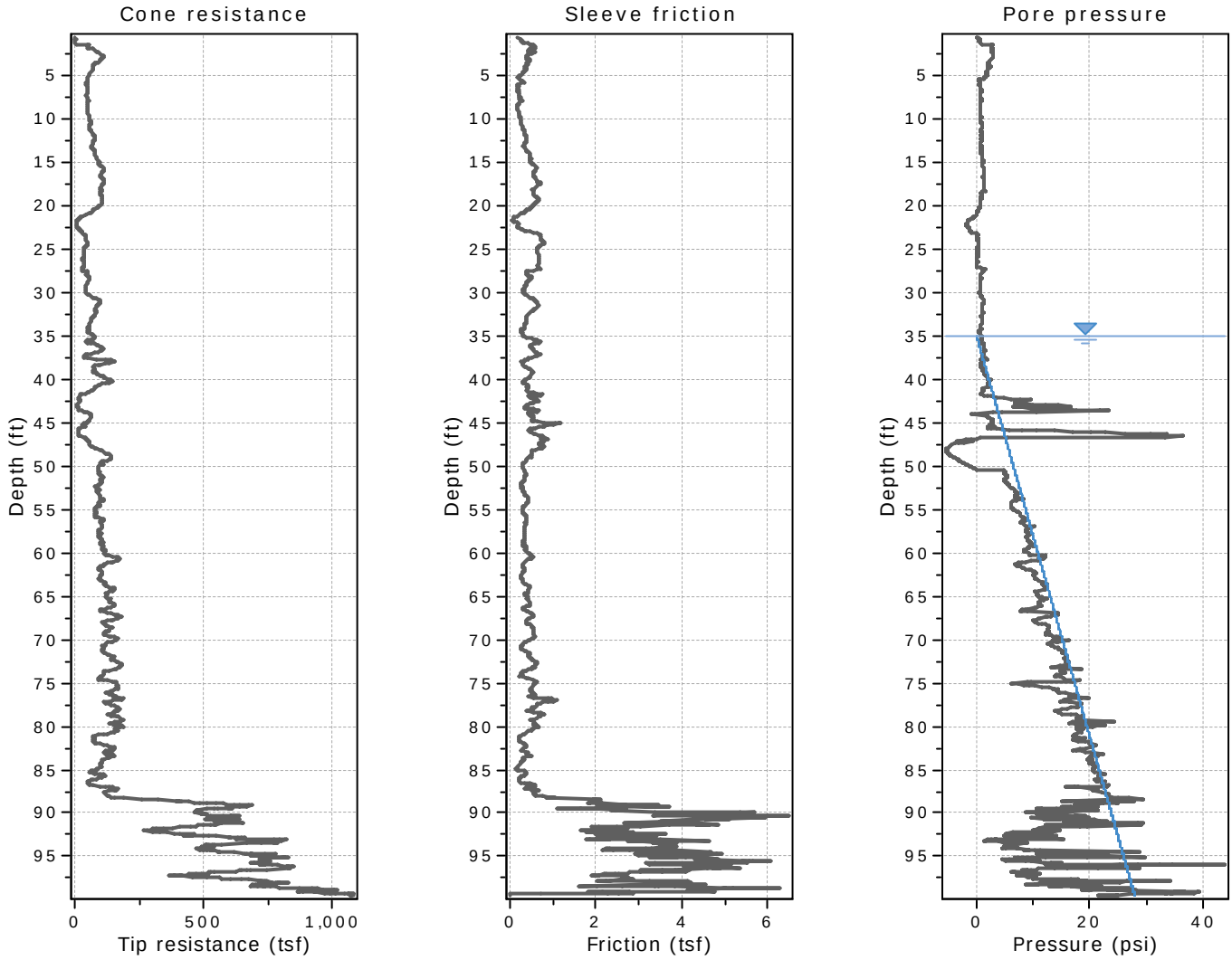
Appendix A
Cone Penetrometer Test Interpretations and Boring Data

CPT Raw Data provided by Kleinfelder

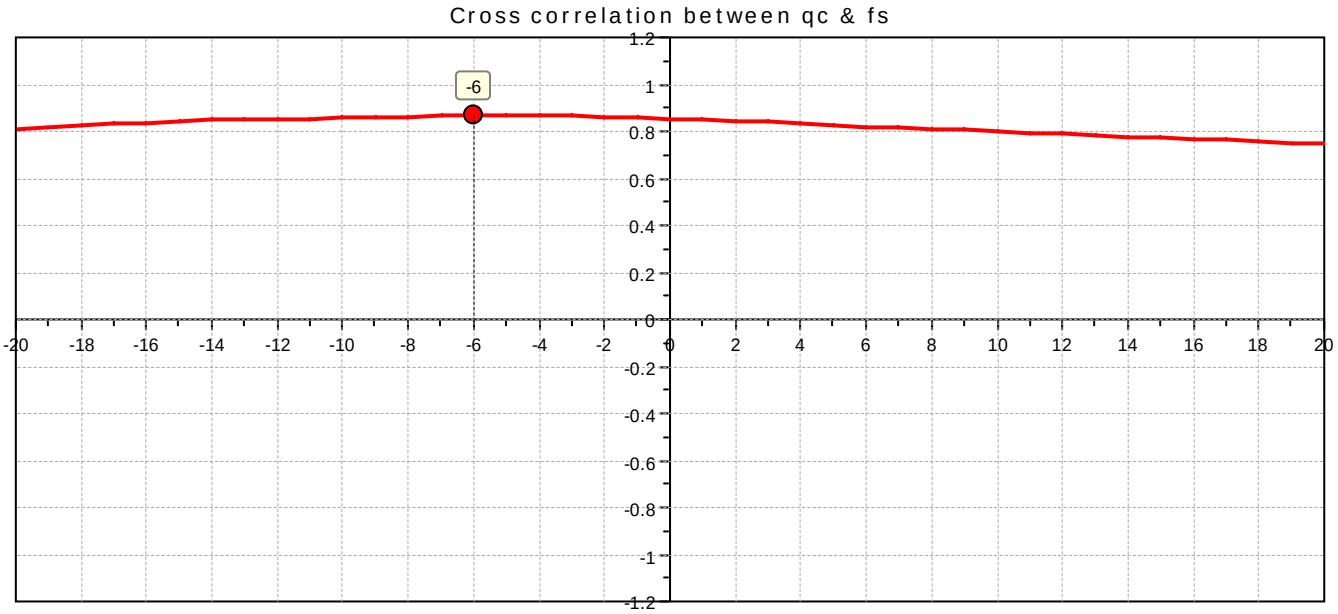
Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-35
Total depth: 99.51 ft, Date: 3/8/2023
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

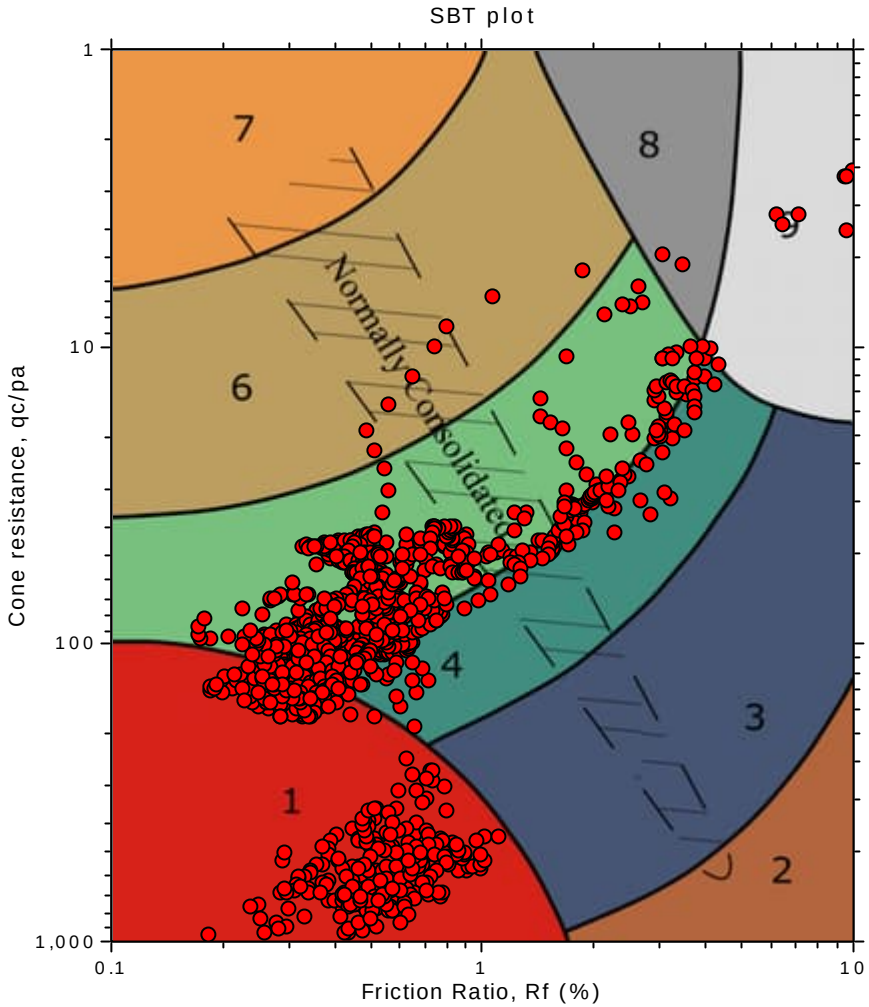
Project: Elkhorn Pumping Plant
Location: Sacramento, CA

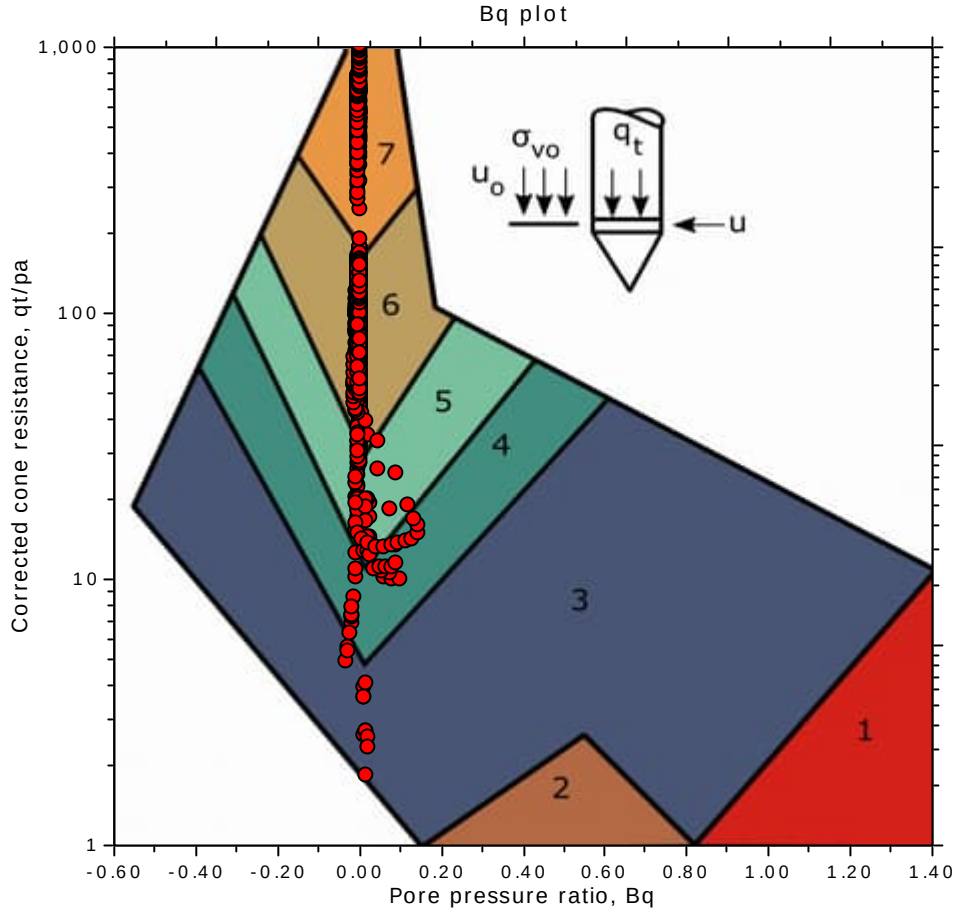


The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



SBT - Bq plots

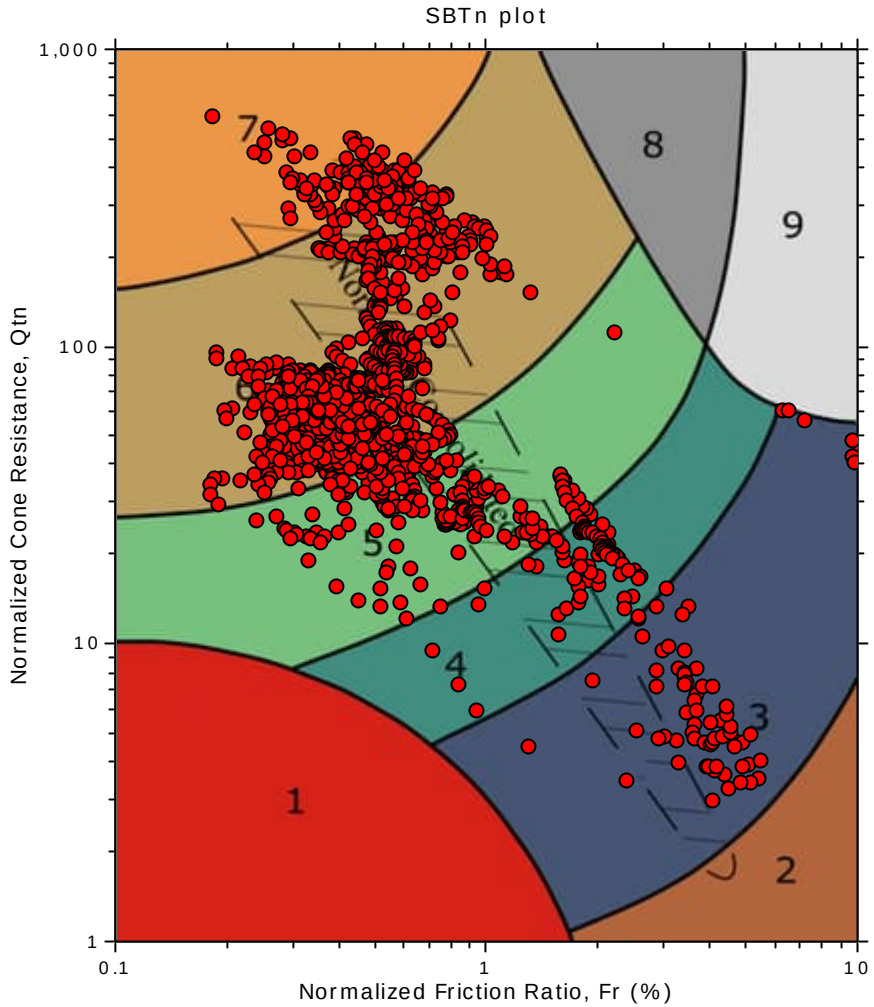


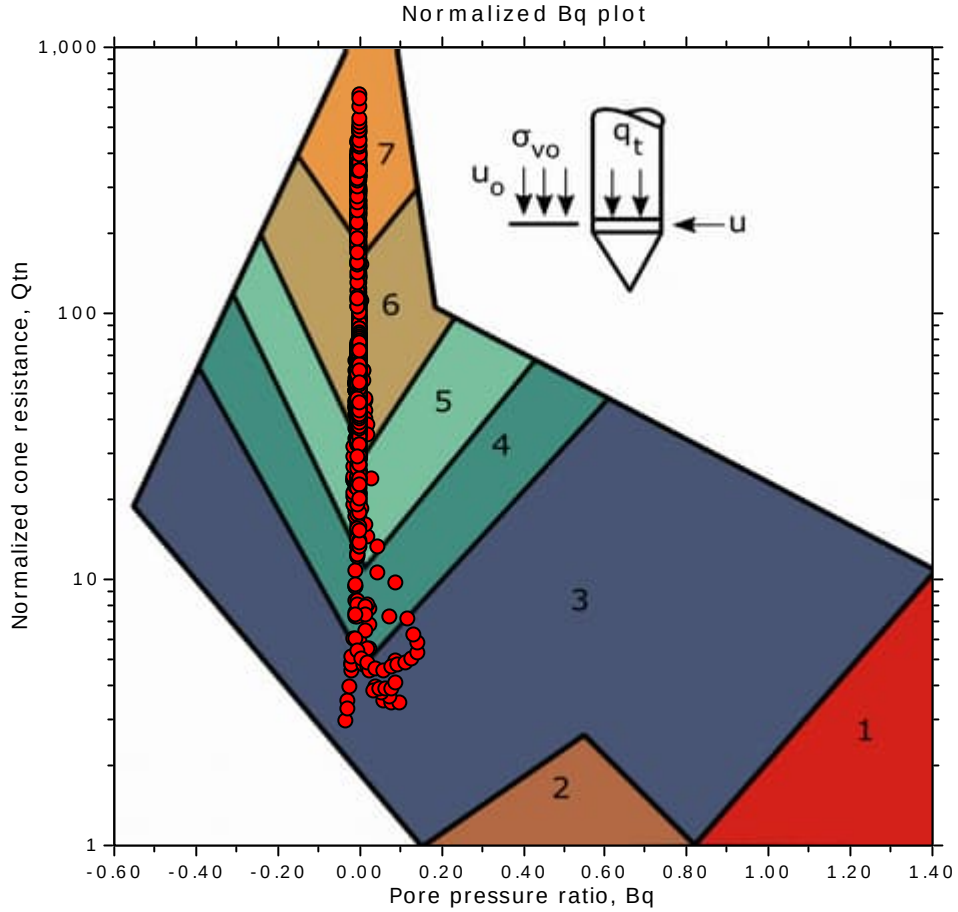


SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravelly sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

SBT - Bq plots (normalized)

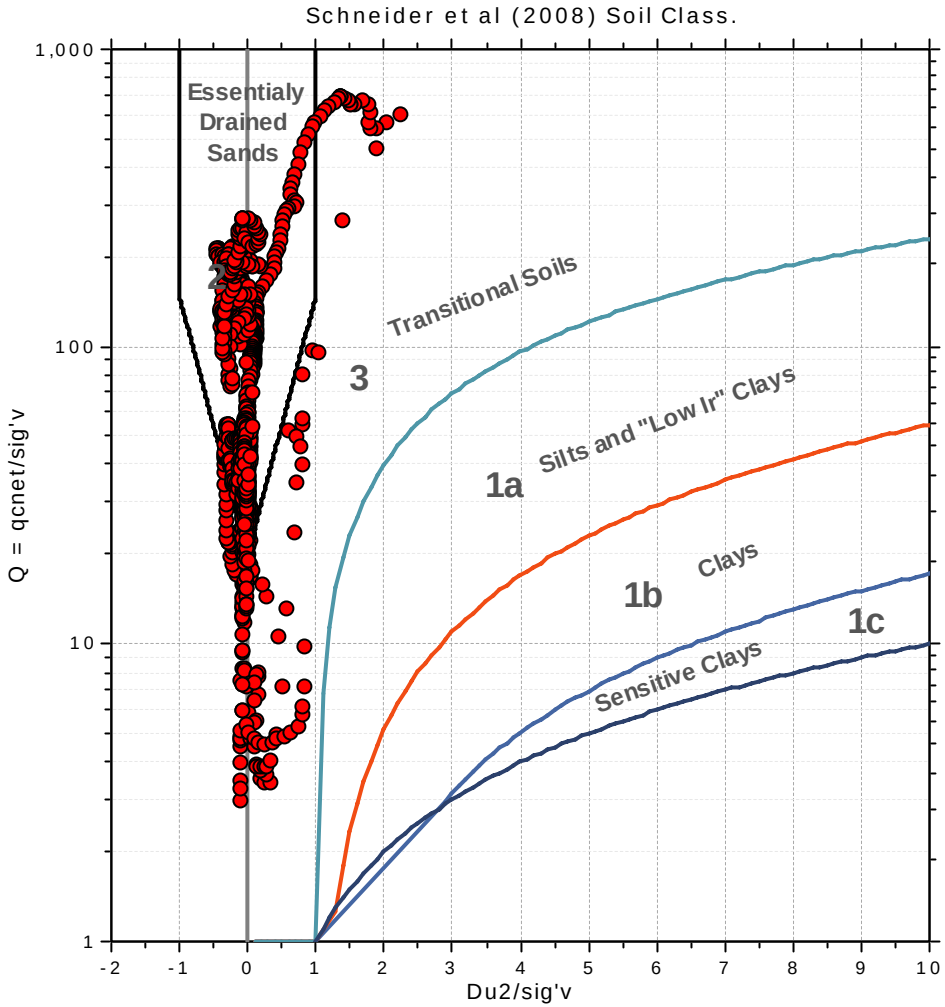


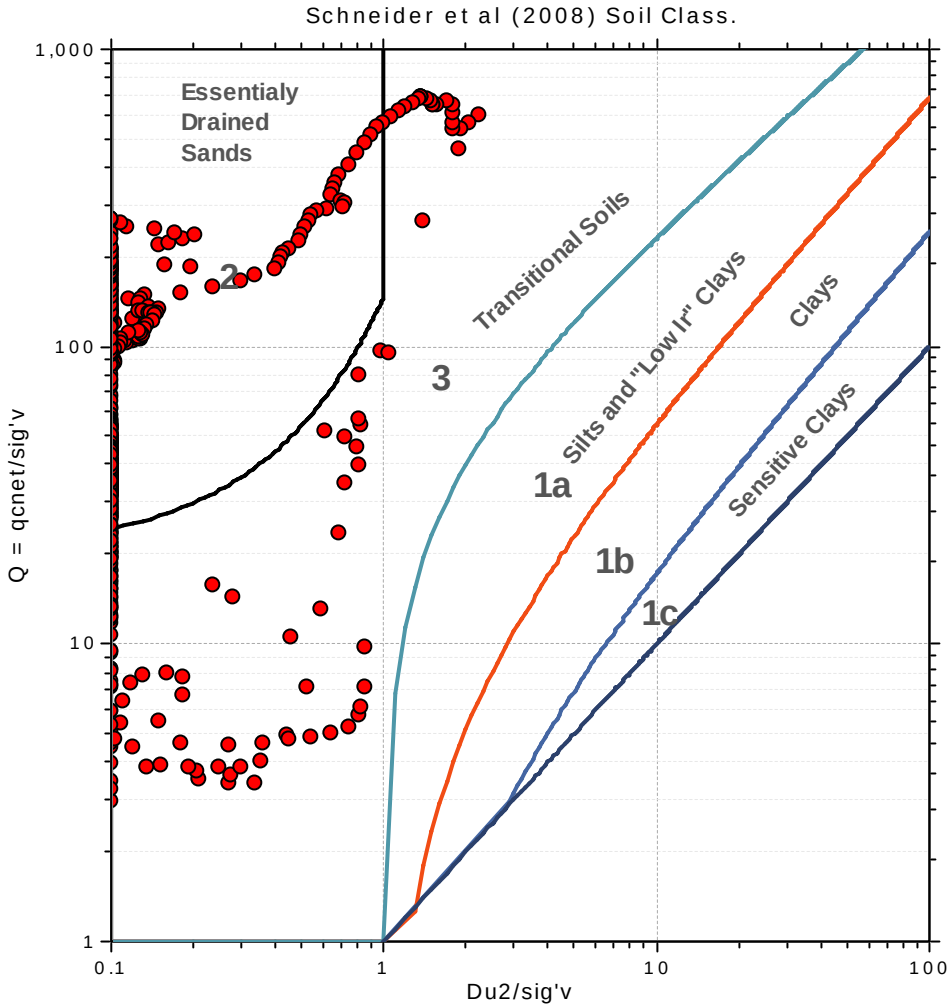


SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Bq plots (Schneider)



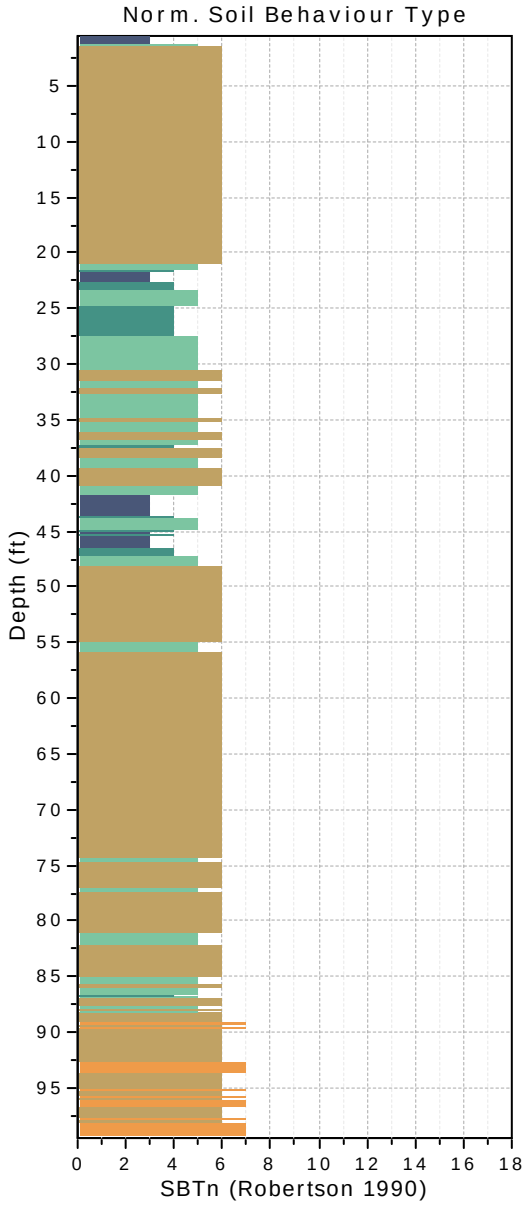


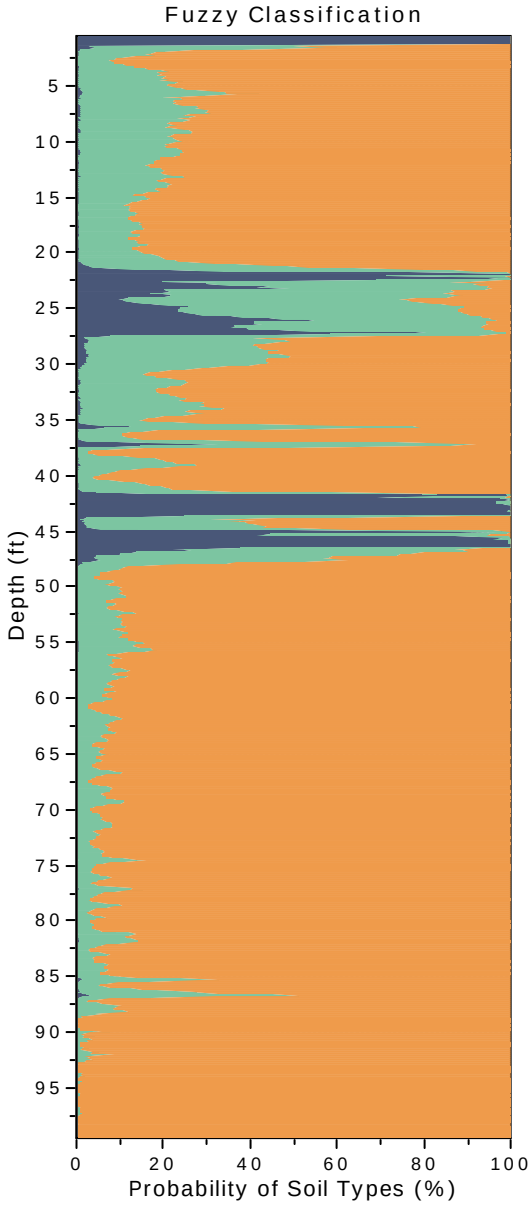
CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-35
Total depth: 99.51 ft, Date: 3/8/2023
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA





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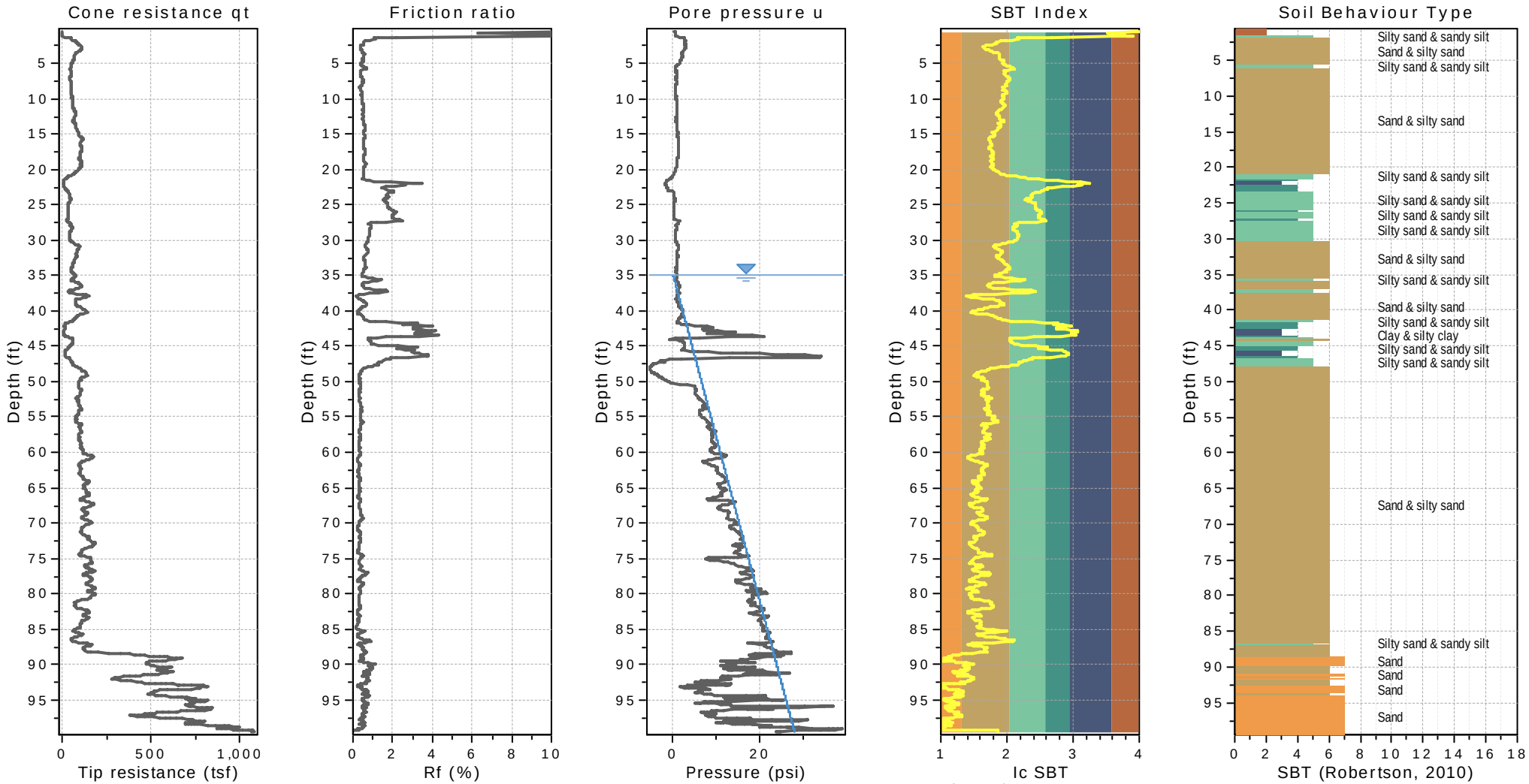

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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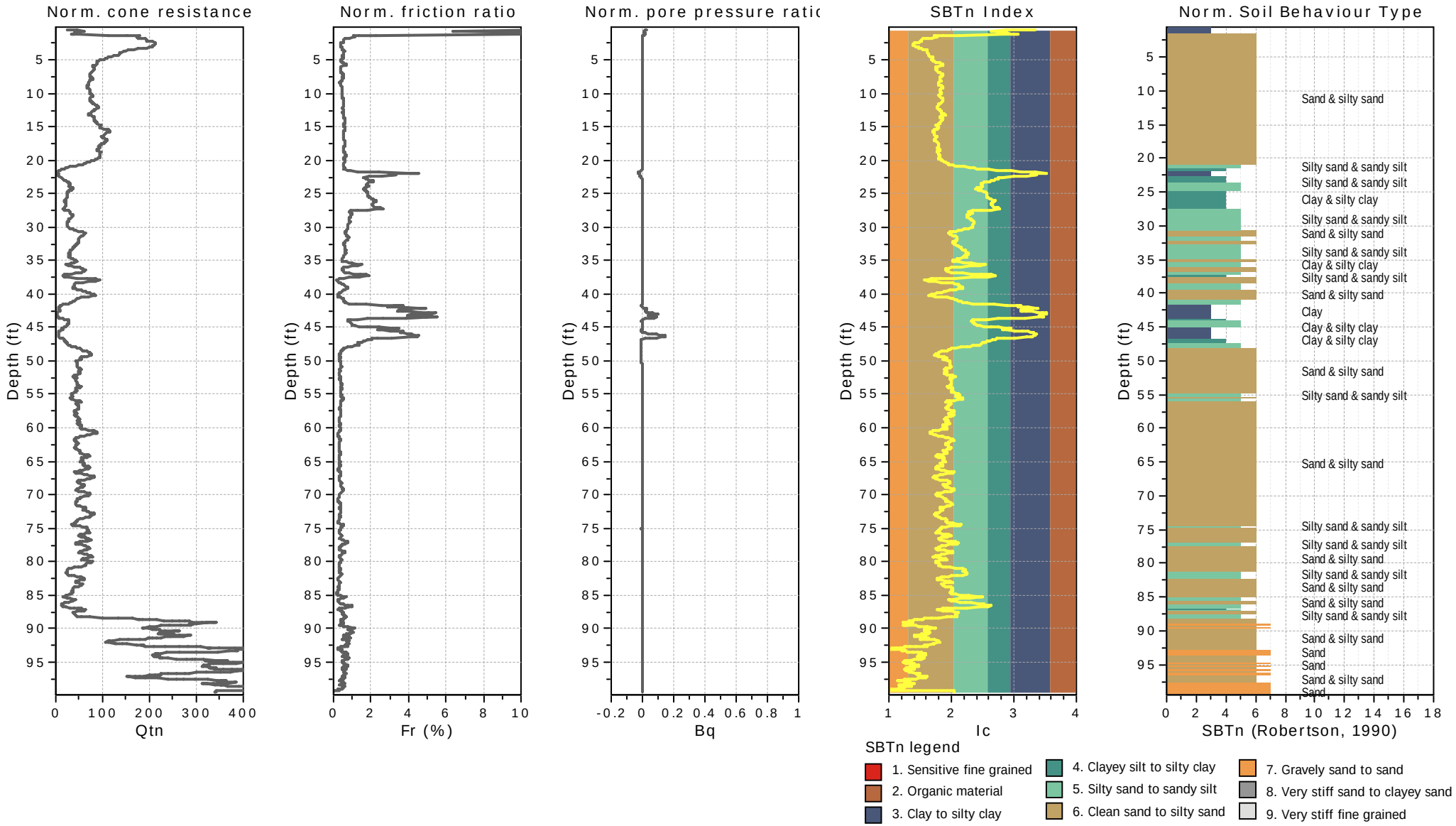

CPT Raw Data provided by Kleinfelder

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Sacramento, CA 95833

CPT: CPT-09-35
Total depth: 99.51 ft, Date: 3/8/2023
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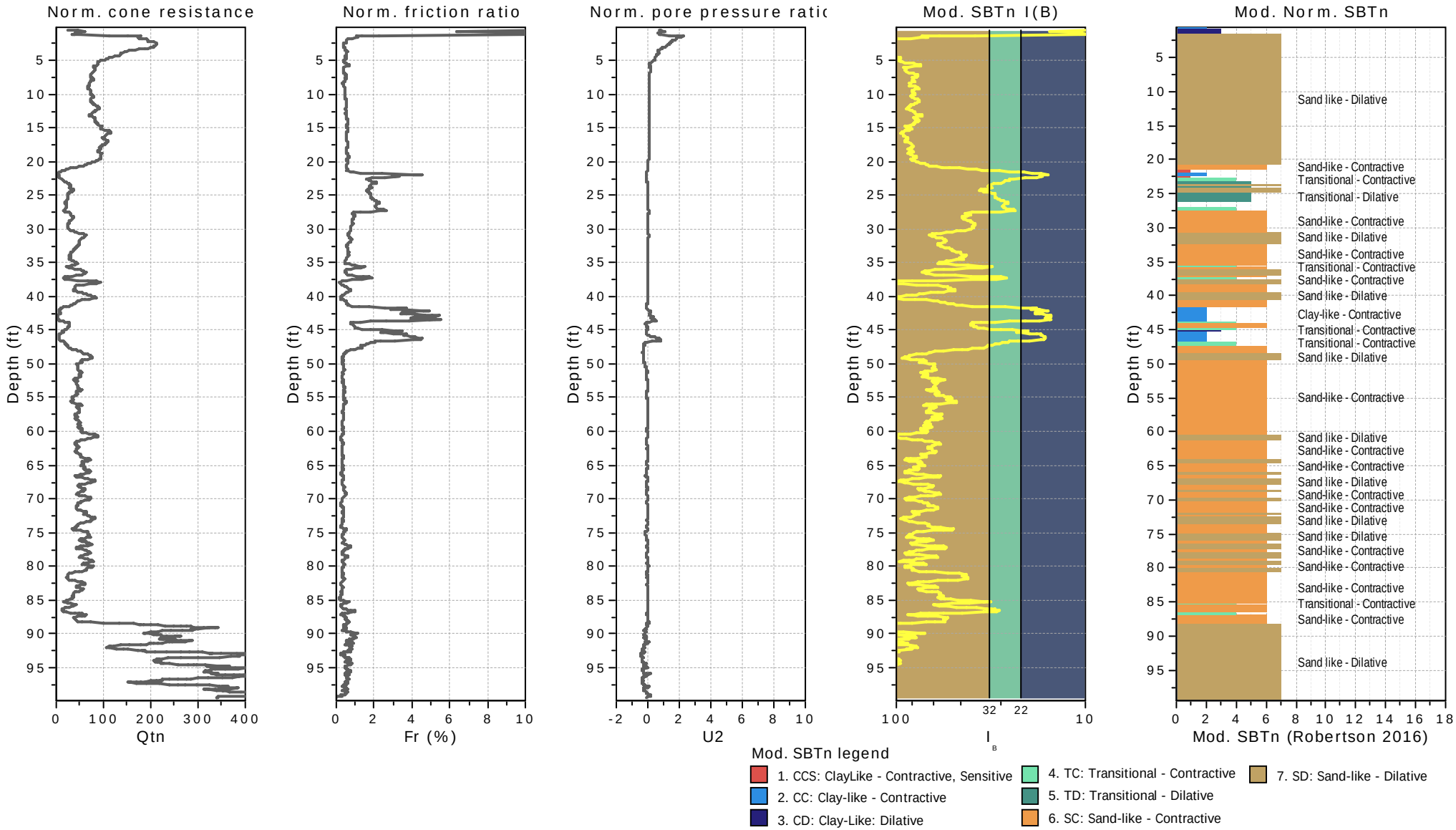
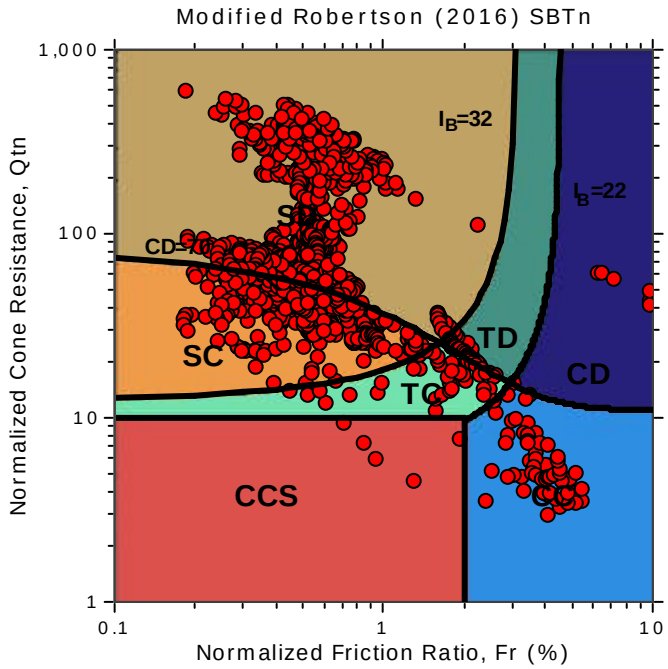
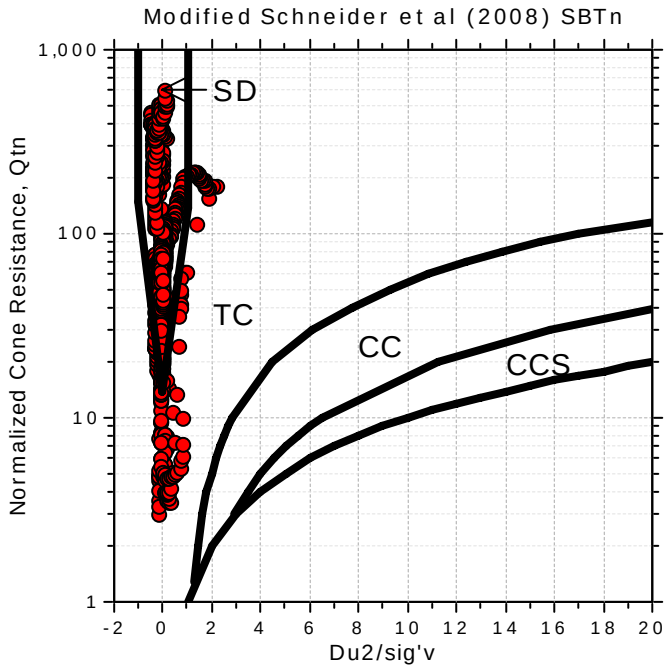
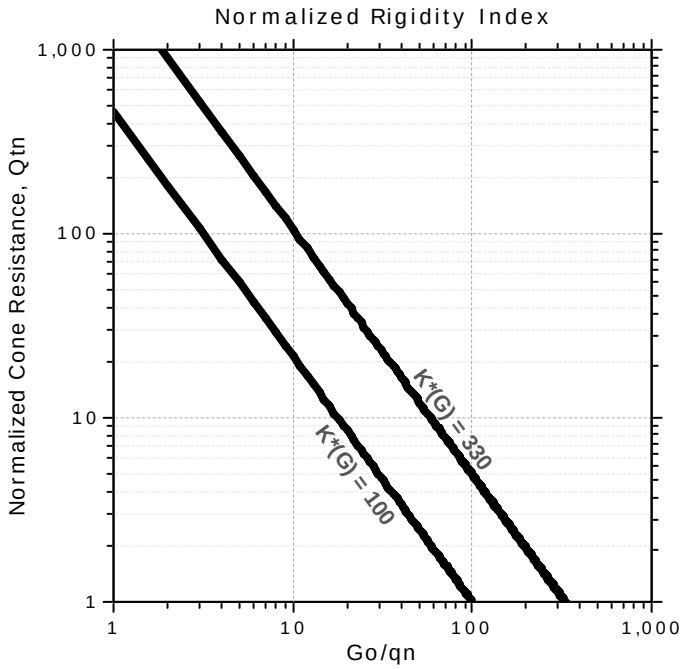


Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
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SC: Sand-like - Contractive
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K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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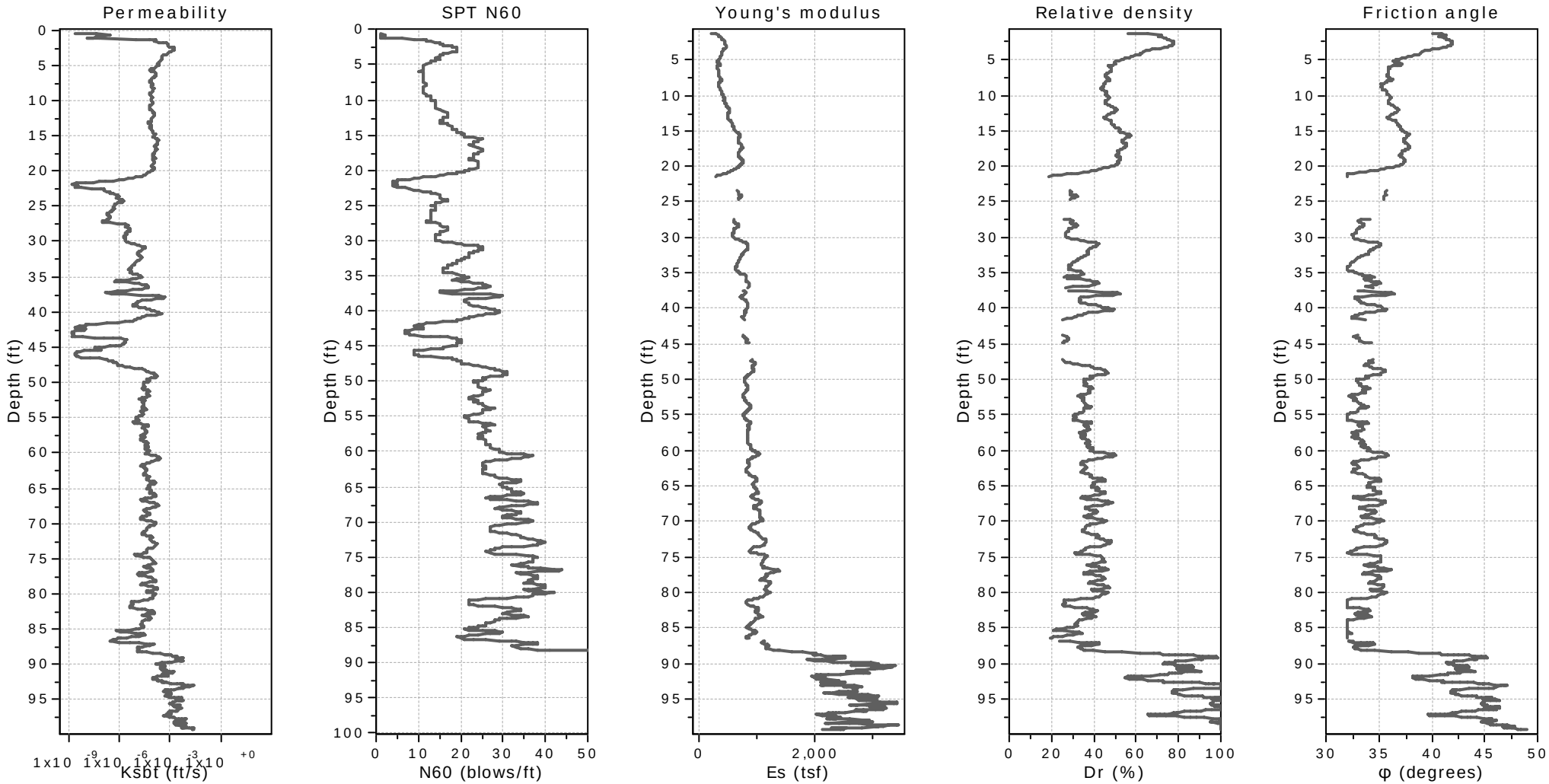
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



Calculation parameters

Permeability: Based on SBT_n

SPT N_{60}: Based on I_c and q_t

Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative density constant, C_{Dr}: 350.0

Phi: Based on Kulhawy & Mayne (1990)

User defined estimation data

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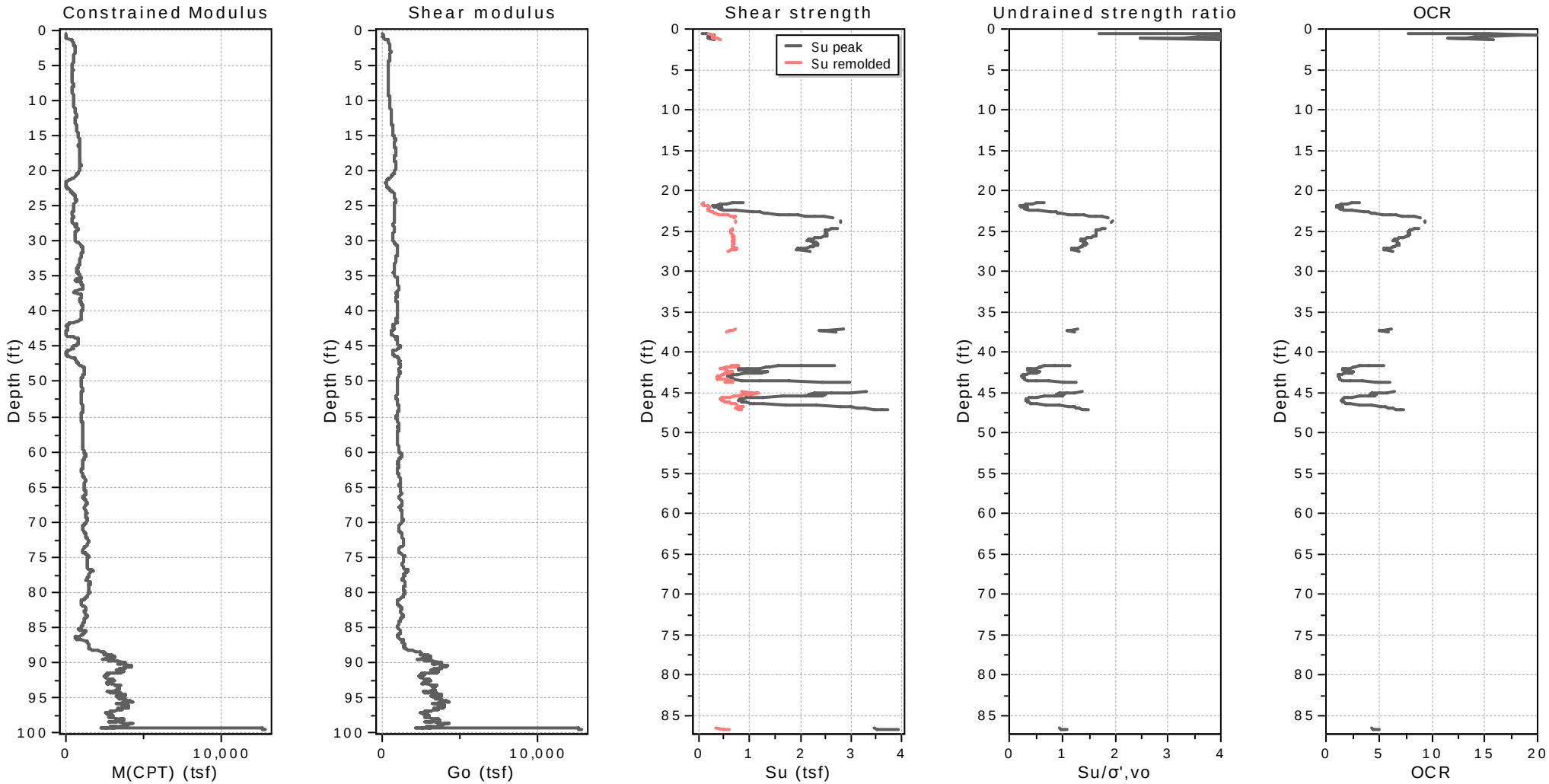

Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)

Go: Based on variable *alpha* using I_c (Robertson, 2009)

Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33

User defined estimation data

Flat Dilatometer Test data

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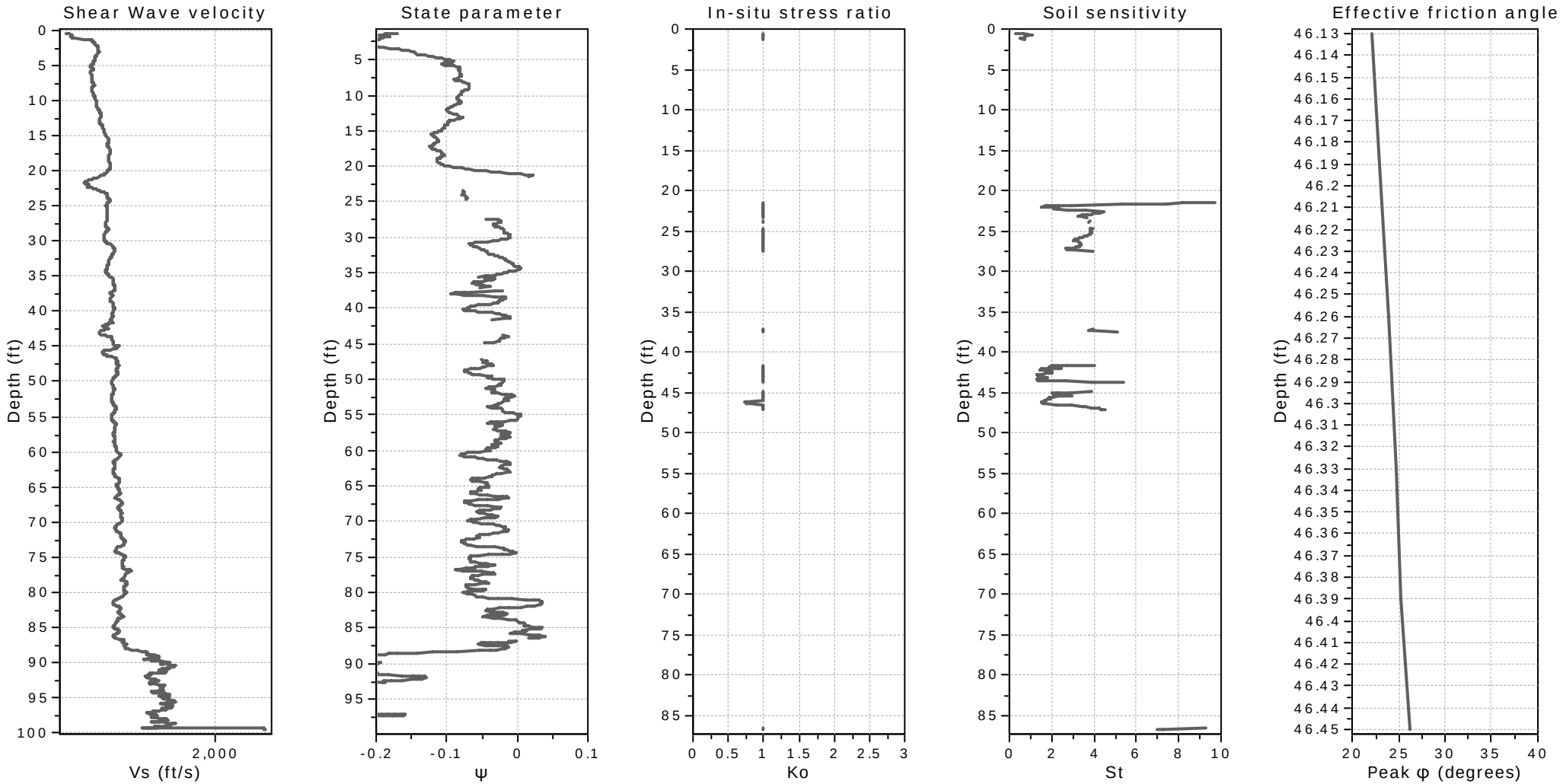

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

User defined estimation data

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236\right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952-3.04 \cdot I_c}$

$I_c \leq 4.00$ and $I_c > 3.27$ then $k = 10^{-4.52-1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, **ψ** ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Drained Friction Angle, **φ** (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \cdot \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$
$\alpha = 14$ for $Q_{tn} > 14$
$\alpha = Q_{tn}$ for $Q_{tn} \leq 14$
$M_{CPT} = \alpha \cdot (q_t - \sigma_v)$

If $I_c \geq 2.20$

$$M_{CPT} = 0.03 \cdot (q_t - \sigma_v) \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))}\right]^{1.25}$$ or user defined

$OCR = k_{OCR} \cdot Q_{tn}$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, **φ'** (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

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Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
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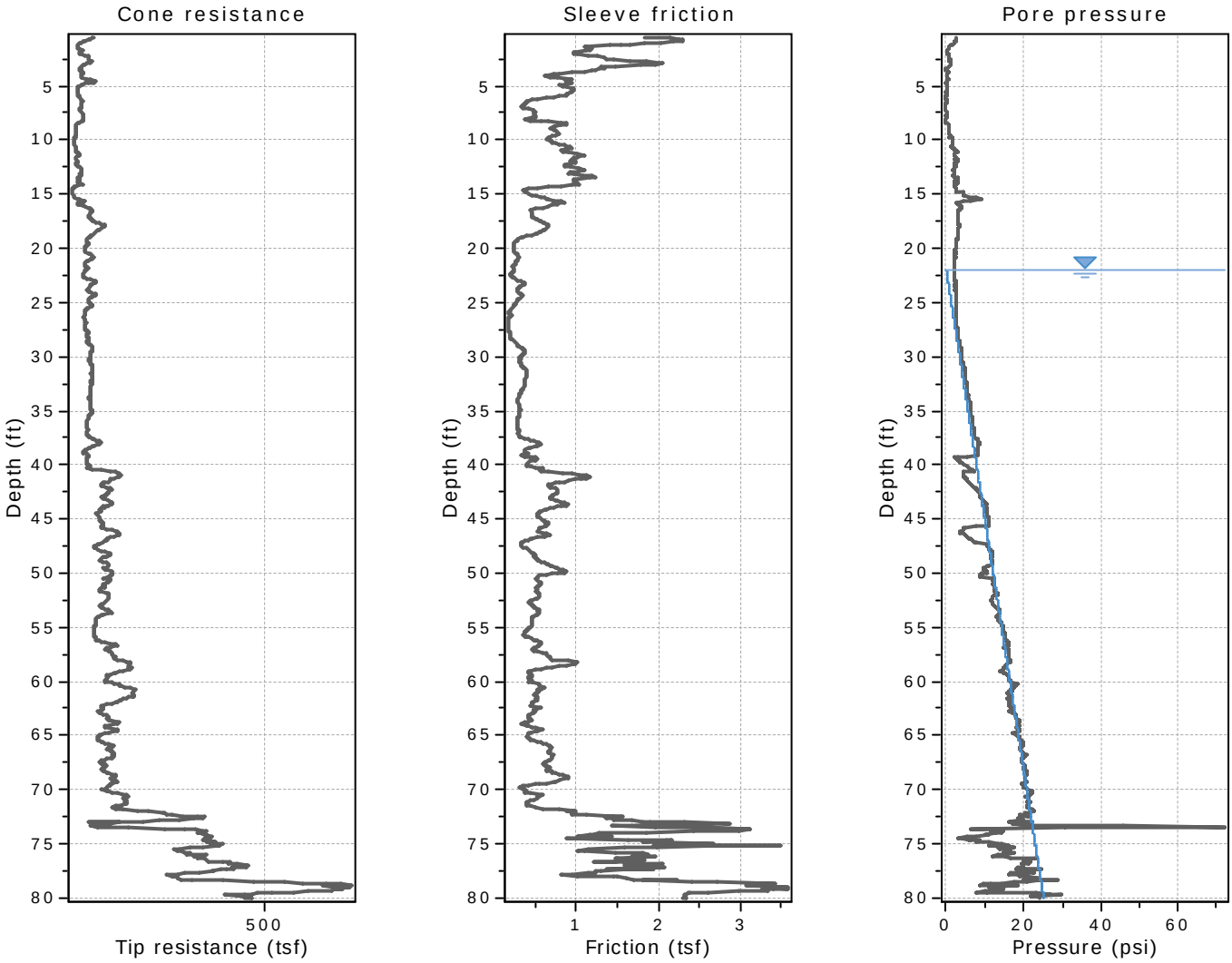
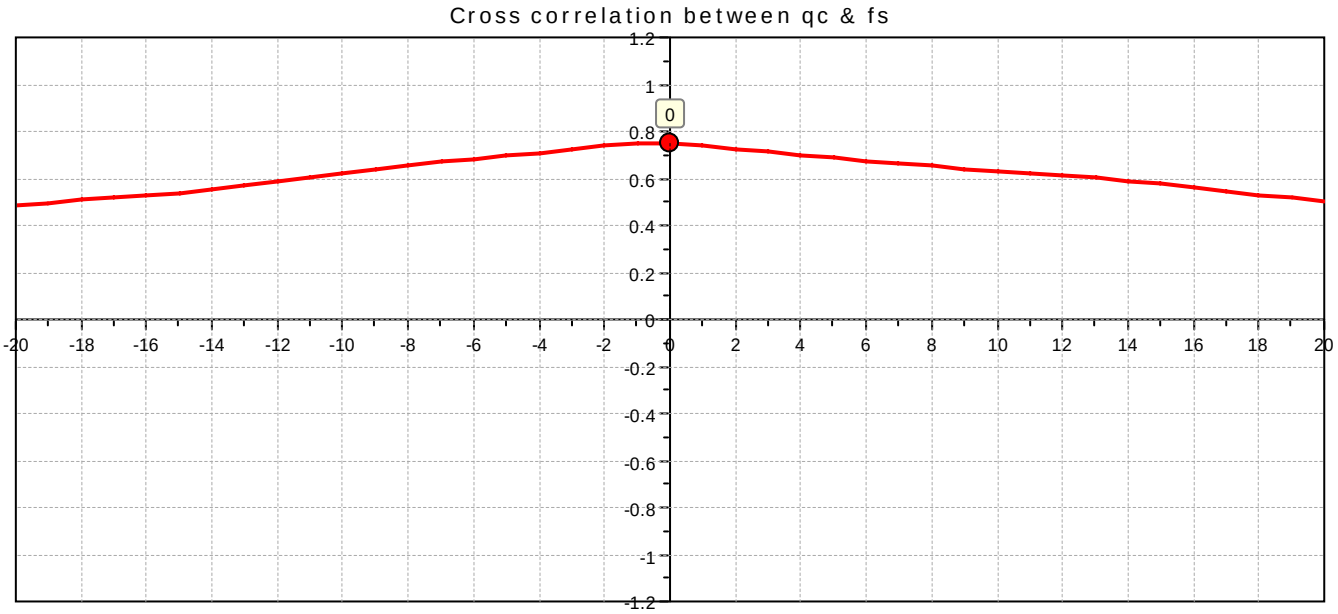
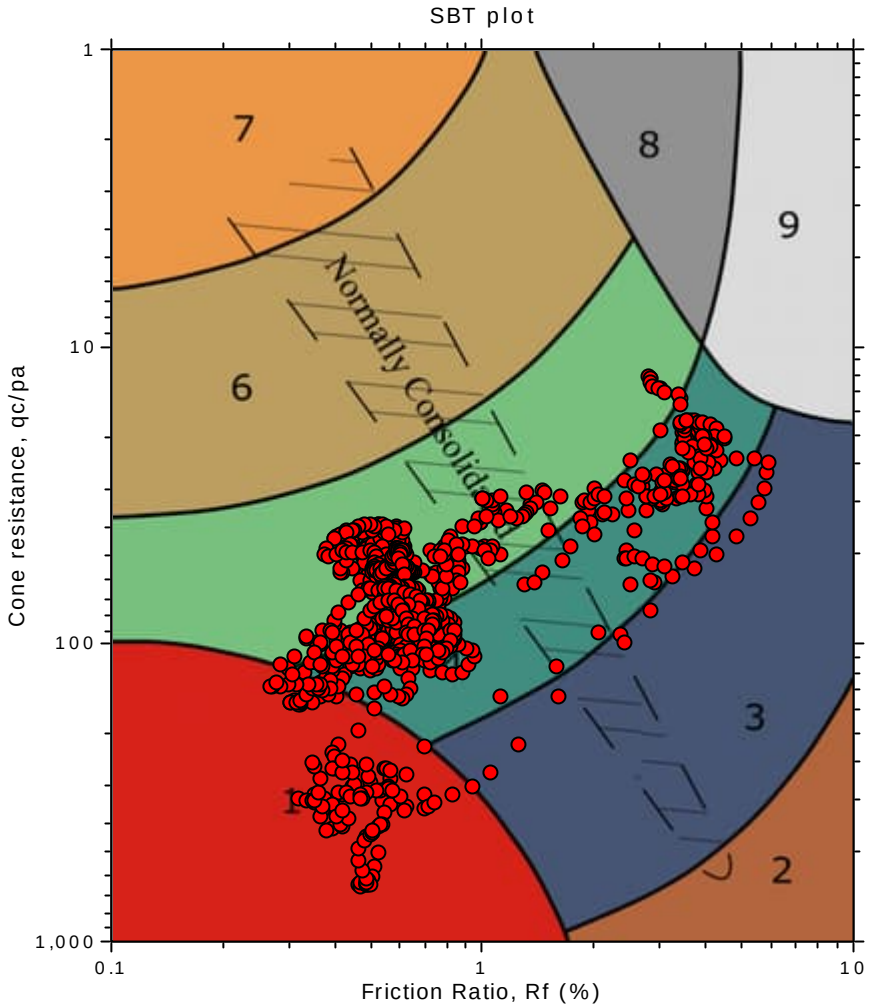
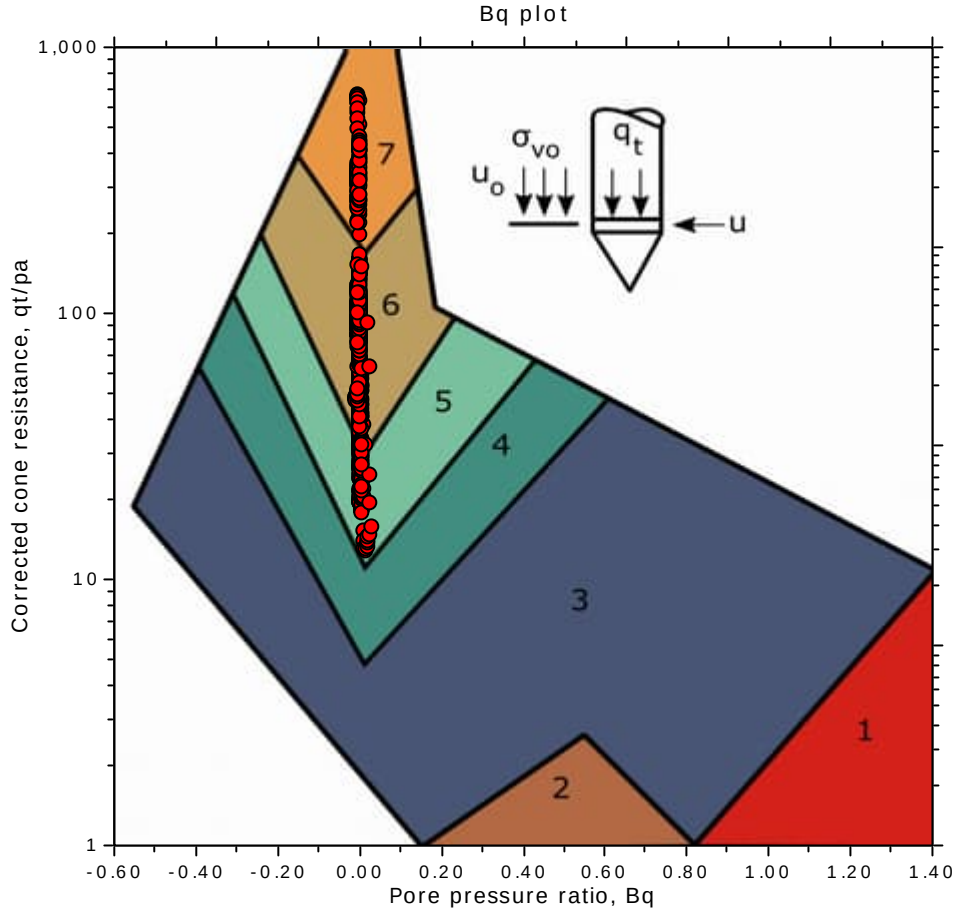


The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



SBT - Bq plots





SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravelly sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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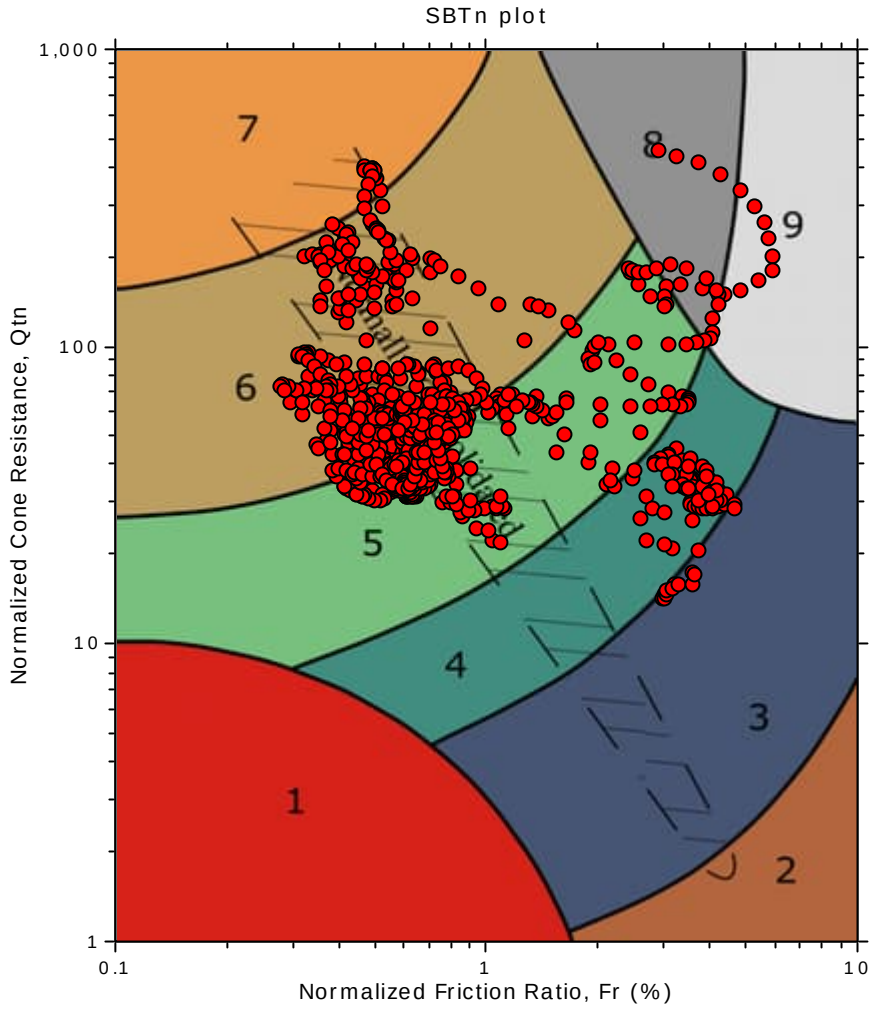
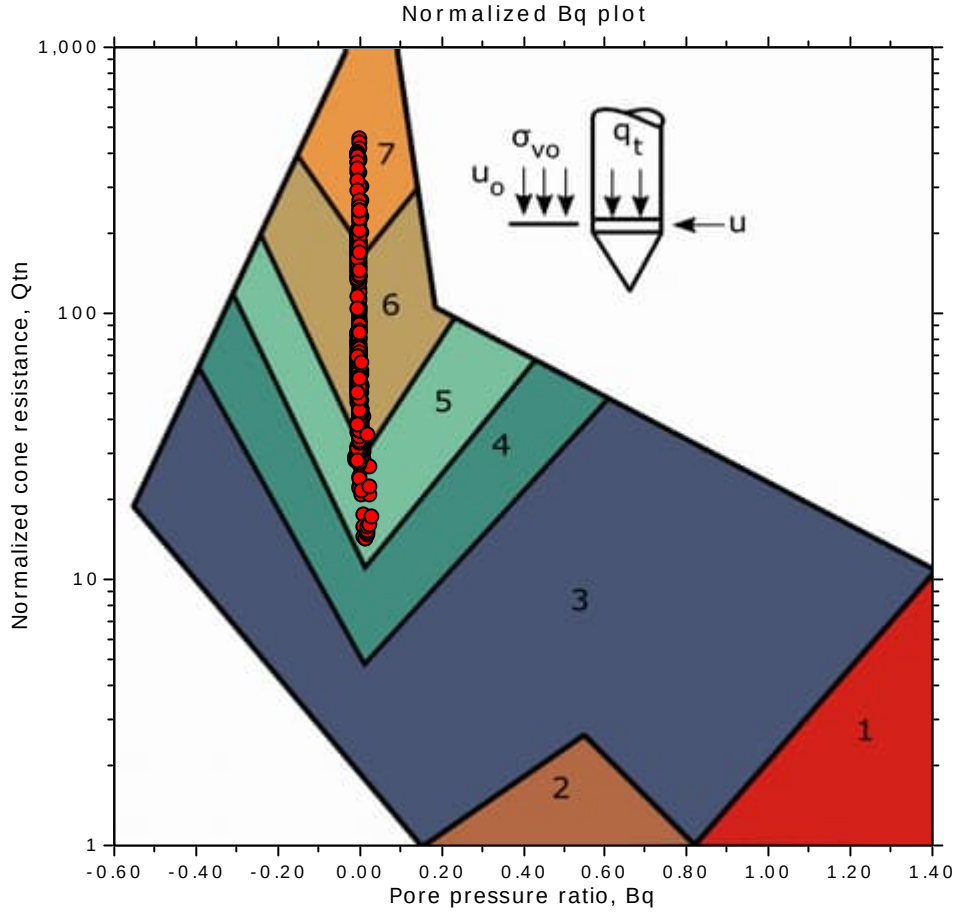
SBT - Bq plots (normalized)





SBTn legend

- 1. Sensitive fine grained
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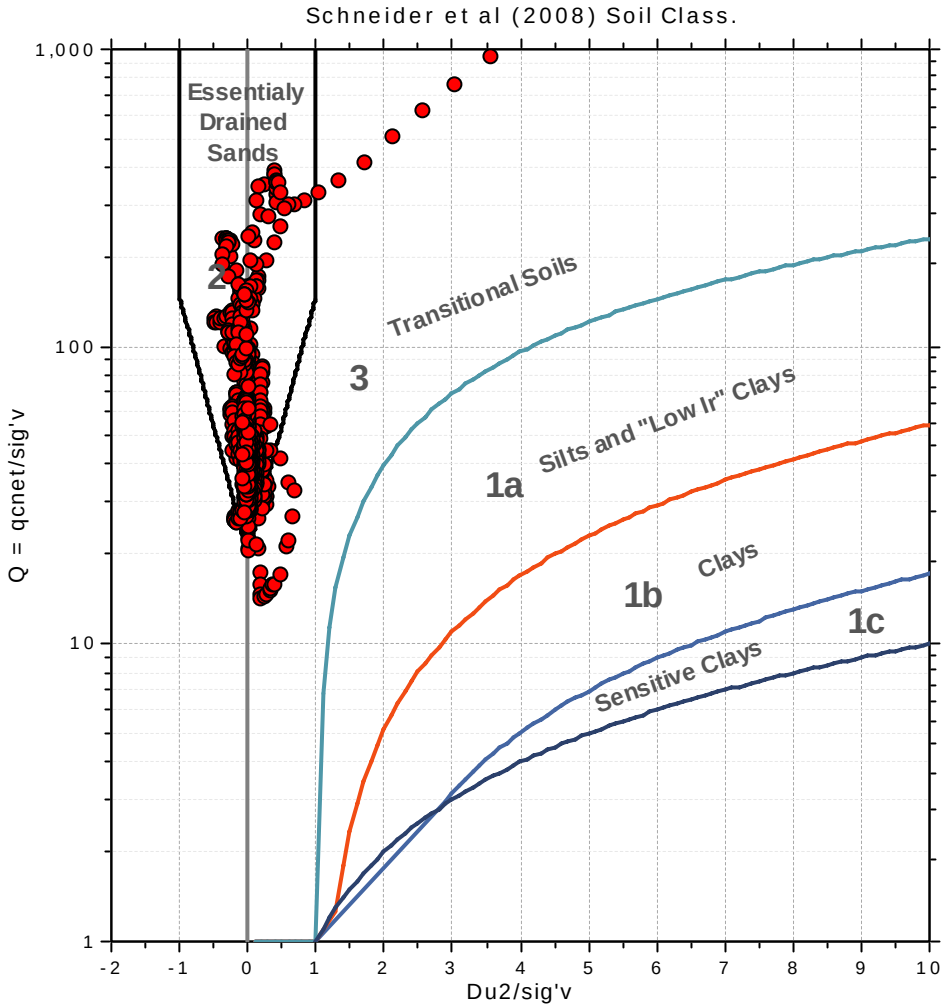
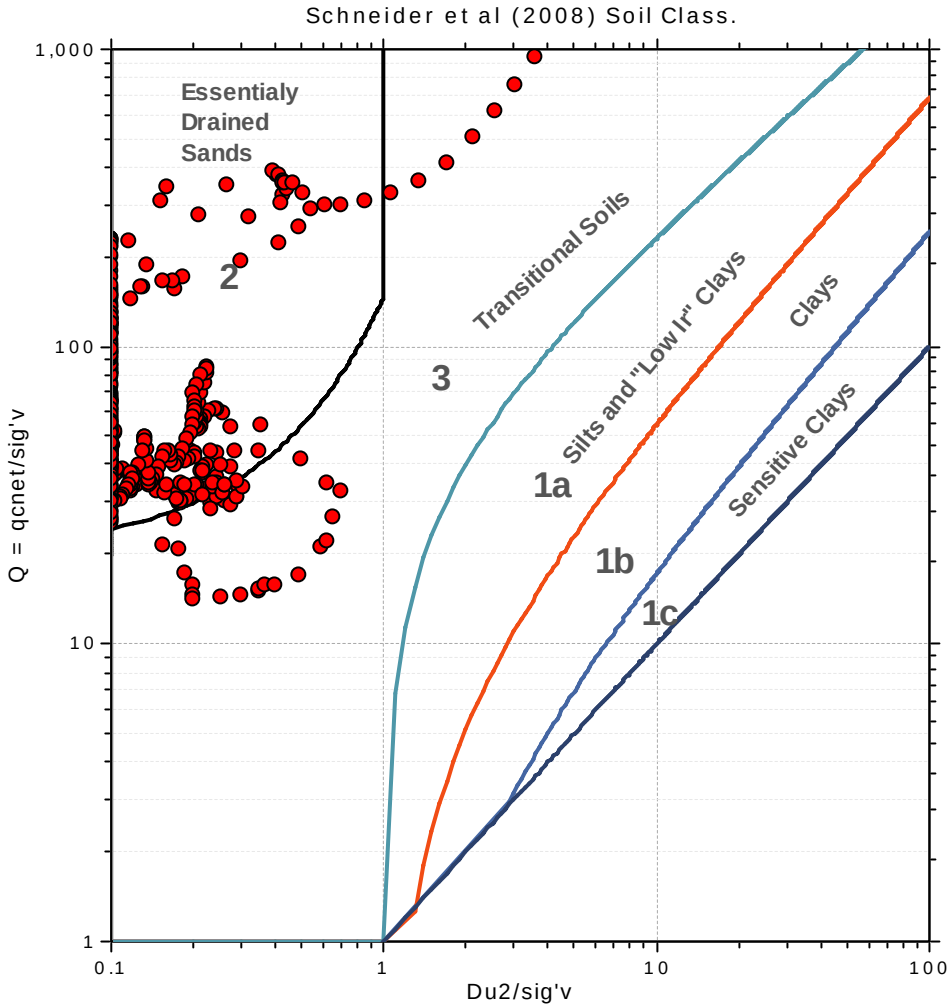
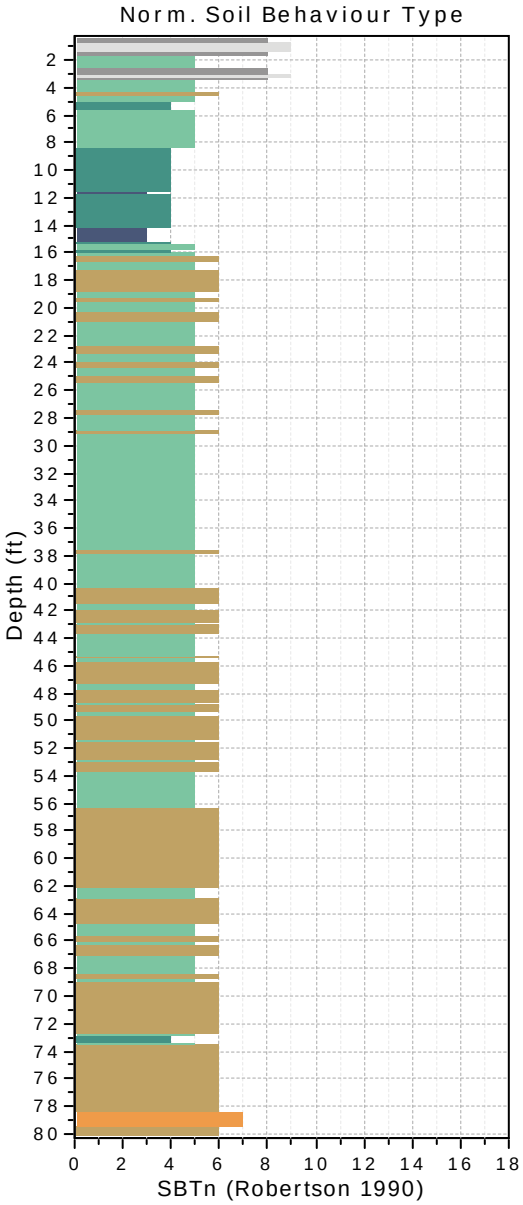
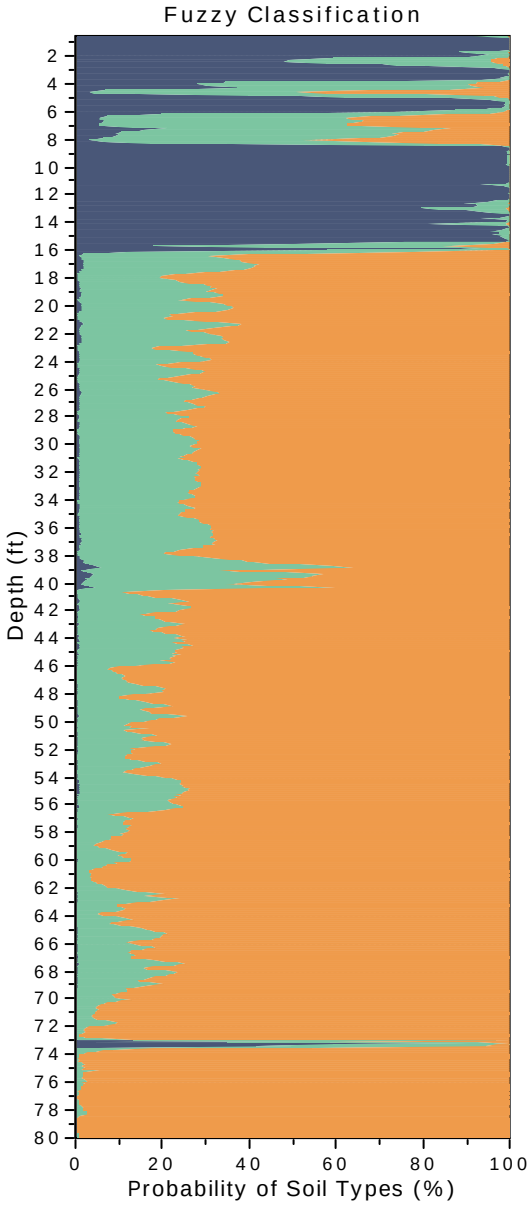
Bq plots (Schneider)






Norm. Soil Behaviour Type
Depth (ft)
SBTn (Robertson 1990)


Fuzzy Classification
Depth (ft)
Probability of Soil Types (%)

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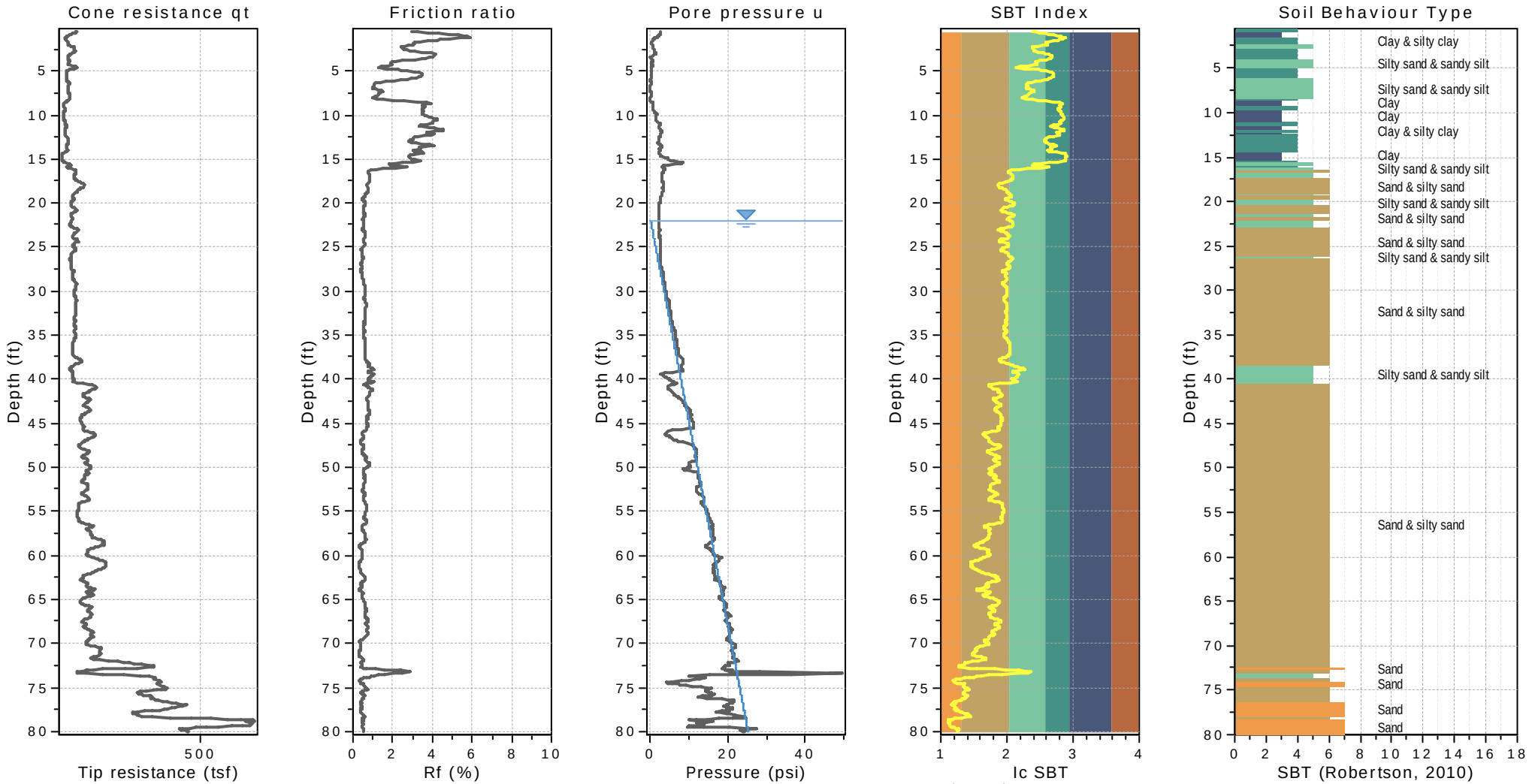

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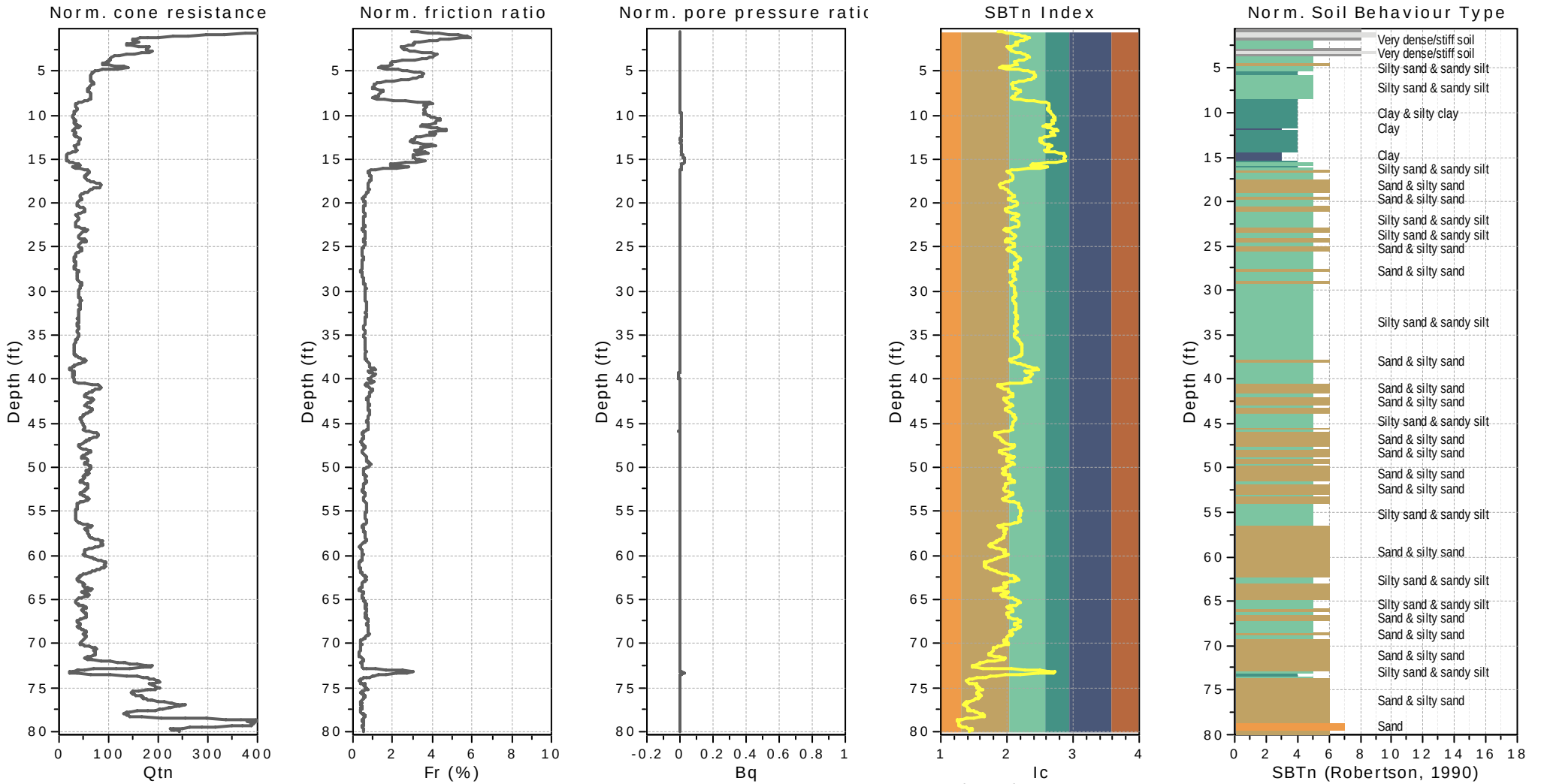

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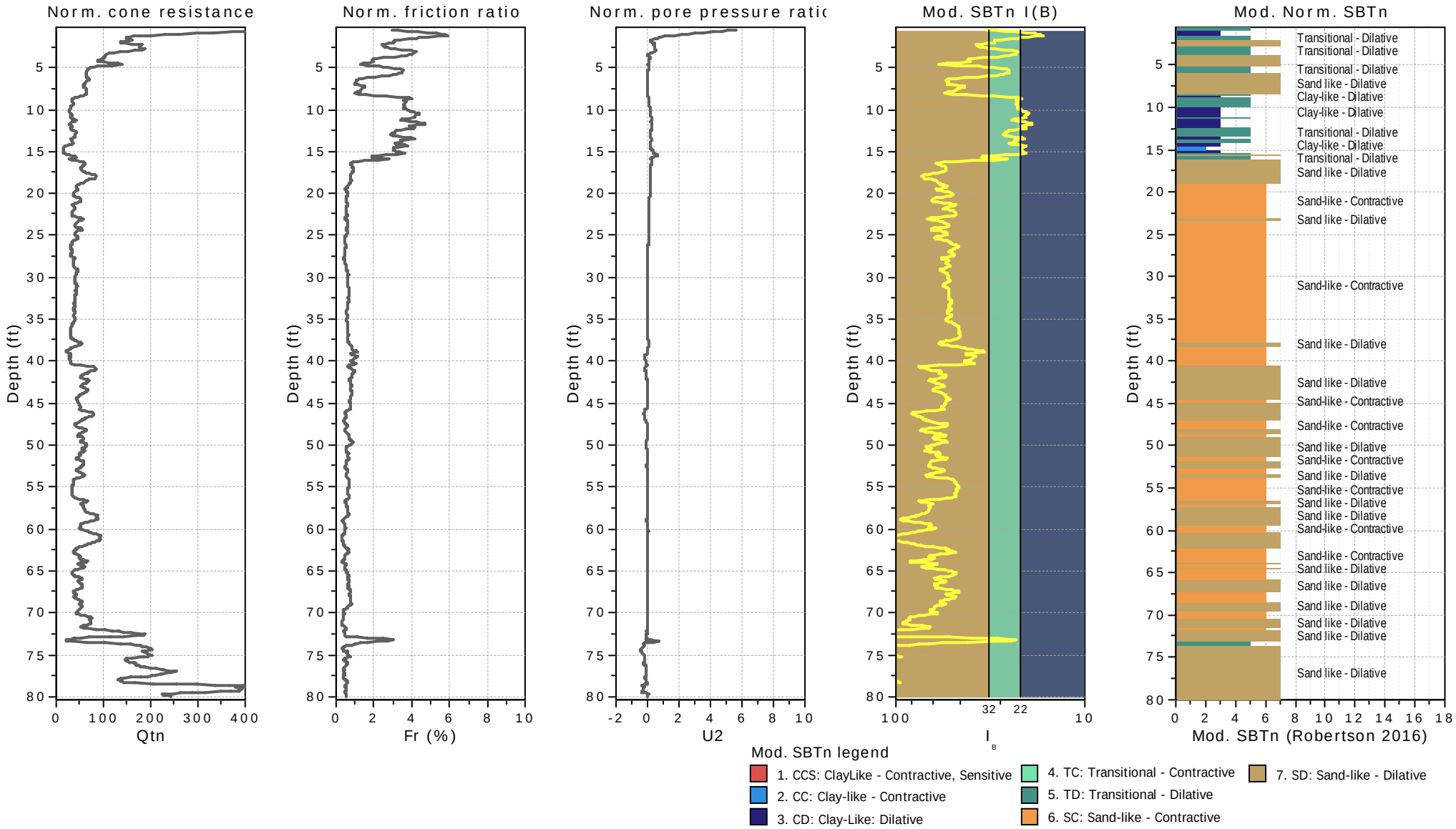
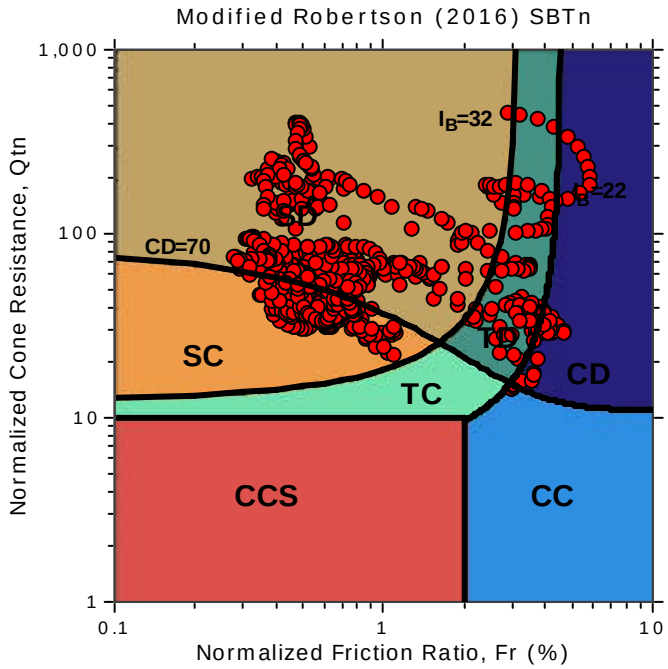
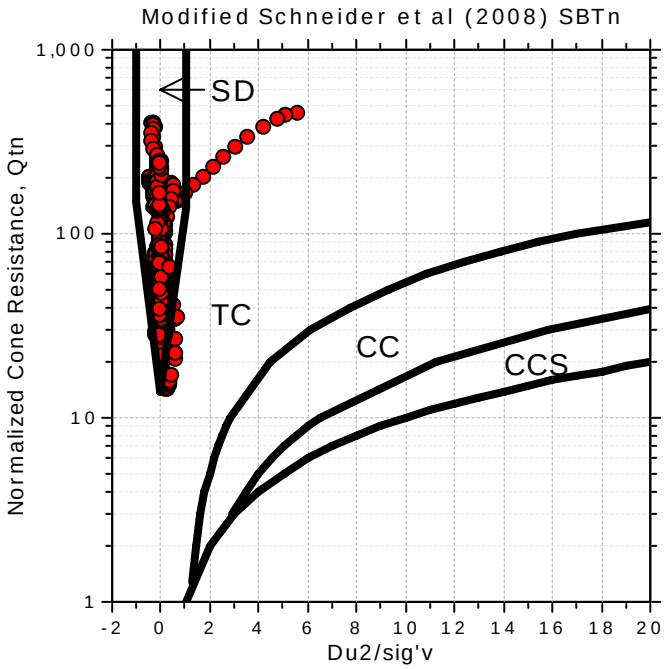
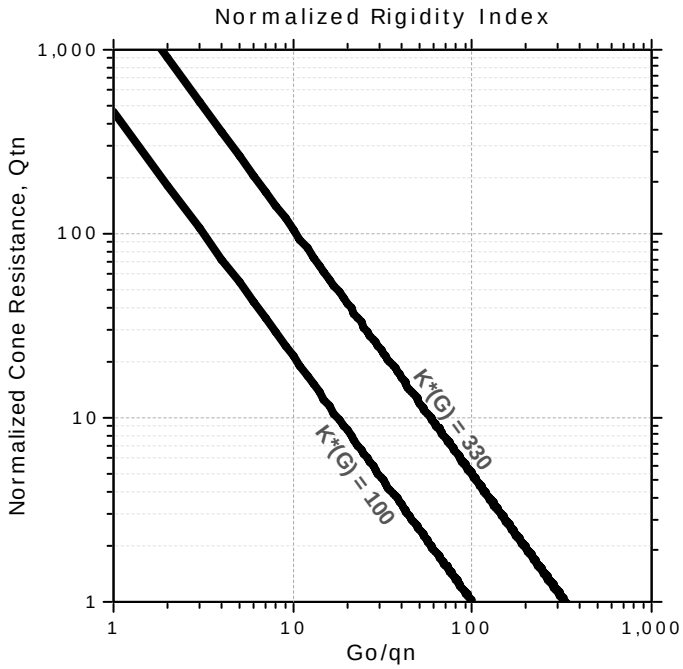


Updated SBTn plots







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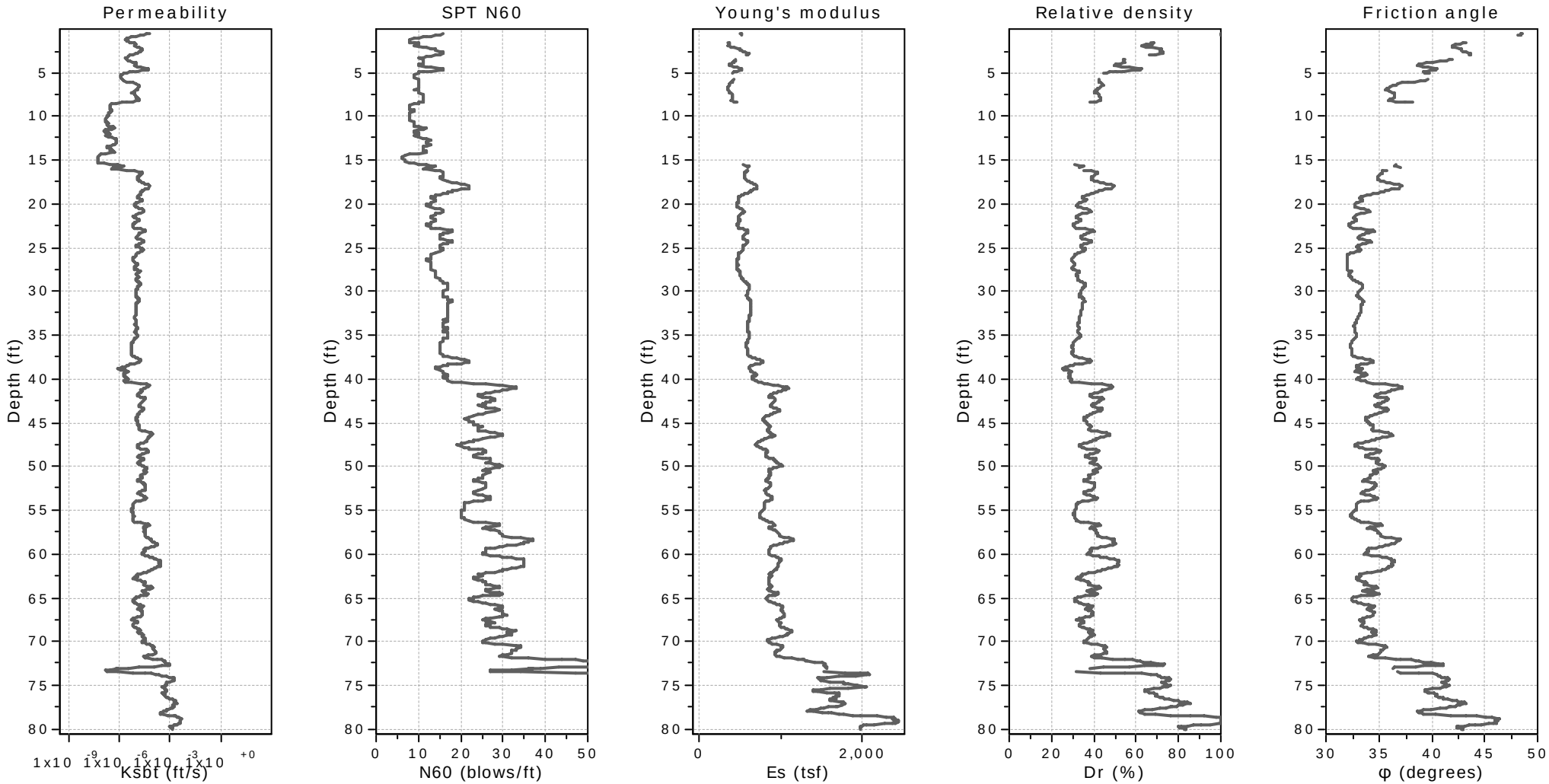

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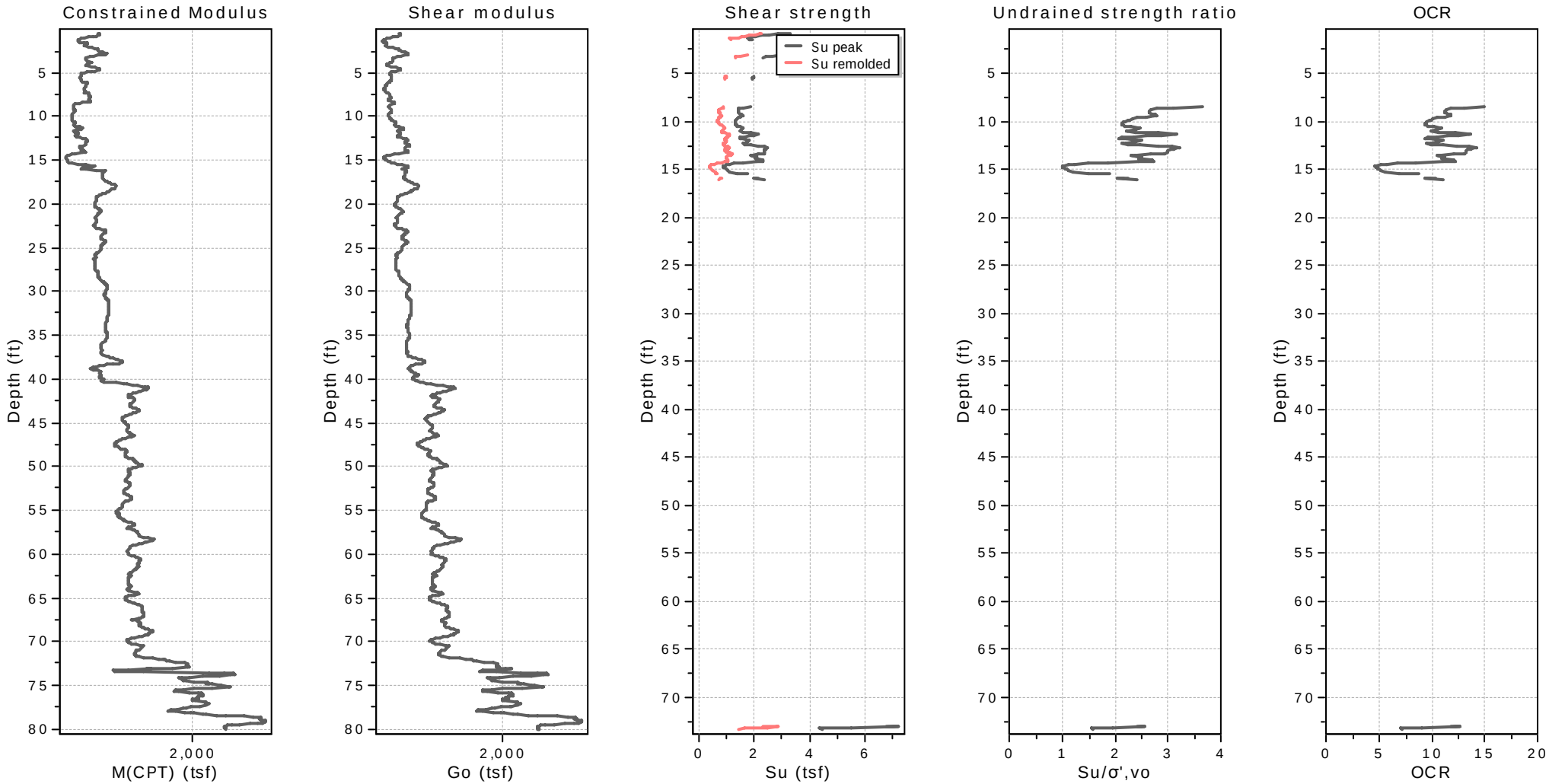

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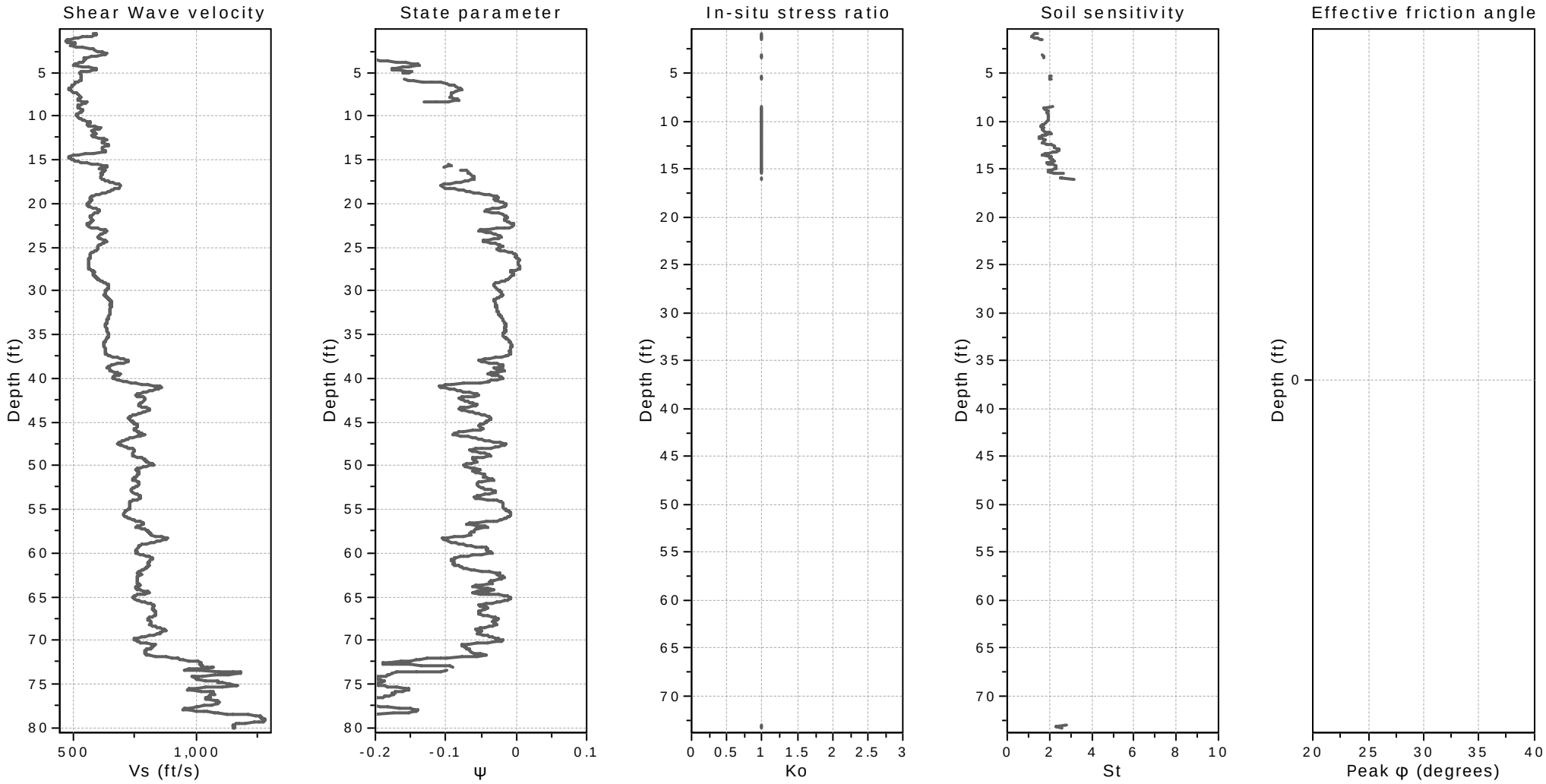

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:: In situ Stress Ratio, Ko ::

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$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, **φ'** (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

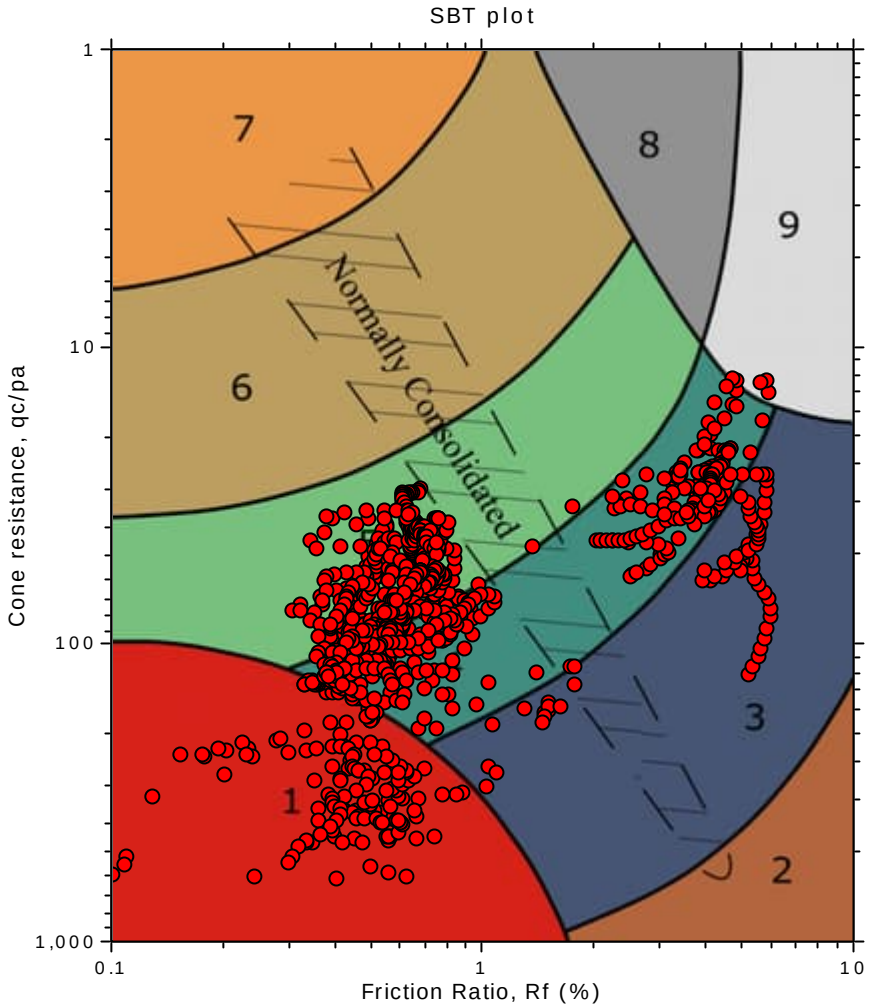
CPT Raw Data provided by Kleinfelder

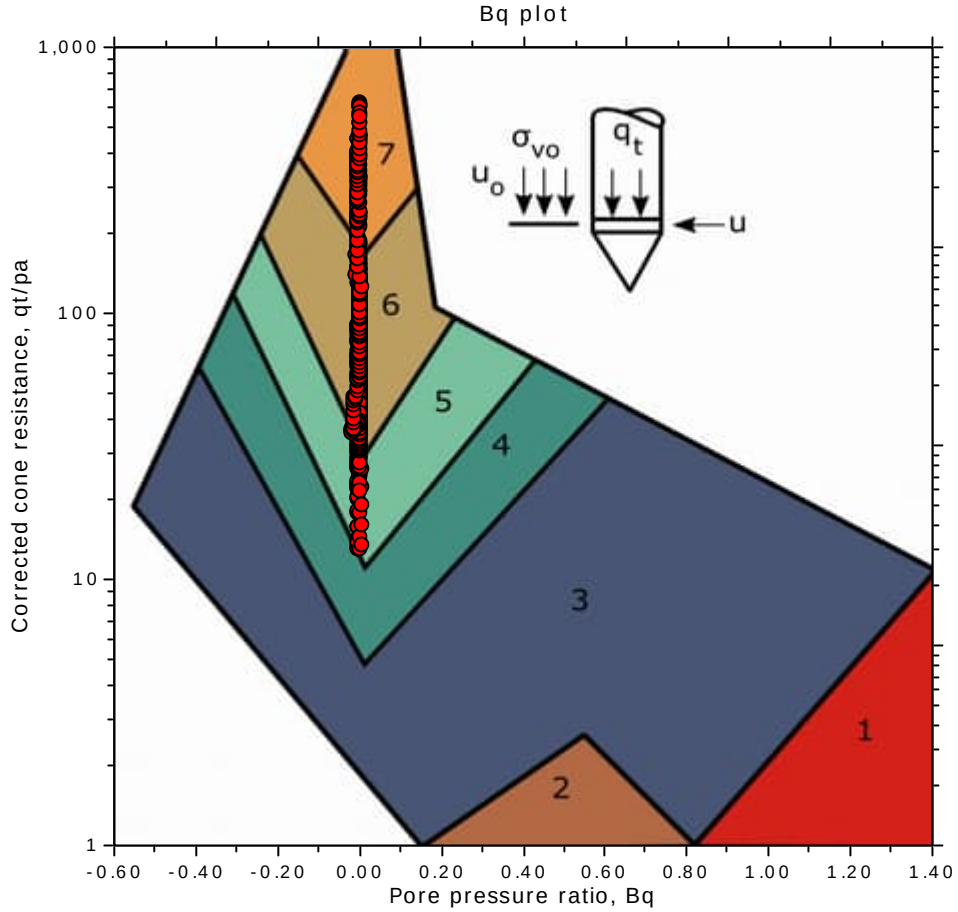
Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA

SBT - Bq plots





SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravelly sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

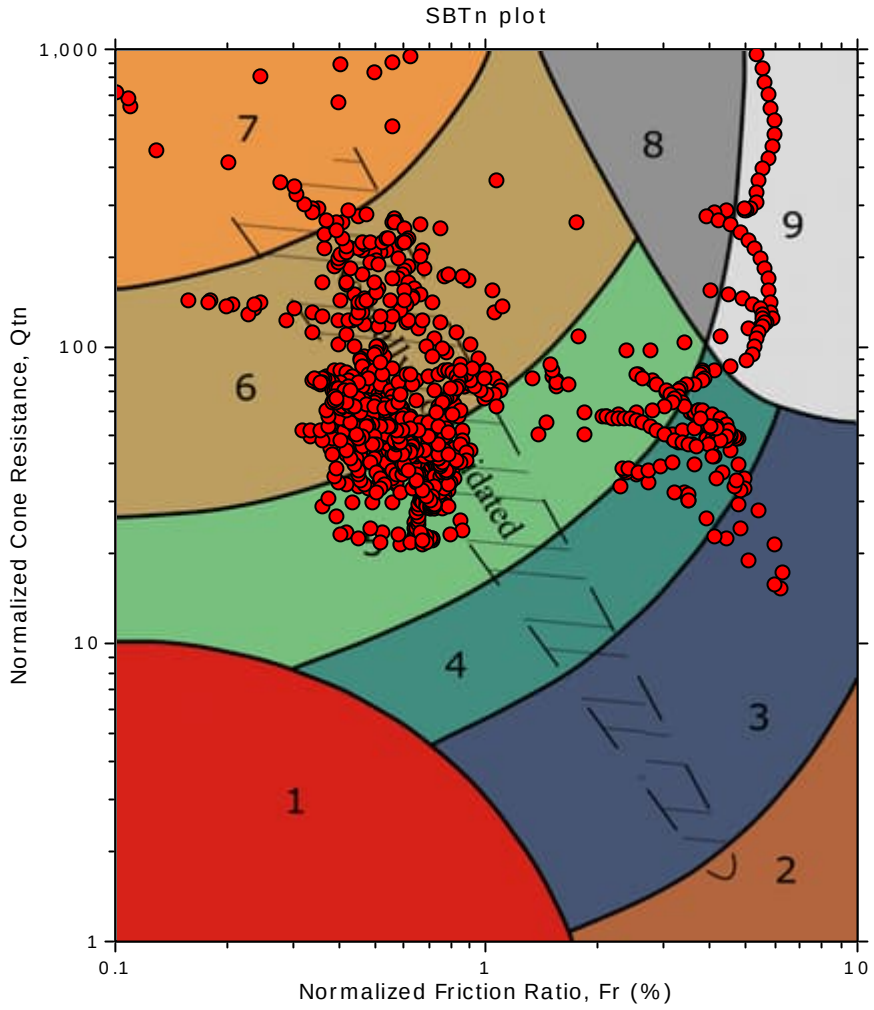
CPT Raw Data provided by Kleinfelder

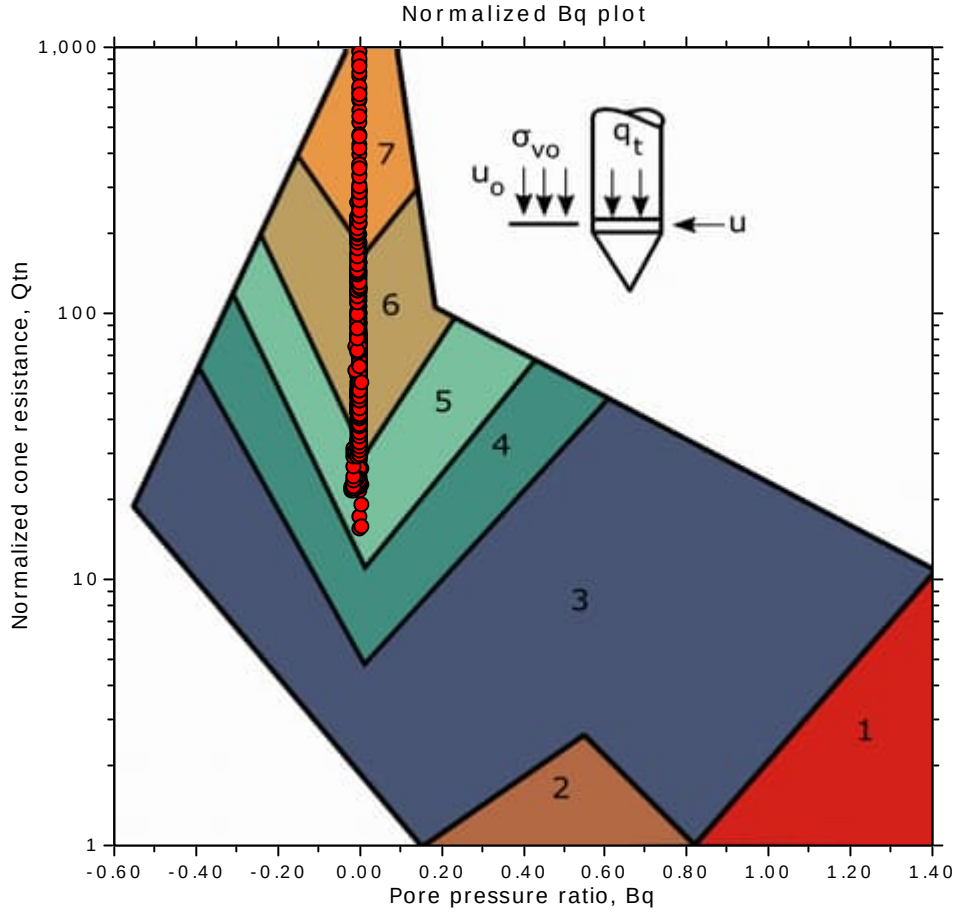
Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA

SBT - Bq plots (normalized)

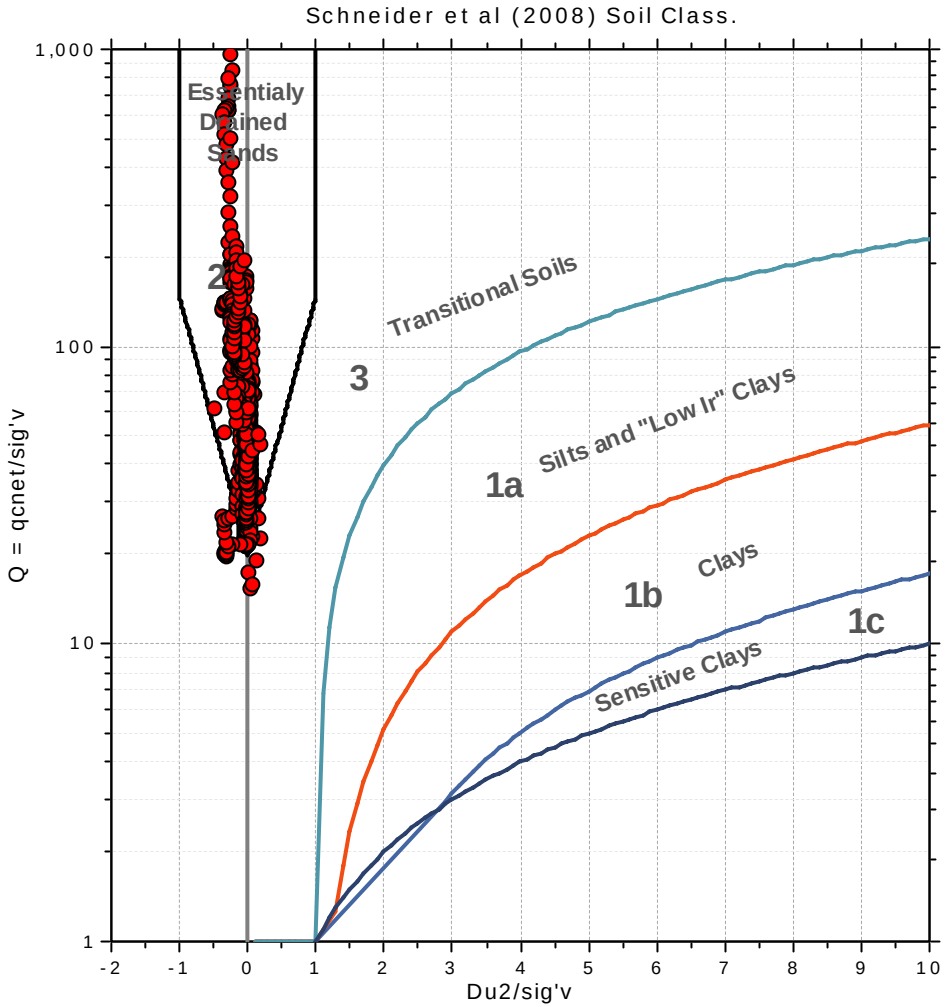


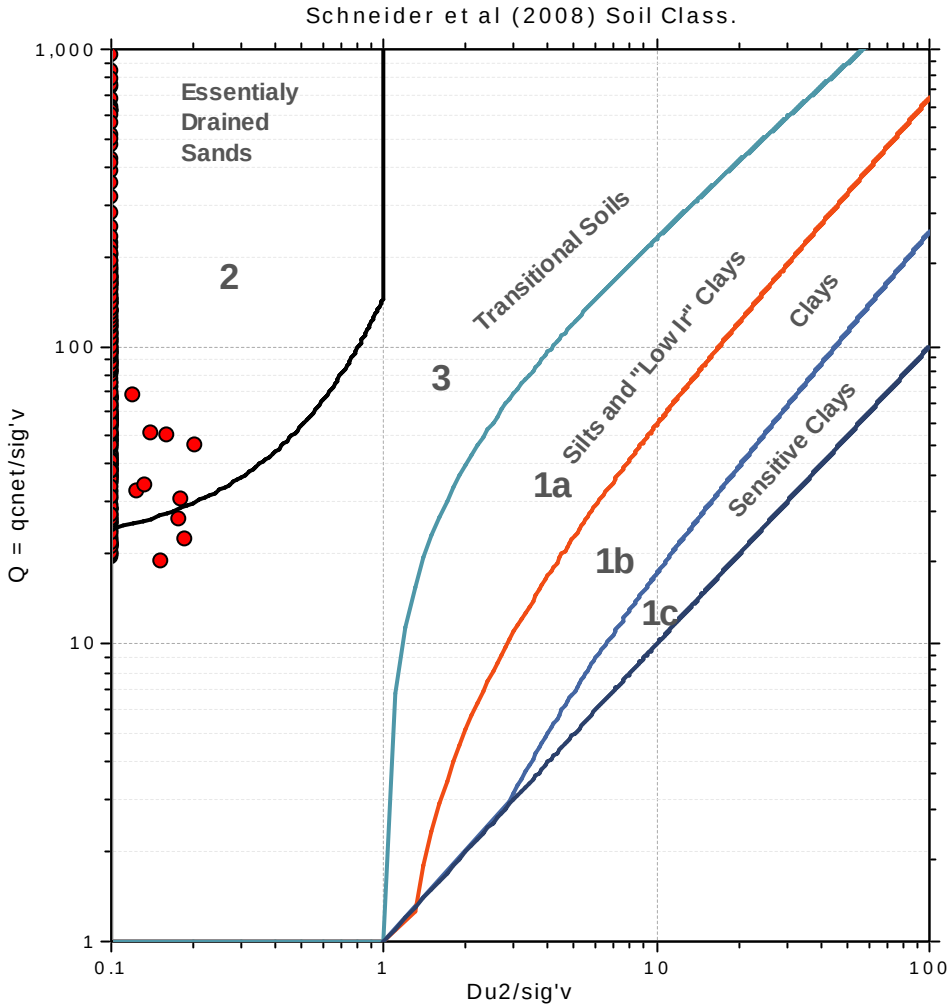


SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Bq plots (Schneider)



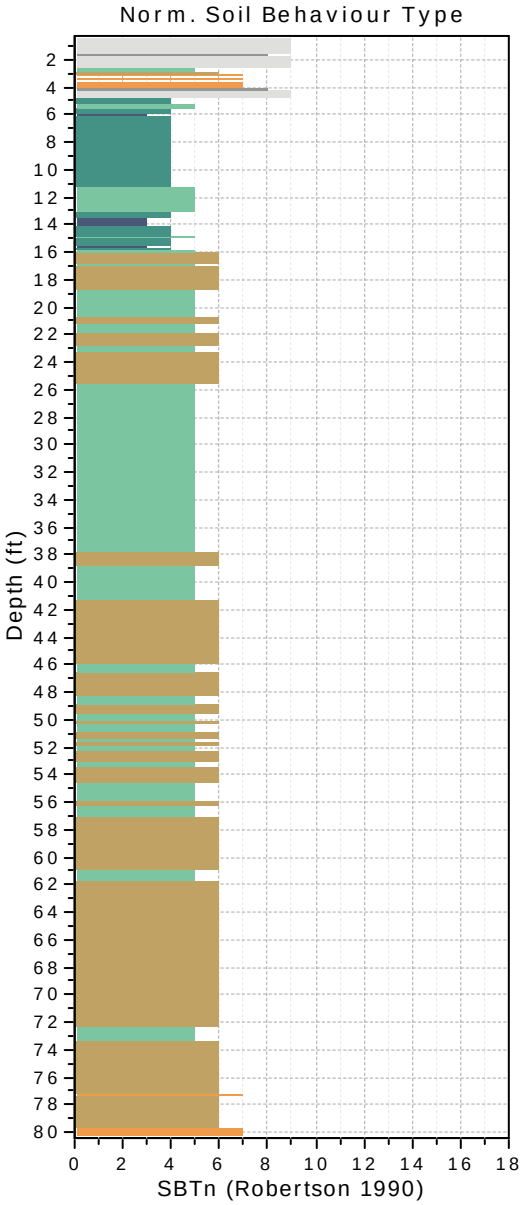


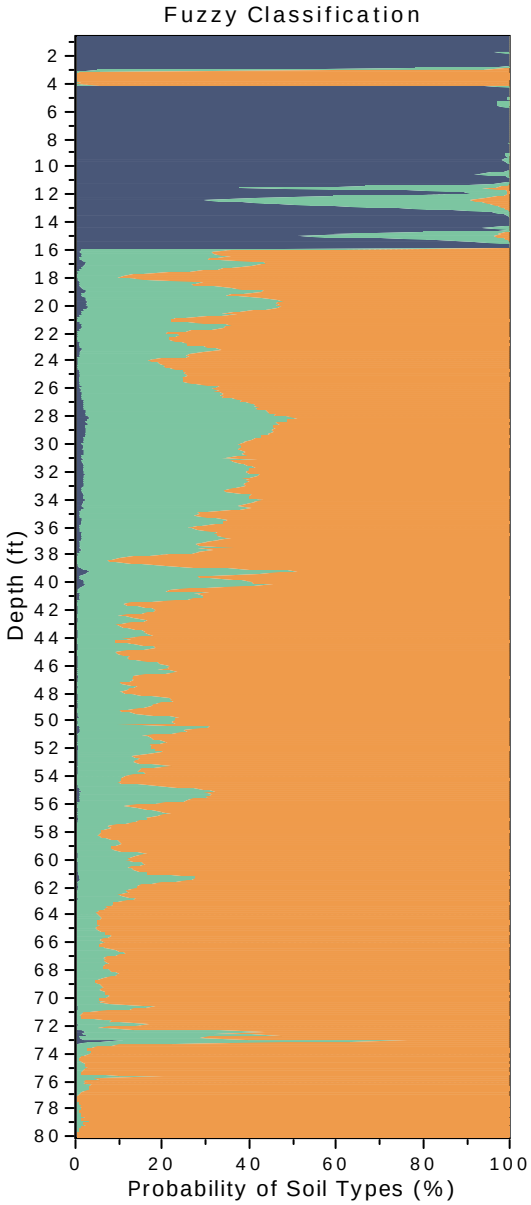
CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



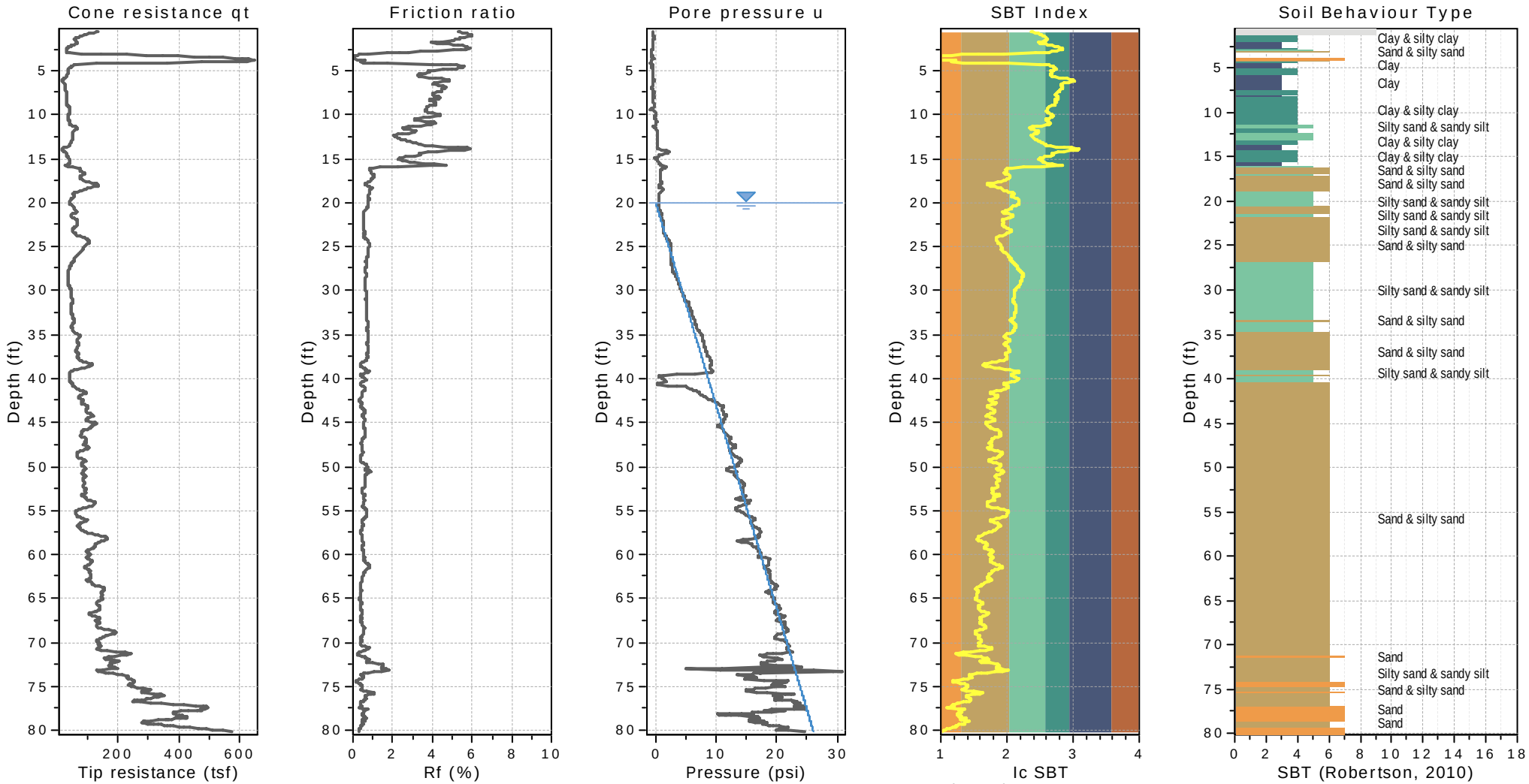


CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



SBT legend

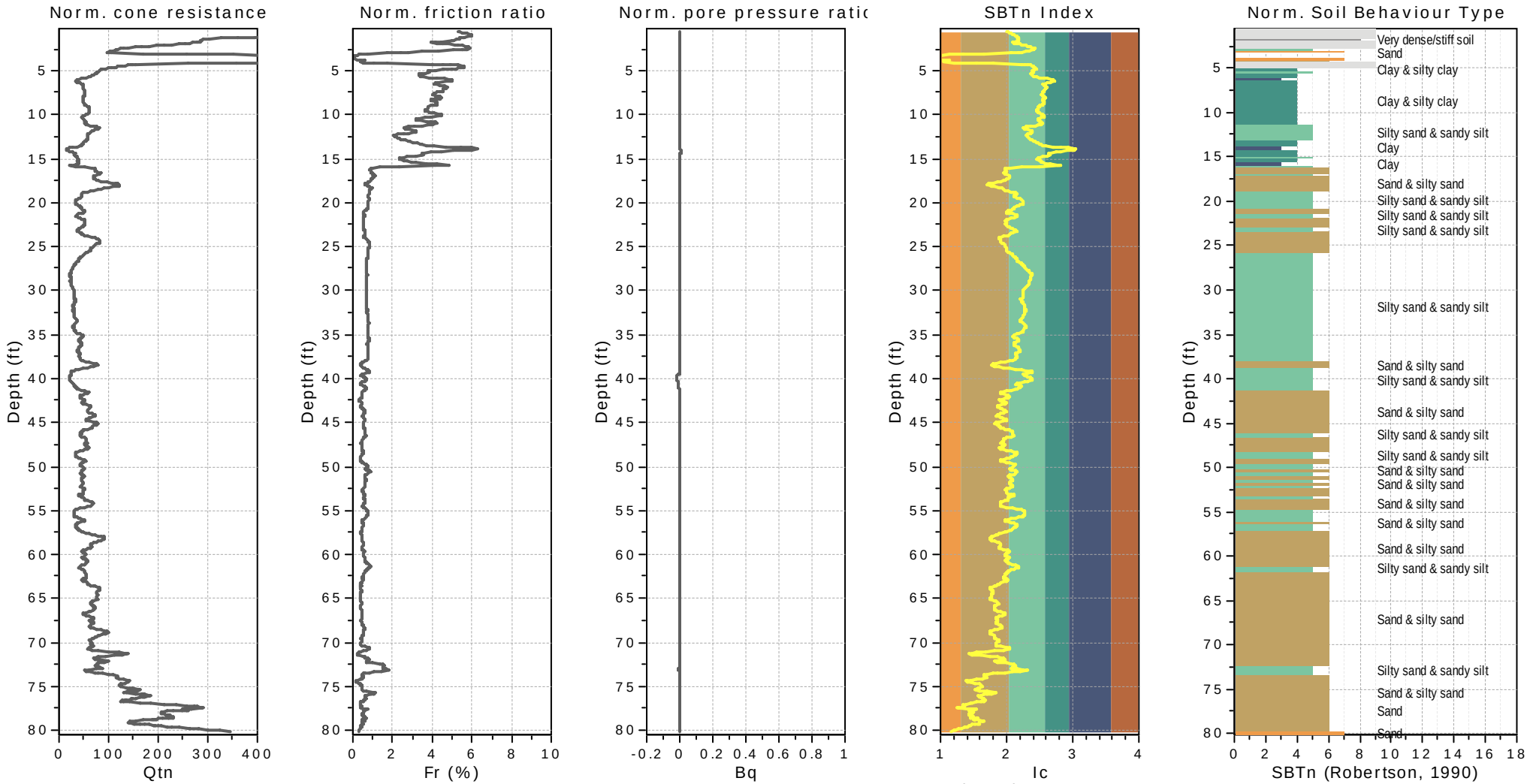
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



SBTn legend

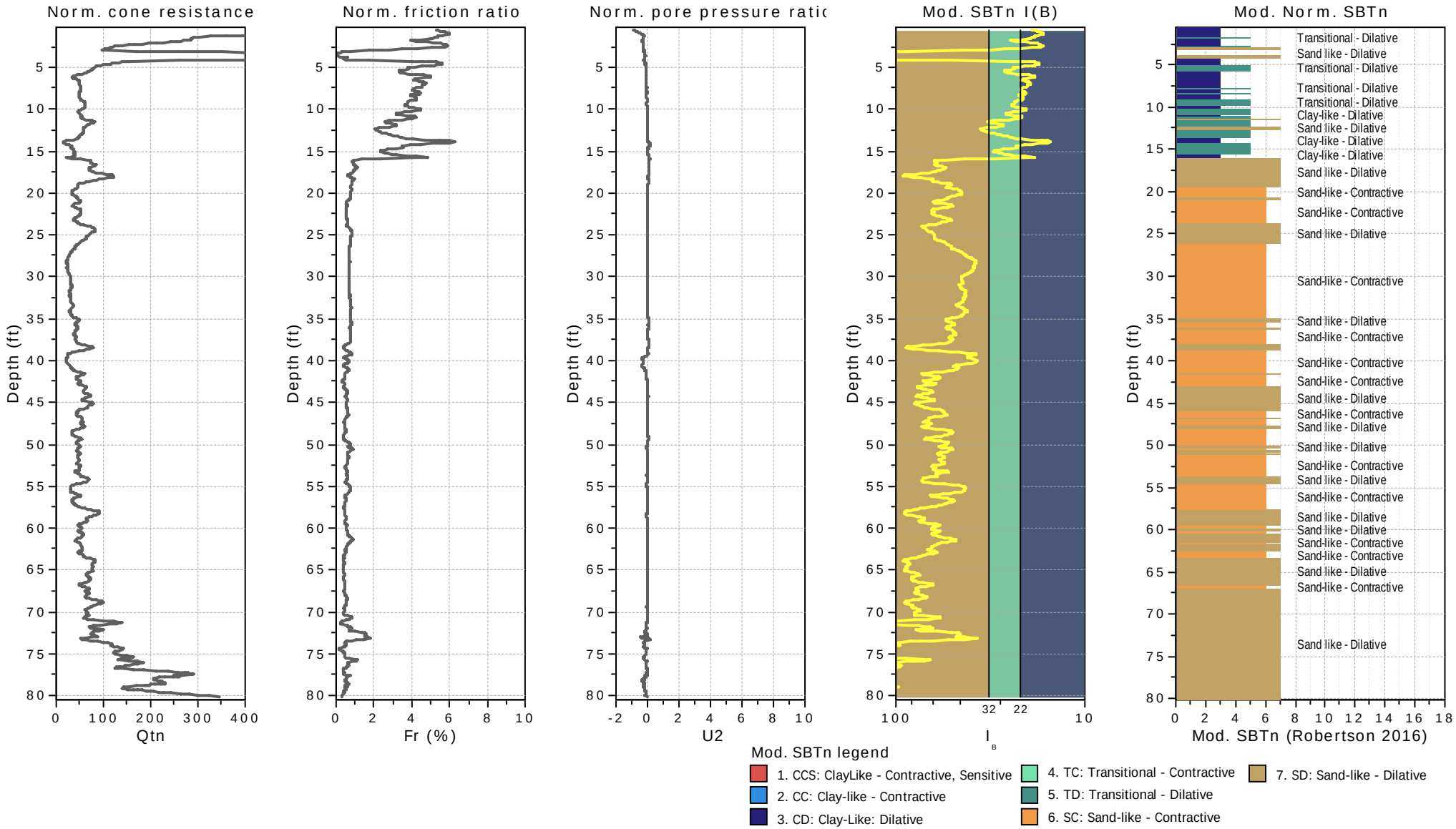
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

CPT Raw Data provided by Kleinfelder

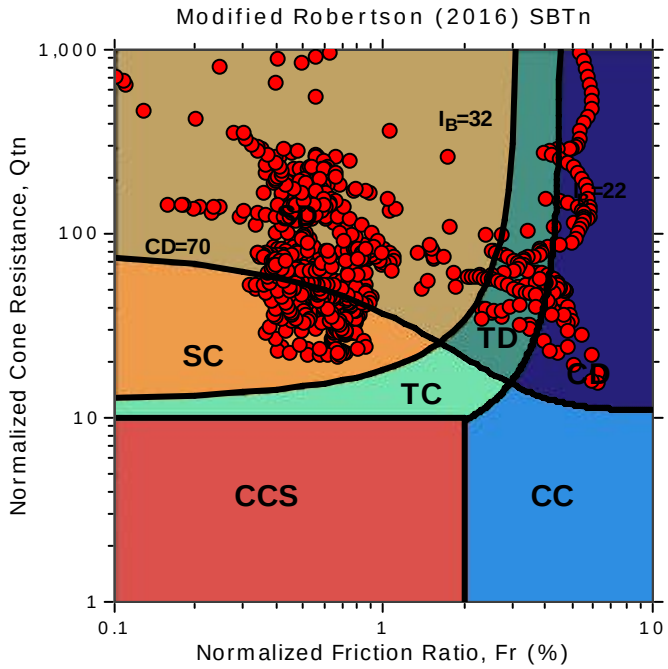
Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

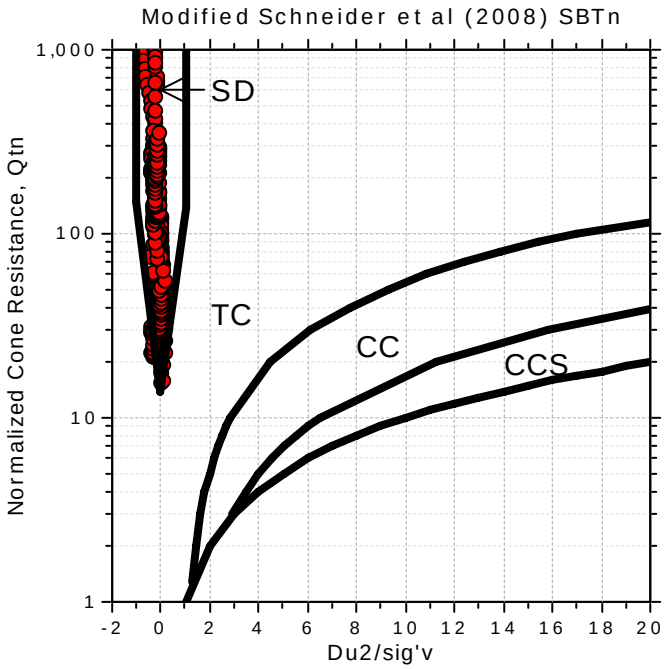
CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

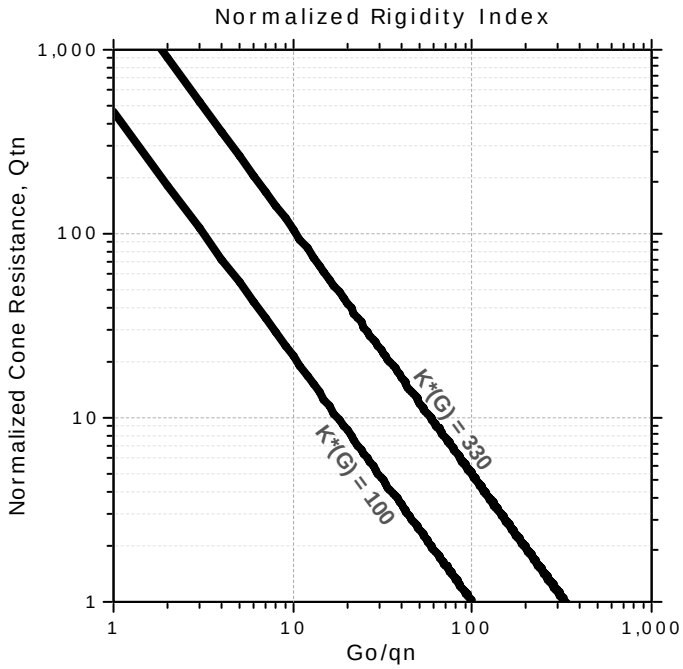
Project: Elkhorn Pumping Plant
Location: Sacramento, CA



Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

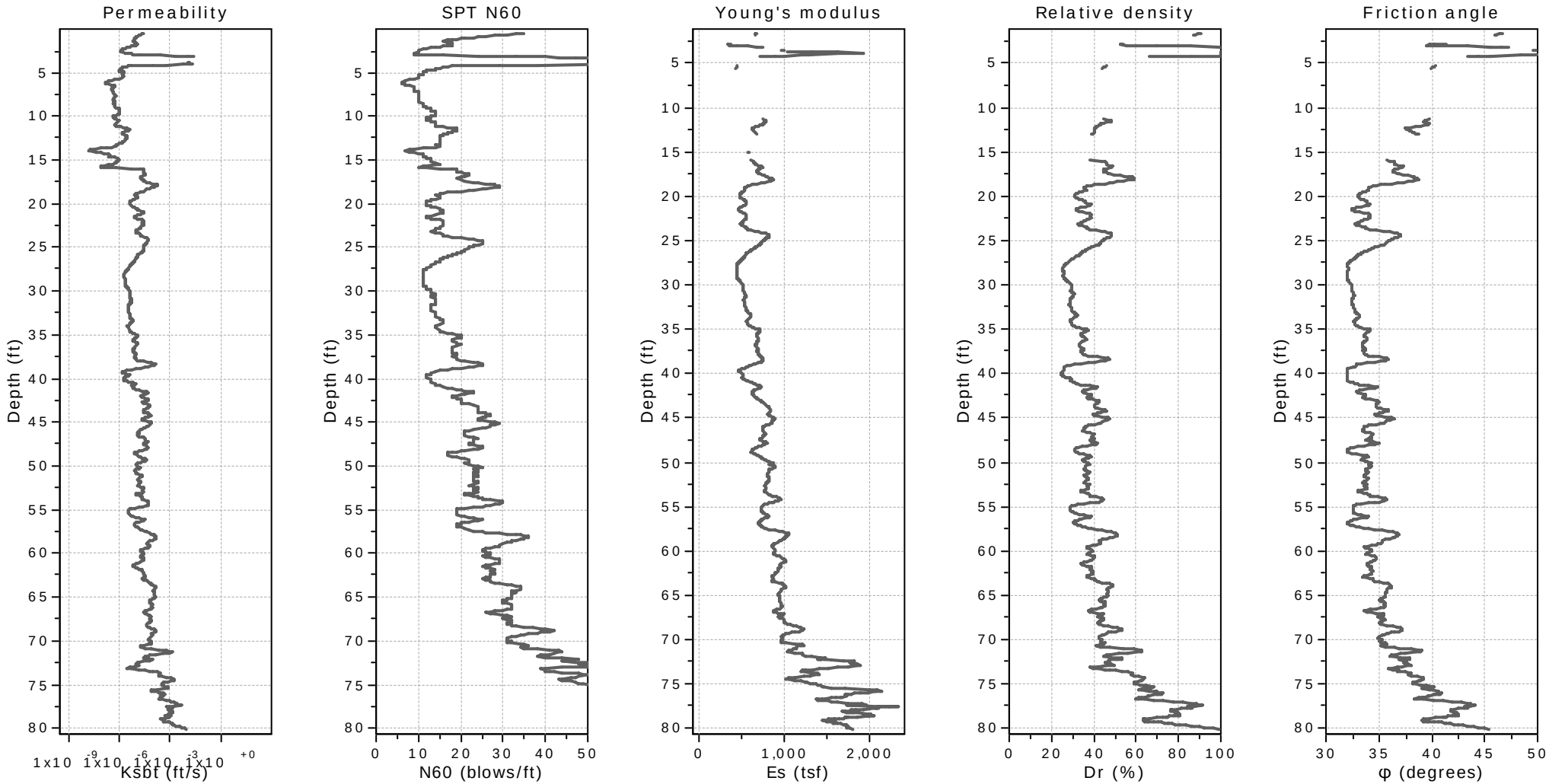
K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



Calculation parameters

Permeability: Based on SBT_n

SPT N_{60}: Based on I_c and q_t

Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative density constant, C_{Dr}: 350.0

Phi: Based on Kulhawy & Mayne (1990)

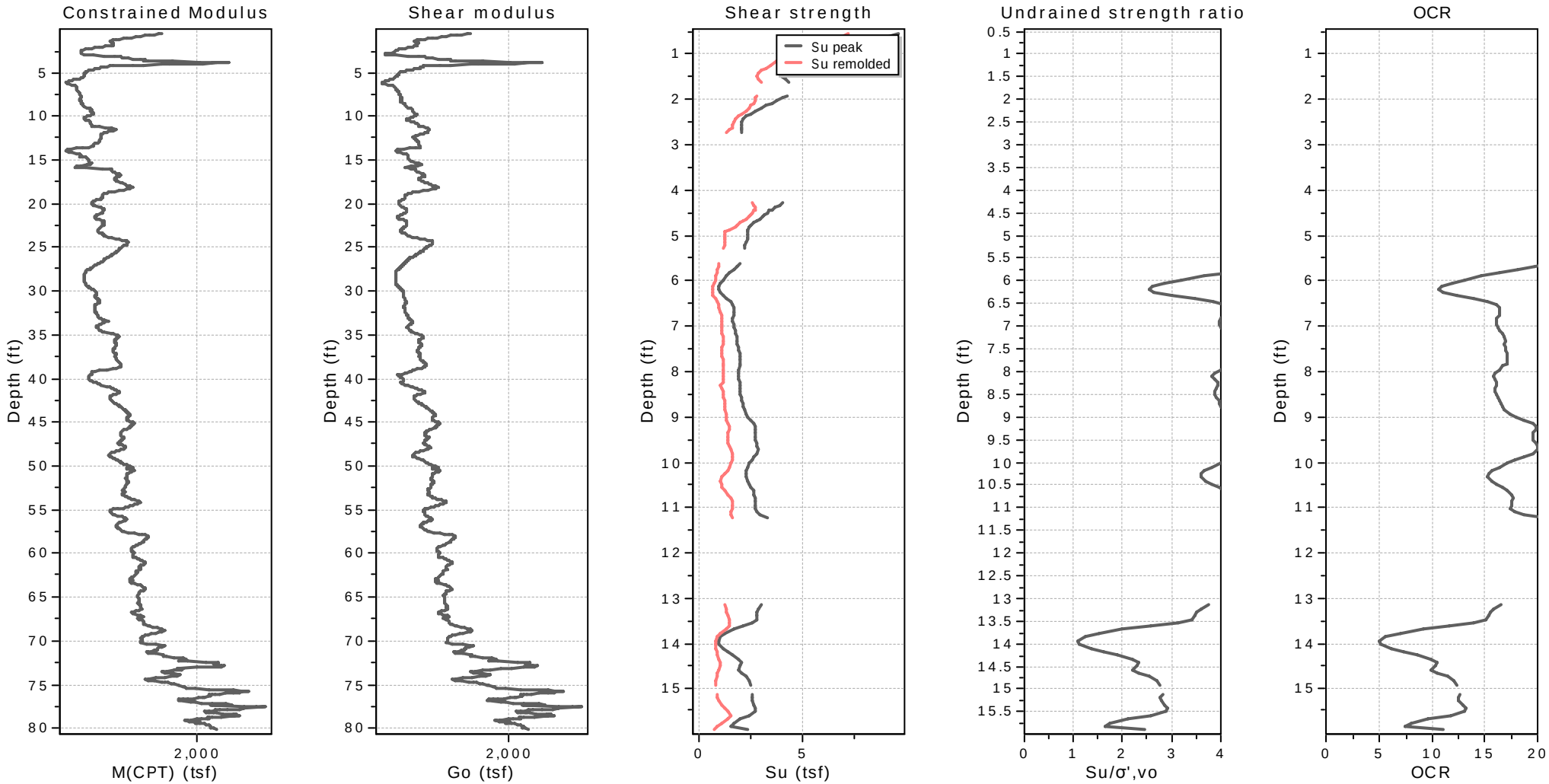
User defined estimation data

CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

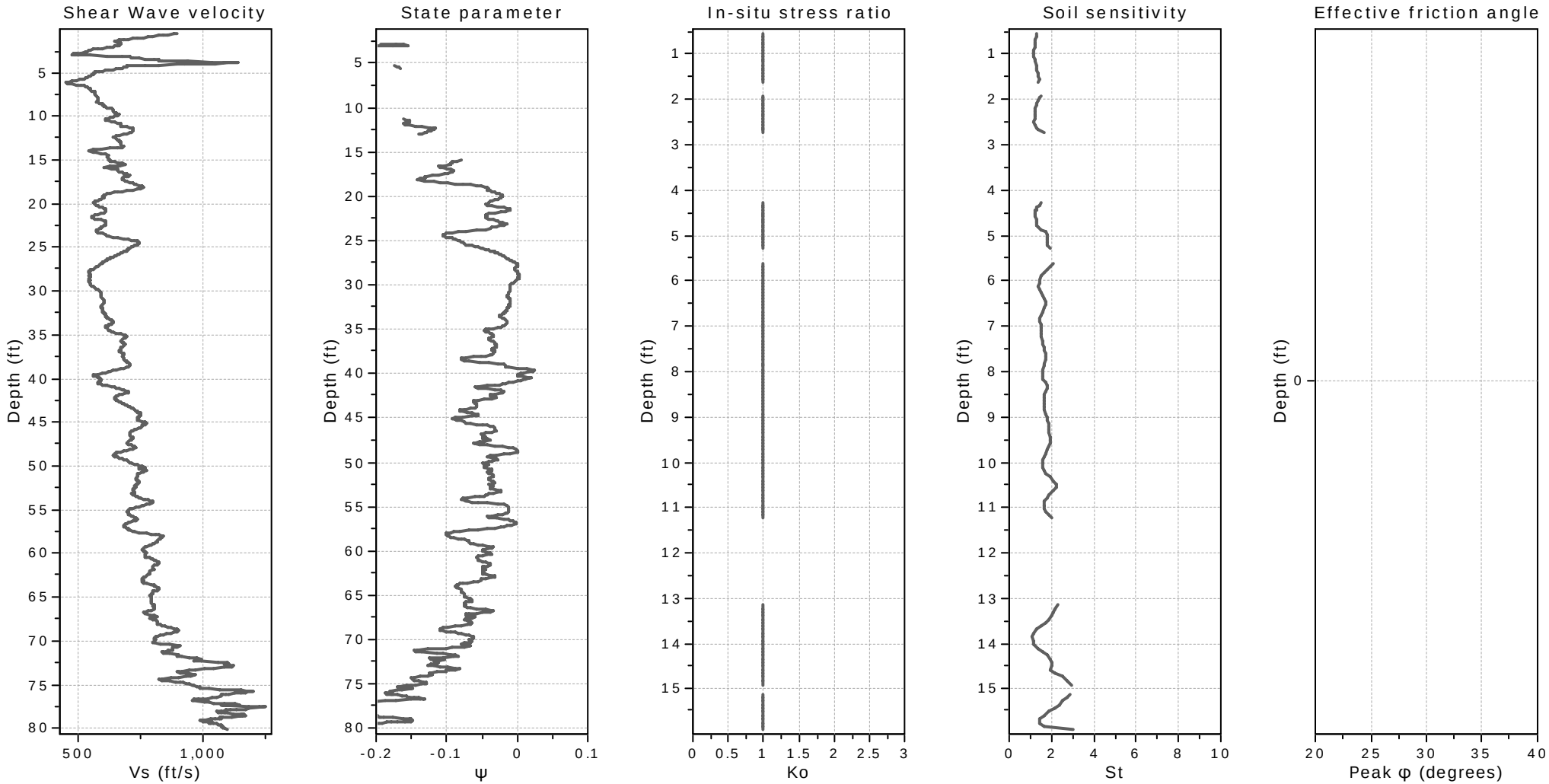
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

CPT Raw Data provided by Kleinfelder

Data Processed with CPeT-IT by Jacobs
2485 Natomas Park Drive
Sacramento, CA 95833

CPT: CPT-09-98
Total depth: 80.11 ft, Date: 3/8/2023
Surface Elevation: 32.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: Elkhorn Pumping Plant
Location: Sacramento, CA



Calculation parameters

Soil Sensitivity factor, N_S: 7.00

User defined estimation data

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236\right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952-3.04 \cdot I_c}$

$I_c \leq 4.00$ and $I_c > 3.27$ then $k = 10^{-4.52-1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, **ψ** ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Drained Friction Angle, **φ** (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \cdot \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$
$\alpha = 14$ for $Q_{tn} > 14$
$\alpha = Q_{tn}$ for $Q_{tn} \leq 14$
$M_{CPT} = \alpha \cdot (q_t - \sigma_v)$

If $I_c \geq 2.20$

$$M_{CPT} = 0.03 \cdot (q_t - \sigma_v) \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))}\right]^{1.25}$$ or user defined

$OCR = k_{OCR} \cdot Q_{tn}$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, **φ'** (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

Surface Conditions: Gravel shoulder

Groundwater: Groundwater encountered at a depth of about 11 feet feet below existing site grade.

Method: Mud Rotary/Auger

Equipment: CME 75 with 140lb. Automatic Hammer

Date Completed: 12/30/2003

Logged By: B. Money

Total Depth: 81-1/2 feet

Boring Diameter: 6 inch inch

Approximate Elevation: 40.5 feet
Approximate Northing: 38.71 feet
Approximate Easting: -121.62 feet

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
														Sandy GRAVEL (GM): Olive-brown to gray-brown, moist, loose, fine to coarse sand, gravel to 1 inch diameter (Fill)
36	5		no recovery	13										
31	10		1b 1a	15										**Poorly Graded SAND** (SP): Olive to olive-brown, moist to wet, loose to medium dense, fine grained sand
26	15		2b 2a	9		99	3				1	Organic Content = 0.2%		trace fine gravel wet
21	20		3b 3a	16		95	6			94	2	Sieve; see Plate F-3		increasing medium to coarse sand (switched to mud rotary drilling method)
16	25		4b 4a	10		84	35							**Poorly Graded SAND with silt** (SP-SM): Olive-brown, wet, loose, fine grained sand, with mica decreasing fines
11	30		5b 5a	17						100	9	Sieve; see Plate F-3		medium dense

KLEINFELDER

Drafted By: D. Ross
Date: 11/21/2008
Project No.: 21879-1.2
File Number: 21879logs

LOG OF BORING E-03-1
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 3
D-3

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
														gray
6	35		6b 6a	24		100	30			100	5	Sieve; see Plate F-3		
1	40		7b 7a	19										
-5	45		8b 8a	23		90	28			100	5	Sieve; see Plate F-3		
-10	50		9b 9a	19								Direct Shear; C=792 psf Ø=32° see Plate F-7		
-15	55		10b 10a	50										dense
-20	60		11b 11a	31		91	27							medium dense
-25	65		12b 12a	12				NP	NP		43	Atterberg; see Plate F-2		**Silty SAND** (SM): Gray, wet, loose, fine grained sand, non plastic
														Poorly Graded SAND with silt (SP-SM): Gray,

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

Drafted By: D. Ross
Date: 11/21/2008
Project No.: 21879-1.2
File Number: 21879logs

LOG OF BORING E-03-1
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
2 of 3
D-3

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
		FIELD				LABORATORY								
-30	70													wet, medium dense, fine to coarse grained sand, with trace fine gravel
			13b 13a	31		111	18							
														thin coarse sand/fine gravel layer
-35	75													
			14b 14a	27						100	6	Sieve; see Plate F-3		
														increasing coarse sand
-40	80													
			15b 15a	32		107	22							
														Boring completed at a depth of 81-1/2 feet below existing site grade.
-45	85													
-50	90													
-55	95													
-60	100													
-65	105													

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

Drafted By: D. Ross
Date: 11/21/2008
Project No.: 21879-1.2
File Number: 21879logs

LOG OF BORING E-03-1
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
3 of 3
D-3

Surface Conditions:	Level bank, heavy brush and trees.	Date Completed:	11/14/2003
Groundwater:	Groundwater level estimated at about 23 feet below existing site grade..	Logged By:	S. Belway
		Total Depth:	71-1/2 feet
Method:	Rotary Wash	Boring Diameter:	3-5/8 inch inch
Equipment:	CME 85 with 140lb. Automatic Hammer		

Approximate Elevation: 27.0 feet
Approximate Northing: 38.71 feet
Approximate Easting: -121.62 feet

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
			Bulk 1									Organic Content = 1.5%		**Sandy SILT** (ML): Yellow-brown, moist, soft, fine sand, trace organics and glass debris
			Bag 2	6								Corrosion, See Plate F-19		brown, less sand
22	5		Shelby 3					NP	NP			Atterberg; see Plate F-2 Direct Shear; C=56 psf Ø=38° see Plate F-8		
17	10		Bag 4	4										increase in fine sand
			Shelby 5									Consolidation; see Plate F-5 Specific Gravity = 2.72		brown, soft, non-plastic, mica flakes
12	15		Bag 6	3										
			Shelby 7					NP	NP		58	Atterberg; see Plate F-2 UC=0.34 tsf		gray
7	20		Bag 8	5										brown with red-brown, interbeds of very fine sand, mica flakes
			Shelby 9											**Poorly Graded SAND** (SP): Olive-gray, wet, medium dense, medium grained
2	25		Bag 10	13								Corrosion, See Plate F-20		
-3	30		Bag 11	7										light gray, fine grained

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

Drafted By: D. Anderson
Date: 11/21/2008
Project No.: 21879-1.2
File Number: 21879logs

LOG OF BORING E-03-2
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 3
D-4

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
		FIELD				LABORATORY								
-8	35		Bag 12	10										
-13	40		Bag 13	3										
			Shelby 14					NP	NP	100	2	Atterberg; see Plate F-2 Sieve; see Plate F-3 Direct Shear; C=294 psf Ø=33° see Pate F-9		**Sandy Lean CLAY** (CL): Olive-gray, wet, soft, moderate plasticity, medium sand
-18	45		Bag 15	16										**Poorly Graded SAND with silt** (SP-SM): Olive-gray, wet, medium dense, fine to medium grained
-23	50		Bag 16	18										
-28	55		Bag 17	32										olive-brown to olive-gray, fine to coarse sand, mica flakes
-33	60		Bag 18	24						99	9	Sieve; see Plate F-3		fine to medium sand
-38	65		Bag 19	26										65 to 65-1/2 feet: gray, fine to medium grained, with gravel

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

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LOG OF BORING E-03-2
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
2 of 3
D-4

Elevation (feet)	Depth (feet)	FIELD: Sample Type	FIELD: Sample No.	FIELD: Blows/6 inches	FIELD: Pocket Penetrometer (tsf)	LABORATORY: Dry Density (pcf)	LABORATORY: Moisture Content (%)	LABORATORY: Liquid Limit	LABORATORY: Plasticity Index	LABORATORY: Passing #4 Sieve (%)	LABORATORY: Passing #200 Sieve (%)	LABORATORY: Other Tests	Graphic Log	DESCRIPTION
-43	70		Bag 20	19						98	5	Sieve; see Plate F-3		fine to coarse sand, with gravel
														Boring completed at a depth of 71-1/2 feet below existing site grade.
-48	75													
-53	80													
-58	85													
-63	90													
-68	95													
-73	100													
-78	105													

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LOG OF BORING E-03-2
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
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D-4

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

Surface Conditions:	Sloping soil access ramp, roadway, levee fill.	Date Completed:	11/24/2003
Groundwater:	Groundwater level estimated at about 13 feet below existing site grade..	Logged By:	S. Belway
		Total Depth:	71-1/2 feet
Method:	Hollow Stem Auger	Boring Diameter:	3-5/8 inch inch
Equipment:	CME 750X with 140lb. Automatic Hammer		

Approximate Elevation: 38.0 feet
Approximate Northing: 38.70 feet
Approximate Easting: -121.62 feet

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
			Bulk 1											**SILT** (ML): Brown, moist, medium stiff, with fine grained sand, trace gravel (FILL)
														(loss of circulation)
			Bag 2	4				NP	NP	69	2	Atterberg; see Plate F-2		**Poorly Graded SAND with gravel** (SP): Dark brown, wet, loose, fine to coarse grained, some gravel
33	5		Shelby 3			98	2					Sieve; see Plate F-3 Opt. MC=9.0% Max. DD=133 pcf; See Plate F-17		
			Composite									Direct Shear; C=83 pcf Ø=39° see Plate F-10		**Well Graded SAND** (SW): Dark brown, wet, medium dense, fine to coarse grained
28	10		Bag 4	17										
			Bag 4	20										
23	15		Bag 5	32										**Well Graded SAND with gravel** (SW): Dark brown, wet, medium dense, fine to coarse grained, 2 inch interbeds of medium grained subrounded gravel to 4 inches diameter (heaving, add mud)
			Bag 5	18						82	4	Sieve; see Plate F-3		
18	20		6A	21										**Lean CLAY** (CL): Gray, light brown and brown mottled, moist, stiff, low to moderate plasticity, with silt
			no recovery	10										
13	25		Shelby 7					40 47	15 23		3	Atterberg; see Plate F-2 Specific Gravity=2.683 UC=1.94 tsf		**Poorly Graded SAND with silt** (SP-SM): White to dark brown, moist, medium dense, fine to medium grained increasing silt
			Bag 8	18										
			Bag 9	16						98	8	Consolidation; see Plate F-6 Organic Content=3.4% Sieve; see Plate F-3		olive-brown, medium grained, with coarse grained
8	30		10b 10a	25										olive to olive-brown interbed of gravel 3 inches thick

P-LOG_2007 BLOWS PER 6 INCHES 21879ED LOGS.GPJ 11/21/08

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LOG OF BORING E-03-3
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 3
D-5

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
			Bag 11	19										olive-brown, medium grained
-3	35		Bag 12	25										olive-gray
			Bag 13	8										loose
-2	40		Bag 14	32										gray, medium dense
														(heaved 3 feet when taking sample, heaved 7 feet on second attempt, added mud)
-7	45		Bag 15	20						95	6	Sieve; see Plate F-3		olive-brown, medium grained
-12	50		Bag 16	40										
			bag 16	20										
-17	55		17b 17a	44								Direct Shear C=847 pcf Ø=38° see Plate F-11		gray, with coarse grained
			Bag 18	21										(heaved 8 feet)
														fine to coarse grained
-22	60		Bag 19	33						99	4	Sieve; see Plate F-3		
			Bag 19	16										
-27	65		20b 20a	46								Direct Shear; C=2204 psf Ø=29° see Plate F-12		medium to coarse grained, some fine gravel
			bag 21	25										medium grained

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LOG OF BORING E-03-3
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
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P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

Elevation (feet)	Depth (feet)	FIELD: Sample Type	FIELD: Sample No.	FIELD: Blows/6 inches	FIELD: Pocket Penetrometer (tsf)	LABORATORY: Dry Density (pcf)	LABORATORY: Moisture Content (%)	LABORATORY: Liquid Limit	LABORATORY: Plasticity Index	LABORATORY: Passing #4 Sieve (%)	LABORATORY: Passing #200 Sieve (%)	LABORATORY: Other Tests	Graphic Log	DESCRIPTION
-32	70		bag 22	41										dense, some coarse grained, trace fine grained
														Boring completed at a depth of 71-1/2 feet below existing site grade.
-37	75													
-42	80													
-47	85													
-52	90													
-57	95													
-62	100													
-67	105													

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

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LOG OF BORING E-03-3
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
3 of 3
D-5

Surface Conditions: Levee toe, grasses and trees.

Groundwater: Groundwater level estimated at about 18 feet below existing site grade..

Method: Rotary Wash

Equipment: CME 75 with 140lb. Automatic Hammer

Date Completed: 11/17/2003

Logged By: S. Belway

Total Depth: 73 feet

Boring Diameter: 3-5/8 inch inch

Approximate Elevation: 29.0 feet
Approximate Northing: 38.70 feet
Approximate Easting: -121.62 feet

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
			bulk 1											**SILT** (ML): Brown, moist, soft, trace organics
			bag 1	5										**Silty SAND** (SM): Brown, moist, loose, fine to medium grained, mica flakes
24	5		Shelby 2 200psi											
			bag 3	8										
			Shelby 4 400 psi			89	14	51	24	100	94	Hydrometer; see Plate F-4 Atterberg; see Plate F-2		**Fat CLAY** (CH): Brown with gray, moist, medium stiff, low plasticity
19	10		bag 5	12								Corrosion; See Plate F-21		
			Shelby 6 800 psi			87	31					UC=0.6 tsf		
14	15		bag 7	7								Organic Content = 0.4%		**Poorly Graded SAND** (SP): Yellow-brown, moist, loose, fine to medium grained
			Shelby 8 400psi			81	3					Direct Shear; C=309 psf Ø=34° see Plate F-13		**Lean CLAY** (CL): Yellow-brown, moist, soft, moderate plasticity
9	20		bag 9	10							8			**Poorly Graded SAND with silt** (SP-SM): Brown, wet, loose to medium dense, fine to medium grained
			no recovery											
4	25		bag 10	8										light olive-brown, loose
-1	30		Bag 11	13										gray, medium dense

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

KLEINFELDER

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LOG OF BORING E-03-4
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 3
D-6

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
-6	35		Bag 12	23										medium grained
-11	40		Bag 13	16						100	7	Sieve; see Plate F-3		light gray, fine to medium grained
-16	45		Bag 14	19										
-21	50		Bag 15	3										trace brown Clayey Silt
			no recovery											
			Bag 16	27				59	32			Atterberg; see Plate F-2		**Fat CLAY** (CH): Olive, wet, stiff, with fine to coarse sand, some organics
-26	55		Bag 17	16						100	15	Opt. MC=13.0% Max. DD=119.0 pcf See Plate F-18 Sieve; see Plate F-3 Direct Shear; C=0psf Ø=37° see Plate F-14		**Silty SAND** (SM): Gray, wet, medium dense, medium grained
-31	60		Bag 18	17										
			Bag 18	23										with fine to medium gravel
-36	65		Bag 19	26								Corrosion; See Plate F-22		
			Bag 19	19										

FIELD | LABORATORY

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

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LOG OF BORING E-03-4
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
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Elevation (feet)	Depth (feet)	FIELD: Sample Type	FIELD: Sample No.	FIELD: Blows/6 inches	FIELD: Pocket Penetrometer (tsf)	LABORATORY: Dry Density (pcf)	LABORATORY: Moisture Content (%)	LABORATORY: Liquid Limit	LABORATORY: Plasticity Index	LABORATORY: Passing #4 Sieve (%)	LABORATORY: Passing #200 Sieve (%)	LABORATORY: Other Tests	Graphic Log	DESCRIPTION
-41	70													
			Bag 20	32										dense
			Bag 20	15										medium dense
														Boring completed at a depth of 73 feet below existing site grade.
-46	75													
-51	80													
-56	85													
-61	90													
-66	95													
-71	100													
-76	105													

P-LOG_2007 BLOWS PER 6 INCHES 21879EDLOGS.GPJ 11/21/08

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LOG OF BORING E-03-4
AMERICAN BASIN FISH SCREEN
HABITAT IMPROVEMENT PROJECT
NATOMAS MUTUAL WATER COMPANY
SACRAMENTO & SUTTER COUNTIES, CALIFORNIA

PLATE
3 of 3
D-6

BORING NO.	SAMPLE DEPTH (ft)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (% of dry weight)	PARTICLE SIZE SIEVE SIZE (percent passing)						ATTERBERG LIMITS		OTHER TESTS
				3"	3/4"	#4	#10	#40	#200	L.L.	P.I.	
E-03- 1	15.5	99	3						1			Organic Content = 0.2%
E-03- 1	20.5	95	6			94	89	52	2			Sieve
E-03- 1	25.5	84	35									
E-03- 1	30.5					100	100	90	9			Sieve
E-03- 1	35.5	100	30			100	100	93	5			Sieve
E-03- 1	45.5	90	28			100	100	99	5			Sieve
E-03- 1	50.5											Direct Shear; C=792 psf Ø=32°
E-03- 1	60.5	91	27									
E-03- 1	65.5								43	NP	NP	
E-03- 1	70.5	111	18									
E-03- 1	75.5					100	100	54	6			Sieve
E-03- 1	80.5	107	22									
E-03- 2	0.3											Organic Content = 1.5%
E-03- 2	2.0											Corrosion
E-03- 2	3.5									NP	NP	Direct Shear; C=56 psf Ø=38°
E-03- 2	10.0											Consolidation Specific Gravity = 2.72
E-03- 2	16.0								58	NP	NP	UC=0.34 tsf
E-03- 2	25.0											Corrosion
E-03- 2	41.5					100	99	98	2	NP	NP	Sieve
												Direct Shear; C=294 psf Ø=33°
E-03- 2	60.0					99	94	73	9			Sieve
E-03- 2	70.0					98	86	45	5			Sieve
E-03- 3	3.0				95	69	58	21	2	NP	NP	Sieve Opt. MC=9.0% M
E-03- 3	4.5	98	2									Direct Shear; C=83 pcf Ø=39°
E-03- 3	16.5				100	82	66	25	4			Sieve
E-03- 3	23.0								3	47	23	Specific Gravity=2.683 UC=1.94 tsf Consolidation
												Organic Content=3.4%
E-03- 3	23.5									40	15	
E-03- 3	26.5					98	84	45	8			Sieve
E-03- 3	44.0				100	95	88	74	6			Sieve
E-03- 3	55.5											Direct Shear C=847 pcf Ø=38°
E-03- 3	60.0					99	93	43	4			Sieve
E-03- 3	65.5											Direct Shear; C=2204 psf Ø=29°
E-03- 4	6.5	89	14			100	100	99	94	51	24	Hydrometer Corrosion
E-03- 4	10.5	87	31									UC=0.6 tsf
E-03- 4	15.0											Organic Content = 0.4%
E-03- 4	16.5	81	3									Direct Shear; C=309 psf Ø=34°
E-03- 4	20.0								8			
E-03- 4	40.0					100		99	7			Sieve
E-03- 4	53.5									59	32	
E-03- 4	55.0					100	95	59	15			Opt. MC=13.0% Max. DD=119 Sieve

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SUMMARY OF LABORATORY TESTS
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
1 of 2

KA-LABSUM 303+00-330+00.GPJ 1/11/10

BORING NO.	SAMPLE DEPTH (ft)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (% of dry weight)	PARTICLE SIZE SIEVE SIZE (percent passing)						ATTERBERG LIMITS		OTHER TESTS
				3"	3/4"	#4	#10	#40	#200	L.L.	P.I.	
												Direct Shear; C=0psf Ø=37°
E-03- 4	65.0											Corrosion
SRB-19	3.5	130	14							28	10	
SRB-19	6.5	128	20									
SRB-19	8.5	119	24							44	23	
SRB-19	23.5								51			
SRB-19	28.0								30			
SRB-19	33.5					100	100	34	6			Sieve
SRB-19	48.5					100	100	60	3			Sieve
SRB-19	65.5					98	94	48	5			Sieve
SRB-20	6.0					79	74	32	1			Sieve
SRB-20	28.5								21			
SRB-20	33.5						100	100	7			Sieve
SRB-20	41.0								57			
SRB-20	76.0					100	99	80	8			Sieve

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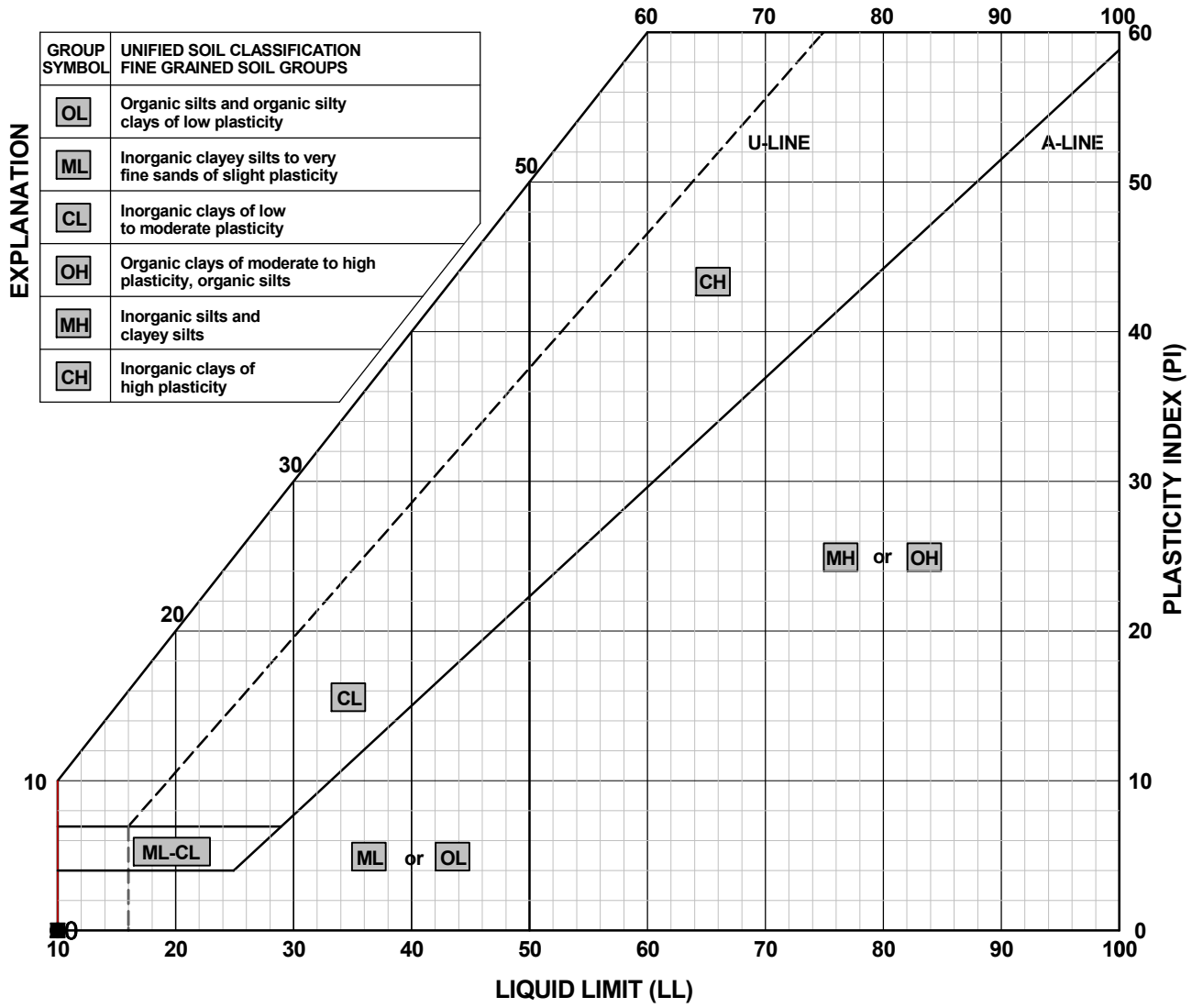
SUMMARY OF LABORATORY TESTS
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE

KA-LABSUM 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	LL	PL	PI	DESCRIPTION
●	E-03- 1	65.5	NP	NP	NP	Silty SAND (SM)
⊠	E-03- 2	3.5	NP	NP	NP	Sandy SILT (ML)
▲	E-03- 2	16.0	NP	NP	NP	Sandy SILT (ML)
★	E-03- 2	41.5	NP	NP	NP	Poorly Graded SAND (SP)
⊙	E-03- 3	3.0	NP	NP	NP	Poorly Graded SAND with gravel (SP)

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PLASTICITY CHART
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
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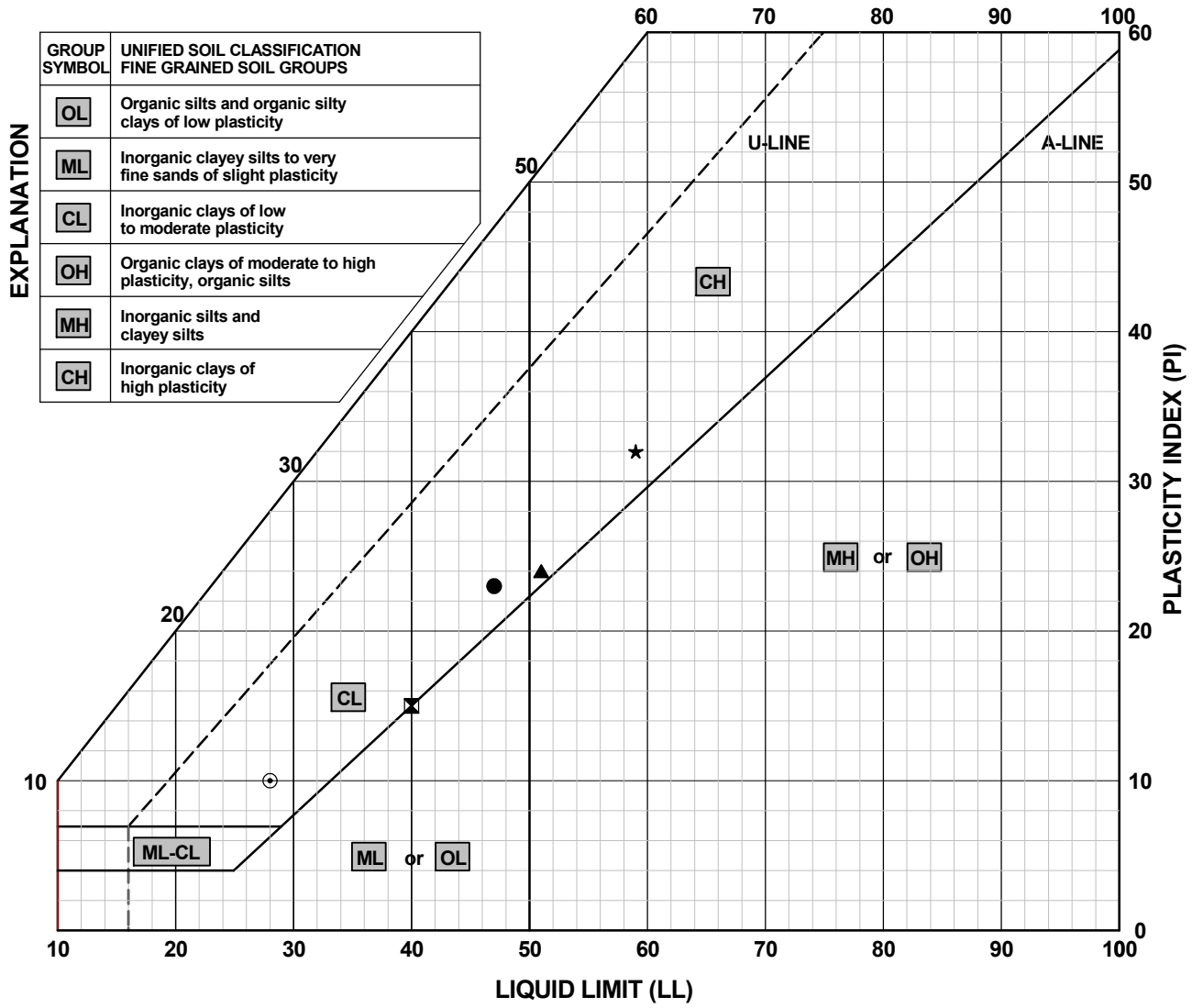
KA_ATTERBERG 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	LL	PL	PI	DESCRIPTION
●	E-03- 3	23.0	47	24	23	Poorly Graded SAND with silt (SP-SM)
⊠	E-03- 3	23.5	40	25	15	Poorly Graded SAND with silt (SP-SM)
▲	E-03- 4	6.5	51	27	24	Fat CLAY (CH)
★	E-03- 4	53.5	59	27	32	Fat CLAY (CH)
⊙	SRB-19	3.5	28	18	10	Clayey SAND (SC)

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PLASTICITY CHART
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
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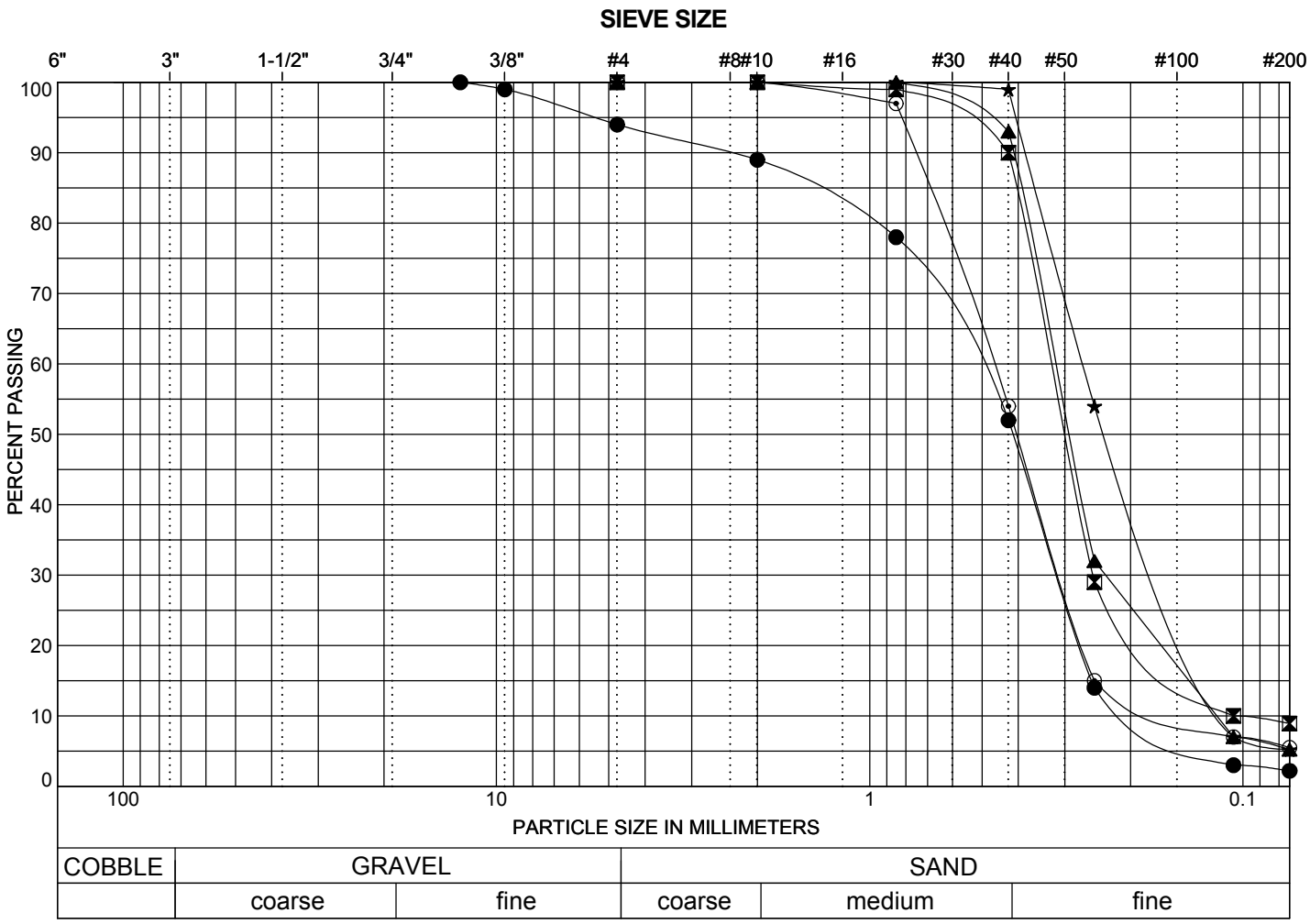
KA_ATTERBERG 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	COBBLE (%)	GRAVEL (%)	SAND (%)	FINES (%)	D60 (mm)	D10 (mm)	Cu	Cc	DESCRIPTION
●	E-03- 1	20.5	0	6	92	2	0.53	0.18	2.9	1	Poorly Graded SAND (SP)
⊠	E-03- 1	30.5	0	0	91	9	0.33	0.11	3.1	1.8	Poorly Graded SAND with silt (SP-SM)
▲	E-03- 1	35.5	0	0	95	5	0.32	0.12	2.7	1.5	Poorly Graded SAND with silt (SP-SM)
★	E-03- 1	45.5	0	0	95	5	0.27	0.11	2.4	0.9	Poorly Graded SAND with silt (SP-SM)
⊙	E-03- 1	75.5	0	0	95	6	0.47	0.15	3.2	1.4	Poorly Graded SAND with silt (SP-SM)

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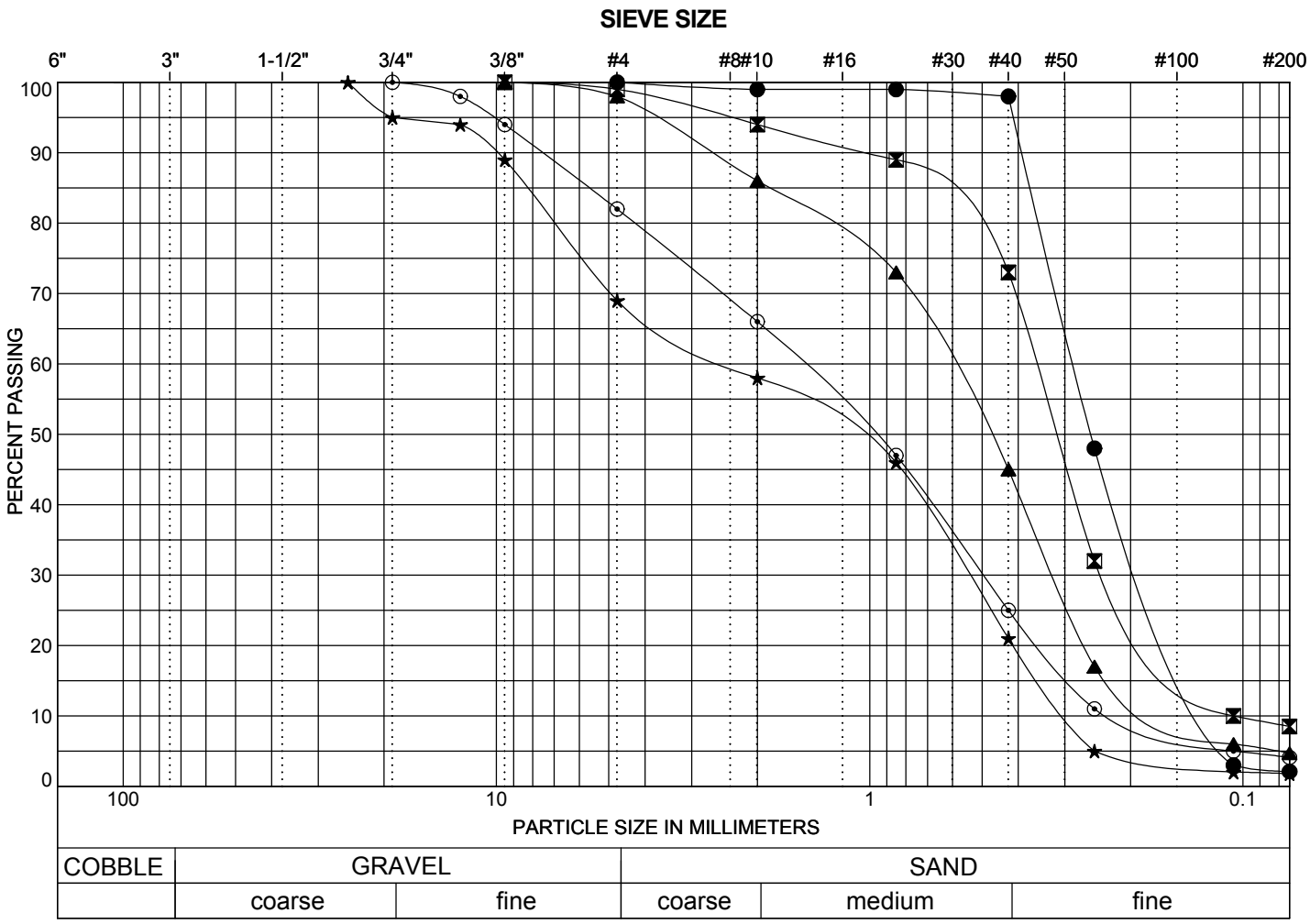
GRAIN SIZE ANALYSES
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
1 of 5

KA_SIEVE 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	COBBLE (%)	GRAVEL (%)	SAND (%)	FINES (%)	D60 (mm)	D10 (mm)	Cu	Cc	DESCRIPTION
●	E-03- 2	41.5	0	0	98	2	0.28	0.12	2.3	0.9	Poorly Graded SAND (SP)
⊠	E-03- 2	60.0	0	1	91	9	0.36	0.11	3.4	1.4	Poorly Graded SAND with silt (SP-SM)
▲	E-03- 2	70.0	0	2	93	5	0.62	0.14	4.3	1.1	Poorly Graded SAND with silt (SP-SM)
★	E-03- 3	3.0	0	31	67	2	2.34	0.3	7.9	0.4	Poorly Graded SAND with gravel (SP)
⊙	E-03- 3	16.5	0	18	78	4	1.53	0.22	7	0.7	Well Graded SAND with gravel (SW)

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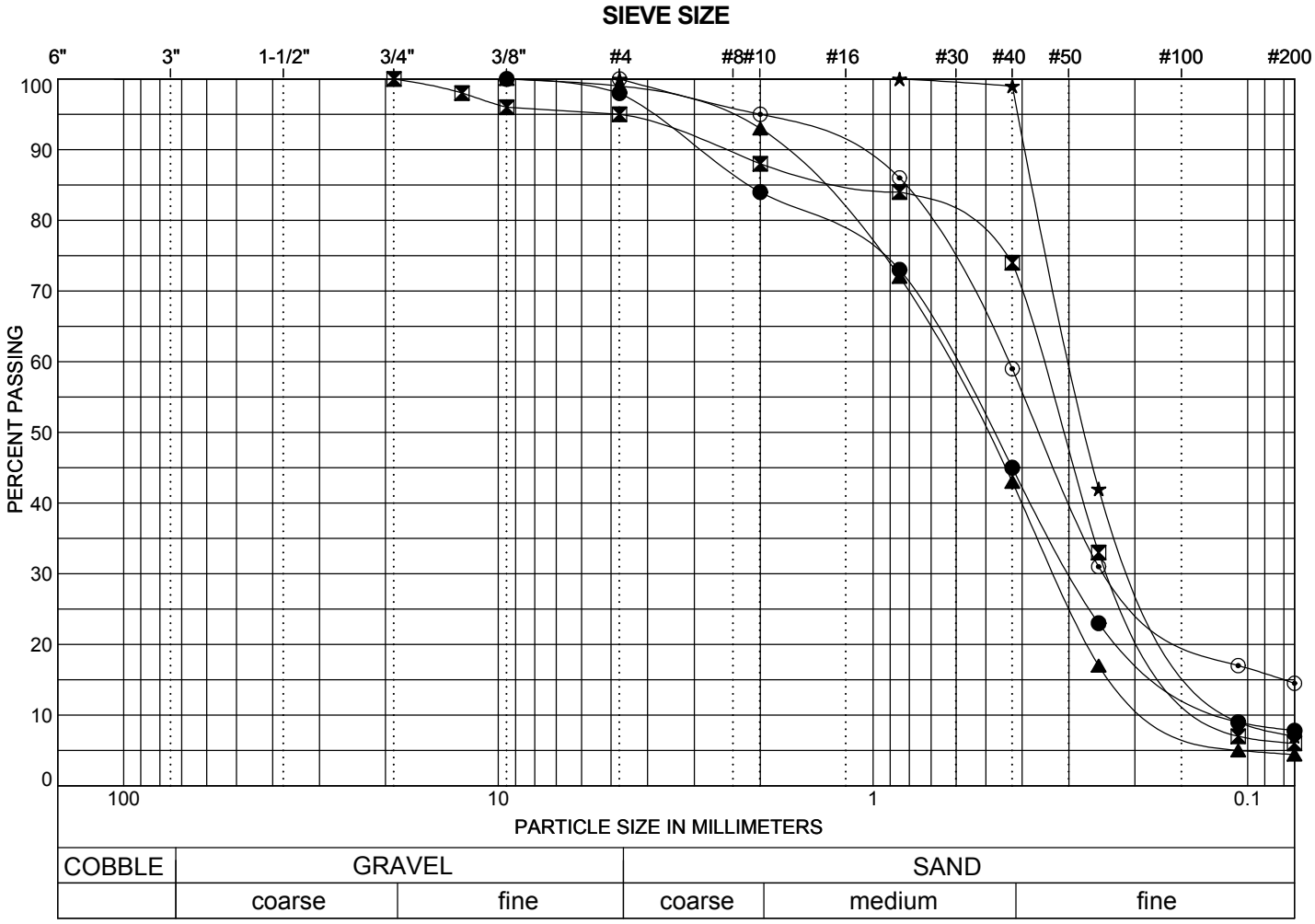
File Number: 94582SR2-4

GRAIN SIZE ANALYSES
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
2 of 5

KA_SIEVE 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	COBBLE (%)	GRAVEL (%)	SAND (%)	FINES (%)	D60 (mm)	D10 (mm)	Cu	Cc	DESCRIPTION
●	E-03- 3	26.5	0	2	90	8	0.62	0.11	5.5	1.3	Poorly Graded SAND with silt (SP-SM)
⊠	E-03- 3	44.0	0	5	89	6	0.35	0.12	3	1.2	Poorly Graded SAND with silt (SP-SM)
▲	E-03- 3	60.0	0	1	95	4	0.64	0.15	4.2	1.1	Poorly Graded SAND with silt (SP-SM)
★	E-03- 4	40.0	0	0	93	7	0.3	0.11	2.7	1	Poorly Graded SAND with silt (SP-SM)
⊙	E-03- 4	55.0	0	0	86	15	0.44				Silty SAND (SM)

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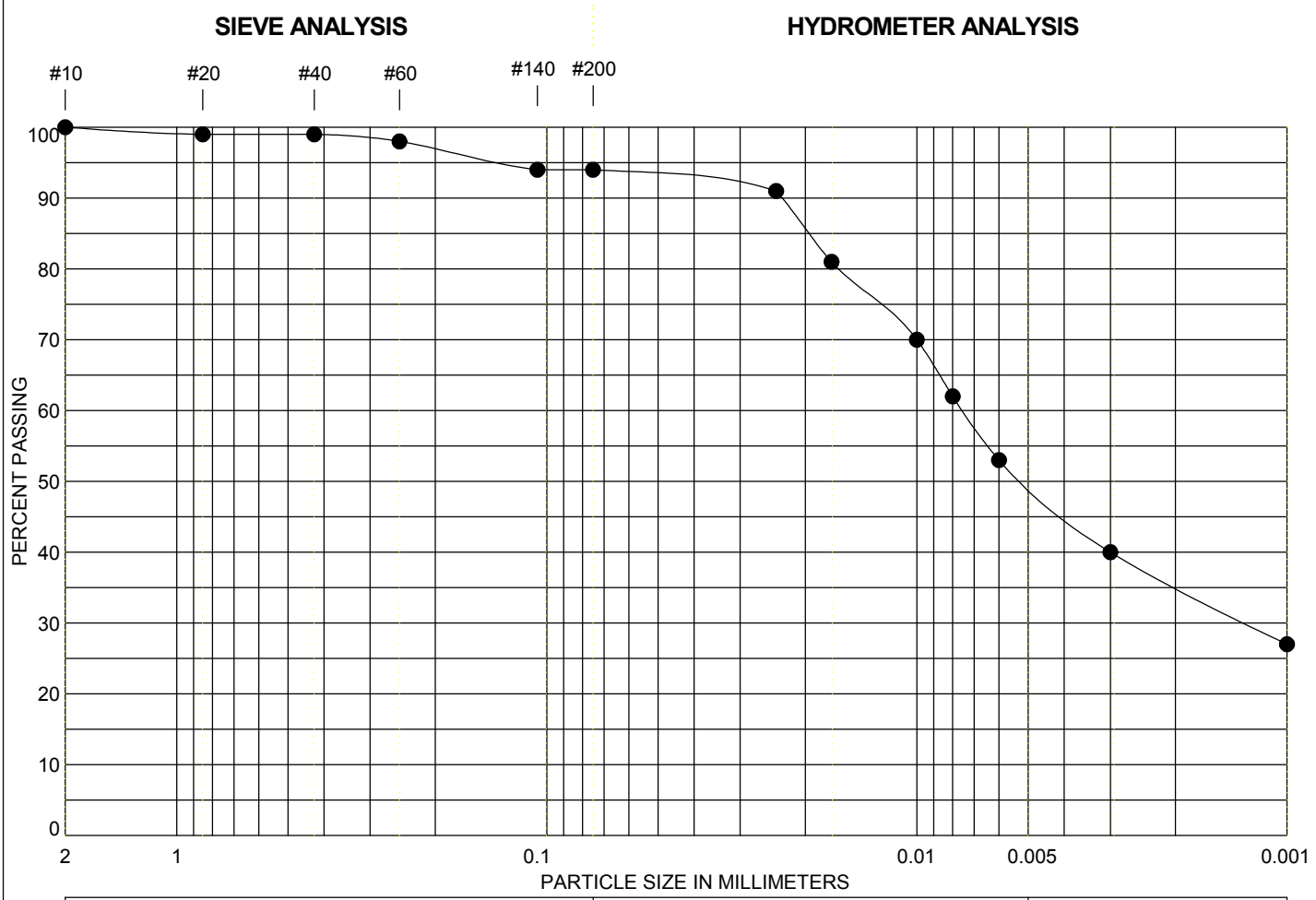
GRAIN SIZE ANALYSES
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
3 of 5

KA_SIEVE 303+00-330+00.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	SAND (%)	SILT (%)	CLAY (%)	DESCRIPTION
●	E-03- 4	6.5	6.0	44.4	49.6	Fat CLAY (CH)

KA_HYDRO 303+00-330+00.GPJ 1/11/10

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GRAIN SIZE ANALYSES
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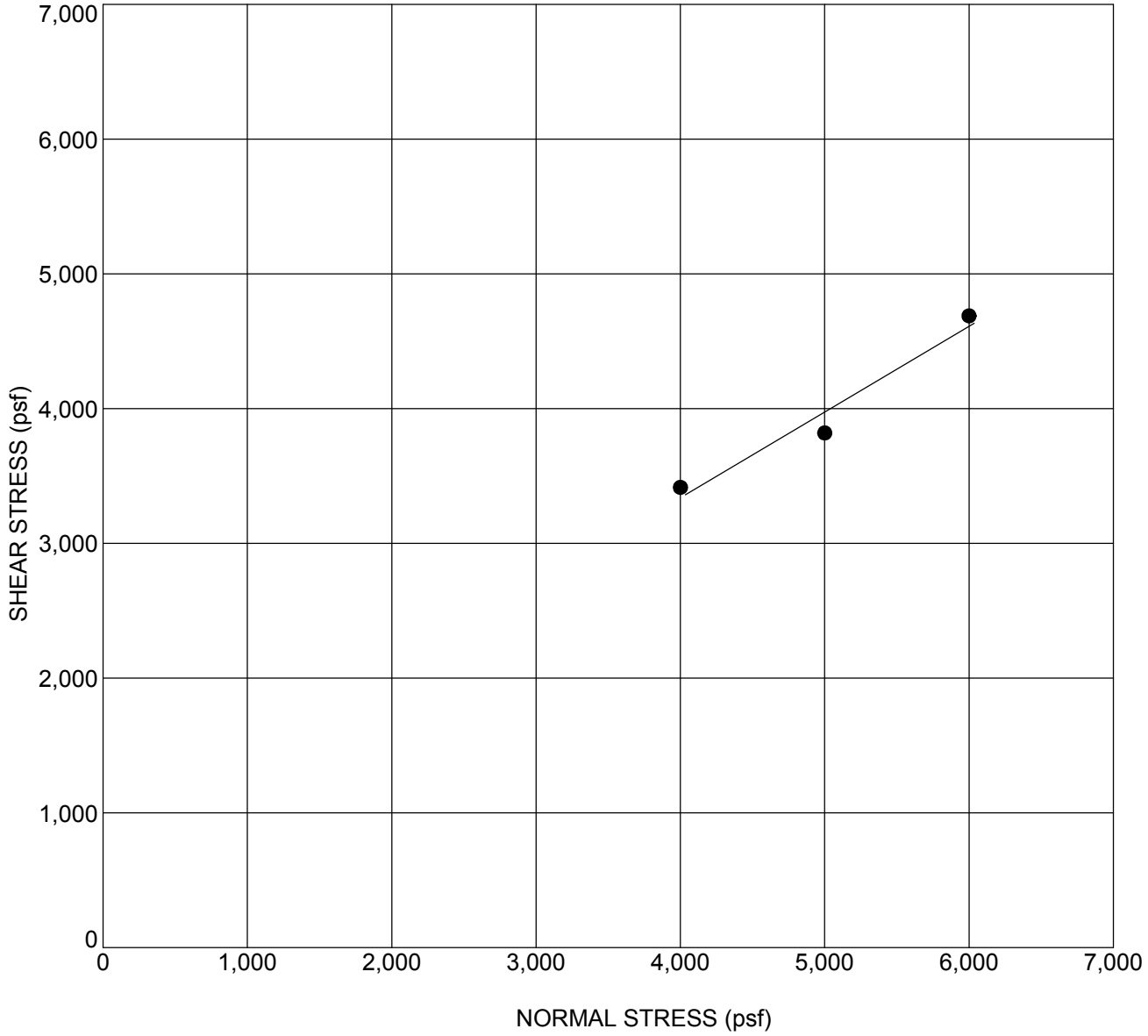
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
1 of 1



SOURCE: E-03- 1
DEPTH: 50.5 ft
SOIL DESCRIPTION: Poorly Graded SAND with silt (SP-SM)

FRICTION ANGLE = 32 deg
COHESION = 792 psf

FINAL DRY DENSITY (pcf)	85.9	87.4	88.8
INITIAL WATER CONTENT (%)	29.5	32.0	30.3
FINAL WATER CONTENT (%)	32.9	33.1	31.7
NORMAL STRESS (psf)	4000	5000	6000
MAXIMUM SHEAR (psf)	3415.5	3819.1	4688.5

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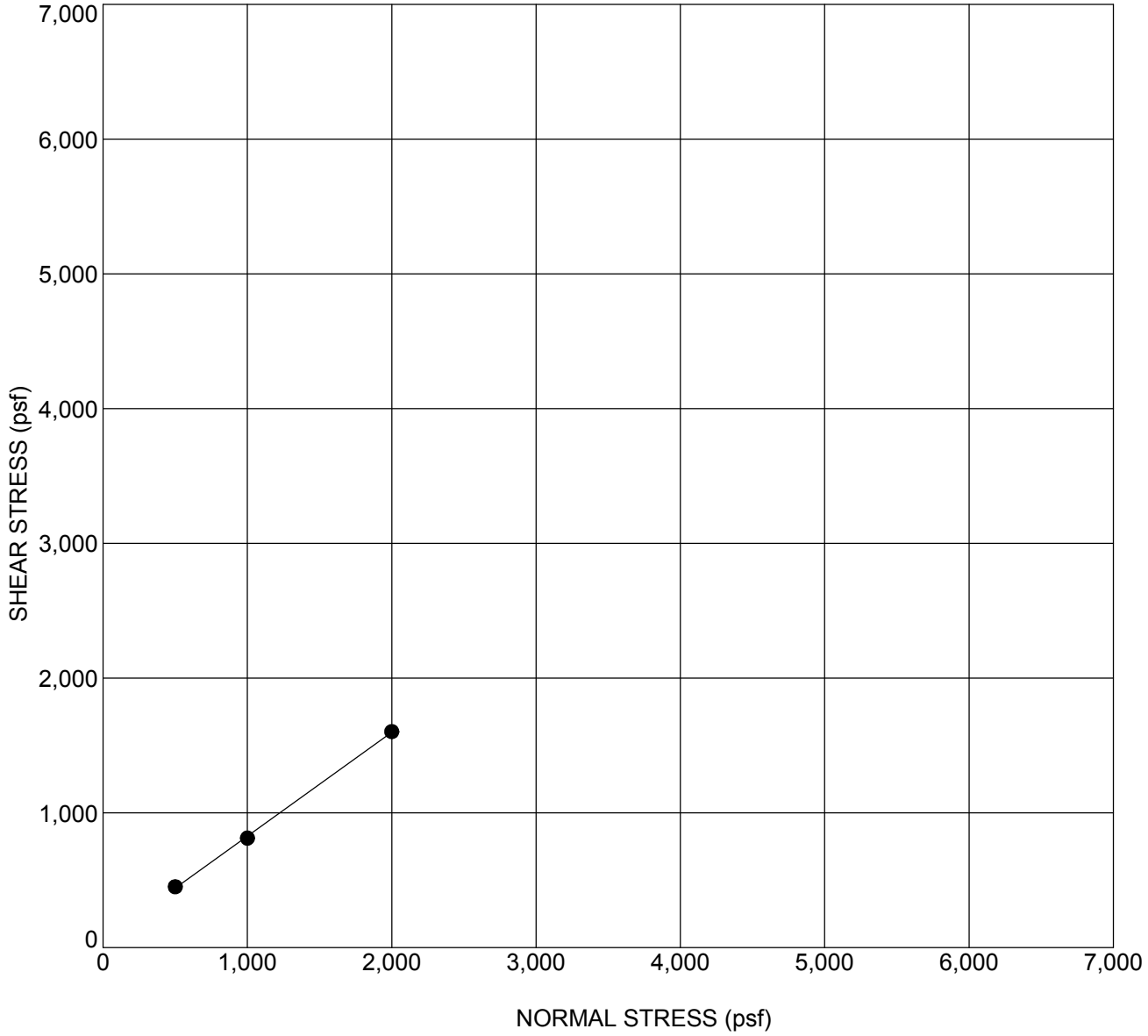
DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
1 of 8

KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



SOURCE: E-03- 2
DEPTH: 3.5 ft
SOIL DESCRIPTION: Sandy SILT (ML)

FRICTION ANGLE = 38 deg
COHESION = 56 psf

FINAL DRY DENSITY (pcf)	65.5	67.4	70.0
INITIAL WATER CONTENT (%)	12.8	16.4	16.8
FINAL WATER CONTENT (%)	37.9	39.1	41.0
NORMAL STRESS (psf)	500	1000	2000
MAXIMUM SHEAR (psf)	451.5	812.6	1602.7

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DIRECT SHEAR TEST
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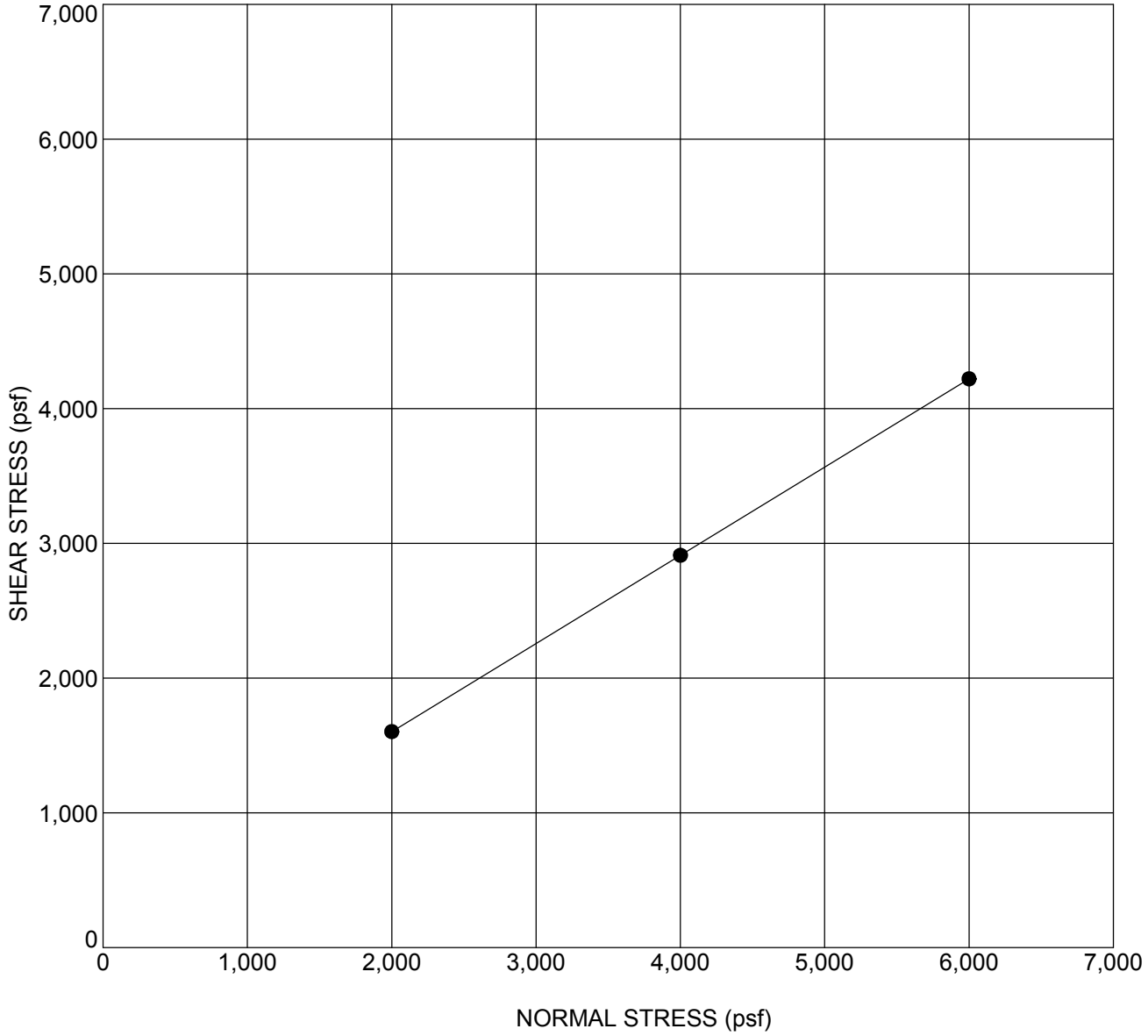
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA



SOURCE: E-03- 2
DEPTH: 41.5 ft
SOIL DESCRIPTION: Poorly Graded SAND (SP)

FRICTION ANGLE = 33 deg
COHESION = 294 psf

FINAL DRY DENSITY (pcf)	68.2	72.8	73.3
INITIAL WATER CONTENT (%)	5.0	5.0	5.0
FINAL WATER CONTENT (%)	32.2	29.9	30.8
NORMAL STRESS (psf)	2000	4000	6000
MAXIMUM SHEAR (psf)	1602.7	2911.9	4221.1

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DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
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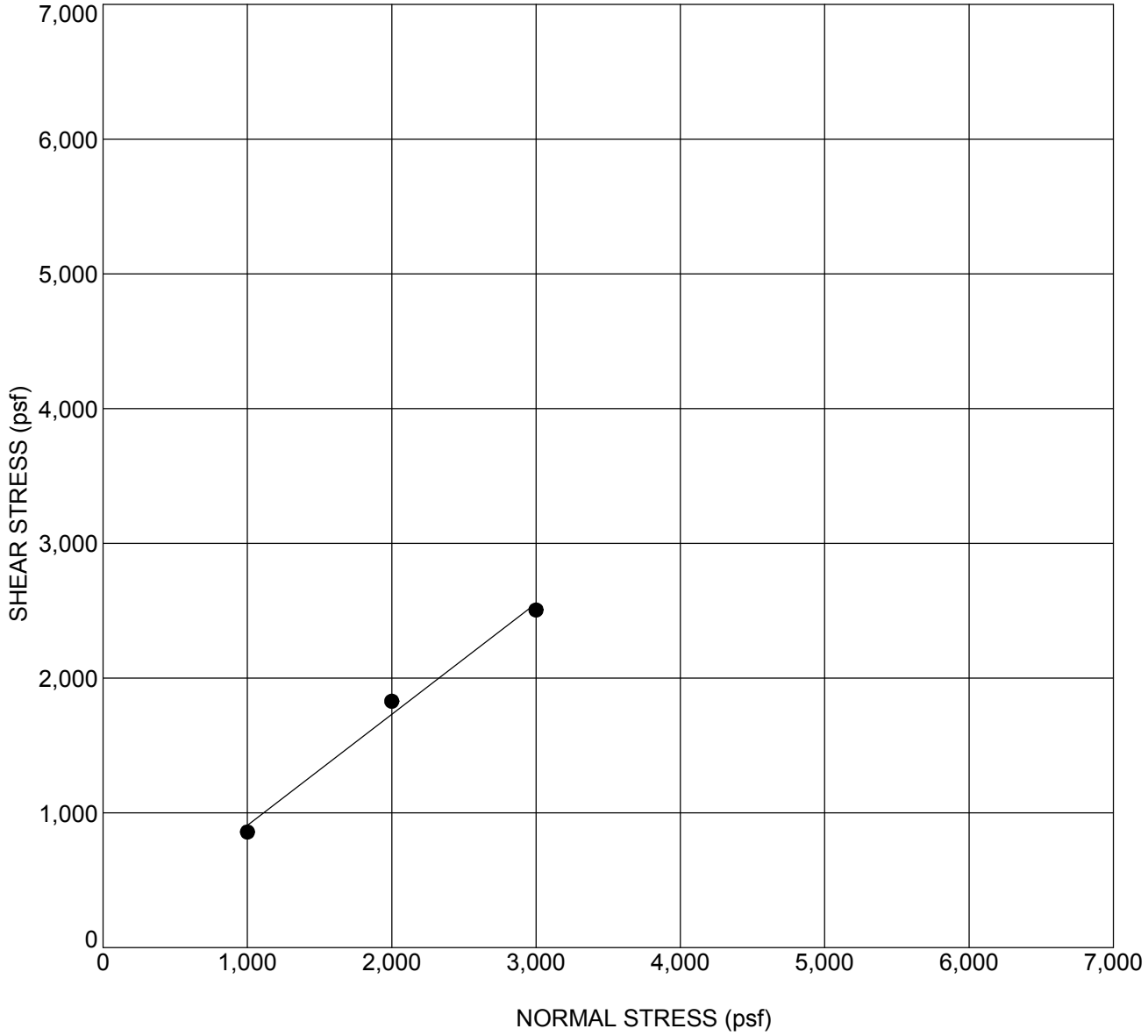
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
3 of 8

KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



SOURCE: E-03- 3
DEPTH: 4.5 ft
SOIL DESCRIPTION: Poorly Graded SAND with gravel (SP)

FRICTION ANGLE = 39 deg
COHESION = 83 psf

FINAL DRY DENSITY (pcf)	82.1	85.3	85.6
INITIAL WATER CONTENT (%)	3.7	3.7	3.7
FINAL WATER CONTENT (%)	22.9	21.9	22.2
NORMAL STRESS (psf)	1000	2000	3000
MAXIMUM SHEAR (psf)	857.8	1828.4	2505.6

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DIRECT SHEAR TEST
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SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
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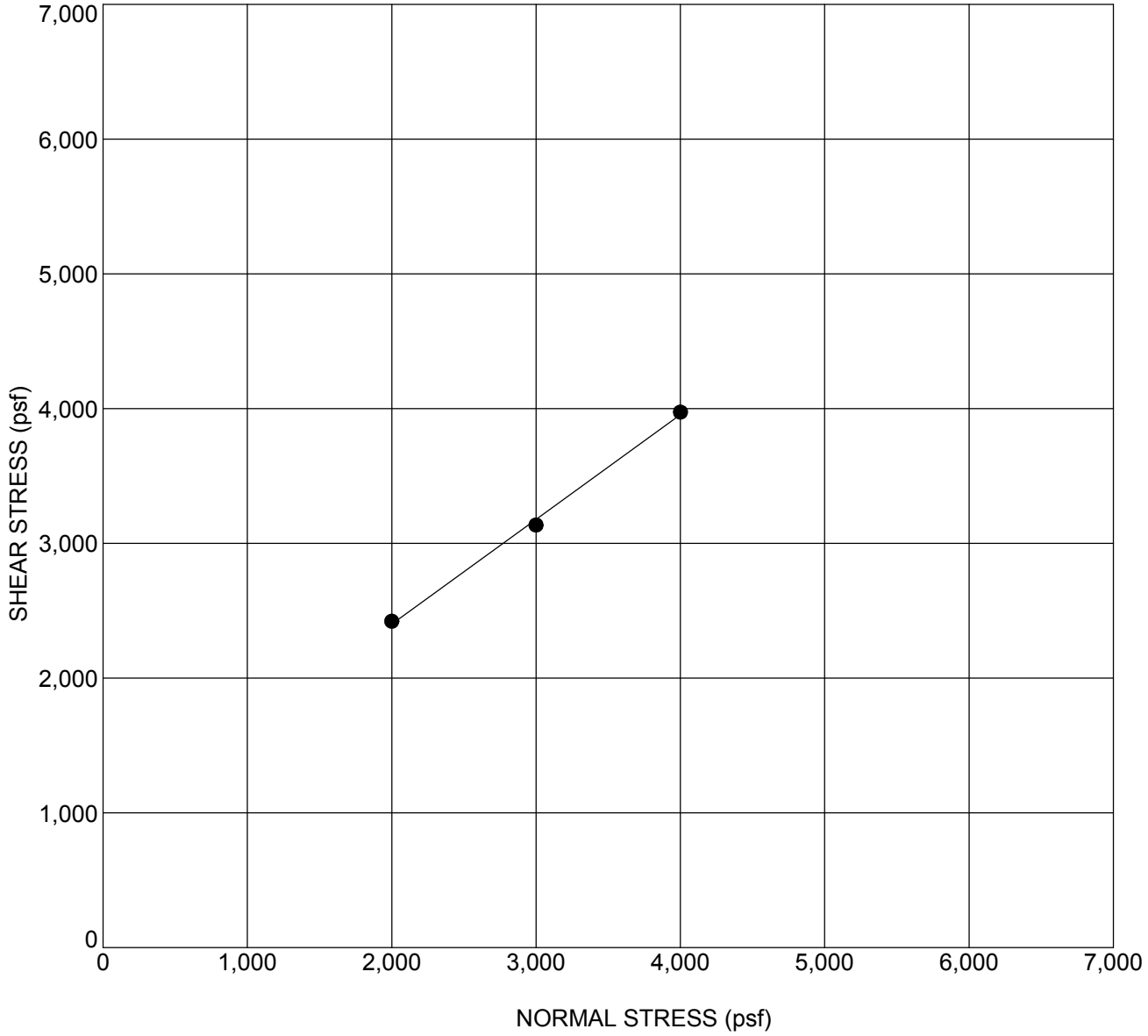
KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



SOURCE: E-03- 3
DEPTH: 55.5 ft
SOIL DESCRIPTION: Poorly Graded SAND with silt (SP-SM)

FRICTION ANGLE = 38 deg
COHESION = 847 psf

FINAL DRY DENSITY (pcf)	95.1	97.7	96.4
INITIAL WATER CONTENT (%)	10.4	20.5	20.3
FINAL WATER CONTENT (%)	22.0	25.2	28.3
NORMAL STRESS (psf)	2000	3000	4000
MAXIMUM SHEAR (psf)	2421.9	3136	3974.4

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DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
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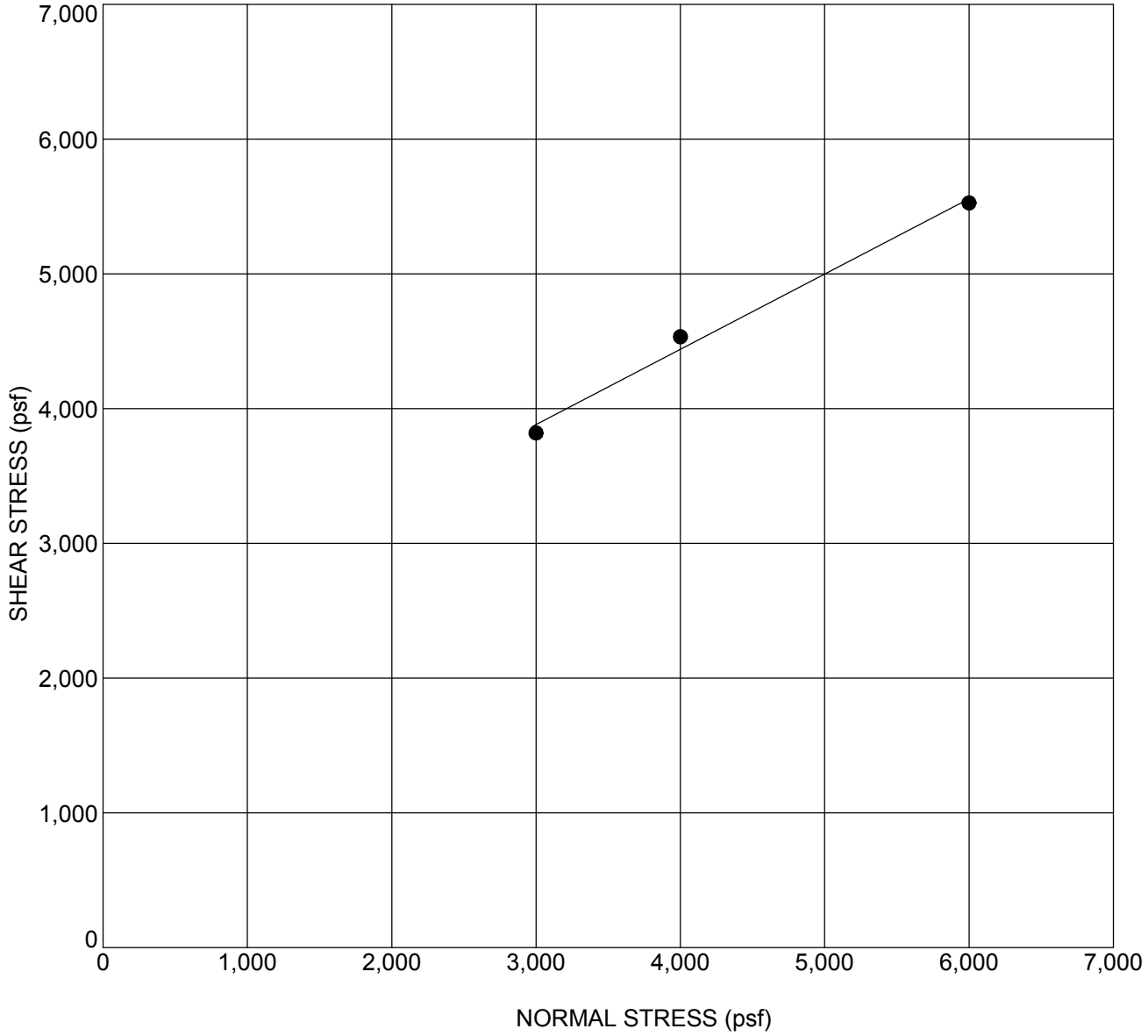
KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



SOURCE: E-03- 3
DEPTH: 65.5 ft
SOIL DESCRIPTION: Poorly Graded SAND with silt (SP-SM)

FRICTION ANGLE = 29 deg
COHESION = 2204 psf

FINAL DRY DENSITY (pcf)	93.9	94.7	93.5
INITIAL WATER CONTENT (%)	4.2	3.7	16.1
FINAL WATER CONTENT (%)	16.9	17.1	21.9
NORMAL STRESS (psf)	3000	4000	6000
MAXIMUM SHEAR (psf)	3819.1	4533.3	5526.9

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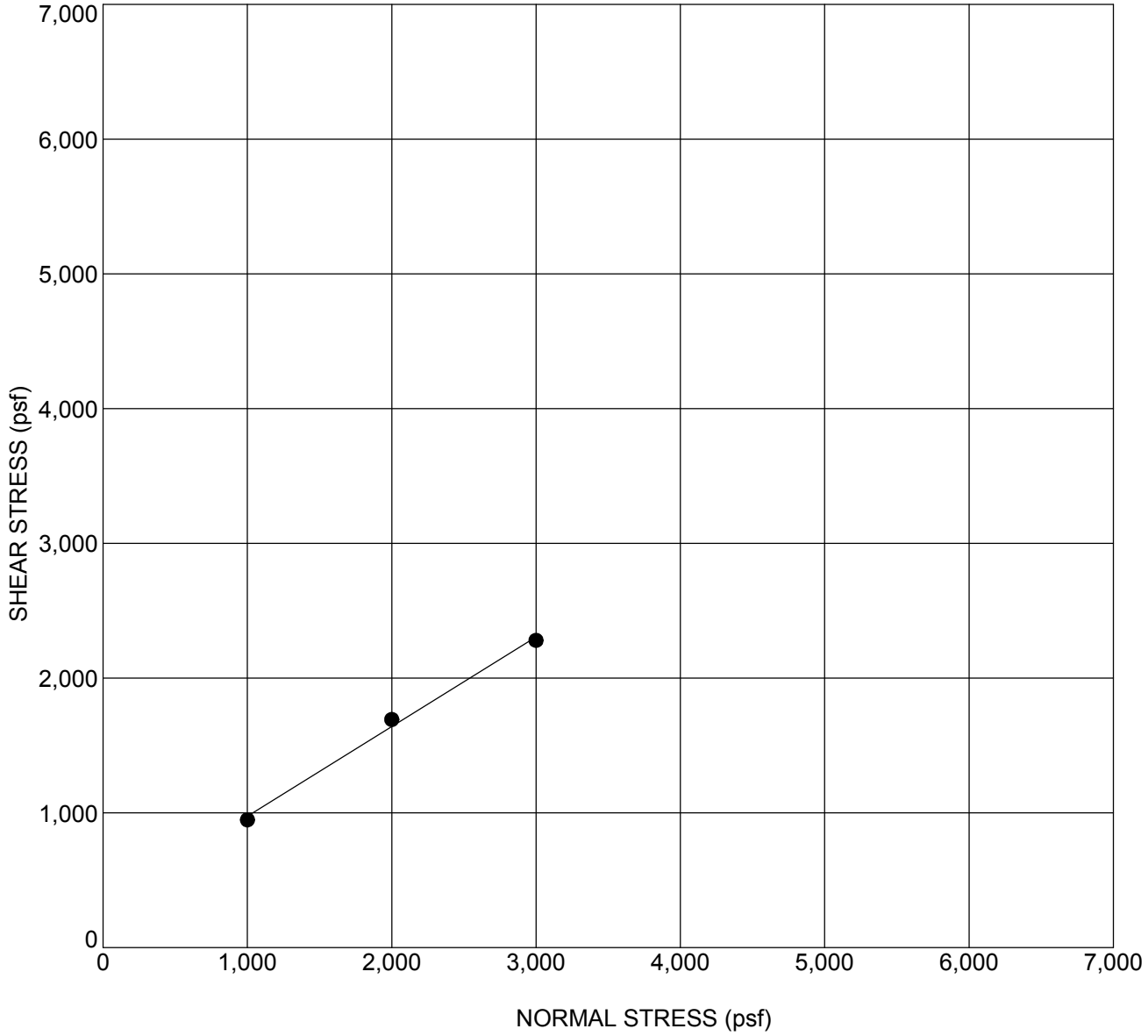
File Number: 94582SR2-4

DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
6 of 8

KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



SOURCE: E-03- 4
DEPTH: 16.5 ft
SOIL DESCRIPTION: Lean CLAY (CL)

FRICTION ANGLE = 34 deg
COHESION = 309 psf

FINAL DRY DENSITY (pcf)	65.5	68.2	66.7
INITIAL WATER CONTENT (%)	3.4	3.4	3.4
FINAL WATER CONTENT (%)	34.3	33.2	34.5
NORMAL STRESS (psf)	1000	2000	3000
MAXIMUM SHEAR (psf)	948.1	1693	2279.8

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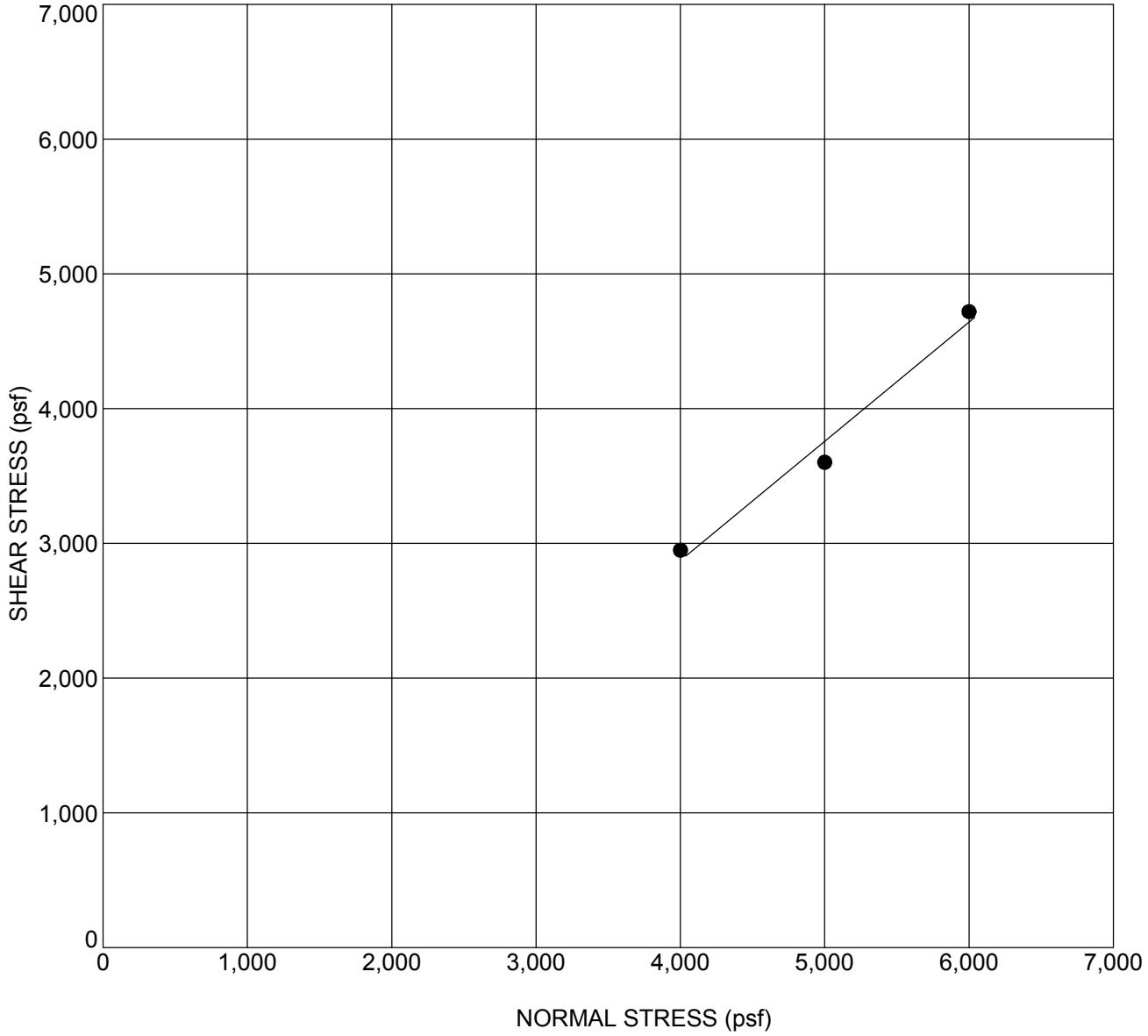
File Number: 94582SR2-4

DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA



SOURCE: E-03- 4
DEPTH: 55 ft
SOIL DESCRIPTION: Silty SAND (SM)

FRICTION ANGLE = 37 deg
COHESION = 0 psf

FINAL DRY DENSITY (pcf)	100.4	104.1	102.8
INITIAL WATER CONTENT (%)	12.9	12.9	12.9
FINAL WATER CONTENT (%)	17.8	17.2	17.1
NORMAL STRESS (psf)	4000	5000	6000
MAXIMUM SHEAR (psf)	2949.7	3601.8	4719.6

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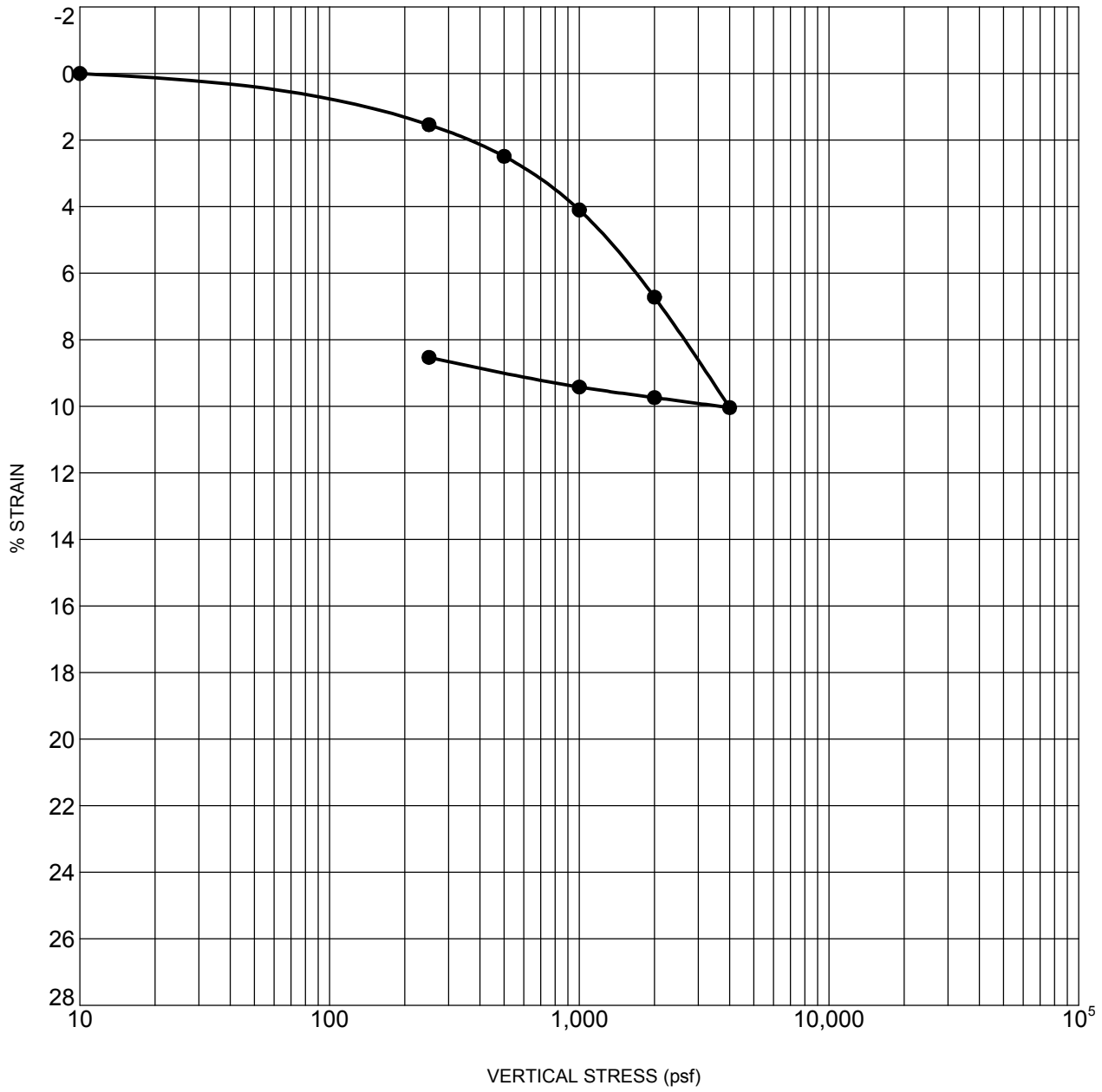
DIRECT SHEAR TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
8 of 8

KA_DIRECT_SHEAR 303+00-330+00.GPJ 1/11/10



		Before	*After*
Boring: E-03- 2	Wet Unit Weight (pcf) =	110.4	120.8
At a depth of approximately 10.0 feet	Moisture Content (%) =	32.0	34.4
Soil Description: Sandy SILT (ML)	Dry Unit Weight (pcf) =	83.6	83.6

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Drafted By: D. Ross
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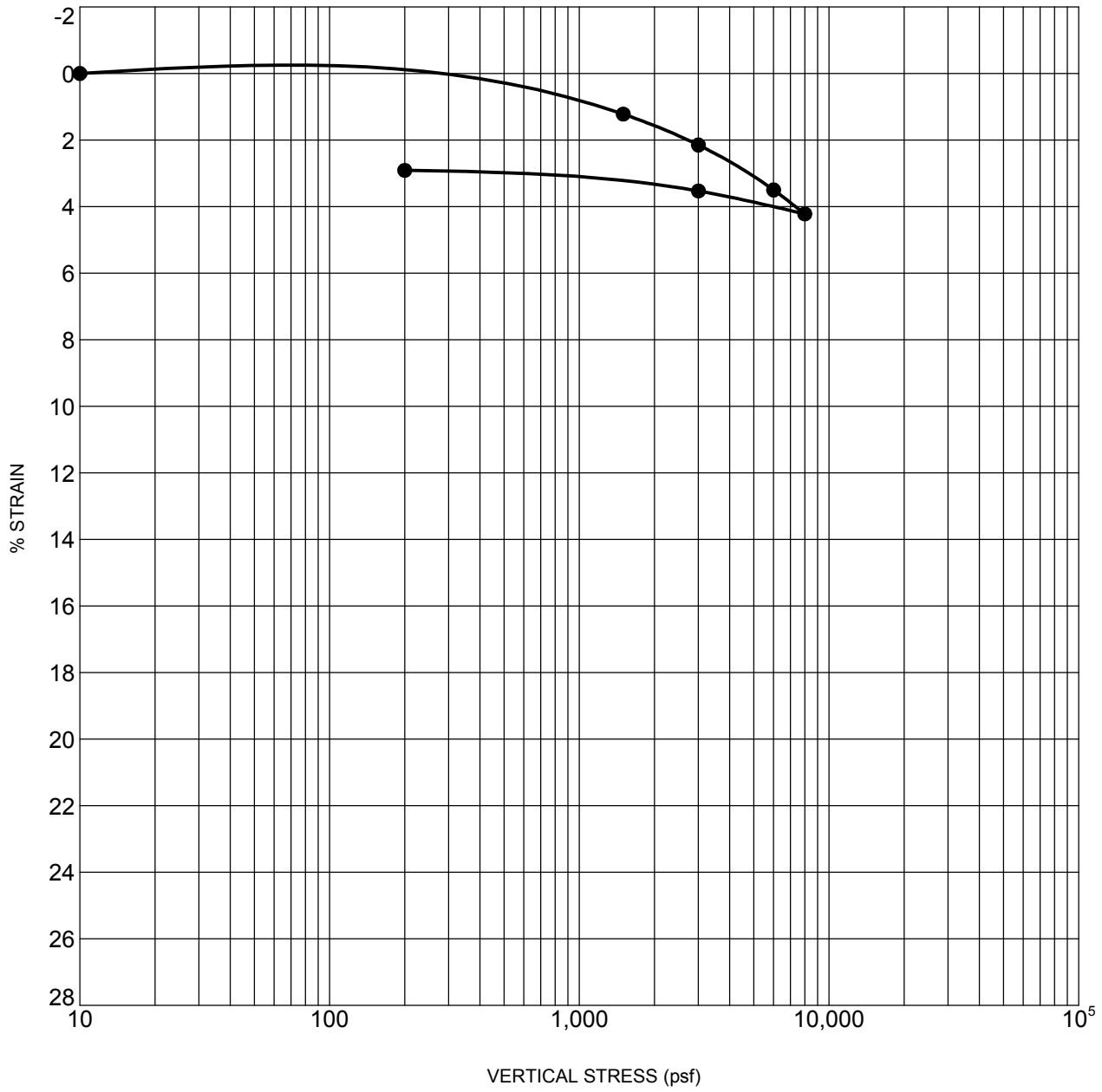
File Number: 94582SR2-4

CONSOLIDATION TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
1 of 2

KA_CONSOL_STRAIN 303+00-330+00.GPJ 1/11/10



		Before	*After*
Boring: E-03- 3	Wet Unit Weight (pcf) =	115.7	120.5
At a depth of approximately 23.0 feet	Moisture Content (%) =	32.6	37.0
Soil Description: Poorly Graded SAND with silt (SP-SM)	Dry Unit Weight (pcf) =	87.3	87.2

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Drafted By: D. Ross
Date: 1/11/2010
Project No.: 94582SR2
File Number: 94582SR2-4

CONSOLIDATION TEST
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORINA

PLATE
2 of 2

KA_CONSOL_STRAIN 303+00-330+00.GPJ 1/11/10

Boring Location/ Surface Conditions:	Levee crown, asphalt concrete	Date Completed:	3/11/2008
		Logged By:	B. Maddy
Groundwater:	Groundwater not measured due to drilling method.	Reviewed By:	M. Briseno
		Total Depth:	116-1/2 feet
Method:	Hollow Stem Auger (20 ft.)/Mud Rotary	Boring Diameter:	8 inch/4 inch
Equipment:	CME 75 with 140 lb. Automatic Hammer		

Approximate Elevation: 43 feet (NAVD88)
Approximate Northing: 2018727 feet
Approximate Easting: 6670742 feet

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
														ASPHALT CONCRETE: About 2 inches
														AGGREGATE BASE: About 2 inches
				6										**Poorly Graded SAND With Gravel** (SP): Gray brown, dry to moist, fine to coarse sand, fine gravel, (Levee)
			1b	10										
			1a	9		103	3			78	1	Grain Size		
				21										
			2b	7										
			2a	6										
38	5													
				11										
			3b	4							2			
			3a	9										
				11										**Poorly Graded SAND** (SP): Gray brown, dry to moist, fine to coarse sand, some fine gravel, (Levee)
			4b	3										
			4a	5										
33	10													
				8										
			5b	3						92	3	HYD		
			5a	5										Brown, moist
				10										
			6b	5										
			6a	7										
28	15													
				10										
			7b	6							3			
			7a	7										
				11										
			8b	9										
			8a	11										
23	20													
				5										
			9b	6							1			
			9a	9										**Well Graded SAND** (SW): Brown, wet, fine to coarse sand, some fine gravel, (Native)
				7										
			10b	9										
			10a	10						94	11	Grain Size		
18	25													**Silty SAND** (SM): Brown, wet, fine sand
				7										
			11b	10										
			11a	10							45			
				2										
			12b	2										
			12a	3										Gray brown

P-LOG_BLOWS PER 6 INCHES 94582SR08-ALL.GPJ 1/14/10

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Date: 1/14/2010
Project No.: 94582SR2
File Number: 94582SR2A-

LOG OF BORING SRE-08- 07
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
					FIELD			LABORATORY						
13	30			12										**SILT** (ML): Brown, moist, firm, low plasticity
			13b	15										
			13a	19							93	HYD		
				6										**Poorly Graded SAND With Silt** (SP-SM): Brown, wet, fine sand
			14b	8										
			14a	10							6			
8	35			3										
			15b	8										
			15a	10										
				5										**Poorly Graded SAND** (SP): Brown, wet, fine sand
			16b	8										
			16a	10							4			
3	40			7										
			17b	9										
			17a	11										
				7										
			18b	11										
			18a	11										
-2	45			11										**Poorly Graded SAND With Silt** (SP-SM): Brown, wet, fine sand
			19b	16										
			19a	18							5			
				6										
			20b	11										
			20a	14										
-7	50			11										
			21b	13										
			21a	18							6			
				8										
			22b	13										Dark gray, with organics
			22a	20										
-12	55			8										**Silty SAND** (SM): Dark gray, wet, fine sand
			23b	11										
			23a	12										
				5										
			24b	9							23			
			24a	11	0.5			NP	NP					
-17	60			11										
			25b	14										
			25a	20							33			
				10										
			26b	16										

P-LOG_BLOWS PER 6 INCHES 94582SR08-ALL.GPJ 1/14/10

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Date: 1/14/2010
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LOG OF BORING SRE-08- 07
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SREL 2 (REACHES 5 THROUGH 9)
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SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
			26a	14										Brown, wet
-22	65													
				14										
			27b	14										
			27a	22							14			
														Poorly Graded SAND (SP): Gray brown, wet, fine sand
				15										
			28b	21										
			28a	20										
-27	70													
				14										
			29b	16										
			29a	19										
														Poorly Graded SAND With Silt (SP-SM): Gray brown, wet, fine to medium sand
				8										
			30b	10										
			30a	14						99	7	Grain Size		
-32	75													
				15										
			31b	20										
			31a	17										
				15										
			32b	19										
			32a	21										
														Well Graded SAND With Gravel (SW): Gray brown, wet, fine to coarse sand, fine gravel
-37	80													
				15										
			33b	19										
			33a	19						84	2	Grain Size		
														Well Graded SAND With Silt And Gravel (SW-SM): Dark gray, wet, fine to coarse sand, fine gravel
-42	85													
				14										
			34b	13										
			34a	13						72	7	Grain Size		
-47	90													
				20										
			35b	21										
			35a	24										
														Poorly Graded GRAVEL With Sand (GP): Dark gray, wet, fine to coarse gravel and sand
-52	95													
			36a	50/6"						21	1	Grain Size		

P-LOG_BLOWS PER 6 INCHES 94582SR08-ALL.GPJ 1/14/10

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Date: 1/14/2010
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LOG OF BORING SRE-08- 07
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SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	Blows/6 inches	Pocket Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphic Log	DESCRIPTION
-57	100		37a	50/6"										
-62	105		38b 38a	6 6 8	1.5			54	28					**FAT CLAY** (CH): Gray, moist, firm, high plasticity
-67	110		39b 39a	8 9 14	1.75									
-72	115		40b 40a	11 17 20	3.0			41	18					**LEAN CLAY** (CL): Gray, moist, hard, medium plasticity
-77	120													Boring completed at a depth of 116-1/2 feet below existing site grade.
-82	125													
-87	130													

P-LOG_BLOWS PER 6 INCHES 94582SR08-ALL.GPJ 1/14/10

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Date: 1/14/2010
Project No.: 94582SR2
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LOG OF BORING SRE-08- 07
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

BORING NO.	SAMPLE DEPTH (ft)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (% of dry weight)	PARTICLE SIZE SIEVE SIZE (percent passing)						ATTERBERG LIMITS		OTHER TESTS
				3"	3/4"	#4	#10	#40	#200	L.L.	P.I.	
EC-08-09	3.5								23			
EC-08-09	6.0								22			
EC-08-09	8.5		23						54	27	4	
EC-08-09	10.5											TXUU
EC-08-09	13.0		30						61	27	7	
EC-08-09	15.0								39			
EC-08-09	17.5								33			
EC-08-09	25.0								44			
EC-08-09	30.0		35							32	9	
EC-08-09	36.0								29			
EC-08-09	41.0		35							56	33	
EC-09-01	3.0								18			
EC-09-01	13.5								4			
EC-09-01	20.0								9			
SRE-08- 07	1.5	103	3		100	78	68	17	1			Grain Size
SRE-08- 07	5.5								2			
SRE-08- 07	10.5				100	92	86	21	3			HYD
SRE-08- 07	15.5								3			
SRE-08- 07	20.5								1			
SRE-08- 07	23.5					94	90	66	11			Grain Size
SRE-08- 07	26.0								45			
SRE-08- 07	31.0								93			HYD
SRE-08- 07	33.5								6			
SRE-08- 07	38.5								4			
SRE-08- 07	46.0								5			
SRE-08- 07	51.0								6			
SRE-08- 07	58.0								23			
SRE-08- 07	58.5									NP	NP	
SRE-08- 07	61.0								33			
SRE-08- 07	66.0								14			
SRE-08- 07	73.5					99	98	42	7			Grain Size
SRE-08- 07	81.0				100	84	64	22	2			Grain Size
SRE-08- 07	86.0				100	72	54	19	7			Grain Size
SRE-08- 07	95.0				80	21	14	7	1			Grain Size
SRE-08- 07	99.0				100	27	7	3	1			Grain Size
SRE-08- 07	105.5									54	28	
SRE-08- 07	116.0									41	18	
SRE-08- 08	1.5	103	3									
SRE-08- 08	3.5				100	80	68	22	4			HYD
SRE-08- 08	8.5								2			
SRE-08- 08	13.5								2			

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SUMMARY OF LABORATORY TESTS
GEOTECHNICAL DATA REPORT
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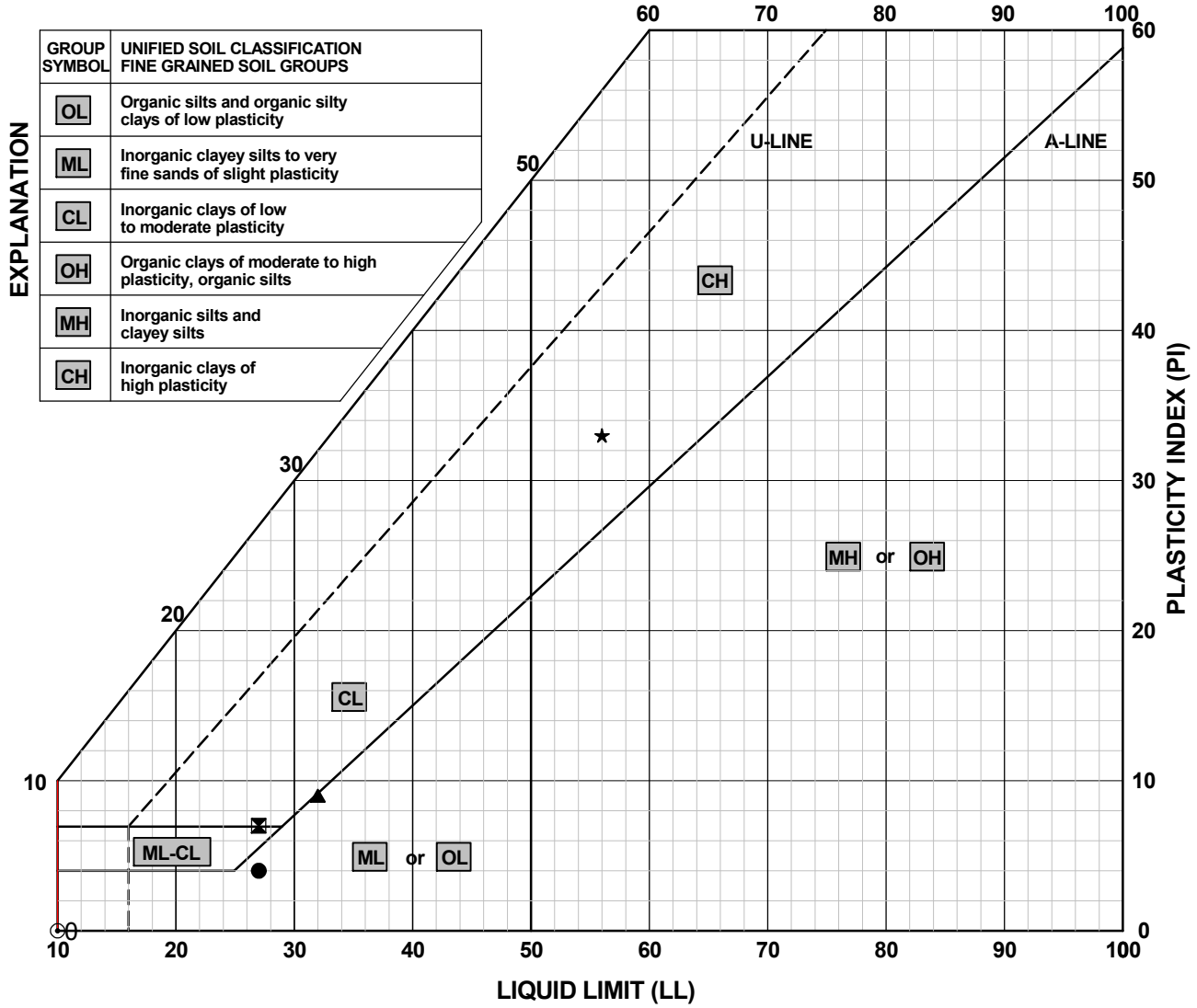
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 3

KA-LABSUM 94582SR08-ALL.GPJ 1/12/10



LEGEND:	SOURCE	DEPTH (ft)	LL	PL	PI	DESCRIPTION
●	EC-08-09	8.5	27	23	4	Sandy Silty CLAY (CL-ML)
⊠	EC-08-09	13.0	27	20	7	Sandy SILT (ML)
▲	EC-08-09	30.0	32	23	9	Sandy LEAN CLAY (CL)
★	EC-08-09	41.0	56	23	33	FAT CLAY (CH)
⊙	SRE-08- 07	58.5	NP	NP	NP	Silty SAND (SM)

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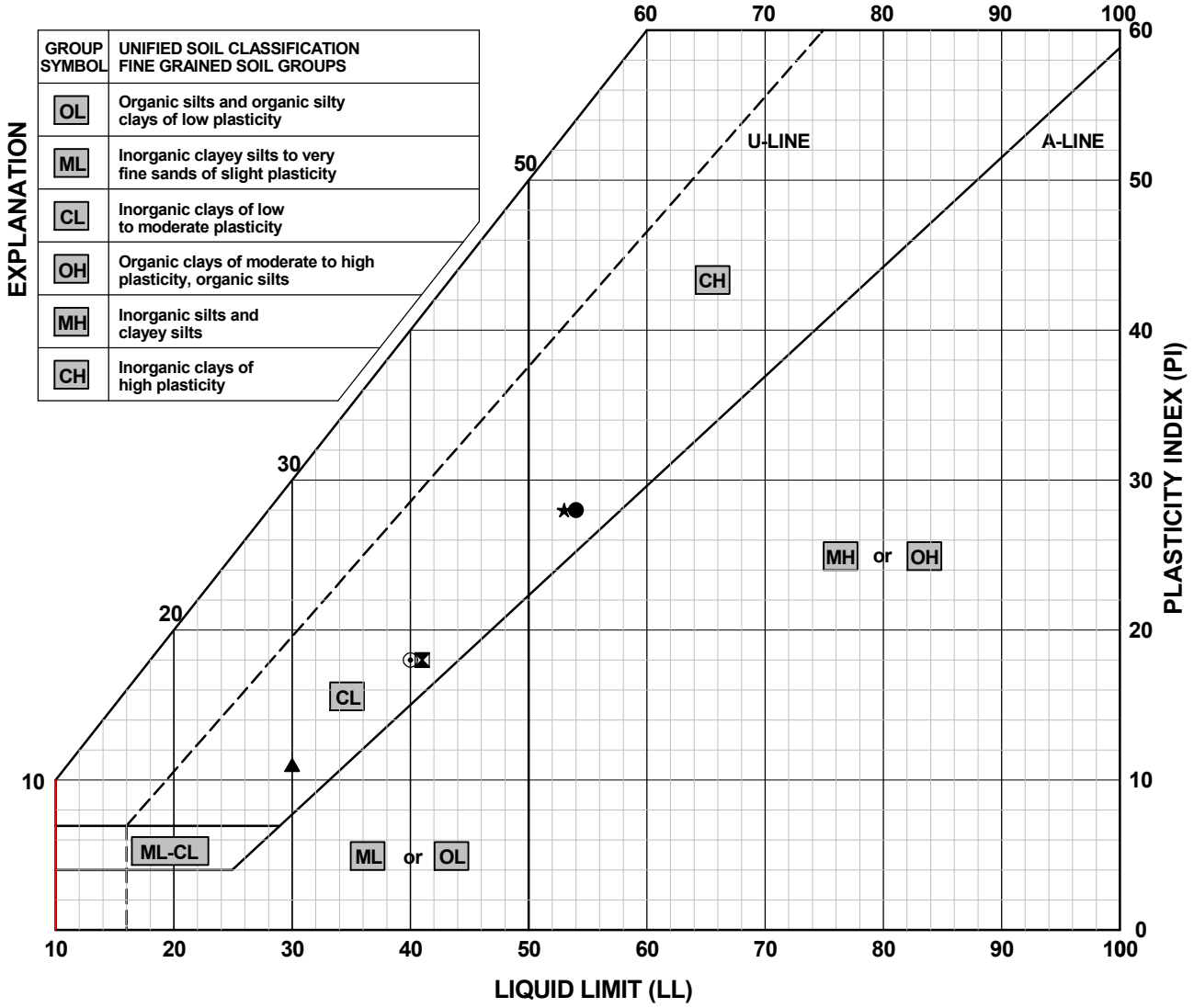
PLASTICITY CHART
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 4

KA_ATTERBERG 94582SR08-ALL.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	LL	PL	PI	DESCRIPTION
●	SRE-08- 07	105.5	54	26	28	FAT CLAY (CH)
⊠	SRE-08- 07	116.0	41	23	18	LEAN CLAY (CL)
▲	SRE-08- 08	26.0	30	19	11	LEAN CLAY (CL)
★	SRE-08- 08	111.0	53	25	28	FAT CLAY (CH)
⊙	SRE-08- 08	116.0	40	22	18	LEAN CLAY (CL)

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PLASTICITY CHART
GEOTECHNICAL DATA REPORT
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SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
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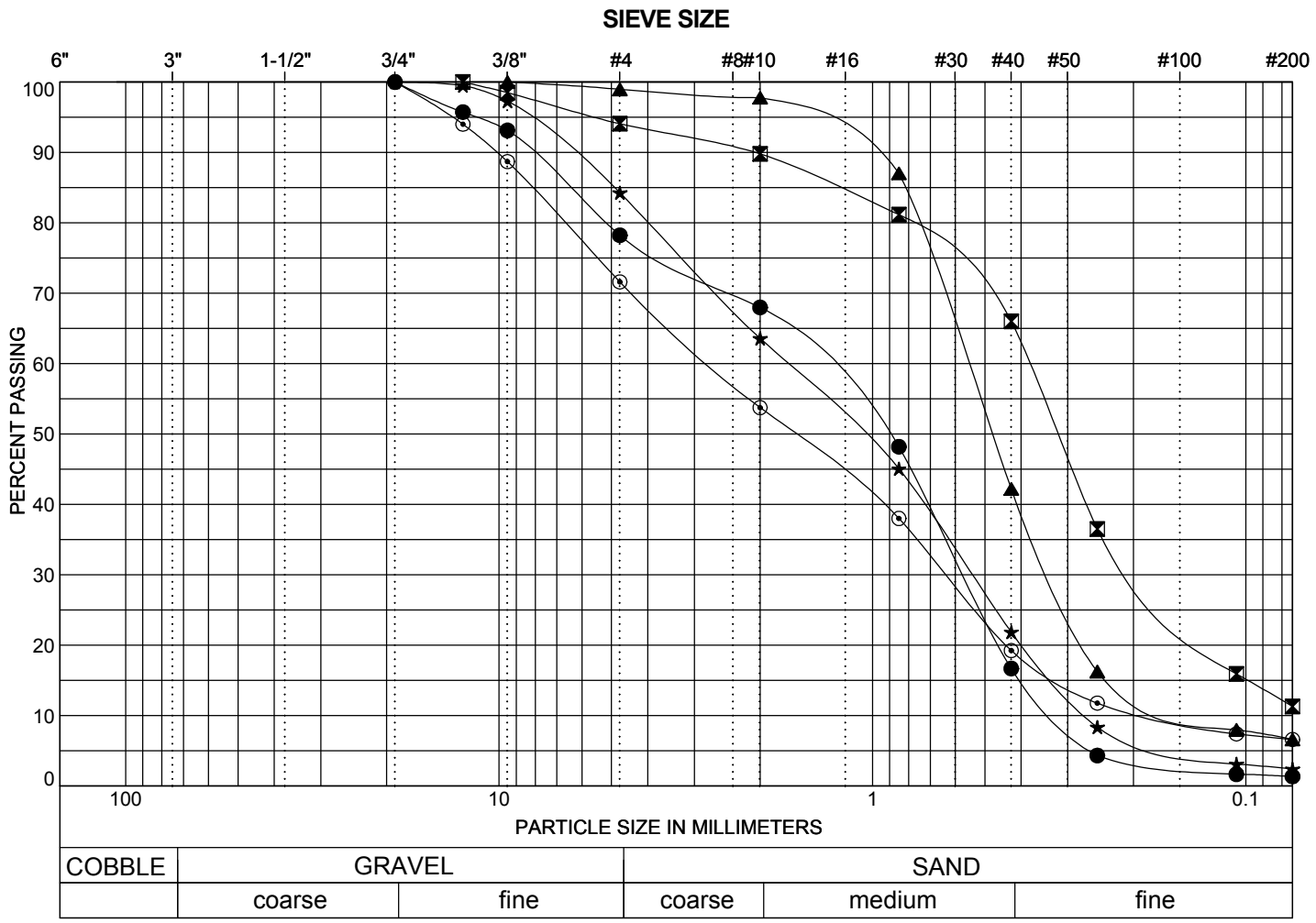
KA_ATTERBERG 94582SR08-ALL.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	COBBLE (%)	GRAVEL (%)	SAND (%)	FINES (%)	D60 (mm)	D10 (mm)	Cu	Cc	DESCRIPTION
●	SRE-08- 07	1.5	0	22	77	1	1.42	0.32	4.4	0.7	Poorly Graded SAND With Gravel (SP)
⊠	SRE-08- 07	23.5	0	6	83	11	0.38		5.6	1.4	Well Graded SAND (SW)
▲	SRE-08- 07	73.5	0	1	92	7	0.56	0.13	4.3	1.5	Poorly Graded SAND With Silt (SP-SM)
★	SRE-08- 07	81.0	0	16	82	2	1.69	0.27	6.4	0.7	Well Graded SAND With Gravel (SW)
⊙	SRE-08- 07	86.0	0	28	65	7	2.71	0.18	15.3	0.8	

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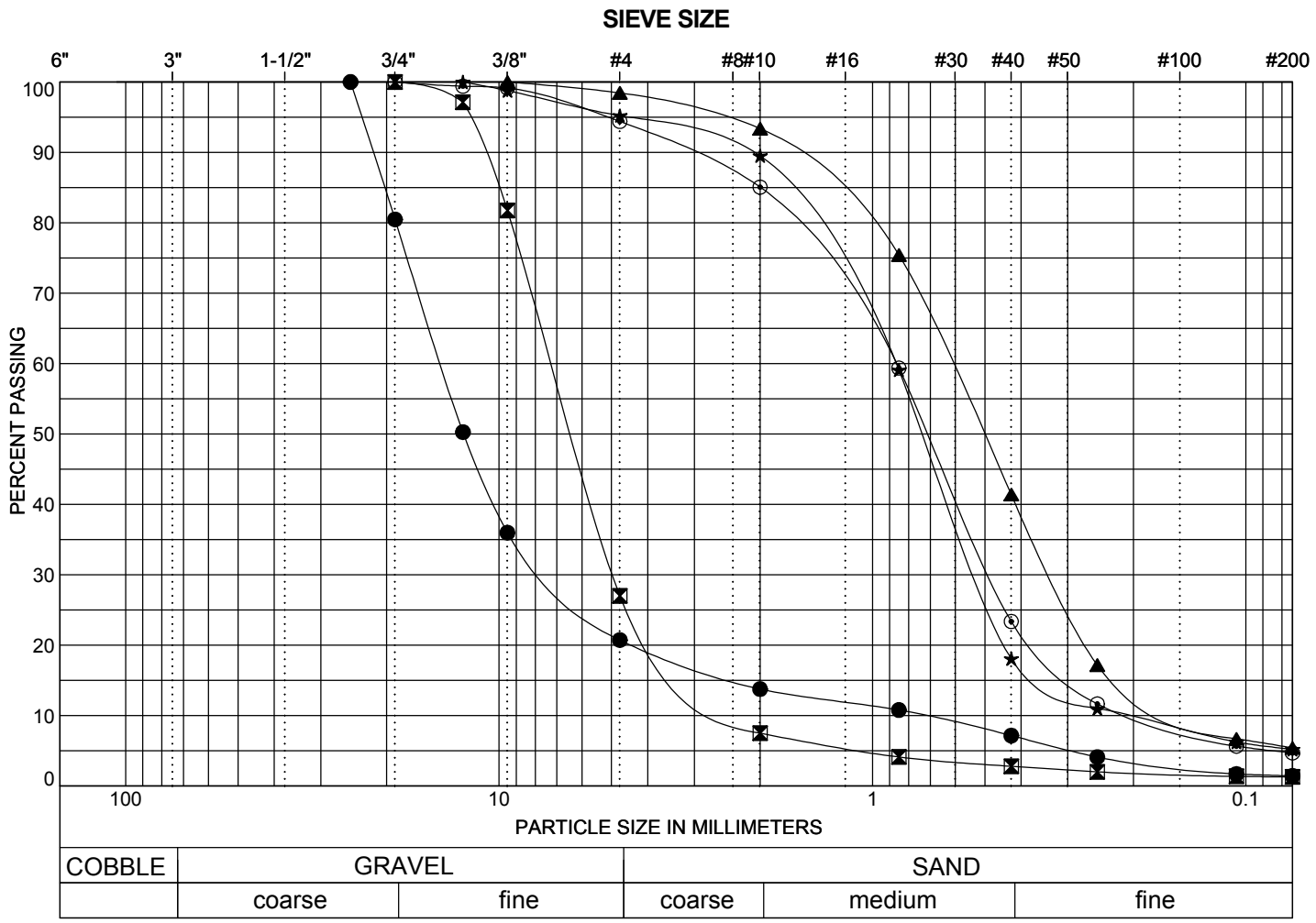
GRAIN SIZE ANALYSES
GEOTECHNICAL DATA REPORT
SACRAMENTO RIVER EAST LEVEE
SREL 2 (REACHES 5 THROUGH 9)
NATOMAS LEVEE IMPROVEMENT PROGRAM
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 5

KA_SIEVE 94582SR08-ALL.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	COBBLE (%)	GRAVEL (%)	SAND (%)	FINES (%)	D60 (mm)	D10 (mm)	Cu	Cc	DESCRIPTION
●	SRE-08- 07	95.0	0	79	19	1	14.31	0.73	19.6	5	Poorly Graded GRAVEL With Sand (GP)
⊠	SRE-08- 07	99.0	0	73	26	1	7.21	2.24	3.2	1.5	Poorly Graded GRAVEL With Sand (GP)
▲	SRE-08- 08	66.0	0	2	93	5	0.62	0.14	4.5	1.3	Poorly Graded SAND With Silt (SP-SM)
★	SRE-08- 08	81.0	0	5	90	5	0.87	0.21	4.2	1.5	Poorly Graded SAND With Silt (SP-SM)
⊙	SRE-08- 08	86.0	0	6	90	5	0.87	0.2	4.4	1.4	Poorly Graded SAND With Silt (SP-SM)

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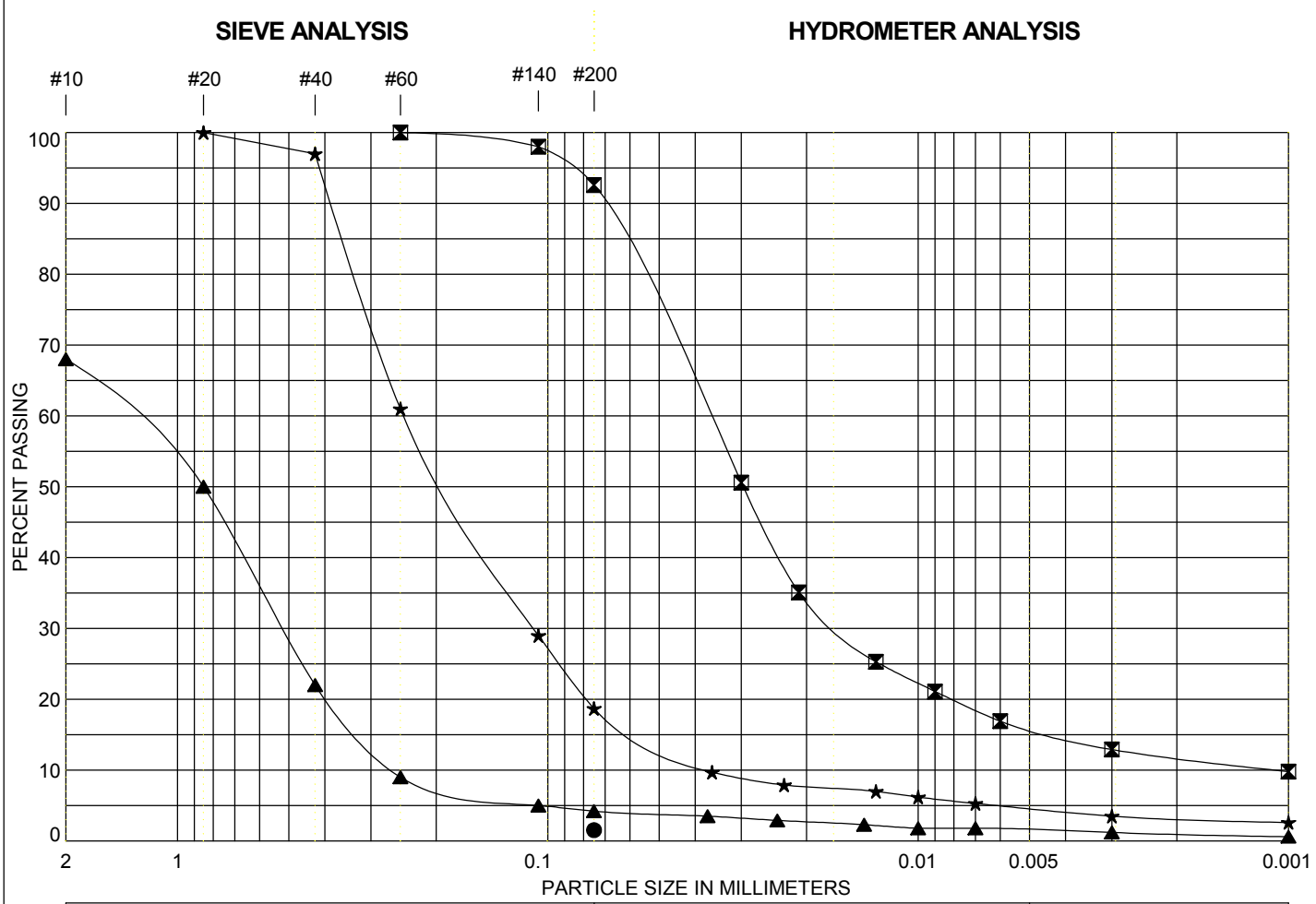
SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
2 of 5

KA_SIEVE 94582SR08-ALL.GPJ 1/11/10



LEGEND:	SOURCE	DEPTH (ft)	SAND (%)	SILT (%)	CLAY (%)	DESCRIPTION
●	SRE-08- 07	5.5	0.0			
⊠	SRE-08- 07	31.0	7.4	76.8	15.8	SILT (ML)
▲	SRE-08- 08	3.5	63.8	2.6	1.6	Poorly Graded SAND With Gravel (SP)
★	SRE-08- 08	18.5	81.3	14.1	4.6	Silty SAND (SM)

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GRAIN SIZE ANALYSES
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SACRAMENTO AND SUTTER COUNTIES, CALIFORNIA

PLATE
1 of 2

KA_HYDRO 94582SR08-ALL.GPJ 1/11/10