CNSU ELK GROVE HOSPITAL

ELK GROVE, CALIFORNIA

GEOTECHNICAL EXPLORATION

SUBMITTED TO
Mr. Matt Spokely
Principal
Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

PREPARED BY
ENGEO Incorporated

April 9, 2019

PROJECT NO.
15747.000.000

ENGEO
Expect Excellence

Project No.
15747.000.000

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Mr. Matt Spokely
Principal
Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

Subject: CNSU Elk Grove Hospital
Elk Grove Boulevard and West Taron Drive
Elk Grove, California

GEOTECHNICAL EXPLORATION

Dear Mr. Spokely:

ENGEO prepared this geotechnical report for Wood Rodgers, Inc. as outlined in our agreement dated January 7, 2018. We characterized the subsurface conditions at the site to provide the enclosed geotechnical recommendations for design.

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to review the project plans and specifications and provide geotechnical observation and testing services during construction. Please let us know when working drawings are nearing completion, and we will be glad to discuss these additional services with you.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

Nicholas Broussard, GE

Mark Gilbert, GE

Paul Cottingham, CEG

nb/pjc/mmg/dt

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

ENGEO prepared this geotechnical report for design of the California Northstate University (CNSU) Elk Grove Hospital in Elk Grove, California. We prepared this report as outlined in our agreement dated January 7, 2019. Wood Rogers authorized ENGEO to conduct the following scope of services for design of the project and to meet the intent of OSHPD requirements including California Geological Survey Note 48:

- Service plan development
- Subsurface field exploration
- Soil laboratory testing
- Data analysis and conclusions
- Report preparation

For our use, we received the following:

1. Fong & Chan Architects; Site Base Schematic received August 6, 2018.
2. Fong & Chan Architects; Project Description, received March 11, 2019
3. Fong & Chan Architects; Elk Grove Hospital Building Section, Sheet Sk-1, pdf dated March 6, 2019.
4. Fong & Chan Architects; Master Plan and Phasing Plans, Renderings of Hospital Building (8 sheets), pdf dated February 21, 2019.
5. Wood Rogers; Base Parcel Map, received January 11, 2019.
6. Wood Rogers; Topographic Plan, CNSU Elk Grove Campus, received January 11, 2019.
7. Wood Rogers; Preliminary Site Plan, California North State University Medical Campus, April 5, 2019.
8. Eric Ko Consulting; Hospital Building Structural Loads and Structure Details email received January 24, 2019.
9. Neil O' Anderson; Geotechnical Investigation, West Taron Office Park, Elk Grove, CA, July 12, 2005.
10. Neil O' Anderson; Supplemental Geotechnical Investigation Letter, West Taron Office Park, Elk Grove, CA; June 10, 2008.

Based on our communication with Eric Ko, the project Structural Engineer, we understand the project will be designed and submitted to OSHPD based on the 2016 California Building Code (CBC).

This report was prepared for the exclusive use of our client, the project consultants, and CNSU for design of this project. If any changes are made in the character, design or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to evaluate whether modifications are recommended. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 PROJECT LOCATION

Figure 1 displays the Site Vicinity Map. The approximately 25-acre site is located southwest of the intersection of Elk Grove Boulevard and West Taron Drive in Elk Grove, California. West Taron Court extends into the central portion of the site from West Taron Drive. The center of the site is at approximately 121°29'W and 38°24'N.

As shown on the Existing Conditions Site Plan, Figure 2, the site is bordered by Elk Grove Boulevard to the north, West Taron Drive to the east, residential development to the south, and a non-federal levee and drainage corridor to the west.

1.3 PROJECT DESCRIPTION

The project description document (Fong & Chan, March 11, 2019) indicates the project will include the construction of numerous structures, as summarized in Table 1.3-1. Figure 3, Proposed Development Site Plan, shows the proposed locations of these project features.

TABLE 1.3-1: Proposed Structure Details

BUILDING	BASEMENT ONE LEVEL BELOW PROPOSED GRADE	MAXIMUM NUMBER OF STORIES ABOVE PROPOSED GRADE
Hospital	Yes	13
Outpatient Clinic	No	3
Central Plant	Yes	2
Administration	No	3
Dormitory	Yes	5
Retail with Parking Above (North)	Yes	5
Retail with Parking Above (South)	Yes	5
Medical Office (MOB)	No	3
Graduation Quad	No	1

Between 2002 and 2009, the site was developed including the CNSU School of Medicine Building, a retail center, a large office building (ALLDATA), utilities, and parking lots. We understand all existing above-grade structures will be demolished except for the existing CNSU building.

The project is to be constructed in three phases, as illustrated in the phasing plan provided by Fong & Chan (February 21, 2019). The hospital and central plant, which are to be constructed in Phase 1, will generally have site grades raised by approximately 7 feet. The 13-story hospital is to be a special reinforced concrete shear wall building that will be up to 255-feet tall, with the first floor at approximately Elevation 24 feet (NAVD88). The basement floor is to be 17 feet below the first floor, or approximately Elevation 7 feet. No information was yet available for the other basement elevations, so we assume they are also roughly 17 feet below the first floor. The hospital typical interior column dead loads will be up to 900 kips and live loads up to 600 kips. At this time, we understand it is planned to support the hospital on either a deep foundation system or a structural mat foundation. The structural engineer indicated that the mat foundation would likely be approximately 5 feet thick if used.

Phase 2 includes a 7-story patient bed tower added on top of the hospital podium, two parking structures, an outpatient clinic, and medical office building (MOB). Phase 3 includes the Dormitory

and Administration buildings. Site grades for Phase 2 and 3 structures are to be generally similar to existing grade.

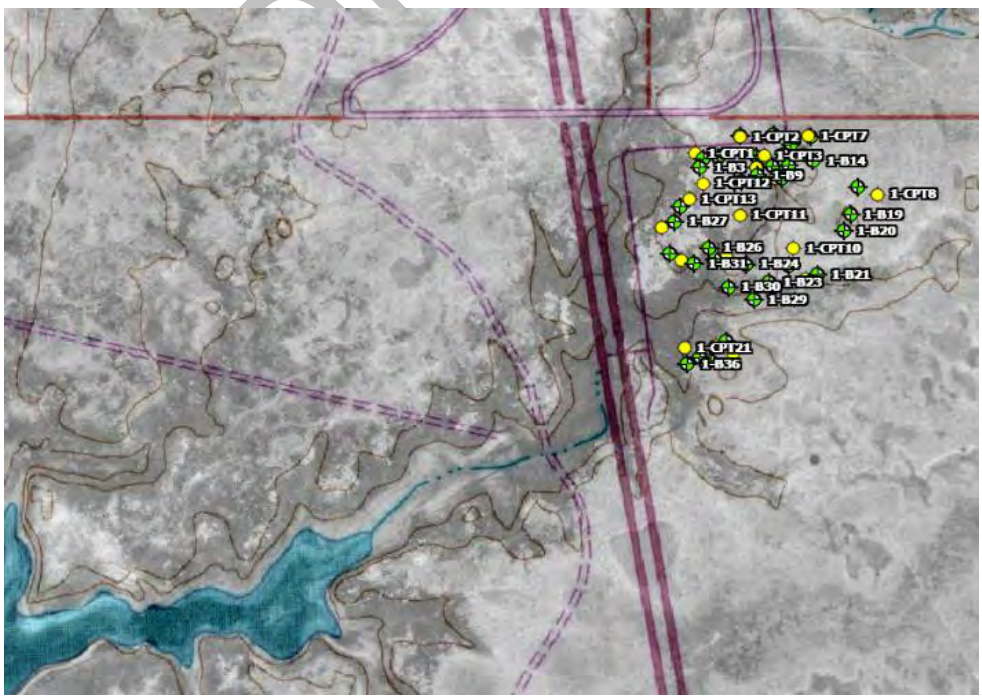
2.0 FINDINGS

2.1 HISTORIC AERIAL REVIEW

We reviewed historic aerial photographs from Google Earth, University of California Santa Barbara historic aerial photograph database, and historicaerials.com. In addition, we reviewed historic USGS topographic maps of the project area.

Historic aerial photos from UCSB in 1937 and 1971 show the site undeveloped and what appeared to have been vegetated natural drainages that fed towards Stone Lake to the southwest. A 1968 USGS topographic map identified these drainage features as having approximately 5 to 10 feet of topographic relief or below approximately Elevation 5 feet (NGVD29). Exhibit 1 is an overlay of the 1937 UCSB aerial photo, the 1968 USGS historic topographic map, and the explorations that we performed. An October 1999 UCSB aerial photo showed grading at the site and throughout the adjacent properties to the south and north with no improvements visible, and a detention basin located in the southern portion of the site. The May 2002 Google Earth aerial photo showed the CNSU Medical School building and parking lot were constructed as well as West Taron Drive and West Taron Court. The July 2006 Google Earth aerial photo showed the commercial development on the north side of West Taron Court was under construction. The 2007 Google Earth aerial photo showed the commercial development north of West Taron Court was completed and the central portion of the site at the ALLDATA center was sheet graded. The May 2009 Google Earth aerial photo shows the ALLDATA building and parking lot nearly completed. We did not observe any significant changes between the Google Earth August 2009 and August 2018 aerial photos.

EXHIBIT 2.1-1: 1968 USGS Topographic and 1937 UCSB Historic Aerial Photo Overlay



2.2 PREVIOUS GEOTECHNICAL STUDIES

We were provided with two previous geotechnical explorations performed at the site by Neil O' Anderson in 2005 and 2008. The explorations were performed for the West Taron Office Park, which ultimately became the ALLDATA building. The associated subsurface exploration locations are shown on Figures 2 and 3.

The 2005 geotechnical exploration consisted of nine soil borings to depths of 5 to 16½ feet and nine test pits to depths of 6 to 10 feet. The test pits were performed in areas that the soil borings had reportedly encountered fill and included in-situ density and moisture contents of the reported fill using a nuclear gauge to measure the relative compaction. The 2005 report concluded that "the primary geotechnical consideration that will influence the development of this site is the presence of suspect fill that was encountered in the southern portion of the [ALLDATA] site. A secondary consideration is the presence of expansive clay soils at foundation and slab elevations." They encountered up to 6 feet of clay fill underlain by up to "3.5 feet of organic sandy clay". In test pits TP-2 through TP-6, they reportedly estimated the percent relative compaction of the existing fill to range between 78 and 87 percent relative compaction. They recommended that the fill be over-excavated and replaced as engineered fill. The borings reported no existing fill on the northern side of the parcel in Boring B-1, B-5, B-7, and B-8.

The 2008 geotechnical exploration consisted of two soil borings to depths of 11½ feet and additional lab testing. The report describes the existing fill as compacted, engineered fill, up to 7 feet in depth and no longer referred to the existing fill as 'uncontrolled.' The letter states that modified consolidation testing was performed on two samples of the fill (ASTM D5333) to "qualitatively estimate the potential of differential settlement that the fill could experience. The samples exhibited 0.5% and 0.6% strain when subjected to flooding". The report provided supplemental recommendations to maintain a minimum of 24 inches of engineered fill below all footings and no longer recommended that the existing fill be removed. It stated that all other recommendations per the original July 12, 2005 report shall apply.

At the time we prepared this report, the geotechnical reports performed for the northern commercial development and the California Northstate University development on the site were not available. In addition, no geotechnical testing and observation documents were available regarding previous grading at the site. The ALLDATA facility manager informed us via personal communication that the near surface soils were lime-treated during the construction of the CNSU building and ALLDATA facility; the extent of the lime treatment is unknown.

2.3 GEOLOGY

The site is located in the Great Valley geomorphic province. The Great Valley is an elongate, northwest-trending structural trough bound by the Coast Range on the west and the Sierra Nevada on the east. The Great Valley has been, and is presently being filled with sediments transported by powerful river systems originating in the surrounding mountains. These sediments of various ages underlie the site to great depths above the Jurassic metamorphic basement rock estimated to be approximately 10,300 feet deep at the site (Helley and Harwood, 1982). The age and character of the alluvial deposits in the Great Valley is varied and complex with a strong influence from paleo-climactic conditions (including Pleistocene glaciations) and the ancient depositional environment.

The site boundaries are shown on the Regional Geologic Map, Figure 4 (Dawson, 2009). The map characterizes the western and southern boundaries of the site as Holocene Basin deposits; these areas appear to correspond to the pre-development drainages that historically sloped towards Stone Lake to the southwest. The Basin deposits are generally composed clays that have accumulated in distal flood plains of the present day river systems; these deposits appear to be relatively thin at the site below the existing fill. The middle unit of the Pleistocene Riverbank Formation is mapped underlying the majority of the site and also underlies the Basin deposit clay. The Riverbank Formation deposits are made up of alluvial sediments derived from the Sierra Nevada generally carried by relatively small ancestral drainages running east to west. The middle unit of the Riverbank Formation is considered to be approximately 260,000 years old ± 45,000 years (Marchland and Allwardt, 1981). This formation is generally composed of clay and silt with varying amounts of sand, clayey sand, and minor lenses of poorly graded sand. Due to the advanced age, this formation commonly includes advanced weathering and cementation.

2.4 SEISMICITY

The site is not located within a currently designated Alquist-Priolo Earthquake Fault Zone and no known surface expression of active faults is believed to exist within the site. Generally, a fault is considered active if it has ruptured within the Holocene epoch (11,000 years before present).

The Regional Faulting and Seismicity map, Figure 5, illustrates the location of the site relative to the 2018 U.S.G.S. Quaternary Fault Database. The site does lie within a seismically active region, as California has numerous faults that are considered active.

The Third Uniform California Earthquake Rupture Forecast (UCERF3) is the latest comprehensive model of earthquake occurrence for California that provides the estimates of magnitude, location, and likelihood of potentially damaging earthquakes in California. This model was used to develop the 2014 update of the USGS National Seismic Hazard Maps. We used the OpenSHA software (http://www.opensha.org/), which incorporates UCERF3, to deaggregate the hazard for a 2,475-year return period (i.e., a 2% in probability of occurrence in a 50-year period) at multiple spectral periods to identify the fault sources contributing to the hazard at the site.

Note that the UCERF3 model divides faults into multiple segments and has numerous rupture scenarios for each fault. Each rupture scenario involves a different number of segments and can include segments from other nearby faults. The maximum magnitudes listed in Table 2.4-1 are associated with very low-probability ruptures that involve the highest possible number of fault segments. We judged a magnitude 6.8 to be appropriate for our liquefaction analysis in Section 3.2. Since the PGA used in the liquefaction analysis is probabilistically derived, we deemed this magnitude to be more appropriate than the magnitudes shown in Table 2.4-1.

TABLE 2.4-1: UCERF3 Fault Sources Contributing More Than 1% to Ground Shaking Hazard at Spectral Period of Peak Ground Acceleration

FAULT NAME	MAXIMUM MOMENT MAGNITUDE* (M_W)	CLOSEST DISTANCE FROM SITE (miles)
Bartlett Springs	7.64	38.8
Calaveras (Central)	7.57	53.6
Calaveras (No)	6.91	50.0
Calaveras (So)	7.68	53.6
Concord	7.68	39.9
Great Valley 03 Mysterious Ridge	7.28	28.1

FAULT NAME	MAXIMUM MOMENT MAGNITUDE* (M_W)	CLOSEST DISTANCE FROM SITE (miles)
Great Valley 03a Dunnigan Hills	6.41	24.7
Great Valley 04a Trout Creek	7.12	30.6
Great Valley 04b Gordon Valley	7.22	30.1
Great Valley 05 Pittsburg - Kirby Hills	6.46	25.3
Great Valley 06 (Midland)	7.23	16.5
Green Valley	7.72	39.9
Greenville (No)	6.85	46.0
Greenville (So)	7.09	41.5
Hayward (No)	7.24	54.8
Hayward (So)	7.51	53.6
Hunting Creek - Bartlett Springs	7.74	51.4
Hunting Creek - Berryessa	7.66	40.4
Maacama	7.50	61.1
Rodgers Creek - Healdsburg	7.52	53.6
San Andreas (Creeping Section)	7.99	73.5
San Andreas (North Coast)	8.21	73.5
San Andreas (Offshore)	8.27	73.5
San Andreas (Peninsula)	7.81	73.5
West Napa	6.88	44.8

*Based on UCERF3. Includes multi-fault ruptures.

Figure 5 also shows the corresponding earthquake magnitude of historic earthquakes that have occurred since 1800 with earthquake magnitudes of 5 or larger. The historic earthquake magnitudes on Figure 5 indicate a magnitude 6 to 7 earthquake occurred approximately 18 miles to the west of the site along the Great Valley Fault. Approximately 23 miles northwest of the site, the figure indicates a magnitude 7+ event has occurred near the Great Valley Fault. One recent significant earthquake in the Bay Area was the magnitude 6.0 South Napa earthquake that occurred on August 24, 2014, approximately 50 miles southwest of the site. According to the USGS Earthquake Hazards Program interactive map for the South Napa earthquake, the estimated modified mercalli intensity near Elk Grove was a III; this correlates to a weak perceived level of shaking as a result of the earthquake.

2.5 FIELD EXPLORATION

Our field exploration included drilling 36 borings and advancing 21 Cone Penetration Test (CPT) soundings at various locations on the site. We paired 1-CPT9 with Boring 1-B9, 1-CPT4 with Boring 1-B8, and 1-CPT2 with Boring 1-B4 to check CPT predicted soil behavior types with drilled borings. We performed our field exploration between January 8 and 22, 2019. The boring logs are located in Appendix A and the CPT logs are included in Appendix C. The locations of the borings and CPTs are illustrated on the Existing Conditions Site Plan and Proposed Development Site Plan, Figures 2 and 3, respectively.

The explorations were permitted and backfilled in accordance with Sacramento County requirements. The location of our explorations were approximately located by estimating from site features and the use of a cell phone GPS. The elevations of the explorations were interpolated from the topographic plan prepared by Wood Rogers. The location and elevations of our explorations should be considered accurate only to the degree implied by the methods used.

Our field exploration also included a geophysical survey to evaluate the building code site class and appropriate shear wave velocity data for the site-specific ground motion hazard analysis.

2.5.1 Borings

We observed drilling of 36 borings at the locations shown on the Existing Conditions Site Plan, Figures 2. An ENGEO representative observed the drilling and logged the subsurface conditions at each location. We retained a truck-mounted Mobile CME55 drill rig and crew to advance borings using 3½-inch-diameter solid flight auger and mud rotary borings. We also retained a track-mounted Mobile CME75 drill rig and crew to advance select borings using mud rotary methods with a 3¾-inch-diameter bit. The borings were advanced to depths ranging from 16½ to 51½ feet below existing grade.

We obtained bulk soil samples from drill cuttings and retrieved soil samples at various intervals in the borings using both 2-inch and 3-inch O.D. split-spoon samplers. The standard penetration resistance blow counts were obtained by dropping a 140-pound hammer through a 30-inch free fall. The split-spoon samplers were driven 18 inches and the number of blows was recorded for each 6 inches of penetration. Unless otherwise indicated, the blows per foot recorded on the boring log represent the accumulated number of blows to drive the last 1 foot of penetration; the blow counts have not been converted using any correction factors. When sampler driving was difficult, penetration was recorded only as inches penetrated for 50 hammer blows.

We used the field logs to develop the report logs in Appendix A. The logs depict subsurface conditions at the exploration locations for the date of exploration; however, subsurface conditions may vary with time.

PHOTO 2.5.1-1: CME55 Truck Rig At 1-B12

PHOTO 2.5.1-2: CME75 Track Rig At 1-B3

2.5.2 Cone Penetration Tests

We retained a CPT rig and crew to advance 21 cone penetrometers to a maximum depth of 74 feet. The CPTs that terminated shallower than 50 feet encountered practical refusal before the target depth. After encountering initial refusal near the ground surface in some locations, the driller used the solid flight auger to predrill the upper approximately 2½ feet of 1-CPT4, 1-CPT9, 1-CPT12, and 1-CPT15. The data shown over these predrill depths was not used in our analysis.

The CPT had a 20-ton compression-type cone with a 10-square-centimeter (cm^2) base area, an apex angle of 60-degrees, and a friction sleeve with a surface area of 225 cm^2. The cone, connected with a series of rods, was pushed into the ground at a constant rate. Cone readings were taken at approximately 5-cm intervals with a penetration rate of 2 cm per second in accordance with ASTM D-5778. Measurements include the tip resistance to penetration of the cone (Qc), the resistance of the surface sleeve (Fs), and pore pressure (U) (Robertson and Campanella, 1988).

Select CPTs were converted to seismic CPTs to measure shear wave velocity to aid in the site response analysis. The CPTs selected included 1-CPT4, 1-CPT9, 1-CPT15, and 1-CPT21.

CPT logs and shear wave velocity data are presented in Appendix C. The shear wave velocity plots shown on the CPeT-IT output in Appendix C are based on correlations and are not the measured shear wave velocity measurements.

2.5.3 Geophysical Testing

We retained the services of GEOvision to perform non-invasive surface wave testing and develop a shear wave profile to a depth of 100 feet or more. For this investigation, the Multi-channel Analysis of Surface Waves (MASW) method was utilized as the active-source surface wave technique, and the Microtremor Array Measurement (MAM) method was utilized as the passive-source. These techniques utilize one- and two-dimensional arrays of sensors, respectively. The array locations are illustrated in the figure below, with the MASW array shown in red, and the MAM array shown in blue. The dispersion curves generated from these methods were combined and modeled using iterative forward and inverse modeling techniques, the final model profile is assumed to represent actual site conditions. The average shear wave velocity for the upper 30 meters (V_{S30}), or 100 feet (V_{S100ft}) using this model was 337 m/s (1,109 ft/s). The geophysical survey results and report are included in Appendix E.

EXHIBIT 2.5.3-1: Geophysical Test Surface Wave Locations

In case future phases of the project incorporate site-specific response spectras, we used horizontal-to-vertical spectral ratio (HVSR) testing to estimate the fundamental shear wave resonant frequency (f_0) of the site (SESAME 2004). This testing involves placing a small three-component seismometer at the ground surface and recording ambient vibrations for a period of approximately 1 hour. The ambient vibration recordings are used to calculate HVSR as a function of frequency. To calculate HVSR, we divided the full time record at each location into 180-second time windows, resulting in 19 to 22 time windows per test location. We smoothed each window using the procedures discussed in Konno and Ohmachi (1998) and tapered the ends using a cosine taper with a width of 5 percent of the time window length. We chose the squared average of the Fourier Amplitude Spectra (FAS) of the north-south and east-west components to represent the average horizontal component. We then divided the average horizontal FAS by the vertical FAS to obtain HVSR. We averaged the HVSR spectra from individual time windows at each location in log space. The results are shown in Exhibit 2.5.3-3.

If a well-defined peak is present in the HVSR spectrum, this can be identified as f_0 (SESAME 2004). It can be seen in Exhibit 2.5.3-3 that there is a broad and relatively low-

amplitude peak between 0.55 and 0.89 Hz. These peaks are not consistent with strong resonance. However, they suggest some possible modest resonance in this frequency range.

EXHIBIT 2.5.3-2: HVSR Test Locations

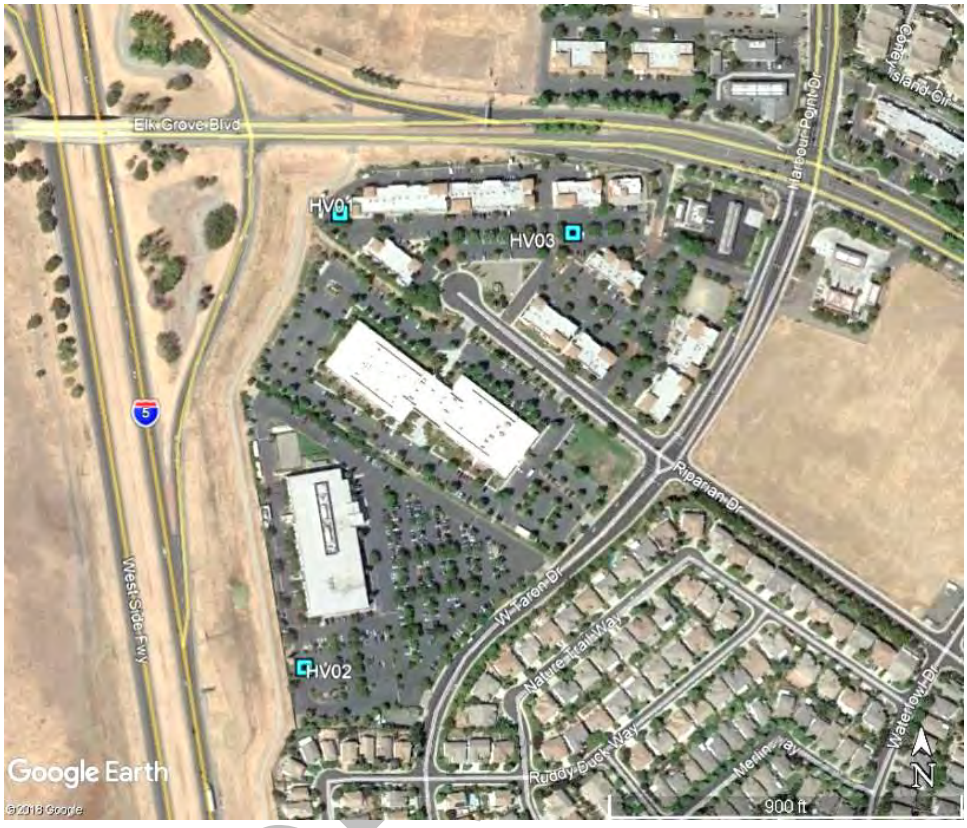
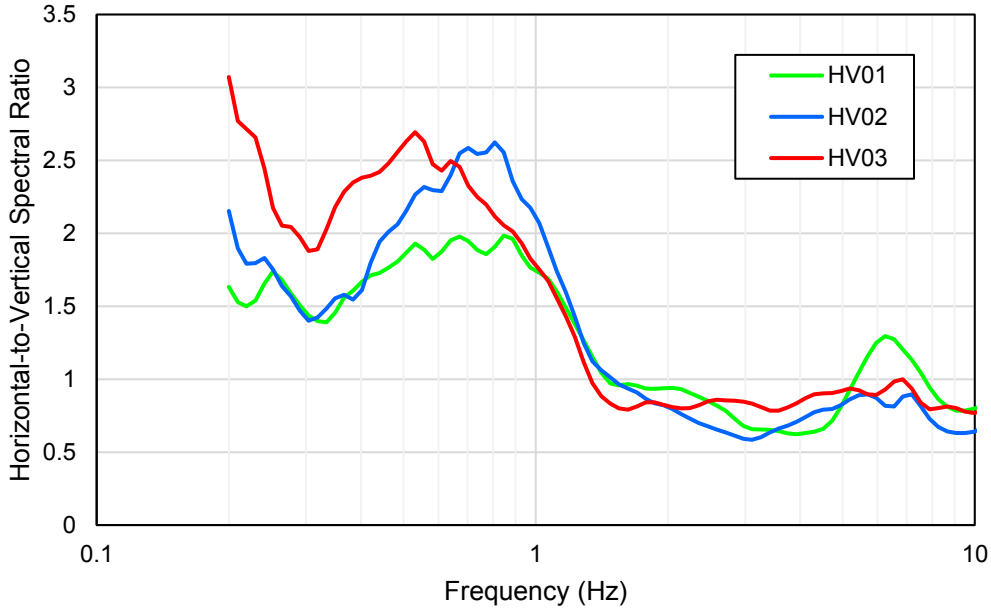


EXHIBIT 2.5.3-3: HVSR Spectra



2.6 SURFACE CONDITIONS

The topographic plan indicates the site has gentle topographic relief. Site grades range from approximately Elevation 15 to 19 feet (NAVD88). The ground surface around the northern commercial building complex generally slopes to the west, while the central and southern portions of the site generally slope towards the east. The site is located approximately 1½ miles east of the Sacramento River.

We observed the following site features during our reconnaissance:

- Multiple structures were located throughout the site as shown in our Existing Conditions Site Plan (Figure 2). The northern portion of the property was occupied by nine single-story commercial buildings, the central portion by a single-story office building, and the southern portion by the 2-story California Northstate University building. The majority of the surface surrounding the structures consisted of asphalt parking lots and landscaped areas that contained trees and shrubs.

- Three undeveloped parcels were located on the site at exploration locations 1-CPT5 (APN 132-248-005), 1-CPT8 (APN 132-248-007), and 1-B21 (APN 132-216-002). Utility stubs were visible near the east side of the lot near 1-CPT8. The building pads near 1-CPT5 and 1-CPT8 were generally covered in gravel and had minimal vegetation. The southern parcel near 1-B21 (APN 132-216-002) was covered in a moderate growth of grasses with a spongy and wet surface from recent rains.

- An approximately 5-foot tall earthen embankment bordered the west side of the site. On the west side of the embankment was a drainage corridor that drains towards the south with invert elevations of approximately Elevation 10 feet. The Elk Grove General Plan Safety Element indicates that this embankment is a non-federal levee that provides 100-year flood protection to the site and nearby residential communities.

PHOTO 2.6-1: Existing Commercial Development

PHOTO 2.6-2: Existing California North State University

2.7 SUBSURFACE CONDITIONS

We provide a summary of the subsurface conditions that we encountered below. Figure 3 indicates the locations where we developed geologic cross sections to illustrate the subsurface conditions at each of the primary structures; the cross sections are included in Appendix D.

FILL

Each of our soil borings encountered fill that ranged in thickness from 3 to 11 feet below ground surface. The fill thickness is shown at each boring location on Figures 2 and 3. The fill encountered generally consisted of stiff to hard lean clay or medium dense to dense clayey sand. Plasticity index (PI) test results ranging from 12 to 20 and an expansion index (EI) test result of 62 indicate the clayey fill exhibits low to moderate expansion potential. In some borings, we encountered lean clay to fat clay fill below a depth of 5 feet that exhibited medium to high plasticity (PI = 33). We observed trace organics in portions of the fill and near the transition to native soil. The fill thickness we encountered is generally thicker than what was reported in the previous 2005 and 2008 explorations performed for the ALLDATA site; however, the fill type and consistency are generally consistent with what we encountered.

Some of our explorations encountered unusually high blow counts or CPT tip resistance at shallow depths in the fill. Due to suspected lime-treatment operations from the former grading at the site, we applied phenolphthalein solution to select soil samples in the laboratory. Phenolphthalein solution can be used to evaluate the presence of lime-treated soil by turning a magenta color at pH of 8.3 to 10. Out of 34 borings that we checked with phenolphthalein, 17 of the borings had positive reactions at depths that ranged from 1 to as deep as 4½ feet. The borings that had phenolphthalein reactions were located within portions of or adjacent to the proposed hospital building, outpatient clinic, northern retail with parking structure, southern retail with parking structure, graduation quad, and administration building; the borings tested within the footprint of the proposed central plant and MOB buildings did not have phenolphthalein reactions. The specific samples that had phenolphthalein reactions are indicated on the boring logs in Appendix A.

Table 2.7-1 indicates the approximate depth at which fill was encountered, as well as the sample depths, which reacted to phenolphthalein.

TABLE 2.7-1: Fill Depths and Phenolphthalein Reactions Summary

EXPLORATION LOCATION	APPROX. FILL DEPTH* (FEET)	PHENOLPHTHALEIN REACTION?	SAMPLE DEPTH(S) WITH REACTION (FEET)
1-B1	5	No	-
1-B2	4½	No	-
1-B3	5	Yes	1½, 2
1-B4	11	No	-
1-B5	4	No	-
1-B6	6	Yes	2½
1-B7	5	Yes	1½
1-B8	3½	Yes	1½
1-B9	4	Yes	1
1-B10	3	Yes	1½

EXPLORATION LOCATION	APPROX. FILL DEPTH* (FEET)	PHENOLPHTHALEIN REACTION?	SAMPLE DEPTH(S) WITH REACTION (FEET)
1-B11	3½	Yes	1½
1-B12	4½	No	-
1-B13	4	Yes	1½
1-B14	6	No	-
1-B15	6	No	-
1-B16	6	Yes	1
1-B17	6	Yes	1, 1½
1-B18	5¾	Yes	1
1-B19	5¾	Yes	1½, 2
1-B20	6¾	No	-
1-B21	6	Yes	2½, 3
1-B22	7	Yes	2½, 3
1-B23	8½	Yes	2, 2½
1-B24	10½	No	-
1-B25	7	No	-
1-B26	8½	Not Tested	-
1-B27	6	No	-
1-B28	7	No	-
1-B29	11	No	-
1-B30	7	Yes	2, 2½, 3, 4½
1-B31	7	Yes	2, 2½, 3
1-B32	6¼	No	-
1-B33	7½	No	-
1-B34	10	Not Tested	-
1-B35	8¼	No	-
1-B36	7½	No	-

*Fill depth referenced from ground surface or top of pavement.

HOLOCENE BASIN (Qhb)

We encountered Holocene Basin deposits directly below the fill in Borings 1-B11, 1-B25, 1-B31, 1-B32, and 1-B36. These clay soils were generally dark bluish gray to dark brown, contained trace roots, exhibited medium to high plasticity, and were stiff to hard. Plasticity index tests on representative samples from 1-B33 and 1-B25 resulted in PIs of 33 and 36, respectively. No cementation or carbonates were observed within these layers. The thickness of the layer in each of these borings was approximately 2 to 3 feet and were less than 10 feet from existing site grade. In 1-B11, the fat clay was as shallow as 3½ feet below grade. Based on similar color and trace roots in the base of some fills, we anticipate the Holocene basin deposits in other locations may have been removed and recompacted as engineered fill.

MIDDLE UNIT – RIVERBANK FORMATION (Qr2)

Beneath the fill or Holocene Basin deposits, our explorations typically encountered stiff to hard, low to medium plasticity clays and silts with interlayered medium dense to very dense sand layers.

Plasticity index tests on representative samples of the lean clay resulted in PIs of 10, 12, 13, and 15. We encountered very stiff to hard fat clay below the fill in Borings 1-B28 and 1-B33. These fat clays were approximately 5 to 7 feet below existing grade.

Clayey to silty sand was encountered in the western side of the hospital building footprint, central portion of the site, and southern portion of the site; the sand appeared to be discontinuous and variable in depth and thickness. However, in the northern and northeastern portion of the site our explorations encountered thicker and more continuous sand layers with fewer fines (i.e., percent passing the No. 200 sieve). Boring 1-B14 encountered this sand layer at an approximate depth of 14 feet to the terminal depth of 31½ feet. Boring 1-B8 encountered an approximately 27-foot thick medium dense to dense sand layer from approximately 24 feet to 51½ feet separated by one 3-foot layer of silt near a depth of 30 feet. This thicker sand layer was encountered in several explorations within the footprint of the hospital building and outpatient clinic. In the northern parking structure footprint, we encountered an approximately 8-foot thick medium dense to dense sand layer in Borings 1-B19 and 1-B20 at depths of approximately 21 to 23 feet. Exploration 1-CPT4, which extended to approximately 74 feet and was paired with Boring 1-B8, suggests that the soil below the thick sand in Boring 1-B8 behaves like hard clay to silty clay. Based on the characteristics of the soils above the sand layers, we interpret these

We processed the CPT data using the commercially available program, CPeT-IT v2.3.1.6 to determine the soil behavior types and characteristics of the soils encountered. Based on our matched pairs, the CPT-predicted soil behavior types appear consistent with the boring logs. The Robertson (2016) modified soil behavior type interpretation indicates that the sands and clays encountered are generally classified as dilative or dense of critical state. According to Robertson 2016, pore pressures decrease when dilative soils are subject to shearing. Based on the modified normalized small strain rigidity index (Kg*) being greater than 330 that we calculated, the soils we encountered are classified as having significant microstructure from cementation, bonding, and aging (Robertson, 2016).

Consult the Site Plan, boring logs, and CPT data for specific subsurface conditions at each location. We include our boring logs in Appendix A and CPT data in Appendix C. The logs contain the soil type, color, consistency, and visual classification in general accordance with the Unified Soil Classification System. The logs graphically depict the subsurface conditions encountered at the time of the exploration.

2.8 GROUNDWATER CONDITIONS

We encountered groundwater in several soil borings at approximate depths of 18½ to 29 feet below existing grade (Elevation -1½ to -10½ feet). The CPT crew was unable to directly measure water following completion of the CPTs generally due to caving of the holes. We summarize our observations in the table below:

TABLE 2.8-1: Groundwater Observations

EXPLORATION LOCATION	APPROX. DEPTH TO GROUNDWATER (FEET)	APPROX. GROUNDWATER ELEVATION (NAVD88, FEET)
1-B2	29	-10½
1-B12	18 ½	-1½
1-B14	19 ½	-2
1-B20	21	-2

EXPLORATION LOCATION	APPROX. DEPTH TO GROUNDWATER (FEET)	APPROX. GROUNDWATER ELEVATION (NAVD88, FEET)
1-B21	25	-7½
1-B26	20	-2
1-B28	19	-1½
1-B32	28	-10
1-B34	20	-3
1-B35	25	-8
1-B36	20	-2½

We also observed perched groundwater in Boring 1-B4 at a depth of 3½ feet below existing grade. This location was adjacent to a landscape area that had recently received rain.

We reviewed publically available groundwater data from the California Water Data Library website. A well located approximately 1 mile northwest of the site reported six data points between 2015 and 2018 that ranged between Elevation -6.7 to 0.7 feet (NAVD88); this well was located approximately ½ mile east of the Sacramento River. State Well 07N05E31C001M, located approximately 1 mile to the northeast, encountered groundwater between 1985 and 1996 at Elevations -27.8 and -10.3 feet (NAVD88). In both wells, the water level readings in spring were generally the high groundwater and in fall the low groundwater. We also reviewed the Groundwater information Center Interactive Map, which provides groundwater elevation contours in the region for spring and fall. The fall groundwater contours between 2013 and 2018 show the site being between the -20 feet and -10 feet (NAVD88) contours. The spring groundwater elevation contours between 2011 and 2018 indicate groundwater is roughly between Elevations -10 feet to 0 feet at the site.

Groundwater was not encountered in the borings performed by others in 2005 and 2008 that terminated at depths of no more than 16½ feet below site grades.

Fluctuations in the level of groundwater may occur due to variations in rainfall, irrigation practice, and other factors not evident at the time measurements were made.

2.9 LABORATORY TESTING

We performed laboratory tests on selected soil samples to evaluate certain engineering properties. For this project, we performed moisture content, dry density, unconfined compression, undrained unconsolidated triaxial compression, plasticity index, expansion index, sieve analysis, direct shear, consolidation, resistance value, and soil corrosion potential testing. In addition, we applied phenolphthalein solution to certain samples in the laboratory to detect the presence of lime in the soil. Moisture contents, dry densities, and phenolphthalein reactions are recorded on the boring logs in Appendix A; other laboratory data is included in Appendix B.

3.0 SEISMIC AND GEOLOGIC HAZARDS

We understand California Geological Survey (CGS) provides an advisory role for the review of engineering geology and seismology reports for public schools, hospitals, and essential services buildings. CGS Note 48 provides a checklist of items, including geologic and seismic hazards that are to be addressed in this report. We summarize these hazards below.

3.1 EXPANSIVE SOIL

We encountered near surface potentially expansive soil. Expansive soils change in volume with changes in moisture. They can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and lightly loaded structures founded on shallow foundations.

We provide expansive soil design considerations and mitigation recommendations in Sections 4.2 and 7.2.

3.2 LIQUEFACTION

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are Holocene-aged, clean, loose, saturated, uniformly graded, fine-grained sands. Empirical evidence indicates that loose silty sands as well as lean silts and some clays are also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures exceed the effective confining stress of the soil, it is said to have liquefied, and if the sand consolidates or vents to the surface during and following liquefaction, ground settlement and surface deformation may occur.

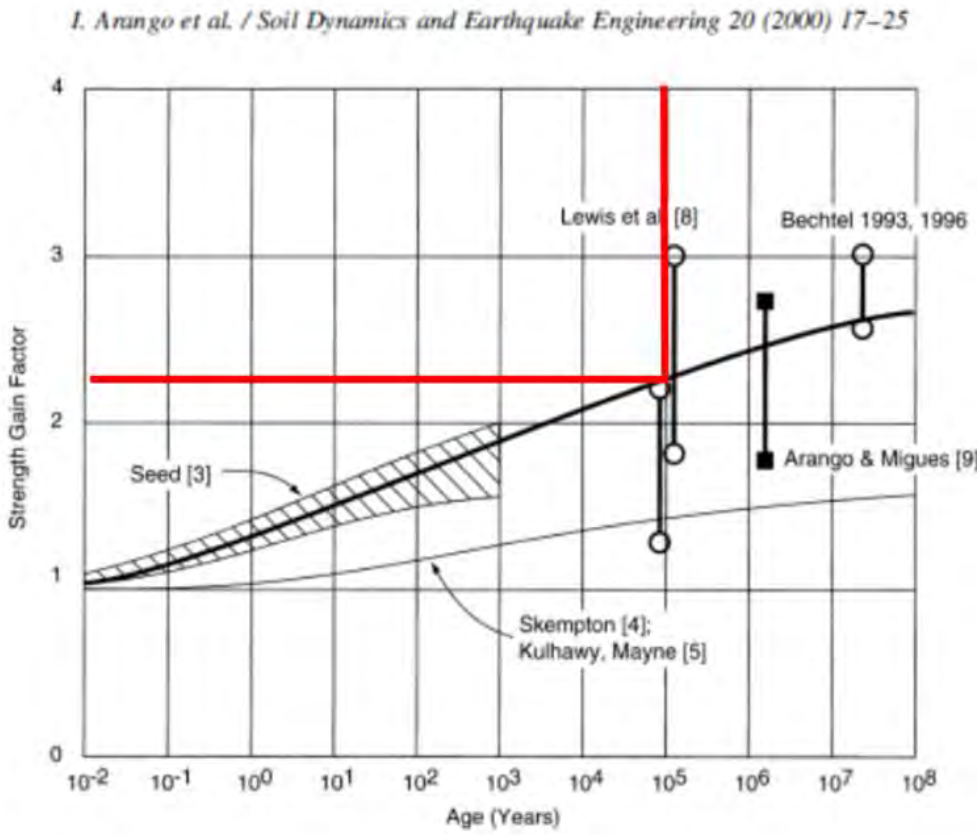
We analyzed the liquefaction potential of the CPTs and mud rotary borings using the highest observed groundwater Elevation of -1.5 feet (NAVD88), an earthquake magnitude of 6.8, and mapped MCE_G peak ground acceleration (PGA_M) of 0.33g for a Site Class D. We evaluated the liquefaction potential using shear wave (V_s), SPT, and CPT-based liquefaction triggering procedures. As described in Section 2.7, we interpreted the soils that we encountered below this design groundwater elevation to be consistent with the middle unit of the Pleistocene-aged Riverbank formation.

In performing our SPT-based liquefaction analysis of the mud rotary borings, we used methods published by Youd et. al. (2001), and Boulanger and Idriss (2014). We corrected each recorded SPT blow count resistance (N-value) for sampler and hammer type, overburden pressure, boring diameter, and fines content. The SPT sampler had room for liners, though no liners were used. For our CPT-based liquefaction analysis, we utilized the commercially available software program CLiq v2.2.1.4 and incorporated Youd et. al (2001), Robertson (2009), and Boulanger and Idriss (2014). We performed shear wave velocity based liquefaction triggering analyses using Youd et. al (2001) and Kayen et. al (2013) methods for the CPTs that we had site-specific shear wave velocity measurements.

The conventional liquefaction analysis methodologies referenced above were developed using empirical data from Holocene-aged soil deposits. As described in Sections 2.3 and 2.7, we encountered Pleistocene-aged (260,000 years old ± 45,000) sands at the site that exhibit dilative behavior and correlate with soils that have significant microstructure. Various researchers and practitioners have documented that the strength of sand increases with age, primarily as a result of chemical cementation and a more stable rearrangement of particles. Several researchers have found that this “aging” effect increases the cyclic shear resistance of the sand even though it may not be reflected in the conventional SPT or CPT penetration resistance (Leon, et. al, 2006, Arango, et. al, 2000). To capture the cyclic strength gain due to aging effects, an aging factor or strength gain factor was developed by Kulhawy and Mayne (1990), Skempton (1986), and Seed (1979). Arango et. al. (2000) used cyclic simple shear laboratory testing on high-quality undisturbed samples of sand to demonstrate the cyclic shear strength gain and updated the strength gain relationship developed previously by others. Based on the age of the sand deposits

and CPT interpretation indicating significant microstructure and dilative behavior, we judged the use of an aging factor appropriate for the SPT- and CPT-based liquefaction evaluation on this site. Using a conservative age of 100,000 years (10^5) for the sands encountered, we applied an aging factor, or strength gain factor, of 2.25 to our analysis using the Arango et. al. (2000) updated relationship, as shown in Exhibit 3.2.1.

Exhibit 3.2-1: Field Cyclic Strength of Aged Sand Deposits: Updated Relationship



Our CPT analyses indicated the sands we encountered as having factors of safety against liquefaction greater than 1.3 for Youd et. al (2001), Robertson (2009), and Boulanger and Idriss (2014). CGS Note 48 requires liquefaction induced settlement calculations for layers with factors of safety less than 1.3. The shear wave velocity based liquefaction triggering analysis on 1-CPT4 indicates a liquefaction factor of safety greater than or equal to 2. The SPT-based liquefaction analyses also indicate factors of safety greater than 1.3. Based on the liquefaction triggering analyses indicating the soils as not liquefiable and with factors of safety greater than 1.3, we estimate the risk of liquefaction and liquefaction-induced settlement to be low to negligible at the site.

The results of the liquefaction analysis are included in Appendix F.

3.3 SOIL CORROSION POTENTIAL

As part of this study, we obtained four representative soil samples and submitted to a qualified analytical lab for determination of pH, resistivity, sulfate, and chloride. The results are included in Appendix B and summarized in the table below.

TABLE 3.3-1: Corrosivity Test Results

SAMPLE LOCATION	DEPTH	PH	RESISTIVITY (OHMS-CM)	CHLORIDE (MG/KG)	SULFATE (MG/KG)
1-B2	3	7.6	1,260	26.2	14.1
1-B15	1.5	9.62	3,750	5.0	29.8
1-B31	5.5	7.84	1,420	16.0	16.7
1-B34	2	7.69	1,850	7.8	15.5

The 2016 CBC references the 2014 American Concrete Institute Manual, ACI 318-14, Section 19.3.1 for concrete durability requirements. According to ACI Table 19.3.1.1 and Table 19.3.2.1, the laboratory results indicate a sulfate exposure category of S0. There is no requirement for cement type or water-cement ratio.

According to the National Association of Corrosion Engineers' book titled *Corrosion Basics an Introduction*, the resistivity results indicate the soils are corrosive to highly corrosive to buried metal piping (Roberg, 2006). Values tested for chloride do not pose a significant impact to metals or concrete.

As described in Section 2.7, phenolphthalein tests indicate that portions of the site contain lime treated soils. Lime treated soils should be expected to have a higher pH than non-lime treated soils and the impacts should be considered for landscaping applications.

If desired to investigate this further, we recommend a corrosion consultant be retained to evaluate if specific corrosion recommendations are advised for the project.

3.4 FLOODING

Based on Flood Insurance Rate Map (FIRM) No. 06067C0315J (FEMA, 2018), the Elk Grove Hospital site is mapped in Zone X, "Area with Reduced Flood Risk due to Levee". In addition, the City of Elk Grove General Plan Safety Element indicates the project site is mapped within the 200-year flood plain. The project is also mapped within the Folsom Dam inundation zone in the Safety Element. The Civil Engineer should review pertinent information relating to possible flood levels for the subject site based on final pad elevations and provide appropriate design measures for development of the project, if necessary.

3.5 LATERAL SPREADING

Lateral spreading is a failure within a nearly horizontal soil zone (possibly due to liquefaction) that causes the overlying soil mass to move towards a free face or down a gentle slope. Generally, the effects of lateral spreading are most significant at the free face or the crest of a slope and diminish with distance from the slope. Based on our liquefaction analysis, it is our opinion that the risk of lateral spreading is low to negligible.

3.6 GROUND RUPTURE

Since there are no known active faults crossing the property and the site is not located within an Earthquake Fault Special Study Zone, it is our opinion that ground rupture is unlikely at the subject site.

3.7 GROUND SHAKING

An earthquake of moderate to high magnitude generated within region could cause considerable ground shaking at the site. To mitigate shaking effects, structures should be designed using sound engineering judgment and the latest California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

3.8 GROUND LURCHING

Ground lurching is a result of the rolling motion imparted to the ground surface during energy released by an earthquake. Such rolling motion can cause ground cracks to form in weaker soils. The potential for the formation of these cracks is considered greater at contacts between deep alluvium and bedrock. Based on the location of the site relative to active faults and depth of alluvium relative to bedrock, it is our opinion that the risk of ground lurching is negligible at the site.

3.9 TSUNAMIS OR SEICHES

Tsunamis are large ocean waves, generated by displacements of vertical faulting beneath the ocean floor, which can reach great heights when they encounter shorelines. The project is located many miles from a shoreline, which makes the potential for damage from tsunamis negligible. Seiches result when earthquake ground motion causes an enclosed or restricted body of water, such as a lake, bay, reservoir or river to oscillate and generate large waves. Based on the distance from any nearby bodies of water, the risk of seiches impacting the site is low, in our opinion.

3.10 LANDSLIDES

The site topography is relatively level with gentle topographic relief. No landslides are mapped within the site and we did not observe any evidence of unstable conditions. For these reasons, it is our opinion that the risk from landslides is negligible at the site. We should be provided an opportunity to review the grading plans to verify that the proposed site raising of 7 feet near the existing non-federal levee and drainage meets the intent of our recommendations.

3.11 VOLCANIC ERUPTION

Areas of known volcanic activity, including Clear Lake, Lassen Park, and Long Valley areas are located significant distances from the site. Therefore, the potential for lava flows or volcanic mudflows (lahars) appears to be very low, in our opinion. The known areas of potential volcanic activity are located to the north (Lassen and Clear Lake), and southeast (Long Valley) of the study area such that dominant weather patterns will generally carry volcanic ash away from the project site. The United States Geological Survey has identified counties in California that could be

directly affected by volcanic hazards (Mangan et al. 2019). Sacramento County has not been identified as a county that could be directly impacted by volcanic hazards.

3.12 HYDROCOLLAPSE

Hydrocollapse occurs when collapsible soils are wetted causing rapid settlement. The settlement can result in movement and potential damage to structures. Collapsible soils form in alluvial environments in semi-arid to arid climates. According to the Colorado Geological Survey, collapsible soils are characterized by low density and low moisture contents (White et al. 2008). Collapsible soils were not encountered in the explorations at the site and in our opinion the risk of hydrocollapse at the site is low.

3.13 REGIONAL SUBSIDENCE AND UPLIFT

The area is not within an area where subsidence resulting from groundwater or oil withdrawal has been documented. The United States Geological Survey provides an interactive map that identifies documented areas of land subsidence (USGS, 2018). The closest areas of reported land subsidence are located west of Sacramento at Davis and Woodland, and west of Lodi within the Sacramento-San Joaquin Delta (Luhdorff & Scalmanini, 2014). Therefore, the risk from regional subsidence is considered low at the site, in our opinion.

3.14 GEOENVIRONMENTAL ISSUES

Environmental issues specific to the project site include naturally occurring hazardous materials such as Radon-222, asbestos, and mercury.

3.14.1 Radon-222

Radon is produced naturally as Radon-222 in gas form. Radon is a byproduct of the natural decay of uranium that is present in small quantities in several rock types such as granitic rocks of the Sierra Nevada and sediment derived rocks in the Sacramento Valley. Radon is soluble and can be transported in groundwater. When water-containing radon is exposed to air (by pumping or through a tap), radon can diffuse into the air where it can be inhaled.

The U.S. Environmental Protection Agency (EPA) lists Sacramento County in Zone 3, the lowest potential radon hazard (less than 2 pCi/L) (U.S. EPA, 2019). Based on the zone assignment, it is our opinion that naturally occurring radon would not be considered a health hazard for this project.

3.14.2 Asbestos

Asbestos occurs naturally in certain geologic settings in California and can cause cancer if inhaled. Asbestos is associated with serpentinite and partially serpentinized ultramafic rocks that are associated with the Franciscan complex. The nearest known location of this rock is in El Dorado Hills, approximately 29 miles to the northeast of the Elk Grove Hospital site (USGS 2019). Based on the geologic mapping of this site and the distance to the nearest potential source, it is our opinion that naturally occurring asbestos would not be considered a health hazard for this project.

3.14.3 Mercury

Mercury was mined historically in California until 1970. Mercury can enter watersheds through storm runoff and enter streams, rivers, tributaries, and eventually deposited in the sediment within the San Francisco Bay Delta area. The project site is underlain by sediments of the Pleistocene Riverbank Formation. This formation is not known to contain native mercury. Based on the site geology, it is our opinion that mercury would not be considered a potential health hazard for this project.

4.0 CONCLUSIONS

From a geotechnical engineering viewpoint, in our opinion, the proposed project may be designed as planned, provided the geotechnical recommendations in this report are properly incorporated into the design plans and specifications.

The primary geotechnical concerns that could affect development on the site are existing fill, expansive soils, and groundwater. We summarize our conclusions below.

4.1 FOUNDATION SUPPORT

Based on our findings, it is our opinion that the site conditions are generally suitable for the use of deep foundations for the hospital building and conventional shallow footings for the other structures. As an alternative, structures with basements can be supported on a structural mat foundation. Refer to Section 5.0 for foundation recommendations.

4.2 EXISTING FILL

Our explorations encountered fill that ranged in thickness from 3 to 11 feet below existing the ground surface. At the time we prepared this report, no supporting documentation was available regarding placement and compaction of the fill. The fill was likely placed during the original site development and portions were lime-treated, as evidenced by our phenolphthalein lab tests. While our explorations showed relatively high penetration resistance in the fill, the lack of supporting documentation regarding fill compaction indicates the fill may not be suitable for support of the proposed new structures. Non-engineered fills can undergo excessive settlement, especially under new fill or building loads. We provide the following mitigation recommendations for the existing fill based on the propose site use:

STRUCTURES WITH BASEMENTS

The hospital, dormitory, central plant, and parking structures will incorporate a below-grade basement. We anticipate the basements will extend below the existing fill and, therefore, no mitigation of existing fill is anticipated for these structures. If the basements do not extend fully through the fill, then the remaining fill should be removed and recompacted.

AT-GRADE STRUCTURES

Without proper documentation of existing fill placed on the site, we recommend the existing fill be completely removed and recompacted within a zone that extends 10 feet beyond the limits of the proposed at-grade building footprints; if the fill extends deeper than 10 feet, the lateral extent of fill removal may need to be increased. This includes the MOB, Admin, and Outpatient Clinic. We present fill removal recommendations in Section 7.1.

SURFACE IMPROVEMENTS / PARKING LOT AND LANDSCAPE AREAS / UTILITIES

In our opinion, the risk of post-construction settlement of existing fill in future paved or landscape areas is likely low. For this reason, we recommend that only the upper 2 feet of existing fill be overexcavated and recompacted to provide adequate support for paved areas.

We should be retained to review the grading plans when ready to aid in identifying the estimated limits of existing fill removal prior to construction and to provide supplemental recommendations if necessary. In addition, any documentation of the existing fill should be provided to ENGEO for review if it becomes available. During construction, we should be retained to observe construction activities and to provide supplemental recommendations if additional or questionable existing fill is encountered.

4.3 EXPANSIVE SOIL

We encountered near surface potentially expansive soil. Expansive soils change in volume with changes in moisture. They can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and lightly loaded structures founded on shallow foundations. Because expansive soils changes in volume with changes in moisture, it is important to limit potential volume change and reduce uplift pressures or settlement by embedding footings below the active zone; the active zone refers to the depth over which soil moisture content variations are likely to cause significant shrink or swell.

For shallow foundations, we provide a minimum footing embedment to place the bearing surface of the footing below the active zone of the expansive soils in Section 5.2. Since the footings structural loads resist uplift, it is not necessary to completely remove expansive soil below the footings. To further reduce the effects of expansive soils on interior floor slabs that have less resisting force than a footing, we also recommend a layer of non-expansive soil underlie interior floor slabs in Section 7.2. Additionally, we provide anticipated total and differential settlements in Section 5.2 that should be used in the structural design of the foundation elements. We provide additional recommendations to further reduce the potential shrink-swell movement of expansive soils in the following sections:

- Specific grading recommendations for compaction of clay soil at the site. The purpose of these recommendations is to reduce the swell potential of the clay by compacting the soil at a high moisture content and controlling the amount of compaction.
- Keeping footing excavations moist prior to placing foundation concrete (Section 7.2)
- Providing positive drainage away from buildings (Section 7.10.1).
- Restricting landscaping near buildings (Section 7.12).
- Providing an impervious seal in utility trenches that pass under the building perimeter (Section 7.8.2).

While our explorations did encounter some lime-treated soil from previous grading operations, we do not recommend reliance on the existing lime treated soils as mitigation of the expansive soil conditions for structures supported at existing grade.

4.4 GROUNDWATER CONSIDERATIONS

As discussed in Section 2.8, groundwater was encountered in our explorations at depths ranging from roughly 17 to 20 feet below existing grade (approximately Elevation -1½ to -10½ feet). This is generally consistent with the groundwater elevation contours from the Groundwater Information Center Interactive website described in Section 2.8. Based on the anticipated bottom of basement elevations approximately 10 to 15 feet below existing site grades (approximately Elevation 7 to 0 feet), we anticipate the basement excavations will be above the groundwater level that we encountered in our explorations. Deep foundations and associated pile cap excavations would be expected to encounter groundwater.

Seasonal groundwater fluctuations are expected and the depth to groundwater may vary over the life of the proposed project. For this reason, and based on engineering judgement, any permanent building excavations that extend below approximately Elevation 5 feet should consider long-term groundwater impacts. These impacts may include buoyancy and seepage. The design team may consider potential sub-slab drainage features involving a network of subdrains with pumps to relieve hydrostatic build-up from potential groundwater rise. Alternatively, the basement could be waterproofed and designed to resist buoyancy.

Any excavations extending near or below groundwater will require temporary dewatering to facilitate construction. Temporary construction dewatering would likely consist of sump pumps or dewatering wells to temporarily lower the groundwater while below-grade construction is completed.

4.5 2016 CBC SEISMIC DESIGN PARAMETERS

The 2016 CBC utilizes design criteria set forth in the 2010 ASCE 7 Standard. Based on the subsurface conditions encountered, we characterized the site as Site Class D in accordance with the 2016 CBC. We understand the structures will be designed using the ASCE 7-10 Chapter 11 tabulated values below.

TABLE 4.5-1: 2016 CBC Seismic Design Parameters,
Latitude: 38.408205 **Longitude:** -121.479707

PARAMETER	VALUE
Site Class	D
Mapped MCE_R Spectral Response Acceleration at Short Periods, S_S (g)	0.741
Mapped MCE_R Spectral Response Acceleration at 1-second Period, S_1 (g)	0.307
Site Coefficient, F_A	1.207
Site Coefficient, F_V	1.786
MCE_R Spectral Response Acceleration at Short Periods, S_{MS} (g)	0.895
MCE_R Spectral Response Acceleration at 1-second Period, S_{M1} (g)	0.549
Design Spectral Response Acceleration at Short Periods, S_{DS} (g)	0.596
Design Spectral Response Acceleration at 1-second Period, S_{D1} (g)	0.366
Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration, PGA (g)	0.253
Site Coefficient, F_{PGA}	1.294
MCE_G Peak Ground Acceleration adjusted for Site Class effects, PGA_M (g)	0.327
Long period transition-period, T_L	12 sec

5.0 FOUNDATION RECOMMENDATIONS

We developed foundation recommendations using data obtained from our field exploration, laboratory test results, and engineering analysis. We provide deep foundation recommendations for the hospital building and shallow footings with interior slab-on-grade floors for the other buildings. We also provide alternative structural mat foundation recommendations for the hospital and other structures that will incorporate a basement.

5.1 PILE FOUNDATIONS – HOSPITAL BUILDING

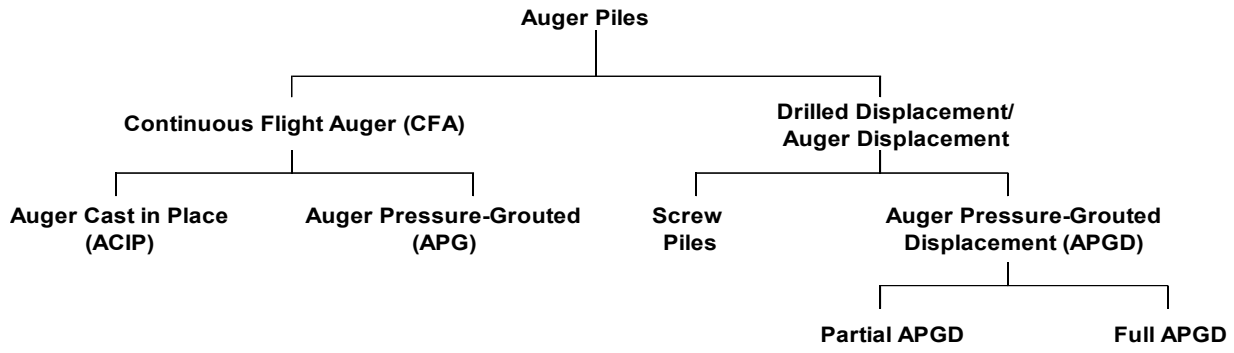
5.1.1 Types

Several deep foundation systems could be considered, each with disadvantages and advantages. Common considerations in selecting an appropriate deep foundation system can include:

- Noise and vibration during construction.
- Amount of soil and groundwater spoils produced during construction.
- Hazardous soil and groundwater concerns of spoils produced during construction.
- Quality control.
- Ability to advance through dense soil deposits.
- Ability to handle varying soil conditions.
- Depth to groundwater.

Due to the proximity to nearby residential and commercial developments and the presence of dense sand deposits, we anticipate the use of driven piles may not be desirable. Therefore, we recommend that auger piles be considered for deep foundations. There are numerous types of auger piles that may be considered. The general categories are shown below. Due to the presence of the variably dense sand at the hospital, we anticipate that a drilled displacement type method may not be able to penetrate the sands. Therefore, we provide recommendations assuming a continuous flight auger (CFA) pile is used. CFA piles are a type of drilled foundation in which the pile is constructed to the final depth in one continuous process using continuous flight auger drilling methods. While the auger is drilled into the ground, the flights of the auger are filled with soil, providing lateral support and maintaining the stability of the hole. When the final design depth of the pile is reached, the auger is withdrawn from the hole while cement grout is placed by pumping the mix through the hollow center of the auger pipe to the tip of the auger. Simultaneous pumping of the grout or concrete and withdrawing of the auger provides continuous support of the hole. Reinforcement for steel-reinforced CFA piles is placed into the hole filled with fluid concrete/grout immediately after withdrawal of the auger. CFA piles also include several subsets of similar pile types, as illustrated in Exhibit 5.1.1, and include auger cast-in-place (ACIP) piles, auger pressure grouted piles, and auger pressure grouted displacement piles. All of these involve an auger rig for construction.

EXHIBIT 5.1.1 – Auger Pile Types



Preliminary design recommendations for auger piles are included below.

5.1.2 Vertical Pile Capacity

Auger piles may be used to support the proposed hospital building. These relatively low vibration piles are generally proprietary and are typically designed by a design-build or specialty contractor. ENGEO should be provided the opportunity to review the pile design to confirm the assumed soil profile, shear strengths, and deflection conditions are in conformance with both static and seismic loading conditions.

Pile lengths are highly dependent on the structural loads, pile geometry, method of installation, and geotechnical behavior of the subsurface soils. We anticipate the piles will derive their vertical capacity primarily from frictional support and strain compatible end bearing within hard clay layers at depth. We developed an idealized subsurface profile using Boring 1-B8 and 1-CPT4 to represent the hospital building subsurface conditions. Using this idealized soil profile, we estimated preliminary auger pile lengths for typical auger cast pile diameters, as summarized in Table 5.1.2-1.

TABLE 5.1.2-1: Preliminary Auger Pile Lengths

CAPACITY TONS	18 INCH DIAMETER	24 INCH DIAMETER
Allowable Downward Capacity (tons)	100	100
Minimum Pile Length (feet)	53	43

The above preliminary pile lengths assume the top of piles for the hospital will be at Elevation 4.5 feet.

Resistance to uplift loads will be developed in friction along the pile shafts. On a preliminary basis, we recommend an allowable uplift frictional resistance of 70 percent of the above downward values, provided appropriate reinforcing is installed. To reduce pile group effects, space piers at least three diameters apart, center to center.

The vertical capacities above consider skin friction and end bearing. For our analysis, we used the computer program SHAFT. We used a factor of safety of 2.0 to calculate to pile allowable skin friction, since we anticipate load testing will be performed to verify the capacities. For end bearing, we used a strain compatible value of 15 percent of the ultimate end bearing calculated. To reduce

pile group effects, the pile spacing should be at least three pile diameters apart, center to center. Refer to Appendix G for the axial static capacity plots.

Foundation plans were not available at the time this report was prepared. On a preliminary basis, we estimate that post-construction pile foundation settlements will be approximately 1 inch. Differential settlement between adjacent columns will be dependent on the final design of these foundation elements, although we anticipate that differential settlement will be less than about ½ inch between columns. Once column spacings, loads and pile group configurations are determined, we should be retained to review the information and update our recommendations as necessary.

5.1.3 Lateral Pile Capacity

Lateral load resistance for pile-supported structures is developed through pile bending/soil interaction. The magnitude of the lateral load resistance is dependent upon several factors, including axial load on the pile, pile stiffness, pile embedment length, conditions of fixity at the pile cap, the physical properties of surrounding soil, and the magnitude of allowable lateral deflections. We used the computer program L-Pile to estimate lateral pile loads for drilled auger piles. We considered the pile properties summarized in Table G-2 in Appendix G for preliminary lateral pile capacity analysis and a minimum 28-day compressive strength of 4,500 psi for the piles. For the 1-inch lateral deflections, we assumed a 50% reduction in moment of inertia. If pile stiffness is significantly different from values listed under Table G-2, ENGEO should be contacted to provide revised lateral pile characteristics. We assumed a pile group p-multiplier of 0.65 for a typical pile group configuration assuming a 3-pile diameter spacing.

We used L-Pile to estimate lateral pile loads for both free head and fixed head conditions with ¼-inch, ½-inch, and 1-inch pile top deflections. The lateral capacities and bending moments provided in Appendix G represent the probable response of a single pile under short-term loading conditions and do not include a factor of safety. Suitable factors of safety should be selected based on the type of loading.

5.1.4 Load Test Program

A load test program for the auger piles is recommended, including instrumented piles. ENGEO should observe the installation and load testing of the piles and confirm the specified deflection limits are not exceeded. The contractor should provide piles that are capable of resisting the design loads specified on the project plans with an appropriate safety factor. As guidance, a safety factor of 2.0 for dead plus live loads and a safety factor of 1.0 for ultimate (extreme event) seismic loads may be used. The load tests should be performed in accordance with ASTM D-1143, Standard Loading Procedure and ASTM D-3689 for compression and tension tests respectively. Tension tests should be conducted with a maximum deflection limit of 1.5 inches. Equipment used for the tests (load frame, jacks, reaction piles, etc.), should be capable of providing at least 500 kips of test load. The Davisson Method should be used to interpret the ultimate pile compression capacity.

The contractor is responsible for the design, operation, and safety of the load test system. This includes supplying and installing the necessary components including the dial gauges and reference beams.

We should be retained to review the load test program prior to mobilization of pile test equipment to the site. We should also be retained to monitor and evaluate the entire pile load test, including test pile installation. Load test piles should not be used as production piles.

5.2 STRUCTURAL MAT FOUNDATION

As an alternative to deep foundations, the hospital can be supported on a structural mat foundation. A structural mat can also be used to support the below-grade basement structures as an alternative to conventional footings and interior slab-on-grade floors.

The structural design of mat foundations for below grade structures should be an iterative process between ENGEO and the structural engineer and will be highly dependent upon the actual bottom of mat elevation, thickness of mat determined by the structural engineer, the column loads, column spacing, and if ground improvement is performed. For the first iteration of design for structural mat foundations, we recommend the structural engineer begin the mat analysis using a uniform modulus of subgrade reaction (k_{v1}) of 100 pounds per square inch per inch of deflection (psi/in).

An average allowable bearing pressure of 2,000 pounds per square foot (psf) may be used with localized increases near column loads of up to 2,500 psf; these may be increased by one-third when considering transient loads such as wind or seismic. If ground improvement is needed, average allowable bearing pressures for individual structures will vary depending on the type and layout of ground improvement implemented and specific soil conditions below the structure. Future collaboration with the structural engineer, ENGEO, and ground improvement contractor if necessary, would be needed to develop specific foundation and ground improvement recommendations once final structural details and loading are developed.

We anticipate a properly designed structural mat foundation would likely experience static total settlements of up to 1½ inches for the hospital and up to 1 inch for the other below-grade structures with differential settlements of about one-half of the total. The actual foundation settlements will be influenced by the soil conditions, applied loads, the depth of excavation, stiffness of the mat, the modulus of subgrade reaction, and the extent of ground improvement, if needed. Where mat foundations transition from below grade to at grade, we recommend that the mat be stepped rather than sloped unless the ground improvement can be designed to accommodate the horizontal load transfer from a sloped mat.

Lateral loads may be resisted by friction along the base and by passive pressure along the sides of the mat foundation. We recommend a passive pressure based on an equivalent fluid pressure of 300 pounds per cubic foot (pcf). We recommend a coefficient of friction along the base of 0.30. These values include a factor of safety of 1.5 and may be increased by one-third for the short-term effects of wind or seismic loading.

5.3 CONVENTIONAL FOOTINGS WITH SLAB-ON-GRADE

With exception to the hospital building, the other proposed structures can be supported on continuous or isolated spread footings bearing in engineered fill.

5.3.1 Footing Dimensions and Allowable Bearing Capacity

Provide minimum footing dimensions as follows in the Table 5.3.1-1 below.

TABLE 5.3.1-1: Minimum Footing Dimensions

FOOTING TYPE	*MINIMUM DEPTH (INCHES)	MINIMUM WIDTH (INCHES)
Continuous	**24**	**18**
Isolated	**24**	**24**

*below lowest adjacent pad grade

The footing plan dimensions should be designed to keep the dead load as high as practical to resist potential uplift from expansive soil. Minimum footing depths shown above are taken from lowest adjacent pad grade. The cold joint between the exterior footing and slab-on-grade should be located at least 4 inches above adjacent exterior grade.

Design footings recommended above for a maximum allowable bearing pressure of 3,000 pounds per square foot (psf) for dead-plus-live loads. Increase this bearing capacity by one-third for the short-term effects of wind or seismic loading. The maximum allowable bearing pressure is a net value; the weight of the footing may be neglected for design purposes. Footings located adjacent to utility trenches should have their bearing surfaces below an imaginary 1:1 (horizontal:vertical) plane projected upward from the bottom edge of the trench to the footing.

5.3.2 Waterstop

If a two-pour system is used for footings and slab, the cold joint between the exterior footing and slab-on-grade should be located at least 4 inches above adjacent finish exterior grade. If this is not done, then we recommend the addition of a waterstop between the two pours to reduce moisture penetration through the cold joint and migration under the slab. Use of a monolithic pour would eliminate the need for the waterstop.

5.3.3 Reinforcement

The structural engineer should design footing reinforcement to support the intended structural loads without excessive settlement. Reinforce continuous footings with top and bottom steel to provide structural continuity and to permit spanning of local irregularities. To help resist expansive soil movement, reinforce continuous footings with at least four No. 4 steel reinforcement bars, two top and two bottom.

5.3.4 Foundation Lateral Resistance

Lateral loads may be resisted by friction along the base and by passive pressure along the sides of foundations. The passive pressure is based on an equivalent fluid pressure in pounds per cubic foot (pcf). We recommend the following allowable values for design:

- Passive Lateral Pressure: 300 pcf
- Coefficient of Friction: 0.30

The above allowable values include a factor of safety of 1.5. Increase the above values by one third for the short-term effects of wind or seismic loading.

Passive lateral pressure should not be used for footings on or above slopes.

5.3.5 Settlement

Provided our report recommendations are followed and given the proposed construction (Section 1.3), we estimate static total and differential foundation settlements to be less than approximately 1 and ¾ inches, respectively. We should be provided an opportunity to confirm these settlement values when structural loads and structural plans are prepared.

6.0 SLABS-ON-GRADE

6.1 INTERIOR CONCRETE FLOOR SLABS

Provided the building pads are prepared in accordance with the recommendations in Section 7, we provide the following recommendations for interior concrete floor slabs.

6.1.1 Minimum Design Section

We recommend the following minimum design section for non-structural interior floor slabs:

1. Provide a minimum concrete thickness of 6 inches for interior slabs subject to traffic loading. Provide a minimum thickness of 5 inches for interior floor slabs subject to only pedestrian loading.
2. Place minimum steel reinforcing of No. 3 rebar on 18-inch centers each way within the middle third of the slab to help control the width of shrinkage cracking that inherently occurs as concrete cures.

The structural engineer should provide final design thickness and additional reinforcement, as necessary, for the intended structural loads.

6.1.2 Slab Moisture Vapor Reduction

When buildings are constructed with concrete slab-on-grade, water vapor from beneath the slab will migrate through the slab and into the building. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. When water vapor migrating through the slab would be undesirable, we recommend the following to reduce, but not stop, water vapor transmission upward through the slab-on-grade.

1. Construct a moisture retarder system directly beneath the slab on-grade that consists of the following:
   a. Vapor retarder membrane sealed at all seams and pipe penetrations and connected to all footings. Vapor retarders shall conform to Class A vapor retarder in accordance with ASTM E 1745, latest edition, “Standard Specification for Plastic Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs”. The vapor retarder should be **underlain by**
   b. 4 inches of clean crushed rock. Crushed rock should have 100 percent passing the ¾_inch sieve and less than 5 percent passing the No. 4 Sieve.
2. Use a concrete water-cement ratio for slabs-on-grade of no more than 0.50.

The structural engineer should be consulted as to the use of a layer of clean sand or pea gravel (less than 5 percent passing the U.S. Standard No. 200 Sieve) placed on top of the vapor retarder membrane to assist in concrete curing.

6.1.3 Subsurface Drainage

We recommend a subsurface drainage system be incorporated into the structures that have basements that extend below an Elevation of 5 feet to account for perched water and the possibility of future shallower groundwater depths.

At a minimum the subdrain system should consist of:

1. A minimum 18-inch-thick layer of washed, crushed rock below the basement slab. Crushed rock should consist of 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Place a nonwoven geotextile filter fabric such as Mirafi 140NC, or equivalent below the rock.
2. Place 4-inch-diameter perforated pipe within the rock layer at a roughly 25-foot spacing or along column midpoints, whichever is less. Place pipes with perforations down, approximately 4 inches from the bottom of the rock layer. Slope pipes toward a central collector pump system.
3. Remove collected water with a suitable collector pump system.
4. Construct cleanouts for drain maintenance.

We should be retained to review the subdrainage system prior to construction. Alternatively, the basement could be waterproofed and designed for buoyancy impacts.

6.2 EXTERIOR FLATWORK

Exterior flatwork includes items such as concrete sidewalks, steps, and outdoor courtyards exposed to foot traffic only. Provide a minimum section of 4 inches of concrete over 4 inches of aggregate base. Compact the aggregate base to at least 90 percent relative compaction (ASTM D1557). Thicken flatwork edges to at least 8 inches to help control moisture variations in the subgrade and place wire mesh or rebar within the middle third of the slab to help control the width and offset of cracks. Construct control and construction joints in accordance with current Portland Cement Association Guidelines.

6.3 TRENCH BACKFILL

Backfill and compact all trenches below building slabs-on-grade and to 5 feet laterally beyond any edge in accordance with Section 7.8.2.

7.0 EARTHWORK RECOMMENDATIONS

The relative compaction and optimum moisture content of soil, rock, and aggregate base referred to in this report are based on the most recent ASTM D1557 test method. Compacted soil is not acceptable if it is unstable. It should exhibit only minimal flexing or pumping, as observed by an ENGEO representative.

As used in this report, the term “moisture condition” refers to adjusting the moisture content of the soil by either drying if too wet or adding water if too dry.

We define “structural areas” in Section 7 of this report as any area sensitive to settlement of compacted soil. These areas include, but are not limited to building pads, sidewalks, pavement areas, and retaining walls.

7.1 EXISTING FILL REMOVAL

Where deemed appropriate in accordance with Section 4.2, remove existing fill to competent native soil, as evaluated by ENGEO. Figures 2 and 3 display the approximate existing fill thickness encountered in the soil borings at the site. The lateral extent and depth of fill is expected to vary. Consult the exploration logs in Appendix A for fill depths at specific locations.

7.2 EXPANSIVE SOIL MITIGATION

To reduce the potential for damage to the planned buildings that will be supported on shallow footings with interior slab-on-grade floors, we recommend that the upper 1½ feet of the building pad, extending at least 10 feet laterally beyond building areas, be underlain by relatively non-expansive soil. For basement non-structural slabs-on-grade, this may be reduced to 1 foot. The rock section recommended in Section 6.1 can be counted as part of this non-expansive section.

In lieu of importing non-expansive fill, it may be cost effective to lime treat the building pads to reduce the expansion potential of the onsite soil. Due to the variability of the lime treated soil encountered and the lack of supporting documentation, we do not recommend reliance on the existing lime treated soils as mitigation of the expansive soil conditions for structures supported at existing grade. We recommend that other structural elements, such as pavements and flatwork be designed for moderately expansive soil conditions. Refer to Section 4.3 for additional recommendations related to expansive soils.

Soil moisture in footing excavations should be maintained until directly before pouring concrete.

7.3 GENERAL SITE CLEARING

Areas to be developed should be cleared of surface and subsurface deleterious materials, including existing building foundations, slabs, buried utility and irrigation lines, pavements, debris, and designated trees, shrubs, and associated roots. Clean and backfill excavations extending below the planned finished site grades with suitable material compacted to the recommendations presented in Section 7.8. Retain ENGEO to observe and test backfilling.

Following clearing, strip any remaining vegetated areas of the site to remove surface organic materials. Strip organics from the ground surface to a depth of at least 2 to 3 inches below the surface. Remove strippings from the site or, if considered suitable by the landscape architect and owner, use them in landscape fill.

7.4 DIFFERENTIAL FILL THICKNESS

Differential building movements may result from conditions where building pads have significant differentials in fill thickness. Although not currently anticipated based on the depth of fill that we encountered and considering proposed site grades, we recommend that the differential fill

thickness across any building be no greater than 10 feet. Local subexcavation of soil material and replacement with compacted fill may be needed to achieve this recommendation.

We should be provided an opportunity to review the grading plans and existing fill thicknesses to provide supplemental recommendations as necessary.

7.5 OVER-OPTIMUM SOIL MOISTURE CONDITIONS

The contractor should anticipate encountering excessively over-optimum (wet) soil moisture conditions during winter or spring grading, or during or following periods of rain. In addition, wet soil conditions may be found in basement excavations or utility trench excavations. Wet soil can make proper compaction difficult or impossible. Wet soil conditions can be mitigated by:

1. Frequent spreading and mixing during warm dry weather.
2. Mixing with drier materials.
3. Mixing with a lime, lime-flyash, or cement product; or
4. Stabilizing with aggregate, geotextile stabilization fabric, or both.

Options 3 and 4 should be evaluated by ENGEO prior to implementation.

7.6 ACCEPTABLE FILL

Onsite soil is suitable as fill material provided it is processed to remove concentrations of organic material, debris, and particles greater than 6 inches in maximum dimension.

Building pads supporting shallow foundations should consist of relatively non-expansive soil in accordance with Section 7.2. Relatively non-expansive soils are defined as having a plasticity index less than 12.

Imported fill materials should meet the above requirements and have a plasticity index less than 12, and at least 20 percent passing the No. 200 sieve. Allow ENGEO to sample and test proposed imported fill materials at least 5 days prior to delivery to the site.

7.7 REUSE OF ONSITE RECYCLED MATERIALS

If desired to reuse asphaltic or Portland Cement concrete as engineered fill, we recommend that it be ground up and thoroughly mixed with onsite or import soil. In general, recycled asphalt or concrete should be ground down to less than 4 inches in greatest dimension, with no more than 25 percent larger than 2½ inches. Recycled material should be thoroughly mixed with a sufficient amount of soil, such that there is no more than 40 percent by weight of recycled material in the final mix.

We recommend that fill containing recycled asphalt and concrete be placed below a depth of 2 feet below subgrade level in roadway, exterior flatwork, or parking lot areas only.

7.8 FILL COMPACTION

7.8.1 Grading in Structural Areas

7.8.1.1 Non-expansive Soil

Perform subgrade compaction prior to fill placement, following cutting operations, and in areas left at grade as follows.

1. Scarify to a depth of at least 8 inches.
2. Moisture condition soil to at least 1 percentage point above the optimum moisture content; **and**
3. Compact the subgrade to at least 90 percent relative compaction. Compact the upper 6 inches of finish pavement subgrade to at least 95 percent relative compaction prior to aggregate base placement.

After the subgrade soil has been compacted, place and compact acceptable fill as follows:

1. Spread fill in loose lifts that do not exceed 8 inches.
2. Moisture condition lifts to at least 1 percentage point above the optimum moisture content; **and**
3. Compact fill to a minimum of 90 percent relative compaction; Compact the upper 6 inches of fill in pavement areas to 95 percent relative compaction prior to aggregate base placement.

7.8.1.2 Expansive Soil

Perform subgrade compaction prior to fill placement, following cutting operations, and in areas left at grade as follows.

1. Scarify to a depth of at least 8 inches.
2. Moisture condition soil to at least 3 percentage points over the optimum moisture content; **and**
3. Compact the soil to between 87 and 92 percent relative compaction. Compact the upper 6 inches of finish pavement subgrade to at least 90 percent relative compaction prior to aggregate base placement. Fills deeper than 10 feet should be compacted to a minimum of 90 percent relative compaction.

After the subgrade has been compacted, place and compact acceptable fill as follows:

1. Spread fill in loose lifts that do not exceed 8 inches.
2. Moisture condition lifts to at least 3 percentage points over the optimum moisture content; **and**
3. Compact fill to between 87 and 92 percent relative compaction; compact the upper 6 inches of fill in pavement areas to at least 90 percent relative compaction prior to aggregate base placement.

7.8.1.3 Lime-Treated Soils

Where lime treatment of the soil is used to mitigate expansive soil conditions, we recommend uniformly mixing the subgrade soil with at least 4 percent high calcium lime by dry weight. The soil should be moisture conditioned to at least 3 percentage points above the optimum moisture content before mixing. The mixing should be performed in accordance with the current version of Caltrans Standard Specifications with the following exceptions:

1. Following mixing, the treated soils should be allowed to fully hydrate prior to compaction.
2. Following hydration, the treated soil should be compacted according to ASTM D-1557 to not less than 95 percent relative compaction at a moisture content at least 2 percentage points above the optimum to a non-yielding surface.

7.8.1.4 Pavement Aggregate Base

Compact the pavement Caltrans Class 2 Aggregate Base section to at least 95 percent relative compaction (ASTM D1557). Moisture condition aggregate base to or slightly above the optimum moisture content prior to compaction.

7.8.2 Underground Utility Backfill

The contractor is responsible for conducting trenching and shoring in accordance with CALOSHA requirements. Project consultants involved in utility design should specify pipe bedding materials.

Where utility trenches cross perimeter building foundations, backfill with native clay soil for pipe bedding and backfill for a distance of 2 feet on each side of the foundation. This will help prevent the normally granular bedding materials from acting as a conduit for water to enter beneath the building. As an alternative, a sand cement slurry (minimum 28-day compressive strength of 500 psi) may be used in place of native clay soil.

7.8.2.1 Non-Expansive Soils

Place and compact trench backfill in structural areas as follows:

1. Trench backfill should have a maximum particle size of 6 inches.
2. Moisture condition trench backfill to at least the optimum moisture content. Moisture condition backfill outside the trench.
3. Place fill in loose lifts not exceeding 12 inches;**and**
4. Compact fill to a minimum of 90 percent relative compaction.

7.8.2.2 Expansive Soils

Place and compact trench backfill in structural areas as follows:

1. Trench backfill should have a maximum particle size of 6 inches.
2. Moisture condition trench backfill to 3 percentage points above the optimum moisture content. Moisture condition backfill outside the trench.

3. Place fill in loose lifts not exceeding 12 inches; **and**
4. Compact fill to a minimum of 87 to 92 percent relative compaction in the upper 3 feet of finish subgrade. Below a depth of 3 feet from finish subgrade, compact to a minimum of 90 percent relative compaction.

Jetting of backfill is not an acceptable means of compaction. We may allow thicker loose lift thicknesses based on acceptable density test results, where increased effort is applied to rocky fill, or for the first lift of fill over pipe bedding.

7.8.3 Landscape Fill

Process, place and compact fill in accordance with Sections 7.3 and 7.8, except compact to at least 85 percent relative compaction (ASTM D1557).

7.9 SLOPE GRADIENTS

Construct final slope gradients to 2:1 (horizontal:vertical) or flatter. The contractor is responsible to construct temporary construction slopes in accordance with CALOSHA requirements.

7.10 SITE SURFACE DRAINAGE

The project civil engineer is responsible for designing surface drainage improvements. With regard to geotechnical engineering issues, we recommend that finish grades be sloped away from buildings and pavements to the maximum extent practical. The latest California Building Code Section 1804.4 specifies minimum slopes of 5 percent away from foundations. As a minimum, we recommend the following:

1. Discharge roof downspouts into closed conduits and direct away from foundations to appropriate drainage devices.
2. Do not allow water to pond near foundations, pavements, or exterior flatwork.

7.11 STORMWATER BIORETENTION AREAS

If bioretention areas are implemented, we recommend that, when practical, they be planned a minimum of 5 feet away from structural site improvements, such as buildings, streets, retaining walls, and sidewalks/driveways. When this is not practical, bioretention areas located within 5 feet of structural site improvements can either:

1. Be constructed with structural side walls capable of withstanding the loads from the adjacent improvements; **or**
2. Incorporate filter material compacted to between 85 and 90 percent relative compaction (ASTM D1557, latest edition) and a waterproofing system designed to reduce the potential for moisture transmission into the subgrade soil beneath the adjacent improvement.
3. We recommend that bioretention design incorporate a waterproofing system lining the bioswale excavation and a subdrain, or other storm drain system, to collect and convey water to an approved outlet. The waterproofing system should cover the bioretention area excavation in such a manner as to reduce the potential for moisture transmission beneath the adjacent improvements.

Site improvements located adjacent to bioretention areas that are underlain by base rock, sand, or other imported granular materials, should be designed with a deepened edge that extends to the bottom of the imported material underlying the improvement.

Given the nature of bioretention systems and possible proximity to improvements, we recommend ENGEO be retained to review design plans and provide testing and observation services during the installation of linings, compaction of the filter material, and connection of designed drains.

It should be noted that the contractor is responsible for conducting all excavation and shoring in a manner that does not cause damage to adjacent improvements during construction and future maintenance of the bioretention areas. As with any excavation adjacent to improvements, the contractor should reduce the exposure time such that the improvements are not detrimentally impacted.

7.12 LANDSCAPING CONSIDERATION

As the near-surface soils are moderately expansive, we recommend greatly restricting the amount of surface water infiltration near structures, pavements, flatwork, and slabs on grade. This may be accomplished by:

- Selecting landscaping that requires little or no watering, especially within 3 feet of structures, slabs-on-grade, or pavements.
- Using low precipitation sprinkler heads.
- Regulating the amount of water distributed to lawn or planter areas by installing timers on the sprinkler system.
- Providing surface grades to drain rainfall or landscape watering to appropriate collection systems and away from structures, slabs-on-grade, or pavements.
- Preventing water from draining toward or ponding near building foundations, slabs-on-grade, or pavements.
- Avoiding open planting areas within 3 feet of the building perimeter.

We recommend that these items be incorporated into the landscaping plans.

8.0 RETAINING WALLS

The following recommendations are applicable for the use of onsite soil used as retaining wall backfill or import soil that meets our acceptable fill recommendations. They are also applicable for the hospital below-grade basement wall design.

8.1 LATERAL SOIL PRESSURES

Design proposed retaining walls to resist lateral earth pressures from adjoining natural materials and/or backfill and from any surcharge loads. Provided that adequate drainage is included as recommended below, design walls restrained from movement at the top to resist an equivalent fluid pressure of 60 pounds per cubic foot (pcf). In addition, design restrained walls to resist an additional uniform pressure equivalent to one-half of any surcharge loads applied at the surface.

Design unrestrained retaining walls with adequate drainage to resist an equivalent fluid pressure of 45 pcf plus one-third of any surcharge loads.

For basement retaining walls taller than 6 feet, we recommend the walls be designed to incorporate a dynamic increment of 15 pcf for restrained walls.

The above lateral earth pressures assume level backfill conditions and sufficient drainage behind the walls to prevent any build-up of hydrostatic pressures from surface water infiltration and/or a rise in the groundwater level. If adequate drainage is not provided, we recommend that an additional equivalent fluid pressure of 40 pcf be added to the values recommended above for both restrained and unrestrained walls. Damp-proofing of the walls should be included in areas where wall moisture would be problematic.

Construct a drainage system, as recommended below, to reduce hydrostatic forces behind the retaining wall.

8.2 RETAINING WALL DRAINAGE

Construct either graded rock drains or geosynthetic drainage composites behind the retaining walls to reduce hydrostatic lateral forces. For rock drain construction, we recommend two types of rock drain alternatives:

1. A minimum 12-inch-thick layer of Class 2 Permeable Filter Material (Caltrans Specification 68-2.02F) placed directly behind the wall, or
2. A minimum 12-inch-thick layer of washed, crushed rock with 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Envelop rock in a minimum 6-ounce, nonwoven geotextile filter fabric.

For both types of rock drains:

1. Place the rock drain directly behind the walls of the structure.
2. Extend rock drains from the wall base to within 12 inches of the top of the wall.
3. Place a minimum of 4-inch-diameter perforated pipe (glued joints and end caps) at the base of the wall, inside the rock drain and fabric, with perforations placed down.
4. Place pipe at a gradient at least 1 percent to direct water away from the wall by gravity to a drainage facility.

ENGEO should review and approve geosynthetic composite drainage systems prior to use.

8.3 BACKFILL

Backfill behind retaining walls should be placed and compacted in accordance with Section 7.8. Use light compaction equipment within 5 feet of the wall face. If heavy compaction equipment is used, the walls should be temporarily braced to avoid excessive wall movement.

8.4 FOUNDATIONS

Retaining walls may be supported on continuous footings designed in accordance with recommendations presented in Section 5.2.1.

9.0 TEMPORARY SHORING AND GROUNDWATER

Temporary construction excavations will require shoring or temporary slope excavations. Where shoring is needed, design excavation bracing to resist lateral earth pressure from adjoining material and from any surcharge loads such as traffic loading or loading from construction activities. For cantilever conditions, active earth pressures should be used as shown in Section 8.1. The recommended apparent lateral earth pressures on Figure 6 may be used for design of temporary braced support systems.

Refer to Section 4.4 for Groundwater Considerations and dewatering.

The choice of shoring should be left to the contractor's judgment since economic considerations and/or the individual contractor's construction experience may determine which method is more economical and/or appropriate. Support of adjacent structures and utilities without distress is the contractor's responsibility. We recommend that ENGEO review the contractor's plan for the excavation bracing prior to construction.

10.0 PAVEMENT DESIGN

10.1 FLEXIBLE PAVEMENTS

We obtained two representative bulk samples of the near surface soils and performed an R-value test on each of the samples to provide data for pavement design. The results of the test are included in Appendix B and indicate an R-value of 19 at boring 1-B1 and 19 at boring 1-B23. Since it is possible these samples were obtained in areas that could have been lime treated, it is possible that some portions of the site will have clays exposed that are not lime treated and could have lower R-values. On a preliminary basis, we recommend designing the pavement sections using an R-value of 19, provided that the actual R-value is confirmed during construction. Using estimated traffic indices for various pavement loading requirements, we developed the following recommended pavement sections using Topic 633 of the Caltrans Highway Design Manual (including the asphalt factor of safety), presented in the table below.

TABLE 10.1-1: Preliminary Recommended Asphalt Concrete Pavement Sections

TRAFFIC INDEX	SECTION	
	ASPHALT CONCRETE (INCHES)	CLASS 2 AGGREGATE BASE (INCHES)
5	3	8
6	3½	10
7	4	13

The civil engineer should determine the appropriate traffic indices based on the estimated traffic loads and frequencies. For offsite improvements, consideration to the City of Elk Grove standards may be necessary. The standards require a geotextile fabric be placed between the basement soil and the aggregate base material in all streets and incorporation of 12-inch deep pavement edge drains that have R-values less than 30.

10.2 RIGID PAVEMENTS

Use concrete pavement sections to resist heavy loads and turning forces in areas such as fire lanes or trash enclosures. Final design of rigid pavement sections, and accompanying reinforcement, should be performed based on estimated traffic loads and frequencies. We recommend the following minimum design sections for rigid pavements:

- Use a minimum section of 6 inches of Portland Cement concrete over 6 inches of Caltrans Class 2 Aggregate Base.
- Concrete pavement should have a minimum 28-day compressive strength of 3,500 psi.
- Provide minimum control joint spacing in accordance with Portland Cement Association guidelines.

10.3 SUBGRADE AND AGGREGATE BASE COMPACTION

Compact finish subgrade and aggregate base in accordance with Section 7.8.1. Aggregate Base should meet the requirements for ¾-inch maximum Class 2 AB in accordance with Section 26 1.02B of the latest Caltrans Standard Specifications.

10.4 CUT-OFF CURBS

Saturated pavement subgrade or aggregate base can cause premature failure or increased maintenance of asphalt concrete pavements. This condition often occurs where landscape areas directly abut and drain toward pavements. If desired to install pavement cutoff barriers, they should be considered where pavement areas lie downslope of any landscape areas that are to be sprinklered or irrigated, and should extend to a depth of at least 4 inches below the base rock layer. Cutoff barriers may consist of deepened concrete curbs or deep-root moisture barriers.

If reduced pavement life and greater than normal pavement maintenance are acceptable to the owner, then the cutoff barrier may be eliminated.

11.0 GROUND HEAT EXCHANGE

Based on our findings and review of the proposed development, we consider the site to be highly suitable for using a Ground Heat-Exchange (GHX) system to achieve energy savings and to potentially eliminate the need for outdoor air conditioner units, if desired. For the thermal properties of the soil and groundwater conditions at the site, a closed-loop GHX system would likely be well suited and could be implemented on select buildings. As project planning progresses, we can meet with you, your architect, and your MEP designer to further assess and develop GHX energy saving opportunities and efficiencies.

12.0 FUTURE SERVICES

As project planning progresses, we recommend that we be retained to perform supplemental confirmation explorations within the hospital building footprint that extend to a depth of 100 feet. These explorations will be used to confirm the soil conditions we encountered from 50 to 74 feet in 1-CPT4 are appropriate for design of the deep foundations or for support of a structural mat slab. This will also be beneficial for identifying the preferred location for load tests on piles.

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to:

1. Review the final grading and foundation plans and specifications prior to construction to evaluate whether our recommendations have been implemented, and to provide additional or modified recommendations, as needed. This also allows us to check if any changes have occurred in the nature, design or location of the proposed improvements and provides the opportunity to prepare a written response with updated recommendations.
2. Perform construction monitoring to check the validity of the assumptions we made to prepare this report. Earthwork operations should be performed under the observation of our representative to check that the site is properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fills has been performed in accordance with our recommendations and the project specifications. Sufficient notification to us prior to earthwork is important.

If we are not retained to perform the services described above, then we are not responsible for any party's interpretation of our report (and subsequent addenda, letters, and verbal discussions).

13.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical recommendations for design of the improvements discussed in Section 1.3 for the Elk Grove Hospital project. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the owner to transmit the information and recommendations of this report to the appropriate organizations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers. The conclusions and recommendations contained in this report are solely professional opinions and are valid for a period of no more than 2 years from the date of report issuance.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in building on or with earth materials. We are unable to eliminate all risks; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of report preparation. We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data are representative of the actual subsurface conditions across the site. Considering possible underground variability of soil and groundwater, additional costs may be required to complete the project. We recommend that the owner establish a contingency fund to cover such costs. If unexpected conditions are encountered, ENGEO must be notified immediately to review these conditions and provide additional and/or modified recommendations, as necessary.

Our services did not include excavation sloping or shoring, soil volume change factors, flood potential, or a geohazard exploration. In addition, our geotechnical exploration did not include work to determine the existence of possible hazardous materials. If any hazardous materials are encountered during construction, the proper regulatory officials must be notified immediately.

This document must not be subject to unauthorized reuse, that is, reusing without written authorization of ENGEO. Such authorization is essential because it requires ENGEO to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to ENGEO's documents. Therefore, ENGEO must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If ENGEO's scope of services does not include on-site construction observation, or if other persons or entities are retained to provide such services, ENGEO cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

We determined the lines designating the interface between layers on the exploration logs using visual observations. The transition between the materials may be abrupt or gradual. The exploration logs contain information concerning samples recovered, indications of the presence of various materials such as clay, sand, silt, rock, existing fill, etc., and observations of groundwater encountered. The field logs also contain our interpretation of the subsurface conditions between sample locations. Therefore, the logs contain both factual and interpretative information. Our recommendations are based on the contents of the final logs, which represent our interpretation of the field logs.

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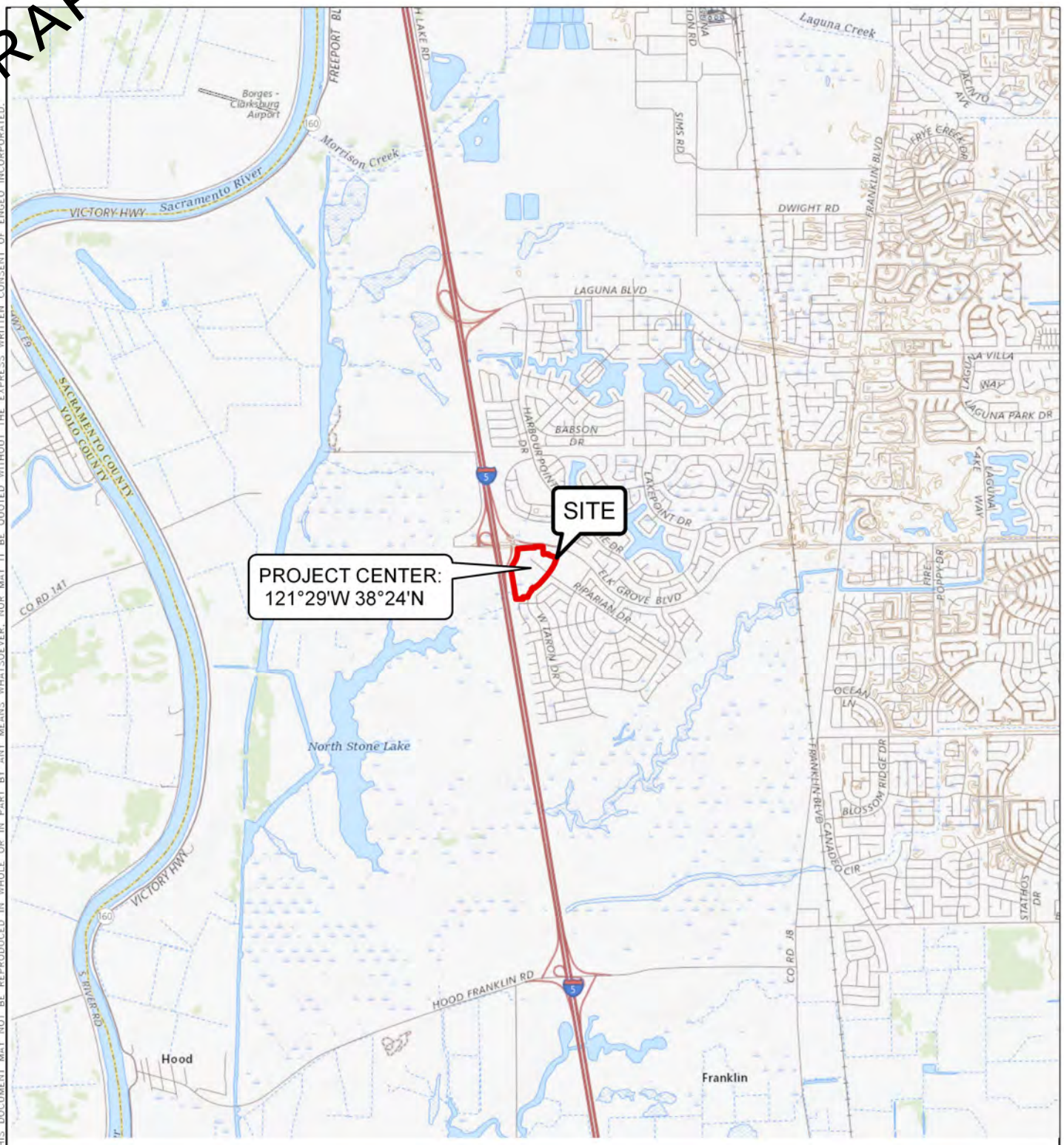
FIGURES

DRAFT



BASEMAP SOURCE: USGS MAPPING SERVICE

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VICINITY MAP
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

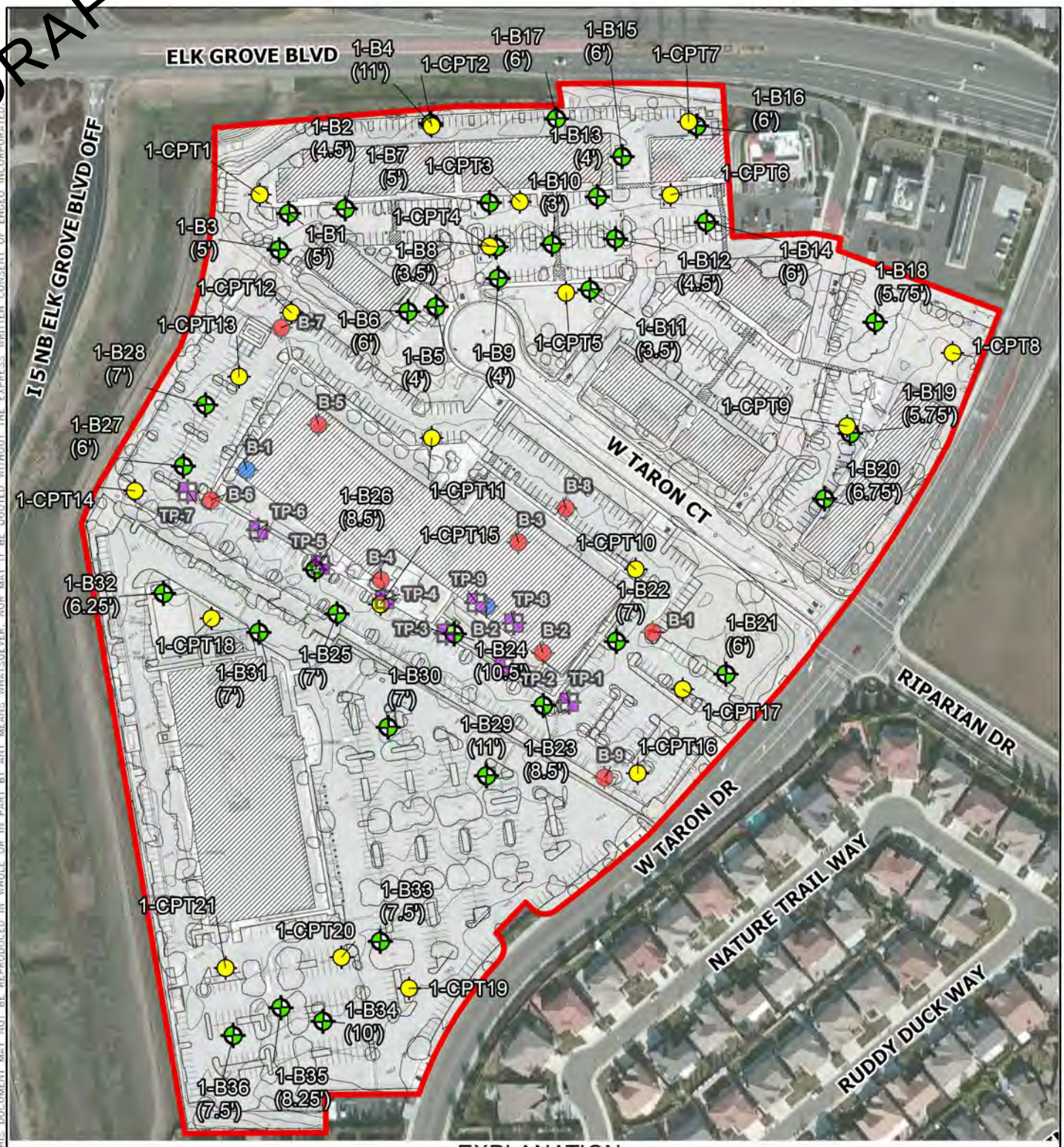
PROJECT NO. :	15747.000.000
SCALE:	AS SHOWN
DRAWN BY: QRL	CHECKED BY: MMG

FIGURE NO. 1

PATH: G:\DRAFTING\DRAFTING2_DWG_13000 PLUS\15747\CNSU ELK GROVE HOSPITAL.APRX
USER: OLIANG

ORIGINAL FIGURE PRINTED IN COLOR

DRAFT



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

- PROJECT SITE
- BORING (ENGEO, 2019)
- CPT (ENGEO, 2019)
- (11') FILL THICKNESS ESTIMATE
- SOIL BORING (N.O.A, 2005)
- SOIL BORING (N.O.A, 2008)
- TEST PIT (N.O.A, 2005)

N

0 100 200

FEET

BASEMAP SOURCE: ESRI MAPPING SERVICE, WOOD RODGERS

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EXISTING CONDITIONS SITE PLAN
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

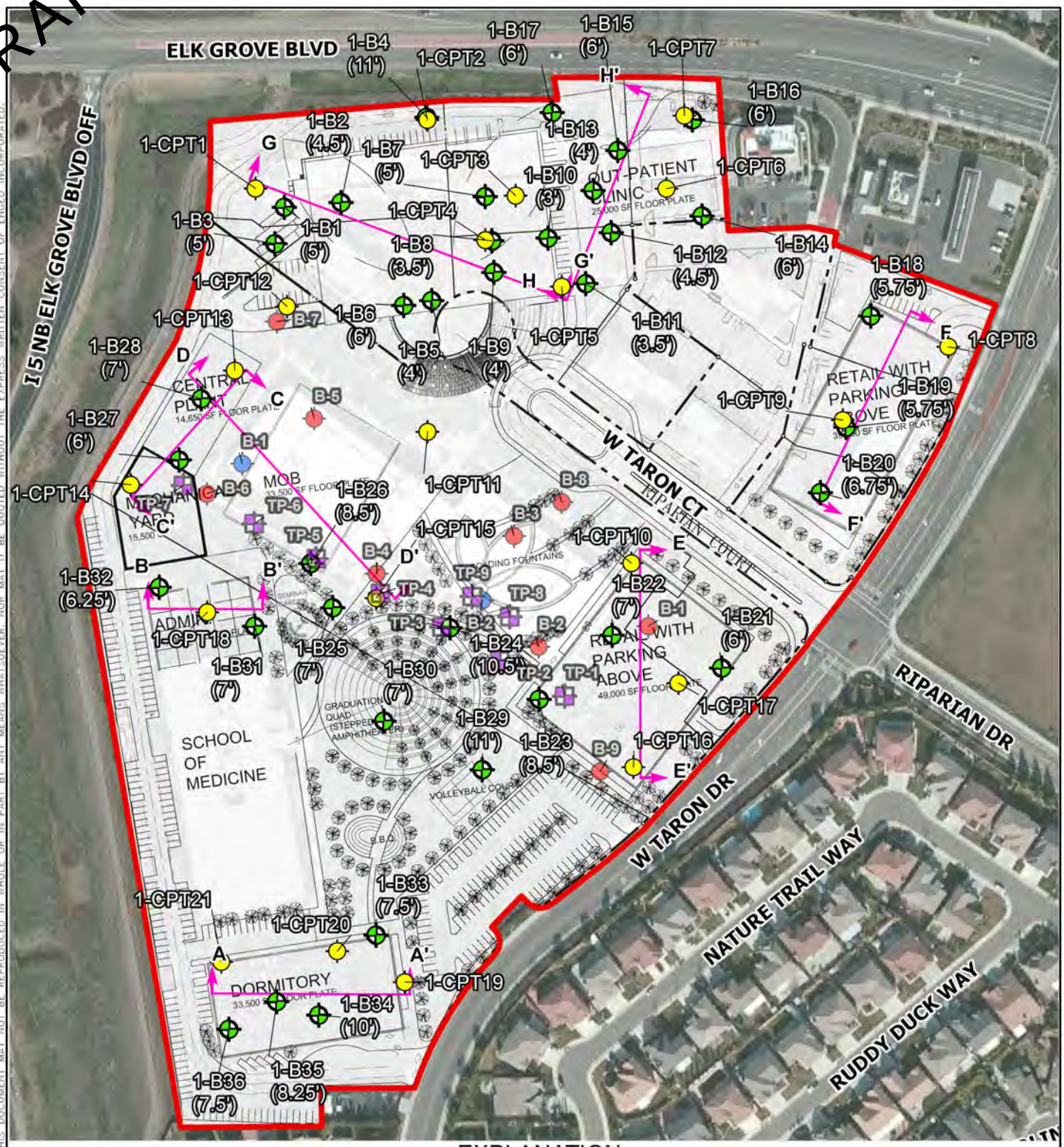
PROJECT NO. : 15747.000.000
SCALE: AS SHOWN
DRAWN BY: QRL
CHECKED BY: MMG

FIGURE NO. 2

PATH: G:\DRAFTING\DRAFTING2_DWG_13000 PLUS\15747\CNSU ELK GROVE HOSPITAL.APRX
USER: QLIANG

ORIGINAL FIGURE PRINTED IN COLOR

DRAFT



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

- PROJECT SITE
- BORING (ENGEO, 2019)
- CPT (ENGEO, 2019)
- (11') FILL THICKNESS ESTIMATE
- CROSS SECTION
- SOIL BORING (N.O.A, 2005)
- SOIL BORING (N.O.A, 2008)
- TEST PIT (N.O.A, 2005)

BASEMAP SOURCE: ESRI MAPPING SERVICE, WOOD RODGERS

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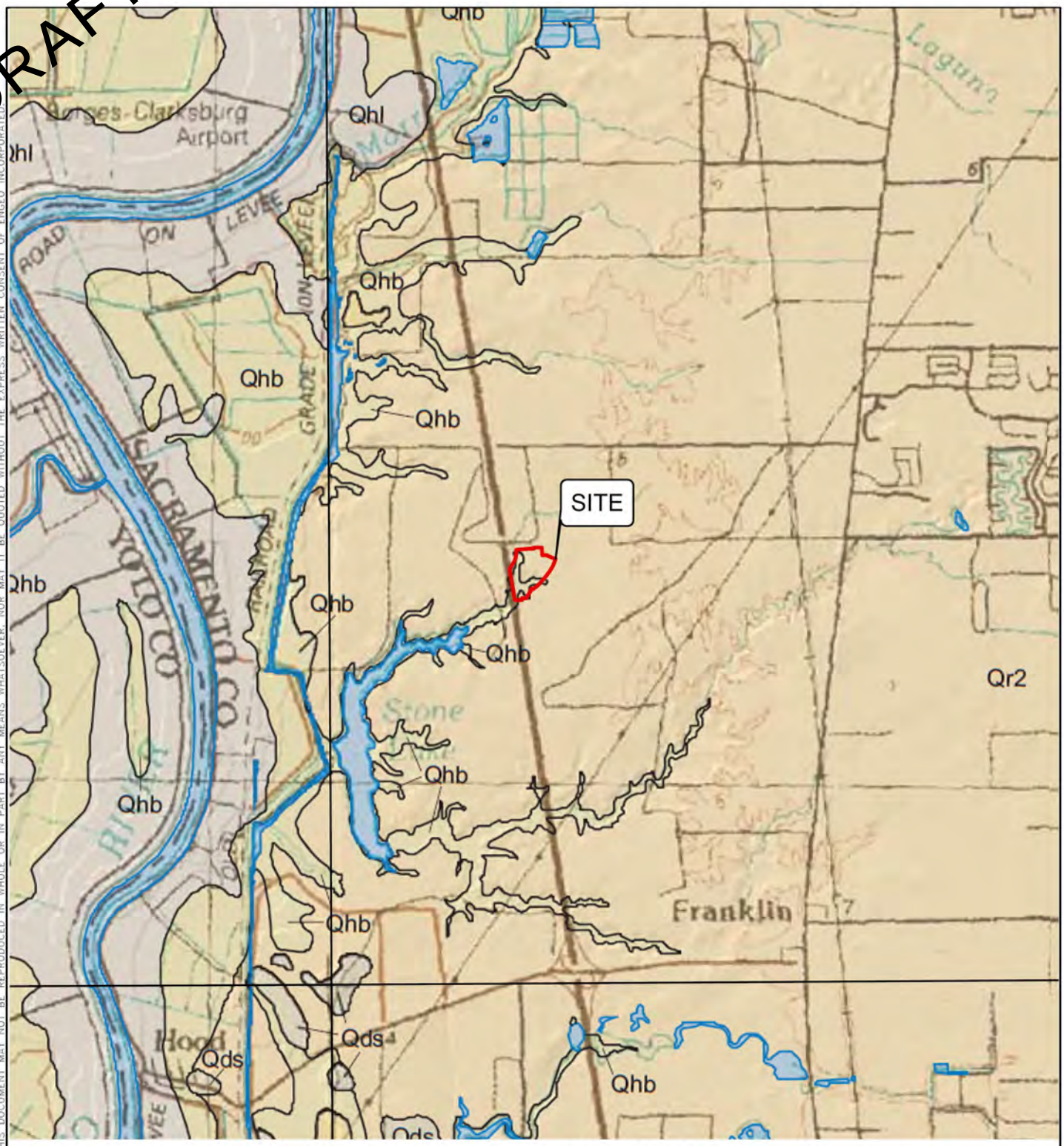
PROPOSED DEVELOPMENT SITE PLAN
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO. : 15747.000.000	FIGURE NO. 3
SCALE: AS SHOWN	
DRAWN BY: QRL	CHECKED BY: MMG

PATH: G:\DRAFTING\DRAFTING2_DWG_13000 PLUS\15747\CNSU ELK GROVE HOSPITAL.APRX
USER: QLIANG

ORIGINAL FIGURE PRINTED IN COLOR

DRAFT



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

- Qhl — HOLOCENE FAN LEVEE DEPOSITS
- Qhb — HOLOCENE BASIN DEPOSITS
- Qds — DUNE SAND
- Qr2 — RIVERBANK FORMATION

N

0 2,000 4,000

FEET

BASEMAP SOURCE: DAWSON 2009

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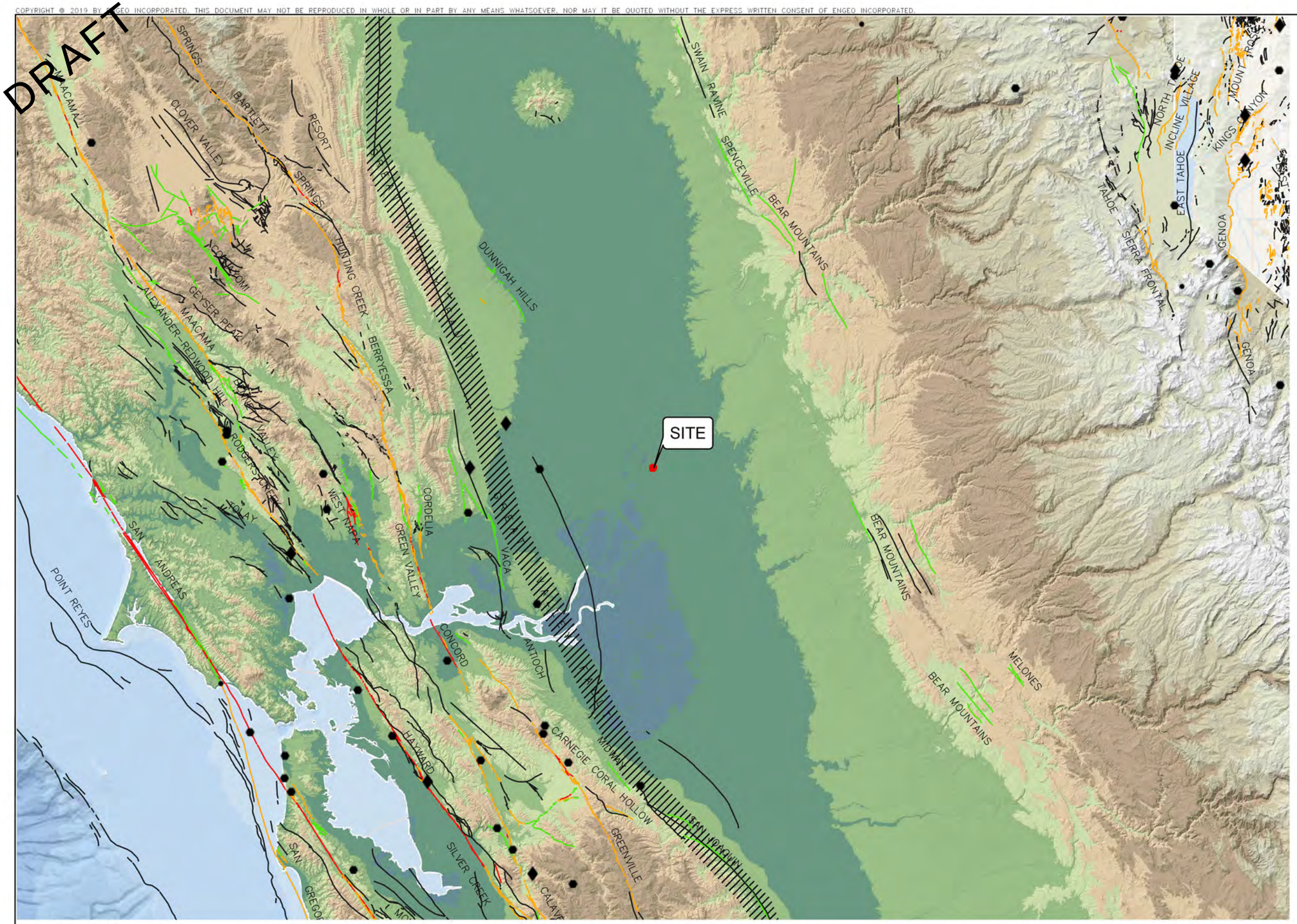
REGIONAL GEOLOGIC MAP
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO. : 15747.000.000		FIGURE NO. 4
SCALE: AS SHOWN		
DRAWN BY: QRL	CHECKED BY: MMG	

PATH: G:\DRAFTING\DRAFTING2_DWG_13000 PLUS\15747\CNSU ELK GROVE HOSPITAL.APRX
USER: QLIANG

ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

EARTHQUAKE

- MAGNITUDE 7+
- MAGNITUDE 6-7
- MAGNITUDE 5-6

USGS QUATERNARY FAULTS

- HISTORICAL
- LATEST QUATERNARY
- LATE QUATERNARY
- UNDIFFERENTIATED QUATERNARY

HISTORIC BLIND THRUST FAULT ZONE

BASE MAP SOURCE
ESRI, GARMIN, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATA SET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, 2018
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800-PRESENT)

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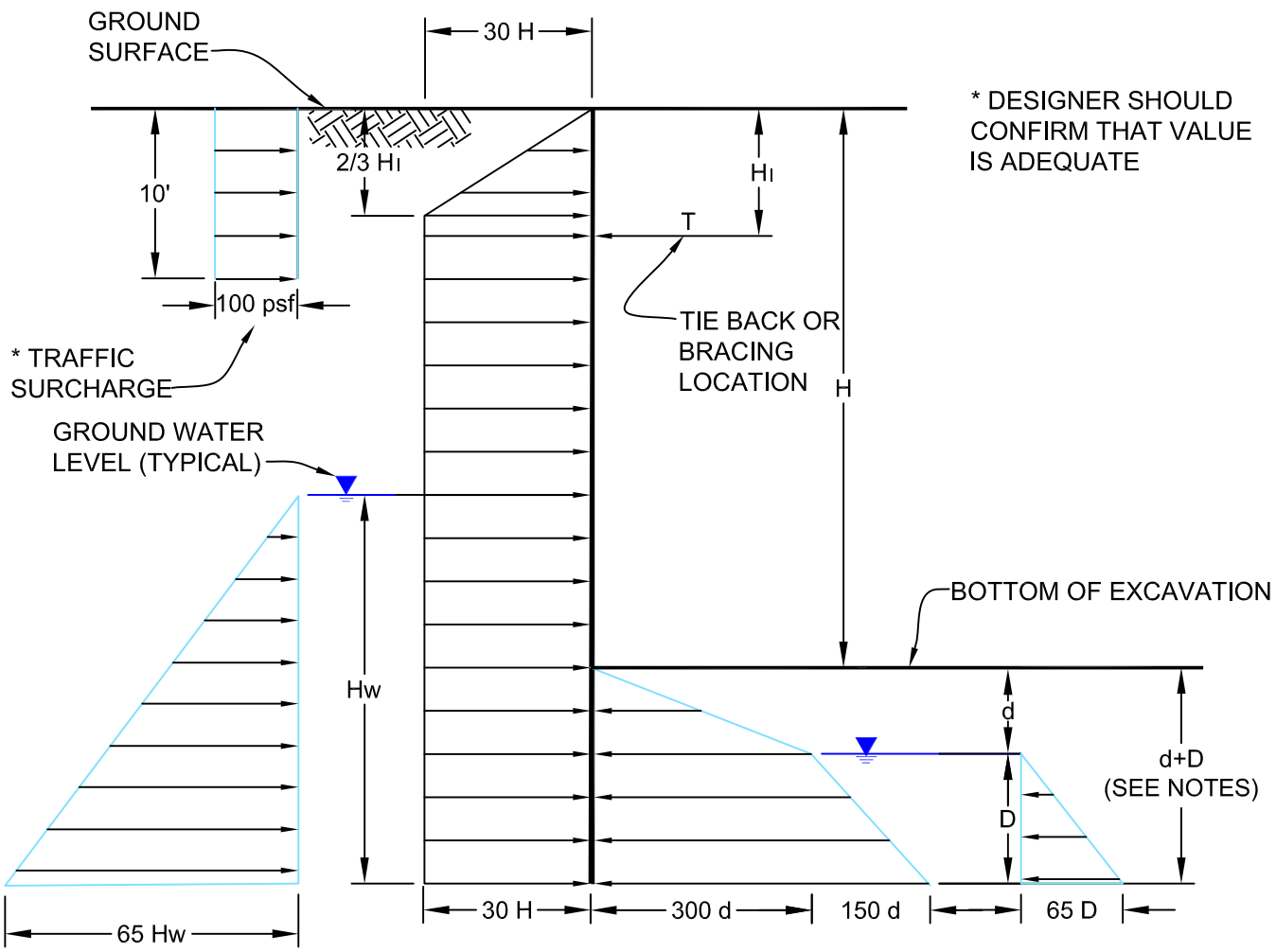
REGIONAL FAULTING AND SEISMICITY
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO. : 15747.000.000	FIGURE NO. 5
SCALE: AS SHOWN	
DRAWN BY: QRL / CHECKED BY: MMG	

PATH: G:\DRAFTING\DRAFTING2_DWG_13000 PLUS\15747\CNSU ELK GROVE HOSPITAL.APRX
USER: QLIANG

ORIGINAL FIGURE PRINTED IN COLOR



NOTES:

1) WATER TABLE IS ASSUMED TO BE A MINIMUM OF 3 FEET BELOW BOTTOM OF EXCAVATION

2) D, d, H, H_I AND H_W ARE TO BE IN FEET. PRESSURES ARE IN PSF

3) SAFETY FACTOR TO BE INCLUDED BY DESIGNER

4) ASSUMES LEVEL GROUND SURFACE AT TOP OF SHORING

5) ASSUMES INTERNALLY BRACED SYSTEMS

6) D+d MUST BE ADEQUATE TO PROVIDE STABILITY TO THE BOTTOM OF THE EXCAVATION AND TO PREVENT PIPING OF WATER

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TEMPORARY SHORING PRESSURE DIAGRAM
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO. 6
SCALE: NO SCALE	
DRAWN BY: QRL	CHECKED BY: MMG

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ORIGINAL FIGURE PRINTED IN COLOR

APPENDIX A

SOIL BORING EXPLORATION SUMMARY
BORING LOG KEY
EXPLORATION LOGS

SOIL BORING EXPLORATION SUMMARY

BORING ID	INTERPRETTED SURFACE ELEVATION (NAVD88)*	TOTAL DEPTH (feet)	GROUNDWATER DEPTH ENCOUNTERED AT TIME OF DRILLING	APPROXIMATED GROUNDWATER ELEVATION AT TIME OF EXPLORATION (ft, NAVD88)
1-B1	18.5	21.5	Not Encountered	NA
1-B2	18.5	31.5	29	-10.5
1-B3	17.5	51.5	Unable to detect due to drilling method	NA
1-B4	19	21.5	Not Encountered	NA
1-B5	17.5	21.5	Not Encountered	NA
1-B6	18	41.5	Unable to detect due to drilling method	NA
1-B7	18.5	21.5	Not Encountered	NA
1-B8	17.5	51.5	Unable to detect due to drilling method	NA
1-B9	17	21.5	Not Encountered	NA
1-B10	16.5	21.5	Not Encountered	NA
1-B11	15.5	21.5	Not Encountered	NA
1-B12	17	21.5	18.5	-1.5
1-B13	18	21.5	Not Encountered	NA
1-B14	17.5	31.5	19.5	-2
1-B15	18.5	21.5	Not Encountered	NA
1-B16	18.5	21.5	Not Encountered	NA
1-B17	18.5	51.4	Unable to detect due to drilling method	NA
1-B18	19	21.5	Not Encountered	NA
1-B19	18.5	51.5	Unable to detect due to drilling method	NA
1-B20	19	31.5	21	-2
1-B21	17.5	31.5	25	-7.5
1-B22	17.5	21.5	Not Encountered	NA
1-B23	17	21.5	Not Encountered	NA
1-B24	18.5	16.5	Not Encountered	NA
1-B25	17.5	51.5	Unable to detect due to drilling method	NA
1-B26	18	31.5	20	-2
1-B27	17.5	21.5	Not Encountered	NA
1-B28	17.5	31.5	19	-1.5
1-B29	16	21.5	Not Encountered	NA
1-B30	17	21.5	Not Encountered	NA
1-B31	18	21.5	Not Encountered	NA
1-B32	18	31.5	28	-10
1-B33	17	21.5	Not Encountered	NA
1-B34	17	21.5	20	-3
1-B35	17	31.5	25	-8
1-B36	17.5	31.5	20	-2.5

*Surface Elevation Interpretted from Wood Rogers Topographic Plan

KEY TO BORING LOGS

MAJOR TYPES			DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW - Well graded gravels or gravel-sand mixtures GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES	GM - Silty gravels, gravel-sand and silt mixtures GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW - Well graded sands, or gravelly sand mixtures SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES	SM - Silty sand, sand-silt mixtures SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity CL - Inorganic clay with low to medium plasticity OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Elastic silt with high plasticity CH - Fat clay with high plasticity OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with >30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAIN SIZES

U.S. STANDARD SERIES SIEVE SIZE				CLEAR SQUARE SIEVE OPENINGS			
200	40	10	4	3/4 "		3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Dames and Moore Piston
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

LINE TYPES

Solid - Layer Break

Dashed - Gradational or approximate layer break

GROUND-WATER SYMBOLS

Groundwater level during drilling

Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

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LOG OF BORING 1-B01

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LATITUDE: 38.40815939 LONGITUDE: -121.4812844

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete								
			6" Aggregate Base								
			CLAYEY SAND (SC), brown, loose, moist, fine-grained sand, trace gravel, approximately 40% fines, trace carbonates [FILL]	10					17.7		
			SANDY LEAN CLAY (CL), olive brown, stiff, moist, low plasticity, approximately 40% fine-grained sand, manganese veining, trace carbonates, trace mica [FILL]								
	15										
5			SANDY LEAN CLAY (CL), dark brown, stiff, moist, low plasticity, fine- to coarse-grained sand [NATIVE]	11	24	14	10				4.0*
			grades to moderate rust staining								
			CLAYEY SAND (SC), yellowish brown, dense, slightly moist, fine-grained sand, approximately 20% fines, minor manganese nodules and rust staining	97/10							4.5+*
	10										
10			SILT (ML), pale olive, hard, moist, low plasticity, abundant rust staining, manganese nodules, trace mica	51							4.5+*
	5										
15			carbonate nodules	55					18.9		4.5+*
	0										
20			grades to less rust staining and carbonates, increasing manganese nodules	47							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.								

Log Symbol

Water Level

LOG OF BORING 1-B02

ENGEO Expect Excellence

LATITUDE: 38.40817669 LONGITUDE: -121.4810062

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
			CLAYEY SAND (SC), brown, medium dense, moist, fine- to medium-grained sand, 20% fines, approximately 20% gravel, trace organics [FILL]			44				20	21.6		4.5+*
	15		LEAN CLAY WITH SAND (CL), dark brown, hard, moist, low plasticity, approximately 15% fine-grained sand [FILL]			16							4.0*
			layer of yellowish brown mottled with olive brown and brown, low to medium plasticity, very stiff, carbonate nodules										3.75*
5			LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, low plasticity, approximately 15% fine-grained sand, mica, manganese nodules, grades to increasing fine-grained sand [NATIVE]										
	10					87					14.2		4.5+*
10			LEAN CLAY (CL), olive brown, hard, moist, low plasticity, approximately 10% fine-grained sand, manganese nodules, rust staining, trace carbonates, sandy lense with trace mica			48							
	5												
15			grades to carbonate nodules, minor rust staining and manganese nodules			60							4.5+*
	0												
20						68					18		4.5+*
	-5												
25													

LOG OF BORING 1-B02

ENGEO Expect Excellence

LATITUDE: 38.40817669 LONGITUDE: -121.4810062

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			LEAN CLAY (CL), olive brown, hard, moist, low plasticity, approximately 10% fine-grained sand, manganese nodules, rust staining, trace carbonates, sandy lense with trace mica grades to approximately 10-15% fine-grained sand, less carbonate			42							4.5+*
	-10				▼								
30			grades to more rust staining		▽	79					22.8		4.5+*
			Bottom of boring at 31½ feet. Groundwater encountered at 31½ feet at time of drilling, groundwater measured at 29 feet at end of drilling.										

LOG OF BORING 1-B03

ENGEO Expect Excellence

LATITUDE: 38.40801892 LONGITUDE: -121.4813318

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt concrete										
			CLAYEY SAND (SC), brown, medium dense, slightly moist, fine- to medium-grained sand, 45% low plasticity fines, trace gravel [FILL] [Phenolphthalein reaction on lab samples at 1½ and 2 ft]			33				45	17.4		4.5+*
	15		Grades to olive brown mottled with pale olive, approximately 20% fines			13							
5			FAT CLAY (CH), dark gray, hard, moist, high plasticity [NATIVE]										
	10					95					18.8		4.5+* 4.5+*
			CLAYEY SAND (SC), yellowish brown, dense, moist, fine-grained sand, approximately 20% fines										
10			LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, medium plasticity, approximately 20% fine-grained sand			33							4.5+*
	5												
			LEAN CLAY WITH SAND (CL), olive brown, hard, moist, medium plasticity, approximately 15% fine-grained sand, manganese nodules, rust spotting, carbonate nodules										
15						46							4.5+*
	0												
			SANDY FAT CLAY (CH), gray, hard, moist, high plasticity, approximately 35% fine-grained sand, carbonate veining, rust staining, manganese nodules										
20						54					19.7		4.5+*
	-5												
			LEAN CLAY WITH SAND (CL), olive brown, very stiff, moist, approximately 20% fine-grained sand, carbonate veining, rust staining, manganese nodules										
25													

LOG OF BORING 1-B03

ENGEO Expect Excellence

LATITUDE: 38.40801892 LONGITUDE: -121.4813318

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
						13							2.5*
			CLAYEY SAND (SC), olive brown, medium dense, moist, fine- to medium-grained sand, approximately 25% fines										
	-10		LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, low plasticity, approximately 20% fine-grained sand										
30						68							4.5+*
			Grades to approximately 35% fine-grained sand										
	-15												
35			Grades to pale olive, manganese nodules, rust staining, approximately 10% fine-grained sand			44					33.2	90	4.5+*
	-20												
40			POORLY GRADED SAND WITH CLAY (SP-SC), yellowish brown, medium dense, moist, fine- to medium-grained sand, rust staining, trace mica			28							2.5*
			SILT (ML), pale olive, very stiff, moist, low plasticity, rapid dilatancy, rust staining, manganese nodules										
	-25												
45			Hard			68					28.2		4.5+*
	-30												
50													

LOG OF BORING 1-B03

LATITUDE: 38.40801892 LONGITUDE: -121.4813318

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SILT (ML), pale olive, very stiff, moist, low plasticity, rapid dilatancy, rust staining, manganese nodules Grades out of manganese nodules, rust staining			93							4.5+*
			POORLY GRADED SAND (SP), yellowish brown, dense, moist, medium-grained sand										
			Bottom of boring at 51½ feet. Groundwater not measured due to drilling method. Switched to mud rotary at 7 feet.										

LOG OF BORING 1-B04

ENGEO — Expect Excellence

LATITUDE: 38.40850213 LONGITUDE: -121.4805819

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
	15		LEAN CLAY WITH SAND (CL), yellowish brown with brown, hard, moist, low plasticity, angular gravel ¼" max size [FILL]			31					22.9		4.5+*
			Perched zone of water at 3½ ft			7							
			grades to dark brown										
5			grades to yellowish brown										
	10		grades to reddish brown staining, fine- to coarse-grained sand			24					19.8		4.5+*
10						14							
			LEAN CLAY WITH SAND (CL), yellowish brown mottled with brown, stiff, moist, trace organics, ¼" cemented soil nodules, manganese nodules [NATIVE]										2.0*
	5												
15			grades to 18% sand, heavy carbonate veining, increasing manganese staining, medium plasticity			54				82	17.5		4.5+*
	0												
20			less manganese staining			53							4.0*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B05

ENGEO Expect Excellence

LATITUDE: 38.40779609 LONGITUDE: -121.4805643

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			5" Aggregate Base										
			CLAYEY SAND WITH GRAVEL (SC), brown, medium dense, moist, fine-grained sand, approximately 35% fines, approximately 10% gravel [FILL]			31							
	15		LEAN CLAY WITH SAND (CL), pale olive, hard, moist, low plasticity, approximately 15% fine-grained sand, rust staining, trace mica [FILL]								21.6		4.5+*
			grades to dark brown, medium plasticity										
5			LEAN CLAY WITH SAND (CL), olive brown, very stiff, moist, medium plasticity, approximately 20% fine-grained sand [NATIVE]			73/10					22.9		2.25*
	10		CLAYEY SAND (SC), light yellowish brown, medium dense, moist, fine-grained sand, approximately 30% fines, moderate cementation, trace mica, minor rust staining and manganese nodules			37							4.5+*
10			SANDY LEAN CLAY (CL), olive brown, hard, moist, low plasticity, approximately 30% fine-grained sand, rust staining, manganese nodules, carbonate nodules, trace mica			44							4.5+*
	5												
15			grades to pale olive, approximately 15% fine-grained sand, manganese veining			45							4.0*
	0												
			SILT (ML), pale olive, hard, moist, low plasticity, minor rust staining, mica, manganese nodules										
20						36					30		4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B06

ENGEO Expect Excellence

LATITUDE: 38.4077779 LONGITUDE: -121.4807016

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 41½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
	15		LEAN CLAY WITH SAND (CL), yellowish brown mottled with brown, stiff, moist, medium plasticity, approximately 25% fine- to coarse-grained sand, manganese nodules [FILL] [Phenolphthalein reaction on lab sample at 2½ ft]			23							
			grades to very stiff			10					20.9		3.75*
5			FAT CLAY (CH), dark brown, very stiff, moist, high plasticity [FILL]										3.5*
	10		LEAN CLAY WITH SAND (CL), yellowish brown mottled with dark brown, hard, moist, low plasticity, fine- to medium-grained sand, mica flakes [NATIVE]										
			22% fine- to medium-grained sand			23				78	21.3		4.5+*
10			Grades to light brownish gray, medium plasticity, approximately 35% fine- to coarse-grained sand, carbonate veining			43							4.5+*
	5												
15			grades to abundant manganese staining, strong cementation, carbonates			73							4.5+*
	0												
20			grades to abundant carbonate, minor rust staining, strong cementation			55					26.4		4.0*
	-5												
25													

LOG OF BORING 1-B06

ENGEO Expect Excellence

LATITUDE: 38.4077779 LONGITUDE: -121.4807016

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 41½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			LEAN CLAY WITH SAND (CL), yellowish brown mottled with dark brown, hard, moist, low plasticity, fine- to medium-grained sand, mica flakes [NATIVE] grades to minor yellowish brown veining increasing with depth, no carbonate			41							4.5+*
	-10												
30			CLAYEY SAND (SC), light yellowish brown, medium dense, moist, approximately 20-30% low plasticity fines, fine- to medium-grained sand										
			LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, yellowish brown staining			27							
	-15												
35			SANDY LEAN CLAY/CLAYEY SAND (SC-CL), yellowish brown, medium dense, moist, 50% fines, fine- to medium-grained sand			14				50			
	-20												
			SANDY LEAN CLAY (CL), pale olive, hard, moist										
40						44							
			Bottom of boring at 41½ feet. Groundwater not measured due to drilling method. Switched to mud rotary at 11½ feet.										

LOG OF BORING 1-B07

ENGEO Expect Excellence

LATITUDE: 38.40819622 LONGITUDE: -121.480299

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt Concrete										
			5" Aggregate Base										
			CLAYEY SAND WITH GRAVEL (SC), olive brown, medium dense, moist, fine-grained sand, approximately 30% fines, approximately 30% fine to coarse gravel [FILL] [Phenolphthalein reaction on lab sample at 1½ ft]			27					16.5		4.5+*
	15		LEAN CLAY WITH SAND (CL), dark brown, very stiff, moist, low plasticity, approximately 20% fine-grained sand, trace organics [FILL]			11							3.0*
5			LEAN CLAY (CL), yellowish brown mottled with olive brown, hard, moist, low plasticity, approximately 10% fine-grained sand [NATIVE]										
						40/4					18.8		4.5+*
	10		Grades to pale yellow, approximately 20% fine-grained sand, manganese nodules										4.5+*
10			Grades to pale olive, approximately 5-10% fine-grained sand, rust staining			58					19		4.5+*
	5												
15			grades to carbonate nodules and veining			45							4.5+*
	0												
20			grades to abundant carbonate			44							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B08

ENGEO Expect Excellence

LATITUDE: 38.40802565 LONGITUDE: -121.4802674

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt concrete										
			CLAYEY SAND (SC), dark brown, medium dense, slightly moist, approximately 20% fines, trace fine gravel, rust staining [FILL] [Phenolphthalein reaction on lab sample at 1½ ft] Grades to moist and no gravel			41					10.4		
	15					11							
			CLAYEY SAND (SC), yellowish brown, medium dense, moist, fine-grained sand, approximately 40% medium plasticity fines, carbonate nodules [NATIVE]										
5			FAT CLAY (CH), dark gray, very stiff, moist, high plasticity			50/6"							
			CLAYEY SAND (SC), yellowish brown, very dense, fine-grained sand, approximately 35% fines										
	10		LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, low plasticity, approximately 15% fine-grained sand, lenses of abundant mica			48							2.75*
			LEAN CLAY (CL), pale olive, hard, moist, medium plasticity, approximately 10% fine-grained sand, rust staining, carbonate nodules, manganese nodules										
10						29					22		4.5+*
	5												
15						42							4.5*
	0												
20			Mottled, abundant cemented soil/carbonate nodules			78							
	-5												
			SILTY SAND (SM), yellowish brown, medium dense, moist, fine-grained sand, 43% low plasticity fines										
25													

LOG OF BORING 1-B08

ENGEO
Expect Excellence

LATITUDE: 38.40802565 LONGITUDE: -121.4802674

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SILTY SAND (SM), yellowish brown, medium dense, moist, fine-grained sand, 43% low plasticity fines			20	27	23	4	43	27.4		
	-10		SANDY SILT (ML), yellowish brown, very stiff, moist, low plasticity, fine-grained sand, 66% fines, rust staining, manganese nodules, trace mica										
30						27	36	27	9	66	36.6		
	-15		SILTY SAND (SM), olive brown, medium dense, moist, low plasticity, fine- to medium-grained sand, approximately 25% fines, minor rust staining and manganese nodules, trace mica										
			Grades to fine-grained sand, approximately 35% fines										
35			CLAYEY SAND (SC), yellowish brown, dense, wet, fine- to coarse-grained sand, 12% fines			50							4.5*
	-20												
40			Grades to gray, medium dense Grades to dark yellowish brown			18				12			
	-25												
			Grades to medium dense, fine- to medium-grained sand, 16% fines, trace mica										
45						28				16			
	-30												
50													

LOG OF BORING 1-B08

LATITUDE: 38.40802565 LONGITUDE: -121.4802674

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			CLAYEY SAND (SC), yellowish brown, dense, wet, fine- to coarse-grained sand, 12% fines Grades to dense			41							
			Bottom of boring at 51½ feet. Groundwater not measured due to drilling method. Switched to mud rotary at 7 feet.										

LOG OF BORING 1-B09

ENGEO Expect Excellence

LATITUDE: 38.40790364 LONGITUDE: -121.4802583

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete								
			5" Aggregate Base								
			CLAYEY SAND WITH GRAVEL (SC), brown, dense, moist, fine- to coarse-grained sand, approximately 40% fines, approximately 10% fine gravel [FILL] [Phenolphthalein reaction on lab sample at 1 ft]	50/2							
	15			18	26	14	12		12.1		3.75*
			LEAN CLAY WITH SAND (CL), dark brown, very stiff, moist, medium plasticity, approximately 15% fine-grained sand, trace gravel, minor manganese nodules, rust staining [FILL]								
5			SANDY LEAN CLAY (CL), reddish brown, hard, moist, low plasticity, approximately 40% fine- to coarse-grained sand [NATIVE]								4.5+*
				26							3.75*
			FAT CLAY (CH), olive brown, very stiff, moist, high plasticity								
	10		CLAYEY SAND (SC), yellowish brown, medium dense, moist, fine-grained sand, approximately 25% fines, trace mica, minor rust staining	48							
			grades to approximately 40% fine-grained sand								
10			LEAN CLAY WITH SAND (CL), pale olive, hard, moist, medium plasticity, approximately 15% fine-grained sand, manganese nodules, minor rust staining, trace mica, trace carbonates								
				73					15.9		4.5+*
	5										
15											
			grades to medium to high plasticity, <5% fine-grained sand, carbonate veining	51							4.5+*
	0										
20											
			Grades to meduim plasticity	41					29		
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.								

Log Symbol

Water Level

LOG OF BORING 1-B10

ENGEO Expect Excellence

LATITUDE: 38.40803502 LONGITUDE: -121.4799917

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 16½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
	15		CLAYEY SAND (SC), dark yellowish brown, medium dense, moist, fine-grained sand, approximately 40% fines, trace carbonates [FILL] [Phenolphthalein reaction on lab sample at 1½ ft]			29							2.5*
			LEAN CLAY WITH SAND (CL), dark brown, hard, moist, medium plasticity, approximately 20% fine-grained sand, trace organics [NATIVE]			9					18.3		4.5+*
5													
	10		LEAN CLAY WITH SAND (CL), pale olive, hard, moist, low plasticity, approximately 20% fine-grained sand, carbonate veining, rust staining, manganese nodules			53							4.5+*
10			SANDY SILT (ML), pale olive, hard, moist, low plasticity, approximately 30% fine-grained sand, minor carbonate veining, rust staining, manganese nodules			31					21		4.5+*
	5		Grades to lenses of silty sand										
15			Grades to minor rust staining, no manganese nodules			41							4.5+*
	0												
			LEAN CLAY WITH SAND (CL), pale olive, hard, moist, medium plasticity, approximately 15% fine-grained sand, carbonate veining, minor rust staining										
20						113							4.5+*
	-5		Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B11

ENGEO Expect Excellence

LATITUDE: 38.40785823 LONGITUDE: -121.4798079

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 15½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
	15		Surface Gravel										
			SANDY CLAY (CL), brown, very stiff, moist, low plasticity, approximately 35% fine-grained sand [FILL] [Phenolphthalein reaction on lab sample at 1½ ft]			12					22.1		3.5*
			grades to with yellowish brown			8							
			FAT CLAY (CH), dark brown mottled with olive brown, stiff, moist, medium plasticity, trace roots [NATIVE]								21.9		1.75*
5	10												
			SANDY LEAN CLAY (CL), yellowish brown, hard, moist, low plasticity, approximately 40% fine- to coarse-grained sand, manganese nodules, minor rust staining, minor carbonate nodules			38							4.5+*
10	5		LEAN CLAY WITH SAND (CL), pale olive, hard, moist, low plasticity, approximately 20% fine-grained sand, carbonate nodules and veining, manganese nodules, rust staining, silty sand lense with trace mica			46					21.1		4.5+*
			SILTY SAND (SM), pale olive, hard, moist, low plasticity, approximately 45% fines, carbonate nodules, rust staining, manganese nodules, trace mica			43							4.5+*
15	0												
			LEAN CLAY (CL), pale olive, hard, moist, medium plasticity, fine gravel to coarse sand sized cemented soil/carbonate nodules, rust staining, manganese nodules, trace mica										
20	-5					41							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B12

ENGEO Expect Excellence

LATITUDE: 38.40805438 LONGITUDE: -121.4796817

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
	15		SANDY LEAN CLAY (CL), light yellowish brown, hard, moist, low plasticity, approximately 40% fine-grained sand, trace carbonates [FILL]			17					14.3		4.5+*
5			LEAN CLAY WITH SAND (CL), dark brown, hard, moist, medium plasticity, approximately 15% medium- to coarse-grained sand, with carbonates, manganese nodules, minor rust staining [NATIVE] [Undrained Shear Strength = 2,593 psf]			47					13.3	121.2	
	10		LEAN CLAY WITH SAND (CL), olive brown, hard, moist, low plasticity, approximately 15% fine-grained sand, rust staining, manganese nodules			88							4.5+*
10			grades to medium plasticity, trace organics, approximately 10% fine-grained sand			46					21.2		4.5+*
	5												
15			grades to low plasaticity, approximately 20% fine-grained sand, trace mica, carbonate nodules			51							4.5+*
	0				▼								
20			CLAYEY SAND (SC), olive brown, medium dense, wet, medium-grained sand, 13% fines, manganese nodules		▽	26				13			
			Bottom of boring at 21½ feet. Groundwater encountered at 20 feet, measured at 18½ feet at end of drilling.										

LOG OF BORING 1-B13

ENGEO Expect Excellence

LATITUDE: 38.40821714 LONGITUDE: -121.4797693

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
			CLAYEY SAND (SC), yellowish brown, dense, moist, approximately 40% fines, trace gravel [FILL] [Phenolphthalein reaction on lab sample at 1½ ft] grades to mottled with olive brown			96							4.5+*
	15		LEAN CLAY WITH SAND (CL), dark brown, very stiff, moist, medium plasticity, approximately 15% fine-grained sand [FILL]			12					21.4		2.25*
5			LEAN CLAY WITH SAND (CL), olive brown, hard, moist, low plasticity, approximately 15% fine-grained sand [NATIVE]										4.5+*
			SANDY LEAN CLAY (CL), yellowish brown, hard, moist, low plasticity, approximately 30% fine- to coarse-grained sand, trace mica, rust staining			66							4.5+*
	10												
10						56							
			POORLY GRADED SAND (SP), yellowish brown, dense, moist, fine- to medium-grained sand, manganese nodules										
	5		LEAN CLAY WITH SAND (CL), pale olive, hard, moist, medium plasticity, approximately 15% fine-grained sand, manganese nodules, rust staining, carbonate nodules										
15						54					21.2		4.5+*
	0												
20			grades to approximately 10% fines approximately 4" lense of clayey sand			53							
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B14

ENGEO Expect Excellence

LATITUDE: 38.40811662 LONGITUDE: -121.4792357

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
			LEAN CLAY WITH SAND (CL), brown, hard, moist, low plasticity, approximately 25% fine- to medium-grained sand, trace gravel [FILL]			35							4.5+*
	15		6" layer of yellowish brown, stiff sandy clay										
			SANDY LEAN CLAY (CL), dark brown, stiff, moist, low plasticity, approximately 30% fine-grained sand, trace organics [FILL]			11					17.4		1.5*
5													
			LEAN CLAY (CL), pale olive, hard, moist, medium plasticity, approximately 5% fine-grained sand, rust staining, minor manganese nodules [NATIVE]										
	10					52							4.5+*
													4.5+*
10			grades to minor rust staining			42					20.6		4.5+*
	5												
			POORLY GRADED SAND WITH CLAY (SP-SC), yellowish brown, medium dense, moist, fine- to medium-grained sand, approximately 5-10% fines, trace mica										
15						36							
	0												
			WELL GRADED SAND WITH CLAY (SW-SC), yellowish brown, medium dense, wet, fine- to coarse-grained sand, 7% fines, trace mica										
20						17				7			
	-5												
25													

LOG OF BORING 1-B14

ENGEO Expect Excellence

LATITUDE: 38.40811662 LONGITUDE: -121.4792357

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			WELL GRADED SAND WITH CLAY (SW-SC), yellowish brown, medium dense, wet, fine- to coarse-grained sand, 7% fines, trace mica grades to trace fine gravel 3 to 6" layer of silt			31							3.5*
	-10												
30			grades to increasing coarse-grained sand, fine gravel, 7% fines			9				7			
			Bottom of boring at 31½ feet. Groundwater encountered at 22 feet at time of drilling, groundwater measured at 19½ feet at end of drilling.										

LOG OF BORING 1-B15

ENGEO Expect Excellence

LATITUDE: 38.40837163 LONGITUDE: -121.4796467

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt Concrete										
			3" Aggregate Base										
			CLAYEY SAND (SC), brown, medium dense, moist, fine-grained sand, approximately 45% fines, trace fine gravel [FILL]			32							4.5+*
	15		LEAN CLAY WITH SAND (CL), dark brown, hard, moist, low plasticity, sandy clay with clasts of greenish gray fat clay, approximately 15% fine-grained sand [FILL] grades out of fat clay clasts, very stiff, trace roots			7					16.3		4.25*
													2.5*
5													
			SANDY LEAN CLAY (CL), reddish yellow, hard, moist, low plasticity, approximately 45% fine-grained sand, trace carbonate, manganese nodules [NATIVE]			77							4.5+*
	10												
10			LEAN CLAY WITH SAND (CL), olive brown, hard, moist, medium plasticity, approximately 15% fine-grained sand, manganese nodules, carbonate nodules			45							4.5+*
	5												
15			grades to approximately 10% fine-grained sand, rust staining, abundant carbonate veining			56					18.5		
	0												
20			grades to approximately <5% fine-grained sand, minor rust staining and manganese nodules			55							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B16

ENGEO Expect Excellence

LATITUDE: 38.40848792 LONGITUDE: -121.4792797

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/15/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
			CLAYEY SAND WITH GRAVEL (SC), brown, dense, moist, fine-grained sand, approximately 40% fines, approximately 20% gravel [FILL]			50/5							
			[Phenolphthalein reaction on lab sample at 1 ft]			12							
	15		LEAN CLAY WITH SAND (CL), dark brown, very stiff, moist, low plasticity, approximately 20% fine-grained sand [FILL]								14.8		2.5*
5													
			LEAN CLAY WITH SAND (CL), yellowish red, hard, moist, low plasticity, approximately 20% fine-grained sand, trace organics, manganese nodules, trace mica, grades to increasing sand content [NATIVE]			92					16.8		4.5+*
	10		LEAN CLAY (CL), pale olive, hard, moist, low plasticity, minor manganese nodules and rust staining										4.5+*
10						69							4.5+*
	5												
15			grades to trace carbonate			48							4.5+*
	0												
20			grades to manganese staining			89					19.5		4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B17

ENGEO Expect Excellence

LATITUDE: 38.40851911 LONGITUDE: -121.479968

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt Concrete										
			4" Aggregate Base										
			SANDY LEAN CLAY (CL), olive brown, hard, moist, fine- to medium-grained sand, rounded gravel ¼" max size [FILL] [Phenolphthalein reaction on lab samples at 1 and 1½ ft]			50					23.4		
	15		FAT CLAY (CH), greenish black, very stiff, moist, medium plasticity, trace roots [FILL]			17					15.9		3.0* 4.5+*
5			LEAN CLAY WITH SAND (CL), pale olive mottled with yellowish brown, hard, moist, low plasticity, approximately 15% fine-grained sand [FILL]										
			CLAYEY SAND (SC), yellowish brown, dense, moist, approximately 20-30% fines, moderate cementation, mica flakes [NATIVE]			50							
	10												
10			SANDY LEAN CLAY (CL), light brownish gray mottled with yellowish brown, hard, moist, medium plasticity, cemented nodules			53					21.5		4.5+*
	5												
15			grades to calcium carbonate veining, moderate reaction to acid			47							4.5+*
	0												
20			grades to coarse sand mixed with clay, manganese veining			45							4.5+*
	-5												
25													

LOG OF BORING 1-B17

ENGEO Expect Excellence

LATITUDE: 38.40851911 LONGITUDE: -121.479968

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			grades to increasing manganese veins, reddish brown stains			57					33.9		
			SILTY SAND (SM), light brownish gray, dense, moist, fine- to coarse-grained sand, approximately 20% fines										
	-10		POORLY GRADED SAND WITH CLAY (SP-SC), gray, medium dense, wet, coarse-grained sand, 9% fines										
30						37				9			
	-15		CLAYEY SAND (SC), reddish brown, medium dense, moist, moderate cementation, 15% fines										
35						22				15	27.1		4.5+*
	-20												
40						12							
	-25		SANDY LEAN CLAY (CL), olive mottled with reddish brown, hard, moist, low plasticity										
45						20					36.4		
	-30												
50													

LOG OF BORING 1-B17

LATITUDE: 38.40851911 LONGITUDE: -121.479968

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/16/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SANDY LEAN CLAY (CL), olive mottled with reddish brown, hard, moist, low plasticity			40							4.5+*
			Bottom of boring at 51½ feet. Groundwater not encountered during drilling. Switched to mud rotary at 11½ feet.										

LOG OF BORING 1-B18

ENGEO Expect Excellence

LATITUDE: 38.40772678 LONGITUDE: -121.4784105

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 19 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			3" Aggregate Base										
			SANDY CLAY (CL), brown to yellowish brown, hard, saturated, low plasticity, approximately 20% fine-grained sand, trace gravel, with carbonate [FILL] [Phenolphthalein reaction on lab sample at 1 ft]			23					16		4.5+*
	15												
5													
			grades to dark reddish brown with pockets of brown			50							4.5+*
			SANDY CLAY (CL), dark brown, hard, moist, low plasticity, approximately 40% fine-grained sand, trace coarse-grained sand, trace roots [NATIVE]										
						44							4.5+*
			LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, low plasticity, approximately 20% fine-grained sand, trace mica, rust staining										
	10												
10			LEAN CLAY (CL), olive brown, hard, moist, low plasticity, trace mica, rust stainig, manganese nodules			61					21.8		4.5+*
	5												
15			grades to carbonate nodules up to 1"			61							4.5+*
	0												
20						56					22.5		4.5+*
			Bottom of boring at 21½ feet. Groundwater not encnountered during drilling.										

LOG OF BORING 1-B19

ENGEO Expect Excellence

LATITUDE: 38.4072978 LONGITUDE: -121.4785349

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt concrete										
			CLAYEY SAND (SC), brown, dense, moist, fine-grained sand, approximately 40% fines, approximately 10% fine gravel [FILL]			54					20.5		4.5+* 4.5+*
			[Phenolphthalein reaction on lab samples at 1½ and 2 ft] Grades to dark gray, fine to coarse gravel										
	15		SANDY LEAN CLAY (CL), dark gray, very stiff, moist, approximately 20% fine-grained sand [FILL]			12	33	13	20				2.5*
			Grades to brown, hard, rust staining, approximately 30% fine-grained sand										4.5+*
5			Grades to very stiff, low plasticity										2.5*
			LEAN CLAY WITH SAND (CL), greenish gray, very stiff, moist, medium plasticity, approximately 15% fine- to medium-grained sand [NATIVE]			21							3.5*
			CLAYEY SAND (SC), yellowish brown, dense, moist, fine-grained sand, approximately 30% fines			72							4.5+* 4.5+*
	10		LEAN CLAY (CL), pale olive, hard, moist, low plasticity, approximately 10% fine-grained sand										
10			Grades to carbonate nodules, manganese nodules, rust staining, approximately 15% fine-grained sand			52					19.5		4.5+*
	5												
15			Grades to approximately 5-10% sand, increase in manganese nodules			45							4.5+*
	0												
20			Grades to increasing cementation										
			CLAYEY SAND (SC), pale olive, medium dense, moist, fine-grained sand, approximately 20% fines, carbonate nodules			42							
	-5												
25			POORLY GRADED SAND (SP), yellowish brown, dense, moist, fine- to medium-grained sand										

LOG OF BORING 1-B19

ENGEO Expect Excellence

LATITUDE: 38.4072978 LONGITUDE: -121.4785349

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			POORLY GRADED SAND (SP), yellowish brown, dense, moist, fine- to medium-grained sand			44							
	-10		LEAN CLAY (CL), yellowish brown, stiff, moist, low plasticity, rust staining, manganese nodules										
30						15	36	23	13		37.4		1.75*
	-15												
35			Grades to hard, approximately 10% fine-grained sand, lenses of silty sand with trace mica			41							4.5+*
	-20												
40			Grades to pale olive mottled with yellowish brown, medium plasticity			34					42.3		4.25*
	-25												
45			Grades to pale olive, low plasticity			43							4.5+*
	-30												
50													

LOG OF BORING 1-B19

LATITUDE: 38.4072978 LONGITUDE: -121.4785349

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			LEAN CLAY (CL), yellowish brown, stiff, moist, low plasticity, rust staining, manganese nodules			44							4.5+*
			Bottom of boring at 51½ feet. Groundwater not measured due to drilling method. Switched to mud rotary at 7 feet.										

LOG OF BORING 1-B20

ENGEO Expect Excellence

LATITUDE: 38.40704599 LONGITUDE: -121.4786628

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 19 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			4" Aggregate Base										
			SANDY LEAN CLAY (CL), brown, hard, moist, low plasticity, approximately 35% fine-grained sand, carbonate and manganese nodules [FILL]			18					16.2		4.5+*
	15												
5			grades to dark brown mottled with pockets of olive brown fat clay, moist, medium plasticity, approximately 25% fine-grained sand			29					13.1		4.5+*
			LEAN CLAY (CL), pale olive, hard, moist, low plasticity, rust staining, manganese nodules, carbonate veining [NATIVE]			85					18.6		4.5+*
	10												
10						64							4.5+*
	5												
15						59					22.7		4.5+*
	0												
20						30							4.5+*
			LEAN CLAY WITH SAND (CL), pale olive, very stiff, moist, low plasticity, approximately 15% fine-grained sand, trace carbonate, trace mica										2.5*
			SILTY SAND (SM), pale olive, dense, wet, fine-grained sand, approximately 20% fines, trace mica		▽								
	-5												
25													

LOG OF BORING 1-B20

LATITUDE: 38.40704599 LONGITUDE: -121.4786628

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/14/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 19 ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SILTY SAND (SM), pale olive, dense, wet, fine-grained sand, approximately 20% fines, trace mica			92							
			POORLY GRADED SAND (SP), yellowish brown, dense, wet, fine- to medium-grained sand, trace mica										
	-10												
30											22.4		4.5+*
			SILT WITH SAND (ML), pale olive, hard, moist, low plasticity, approximately 15% fine-grained sand, rust staining			40							
			Bottom of boring at 31½ feet. Groundwater encountered at 23 feet, measured at 21 feet at end of drilling.										

LOG OF BORING 1-B21

ENGEO Expect Excellence

LATITUDE: 38.40637123 LONGITUDE: -121.4791517

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			4" Aggregate base										
	15		LEAN CLAY (CL), olive yellow, hard, moist, medium plasticity, approximately 10% medium to coarse sand [FILL]			16					17.3		
			[Phenolphthalein reaction on lab samples at 2½ and 3 ft]										
			Cuttings grade to brown										
5			Grades to mottled with olive brown, stiff, approximately 20% sand, medium plasticity			84							1.5*
			LEAN CLAY WITH SAND (CL), olive yellow mottled with reddish brown, hard, moist, medium plasticity, approximately 20% sand [NATIVE]										
	10					58					25.9		4.5+*
			CLAYEY SAND (SC), reddish brown, dense, moist										
10			LEAN CLAY WITH SAND (CL), light brownish gray mottled with yellowish brown, hard, moist, low plasticity			82							4.5+*
	5												
15			Carbonate veining, trace fine gravel, approximately 15-20% fine sand, <5% gravel			37							4.5+*
	0												
			SILTY SAND (SM), olive brown, medium dense, moist, fine- to medium-grained sand										
20						33							
	-5												
25					▽								

LOG OF BORING 1-B21

LATITUDE: 38.40637123 LONGITUDE: -121.4791517

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SILTY SAND (SM), olive brown, medium dense, moist, fine- to medium-grained sand Grades to wet, 37% fines, rust veining			33				37			
	-10		LEAN CLAY WITH SAND (CL), olive, hard, moist, low plasticity, approximately 15% fine-grained sand, trace coarse sand										
30						57							
			Bottom of boring at 31½ feet. Groundwater encountered at approximatley 25 feet during drilling.										

LOG OF BORING 1-B22

ENGEO Expect Excellence

LATITUDE: 38.4065002 LONGITUDE: -121.4796882

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			4" Aggregate base										
	15		CLAYEY SAND (SC), yellowish brown, medium dense, moist, 26% fines [FILL] [Phenolphthalein reaction on lab samples at 2½ and 3 ft]			37				26	23.7	97.8	4.5+*
5			SANDY LEAN CLAY (CL), yellowish brown mottled with olive gray, stiff, moist, low plasticity, rootlet voids [FILL] [C'=315 psf, Phi'=26]			11	28	14	14		16.5		2.5*
	10		CLAYEY SAND (SC), olive yellow, very dense, moist, moderate cementation, 35% fines [NATIVE]			88				35			4.5+*
10			POORLY GRADED SAND WITH CLAY (SP-SC), yellowish brown, medium dense, moist, fine- to medium-grained sand, approximately 10% fines			21							
	5		SANDY LEAN CLAY (CL), light brownish gray, hard, moist, low plasticity, coarse sand, calcium carbonate										
15						70					19.6		4.5+*
	0												
20						55							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B23

ENGEO Expect Excellence

LATITUDE: 38.40625452 LONGITUDE: -121.4800484

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2.5" Asphalt concrete										
			5" Aggregate base										
	15		CLAYEY SAND (SC), olive brown, very dense, moist, 19% fines [FILL] [Phenolphthalein reaction on lab samples at 2 and 2½ ft]			94				19	24.8		4.5+*
5													
			FAT CLAY (CH), greenish black, hard, moist, medium to high plasticity, contains roots [FILL]			36					23.1		4.0*
	10		LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, medium plasticity, contains rootlets, increased yellowish brown mottling with depth, manganese nodules [FILL]			44							4.5+*
			LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, medium plasticity, contains rootlets, increased yellowish brown mottling with depth, manganese nodules [NATIVE]										
10			Grades to increased mottling, contains rootlets and calcium carbonate			74					20.4		4.5+*
	5												
15			Grades to less mottling			56							4.5+*
	0												
20			Grades to pale olive, less sand			49							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B24

ENGEO Expect Excellence

LATITUDE: 38.40653266 LONGITUDE: -121.4804834

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 16½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SANDY LEAN CLAY (CL), olive brown mottled with yellowish brown, very stiff, moist, medium plasticity, approximately 30-40% sand [FILL]										
						14	34	16	18		21.1	90.7	4.5+*
	15		Grades to reddish brown mottling										
5			Grades to olive gray, hard, contains rootlets			36							4.0*
			SANDY LEAN CLAY (CL), greenish gray, hard, moist, medium plasticity [FILL]										
	10					34					18.6		4.5+*
			Grades to olive gray with black mottling										
10			Grades to light brownish gray mottled with yellowish brown, calcium carbonate			38					17.5		4.5+*
			SANDY LEAN CLAY (CL), greenish gray, hard, moist, calcium carbonate [NATIVE]										
	5												
15			Contains sand seam, heavy oxidation staining, increase in calcium carbonate			56							4.5+*
			Bottom of boring at 16½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B25

ENGEO Expect Excellence

LATITUDE: 38.40661276 LONGITUDE: -121.4810584

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			1" Asphalt concrete										
			SANDY LEAN CLAY (CL), brown, very stiff, moist, low plasticity, 64% fines, fine-grained sand, approximately 10% fine gravel [FILL] Grades to dark gray, medium-high plasticity			25				64	21.3		3.5*
	15		Grades to dark brown, no gravel, approximately 30% fine-grained sand, grades to no gravel			14							
5			Grades to pale yellow, medium-high plasticity, carbonate nodules, approximately 20% fine-grained sand			19					29	65.4	2.14
	10		FAT CLAY (CH), dark gray, hard, moist, high plasticity, approximately 5-10% fine-grained sand, manganese nodules [NATIVE]			33	51	15	36		16.5		4.5+*
10			LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, low plasticity, 85% medium-high plasticity fines, carbonate veining, manganese nodules, rust staining			32				85	18.9		4.5+*
	5												
15			Grades to pale olive, approximately 10% fine-grained sand			43					19.5		4.5+*
	0												
20			Grades to decrease in manganese nodules, decrease in carbonates Grades to abundant carbonates and manganese nodules			58							4.5+*
	-5												
25			CLAYEY SAND (SC), yellowish brown, dense, moist, poorly graded, fine- to medium-grained sand, 22% fines, trace mica										

LOG OF BORING 1-B25

ENGEO Expect Excellence

LATITUDE: 38.40661276 LONGITUDE: -121.4810584

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			CLAYEY SAND (SC), yellowish brown, dense, moist, poorly graded, fine- to medium-grained sand, 22% fines, trace mica			47				22			
	-10												
30			SANDY LEAN CLAY (CL), yellowish brown, stiff, moist, low plasticity, 69% fines, minor rust staining, minor manganese nodules, trace mica			14	36	24	12	69	29.8		1.5*
	-15												
35			Grades to hard			44							4.5+*
			Grades to pale olive, low-medium plasticity										
	-20												
40			Grades to yellowish brown, low plasticity, approximately 15% fine-grained sand			38							4.5+*
	-25												
			SILT (ML), yellowish brown, medium stiff, wet, low plasticity, rapid dilatancy, trace mica, approximately 5-10% fine-grained sand										
45						22							0.75*
	-30												
50													

LOG OF BORING 1-B25

LATITUDE: 38.40661276 LONGITUDE: -121.4810584

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: SFA, Switch to Mud
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SILT (ML), yellowish brown, medium stiff, wet, low plasticity, rapid dilatancy, trace mica, approximately 5-10% fine-grained sand Grades to stiff			29							1.25*
			Bottom of boring at 51½ feet. Groundwater not measured due to drilling method. Switched to mud rotary at 7 feet.										

LOG OF BORING 1-B26

ENGEO Expect Excellence

LATITUDE: 38.40678388 LONGITUDE: -121.481165

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			5" Asphalt concrete										
			SANDY LEAN CLAY (CL), dark brown, hard, moist, medium plasticity, 51% fines [FILL]			50				51	20.1		
	15												
5			LEAN CLAY WITH SAND (CL), yellowish brown mottled with reddish brown, hard, moist, medium plasticity, approximately 20% fine-grained sand [FILL]			34					23.6		4.5+*
	10					38							4.5+*
			LEAN CLAY WITH SAND (CL), yellowish brown, hard, moist, medium plasticity, approximately 20% fine-grained sand [NATIVE]										
10			SANDY SILT (ML), light brownish gray mottled with reddish brown, very stiff, moist, low plasticity, contains calcium carbonate, manganese nodules			35					22.7		
	5		CLAYEY SAND (SC), reddish brown, medium dense, moist										
15						42							
			LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, medium plasticity, approximately 20% fine-grained sand										
	0												
20			Contains roots and calcium carbonate lense		▼	26					26.8		
	-5												
			SANDY LEAN CLAY (CL), light brownish gray, medium dense, moist, 50% fine-grained sand, trace coarse-grained sand		▽								
25													

LOG OF BORING 1-B26

LATITUDE: 38.40678388 LONGITUDE: -121.481165

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SANDY LEAN CLAY (CL), light brownish gray, medium dense, moist, 50% fine-grained sand, trace coarse-grained sand			38				50	24.5		
	-10		LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, 20% fine-grained sand										
30						22				80			
			Bottom of boring at 31½ feet. Groundwater measured at 24½ feet during drilling, groundwater measured at 20 feet at end of drilling.										

LOG OF BORING 1-B27

ENGEO Expect Excellence

LATITUDE: 38.40718629 LONGITUDE: -121.4818074

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			7" Aggregate Base										
			SANDY LEAN CLAY (CL), yellowish brown, very stiff, moist, low plasticity, 41% fine-grained sand, trace gravel, carbonate nodules, manganese nodules [FILL]			8				59	23.5		2.25*
	15												
5			grades to pale olive, medium plasticity			43	32	17	15		20.7		4.5+*
			LEAN CLAY (CL), dark brown, hard, moist, low plasticity, trace organics [NATIVE]										
	10		grades to pale olive mottled with yellowish brown			32					22.8		4.5+*
			grades to reddish brown mottled with pale olive										
10			LEAN CLAY (CL), olive brown mottled with gray, hard, moist, medium plasticity, trace organics, carbonate nodules, manganese nodules, minor rust staining			47					18.1		4.5+*
	5												
15			grades to olive brown			63					16.7		4.5+*
	0												
20			grades to rust staining			46							4.5+*
			Bottom of boring at 21½ feet. No groundwater encountered during drilling.										

LOG OF BORING 1-B28

ENGEO Expect Excellence

LATITUDE: 38.40742214 LONGITUDE: -121.4816976

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			2" Asphalt Concrete										
			3" Aggregate Base										
			SANDY LEAN CLAY WITH GRAVEL (CL), yellowish brown, hard, moist, 64% fines, fine-grained sand, approximately 10% gravel [FILL]			16				64	19.5		4.25*
	15		grades to dark brown mottled with gray										
			grades to pale olive, medium plasticity, approximately 20% fine-grained sand, no gravel, black spotting, carbonates										
5			grades to yellowish brown mottled with gray, trace mica			32					24.3		4.5+*
	10		FAT CLAY (CH), dark brown, hard, moist, high plasticity, rust staining [NATIVE]			39					15.9	118.6	4.5*
			grades to carbonate lensing										
10			grades to gray mottled with yellowish brown, black spotting, trace organics, trace fine-grained sand			44					17.9		4.5+*
	5		LEAN CLAY (CL), yellowish brown mottled with gray, hard, moist, low plasticity, approximately 10% fine-grained sand, carbonate nodules, manganese nodules, rust staining, trace mica										
15						65					19		4.5+*
	0												
20			grades to low to medium plasticity, abundant carbonate, no rust colored staining			54							
	-5												
			CLAYEY SAND (SC), olive brown, medium dense, moist, fine-grained sand, 36% fines, carbonate nodules, trace mica										
25													

LOG OF BORING 1-B28

LATITUDE: 38.40742214 LONGITUDE: -121.4816976

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/11/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: K. Castro / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			CLAYEY SAND (SC), olive brown, medium dense, moist, fine-grained sand, 36% fines, carbonate nodules, trace mica		▽	38				36			
	-10												
30			SANDY SILT (ML), yellowish brown, very stiff, wet, low plasticity, 42% fine-grained sand, rust staining, black manganese veining, trace mica			9				58	21.7		2.5*
			Bottom of boring at 31½ feet. Groundwater encountered at 26 feet, measured at 19 feet at end of drilling.										

LOG OF BORING 1-B29

ENGEO Expect Excellence

LATITUDE: 38.40598402 LONGITUDE: -121.4803293

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 16 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			8" Aggregate base										
	15		SANDY LEAN CLAY (CL), olive brown, hard, moist, medium plasticity, approximately 10-20% sand, contains rootlets [FILL]			52							4.5+*
5			Grades to mottled with yellowish brown, very stiff										
	10		Grades to light brownish gray			17							2.5*
			Grades to bluish black mottled with gray, contains rootlets, approximately 10% coarse grained sand, increase in plasticity			15							2.5*
10			Grades to hard			37							4.0*
	5		CLAYEY SAND (SC), yellowish brown, dense, moist, medium- to coarse-grained sand, approximately 15% fines [NATIVE]										
			SANDY LEAN CLAY (CL), pale olive, hard, moist, low plasticity										
15			Carbonate veining										
	0					39							4.5+*
20													
	-5					46							4.5+*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B30

ENGEO Expect Excellence

LATITUDE: 38.40617388 LONGITUDE: -121.4808107

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			4" Aggregate base										
	15		SANDY LEAN CLAY (CL), greenish black, hard, moist, medium plasticity, carbonate [FILL] [Phenolphthalein reaction on lab samples at 2 and 2½ ft]			70							4.5+*
5			Brown to olive with reddish brown mottling, fine- to coarse-grained sand [Phenolphthalein reaction on lab samples at 3 and 4½ ft]			31							4.5+*
	10		SANDY LEAN CLAY (CL), light brownish gray mottled with yellowish brown, hard, moist, medium plasticity, approximately 30-40% fine-grained sand [NATIVE]			45							4.5+*
10			Carbonate veining, manganese nodules			41							4.5+*
	5												
15			Grades to less mottling, low plasticity			45							
	0												
20						41							
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B31

ENGEO Expect Excellence

LATITUDE: 38.40654291 LONGITUDE: -121.4814419

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/8/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3.5" Asphalt concrete										
			6" Aggregate base										
			CLAYEY SAND (SC), brown, loose, moist, fine-grained sand, 47% fines, chunks of cemented soil, angular gravel fragments with carbonate [FILL]			15				47	21.5		
	15		[Phenolphthalein reaction on lab samples at 2, 2½, and 3 ft]										
5			Grades to medium dense			23							2.5*
	10		LEAN CLAY WITH SAND (CL), dark bluish gray mottled with light bluish gray, very stiff, moist, medium plasticity, trace organics [NATIVE]			22	48	15	33		18.9		2.5*
10			LEAN CLAY (CL), dark olive brown, hard, moist, medium plasticity, approximately 10% fine-grained sand, carbonate veining			37					20.5		4.5+*
	5												
15			Manganese nodules			48							4.5+*
	0												
20			Significant carbonate veining			42							4.0*
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B32

ENGEO Expect Excellence

LATITUDE: 38.40669537 LONGITUDE: -121.4819087

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			SANDY LEAN CLAY (CL), olive mottled with yellowish brown, very stiff, moist, low plasticity, 46% fine-grained sand [FILL]										
						20	37	22	15	54	22.2		3.0*
	15												
5			Grades to clay inclusions in clayey sand matrix										
						33					20.9		
			FAT CLAY WITH SAND (CH), greenish black, hard, moist, high plasticity, approximately 15% fine-grained sand [NATIVE]										
	10										20.6		
						26							4.5+*
			LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, medium plasticity, 18% fine- to coarse-grained sand										
10													
						53				82			
	5												
15			Contains carbonate, manganese										
						31							4.5+*
	0												
20			Increased carbonate										
						36					24.5		4.5+*
	-5												
25													

LOG OF BORING 1-B32

LATITUDE: 38.40669537 LONGITUDE: -121.4819087

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 18 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			LEAN CLAY WITH SAND (CL), light brownish gray, hard, moist, medium plasticity, 18% fine- to coarse-grained sand Grades to mottled with olive yellow			25							
	-10		CLAYEY SAND (SC), light brownish gray, medium dense, moist, fine- to coarse-grained sand, 46% fines		▼								
30						47				46			
			Bottom of boring at 31½ feet. Groundwater measured at 28 feet at end of drilling.										

LOG OF BORING 1-B33

ENGEO Expect Excellence

LATITUDE: 38.40534765 LONGITUDE: -121.4808548

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			6" Aggregate base										
	15		SANDY LEAN CLAY (CL), olive yellow mottled with gray, hard, moist, medium plasticity, trace subangular gravel, trace organics [FILL]			33					24.5	97.9	4.5+*
5			FAT CLAY (CH), dark brown mottled with yellowish brown, hard, moist, medium to high plasticity [FILL]			33					16.9		4.5+*
	10		FAT CLAY (CH), light olive brown, hard, moist, high plasticity, mottled with carbonate, subangular gravel [NATIVE]			45					14.6		4.5+*
10			Grades to pale olive mottled with reddish brown			55							4.5+*
			CLAYEY SAND (SC), reddish brown, dense, moist										
	5		SANDY LEAN CLAY (CL), pale olive, hard, moist, medium plasticity, minor oxidation										
15			Grades to increase in oxidation staining, mangnaese nodules			44					22.3		
	0												
20			Grades to light brownish gray, coarse-grained sand and carbonate			23							
			Bottom of boring at 21½ feet. Groundwater not encountered during drilling.										

LOG OF BORING 1-B34

ENGEO Expect Excellence

LATITUDE: 38.40504022 LONGITUDE: -121.4811384

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/10/2019
HOLE DEPTH: Approx. 21½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			4.5" Aggregate base										
	15		SANDY LEAN CLAY (CL), olive yellow, hard, moist, low plasticity, 31% fine- to coarse-grained sand [FILL]			56				69	13.4		4.5+*
5						27							4.5+*
	10		FAT CLAY (CH), olive yellow to greenish black, hard, moist, medium to high plasticity, contains 1/4" rounded gravel [FILL]										
			Grades to light brownish gray, contains roots and calcium carbonate			40					18.9		4.5+*
10			SANDY LEAN CLAY (CL), grayish brown, hard, moist, low plasticity, 26% fine- to medium-grained sand, trace mica, cemented carbonate noduels [NATIVE]			38				74			4.5+*
	5												
15			Grades to approximately 15% fines, oxidation staining and rootlets			48							
	0		CLAYEY SAND (SC), pale olive, medium dense, moist, fine- to medium-grained sand, 43% fines			16				43			
20					▼	23							
			SANDY LEAN CLAY (CL), light brownish gray, hard, moist, low plasticity										
			Bottom of boring at 21½ feet. Groundwater measured at 20 feet at end of drilling.										

LOG OF BORING 1-B35

ENGEO Expect Excellence

LATITUDE: 38.40509352 LONGITUDE: -121.4813443

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3" Asphalt concrete										
			6" Aggregate base										
	15		SANDY LEAN CLAY (CL), olive yellow, hard, moist, medium plasticity, 32% fine-grained sand [FILL] [EI = 62]			46				68	13		4.5+*
5			Grades to clasts of dark gray fat clay, carbonate inclusions, trace coarse gravel			35							4.5+*
	10		Grades to greenish gray with olive yellow										
			FAT CLAY WITH SAND (CH), dark gray, hard, moist, high plasticity [NATIVE]			52							4.5+*
10			SANDY LEAN CLAY (CL), yellowish brown, hard, moist, low plasticity, approximately 30-40% fine-grained sand Grades to yellowish brown			56					8.1		4.5+*
	5		SILTY SAND (SM), reddish brown, dense, moist, fine-grained sand, approximately 15% fines										
15						28							
	0		SANDY LEAN CLAY (CL), yellowish brown, hard, moist, low plasticity										
20			Grades to light brownish gray			80					23.3		4.5+*
	-5												
25					▽								

LOG OF BORING 1-B35

LATITUDE: 38.40509352 LONGITUDE: -121.4813443

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17 ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SANDY LEAN CLAY (CL), yellowish brown, hard, moist, low plasticity			36							4.5+*
			Grades to yellow mottling, increased plasticity, less sand										
	-10												
30			Grades to increased mottling			54					28.9		4.5+*
			Bottom of boring at 31½ feet. Groundwater measured at 25 feet at end of drilling.										

LOG OF BORING 1-B36

ENGEO Expect Excellence

LATITUDE: 38.40498755 LONGITUDE: -121.4815797

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			3.5" Asphalt concrete										
			6" Aggregate base										
	15		SANDY LEAN CLAY (CL), olive brown, hard, moist, medium plasticity, 16% fine-grained sand [FILL]			37	38	16	22	84	16.6	111.6	5.54
5			Grades to mottled with bluish gray, less sand, medium to high plasticity			52					15.6		4.5+*
	10		FAT CLAY WITH SAND (CH), dark gray, hard, moist [NATIVE]			31							4.5+*
			Grades to light brownish gray, contains rootlets, moderate organic odor, approximately 10% sand										
10			LEAN CLAY WITH SAND (CL), olive mottled with yellowish brown, hard, moist, low plasticity, 20% fine-grained sand, carbonate, roots			66				80	15.9		4.5+*
	5		Sandy cuttings										
15			Grades to olive, manganese staining, no roots, trace coarse-grained sand			45							
	0												
20			Grades to light brownish gray, wet, 26% fine-grained sand		▼	42				74	24.2		
	-5												
25													

LOG OF BORING 1-B36

LATITUDE: 38.40498755 LONGITUDE: -121.4815797

Geotechnical Exploration
Elk Grove Hospital
Elk Grove, California
15747.000.000

DATE DRILLED: 1/9/2019
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 3.5 in.
SURF ELEV (NAVD88): Approx. 17½ ft.

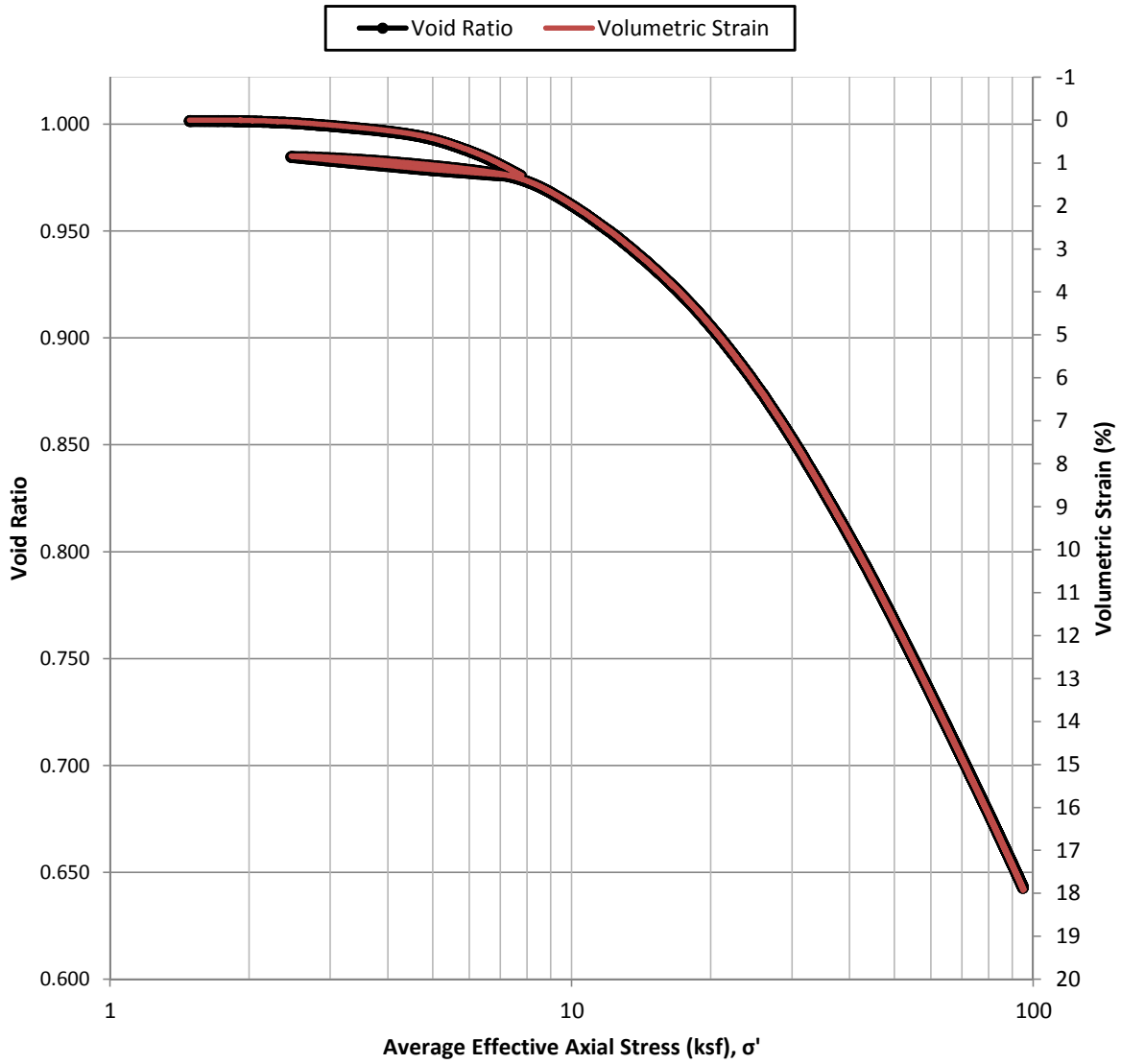
LOGGED / REVIEWED BY: S. Neumayr / NB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: Automatic Trip Hammer

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
			SANDY LEAN CLAY (CL), olive, hard, moist, low plasticity, approximately 30-40% fine grained sand			27							4.5+*
	-10												
30			Grades to olive yellow mottled with yellowish brown, decreased fines content			47							4.5+*
			Bottom of boring at 31½ feet. Groundwater measured at 20 feet during drilling.										

APPENDIX B

LABORATORY TEST DATA (68 pages)

Constant Rate of Strain Consolidation
ASTM D4186

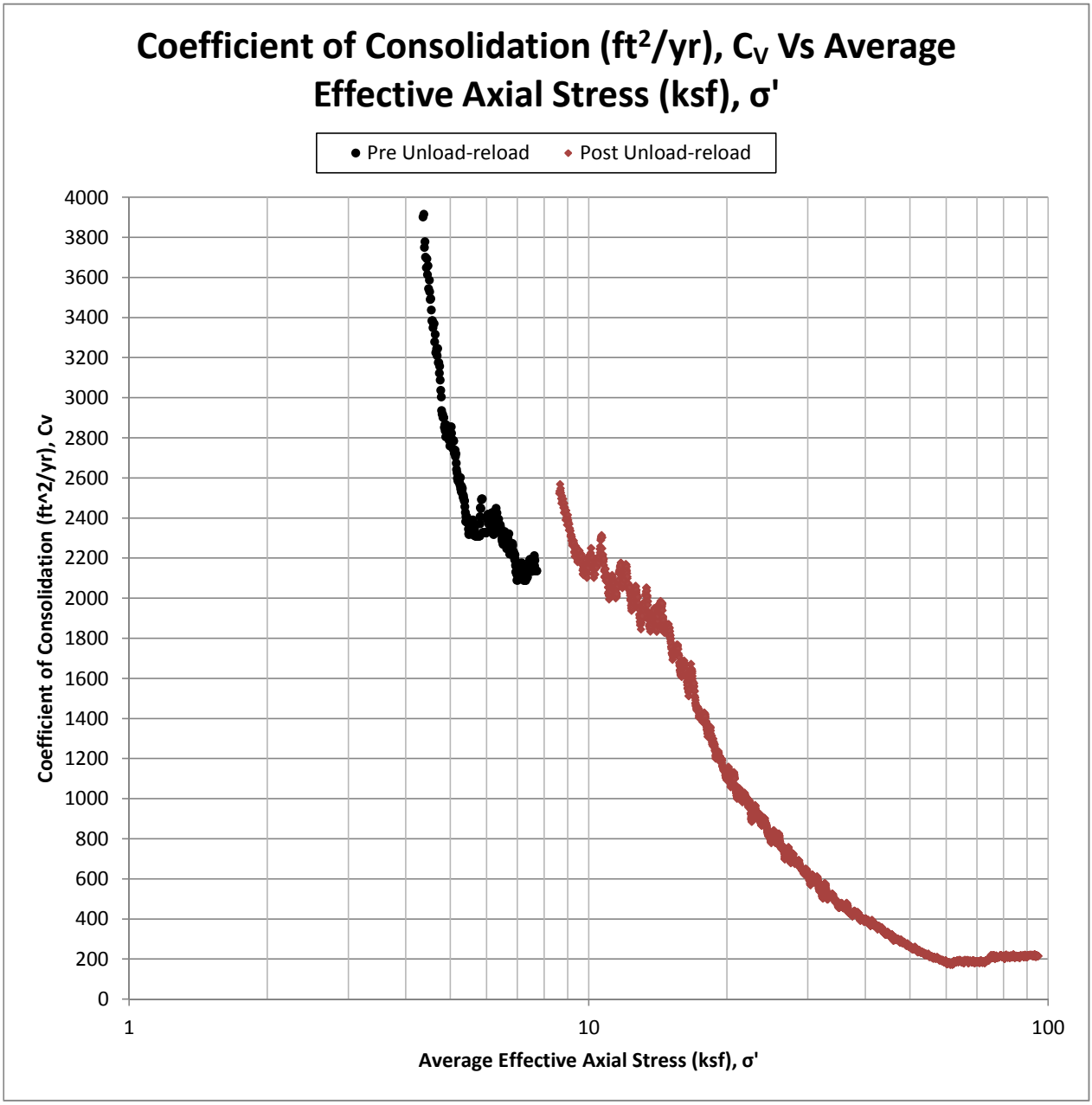


ASTM D2216					Test Date: 2/13/2019
	As Received	Final	ASTM D4318 - Wet Method		
Moisture (%):	35.44%	25.17%	Liquid Limit:		
Dry Density (pcf):	86.43	102.54	Plastic Limit:		
Saturation (%):	98.22%	100.00%	ASTM D854 - Measured		
Void Ratio:	1.0017	0.6871	Specific Gravity:	2.776	
			Soil Description:	See exploration logs	

Project Number:	15747.000.000	Depth:	21-21.5 ft
Sample Number:	1-B11 @ 21	Boring #:	1-B11
Project Name:	Elk Grove Hospital Site		
Client:	Wood Rogers, Inc.		
Location:	Elk Grove, California		
Tested By:	D. Seibold	Reviewed By:	N. Broussard

Remarks:

Constant Rate of Strain Consolidation
ASTM D4186



ASTM D2216				
	As Received	Final	ASTM D4318 - Wet Method	
Moisture (%):	35.44%	25.17%	Liquid Limit:	
Dry Density (pcf):	86.43	102.54	Plastic Limit:	
Saturation (%):	98.22%	100.00%	ASTM D854 - Measured	
Void Ratio:	1.0017	0.6871	Specific Gravity:	2.776
			Soil Description:	See exploration logs

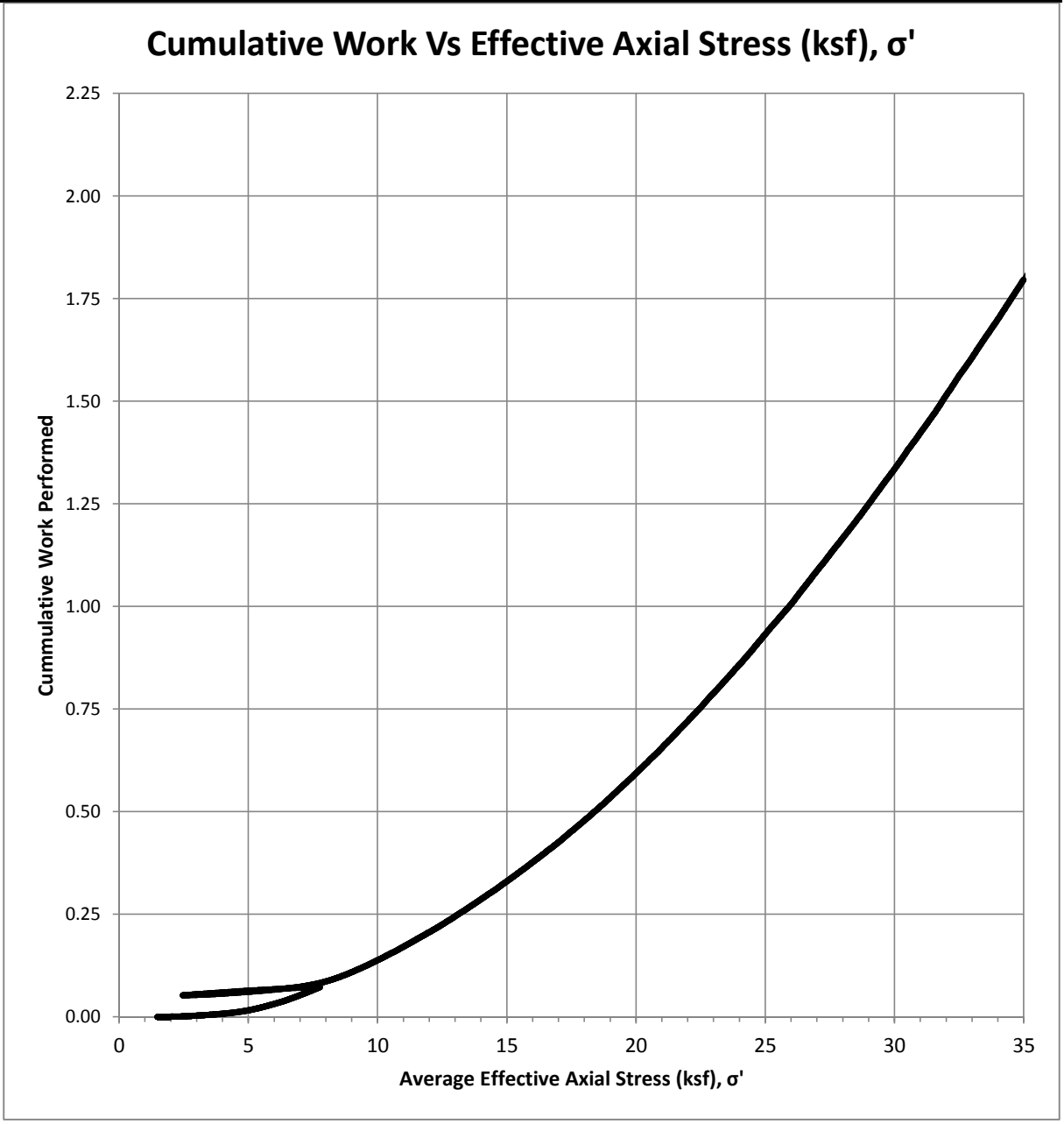
Test Date: 2/13/2019

Project Number:	15747.000.000	**Depth:**	21-21.5 ft
Sample Number:	1-B11 @ 21	**Boring #:**	1-B11
Project Name:	Elk Grove Hospital Site		
Client:	Wood Rogers, Inc.		
Location:	Elk Grove, California		
Tested By:	D. Seibold	**Reviewed By:**	N. Broussard

ENGEO Expect Excellence

Remarks:

Constant Rate of Strain Consolidation
ASTM D4186



ASTM D2216					Test Date: 2/13/2019
	As Received	Final	ASTM D4318 - Wet Method		
Moisture (%):	35.44%	25.17%	Liquid Limit:		
Dry Density (pcf):	86.43	102.54	Plastic Limit:		
Saturation (%):	98.22%	100.00%	ASTM D854 - Measured		
Void Ratio:	1.0017	0.6871	Specific Gravity:	2.776	
			Soil Description:	See exploration logs	

Project Number:	15747.000.000	Depth:	21-21.5 ft
Sample Number:	1-B11 @ 21	Boring #:	1-B11
Project Name:	Elk Grove Hospital Site		
Client:	Wood Rogers, Inc.		
Location:	Elk Grove, California		
Tested By:	D. Seibold	Reviewed By:	N. Broussard

Remarks:

ENGEO Expect Excellence

ENGEO Incorporated

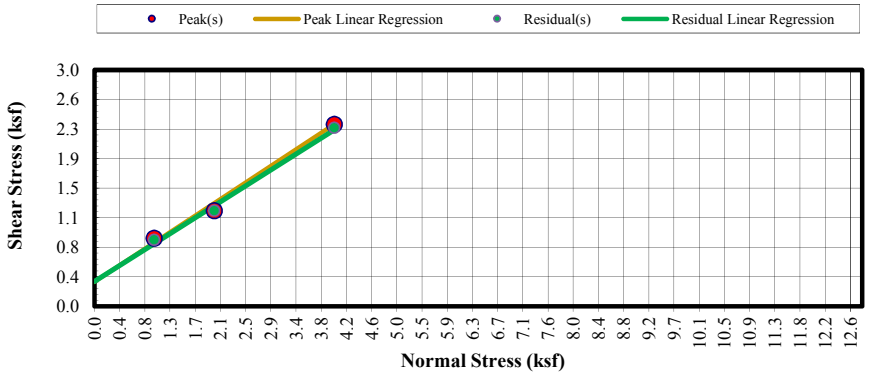
Direct Shear Test (ASTM D3080)

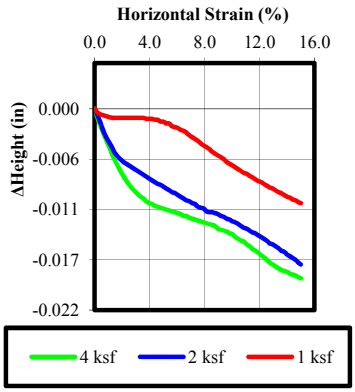
Date 2/6/2019

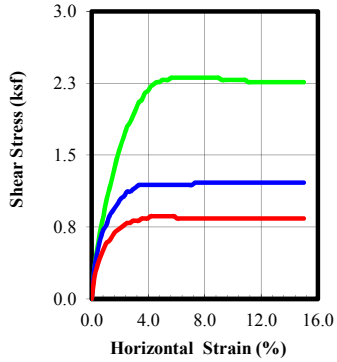
Checked By G. Criste

Date 2/6/2019

Tested By K. Lecce







Initial	Specimen 4 ksf	2 ksf	1 ksf	
Moisture (%)	16.24	17.33	16.01	
Dry Density (pcf)	116.63	113.63	116.86	
Void Ratio	0.560	0.601	0.556	
Saturation (%)	84.55	84.05	83.82	
Diameter (in)	2.405	2.405	2.405	
Height (in)	1.000	1.000	1.000	
Diameter-to-Height Ratio	2.405	2.405	2.405	
Specific Gravity (Measured)	2.914	2.914	2.914	
Pre-shear	**4 ksf**	**2 ksf**	**1 ksf**	
Moisture (%)	14.86	15.11	15.37	
Dry Density (pcf)	123.01	123.16	124.96	
Void Ratio	0.433	0.440	0.448	
Saturation (%)	100.00	100.00	100.00	
Diameter (in)	2.405	2.405	2.405	
Height (in)	0.969	0.975	0.995	
Normal Stress (ksf)	4.00	2.00	1.00	
Peak Stress (ksf)	2.31	1.21	0.86	
Residual Stress (ksf)	2.26	1.21	0.84	
Peak Strain (%)	8.977	7.306	4.170	
Max. Residual Strain (%)	15.0	15.0	15.0	
Rate (in/min)	0.00029	0.00025	0.00025	
Diameter-to-Height Ratio	2.482	2.466	2.418	

Report Date	2/6/2019

			Phi	C(psf)
Project:	Elk Grove Hospital Site			
Location:	Elk Grove, CA	**Peak Strength:**	26.2	314.7
Project Number:	15747.000.000	**Res./Ult. Strength:**	25.7	314.7
Client:	Wood Rodgers, Inc.	**ASTM D4318**		
Boring Number	1-B22	**Liquid Limit:**	28	
Sample Number:	1-B22 @ 6	**Plastic Limit:**	14	
Depth:	6 feet	**ASTM D422**		
Sample Type:	Undisturbed	**%Sand**	n/a	
Description:	See exploration logs	**%Silt**	n/a	
Test Type:	Consolidated Drained	**%Clay**	n/a	
Remarks:	Consolidation data inconclusive for 2 ksf and 1 ksf loads. Default shear rate used.	**ASTM D854**		
		Material Passing the #4 Sieve		

EXPANSION INDEX TEST REPORT
ASTM D4829

SAMPLE ID	SOIL DESCRIPTION	SAMPLE LOCATION	INITIAL DRY DENSITY (pcf)	INITIAL MOISTURE CONTENT (%)	FINAL MOISTURE CONTENT (%)	EXPANSION INDEX
1-B35@2	See exploration logs	1-B35@2	104.9	11.6	22.2	62

TABLE 1: CLASSIFICATION OF EXPANSIVE SOIL
ASTM D4829

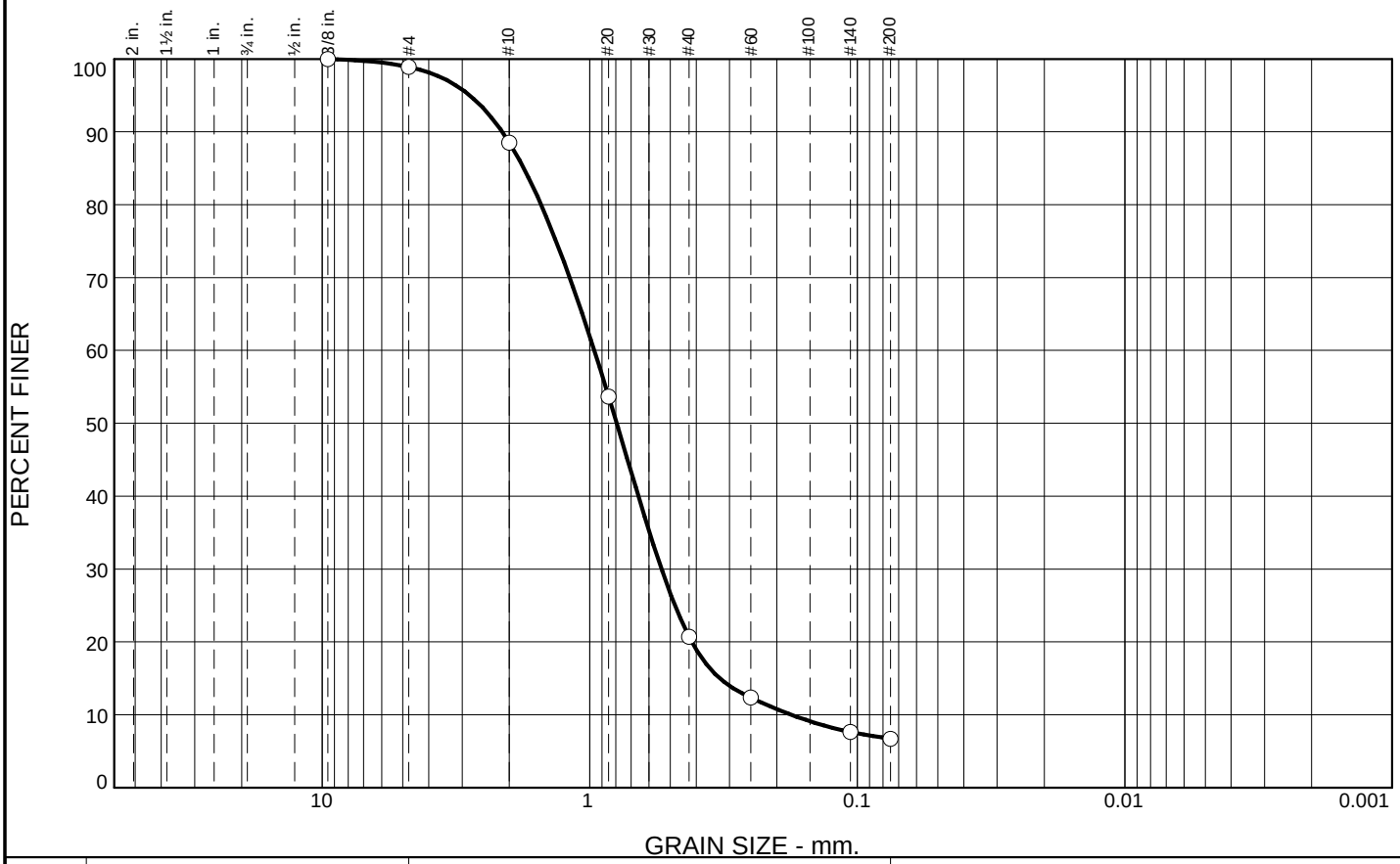
EXPANSION INDEX	POTENTIAL EXPANSION
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

ENGEO
Expect Excellence

PROJECT NAME: Elk Grove Hospital Site
PROJECT NO: 15747.000.000 **PHASE:** 001
CLIENT: Wood Rodgers, Inc.

REPORT DATE: 1/23/2019
TESTED BY: R. Montalvo
REVIEWED BY: M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	10.4	67.8	14.0	6.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	98.9		
#10	88.5		
#20	53.7		
#40	20.7		
#60	12.4		
#140	7.6		
#200	6.7		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.1256 D_{85}= 1.7653 D_{60}= 0.9616
D_{50}= 0.7932 D_{30}= 0.5390 D_{15}= 0.3264
D_{10}= 0.1764 C_u= 5.45 C_c= 1.71

Classification

USCS= AASHTO=

Remarks

GS: ASTM D6913 Method B

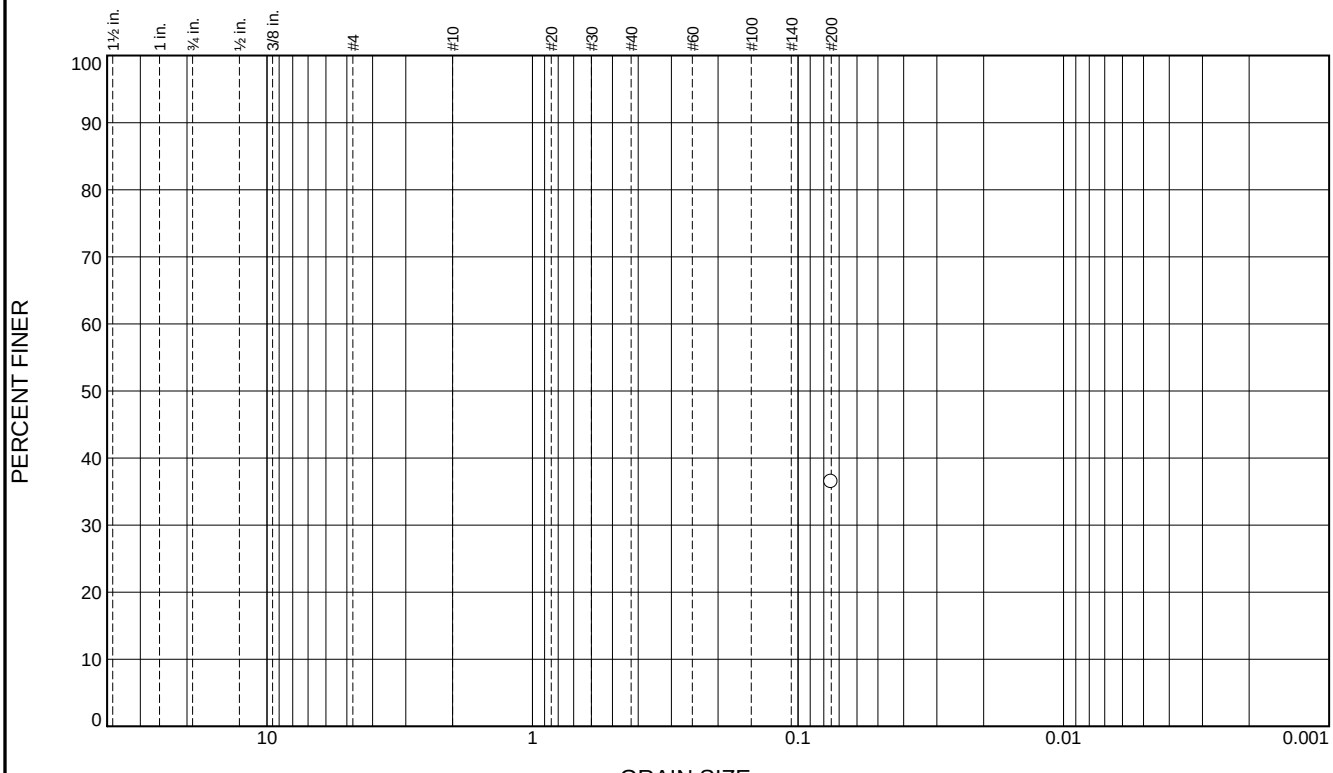
Source of Sample: GEX **Depth:** 20 feet
Sample Number: 1-B14@20 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						36.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	36.5		

* (no specification provided)

Material Description

Light brown sitly SAND with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

#200: ASTM D1140, Method A

Sample Number: 1-B21 **Depth:** 25ft

Date: 1/24/2019

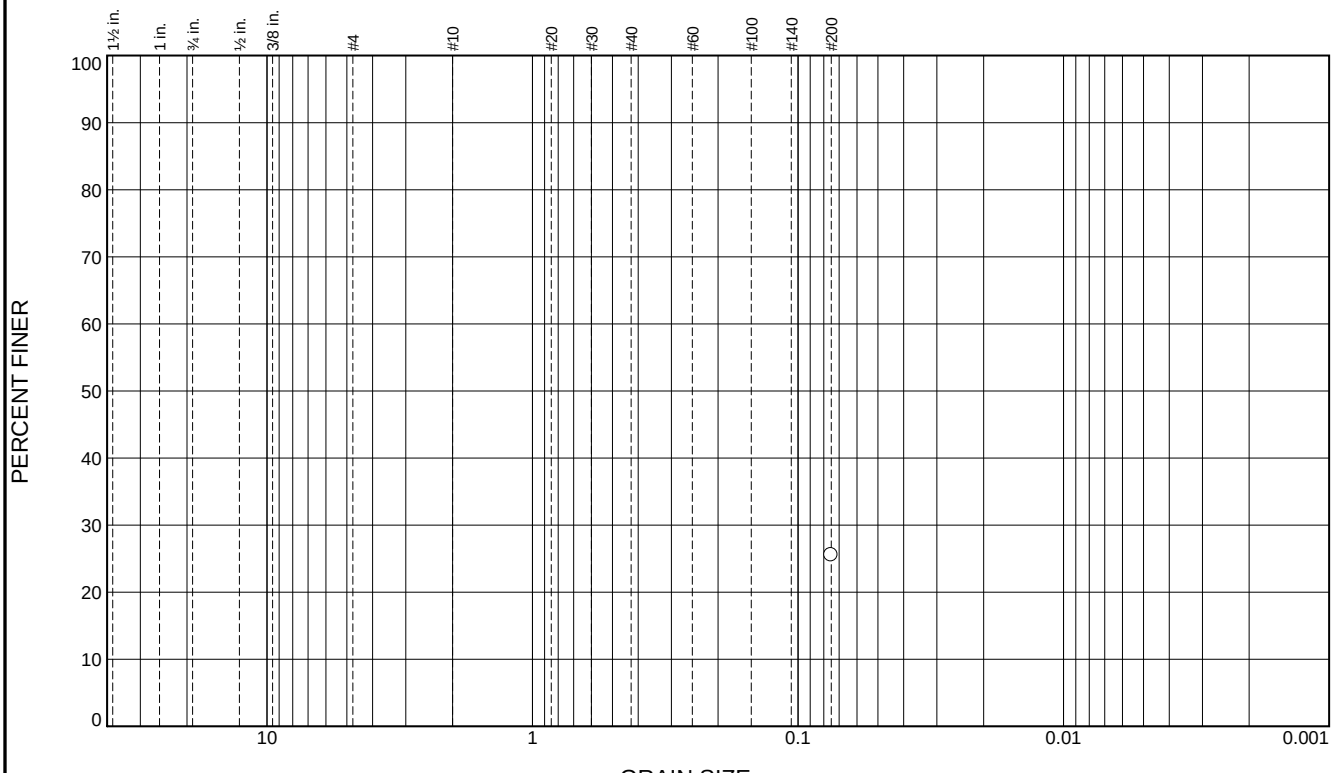
ENGEO INCORPORATED

Client: Wood Rodgers INC
Project: Elk Grove Hospital Site

Project No: 15747.000.000 P:001

Tested By: Anthony C **Checked By:** Richard M

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						25.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	25.5		

* (no specification provided)

Material Description

Brown silty SAND with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

#200: ASTM D1140, Method A

Sample Number: 1-B22 **Depth:** 2ft

Date: 1/24/2019

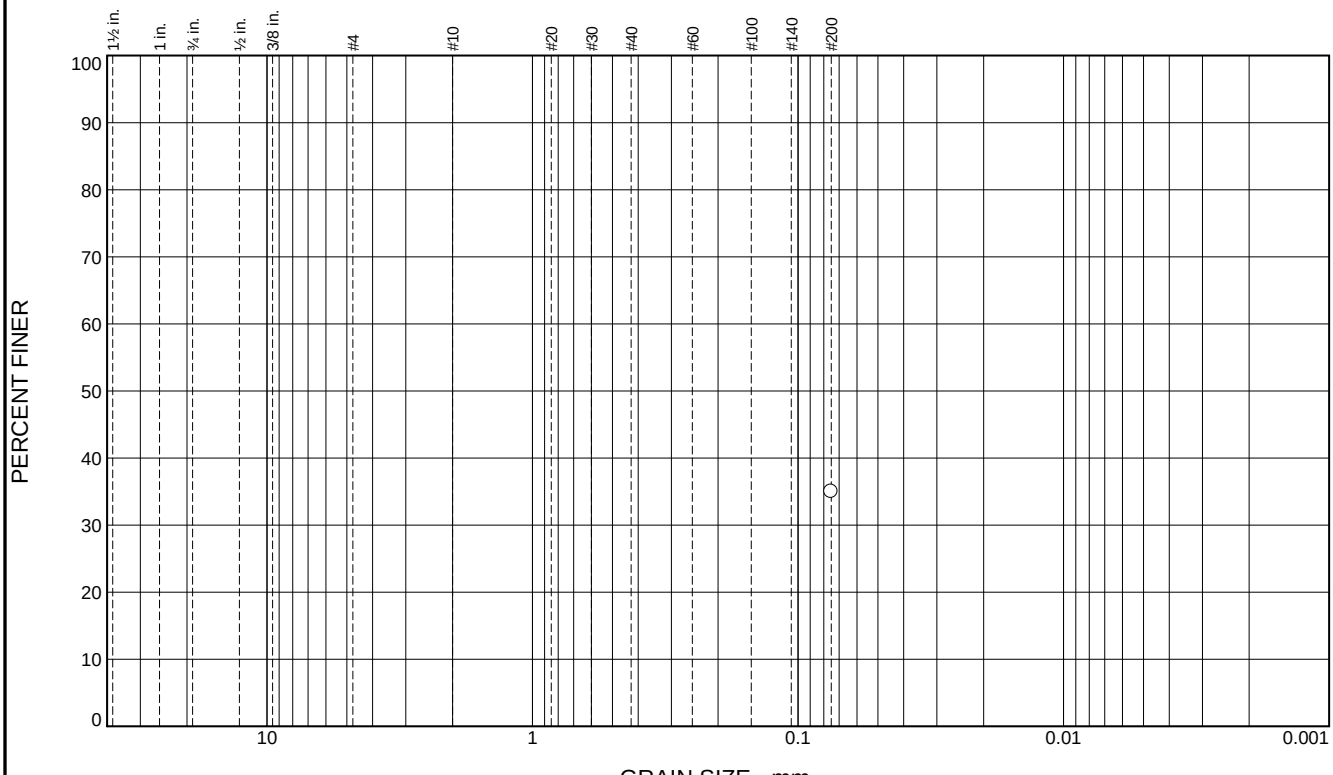
ENGEO INCORPORATED

Client: Wood Rodgers INC
Project: Elk Grove Hospital Site

Project No: 15747.000.000 P:001

Tested By: Anthony C **Checked By:** Richard M

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						35.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	35.0		

* (no specification provided)

Material Description

Reddish brown silty SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

#200: ASTM D1140, Method A

Sample Number: 1-B22 **Depth:** 8ft

Date: 1/24/2019

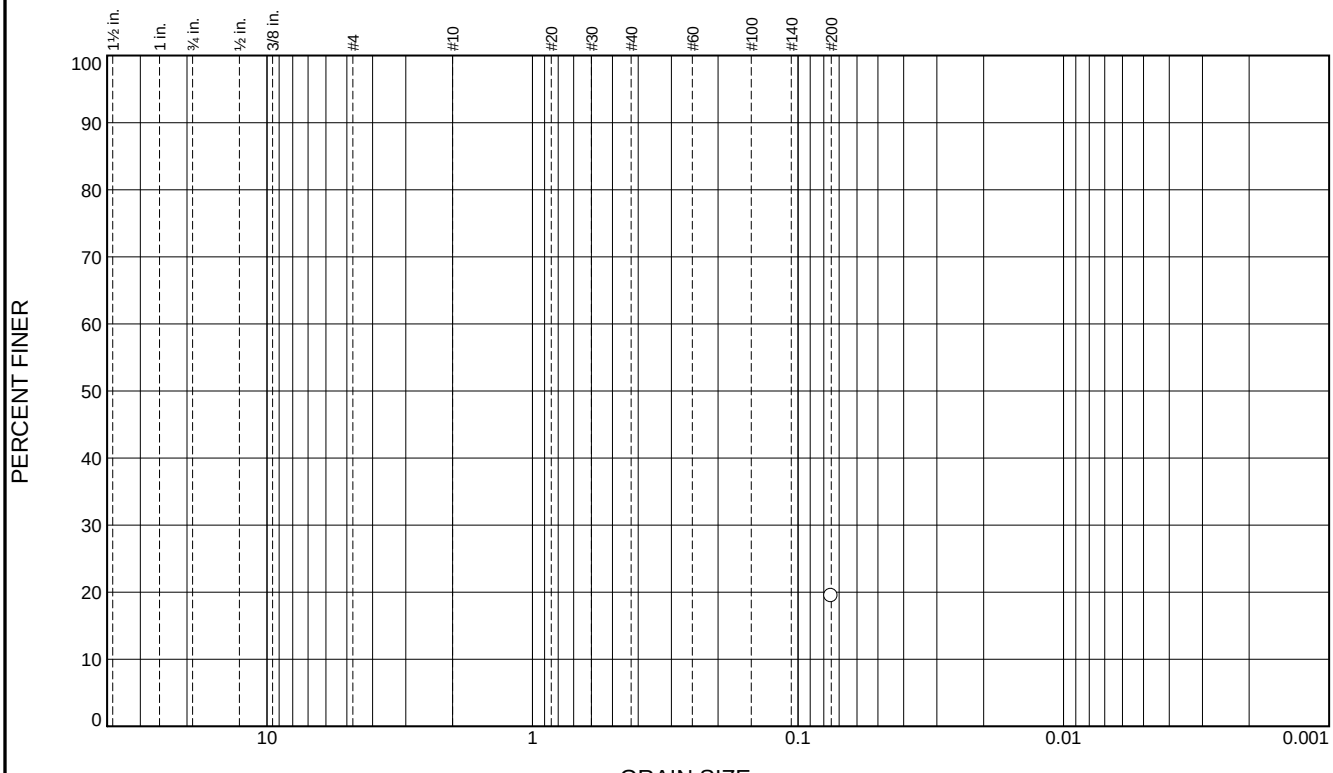
ENGEO INCORPORATED

Client: Wood Rodgers INC
Project: Elk Grove Hospital Site

Project No: 15747.000.000 P:001

Tested By: Anthony C **Checked By:** Richard M

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						19.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	19.4		

* (no specification provided)

Material Description

Light brown silty SAND with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

#200: ASTM D1140, Method A

Sample Number: 1-B23 **Depth:** 2ft

Date: 1/24/2019

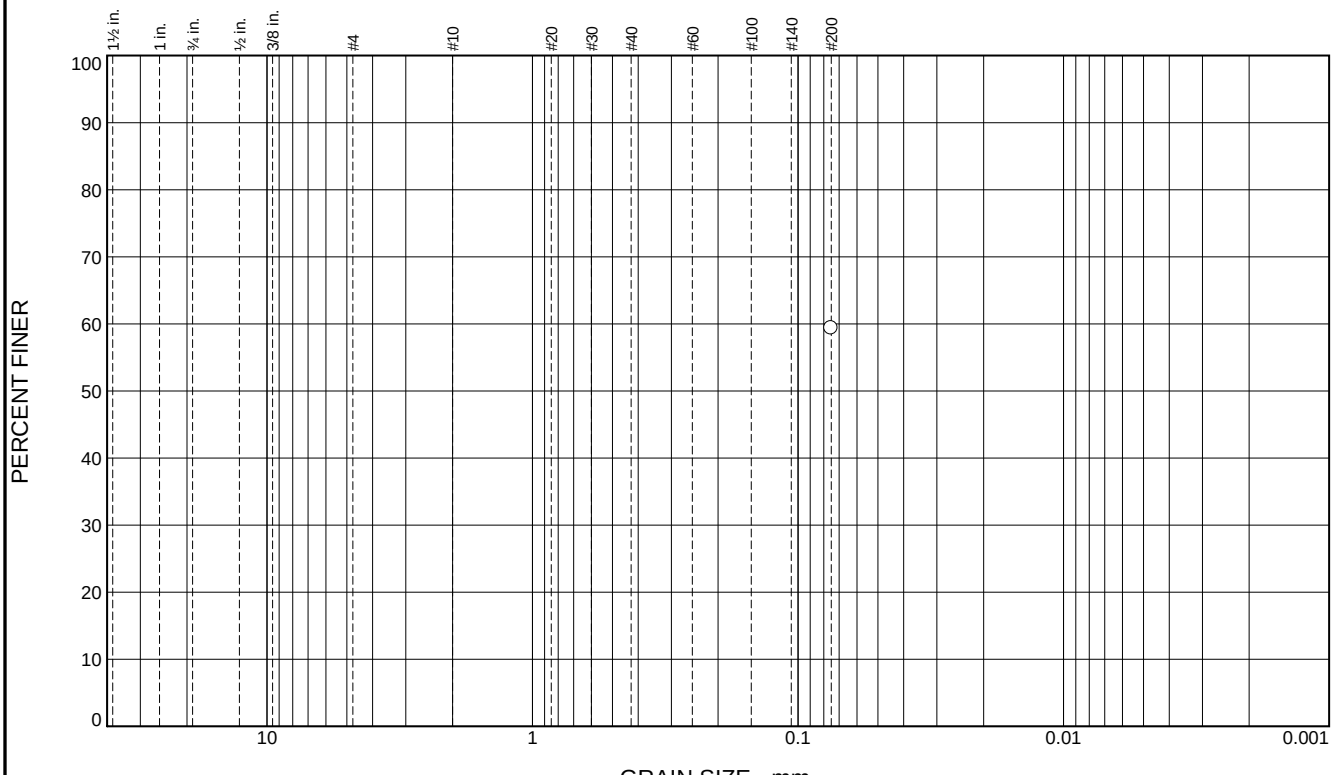
ENGEO INCORPORATED

Client: Wood Rodgers INC
Project: Elk Grove Hospital Site

Project No: 15747.000.000 P:001

Tested By: Anthony C **Checked By:** Richard M

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						59.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	59.4		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample Weight = 256.4; Soak Time = 4 hrs

Sample Number: 1-B27 @ 1

Date: 1/25/2019

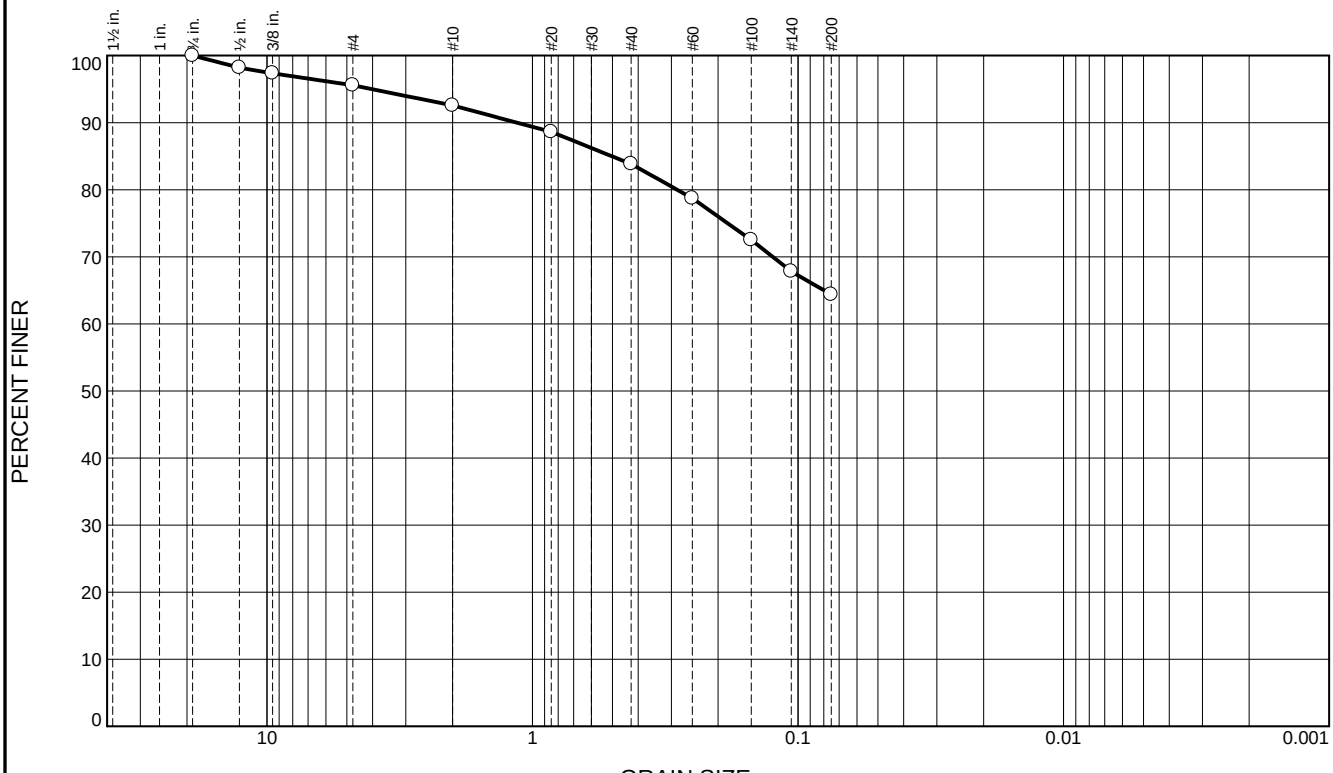
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.4	3.0	8.8	19.4	64.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	98.2		
3/8	97.4		
#4	95.6		
#10	92.6		
#20	88.6		
#40	83.8		
#60	78.7		
#100	72.5		
#140	67.8		
#200	64.4		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1436 D_{85}= 0.5031 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D6913, Method B

Sample Number: 1-B28 @ 1

Date: 1/25/2019

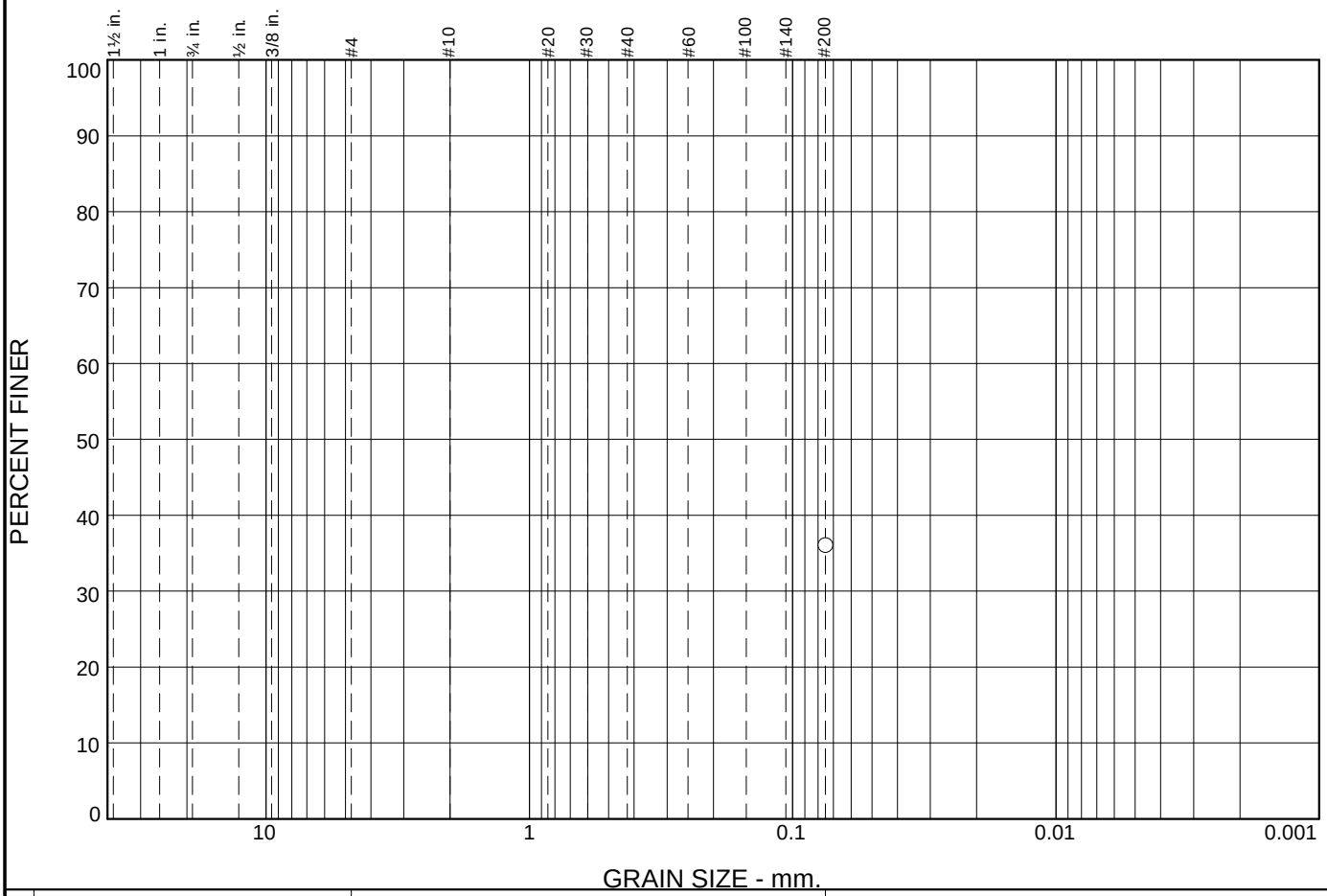
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						36.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	36.1		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 26 feet
Sample Number: 1-B28@26 **Date:** 1/30/2019

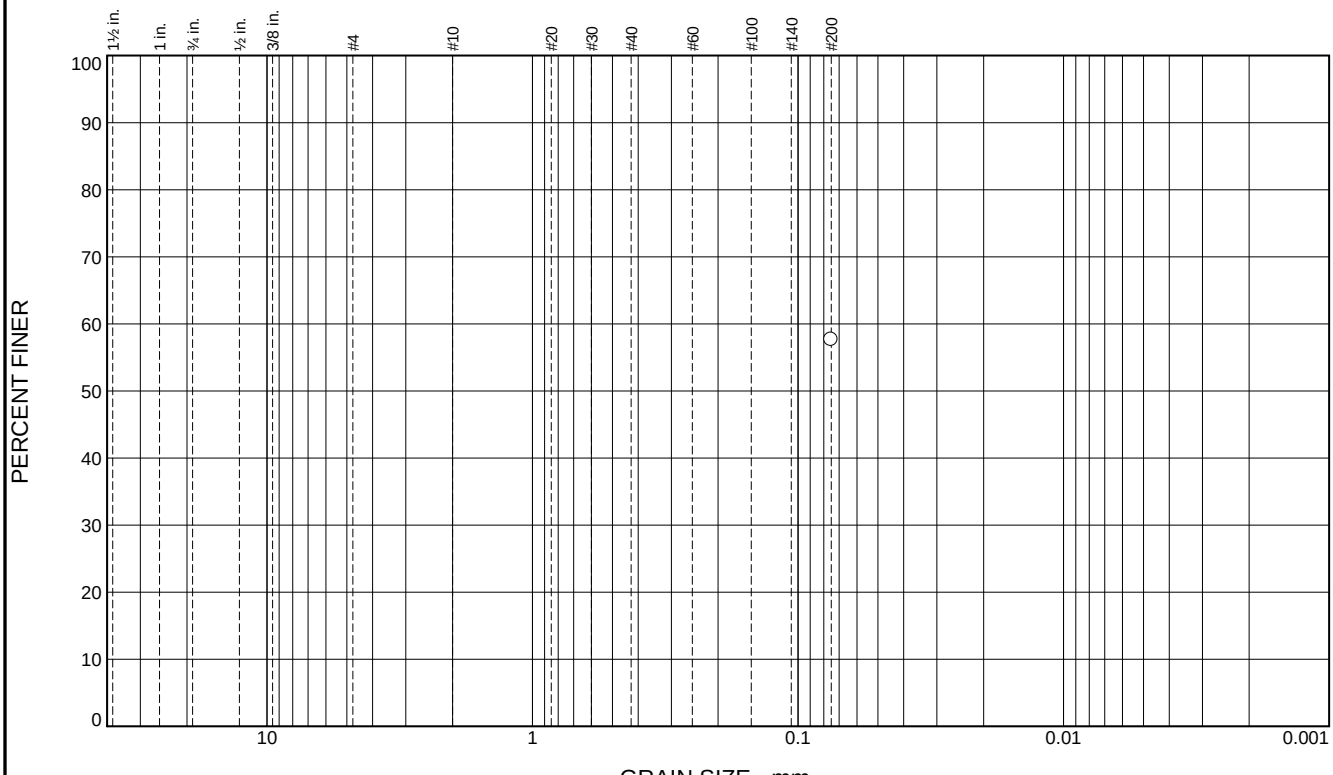
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						57.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	57.7		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample weight = 59.30; Soak Time = 4 hrs

Sample Number: 1-B28 @ 30.5

Date: 1/25/2019

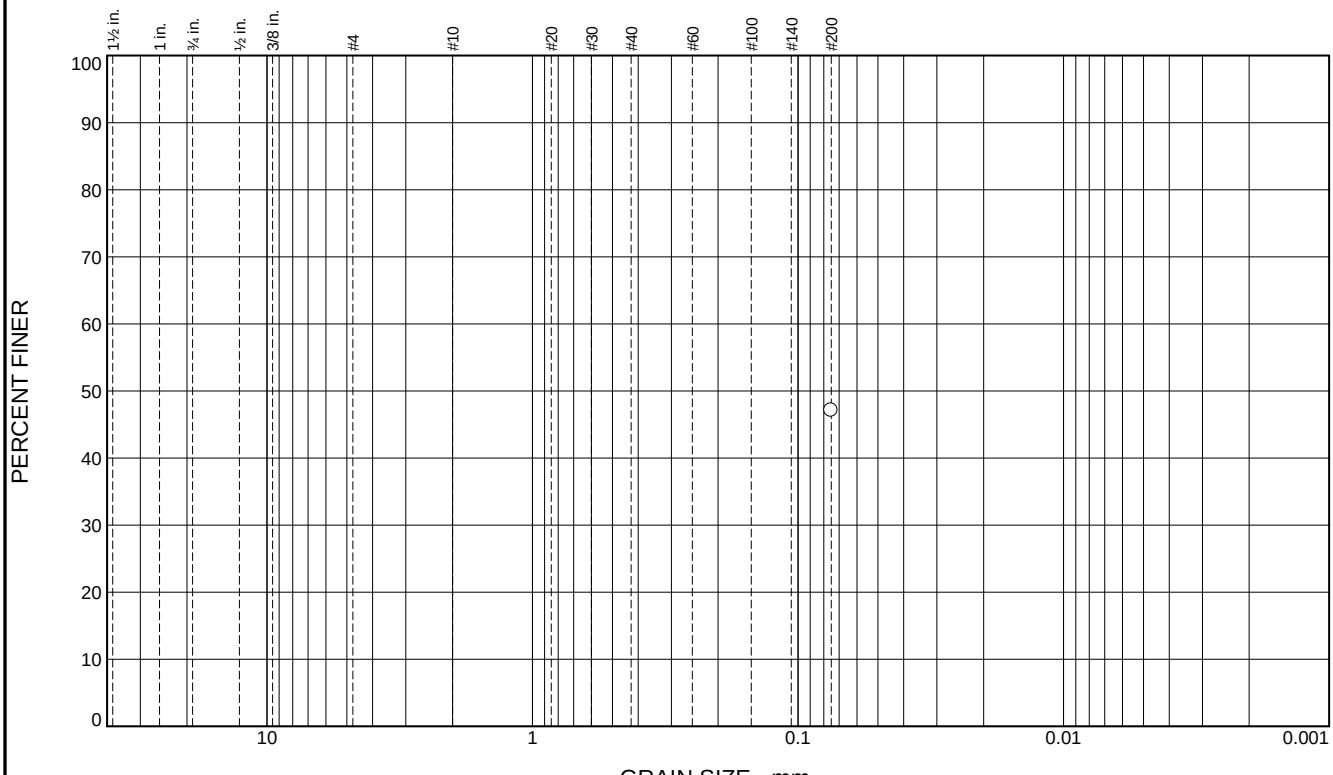
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						47.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	47.1		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample Weight = 149.35; Soak time = 4 hrs

Sample Number: 1-B31 @ 1.5

Date: 1/25/2019

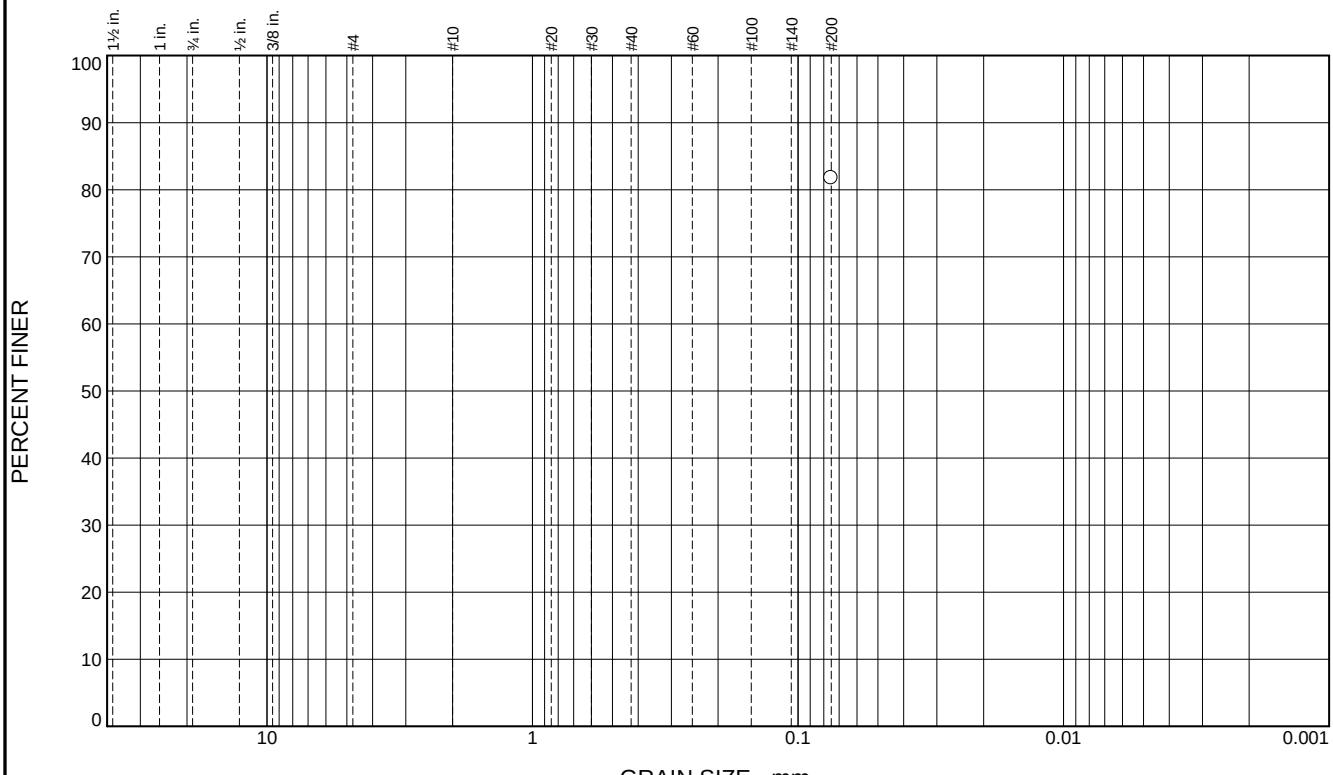
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						81.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	81.8		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample Weight = 353.3; Soak Time = 4 hrs

Sample Number: 1-B32 @ 11

Date: 1/25/2019

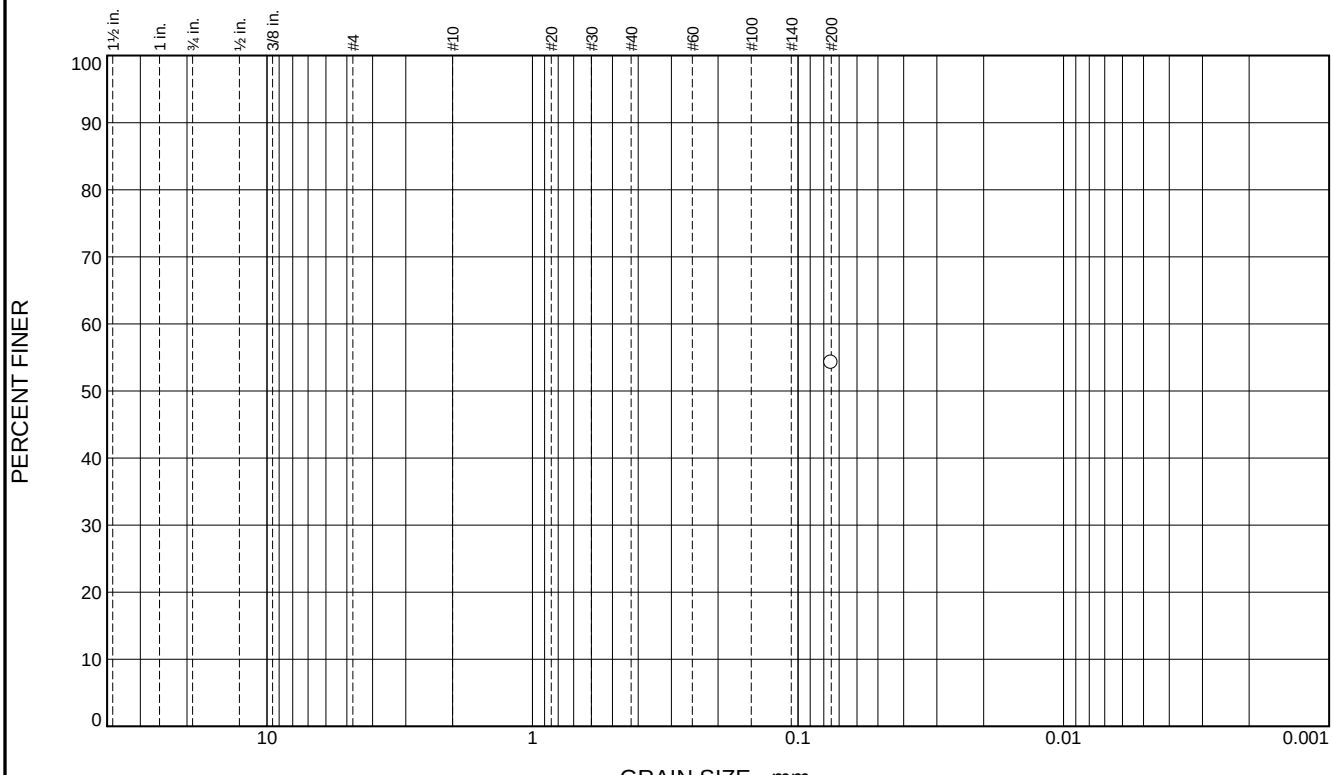
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						54.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	54.2		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= 22 LL= 37 PI= 15

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample Weight = 344.03; Soak Time = 4 hrs

Sample Number: 1-B32 @ 2

Date: 1/25/2019

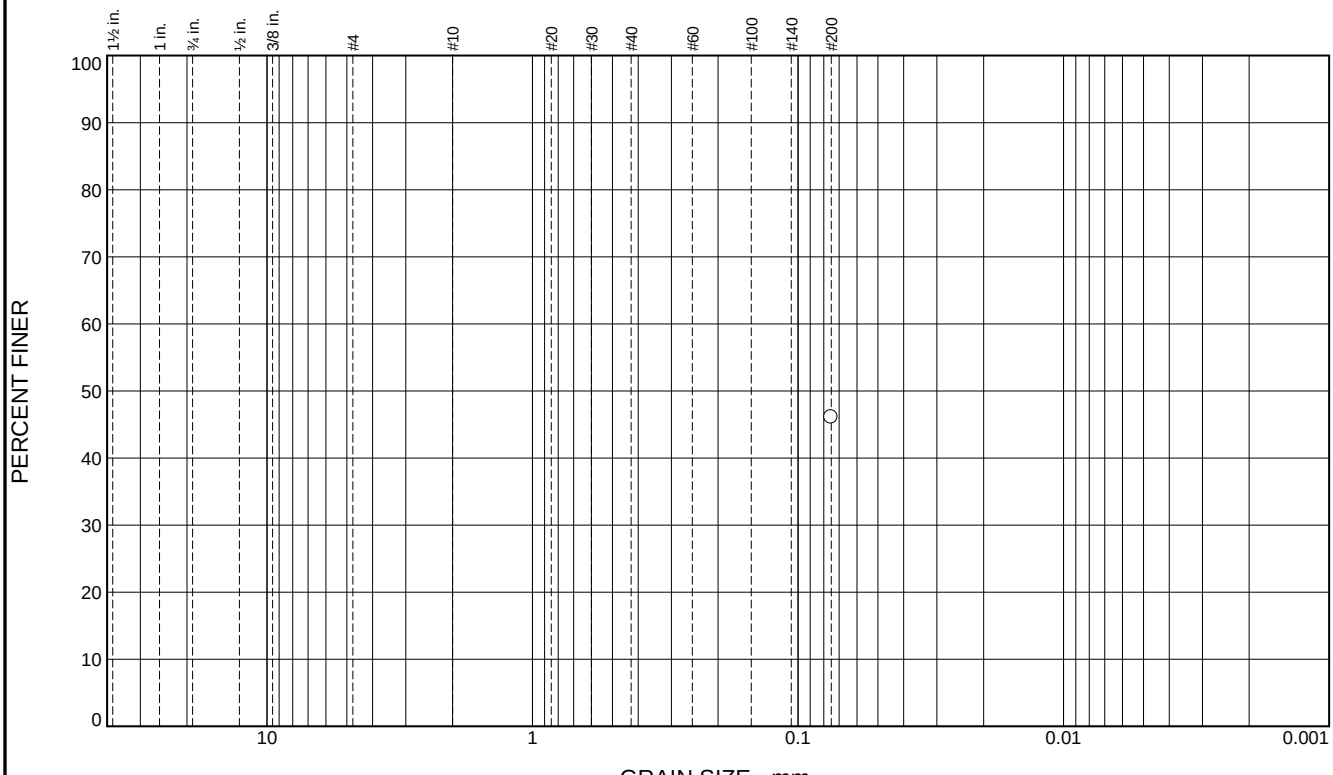
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						46.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	46.1		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Dry Sample Weight = 202.84; Soak Time = 4 hrs

Sample Number: 1-B32 @ 31

Date: 1/25/2019

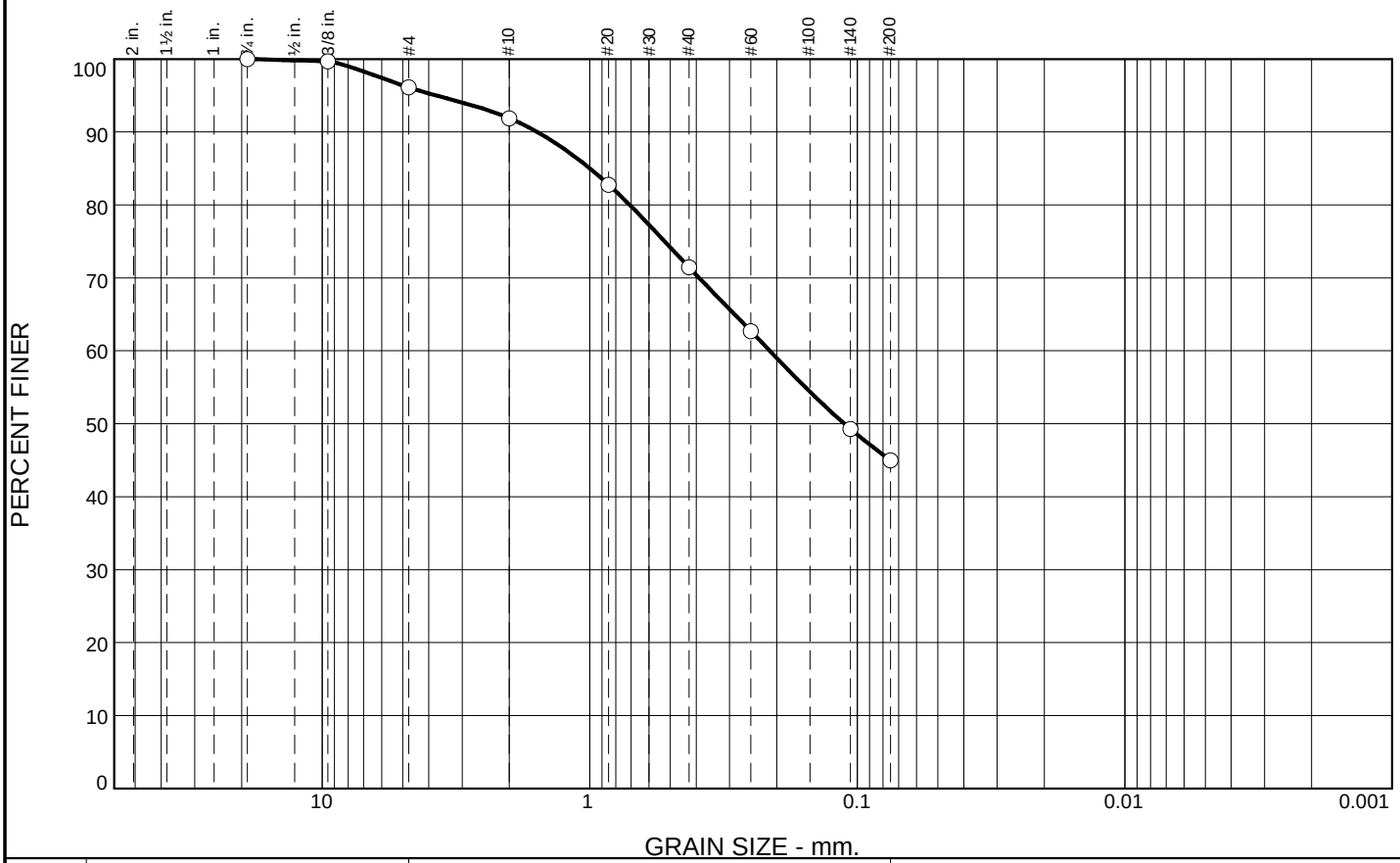
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000

Tested By: M. Bromfield **Checked By:** M. Quasem

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.9	4.2	20.5	26.4	45.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	99.7		
#4	96.1		
#10	91.9		
#20	82.8		
#40	71.4		
#60	62.7		
#140	49.3		
#200	45.0		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.5737 D_{85}= 0.9992 D_{60}= 0.2123
D_{50}= 0.1117 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D6913 Method B

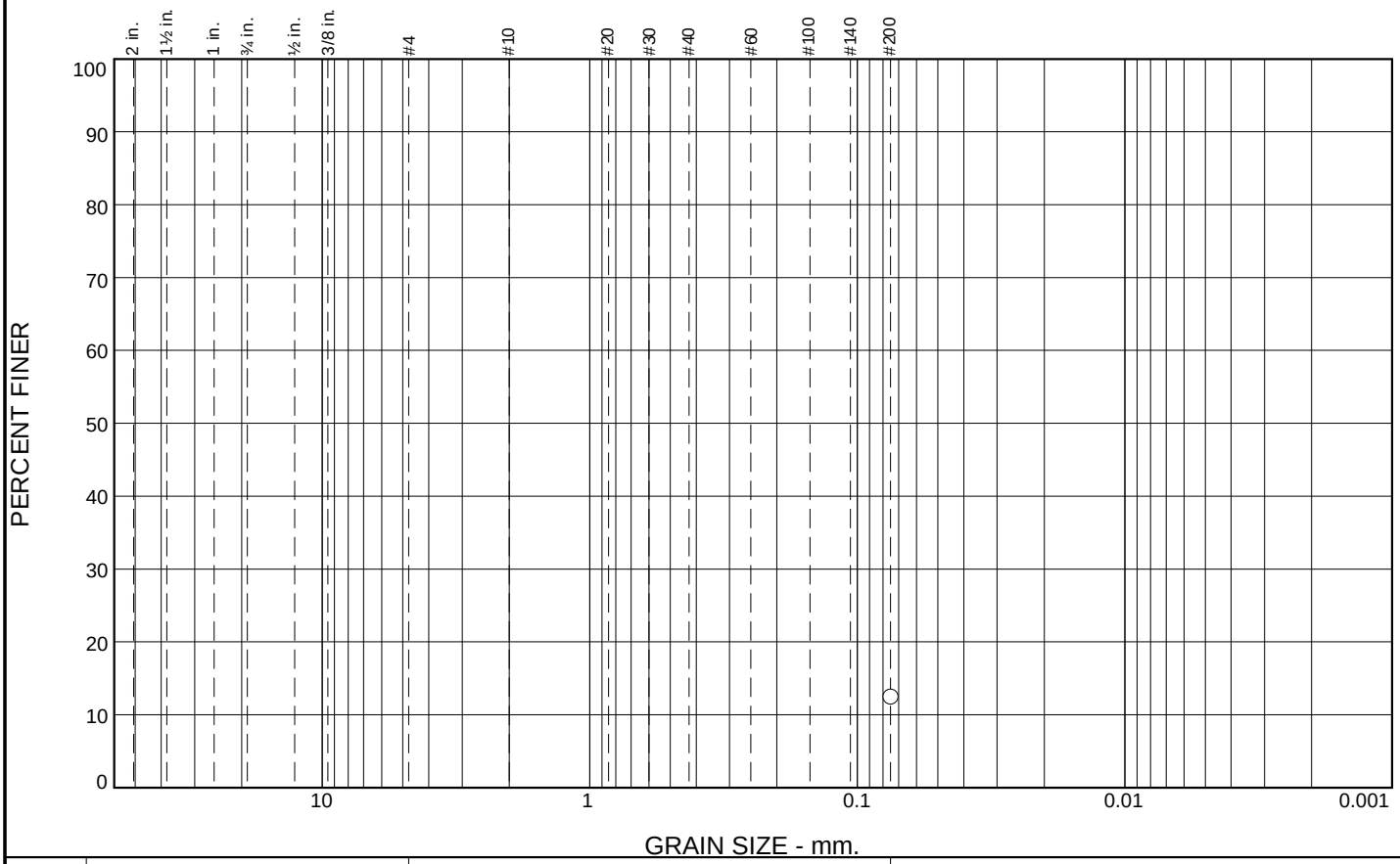
Source of Sample: GEX **Depth:** 2 feet
Sample Number: 1-B3@2 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						12.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	12.5		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

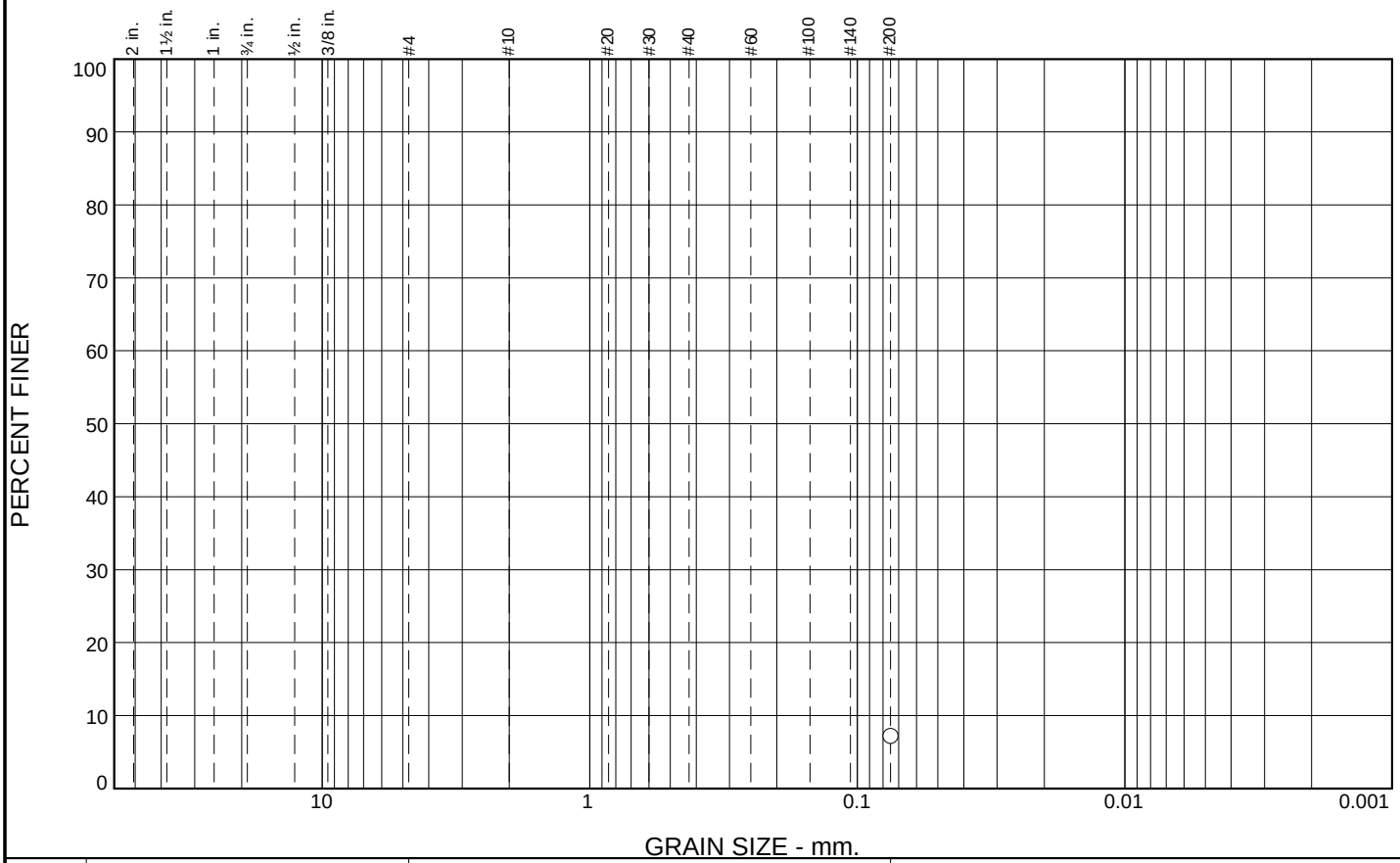
Source of Sample: GEX **Depth:** 20 feet
Sample Number: 1-B12@20 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						7.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	7.2		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

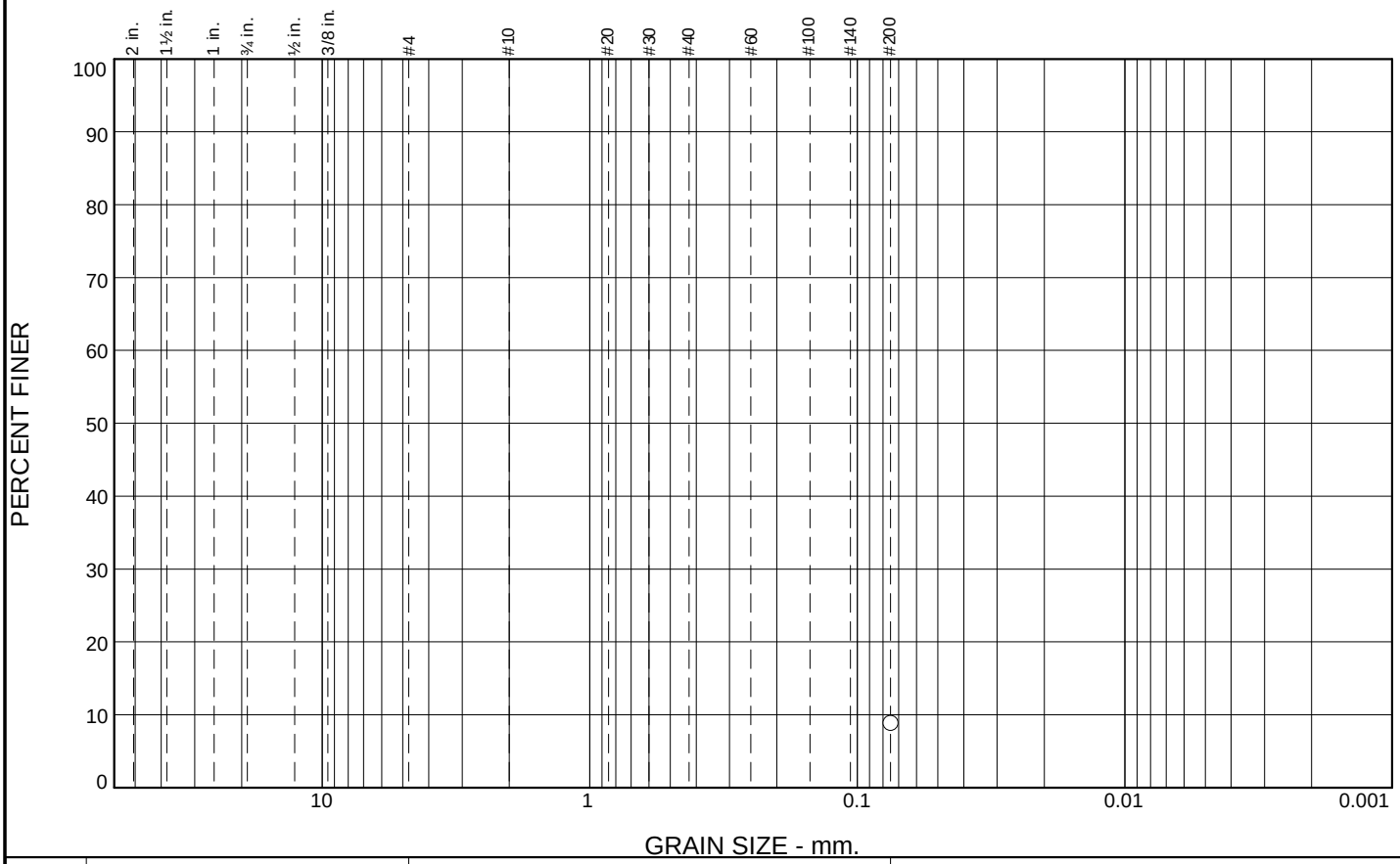
Source of Sample: GEX **Depth:** 30.5 feet
Sample Number: 1-B14@30.5 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						8.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	8.9		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 30.5 feet
Sample Number: 1-B17@30.5 **Date:** 02/01/2019

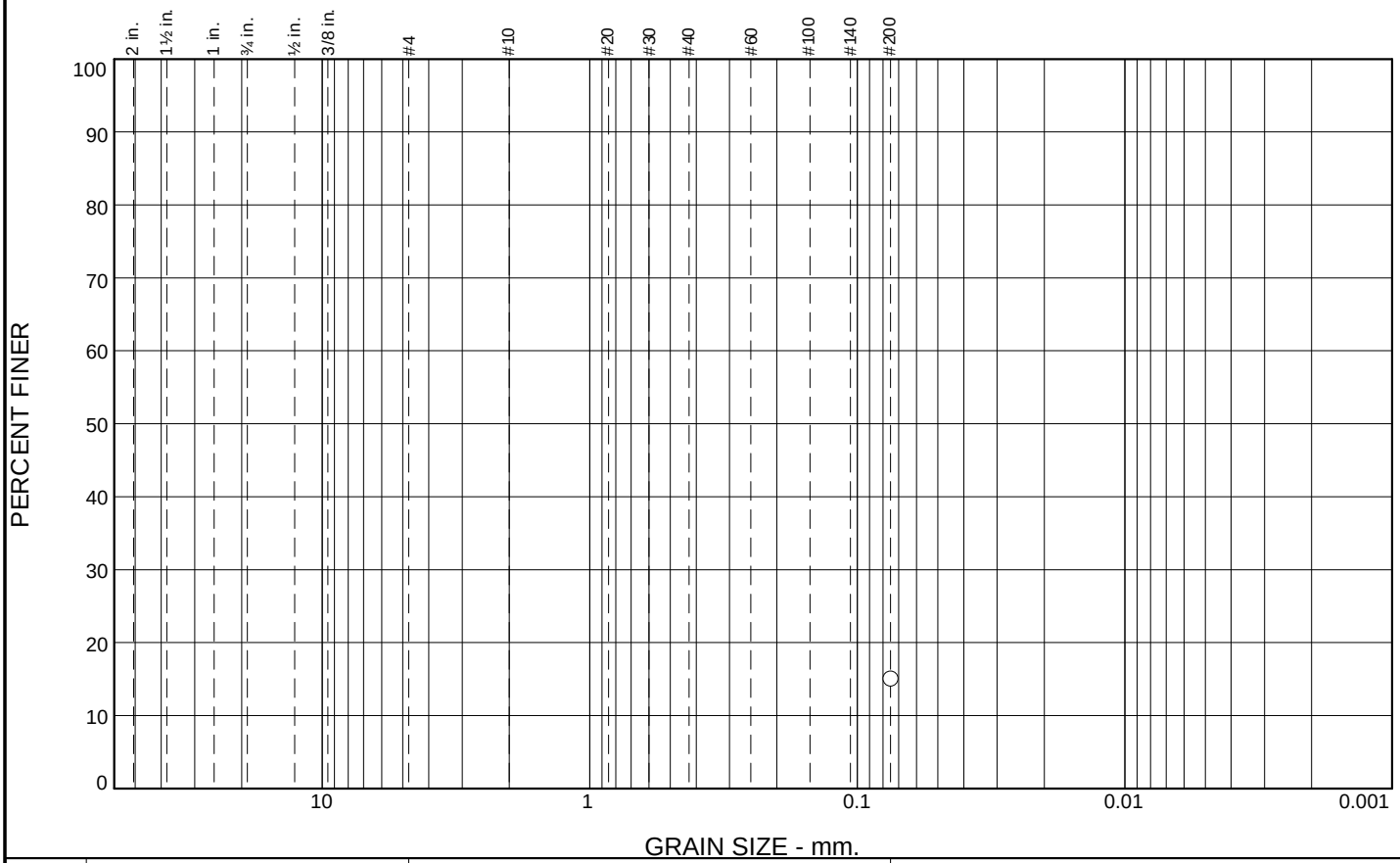
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						15.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	15.1		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 35 feet
Sample Number: 1-B17@35 **Date:** 02/01/2019

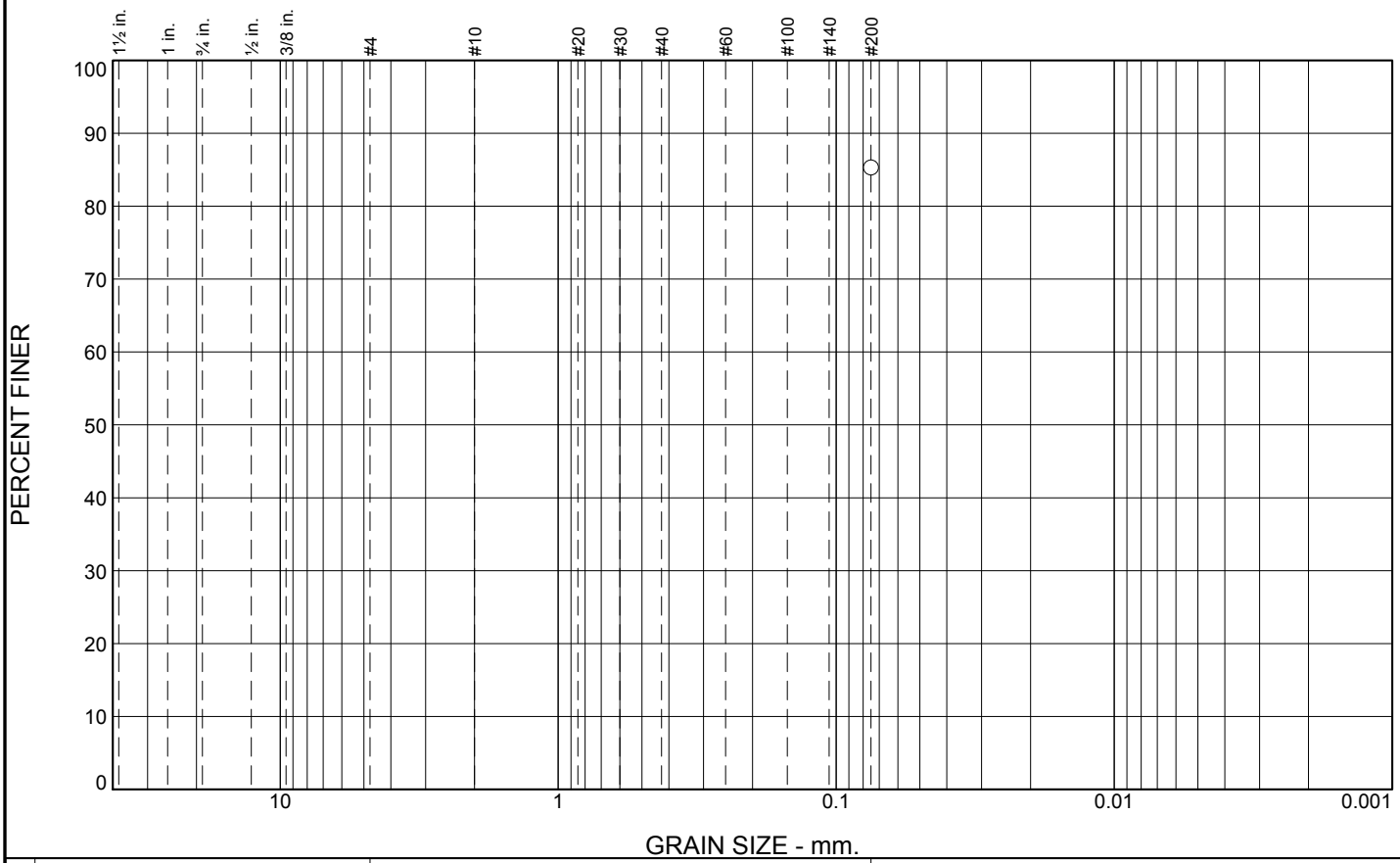
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						85.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	85.3		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

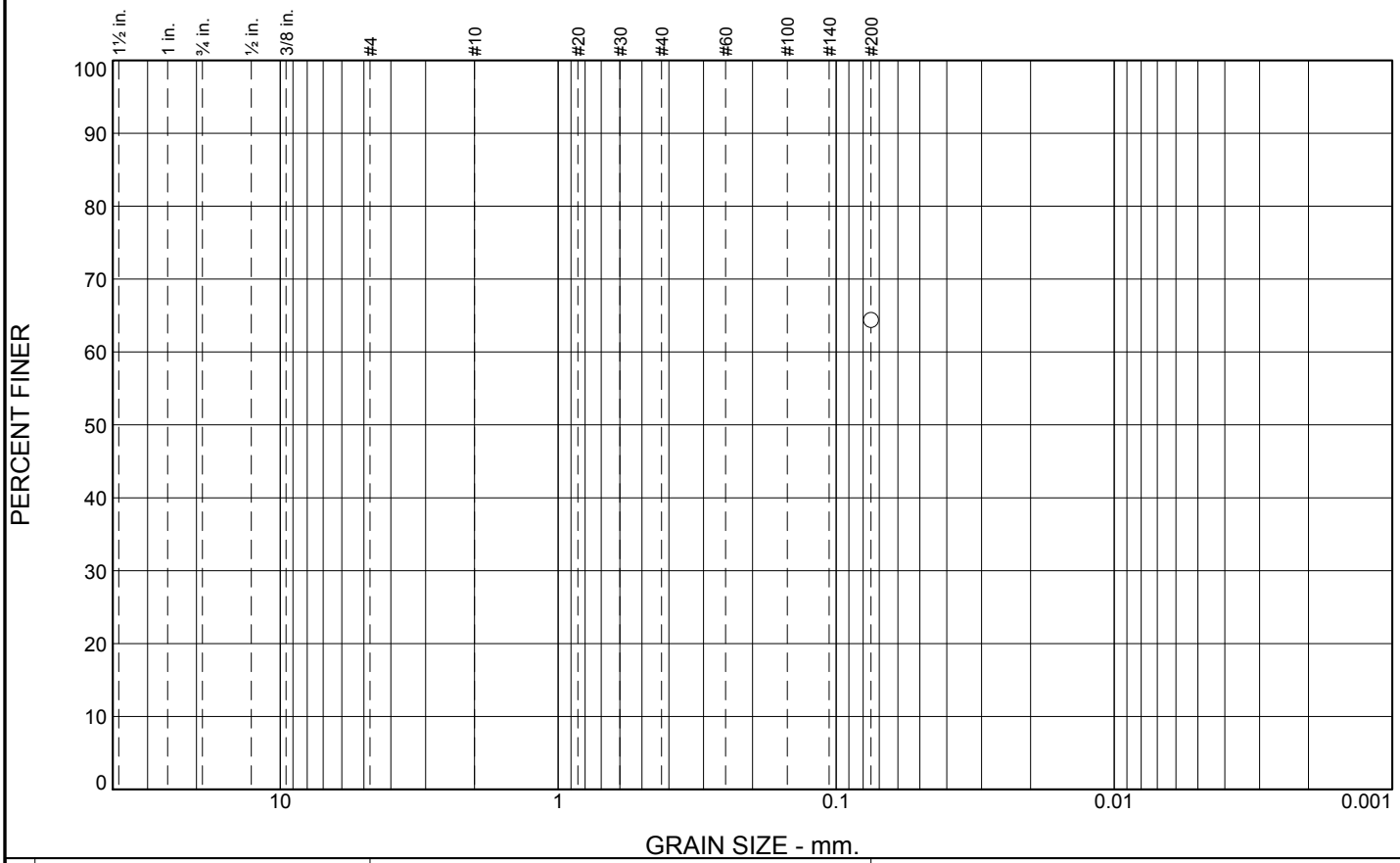
Source of Sample: GEX **Depth:** 11 feet
Sample Number: 1-B25@11 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						64.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	64.4		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

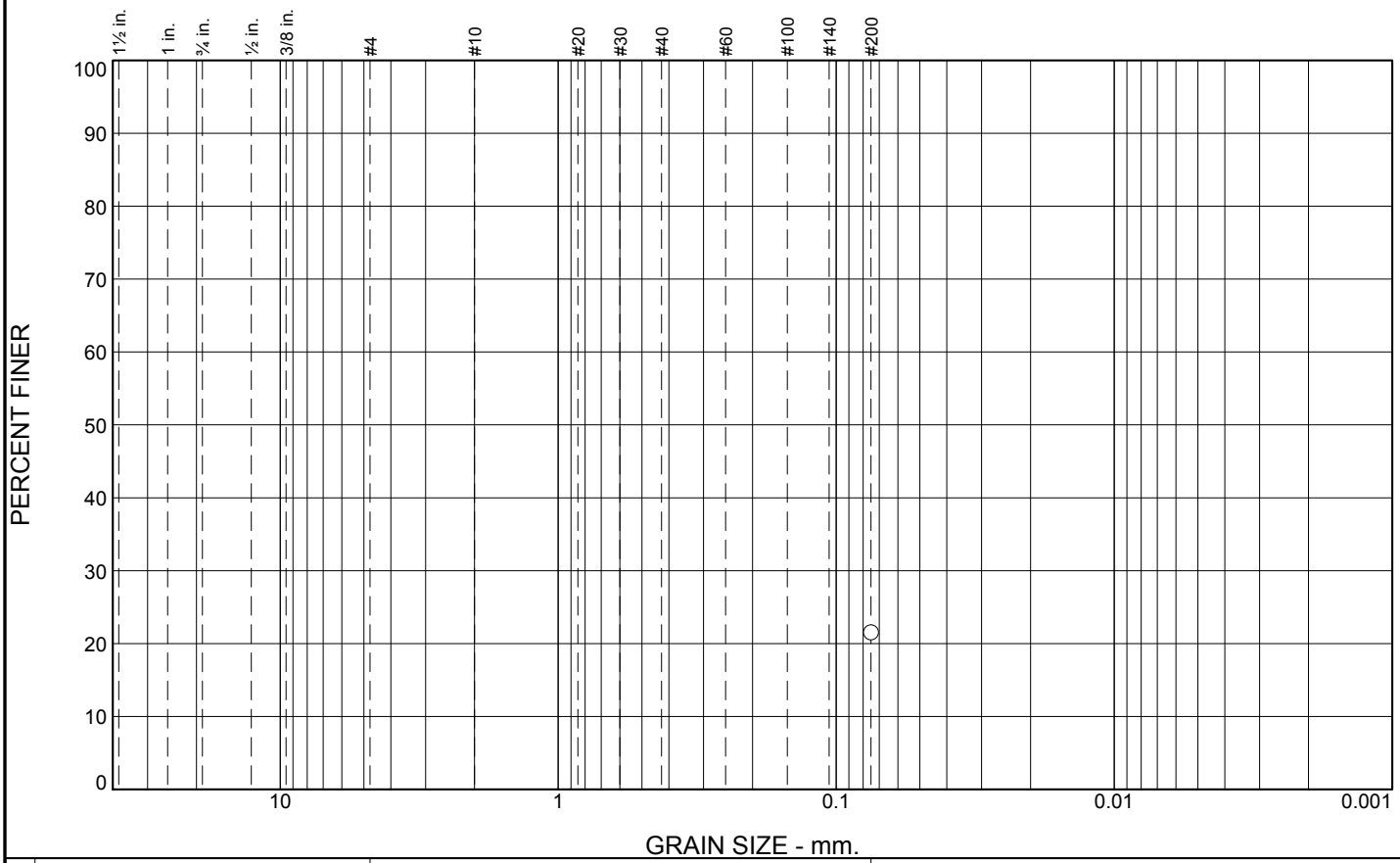
Source of Sample: GEX **Depth:** 2 feet
Sample Number: 1-B25@2 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						21.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	21.5		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

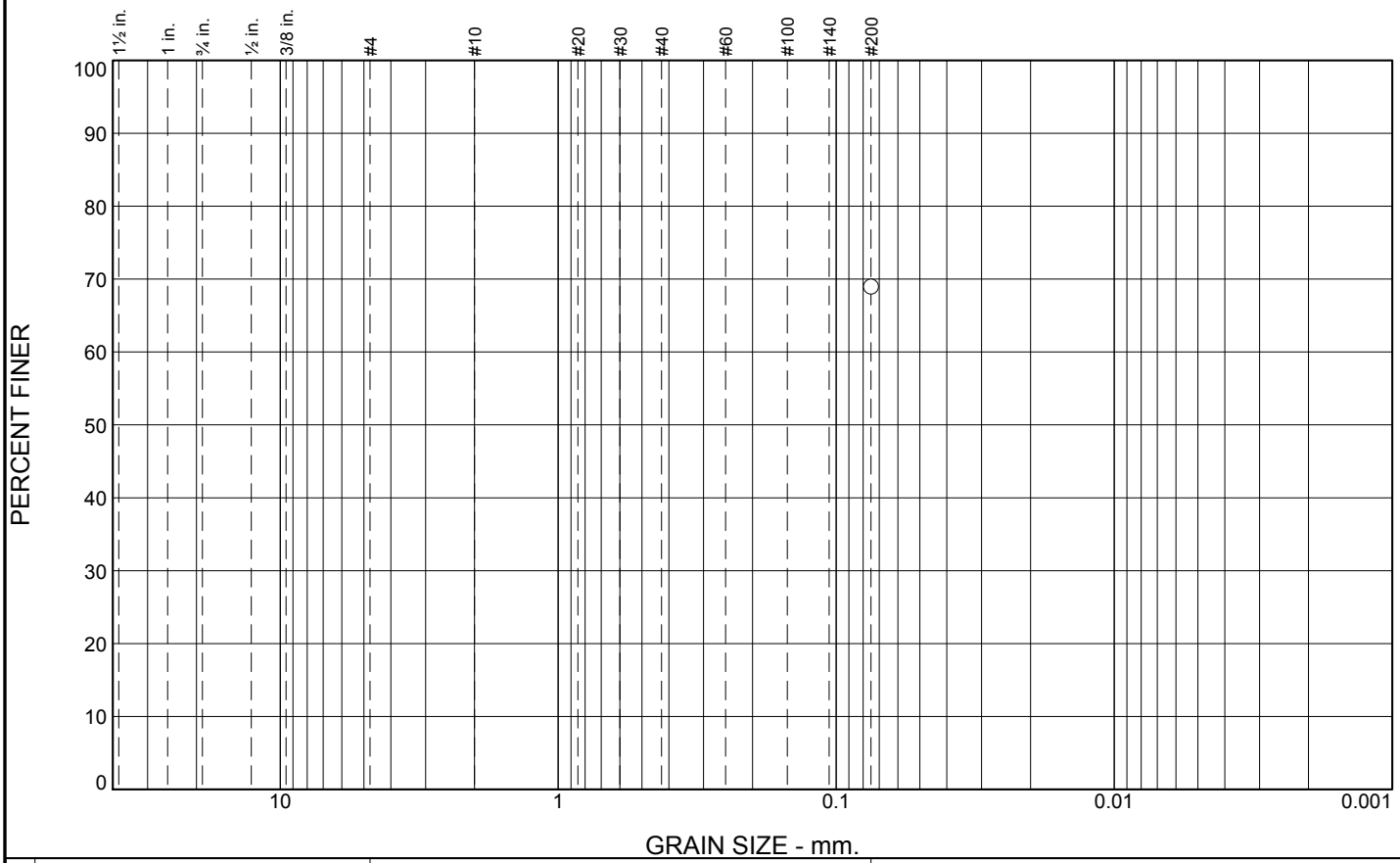
Source of Sample: GEX **Depth:** 26 feet
Sample Number: 1-B25@26 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						69.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	69.0		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= 24 LL= 36 PI= 12

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

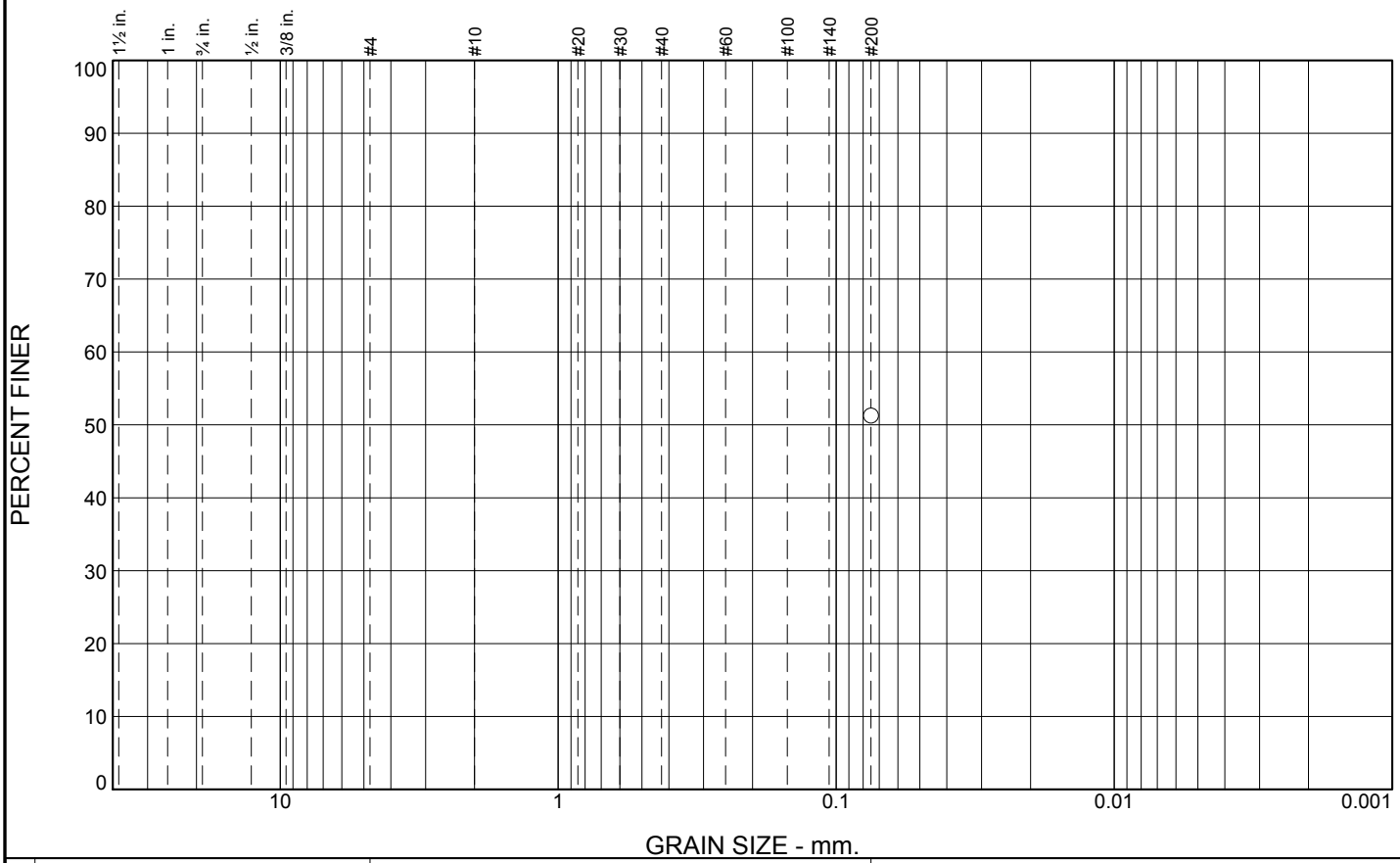
Source of Sample: GEX **Depth:** 30 feet
Sample Number: 1-B25@30 **Date:** 01/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						51.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	51.3		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

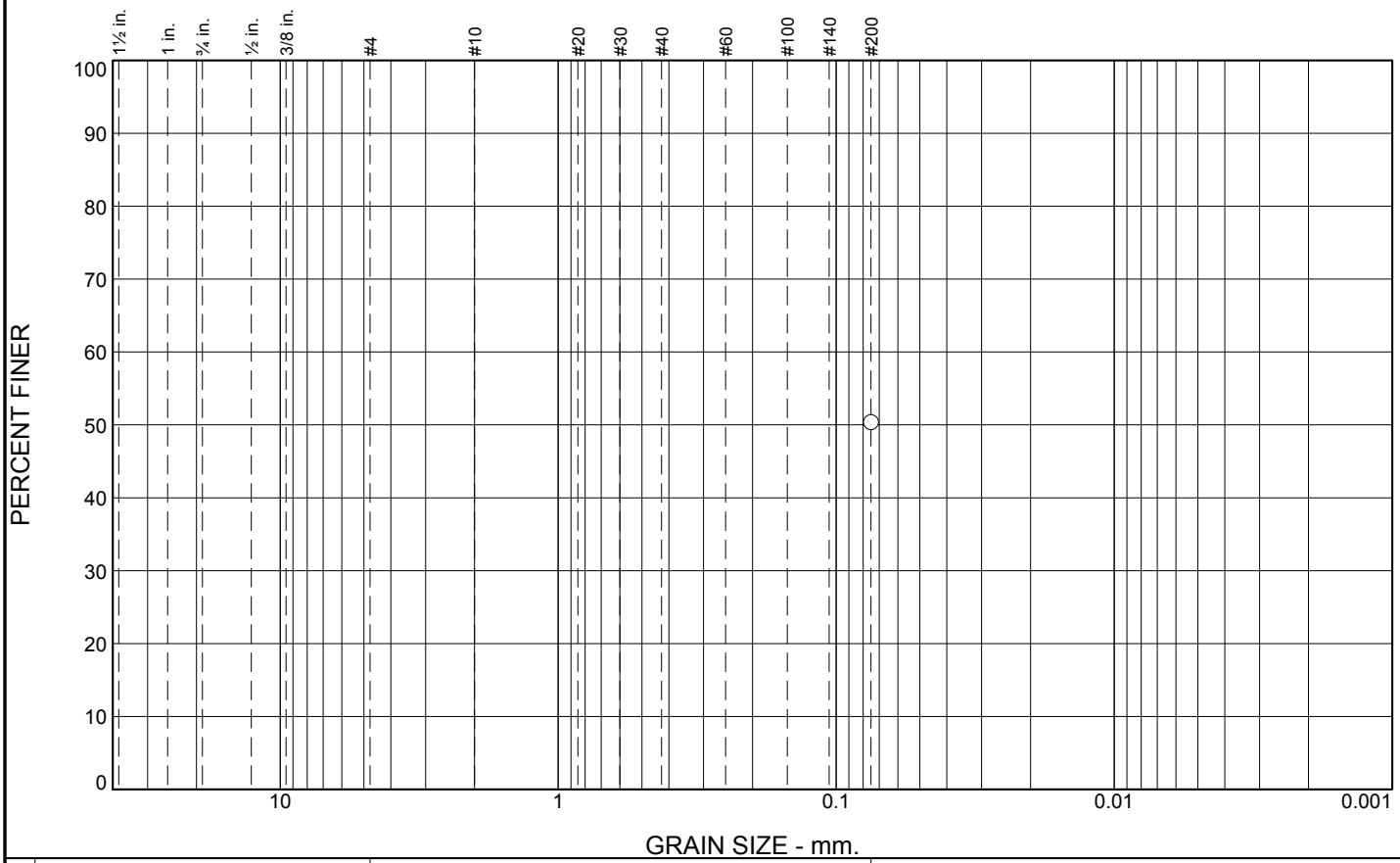
Source of Sample: GEX **Depth:** 2 feet
Sample Number: 1-B26@2 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						50.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	50.4		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

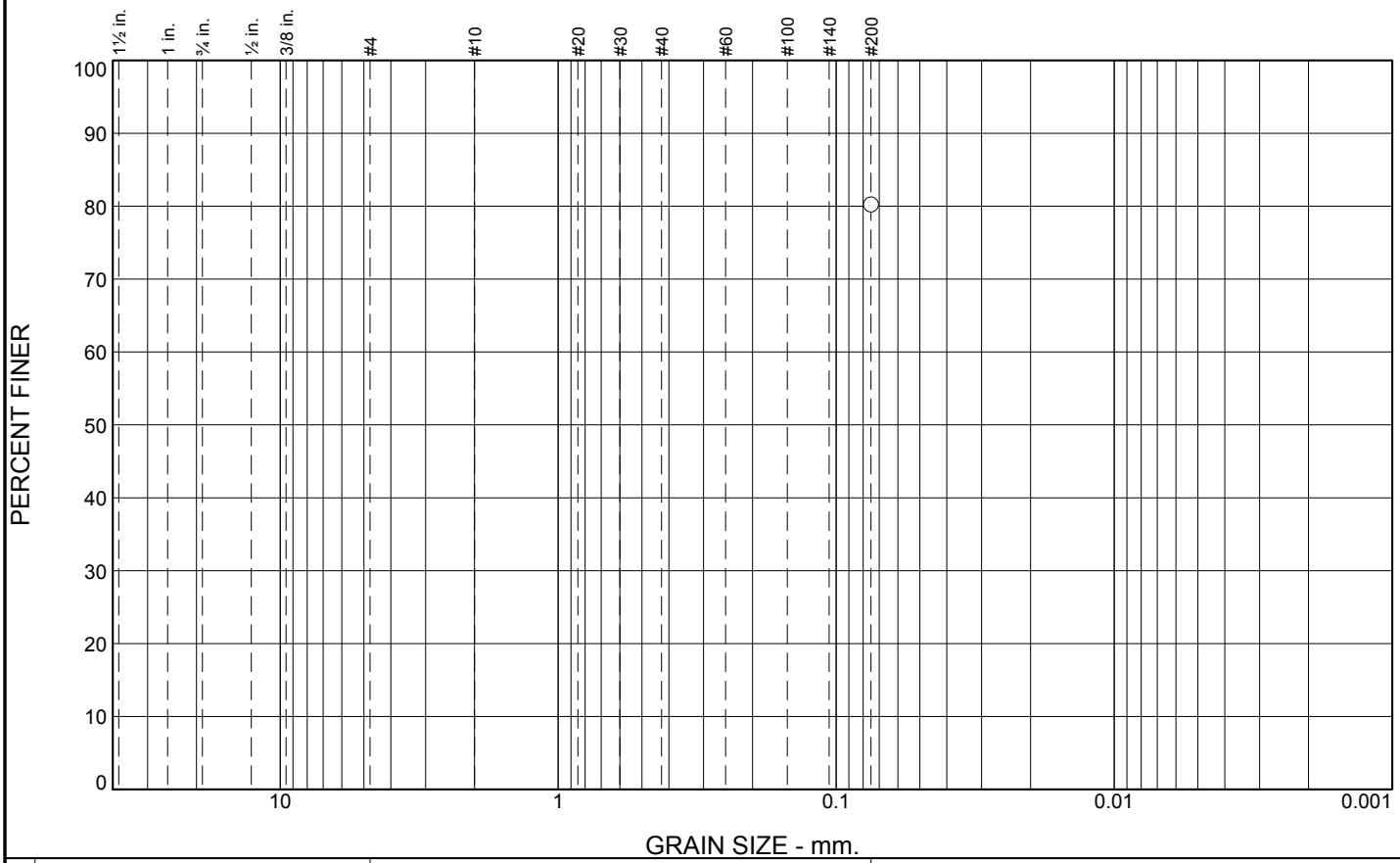
Source of Sample: GEX **Depth:** 26 feet
Sample Number: 1-B26@26 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						80.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	80.3		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

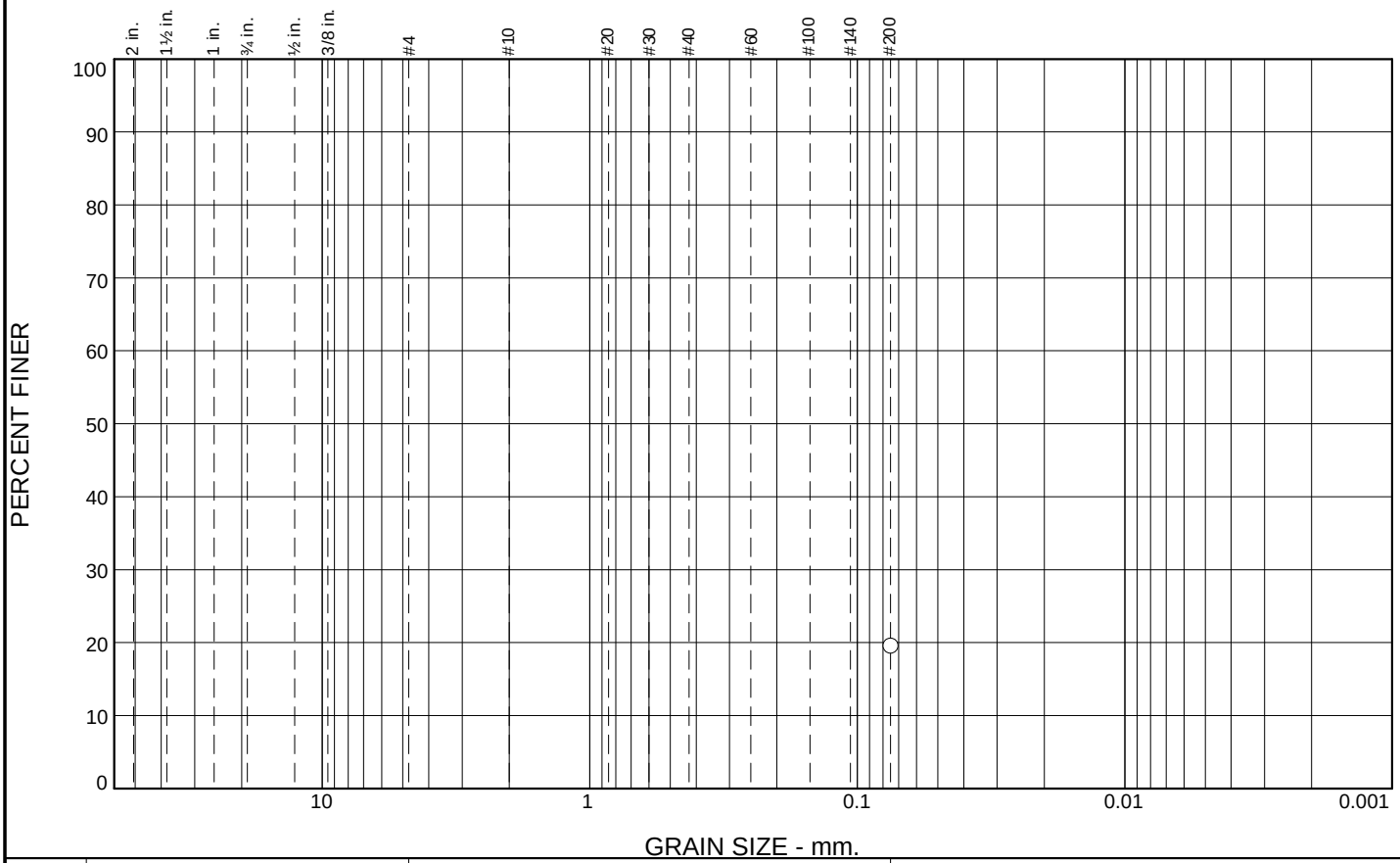
Source of Sample: GEX **Depth:** 31 feet
Sample Number: 1-B26@31 **Date:** 1/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						19.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	19.6		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

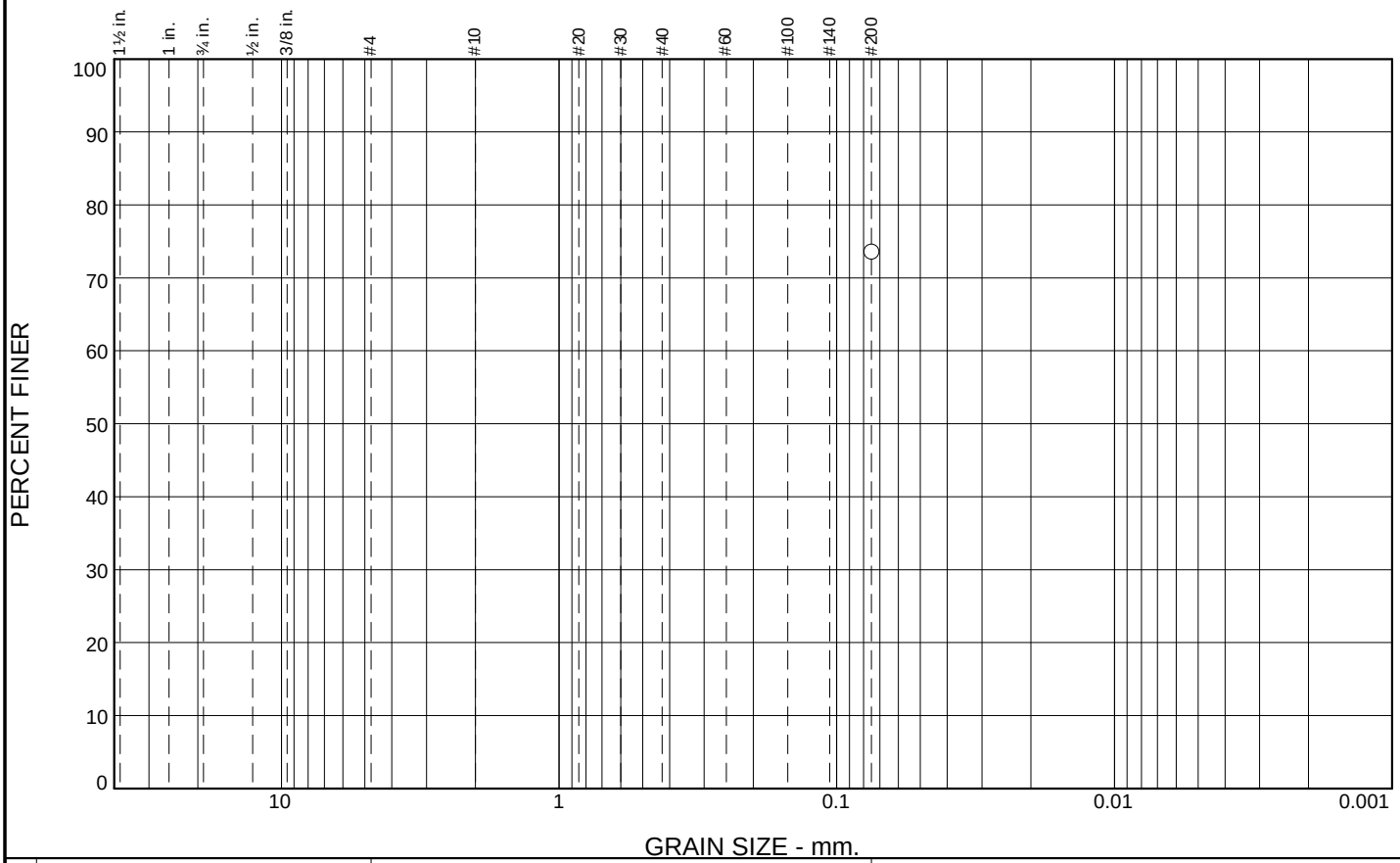
Source of Sample: GEX **Depth:** 1.5 feet
Sample Number: 1-B2@1.5 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						73.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	73.6		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 11 feet
Sample Number: 1-B34@11 **Date:** 01/23/2019

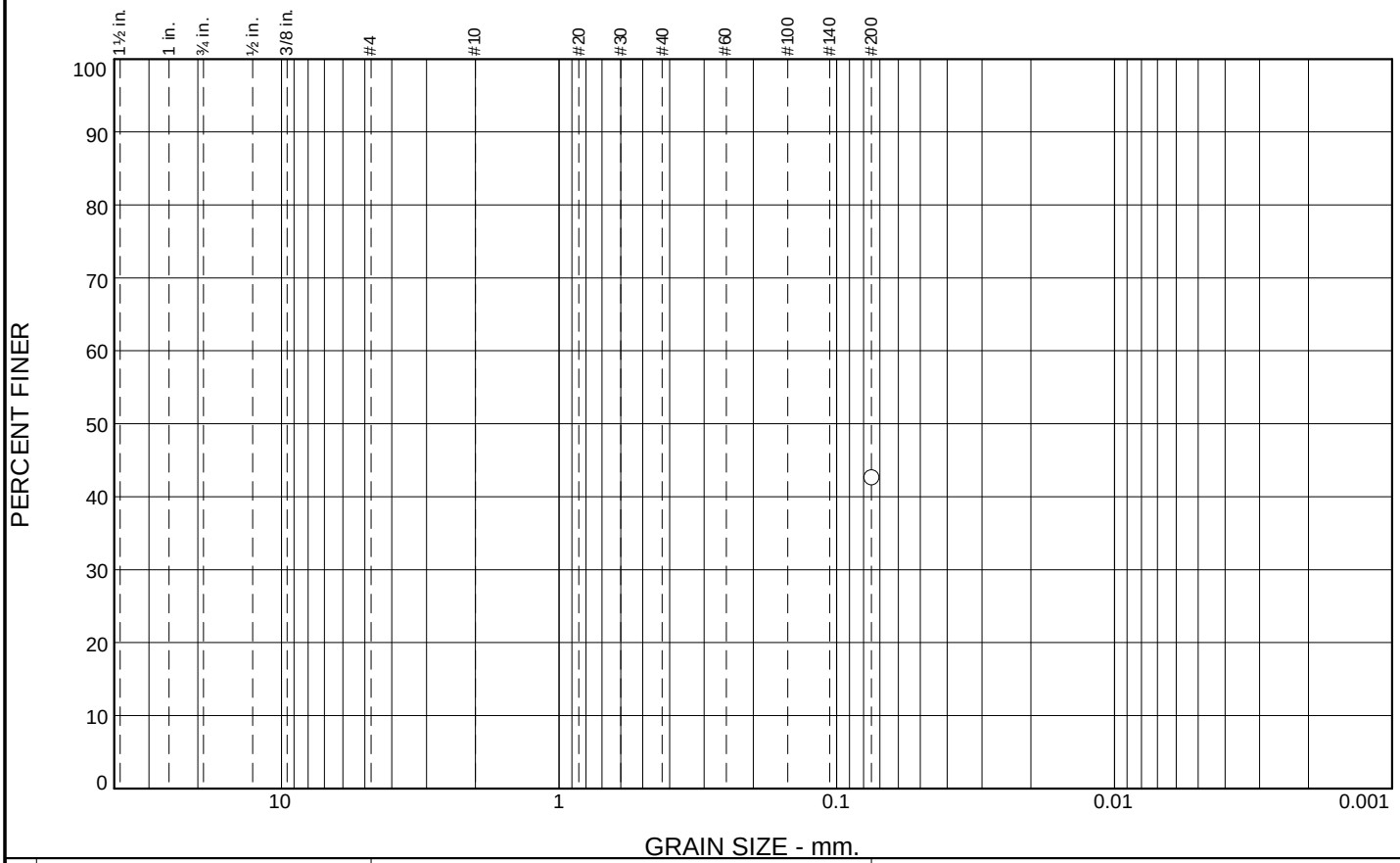
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						42.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	42.6		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 18 feet
Sample Number: 1-B34@18 **Date:** 01/23/2019

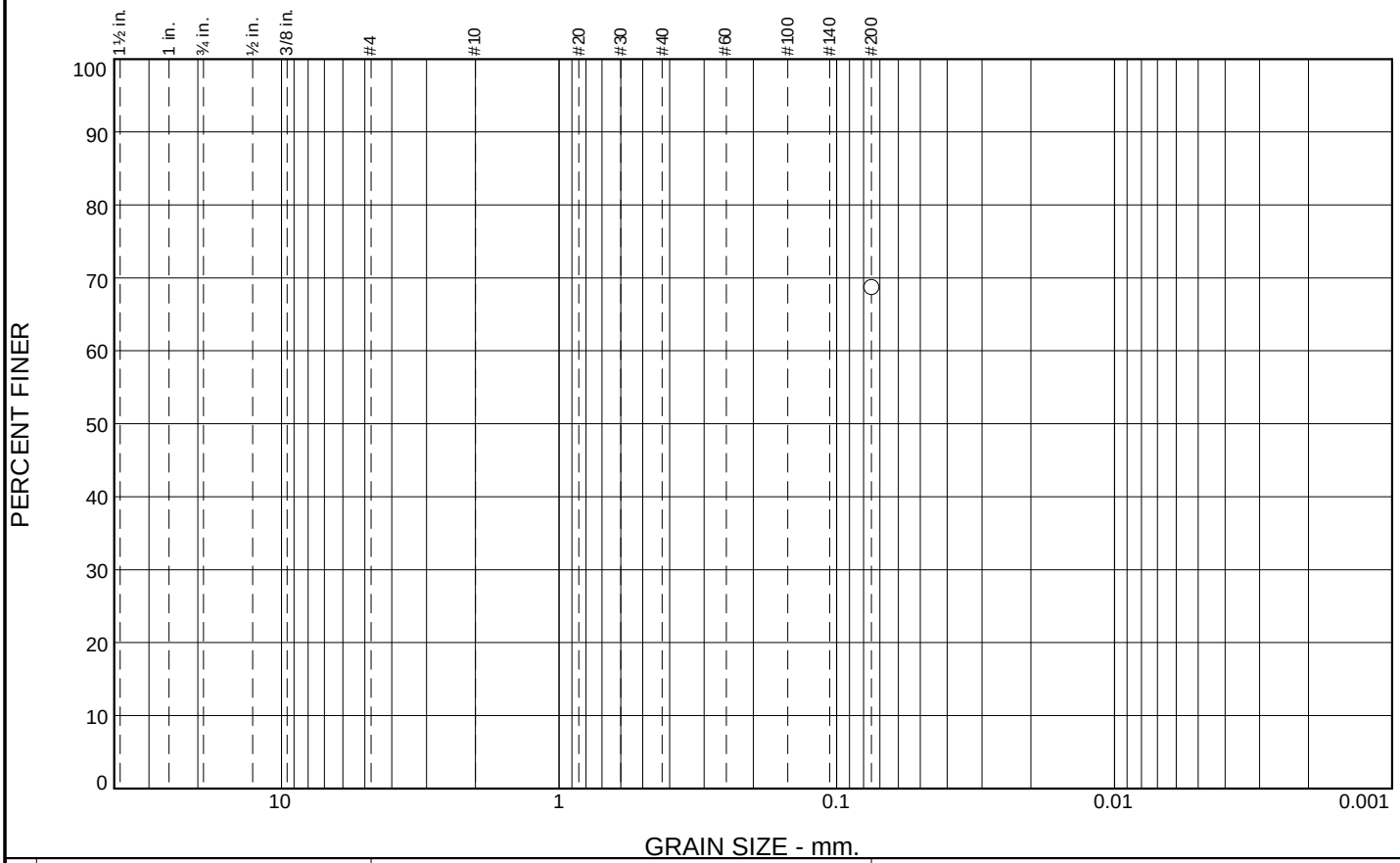
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						68.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	68.7		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 2 feet
Sample Number: 1-B34@2 **Date:** 01/23/2019

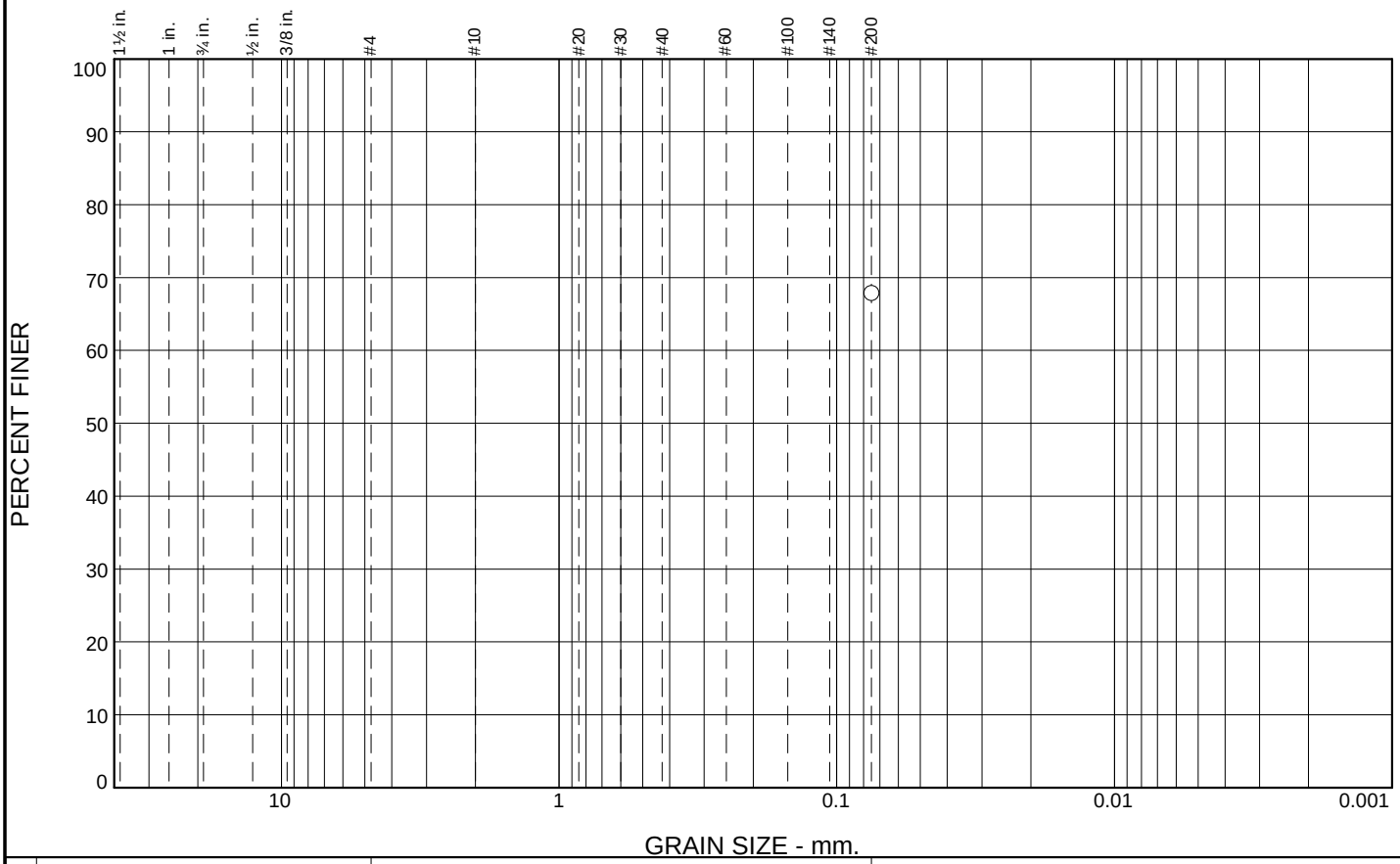
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						67.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	67.9		

* (no specification provided)

Material Description

See eploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 2.5 feet
Sample Number: 1-B35@2.5 **Date:** 01/23/2019

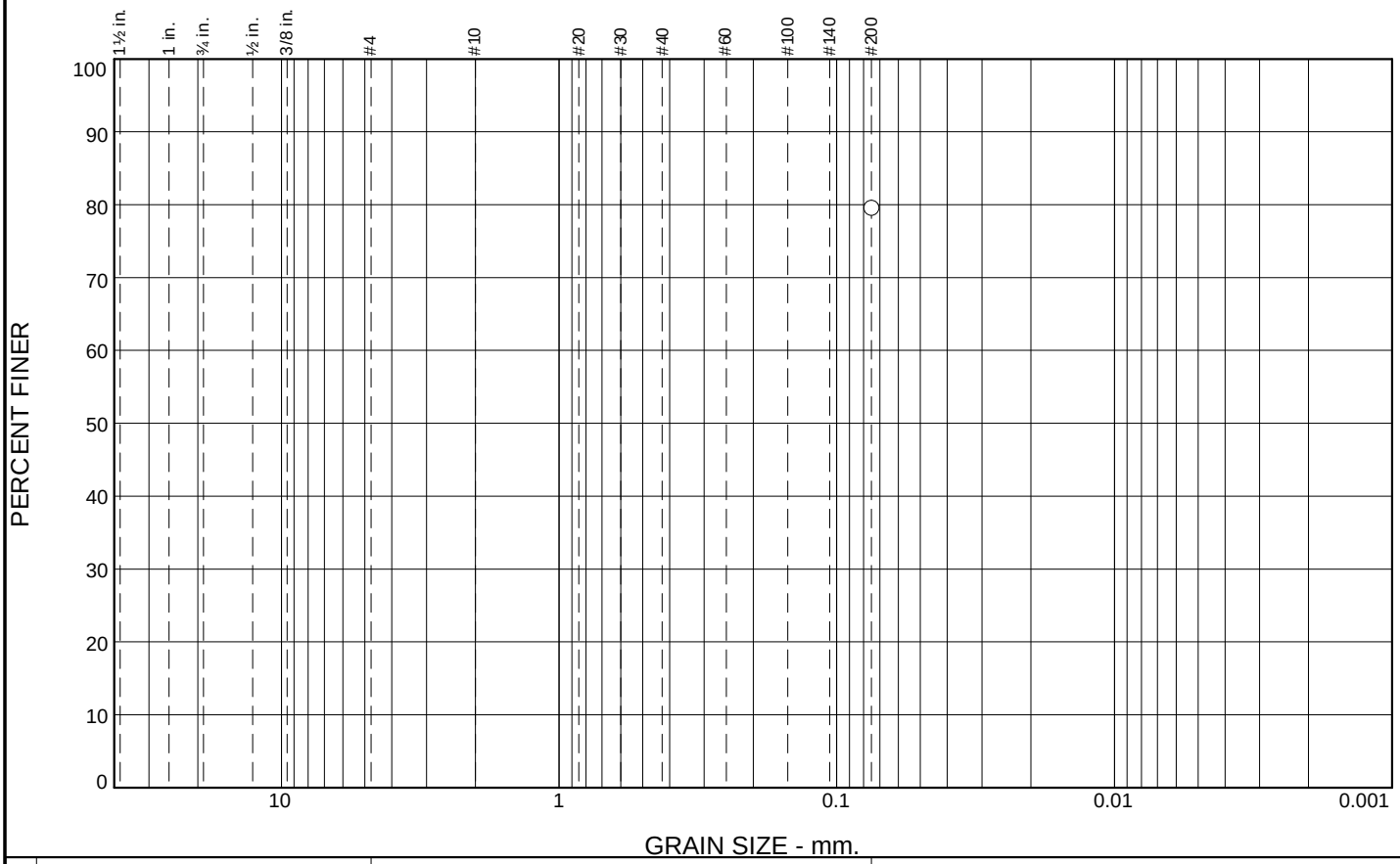
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						79.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	79.6		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 11 feet
Sample Number: 1-B36@11 **Date:** 01/23/2019

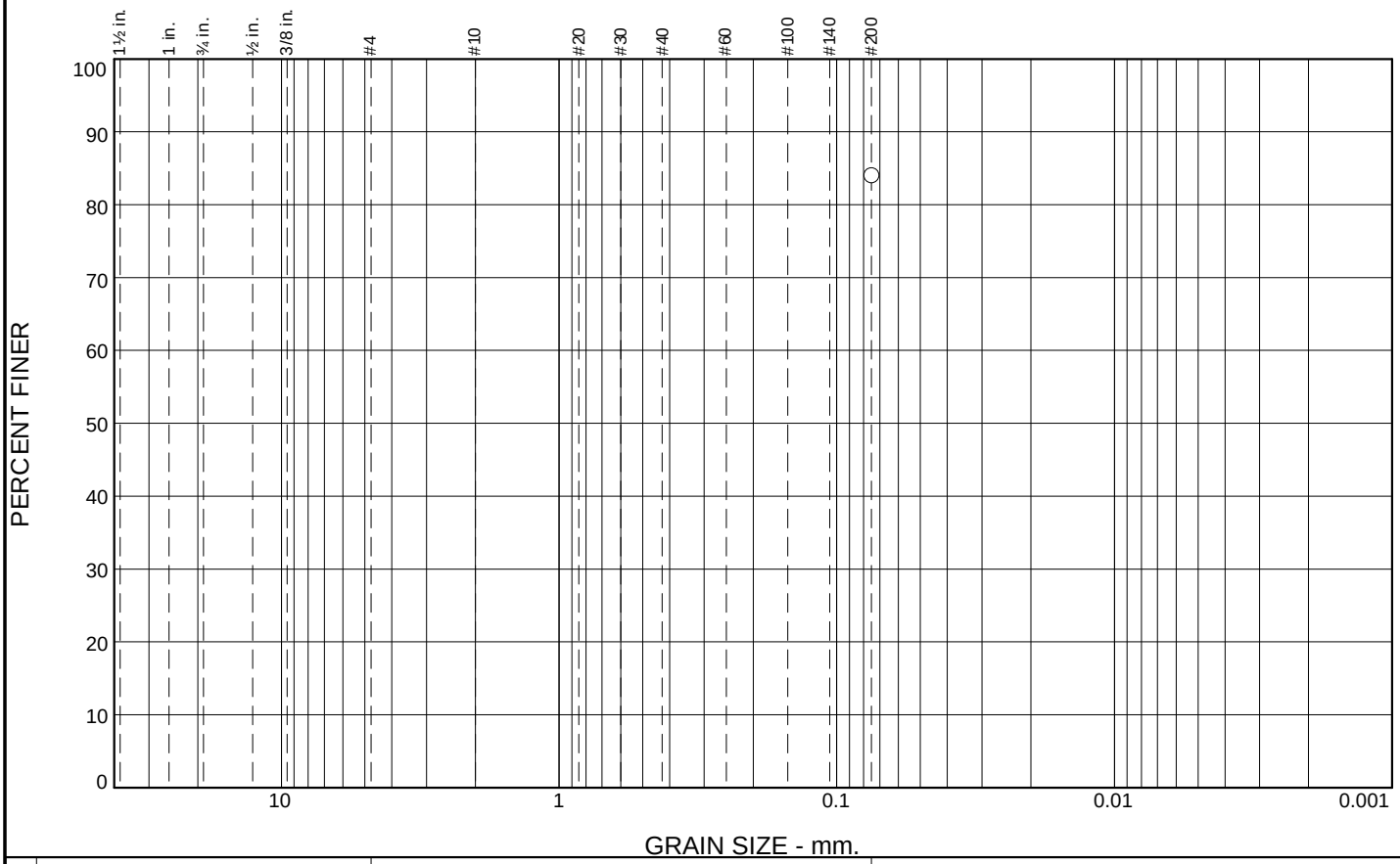
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						84.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	84.0		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= 16 LL= 38 PI= 22

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

GS: ASTM 1140 Method B

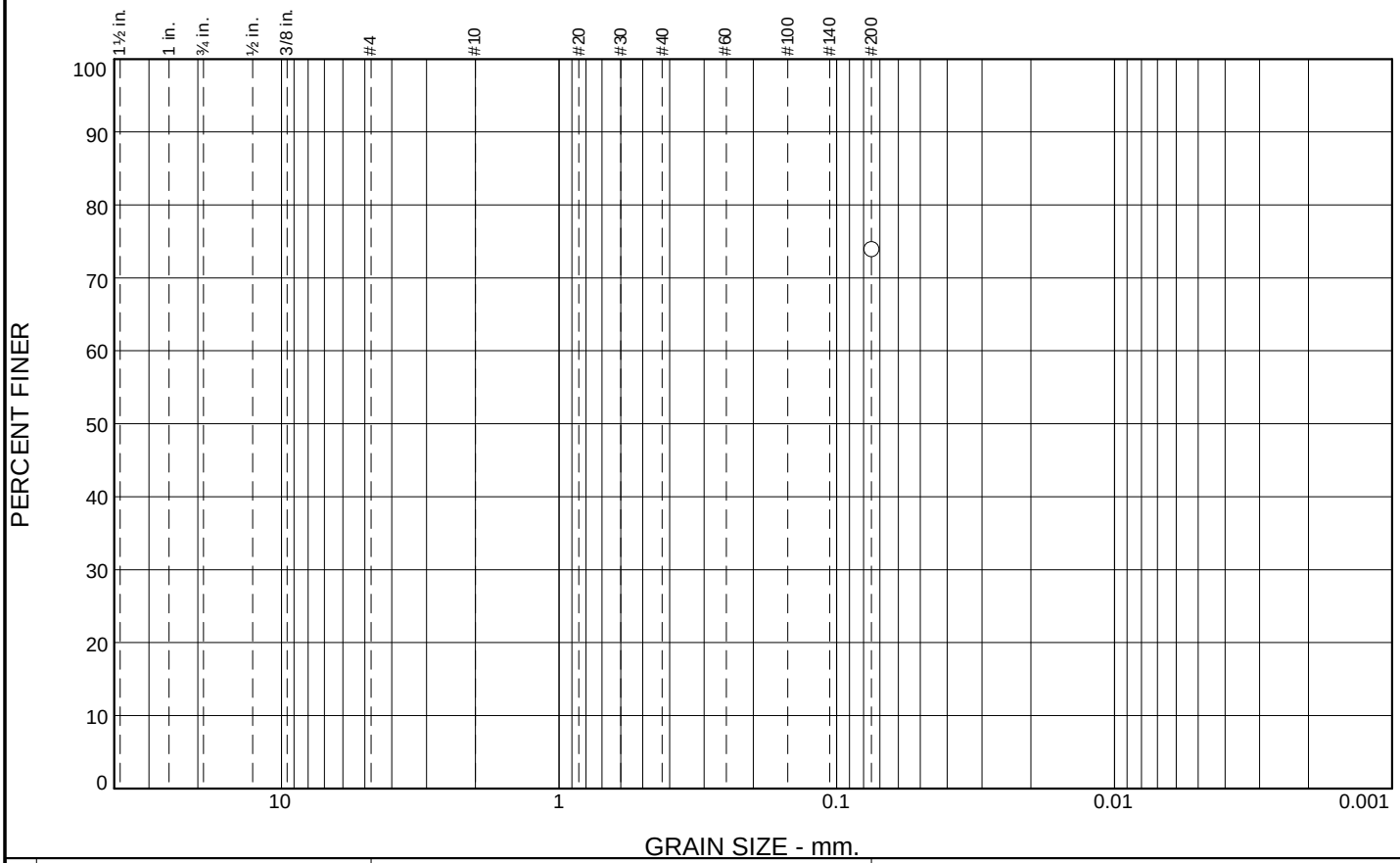
Source of Sample: GEX **Depth:** 2 feet
Sample Number: 1-B36@2 **Date:** 01/23/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						73.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	73.9		

* (no specification provided)

Material Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM 1140 Method B

Source of Sample: GEX **Depth:** 21 feet
Sample Number: 1-B36@21 **Date:** 01/23/2019

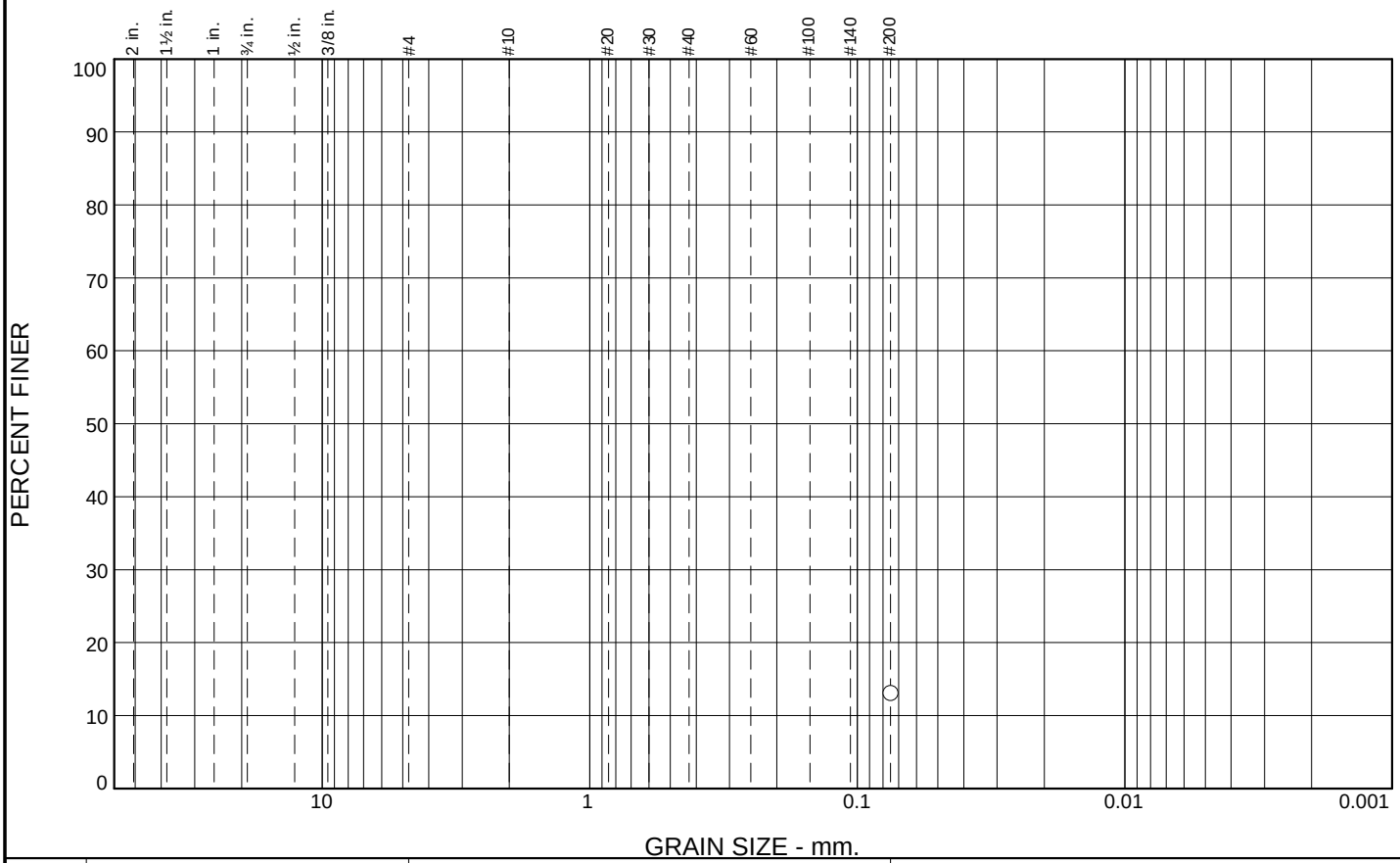
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						13.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	13.1		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

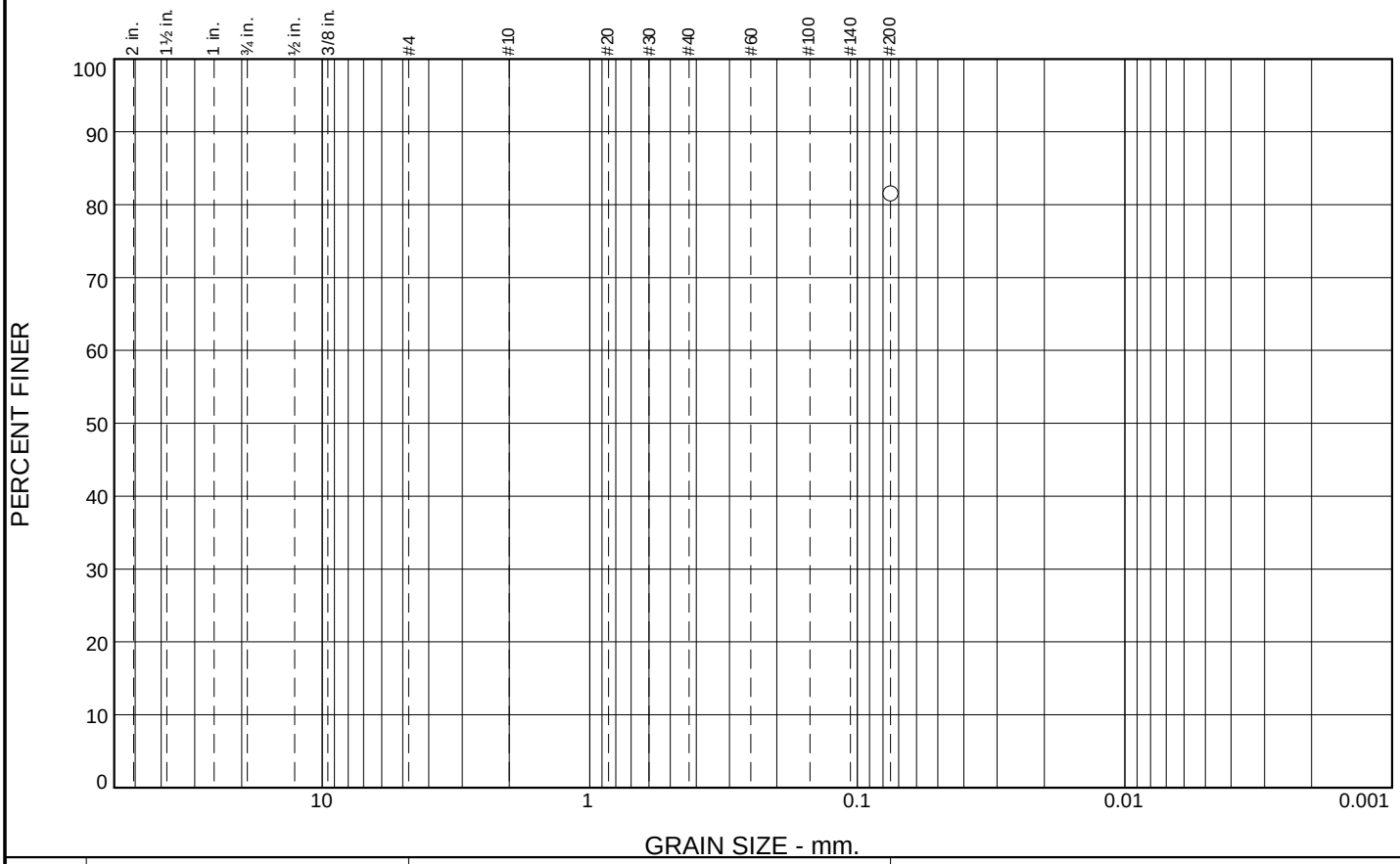
Source of Sample: GEX **Depth:** 40.5 feet
Sample Number: 1-B3@40.5 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						81.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	81.6		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 16 feet
Sample Number: 1-B4@16 **Date:** 02/01/2019

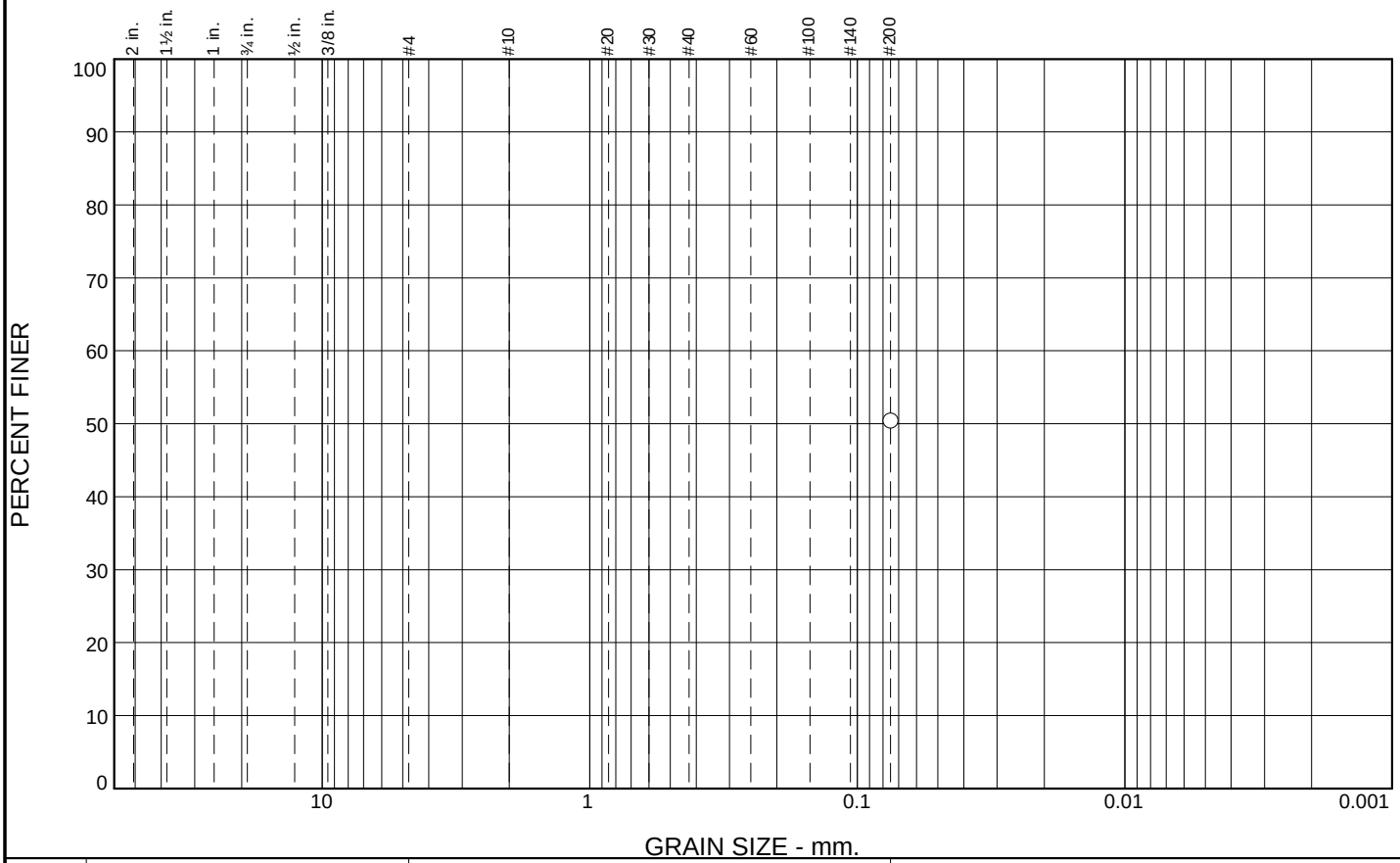
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						50.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	50.4		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 35 feet
Sample Number: 1-B6@35 **Date:** 02/01/2019

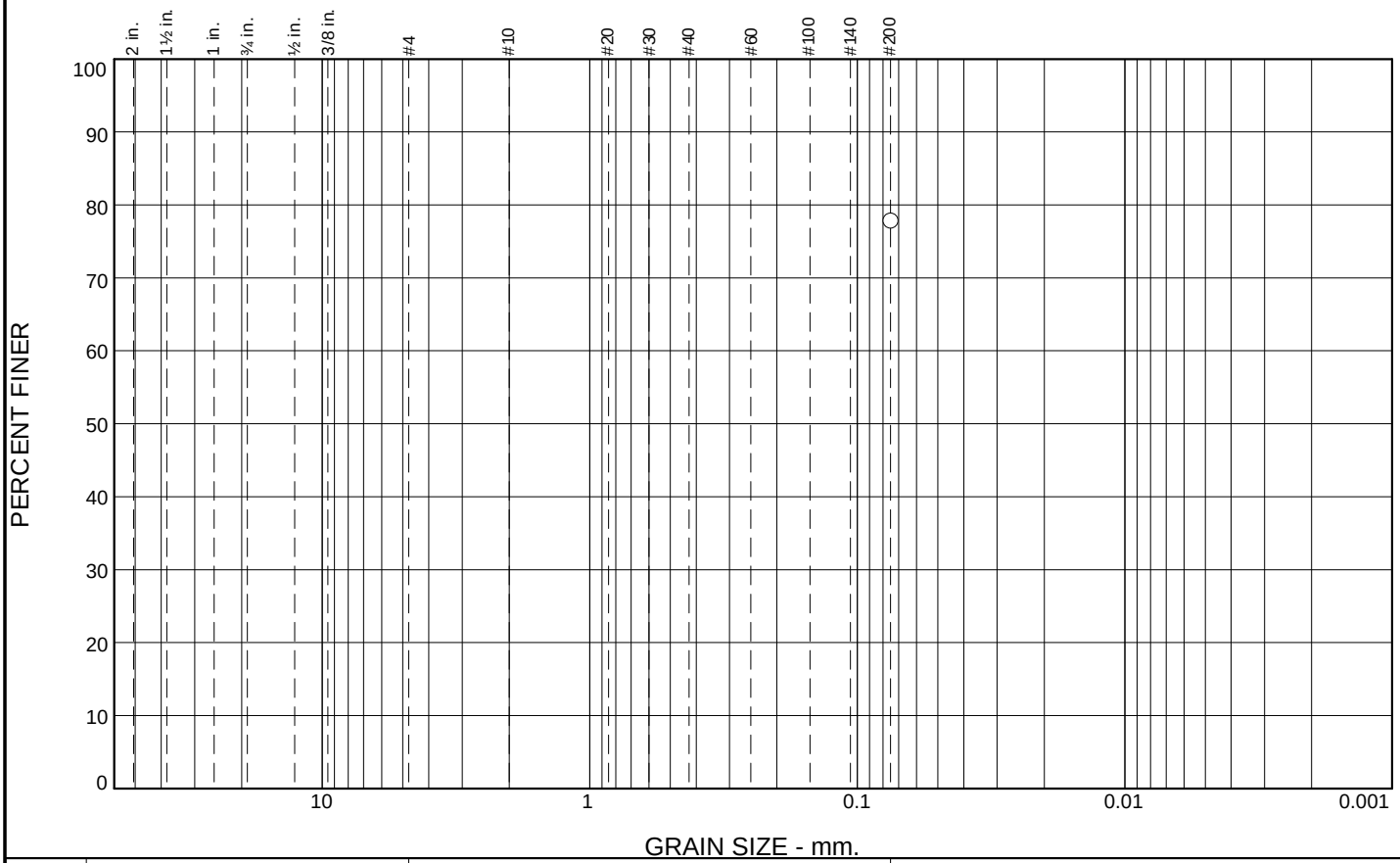
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						77.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	77.8		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

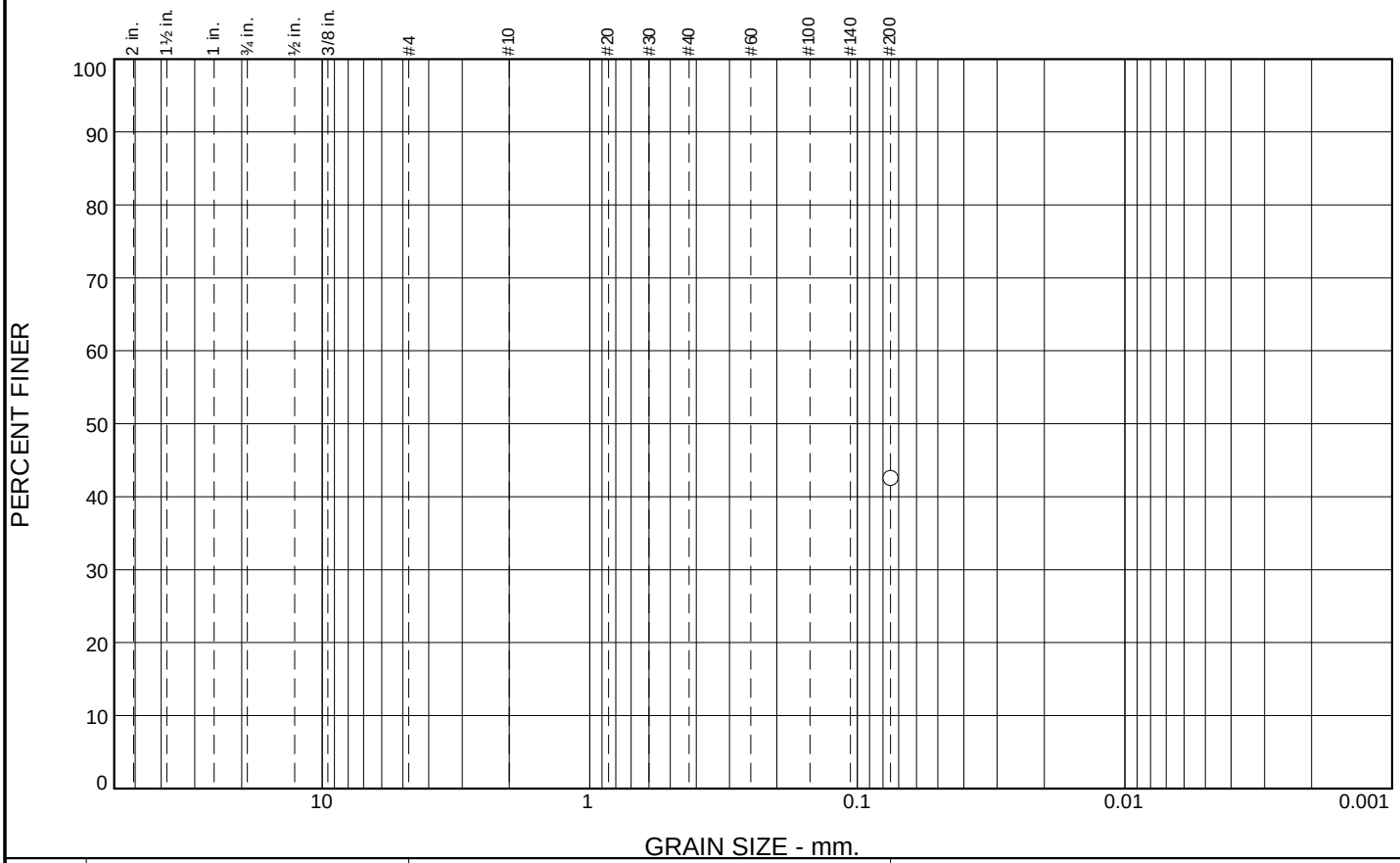
Source of Sample: GEX **Depth:** 8.5 feet
Sample Number: 1-B6@8.5 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						42.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	42.6		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 26 feet
Sample Number: 1-B8@26 **Date:** 02/01/2019

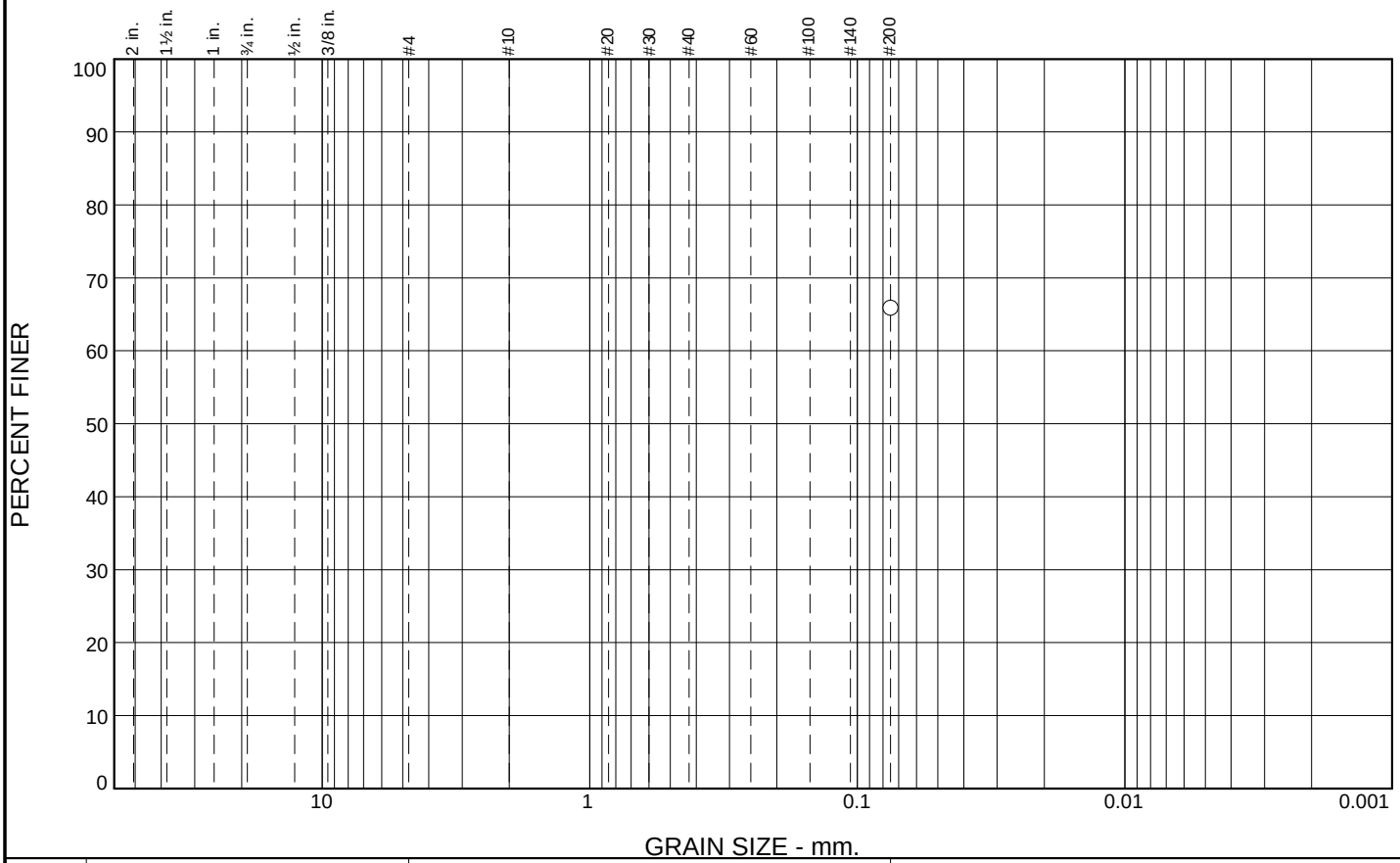
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						65.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	65.9		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 30.5 feet
Sample Number: 1-B8@30.5 **Date:** 02/01/2019

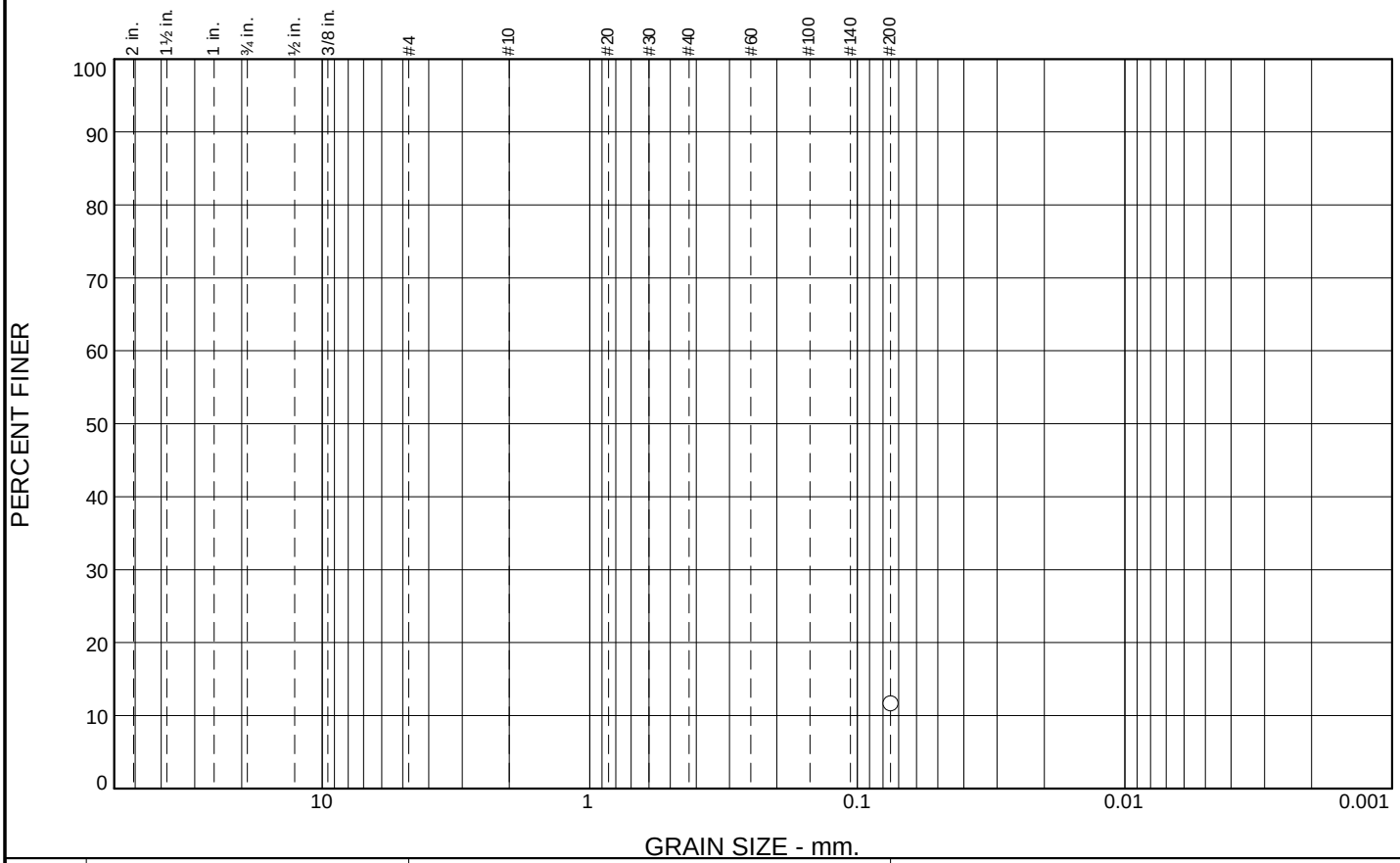
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						11.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	11.7		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

Source of Sample: GEX **Depth:** 40 feet
Sample Number: 1-B8@40 **Date:** 02/01/2019

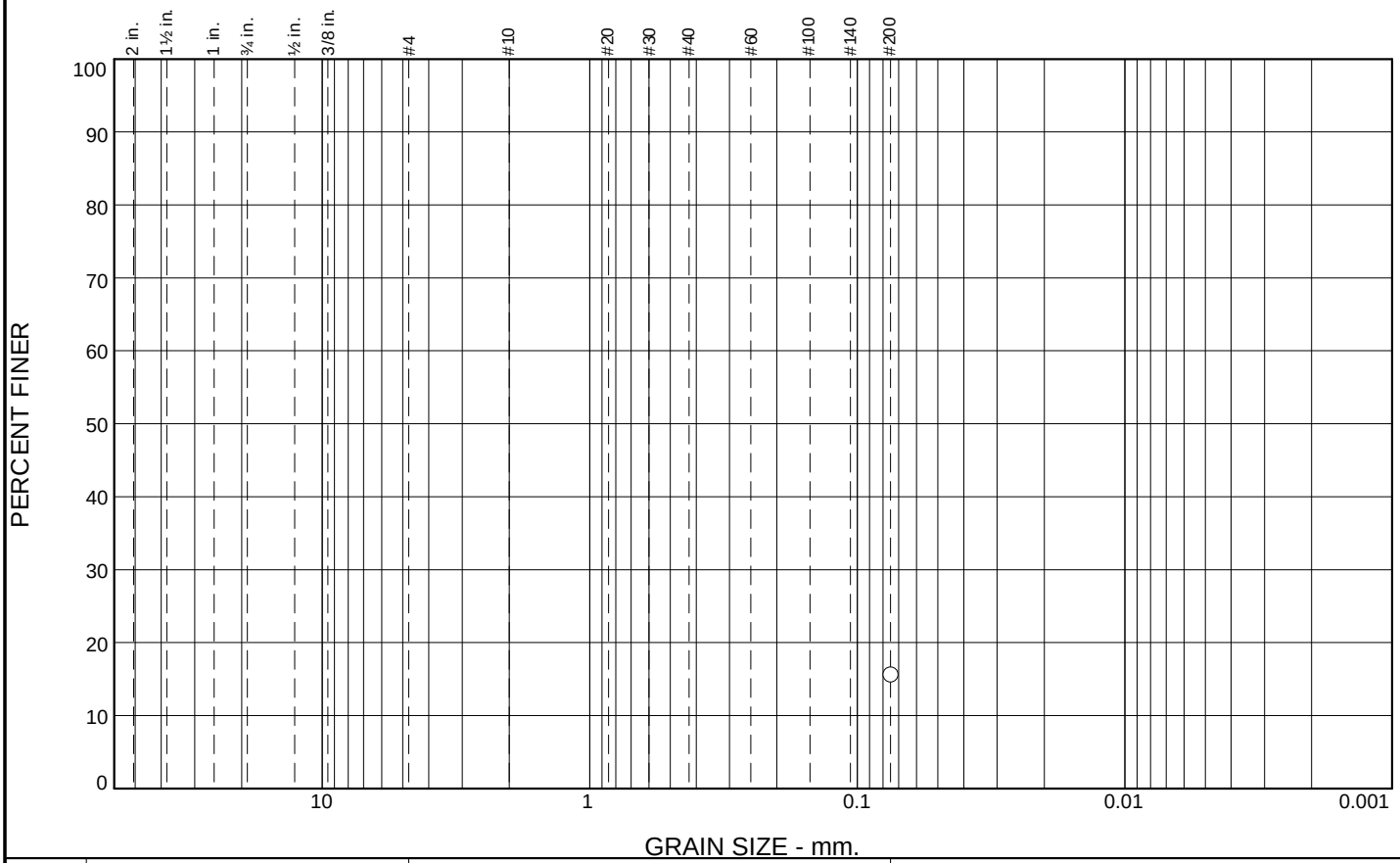
ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site

Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						15.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	15.6		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140 Method B

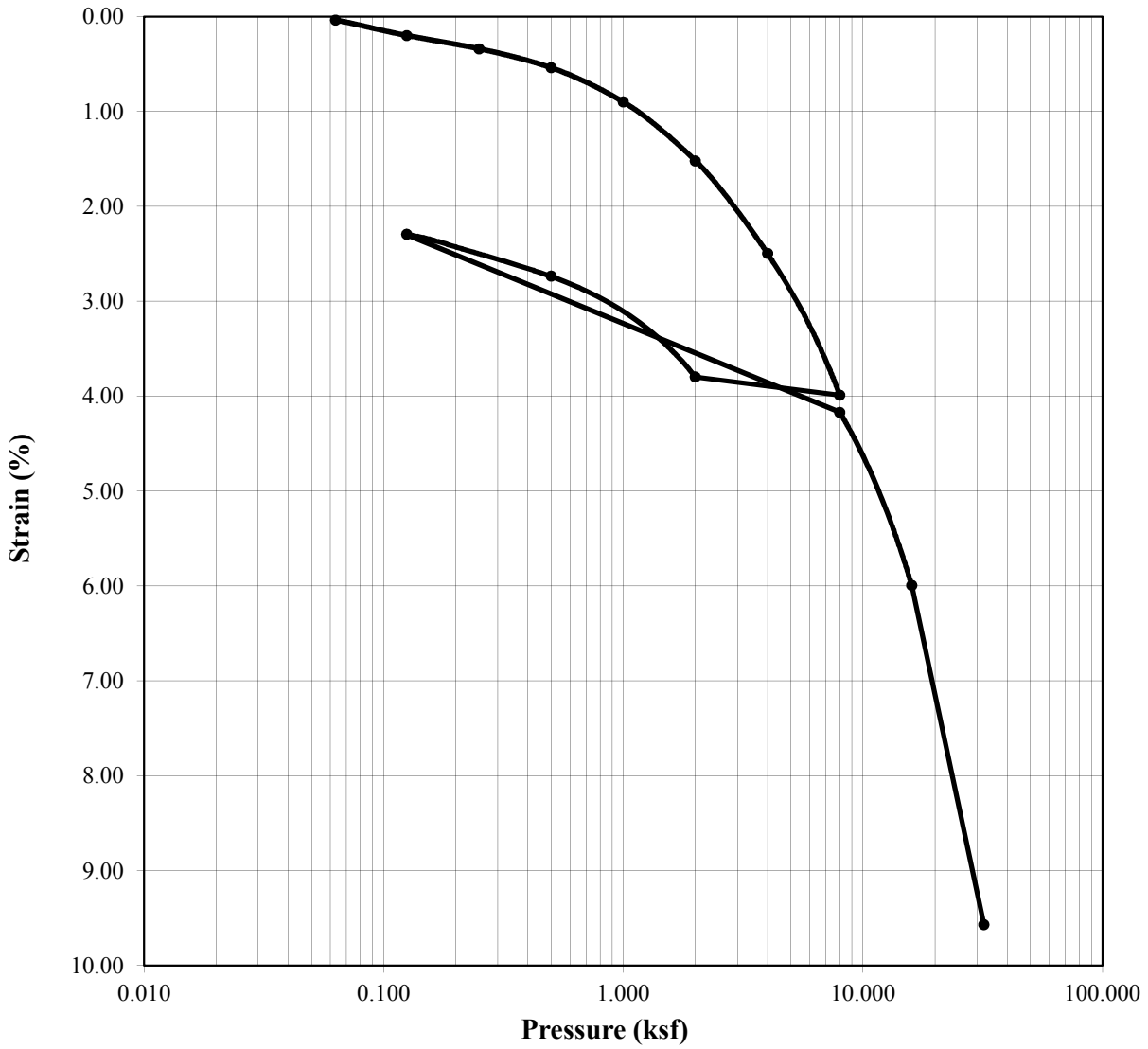
Source of Sample: GEX **Depth:** 45 feet
Sample Number: 1-B8@45 **Date:** 02/01/2019

ENGEO INCORPORATED

Client: Wood Rodgers, Inc.
Project: Elk Grove Hospital Site
Project No: 15747.000.000 PH001 **Figure**

Tested By: R. Montalvo **Checked By:** M. Gilbert

Incremental Consolidation
ASTM D2435 - Method B



	Before	After	ASTM D4318 - Wet Method		Date: 02/06/19
Moisture (%):	33.24	22.29	Liquid Limit:	n/a	
Dry Density (pcf):	90.22	107.60	Plastic Limit:	n/a	
Saturation (%):	99.31	99.99	ASTM D854 - Measured		
Void Ratio:	0.9327	0.7477	Specific Gravity:	2.799	
Sample Description:	See exploration logs		Remarks:		

Project Number:	15747.000.000	Depth:	36.0 feet
Sample Number:	1-B03@36	Boring #:	1-B03
Project Name:	Elk Grove Hospital Site		
Client:	Wood Rodgers, Inc.		
Location:	Elk Grove, California		
Tested By: G. Criste	Checked By: K. Lecce		

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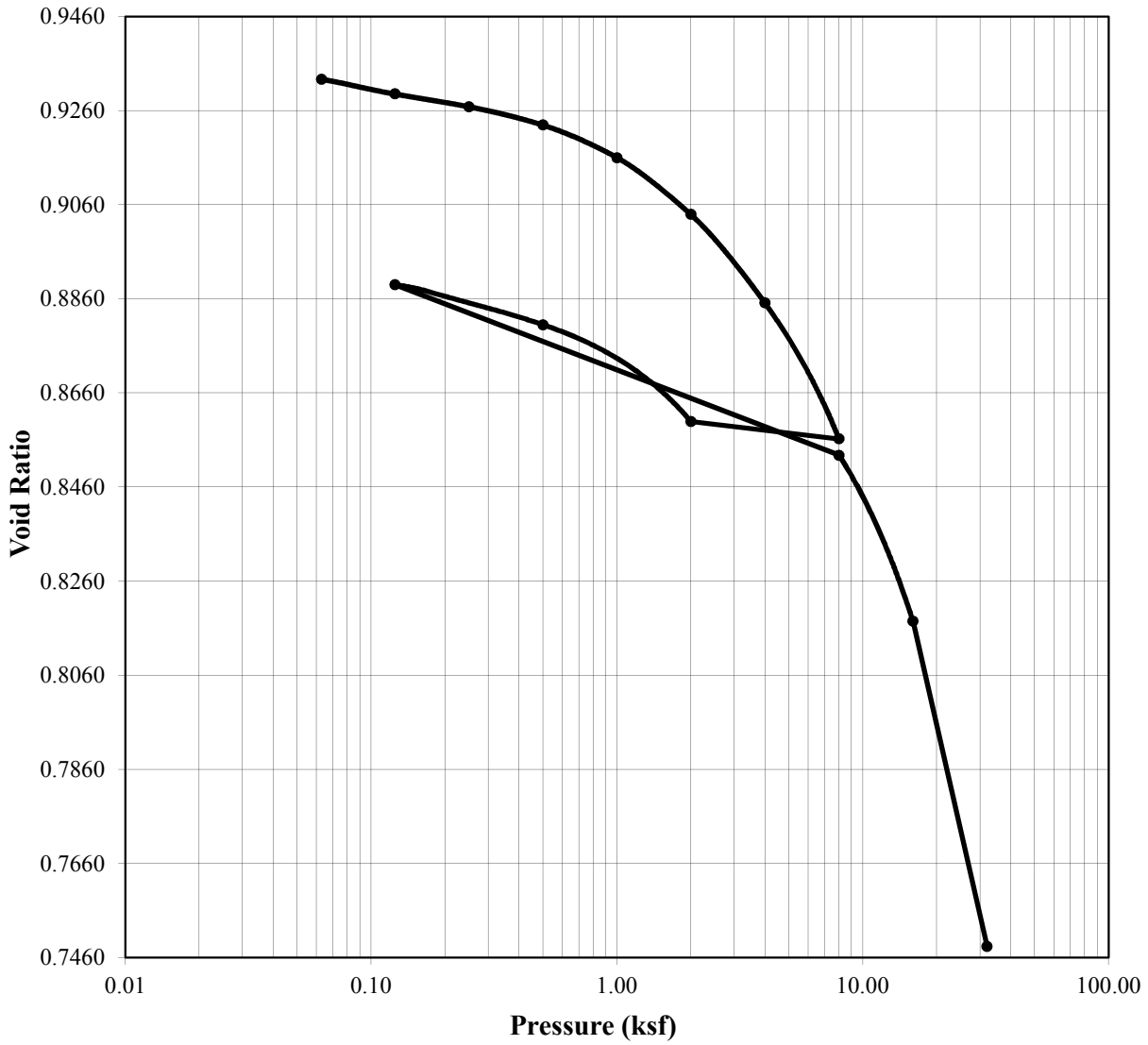
Incremental Consolidation
ASTM D2435 - Method B

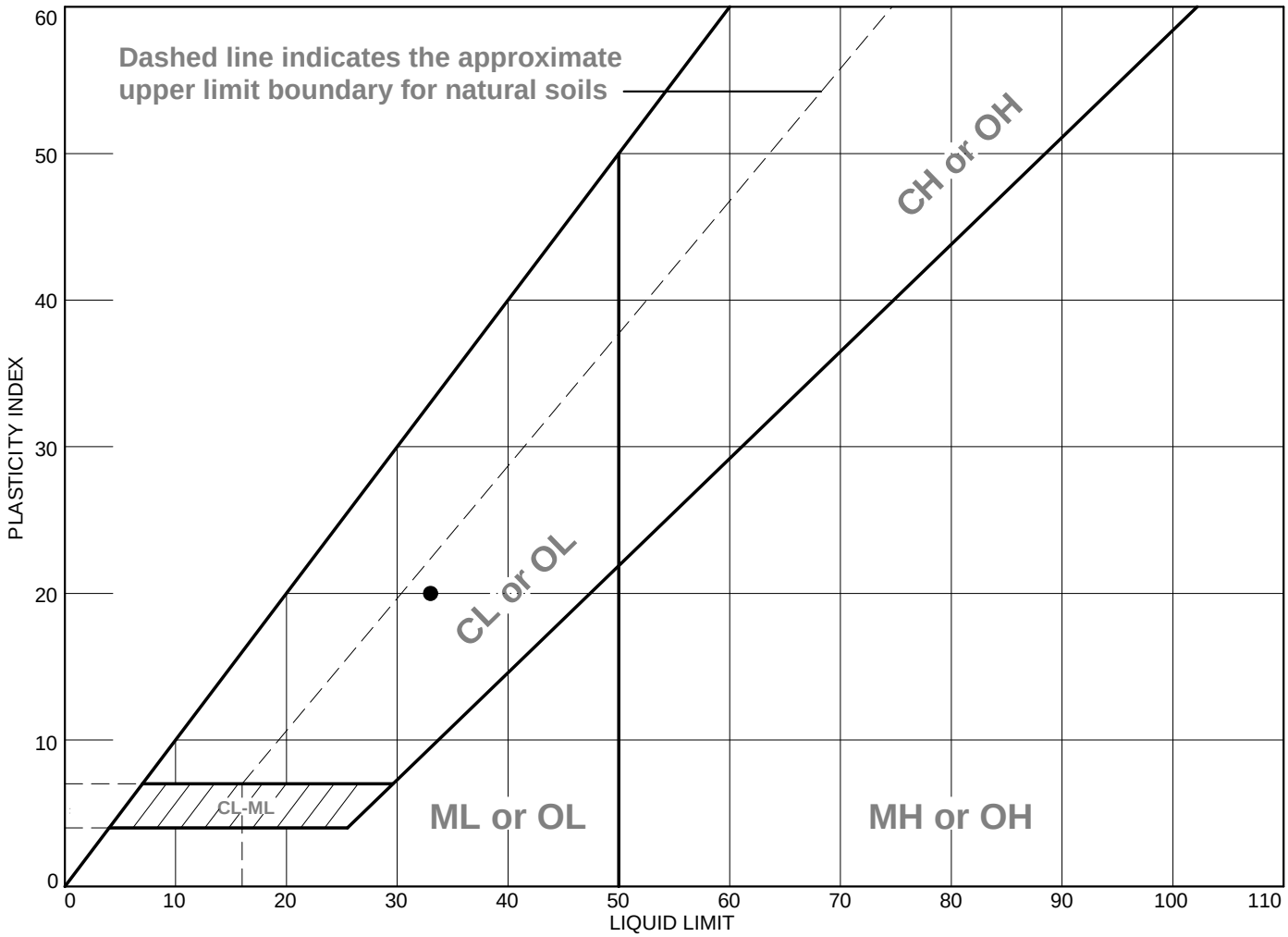


	Before	After	ASTM D4318 - Wet Method		Date: 02/06/19
Moisture (%):	33.24	22.29	Liquid Limit:	n/a	
Dry Density (pcf):	90.22	107.60	Plastic Limit:	n/a	
Saturation (%):	99.31	99.99	ASTM D854 - Measured		
Void Ratio:	0.9327	0.7477	Specific Gravity:	2.799	
Soil Description:	See exploration logs		Remarks:		

Project Number:	15747.000.000	Depth:	36.0 feet
Sample Number:	1-B03@36	Boring #:	1-B03
Project Name:	Elk Grove Hospital Site		
Client:	Wood Rodgers, Inc.		
Location:	Elk Grove, California		
Tested By: G. Criste	Checked By: K. Lecce		

ENGEO
Expect Excellence

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	33	13	20			

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 2.5 feet **Sample Number:** 1-B19@2.5

Remarks:

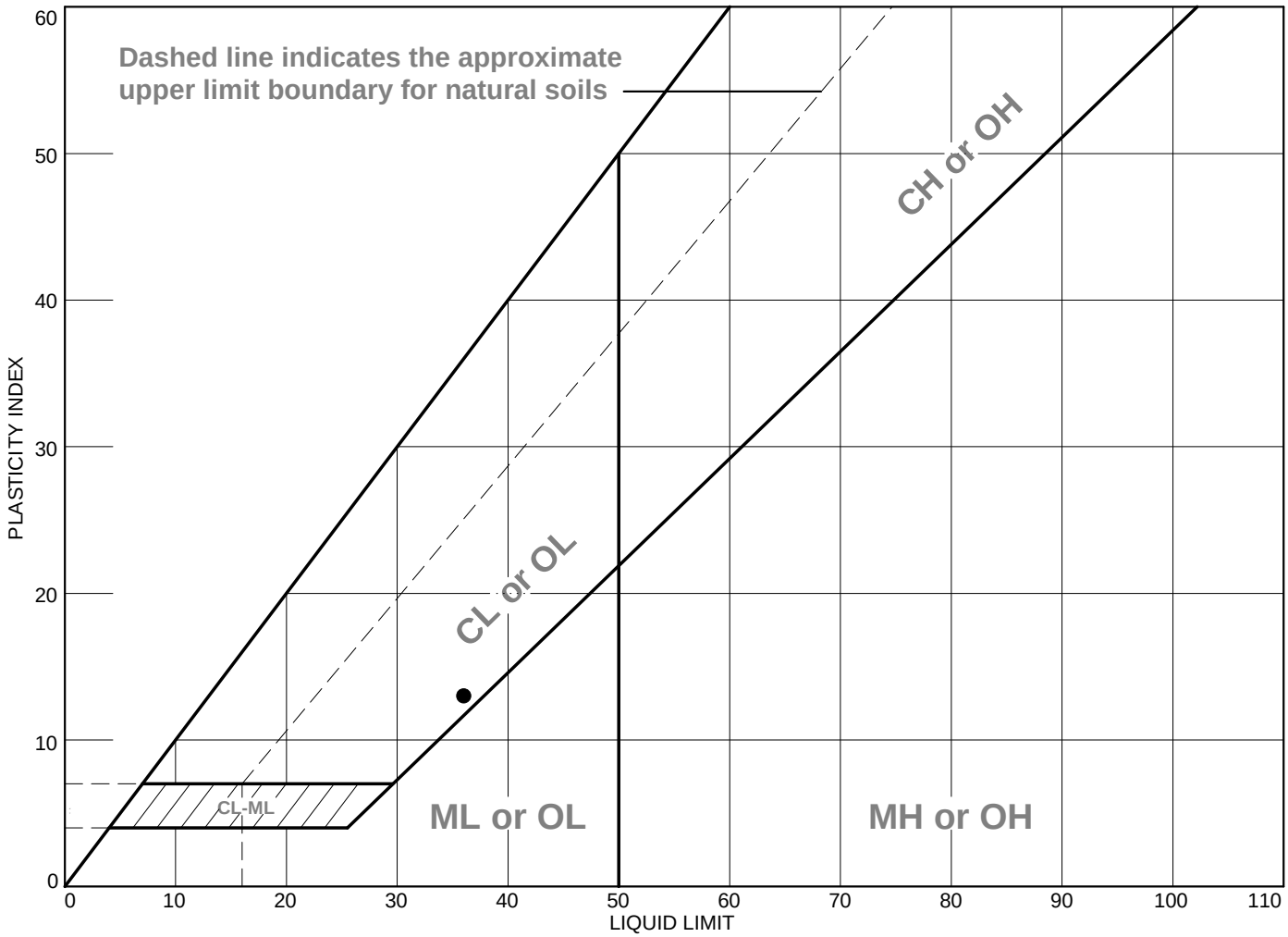
●PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	36	23	13			

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 30 feet **Sample Number:** 1-B19@30

Remarks:

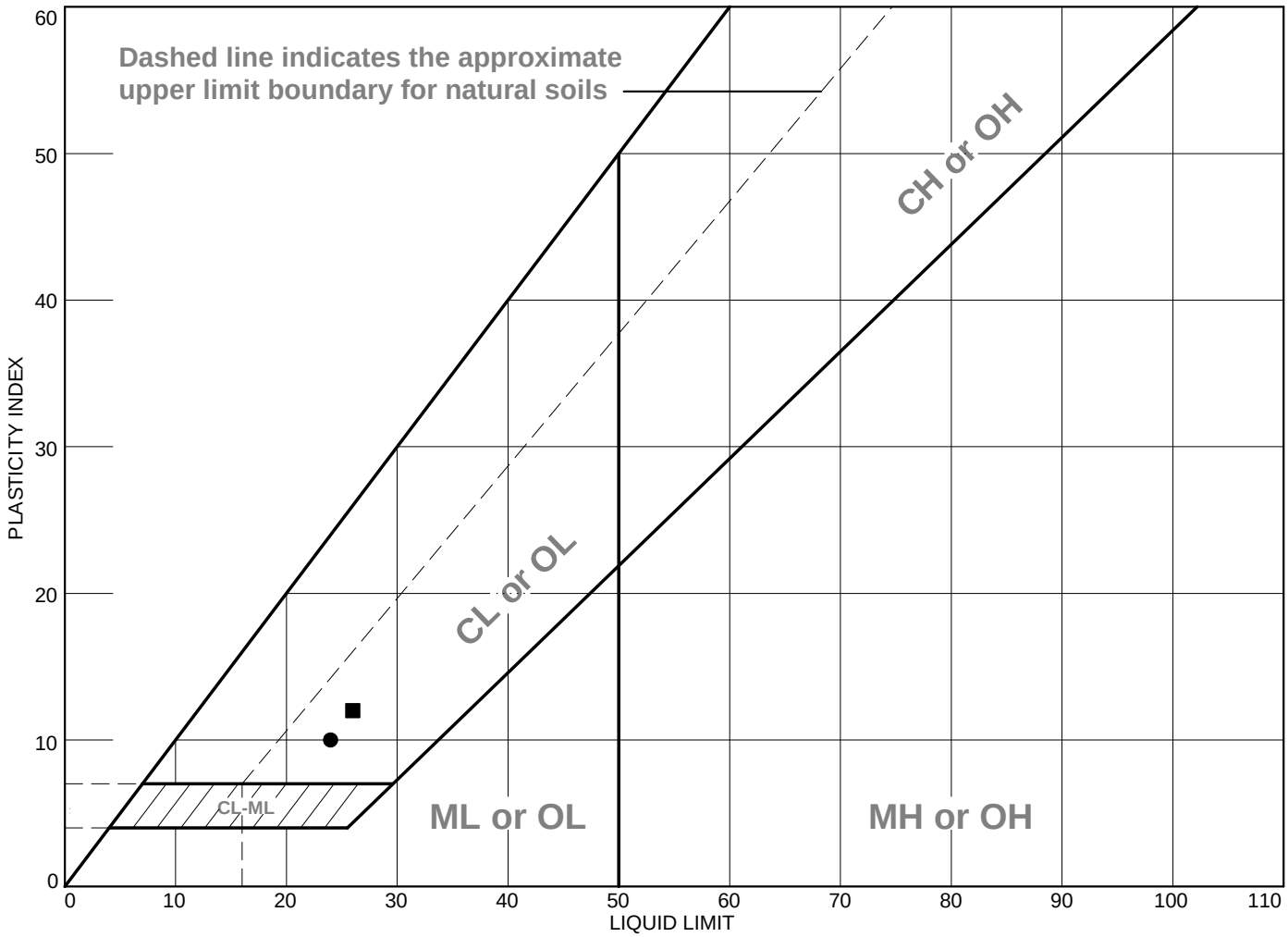
●PI: ASTM D4318 Dry Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	24	14	10		68.7	CL
■	See exploration logs	26	14	12			

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 6 feet **Sample Number:** 1-B1@6

■**Source of Sample:** GEX **Depth:** 1.75 feet **Sample Number:** 1-B9@1.75

Remarks:

●PI: ASTM D4318 Wet Method

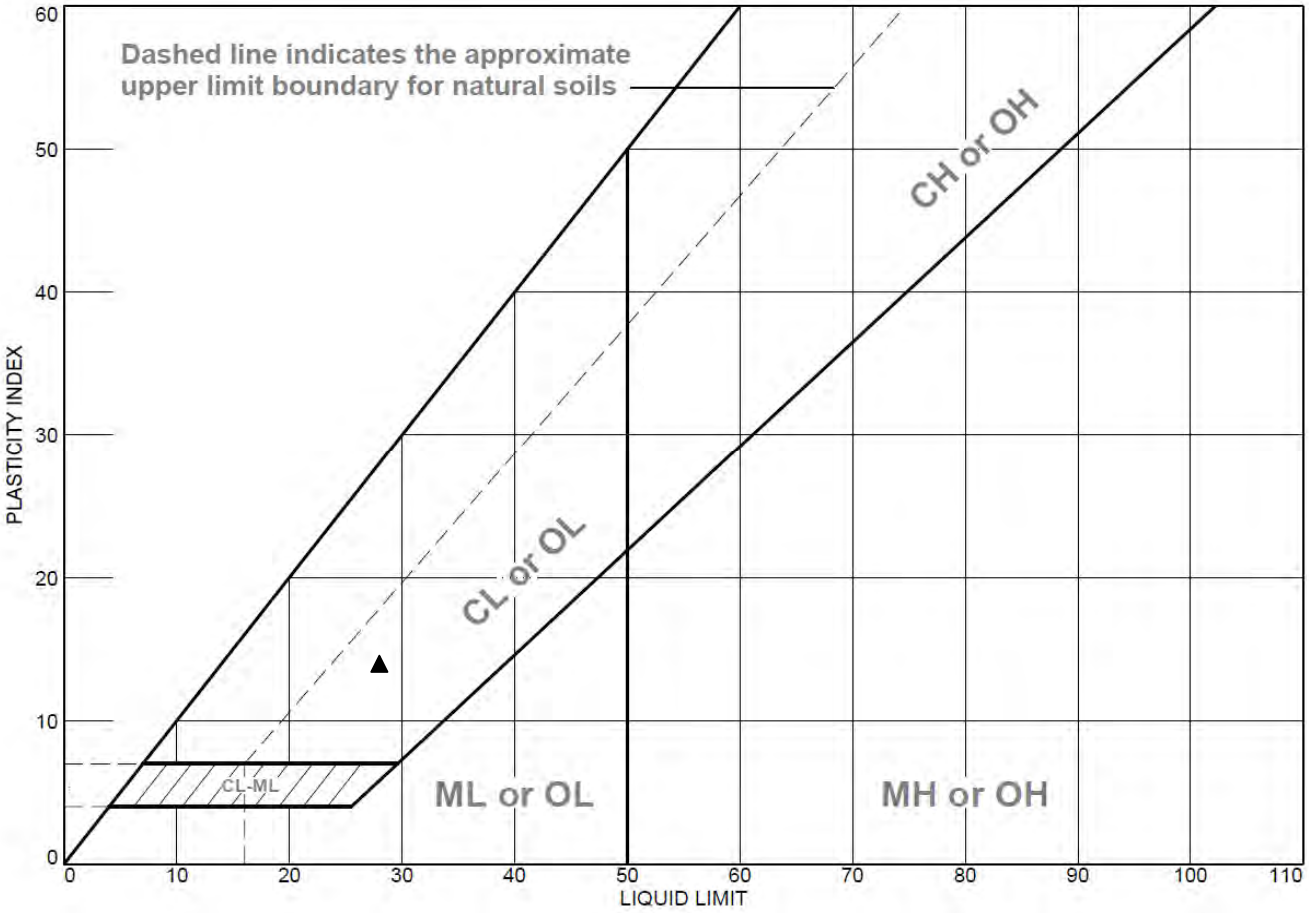
■PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
▲	See exploration logs	28	14	14			

Project No.: 15747.000.000 **Date:** 2/6/2019

Project Name: Elk Grove Hospital Site

Project location: Elk Grove, CA

Client: Wood Rodgers, Inc.

▲ **Sample Number:** 1-B22 **Depth:** 6

Remarks:

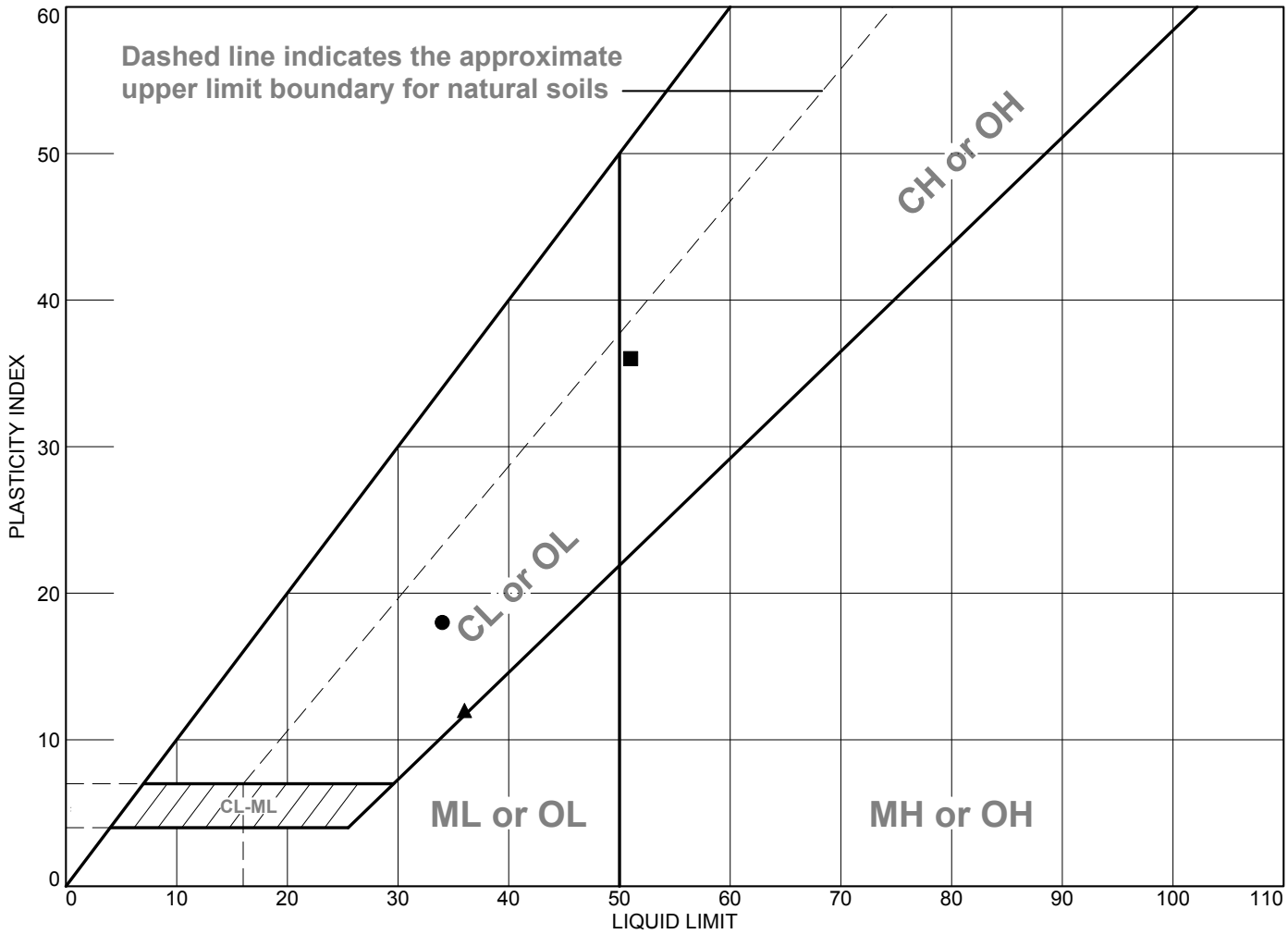
▲ PI: ASTM D4318,

ENGEO
Expect Excellence

Tested By: K. Lecce Checked By: C. Crawford

Test Location: 17278 Golden Valley Parkway, Lathrop, CA 95330

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	34	16	18			
■	See exploration logs	51	15	36			
▲	See exploration logs	36	24	12		69.0	CL

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

● **Source of Sample:** GEX **Depth:** 2 feet **Sample Number:** 1-B24@2

■ **Source of Sample:** GEX **Depth:** 8 feet **Sample Number:** 1-B25@8

▲ **Source of Sample:** GEX **Depth:** 30 feet **Sample Number:** 1-B25@30

Remarks:

● PI: ASTM D4318 Wet Method

■ PI: ASTM D4318 Wet Method

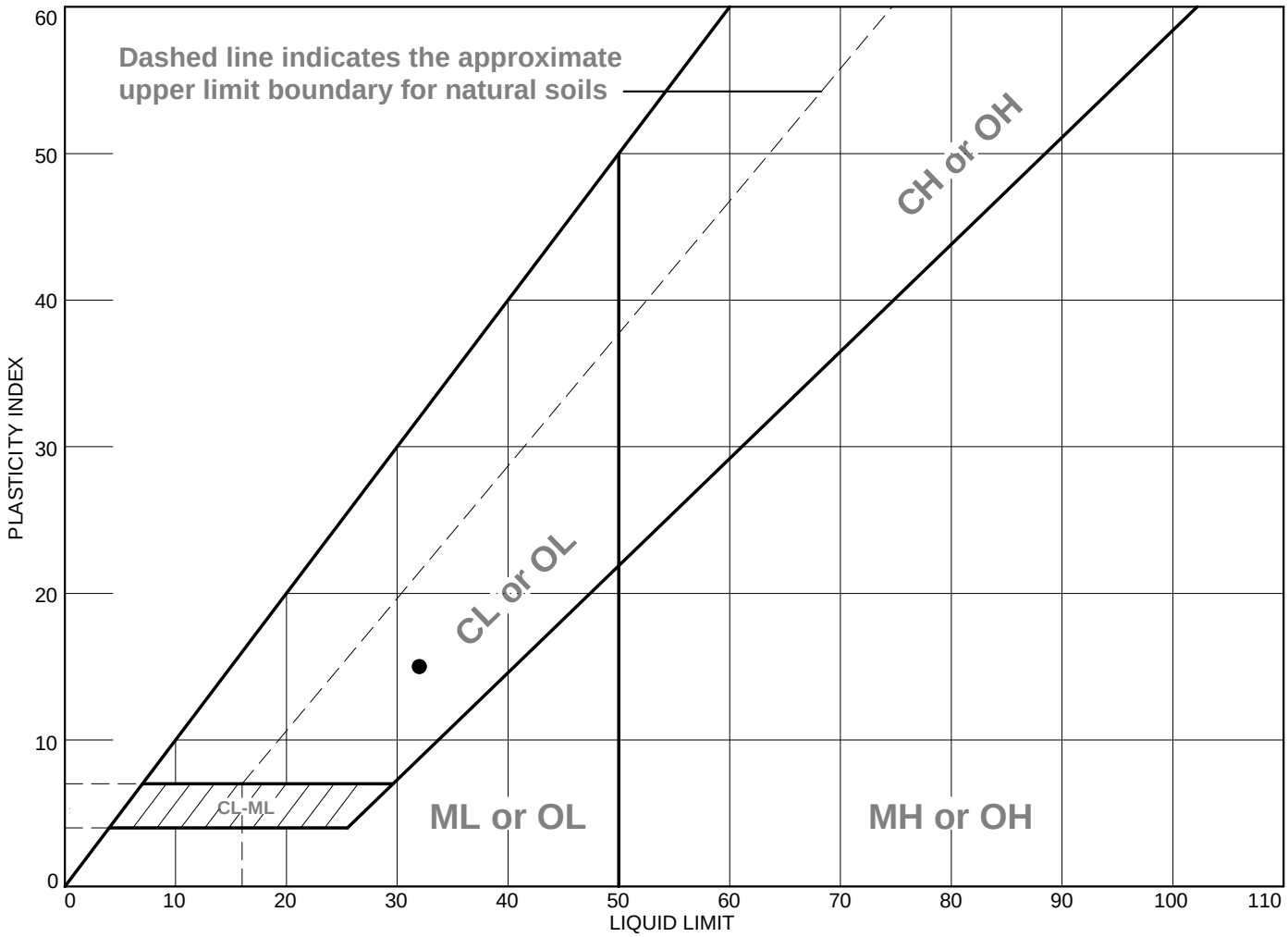
▲ PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	32	17	15			

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 6 feet **Sample Number:** 1-B27@6

Remarks:

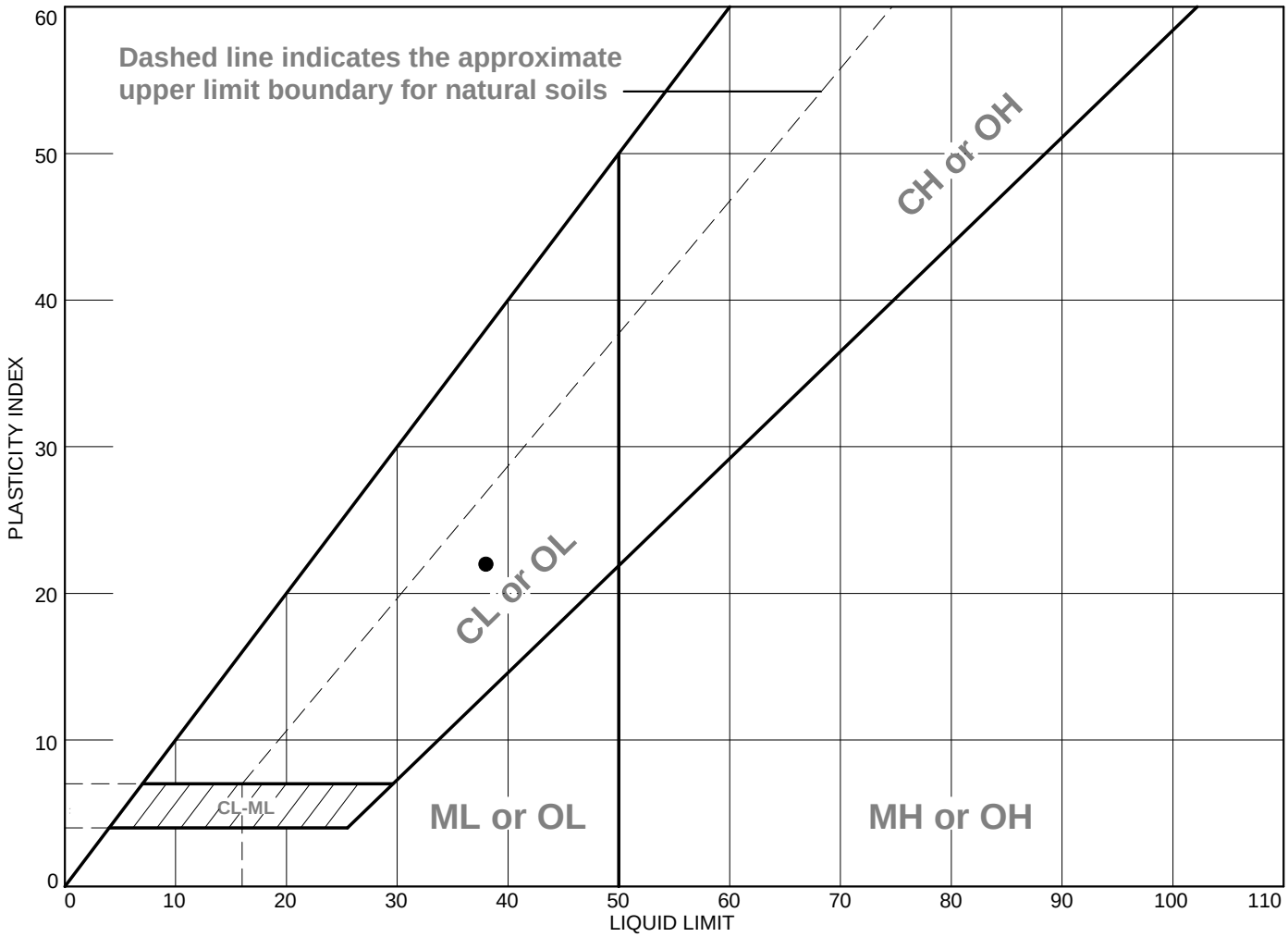
●PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	38	16	22		84.0	CL

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 2 feet **Sample Number:** 1-B36@2

Remarks:

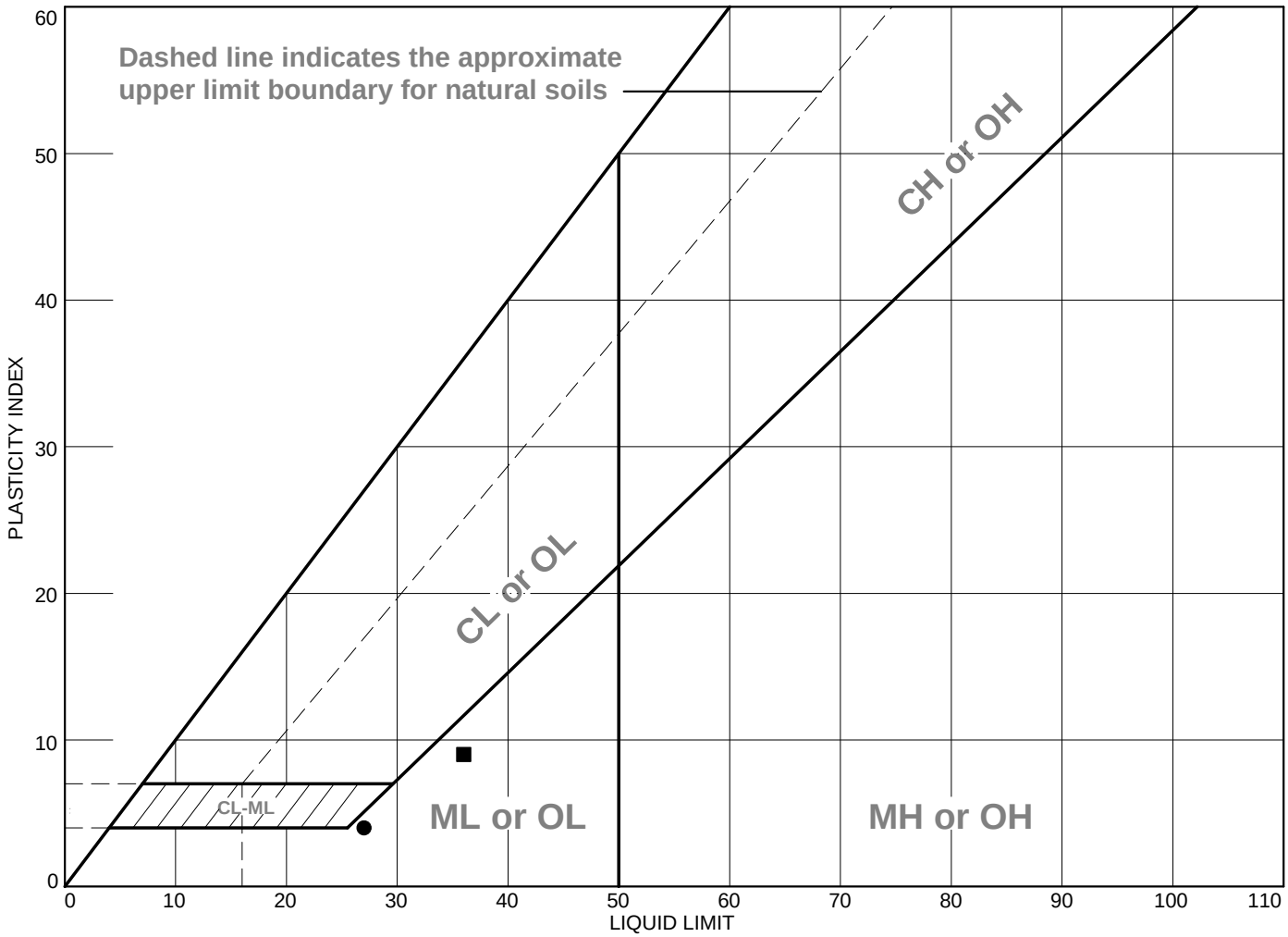
●PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	27	23	4		42.6	
■	See exploration logs	36	27	9		65.9	

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Source of Sample:** GEX **Depth:** 26 feet **Sample Number:** 1-B8@26

■**Source of Sample:** GEX **Depth:** 30.5 feet **Sample Number:** 1-B8@30.5

Remarks:

●PI: ASTM D4318 Wet Method

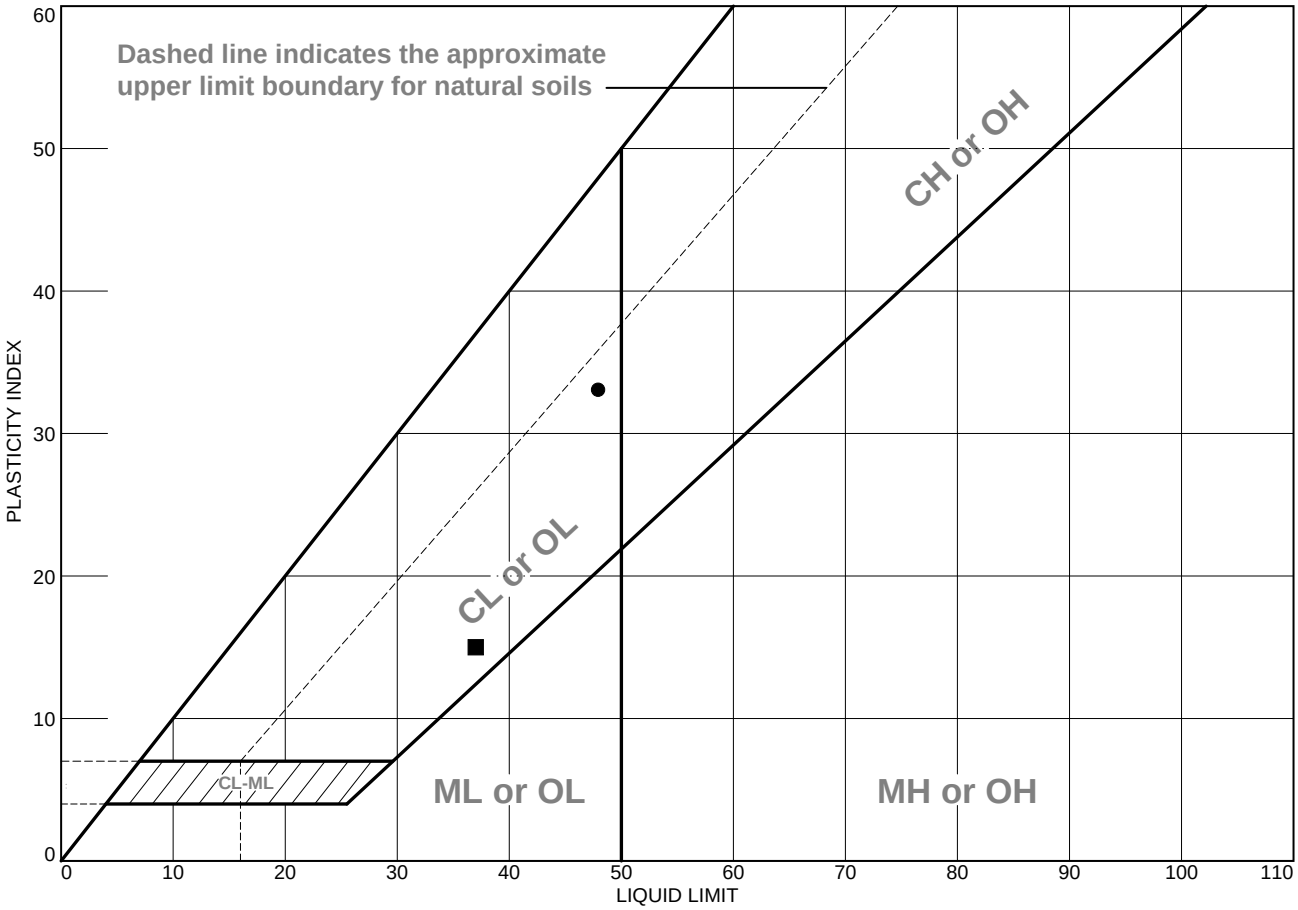
■PI: ASTM D4318 Wet Method

ENGEO INCORPORATED

Figure

Tested By: R. Montalvo **Checked By:** M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	48	15	33			
■	See exploration logs	37	22	15		54	

Project No. 15747.000.000 **Client:** Wood Rodgers, Inc.

Project: Elk Grove Hospital Site

●**Sample Number:** 1-B31 @ 8

■**Sample Number:** 1-B32 @ 2

Remarks:

●ASTM D4318, Wet method

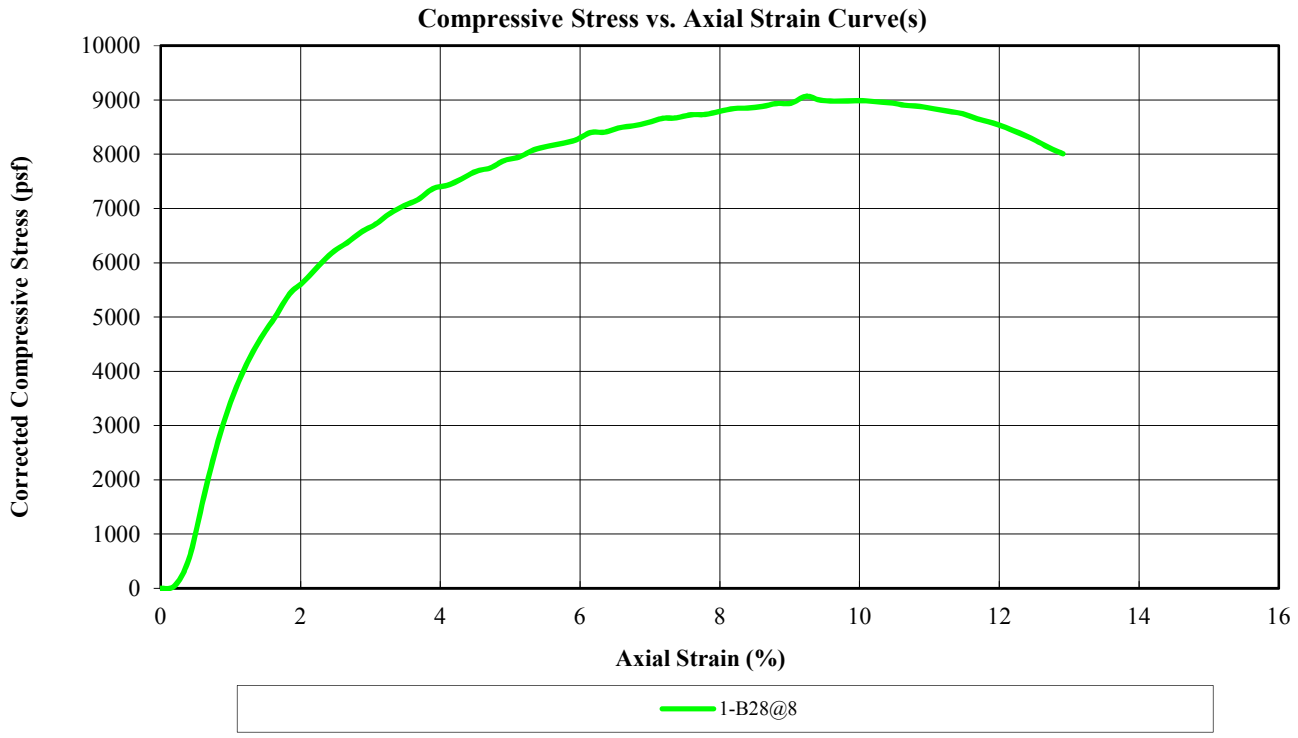
■PI: ASTM D4318, Wet method

GS: ASTM D1140, Method B

ENGEO INCORPORATED

Tested By: M. Bromfield **Checked By:** M. Quasem

UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B28@8
Moisture Content (%)	15.9
Dry Density (pcf)	118.6
Saturation (%)	100.0
Void Ratio	0.43
Diameter (in)	2.350
Height (in)	5.01
Height-To-Diameter Ratio	2.13
TEST DATA	
Unconfined Compressive Strength (psf)	9068
Undrained Shear Strength (psf)	4534
Strain Rate (in./min.)	0.05
Specific Gravity (Assumed)	2.710
Strain at Failure (%)	9.23
Liquid Limit	-
Plastic Limit	-
Test Remarks	

SPECIMEN	DESCRIPTION
1-B28@8	See exploration logs

PROJECT NAME: Elk Grove Hospital Site
PROJECT NO: 15747.000.000
CLIENT: Wood Rodgers, Inc.
LOCATION: Elk Grove, CA
PHASE NO: 001

Test Date: 01/24/18
Tested By: M. Quasem
Reviewed By: M. Bromfield

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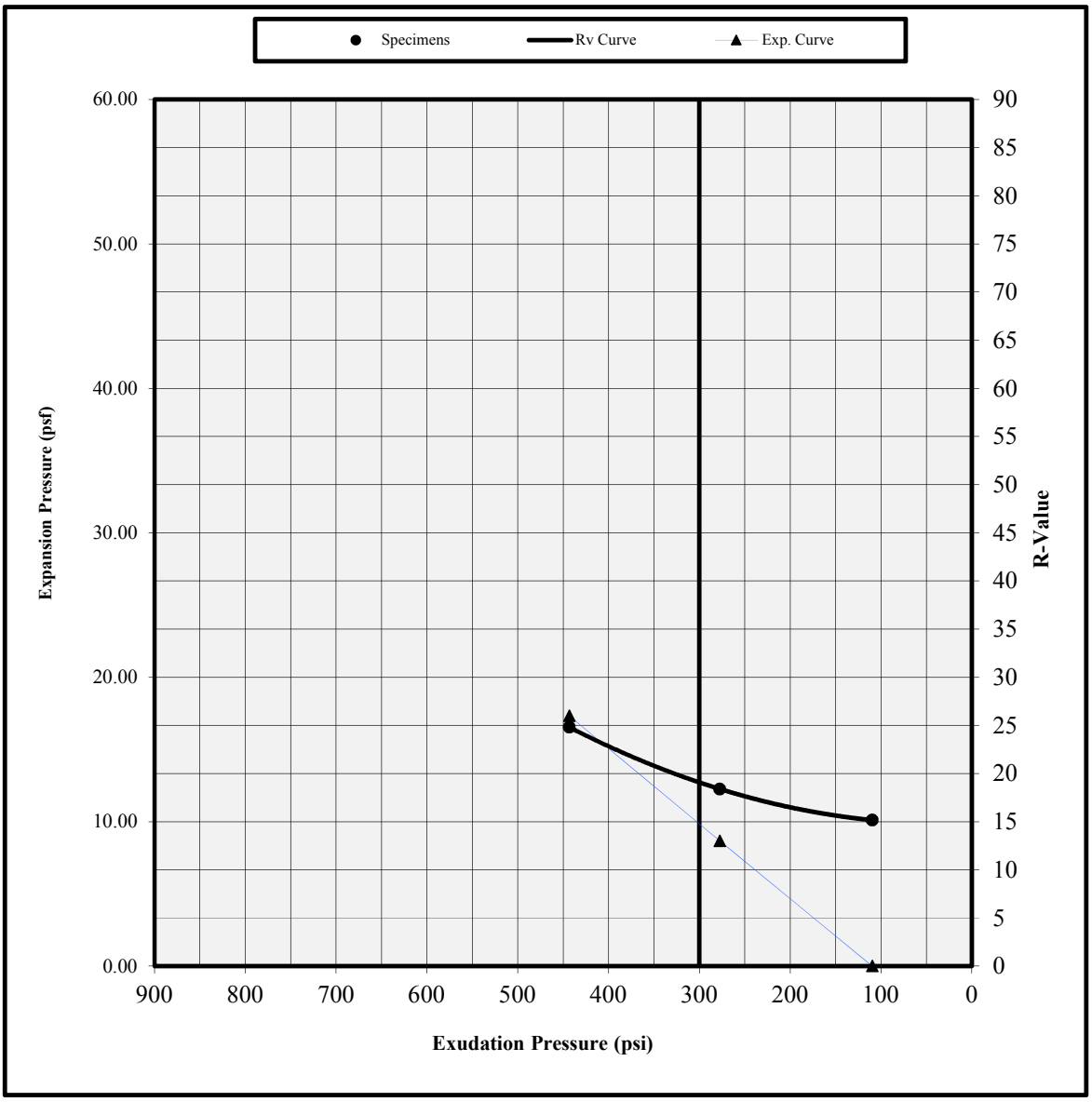
R VALUE TEST REPORT
CTM-301



Sample ID/Location: 1-B1@2-5'
Description: See exploration logs
Test remarks:

Specimen	Specimen 1	Specimen 2	Specimen 3
Exudation Pressure (p.s.i.)	443	277	110
Expansion dial (0.0001")	4	2	0
Expansion Pressure (p.s.f.)	17	9	0
Resistance Value, "R"	25	18	15
% Moisture at Test	18.3	20.2	22.1
Dry Density at Test, p.c.f.	110.9	106.6	103.4
"R" Value at Exudation Pressure of 300 psi.	19		
Expansion Pressure (psf) at Exudation Pressure of 300 psi.	10		

PROJECT NAME: Elk Grove Hospital Site
PROJECT NUMBER: 15747.000.000
CLIENT: Wood Rodgers
PHASE NUMBER: 001

DATE: 01/30/19

ENGEO
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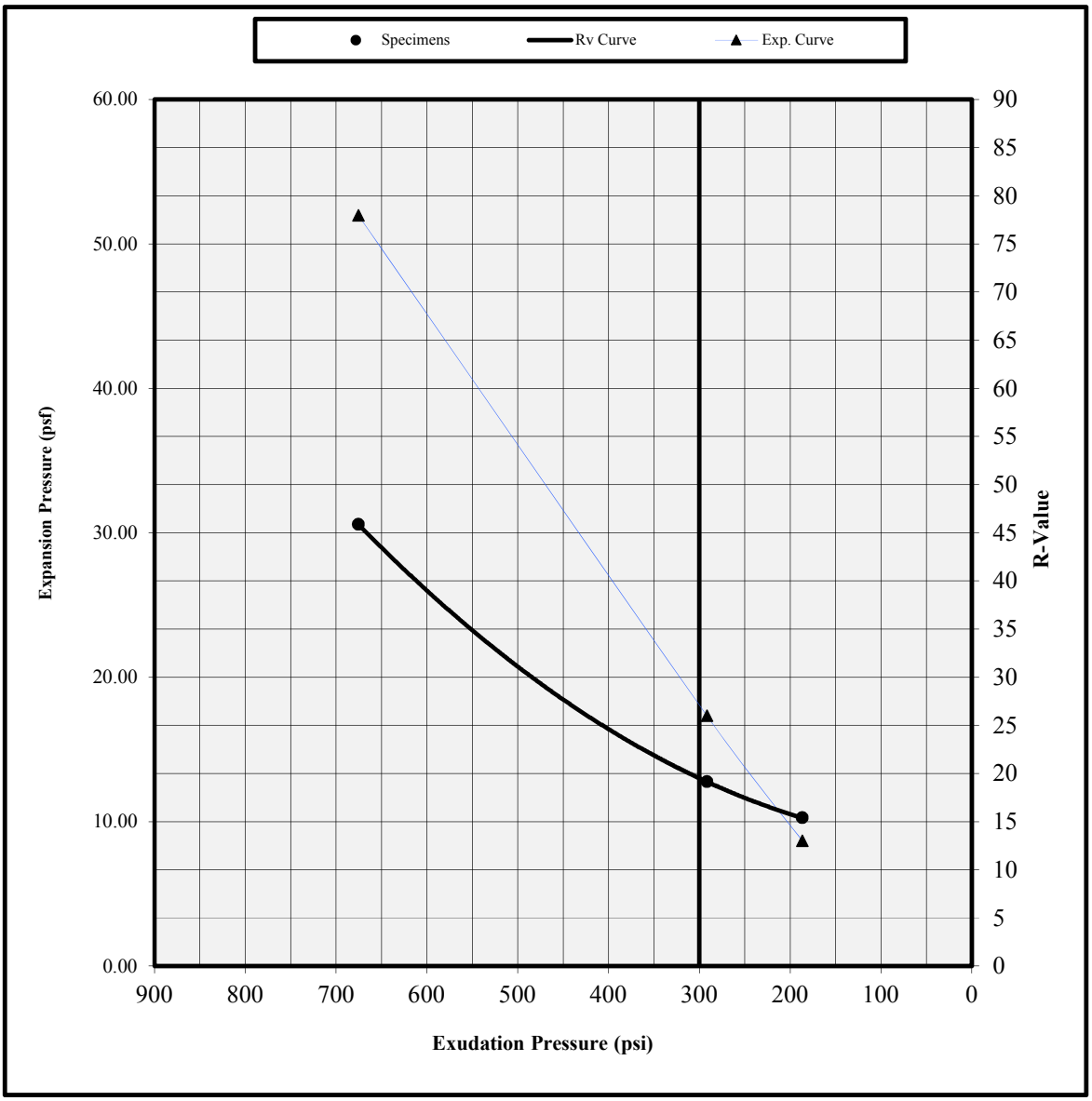
Tested by: R. Montalvo
Reviewed by: M. Gilbert

Lab Address: 2213 Plaza Drive, Rocklin, CA 95765

R VALUE TEST REPORT
CTM-301



Sample ID/Location: 1-B23@0-5'
Description: See exploration logs
Test remarks:

Specimen	Specimen 1	Specimen 2	Specimen 3
Exudation Pressure (p.s.i.)	675	292	187
Expansion dial (0.0001")	12	4	2
Expansion Pressure (p.s.f.)	52	17	9
Resistance Value, "R"	46	19	15
% Moisture at Test	16.3	18.6	20.0
Dry Density at Test, p.c.f.	114.3	109.3	107.0
"R" Value at Exudation Pressure of 300 psi.	19		
Expansion Pressure (psf) at Exudation Pressure of 300 psi.	18		

PROJECT NAME: Elk Grove Hospital Site
PROJECT NUMBER: 15747.000.000
CLIENT: Wood Rodgers
PHASE NUMBER: 001

DATE: 01/30/19

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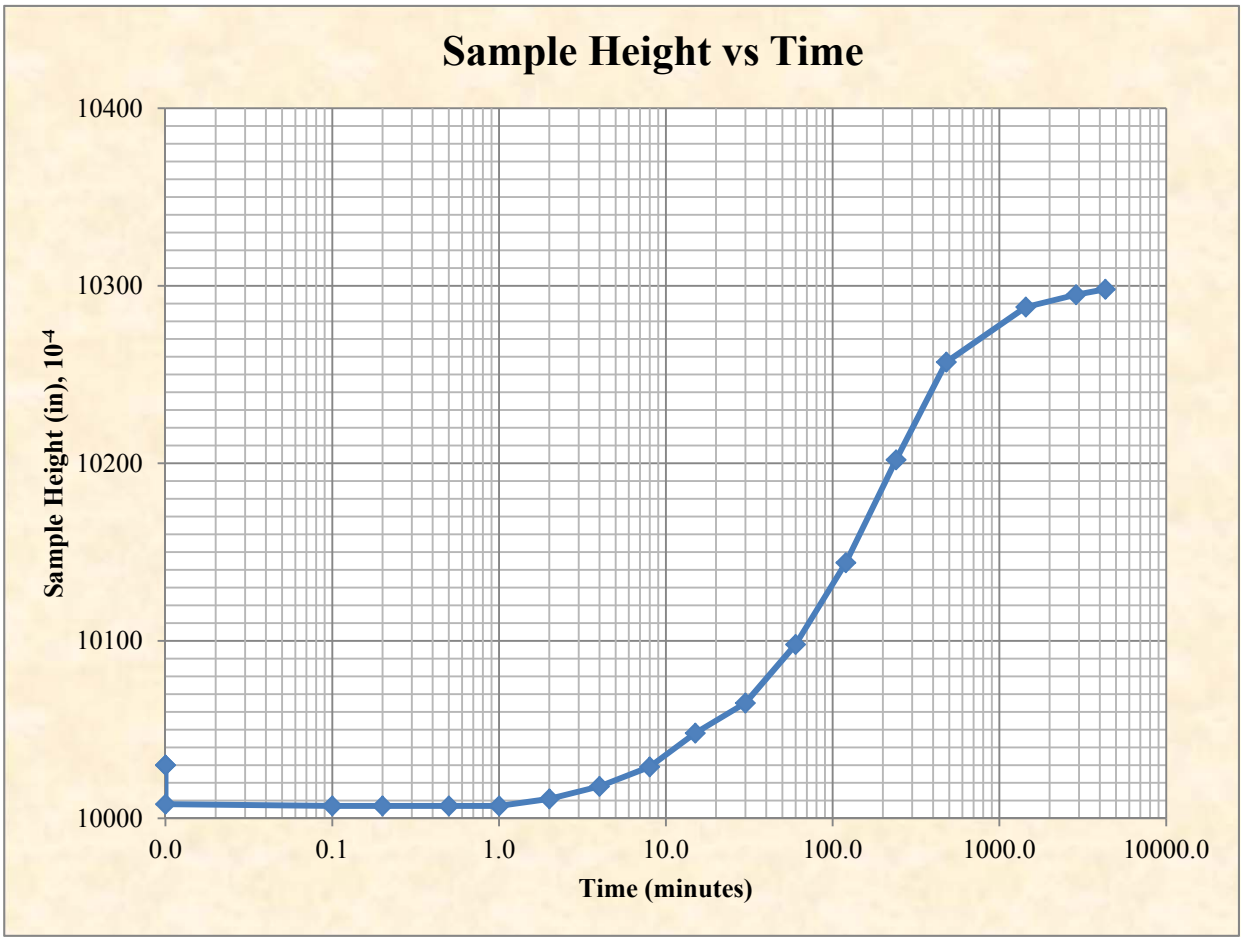
Tested by: R. Montalvo
Reviewed by: M. Gilbert

Lab Address: 2213 Plaza Drive, Rocklin, CA 95765

ONE DIMENSIONAL SWELL/COLLAPSE POTENTIAL - METHOD 'B'
ASTM D4546



SAMPLE ID:	**1-B35 @ 6-6.5**	**VERTICAL LOAD (psf):**	**720**
SAMPLE DESCRIPTION:	**See exploration logs**	**USCS:**	**n/a**
TYPE OF WATER USED:	**Tap**	**SOURCE OF WATER:**	**faucet**
TRANSPORTATION METHOD:	**Insulated bucket**	**SAMPLING DATE:**	**n/a**
STORAGE ENVIRONMENT:	**Controlled**	**TEST DATE:**	**01/24/19**
Specific Gravity, ≥#4:	**n/a**	**Initial % Saturation:**	**78.20**
Specific Gravity, <#4 (Measured):	**2.778**	**Final %Saturation:**	**99.99**
Initial sample height (in):	**1.0030**	**Initial water content:**	**14.32**
Post-seating load height (in):	**1.0030**	**Final water content:**	**19.7**
Sample height after dry loading (in):	**0.9998**	**Post-test dry density (pcf):**	**112.04**
Final sample height (in):	**1.0290**	***Surcharge + seating load %SWELL/COLLAPSE:***	***-0.3***
Initial sample mass (g):	**158.70**	***Net %SWELL/COLLAPSE:***	***2.6***
Final saturated sample mass (g):	**166.14**	***Overall %SWELL/COLLAPSE:***	***2.3***

Testing remarks:

PROJECT NAME:	**Elk Grove Hospital Site**	**REPORT DATE:**	**01/28/19**
PROJECT NUMBER:	**15747.000.000**		
CLIENT:	**Wood Rodgers, Inc.**		
PHASE NUMBER:	**001**		

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Tested by: G. Criste Reviewed by: K. Lecce

Lab Address: 3420 Fostoria Way Suite E, Danville, CA 94526. Phone No. (925) 355-9047.

Isotropic Unconsolidated Undrained Triaxial Test

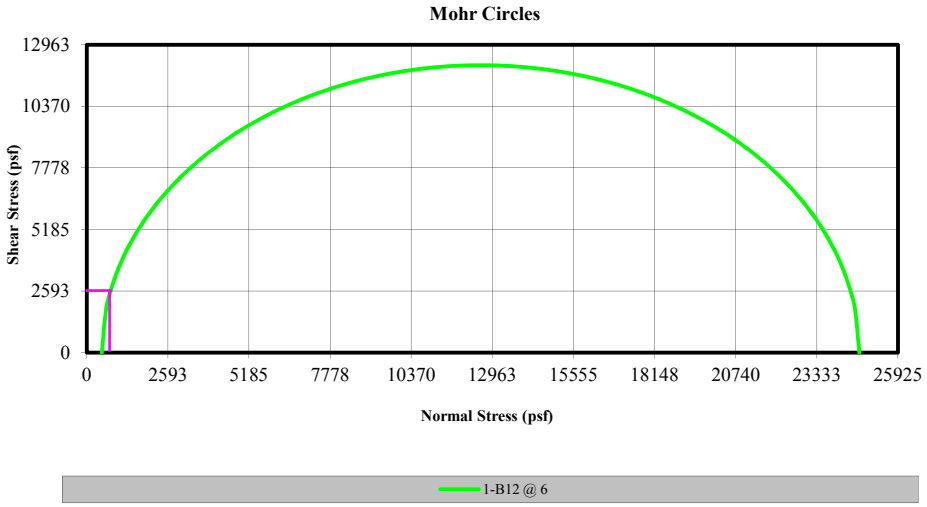
(ASTM D2850)

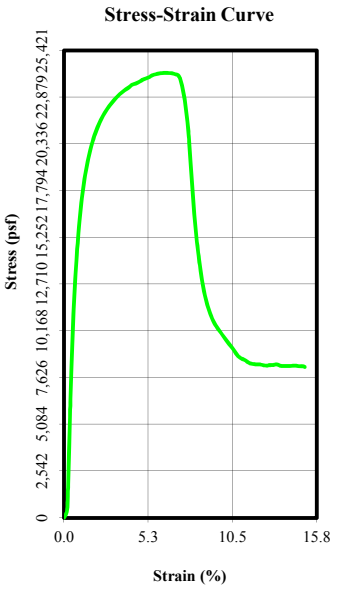
Date: 02/01/19

Checked By: C. Crawford

Date: 02/01/19

Tested By: K. Lecce





Before Test	1-B12 @ 6			
	Specimen			
Water Content (%)	13.32			
Dry Density (pcf)	121.24			
Saturation (%)	96.83			
Void Ratio	0.36			
Diameter (in)	2.380			
Height (in)	5.060			
Height-to-Diameter Ratio	2.126			
ASTM D4318 - Wet Method				
Liquid Limit	-			
Plastic Limit	-			
ASTM D854 - Measured				
Specific Gravity	2.650			
After Test	**1-B12 @ 6**			
Water Content (%)	13.32			
Saturation (%)	96.83			
Strain Rate (in/min)	0.05			
Peak Deviator Stress (psf)	24210.1			
Axial Strain @ Failure (%)	6.351			
	Cell Pressure			
Cell (psf)	479.5			
Back (psf)	n/a			
	Principle Stresses at Failure			
σ1 (psf)	24689.6			
σ3 (psf)	479.5			
Corrected Peak Deviator Stress				

Mohr-Coulomb Parameters with a Non-zero Friction Angle (Ø≠0)			Cohesion at Failure with a Zero Friction Angle (Ø=0)			
Cohesion, c (psf)	0.0		12105.1			
Friction Angle Ø	0.00		n/a			

Project Information	
Project Name:	Elk Grove Hospital Site
Project Number:	15747.000.000
Project Location:	Elk Grove, CA
Client:	Wood Rodgers, Inc.
Description:	See exploration logs
Test Remarks:	

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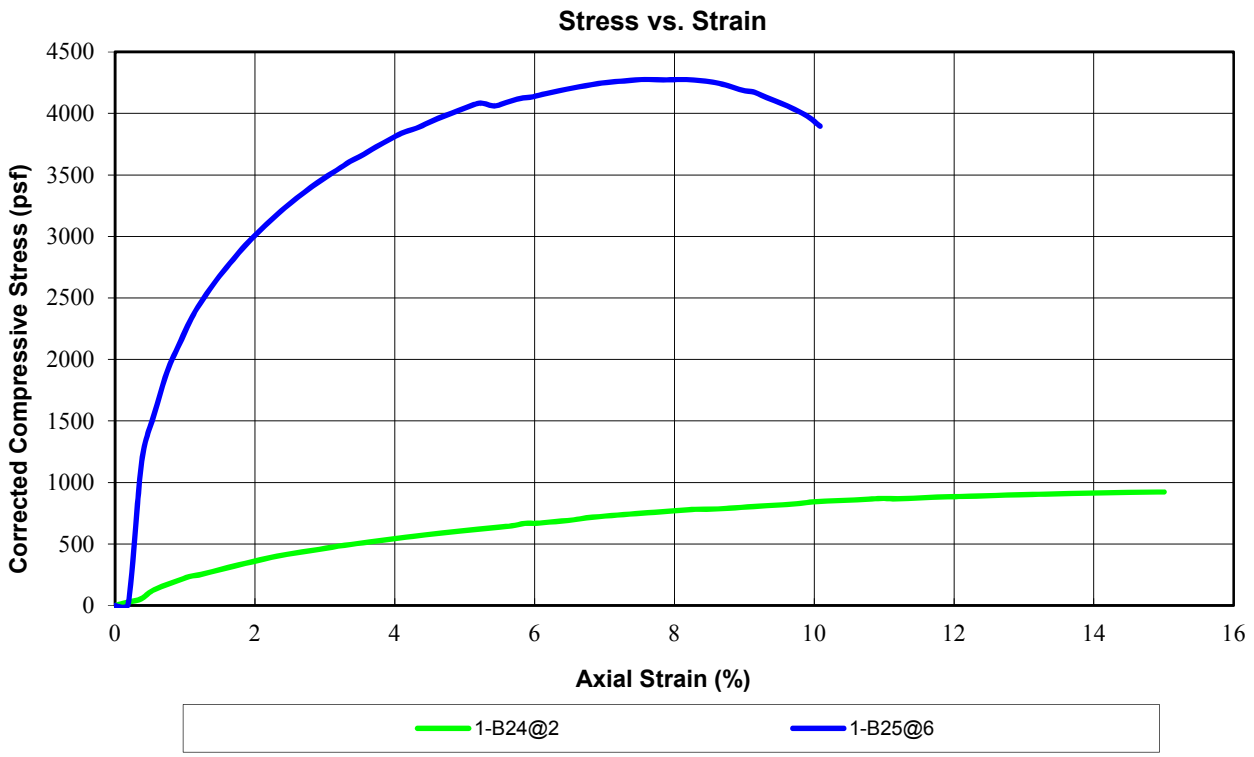
UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B24@2	1-B25@6
Moisture Content (%)	21.1	29.0
Dry Density (pcf)	90.7	95.4
Saturation (%)	67.7	100.0
Void Ratio	0.82	0.73
Diameter (in)	2.593	2.403
Height (in)	5.71	5.42
Height-To-Diameter Ratio	2.20	2.26
TEST DATA		
Unconfined Compressive Strength (psf)	923	4276
Undrained Shear Strength (psf)	461	2138
Strain Rate (in./min.)	0.05	0.05
Specific Gravity	2.650	2.650
Strain at Failure (%)	15.01	7.66
Liquid Limit		
Plastic Limit		
Test Remarks	Specific Gravity assumed	

SPECIMEN	DESCRIPTION
1-B24@2	See exploration logs
1-B25@6	See exploration logs

PROJECT NAME: Elk Grove Hospital Site
PROJECT NO: 15747.000.000
CLIENT: Wood Rodgers, Inc.
LOCATION: Elk Grove , CA
PHASE NO: 1

Report Date: 1/30/2019
Tested By: R. Montalvo
Reviewed By: M. Gilbert

ENGEO — Expect Excellence —

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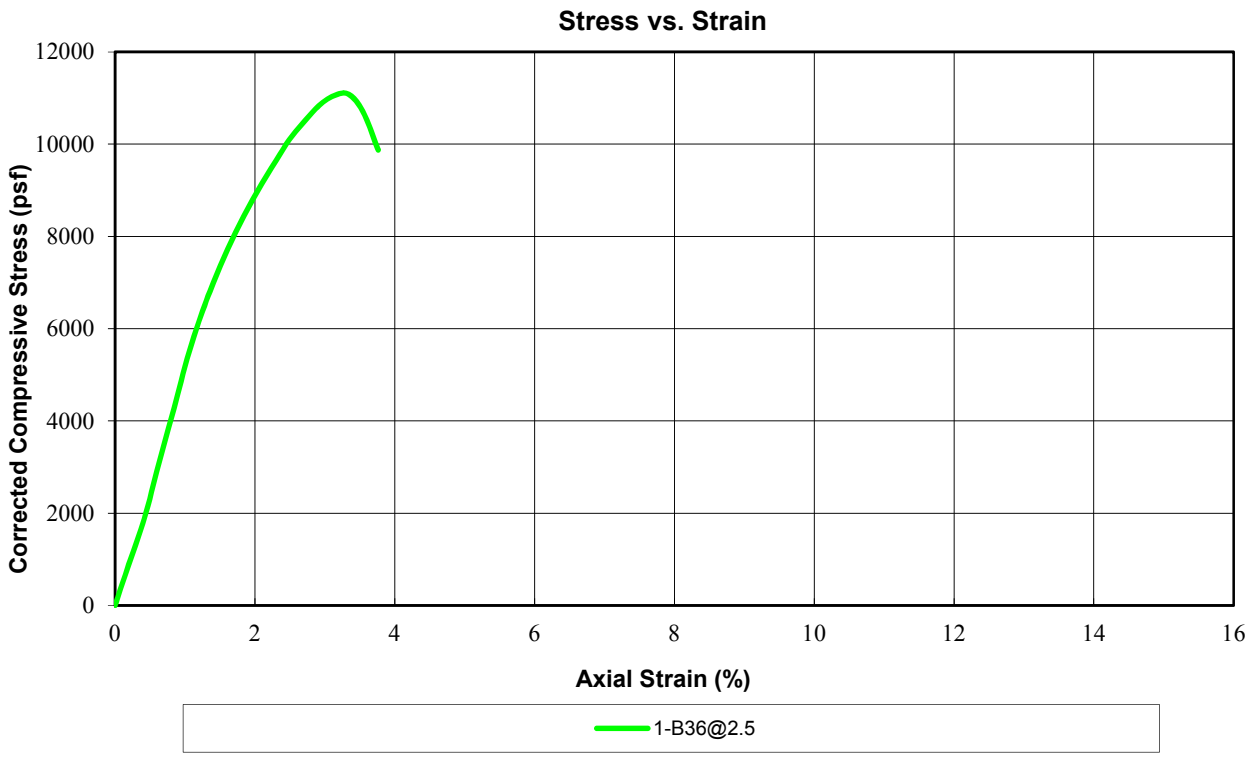
UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B36@2.5
Moisture Content (%)	16.6
Dry Density (pcf)	111.6
Saturation (%)	91.4
Void Ratio	0.48
Diameter (in)	2.395
Height (in)	4.85
Height-To-Diameter Ratio	2.03
TEST DATA	
Unconfined Compressive Strength (psf)	11085
Undrained Shear Strength (psf)	5543
Strain Rate (in./min.)	0.05
Specific Gravity	2.650
Strain at Failure (%)	3.34
Liquid Limit	
Plastic Limit	
Test Remarks	Specific Gravity assumed

SPECIMEN	DESCRIPTION
1-B36@2.5	See exploration logs

PROJECT NAME: Elk Grove Hospital Site
PROJECT NO: 15747.000.000
CLIENT: Wood Rodgers, Inc.
LOCATION: Elk Grove, CA
PHASE NO: 1

Report Date: 1/30/2019
Tested By: R. Montalvo
Reviewed By: M. Gilbert

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

Date Reported 02/06/2019
Date Submitted 02/01/2019

To: Nick Broussard
Engeo, Inc.
2213 Plaza Dr.
Rocklin, CA 95765

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

The reported analysis was requested for the following location:
Location : 15747.000.000 PH001 Site ID : 1-B2@3FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 78919-164985.

EVALUATION FOR SOIL CORROSION

Soil pH	7.60	
Minimum Resistivity	1.26 ohm-cm (x1000)	
Chloride	26.2 ppm	00.00262 %
Sulfate	14.1 ppm	00.00141 %

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

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

Date Reported 02/06/2019
Date Submitted 02/01/2019

To: Nick Broussard
Engeo, Inc.
2213 Plaza Dr.
Rocklin, CA 95765

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

The reported analysis was requested for the following location:
Location : 15747.000.000 PH001 Site ID : 1-B15@1.5FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 78919-164986.

EVALUATION FOR SOIL CORROSION

Soil pH	9.62		
Minimum Resistivity	3.75 ohm-cm (x1000)		
Chloride	5.0 ppm	00.00050	%
Sulfate	29.8 ppm	00.00298	%

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

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

Date Reported 02/06/2019
Date Submitted 02/01/2019

To: Nick Broussard
Engeo, Inc.
2213 Plaza Dr.
Rocklin, CA 95765

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

The reported analysis was requested for the following location:
Location : 15747.000.000 PH001 Site ID : 1-B31@5.5FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 78919-164987.

EVALUATION FOR SOIL CORROSION

Soil pH	7.84	
Minimum Resistivity	1.42 ohm-cm (x1000)	
Chloride	16.0 ppm	00.00160 %
Sulfate	16.7 ppm	00.00167 %

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

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

Date Reported 02/06/2019
Date Submitted 02/01/2019

To: Nick Broussard
Engeo, Inc.
2213 Plaza Dr.
Rocklin, CA 95765

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

The reported analysis was requested for the following location:
Location : 15747.000.000 PH001 Site ID : 1-B34@2FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 78919-164988.

EVALUATION FOR SOIL CORROSION

Soil pH	7.69		
Minimum Resistivity	1.85 ohm-cm (x1000)		
Chloride	7.8 ppm	00.00078	%
Sulfate	15.5 ppm	00.00155	%

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

APPENDIX C

CPT EXPLORATION SUMMARY
CPT DATA

CPT EXPLORATION SUMMARY

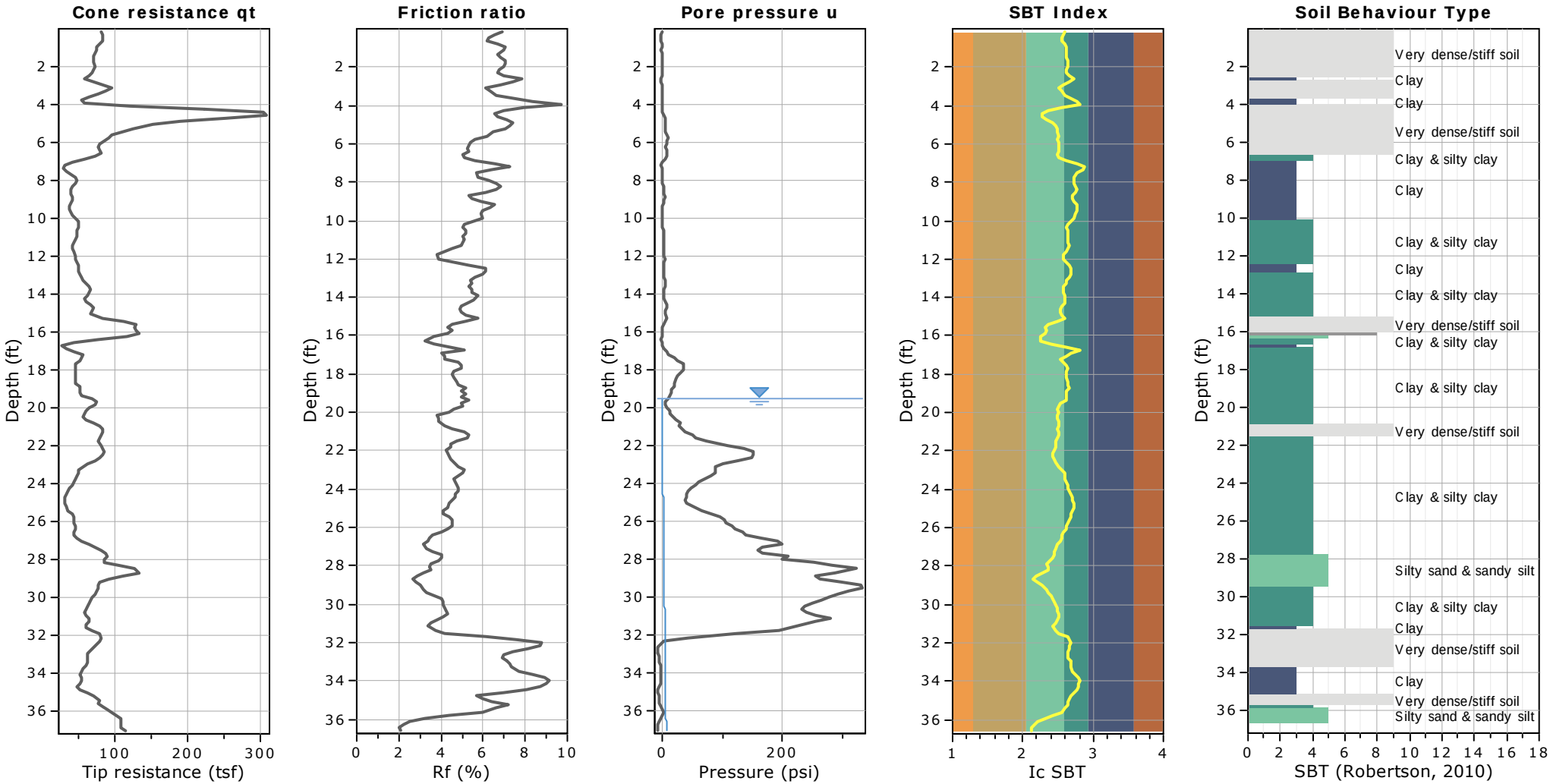
CPT ID	INTERPRETTED SURFACE ELEVATION (NAVD88)*	TOTAL DEPTH (feet)	APPROXIMATED GW DEPTH AT TIME OF EXPLORATION	APPROXIMATED GROUNDWATER ELEVATION AT TIME OF EXPLORATION (ft, NAVD88)	SEISMIC CPT Vs MEASUREMENTS PERFORMED
1-CPT1	18	37	19.5	-1.5	No
1-CPT2	19	34	20.5	-1.5	No
1-CPT3	18	50	19.5	-1.5	No
1-CPT4	17.5	73.5	19	-1.5	Yes
1-CPT5	15.5	50	17	-1.5	No
1-CPT6	18.5	50	20.5	-2	No
1-CPT7	18.5	50	20.5	-2	No
1-CPT8	19	50	21	-2	No
1-CPT9	18	50	20	-2	Yes
1-CPT10	18	40.5	20	-2	No
1-CPT11	17.5	37.5	19	-1.5	No
1-CPT12	17	50	18.5	-1.5	No
1-CPT13	17.5	50	19	-1.5	No
1-CPT14	17	50	18.5	-1.5	No
1-CPT15	18	50	20	-2	Yes
1-CPT16	15.5	50	17.5	-2	No
1-CPT17	16	50	18	-2	No
1-CPT18	18.5	50	20.5	-2	No
1-CPT19	16	50	18.5	-2.5	No
1-CPT20	17	50	19.5	-2.5	No
1-CPT21	18	50	20.5	-2.5	Yes

*Surface Elevation Interpretted from Wood Rogers Topographic Plan

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-1
Total depth: 37.07 ft
Surface Elevation: 0.00 ft



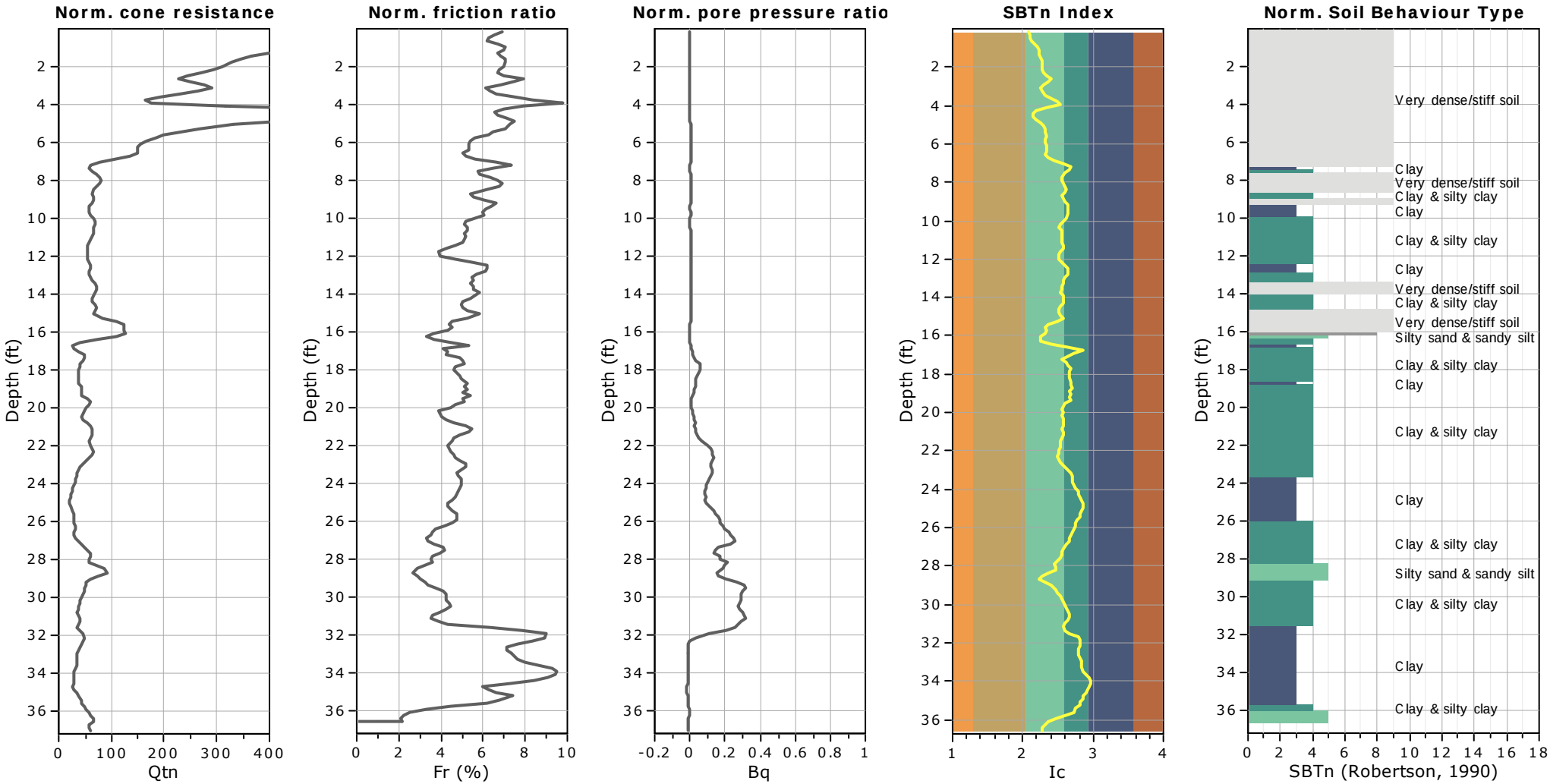
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-1
Total depth: 37.07 ft
Surface Elevation: 0.00 ft



SBTn legend

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2. Organic material
3. Clay to silty clay
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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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
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CPT: 1-CPT-1
Total depth: 37.07 ft
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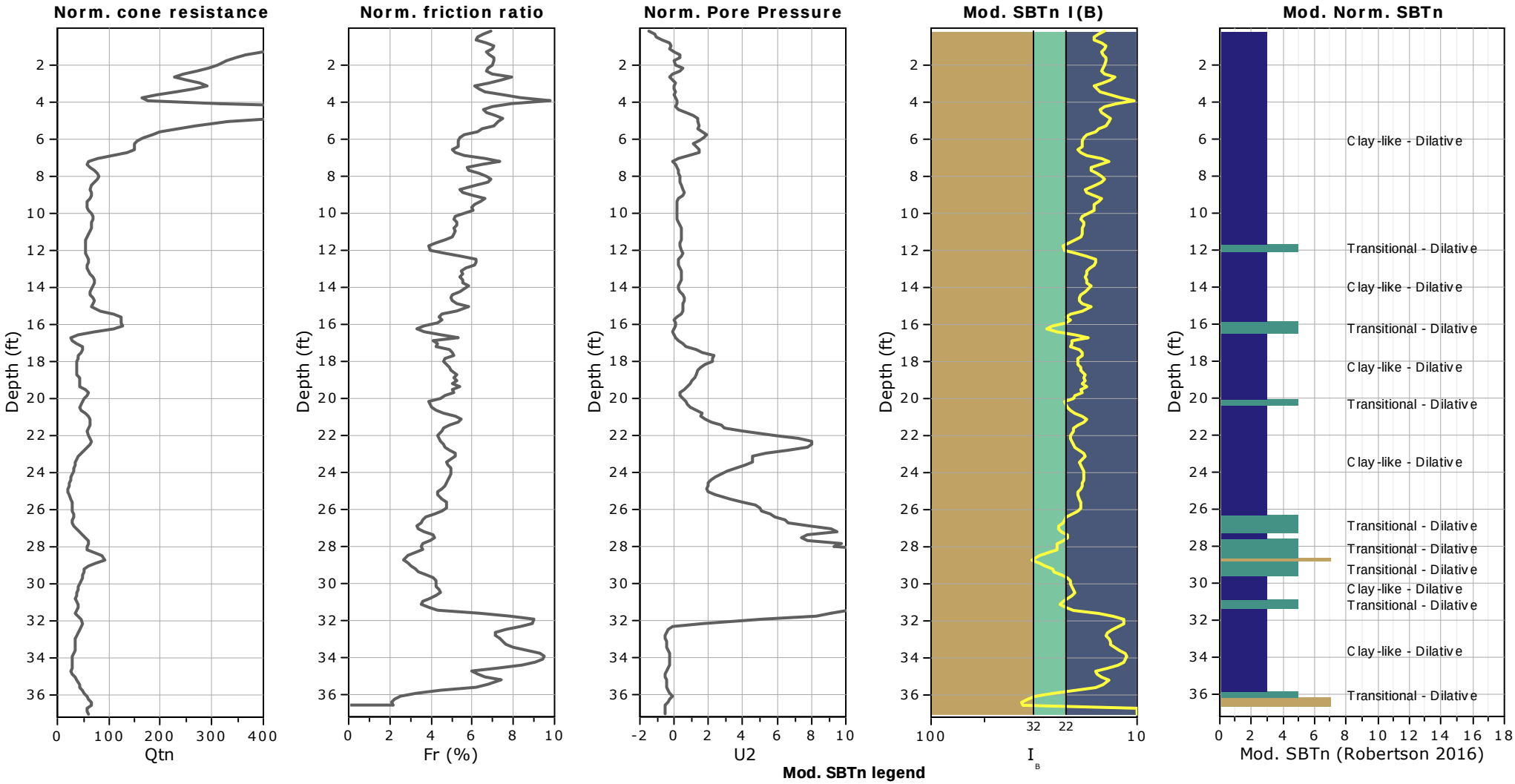

Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-1
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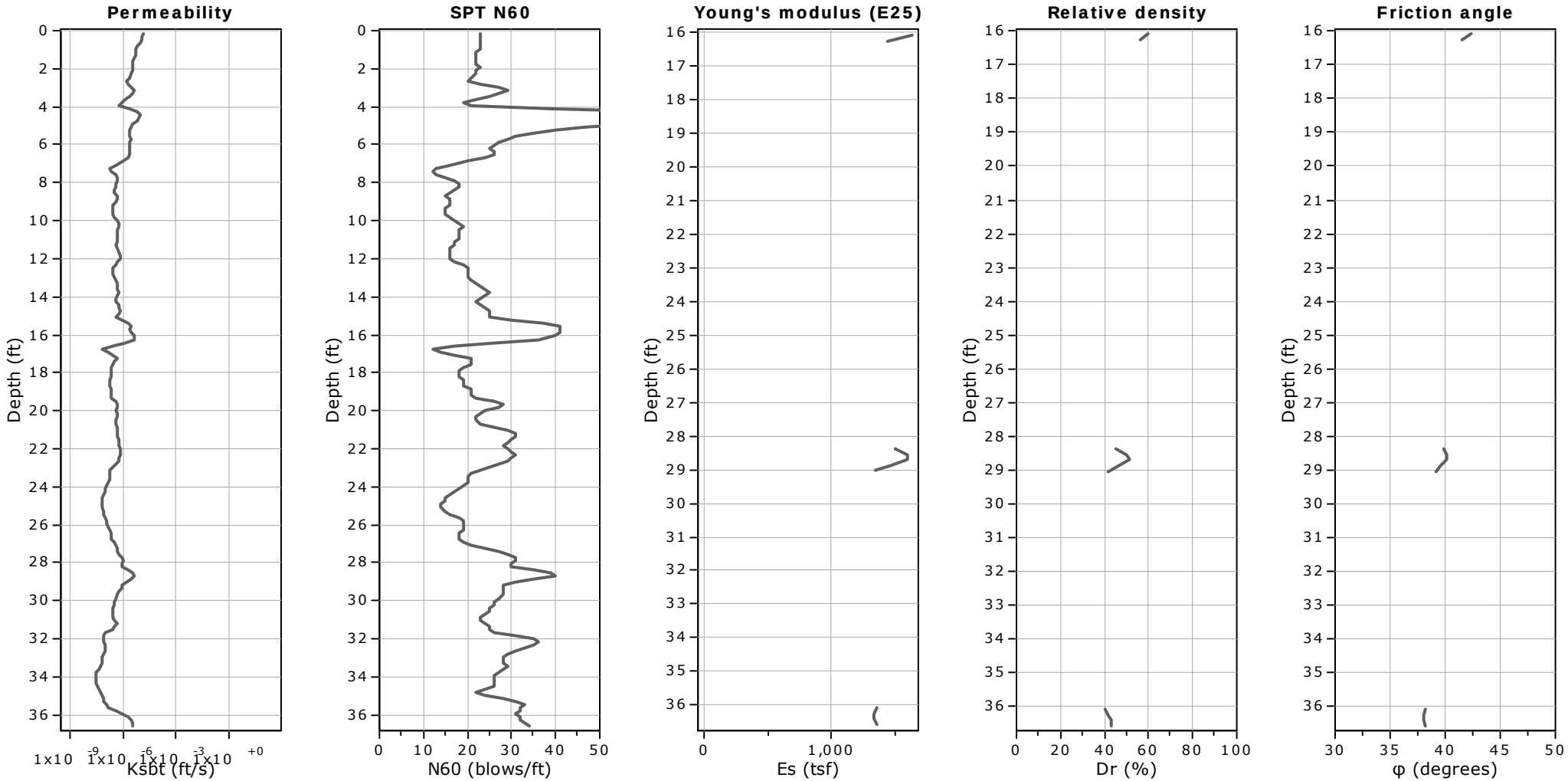
Surface Elevation: 0.00 ft



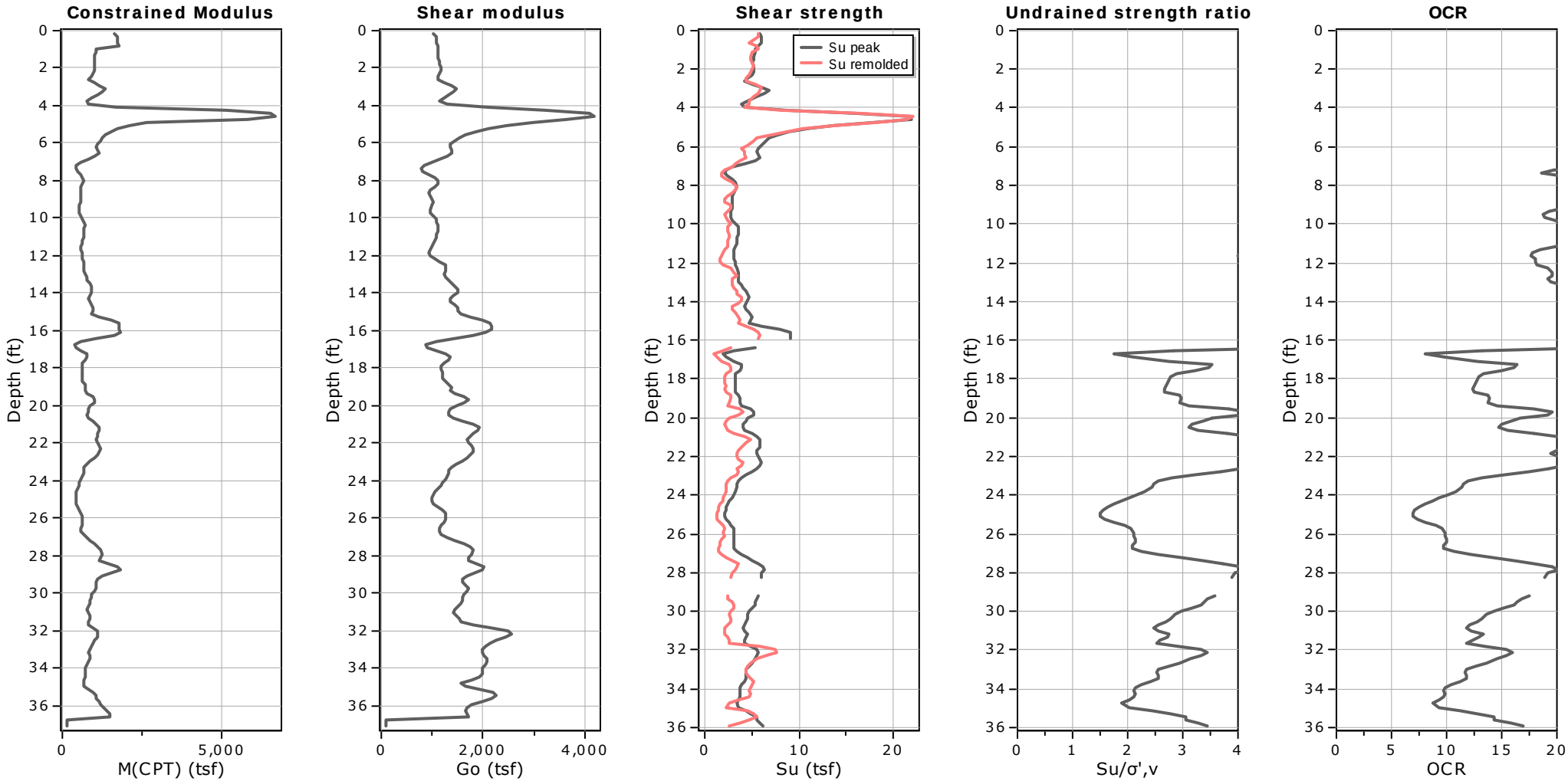
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-1
Total depth: 37.07 ft
Surface Elevation: 0.00 ft



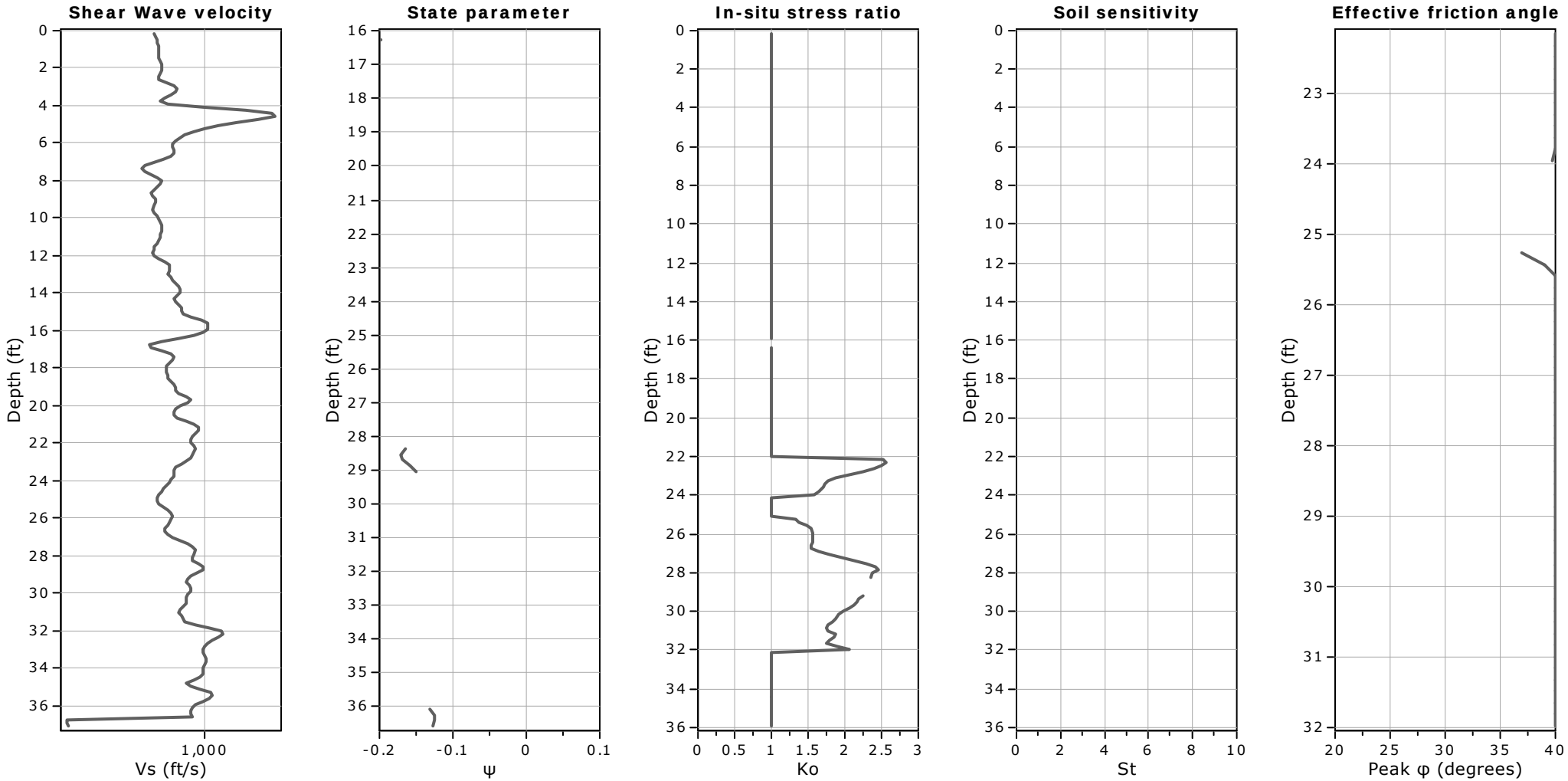
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-1
Total depth: 37.07 ft
Surface Elevation: 0.00 ft



Calculation parameters

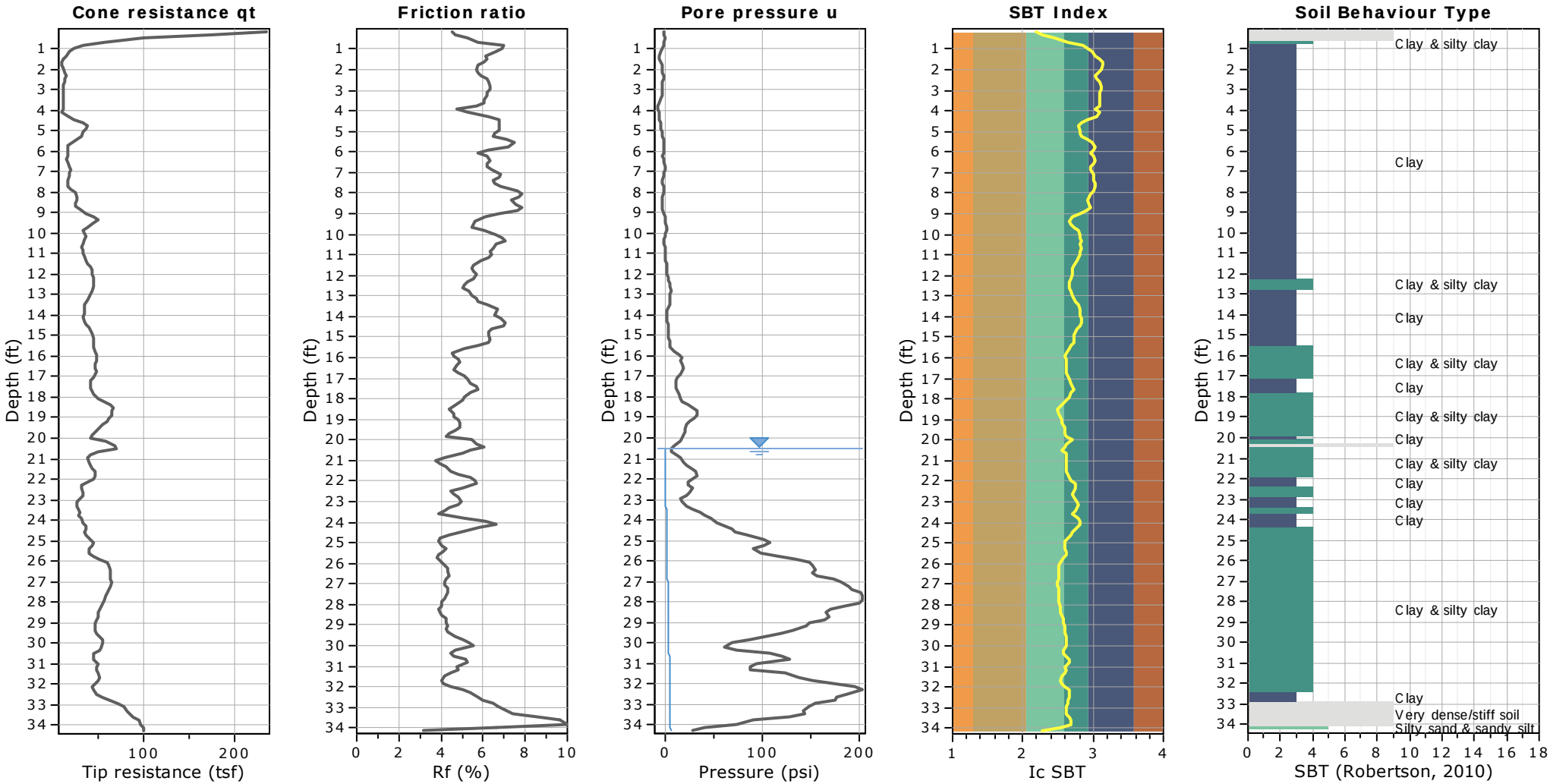
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-2
Total depth: 34.28 ft
Surface Elevation: 0.00 ft



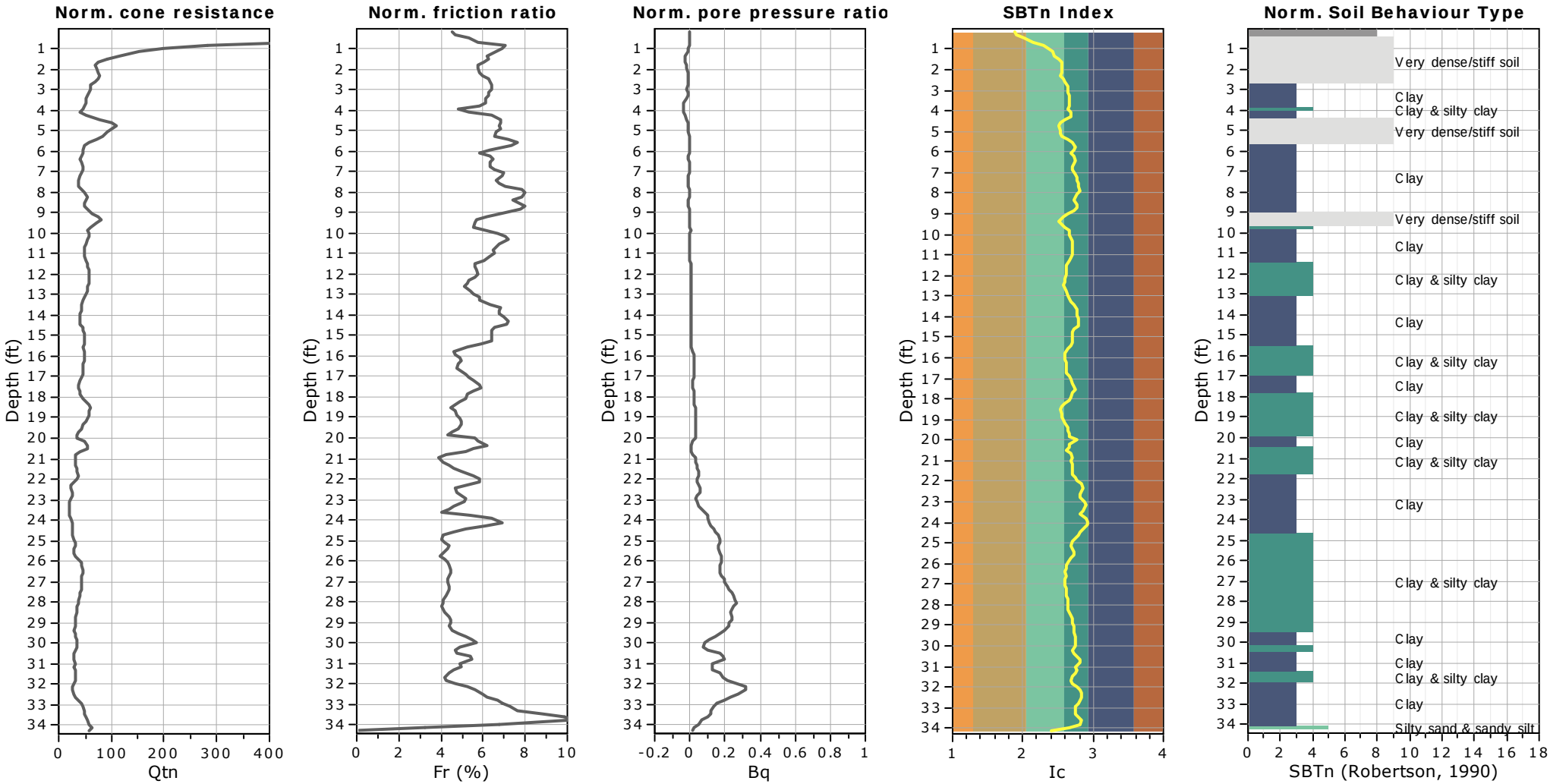
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-2
Total depth: 34.28 ft
Surface Elevation: 0.00 ft



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8. Very stiff sand to clayey sand
9. Very stiff fine grained

ENGEO
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Rocklin, CA 95765

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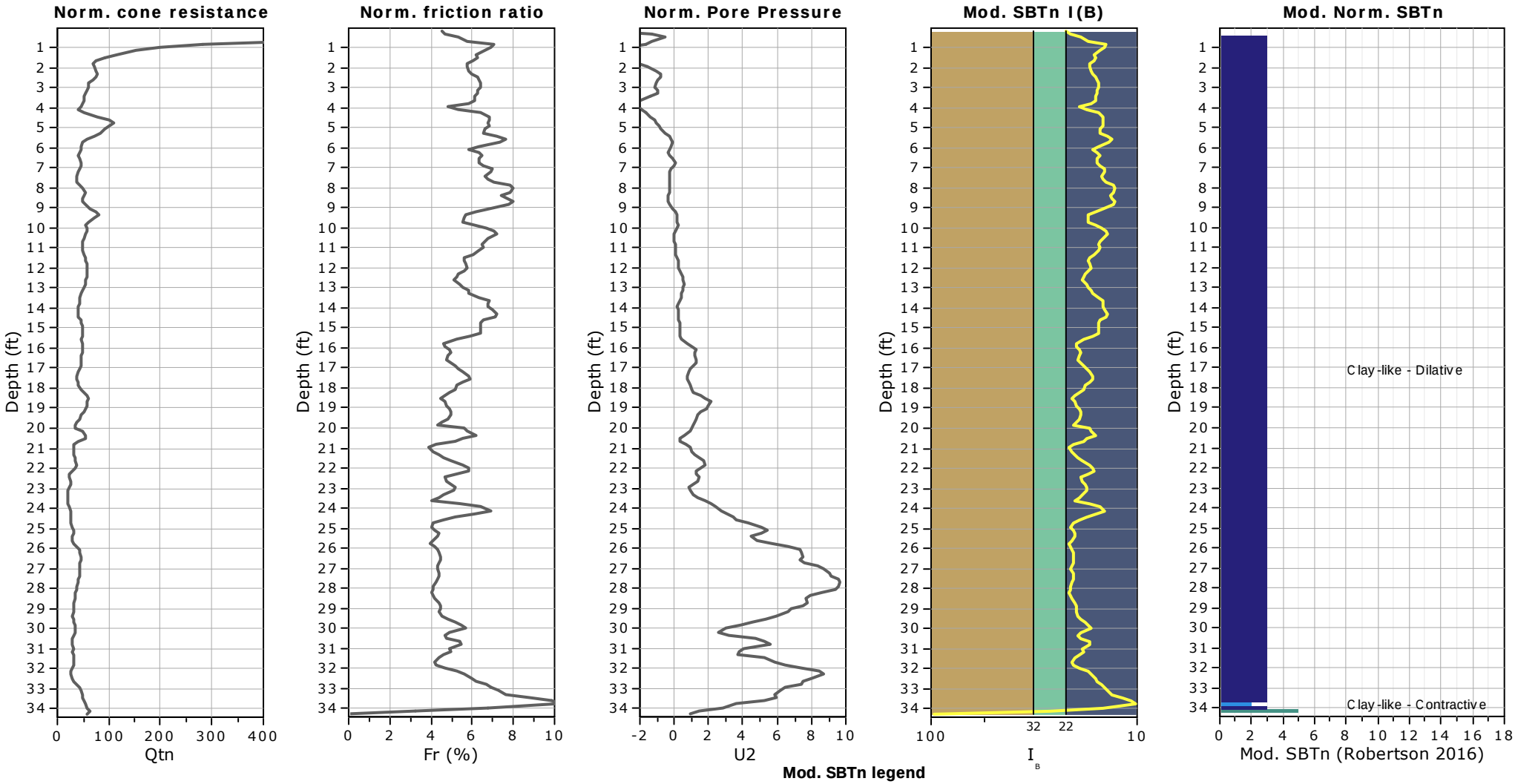

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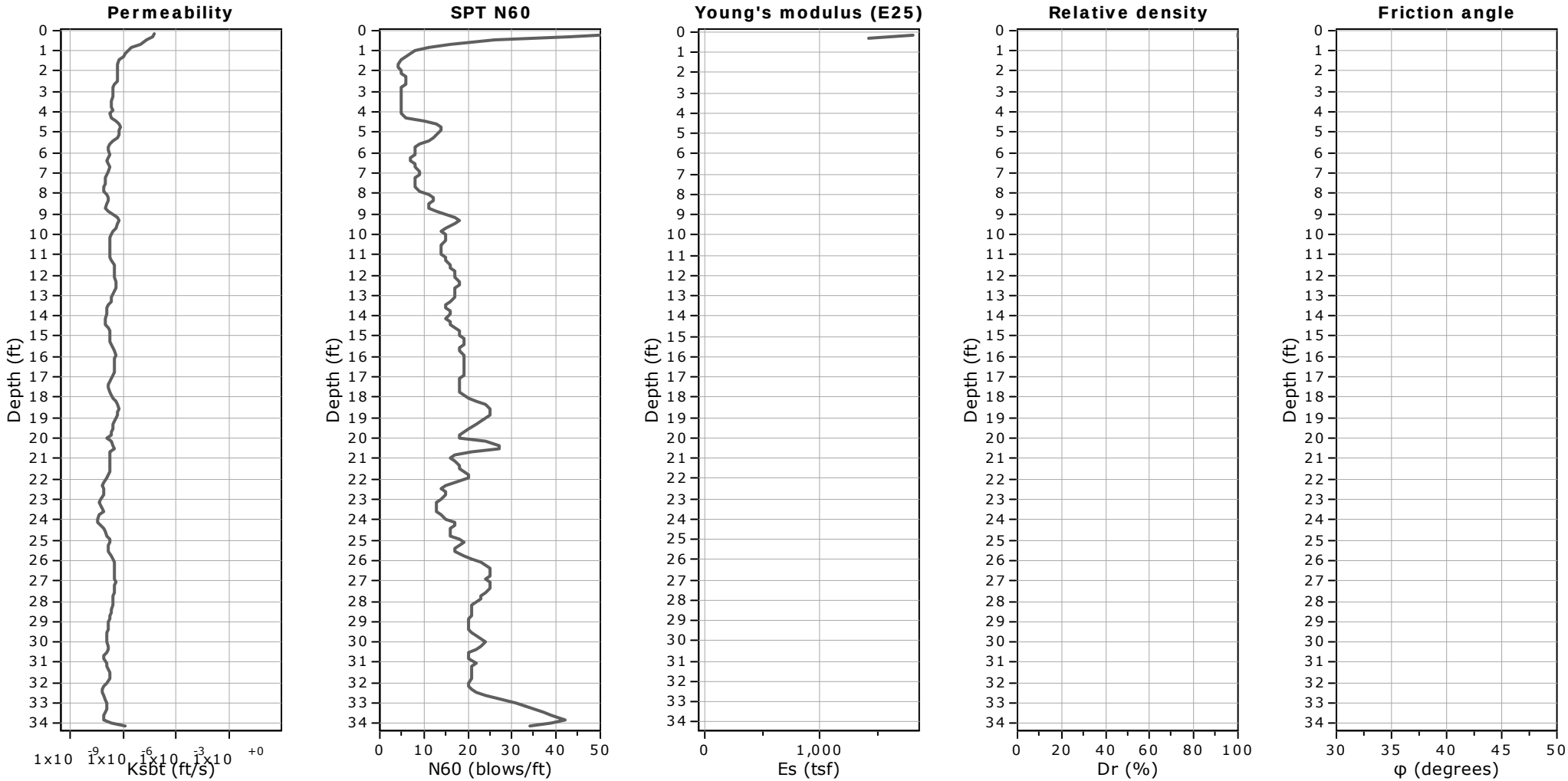
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-2
Total depth: 34.28 ft
Surface Elevation: 0.00 ft



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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

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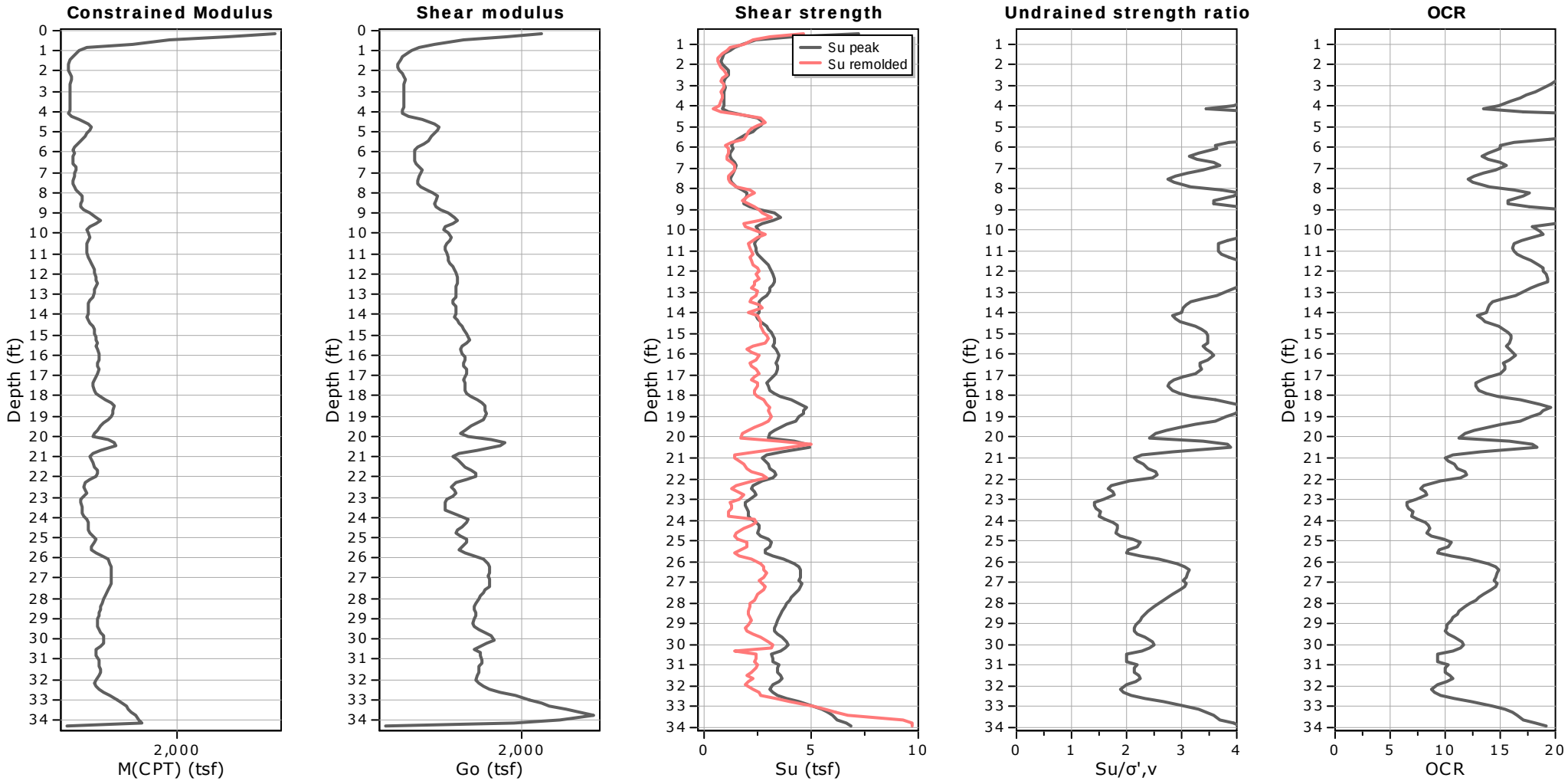
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-2
Total depth: 34.28 ft
Surface Elevation: 0.00 ft



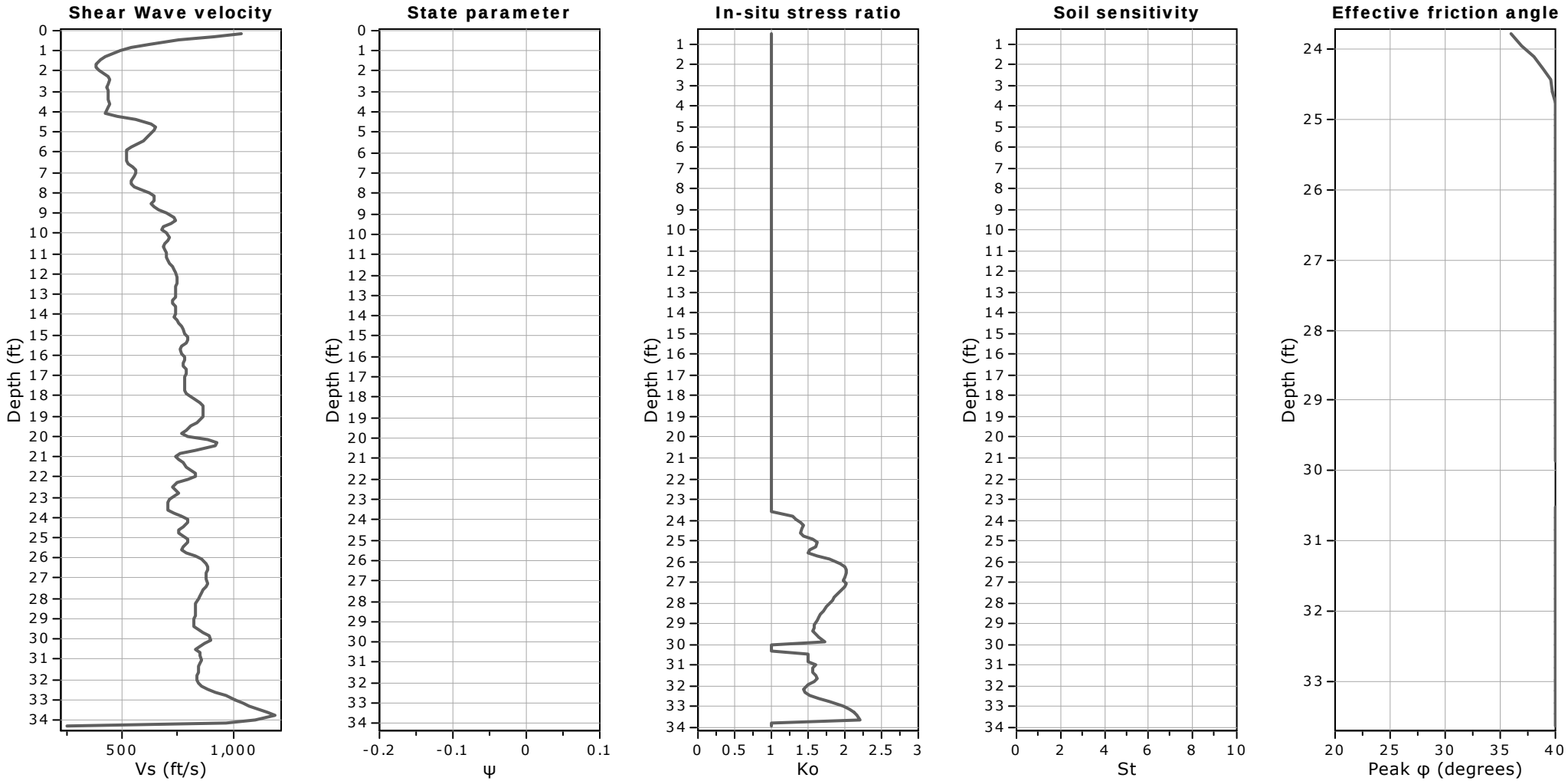
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-2
Total depth: 34.28 ft
Surface Elevation: 0.00 ft



Calculation parameters

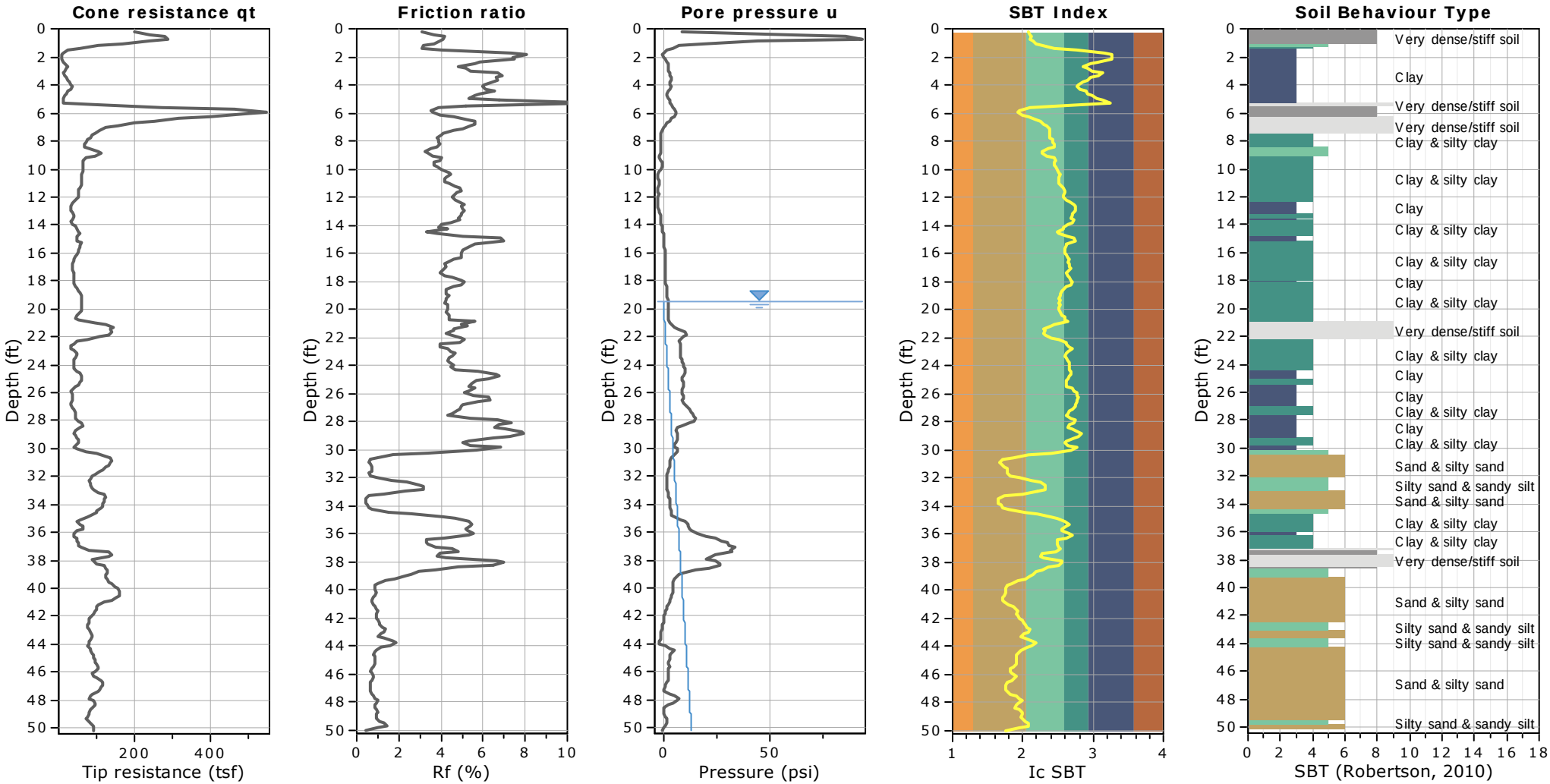
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



SBT legend

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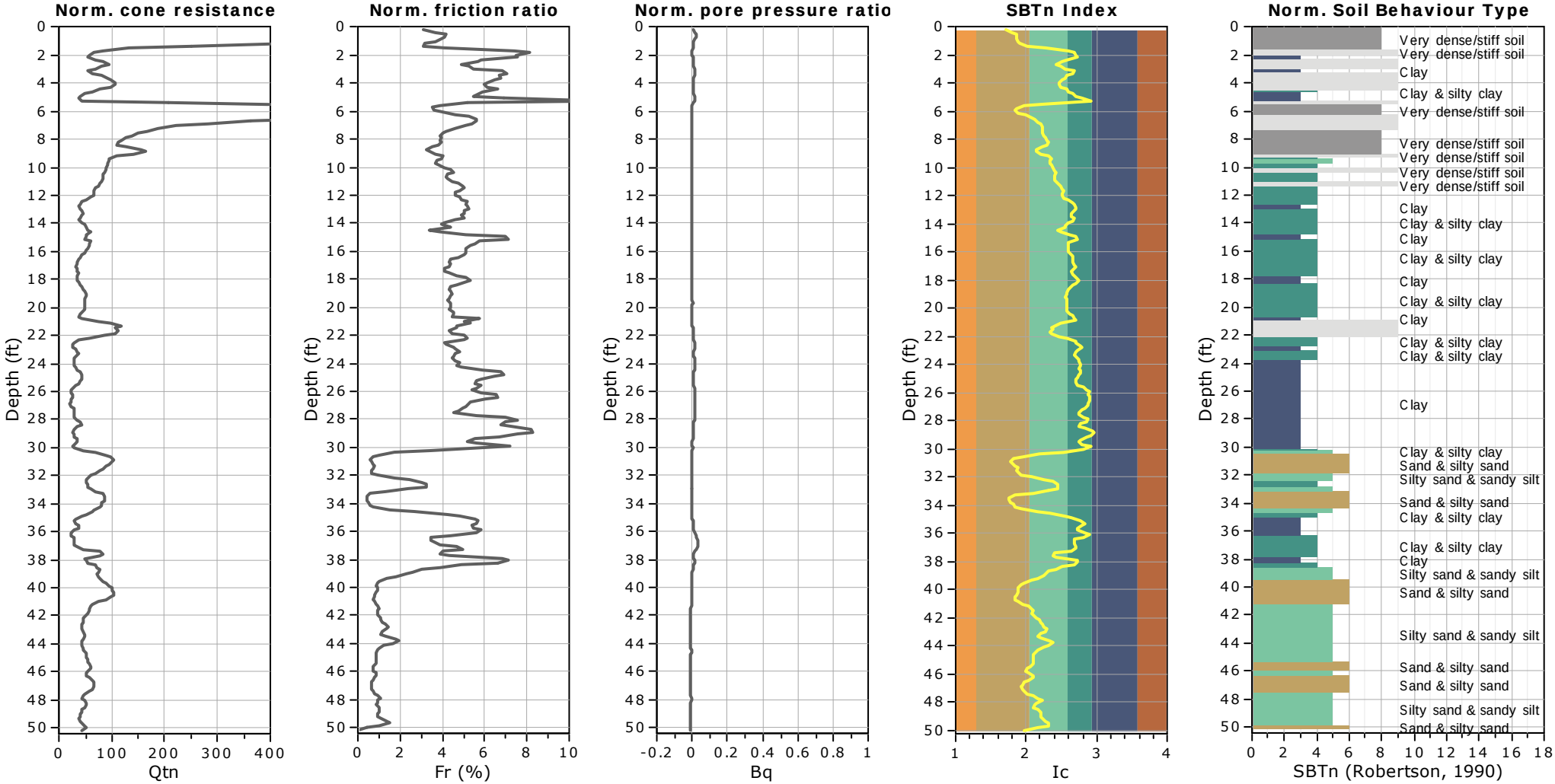
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



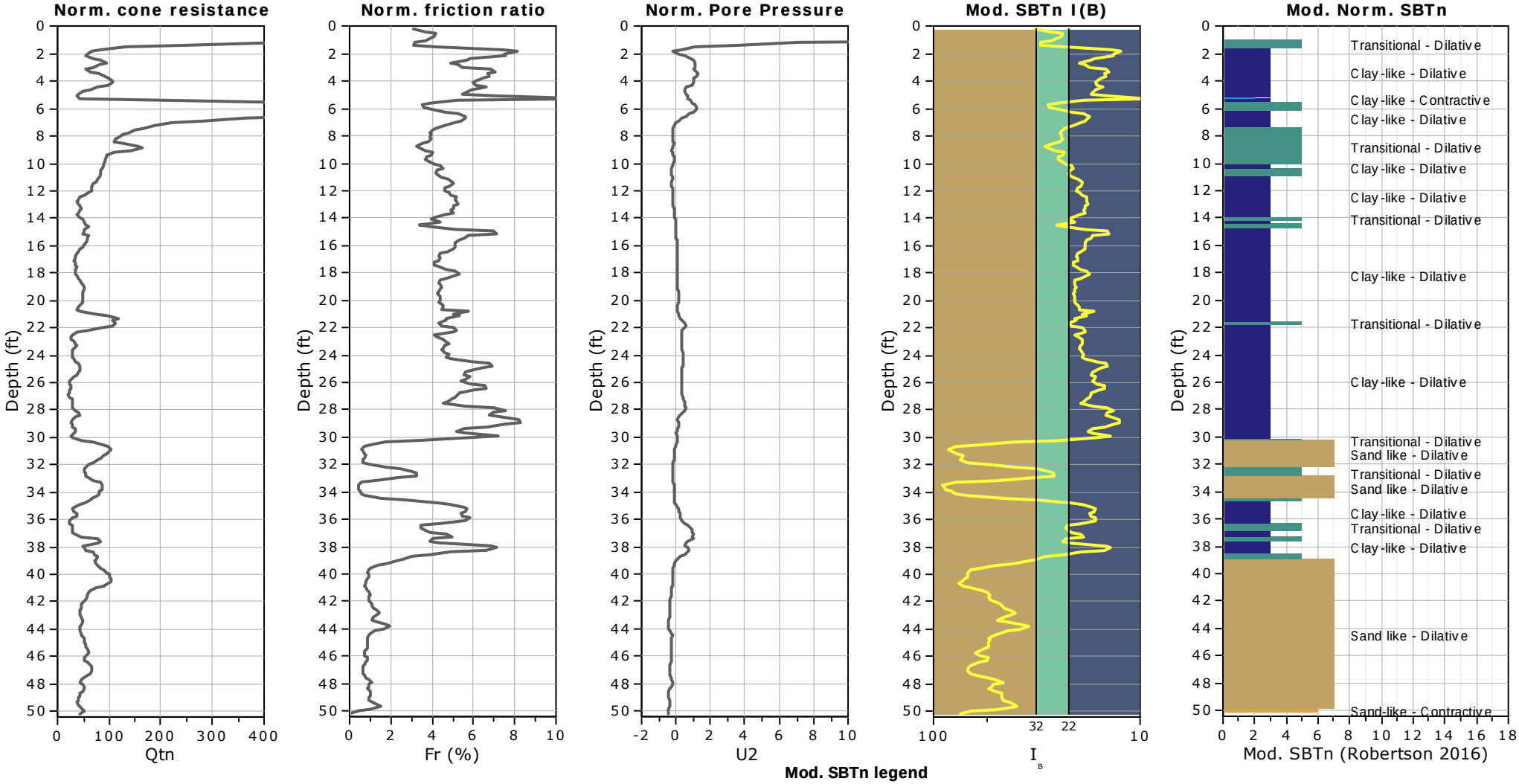
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



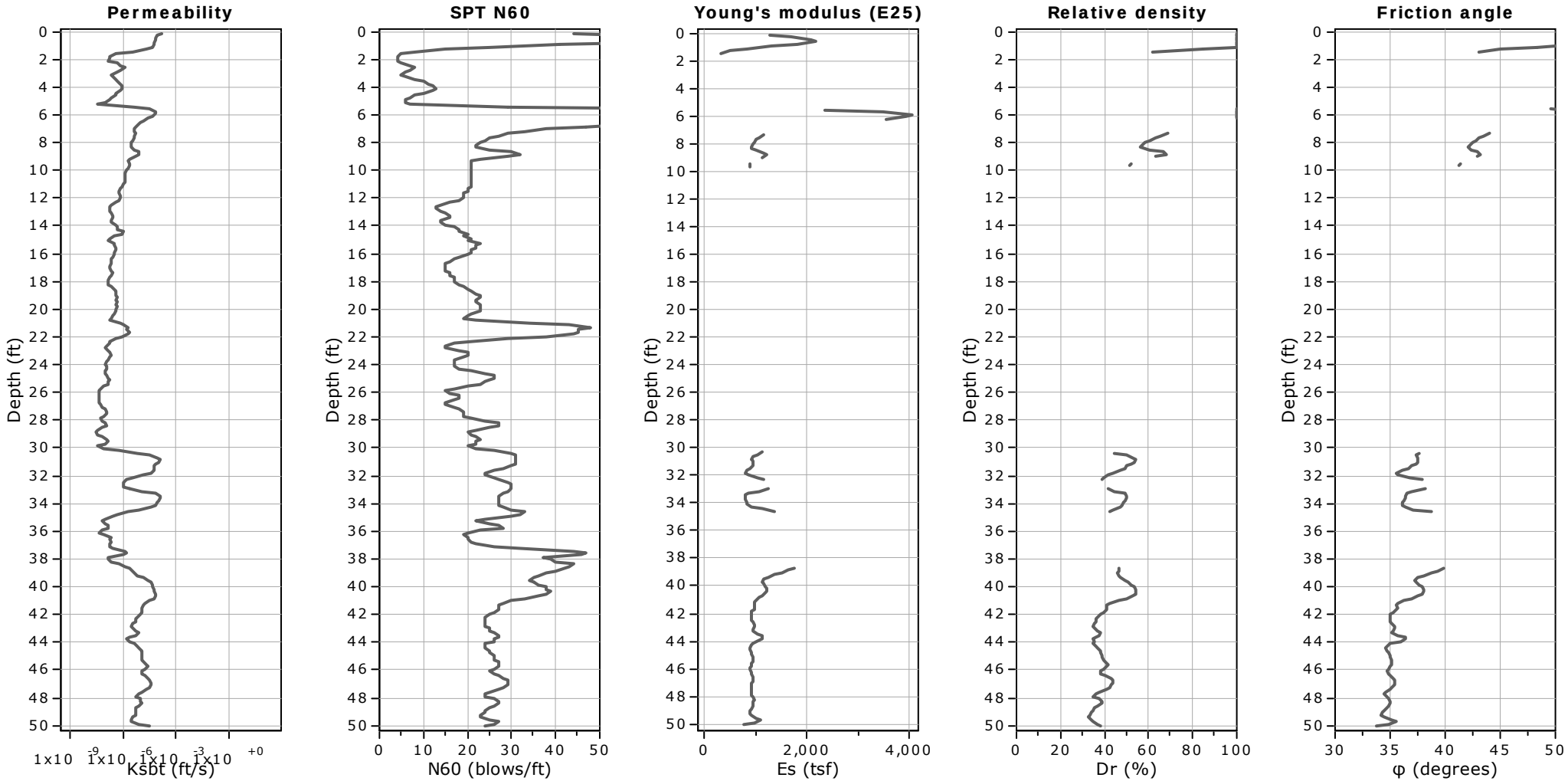
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



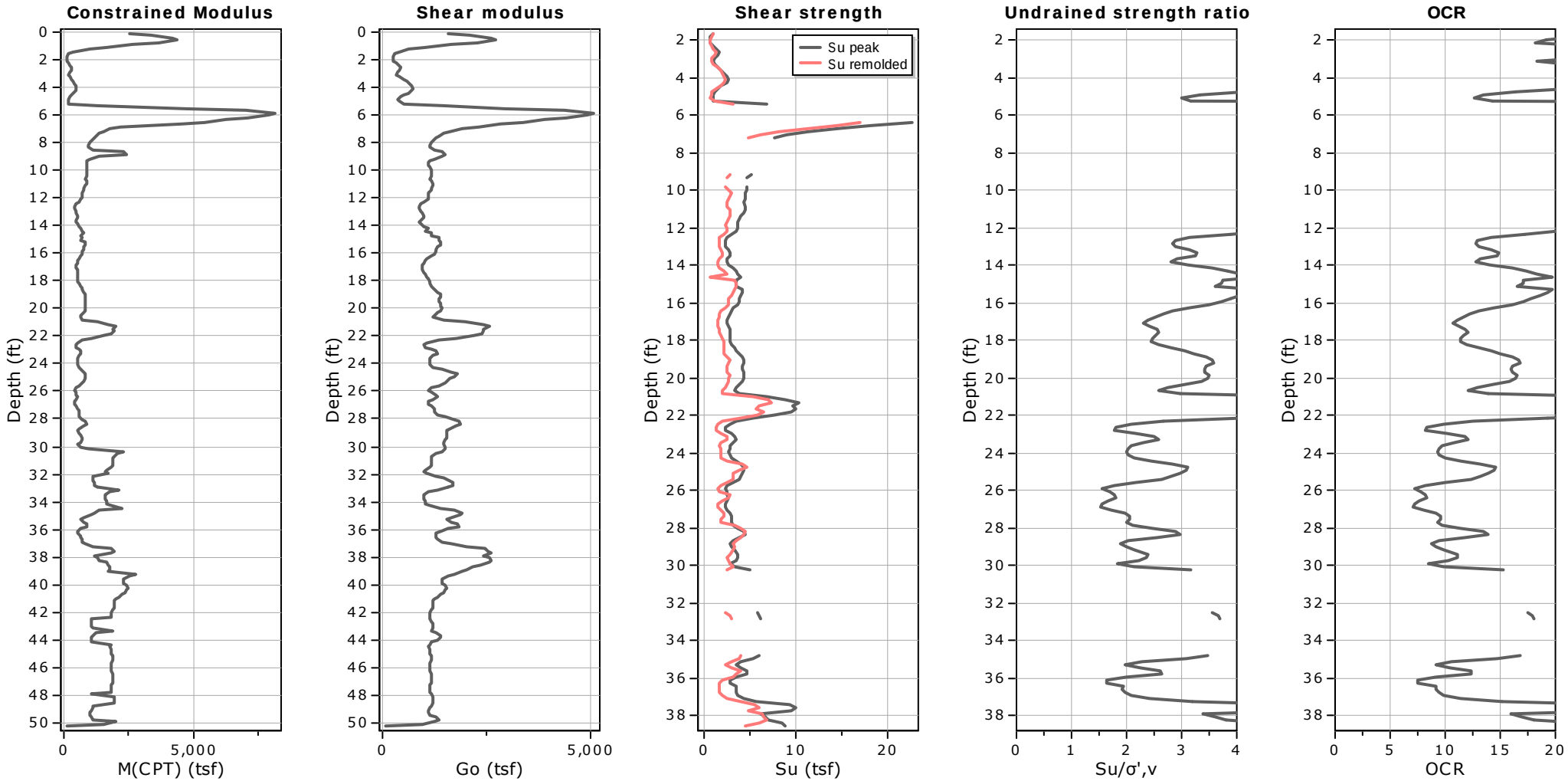
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



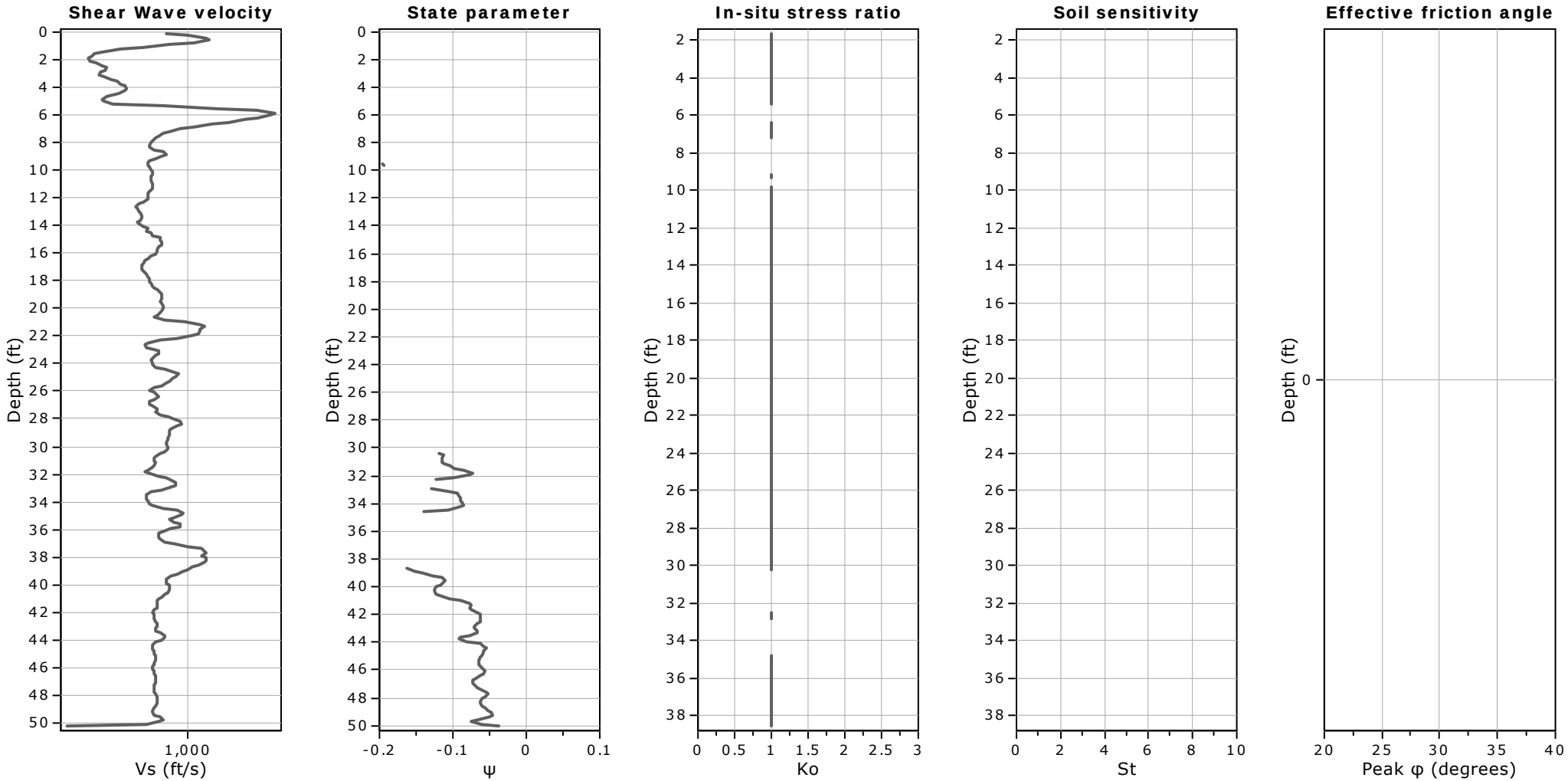
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-3
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



Calculation parameters

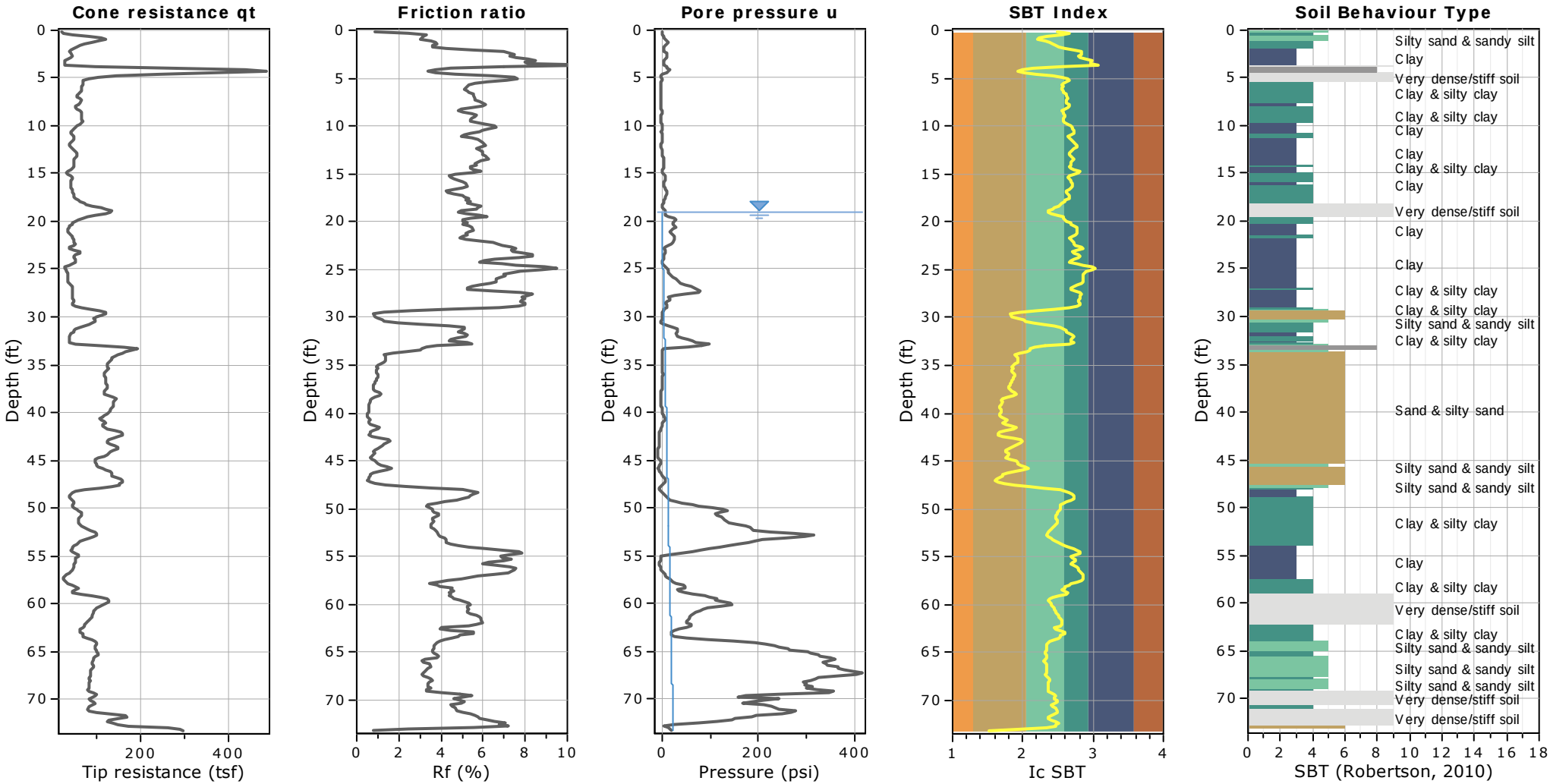
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



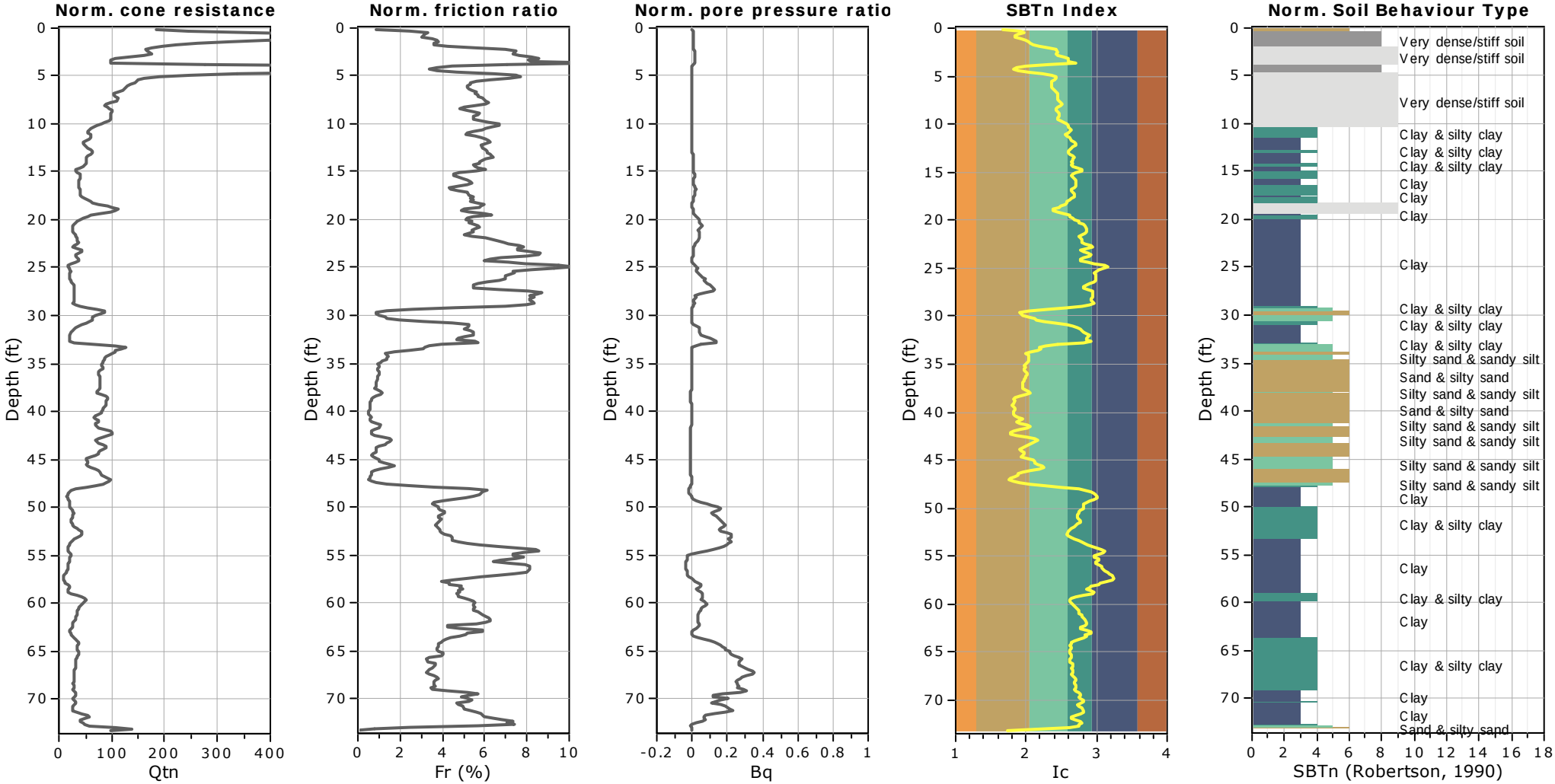
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



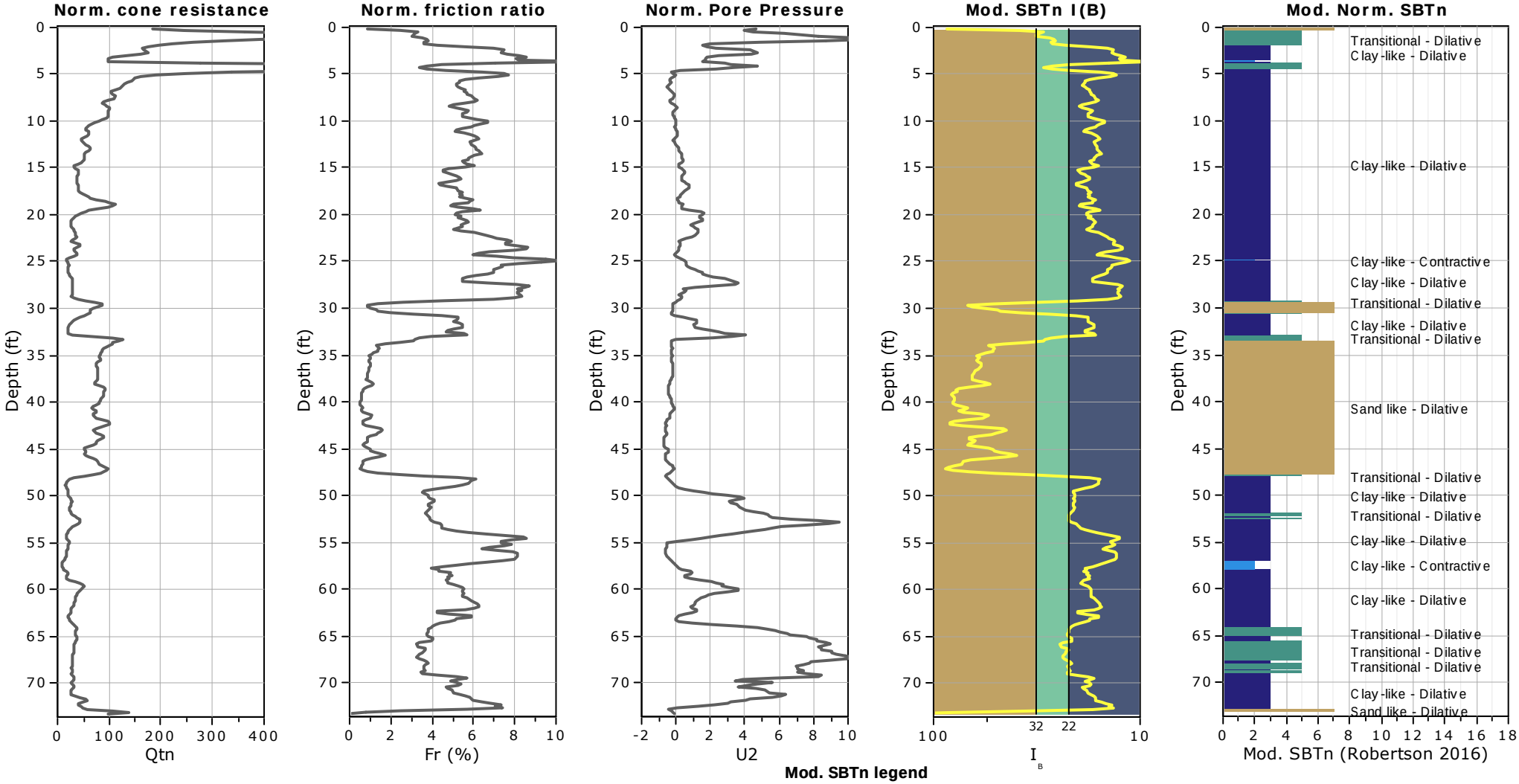
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



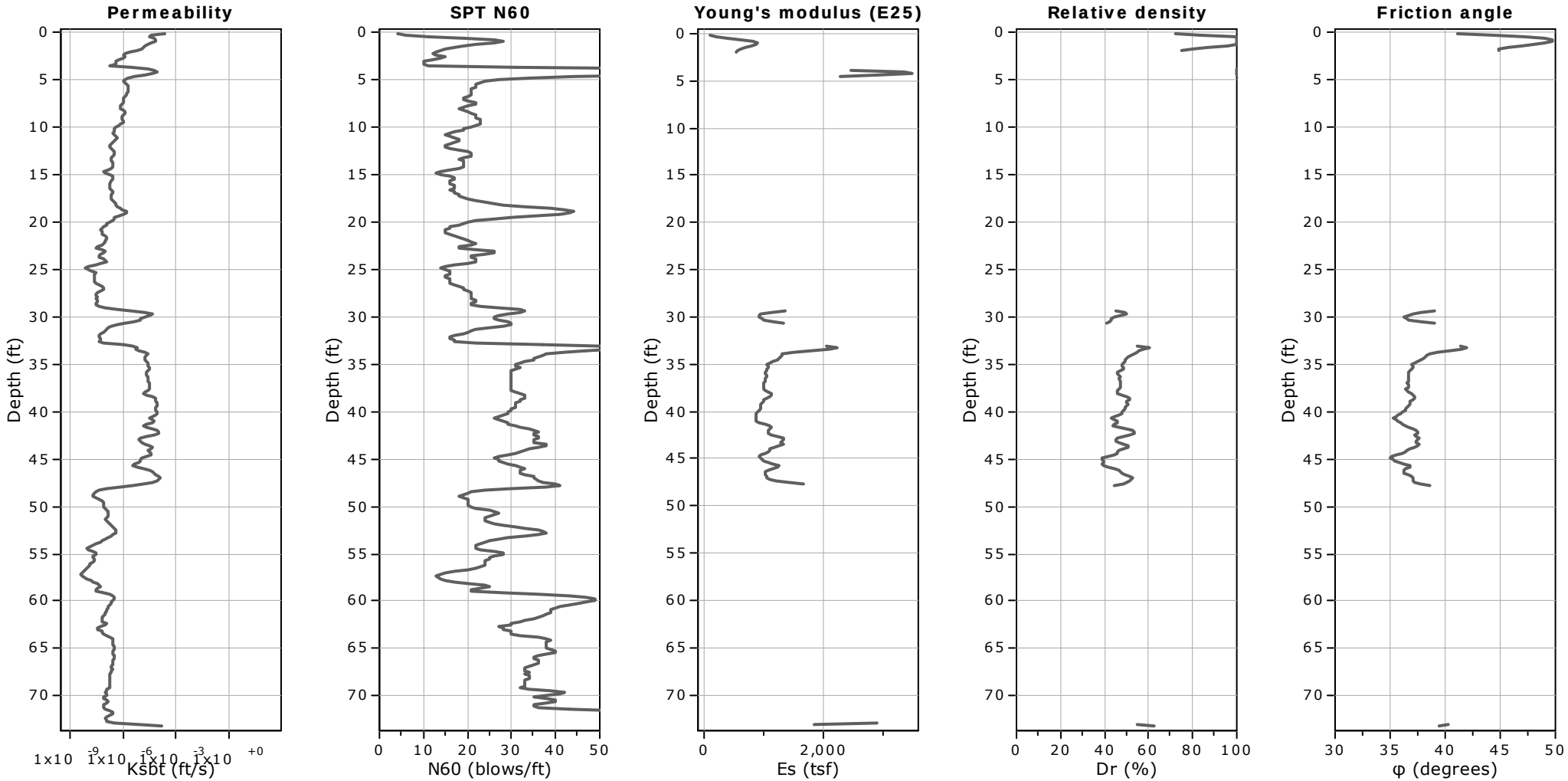
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



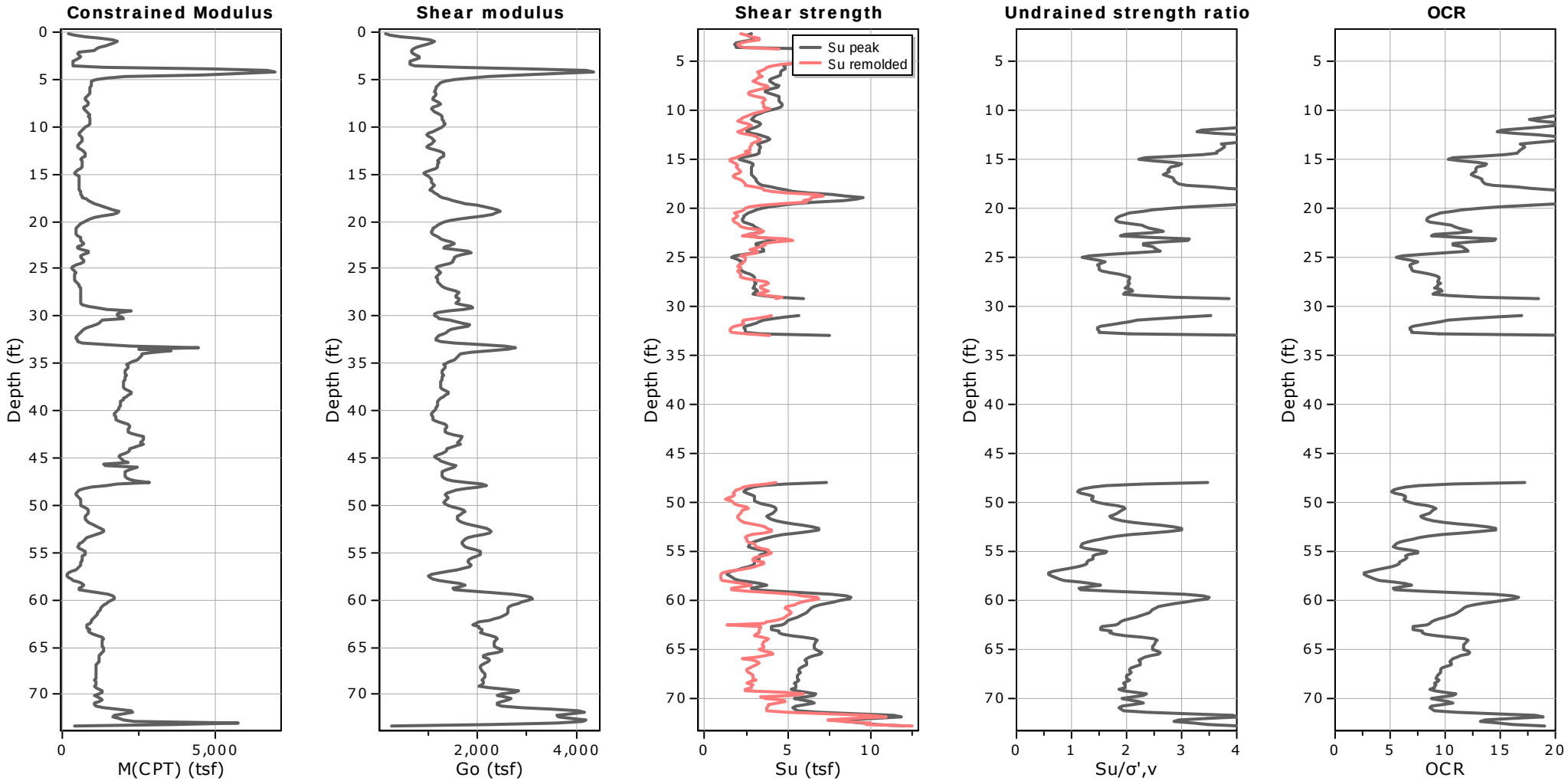
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



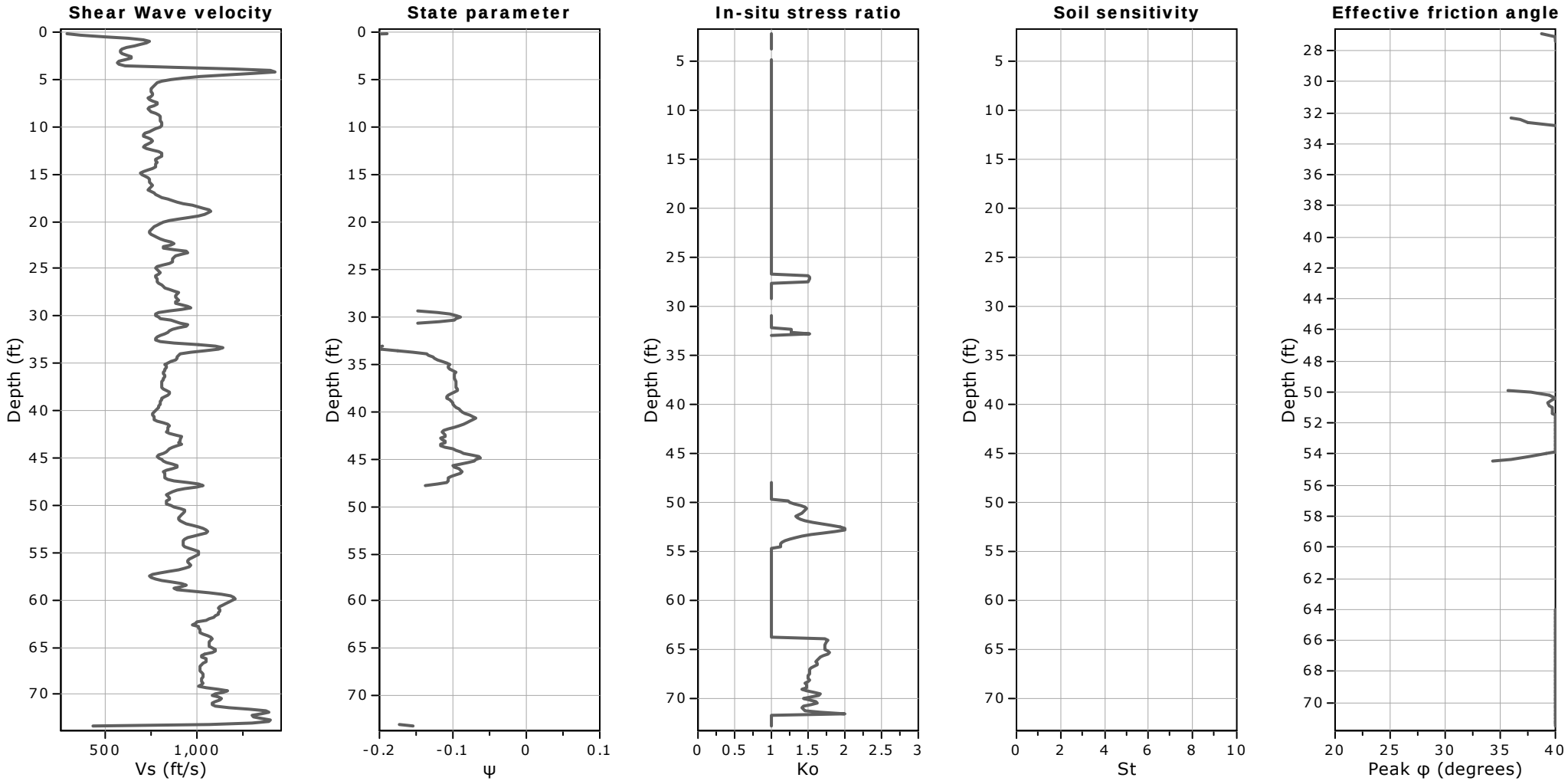
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-4
Total depth: 73.33 ft
Surface Elevation: 0.00 ft



Calculation parameters

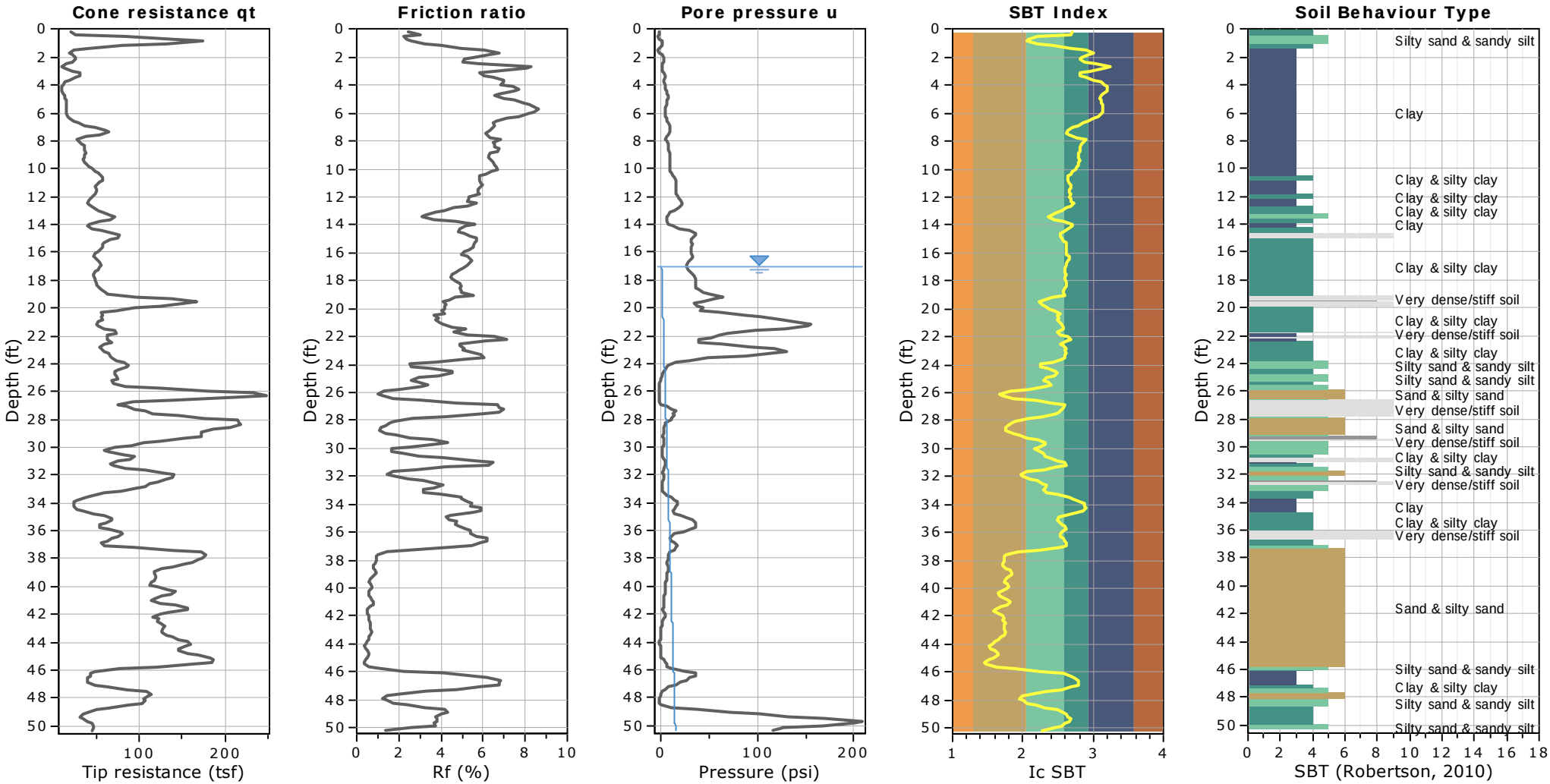
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



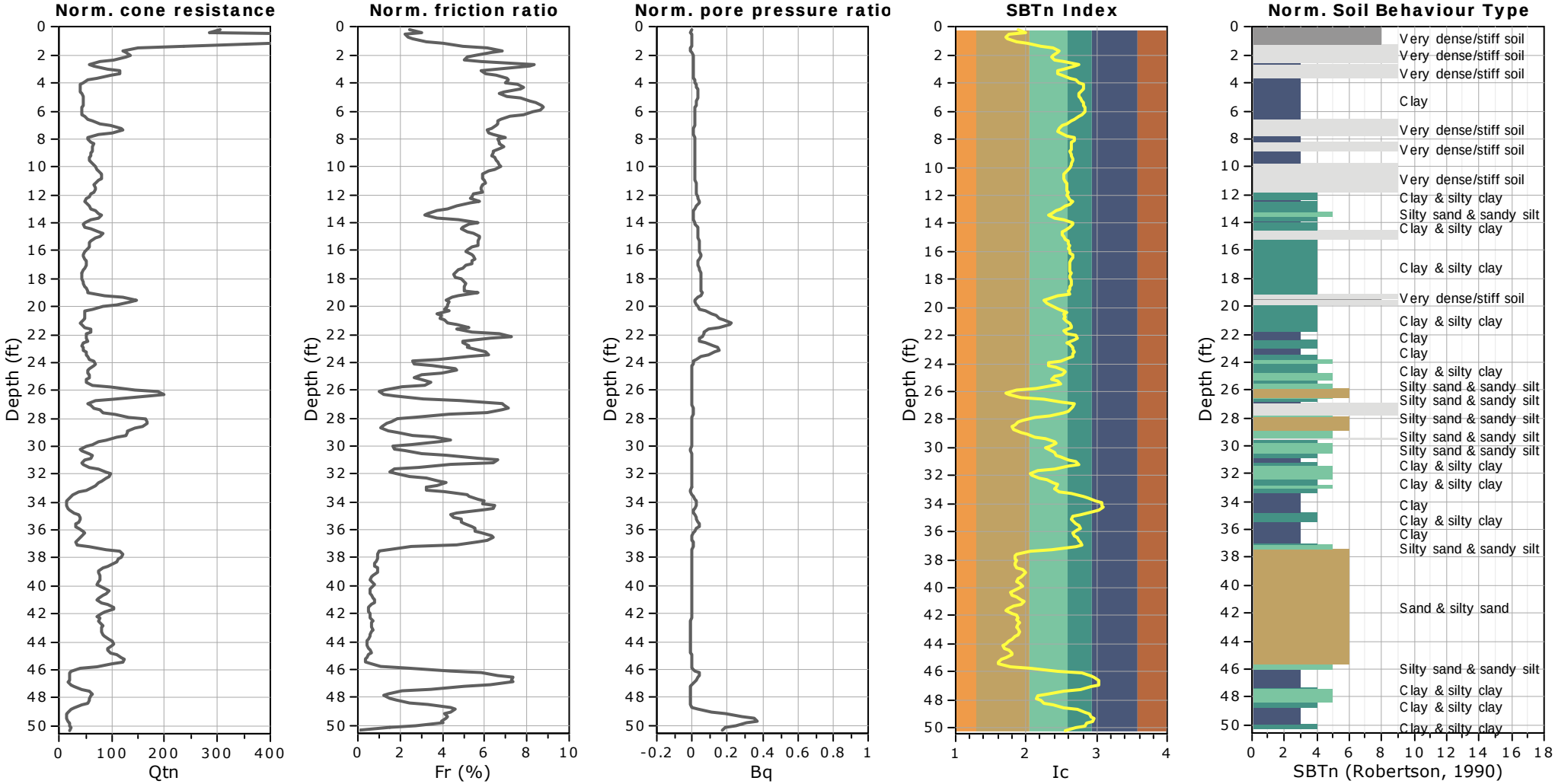
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



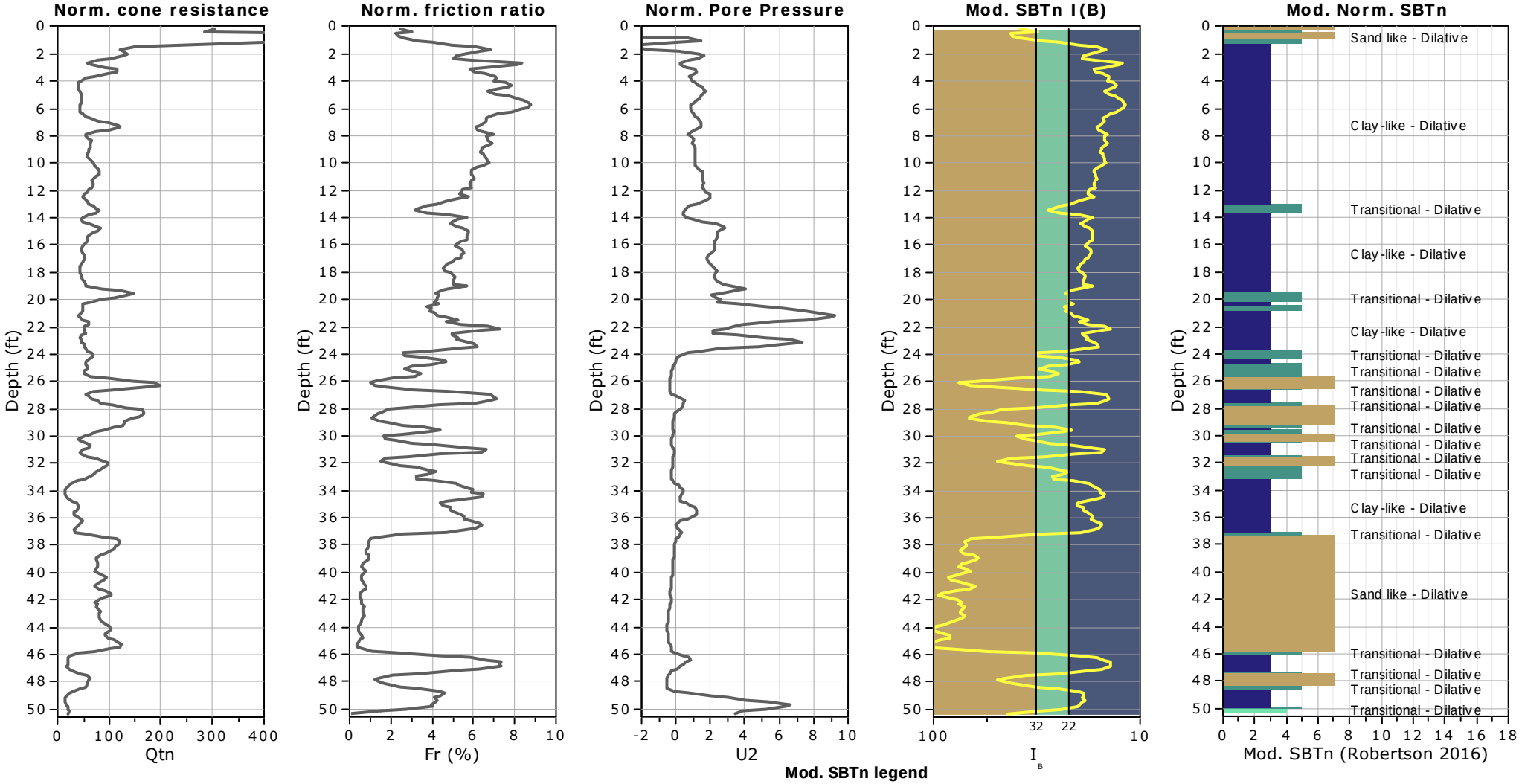
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

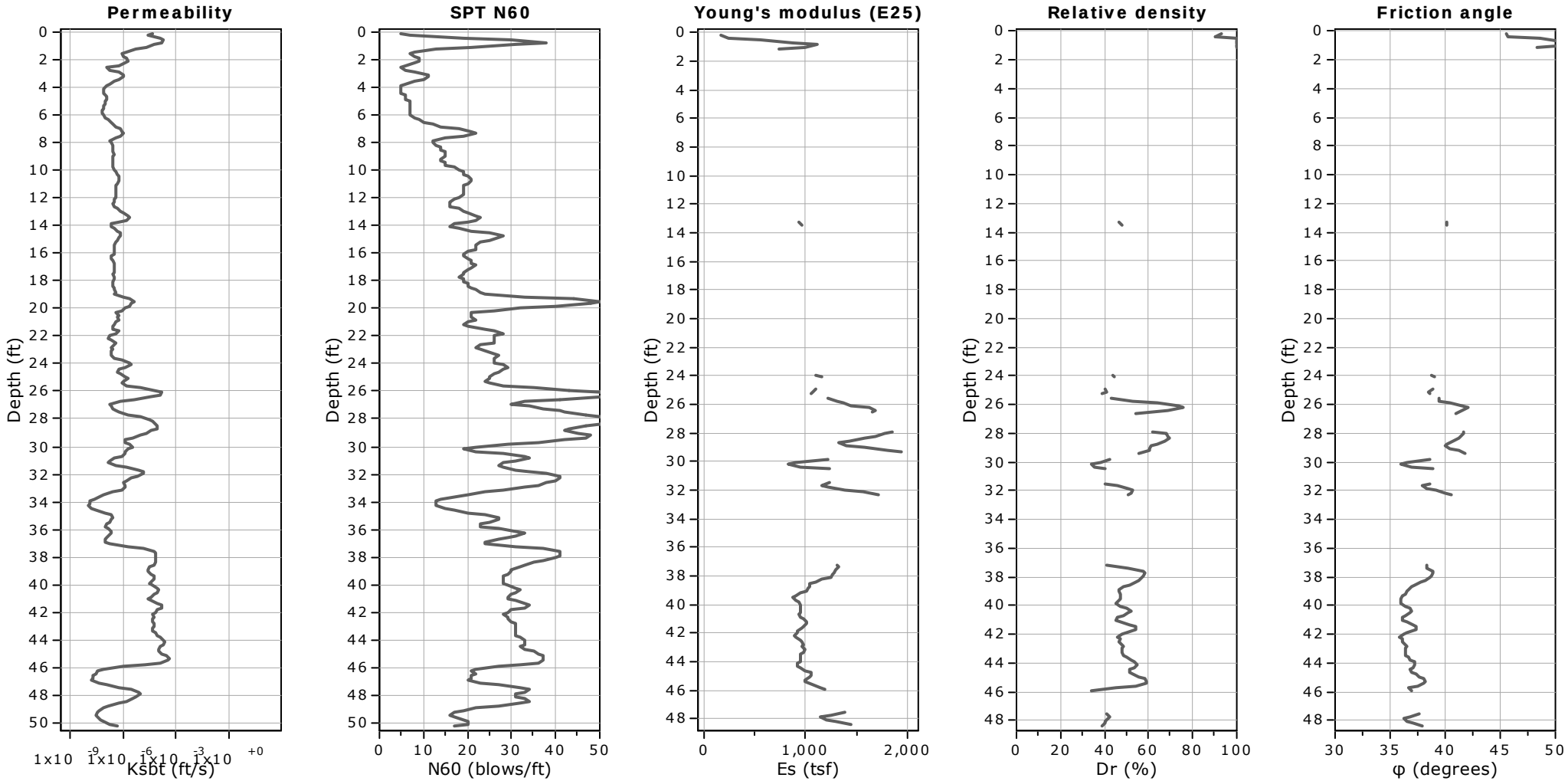
CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



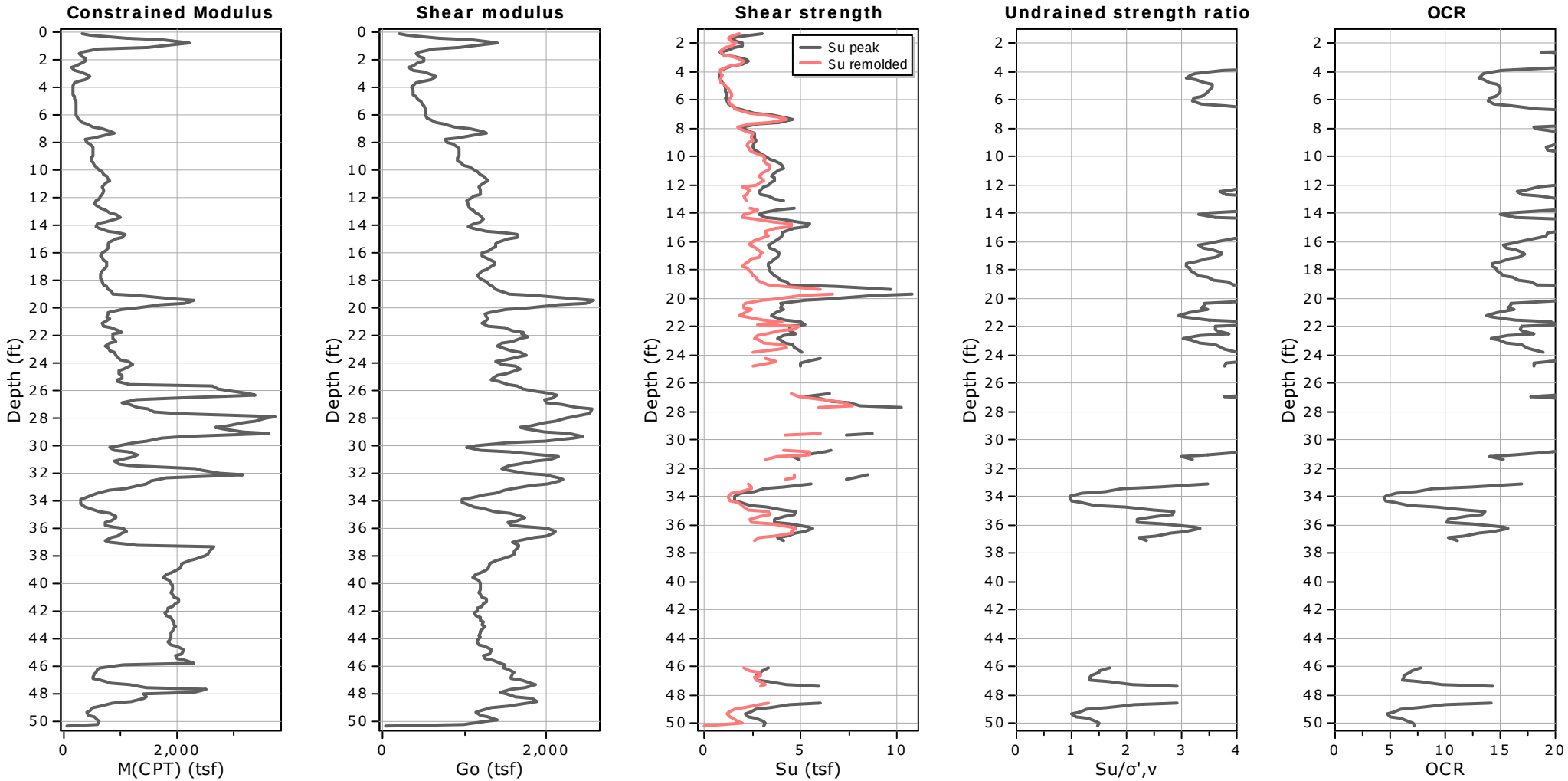
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



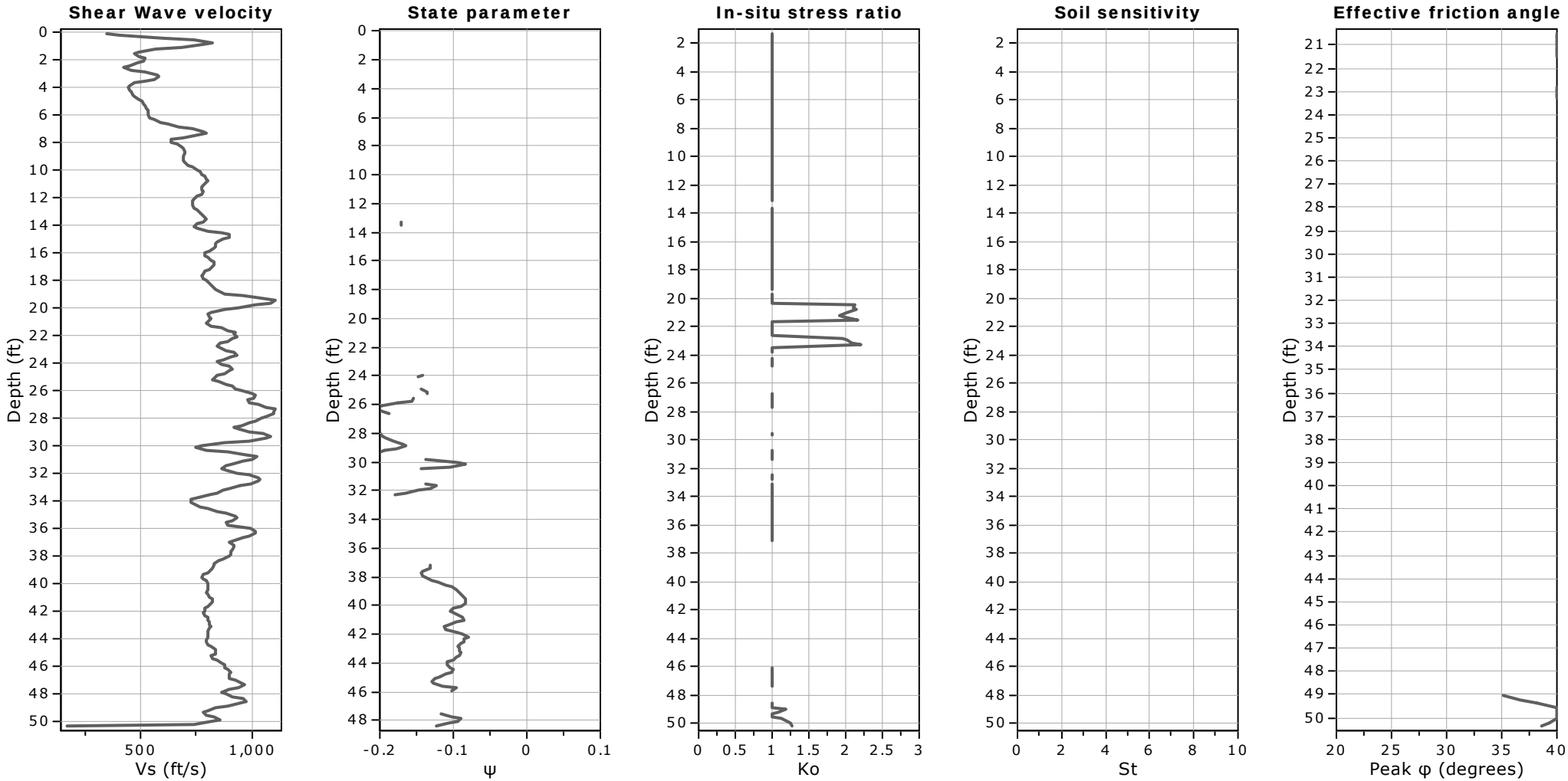
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-5
Total depth: 50.36 ft
Surface Elevation: 0.00 ft



Calculation parameters

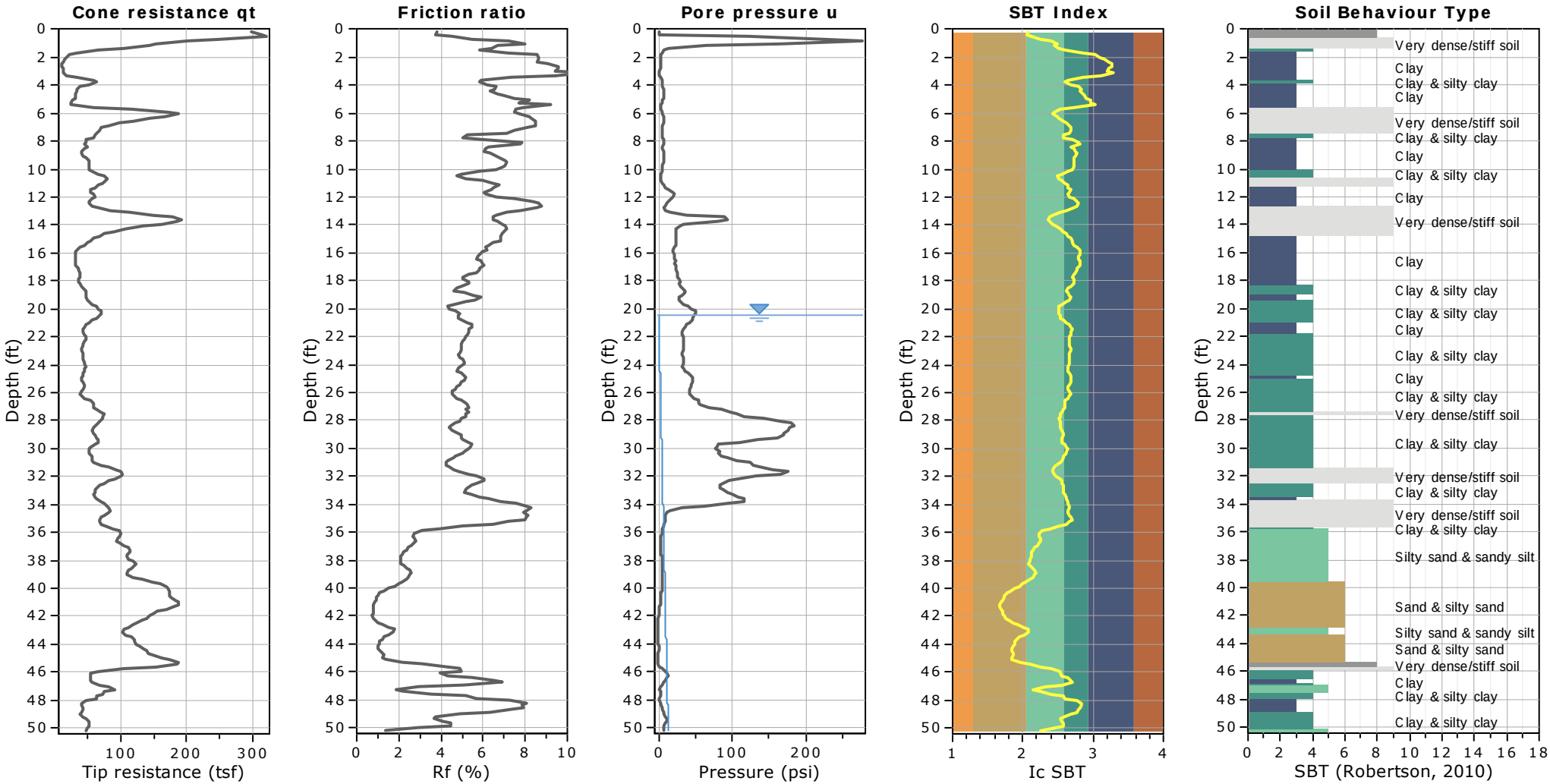
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



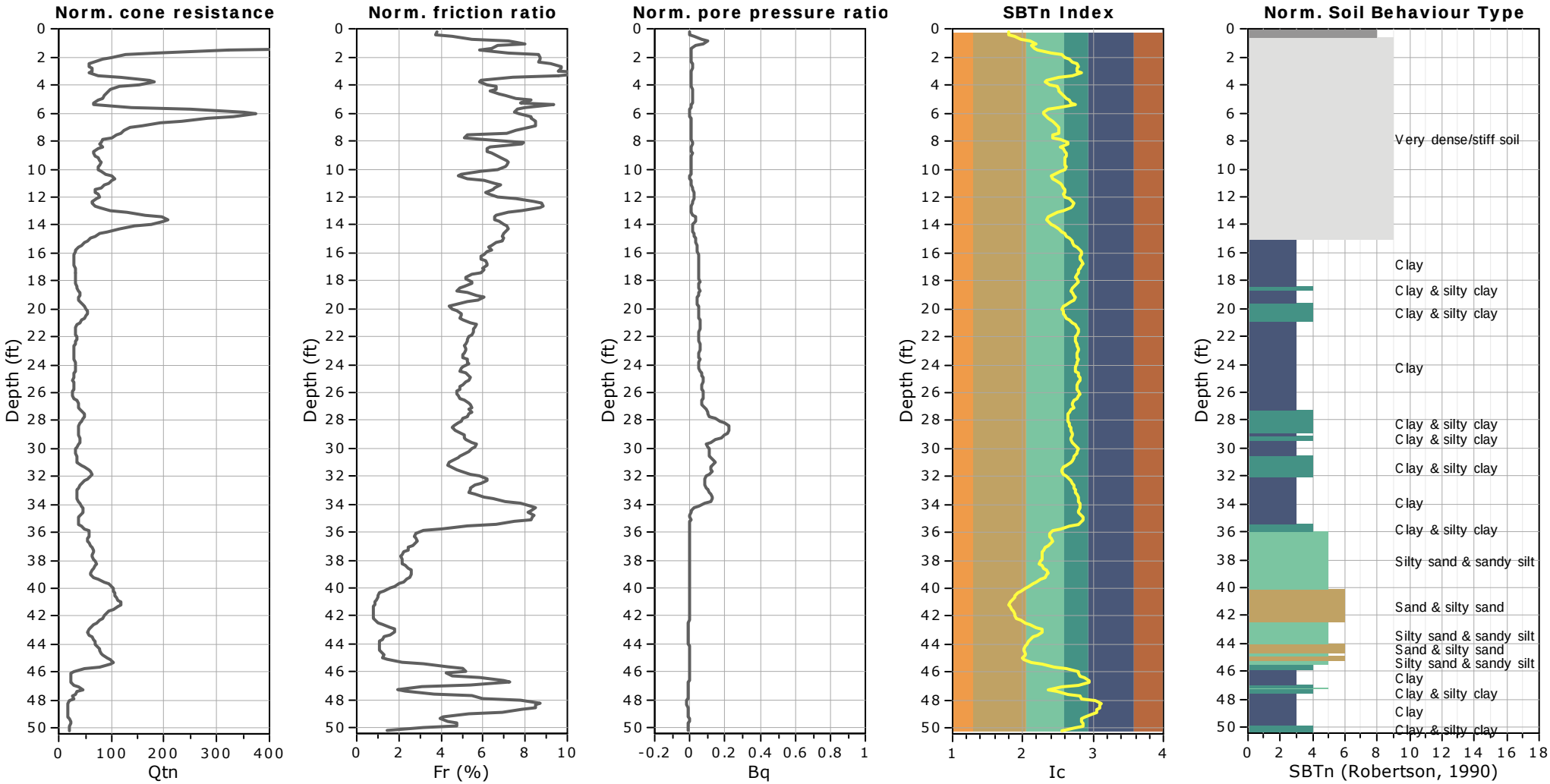
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



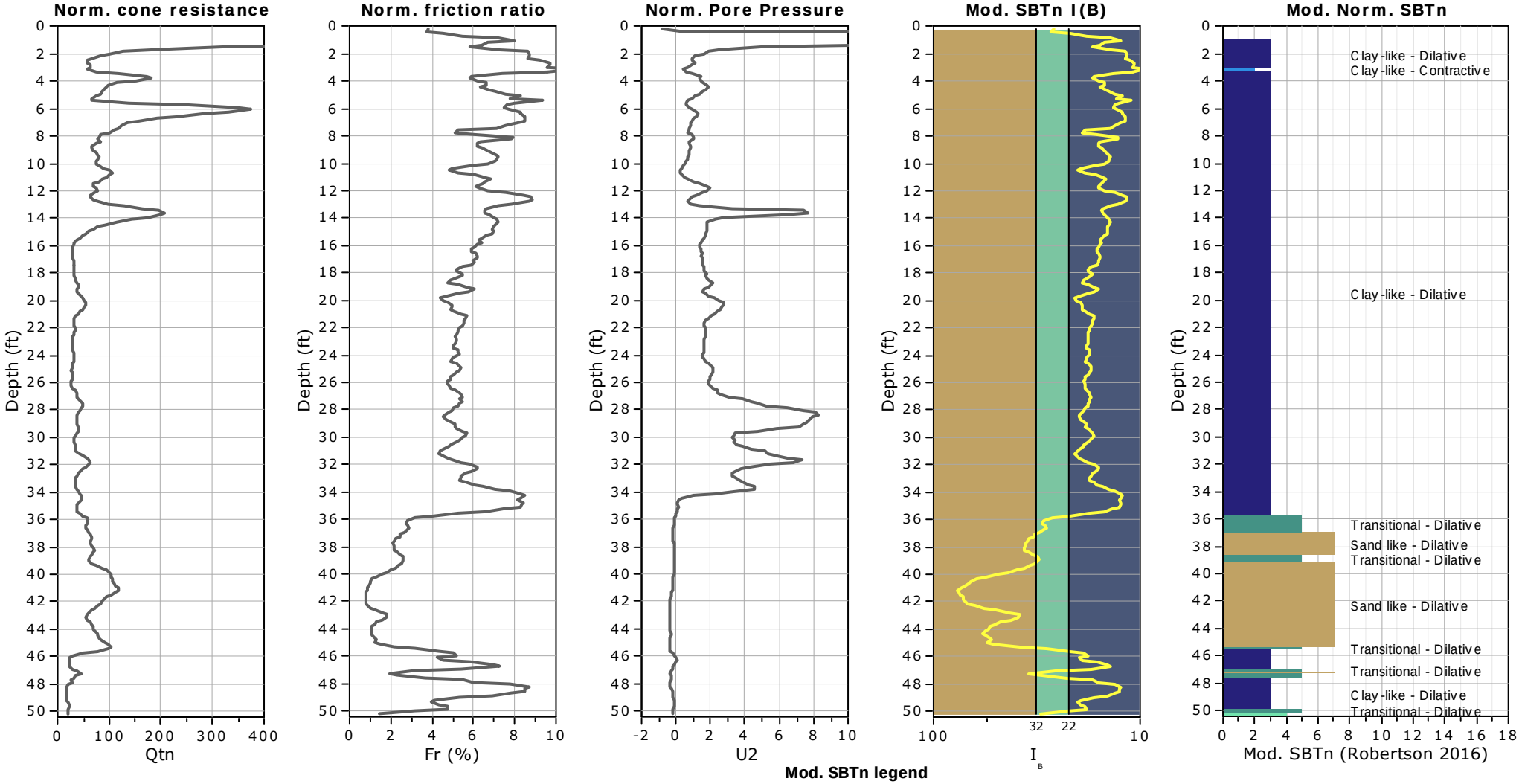
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



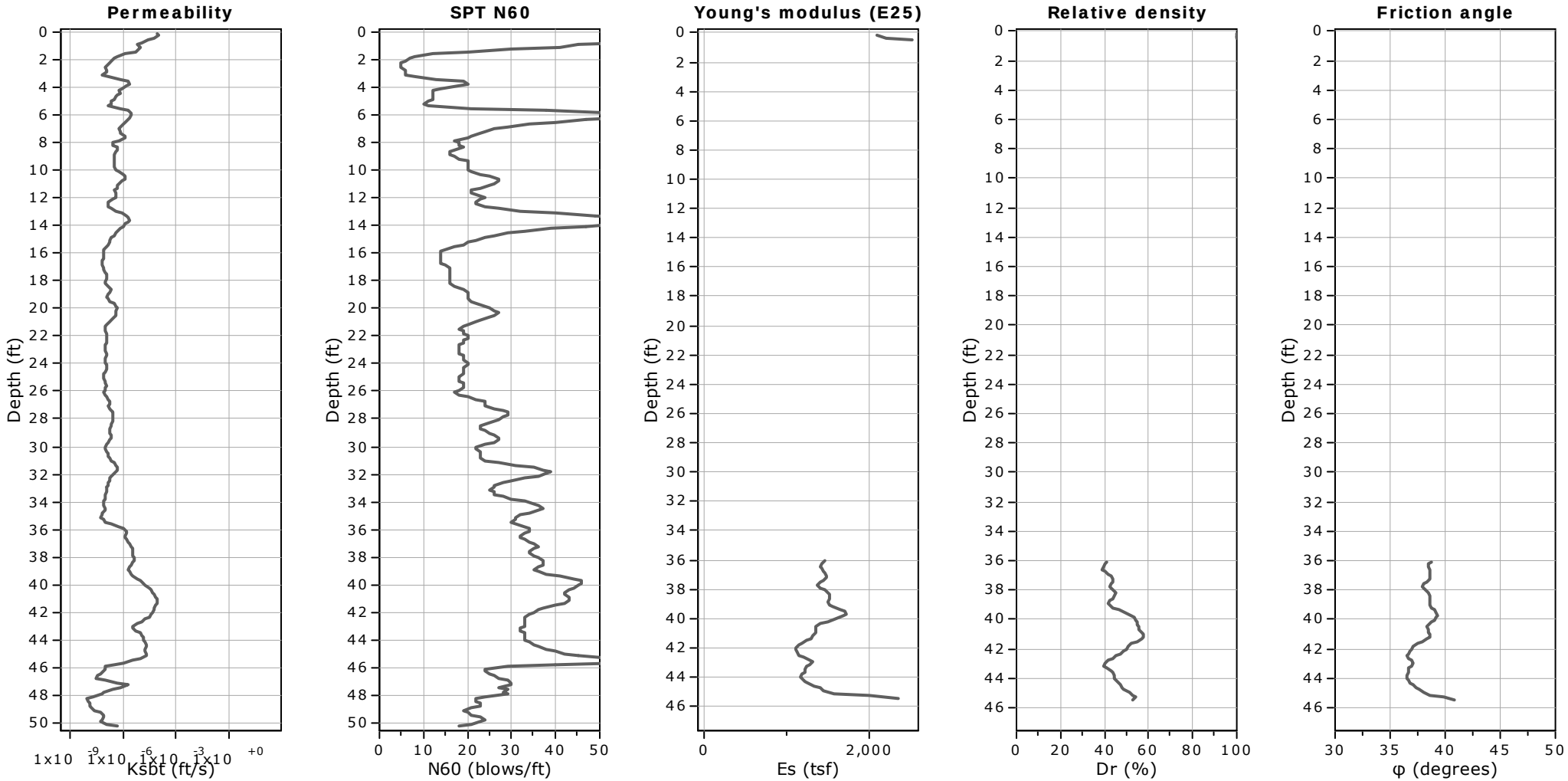
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



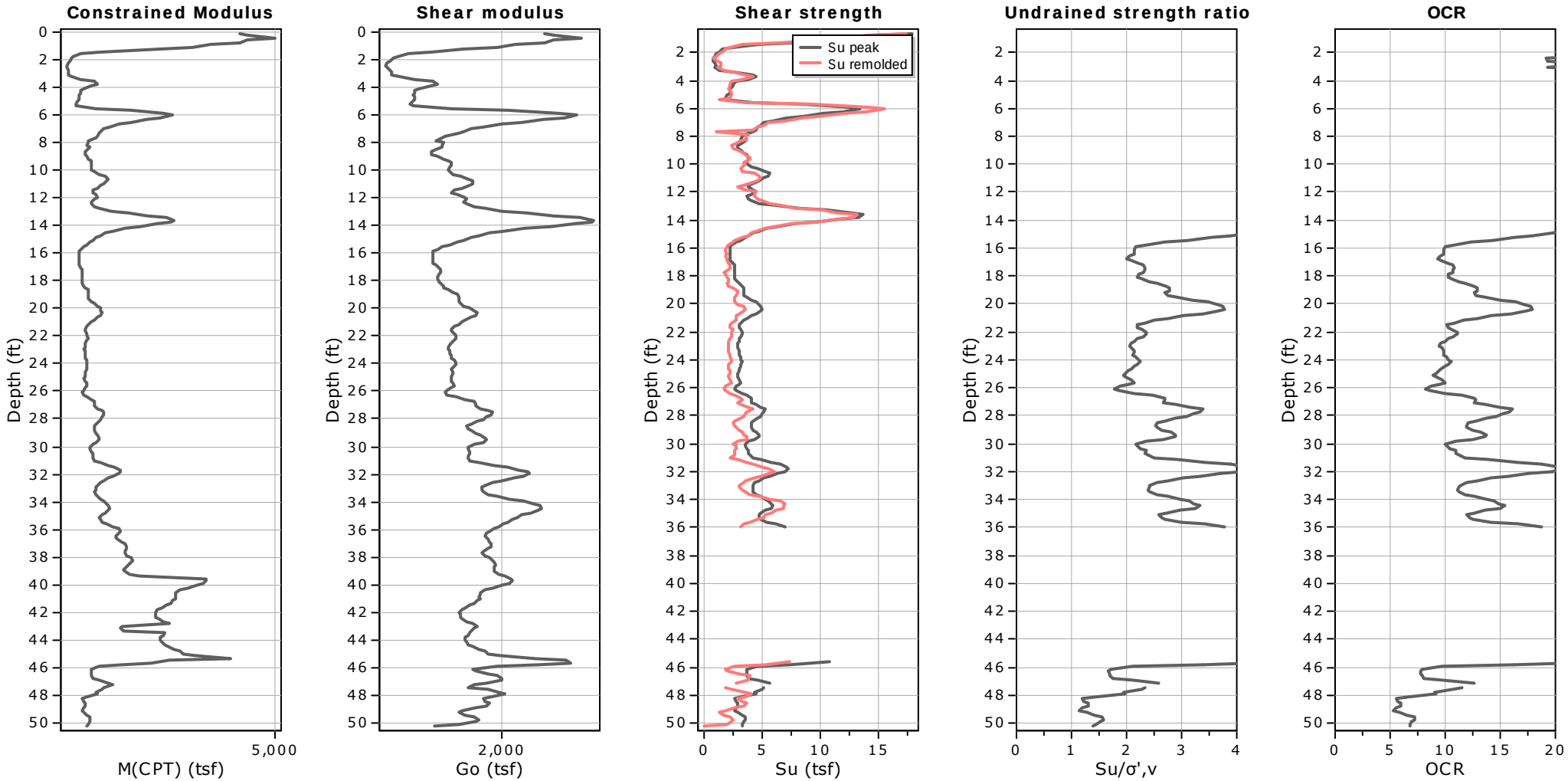
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



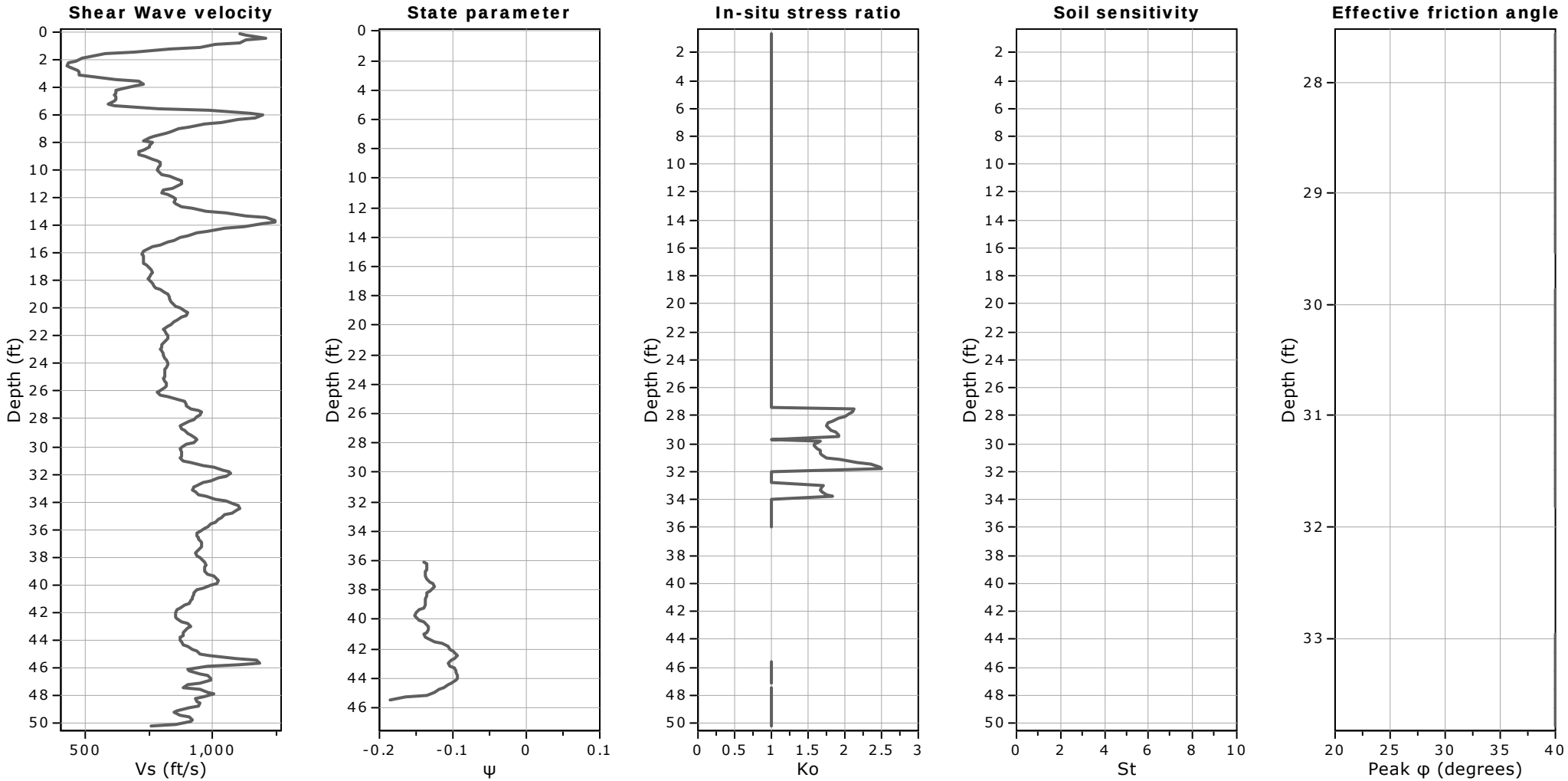
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-6
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



Calculation parameters

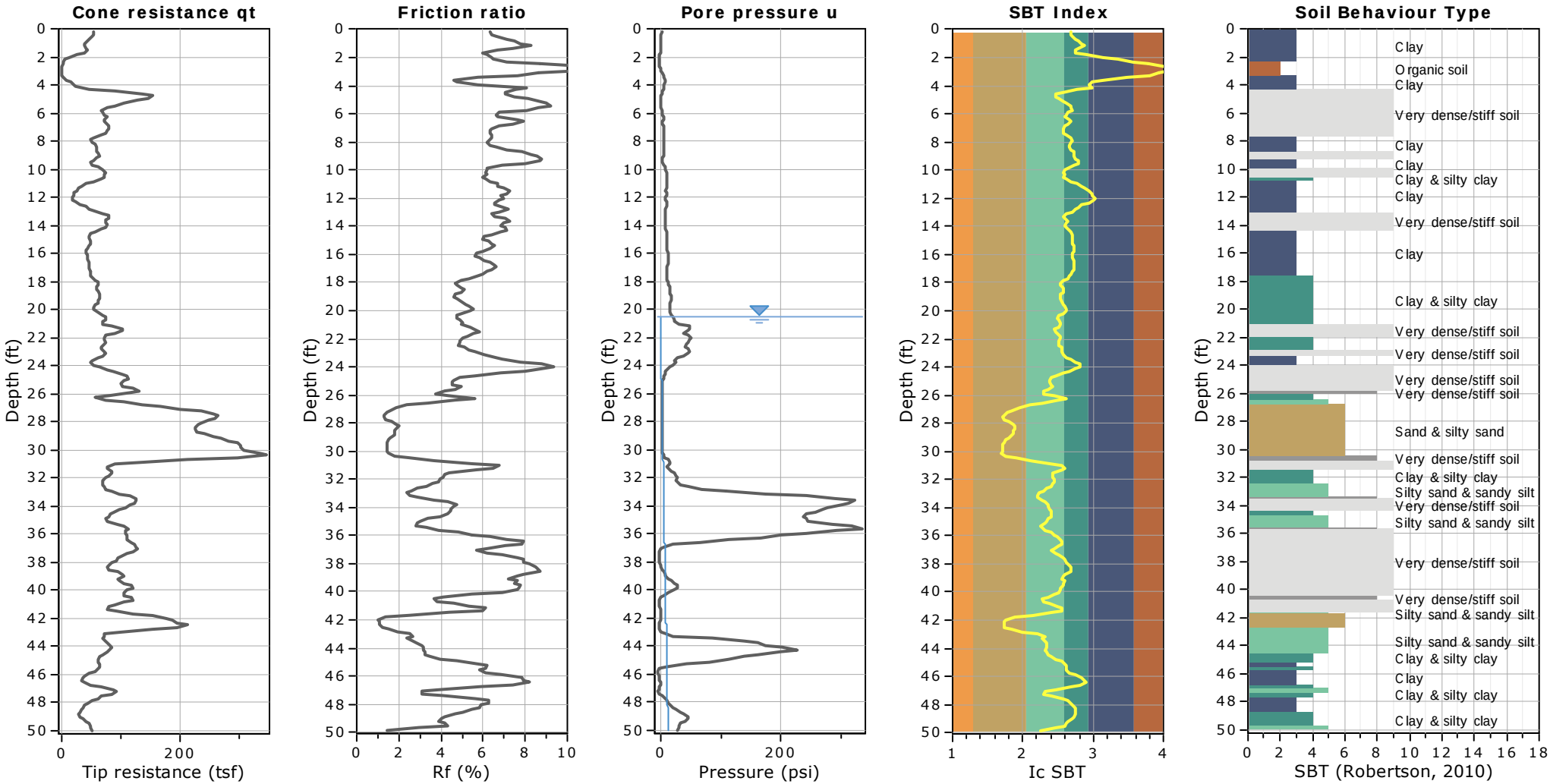
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



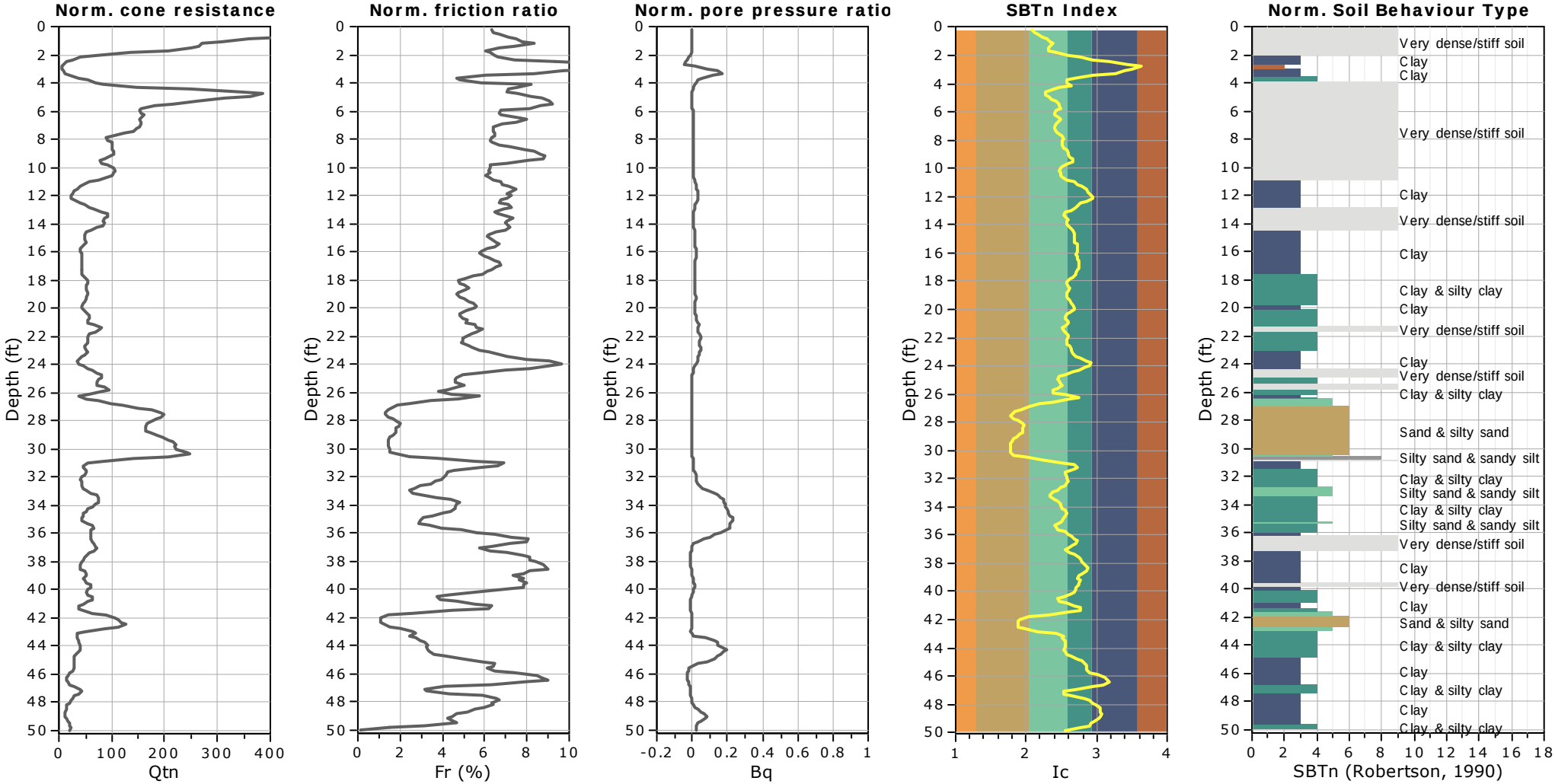
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



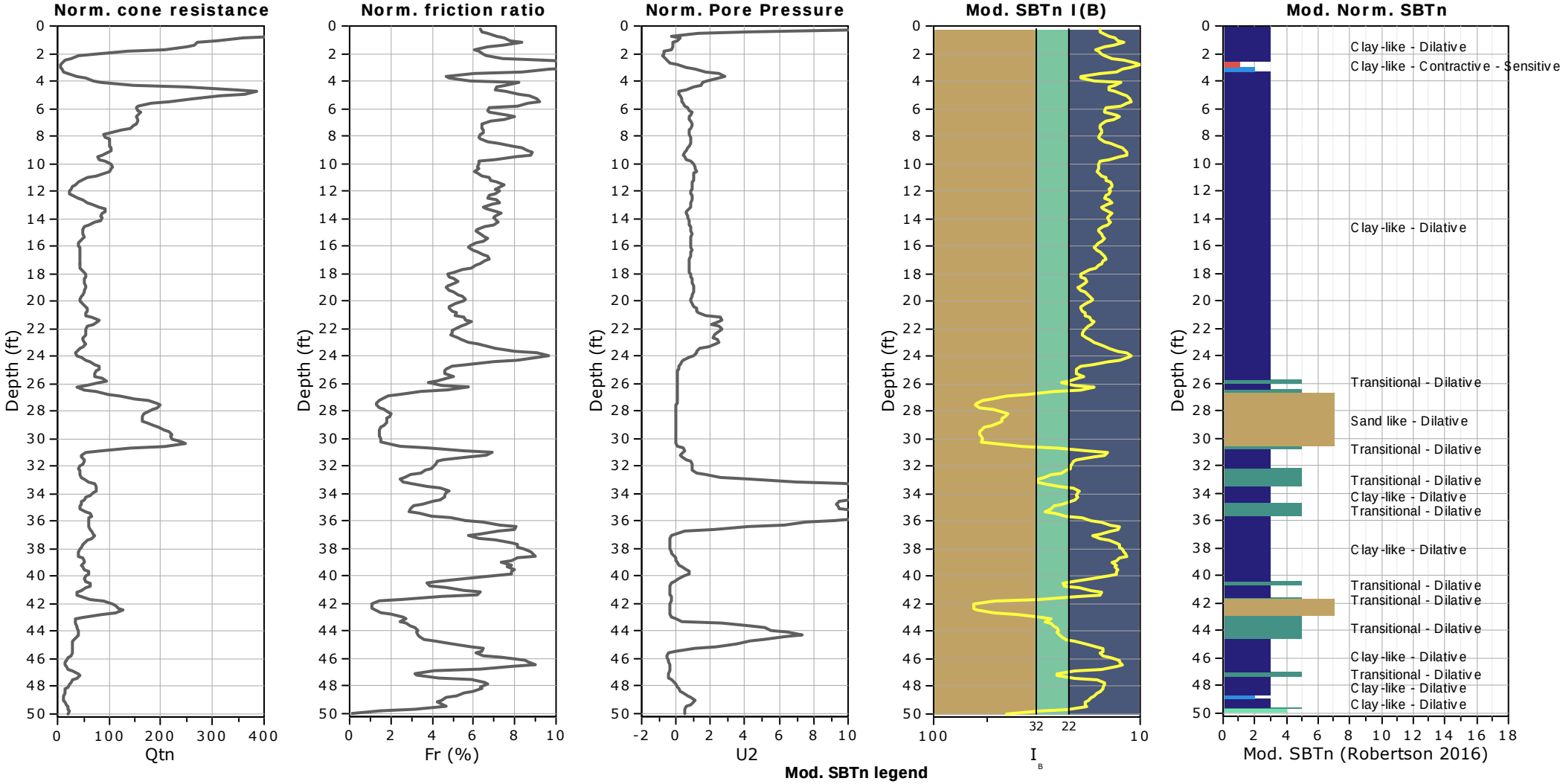
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



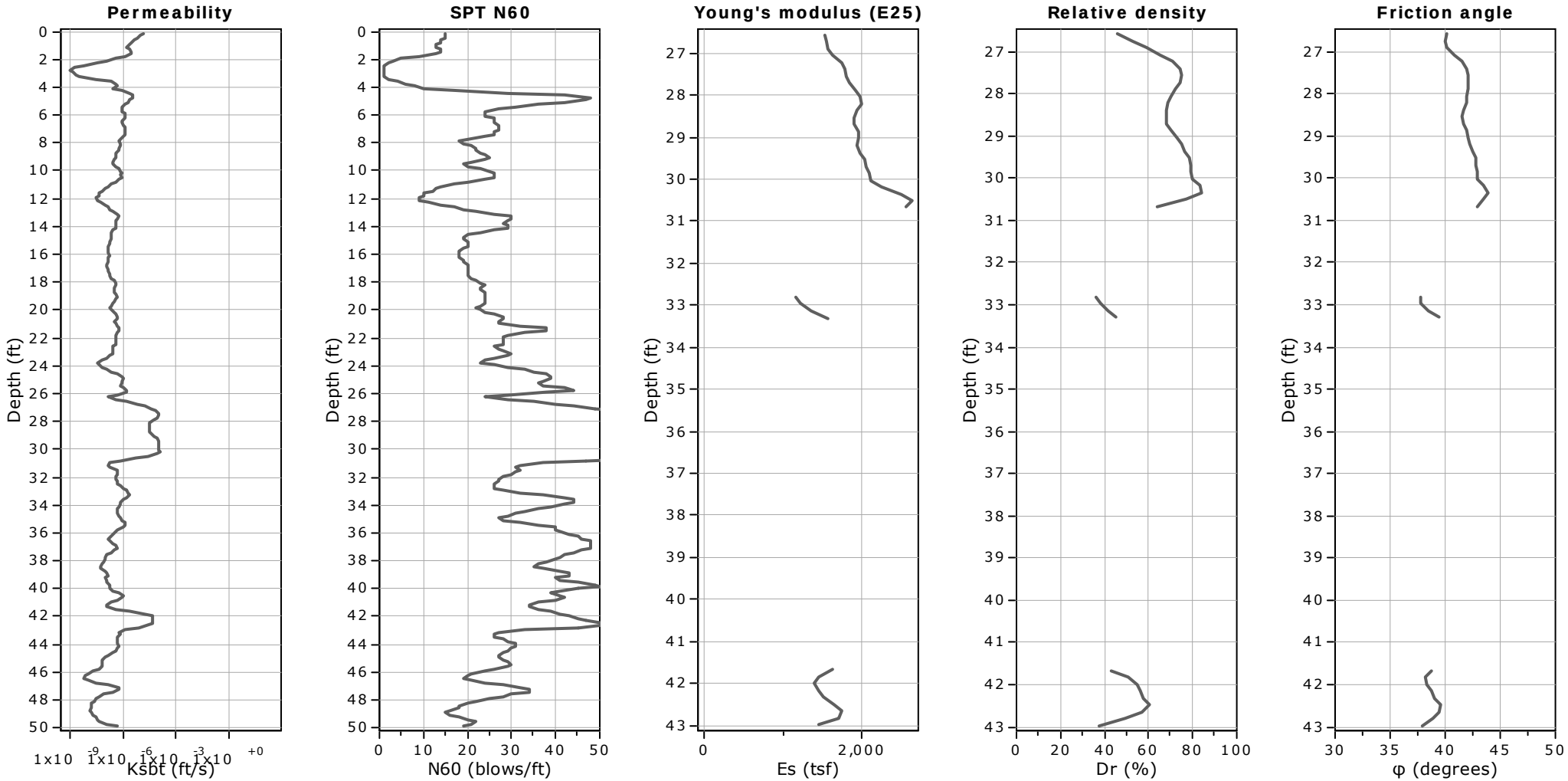
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



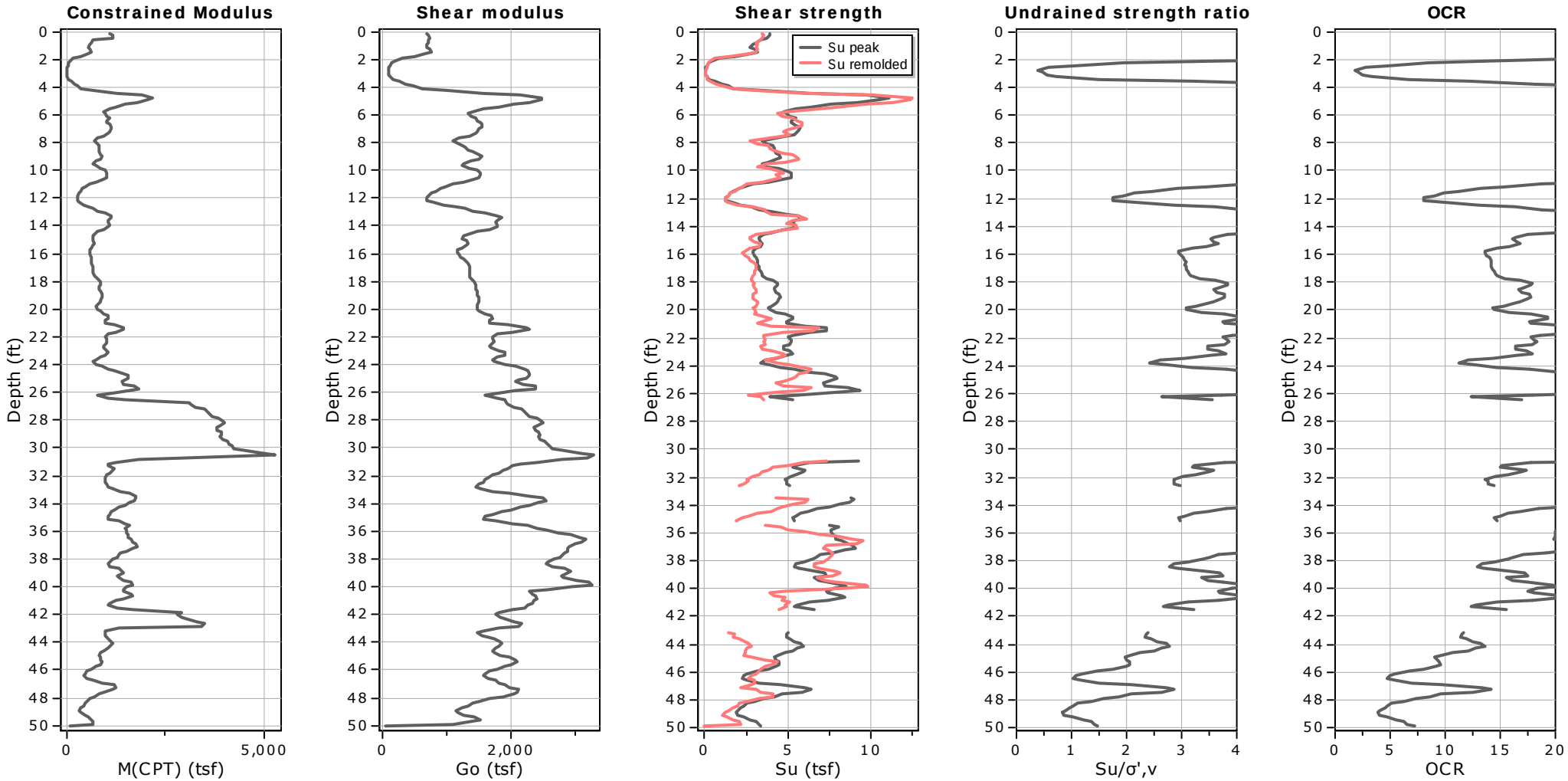
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



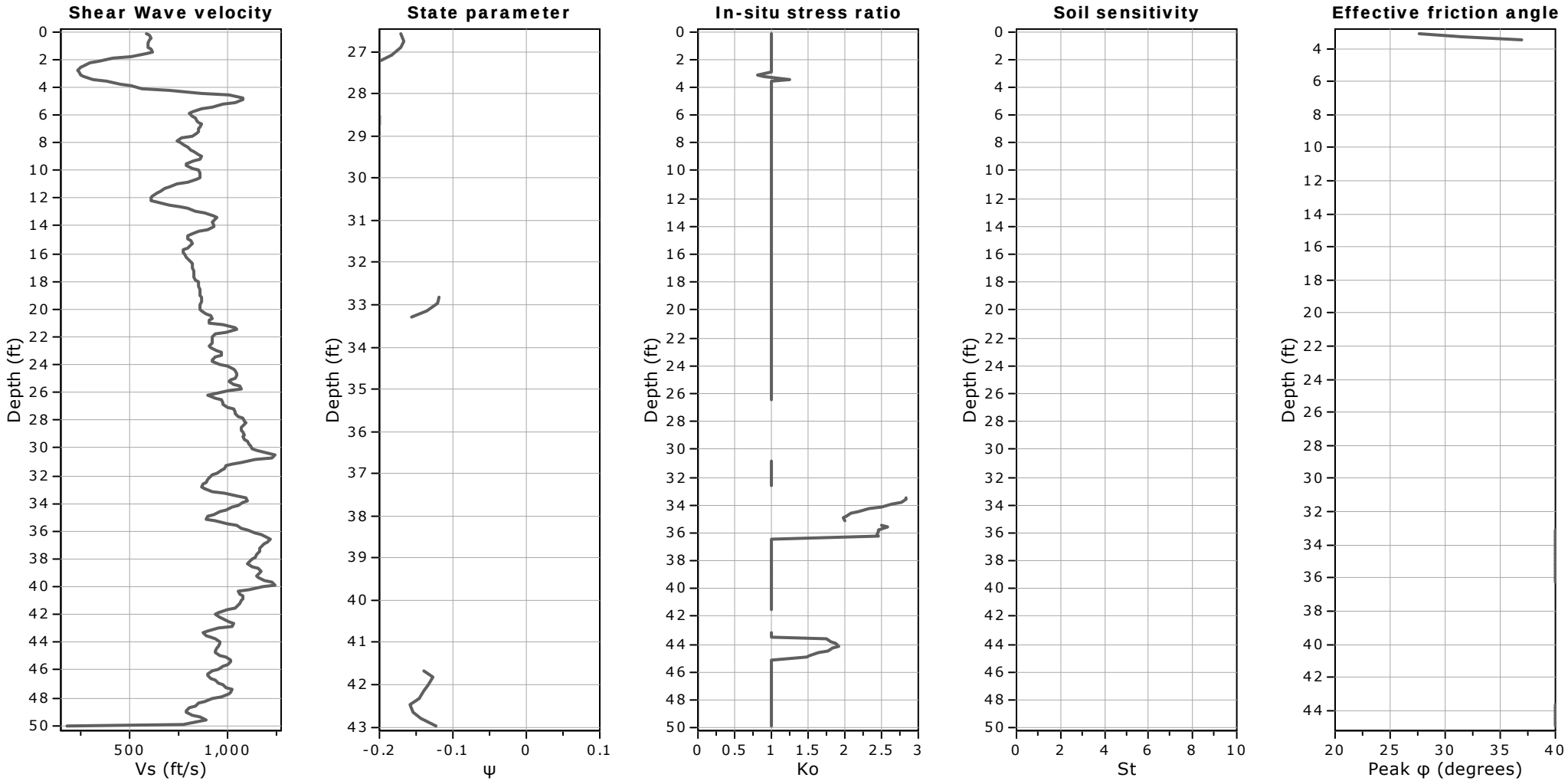
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-7
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

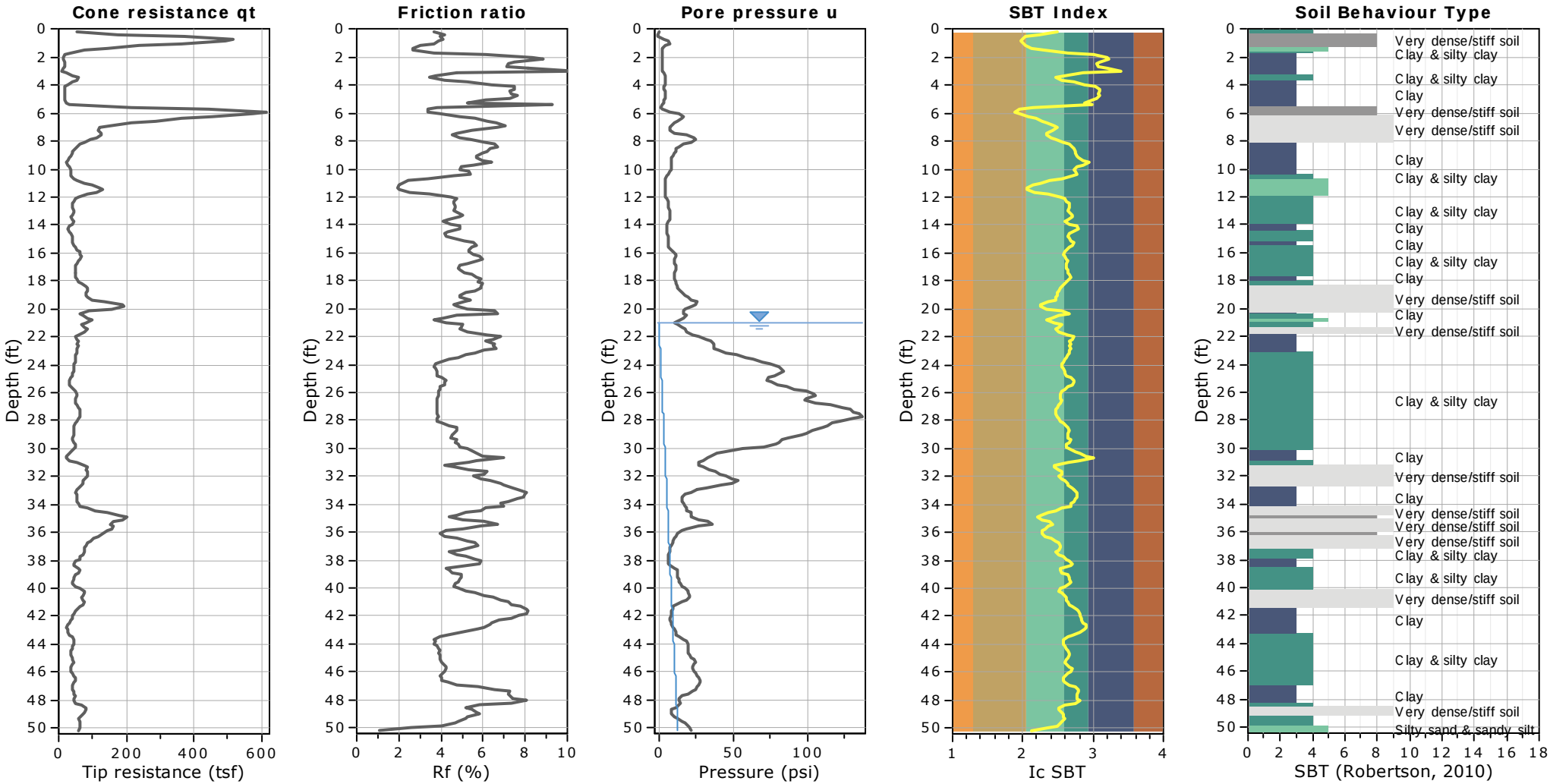
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



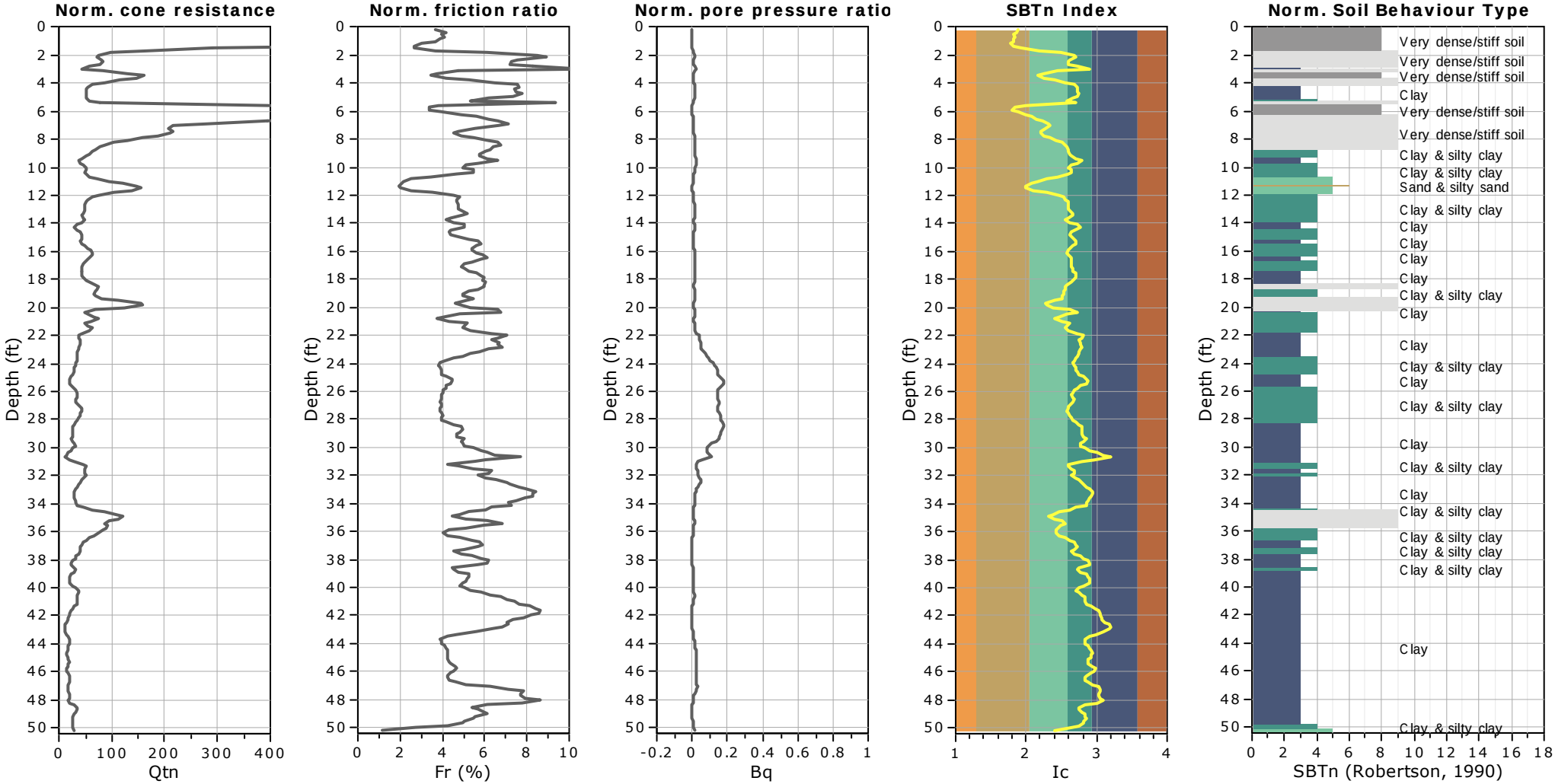
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



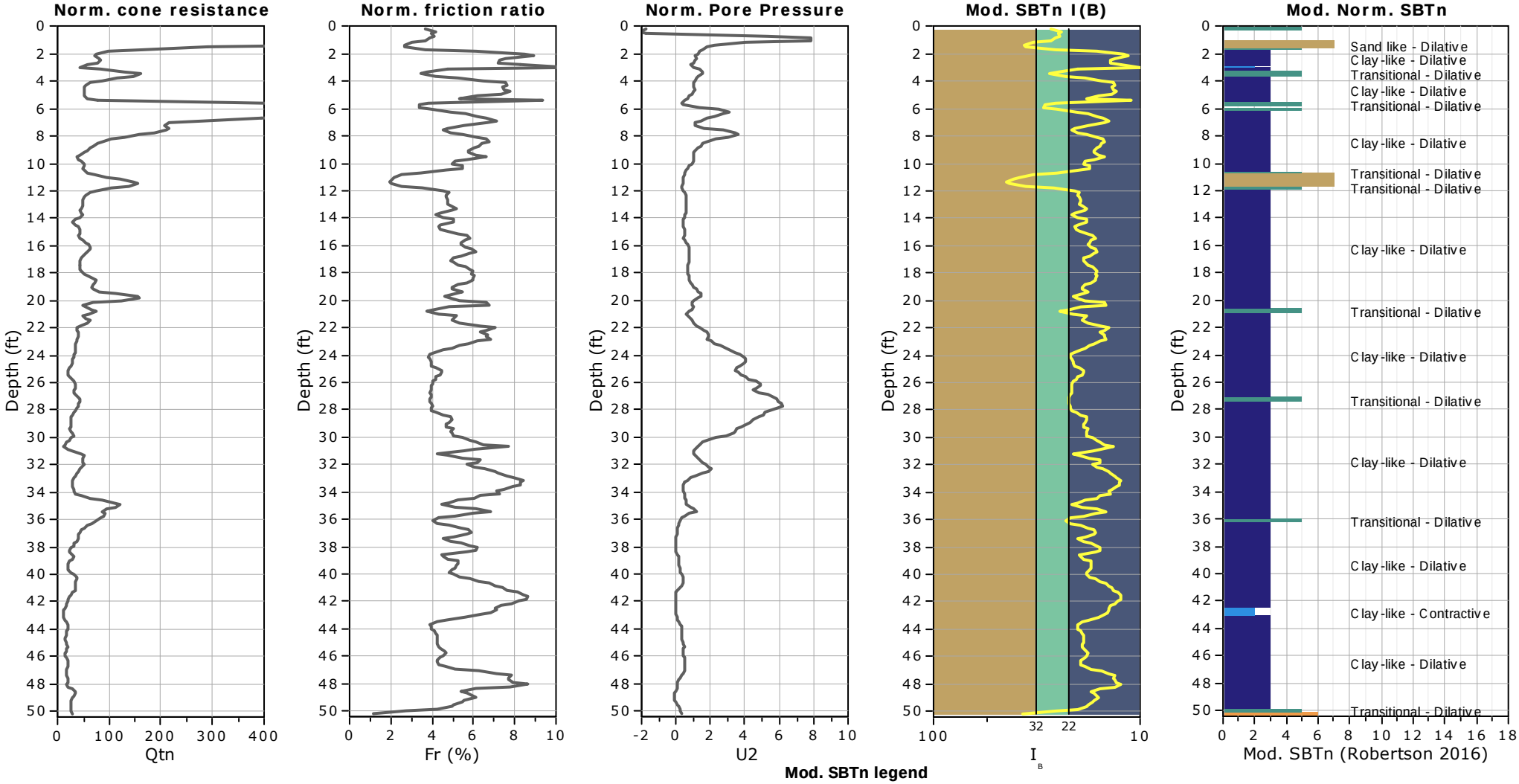
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



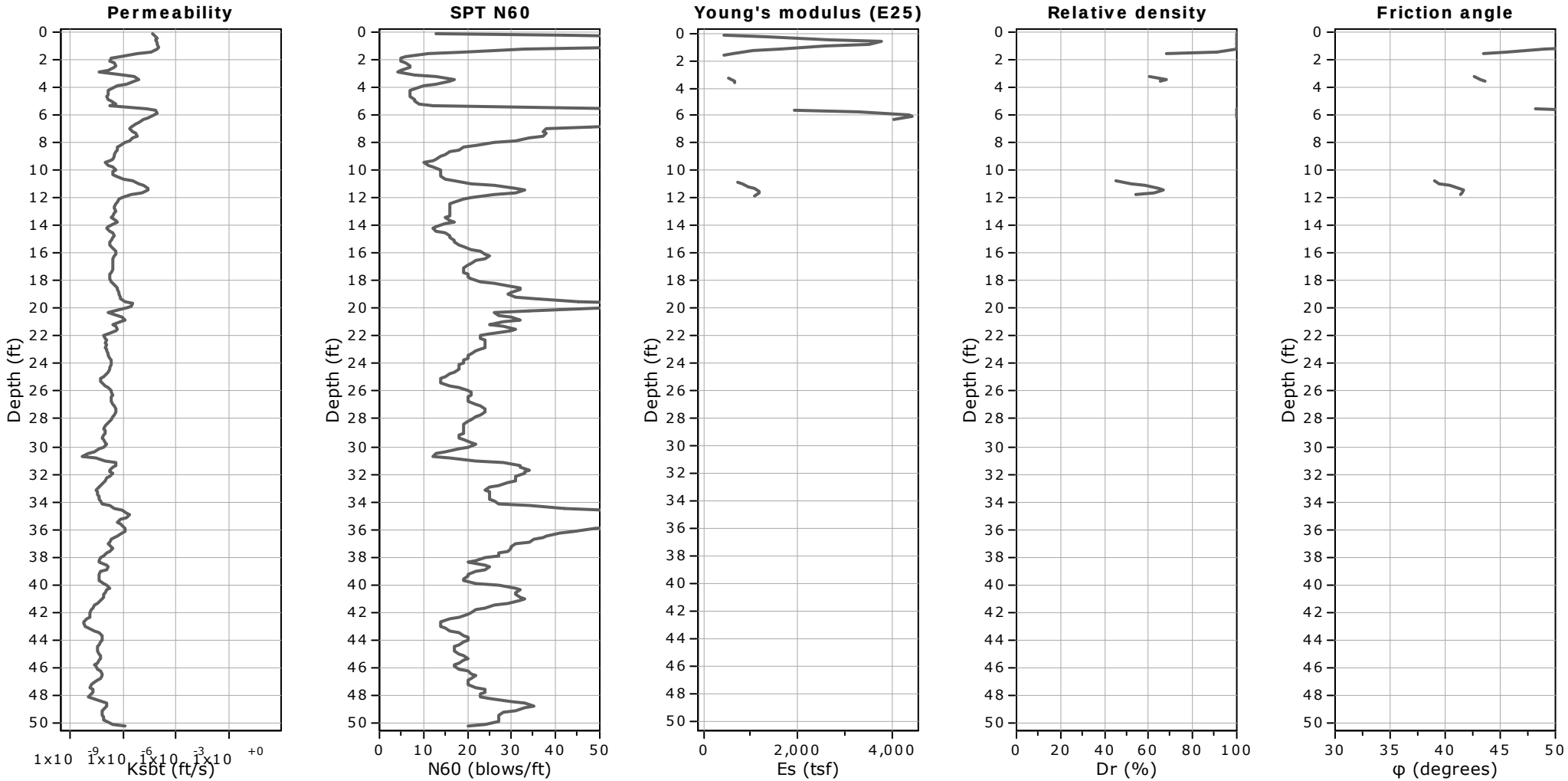
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



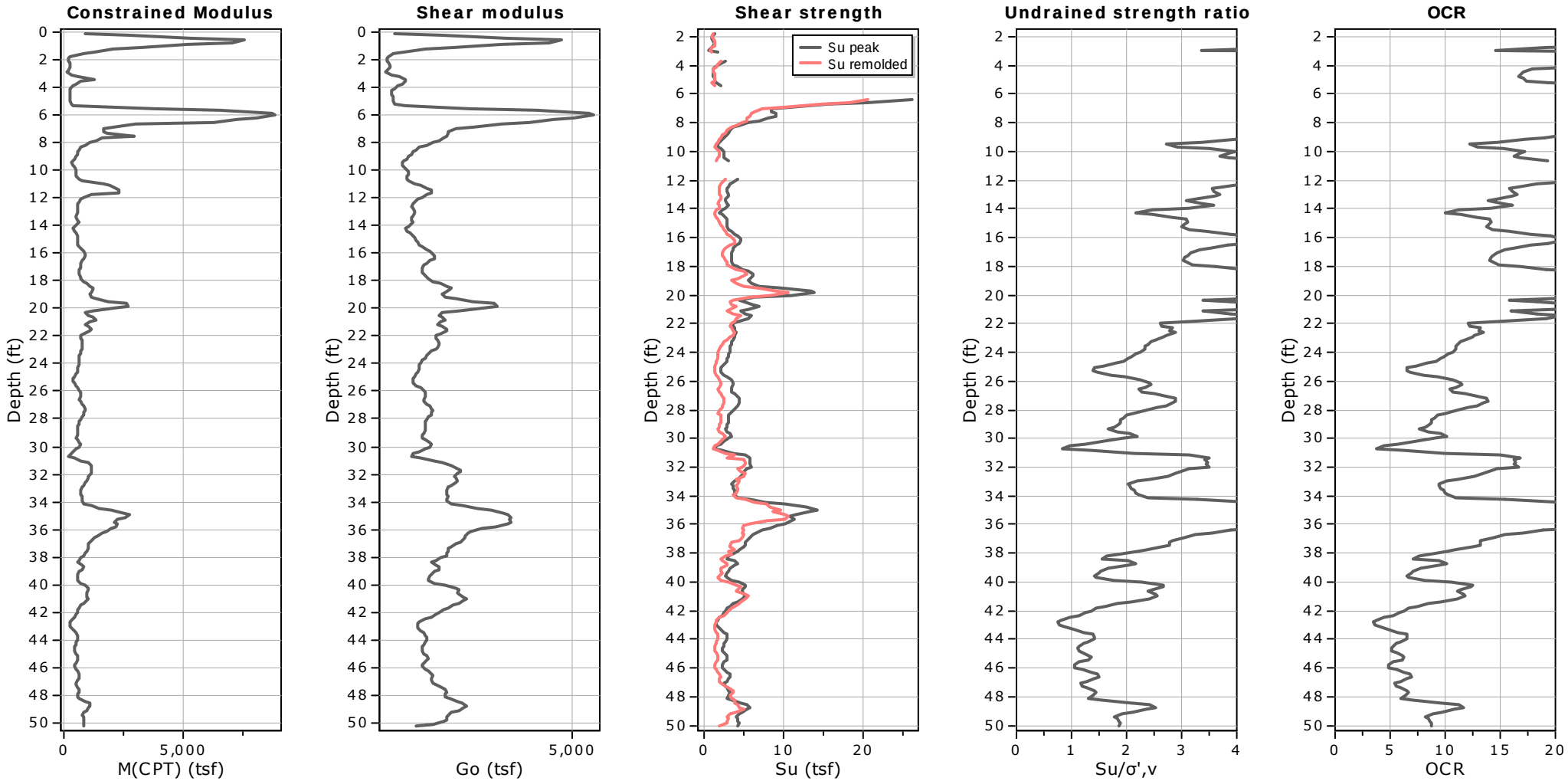
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



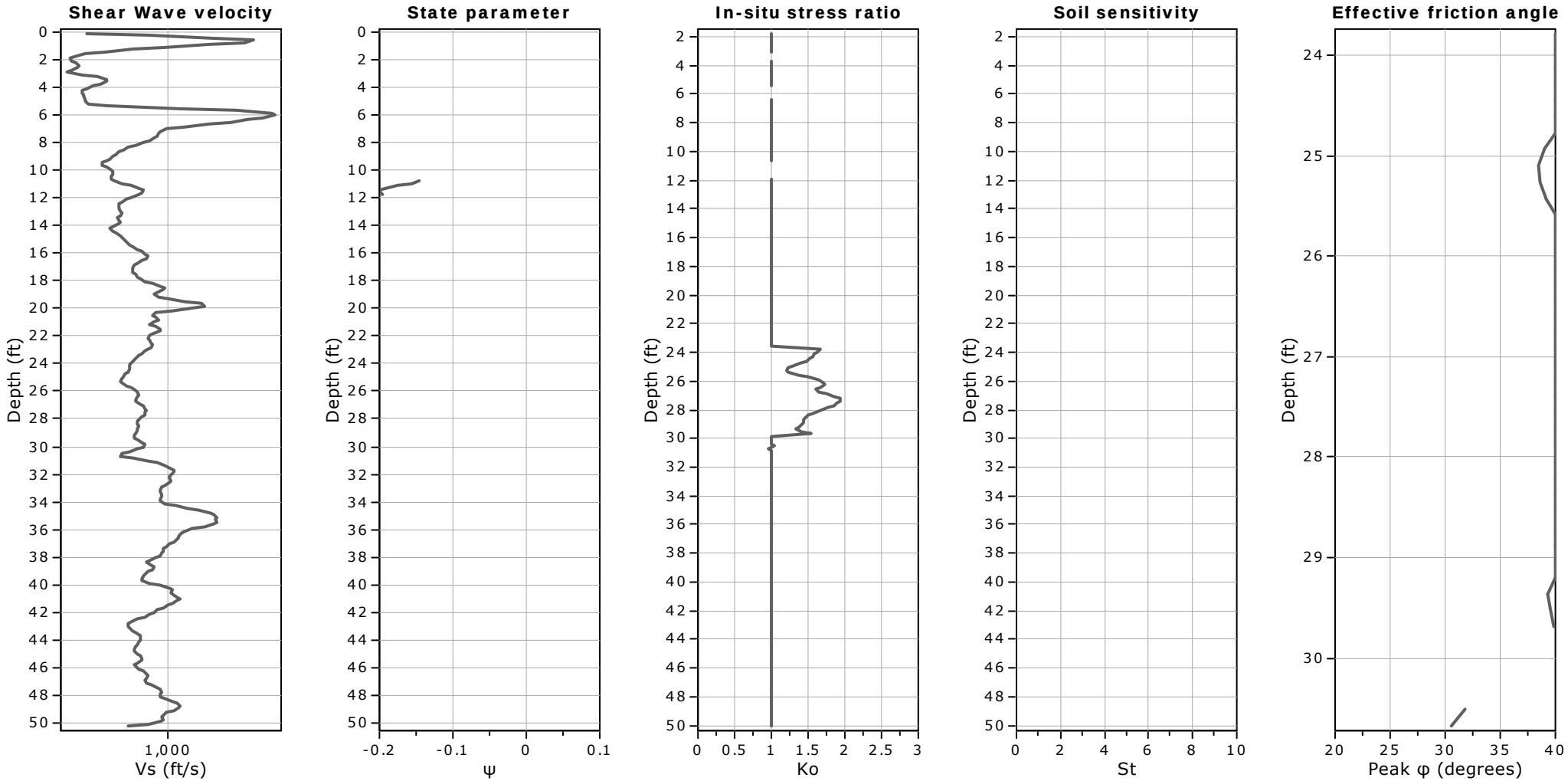
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-8
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



Calculation parameters

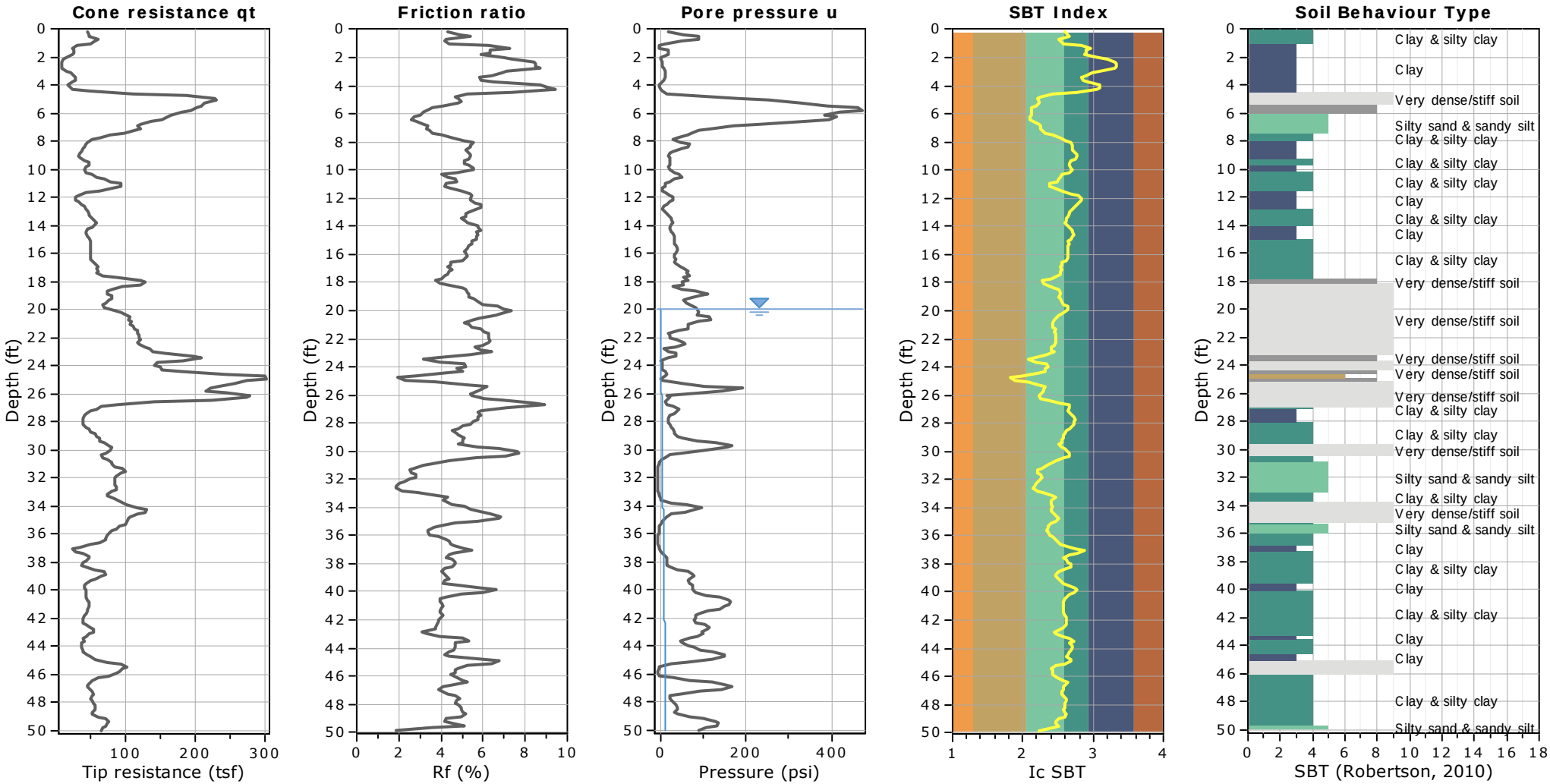
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



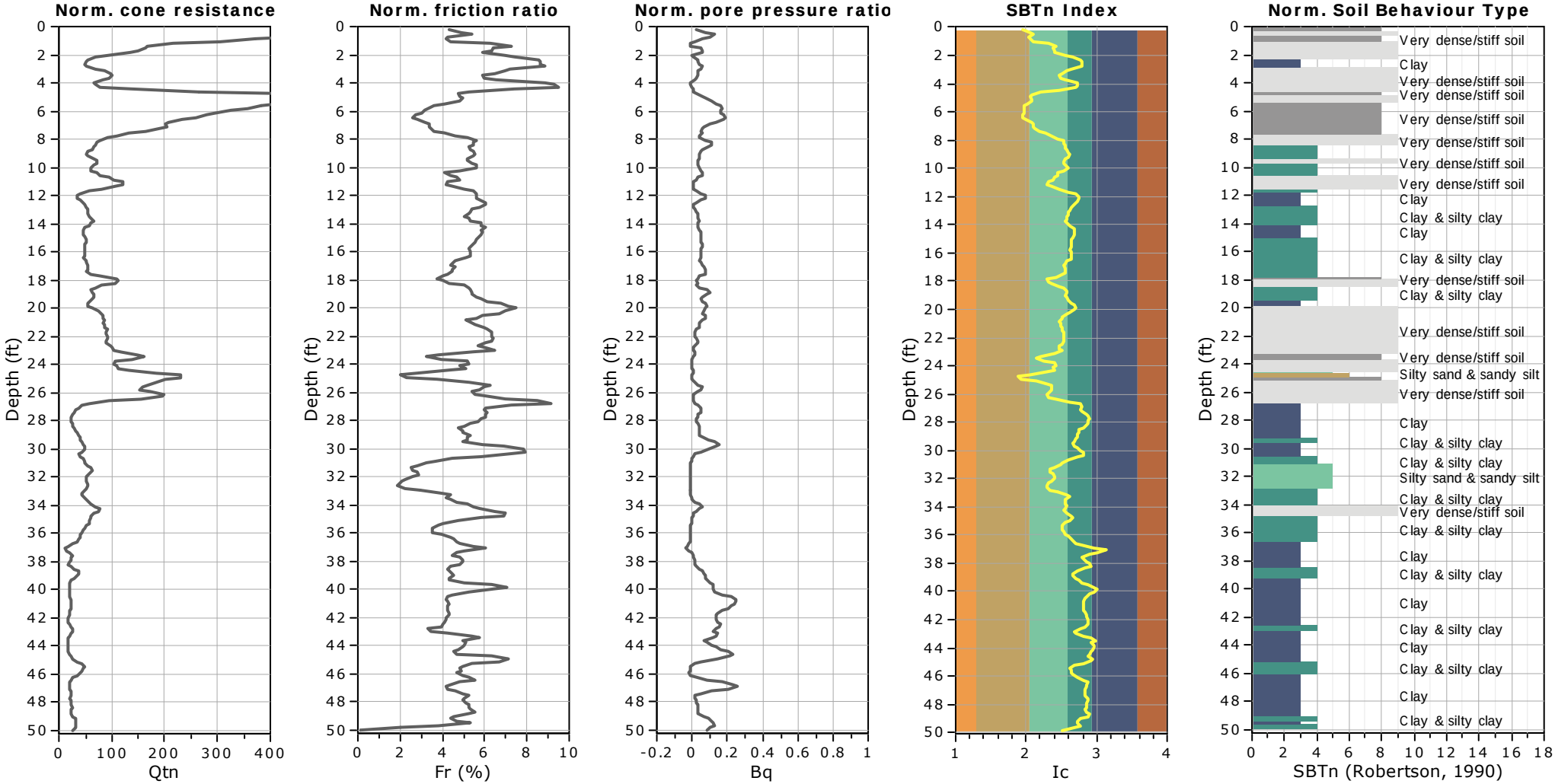
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



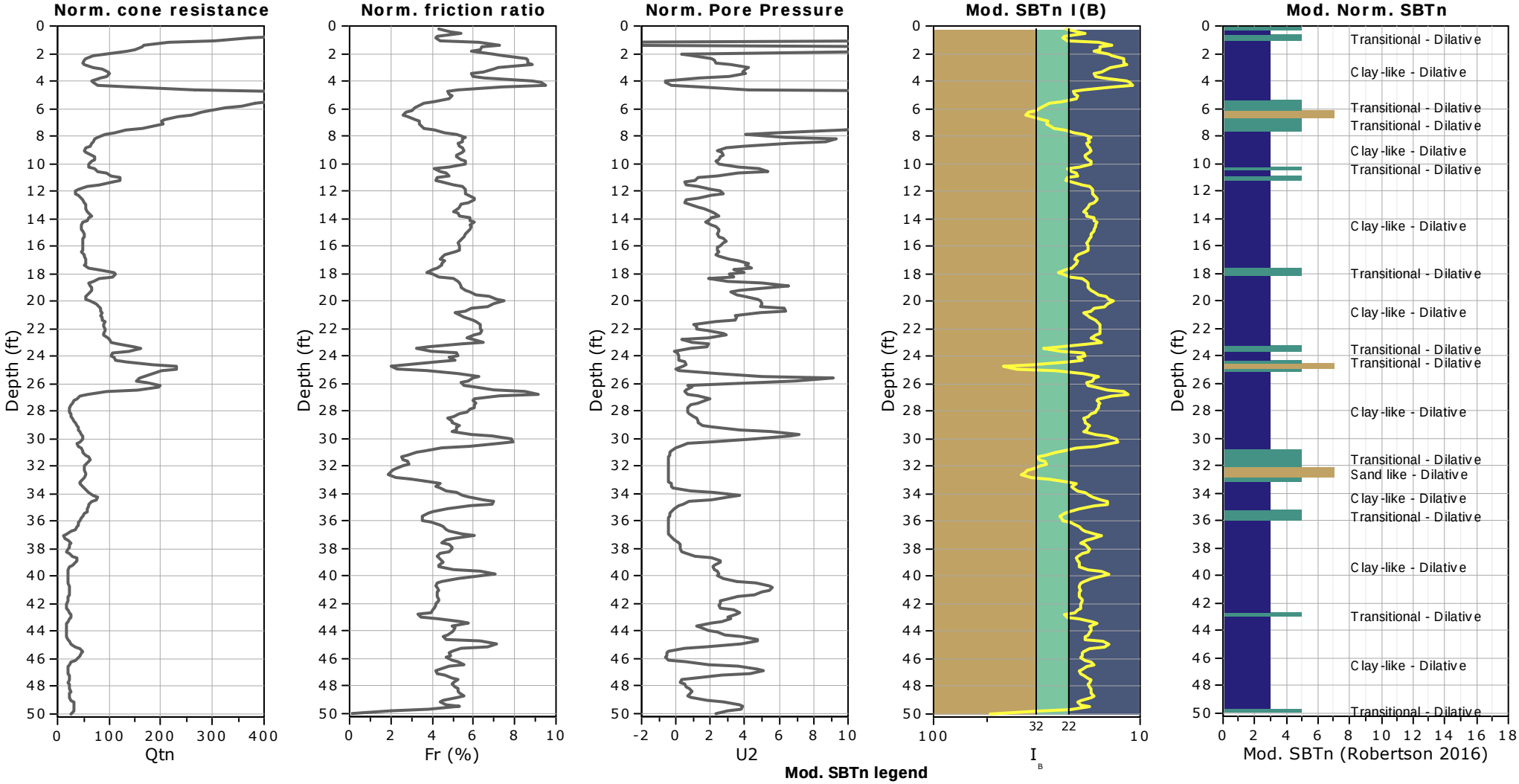
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



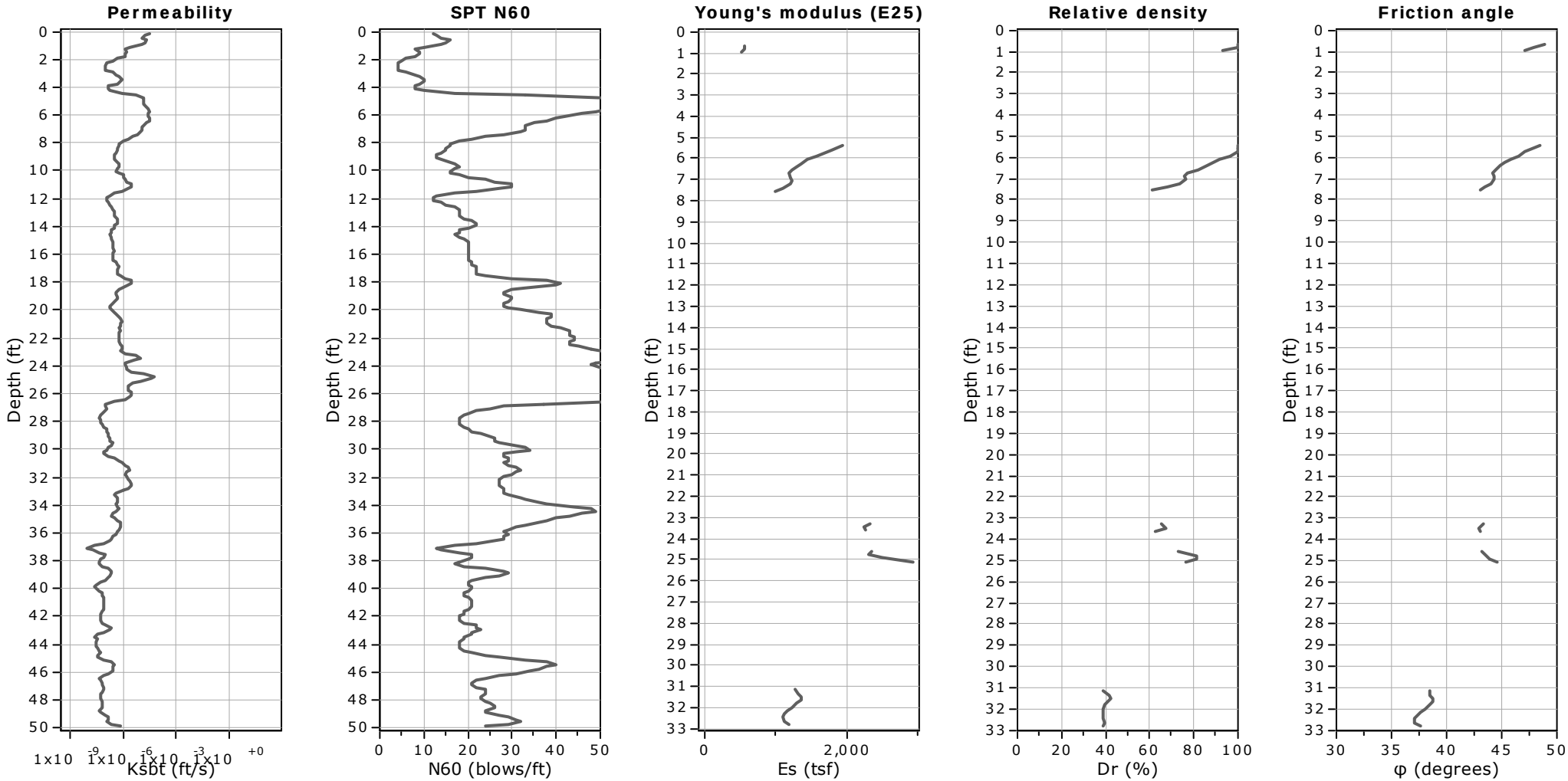
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



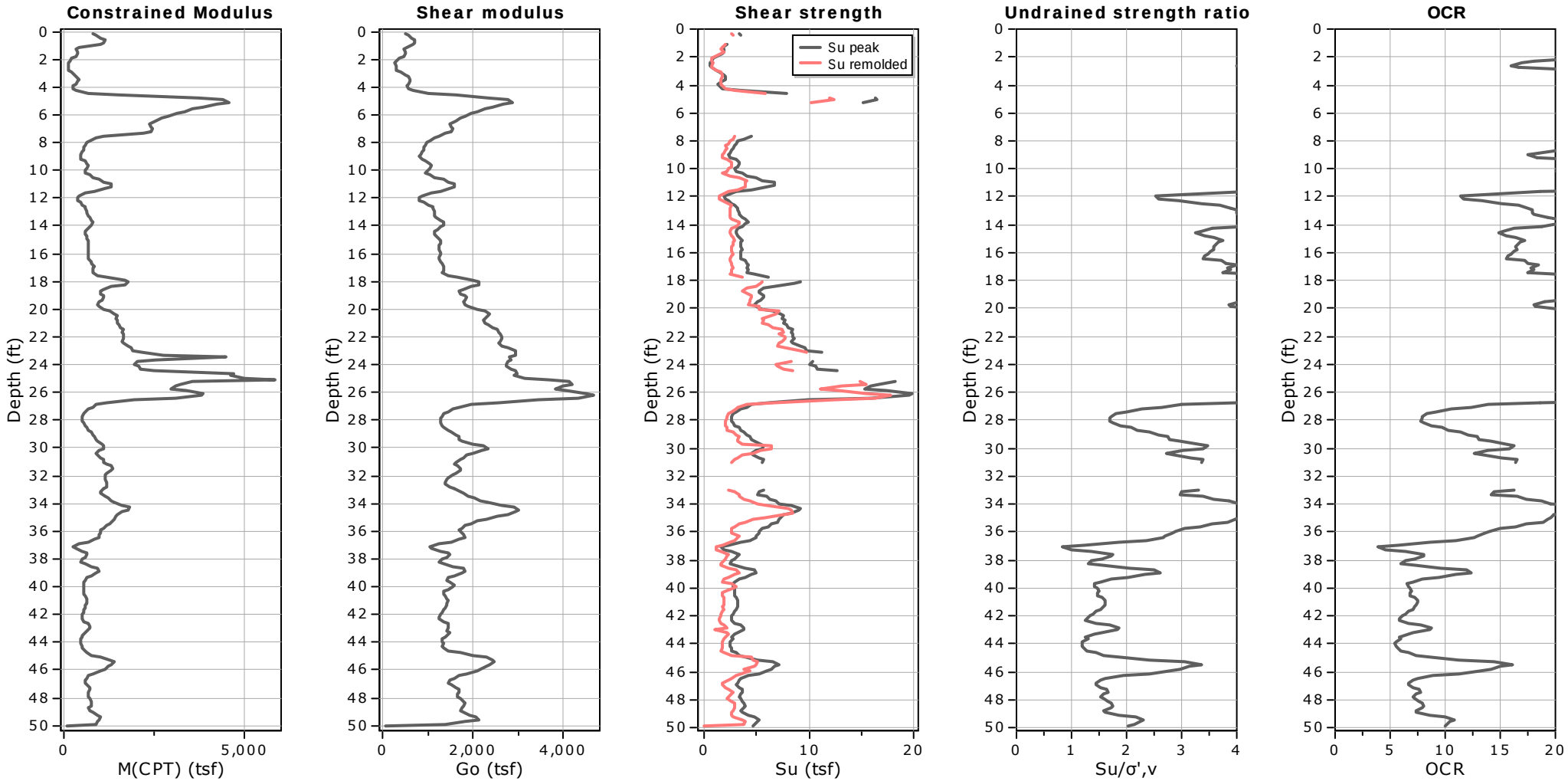
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



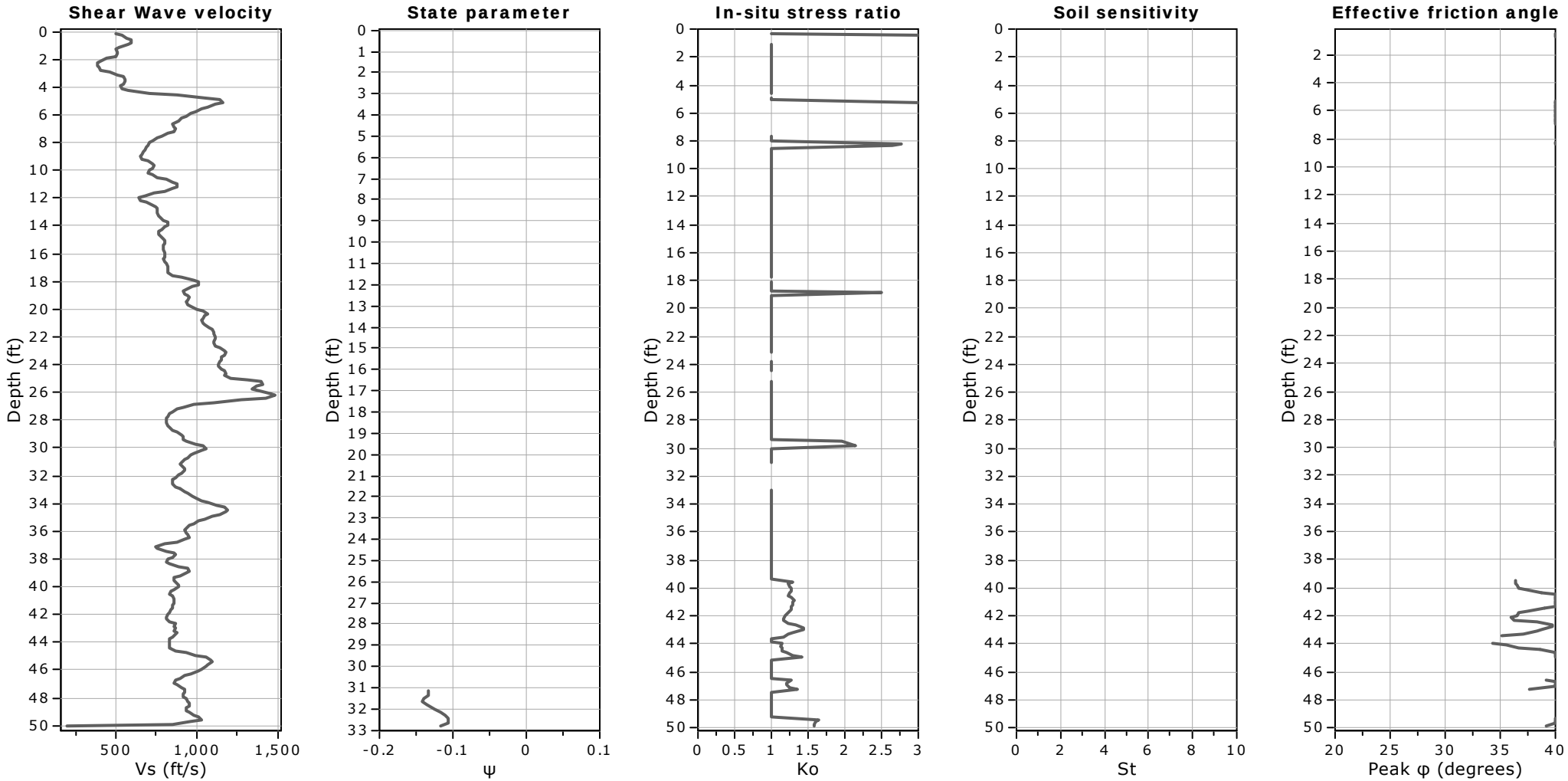
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-9
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

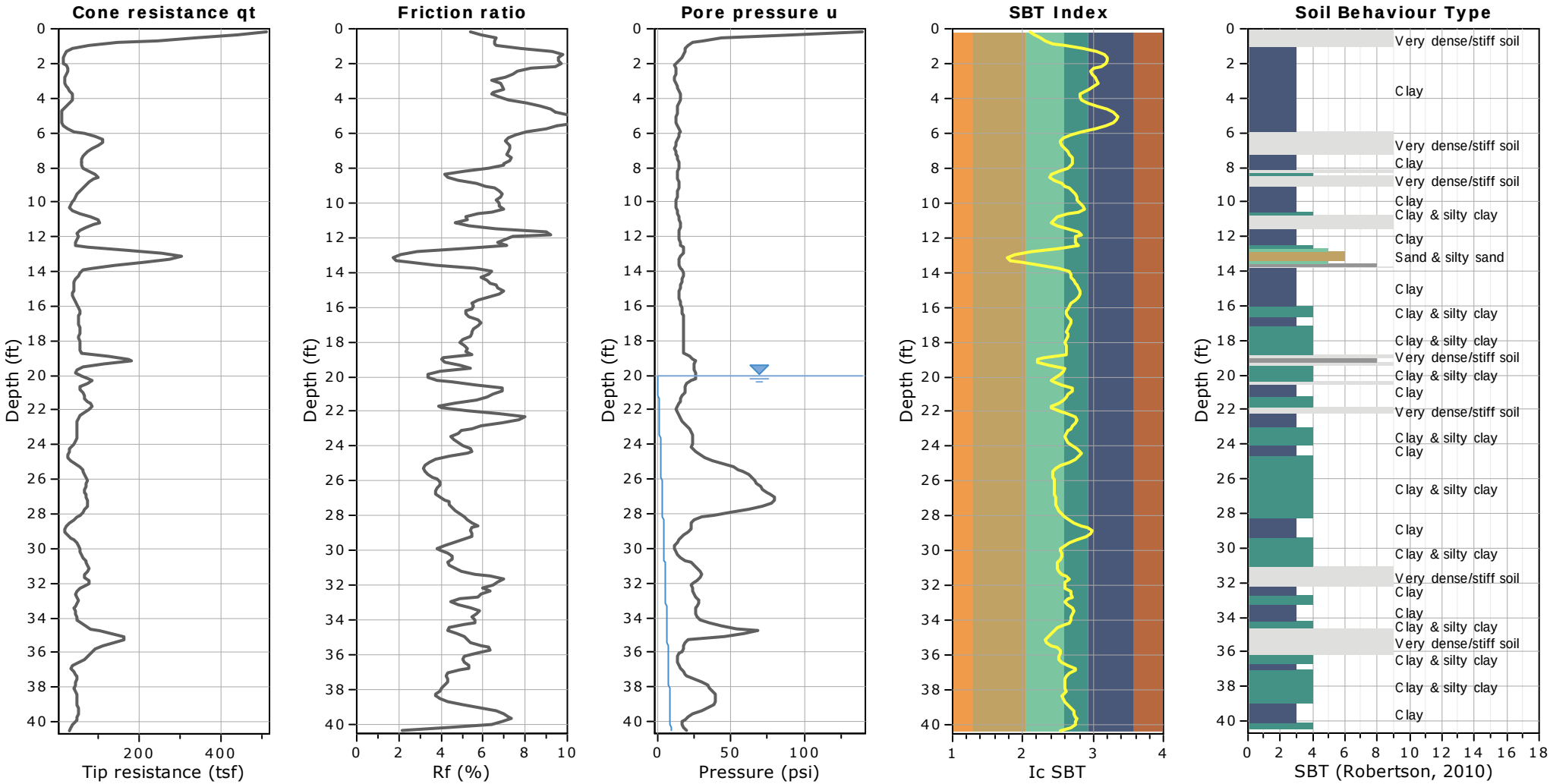
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



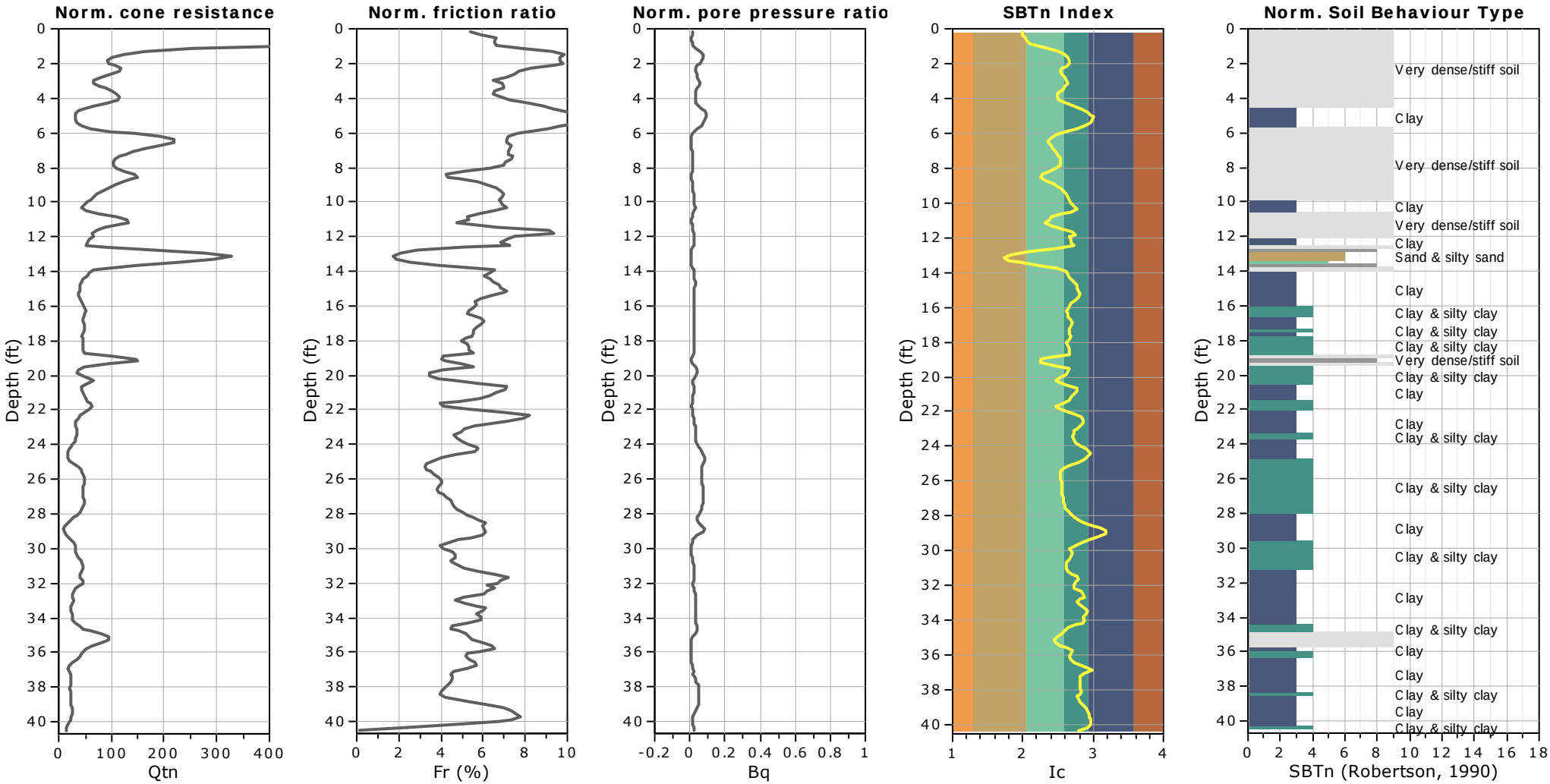
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



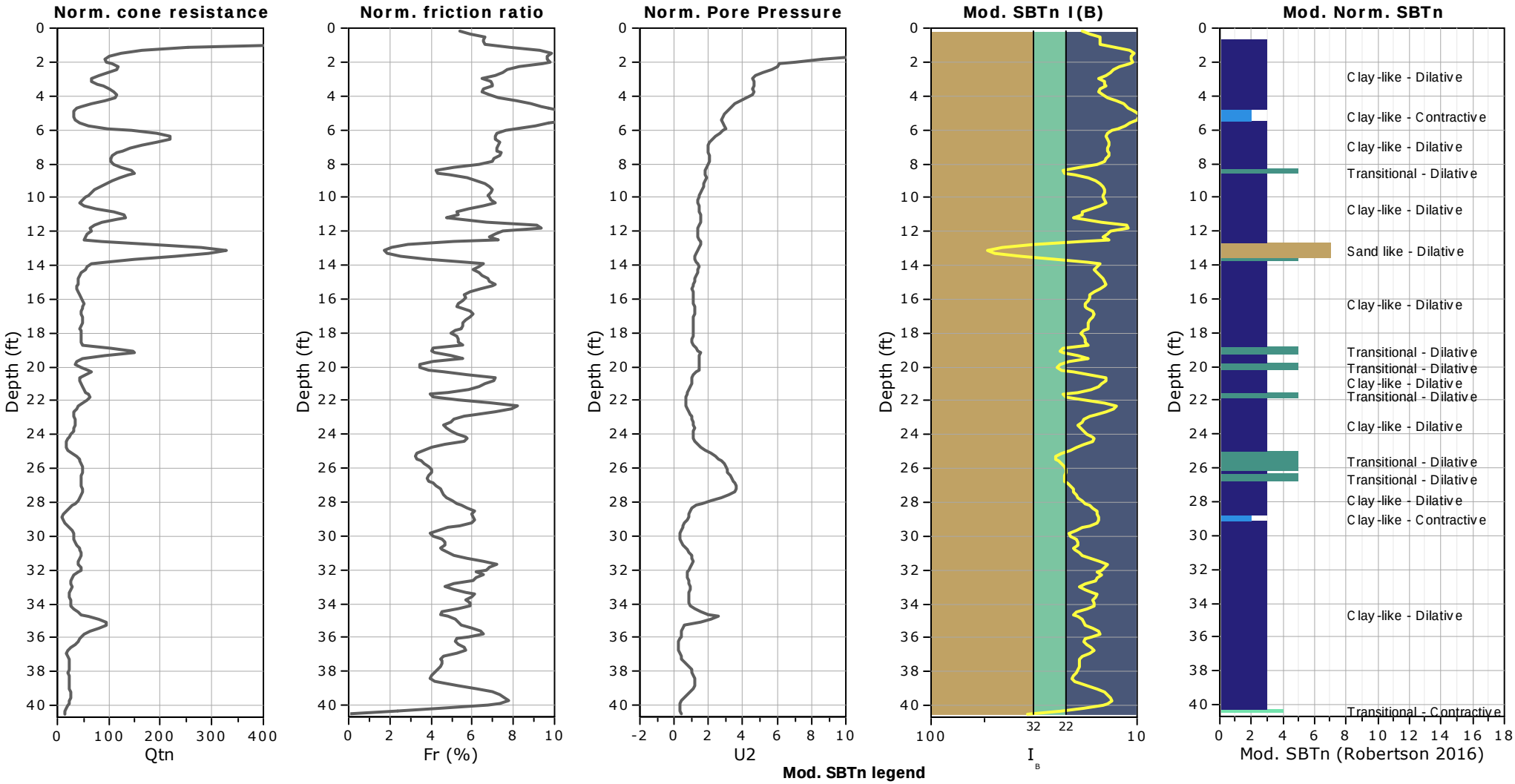
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



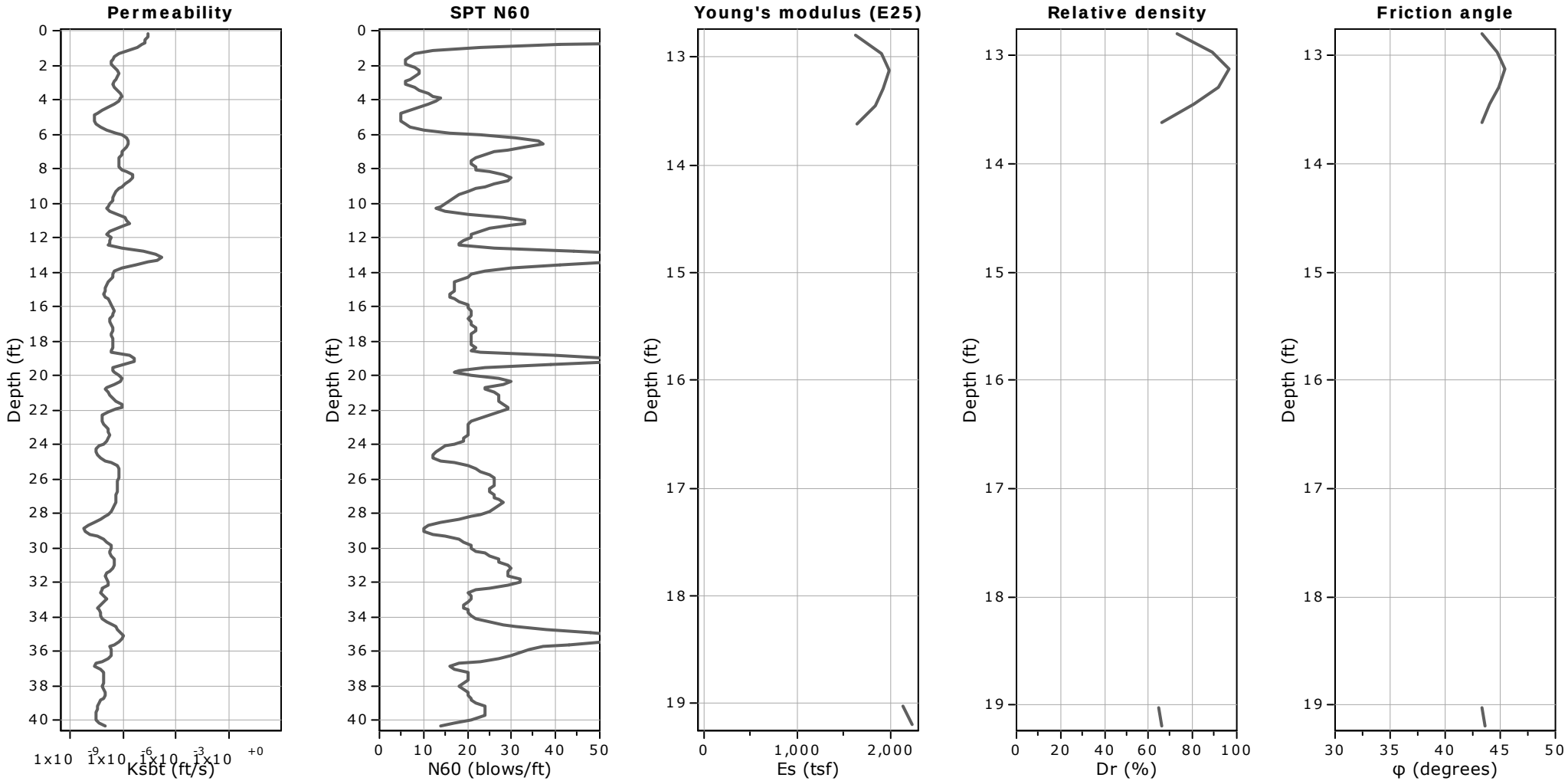
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



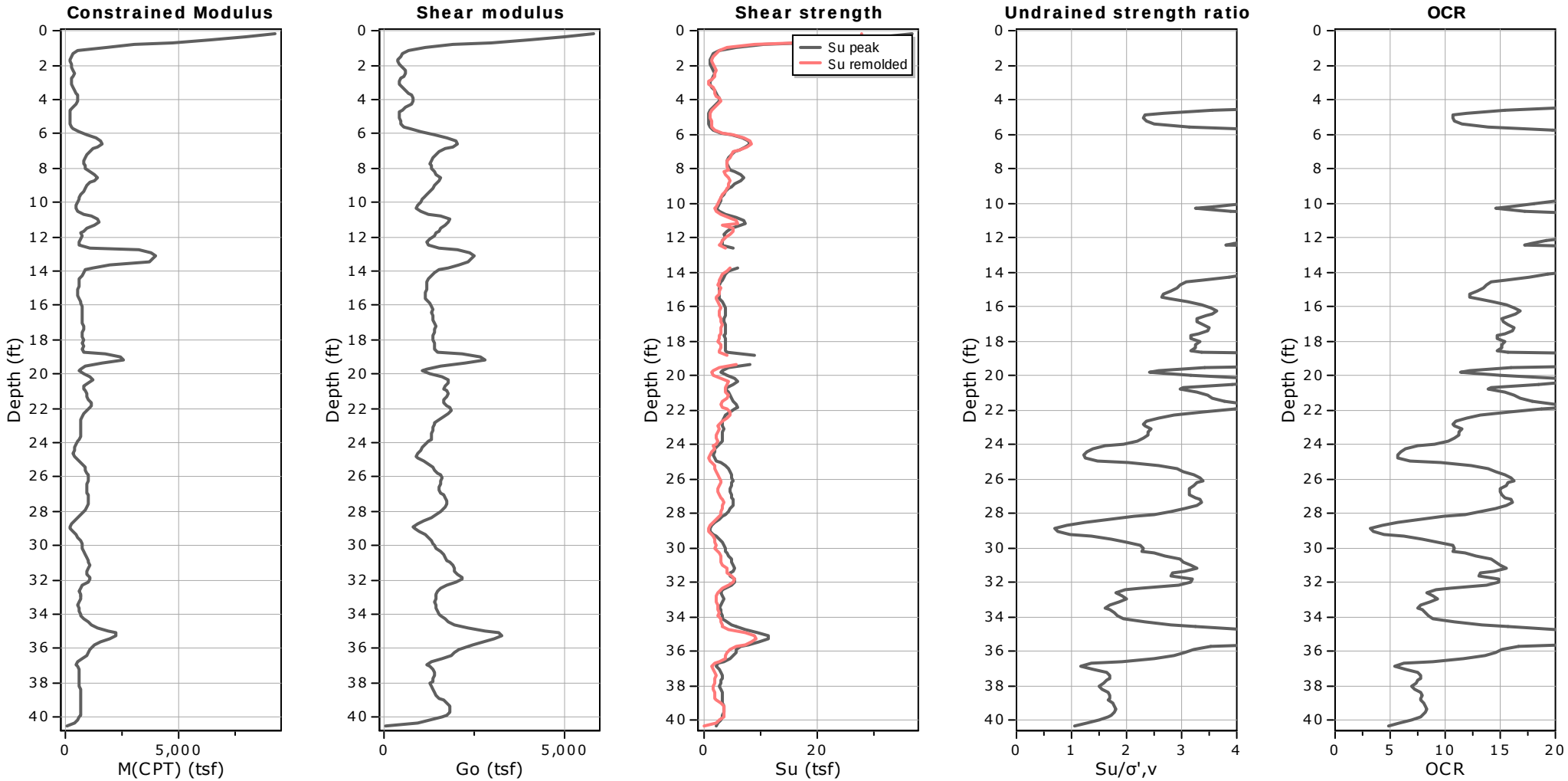
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



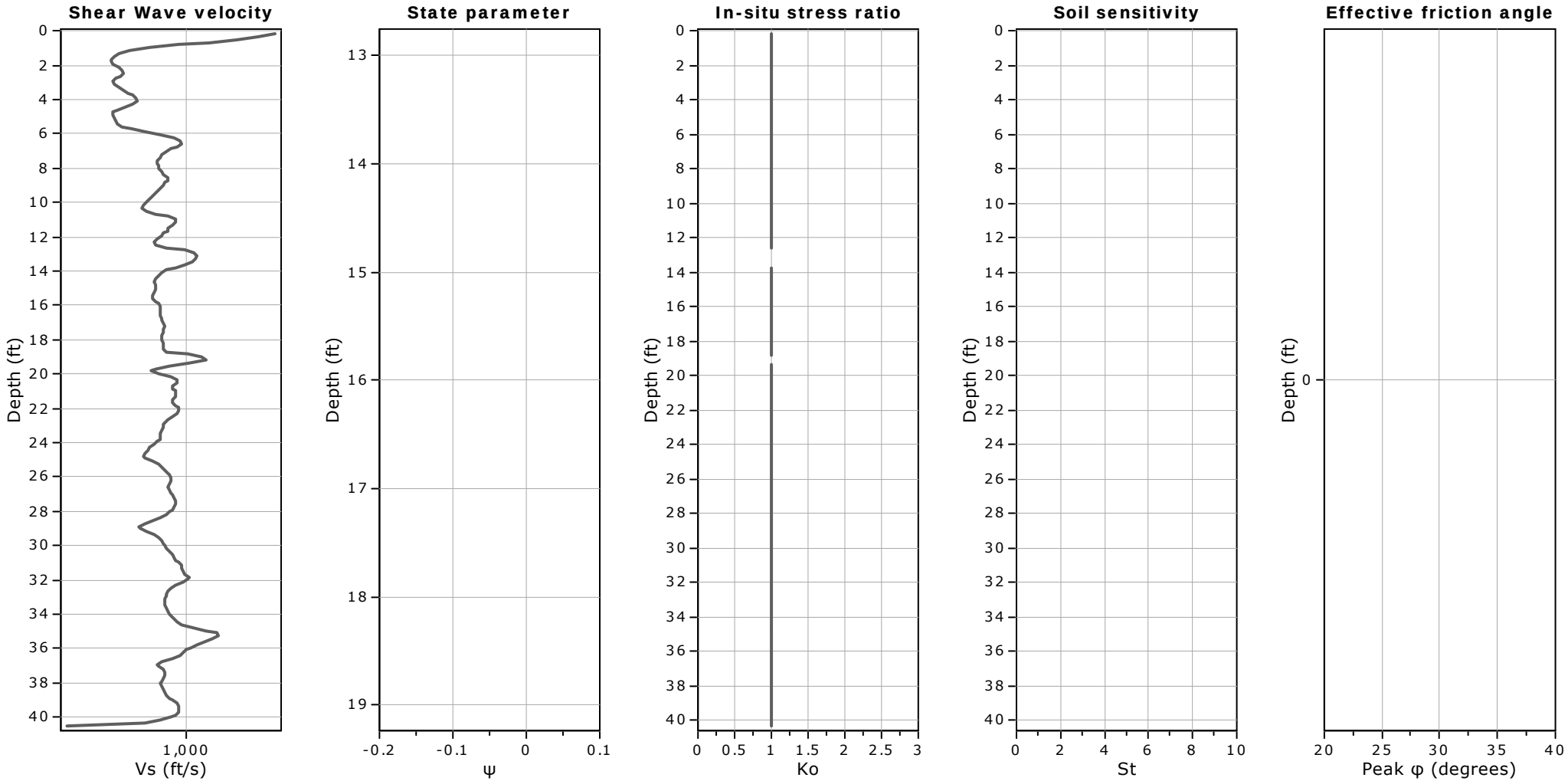
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-10
Total depth: 40.52 ft
Surface Elevation: 0.00 ft



Calculation parameters

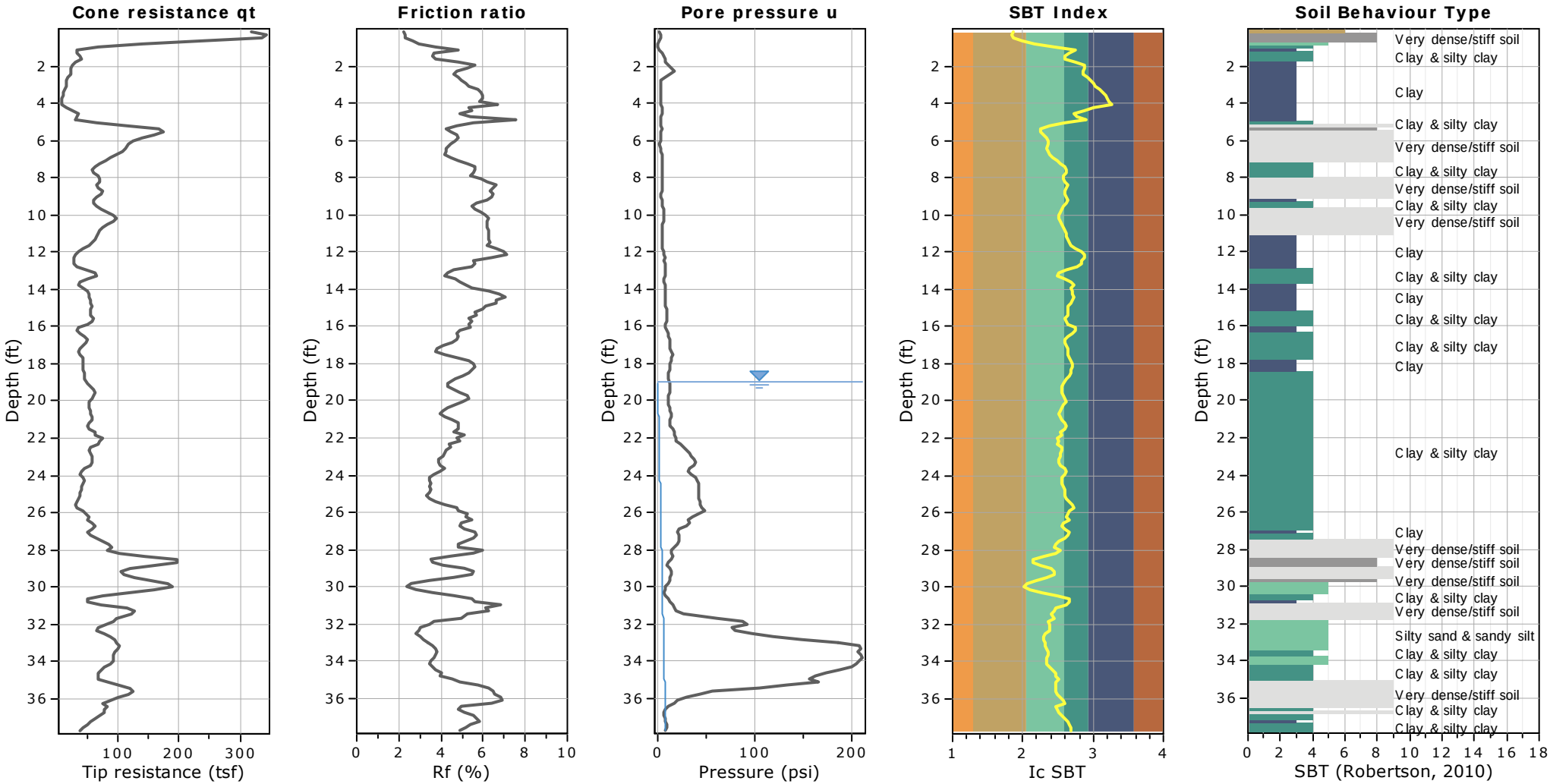
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



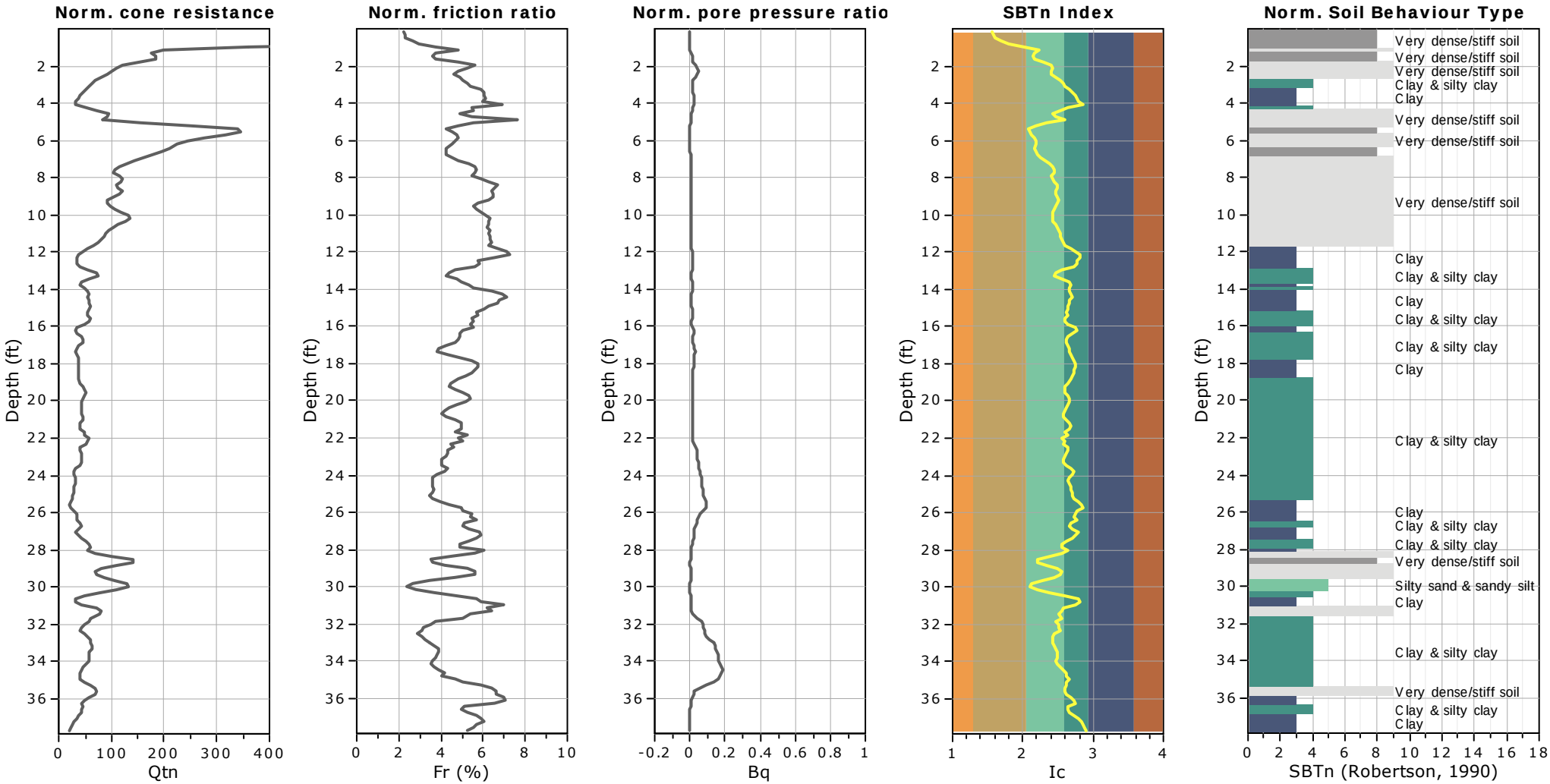
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



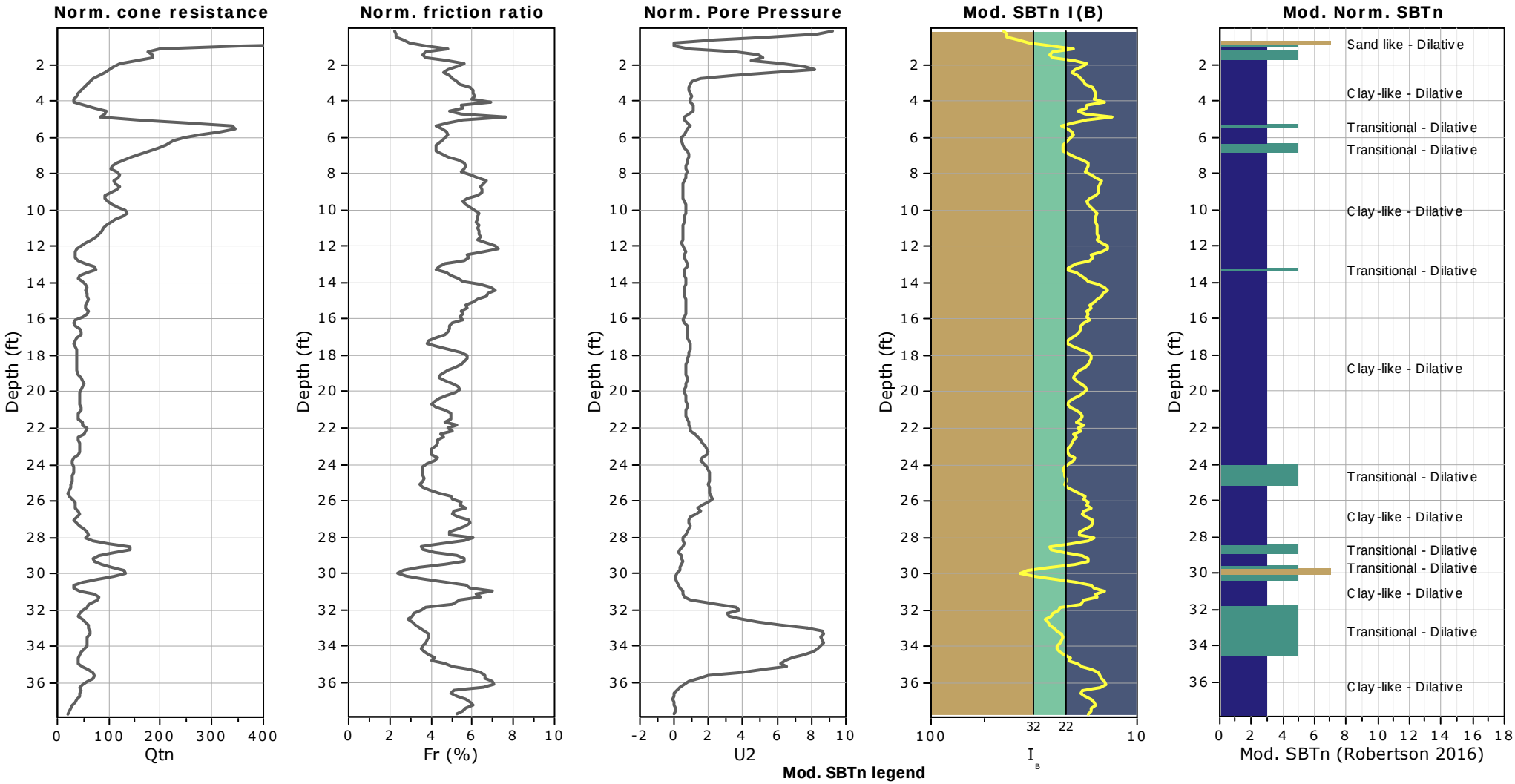
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



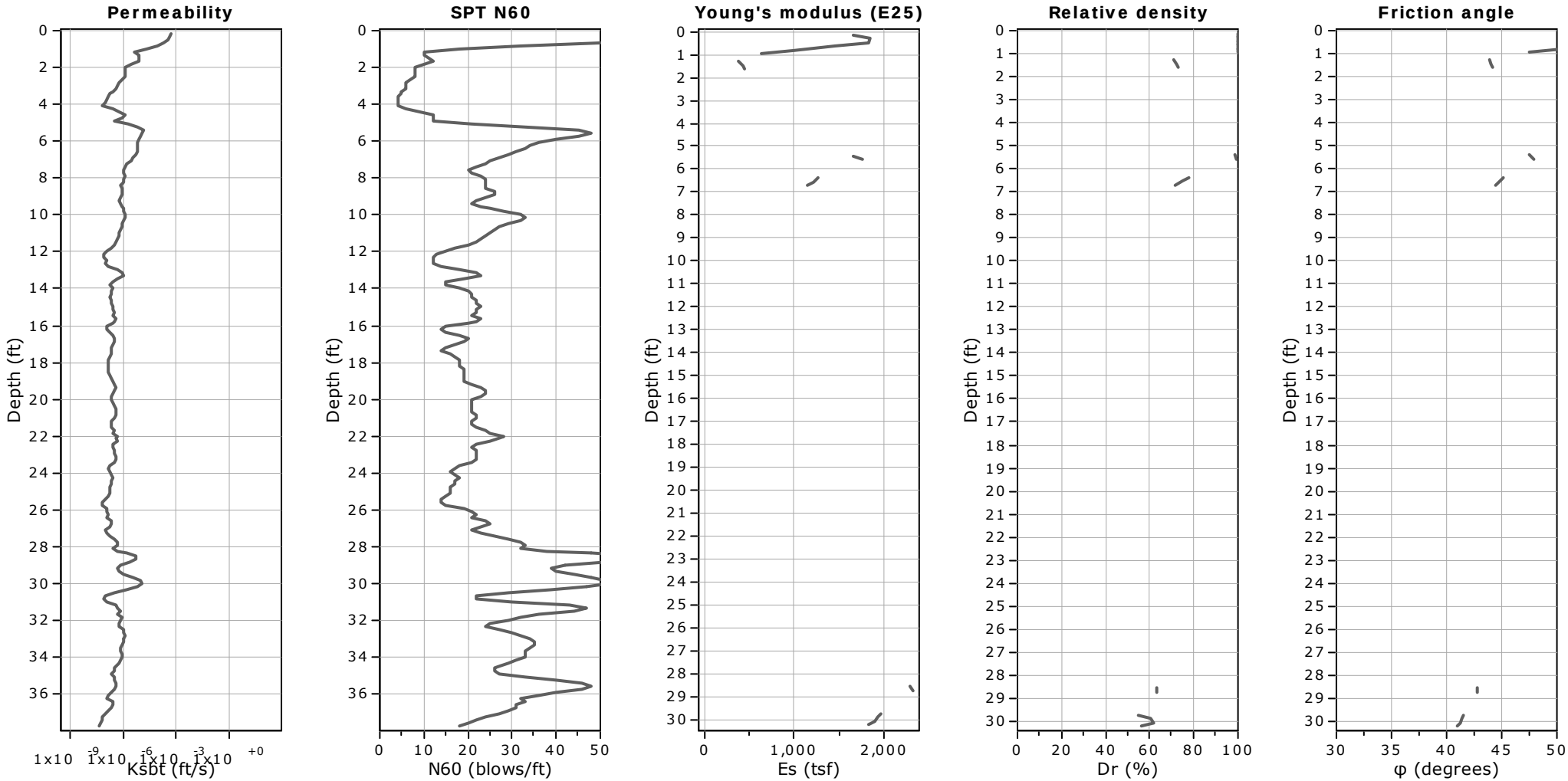
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



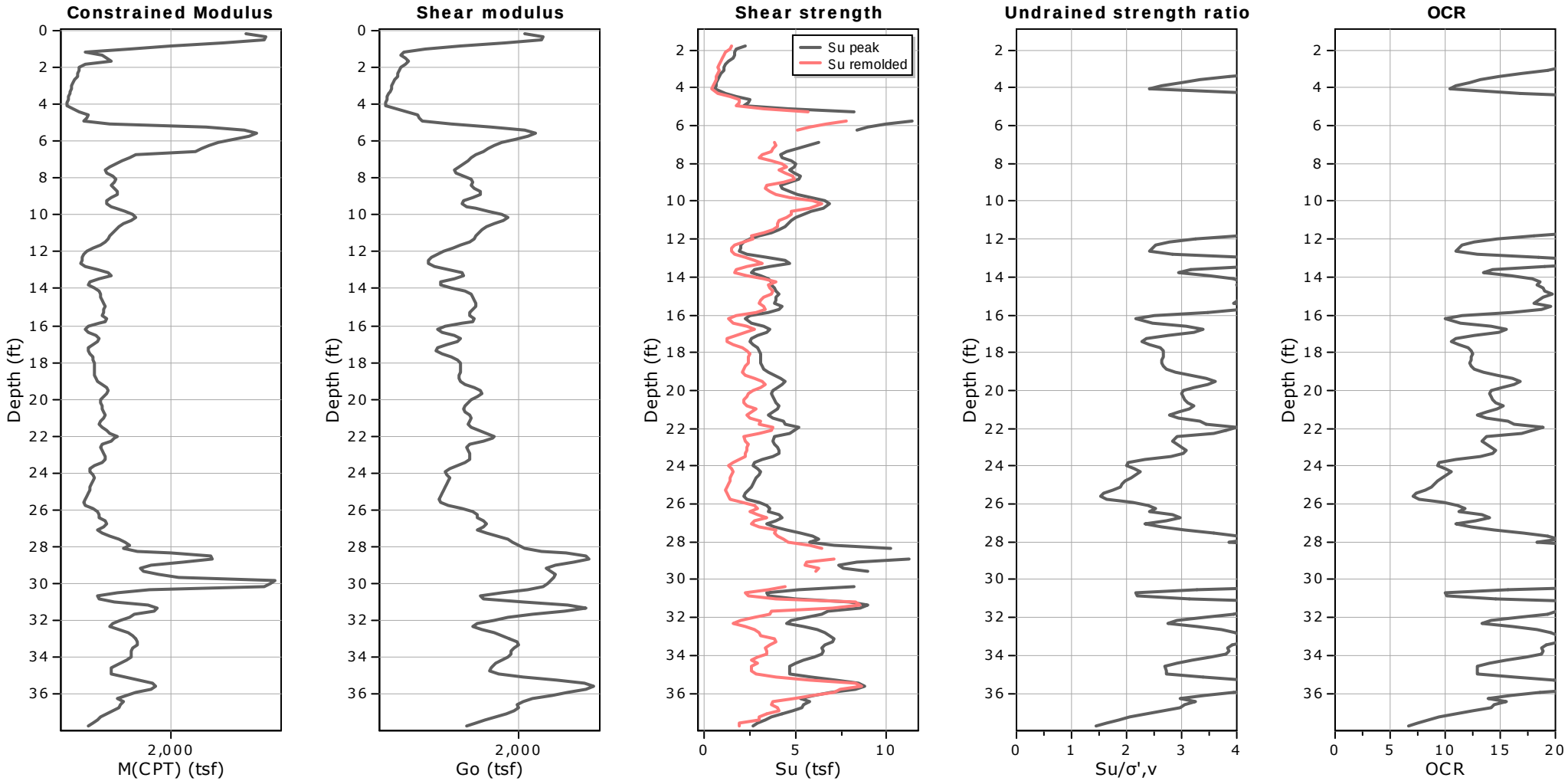
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



Calculation parameters

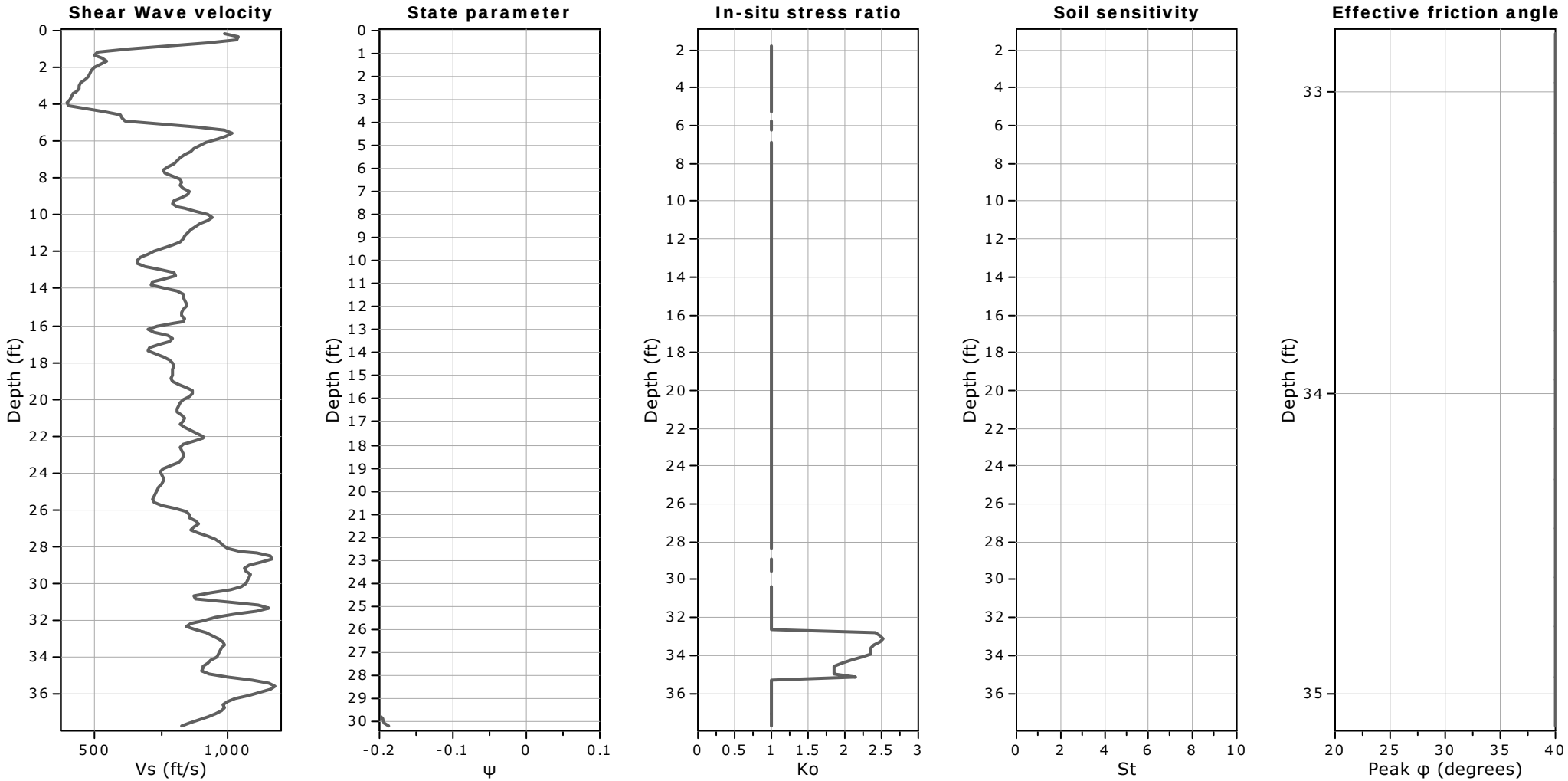
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-11
Total depth: 37.73 ft
Surface Elevation: 0.00 ft



Calculation parameters

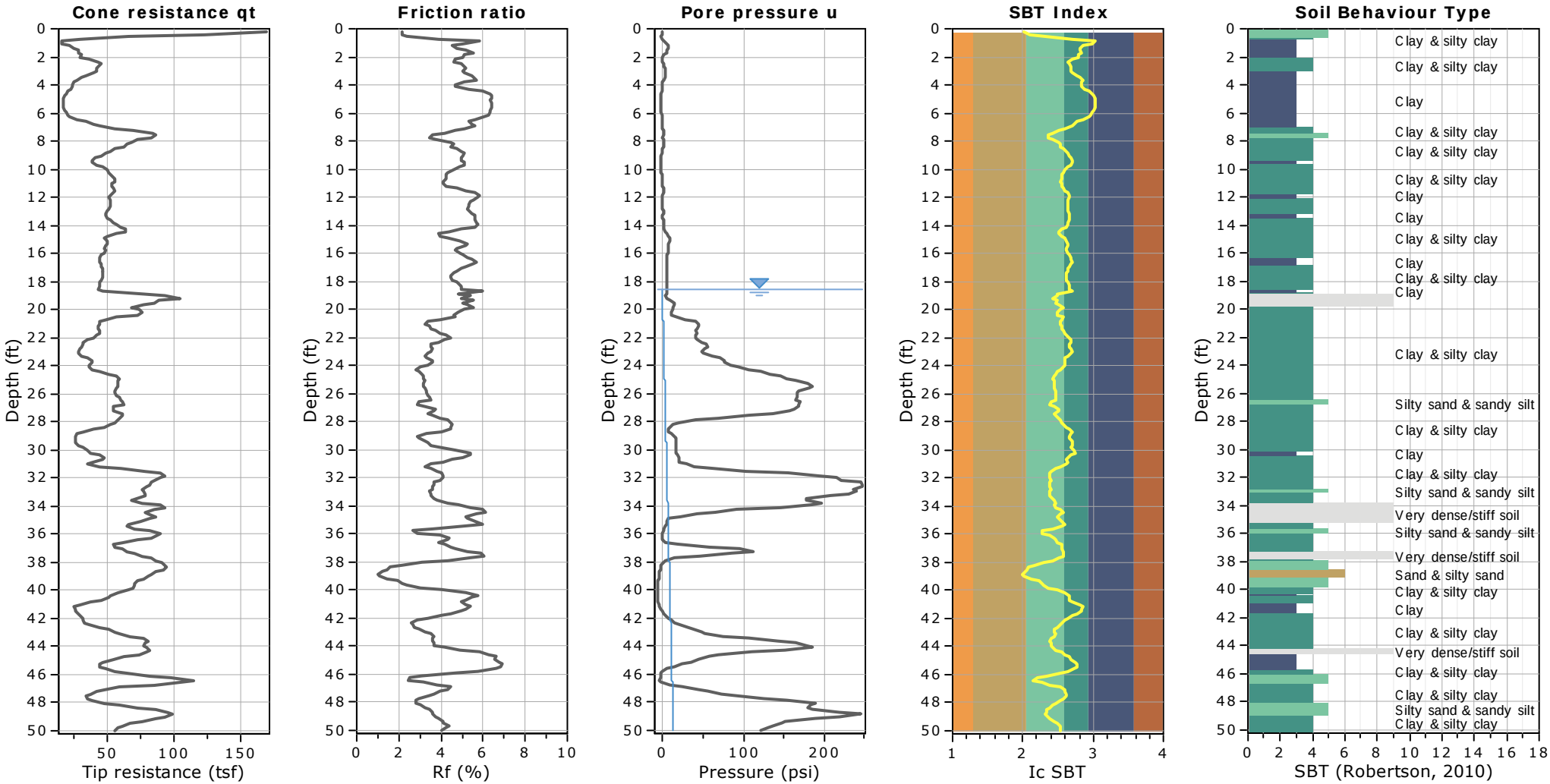
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



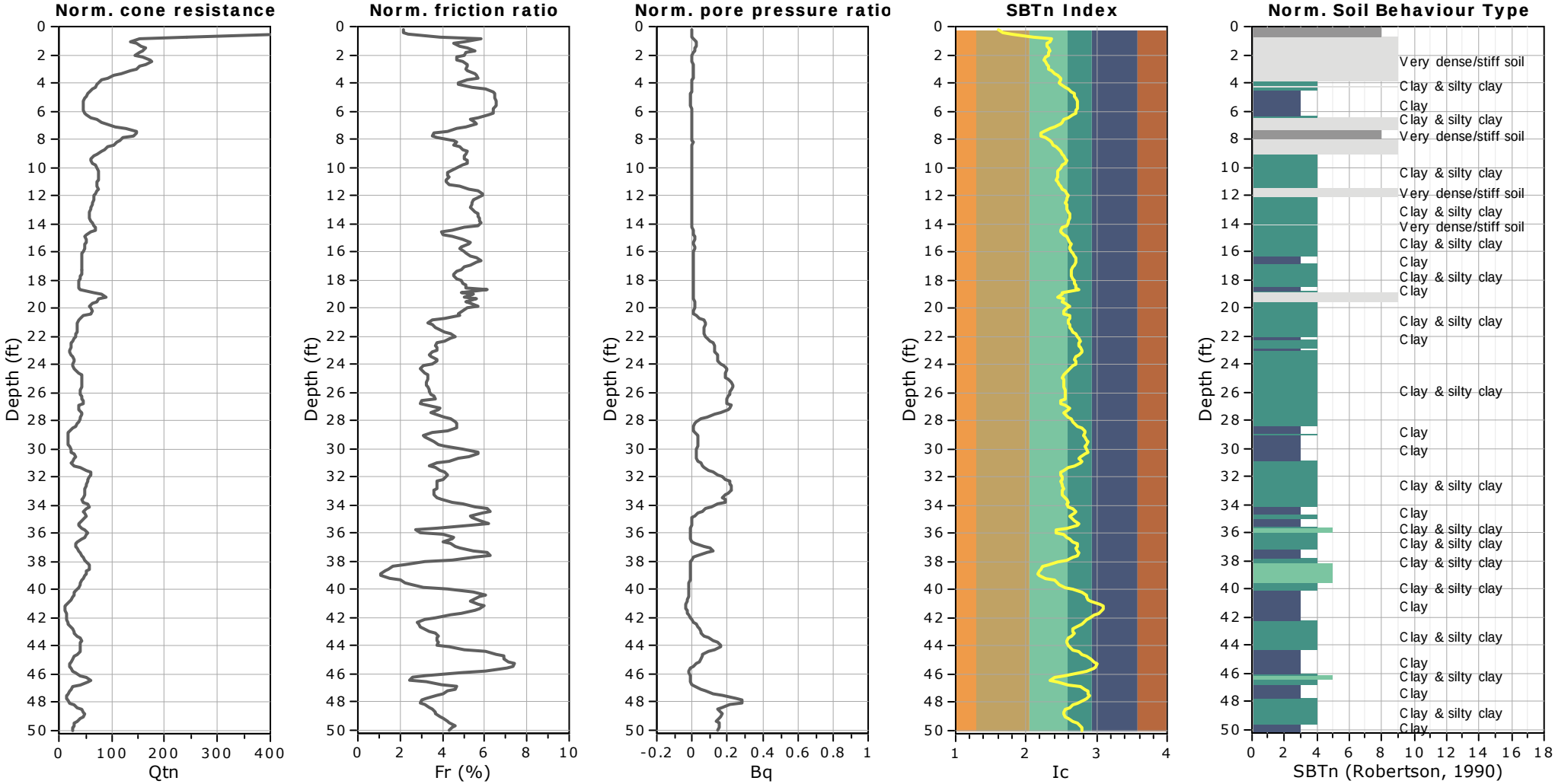
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



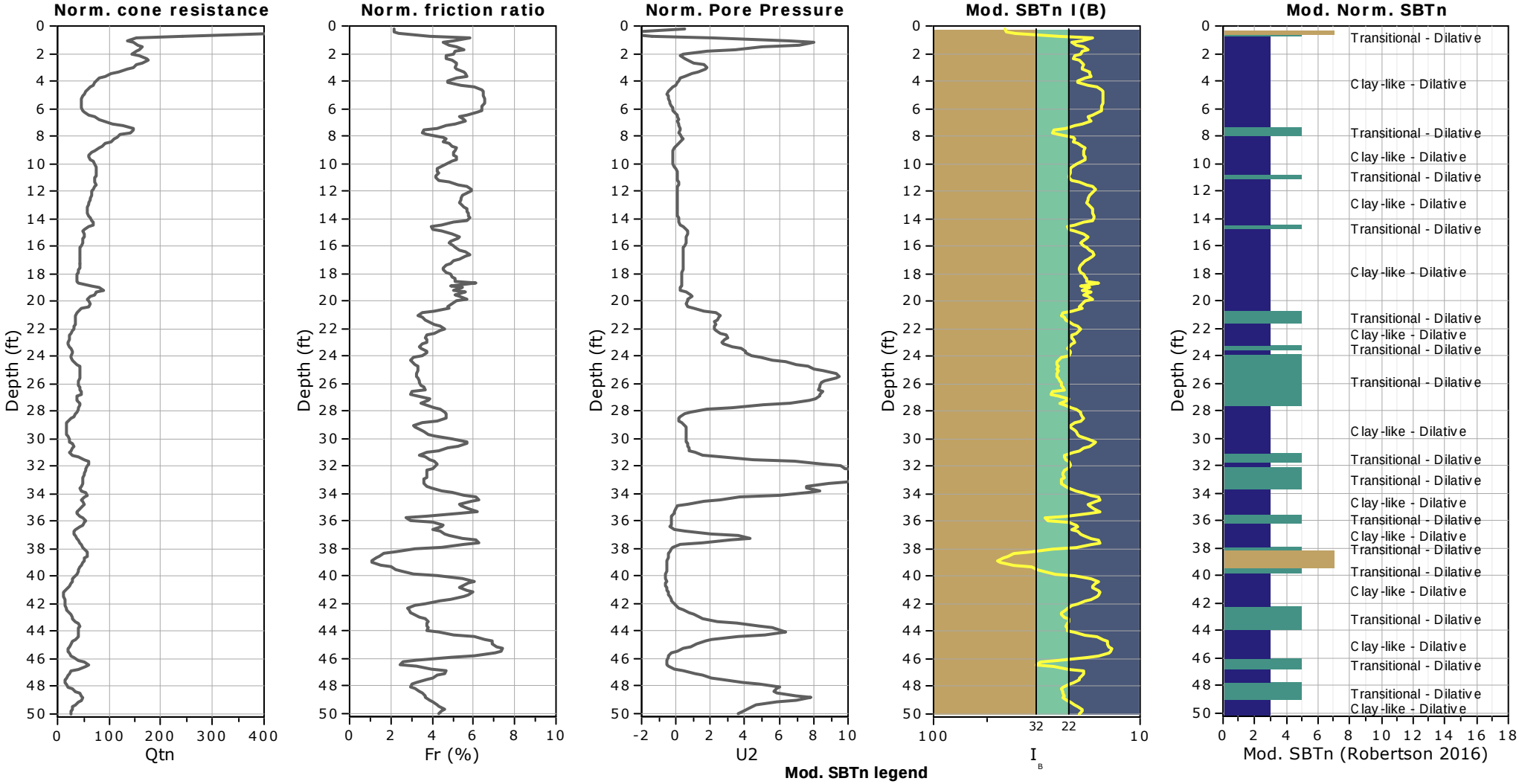
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



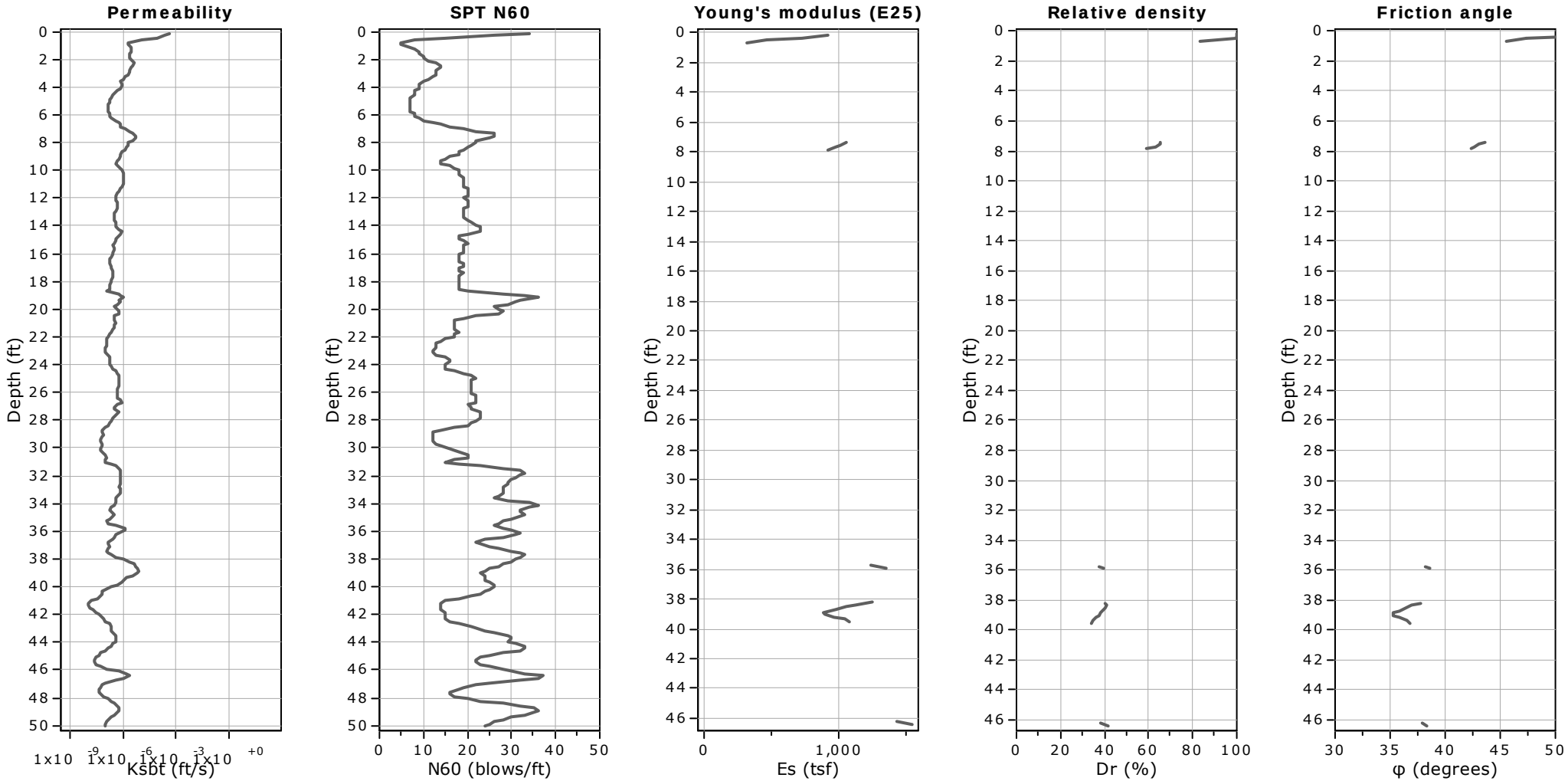
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



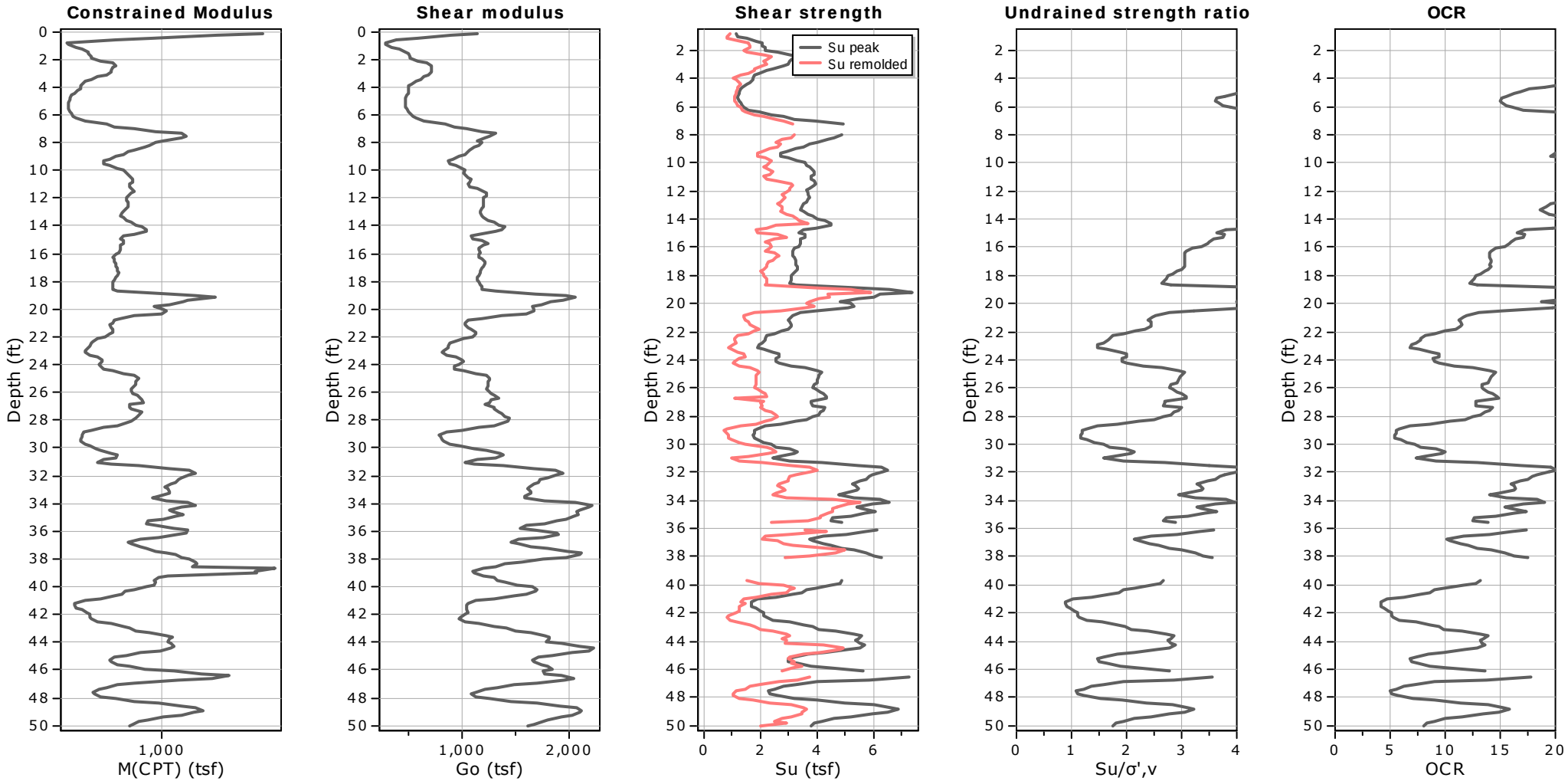
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



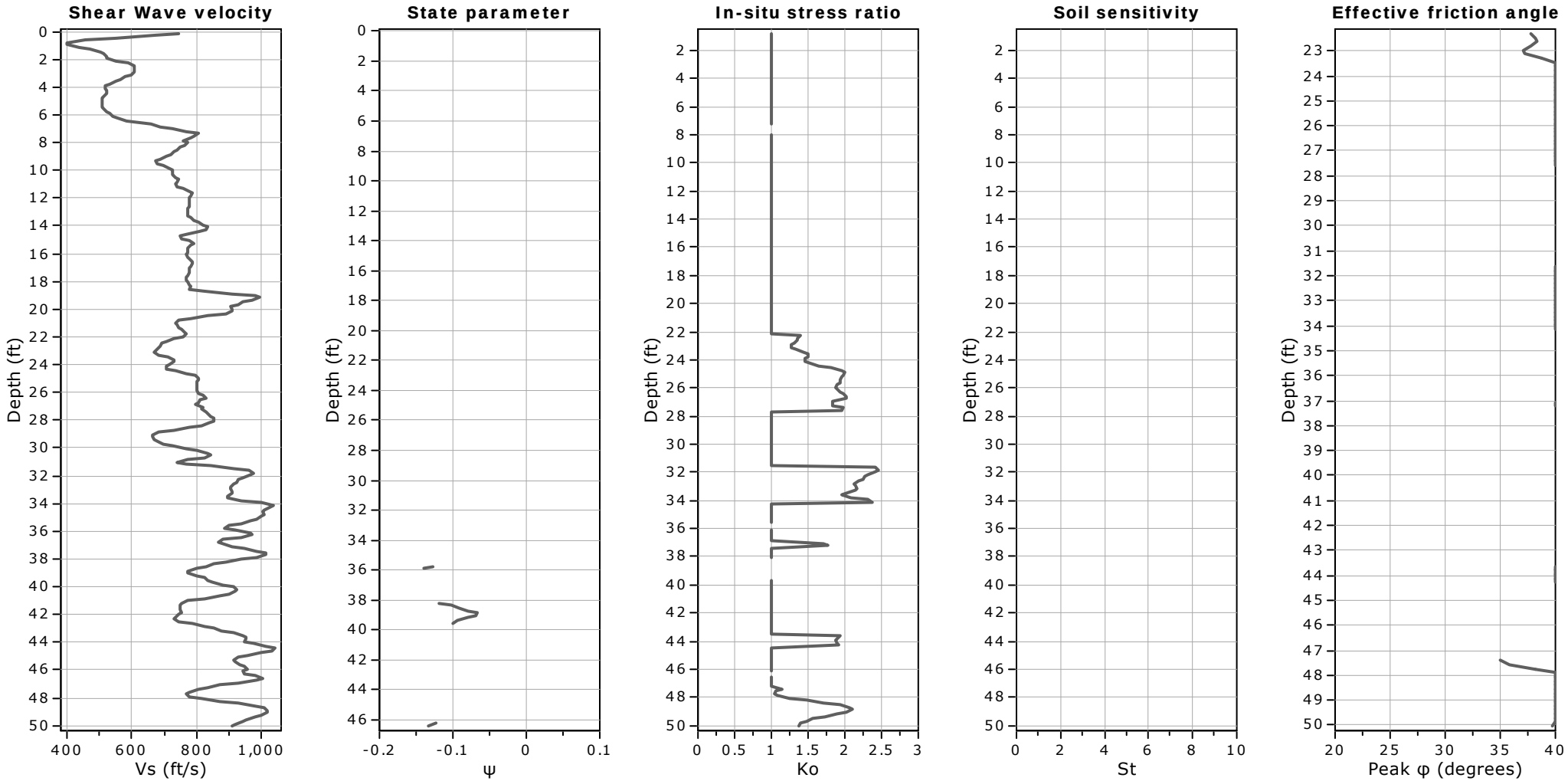
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-12
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

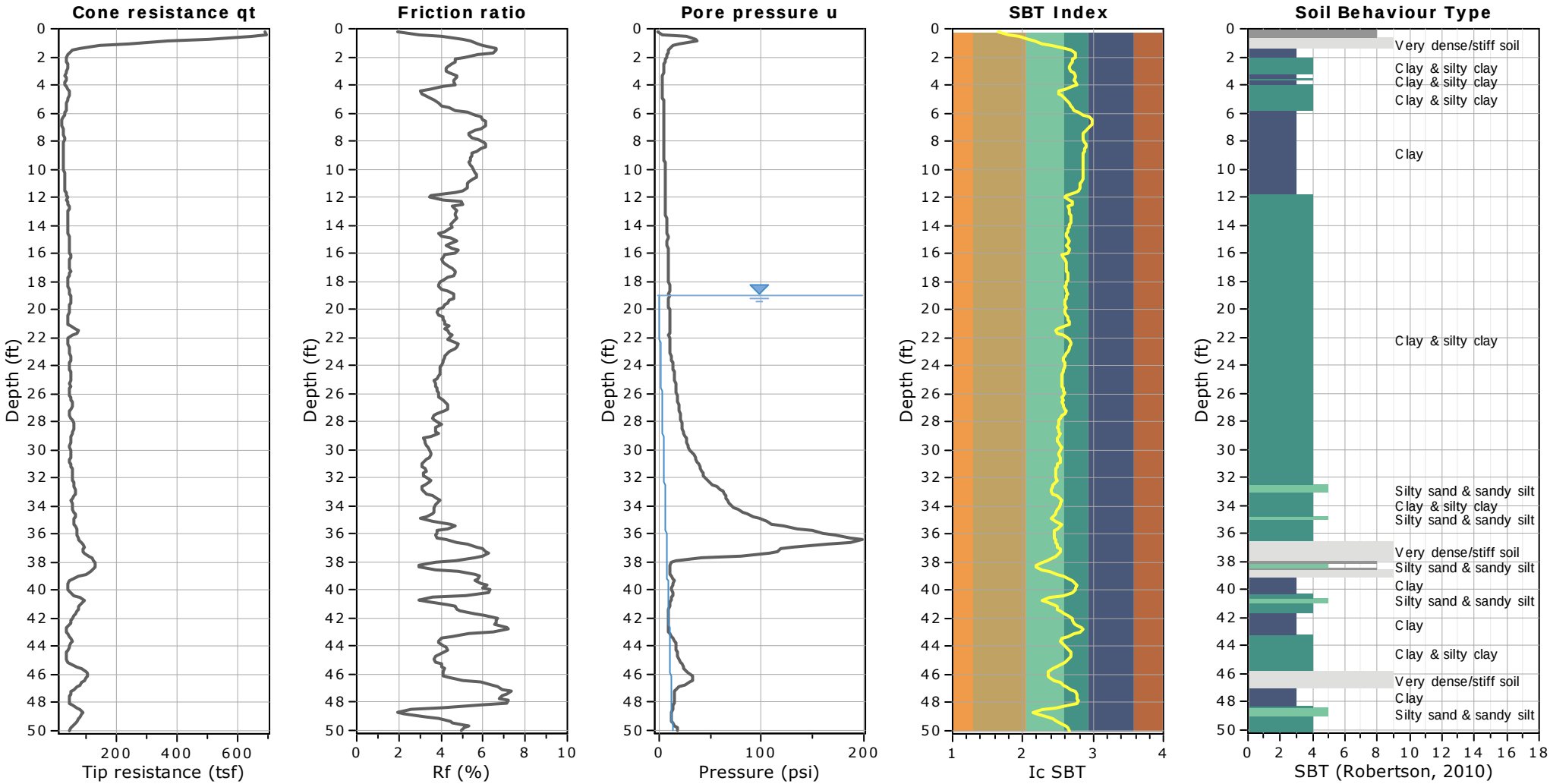
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



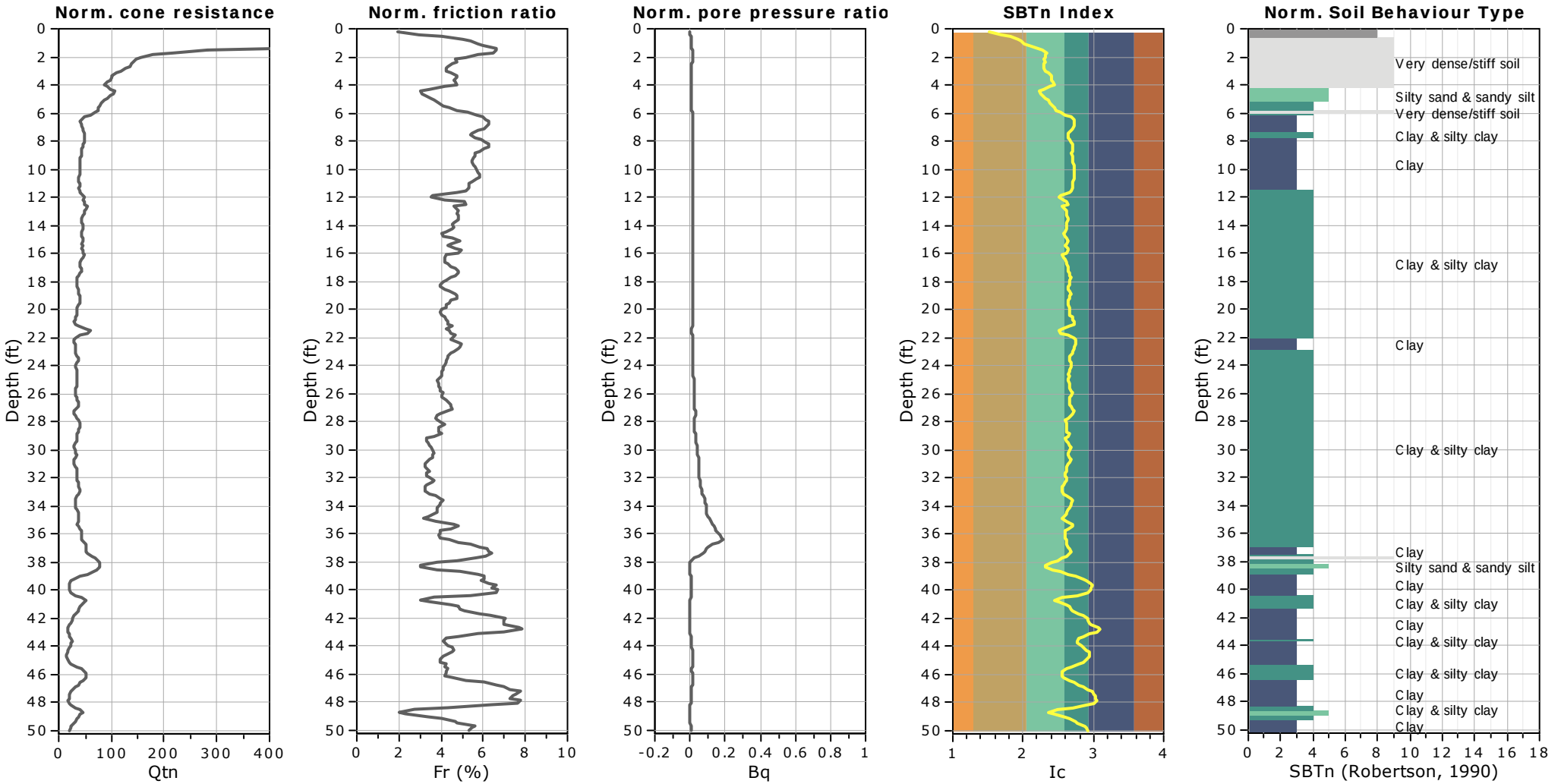
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



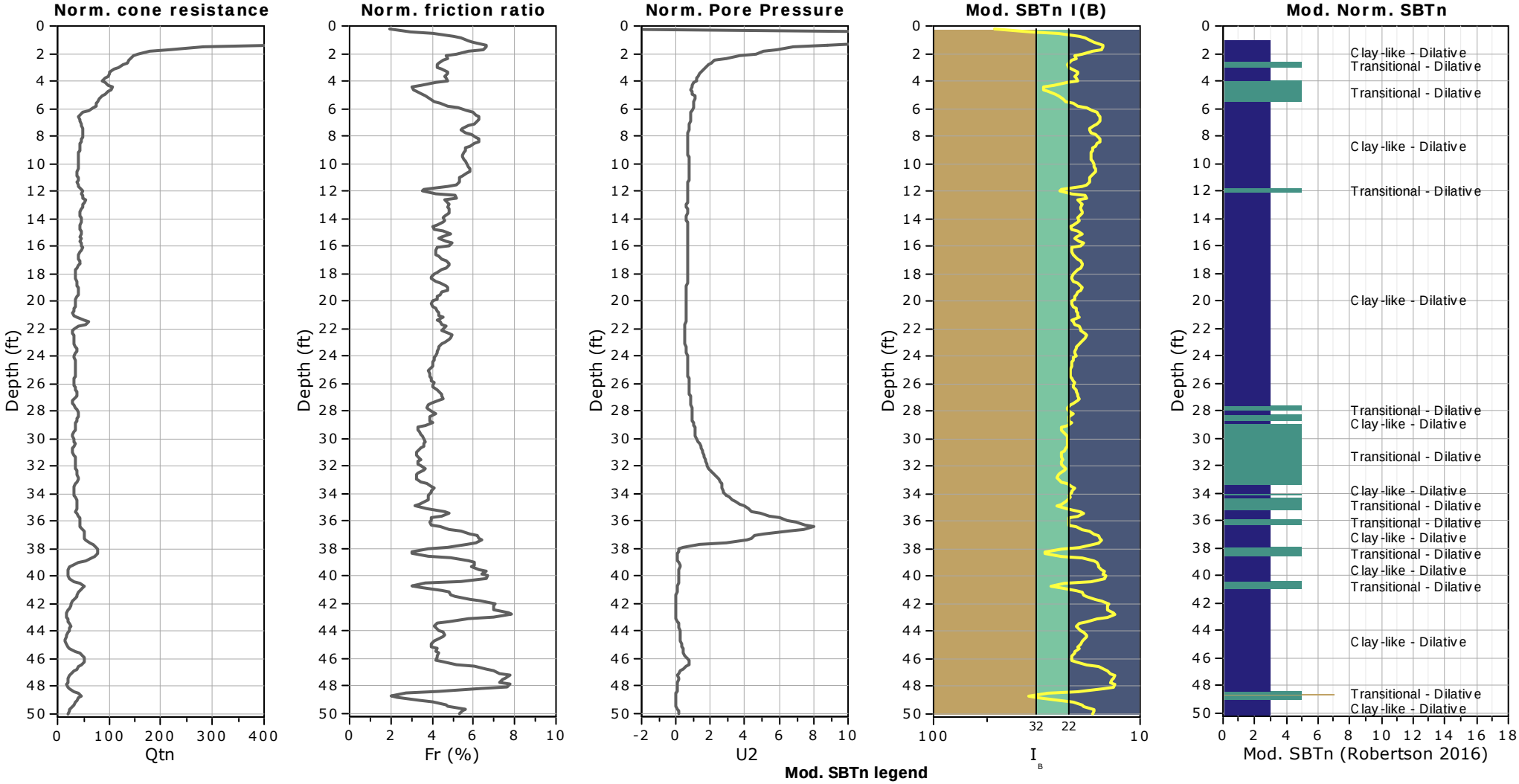
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



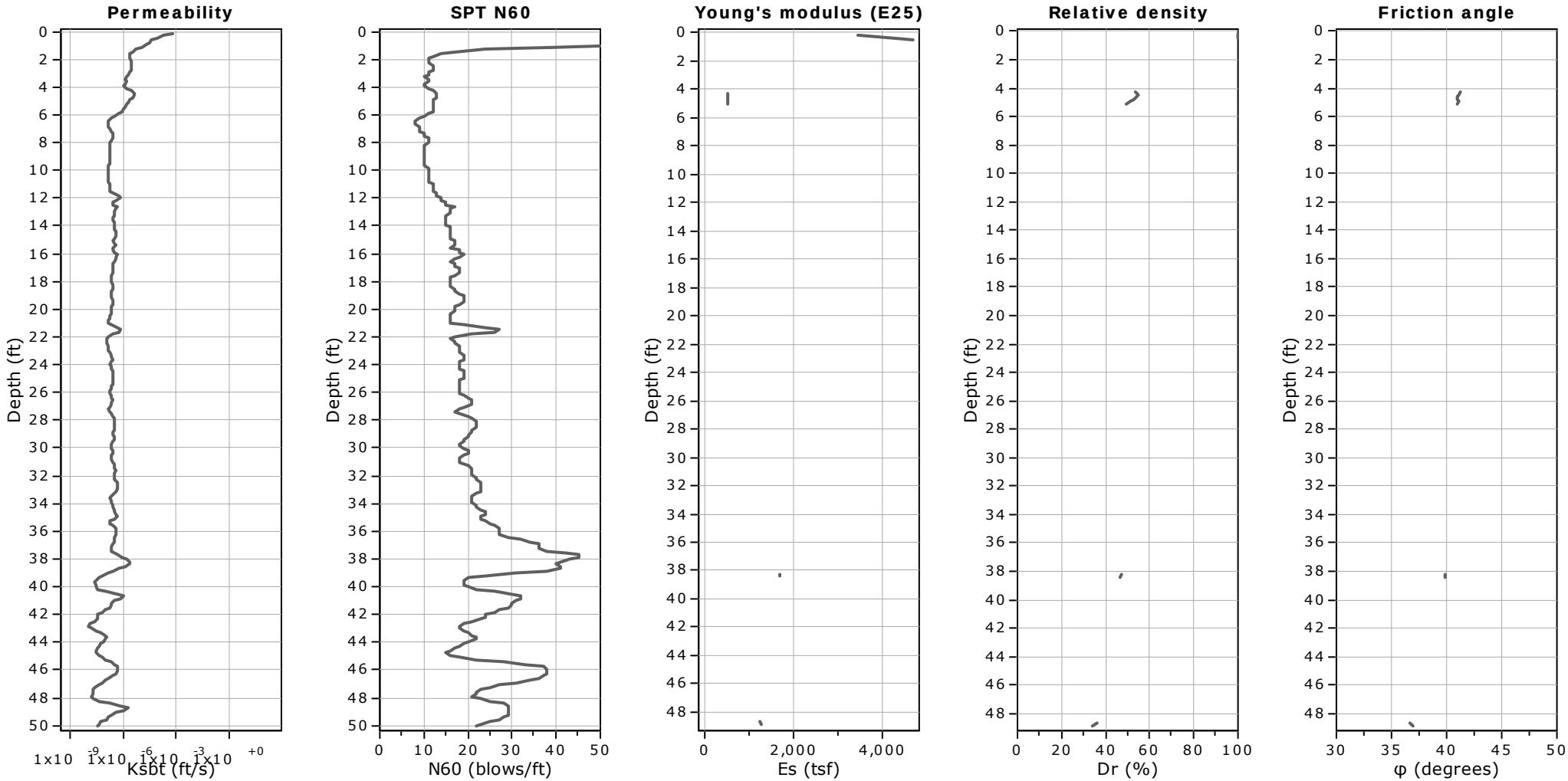
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



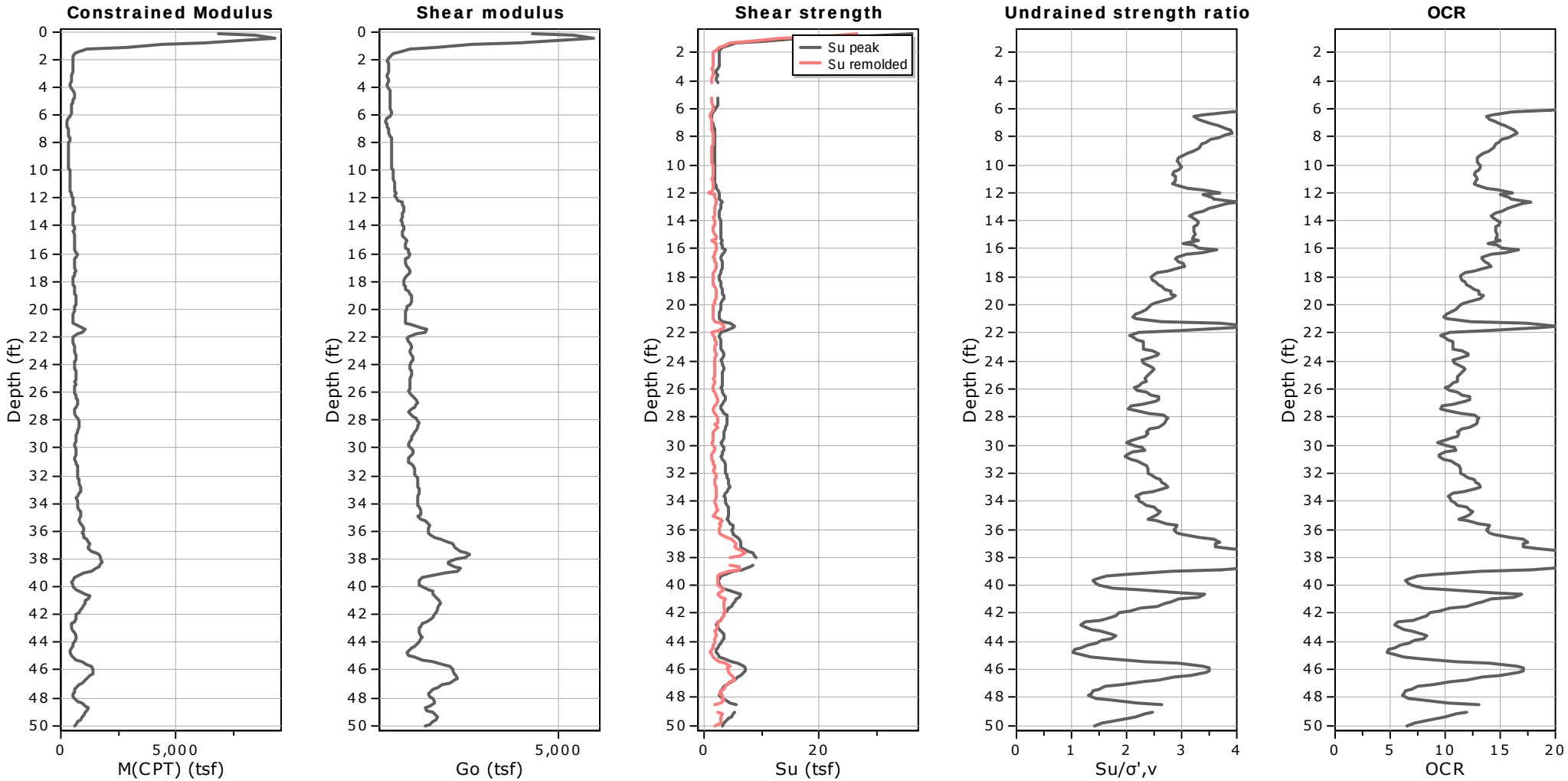
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



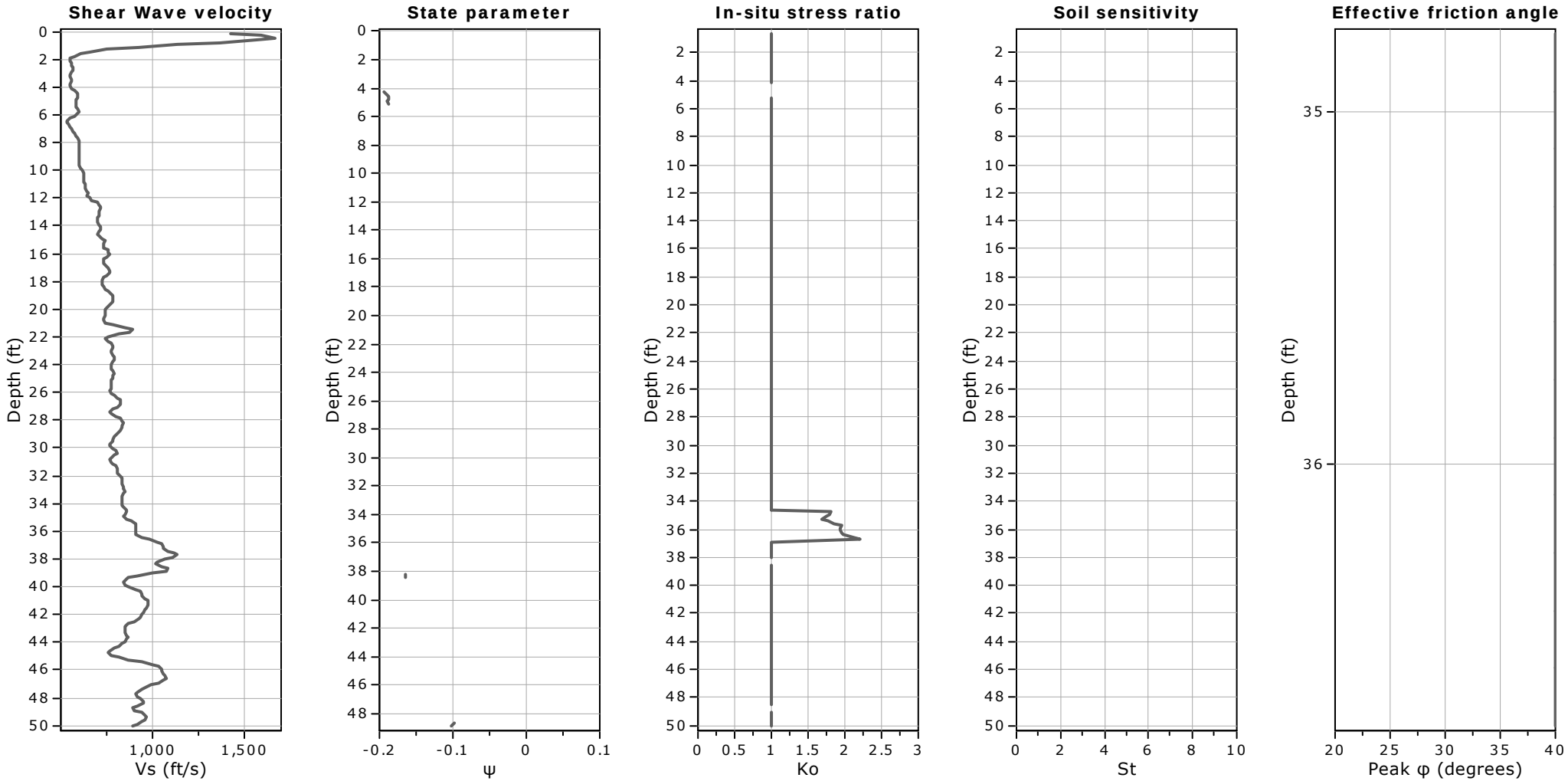
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-13
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

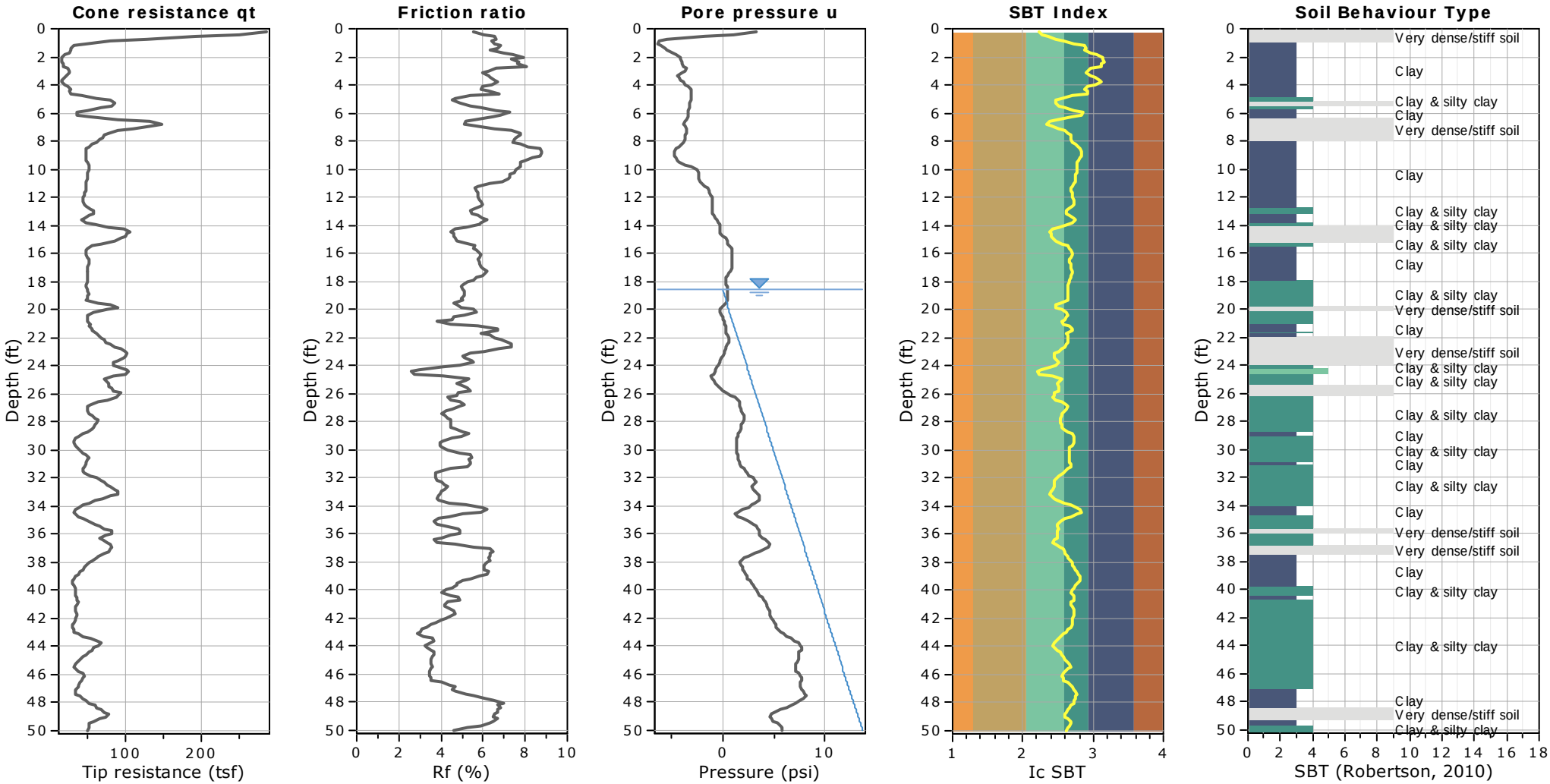
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



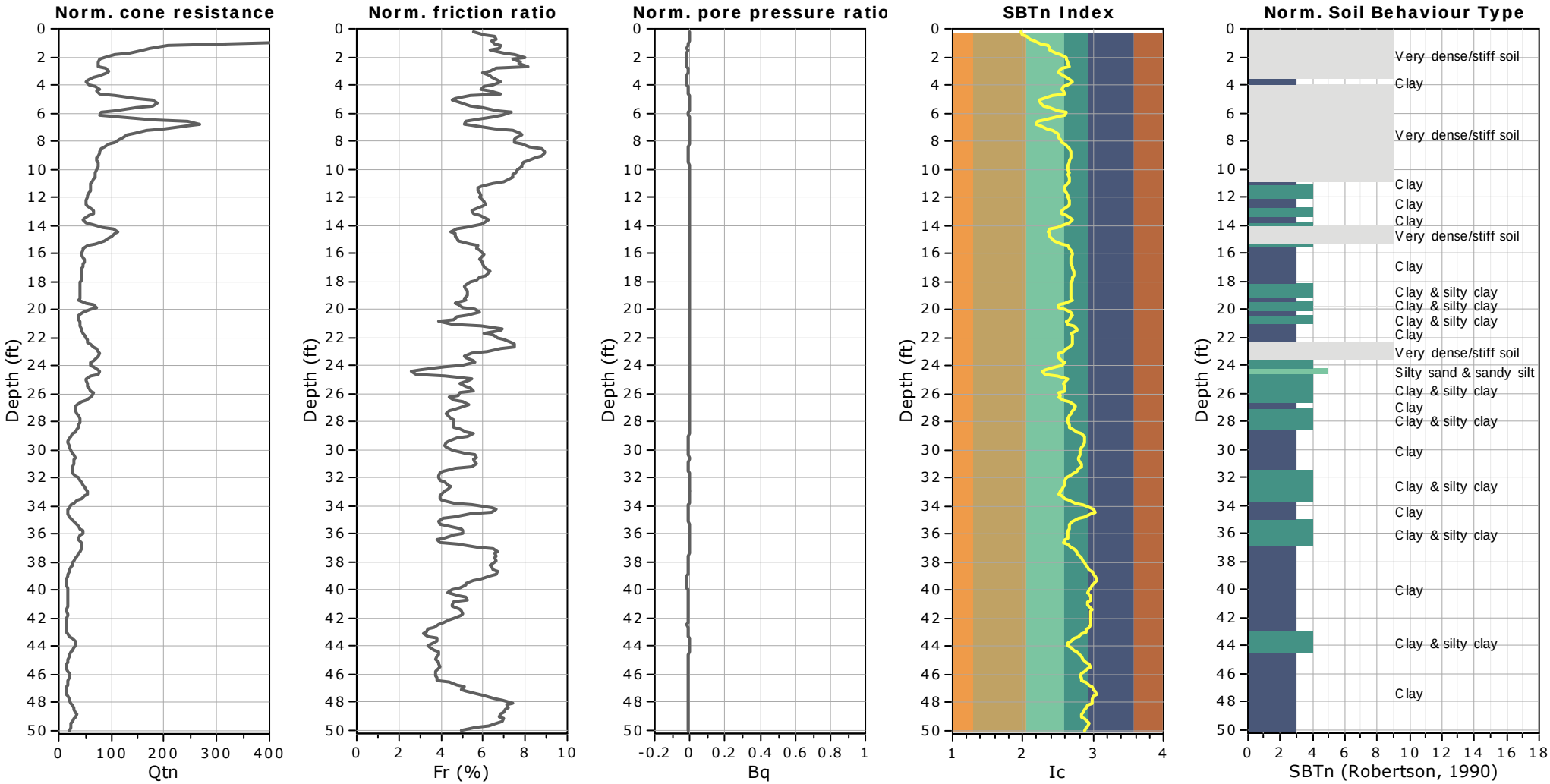
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



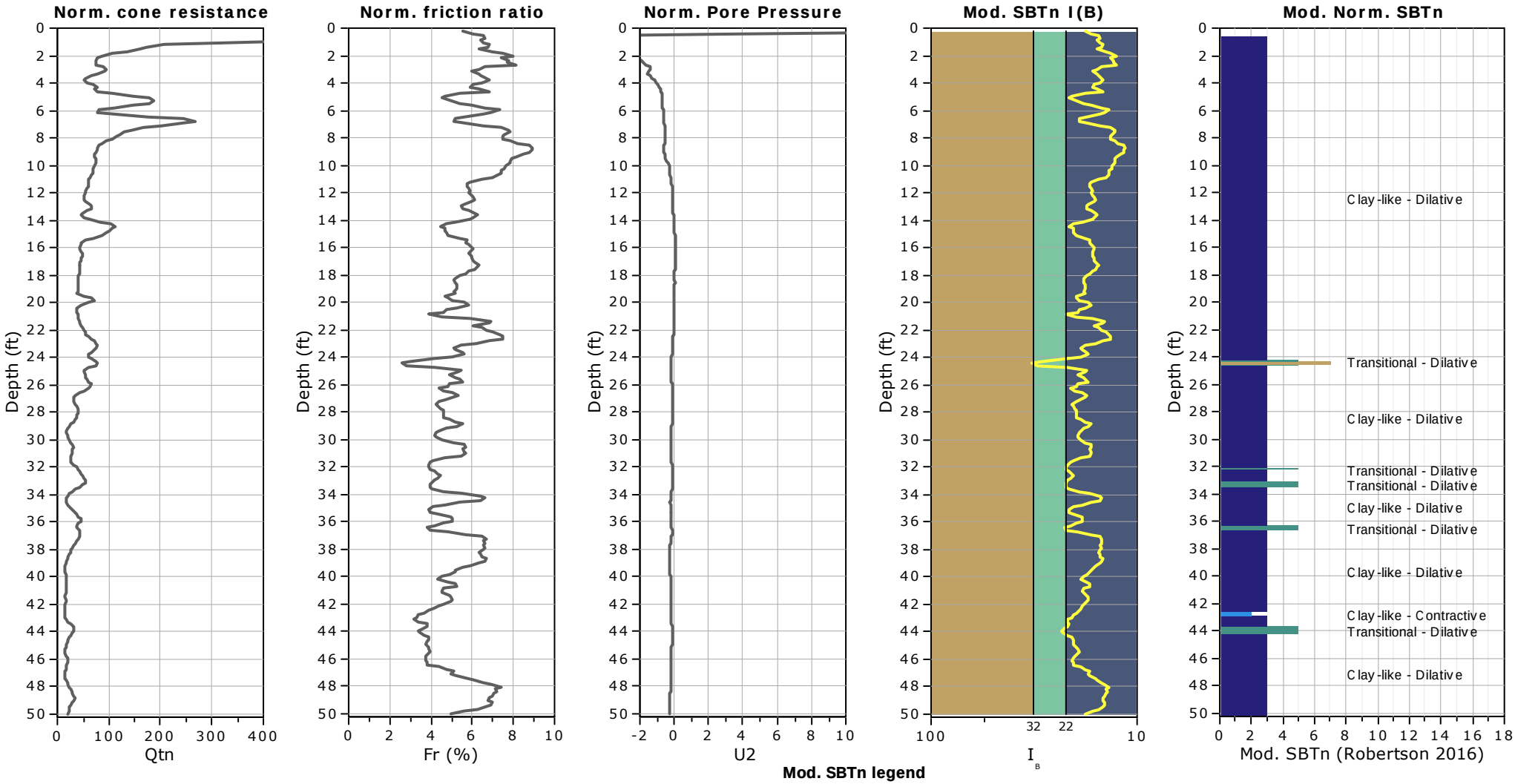
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



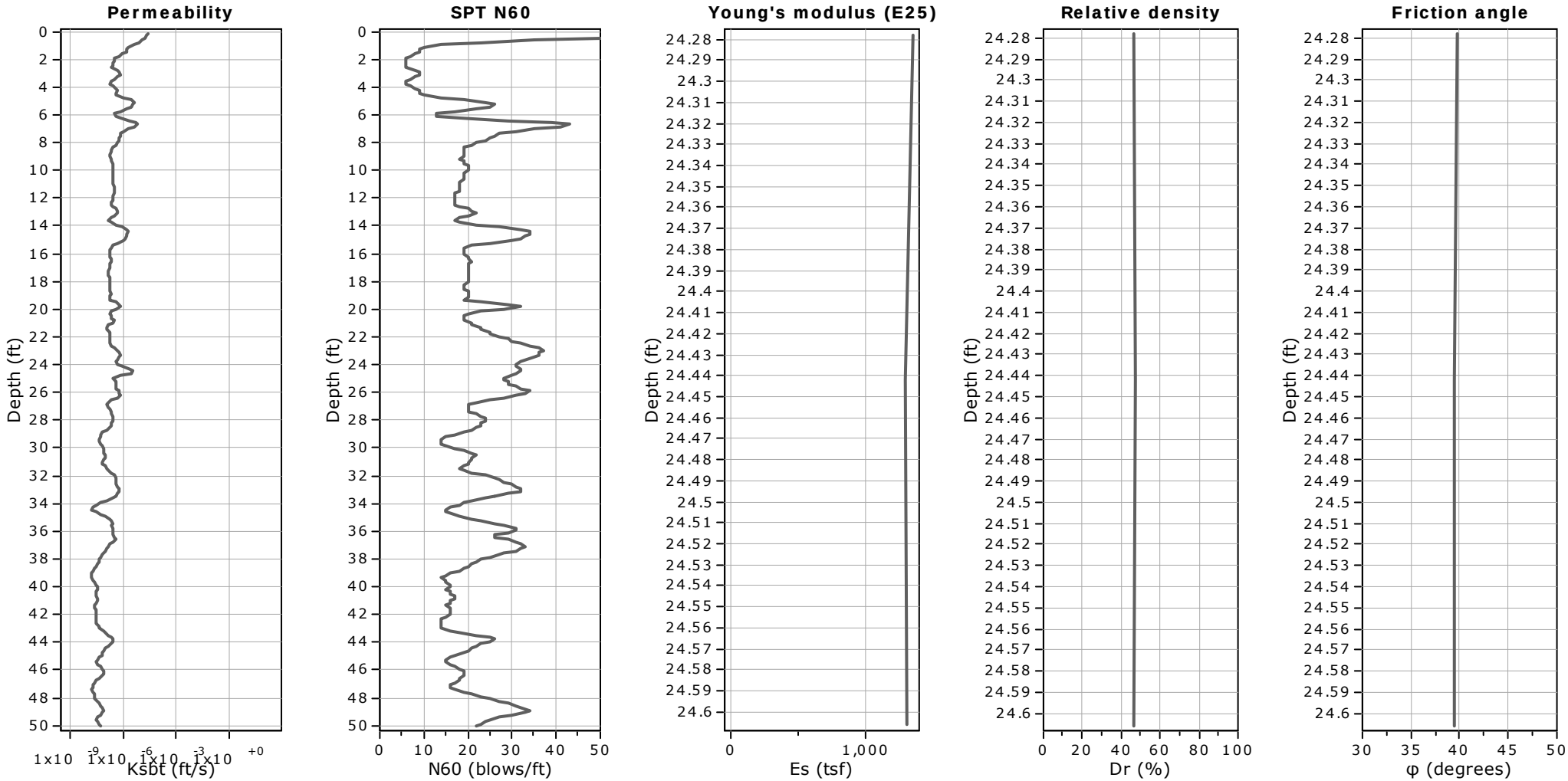
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



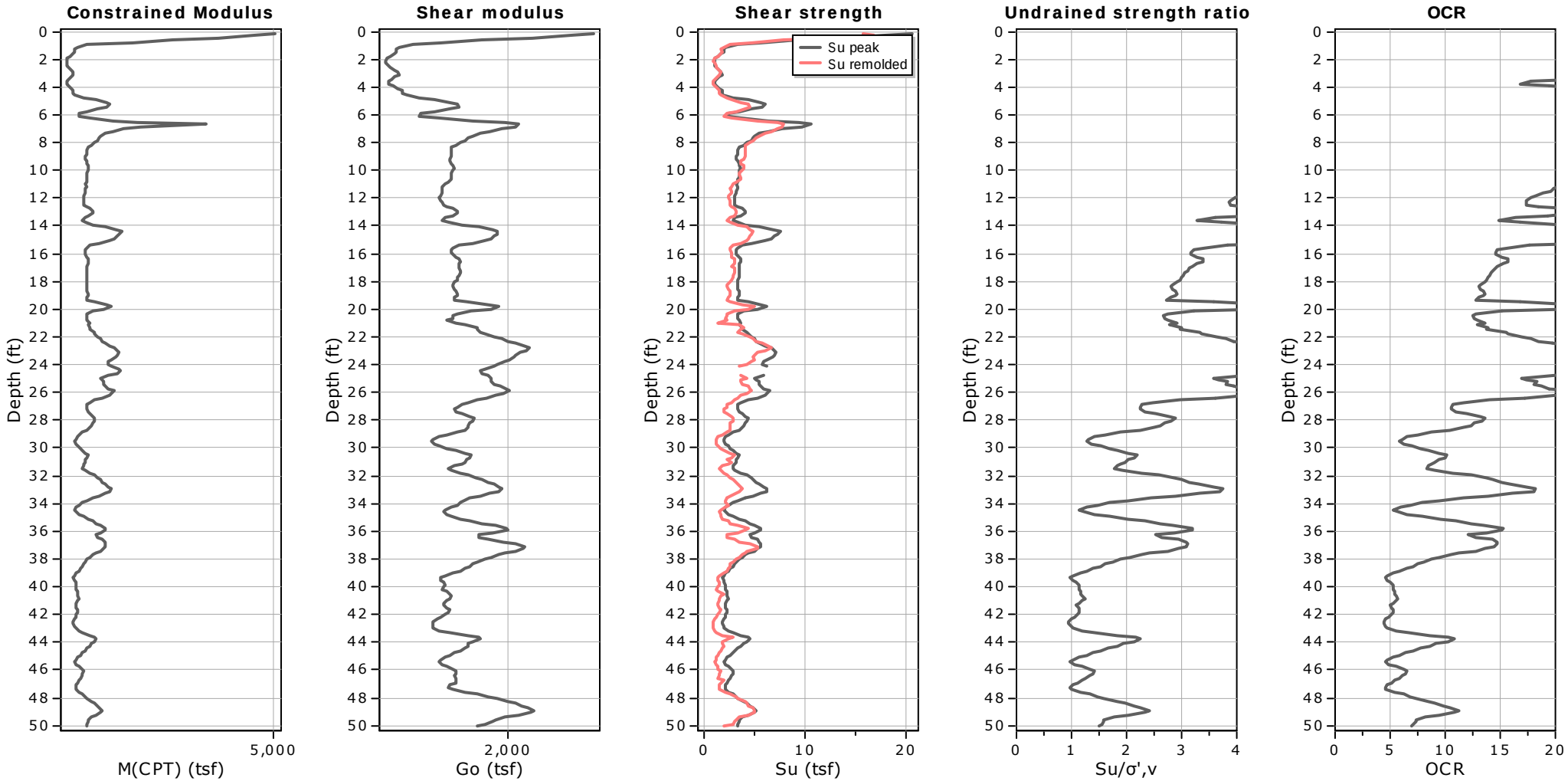
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



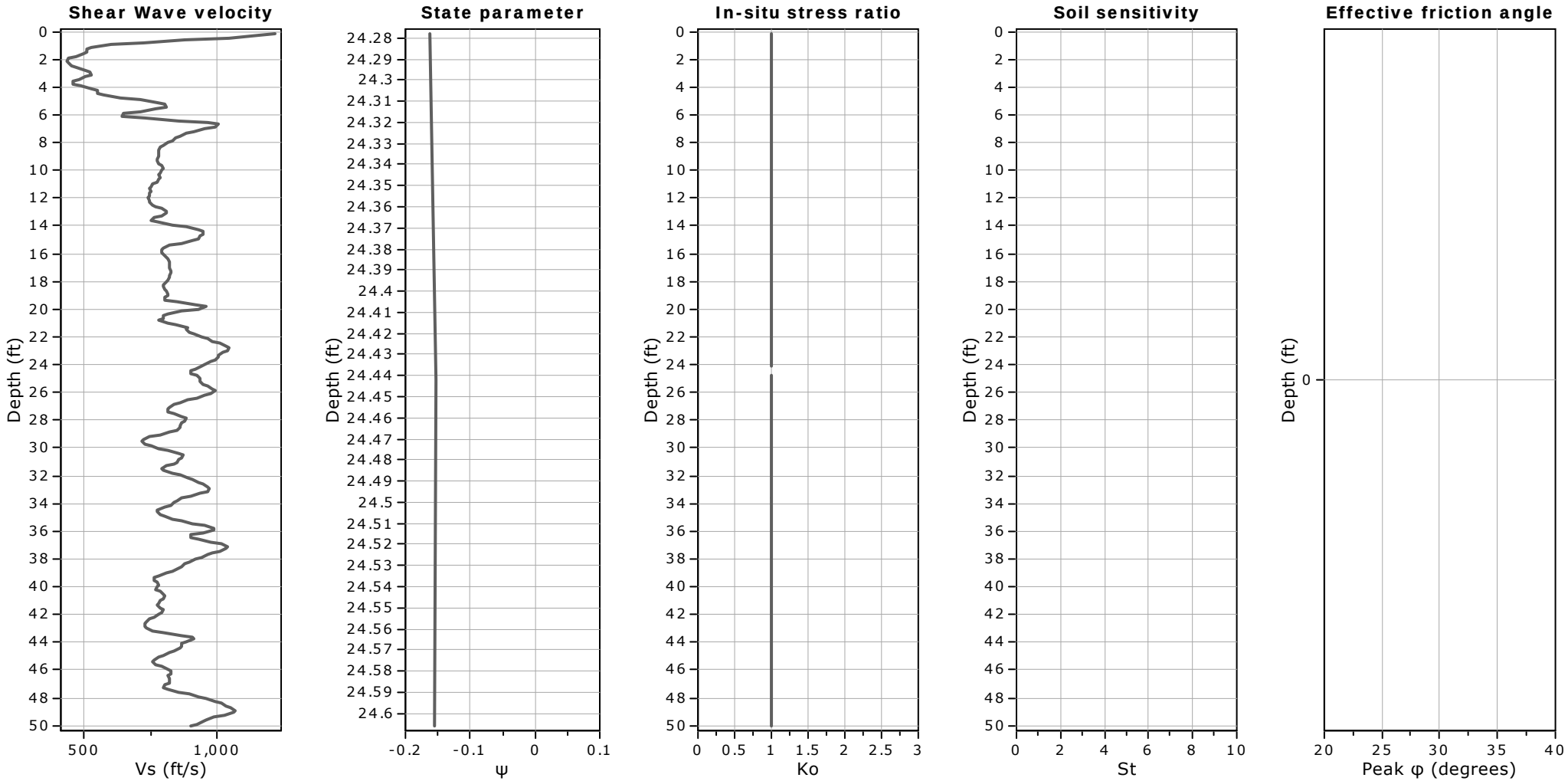
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-14
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

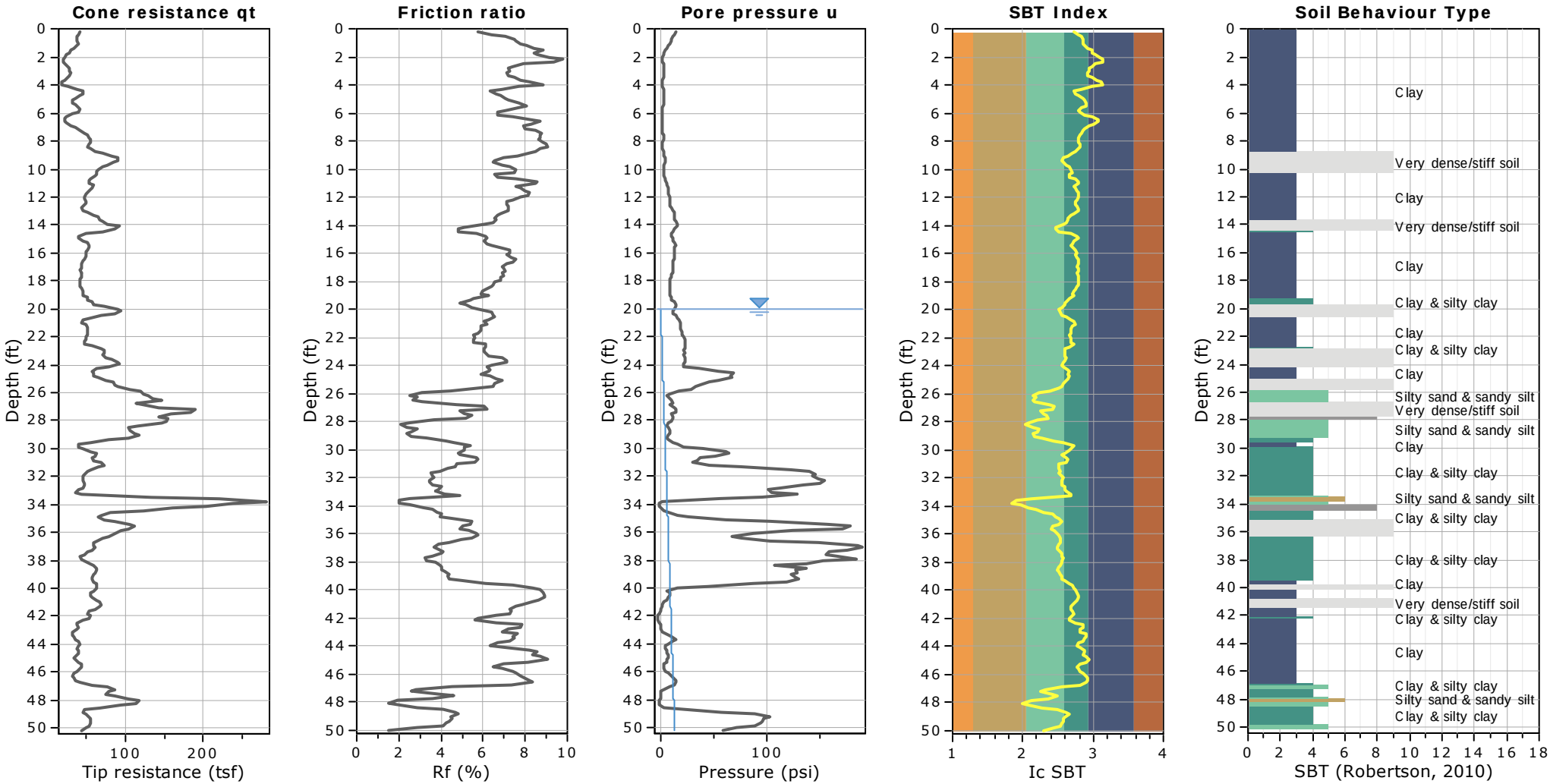
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



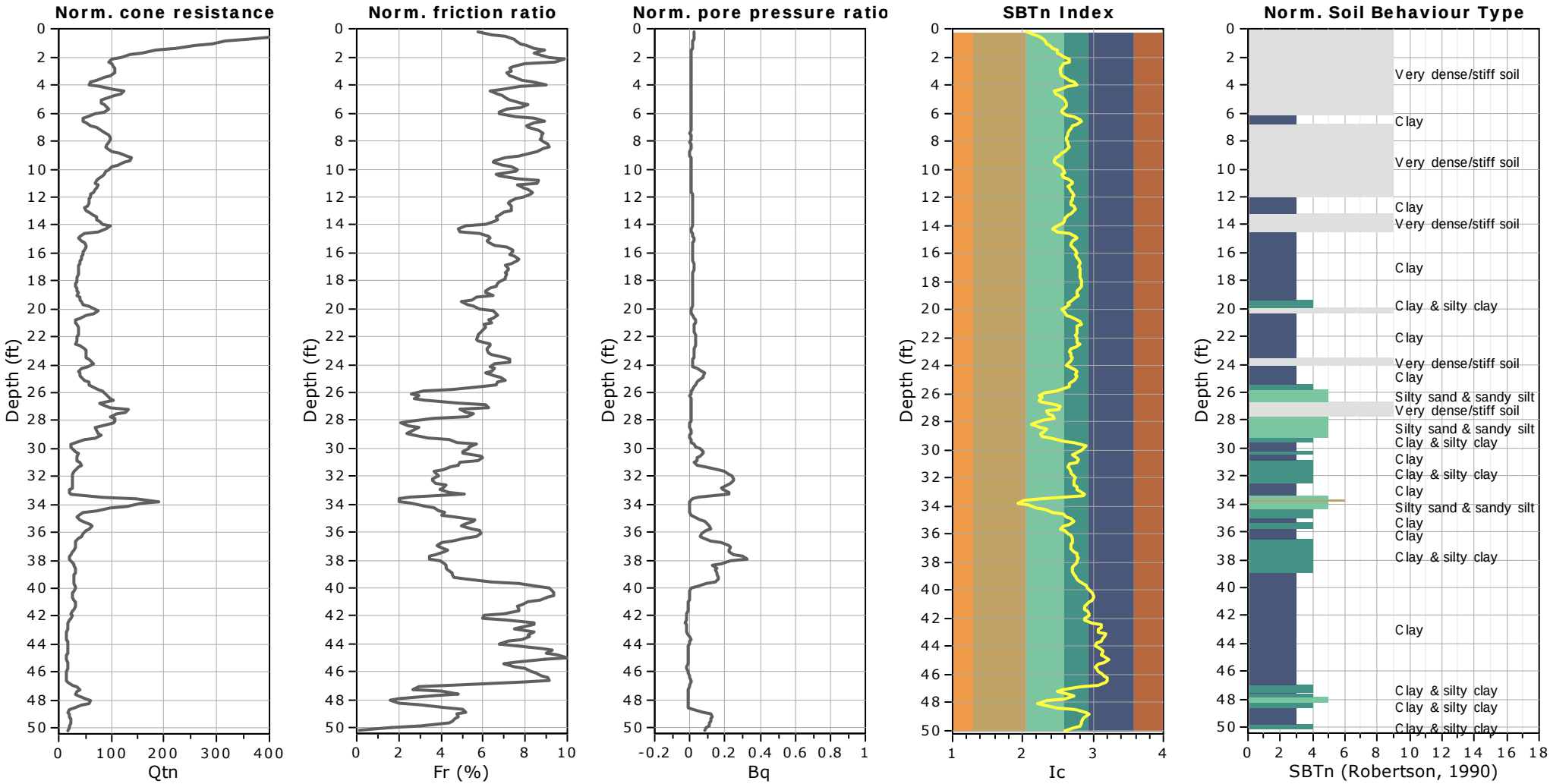
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



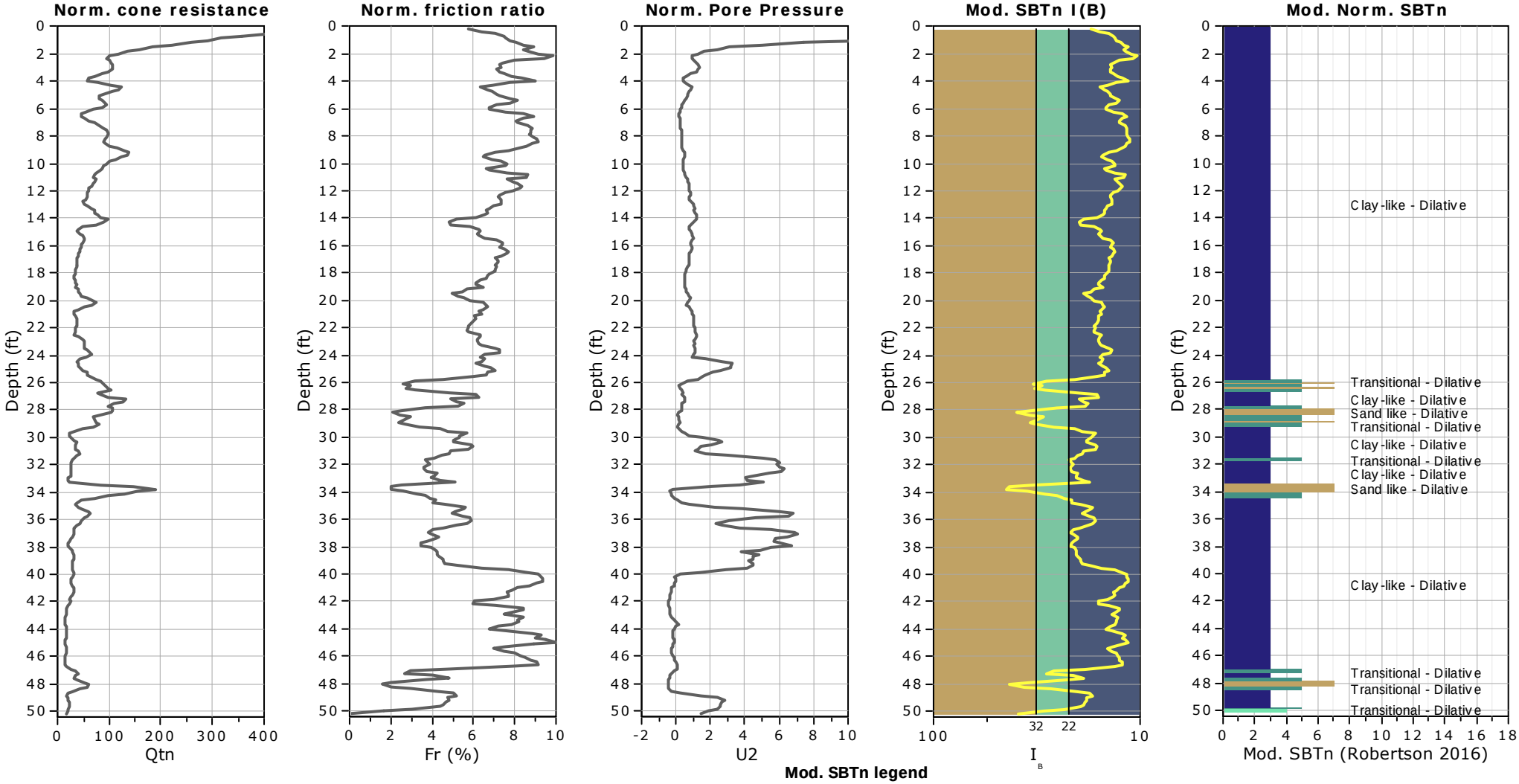
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



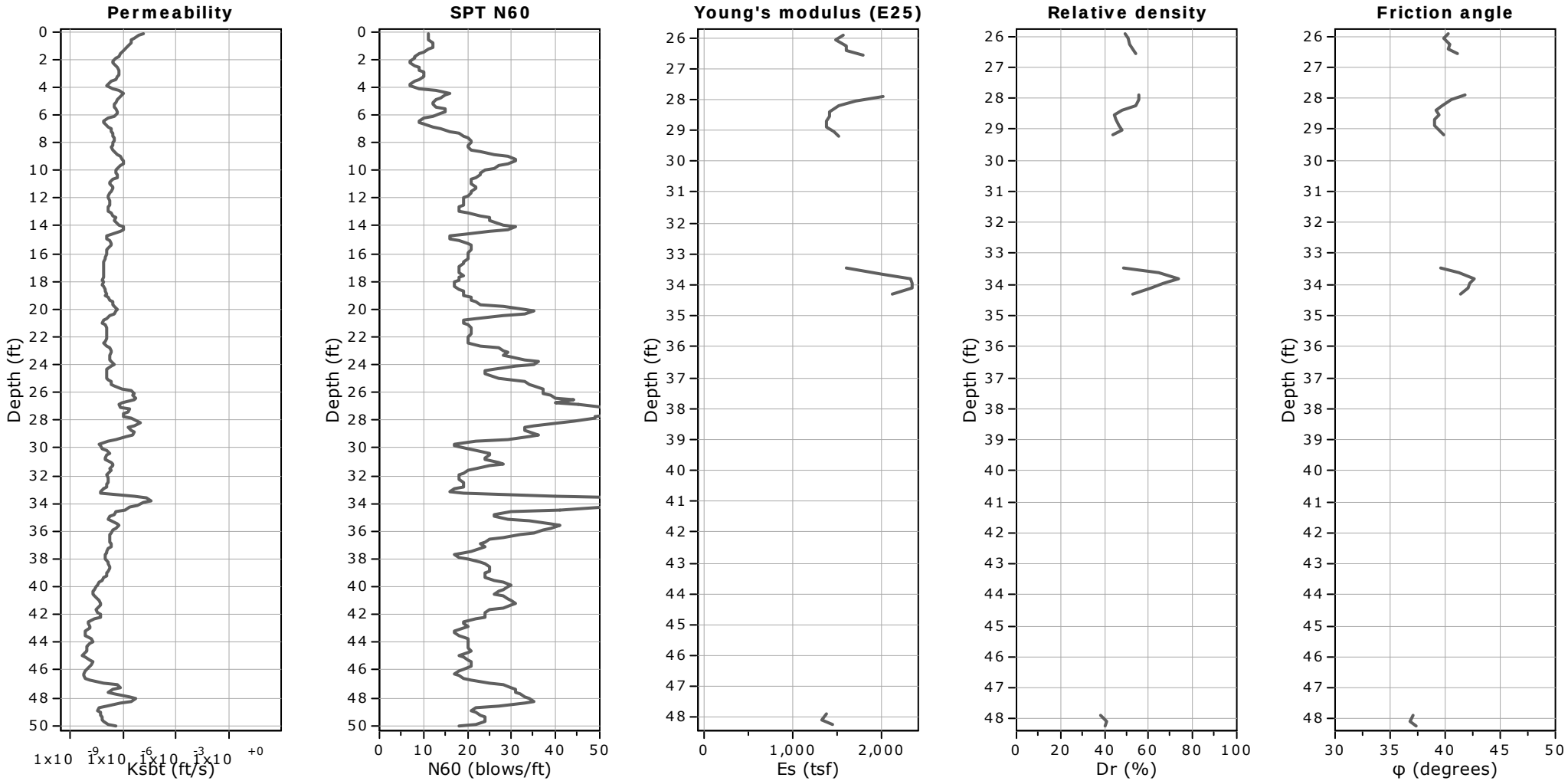
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



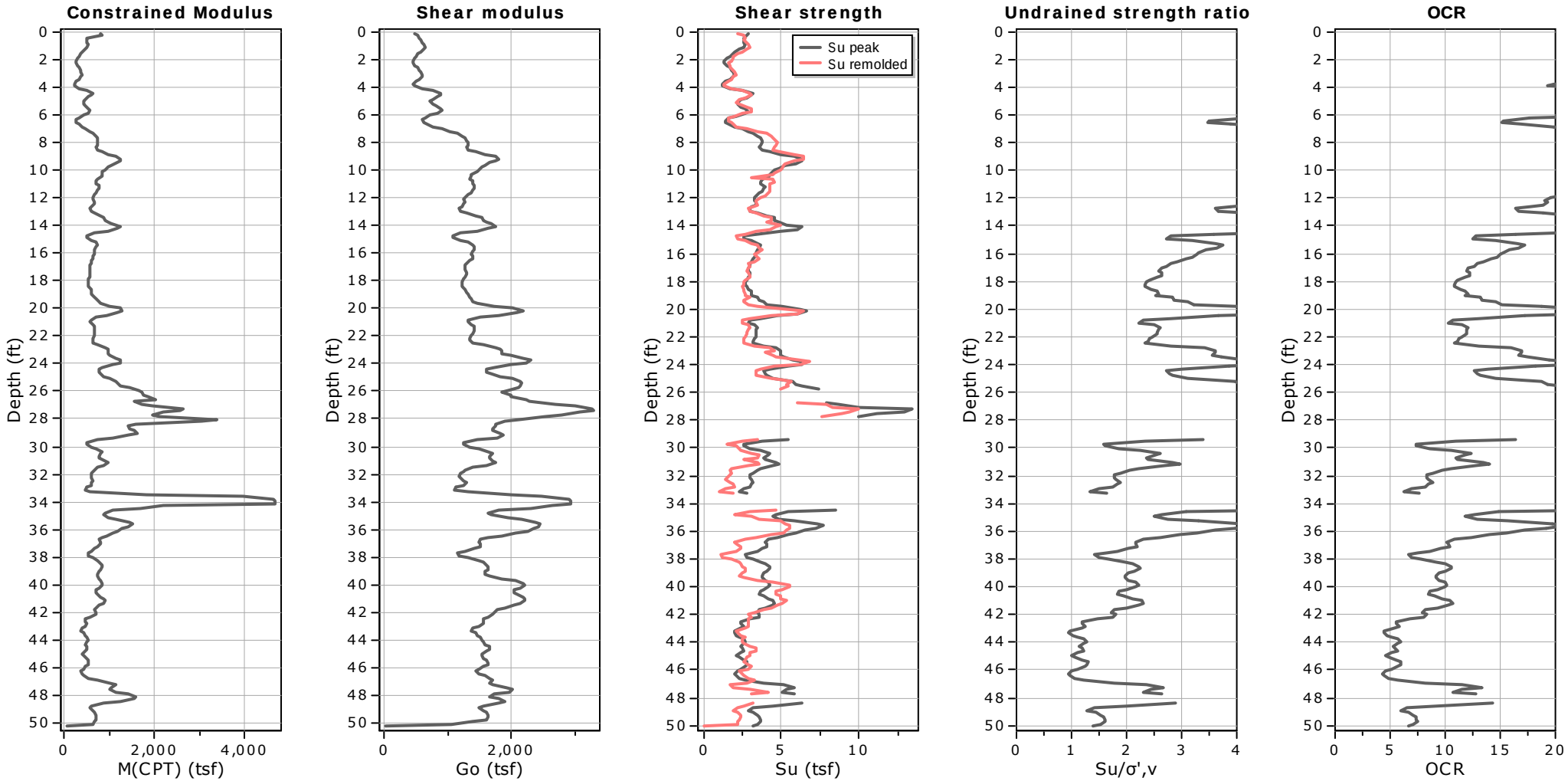
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



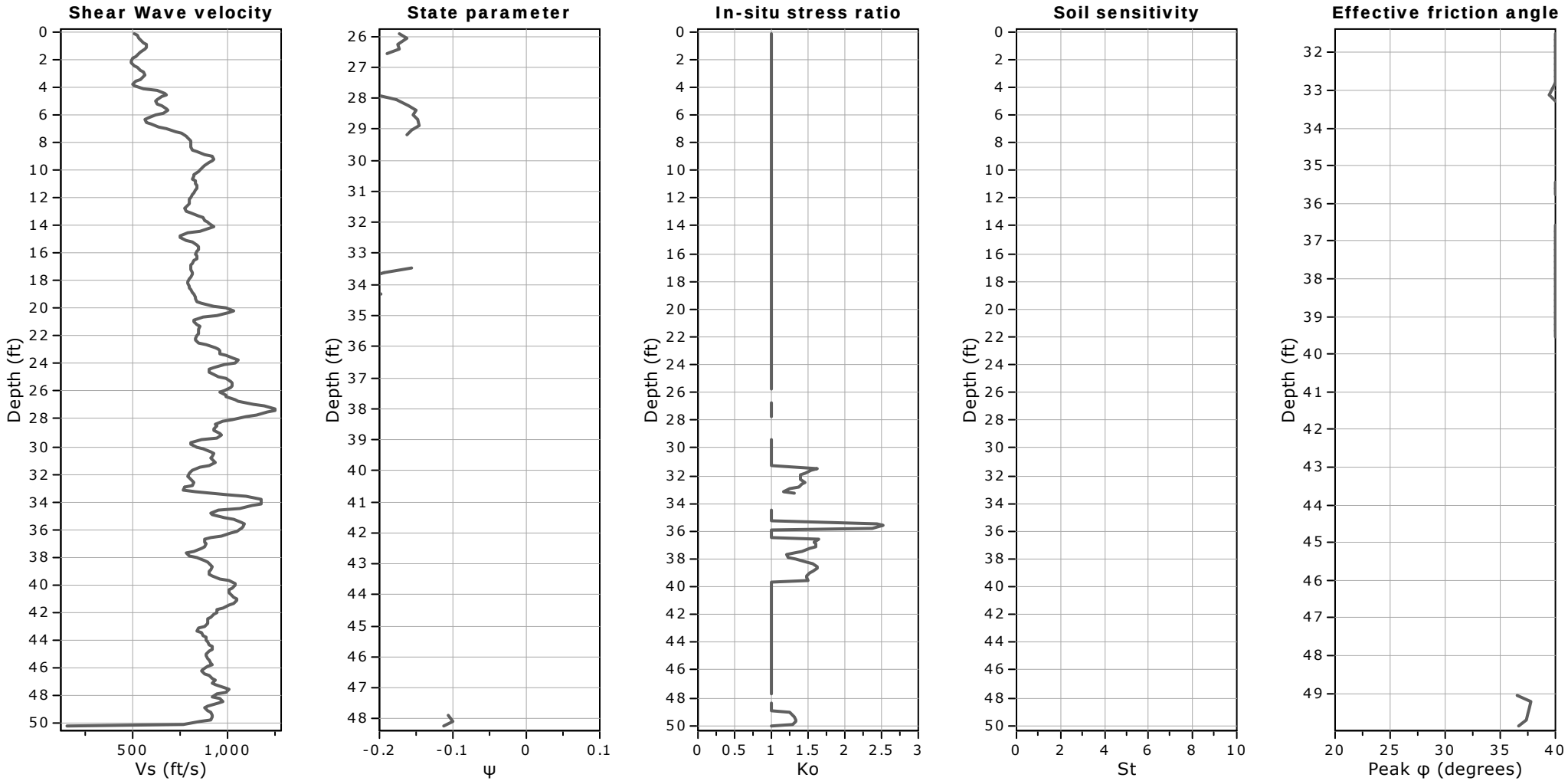
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-15
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



Calculation parameters

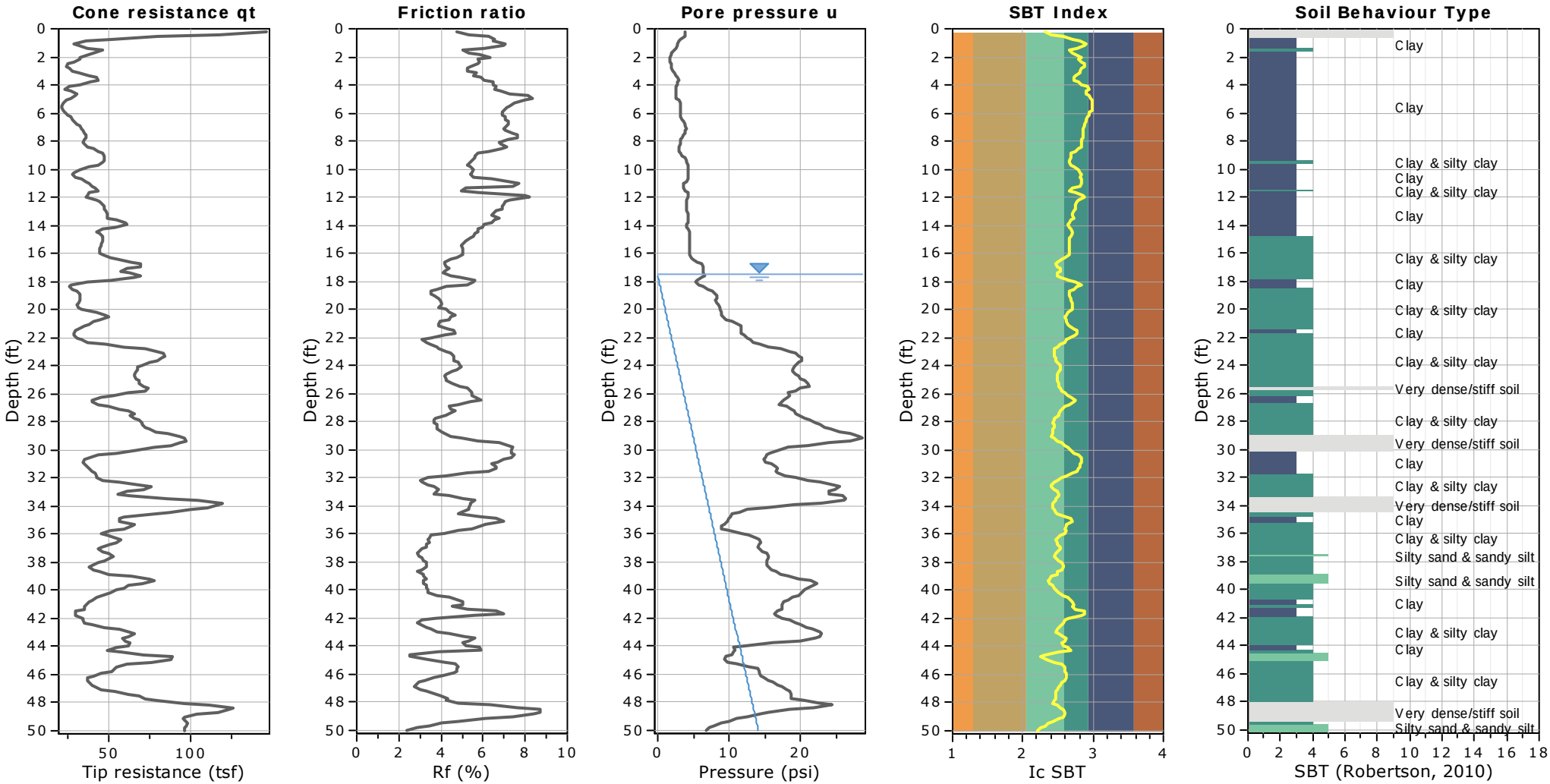
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



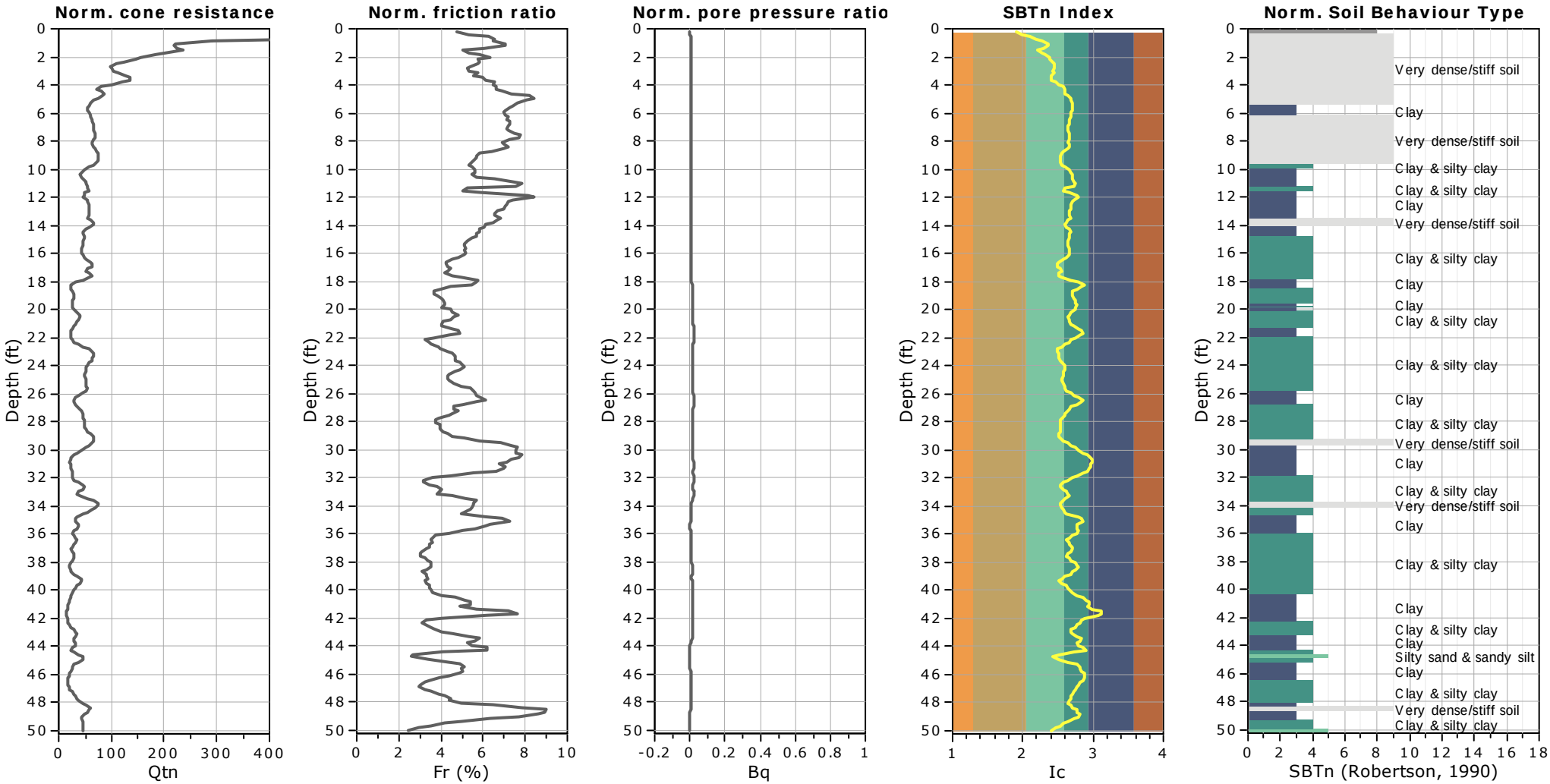
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



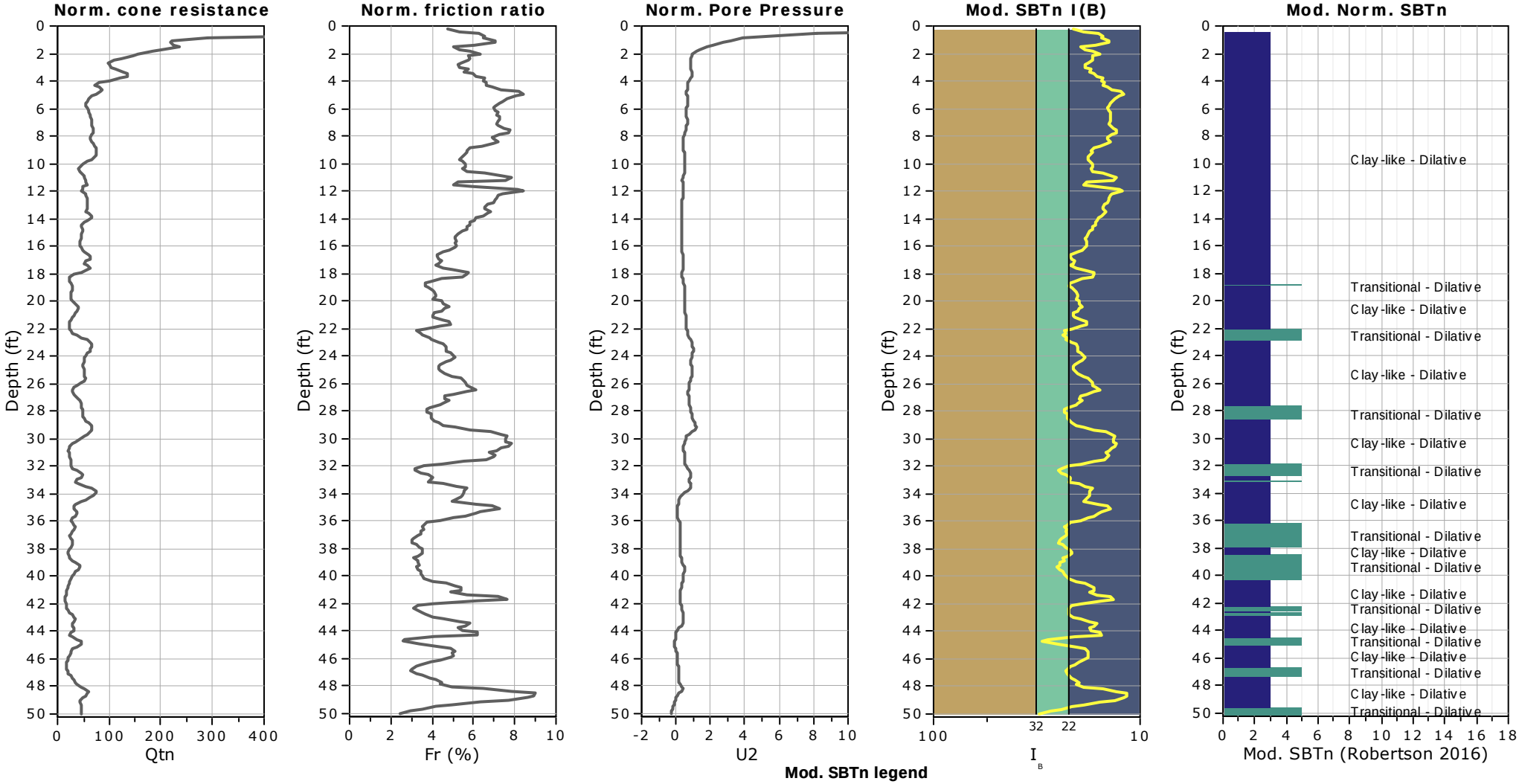
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



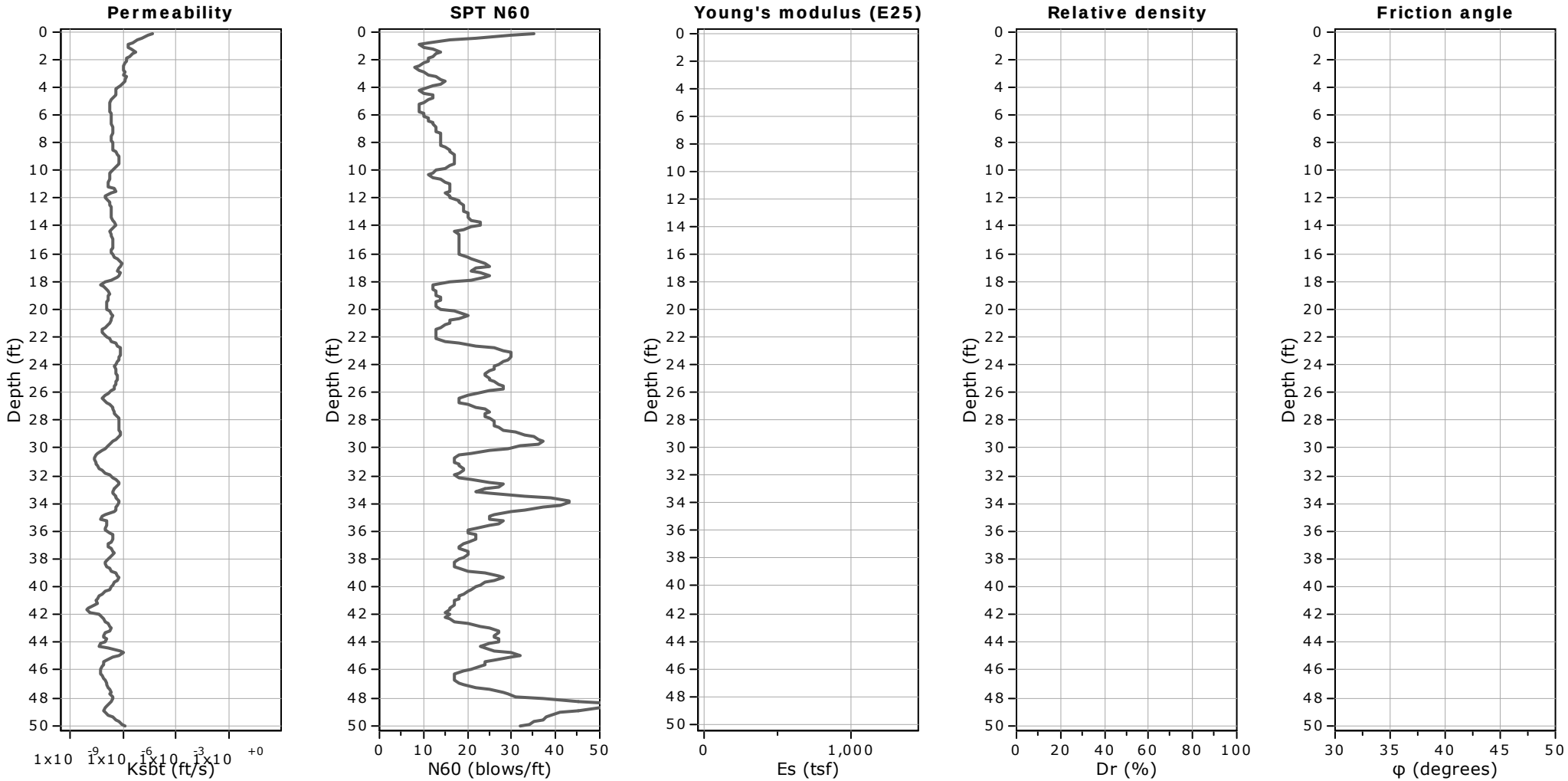
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



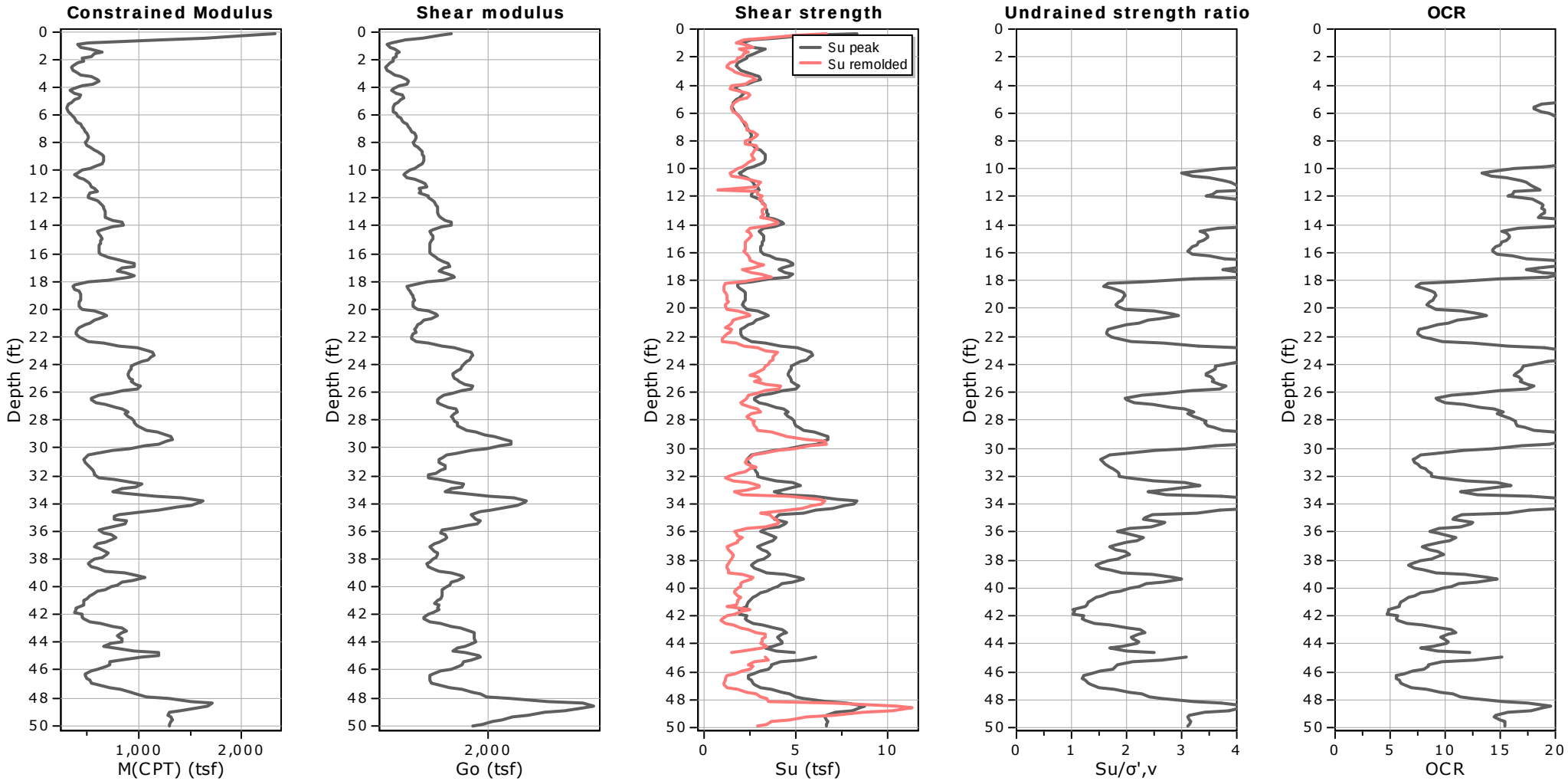
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



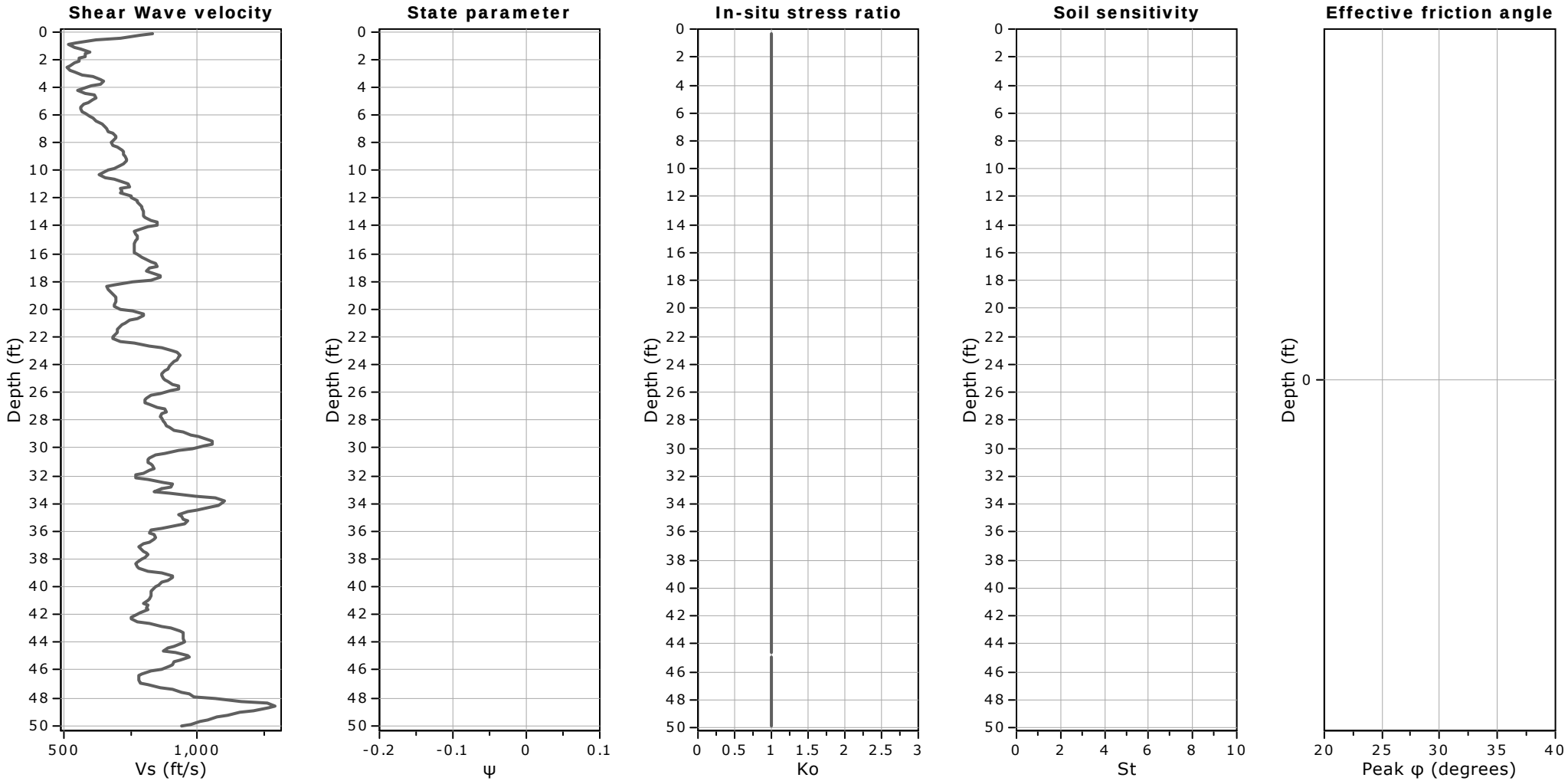
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-16
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

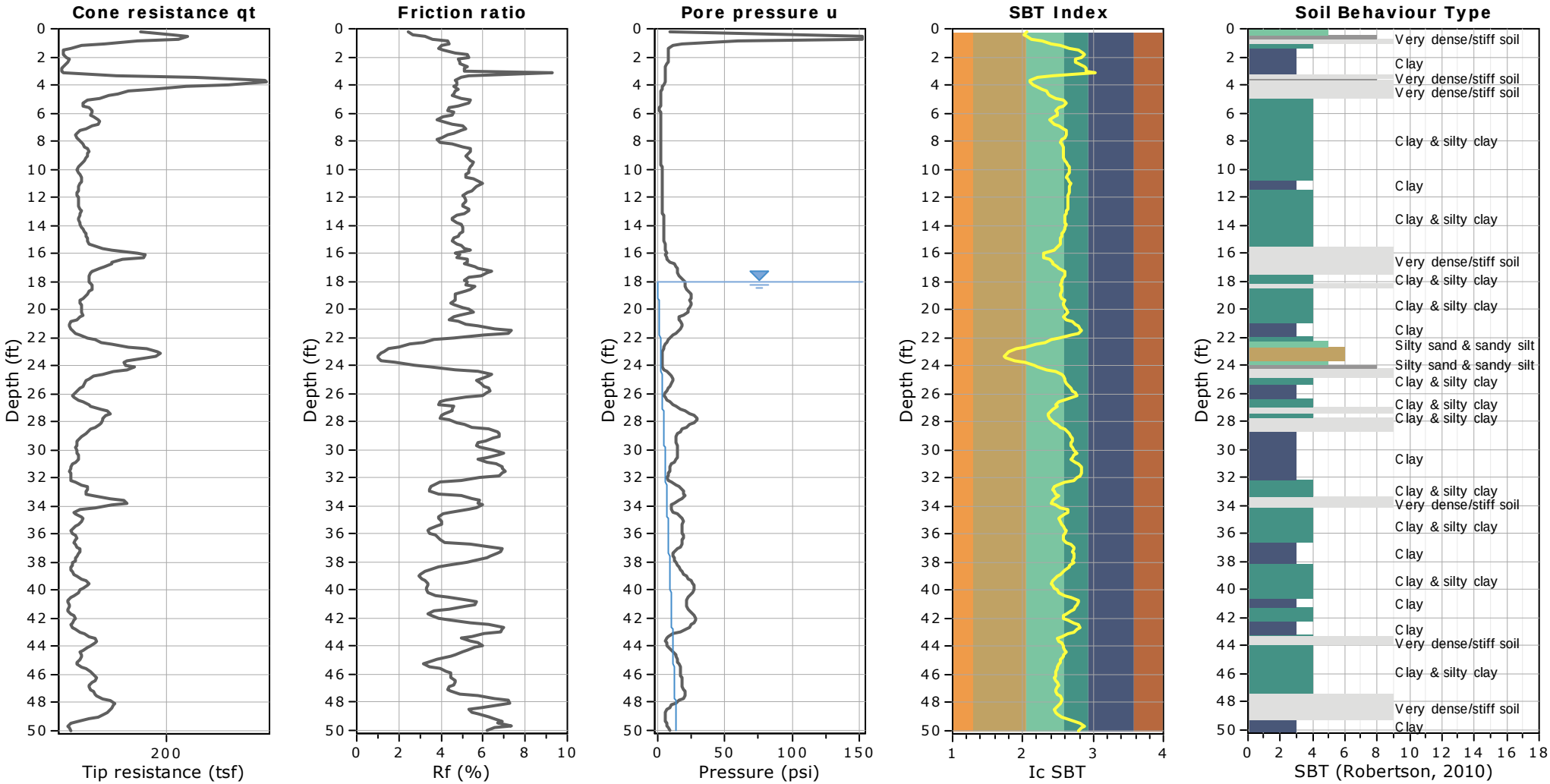
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



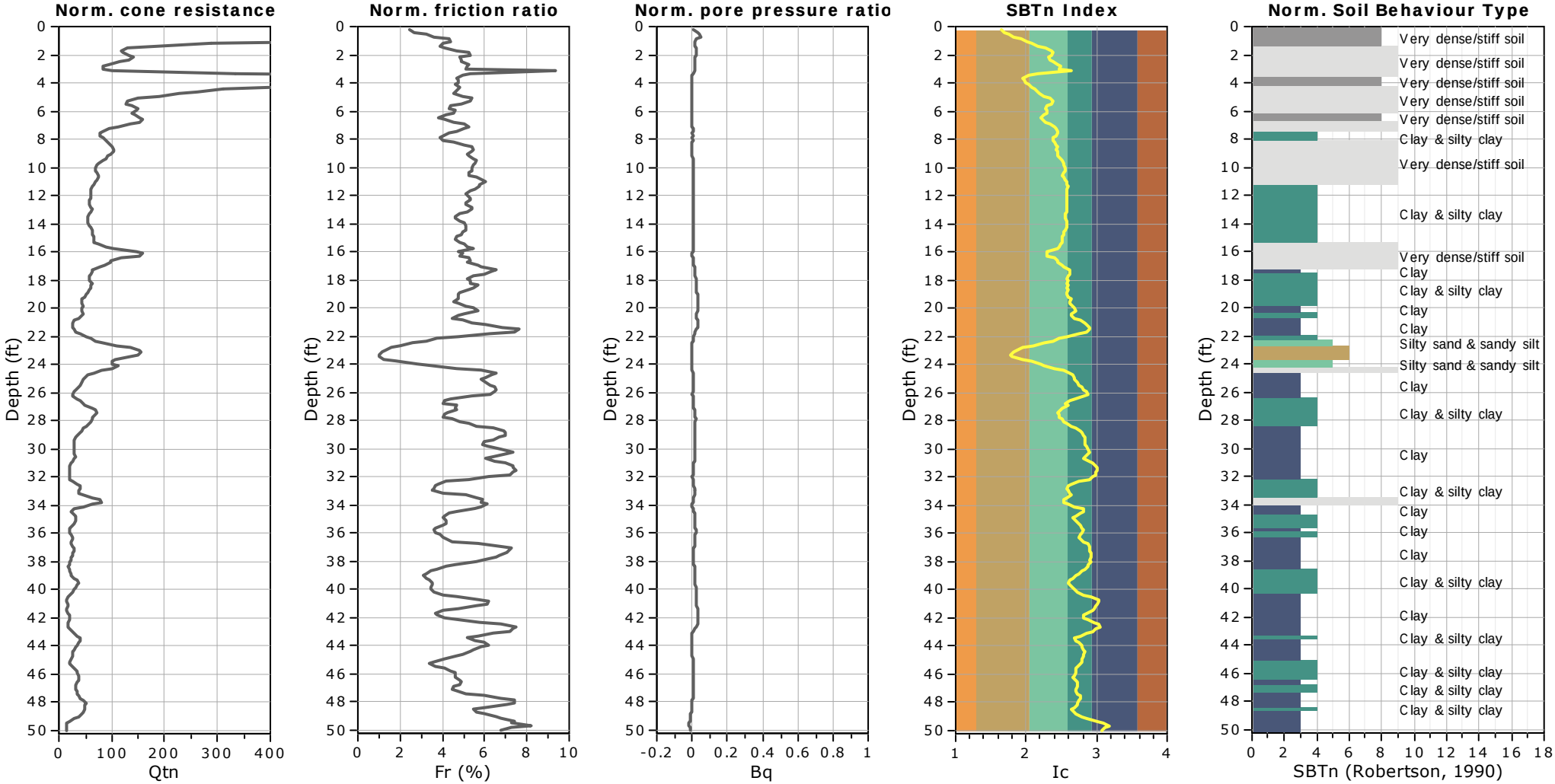
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



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
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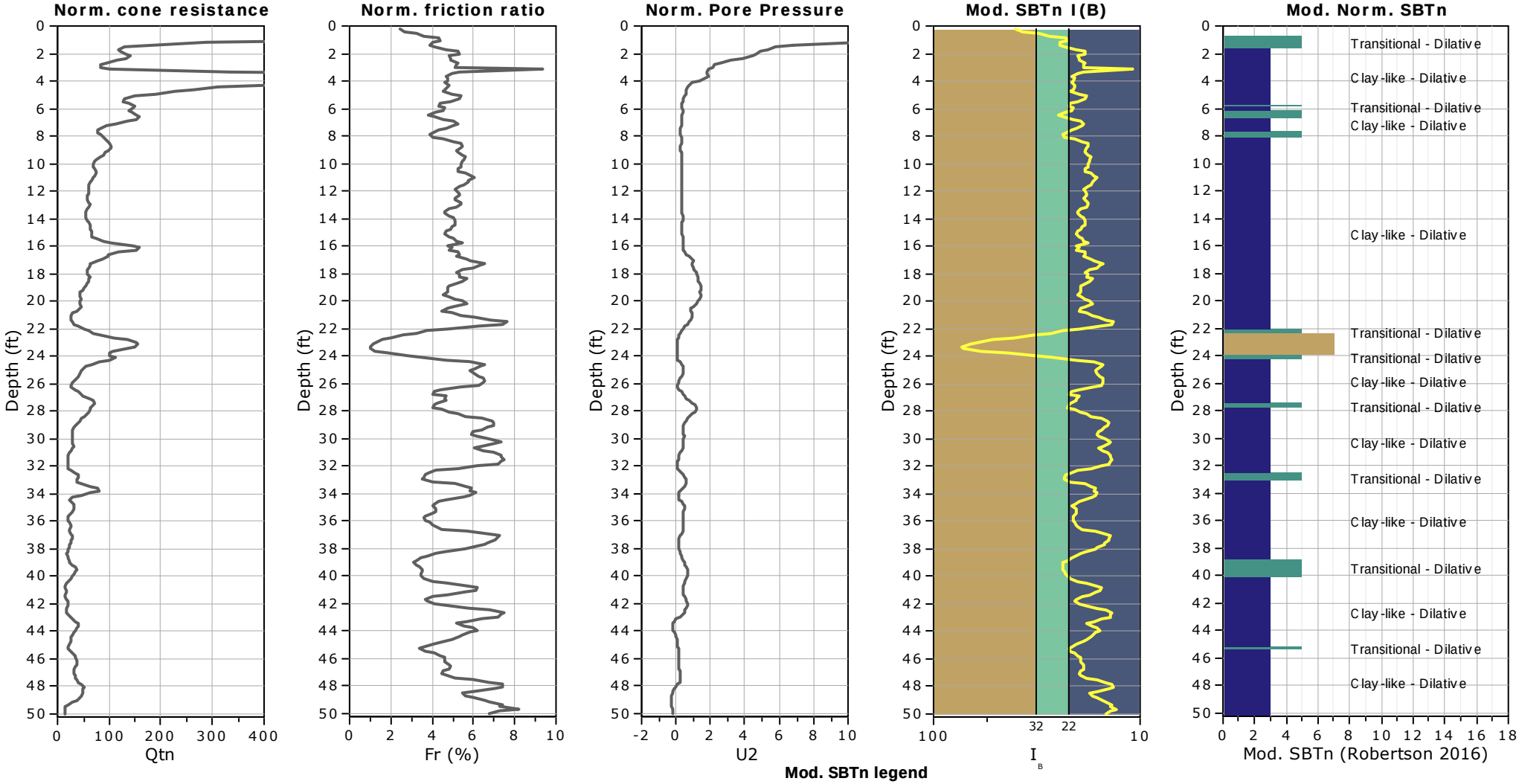
ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



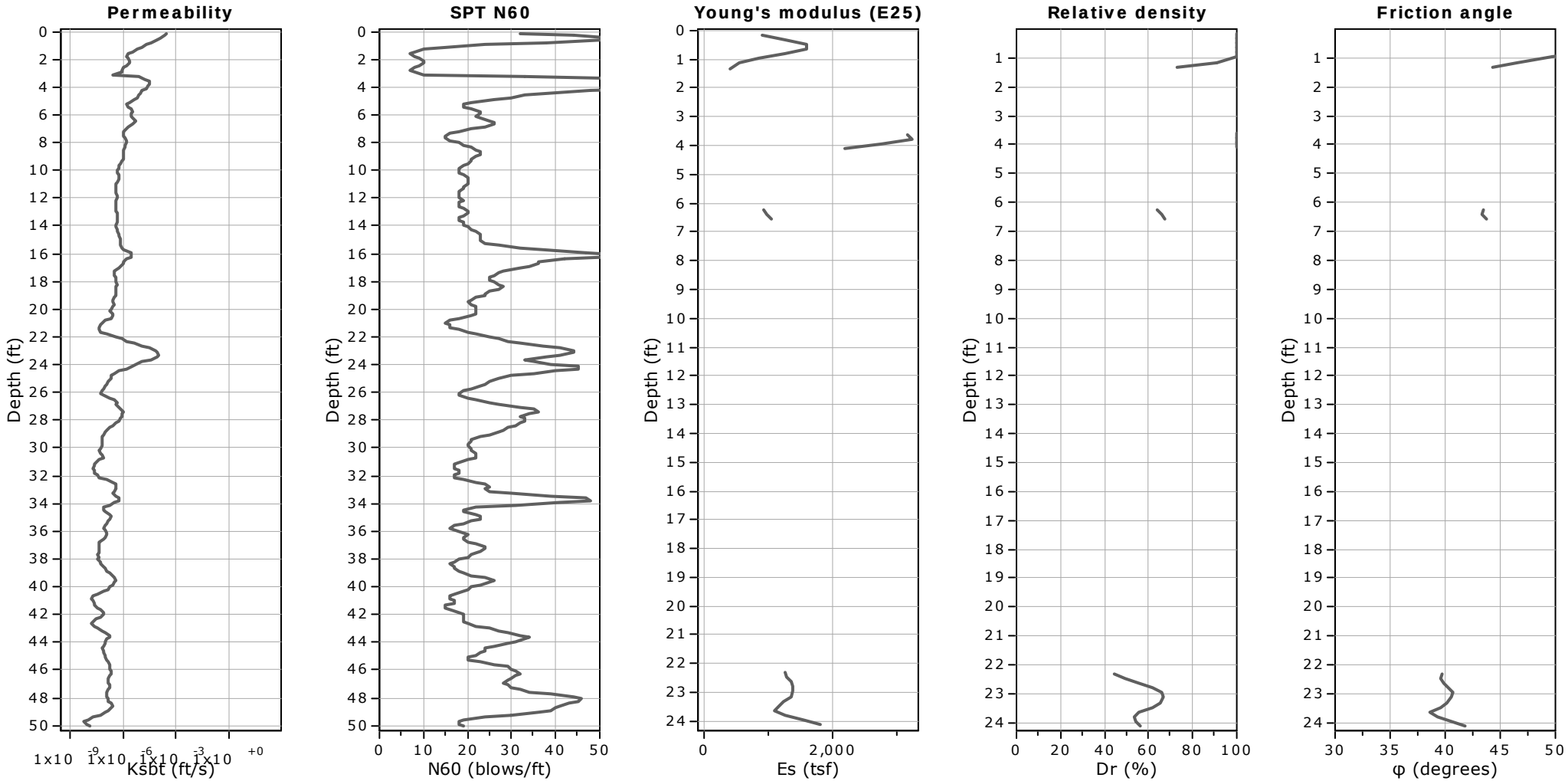
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



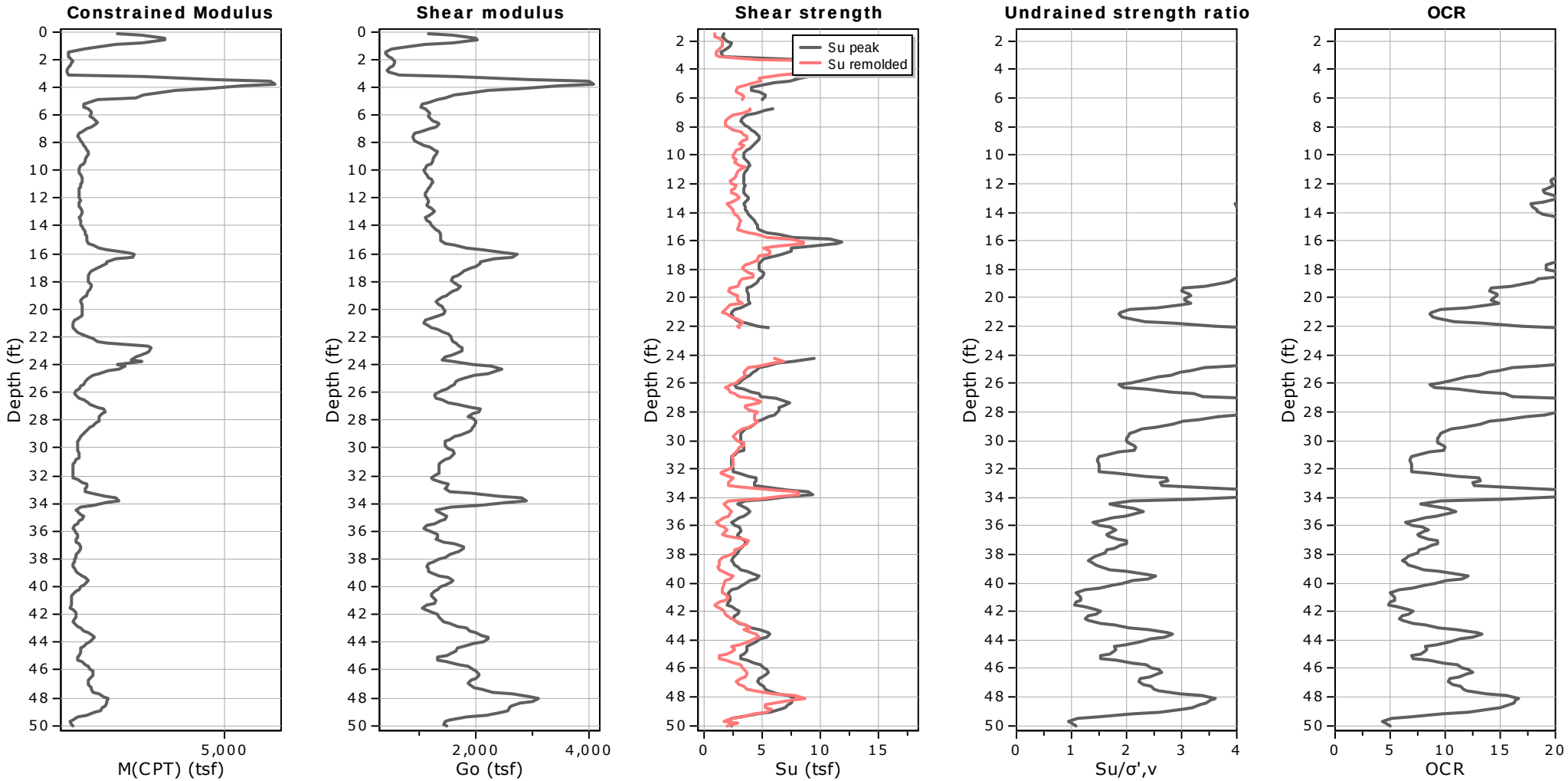
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



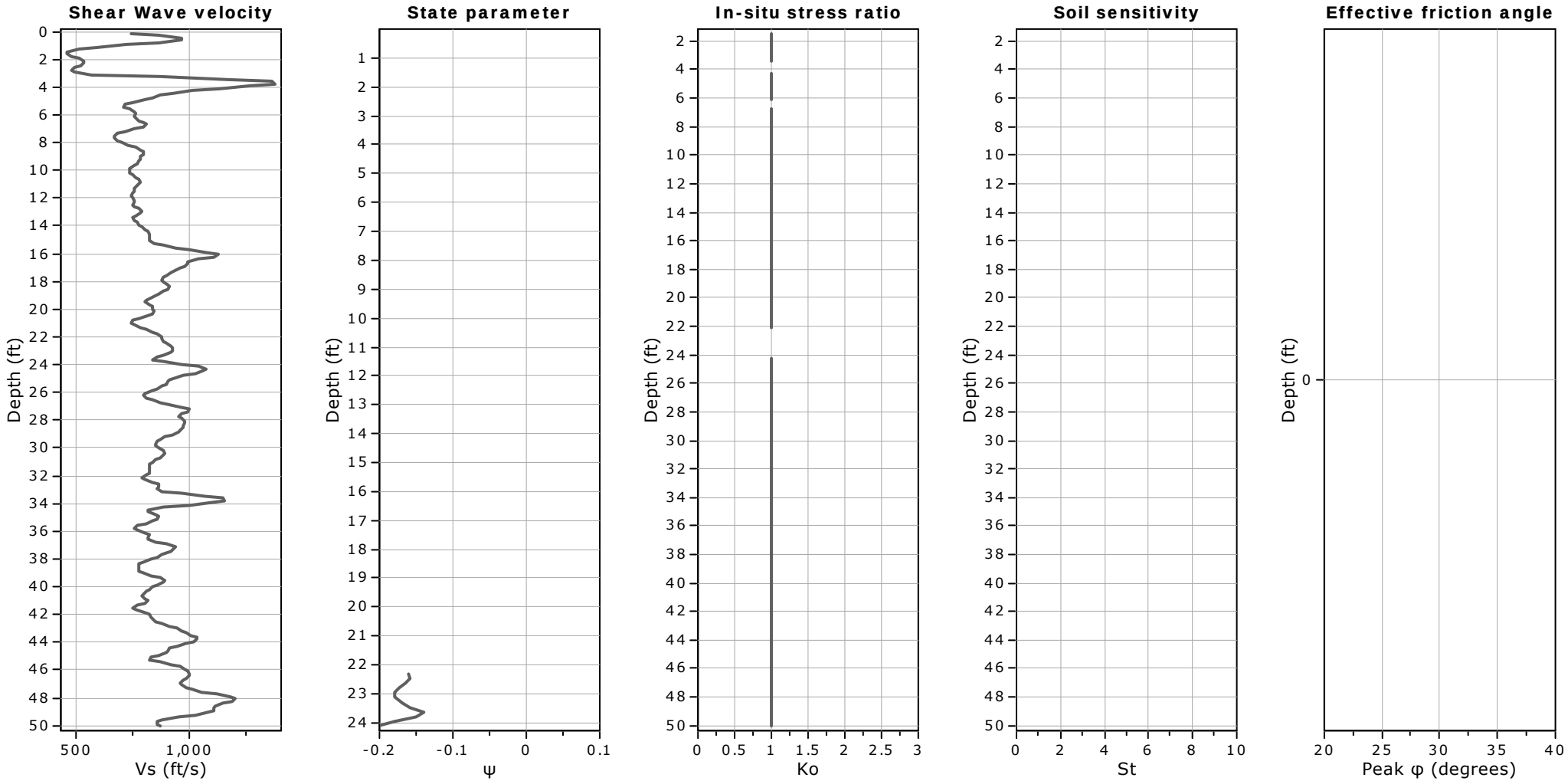
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-17
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

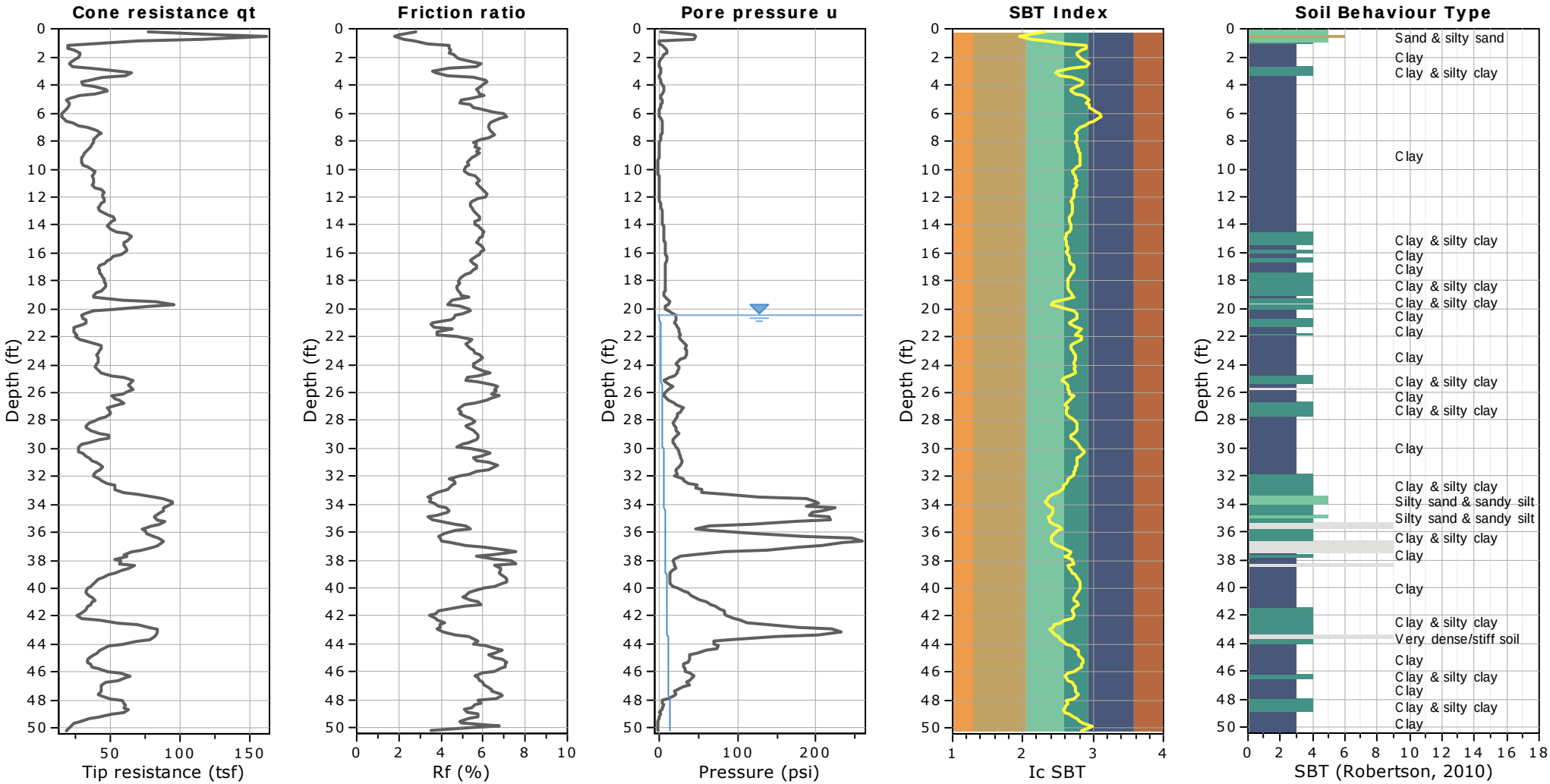
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



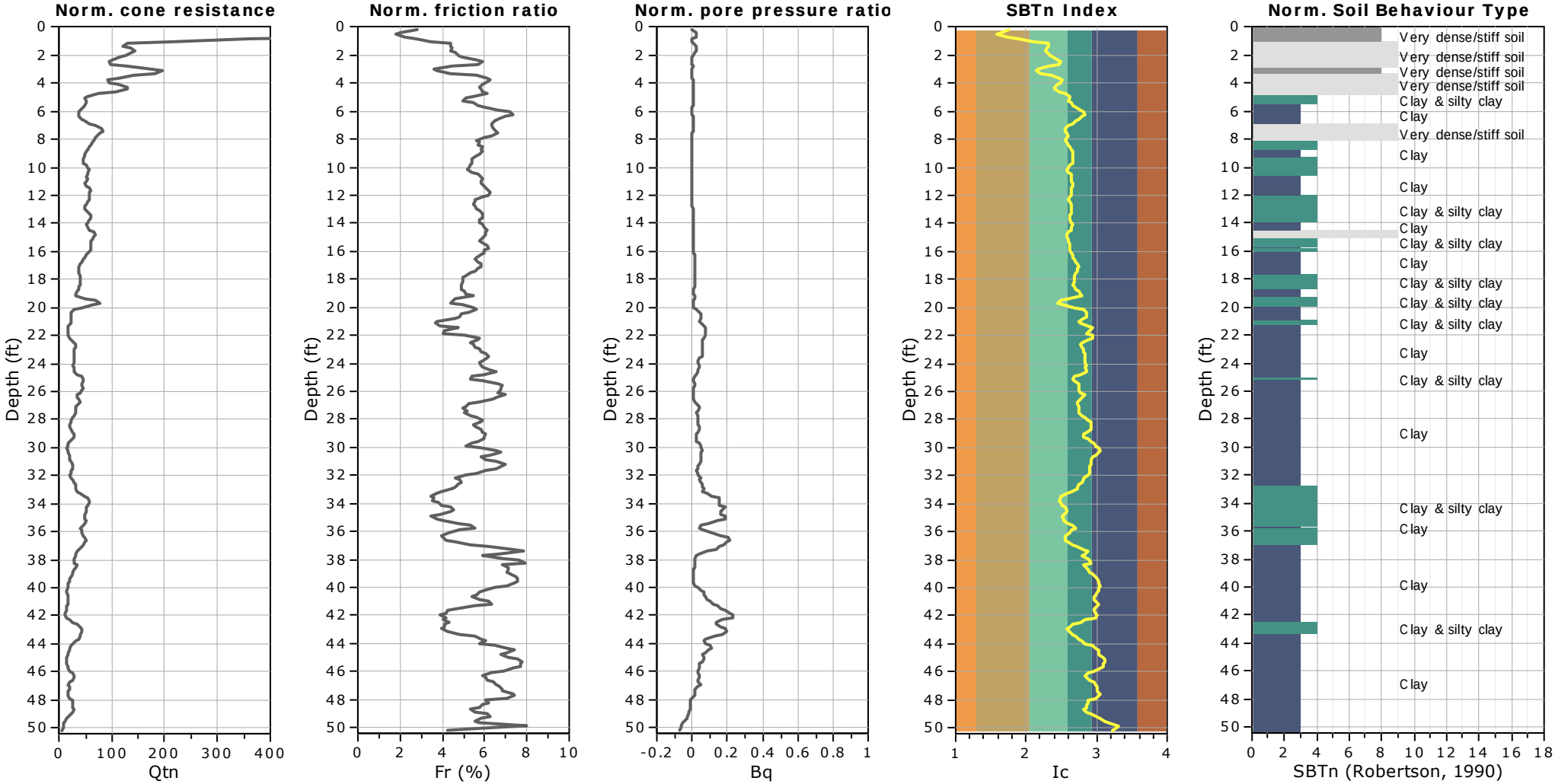
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



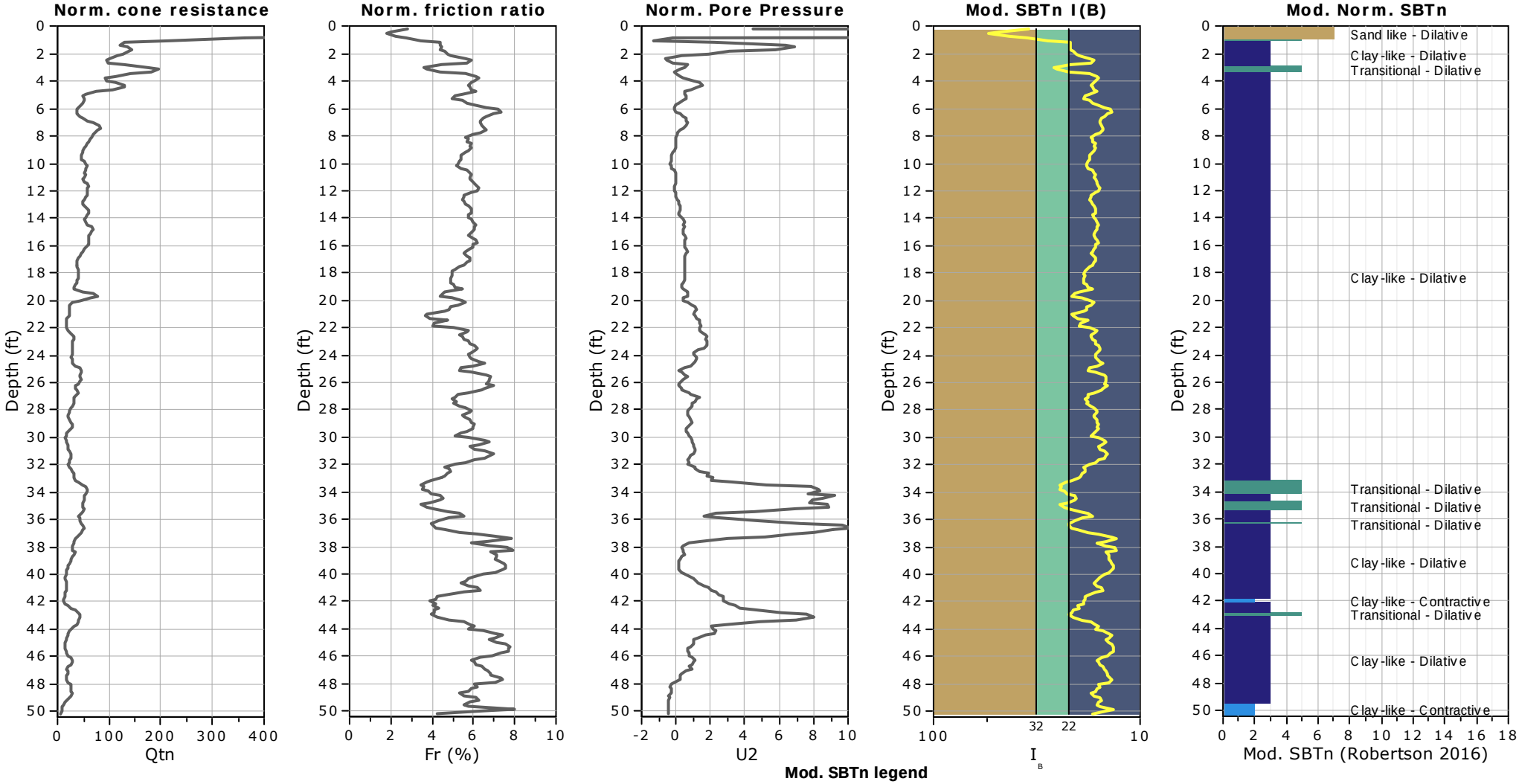
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



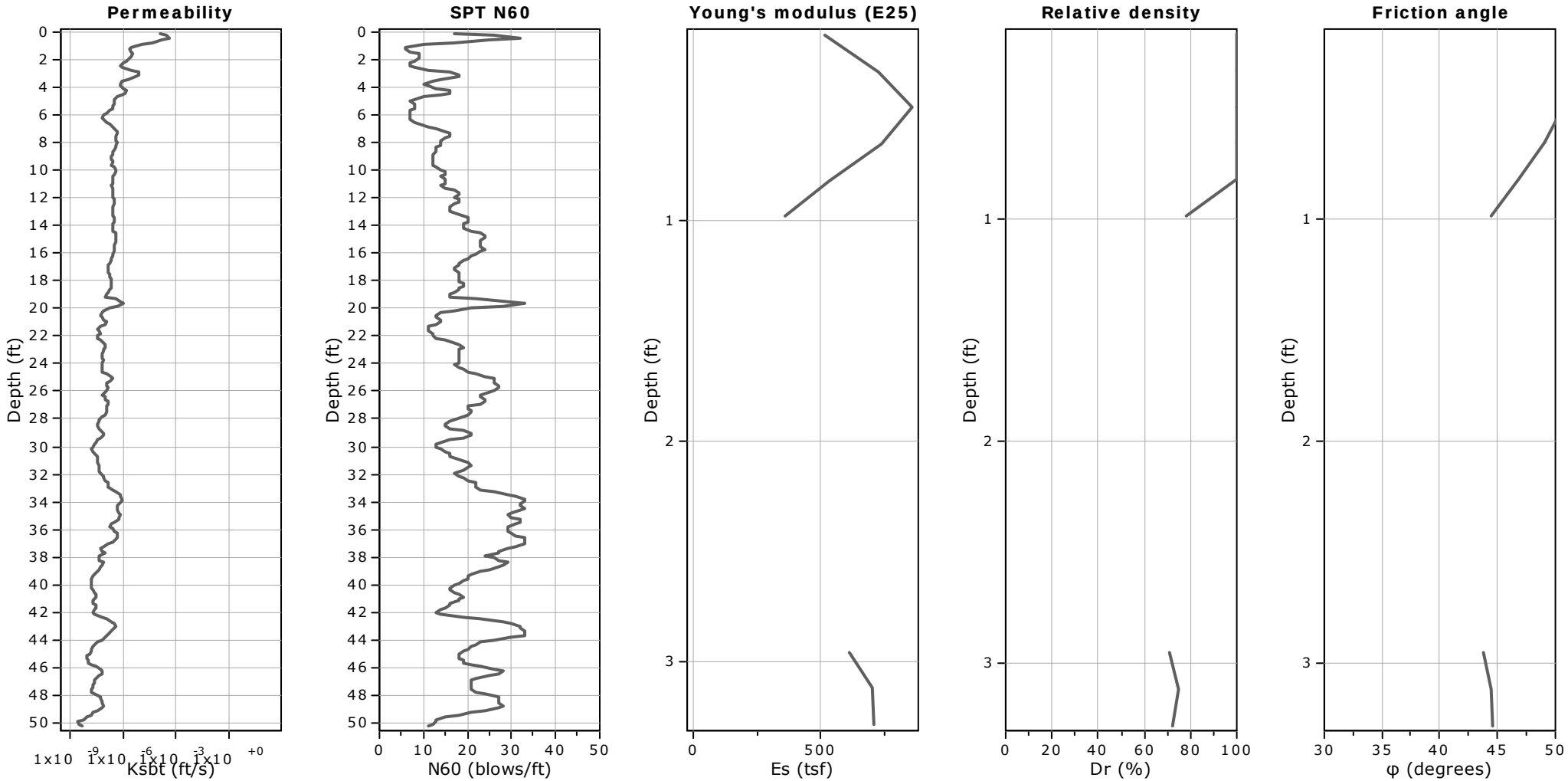
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



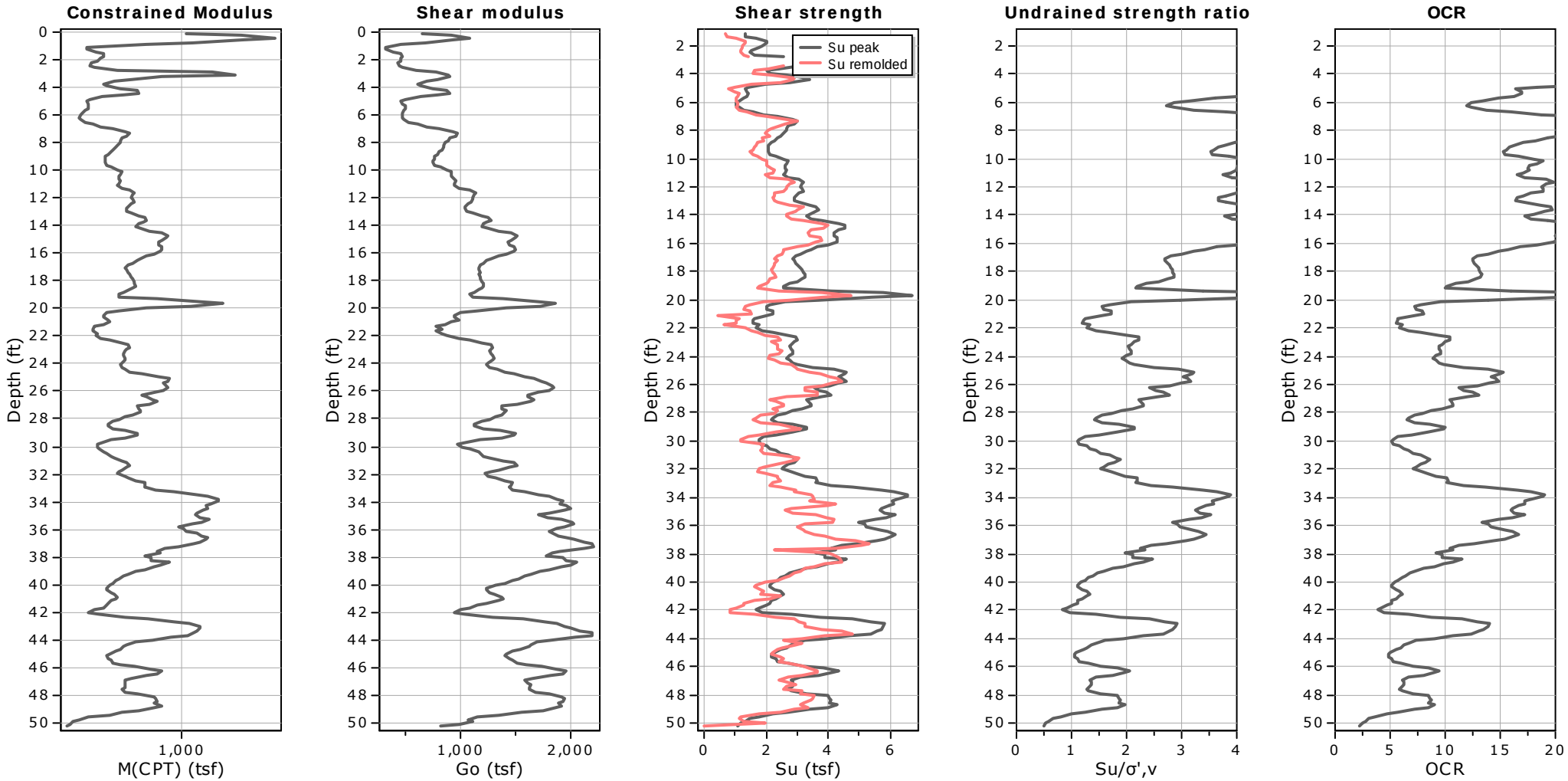
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



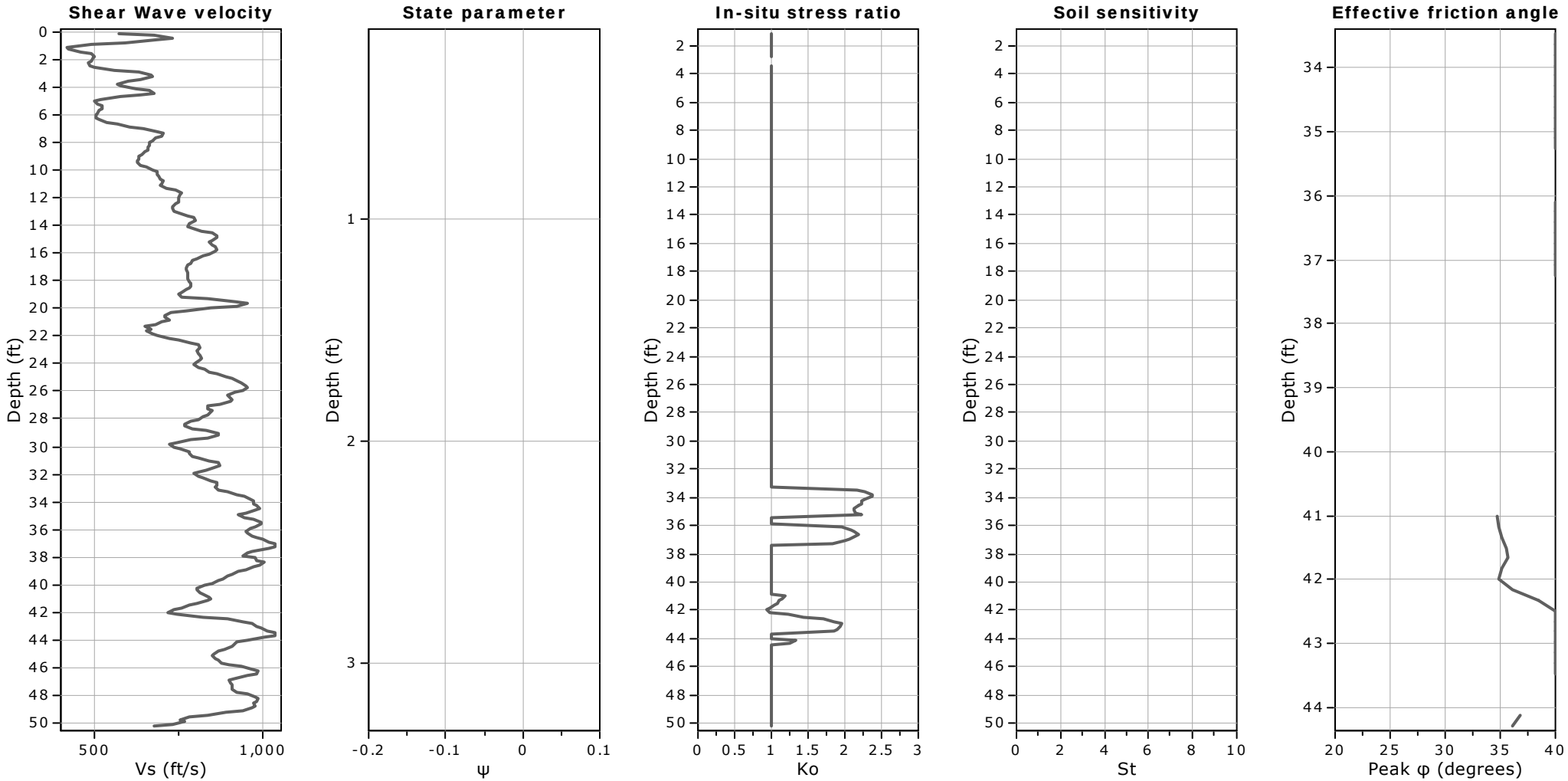
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-18
Total depth: 50.20 ft
Surface Elevation: 0.00 ft



Calculation parameters

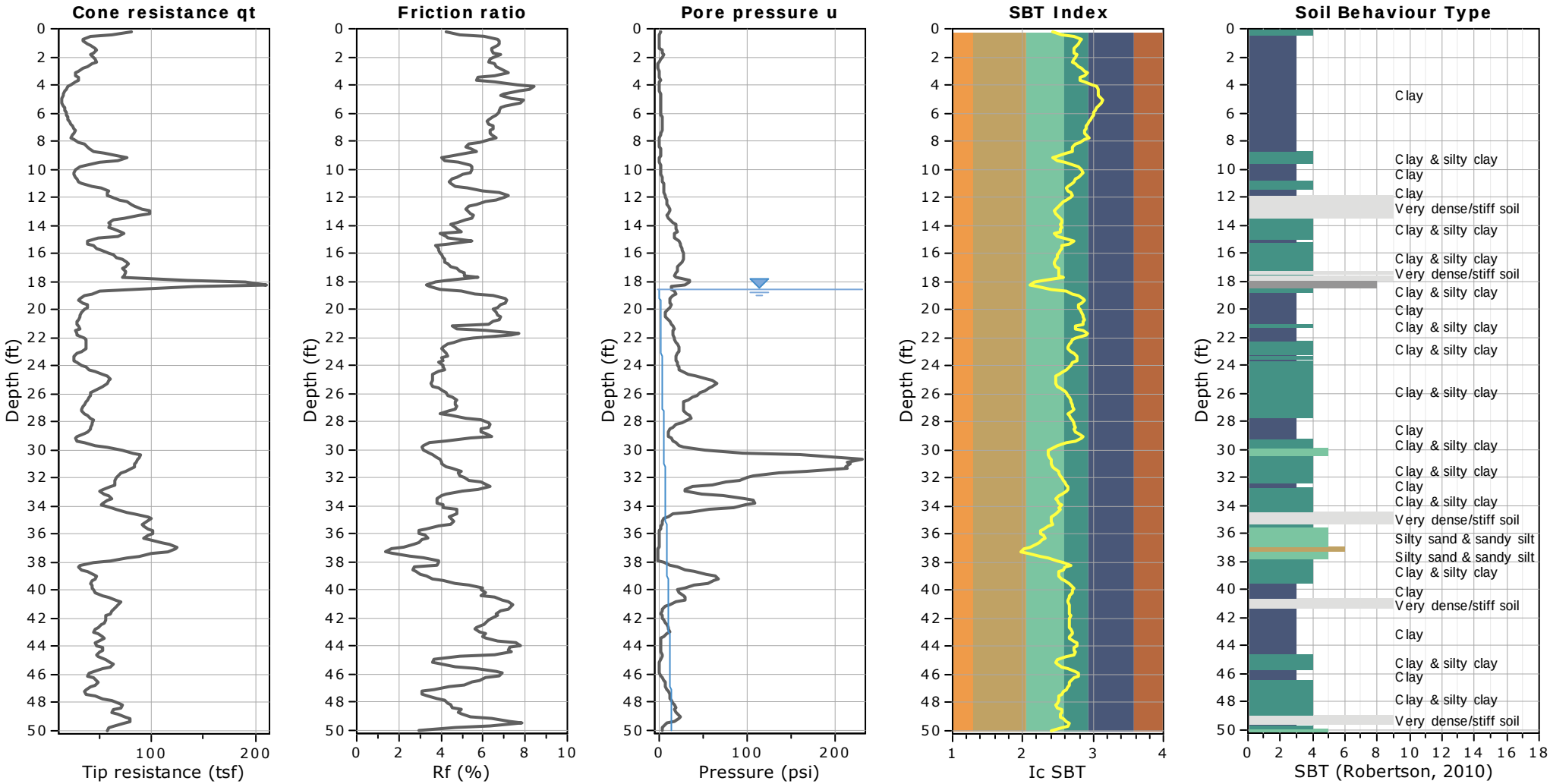
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



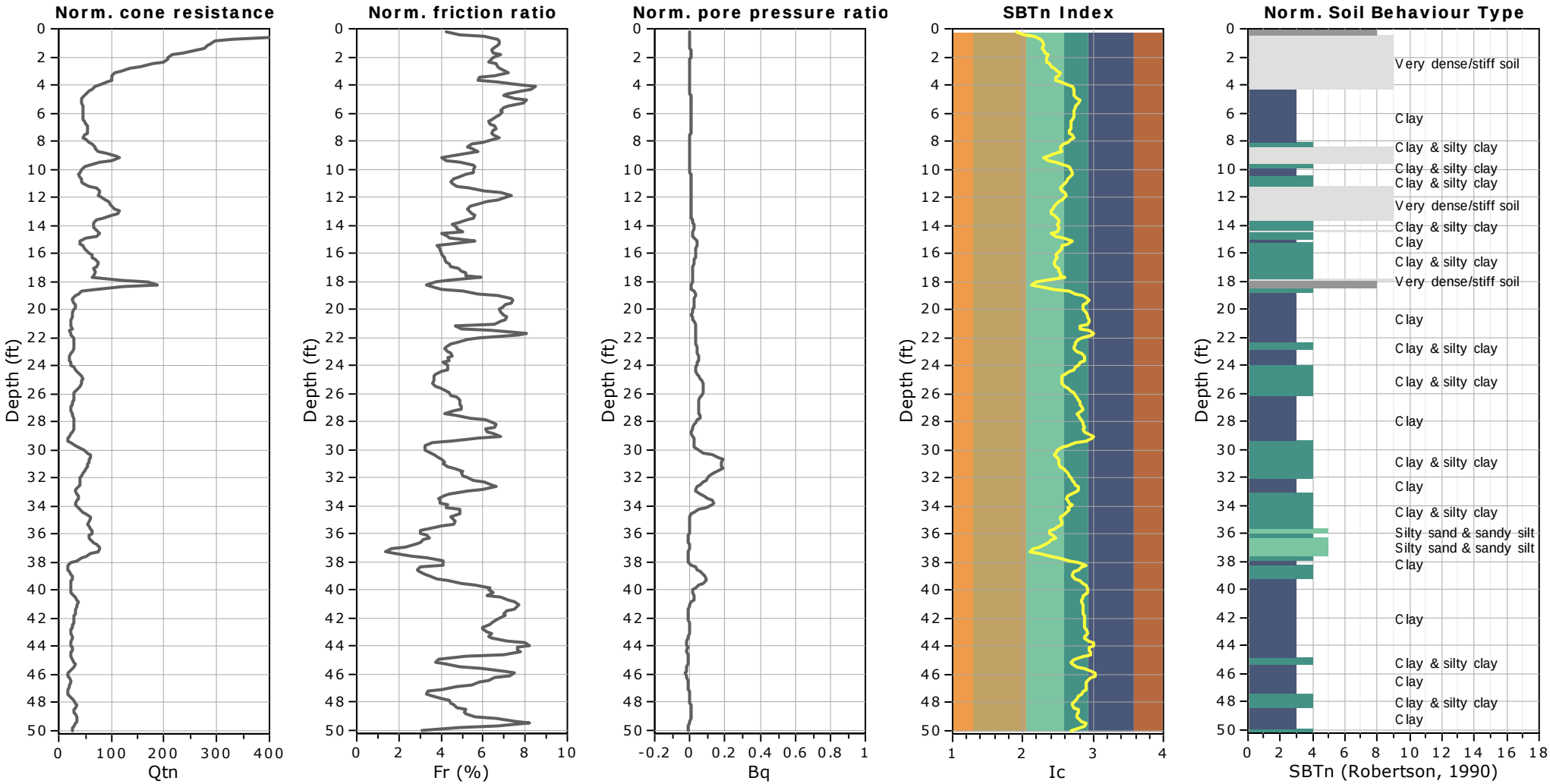
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



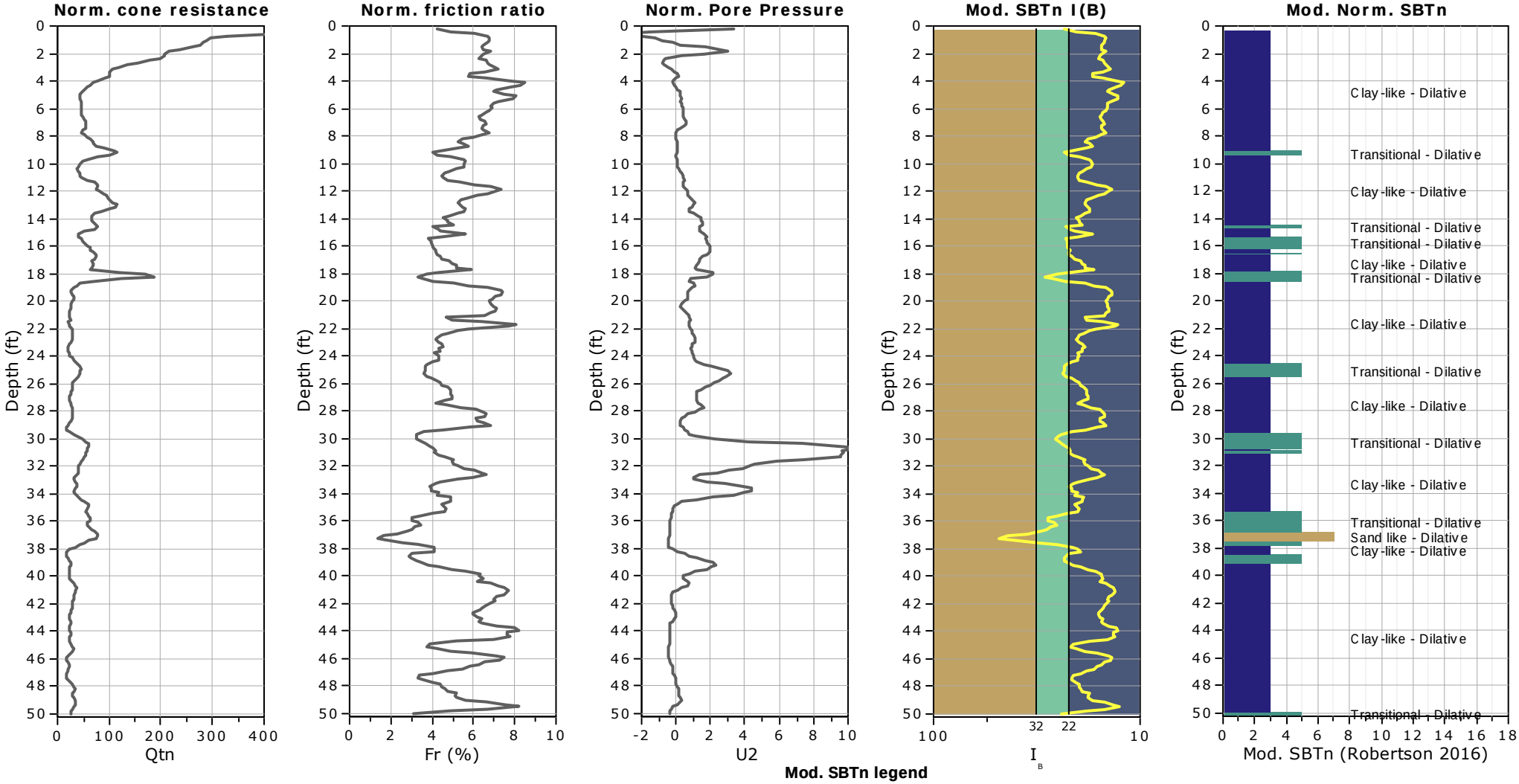
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



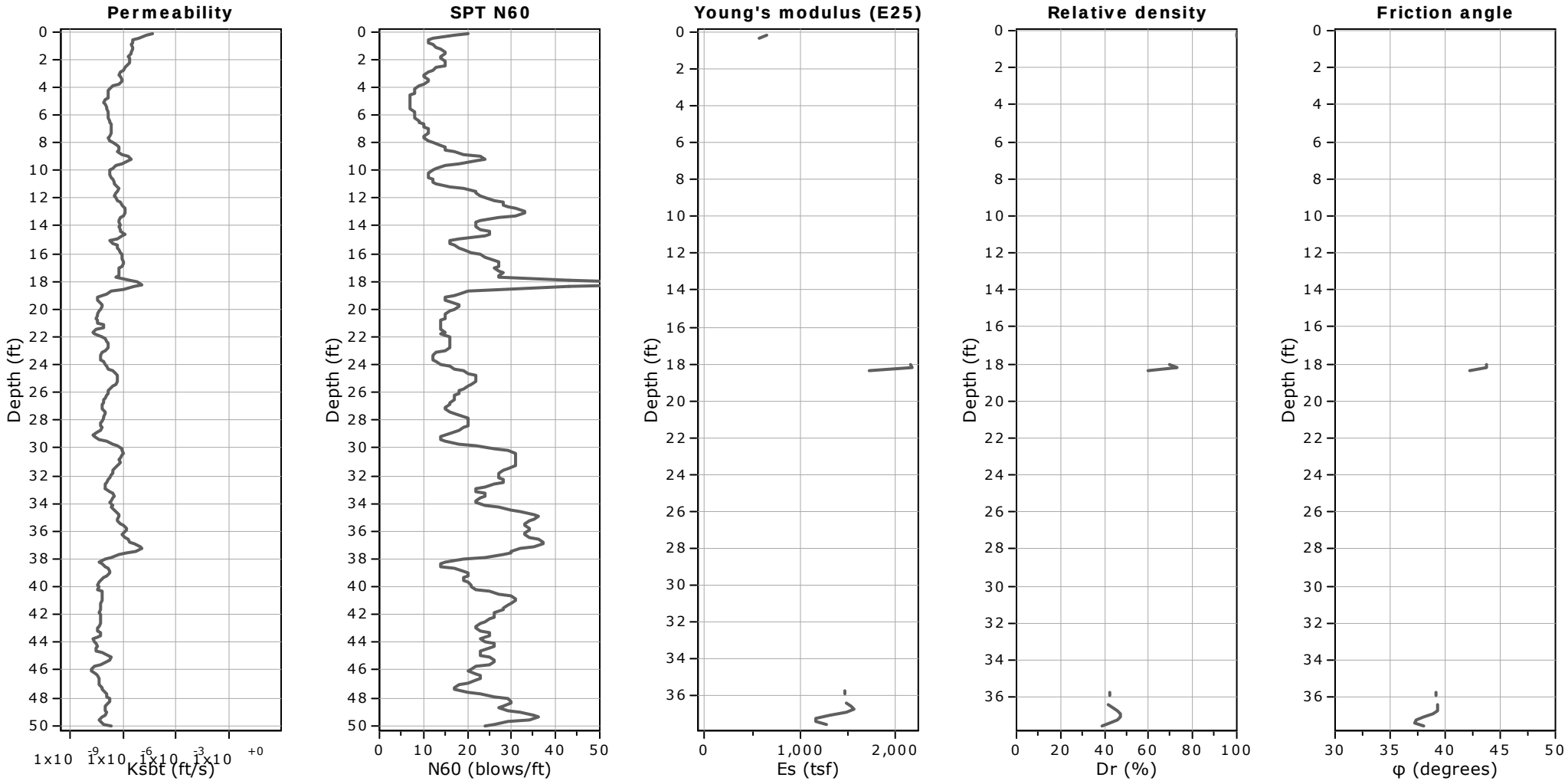
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



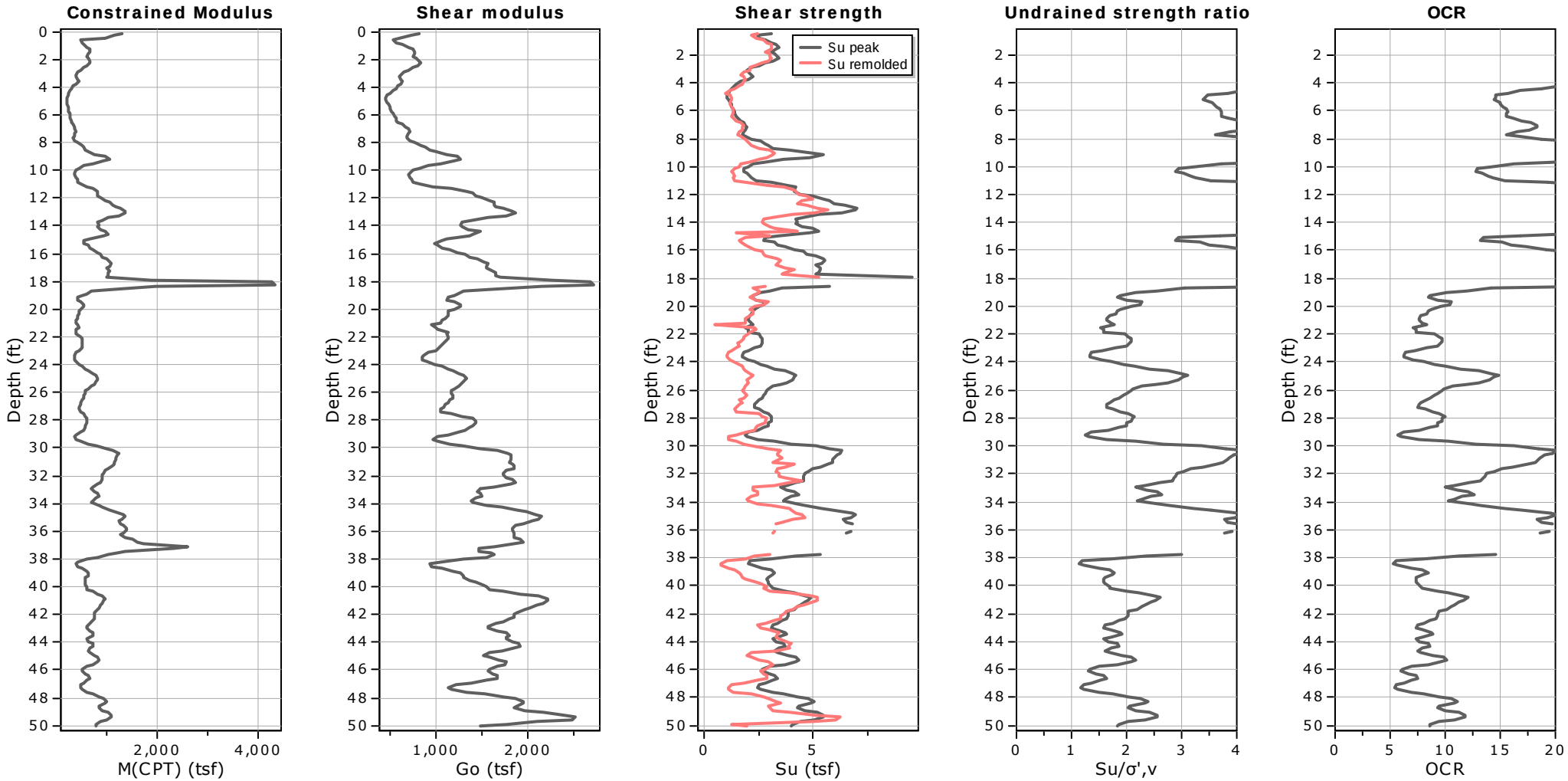
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



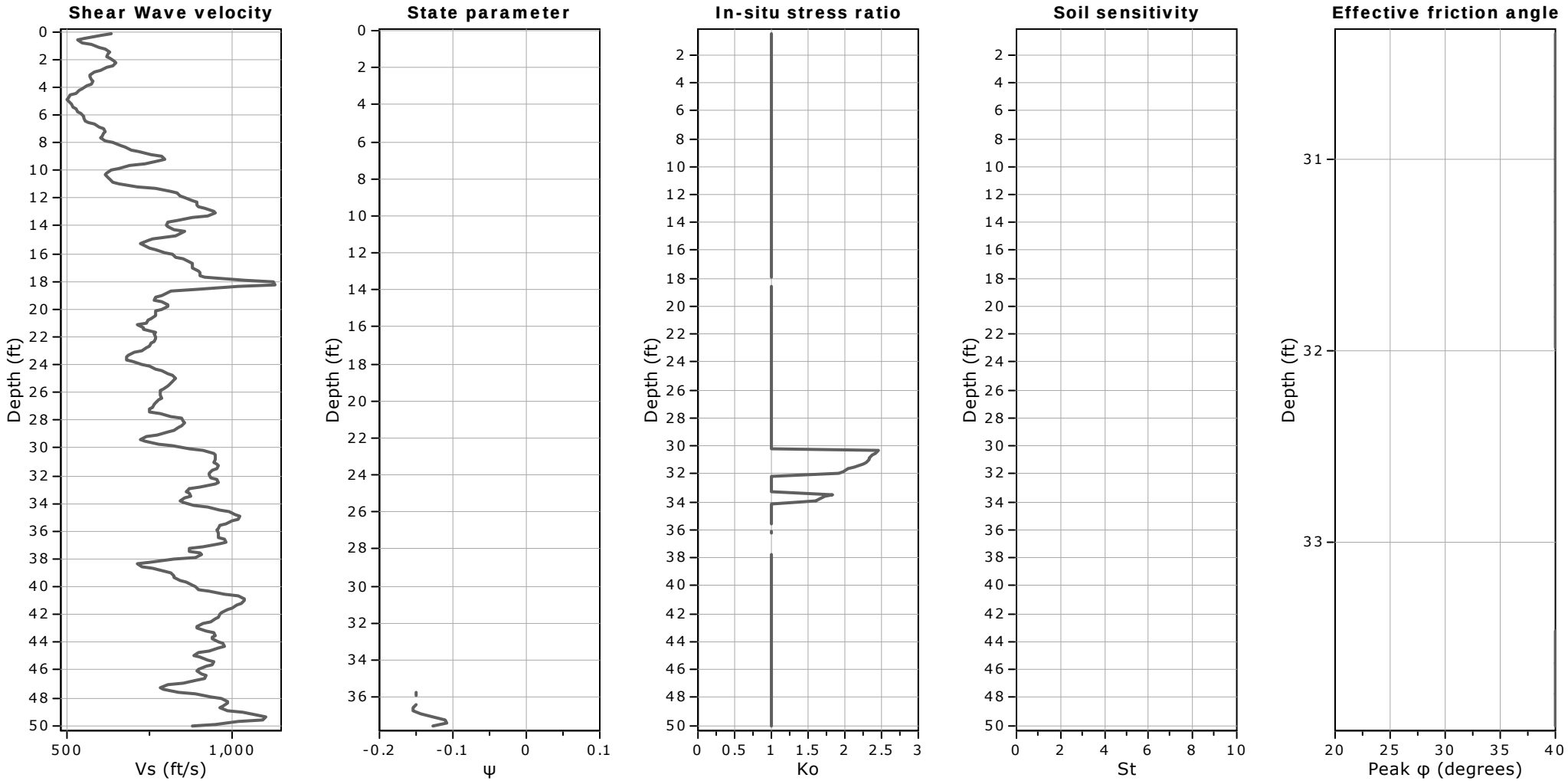
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: **Elk Grove Hospital**
Location: **Elk Grove, CA**

CPT: 1-CPT-19
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

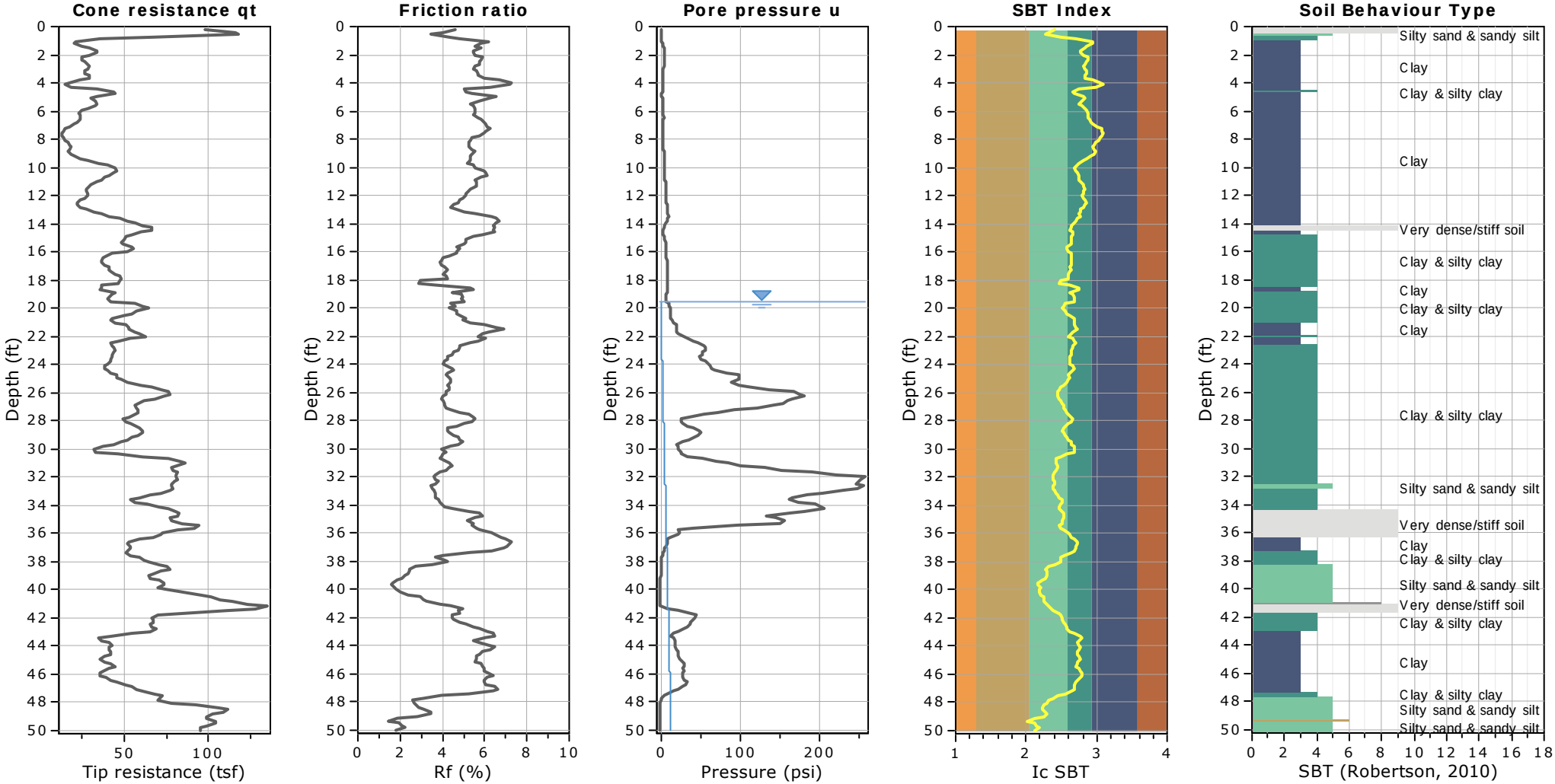
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



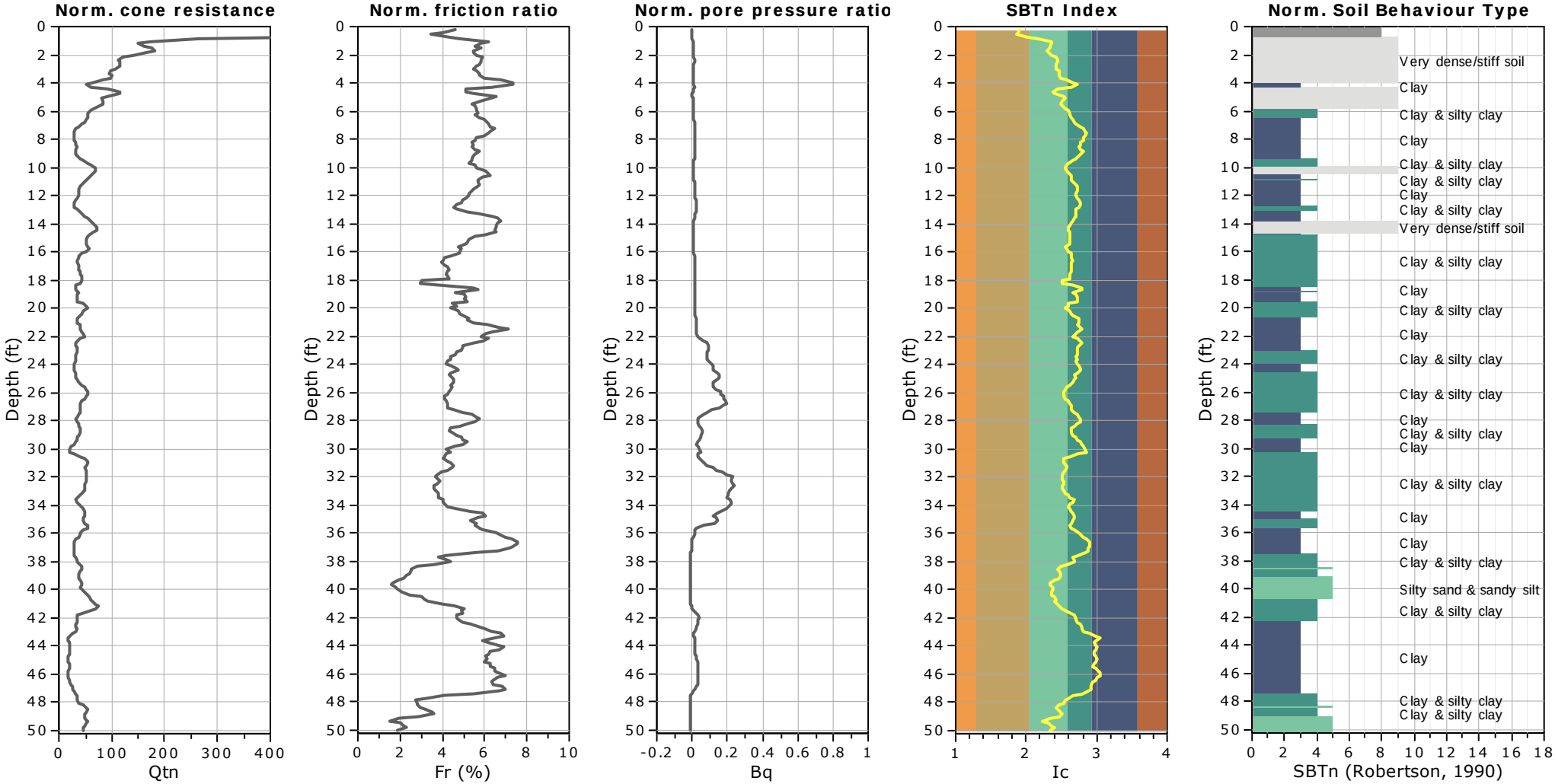
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



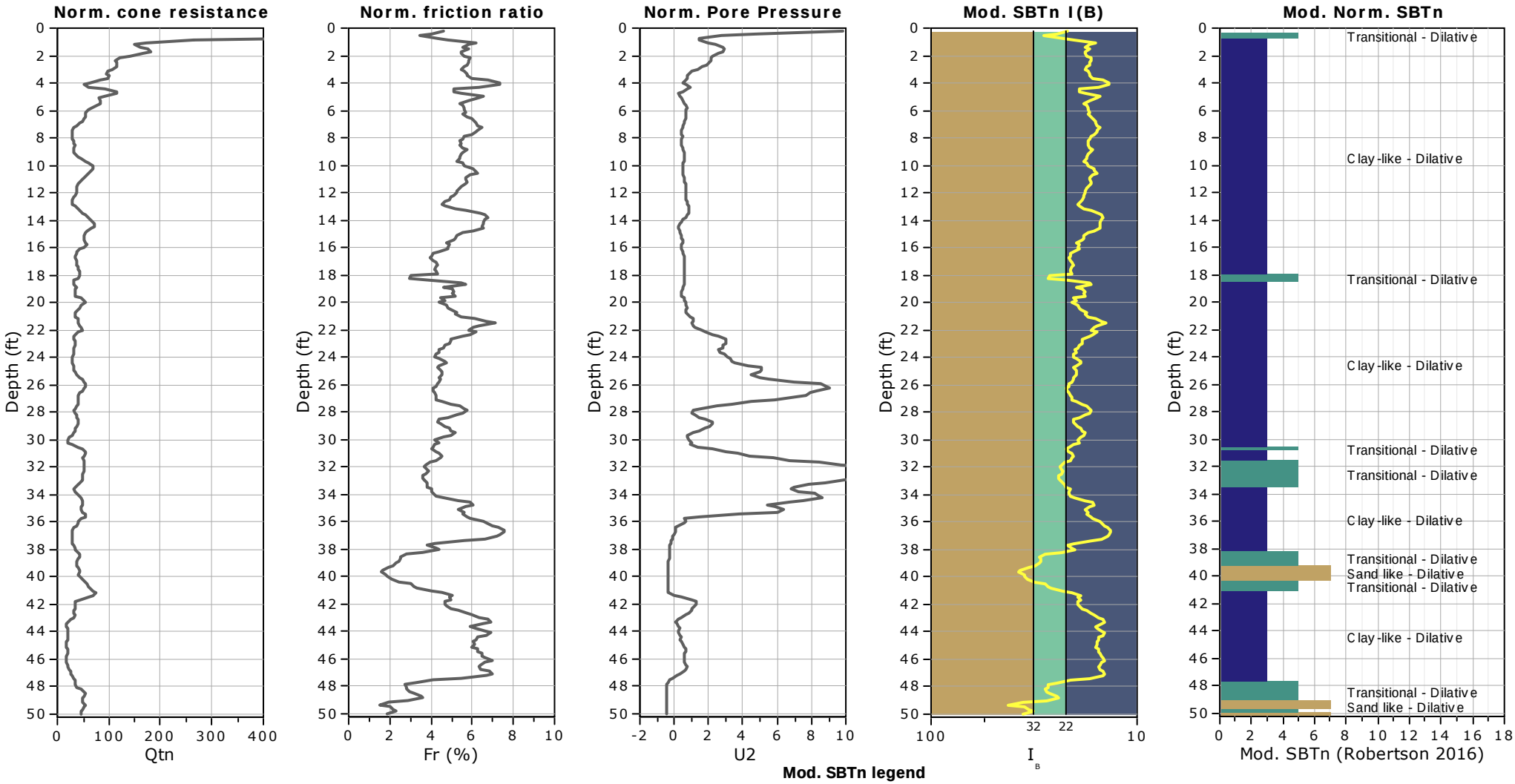
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



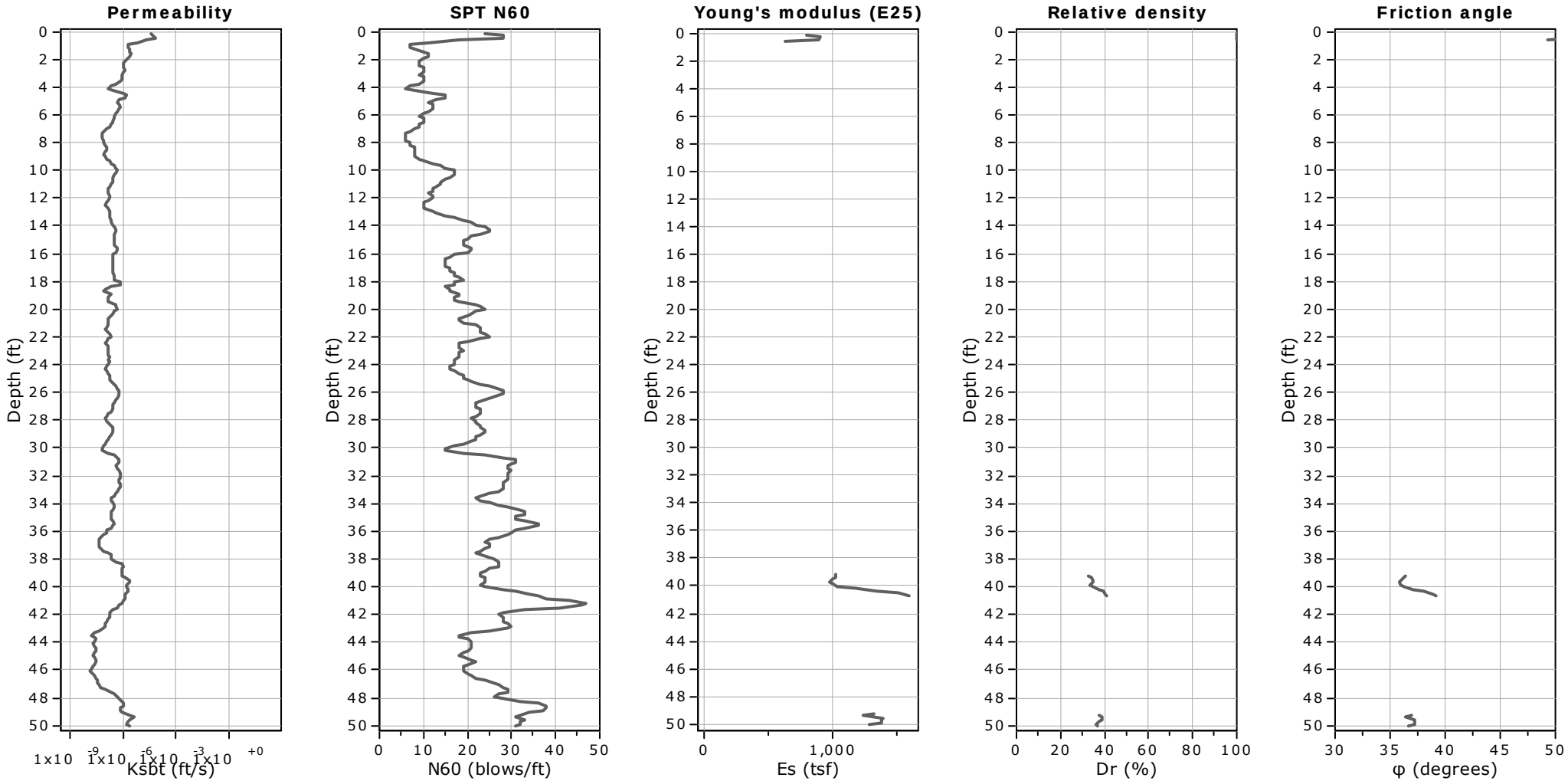
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



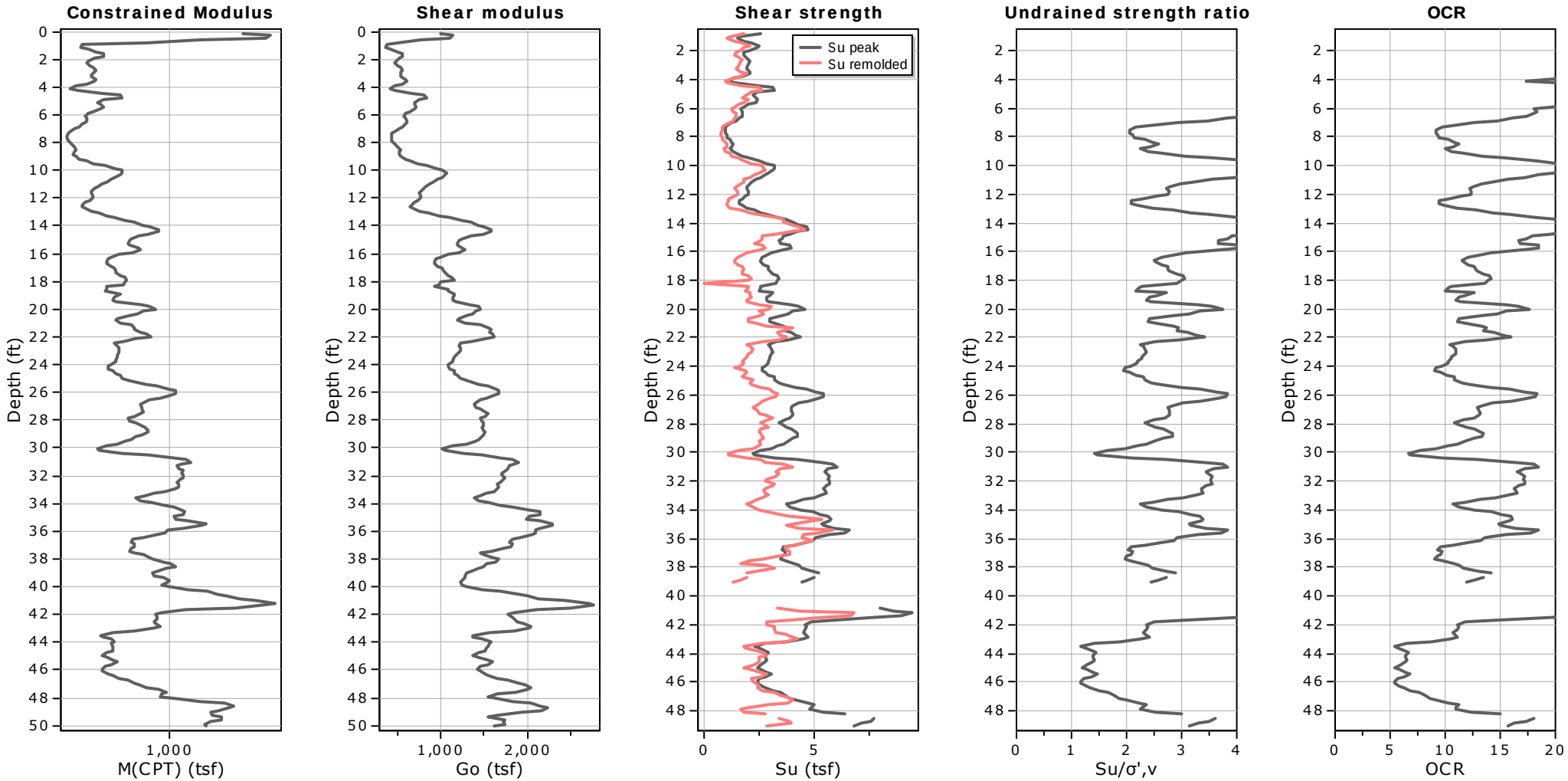
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



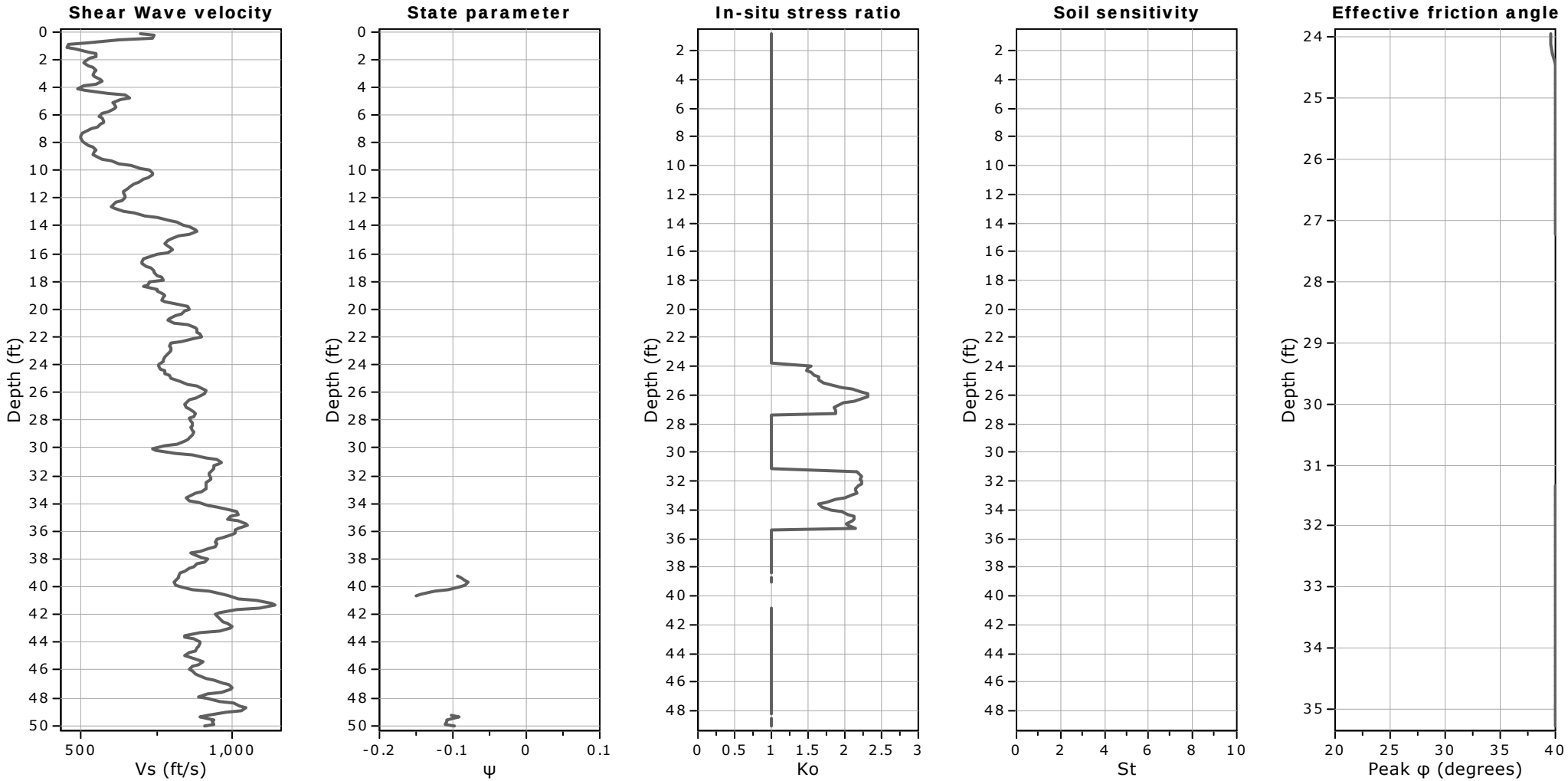
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-20
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

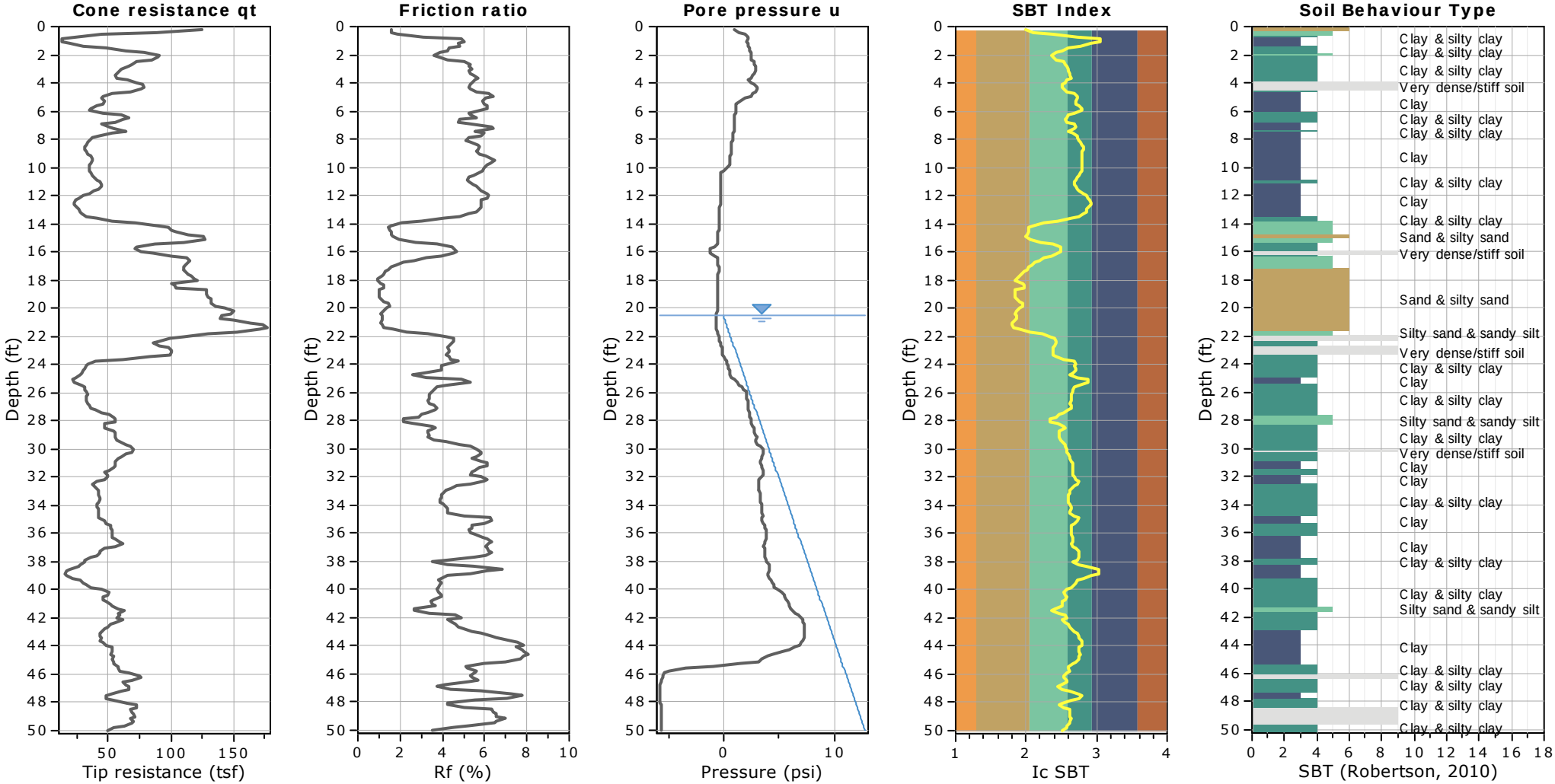
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



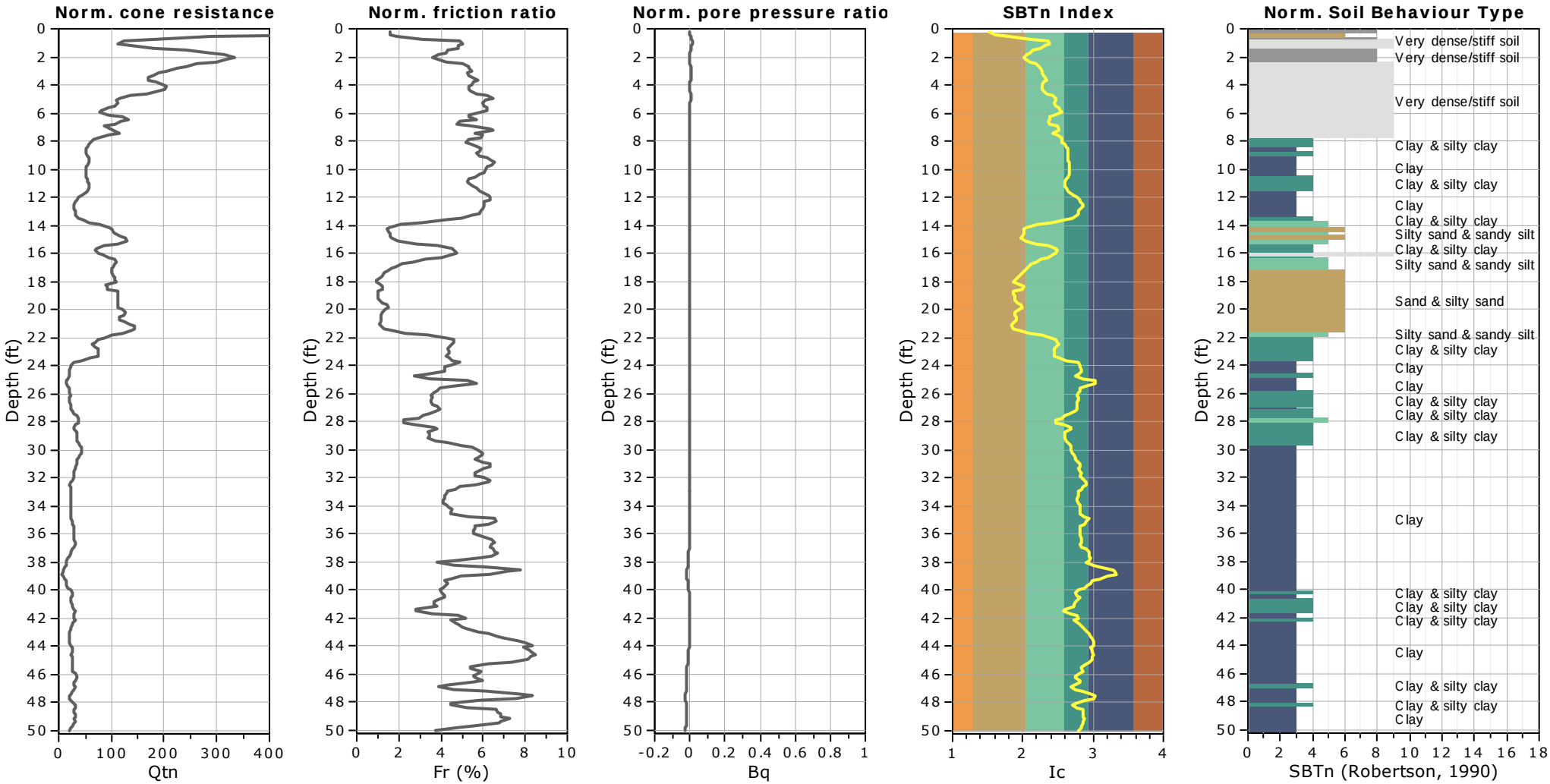
SBT legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



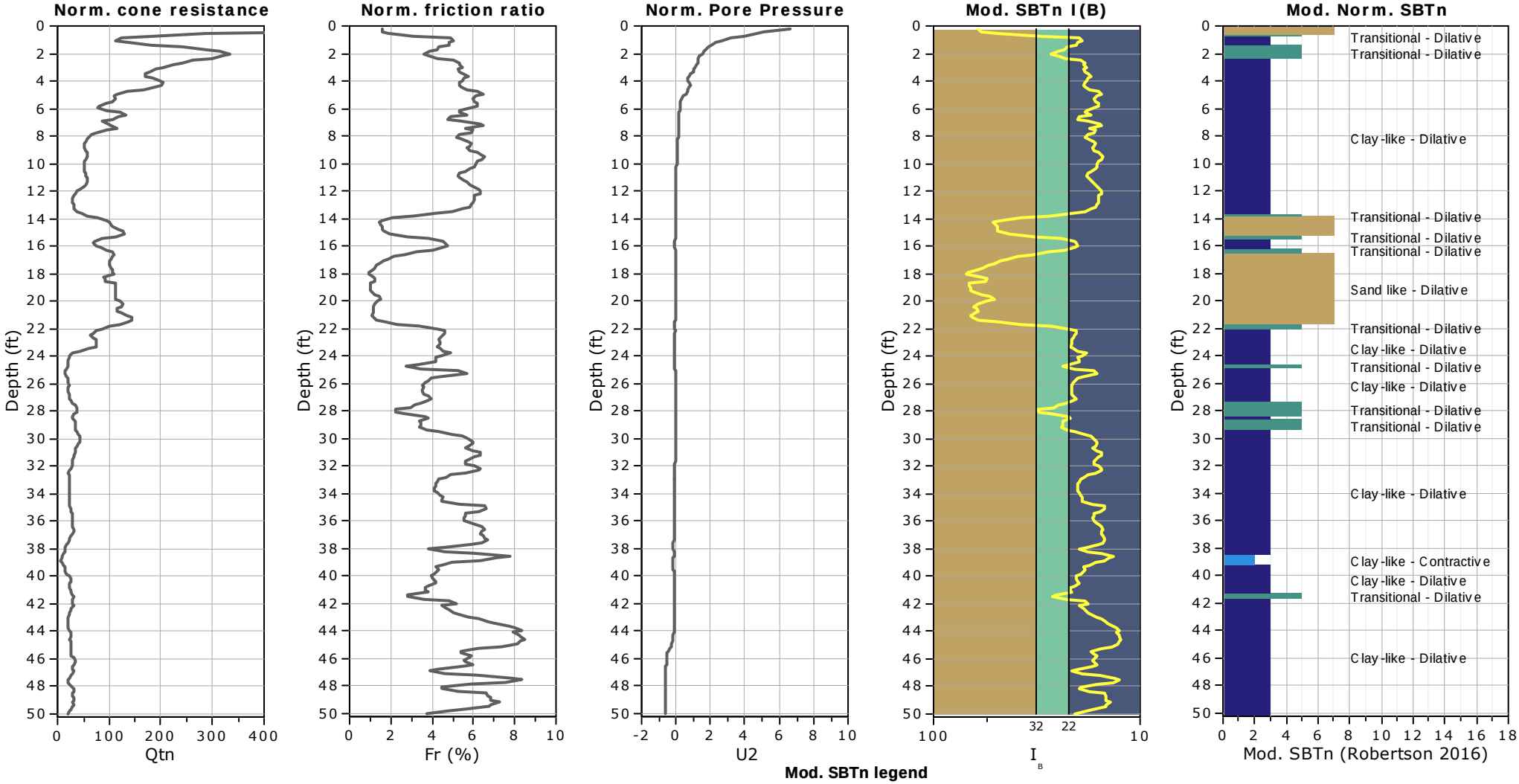
SBTn legend

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



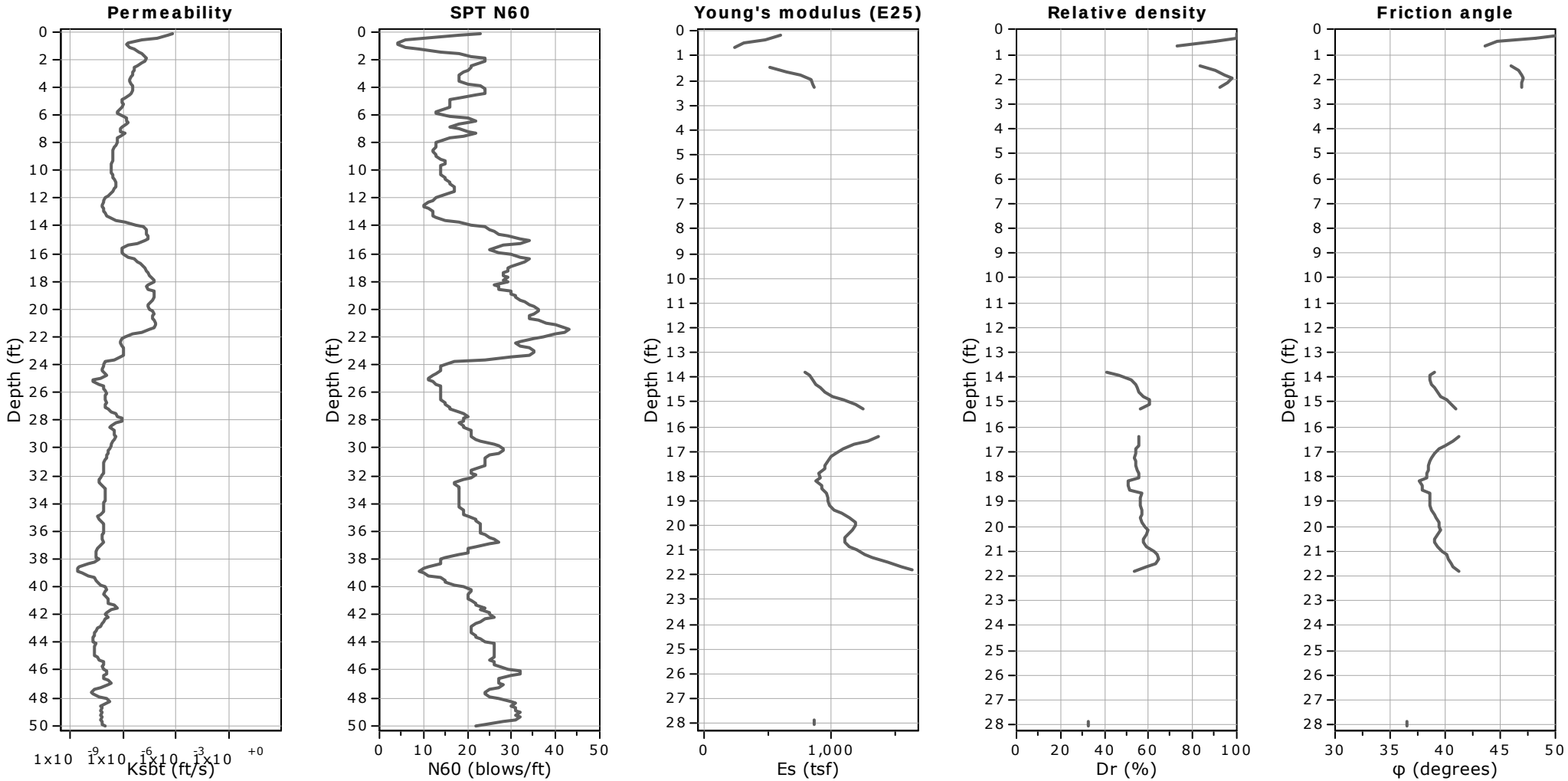
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



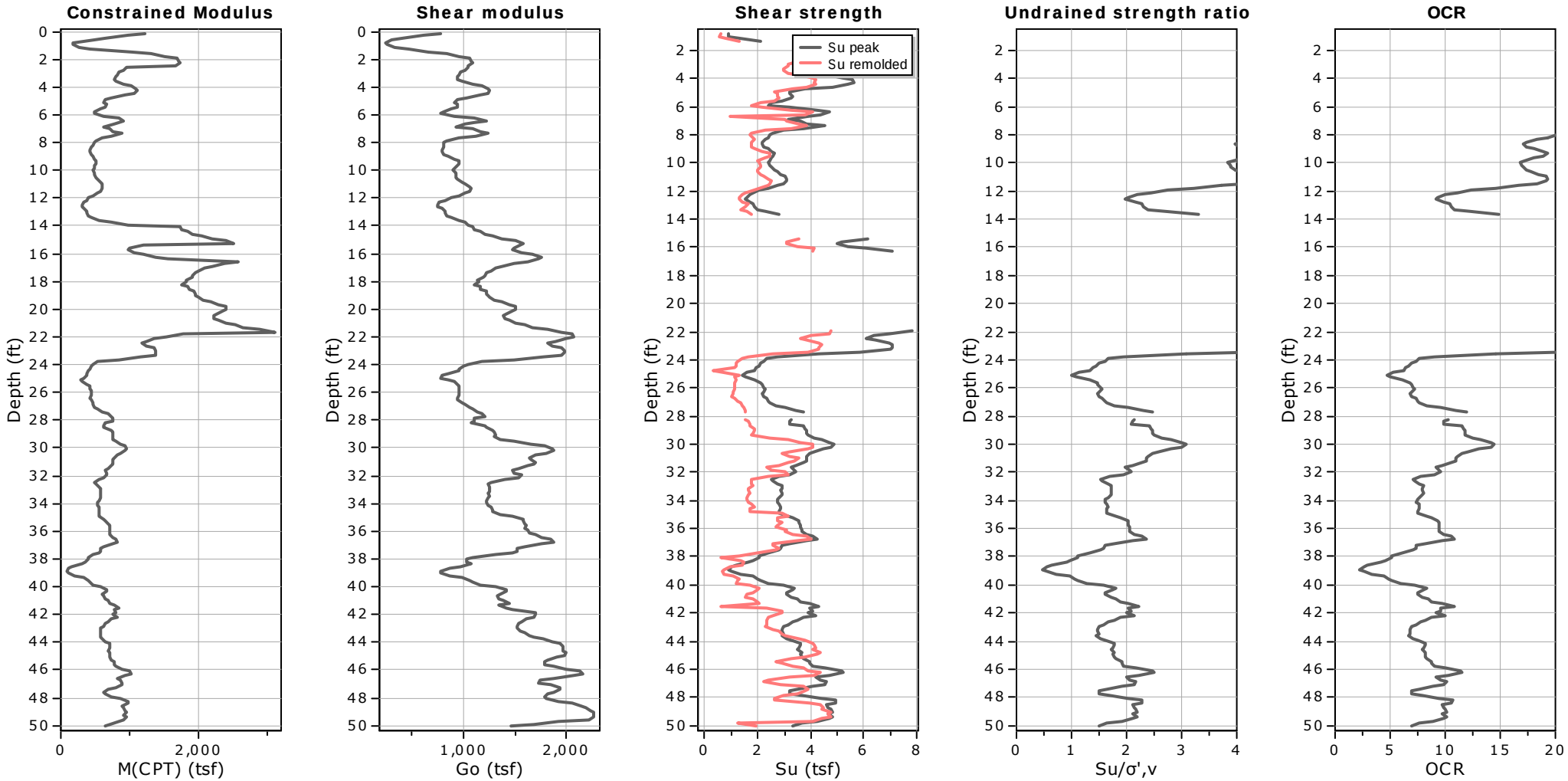
Calculation parameters

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 desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



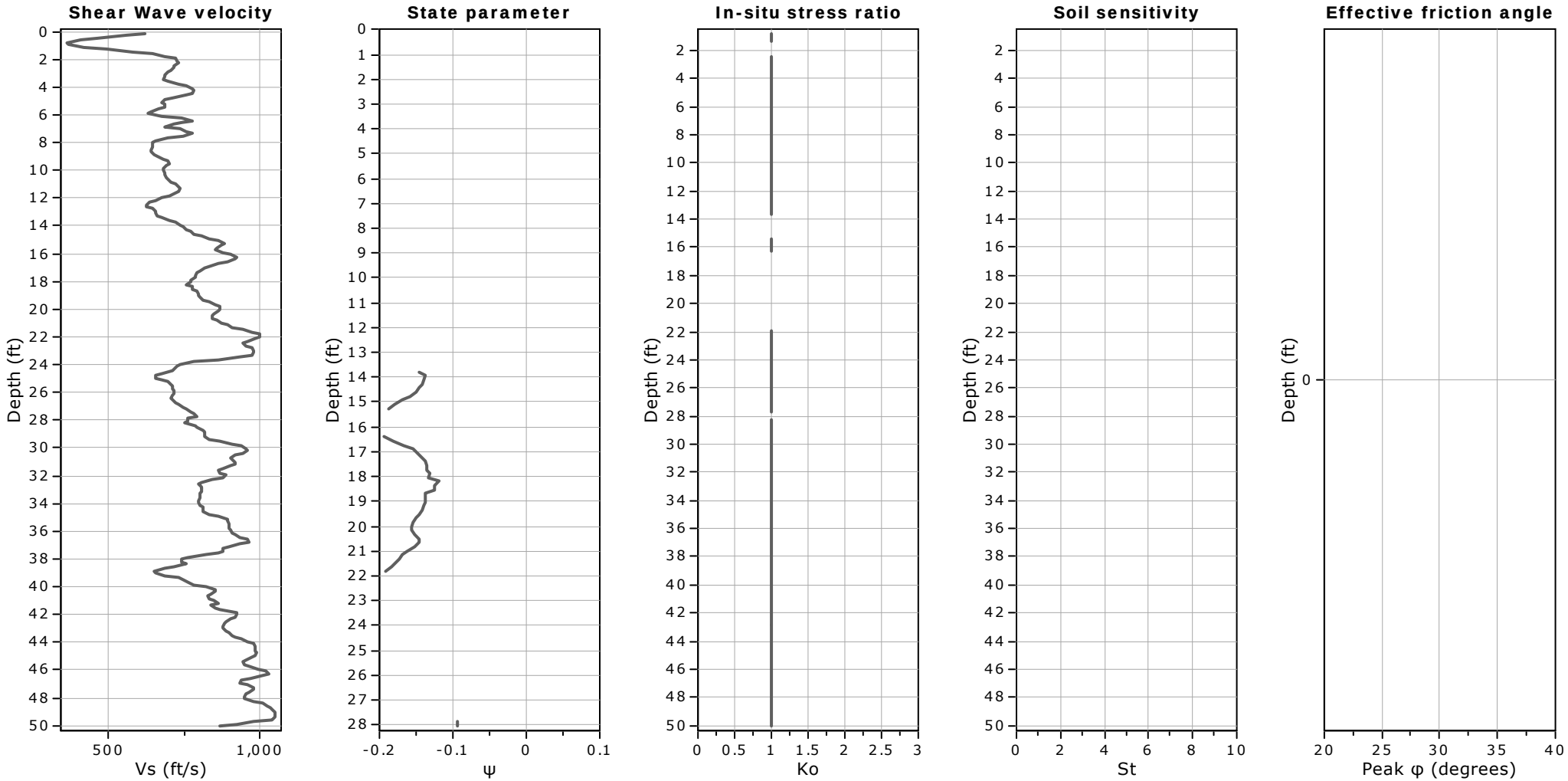
Calculation parameters

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

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

Project: Elk Grove Hospital
Location: Elk Grove, CA

CPT: 1-CPT-21
Total depth: 50.03 ft
Surface Elevation: 0.00 ft



Calculation parameters

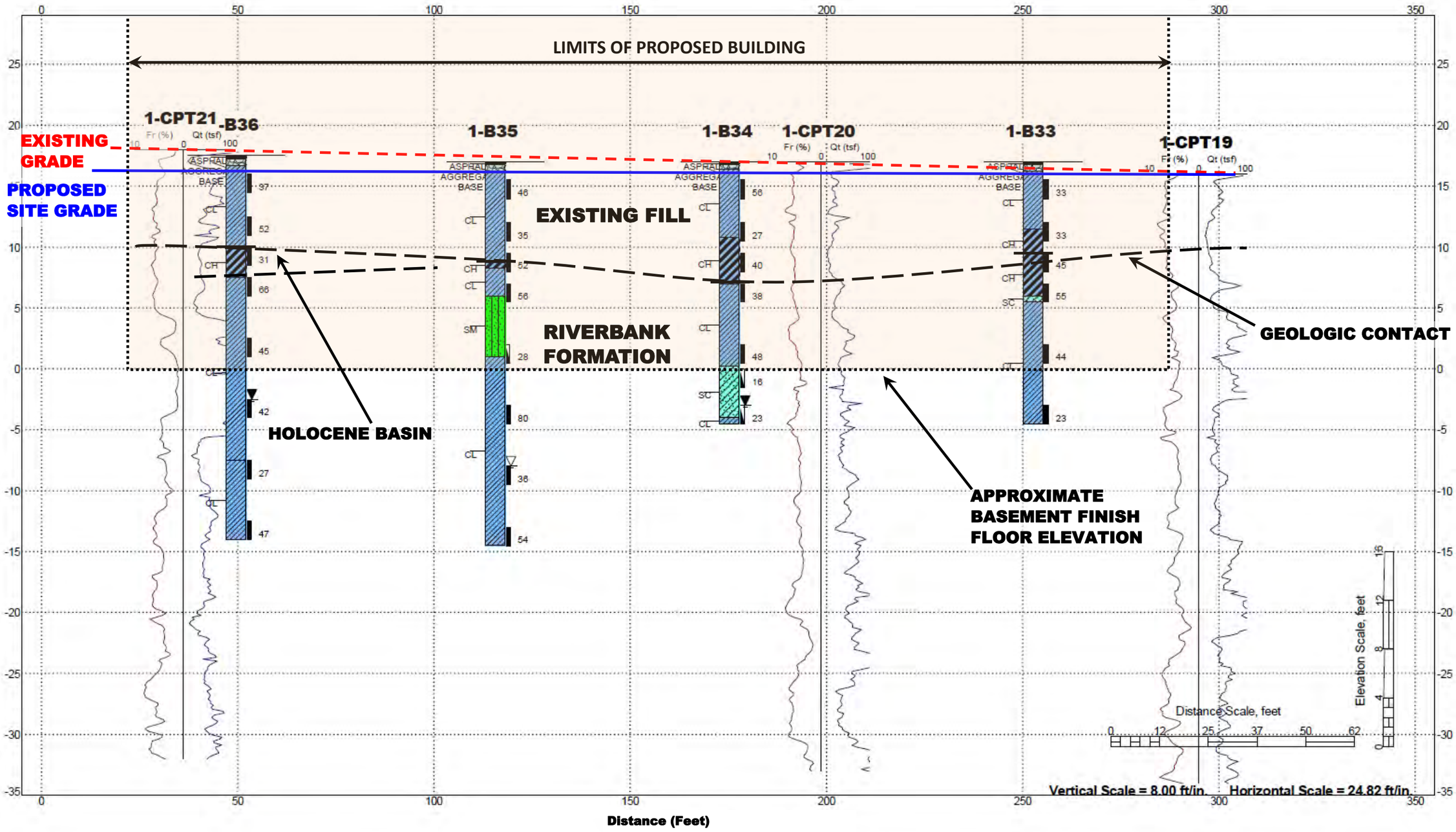
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

APPENDIX D

DRAFT

DORMITORY



Depictions of grades and the proposed building limits are approximate.

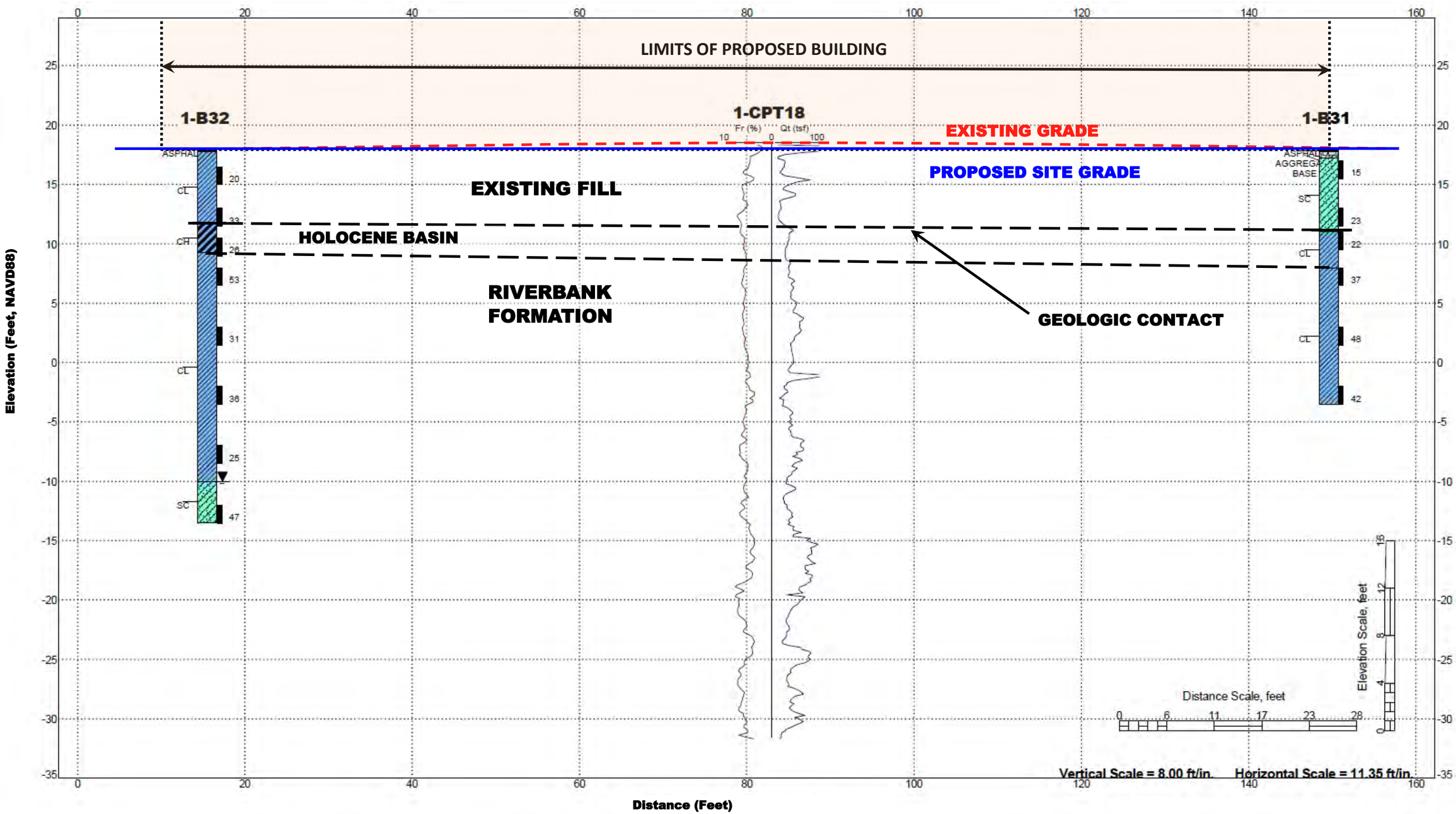
ENGEO
Expect Excellence

CROSS SECTION A-A' - DORMITORY
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.1
DRAWN BY: KC / CHECKED BY: MG	

DRAFT

ADMINISTRATION BUILDING

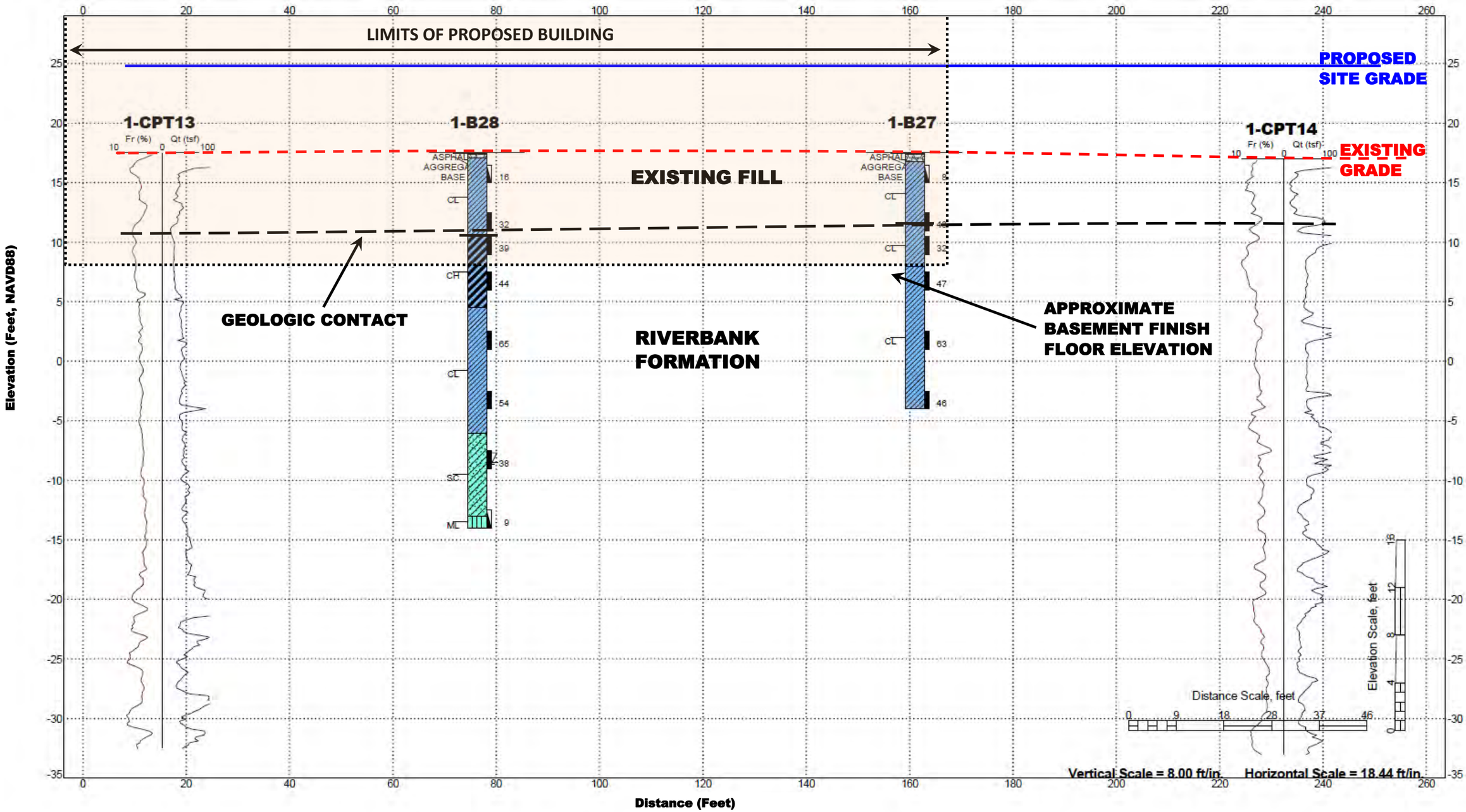


Depictions of grades and the proposed building limits are approximate.

ENGEO Expect Excellence	CROSS SECTION B-B' - ADMIN BUILDING CNSU ELK GROVE HOSPITAL ELK GROVE, CALIFORNIA	PROJECT NO.: 15747.000.000 SCALE: AS SHOWN (X=Y) DRAWN BY: KC CHECKED BY: MG	FIGURE NO. D.2

DRAFT

CENTRAL PLANT



Depictions of grades and the proposed building limits are approximate.

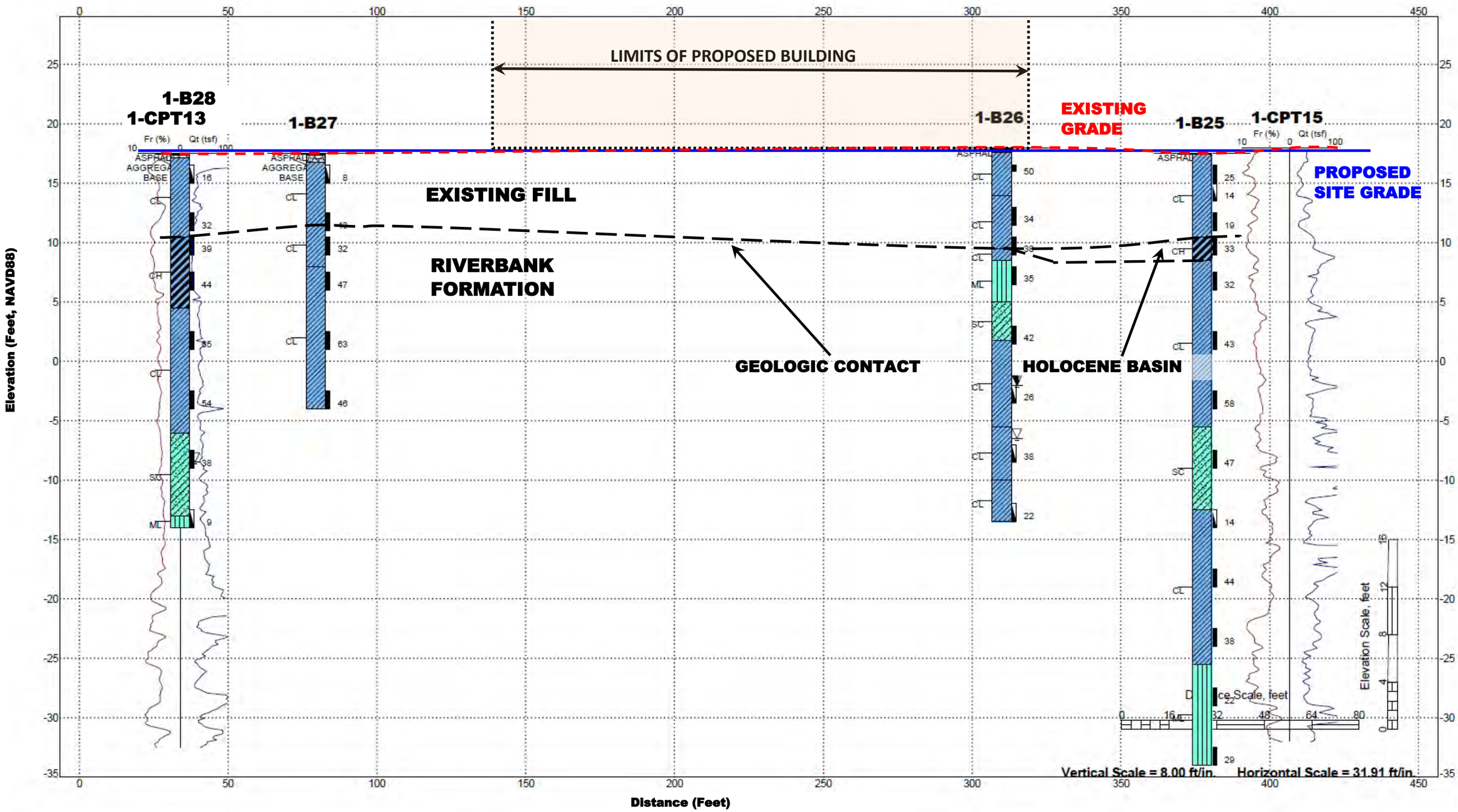
ENGEO Expect Excellence

CROSS SECTION C-C' - CENTRAL PLANT
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.3
DRAWN BY: KC / CHECKED BY: MG	

DRAFT

MEDICAL OFFICE BUILDING



Depictions of grades and the proposed building limits are approximate.

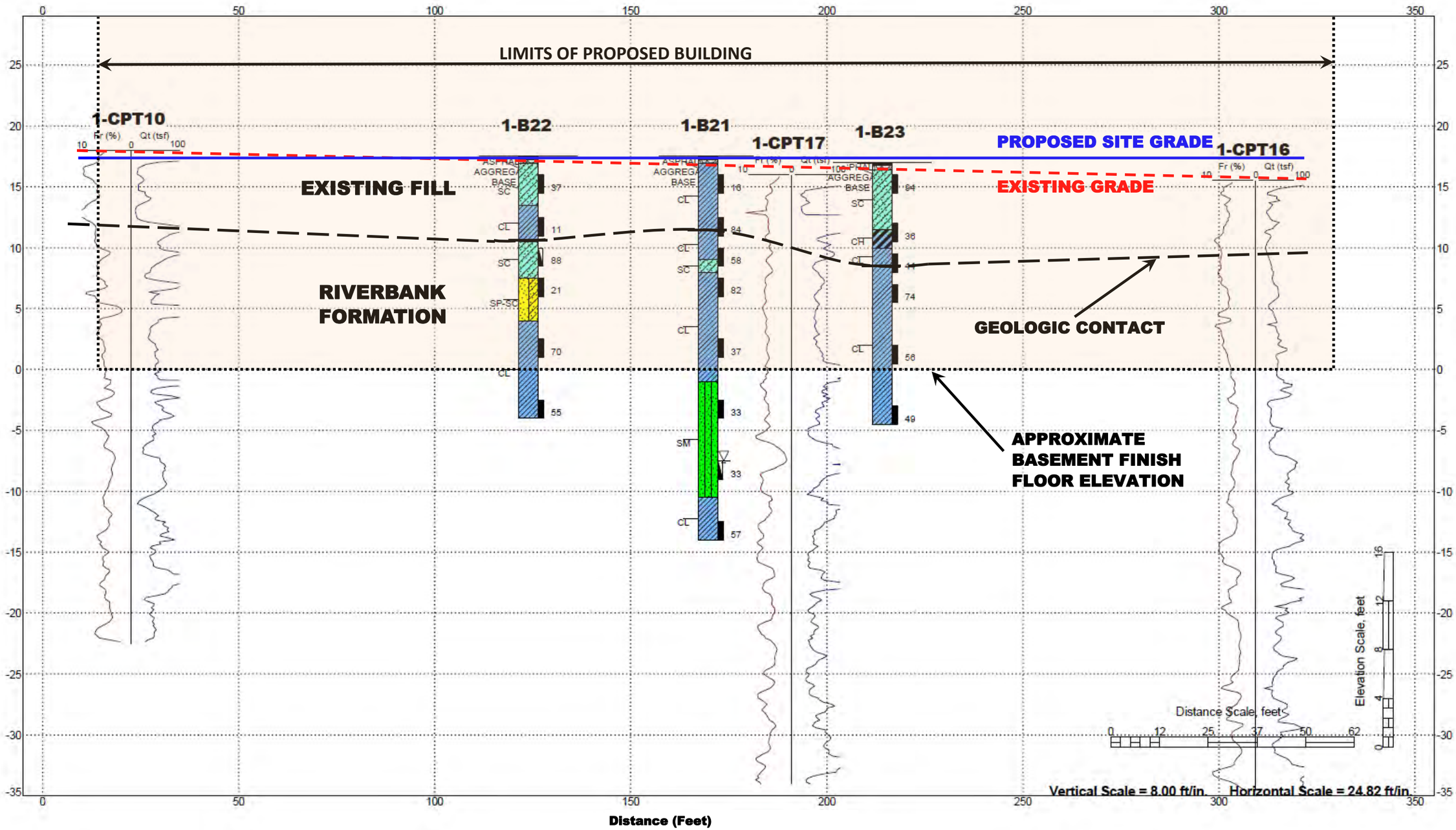
ENGEO
Expect Excellence

CROSS SECTION D-D' - MOB
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.4
DRAWN BY: KC / CHECKED BY: MG	

DRAFT

RETAIL WITH PARKING (SOUTH)



Depictions of grades and the proposed building limits are approximate.

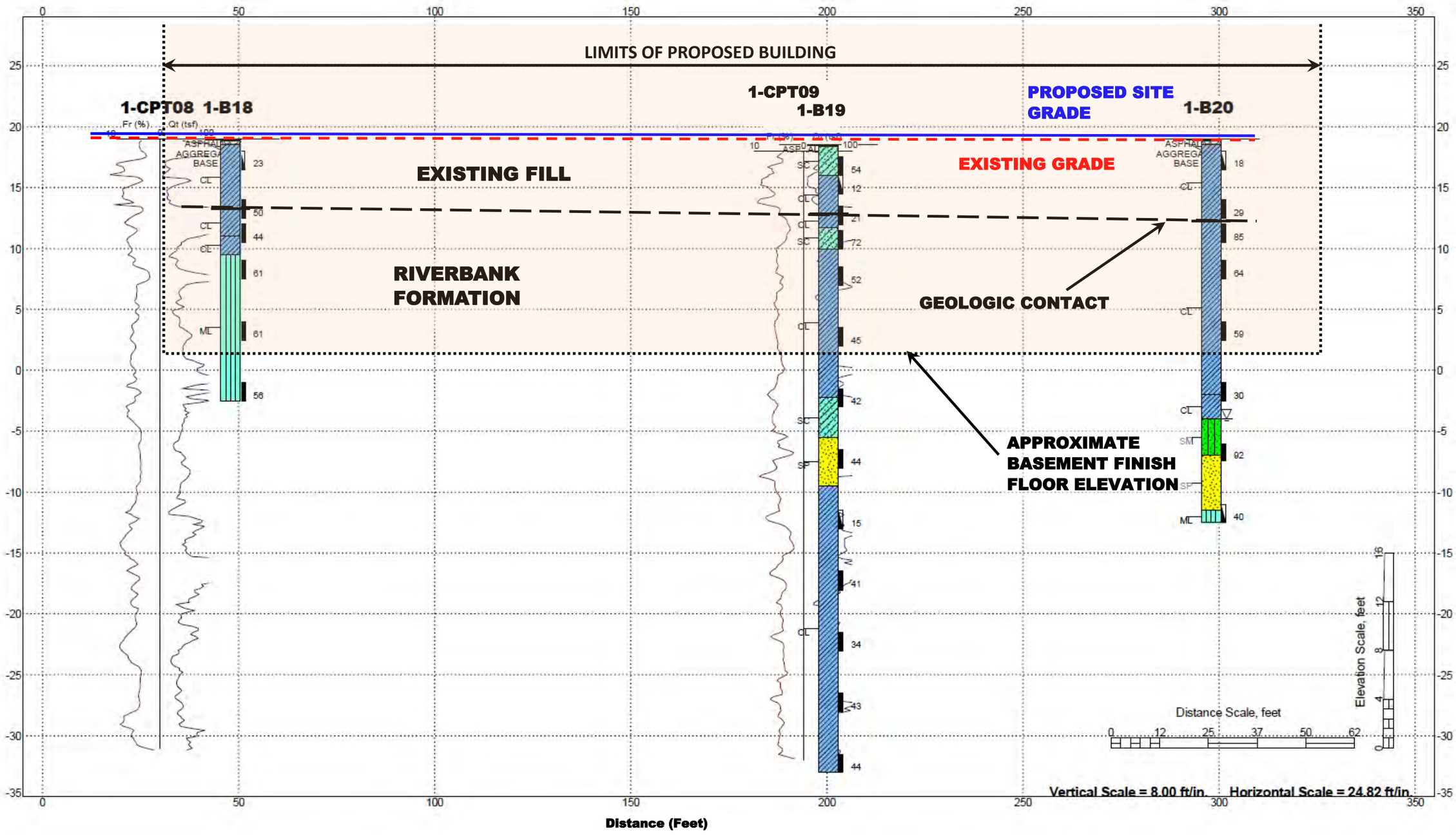
ENGEO
Expect Excellence

CROSS SECTION E-E' - RETAIL/PARKING (S)
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.5
DRAWN BY: KC / CHECKED BY: MG	

DRAFT

RETAIL WITH PARKING (NORTH)



Depictions of grades and the proposed building limits are approximate.

ENGEO Expect Excellence

CROSS SECTION F-F' - RETAIL/PARKING (N)
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.6
DRAWN BY: KC / CHECKED BY: MG	

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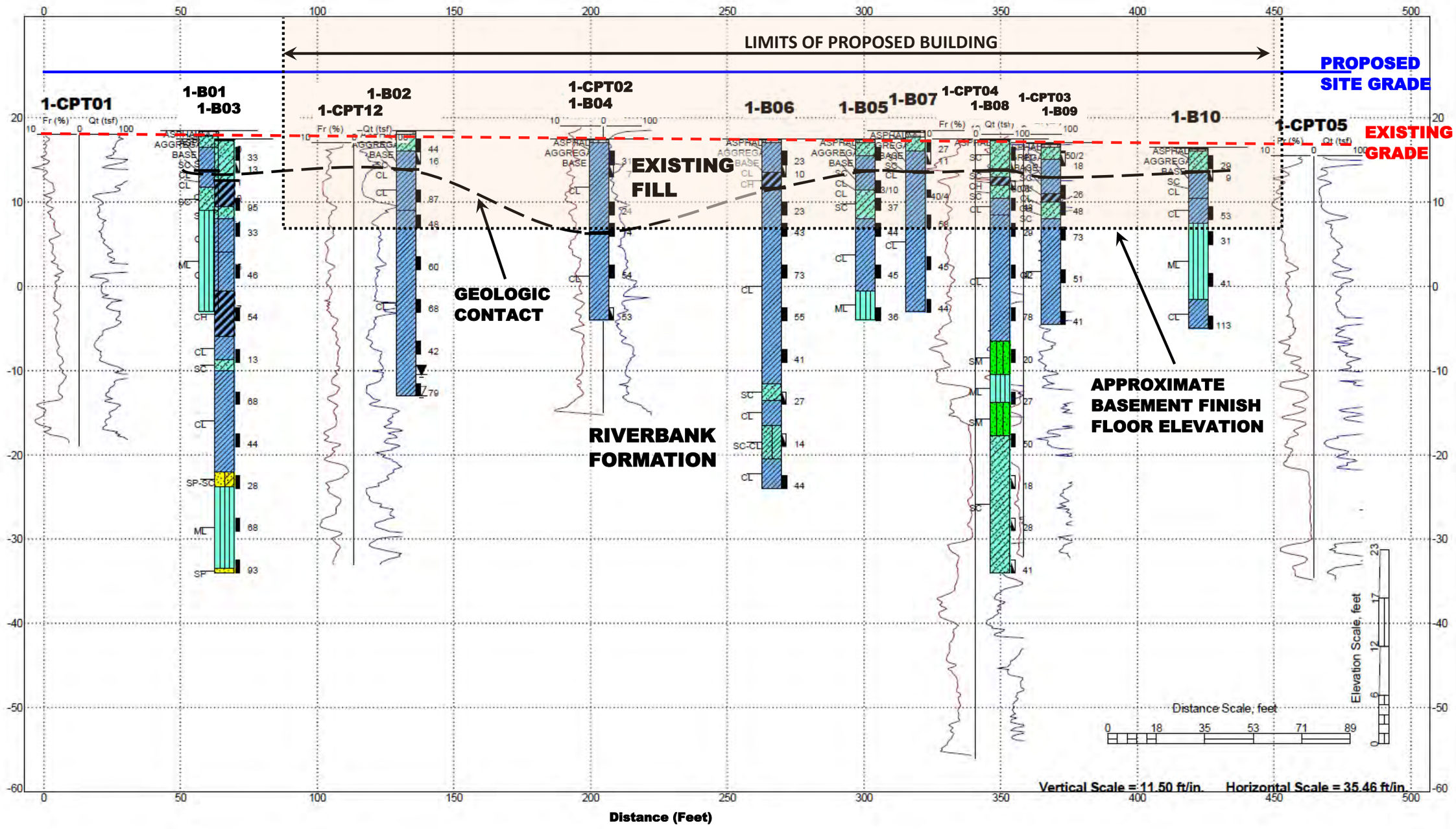
HOSPITAL

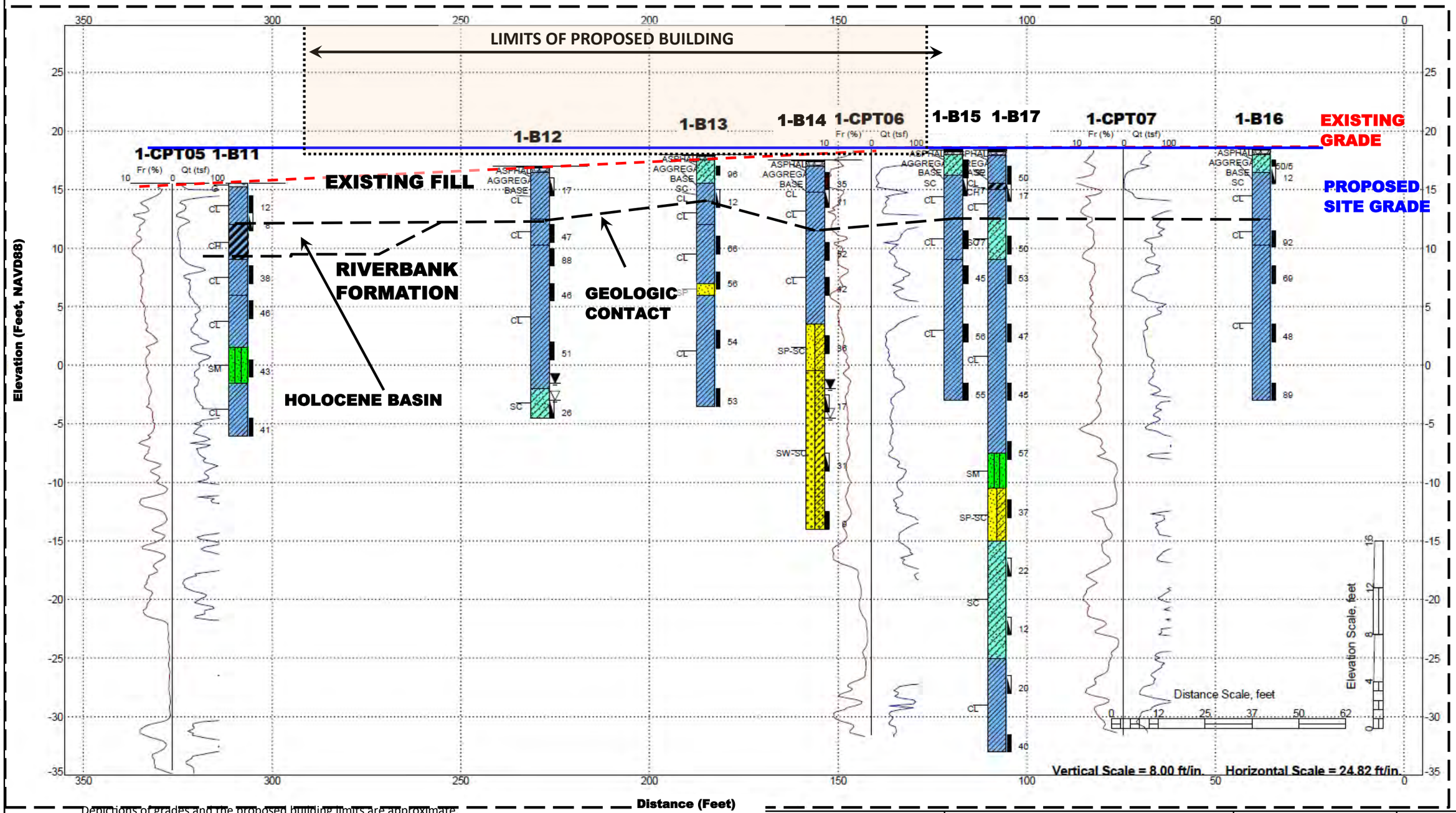


Depictions of grades and the proposed building limits are approximate.

ENGEO Expect Excellence	CROSS SECTION G-G' - HOSPITAL CNSU ELK GROVE HOSPITAL ELK GROVE, CALIFORNIA	PROJECT NO.: 15747.000.000 SCALE: AS SHOWN (X=Y) DRAWN BY: KC CHECKED BY: MG	FIGURE NO. D.7

DRAFT

OUTPATIENT CLINIC



Depictions of grades and the proposed building limits are approximate.

ENGEO Expect Excellence

CROSS SECTION H-H' - OUTPATIENT CLINIC
CNSU ELK GROVE HOSPITAL
ELK GROVE, CALIFORNIA

PROJECT NO.: 15747.000.000	FIGURE NO.
SCALE: AS SHOWN (X=Y)	D.8
DRAWN BY: KC / CHECKED BY: MG	

APPENDIX E

GEOPHYSICAL SURVEY REPORT

REPORT

SURFACE WAVE MEASUREMENTS

ELK GROVE HOSPITAL PROJECT
ELK GROVE, CALIFORNIA

GEO*Vision* Project No. 18528

Prepared for

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Report 18528-01

January 18, 2019

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1 INTRODUCTION

In-situ seismic measurements using active- and passive-source surface wave techniques were performed at the Elk Grove Hospital Project Site in Elk Grove, California on December 28, 2018. The purpose of this investigation was to provide a shear (S) wave velocity profile to a depth of 30 m (100 ft), or greater, and estimate the average S-wave velocity of the upper 30 m (V_{S30}) or 100 ft (V_{S100ft}). The active-source surface wave technique utilized during this investigation consisted of the multi-channel analysis of surface waves (MASW) method. The passive-source surface wave technique consisted of the array microtremor method. The locations of the active- and passive-source surface wave testing locations are shown on Figure 1.

Array microtremor measurements were made using an L-shaped array (Array 1) with a 124.5 degree angle between the two legs of the array as shown on Figure 1. MASW measurements were made along a linear array parallel to the east-west leg of the Array 1 (Array 2).

V_{S30} is used in the NEHRP provisions and the Uniform Building Code (UBC) to separate sites into classes for earthquake engineering design (BSSC, 2003). V_{S100ft} is used in the International Building Code (IBC) for site classification. These site classes are as follows:

Class A – hard rock – $V_{S30} > 1500$ m/s (UBC) or $V_{S100ft} > 5{,}000$ ft/s (IBC)
Class B – rock – $760 < V_{S30} \leq 1500$ m/s (UBC) or $2{,}500 < V_{S100ft} \leq 5{,}000$ ft/s (IBC)
Class C – very dense soil and soft rock – $360 < V_{S30} \leq 760$ m/s (UBC)
or $1{,}200 < V_{S100ft} \leq 2{,}500$ ft/s (IBC)
Class D – stiff soil – $180 < V_{S30} \leq 360$ m/s (UBC) or $600 < V_{S100ft} \leq 1{,}200$ ft/s (IBC)
Class E – soft soil – $V_{S30} < 180$ m/s (UBC) or $V_{S100ft} < 600$ ft/s (IBC)
Class F – soils requiring site-specific evaluation

At many sites, active surface wave techniques (MASW) with the utilization of portable energy sources, such as hammers and weight drops, are sufficient to obtain a S-wave velocity sounding to 30 m (100 ft) depth. At sites with high ambient noise levels and/or very soft soils, these energy sources may not be sufficient to image to this depth and a larger energy source, such as a bulldozer, is necessary. Alternatively, passive surface wave techniques, such as the array microtremor technique can be used to extend the depth of investigation at sites that have adequate ambient noise conditions. It should be noted that two-dimensional passive-source surface wave arrays (e.g. triangular, circular, or L-shaped arrays) are expected to perform better than linear arrays.

This report contains the results of the active and passive surface wave measurements conducted at the site. An overview of the surface wave methods is given in Section 2. Field and data reduction procedures are discussed in Sections 3 and 4, respectively. Data modeling is presented in Section 5 and interpretation and results are presented in Section 6. References and our professional certification are presented in Sections 7 and 8, respectively.

Legend

- HVSR Location
- Active Surface Wave Array MASW
- Passive Surface Wave L-Array

NOTES:
1. California State Plane Coordinate System, NAD 83, Zone II (0402), US Survey Feet
2. Base map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aerogrid, IGN, and the GIS User Community

GEOVision geophysical services

Date:	1/10/2019
GV Project:	18528
Developed by:	D Levy
Drawn by:	T Rodriguez
Approved by:	A Martin
File Name:	18528_1.MXD

FIGURE 1
SITE MAP

ELK GROVE HOSPITAL PROJECT
ELK GROVE, CALIFORNIA

PREPARED FOR
ENGEO, INC.

2 OVERVIEW OF SURFACE WAVE TECHNIQUES

2.1 Introduction

Active- and passive-source (ambient vibration) surface wave techniques are routinely utilized for site characterization. Active surface wave techniques include the spectral analysis of surface waves (SASW) and multi-channel array surface wave (MASW) methods. Passive surface wave techniques include the horizontal over vertical spectral ratio (HVSR) technique and the array and refraction microtremor methods.

The basis of surface wave methods is the dispersive characteristic of Rayleigh and Love waves when propagating in a layered medium. Surface waves of different wavelengths (λ) or frequencies (f) sample different depth. As a result of the variance in the shear stiffness of the distinct layers, waves with different wavelengths propagate at different phase velocities; hence, dispersion. A surface wave dispersion curve is the variation of V_R or V_L with λ or f. The Rayleigh wave phase velocity (V_R) depends primarily on the material properties (V_S, mass density, and Poisson's ratio or compression wave velocity) over a depth of approximately one wavelength. The Love wave phase velocity (V_L) depends primarily on V_S and mass density. Rayleigh and Love wave propagation are also affected by damping or seismic quality factor (Q). Rayleigh wave techniques are utilized to measure vertically polarized S-waves (S_V-wave); whereas, Love wave techniques are utilized to measure horizontally polarized S-waves (S_H-wave).

2.2 Surface Wave Techniques

The MASW and array microtremor techniques were utilized during this investigation and are discussed below.

2.2.1 MASW Technique

A description of the MASW method is given by Park, 1999a and 1999b and Foti, 2000. Ground motions are typically recorded by 24, or more, geophones typically spaced 1 to 3 m apart along a linear array and connected to a seismograph. Energy sources for shallow investigations include various sized hammers and vehicle mounted weight drops. When applying the MASW technique to develop a one-dimensional (1-D) V_S model, the surface-wave data, preferably, are acquired using multiple-source offsets at both ends of the array. The most commonly applied MASW technique is the Rayleigh-wave based MASW method, which we refer to as MAS_RW to distinguish from Love-wave based MASW (MAS_LW). MAS_RW and MAS_LW acquisition can easily be combined with P- and S-wave seismic refraction acquisition, respectively. MAS_RW data are generally recorded using a vertical source and vertical geophone, but may also be recorded using a horizontal geophone with radial (in-line) orientation. MAS_LW data are recorded using transversely orientated horizontal source and transverse horizontal geophone.

A wavefield transform is applied to the time-history data to convert the seismic record from time-offset space to frequency-wavenumber (f-k) space in which the fundamental or higher surface-wave modes can be easily identified as energy maxima and picked. Frequency and/or wavenumber can easily be mapped to phase velocity, slowness, or wavelength using the following properties: $k = 2\pi/\lambda$, $\lambda = v/f$. Common wave-field transforms include: the f-k transform (a 2D fast Fourier transform), slant-stack transform (also referred to as intercept-

slowness or τ-p transform and equivalent to linear Radon transform), frequency domain beamformer, and phase-shift transform. The minimum wavelength that can be recovered from an MASW data set without spatial aliasing is equal to the minimum receiver spacing. Occasionally, SASW analysis procedures are used to extract surface wave dispersion data, from fixed receiver pairs, at smaller wavelengths than can be recovered by wavefield transformation. Construction of a dispersion curve over the wide frequency/wavelength range necessary to develop a robust V_S model while also limiting the maximum wavelength based on an established near-field criterion (e.g. Yoon and Rix, 2009; Li and Rosenblad, 2011), generally requires multiple source offsets.

Although the clear majority of MASW surveys record Rayleigh waves, it has been shown that Love wave techniques can be more effective in some environments, particularly shallow rock sites and sites with a highly attenuative, low velocity surface layer (Xia, et al., 2012; **GEO***Vision*, 2012; Yong, et al., 2013; Martin, et al., 2014). Rayleigh wave techniques, however, are generally more effective at sites where velocity gradually increases with depth because larger energy sources are readily available for generation of Rayleigh waves. Rayleigh wave techniques are also more applicable to sites with high velocity layers and/or velocity inversions because the presence of such structures is more apparent in the Rayleigh wave dispersion curves than in Love wave dispersion curves. Rayleigh wave techniques are preferable at sites with a high velocity surface layer because Love waves do not theoretically exist in such environments. Occasionally, the horizontal radial component of a Rayleigh wave may yield higher quality dispersion data than the vertical component because different modes of propagation may have more energy in one component than the other. Recording both the vertical and horizontal components of the Rayleigh wave is particularly useful at sites with complex modes of propagation or when attempting to recover multiple Rayleigh wave modes for multi-mode modeling as demonstrated in Dal Moro, et al, 2015. Joint inversion of Rayleigh and Love wave data may yield more accurate V_S models and also offer a means to investigate anisotropy, where S_V- and S_H-wave velocity are not equal, as shown in Dal Moro and Ferigo, 2011.

2.2.2 Array Microtremor Technique

A detailed discussion of the array microtremor method can be found in Okada, 2003. Unlike active source techniques which use an active energy source (i.e. hammer), the array microtremor technique (also referred to as passive surface wave or array ambient vibration method) records background noise (ambient vibrations) emanating from ocean wave activity, wind noise, traffic, industrial activity, construction, etc. The technique uses 4, or more, receivers aligned in a 2-dimensional array. Triangle, circle, semi-circle, and “L” shaped arrays are commonly used, although any 2-dimensional arrangement of receivers can be used. For investigation of the upper 100 m, receivers typically consist of 1 to 4.5 Hz geophones. For deeper investigations, 5 to 120 s seismometers are generally utilized. The nested triangle array, which consists of several embedded equilateral triangles, is popular as it provides accurate dispersion curves with a relatively small number of geophones. The “L” array is useful at sites located at the corner of intersecting streets. The maximum receiver separation in an array should be at a minimum equal to the desired depth of investigation. Typically, 15 to 60 minutes of ambient vibration data is recorded depending on the size of the array, desired depth of investigation, and noise conditions. Investigations to depths on the order of 1 km may require that ambient vibrations are recorded for a much longer duration. The surface wave dispersion curve is typically estimated from array microtremor data using various f-k methods such as beam-forming (Lacoss, et al., 1969), and

maximum-likelihood (Capon, 1969), and the spatial-autocorrelation (SPAC) method. The beam-forming and maximum-likelihood methods are generally referred to as the frequency wavenumber (FK) and high-resolution frequency wavenumber (HRFK or HFK) methods. The SPAC method was originally based on work by Aki, 1957 and has since been extended and modified (Ling and Okada, 1993 and Ohori *et al*., 2002) to permit the use of noncircular arrays, and is now collectively referred to as extended spatial autocorrelation (ESPAC or ESAC). Further modifications to the SPAC method permit the use of irregular or random arrays (Bettig *et al*., 2001). Although it is common to apply SPAC methods to obtain a surface wave dispersion curve for modeling, other approaches involve direct modeling of the coherency data, also referred to as SPAC coefficients (Asten, 2006 and Asten, *et al*., 2015).

FK and HRFK methods are generally expected to perform better when ambient vibration sources are not azimuthally well-distributed (e.g. rural area where primary noise source is a large industrial facility). SPAC methods are expected to perform better when noise sources are azimuthally well-distributed (e.g. in a large urbanized area).

The minimum and maximum wavelength surface wave that can be extracted from an array microtremor dataset acquired utilizing a symmetric array is typically set equal to the minimum and twice the maximum receiver spacings, respectively.

2.3 Surface Wave Dispersion Curve Modeling

The dispersion curves generated from the active and passive surface wave soundings are generally combined and modeled using iterative forward and inverse modeling routines. The final model profile is assumed to represent actual site conditions. The theoretical model used to interpret the dispersion curve assumes horizontally layered, laterally invariant, homogeneous-isotropic material. Although these conditions are seldom strictly met at a site, the results of active and/or passive surface wave testing provide a good “global” estimate of the material properties along the array. The results may be more representative of the site than a borehole “point” estimate.

The surface wave forward problem is typically solved using the Thomson-Haskell transfer-matrix (Thomson, 1950; Haskell, 1953) later modified by Dunkin (1965) and Knopoff (1964), dynamic stiffness matrix (Kausel and Roësset, 1981), or reflection and transmission coefficient (Kennett, 1974) methods. All of these methods can determine fundamental- and higher-mode phase velocities, which correspond to plane waves in 2-D space. The transfer-matrix method is often used in MASW and passive surface-wave software packages, whereas the dynamic stiffness matrix is utilized in many SASW software packages. MAS_RW and/or passive surface-wave modeling may involve modeling of the fundamental mode, some form of effective mode, or multiple individual modes (multi-mode). As outlined in Roësset et al. (1991), several options exist for forward modeling of Rayleigh wave SASW data. One formulation takes into account only fundamental mode plane Rayleigh-wave motion (called the 2-D solution), whereas another includes all stress waves (e.g. body, fundamental, and higher mode surface waves) and incorporates a generalized receiver geometry (3-D global solution) or actual receiver geometry (3-D array solution).

The fundamental mode assumption is generally applicable to modeling Rayleigh-wave dispersion data collected at normally dispersive sites, providing there are not abrupt increases in

velocity or steep velocity gradients. Effective-mode or multi-mode approaches are often required for irregularly dispersive sites and sites with steep velocity gradients at shallow depth. If active and passive surface wave data are combined or MAS_RW data are combined from multiple seismic records with different source offsets and receiver gathers, then effective-mode computations are limited to algorithms that assume far-field plane Rayleigh wave propagation. Local search (e.g. linearized matrix inversion methods) or global search methods (e.g., Monte Carlo approaches such as simulated annealing, generic algorithms and neighborhood algorithm) are typically used to solve the inverse problem.

The maximum wavelength (λ_{max}) recovered from a surface wave data set is typically used to estimate depth of investigation although a sensitivity analysis of the V_S models would be a more robust means to estimate depth of investigation. For normally dispersive velocity profiles with a gradual increase in V_S with depth, maximum depth of investigation is on the order of $\lambda_{max}/2$ for both Rayleigh and Love wave dispersion data. Velocity profiles with an abrupt increase in V_S at depth, maximum depth of investigation is on the order of $\lambda_{max}/3$ for Rayleigh wave dispersion data but less than $\lambda_{max}/3$ for Love wave dispersion data. Depth of investigation can be highly variable for sites with complex velocity structure (e.g. high velocity layers).

As with all surface geophysical methods, inversion of surface wave dispersion data does not yield a unique V_S model and there are multiple possible solutions that may equally well fit the experimental data. Based on our experience at other sites, the shear wave velocity models (V_S and layer thicknesses) determined by surface wave testing are within 20% of the velocities and layer thicknesses that would be determined by other seismic methods (Brown, 1998). The average velocity of the upper 30 m or 100 ft, however, is much more accurate, often to better than 5%, because it is not sensitive to the layering in the model. V_{S30} does not appear to suffer from the non-uniqueness inherent in V_S models derived from surface wave dispersion curves (Martin et al., 2006, Comina et al., 2011). Therefore, V_{S30} is more accurately estimated from inversion of surface wave dispersion data than the resulting V_S models.

It may not always be possible to develop a coherent, fundamental mode dispersion curve over sufficient frequency range for modeling due to dominant higher modes with the higher modes not clearly identifiable for multi-mode modeling. It may, however, be possible to identify the Rayleigh wave phase velocity of the fundamental mode at 40 m wavelength (V_{R40}) in which case V_{S30} can at least be estimated using the Brown et al., 2000 relationship:

$$V_{S30} = 1.045V_{R40}$$

This relationship was established based on statistical analysis of a large number of surface wave data sets from sites with control by velocities measured in nearby boreholes and has been further evaluated by Martin and Diehl, 2004, and Albarello and Gargani, 2010. Further investigation of this approach has revealed that V_{S30} is generally between V_{R40} and V_{R45} with V_{R40} often being most appropriate for shallow groundwater sites and V_{R45} for deep ground water sites. A detailed study of such an approach for Love wave dispersion data has not been conducted; however, preliminary analysis demonstrates that V_{S30} is generally between V_{L50} and V_{L55}. Although we do not recommend that these empirical V_{S30} estimates replace modeling of surface wave dispersion data, they do offer a means of cost effectively evaluating V_{S30} over a large area. V_{R40} or V_{L55} can also be used to quantify error in V_{S30} by evaluating the scatter in the dispersion data at these wavelengths.

3 FIELD PROCEDURES

The active- and passive-source surface wave sounding locations at the site were established by **GEO***Vision* personnel and are shown in Figure 1. Two types of surface wave data were acquired at the site: an active-source surface wave array to characterize near-surface velocity structure and a passive-source surface wave array to characterize deeper velocity structure.

Active surface wave data were acquired along Array 2 using the MASW technique. Passive surface wave data were acquired along Array 1 using the array microtremor method.

MASW equipment used during this investigation consisted of two Geometrics Geode signal enhancement seismographs, 4.5 Hz vertical geophones, seismic cable, a 4 lb hammer, 12 lb sledgehammer, and 240 lb accelerated weight drop (AWD). MASW data were acquired along a linear array of 48 geophones spaced 1.5 m (4.9 ft) apart. Shot points were located between 1.5 and 30 m (4.9 and 98 ft) from the end geophone locations and at 12 m (39 ft) intervals in the interior of the array. The 4 lb hammer was used for the near offset source locations and interior source location at the center of the array. The 12 lb sledgehammer was used for the near offset source locations and interior source locations at 12 m (39 ft) intervals. The AWD was used for all source locations offset from the ends of the array. Data from the transient impacts (hammers) were generally averaged 10 times to improve the signal-to-noise ratio. All field data were saved to hard disk and documented on field data acquisition forms.

The passive surface wave equipment consisted of two Geometrics Geode signal enhancement seismographs, 4.5 Hz vertical geophones, and seismic cables. The L-shaped Array 1 consisted of 48, 4.5 Hz geophones spaced 5 m (16.4 ft) apart with the linear legs of the array being 115 and 120 m (377 and 394 ft) long, respectively with an angle of 124.5 degrees between the legs of the array.

Ambient noise measurements were made along this array for over 80 minutes with a 2 ms sample rate (165, 30 second records). All passive surface wave data were stored on a laptop computer for later processing. The field geometry and associated files names were documented in field data acquisition forms.

4 DATA REDUCTION

The MASW data were reduced using the software Seismic Pro Surface V9.0 developed by Geogiga and multiple in-house scripts for various data extraction and formatting tasks, with all data reduction documented in a Microsoft Excel spreadsheet.

The following steps were used for data reduction:

- Input seismic records to be used for analysis into software package.
- Check and correct source and receiver geometry as necessary.
- Select offset range used for analysis (multiple offset ranges utilized for each seismic record as discussed below) and document in spreadsheet.
- Apply phase shift transform to seismic record to convert the data from time – offset to frequency – phase velocity space.
- Identify, pick, save, and document dispersion curve.
- Change the receiver offset range and repeat process.
- Repeat process for all seismic records.
- Use in-house script to apply near-field criteria with maximum wavelength set equal to lesser of 40 m (source frequency limitation) or 1 times the source to midpoint of receiver array distance.
- Use in-house script to merge multiple dispersion curves extracted from the MASW data collected along each seismic line for a specific source type (different source locations, different receiver offset ranges, etc.).
- Edit dispersion data, as necessary (e.g. delete poor quality curves and outliers).
- Calculate a representative dispersion curve at equal log-frequency or log-wavelength spacing for the MASW dispersion data using a moving average, polynomial curve fitting routine.

This unique data reduction strategy, which can involve combination of over 100 dispersion curves for a 1D sounding, is designed for characterizing sites with complex velocity structure that do not yield surface wave dispersion data over a wide frequency range from a single source type or source location. The data reduction strategy ensures that the dispersion curve selected for modeling is representative of average conditions beneath the array and spans as broad a frequency/wavelength range as possible while considering near field effects.

The array microtremor data were reduced using the Seisimager software package developed by Oyo Corporation/Geometrics, Inc. and the following steps:

The processing sequence for implementation of the ESAC method in the SeisImager software package is as follows:

- Input all seismic records for a dataset into software.
- Load receiver geometry (x and y positions) for each channel in seismic record.
- Apply time-segmentation routine, as necessary, to break data file into multiple seismic records.
- Calculate the SPAC coefficients for each seismic record and average.
- Optionally, select a subset of receiver offset ranges for analysis (e.g. only select receiver offsets with multiple azimuths).

- For each frequency calculate the RMS error between the SPAC coefficients and a Bessel function of the first kind and order zero over a user defined phase velocity range and velocity step.
- Plot an image of RMS error as a function for frequency (f) and phase velocity (v).
- Identify and pick the dispersion curve as the continuous trend on the f-v image with the lowest RMS error.
- Repeat process for all arrays and time blocks.
- Use in-house script to convert dispersion curves to appropriate format for editing.
- Edit dispersion data, as necessary, and use in-house script to combine all dispersion data after setting maximum wavelength to about 2 times the maximum receiver spacing (2 times maximum receiver spacing approximately equivalent to $k_{min}/2$ for a symmetrical array).
- Calculate a representative dispersion curve for the passive dispersion data from each array using a moving average polynomial curve fitting routine.

The representative dispersion curves from the active and passive surface wave data were combined and the moving average polynomial curve fitting routine in WinSASW V3 was used to generate a composite representative dispersion curve for modeling. During this process the active and passive surface wave dispersion data were given equal weights. An equal logarithm wavelength sample rate was used for the representative dispersion curve to reflect the gradual loss in model resolution with depth.

5 DATA MODELING

Surface wave data were modeled using the fundamental mode routine in WinSASW V3 software package. The final composite representative dispersion curve was loaded into the inverse modeling software package and data modeled using the fundamental mode solution in WinSASW. During this process an initial velocity model was generated based on general characteristics of the dispersion curve and the inverse modeling routine utilized to adjust the layer V_S until an acceptable agreement with the observed data was obtained. Layer thicknesses were adjusted, and the inversion process repeated until a V_S model was developed with low RMS error between the observed and calculated dispersion curves. In many cases, once an acceptable V_S model was developed, layer thicknesses are again adjusted, and the inversion process repeated to develop an ensemble of V_S models with similar RMS error to quantify non-uniqueness. However, at this site S-wave velocity was found to gradually increase with depth and it was not considered necessary to quantify non-uniqueness as all velocity models would show the same velocity-depth trend. Data inputs into the modeling software include layer thickness, S-wave velocity, P-wave velocity or Poisson's ratio, and mass density. P-wave velocity and mass density only have a very small influence (i.e. less than 10%) on the S-wave velocity model generated from a surface wave dispersion curve. However, realistic assumptions for P-wave velocity, which is significantly impacted by the location of the saturated zone, and mass density will slightly improve the accuracy of the S-wave velocity model.

Constant mass density values of 1.9 to 2.0 gm/cm^3 (119 to 125 lb/ft^3) were used in the velocity profiles for subsurface soils/rock depending on P- and S-wave velocity. Within the normal range encountered in geotechnical engineering, variation in mass density has a negligible (±2%) affect on the estimated V_S from surface wave dispersion data. During modeling of Rayleigh wave dispersion data, the compression wave velocity, V_P, for unsaturated sediments was estimated using a Poisson's ratio, v, of 0.3 and the relationship:

$$V_P = V_S\,[(2(1-v))/(1-2v)]^{0.5}$$

Poisson's ratio has a larger affect than density on the estimated V_S from Rayleigh wave dispersion data. Achenbach (1973) provides approximate relationship between Rayleigh wave velocity (V_R), V_S and v:

$$V_R = V_S\,[(0.862 + 1.14\,v)/(1+ v)]$$

Using this relationship, it can be shown that V_S derived from V_R only varies by about 10% over possible 0 to 0.5 range for Poisson's ratio where:

$$V_S = 1.16V_R \text{ for } v = 0$$
$$V_S = 1.05V_R \text{ for } v = 0.5$$

The realistic range of the Poisson's ratio for typical unsaturated sediments is about 0.25 to 0.35. Over this range, V_S derived from modeling of Rayleigh wave dispersion data will vary by about 5%. An intermediate Poisson's ratio of 0.3 was selected for modeling to minimize any error associated with the assumed Poisson's ratio.

To reduce errors associated with expected high Poisson's ratio of saturated sediments, the saturated zone was anchored at a depth of about 8 m (26 ft), based on inspection of seismic refraction first arrival data. V_P of the saturated zone was set to velocity of at least 1,500 m/s (4,921 ft/s) and allowed to gradually increase with depth as V_S increases.

6 INTERPRETATION AND RESULTS

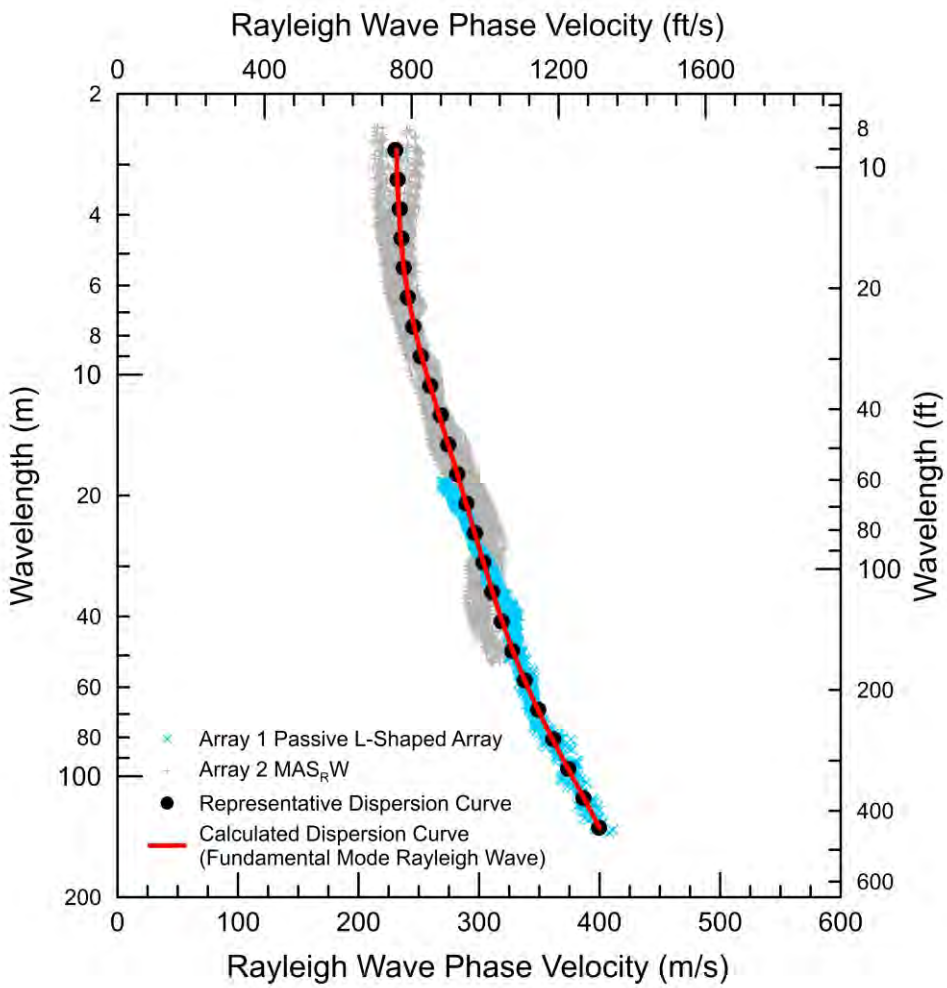
The fit of the calculated fundamental mode dispersion curve to the experimental data collected along Arrays 1 and 2 and the modeled V_S profile for the surface wave sounding is presented as Figure 2. The resolution decreases gradually with depth due to the loss of sensitivity of the dispersion curve to changes in V_S at greater depth. The V_S profile used to match the field data is provided in tabular form in metric and Imperial units as Tables 1 and 2, respectively.

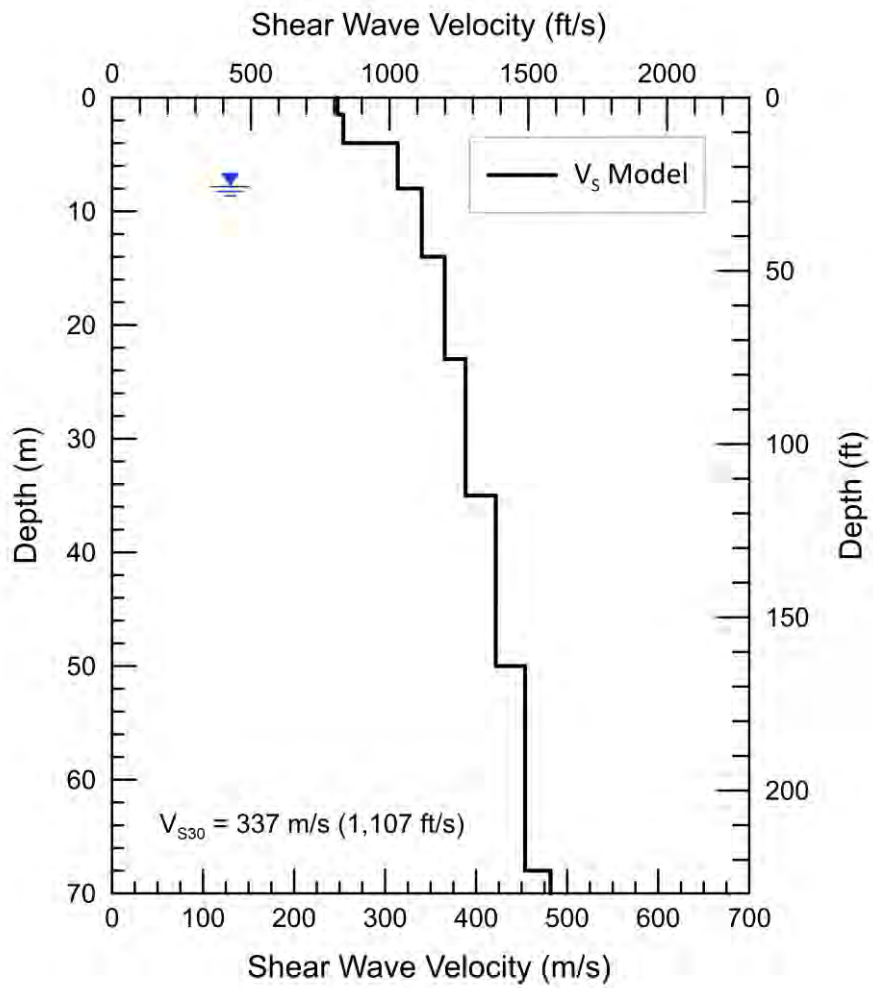
Table 1 V_S Model (Metric Units)

Depth to Top of Layer (m)	Layer Thickness (m)	S-Wave Velocity (m/s)	Inferred P-Wave Velocity (m/s)	Inferred Poisson's Ratio	Assumed Density (g/cm^3)
0	1.5	248	464	0.300	1.90
1.5	2.5	254	475	0.300	1.90
4	4	314	587	0.300	1.93
8	6	340	637	0.300	1.95
14	9	365	1600	0.472	1.96
23	12	388	1625	0.470	1.97
35	15	422	1650	0.465	1.99
50	18	454	1675	0.460	2.00
68	>2	482	1700	0.456	2.01

Table 2 V_S Model (Imperial Units)

Depth to Top of Layer (ft)	Layer Thickness (ft)	S-Wave Velocity (ft/s)	Inferred P-Wave Velocity (ft/s)	Inferred Poisson's Ratio	Assumed Density (lb/ft^3)
0.0	4.9	813	1521	0.300	119
4.9	8.2	834	1559	0.300	119
13.1	13.1	1030	1927	0.300	120
26.2	19.7	1116	2088	0.300	122
45.9	29.5	1199	5249	0.472	122
75.5	39.4	1274	5331	0.470	123
114.8	49.2	1383	5413	0.465	124
164.0	59.1	1489	5495	0.460	125
223.1	>6.6	1580	5577	0.456	125





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Project No: 18528
Date: JAN 16, 2019
Drawn By: A MARTIN
Approved By:
R:\GVProjects\2018\18528ENGEO\Report\Figure 2.cdr

FIGURE 2
SURFACE WAVE MODEL

ELK GROVE HOSPITAL PROJECT
ELK GROVE, CALIFORNIA

PREPARED FOR
ENGEO, INC.

The V_S model (Figure 2 and Tables 1 and 2) was developed from the surface wave dispersion data derived from array microtremor and MASW data acquired along Arrays 1 and 2, respectively. The Rayleigh wave phase velocities from the passive surface wave array are in reasonable agreement with those from the MASW data in the regions of overlapping wavelength. Differences in dispersion data from the two methods are expected to be associated with minor lateral velocity variability between the footprints of the two arrays.

The estimated depth of investigation for the combined active and passive surface wave sounding is about 70 m (230 ft), about one-half the maximum Rayleigh wave wavelength. The V_S model indicates that S-wave velocity gradually increases with depth from about 250 m/s (820 ft/s) near the surface to about 480 m/s (1,575 ft/s) at a depth of about 68 m (223 ft).

The average shear wave velocity to a depth of 30 m (V_{S30}) is 337 m/s for the presented V_S model. The average shear wave velocity to a depth of 100 ft (V_{S100ft}) is 1,109 ft/s. Therefore, according to the NEHRP provisions of the Uniform Building Code, the site is classified as Site Class D, stiff soil.

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8 CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO*Vision*** California Professional Geophysicist.

Prepared by,

1/18/2019

Antony J. Martin
California Professional Geophysicist, P. Gp. 989
GEO*Vision* Geophysical Services

Date

* This geophysical investigation was conducted under the supervision of a California Professional Geophysicist using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing interpretation and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

  A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations or ordinances.

APPENDIX F

LIQUEFACTION ANALYSIS RESULTS

ENGEO
2213 Plaza Drive
Rocklin, CA 95765

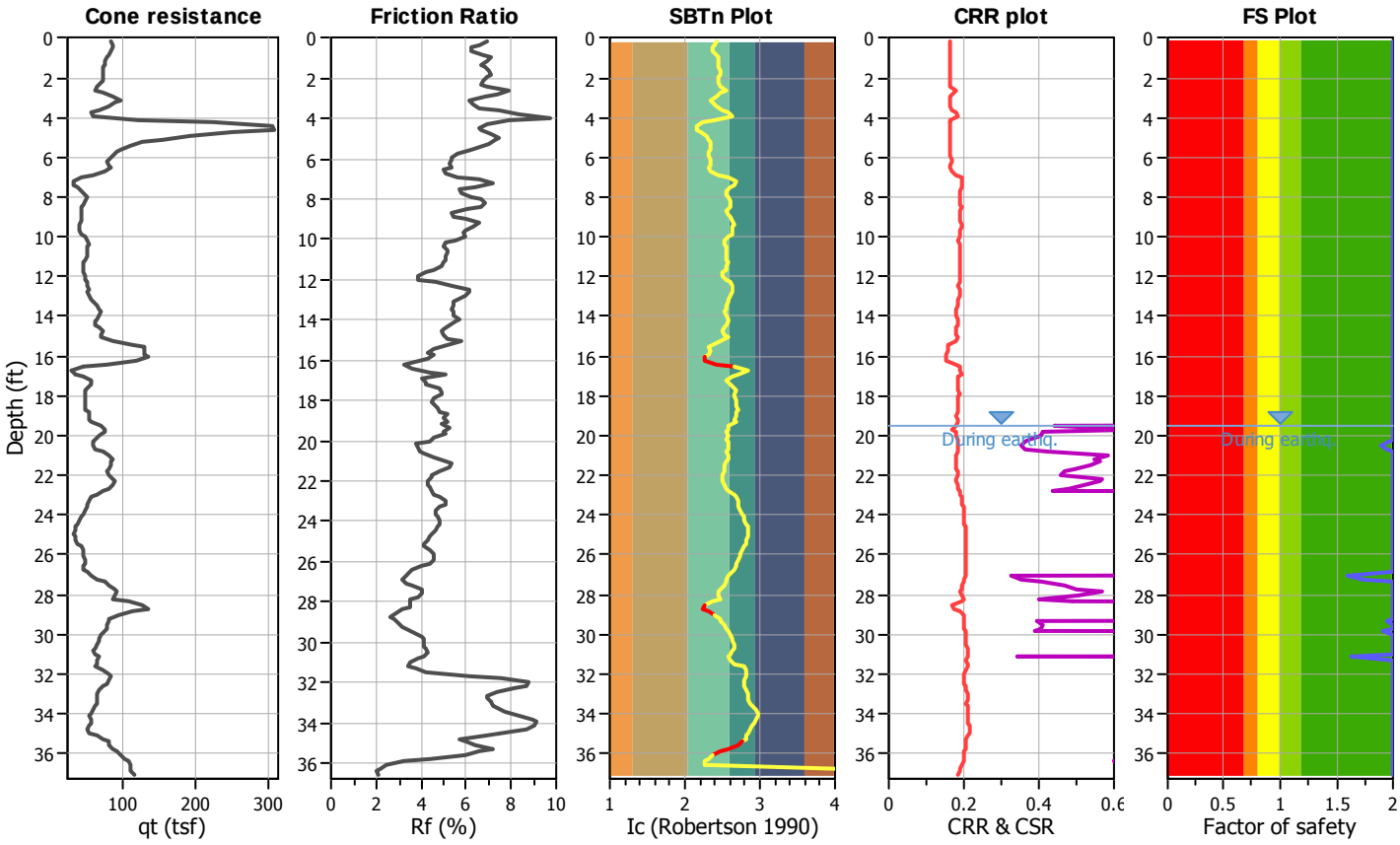
LIQUEFACTION ANALYSIS REPORT

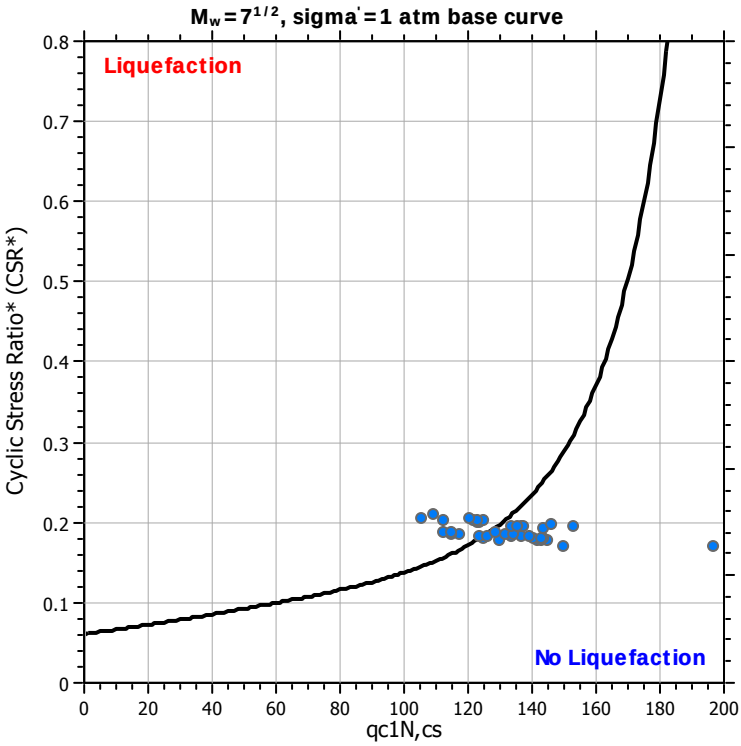
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

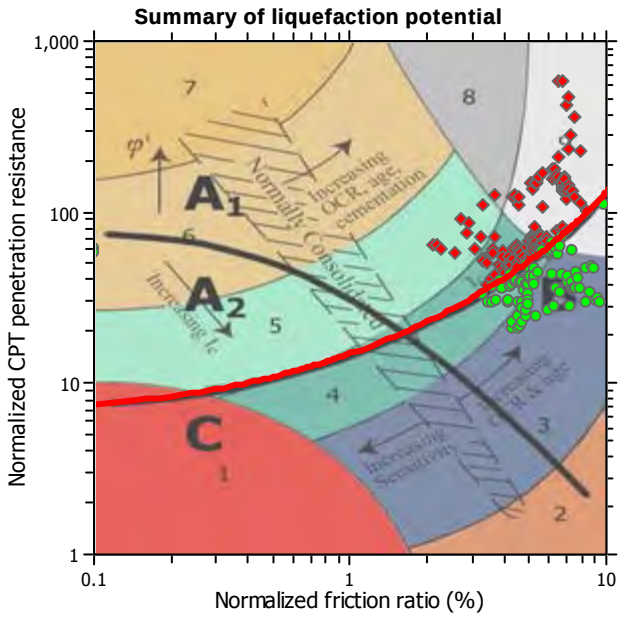
CPT file : 1-CPT-1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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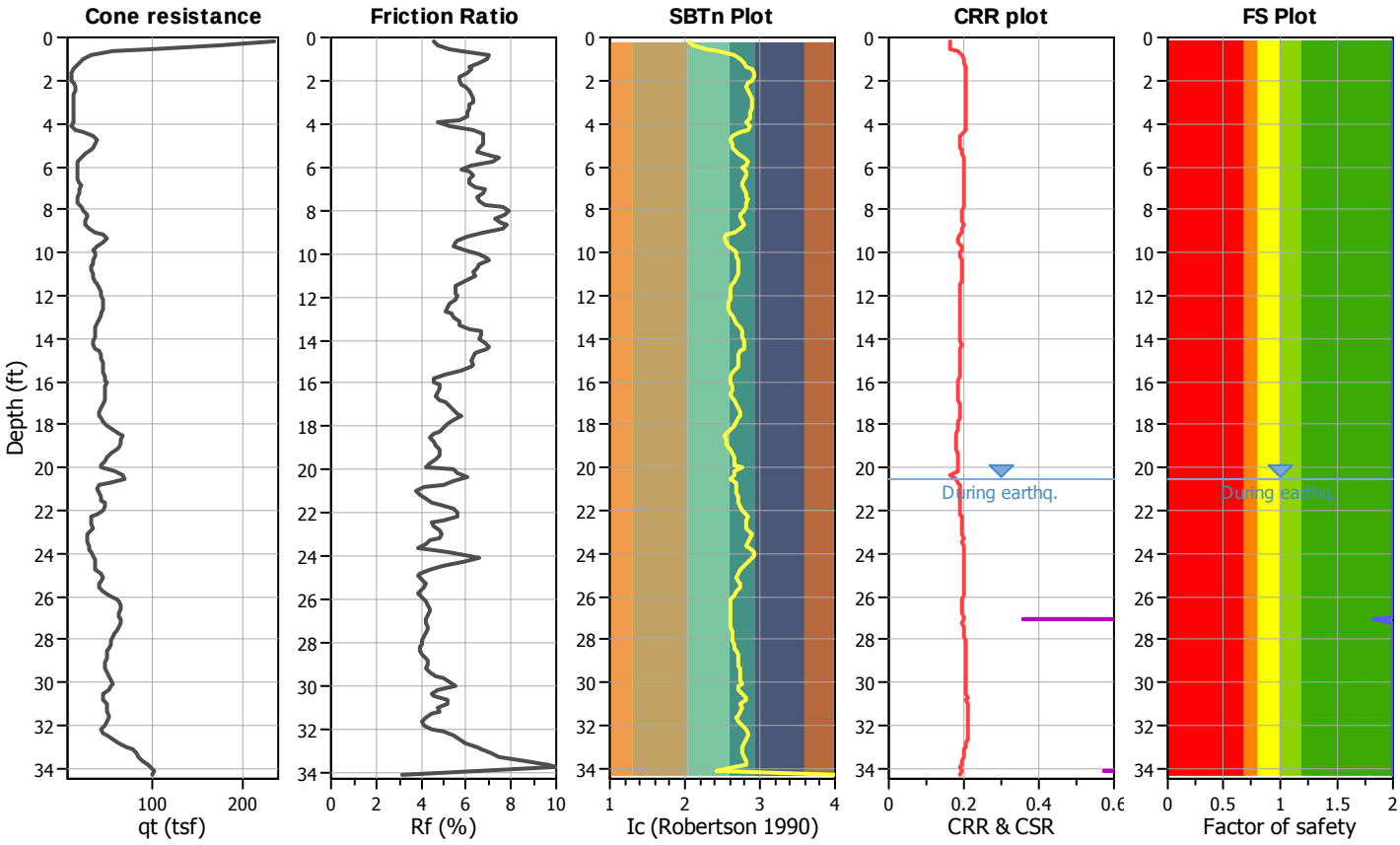
LIQUEFACTION ANALYSIS REPORT

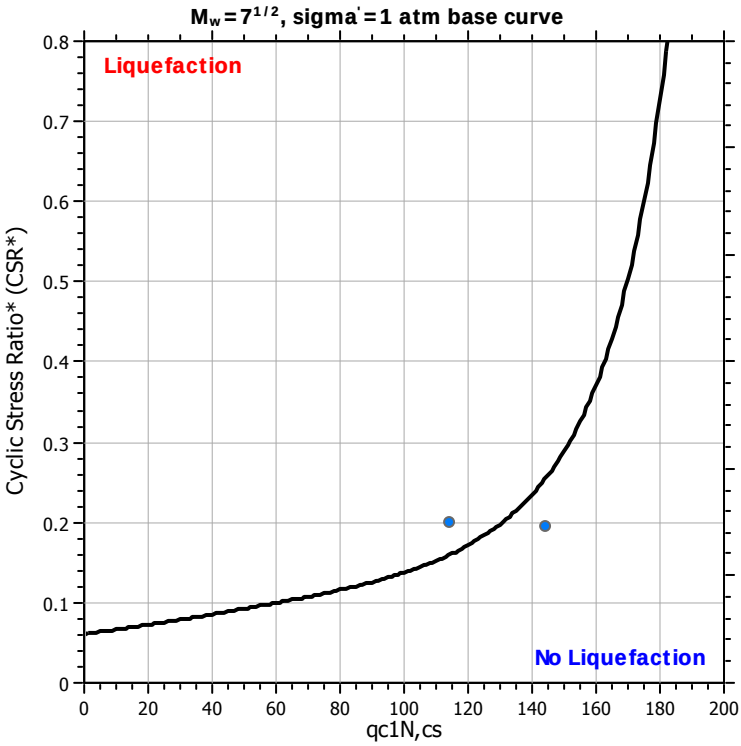
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

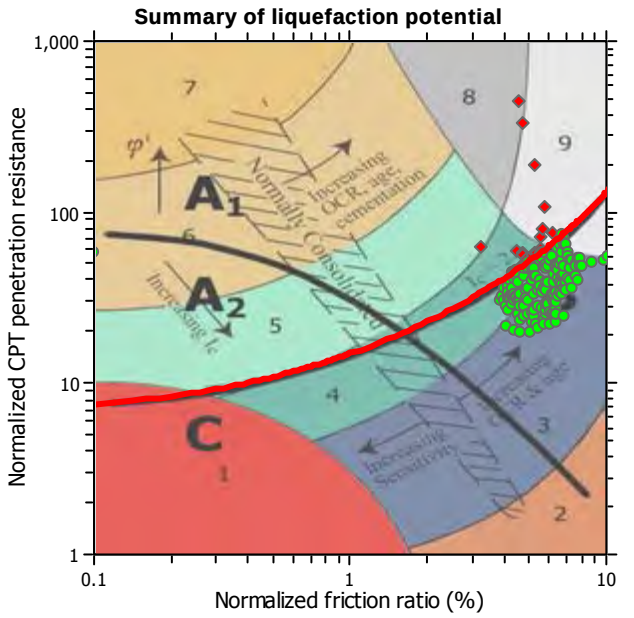
CPT file : 1-CPT-2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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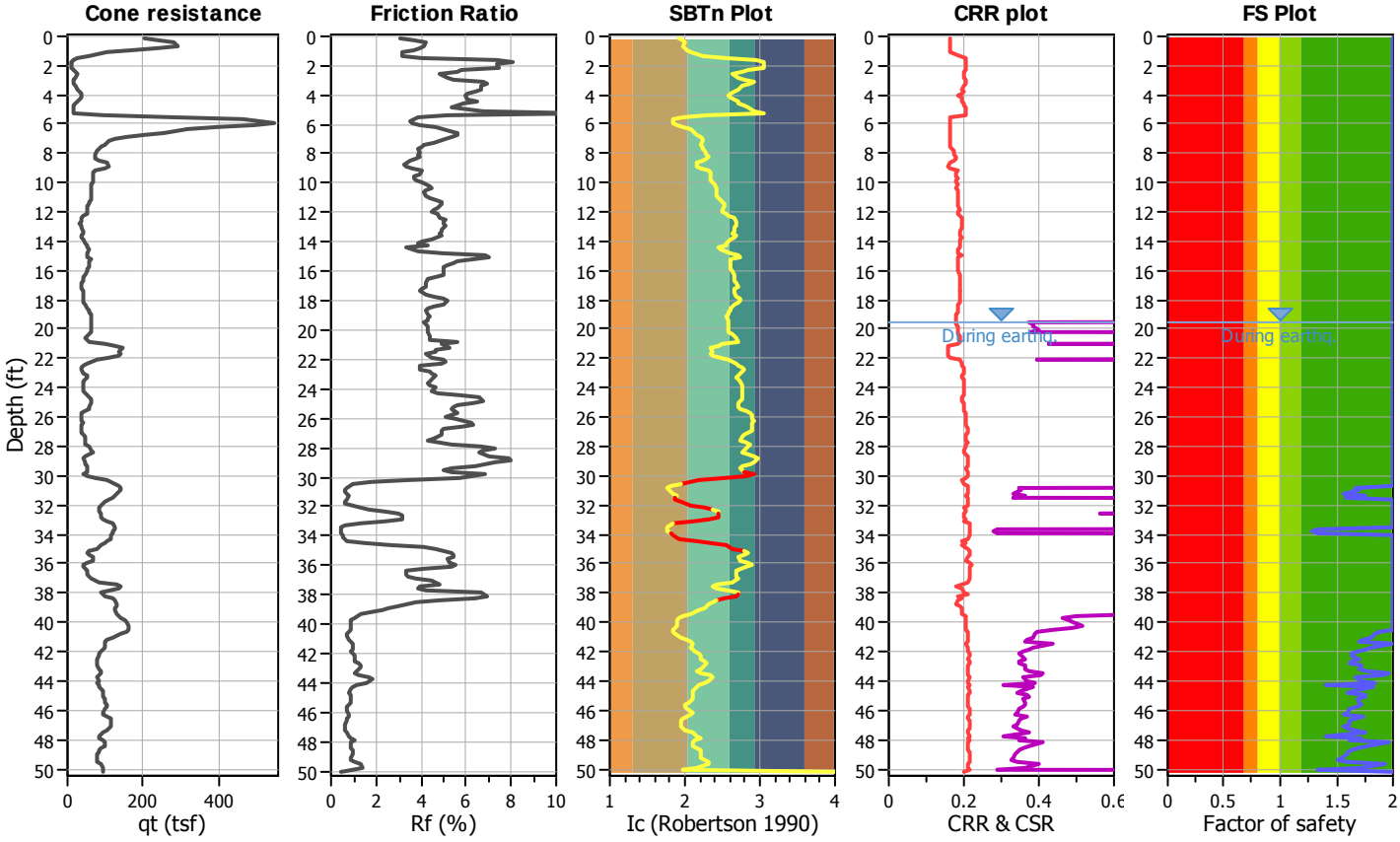
LIQUEFACTION ANALYSIS REPORT

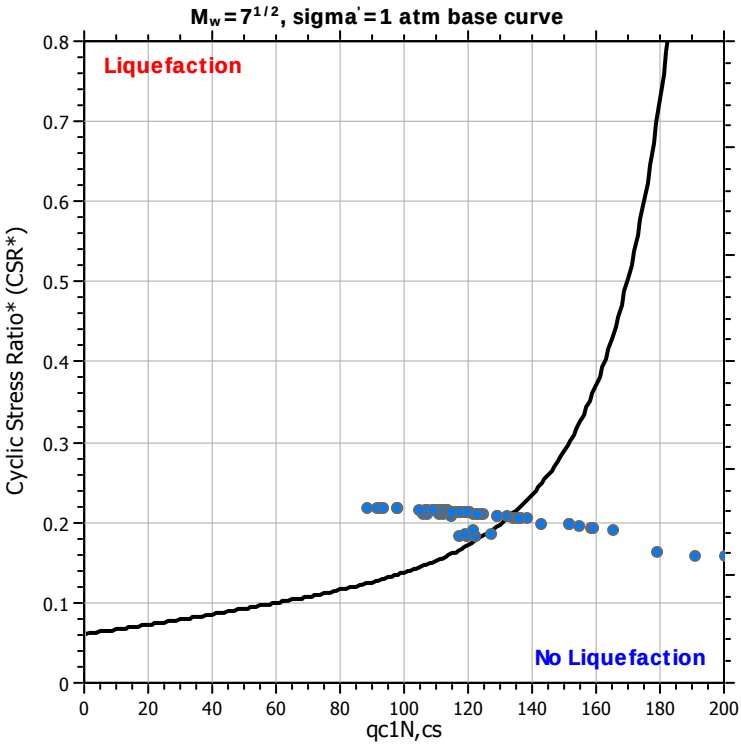
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

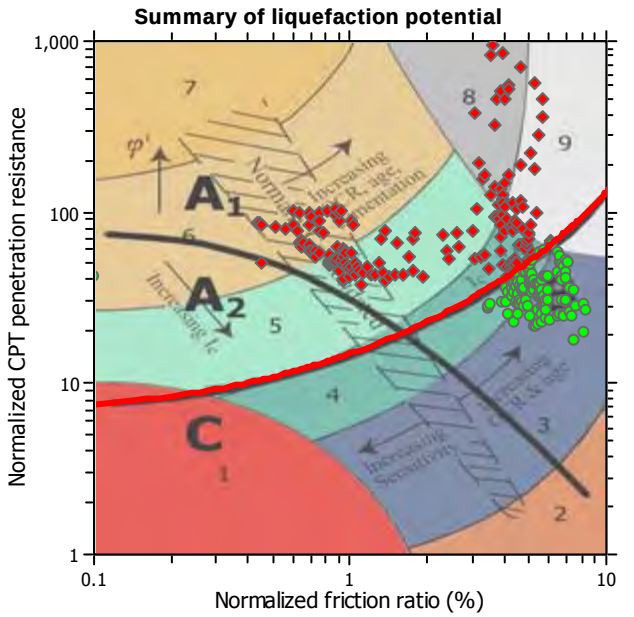
CPT file : 1-CPT-3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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Rocklin, CA 95765

Expect Excellence

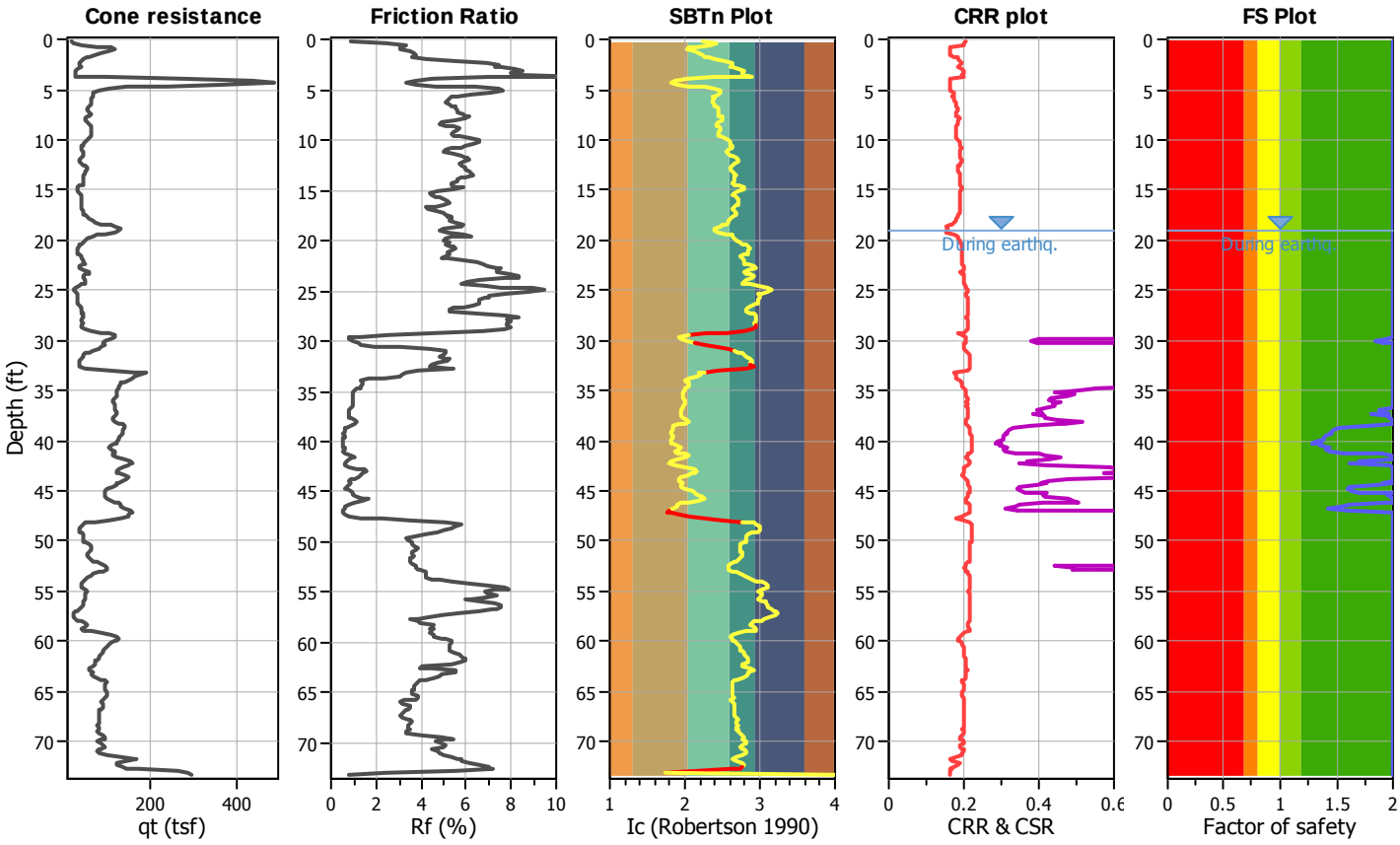
LIQUEFACTION ANALYSIS REPORT

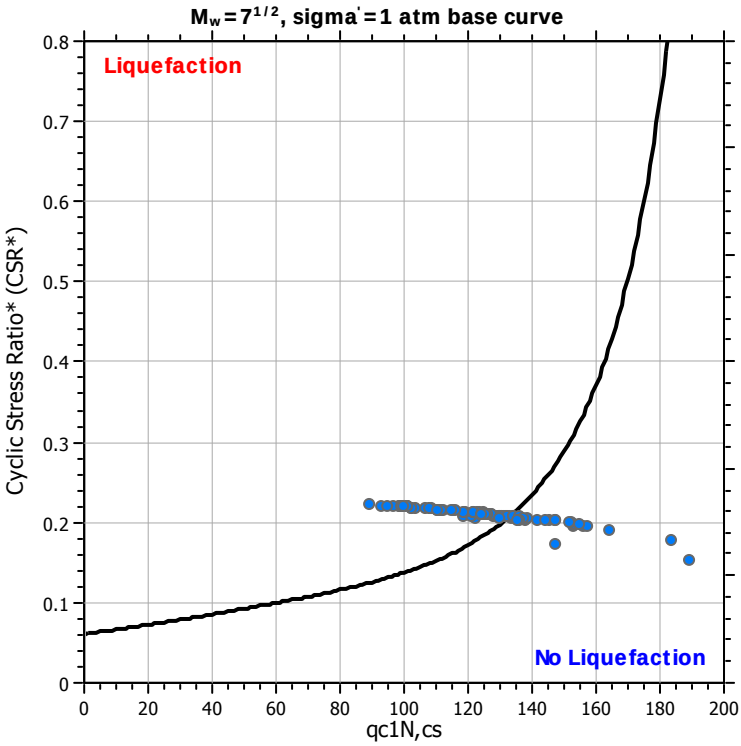
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

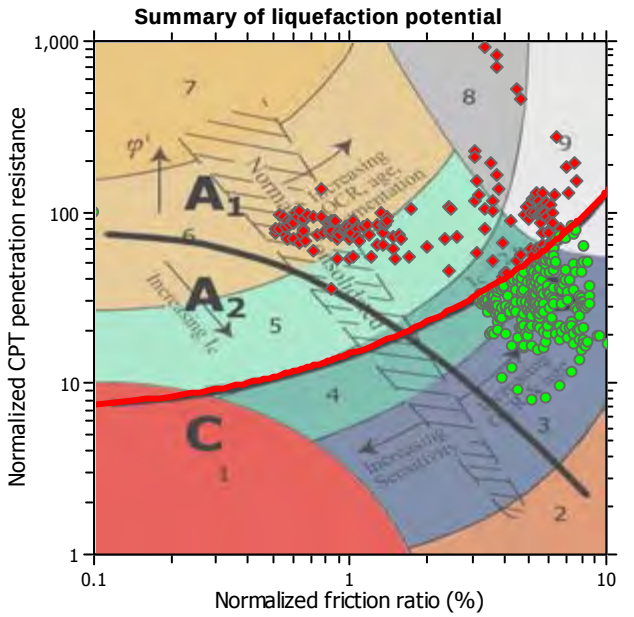
CPT file : 1-CPT-4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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LIQUEFACTION ANALYSIS REPORT

Project title : Elk Grove Hospital **Location : Elk Grove, CA**

CPT file : 1-CPT-5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	17.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
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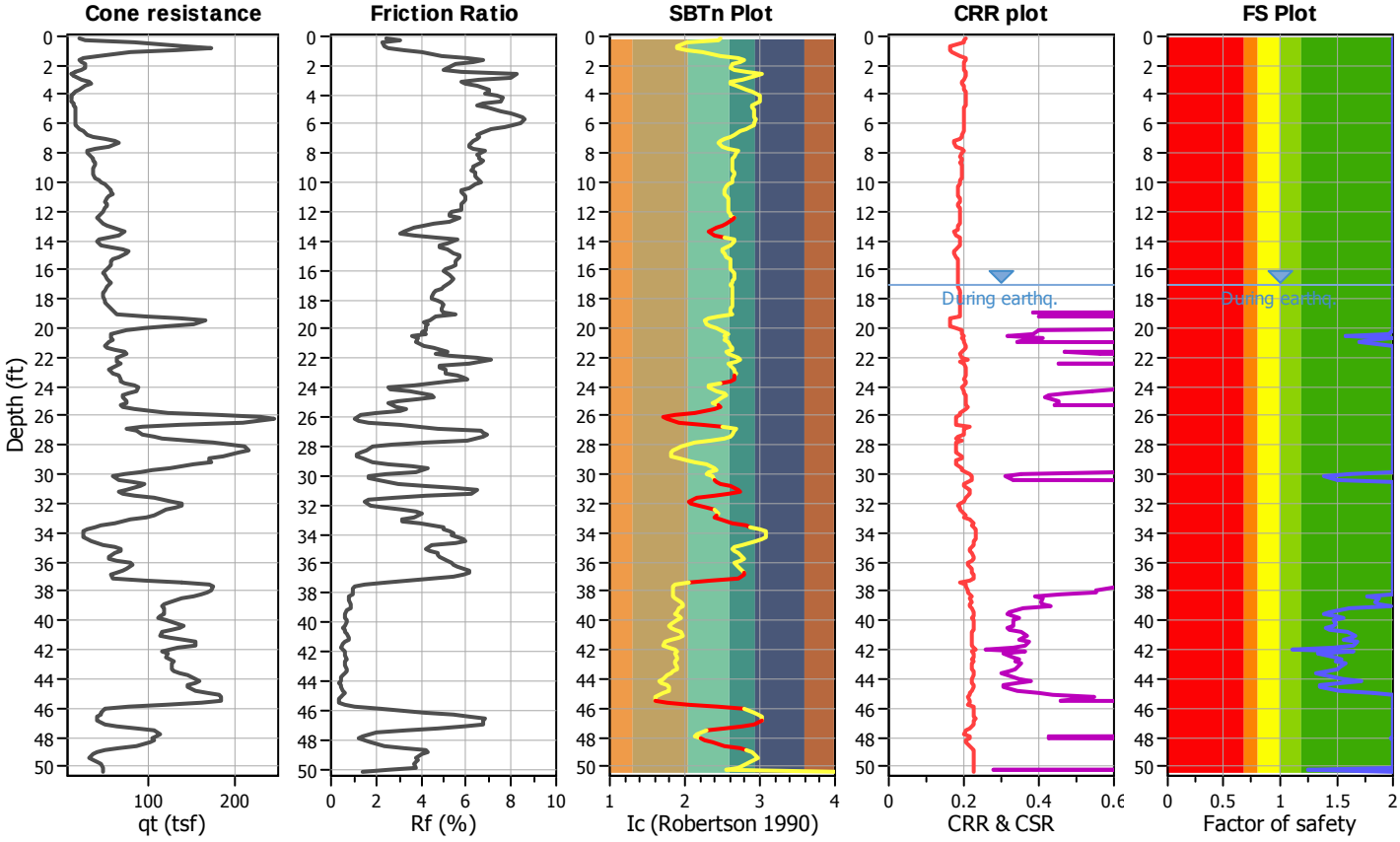
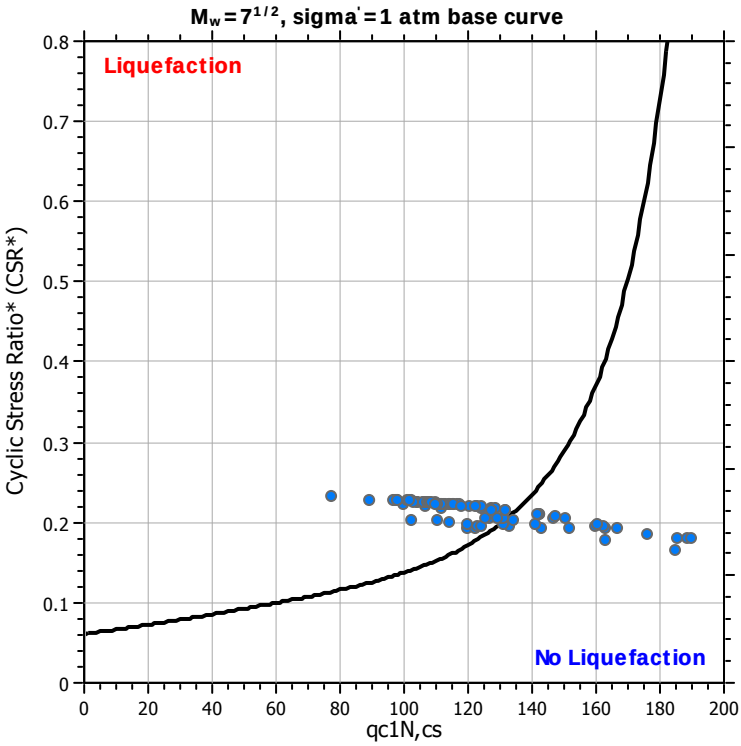
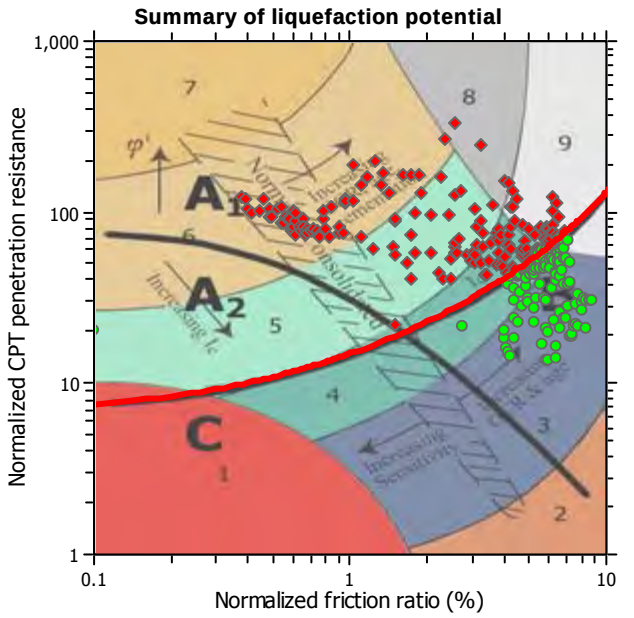
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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LIQUEFACTION ANALYSIS REPORT

Project title : Elk Grove Hospital **Location : Elk Grove, CA**

CPT file : 1-CPT-6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
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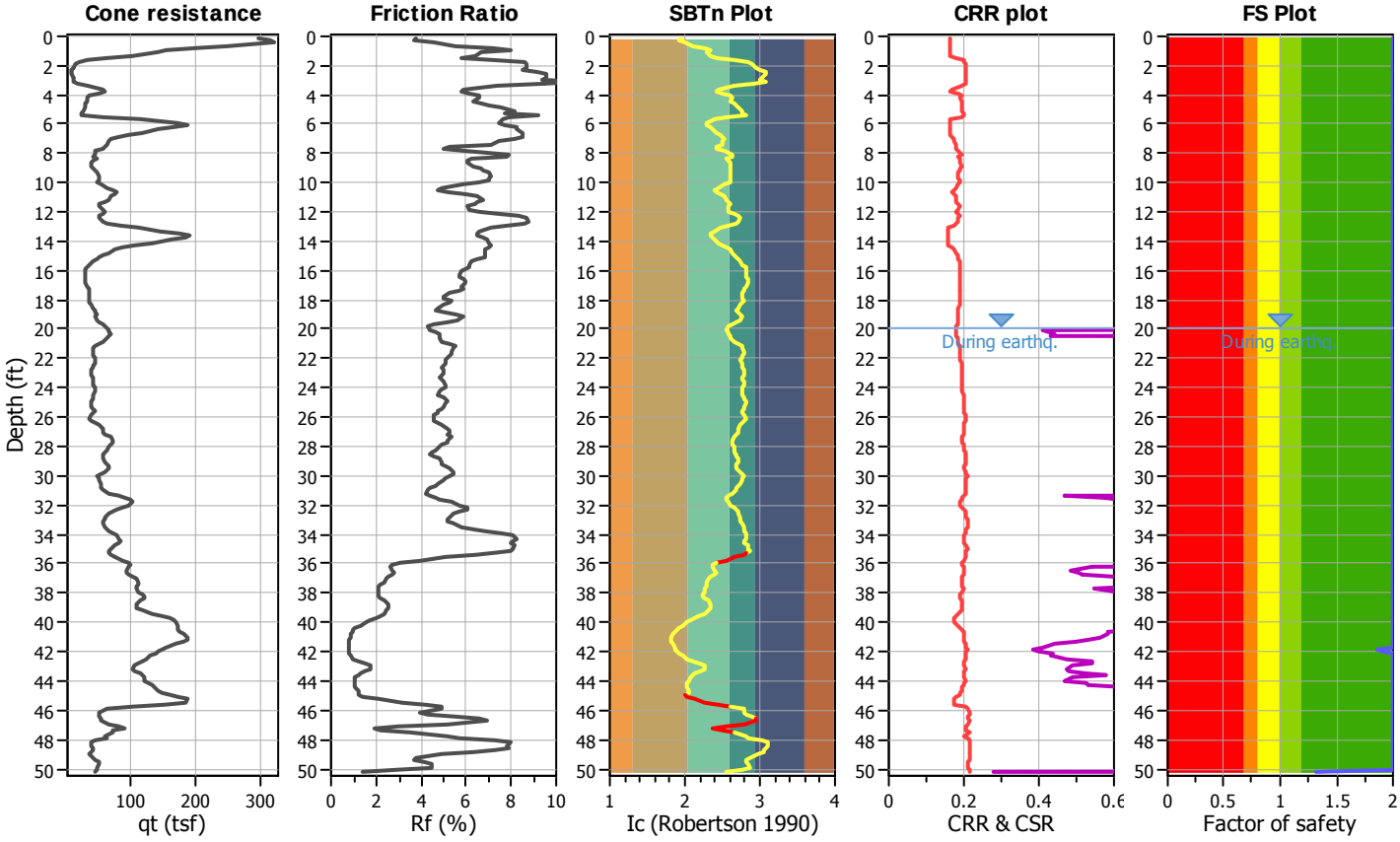
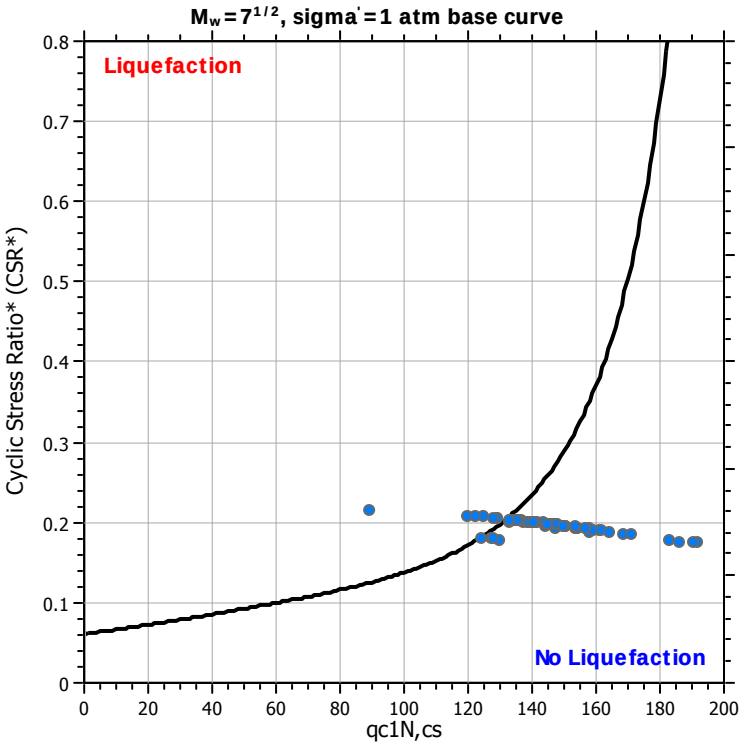
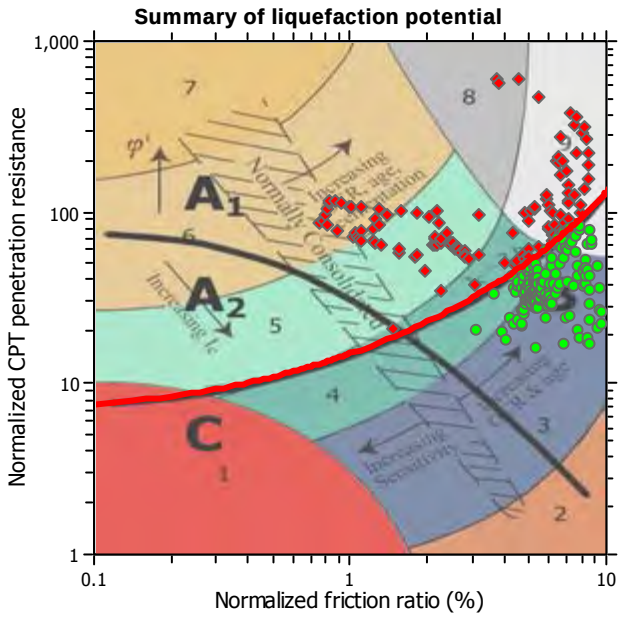
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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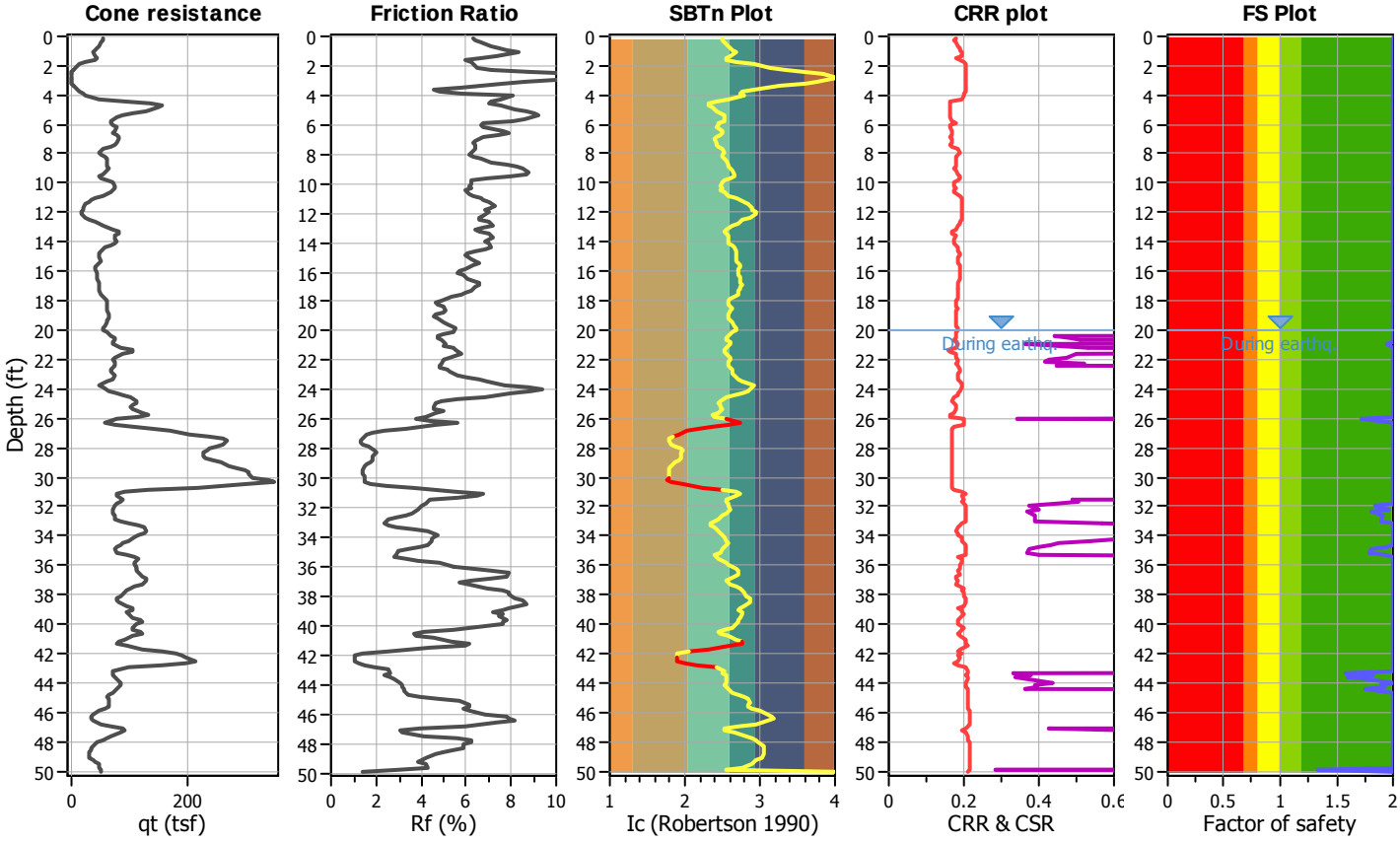
LIQUEFACTION ANALYSIS REPORT

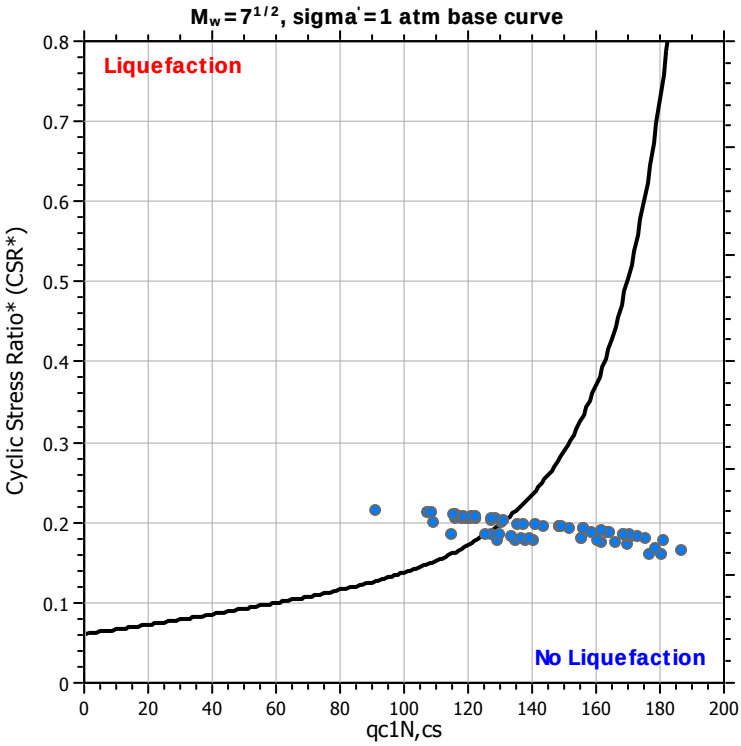
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

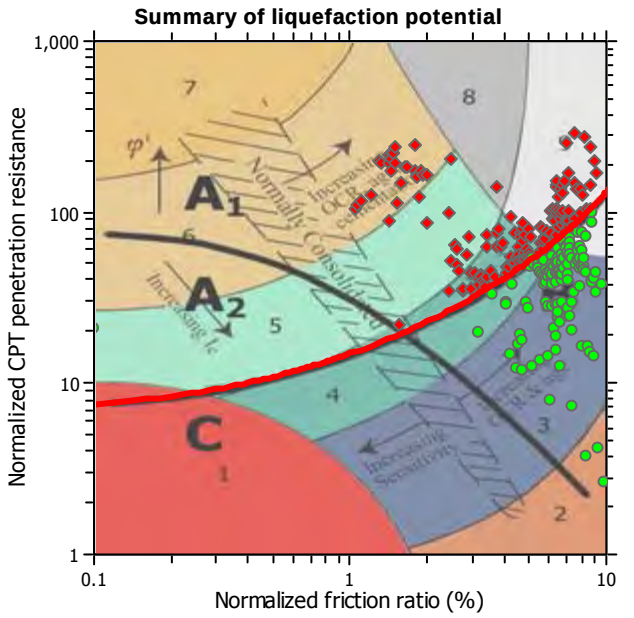
CPT file : 1-CPT-7

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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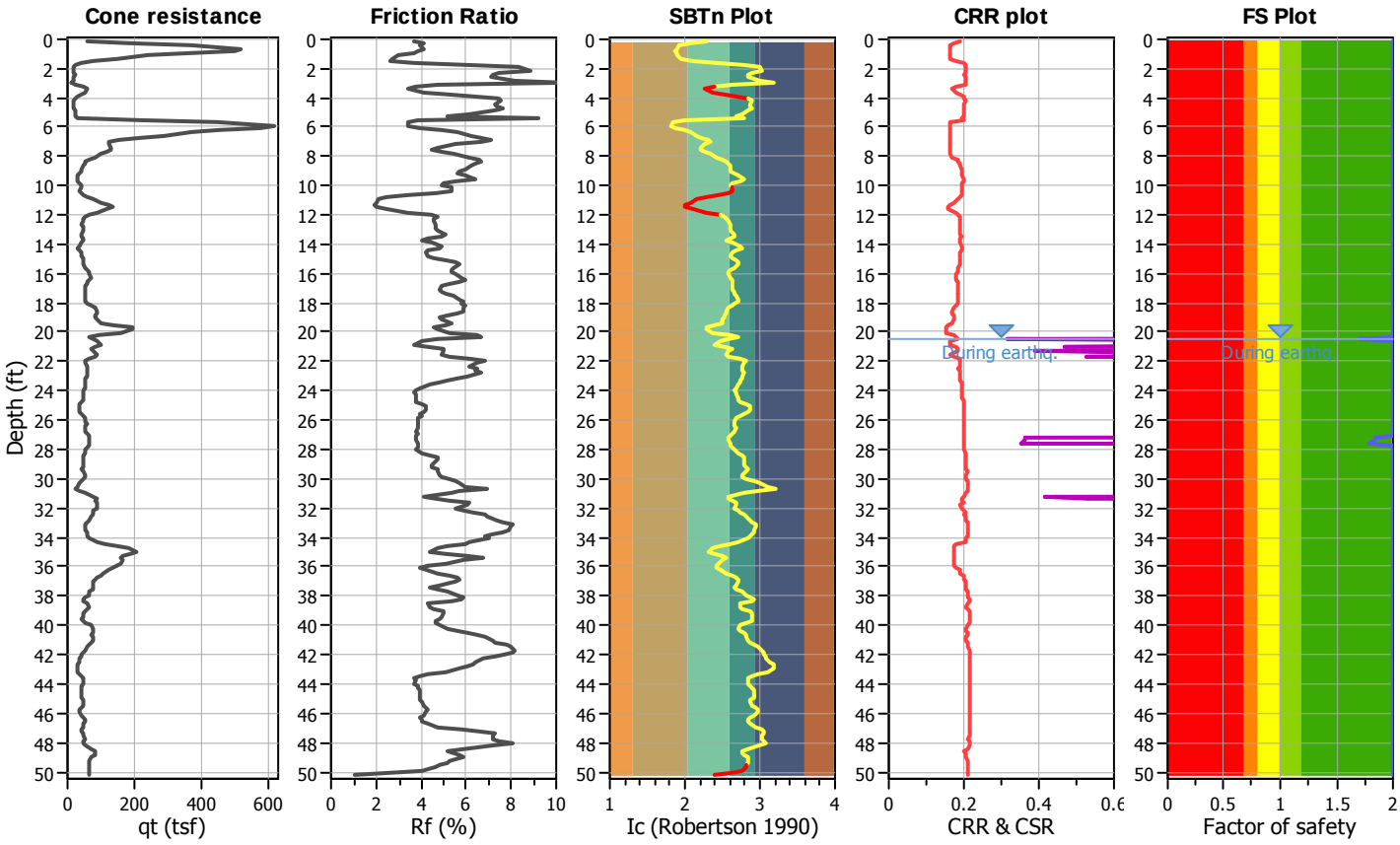
LIQUEFACTION ANALYSIS REPORT

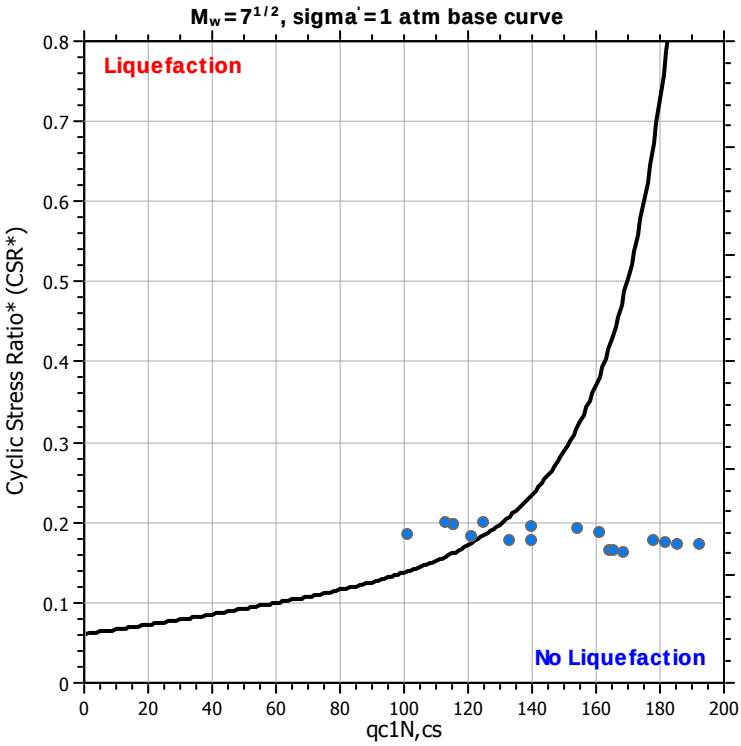
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

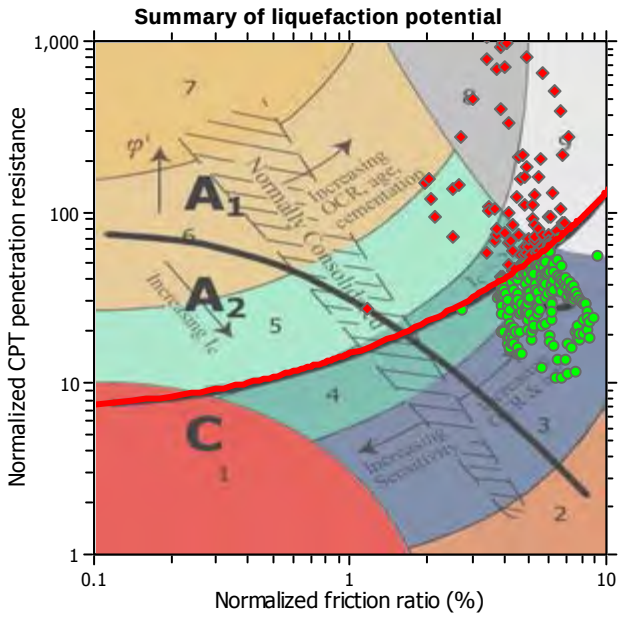
CPT file : 1-CPT-8

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	21.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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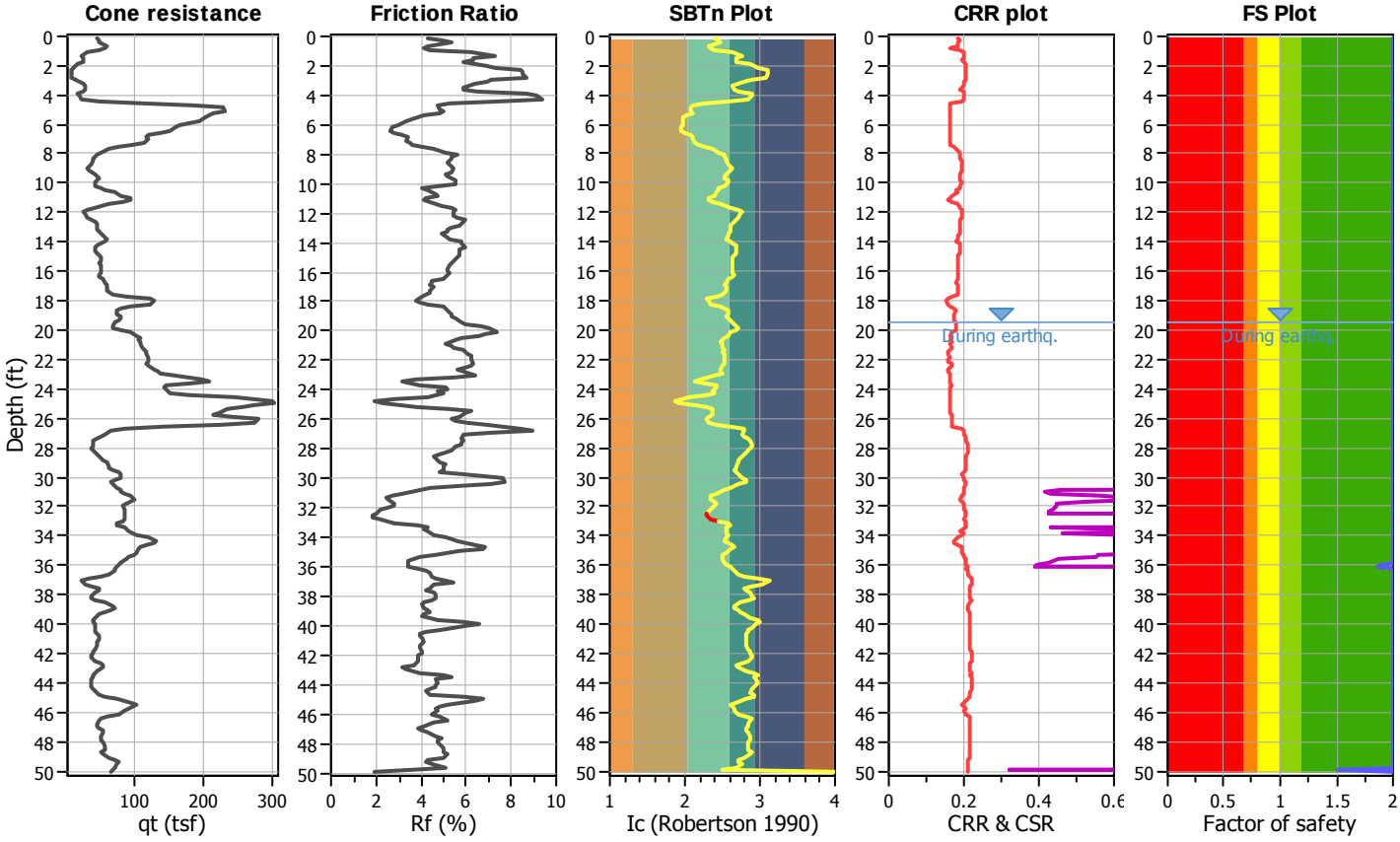
LIQUEFACTION ANALYSIS REPORT

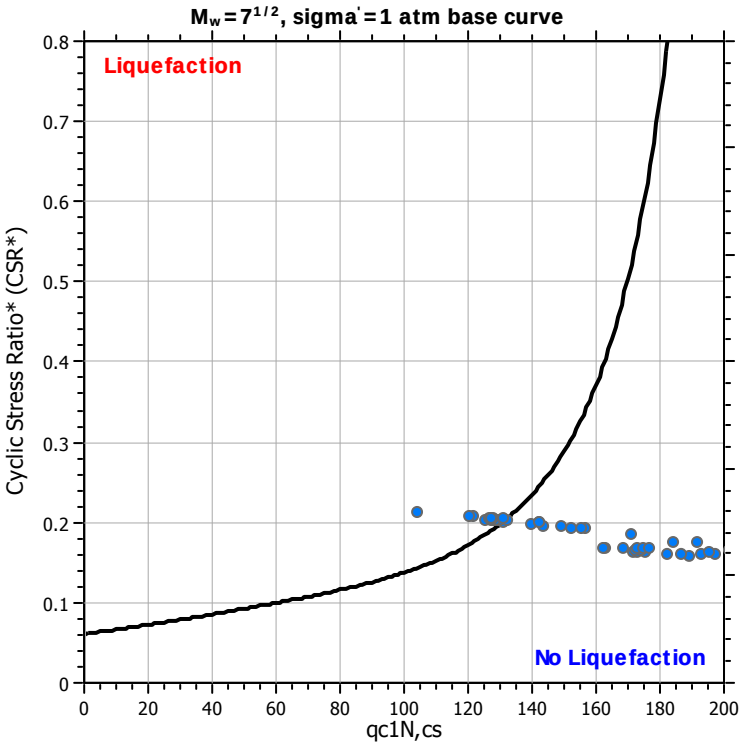
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

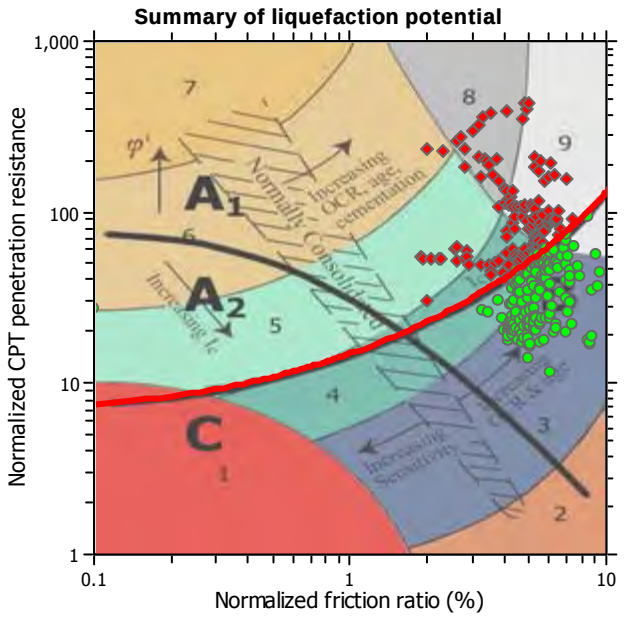
CPT file : 1-CPT-9

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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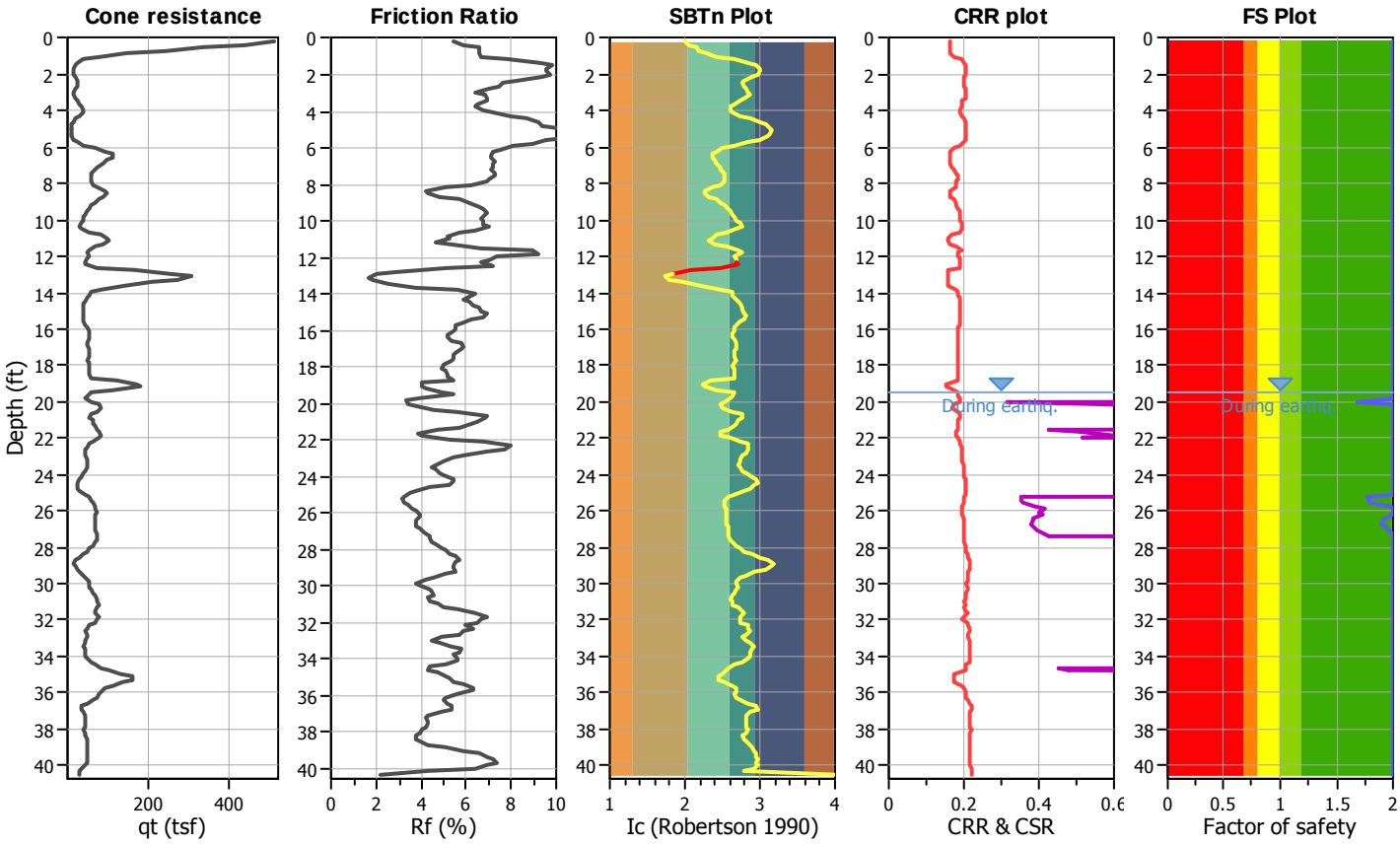
LIQUEFACTION ANALYSIS REPORT

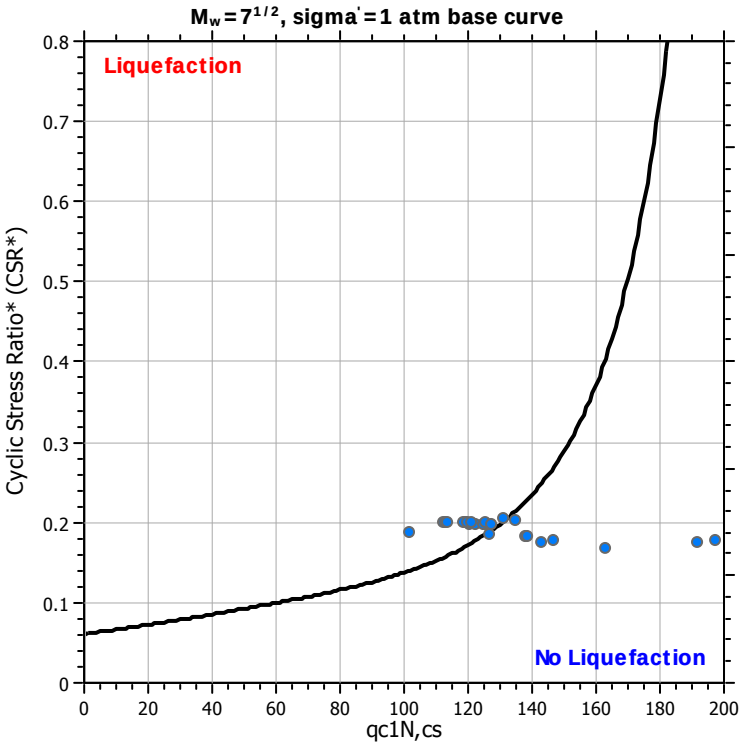
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

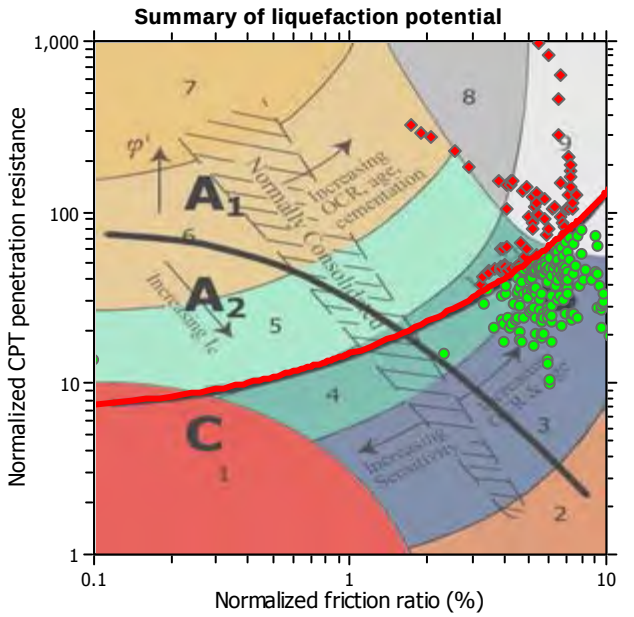
CPT file : 1-CPT-10

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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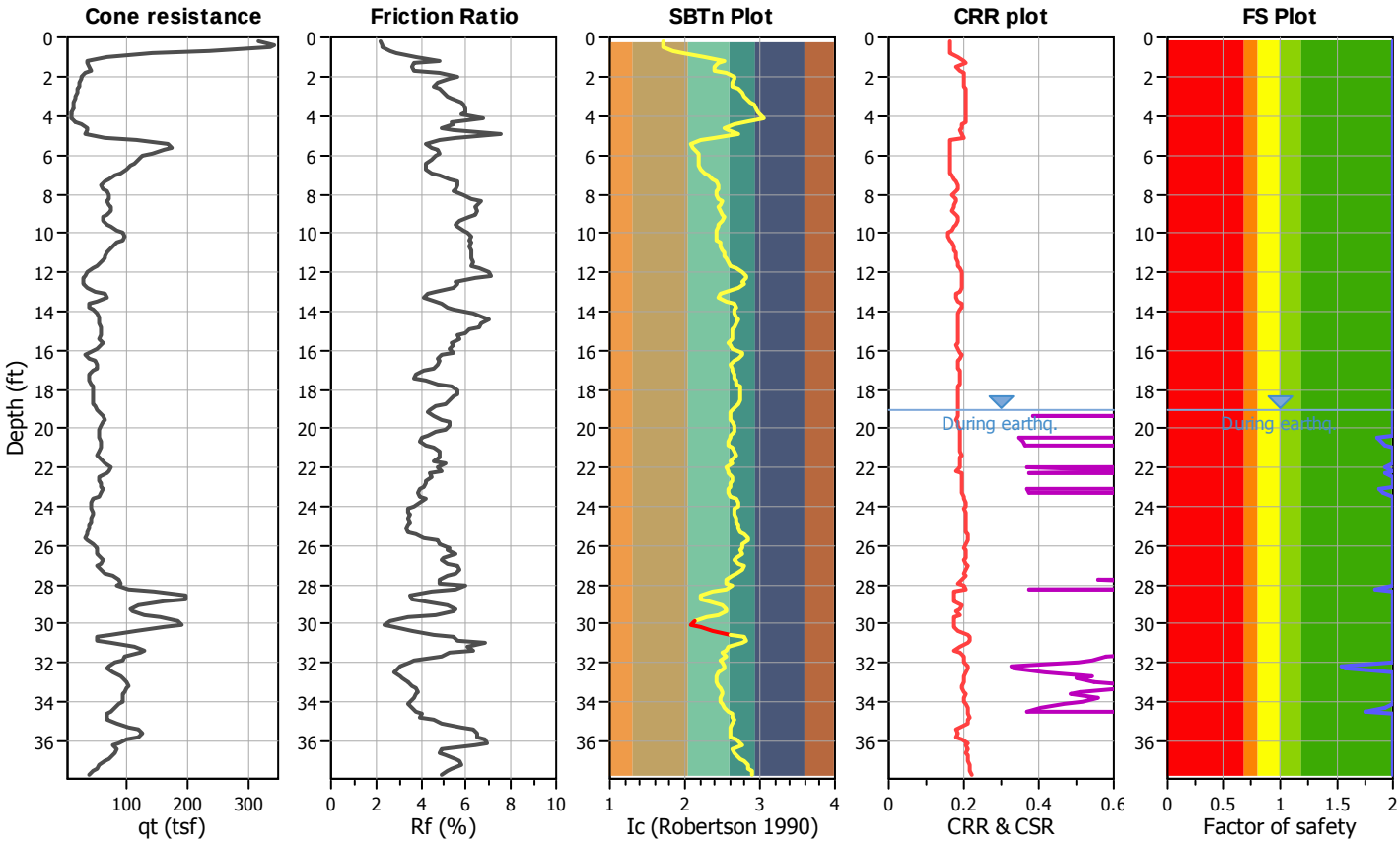
LIQUEFACTION ANALYSIS REPORT

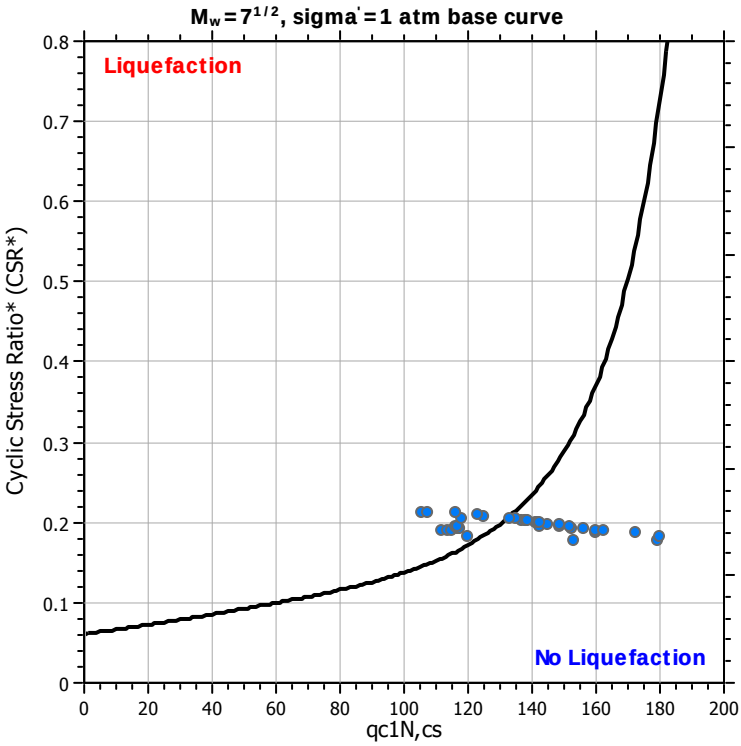
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

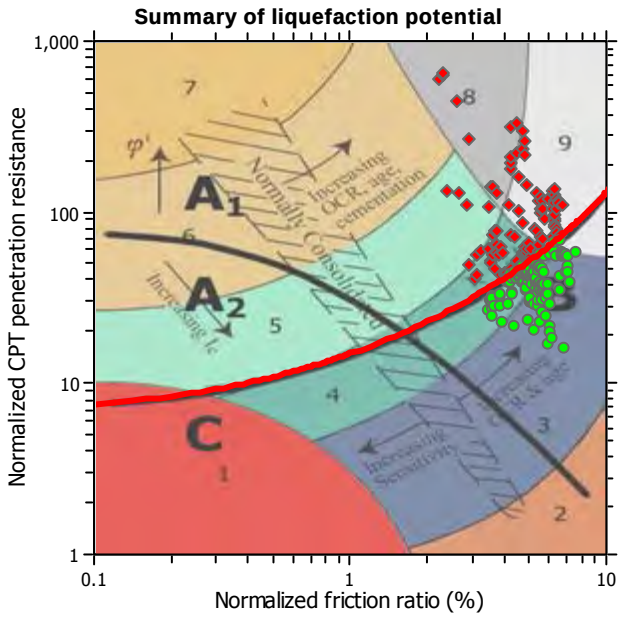
CPT file : 1-CPT-11

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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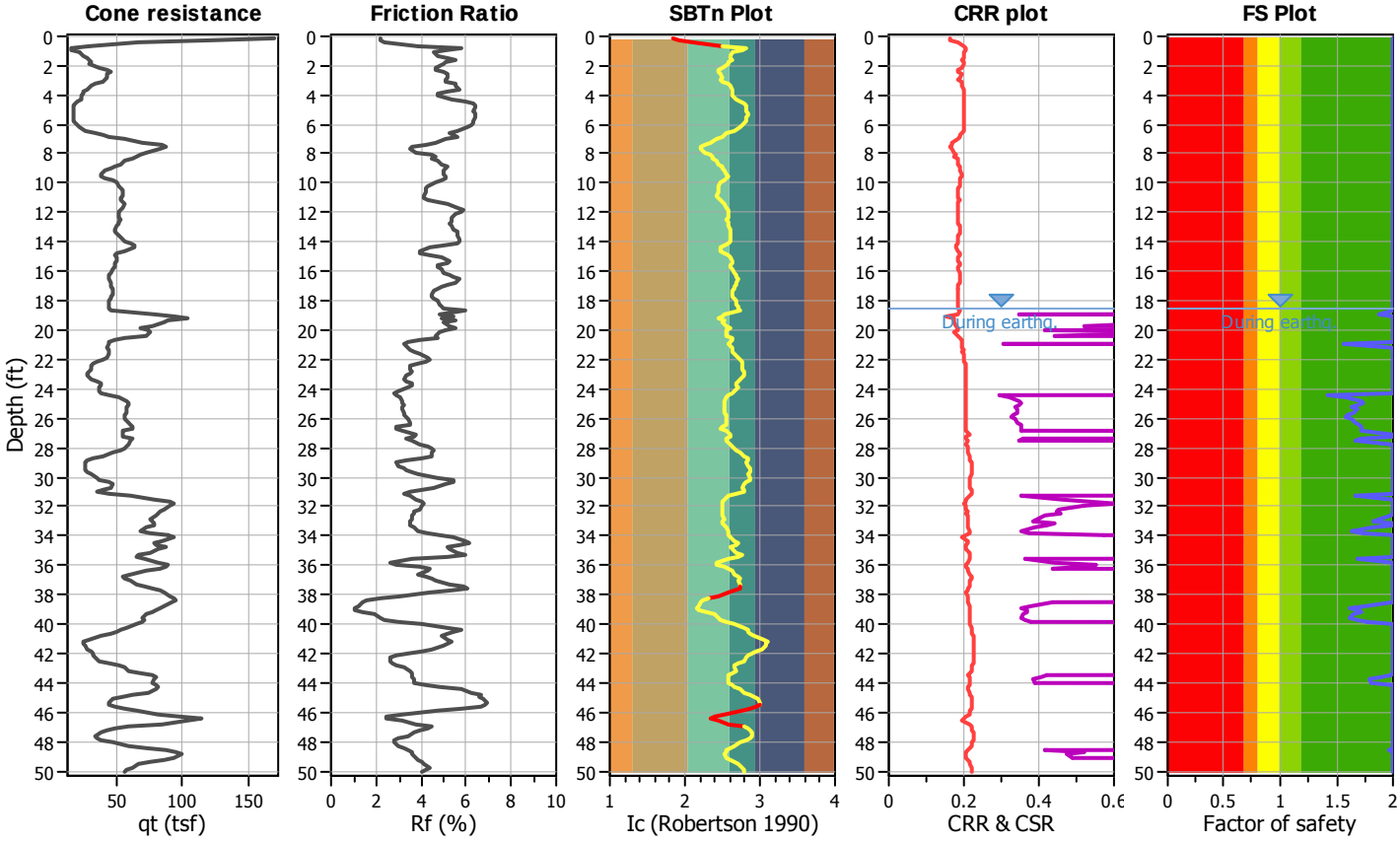
LIQUEFACTION ANALYSIS REPORT

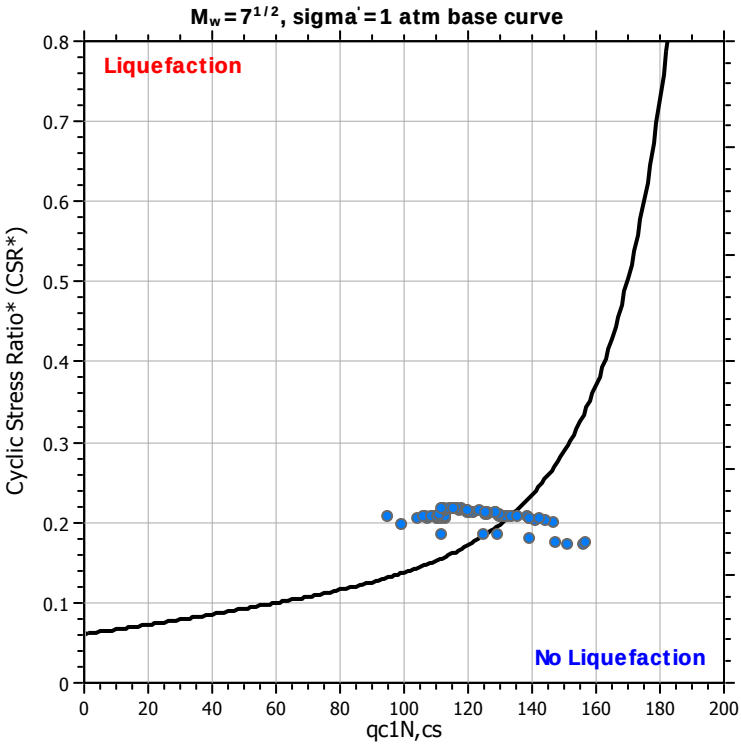
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

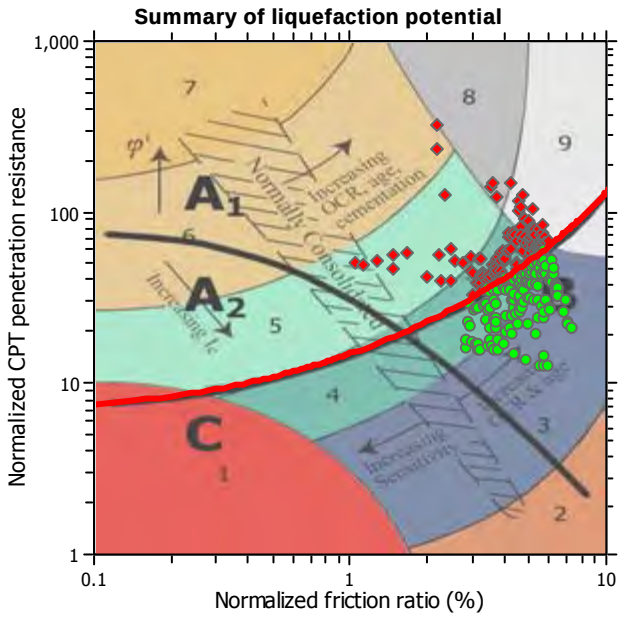
CPT file : 1-CPT-12

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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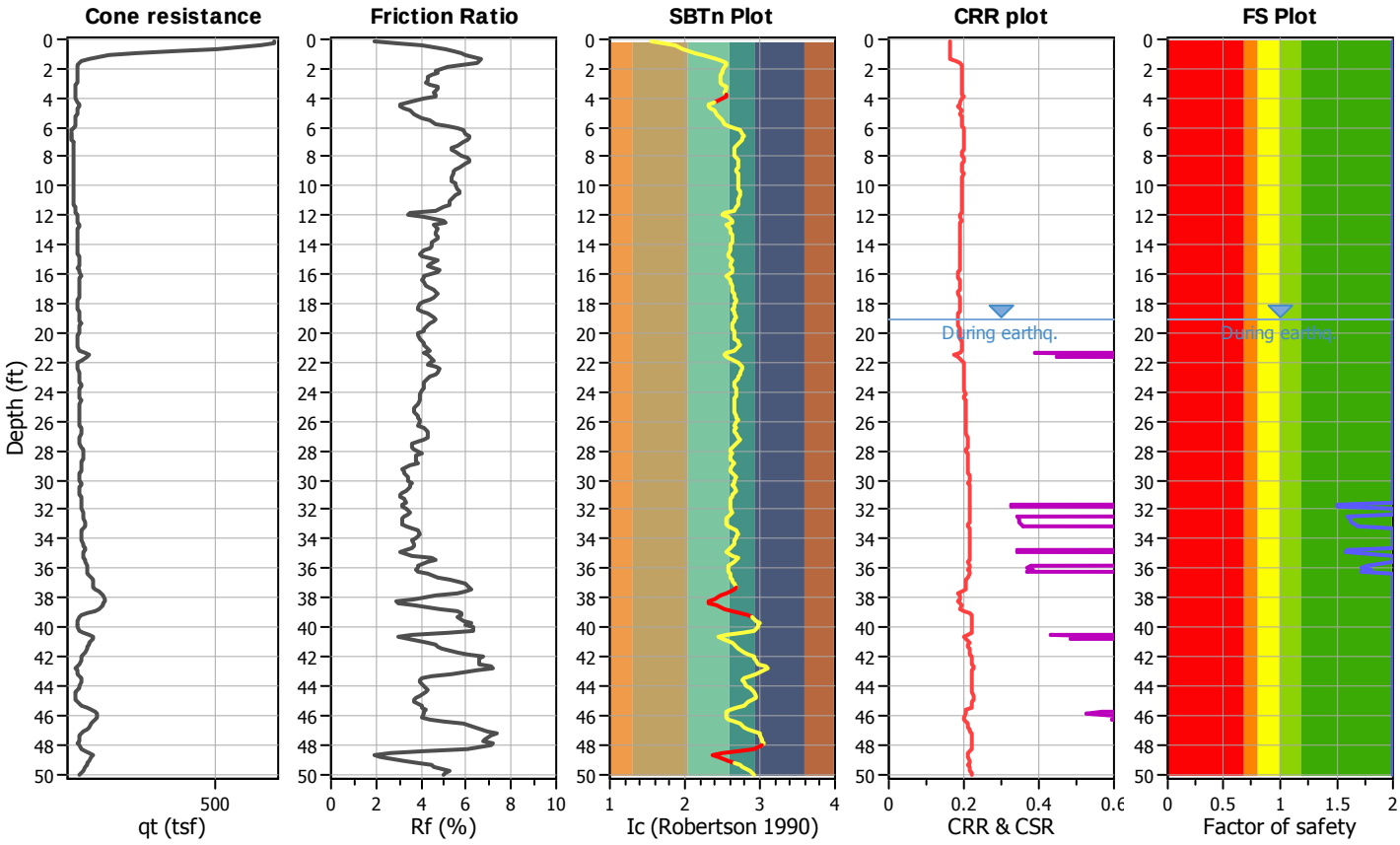
LIQUEFACTION ANALYSIS REPORT

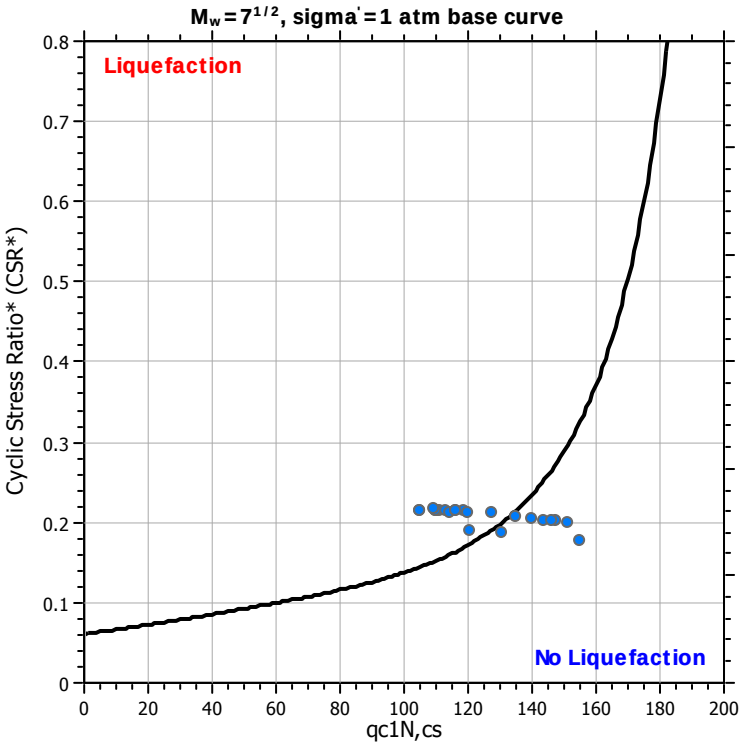
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

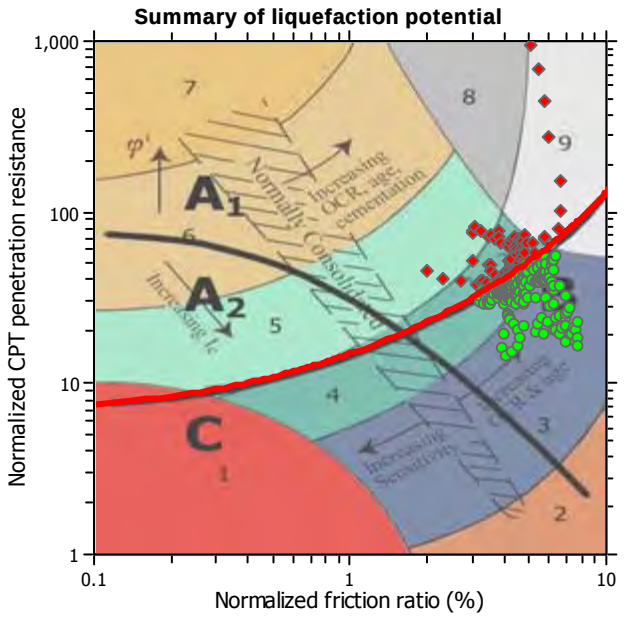
CPT file : 1-CPT-13

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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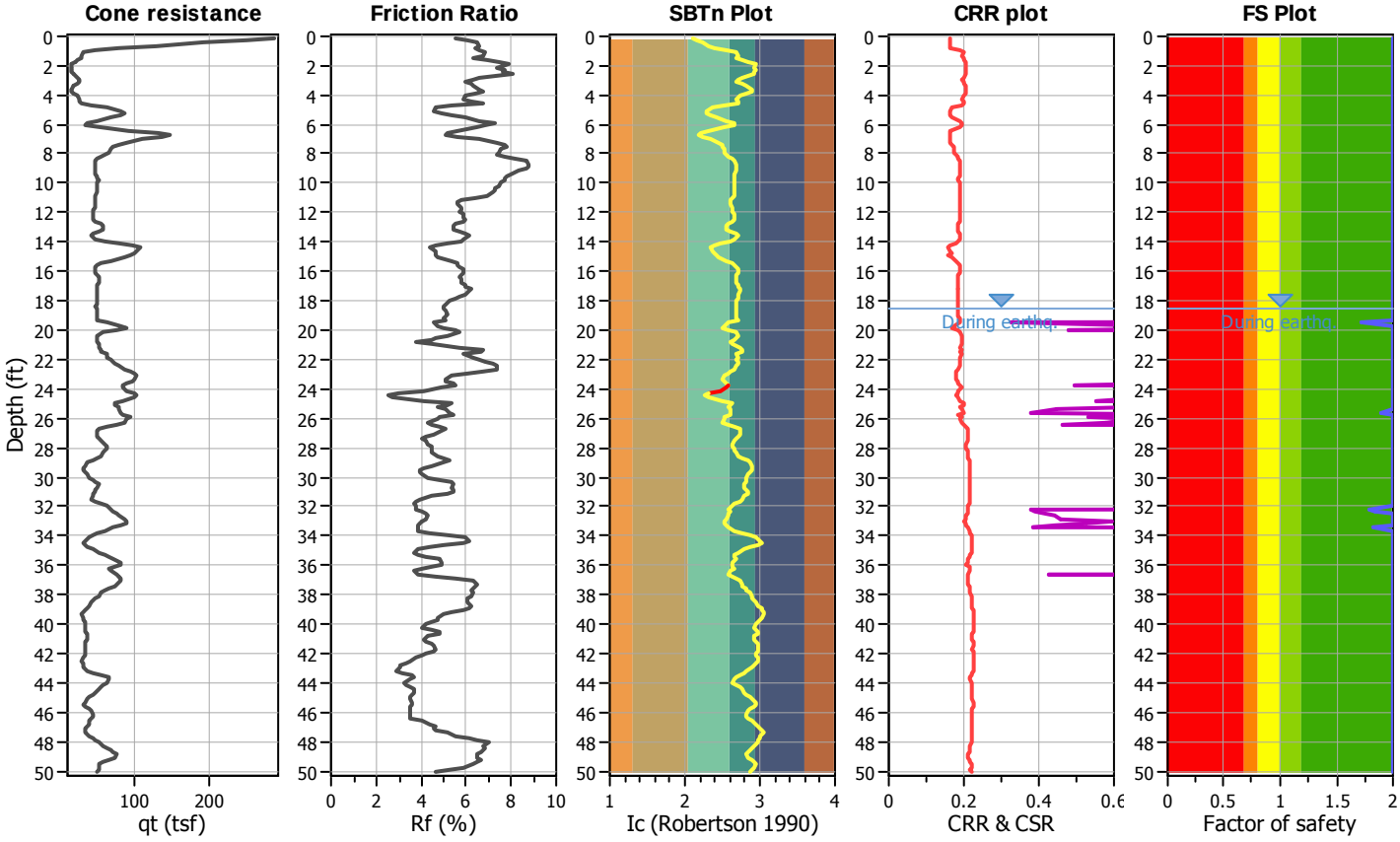
LIQUEFACTION ANALYSIS REPORT

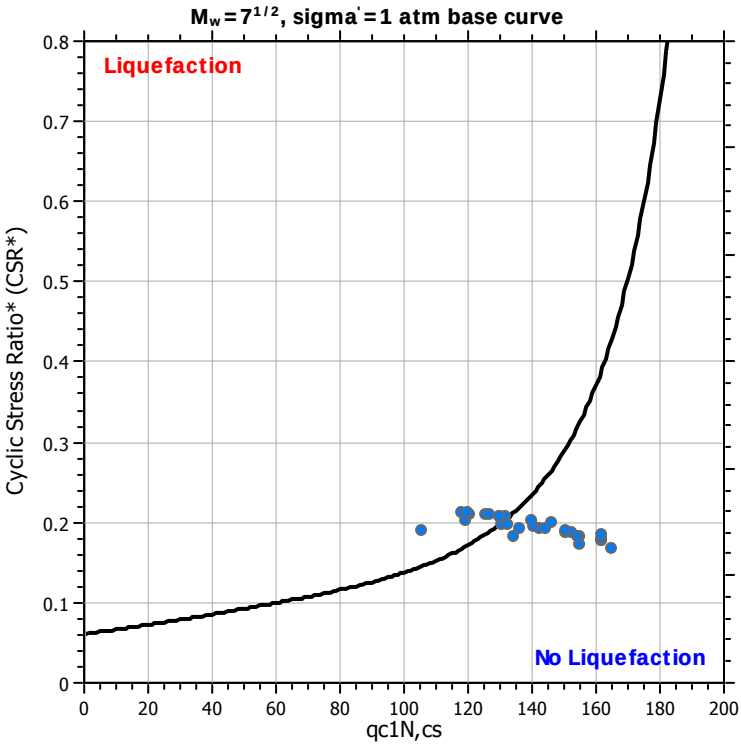
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

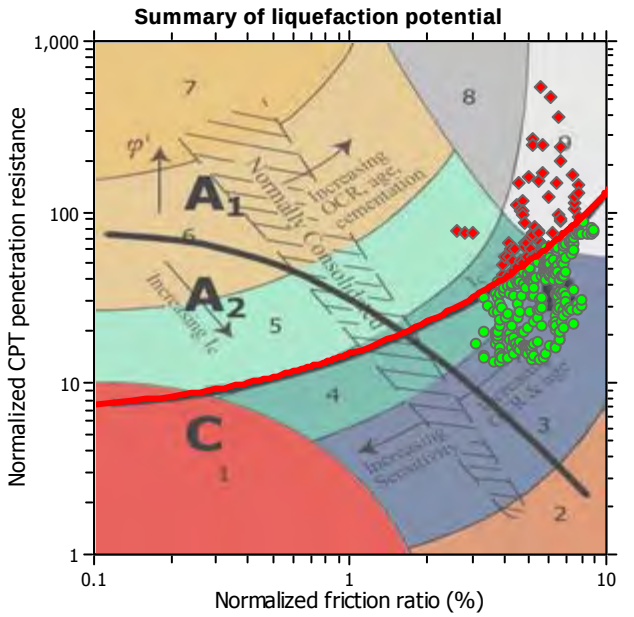
CPT file : 1-CPT-14

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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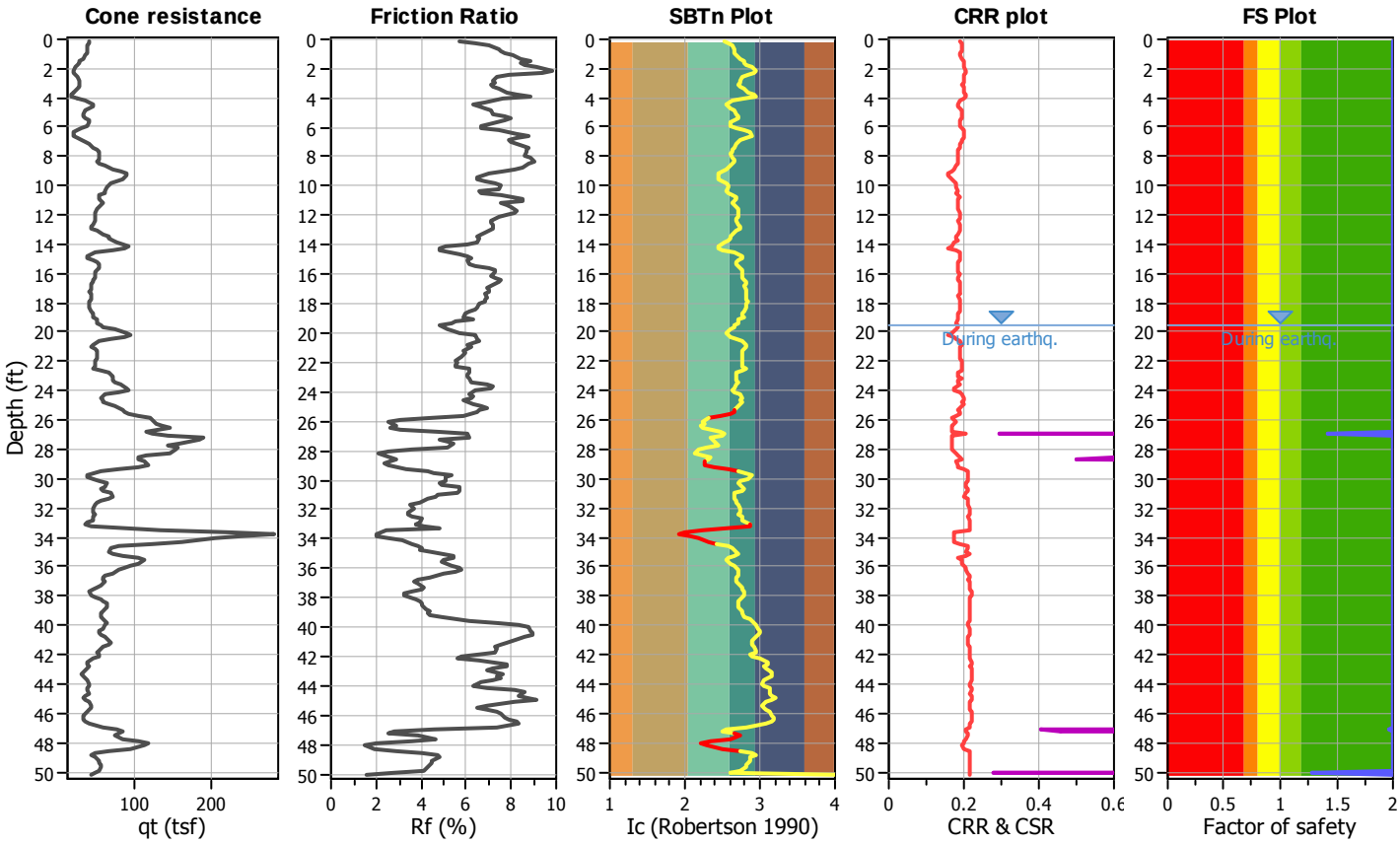
LIQUEFACTION ANALYSIS REPORT

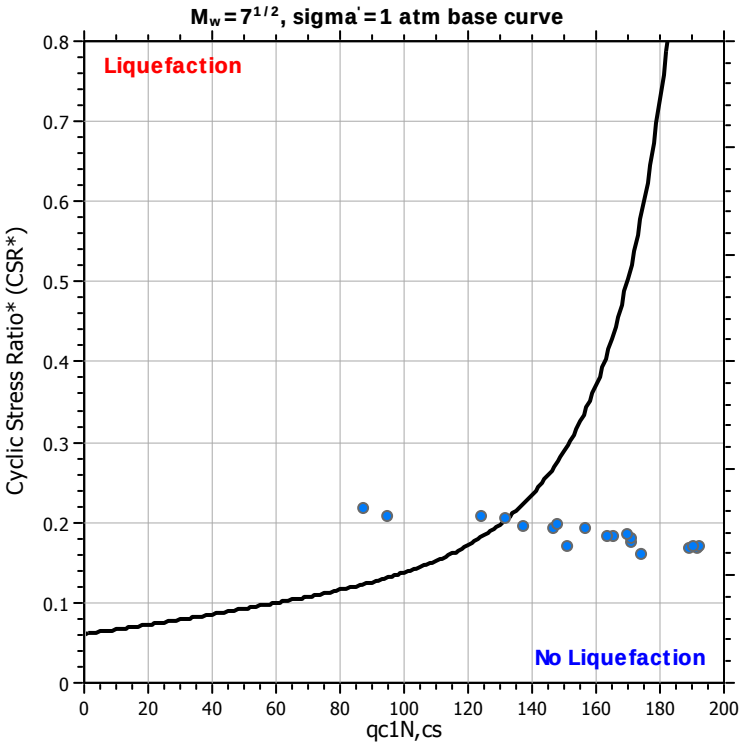
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

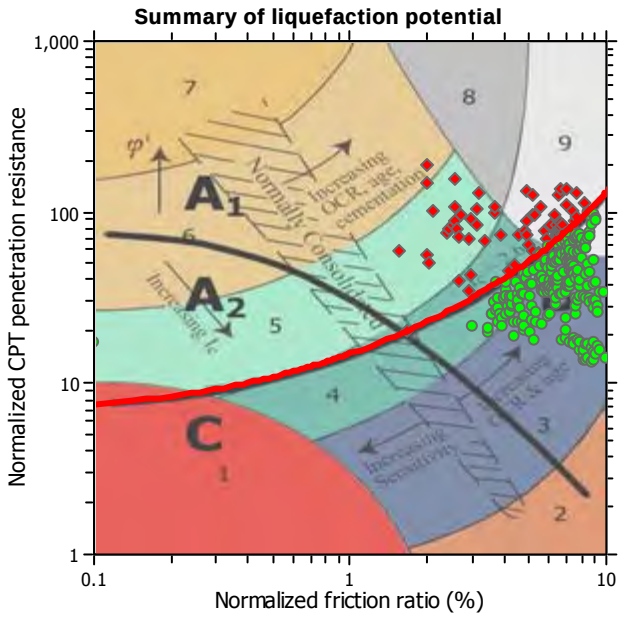
CPT file : 1-CPT-15

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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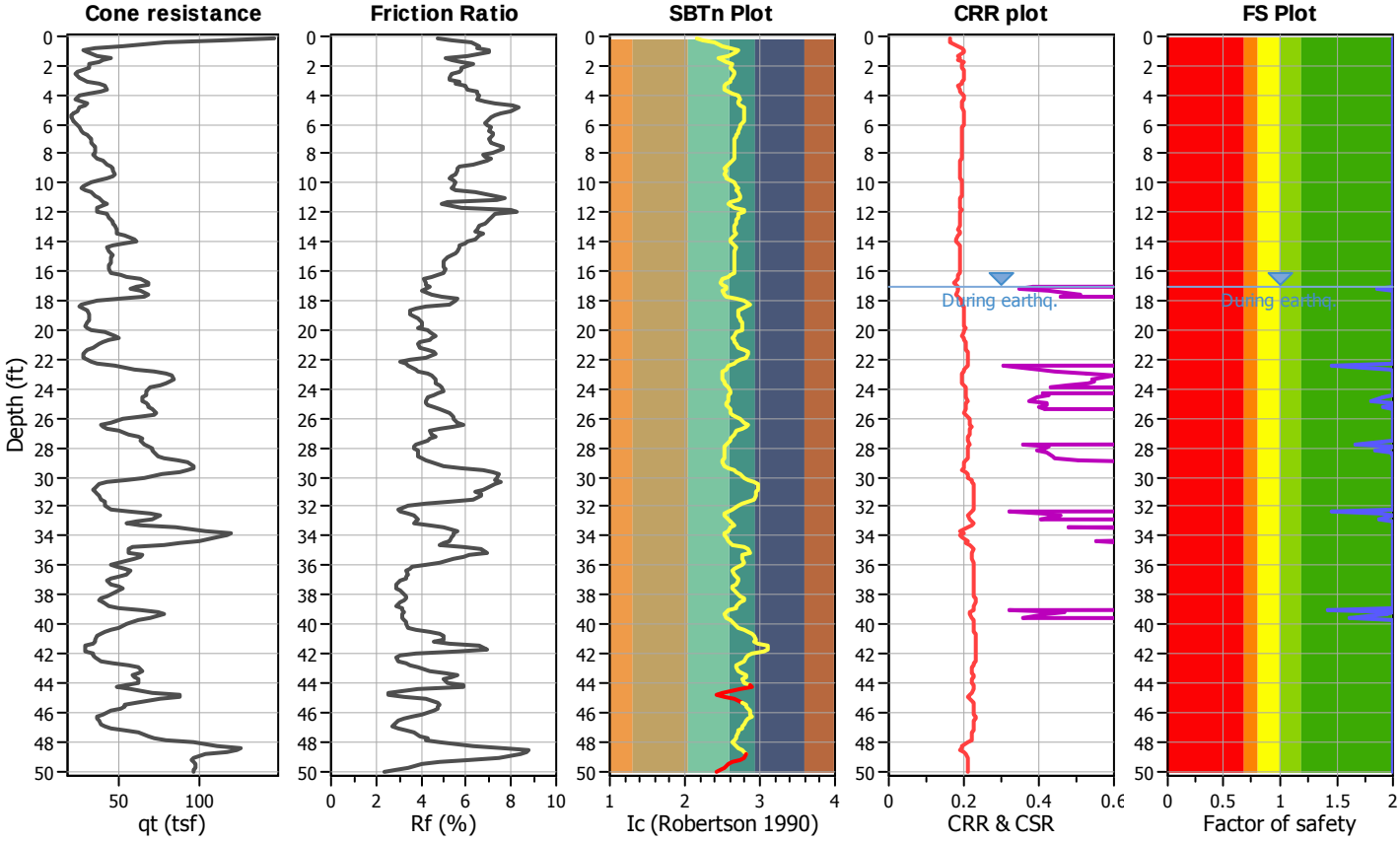
LIQUEFACTION ANALYSIS REPORT

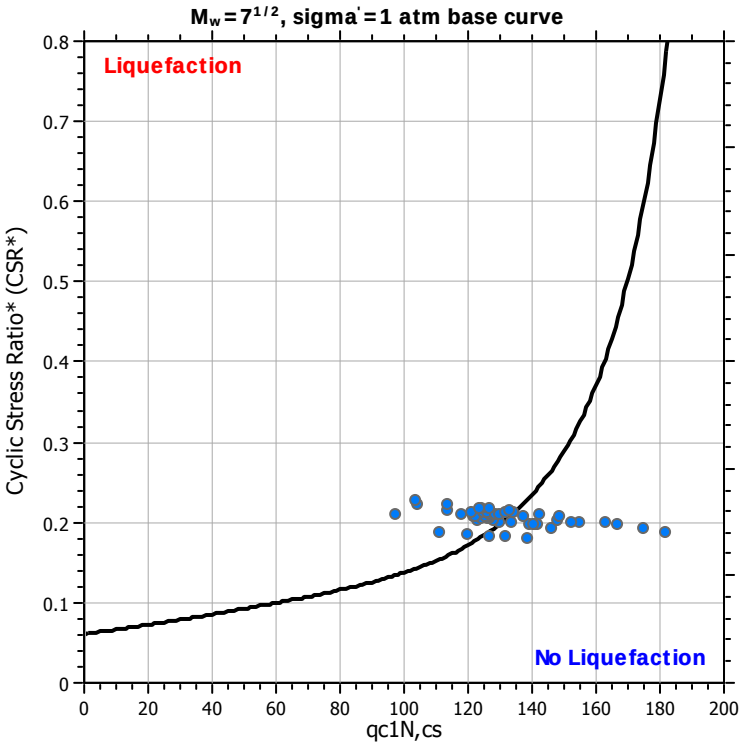
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

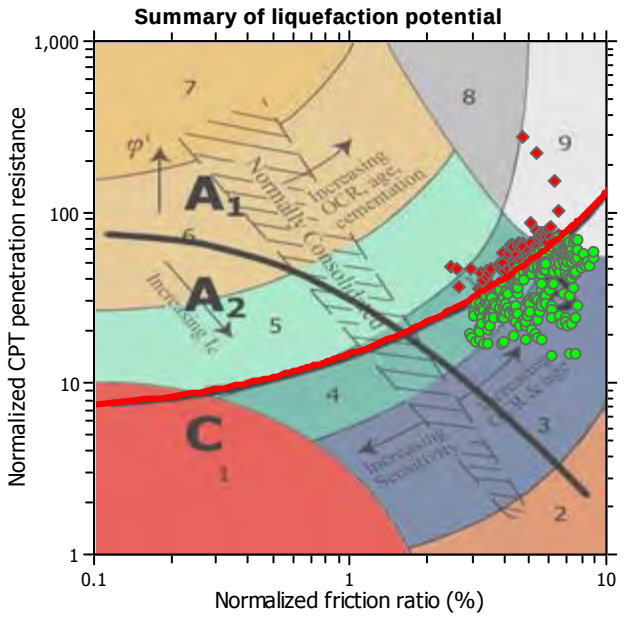
CPT file : 1-CPT-16

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	17.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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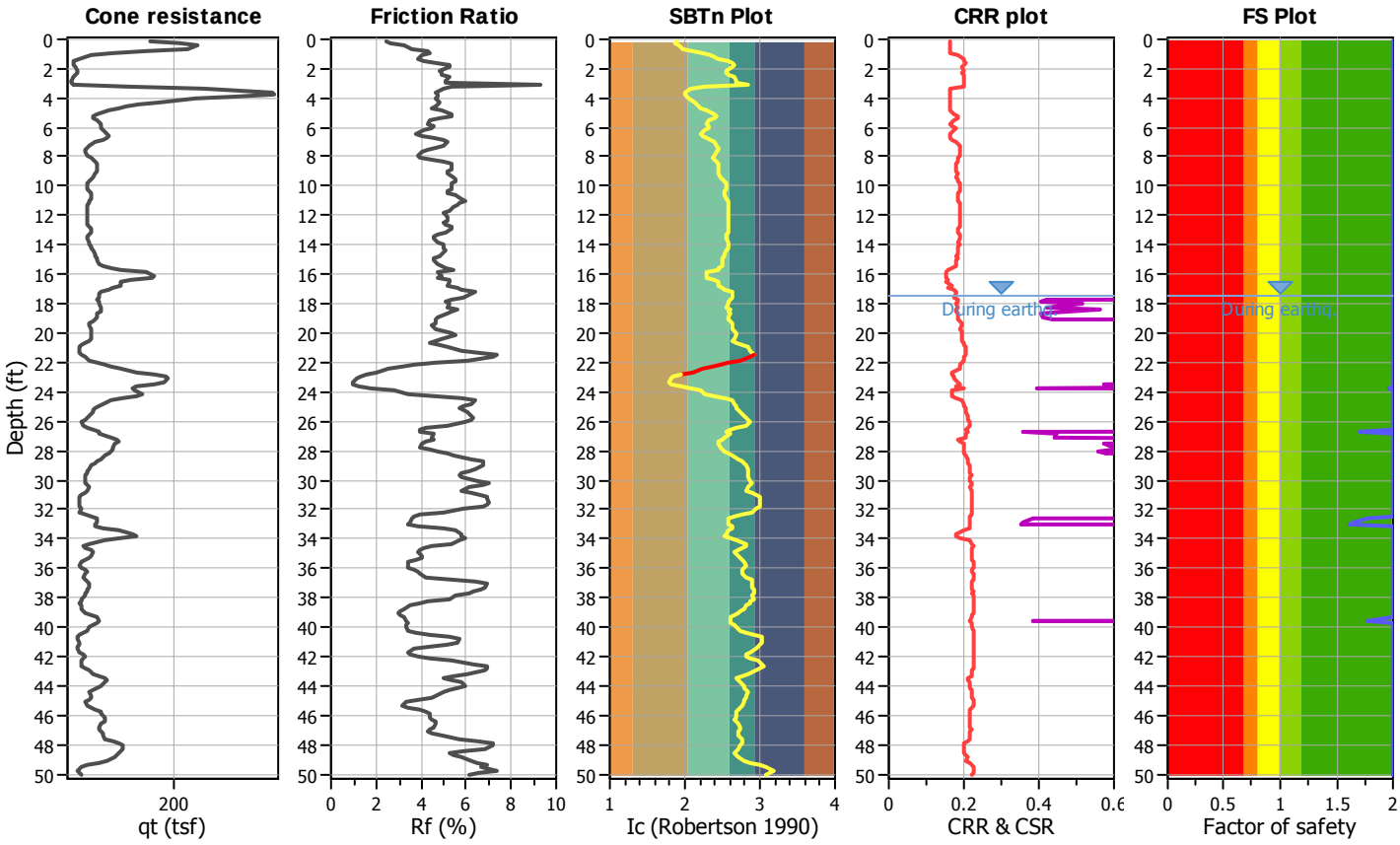
LIQUEFACTION ANALYSIS REPORT

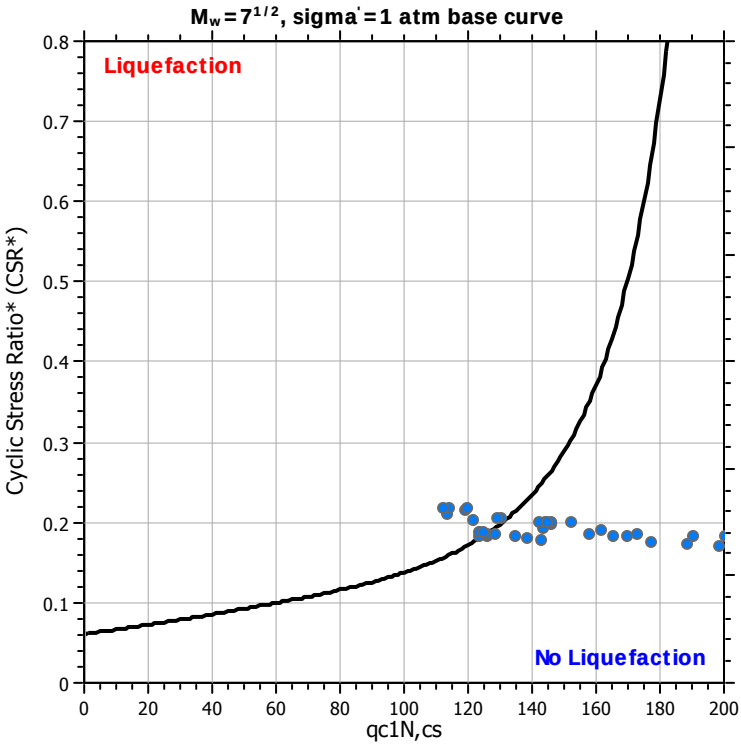
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

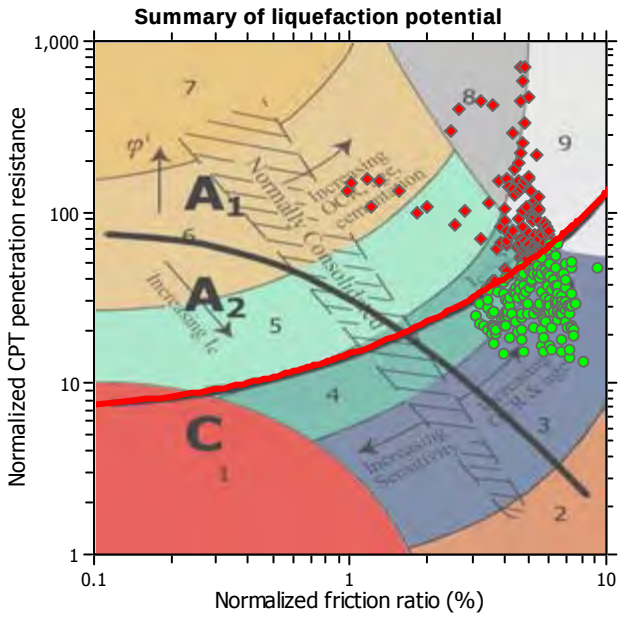
CPT file : 1-CPT-17

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	18.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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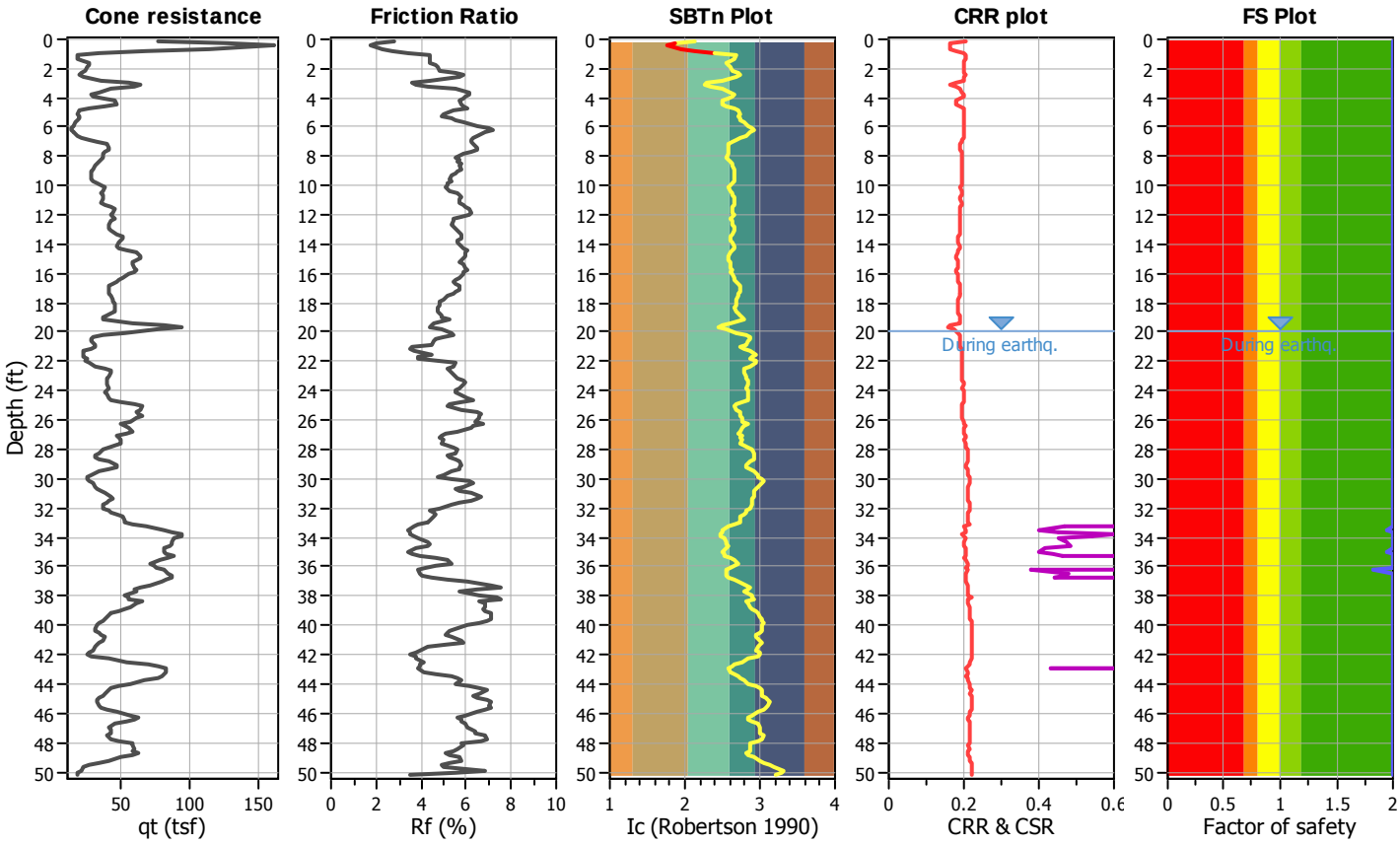
LIQUEFACTION ANALYSIS REPORT

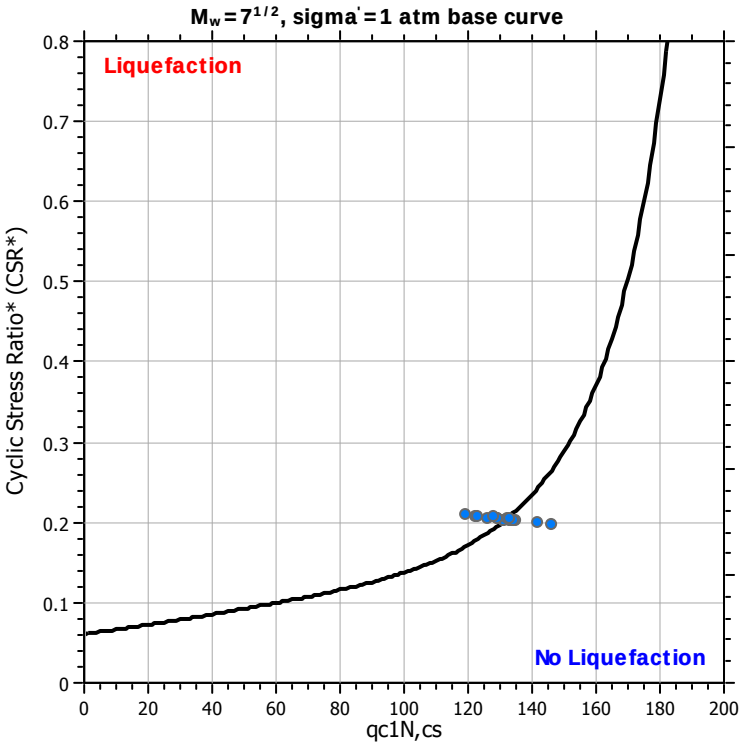
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

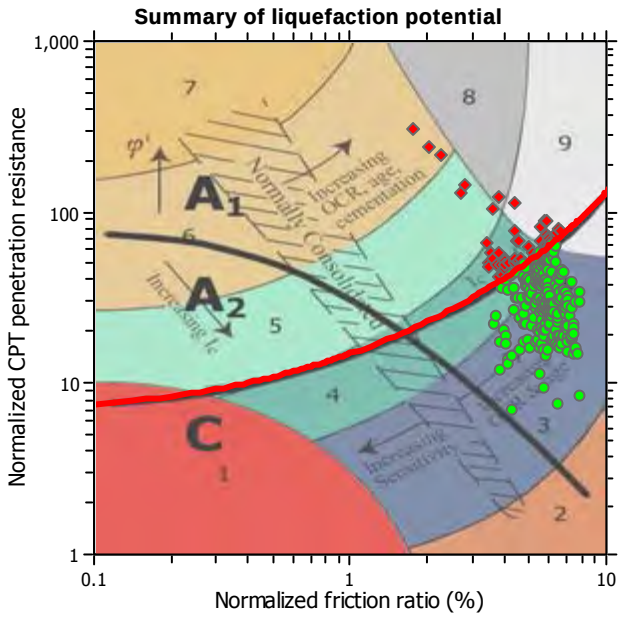
CPT file : 1-CPT-18

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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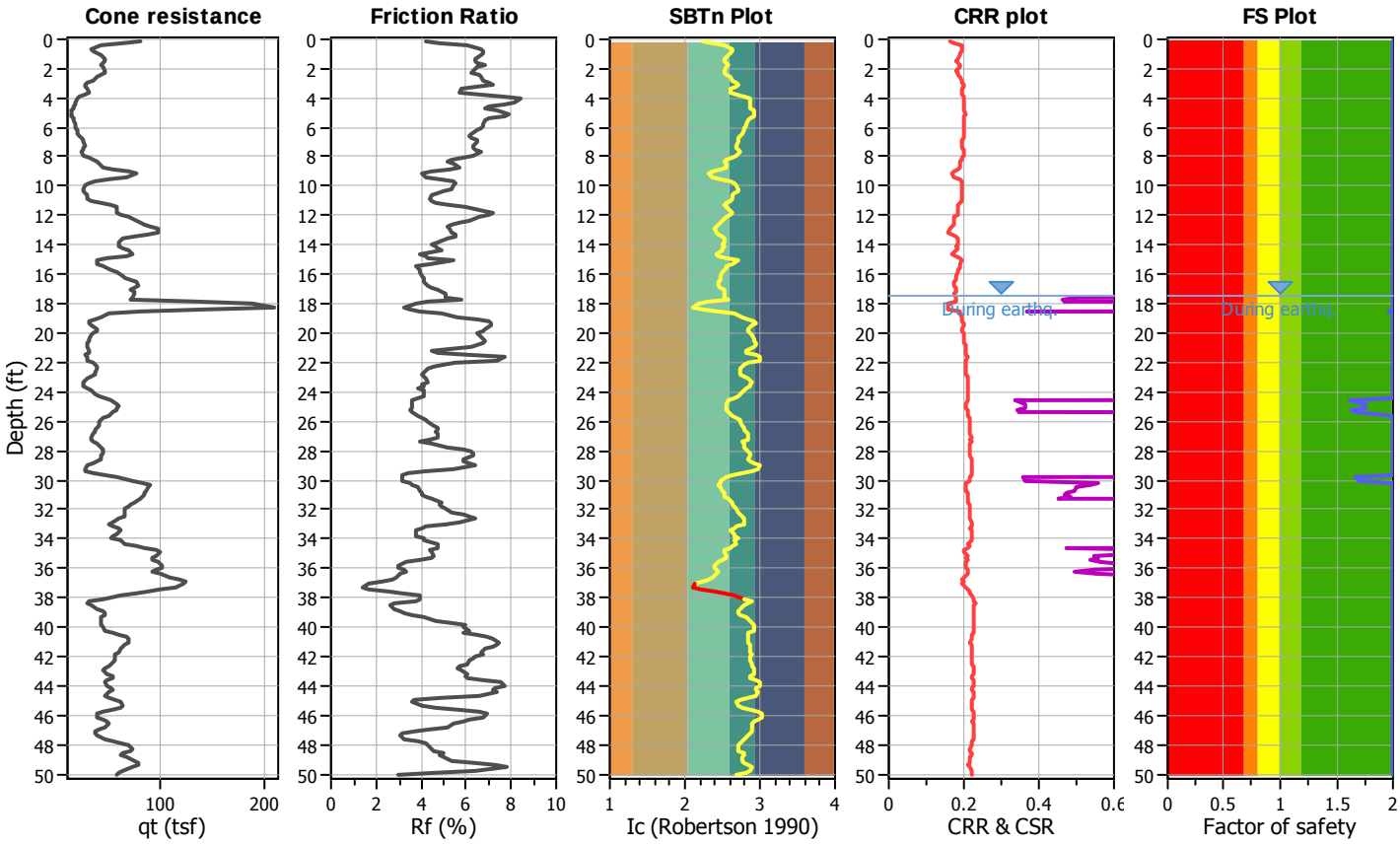
LIQUEFACTION ANALYSIS REPORT

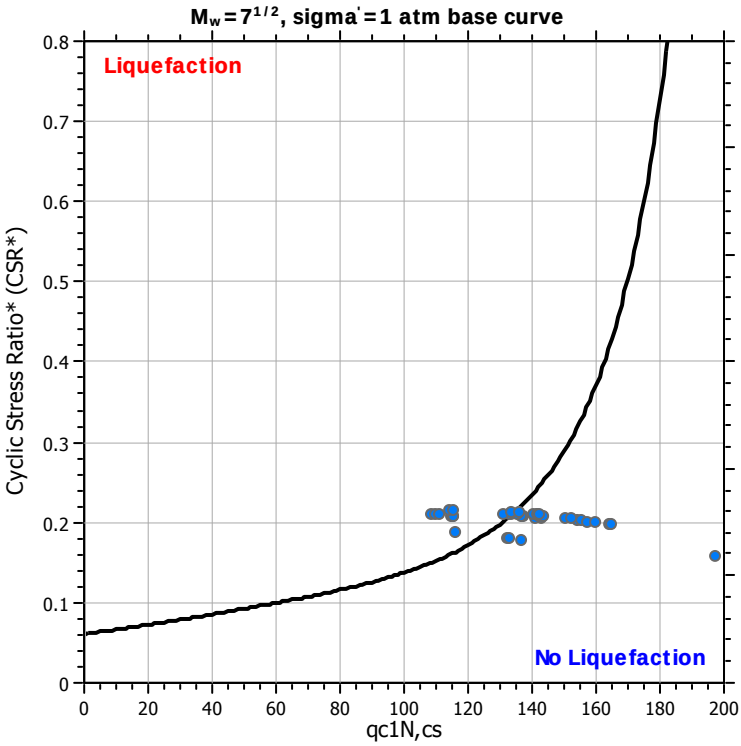
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

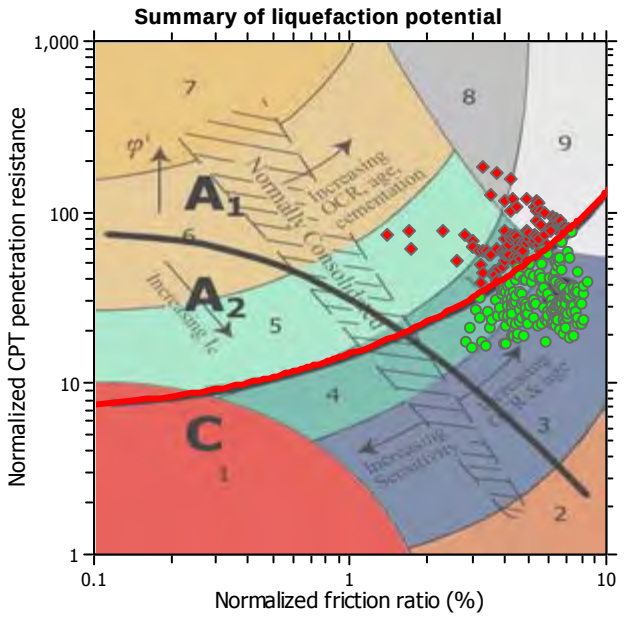
CPT file : 1-CPT-19

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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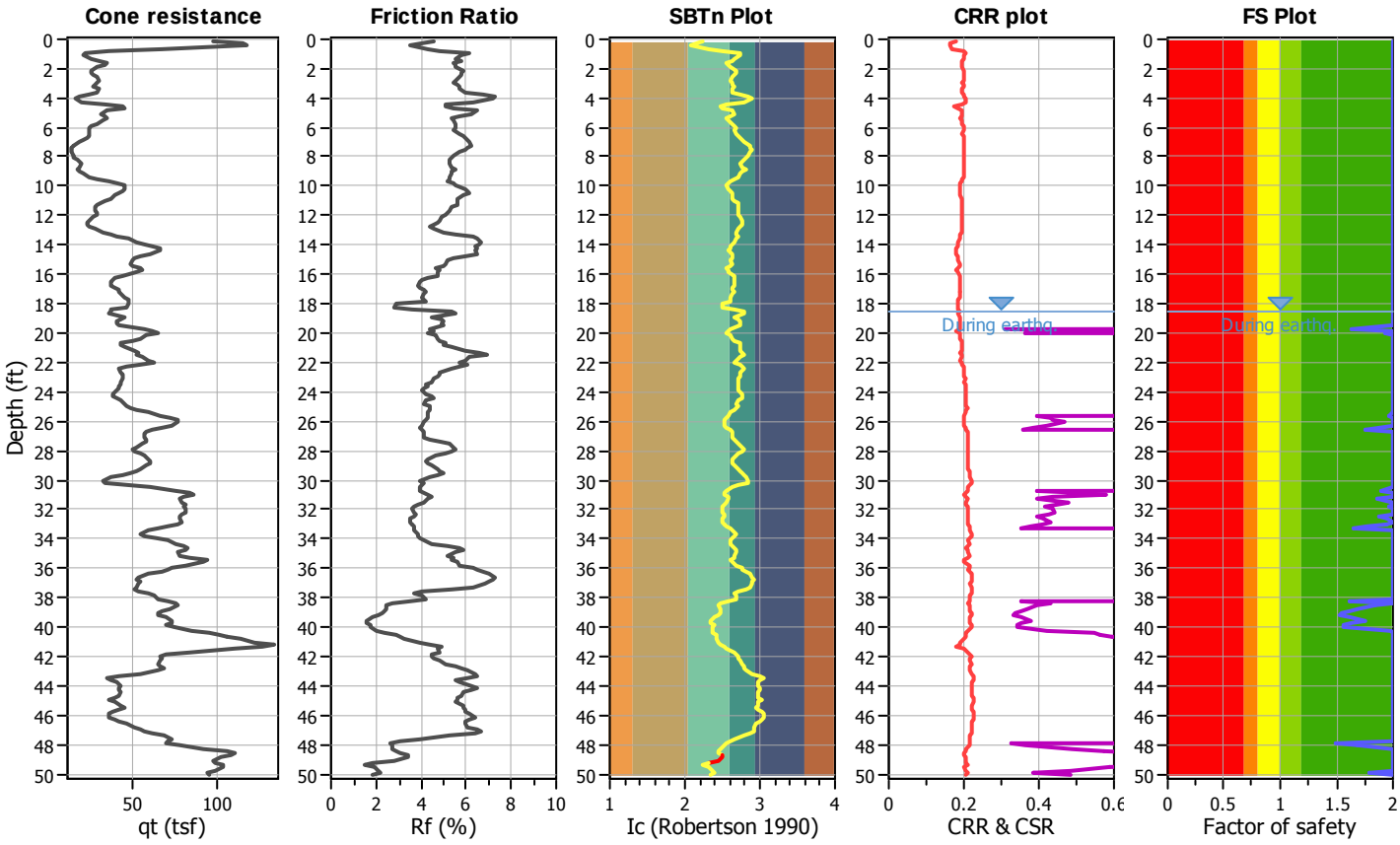
LIQUEFACTION ANALYSIS REPORT

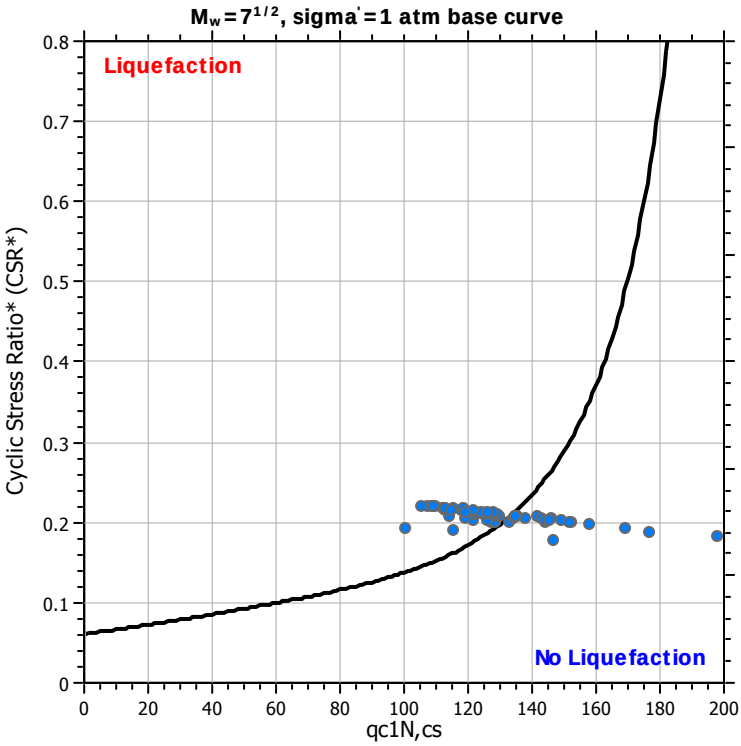
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

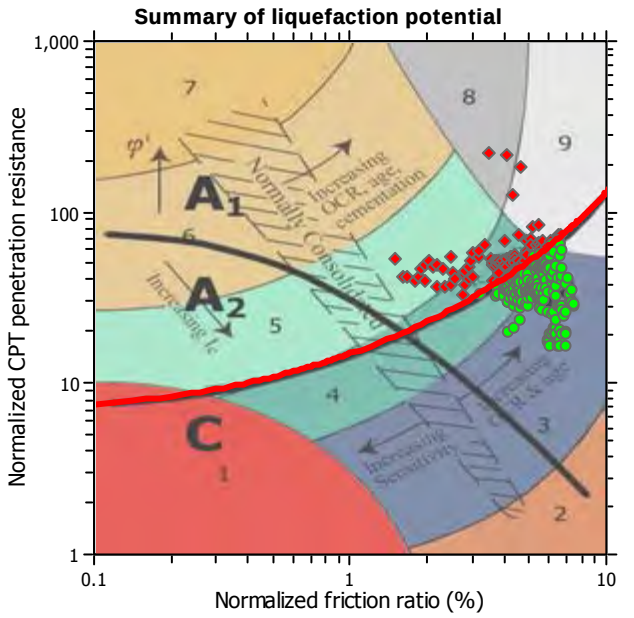
CPT file : 1-CPT-20

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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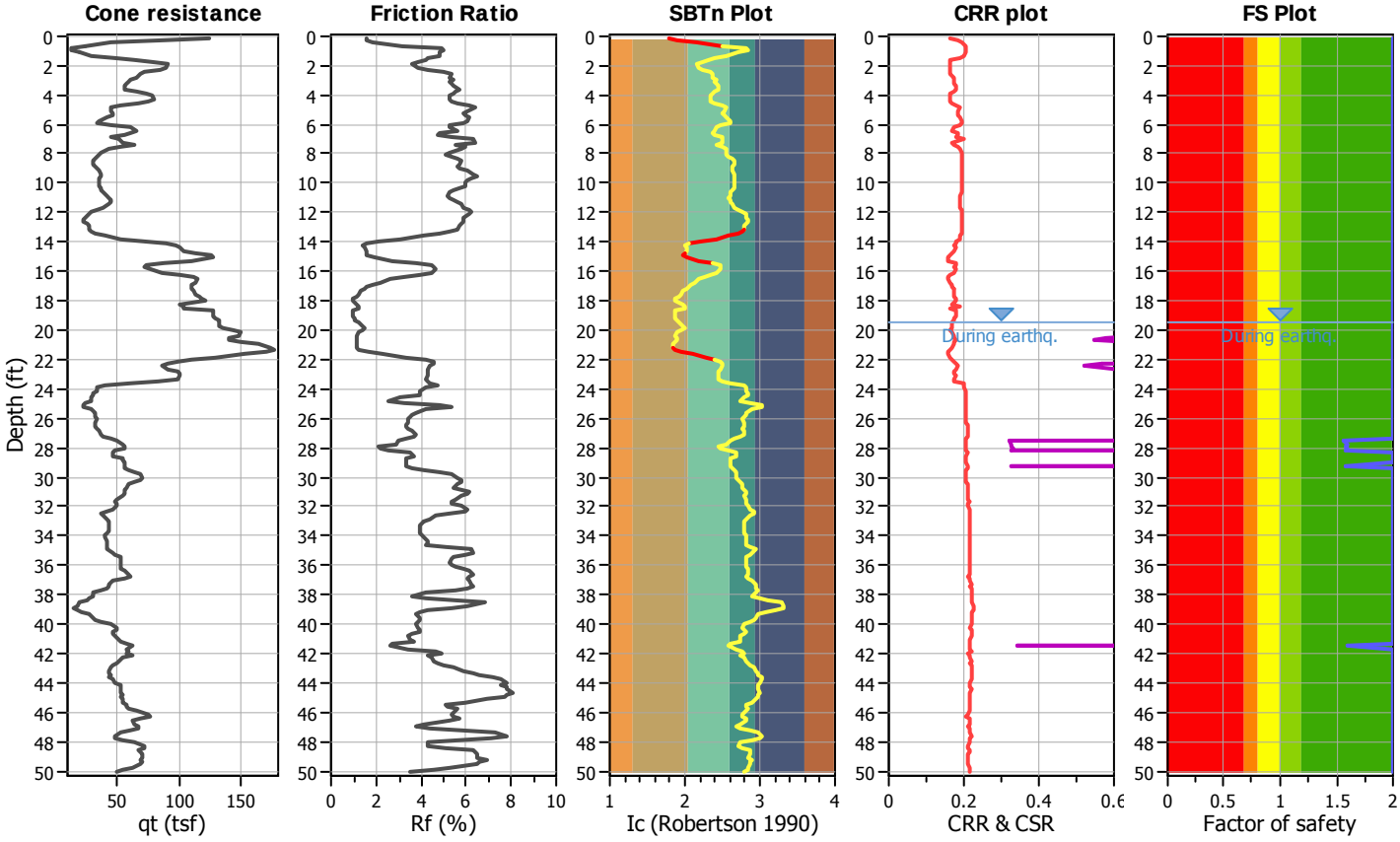
LIQUEFACTION ANALYSIS REPORT

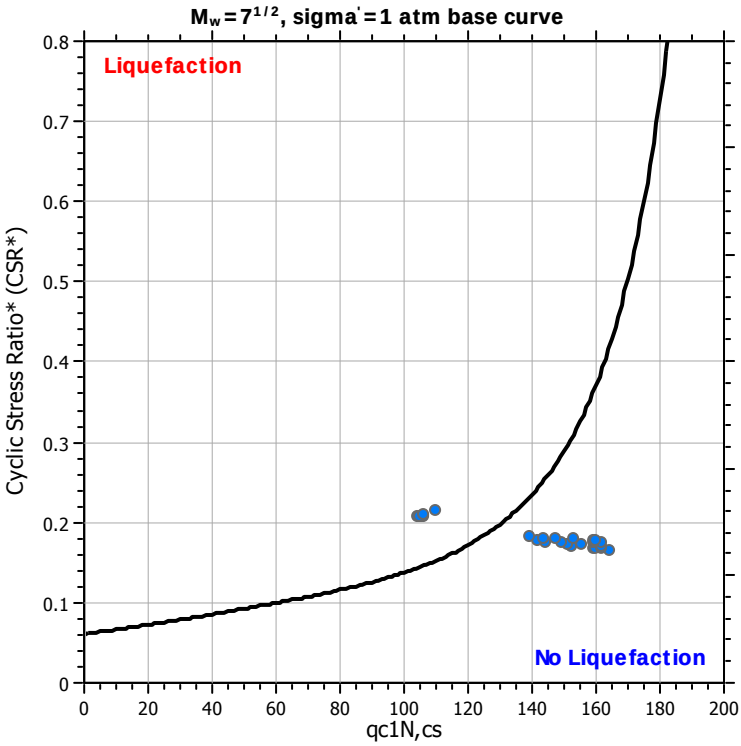
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

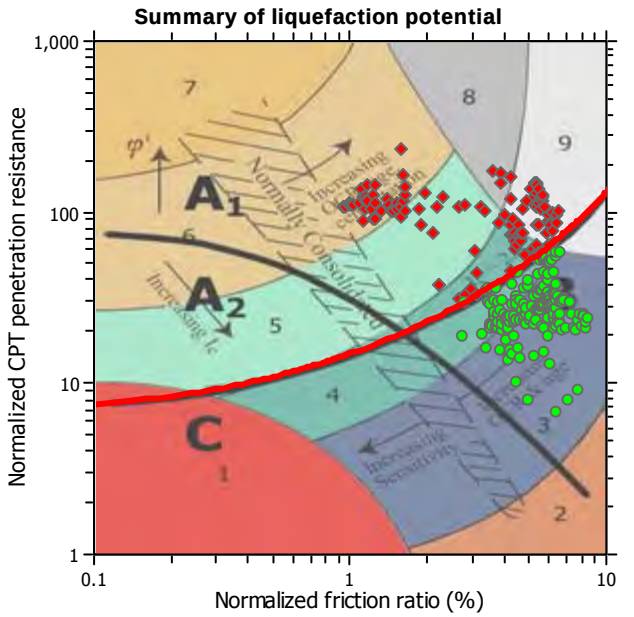
CPT file : 1-CPT-21

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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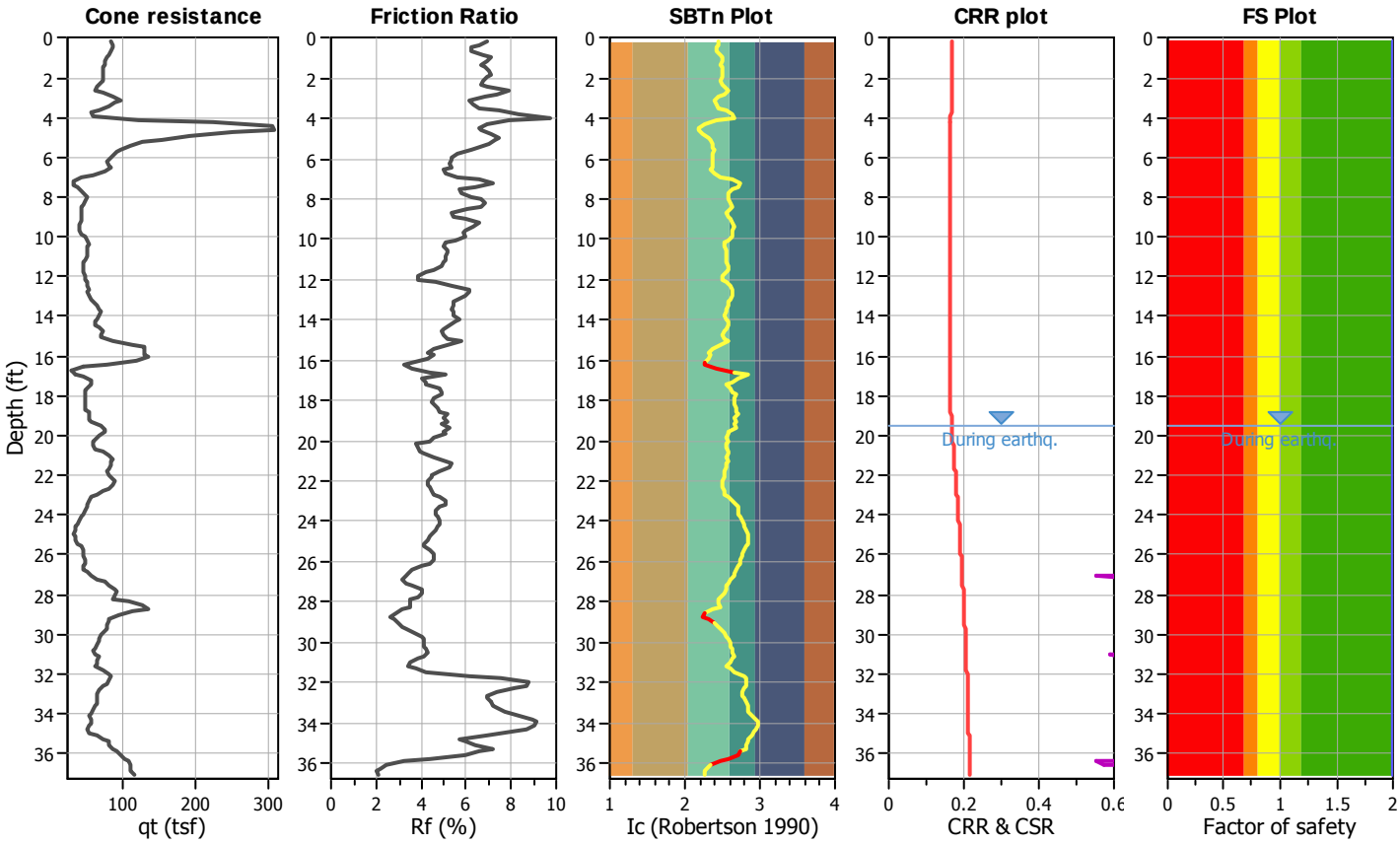
LIQUEFACTION ANALYSIS REPORT

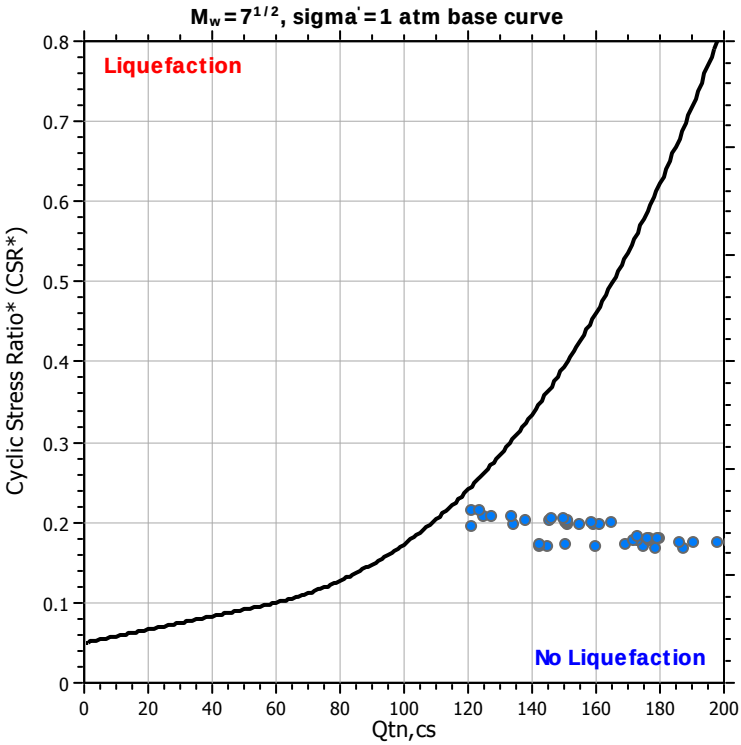
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

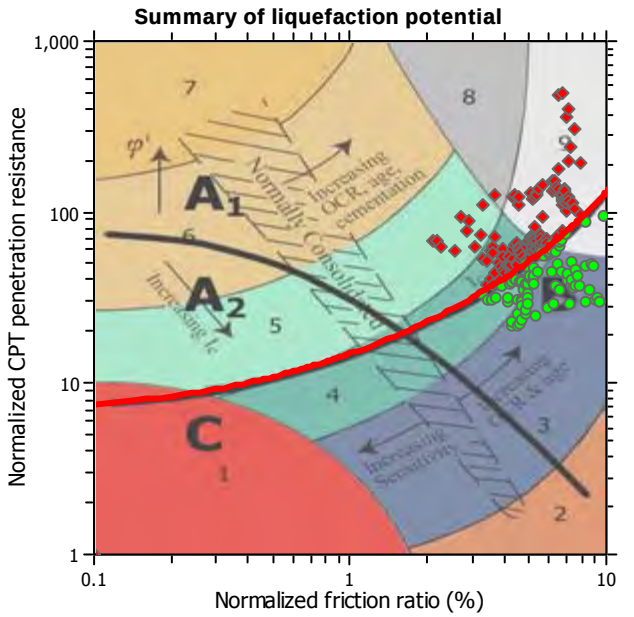
CPT file : 1-CPT-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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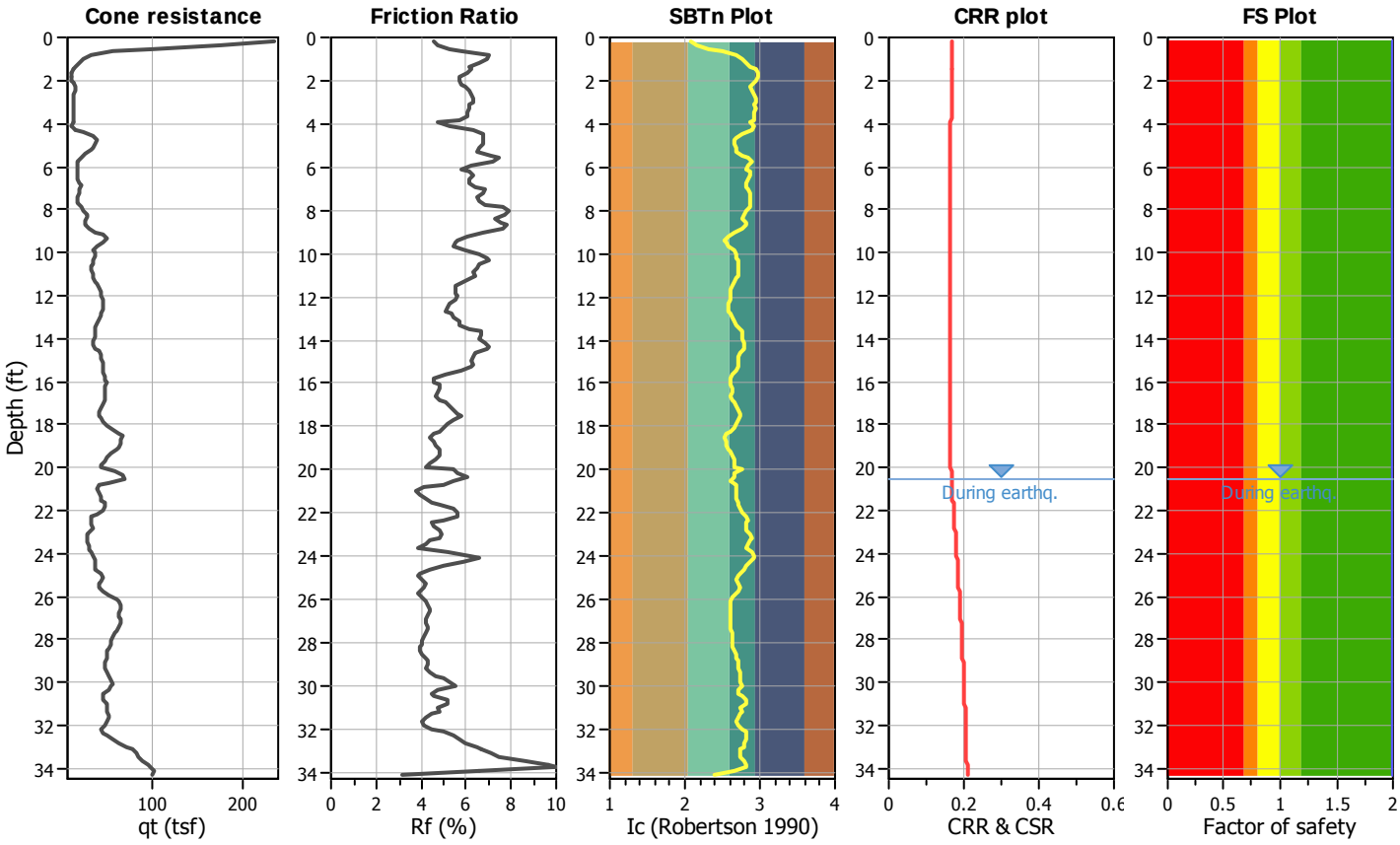
LIQUEFACTION ANALYSIS REPORT

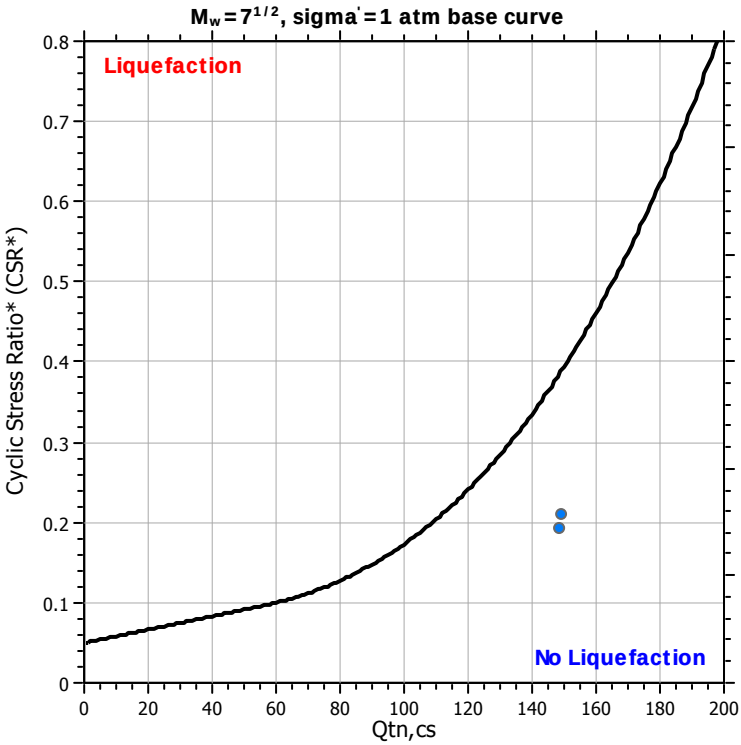
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

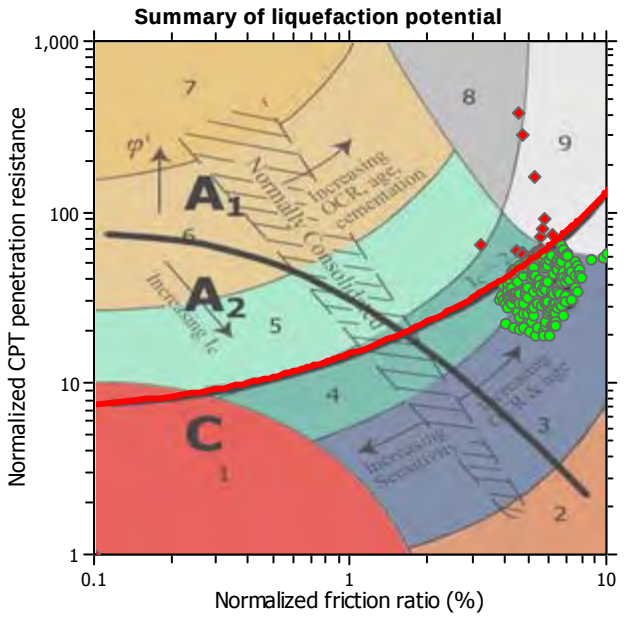
CPT file : 1-CPT-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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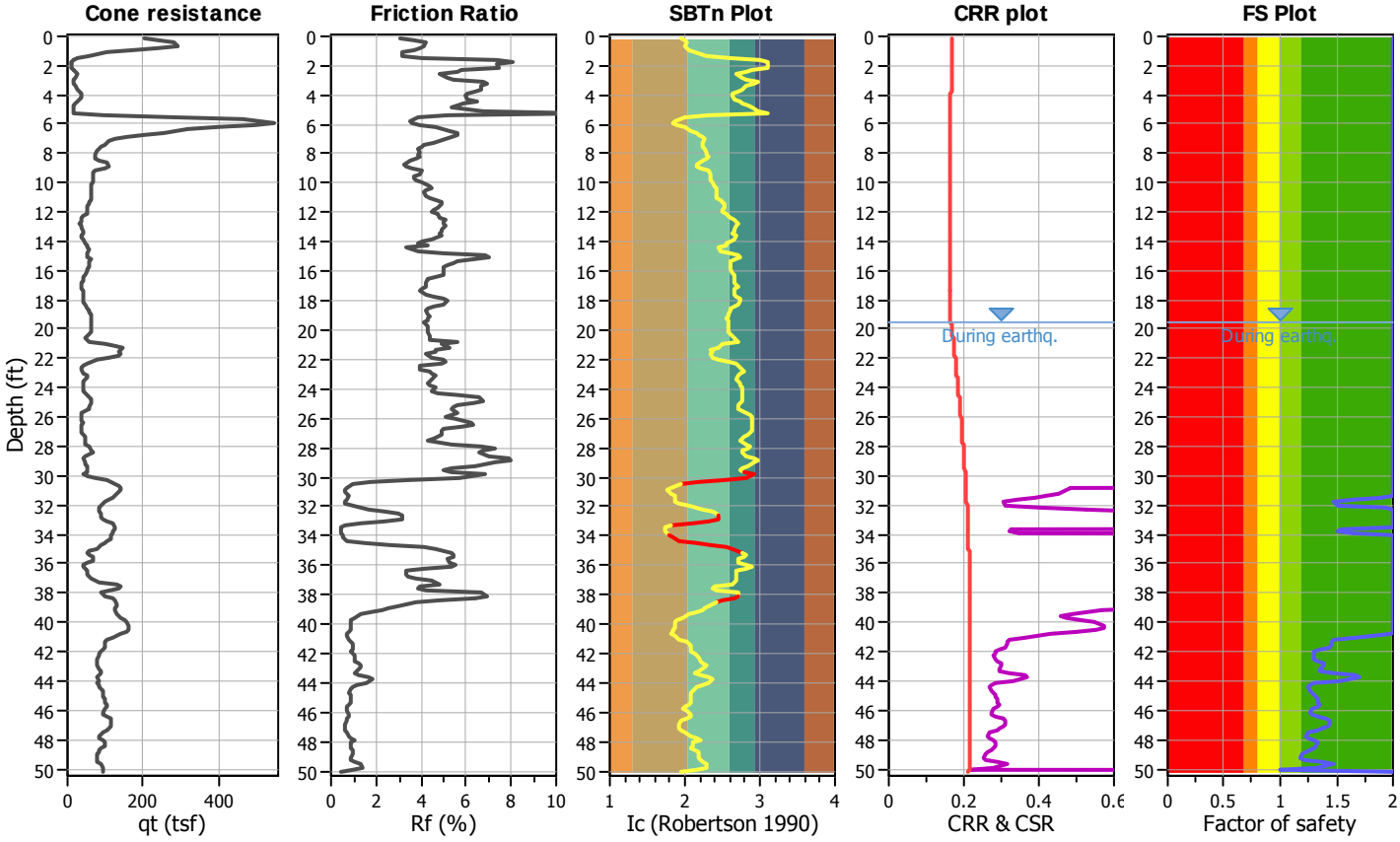
LIQUEFACTION ANALYSIS REPORT

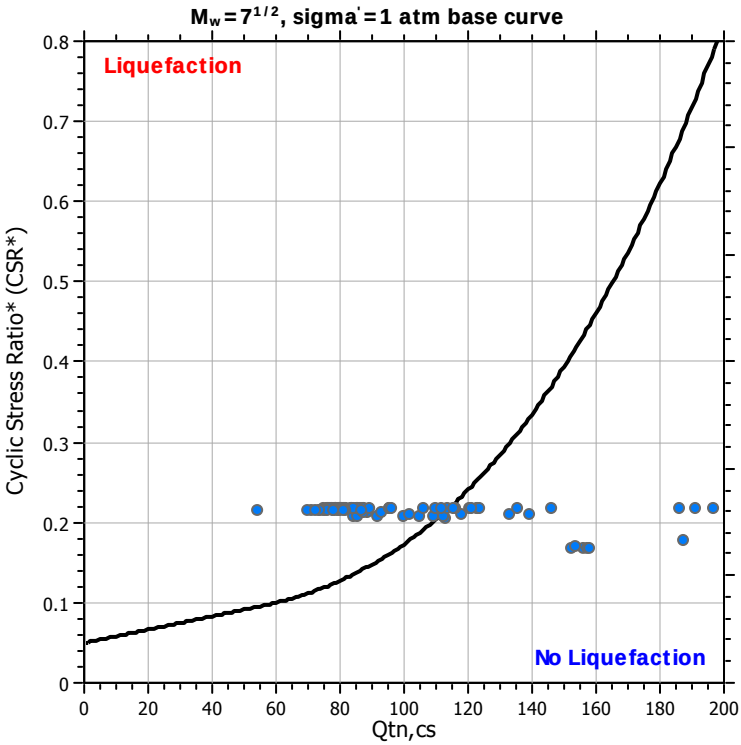
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

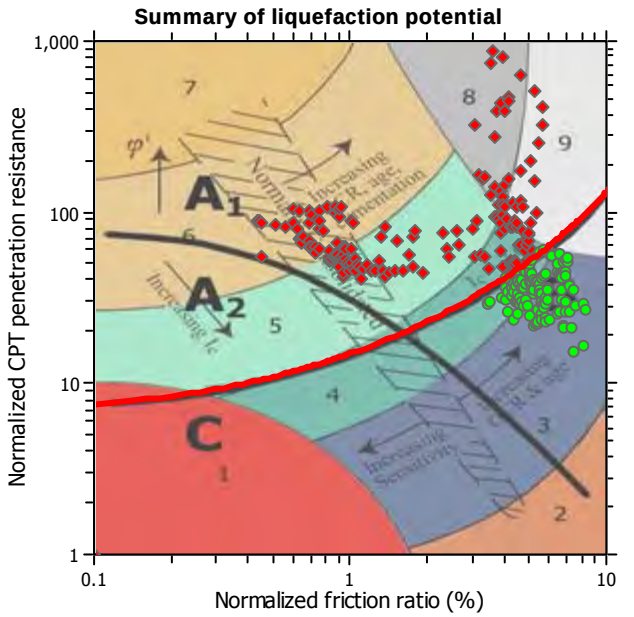
CPT file : 1-CPT-3

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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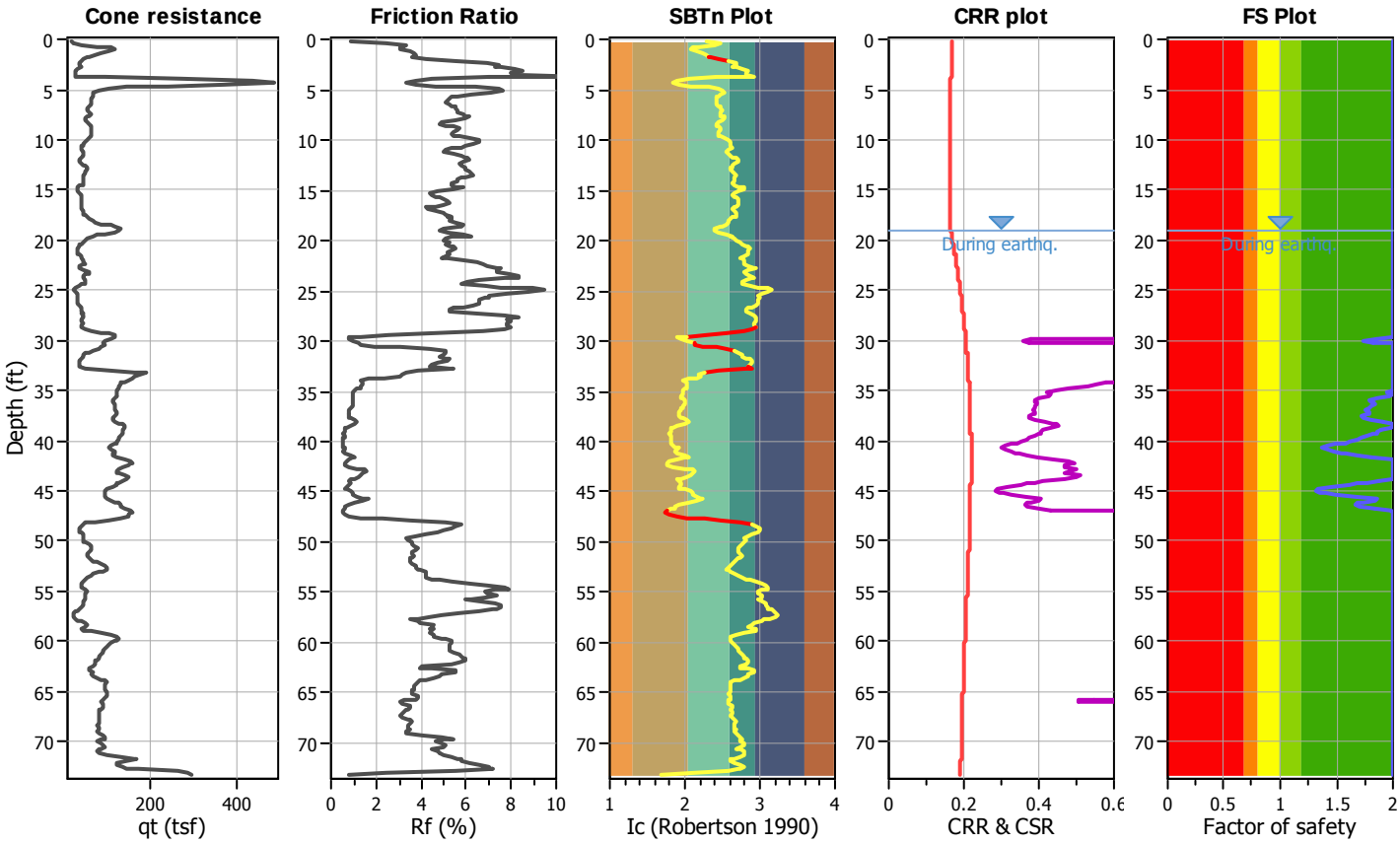
LIQUEFACTION ANALYSIS REPORT

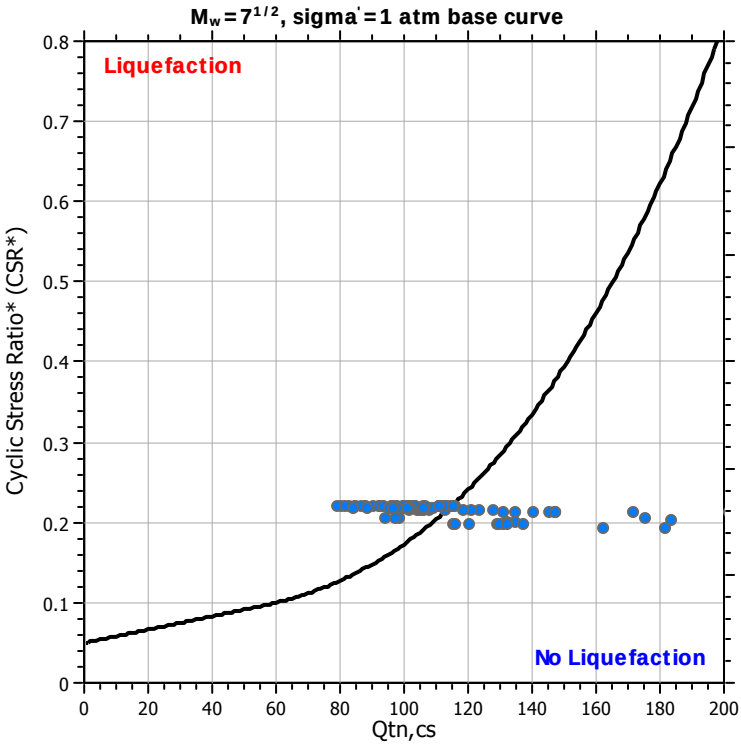
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

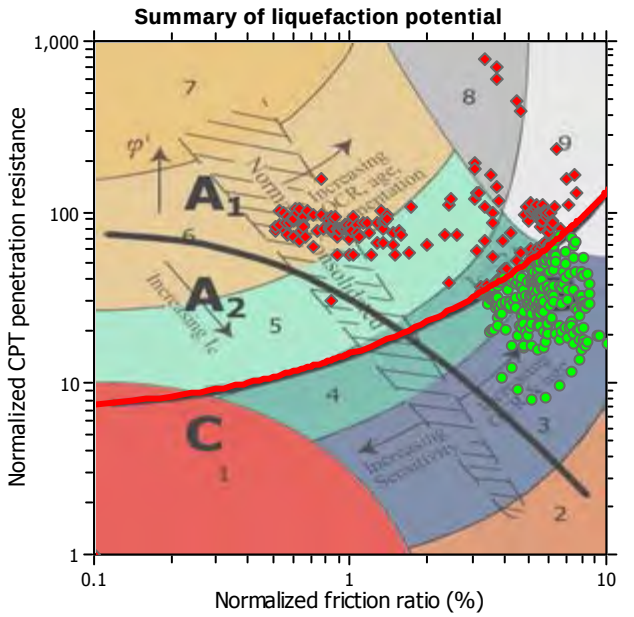
CPT file : 1-CPT-4

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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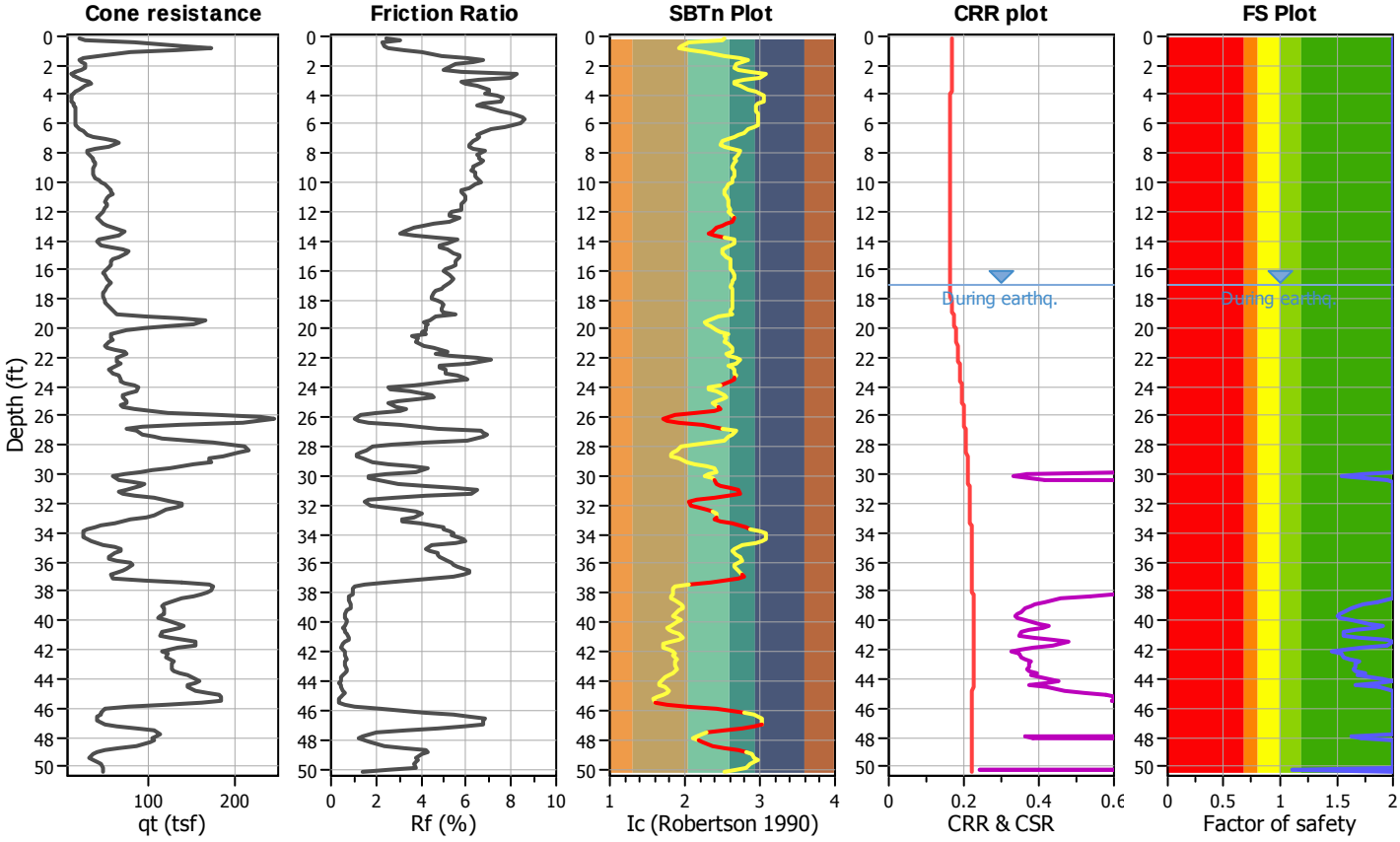
LIQUEFACTION ANALYSIS REPORT

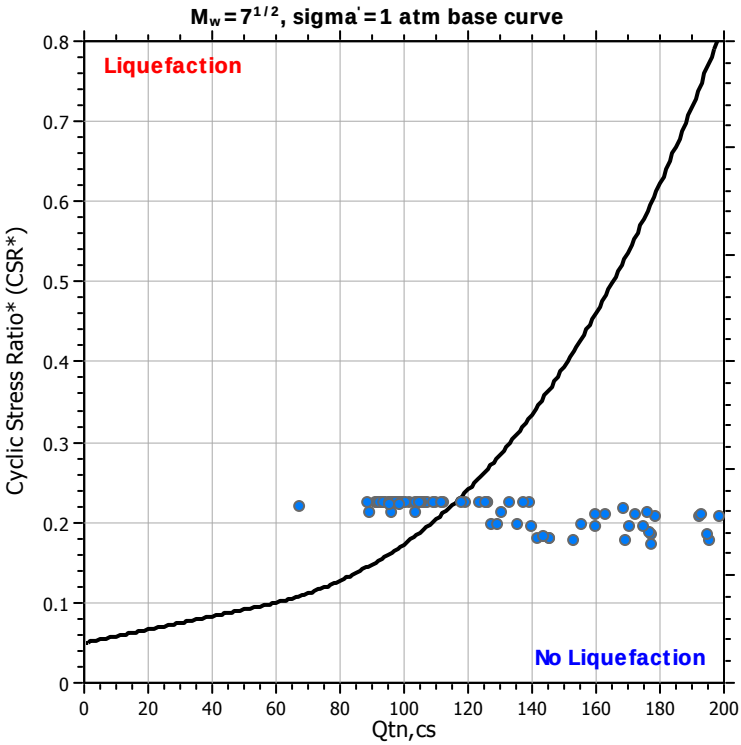
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

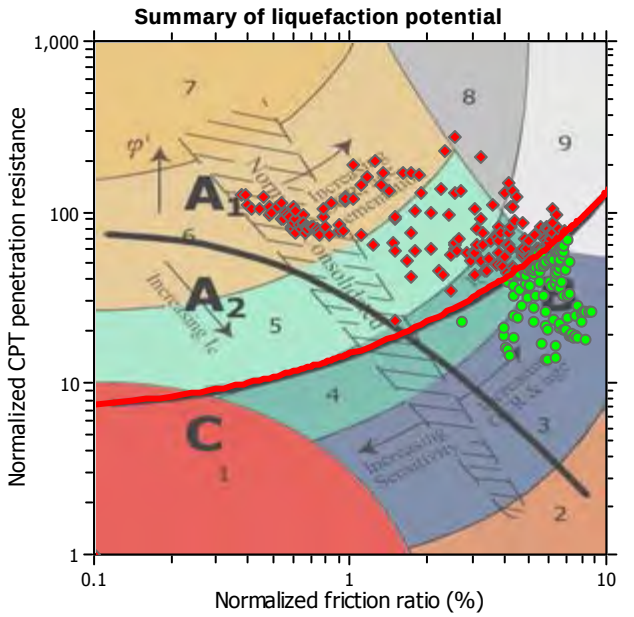
CPT file : 1-CPT-5

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	17.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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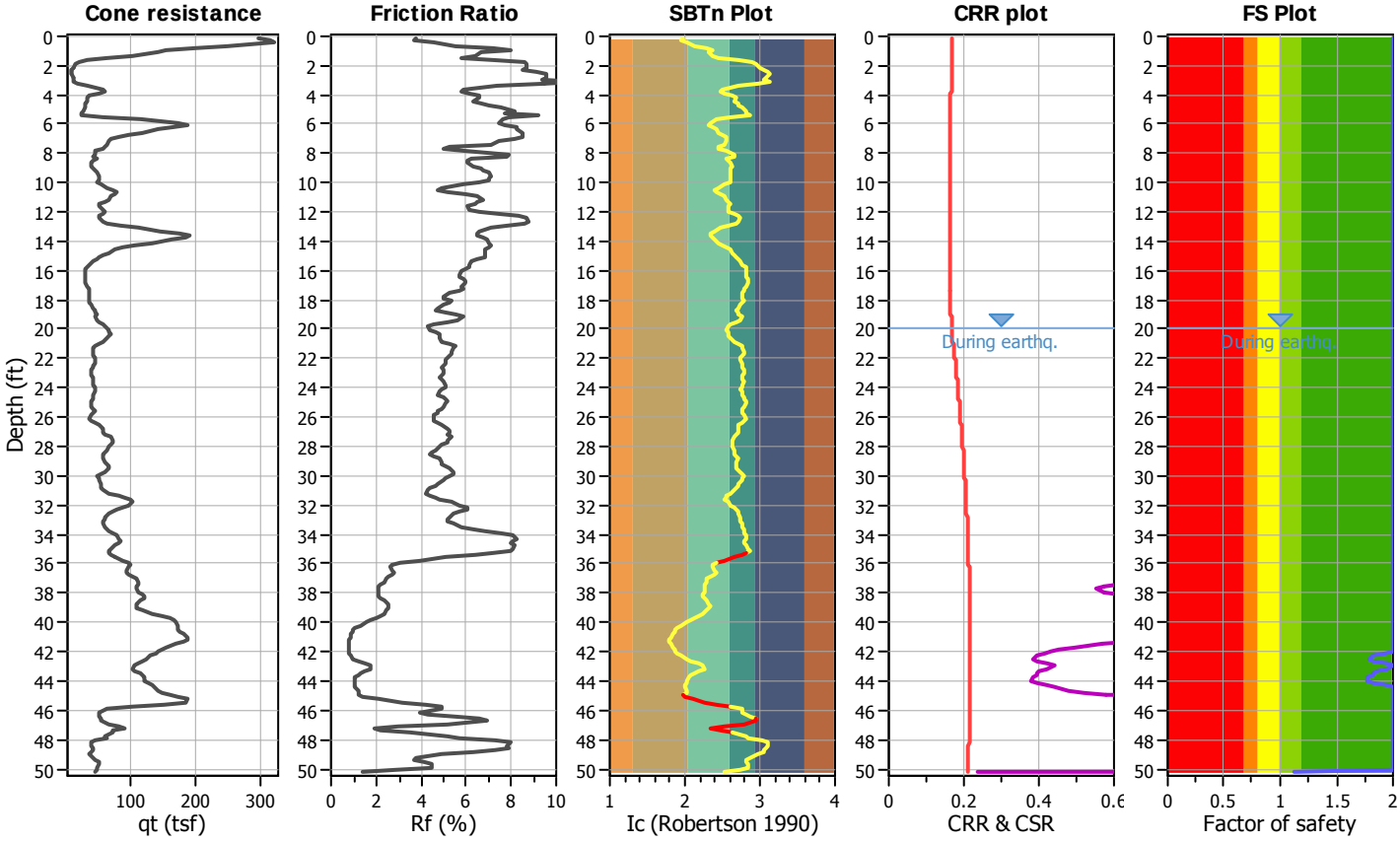
LIQUEFACTION ANALYSIS REPORT

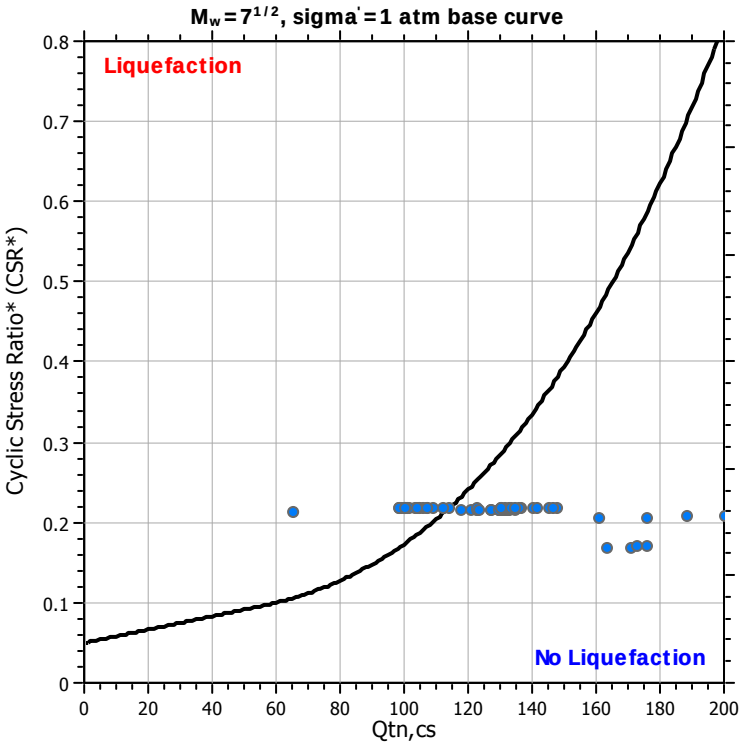
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

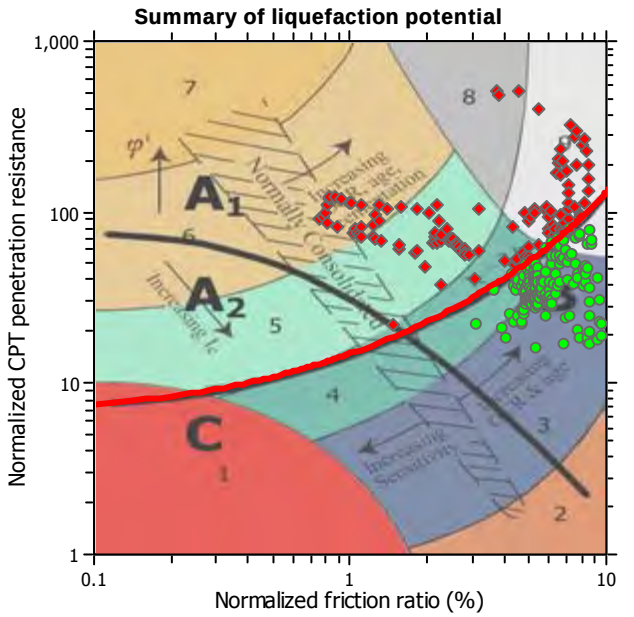
CPT file : 1-CPT-6

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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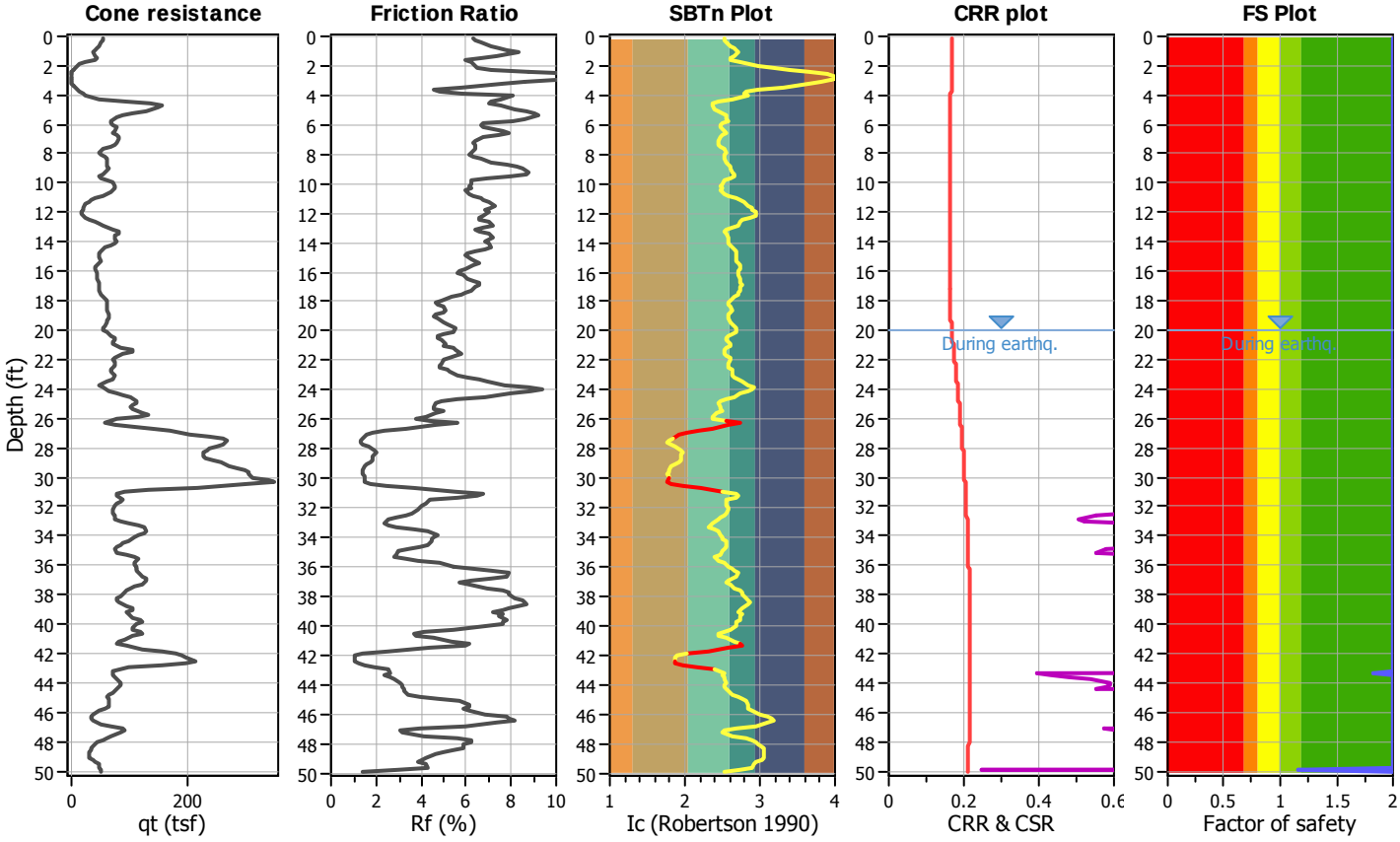
LIQUEFACTION ANALYSIS REPORT

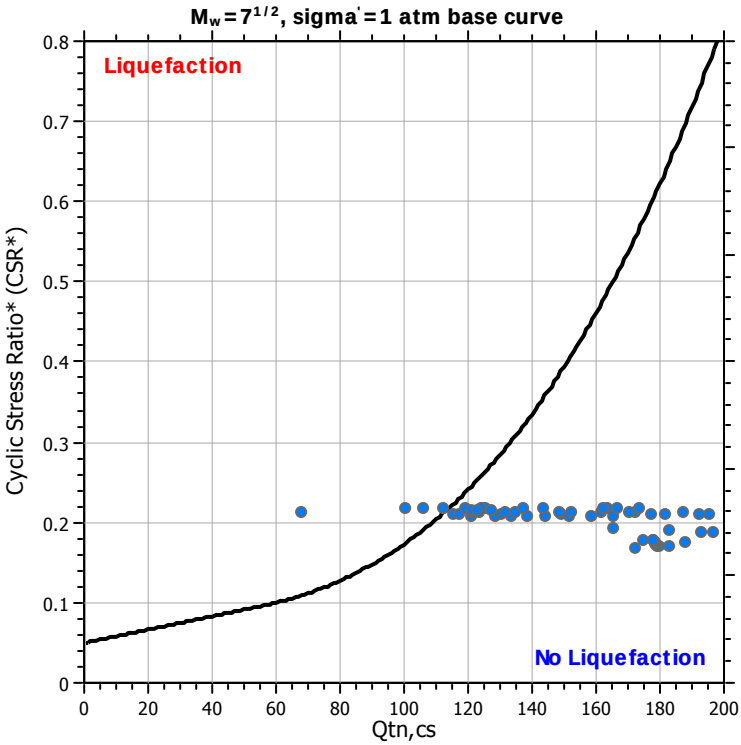
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

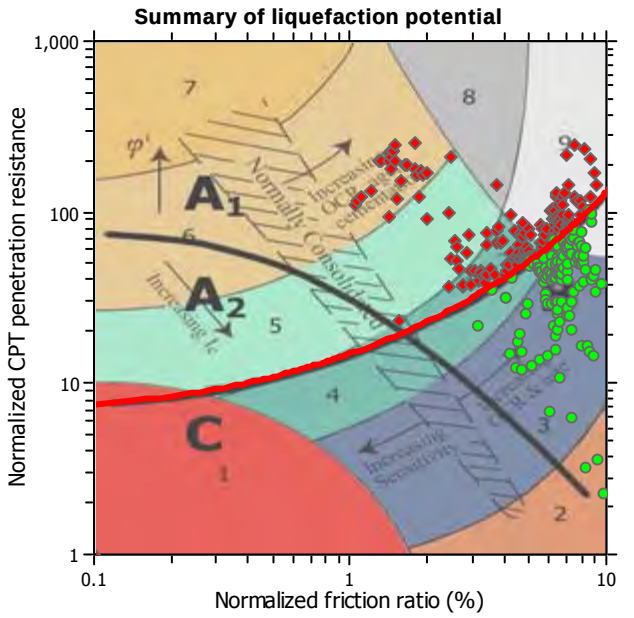
CPT file : 1-CPT-7

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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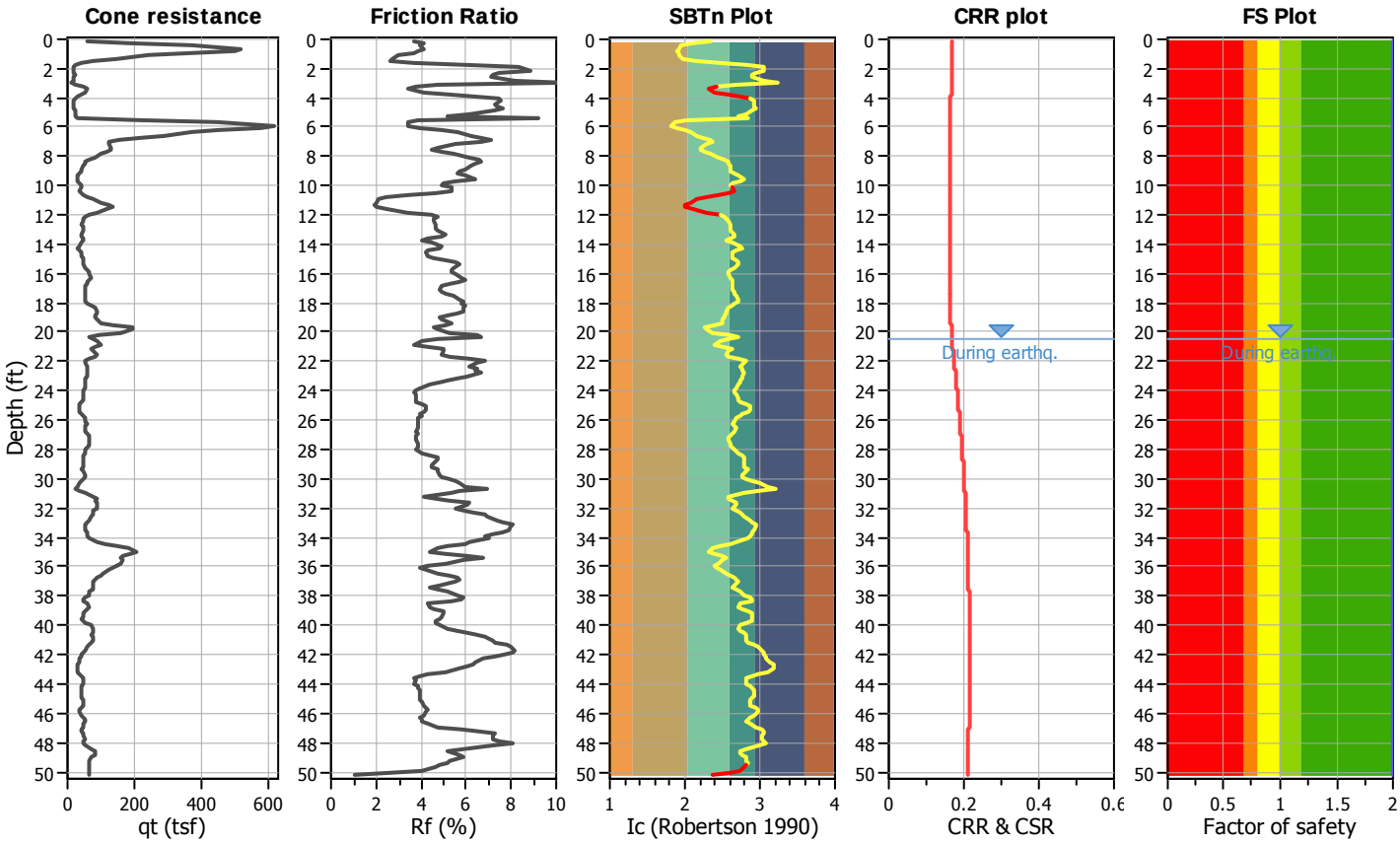
LIQUEFACTION ANALYSIS REPORT

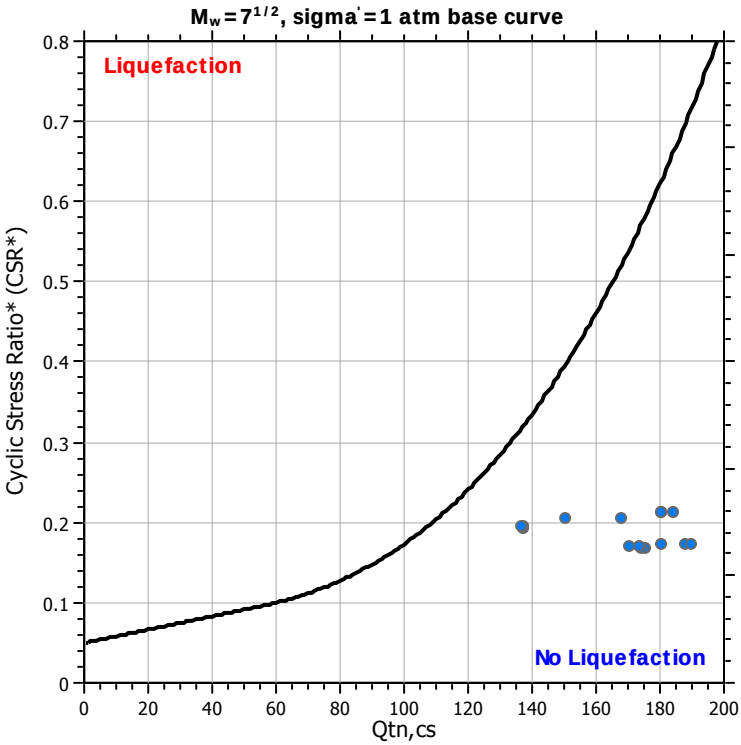
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

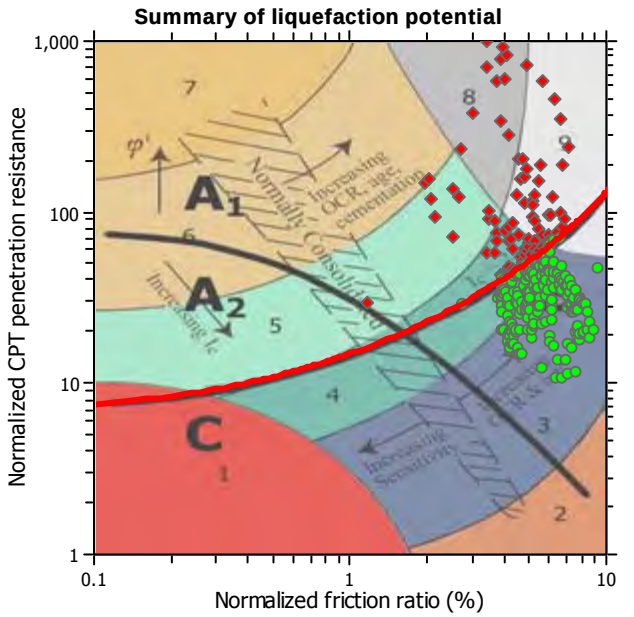
CPT file : 1-CPT-8

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	21.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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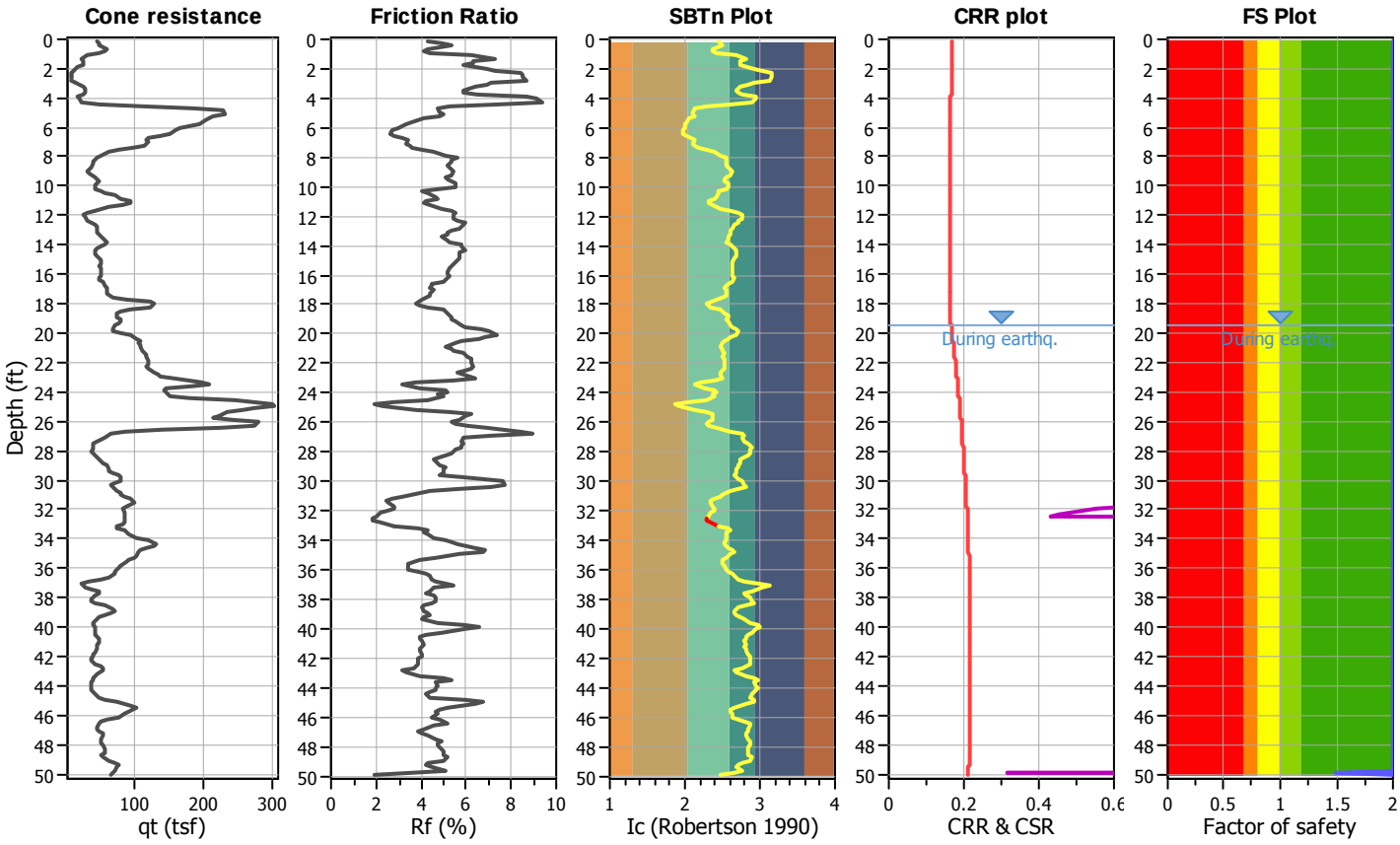
LIQUEFACTION ANALYSIS REPORT

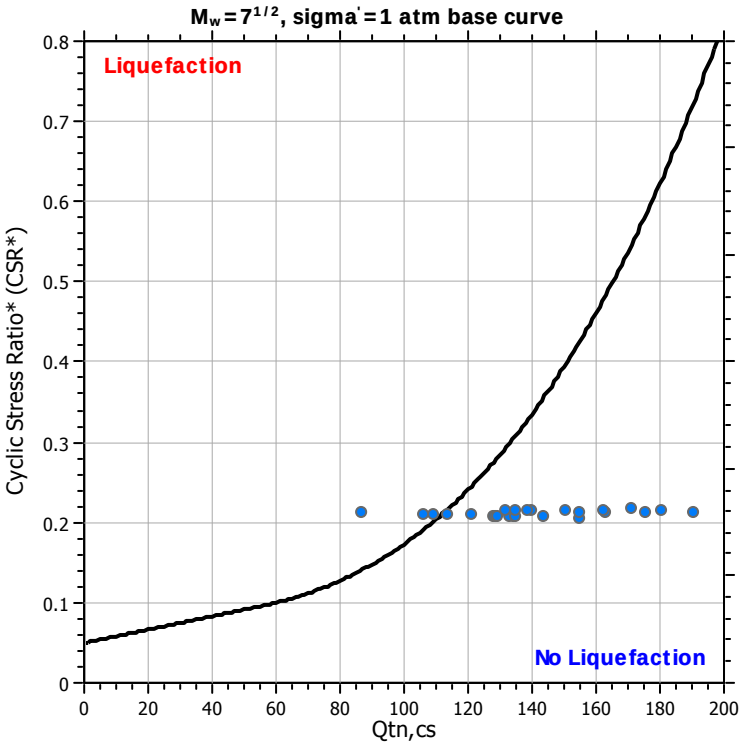
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

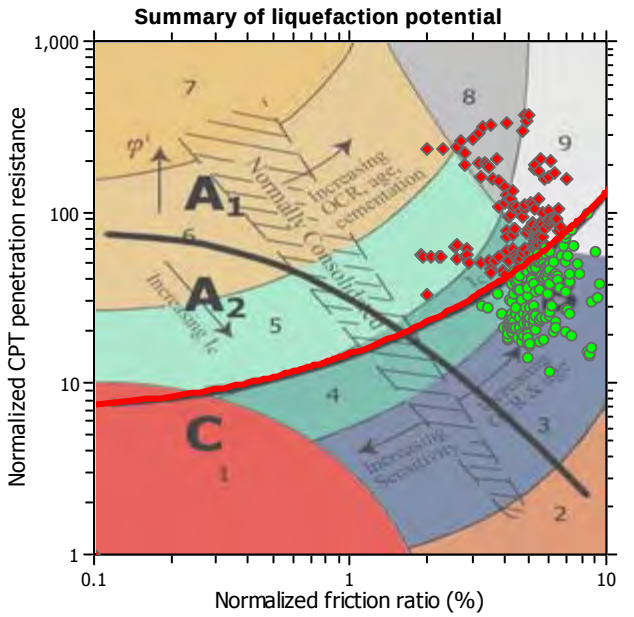
CPT file : 1-CPT-9

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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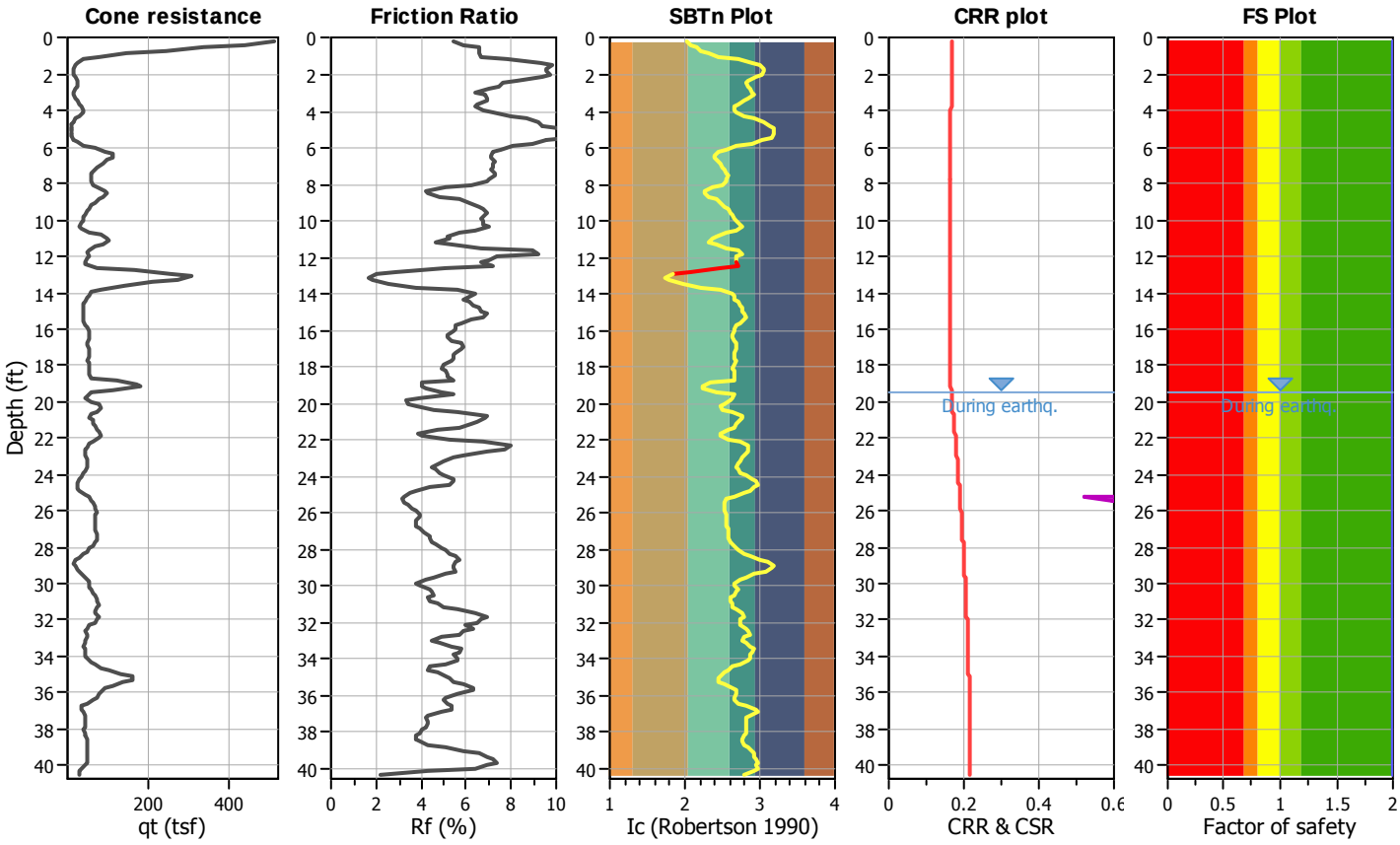
LIQUEFACTION ANALYSIS REPORT

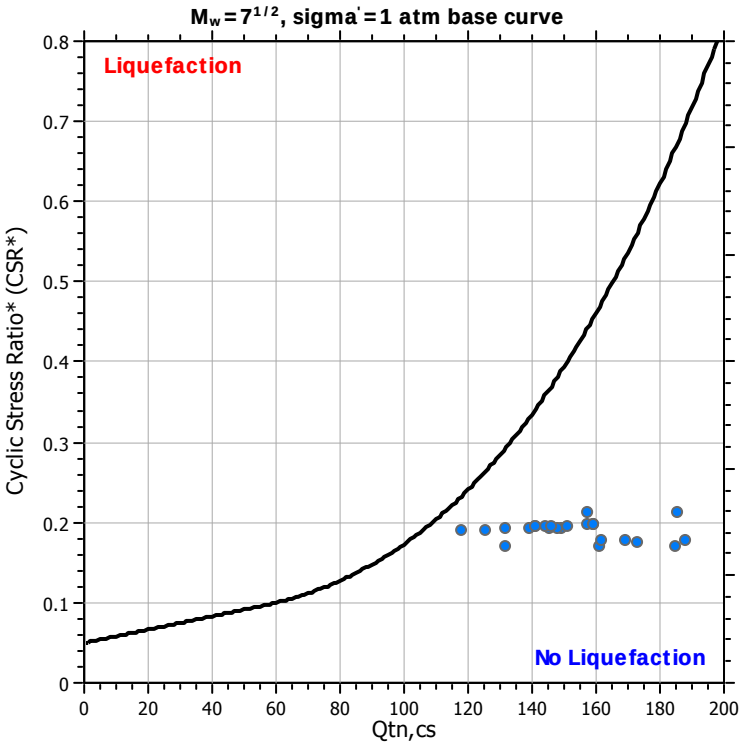
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

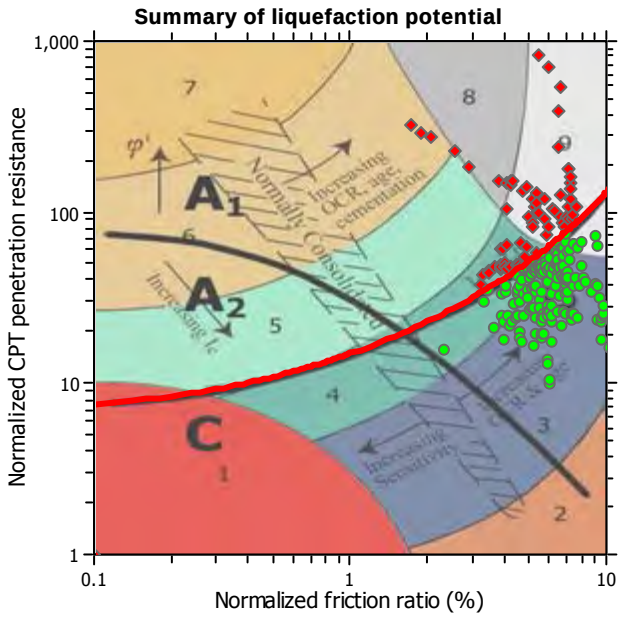
CPT file : 1-CPT-10

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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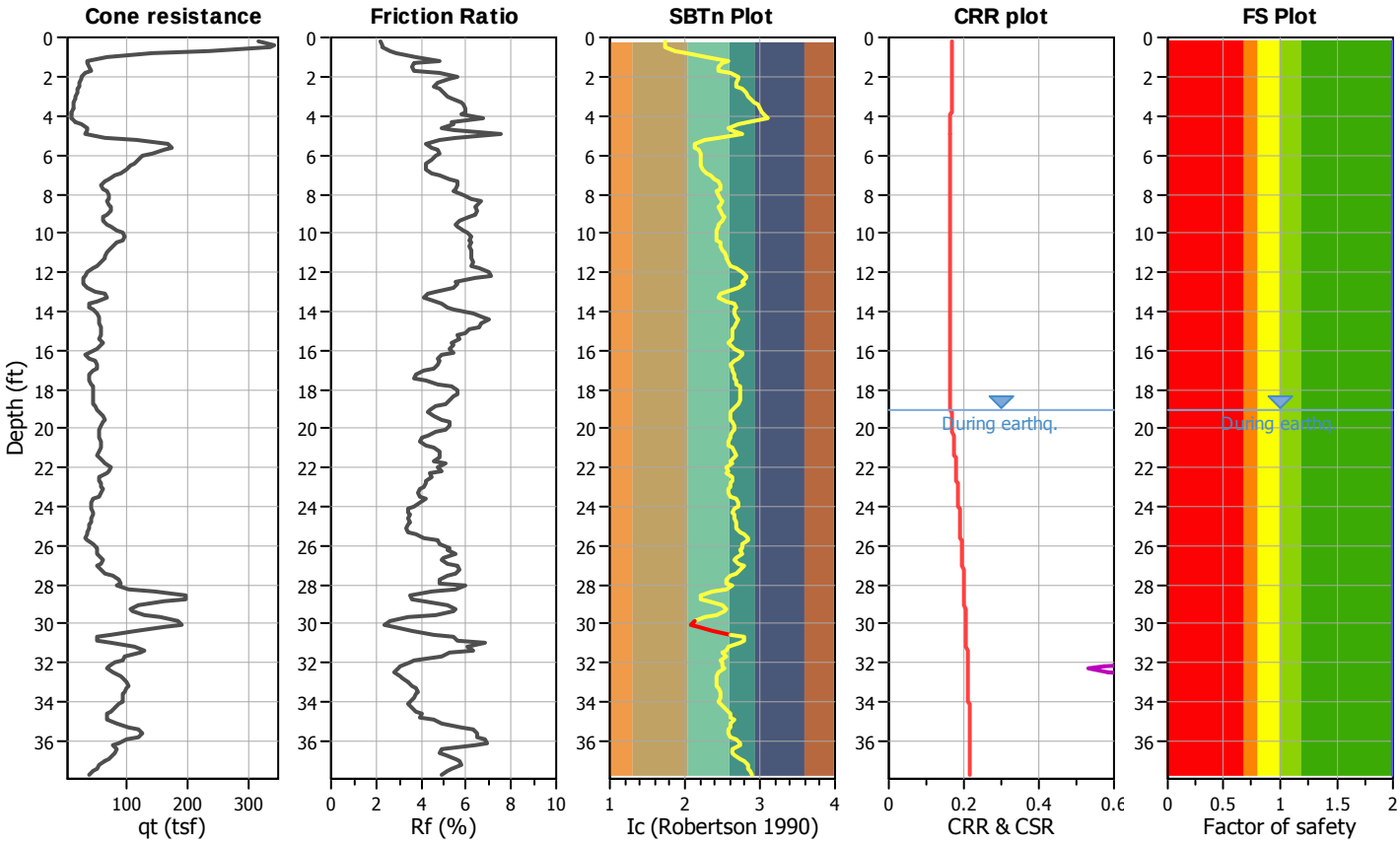
LIQUEFACTION ANALYSIS REPORT

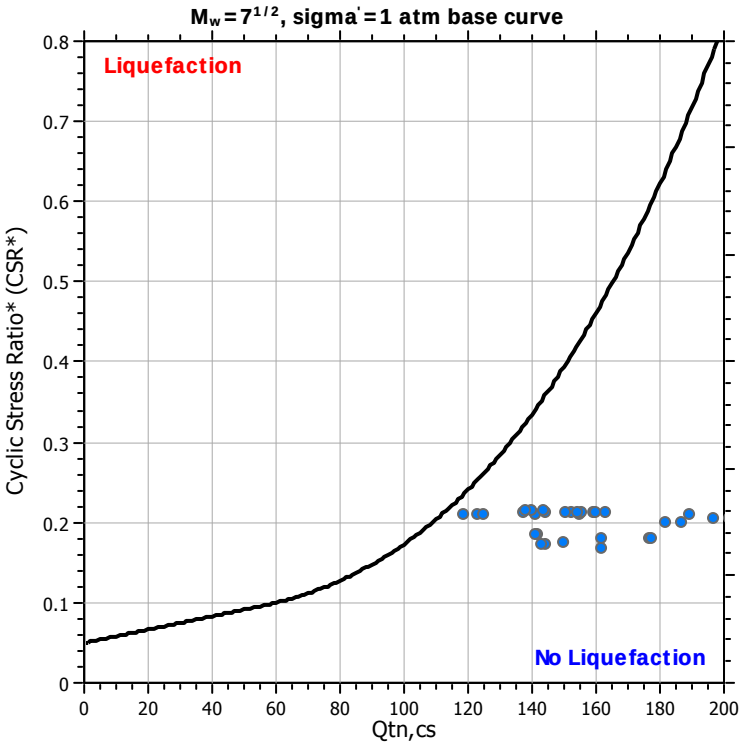
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

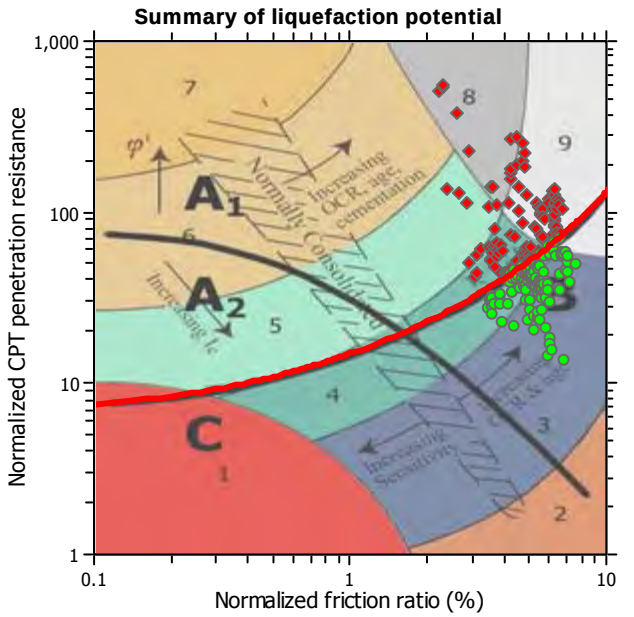
CPT file : 1-CPT-11

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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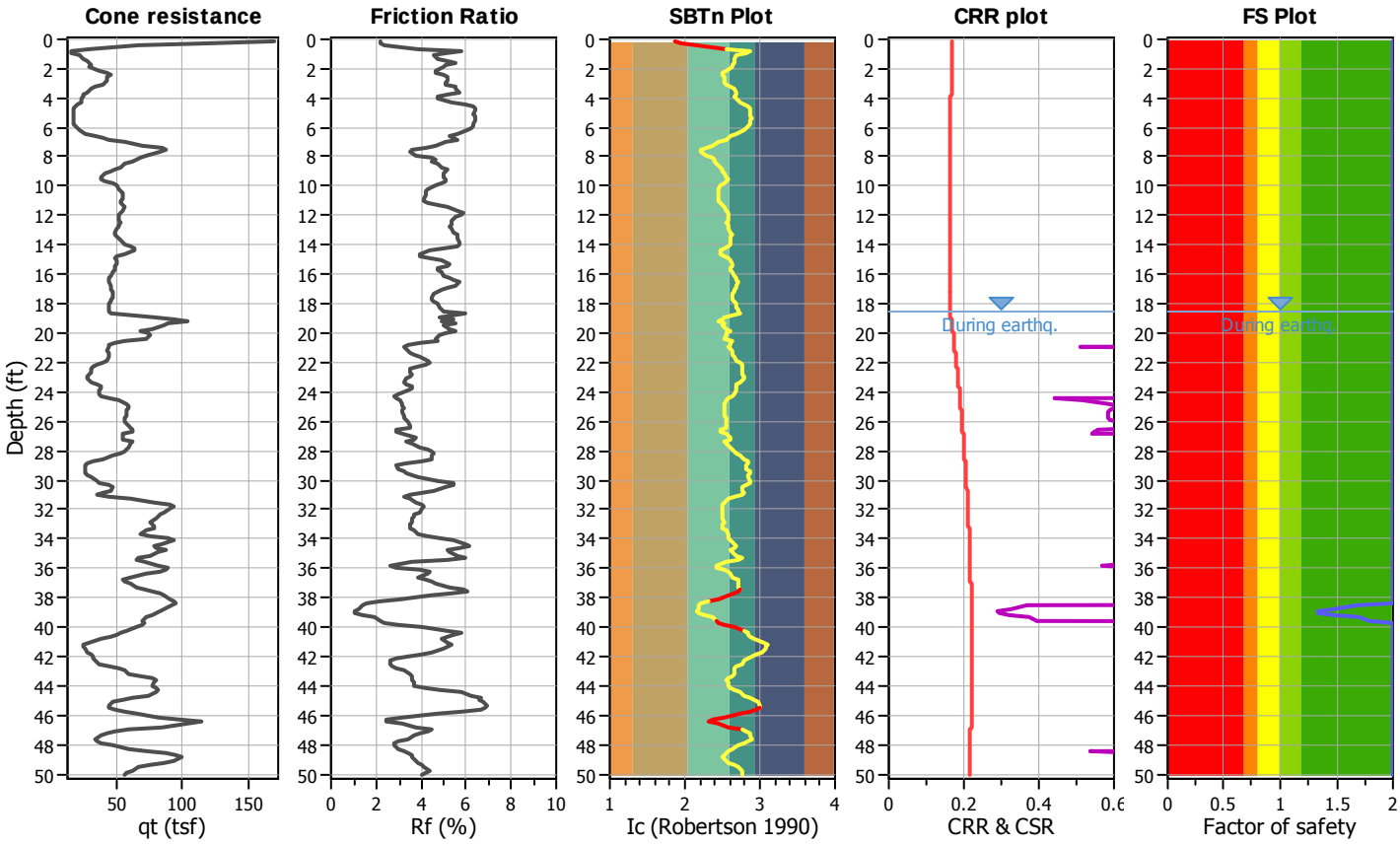
LIQUEFACTION ANALYSIS REPORT

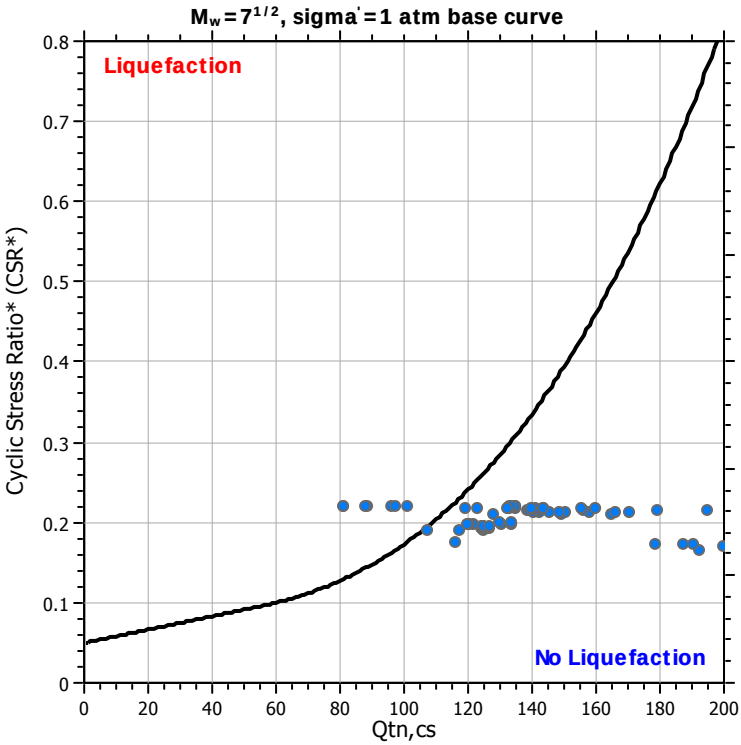
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

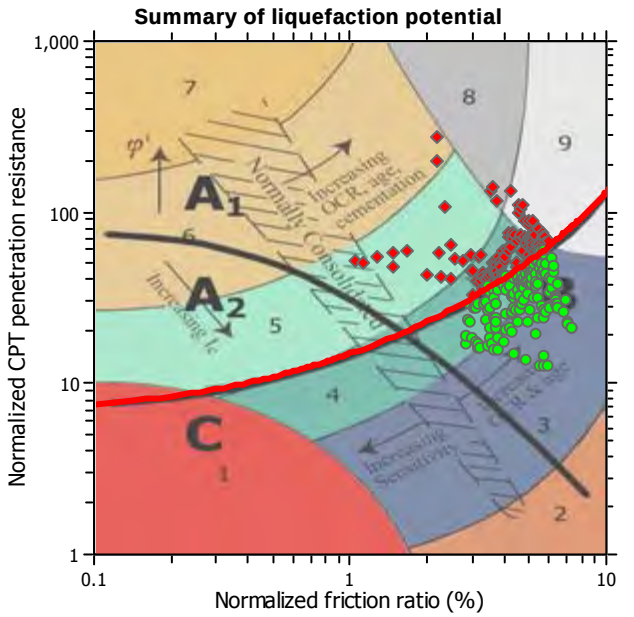
CPT file : 1-CPT-12

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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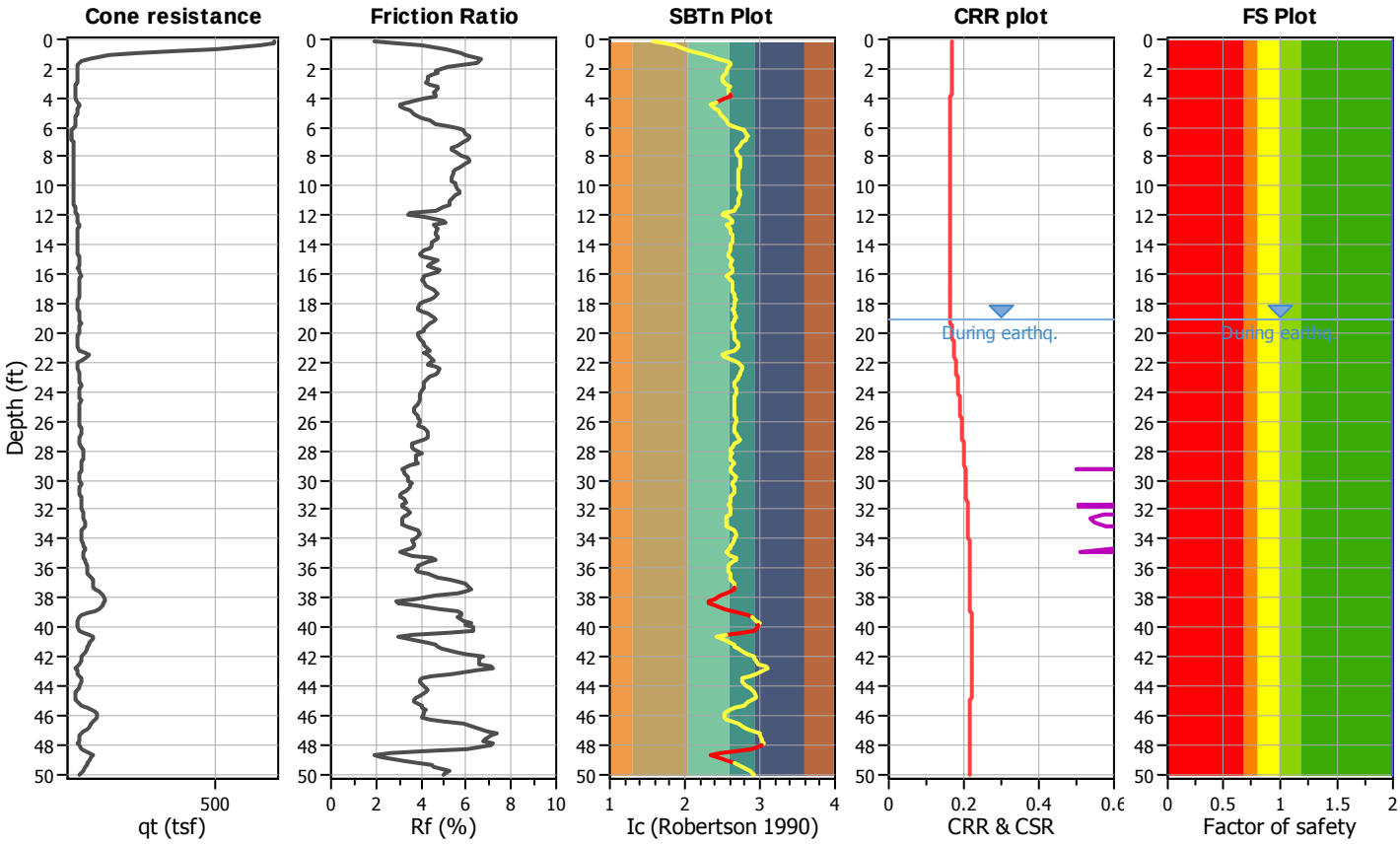
LIQUEFACTION ANALYSIS REPORT

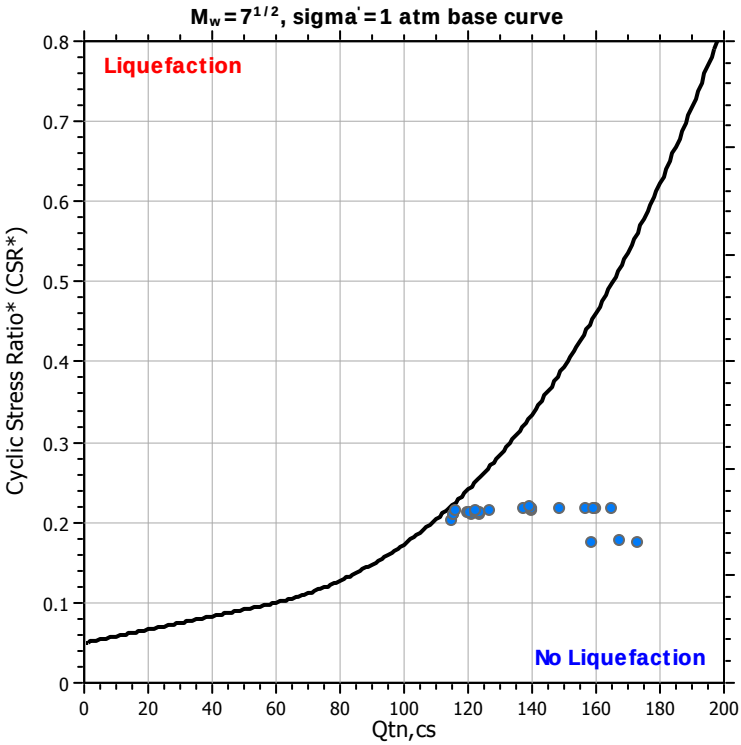
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

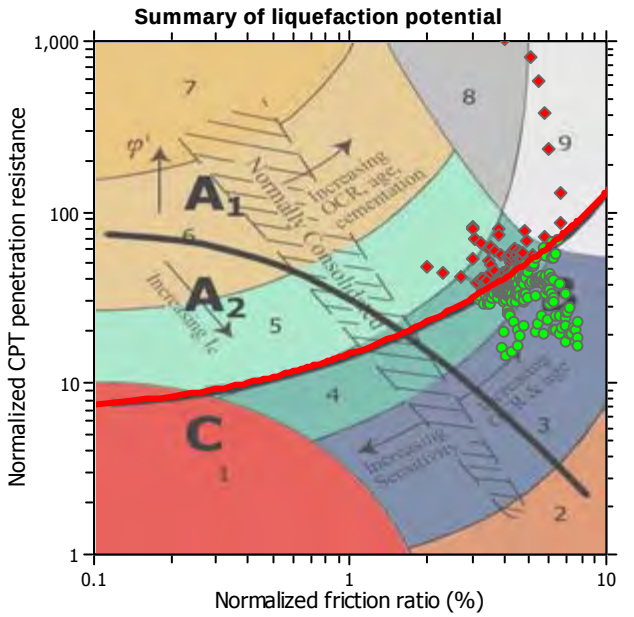
CPT file : 1-CPT-13

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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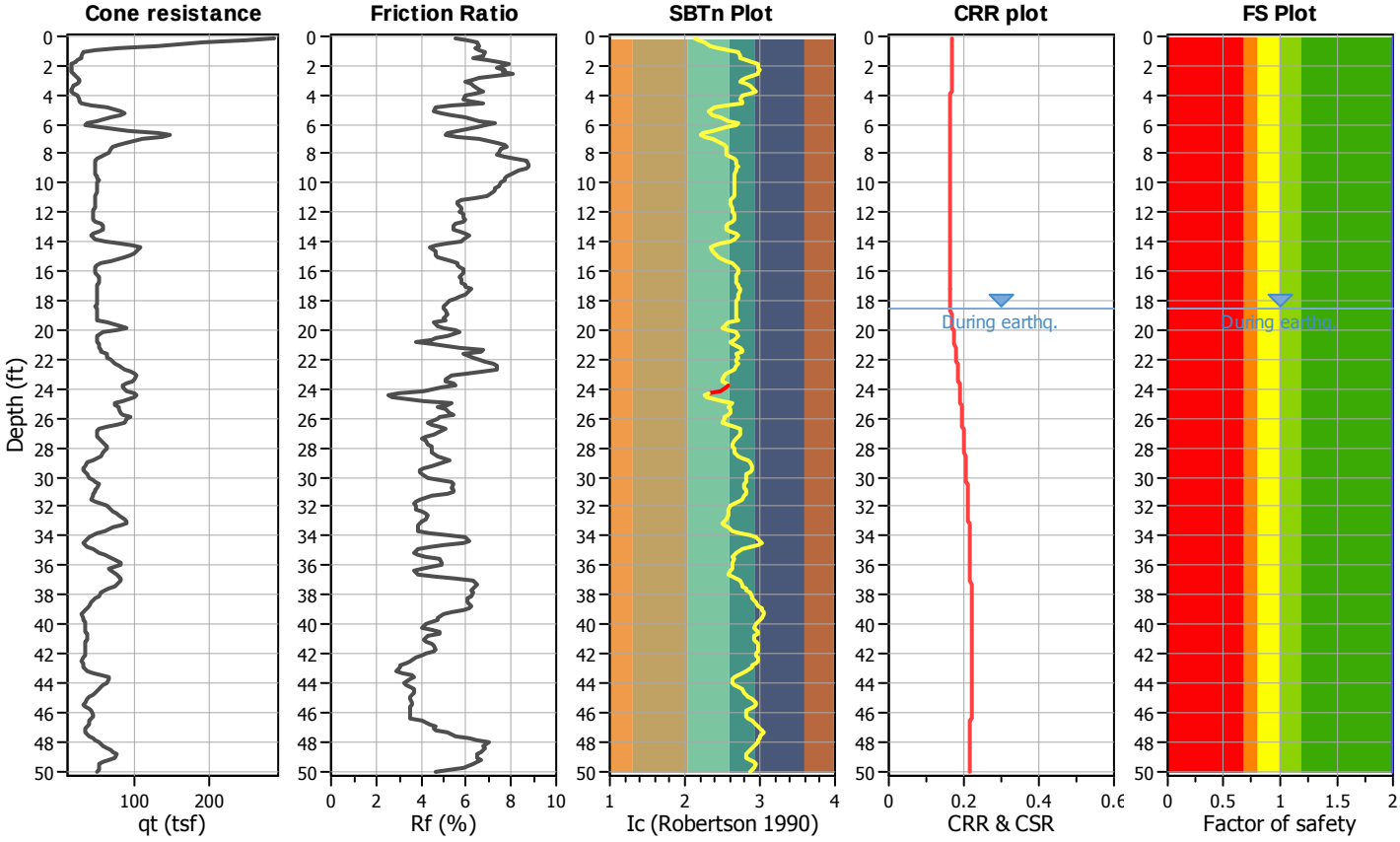
LIQUEFACTION ANALYSIS REPORT

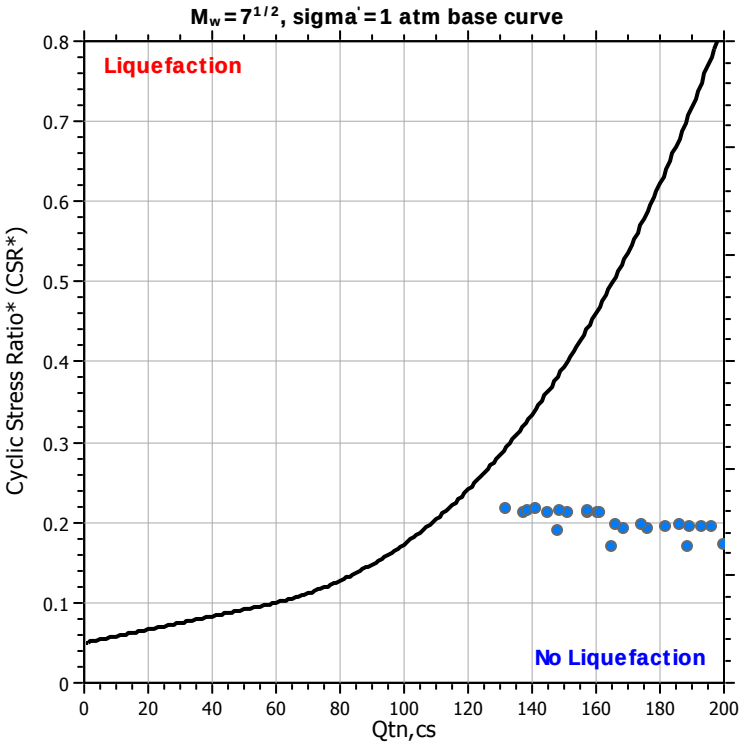
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

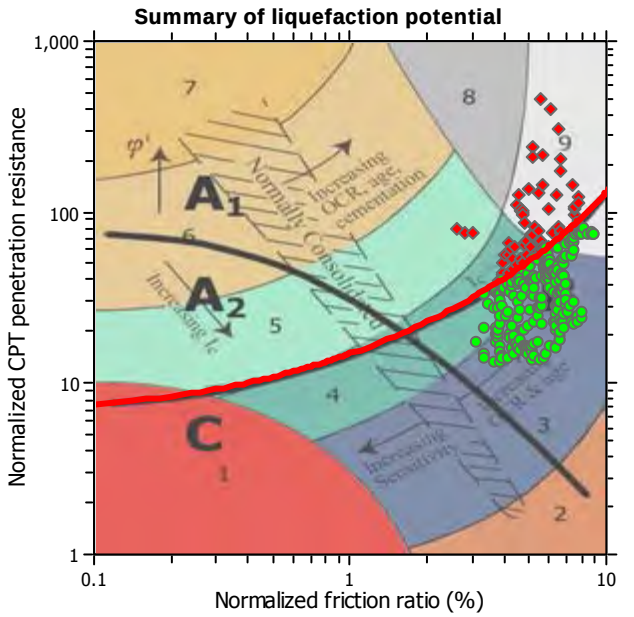
CPT file : 1-CPT-14

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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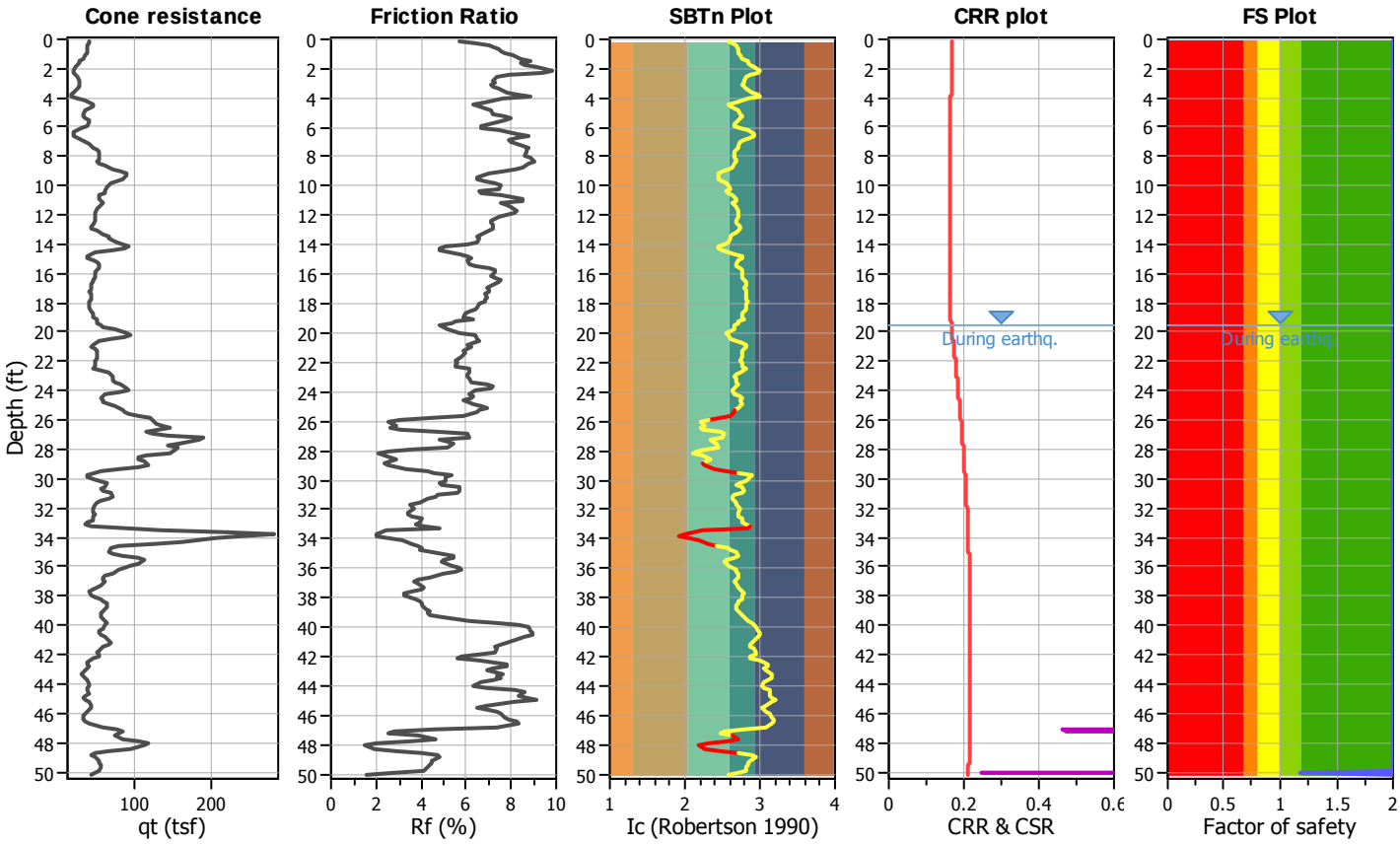
LIQUEFACTION ANALYSIS REPORT

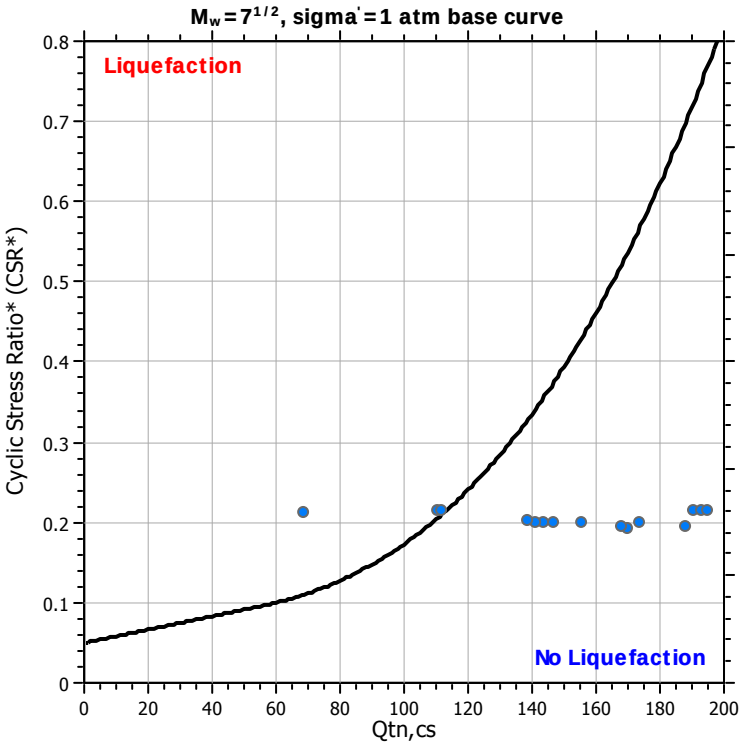
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

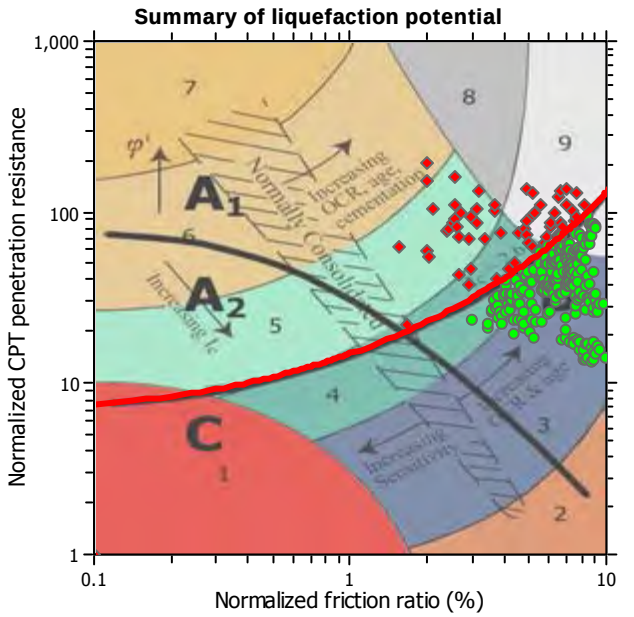
CPT file : 1-CPT-15

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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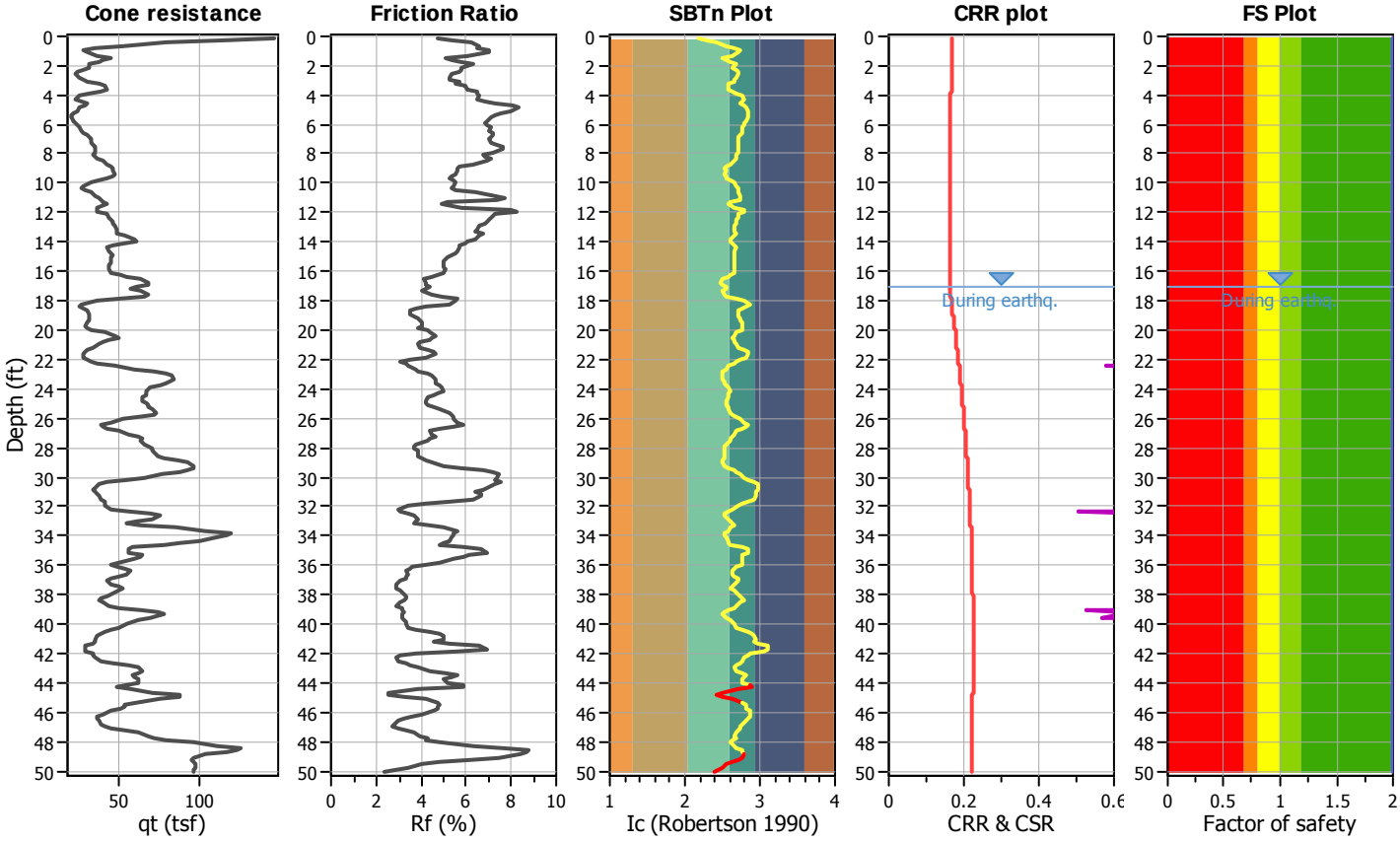
LIQUEFACTION ANALYSIS REPORT

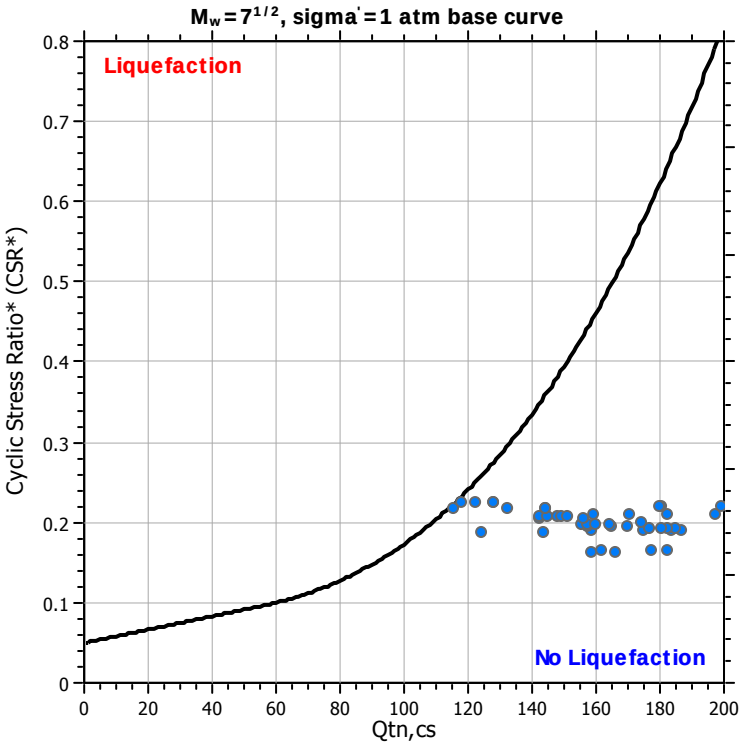
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

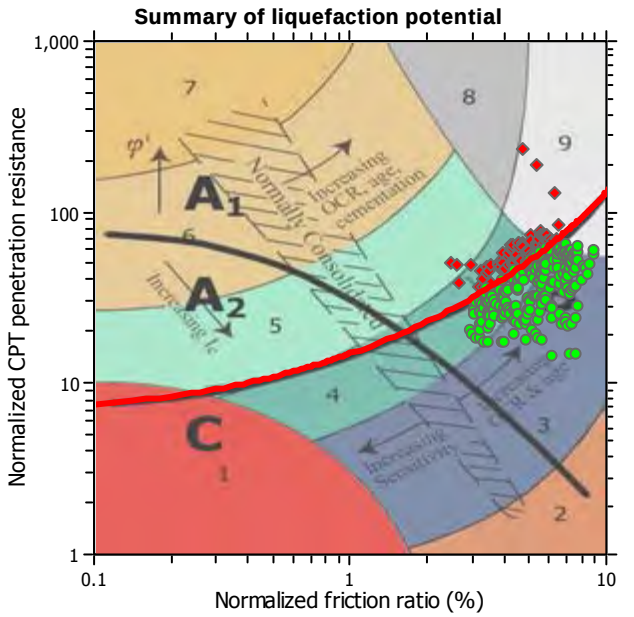
CPT file : 1-CPT-16

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	17.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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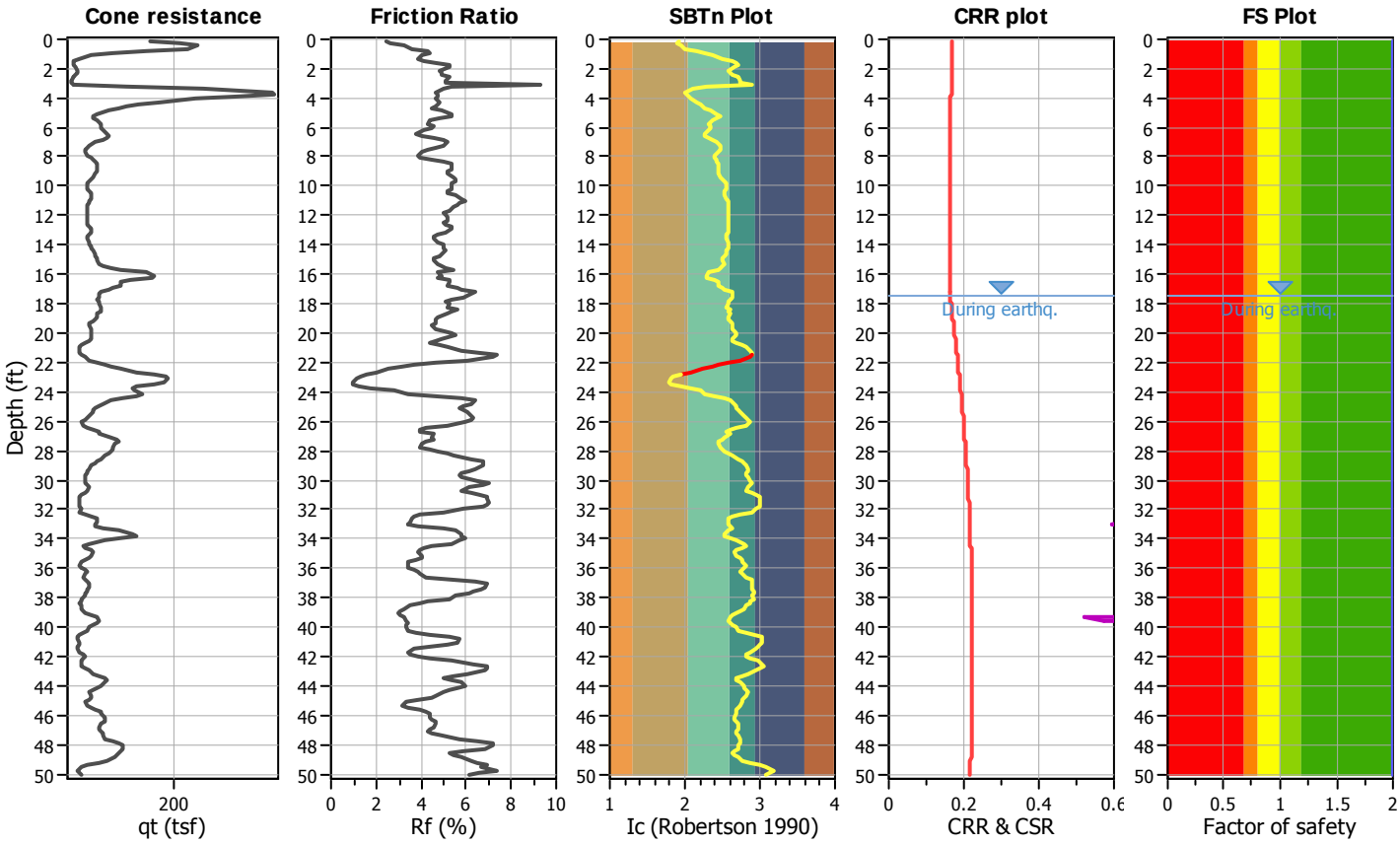
LIQUEFACTION ANALYSIS REPORT

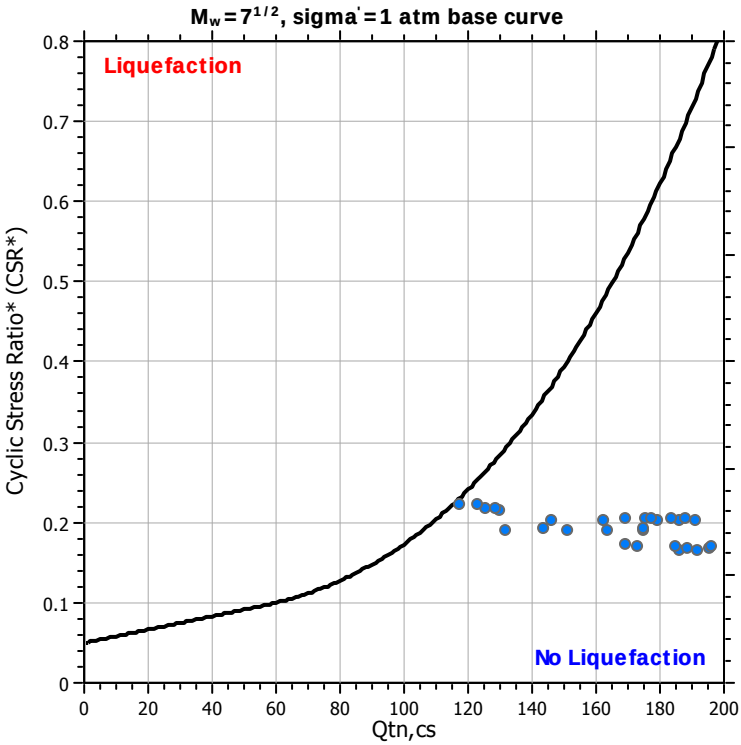
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

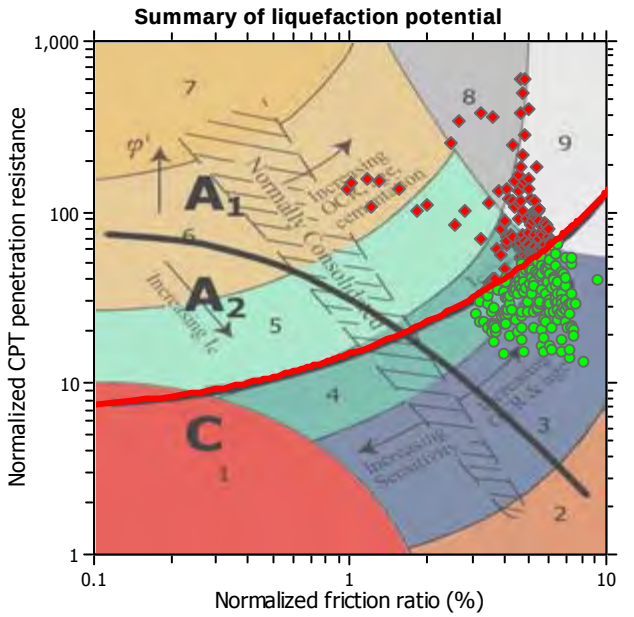
CPT file : 1-CPT-17

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	18.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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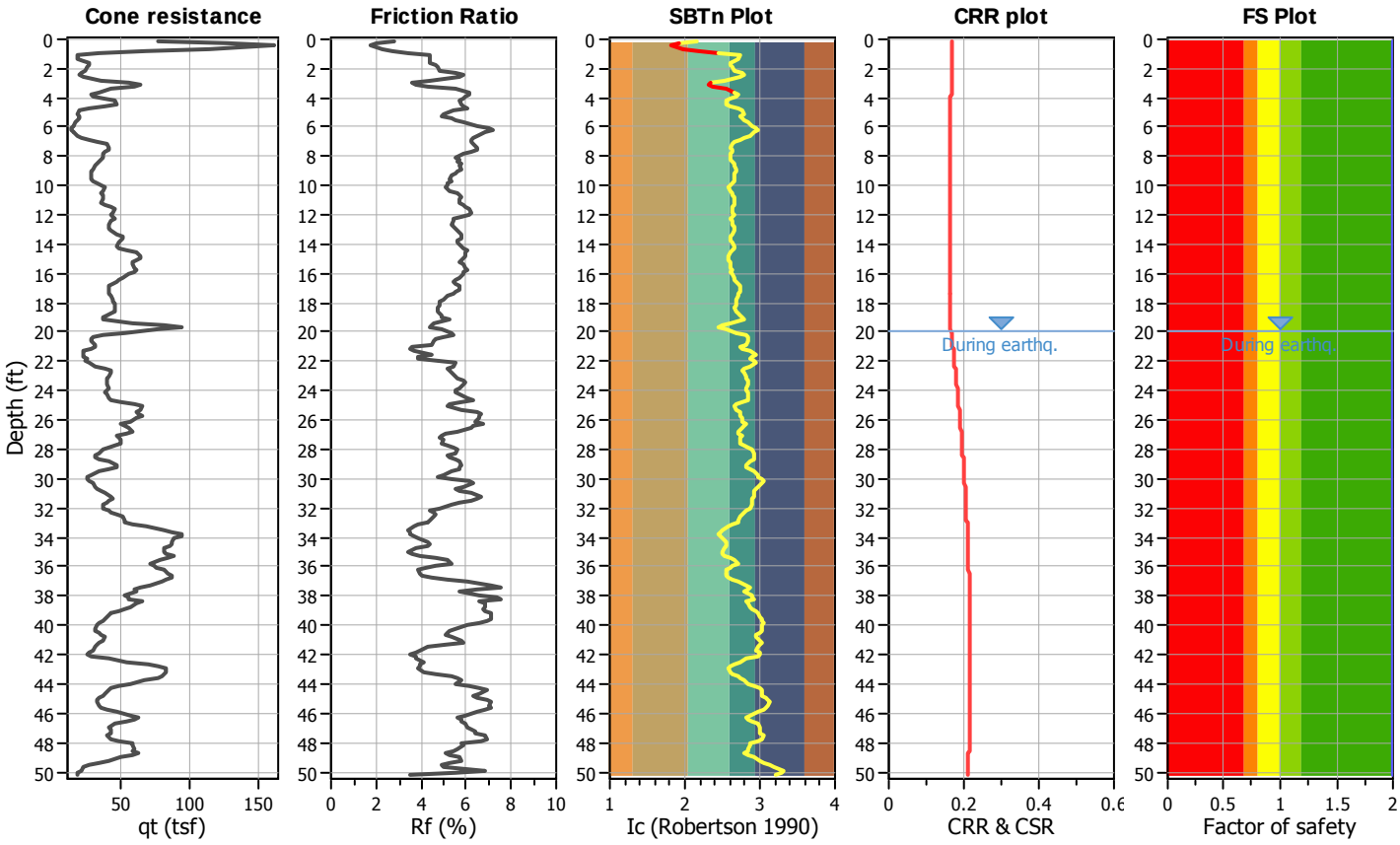
LIQUEFACTION ANALYSIS REPORT

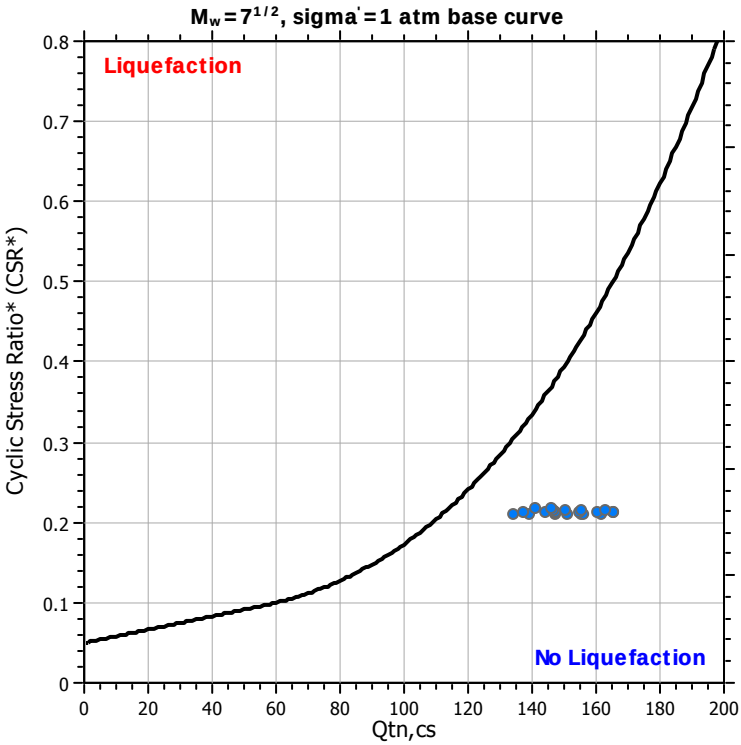
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

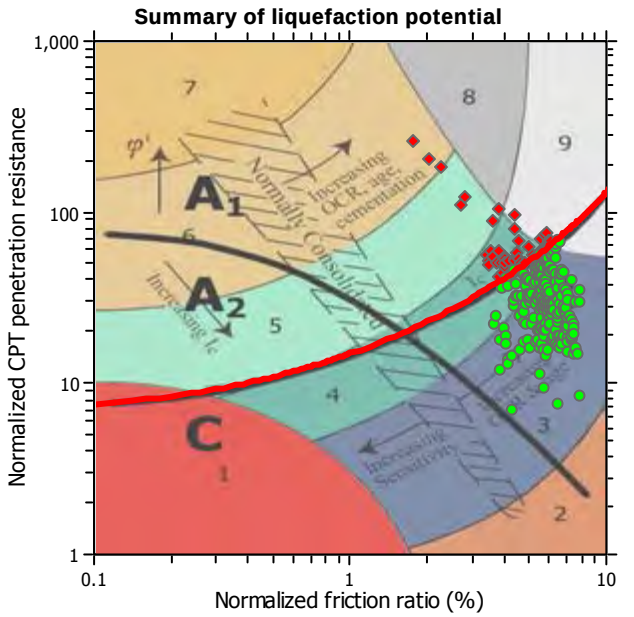
CPT file : 1-CPT-18

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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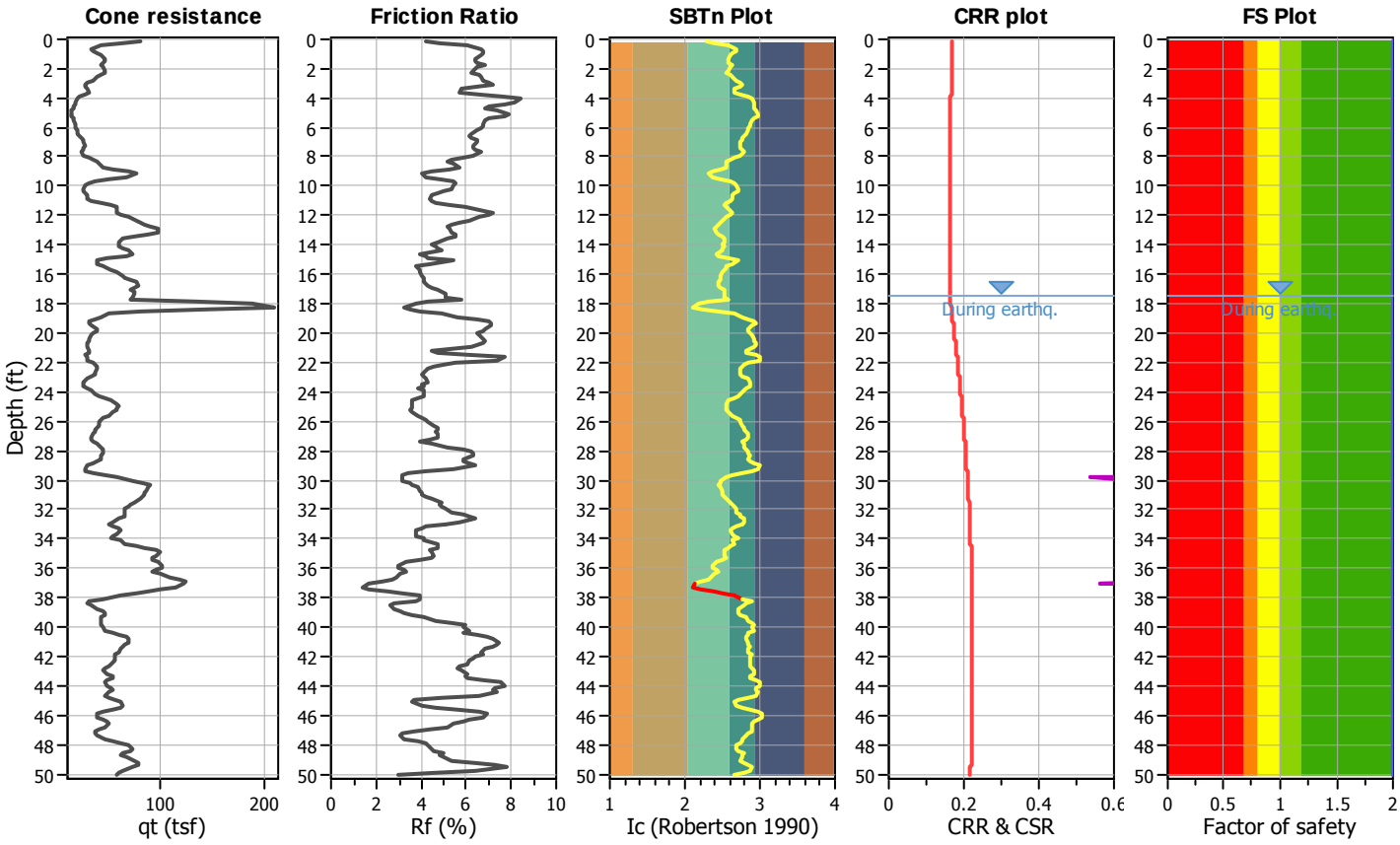
LIQUEFACTION ANALYSIS REPORT

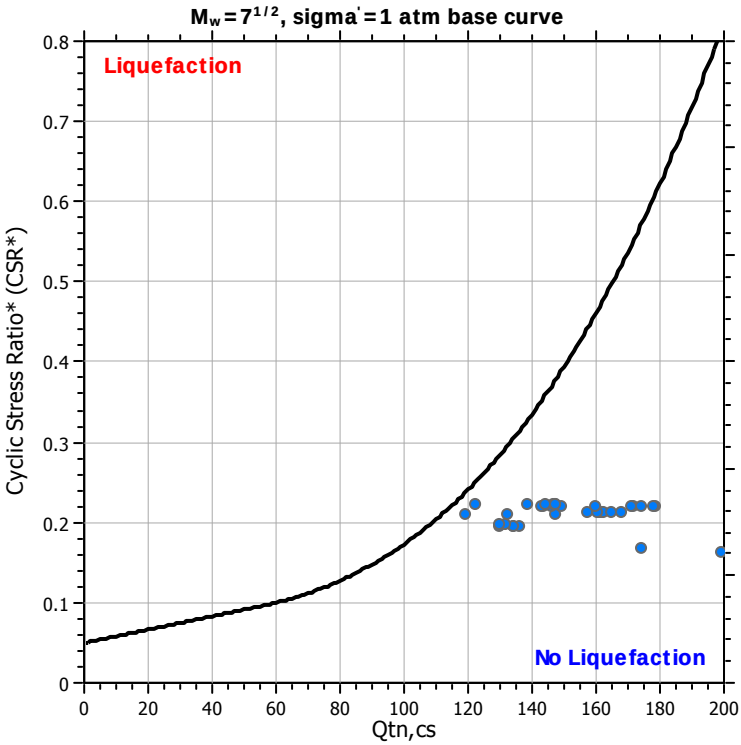
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

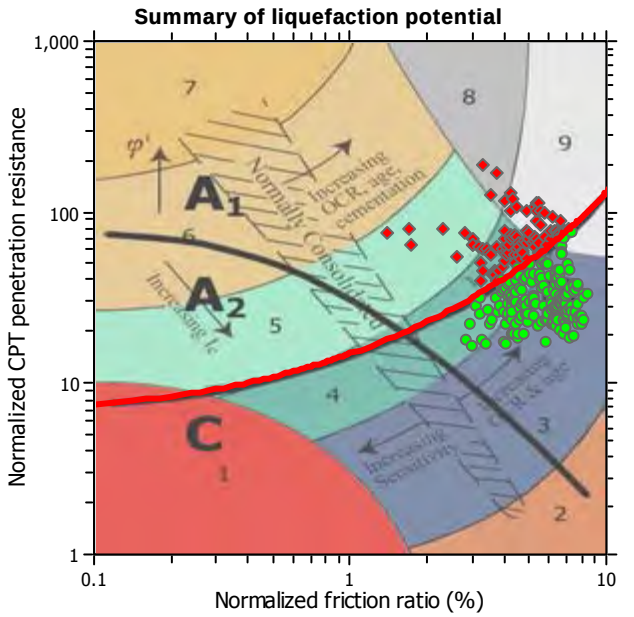
CPT file : 1-CPT-19

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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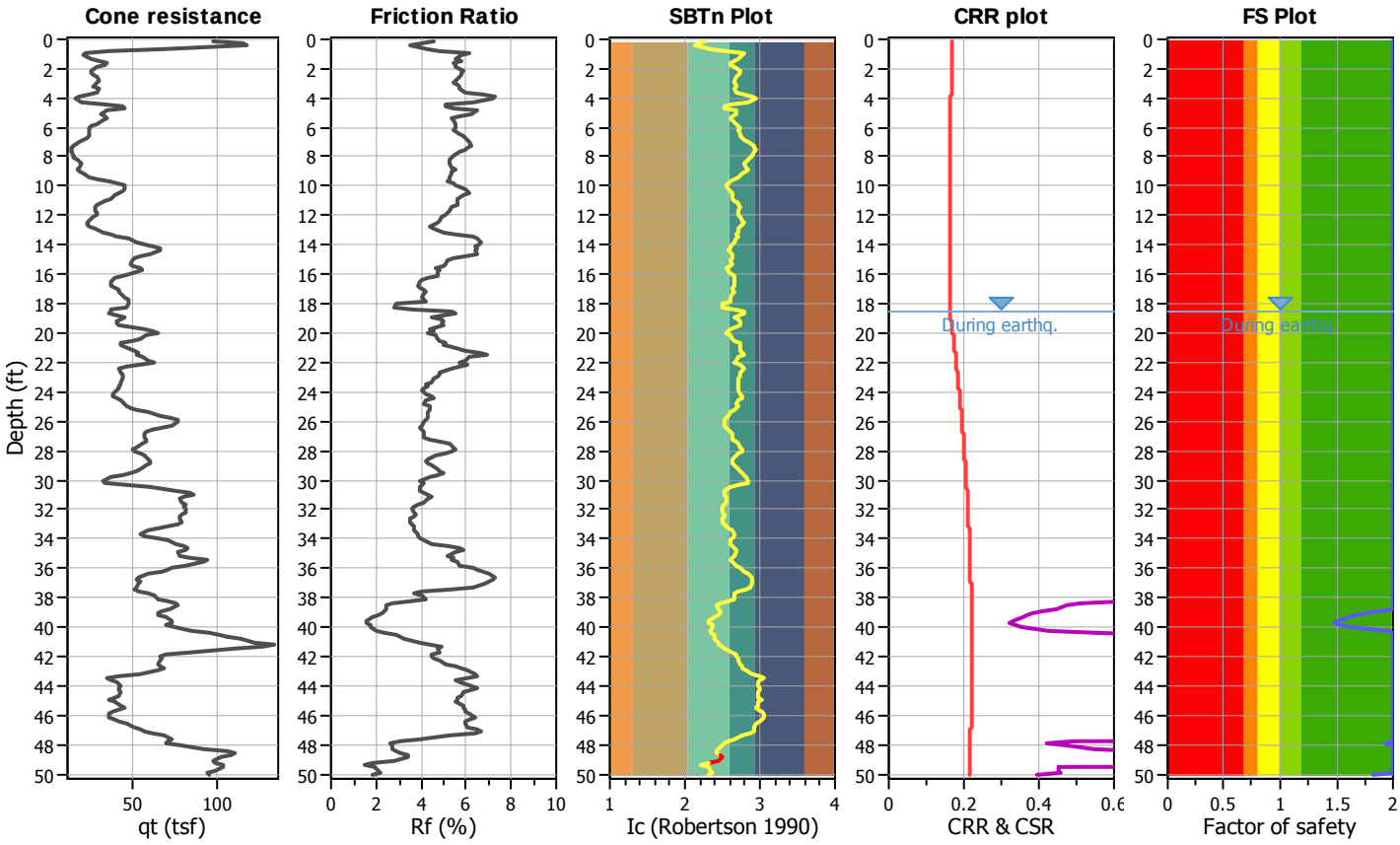
LIQUEFACTION ANALYSIS REPORT

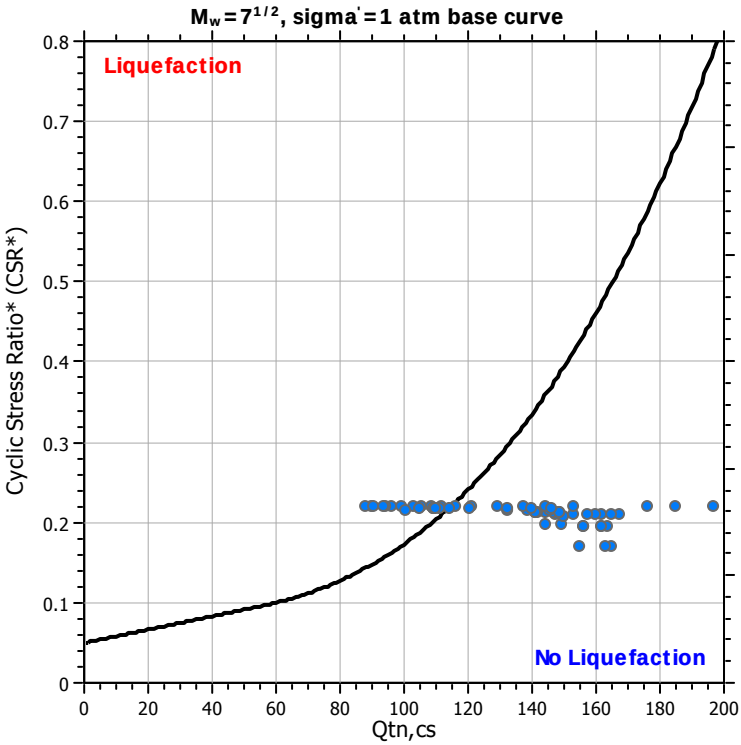
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

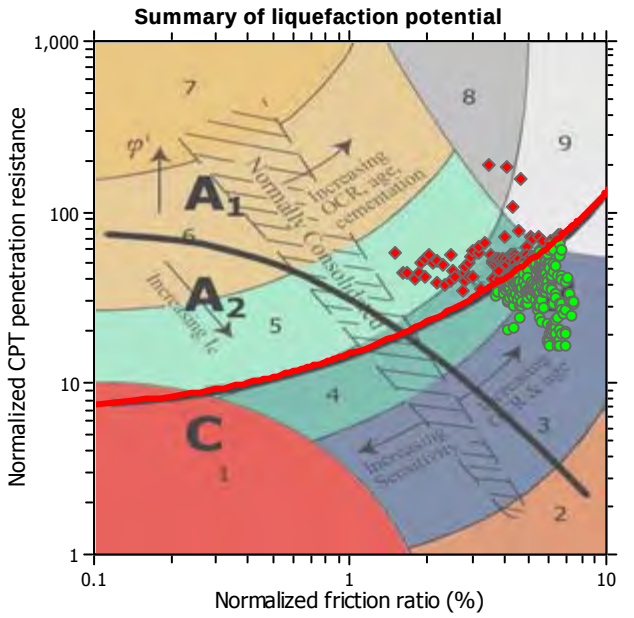
CPT file : 1-CPT-20

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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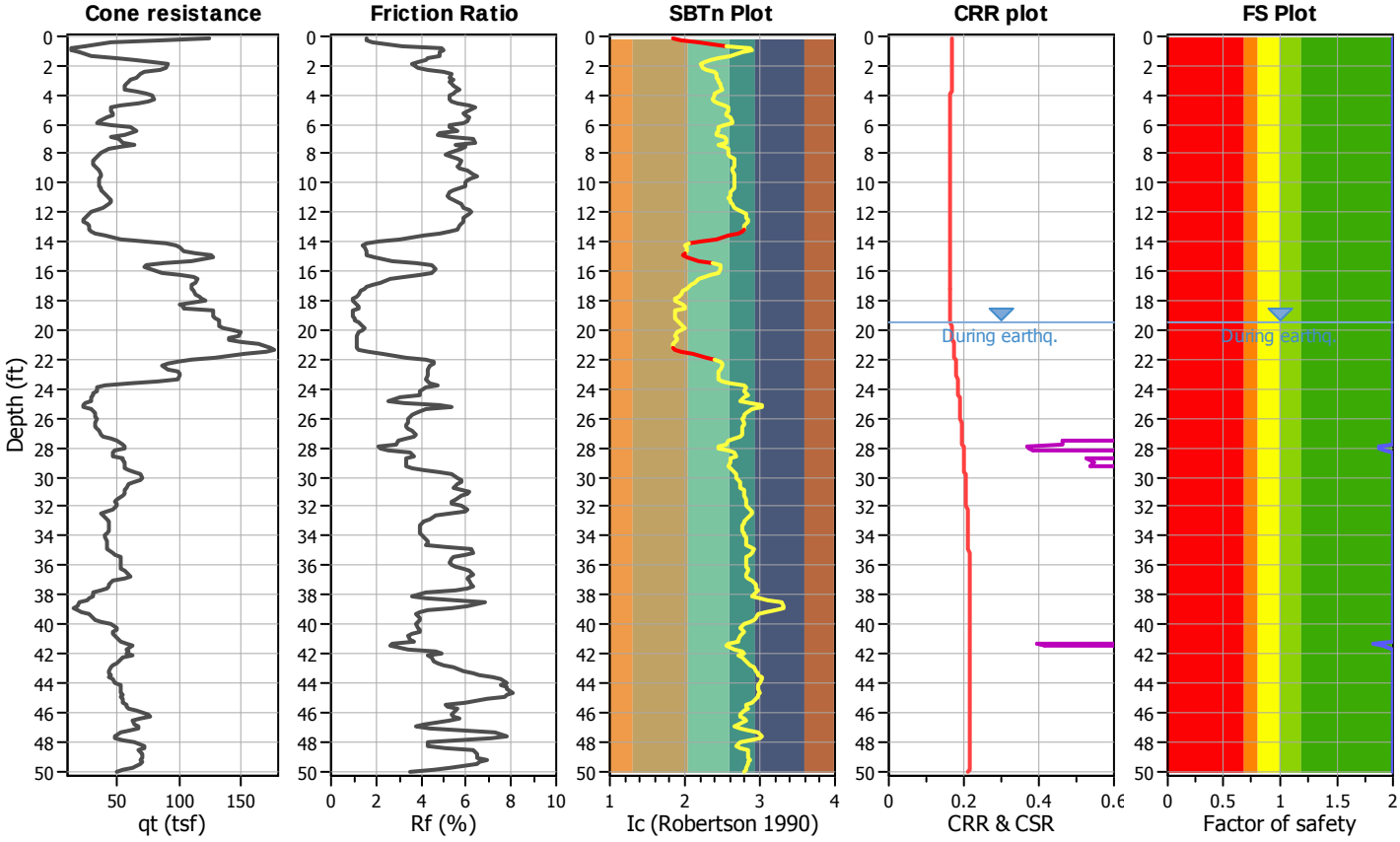
LIQUEFACTION ANALYSIS REPORT

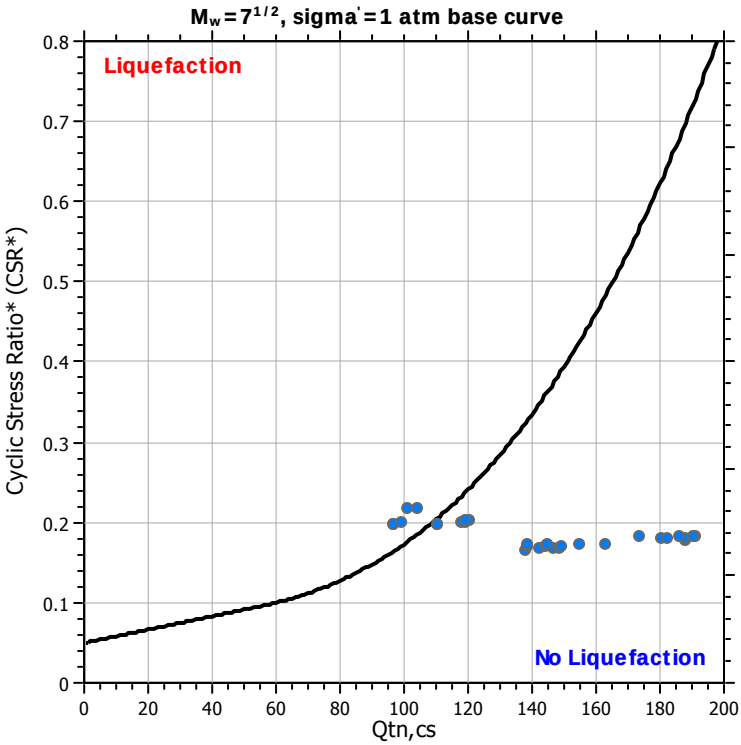
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

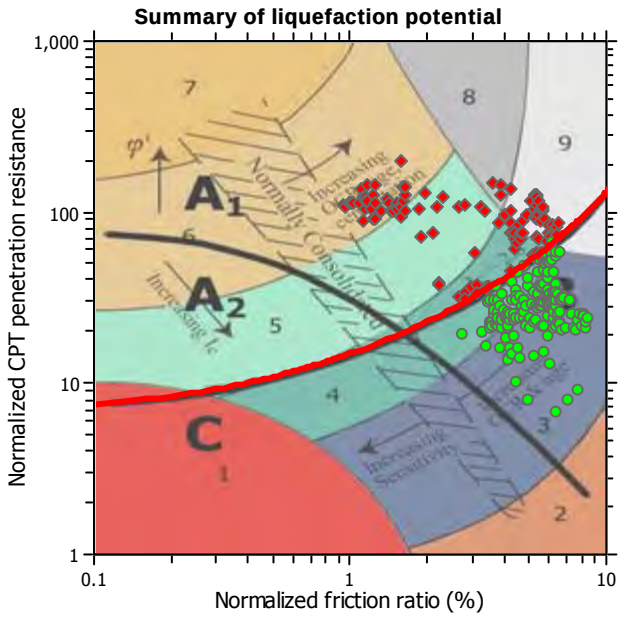
CPT file : 1-CPT-21

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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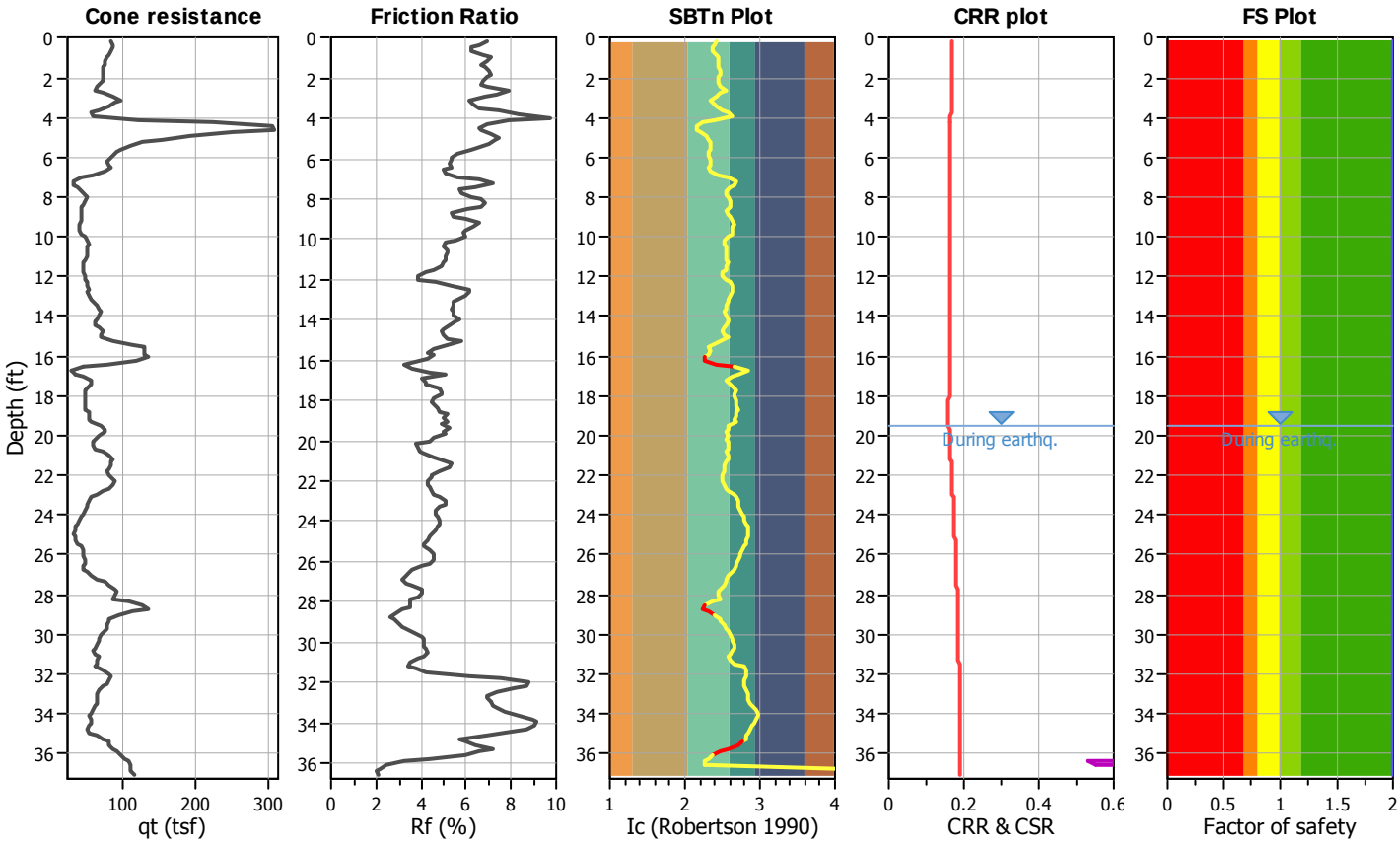
LIQUEFACTION ANALYSIS REPORT

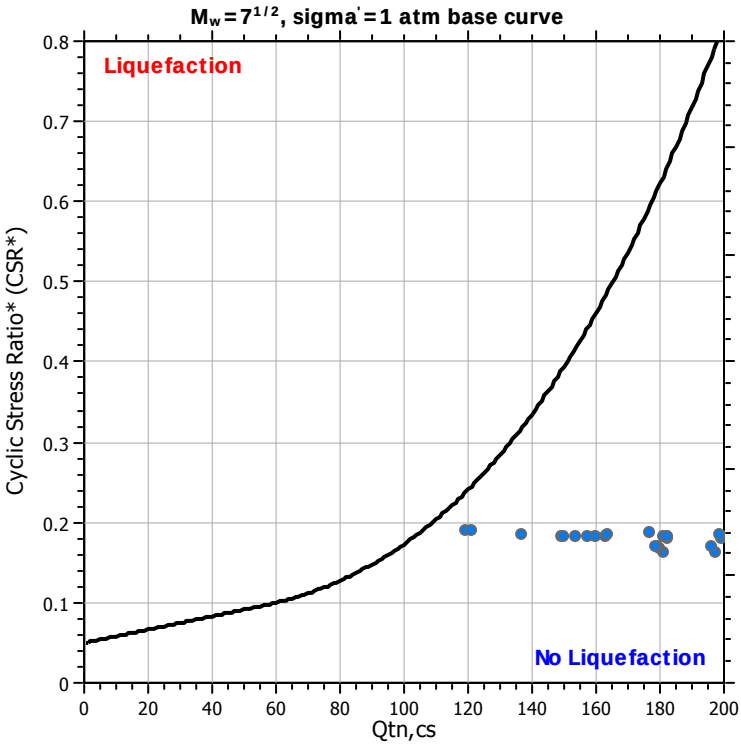
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

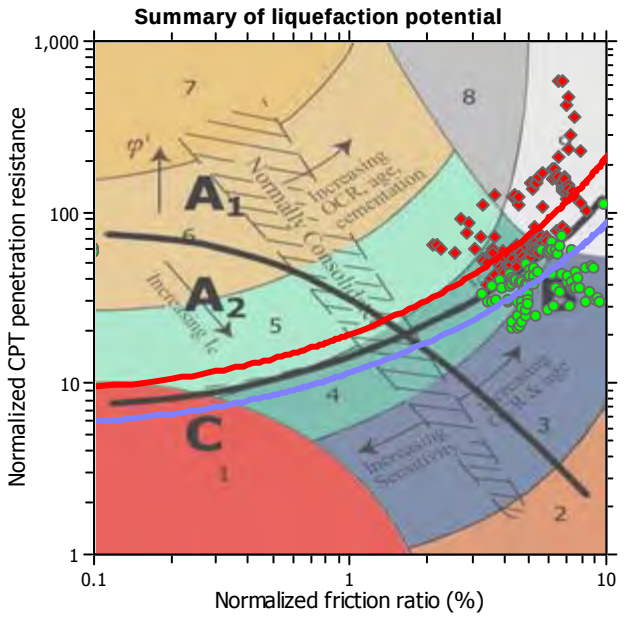
CPT file : 1-CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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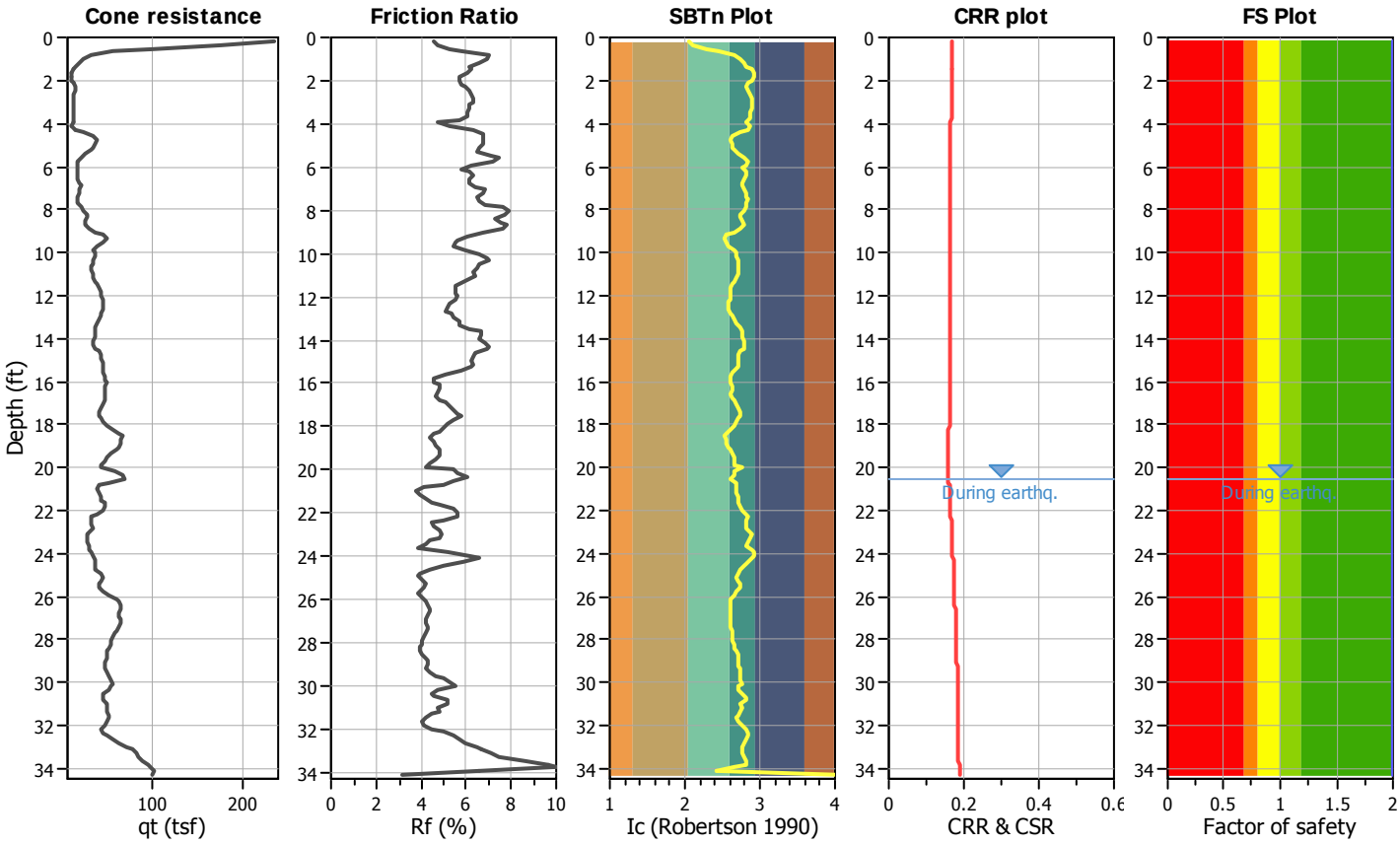
LIQUEFACTION ANALYSIS REPORT

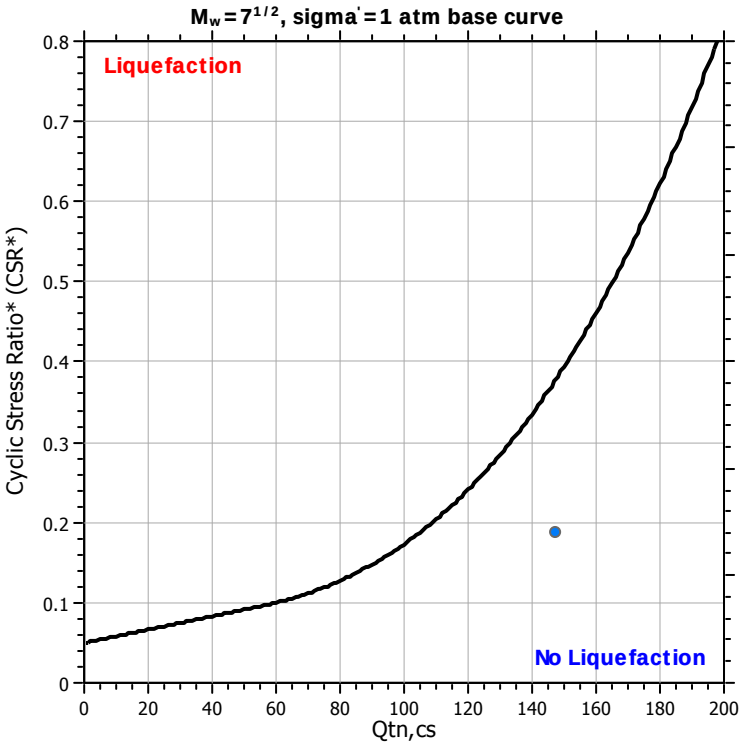
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

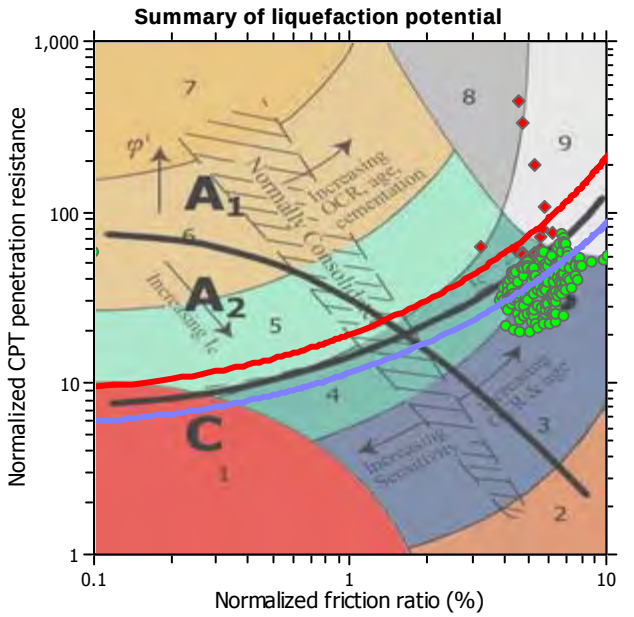
CPT file : 1-CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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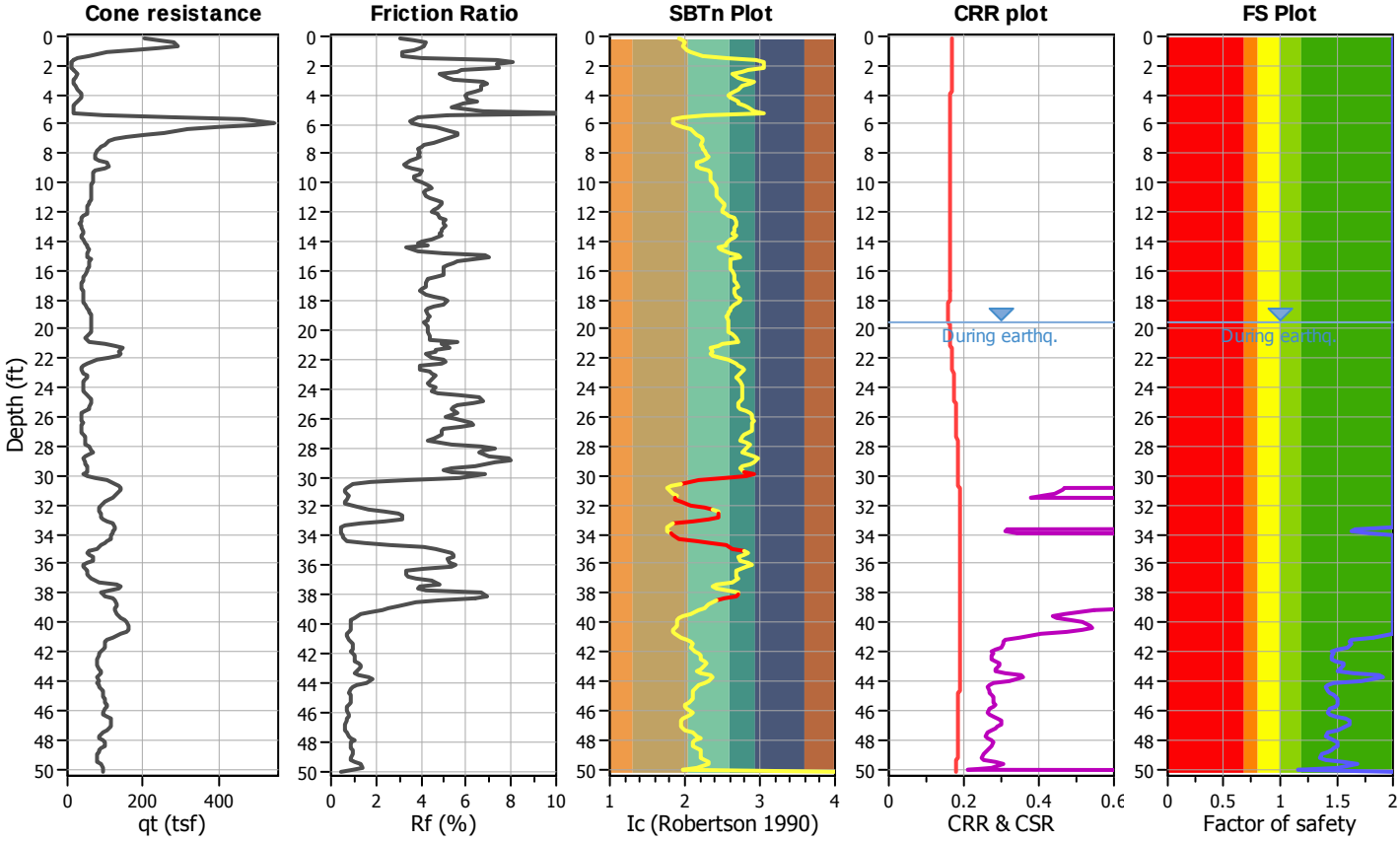
LIQUEFACTION ANALYSIS REPORT

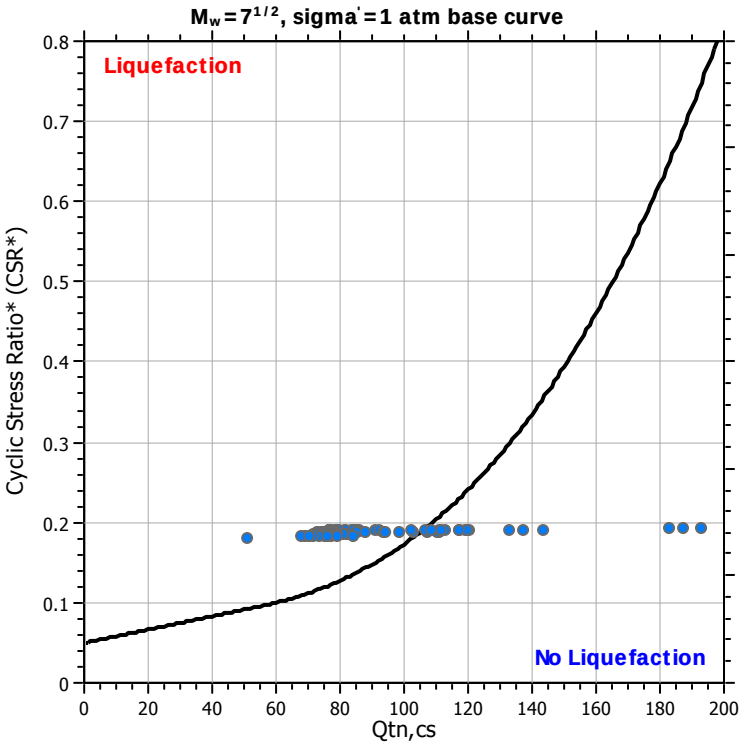
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

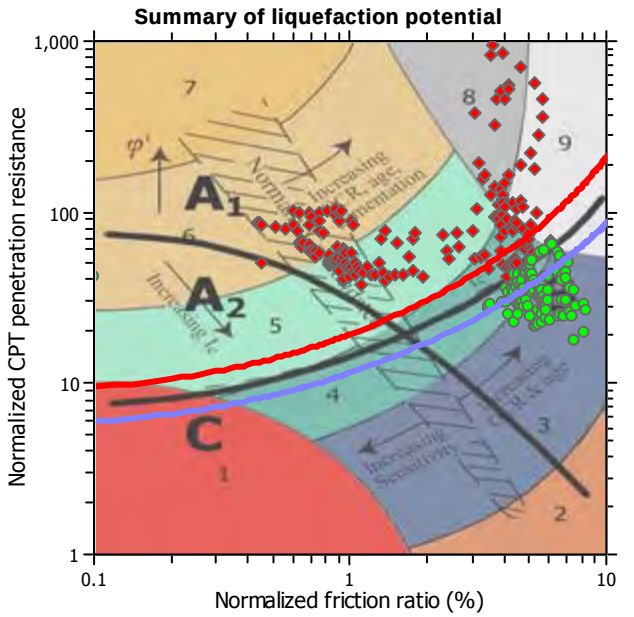
CPT file : 1-CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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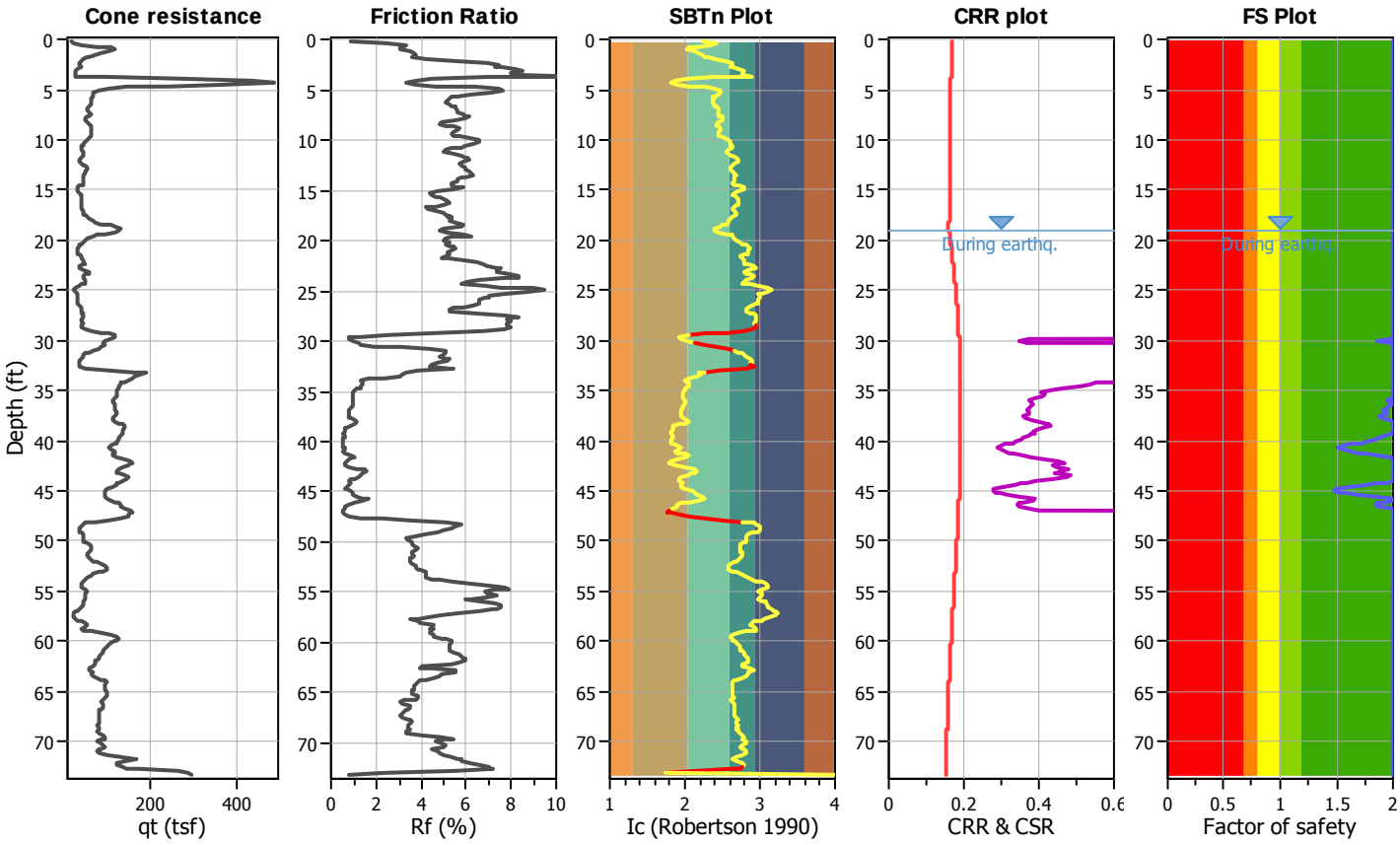
LIQUEFACTION ANALYSIS REPORT

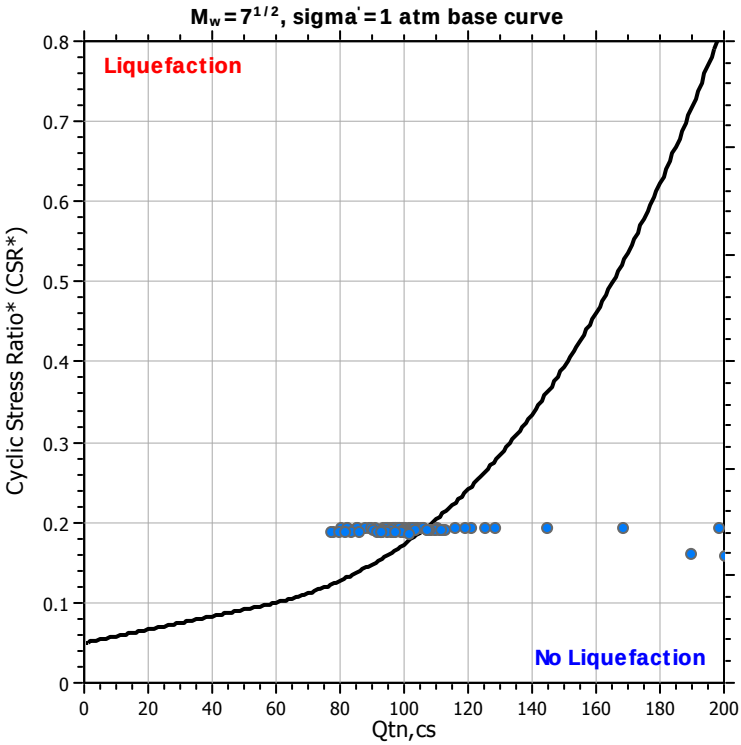
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

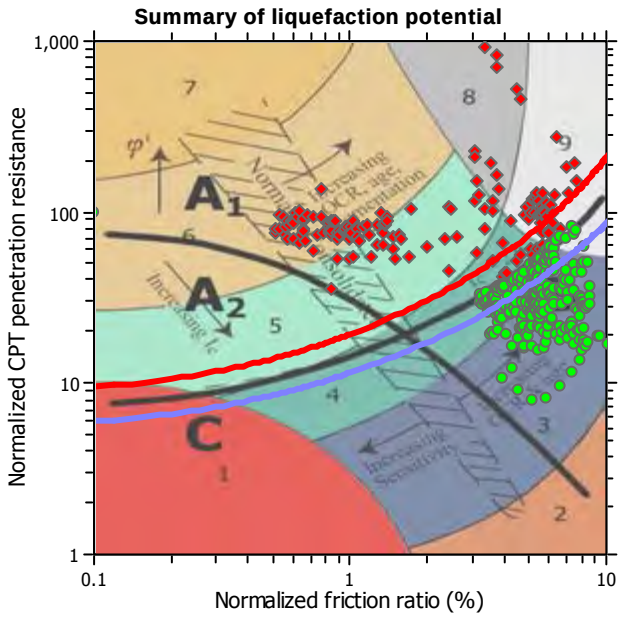
CPT file : 1-CPT-4

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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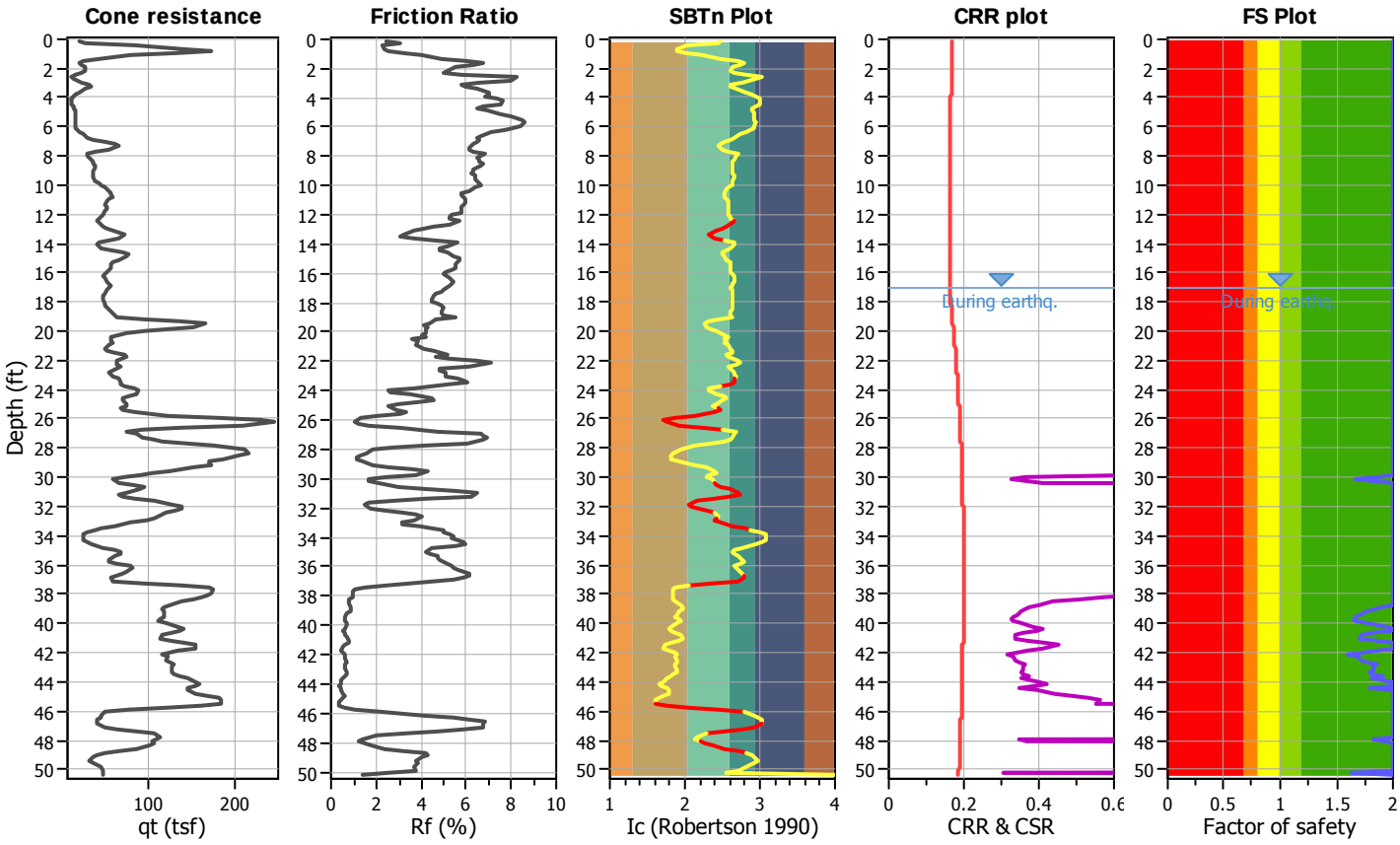
LIQUEFACTION ANALYSIS REPORT

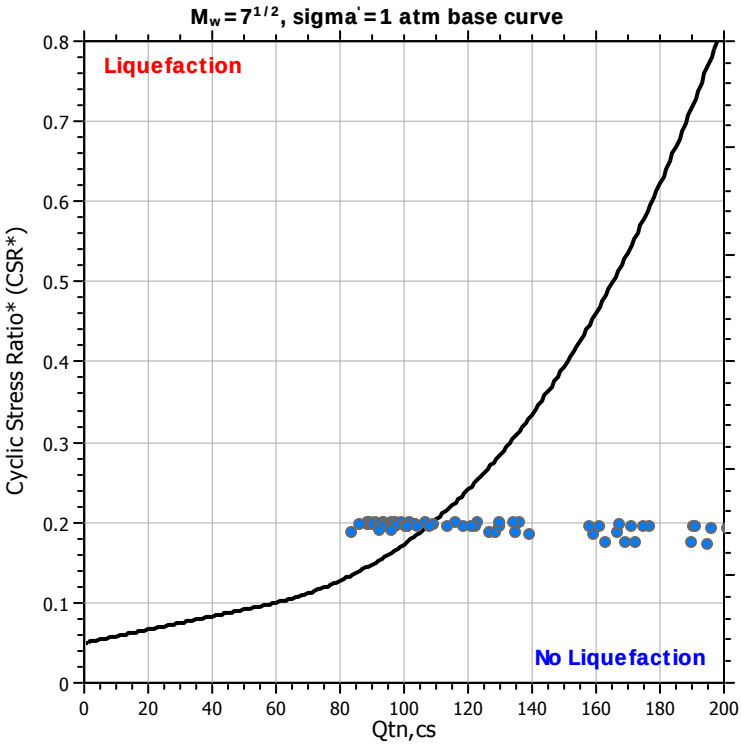
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

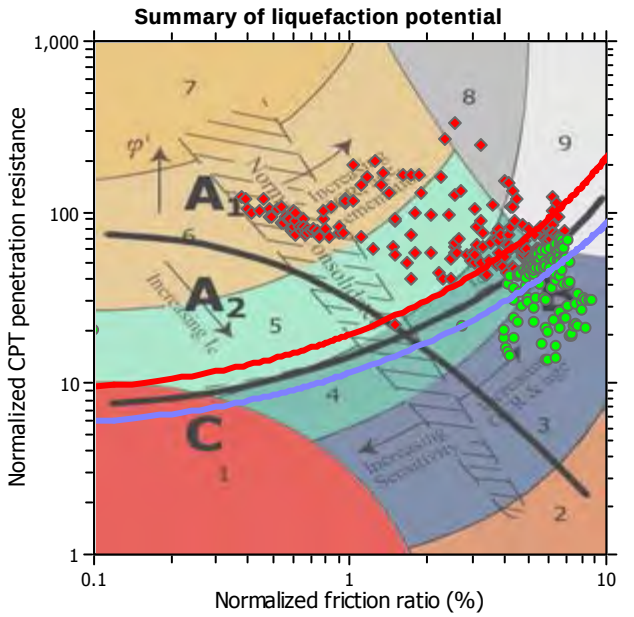
CPT file : 1-CPT-5

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	17.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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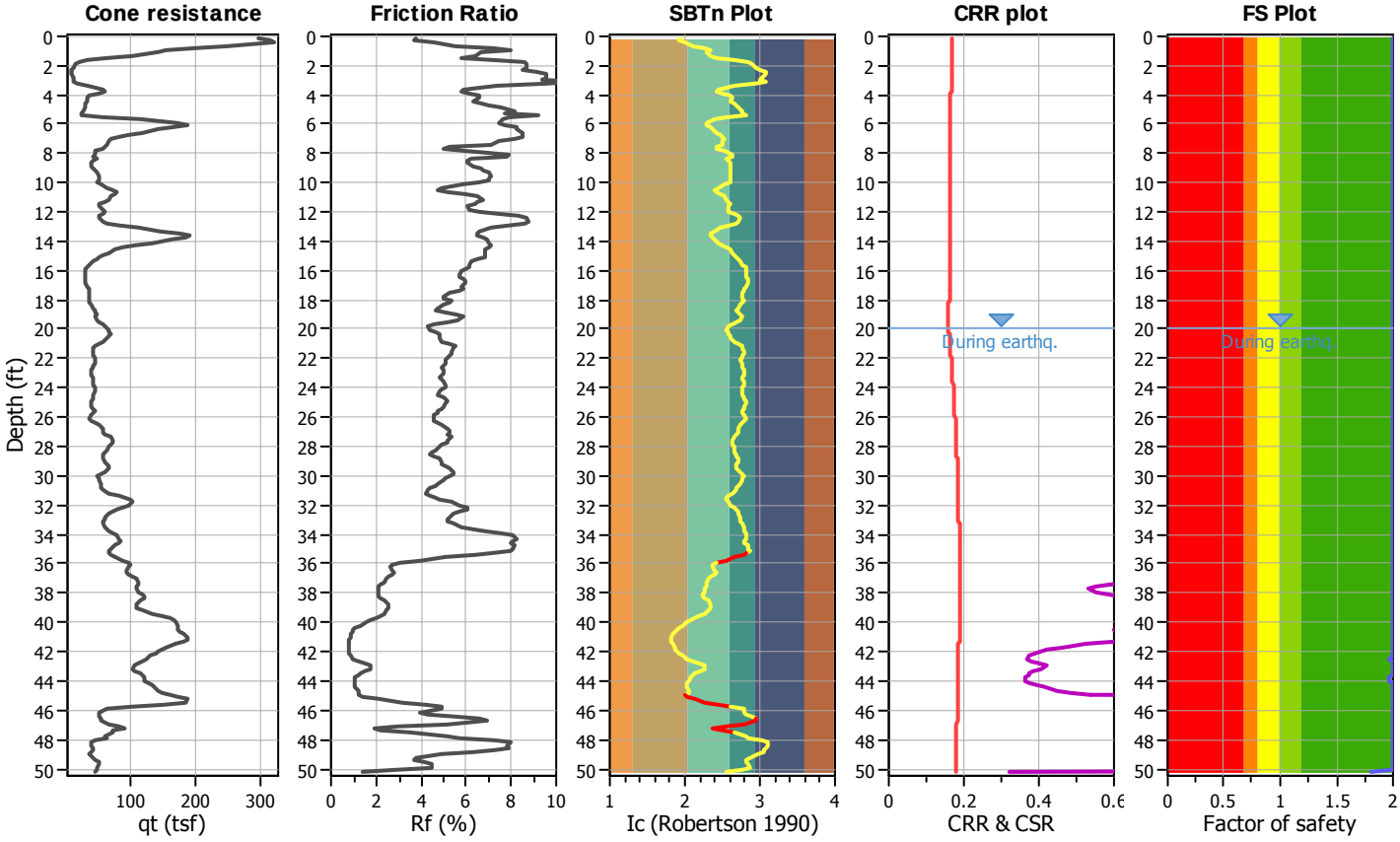
LIQUEFACTION ANALYSIS REPORT

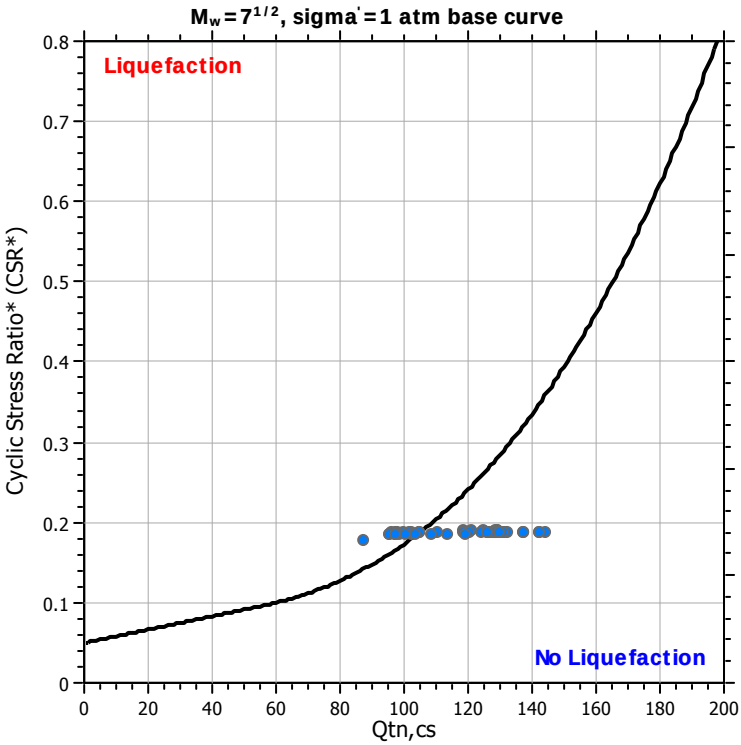
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

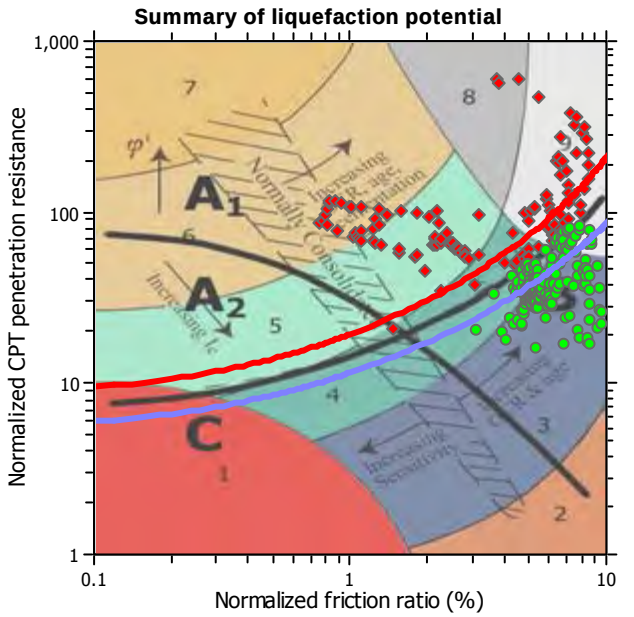
CPT file : 1-CPT-6

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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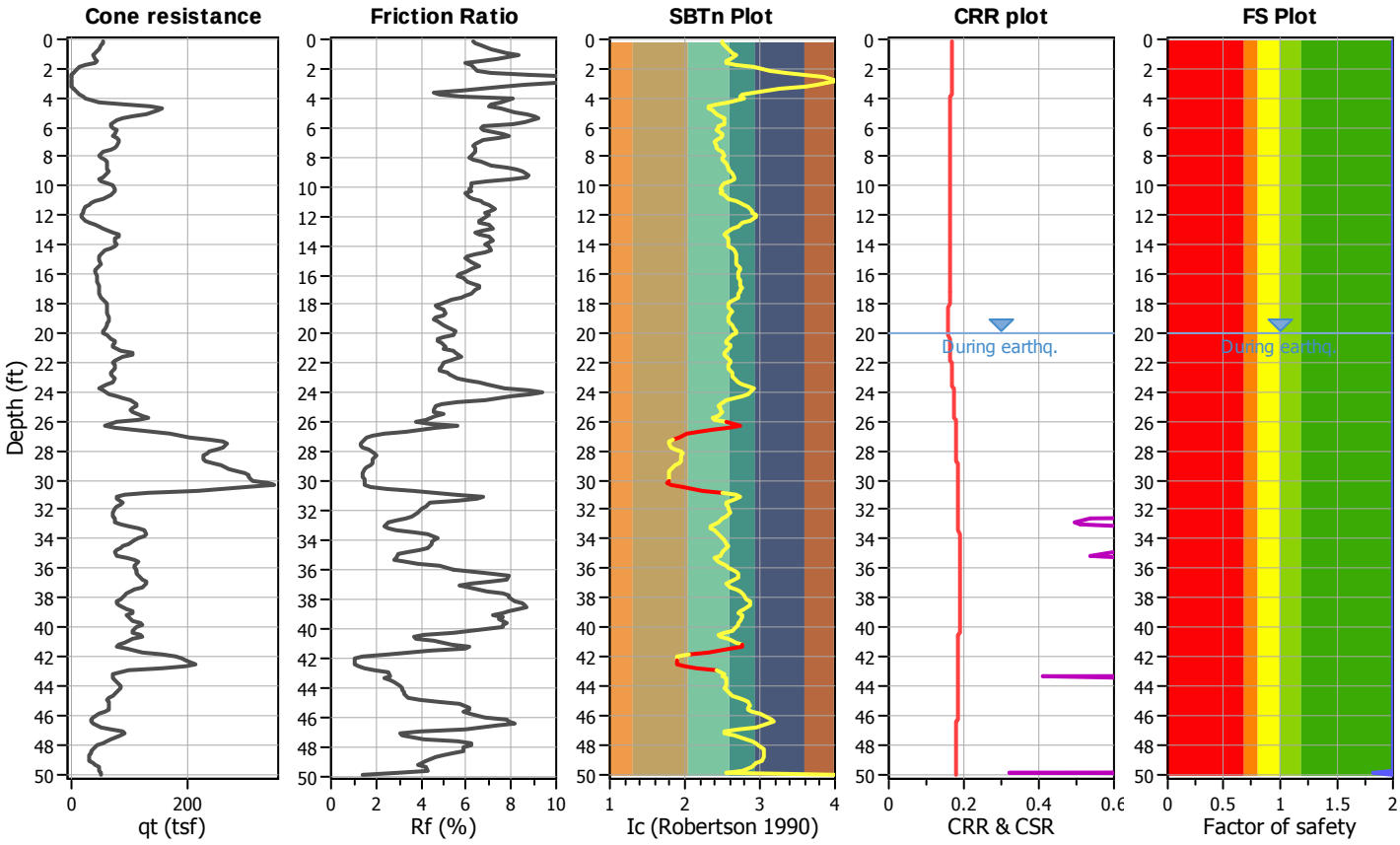
LIQUEFACTION ANALYSIS REPORT

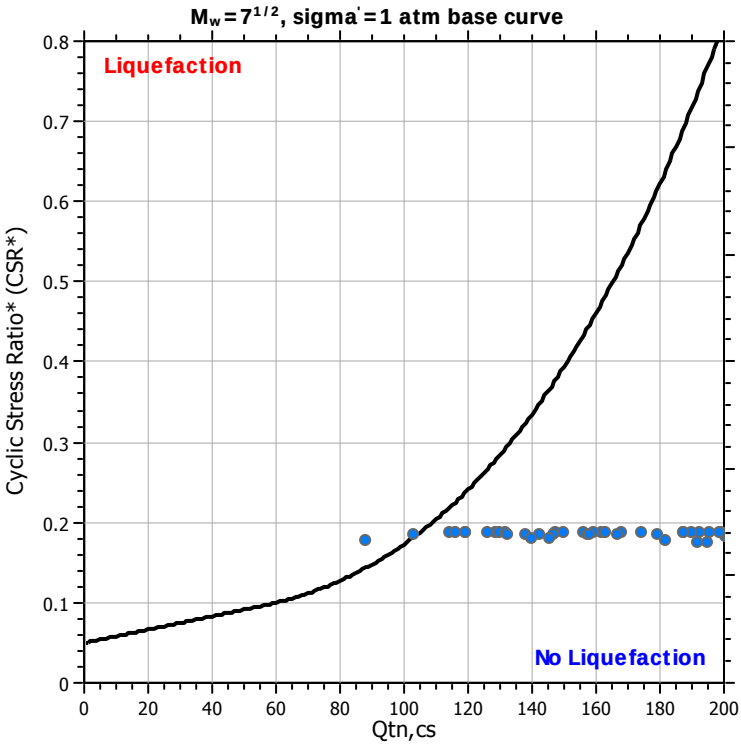
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

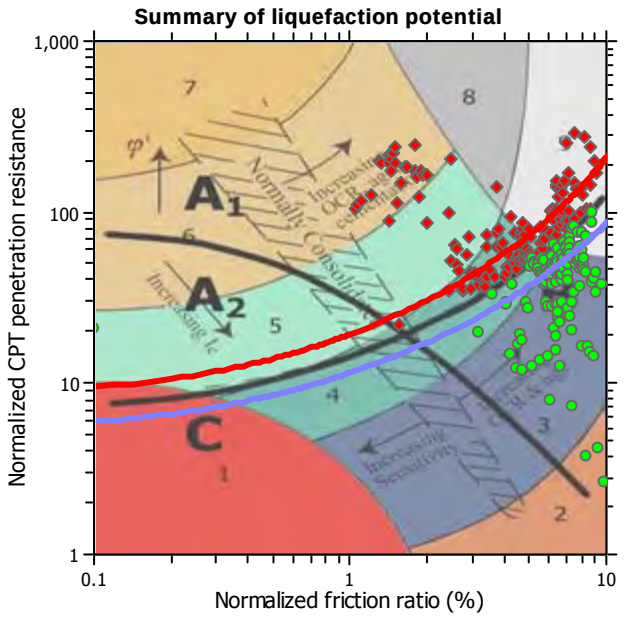
CPT file : 1-CPT-7

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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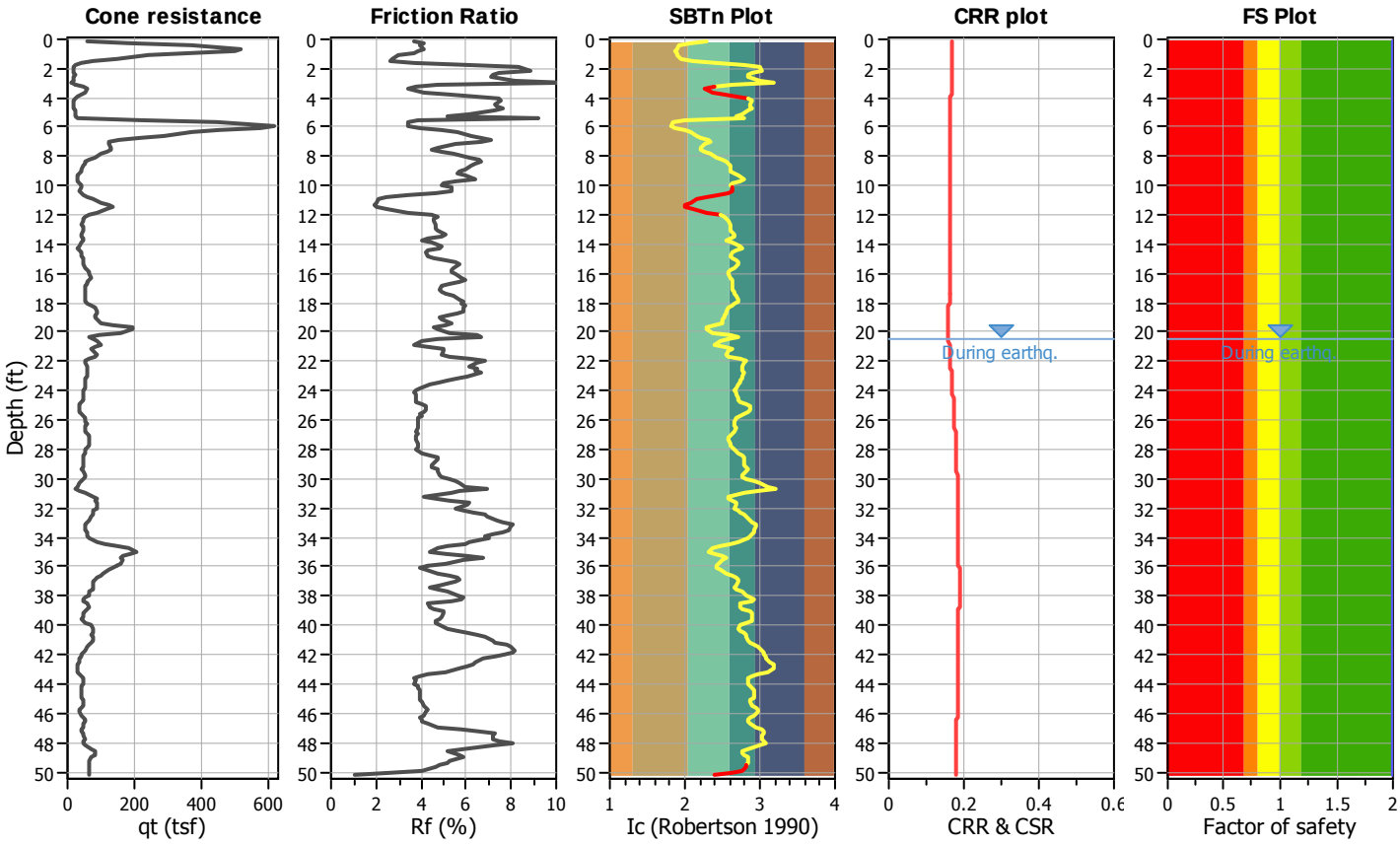
LIQUEFACTION ANALYSIS REPORT

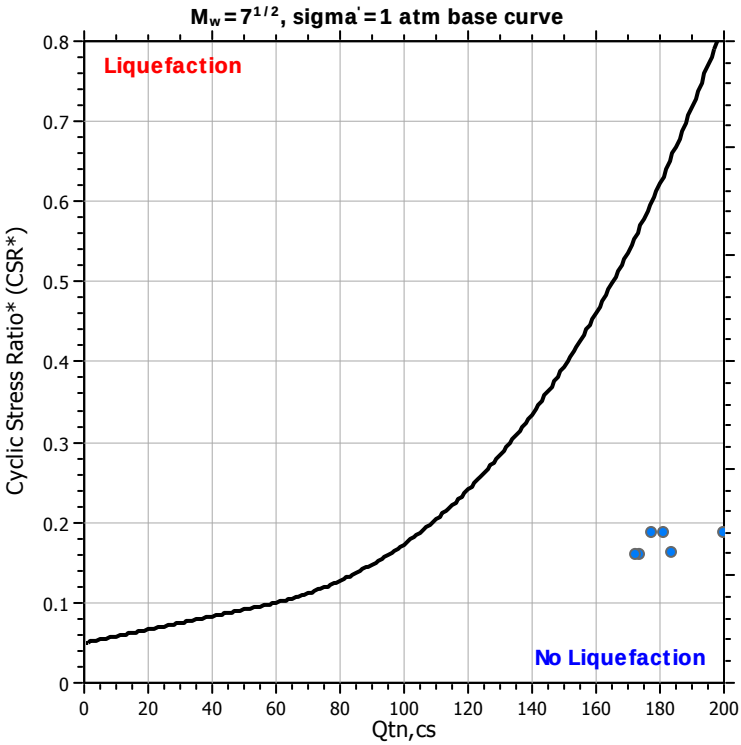
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

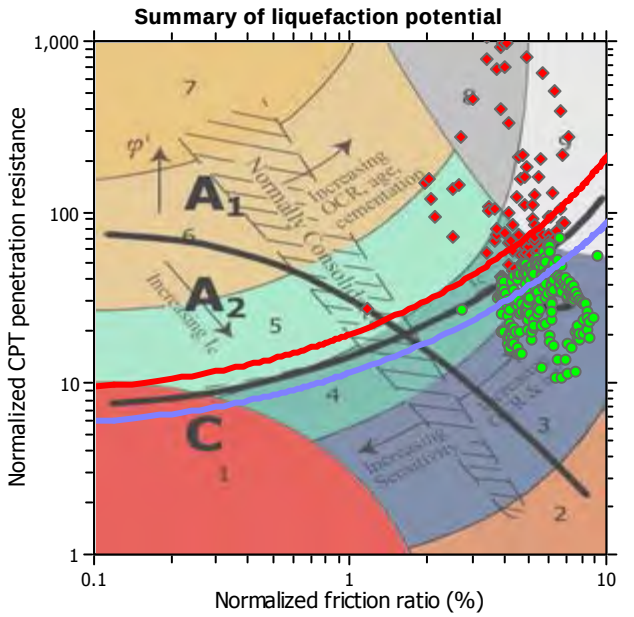
CPT file : 1-CPT-8

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	21.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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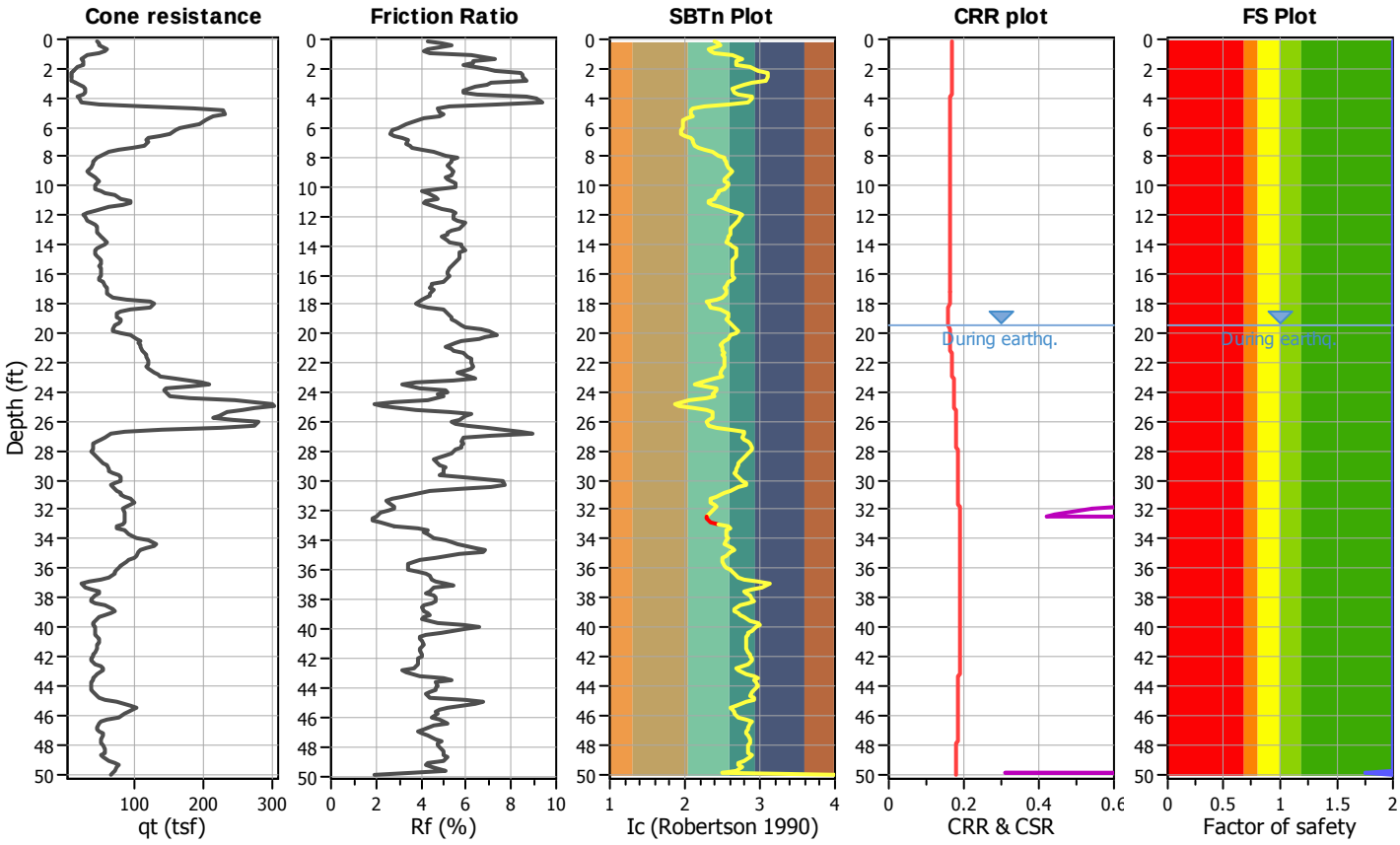
LIQUEFACTION ANALYSIS REPORT

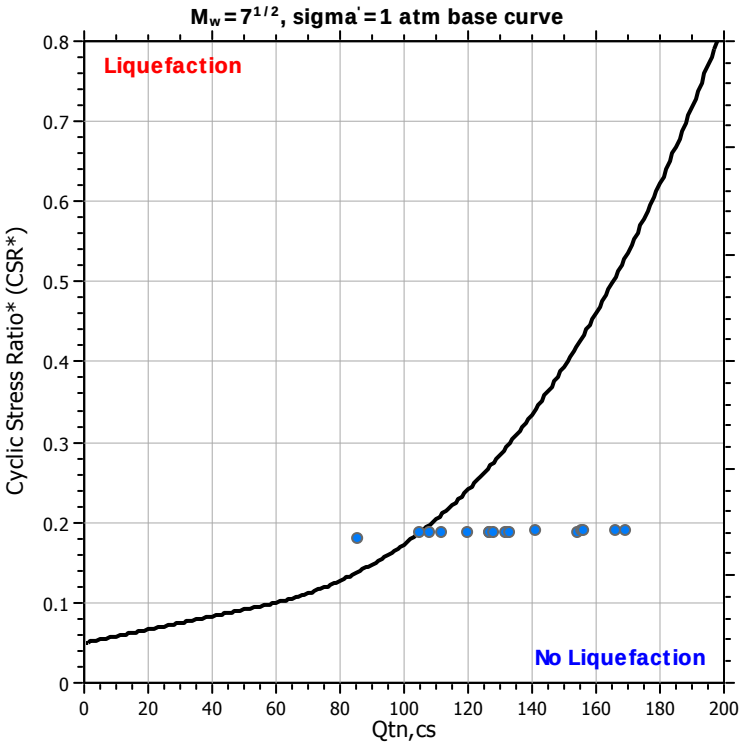
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

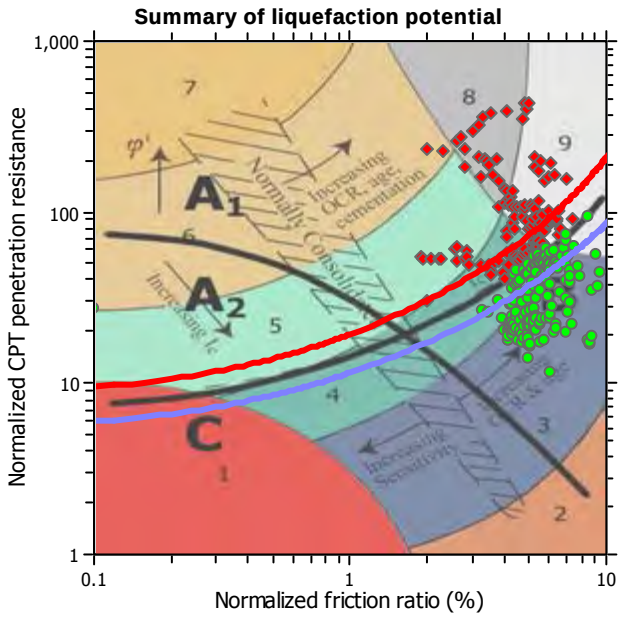
CPT file : 1-CPT-9

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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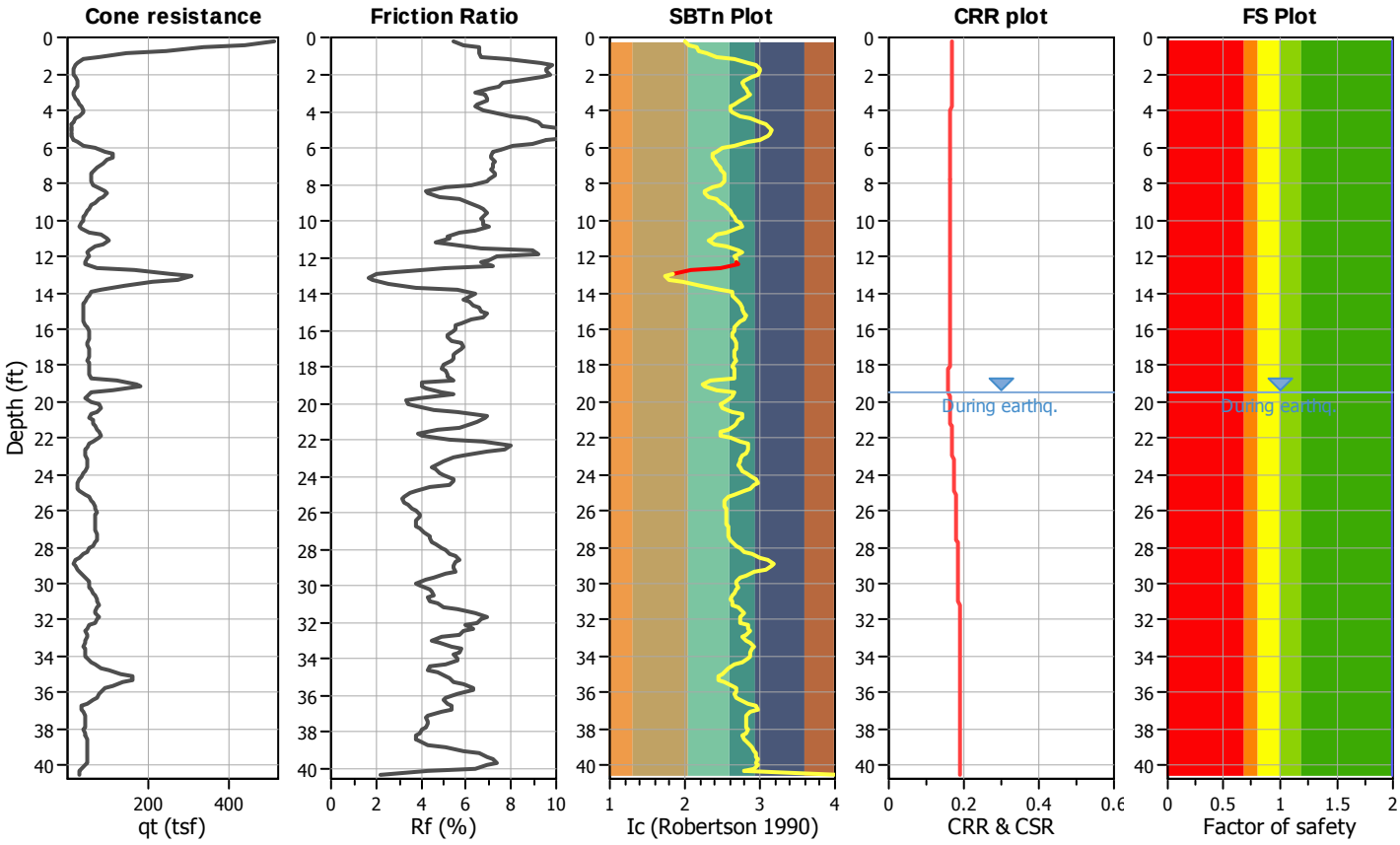
LIQUEFACTION ANALYSIS REPORT

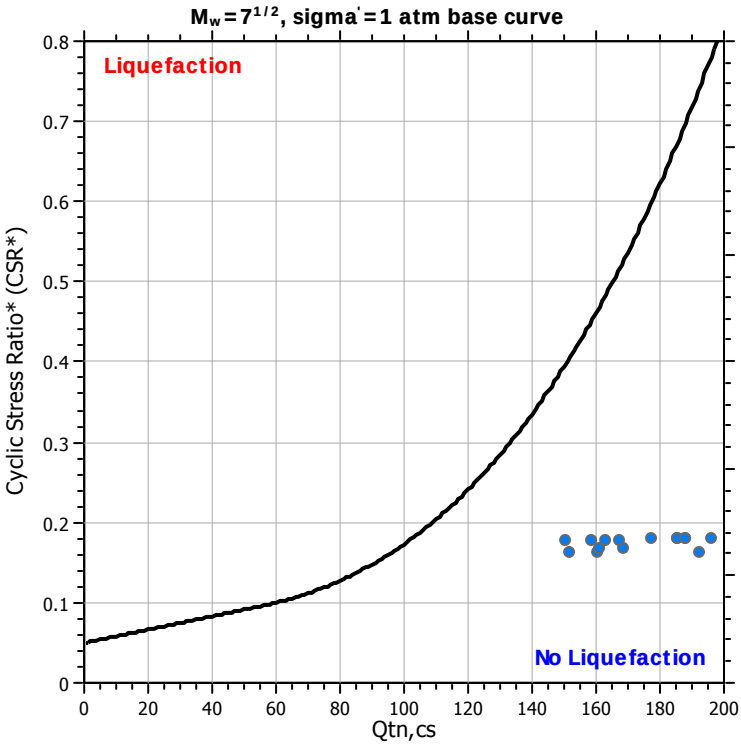
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

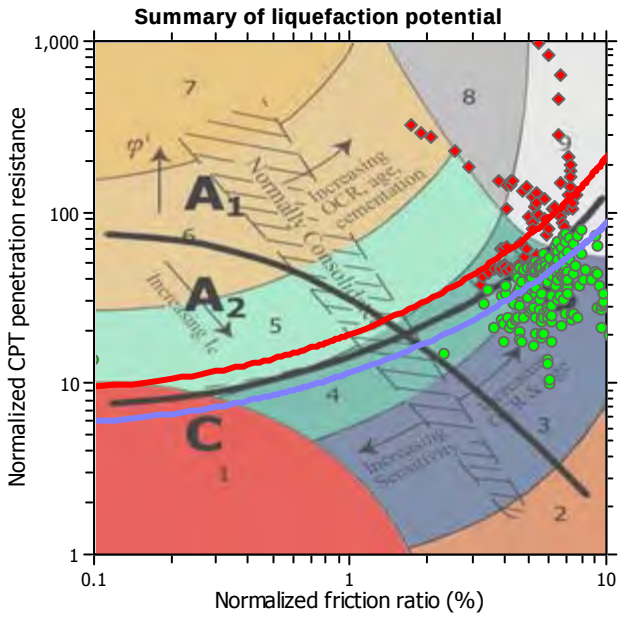
CPT file : 1-CPT-10

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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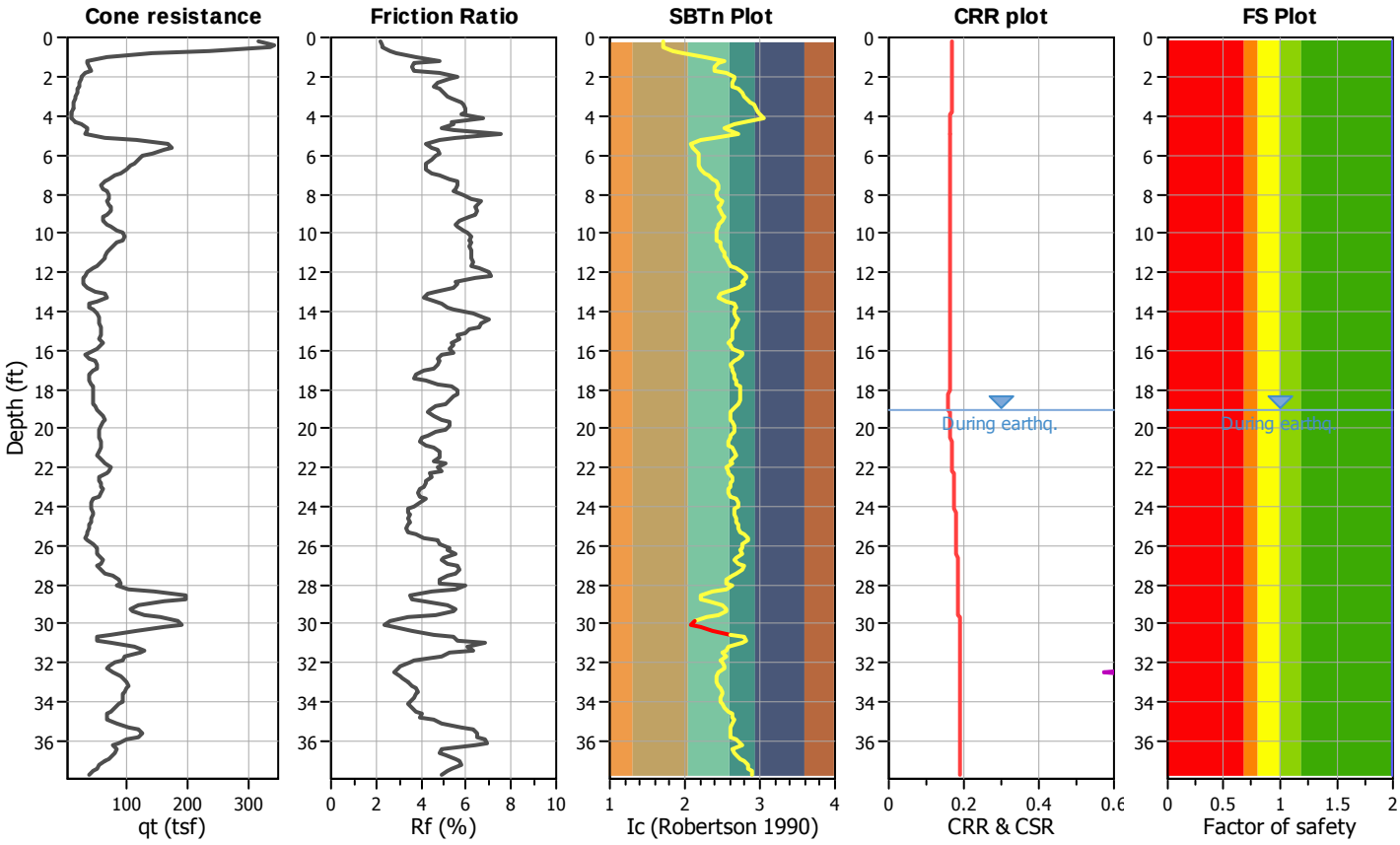
LIQUEFACTION ANALYSIS REPORT

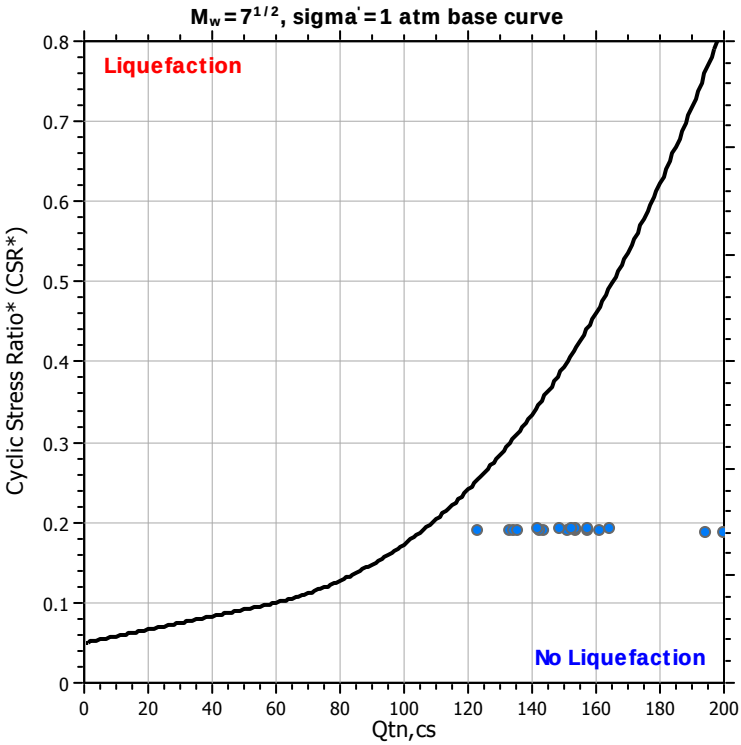
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

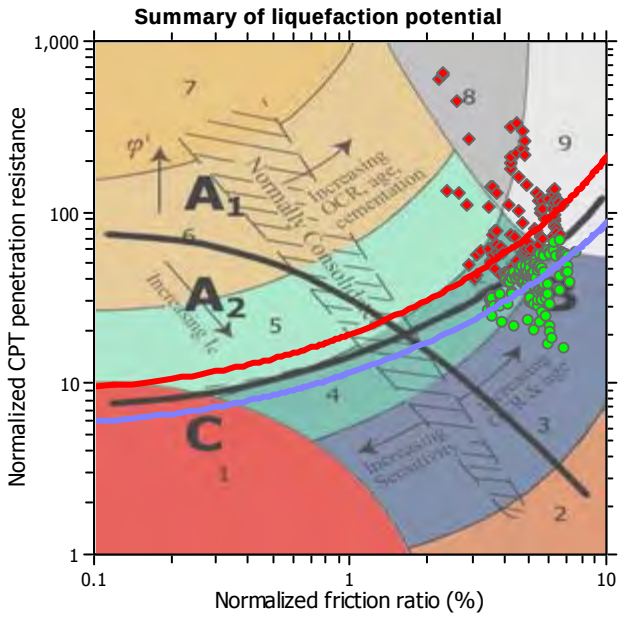
CPT file : 1-CPT-11

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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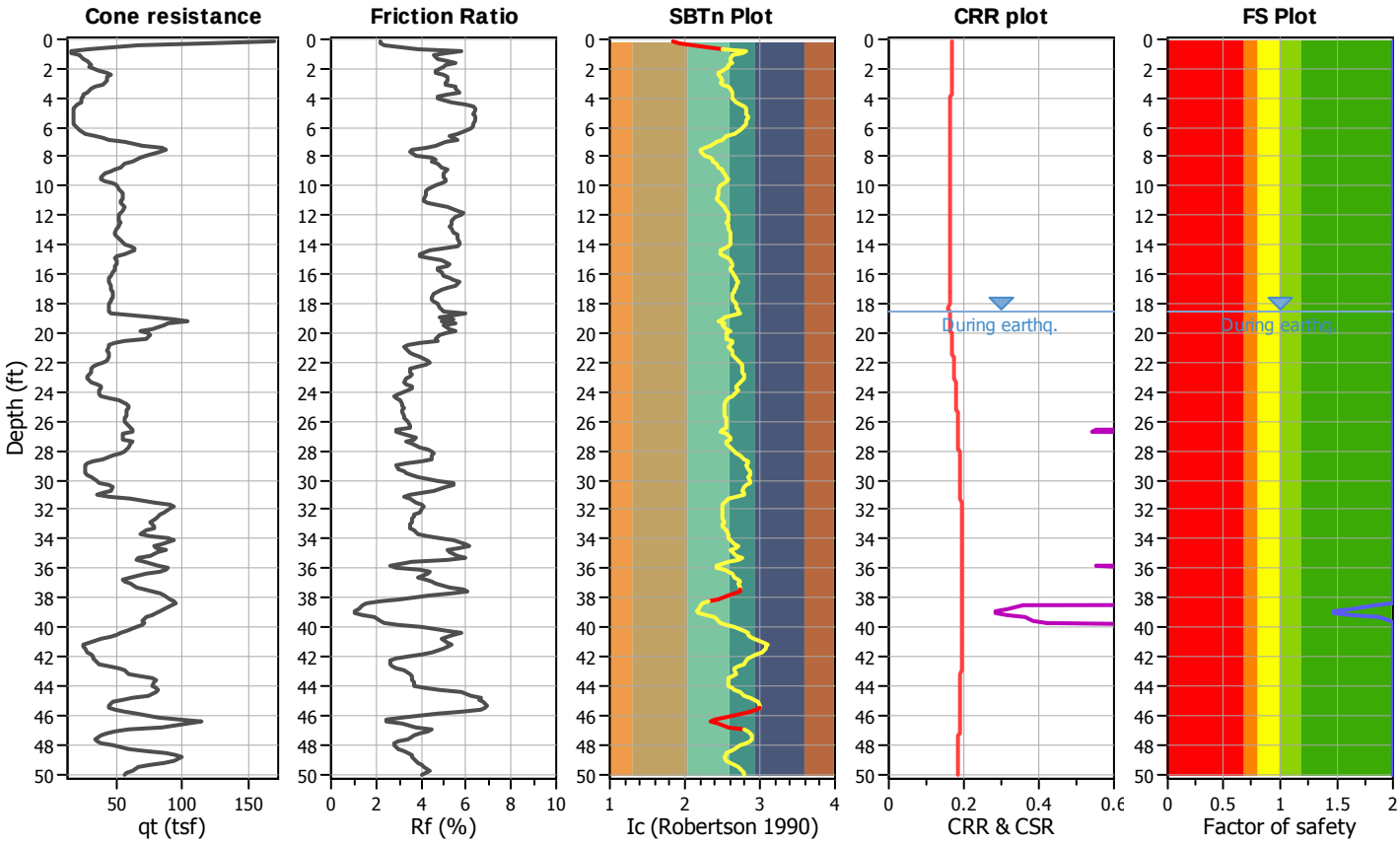
LIQUEFACTION ANALYSIS REPORT

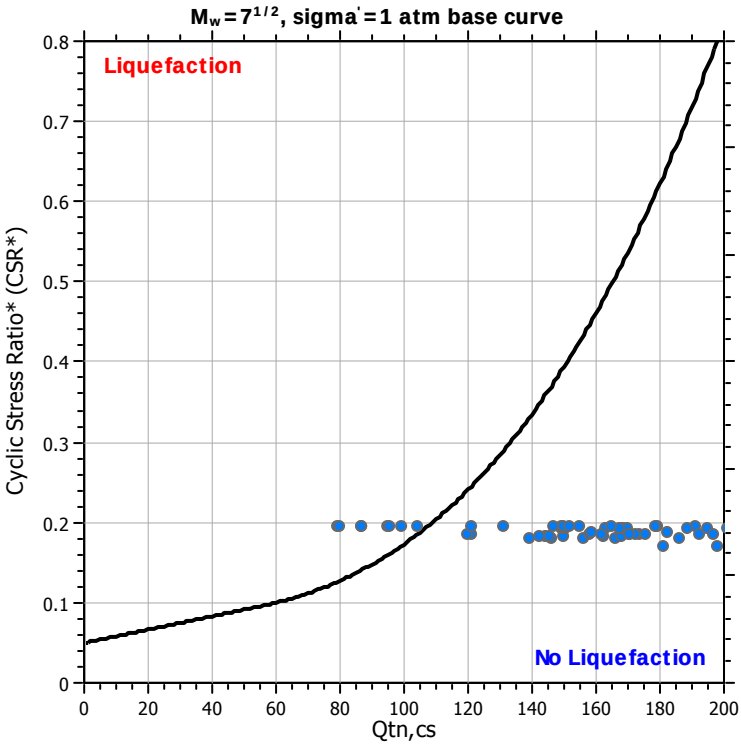
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

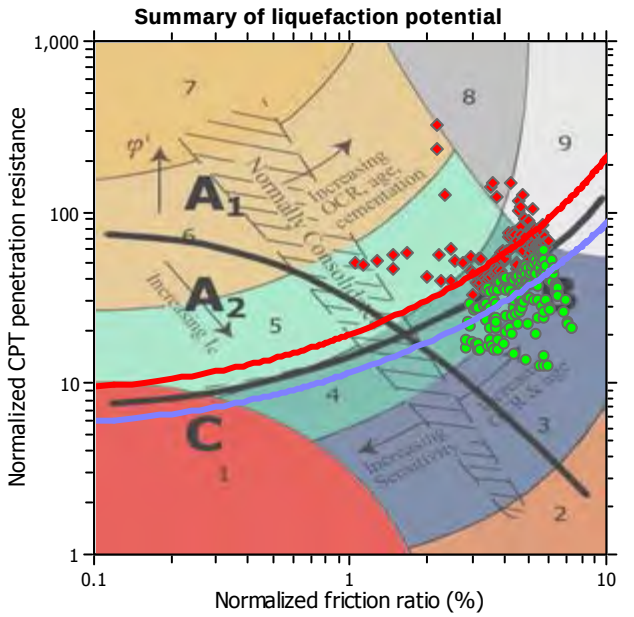
CPT file : 1-CPT-12

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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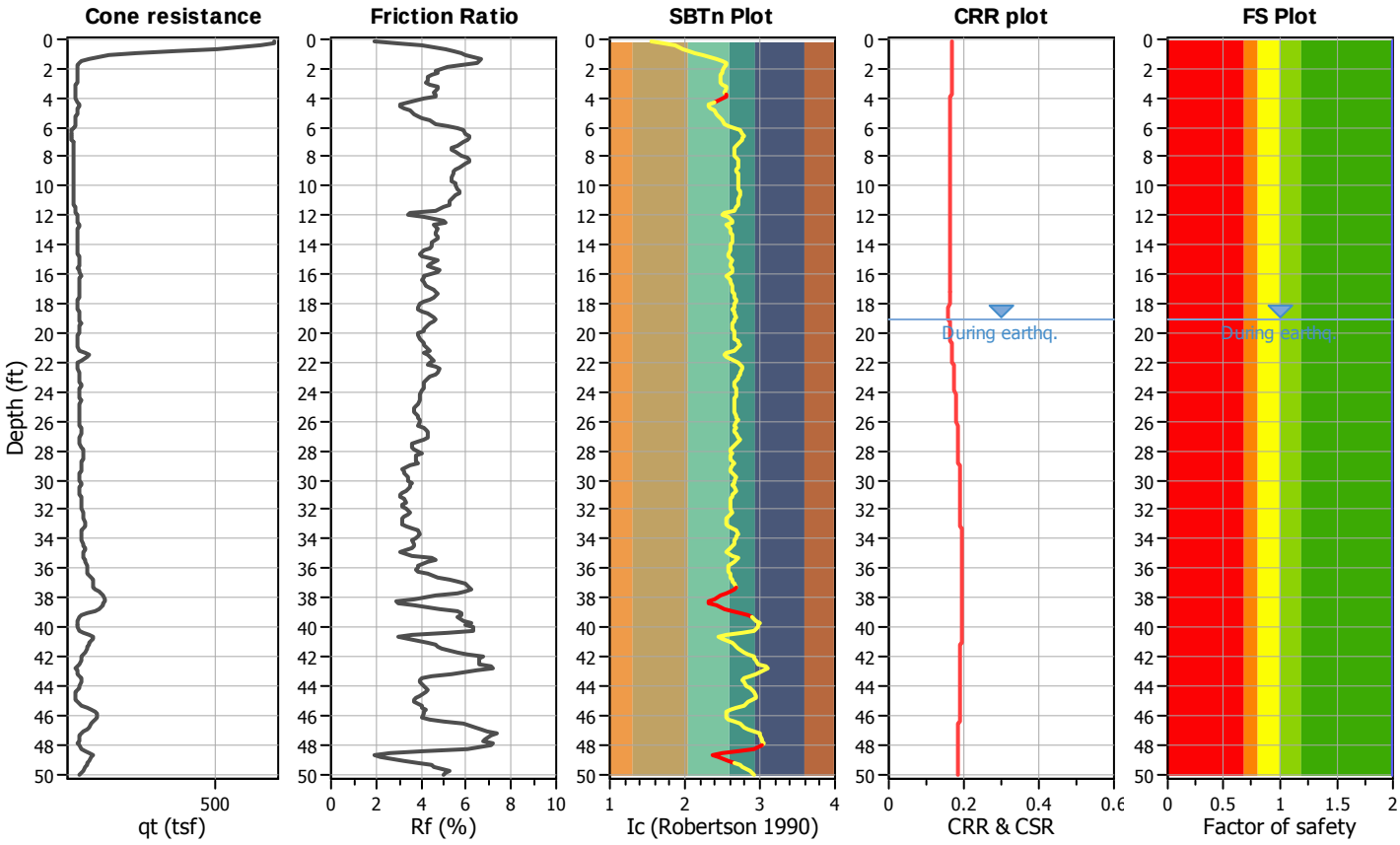
LIQUEFACTION ANALYSIS REPORT

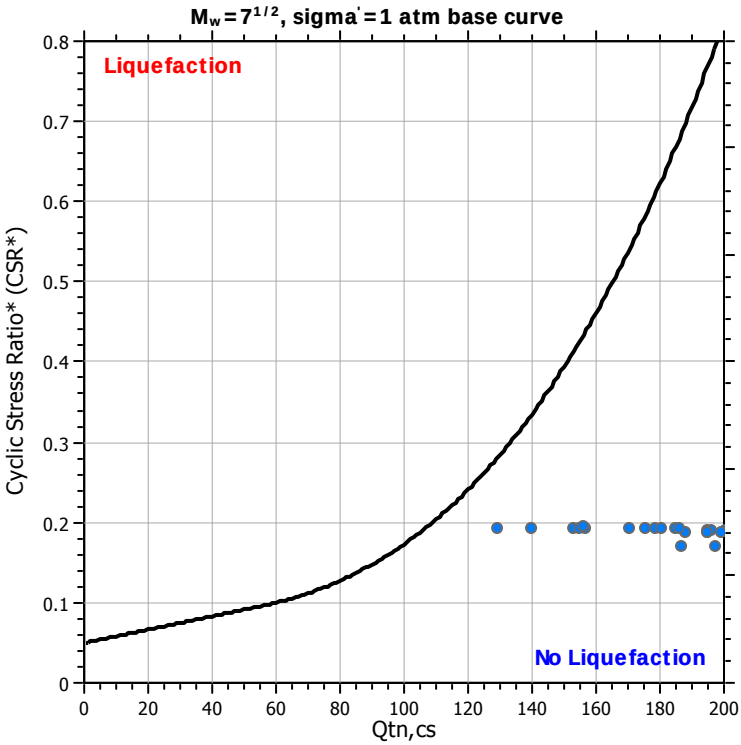
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

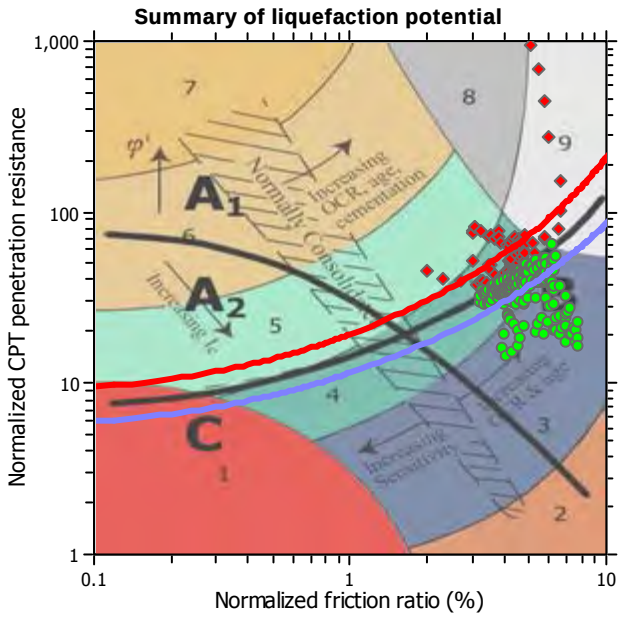
CPT file : 1-CPT-13

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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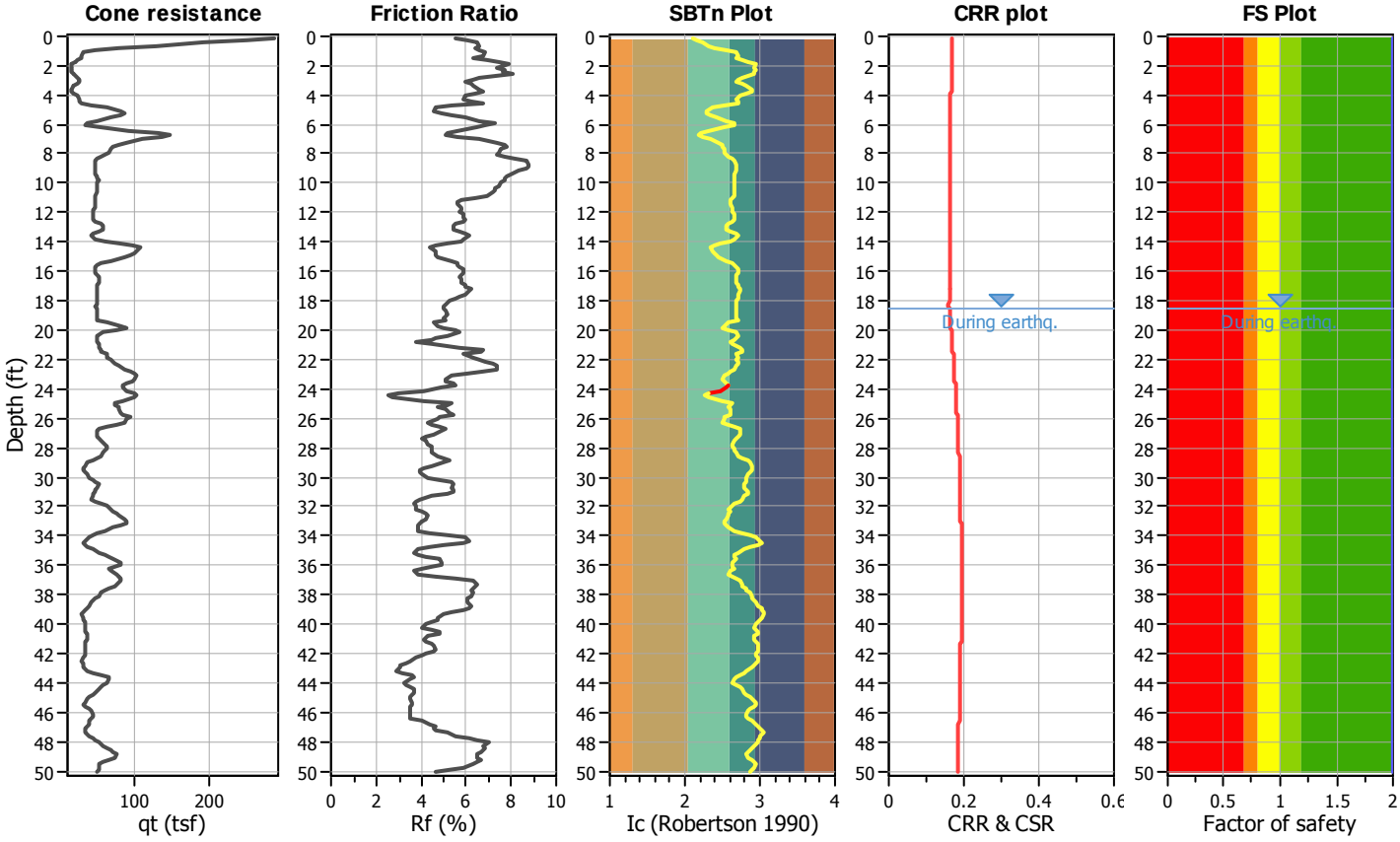
LIQUEFACTION ANALYSIS REPORT

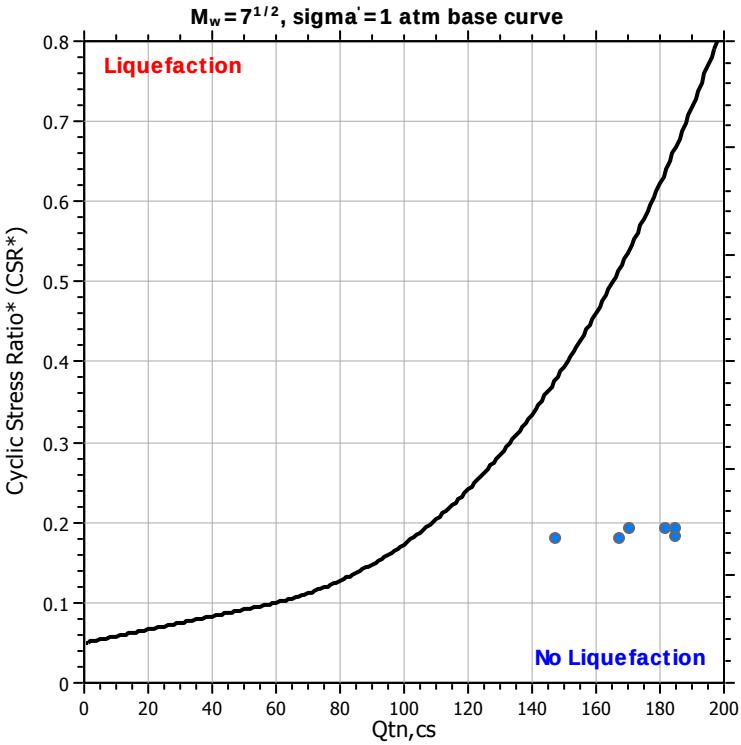
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

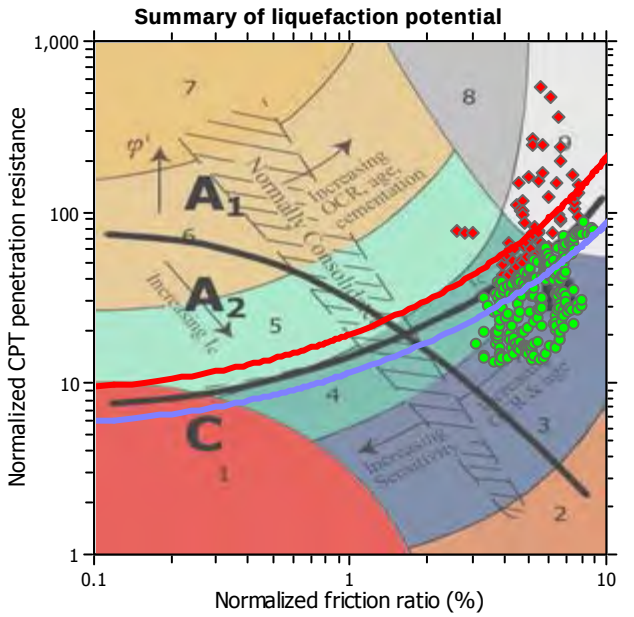
CPT file : 1-CPT-14

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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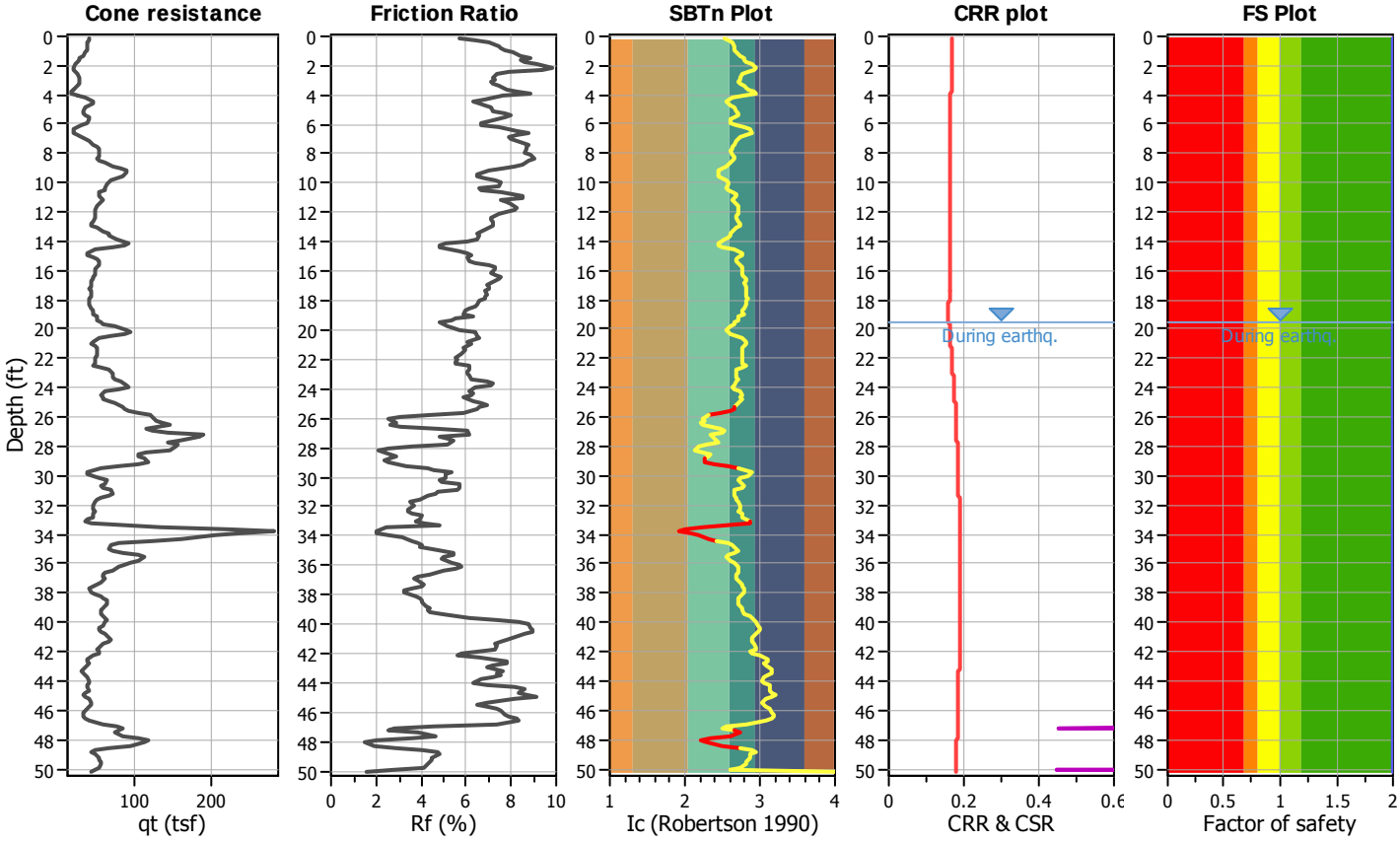
LIQUEFACTION ANALYSIS REPORT

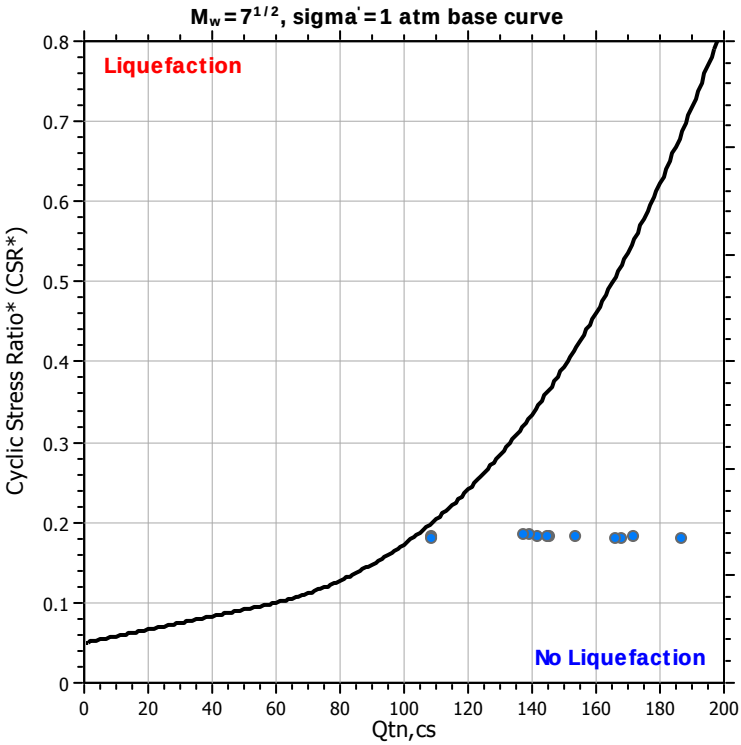
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

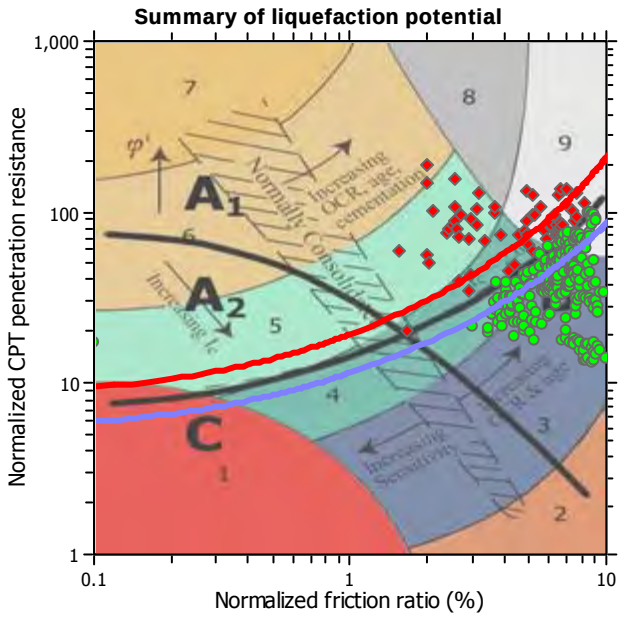
CPT file : 1-CPT-15

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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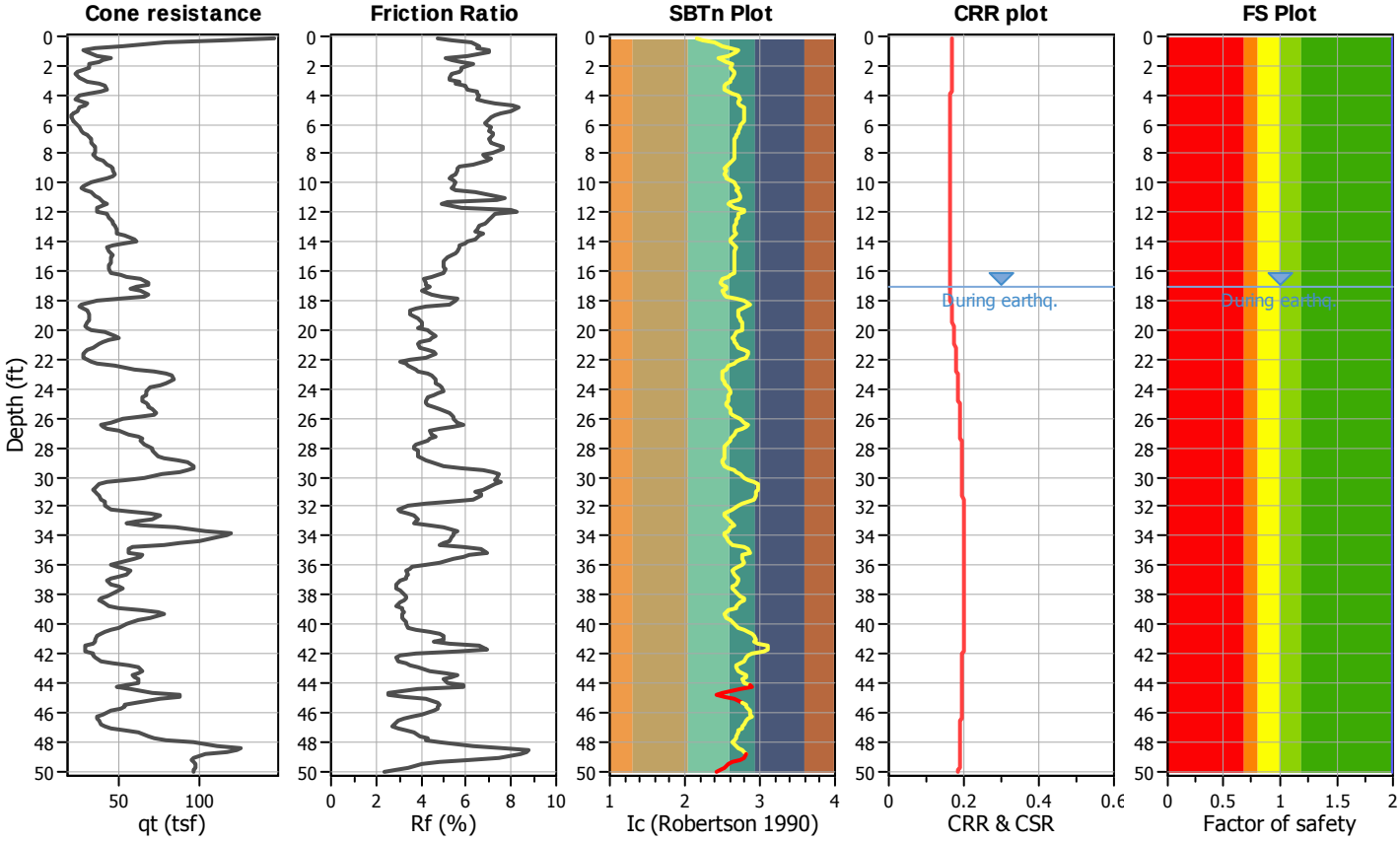
LIQUEFACTION ANALYSIS REPORT

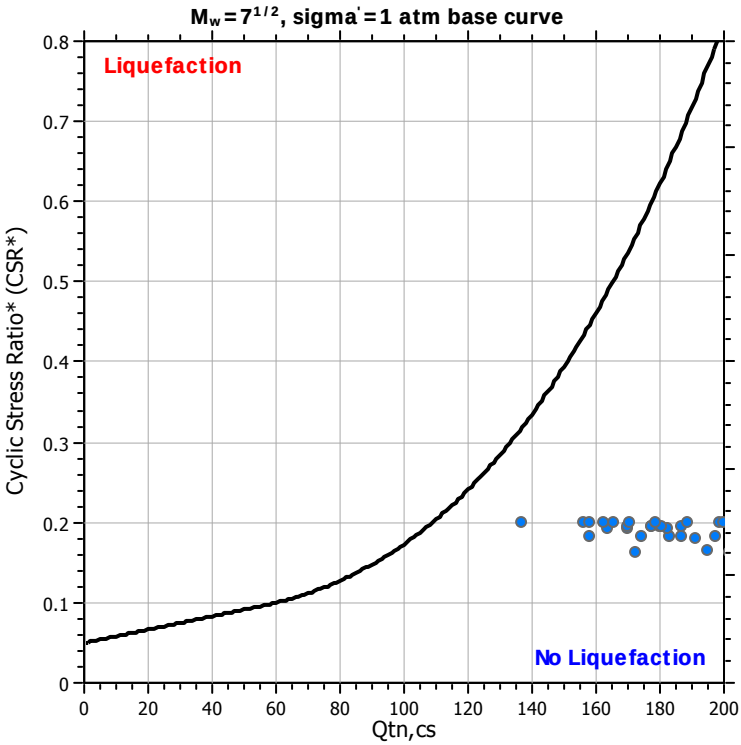
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

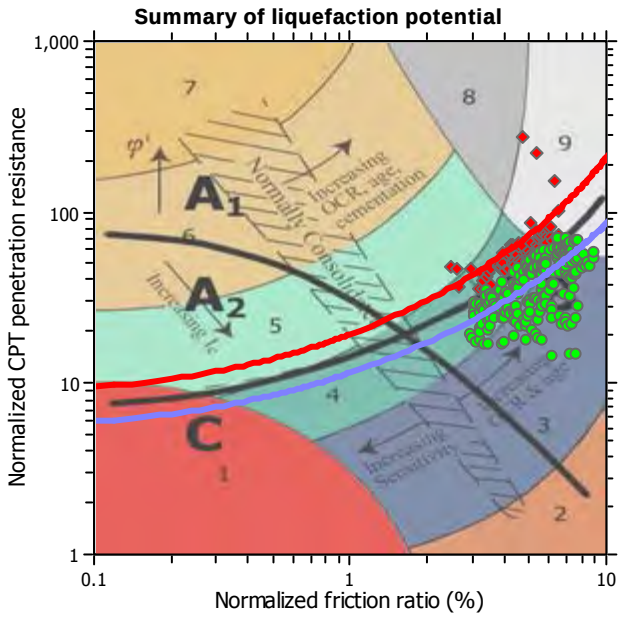
CPT file : 1-CPT-16

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	17.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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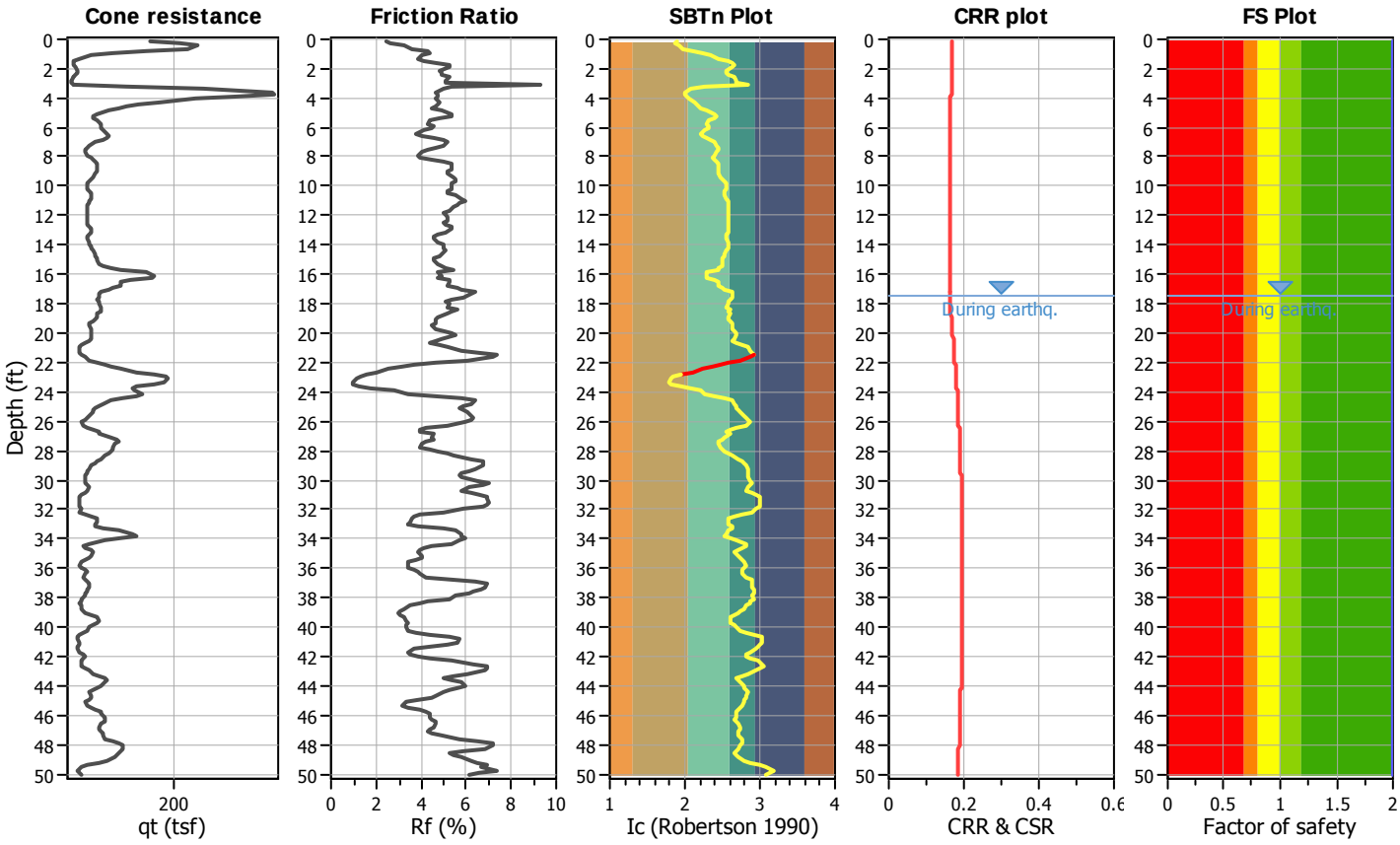
LIQUEFACTION ANALYSIS REPORT

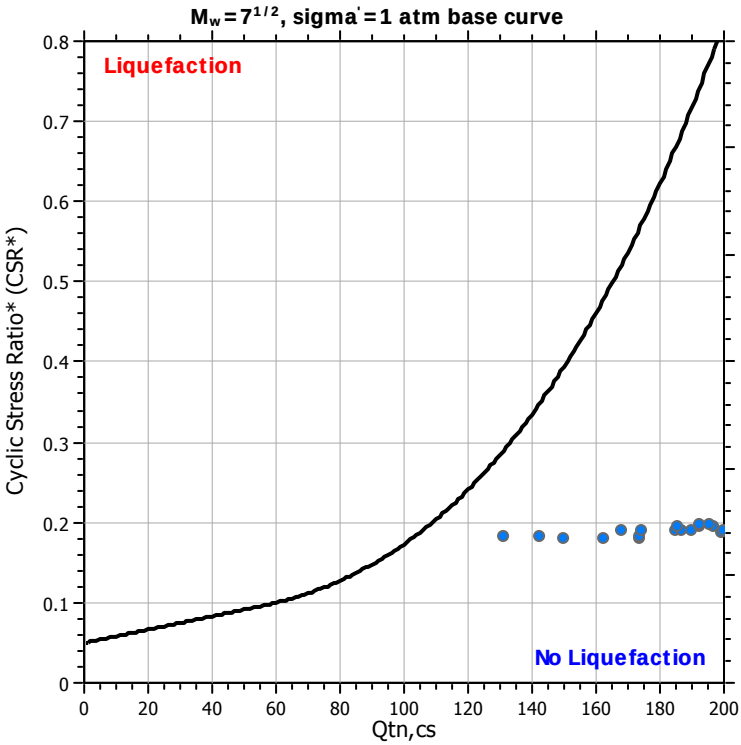
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

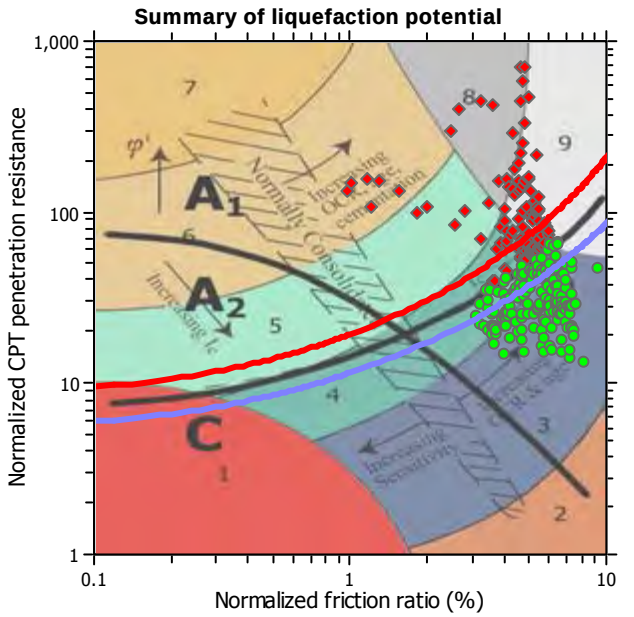
CPT file : 1-CPT-17

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	18.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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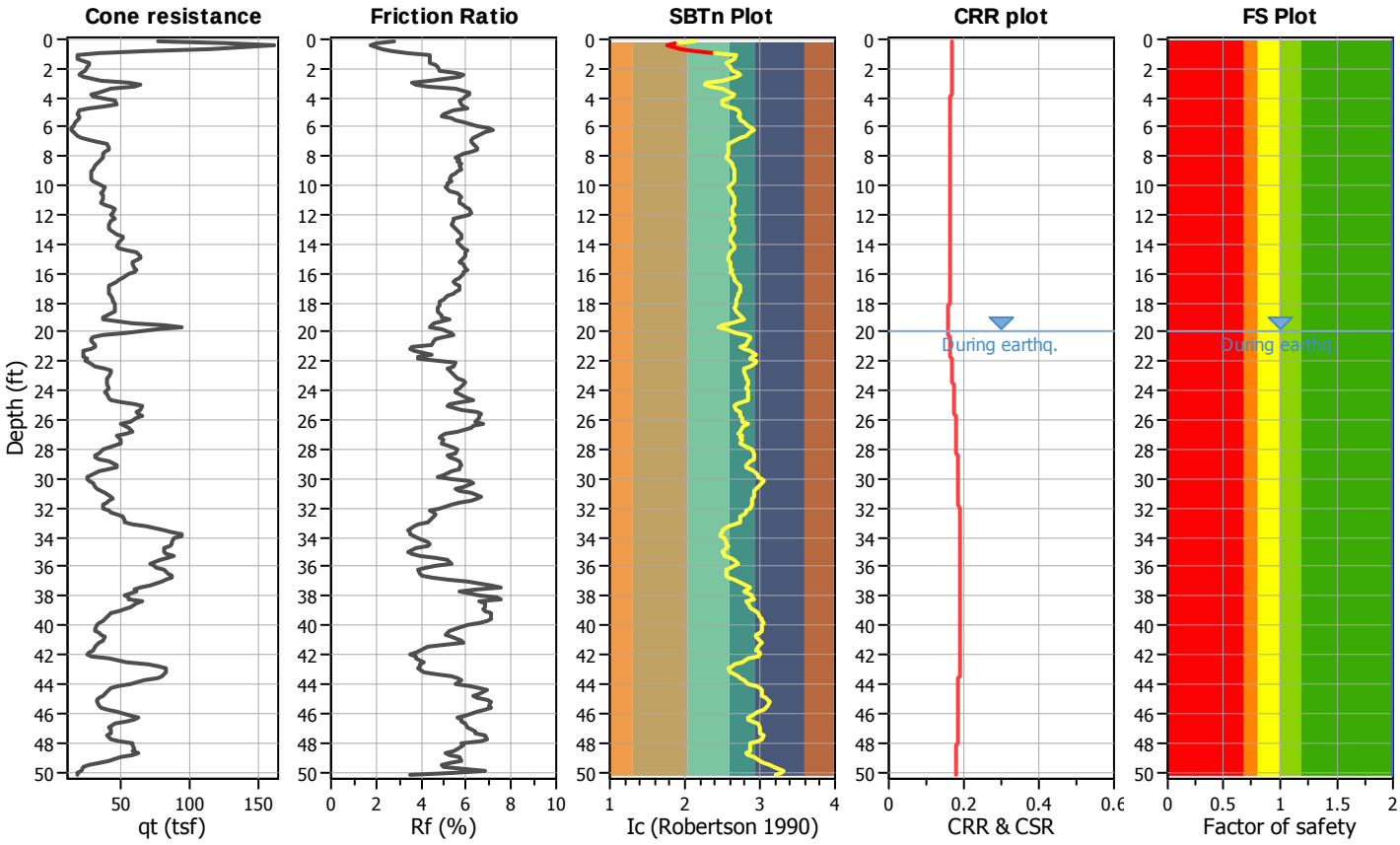
LIQUEFACTION ANALYSIS REPORT

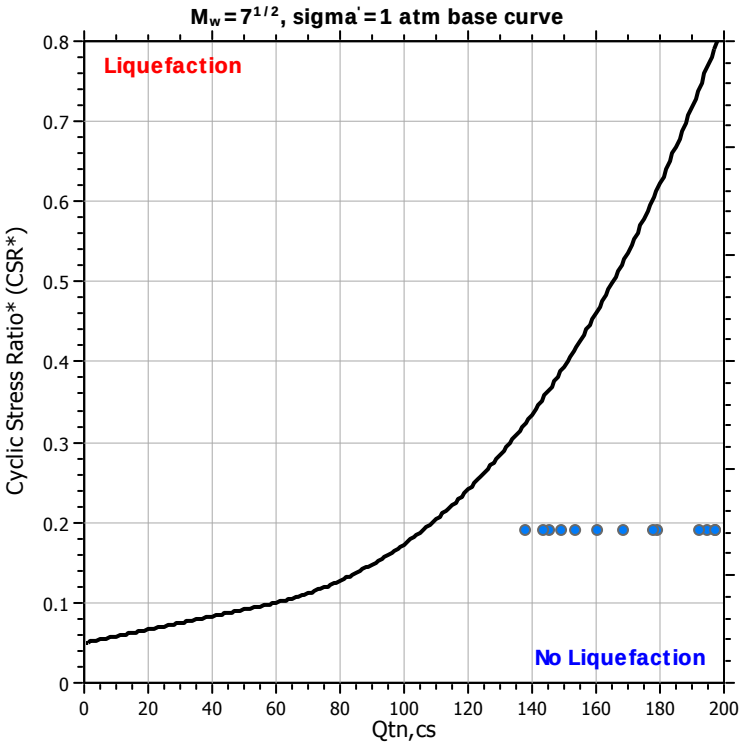
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

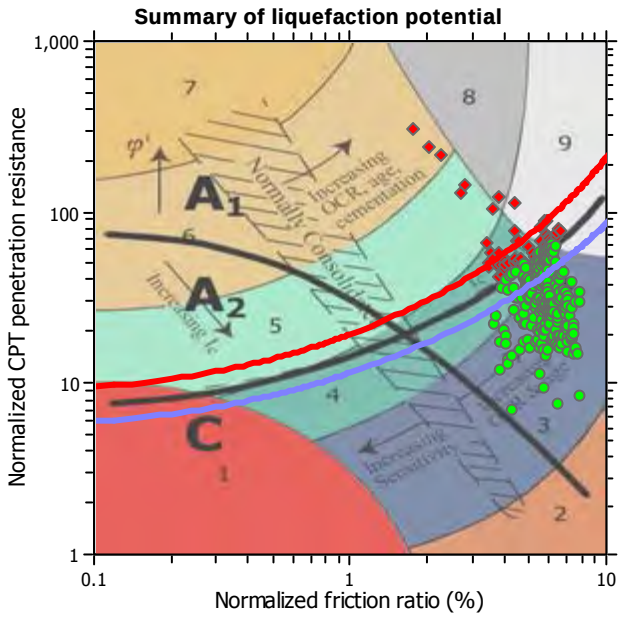
CPT file : 1-CPT-18

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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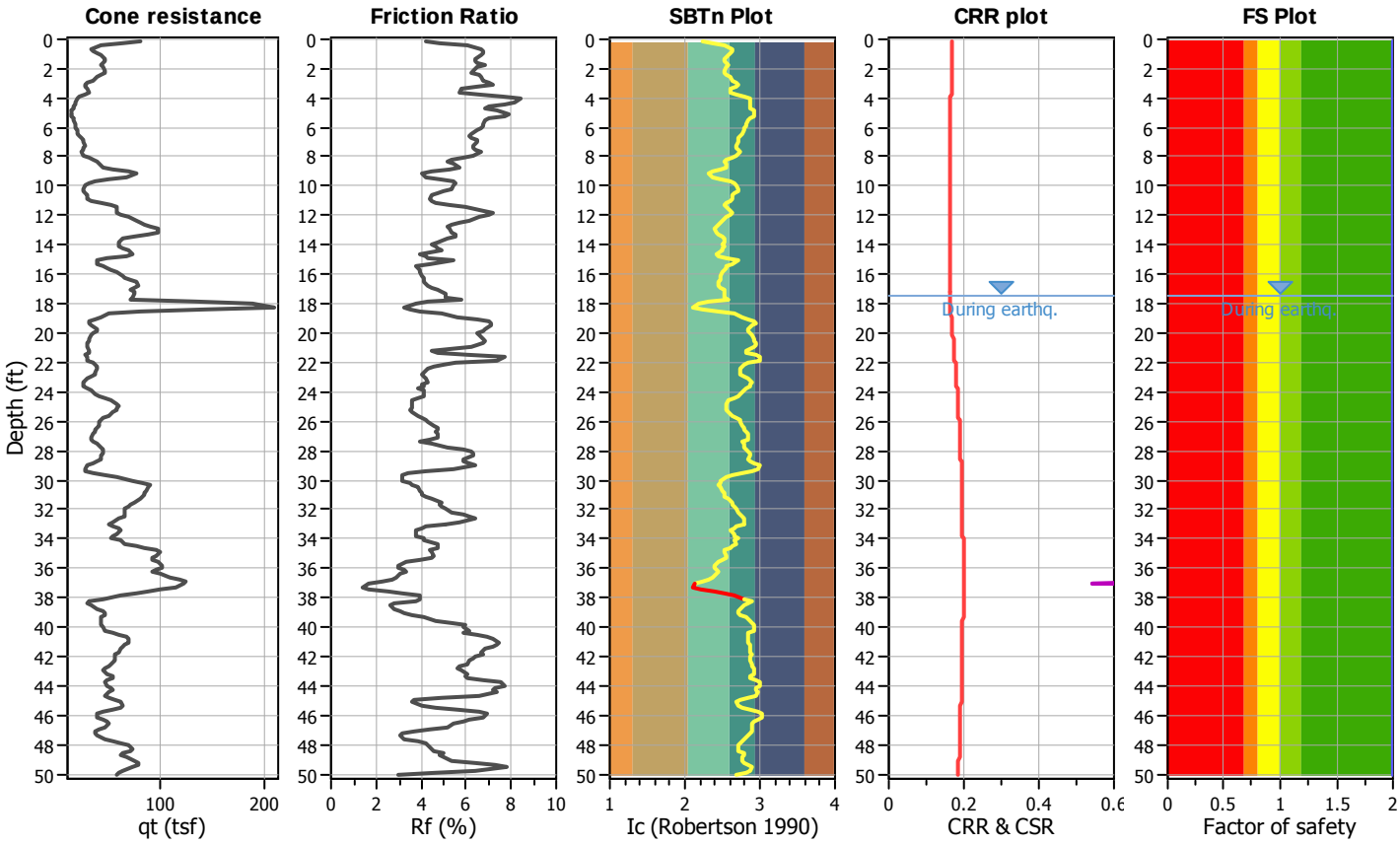
LIQUEFACTION ANALYSIS REPORT

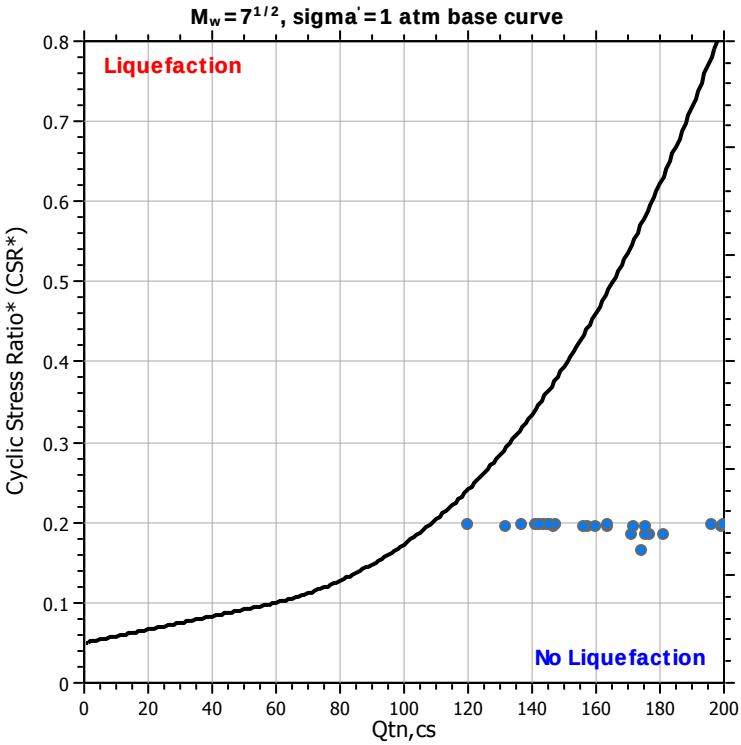
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

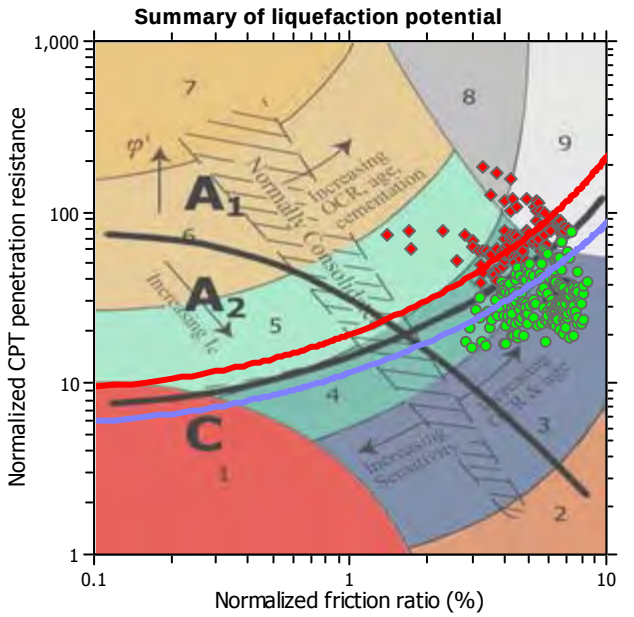
CPT file : 1-CPT-19

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	18.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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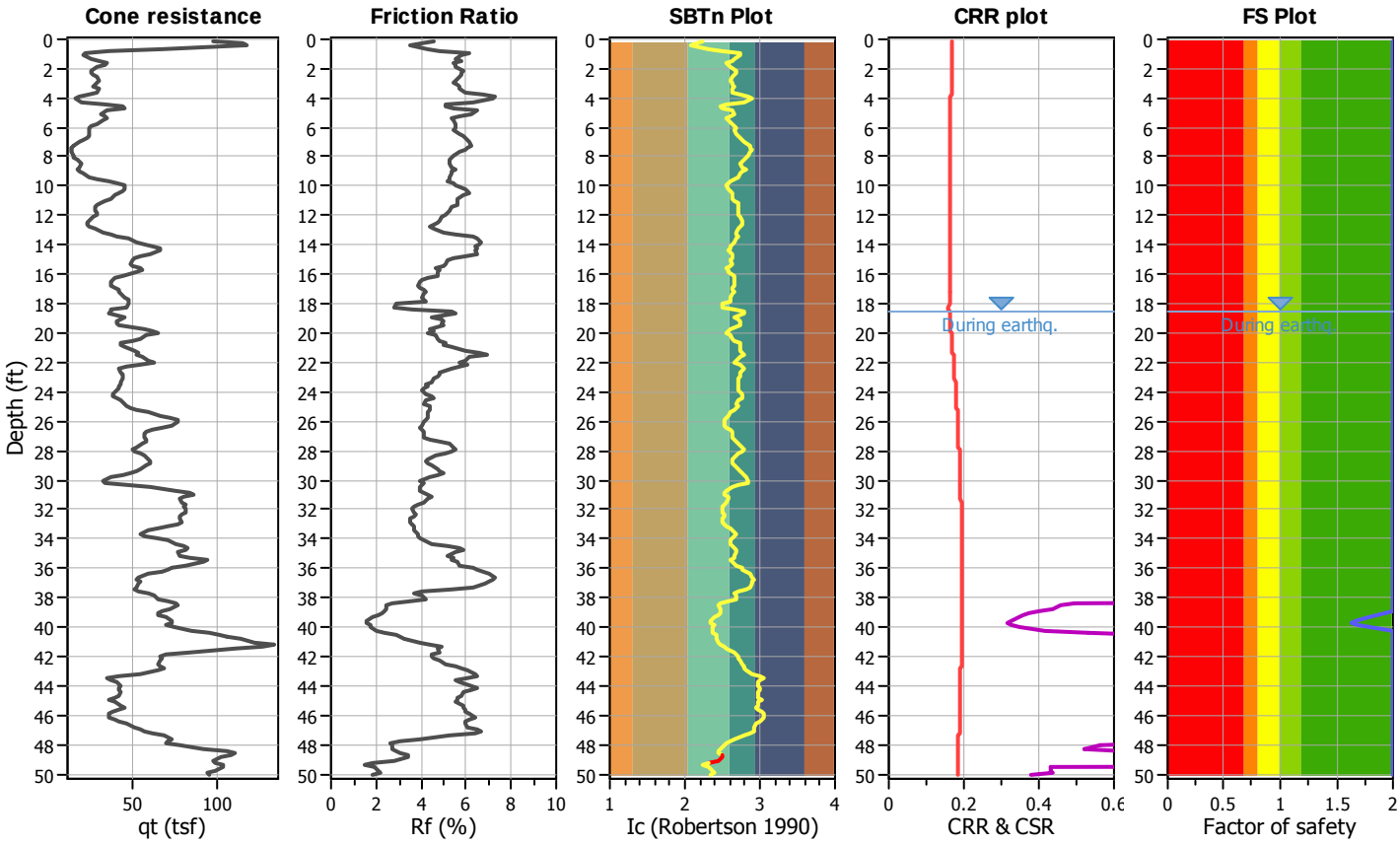
LIQUEFACTION ANALYSIS REPORT

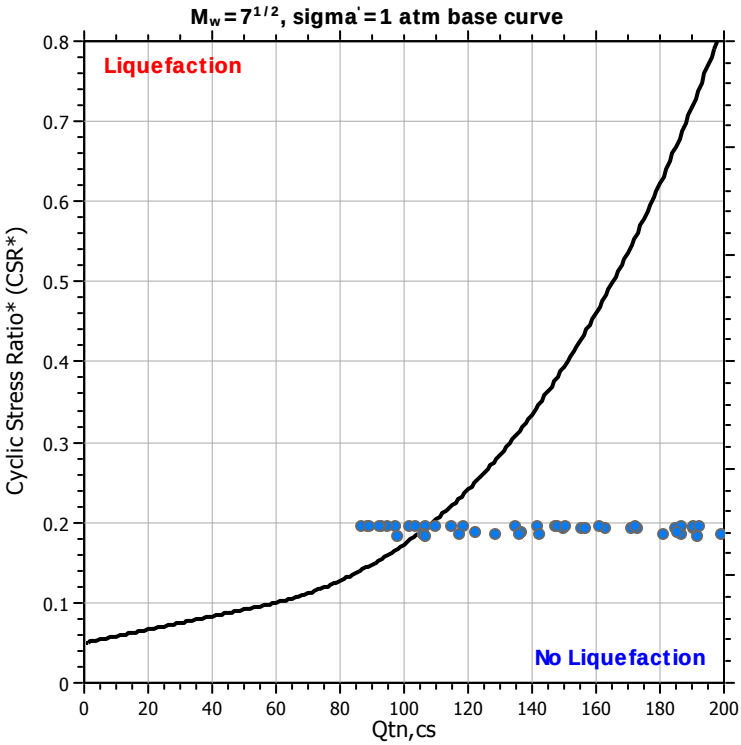
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

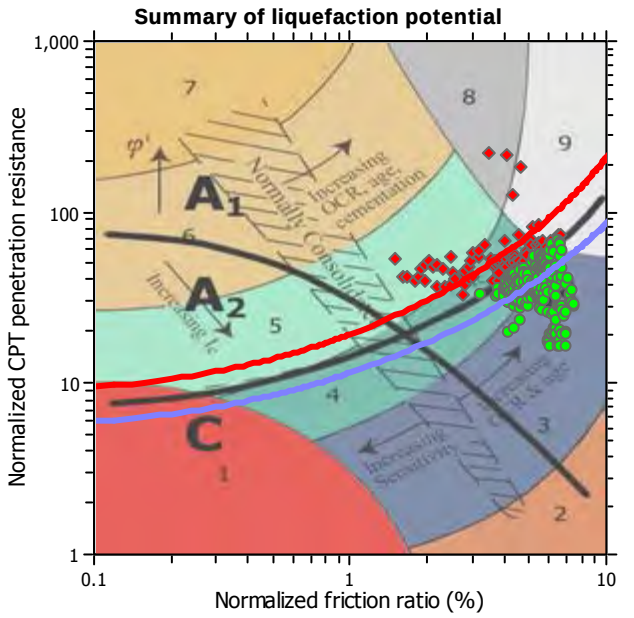
CPT file : 1-CPT-20

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	19.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	18.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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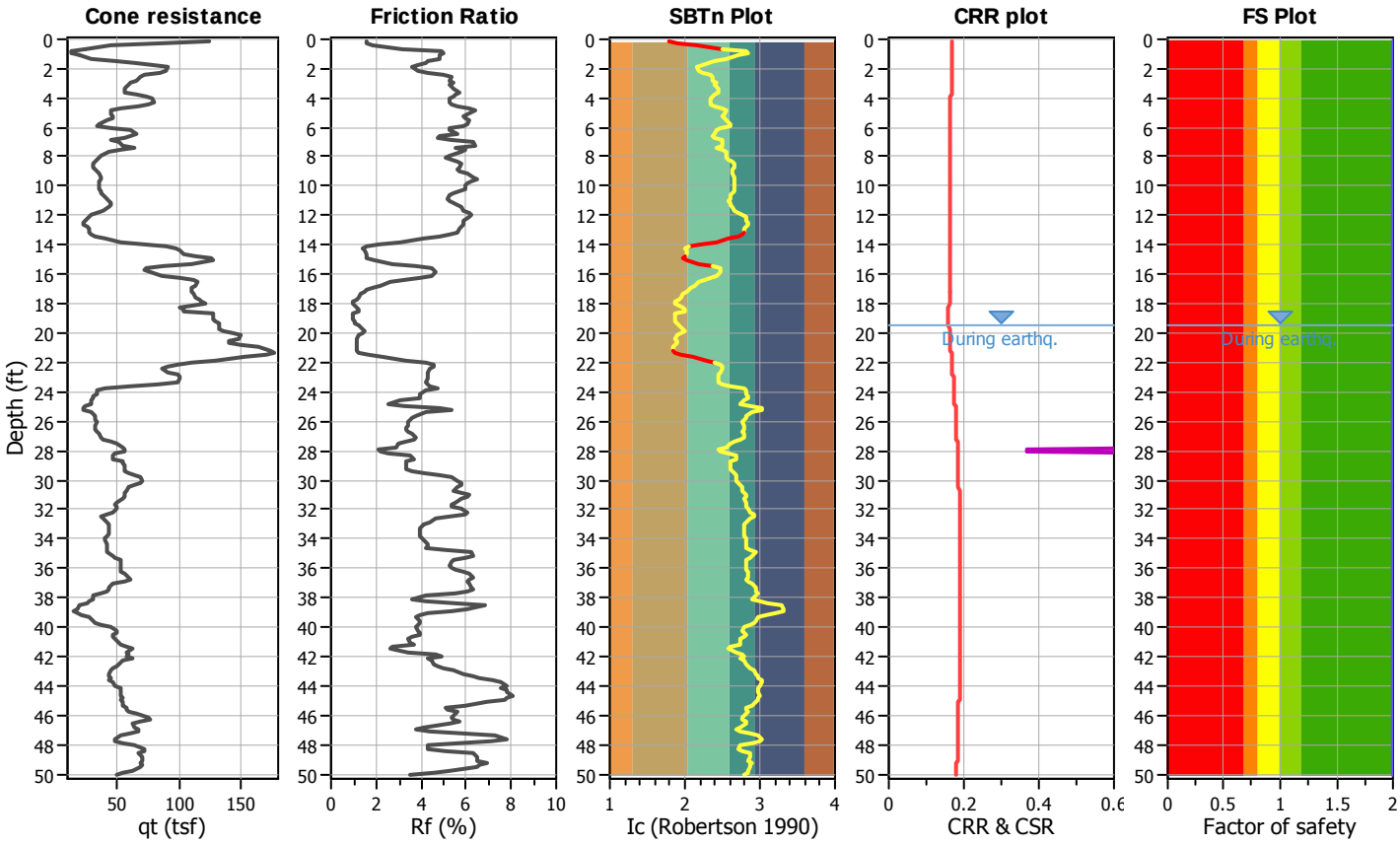
LIQUEFACTION ANALYSIS REPORT

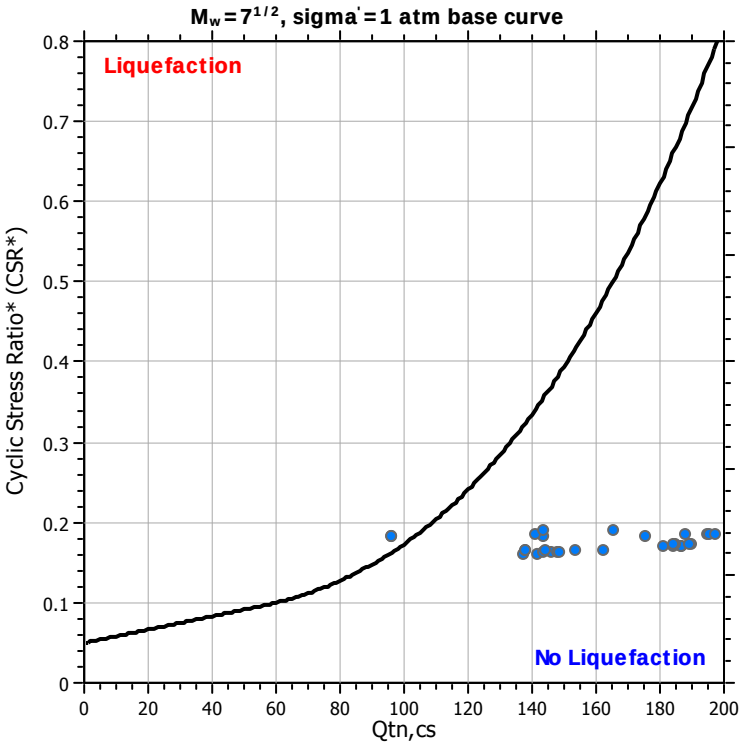
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

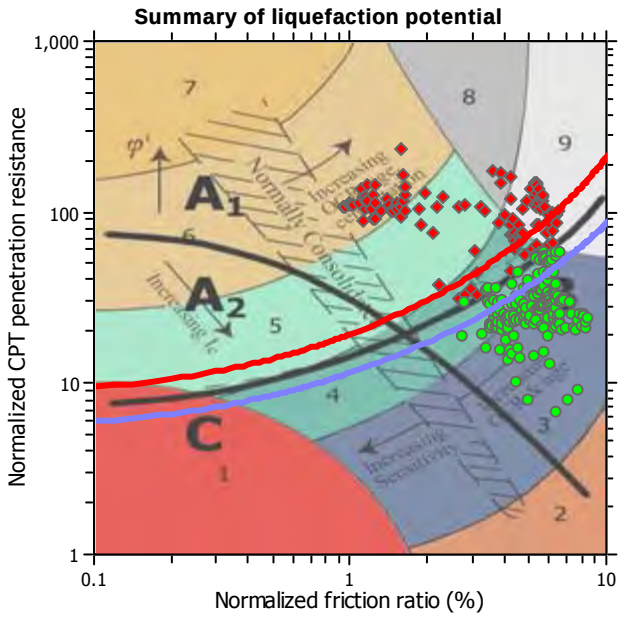
CPT file : 1-CPT-21

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.50 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	19.50 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.80	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.33	Unit weight calculation:	Based on SBT	K_σ applied:	No		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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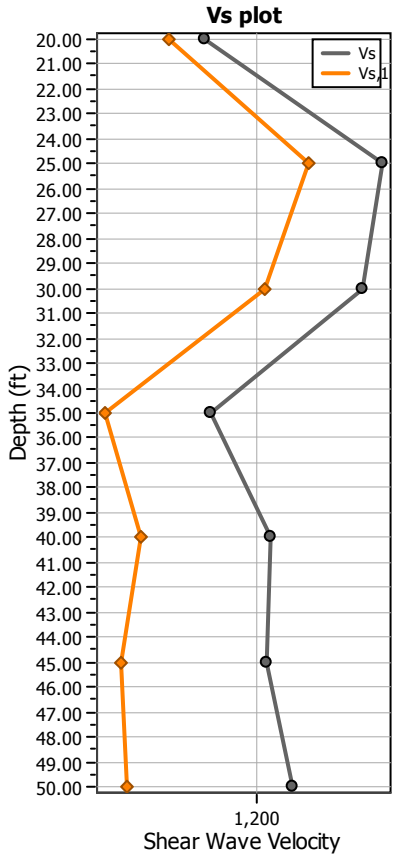
Vs BASED LIQUEFACTION ANALYSIS REPORT (NCEER 1998)

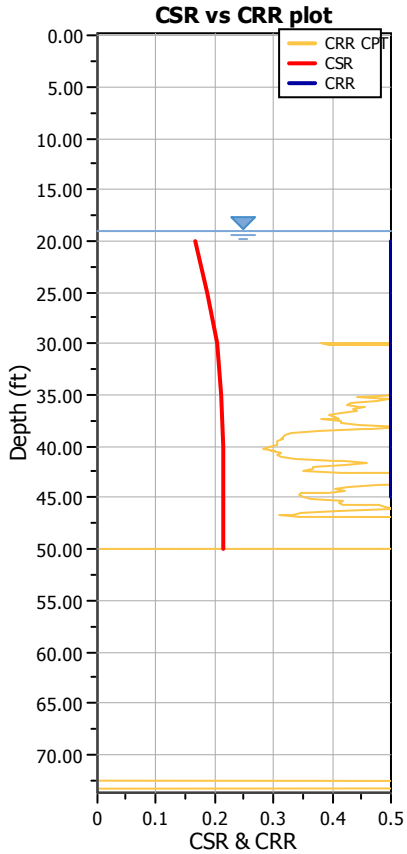
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

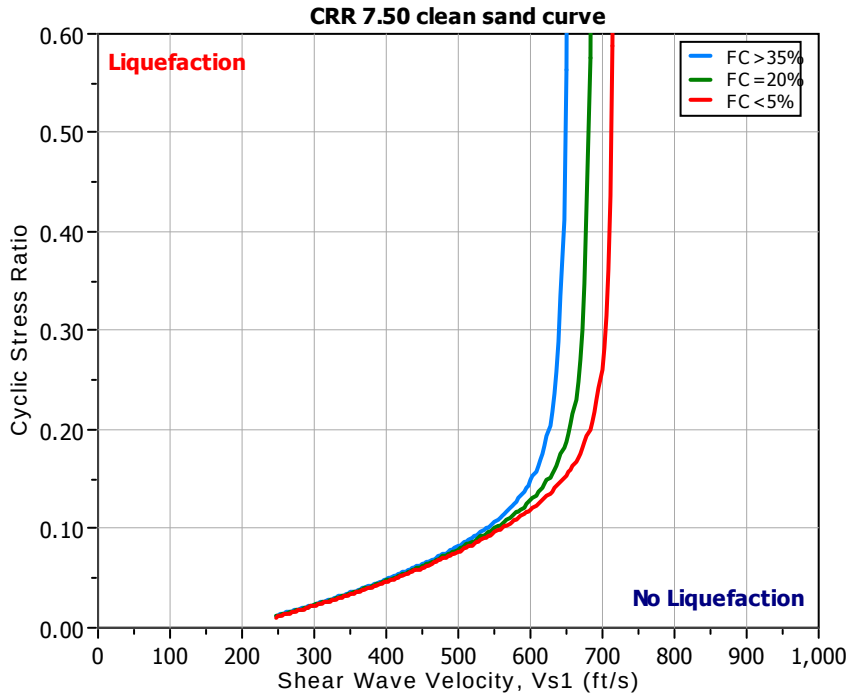
CPT file : 1-CPT-4

:: Input parameters and analysis properties ::

Calculation m;ethod:	NCEER (1998)
G.W.T. (in-situ):	19.00 ft
G.W.T. (earthq.):	19.00 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	126.64	0.03	1.27	1.24	0.95	0.210	0.97	1.28	0.168	Yes
2	25.00	124.48	0.19	1.58	1.39	0.94	0.229	0.95	1.28	0.188	Yes
3	30.00	121.16	0.34	1.88	1.54	0.93	0.244	0.93	1.28	0.205	Yes
4	35.00	123.95	0.50	2.19	1.69	0.89	0.247	0.91	1.28	0.211	Yes
5	40.00	118.96	0.66	2.49	1.83	0.85	0.247	0.90	1.28	0.215	Yes
6	45.00	119.87	0.81	2.79	1.98	0.81	0.245	0.88	1.28	0.216	Yes
7	50.00	123.68	0.97	3.10	2.13	0.77	0.240	0.87	1.28	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	V_{s1c} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	1,138.00	90.00	0.25	1094.81	656.17	0.500	2.97	Yes
2	25.00	1,350.00	43.00	0.25	1260.90	656.17	0.500	2.65	Yes
3	30.00	1,327.00	66.00	0.25	1208.69	656.17	0.500	2.44	Yes
4	35.00	1,144.00	12.00	0.25	1017.45	693.90	0.500	2.36	Yes
5	40.00	1,217.00	12.00	0.25	1060.86	693.90	0.500	2.33	Yes
6	45.00	1,212.00	16.00	0.25	1036.75	687.34	0.500	2.32	Yes
7	50.00	1,243.00	12.00	0.25	1043.61	693.90	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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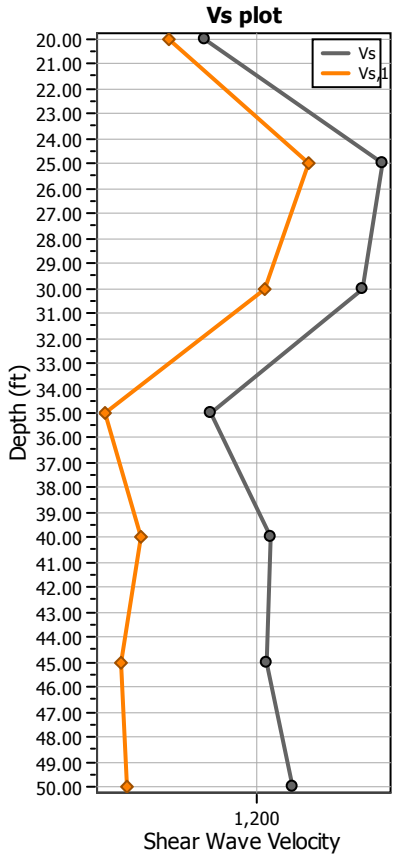
Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

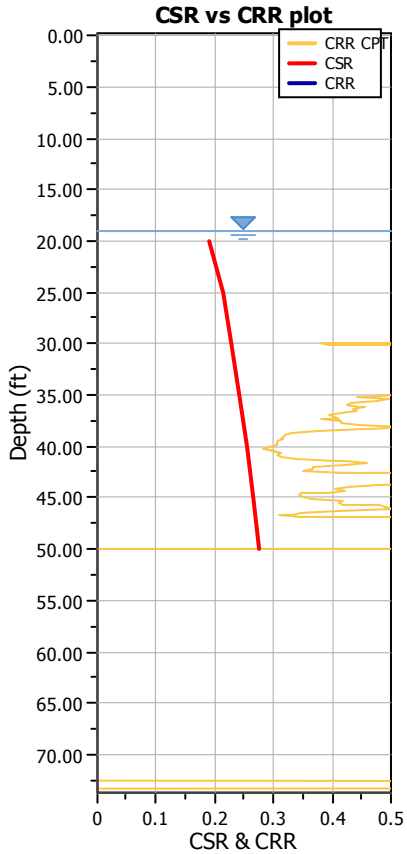
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

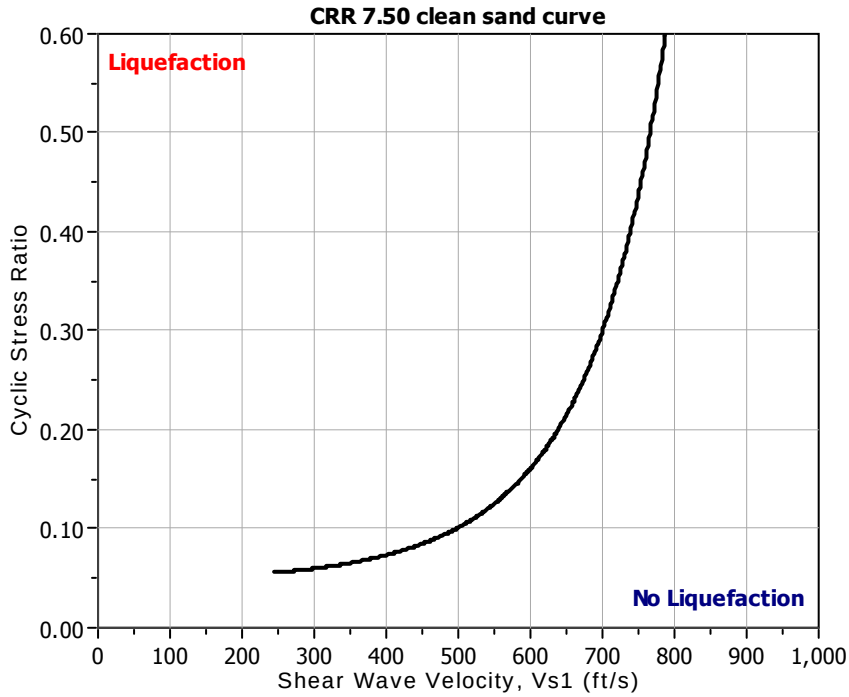
CPT file : 1-CPT-4

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	19.00 ft
G.W.T. (earthq.):	19.00 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	126.64	0.03	1.24	1.27	1.00	0.220	1.00	1.15	0.192	Yes
2	25.00	124.48	0.19	1.39	1.58	1.00	0.244	1.00	1.15	0.213	Yes
3	30.00	121.16	0.34	1.54	1.88	1.00	0.263	1.00	1.15	0.229	Yes
4	35.00	123.95	0.50	1.69	2.19	1.00	0.278	1.00	1.15	0.243	Yes
5	40.00	118.96	0.66	1.83	2.49	1.00	0.292	1.00	1.15	0.255	Yes
6	45.00	119.87	0.81	1.98	2.79	1.00	0.304	1.00	1.15	0.265	Yes
7	50.00	123.68	0.97	2.13	3.10	1.01	0.314	1.00	1.15	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	1,138.00	90.00	0.96	1094.81	64.989	338.31	Yes
2	25.00	1,350.00	43.00	0.93	1260.90	1244.727	5853.78	Yes
3	30.00	1,327.00	66.00	0.91	1208.69	458.136	1997.74	Yes
4	35.00	1,144.00	12.00	0.89	1017.45	18.304	75.34	Yes
5	40.00	1,217.00	12.00	0.87	1060.86	34.341	134.72	Yes
6	45.00	1,212.00	16.00	0.86	1036.75	24.212	91.26	Yes
7	50.00	1,243.00	12.00	0.84	1043.61	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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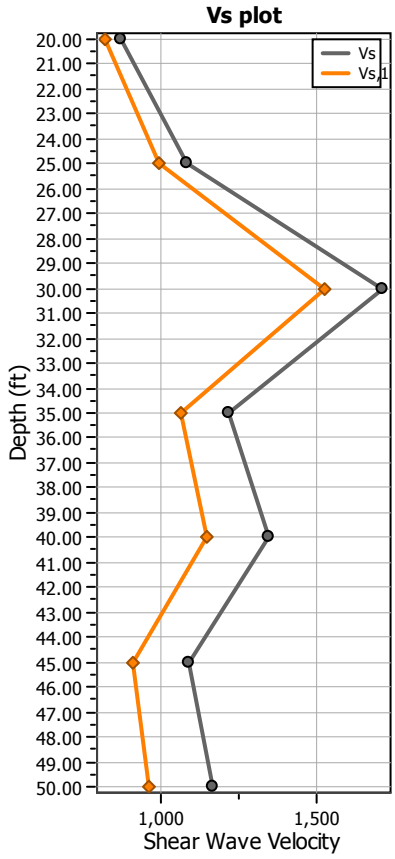
Vs BASED LIQUEFACTION ANALYSIS REPORT (NCEER 1998)

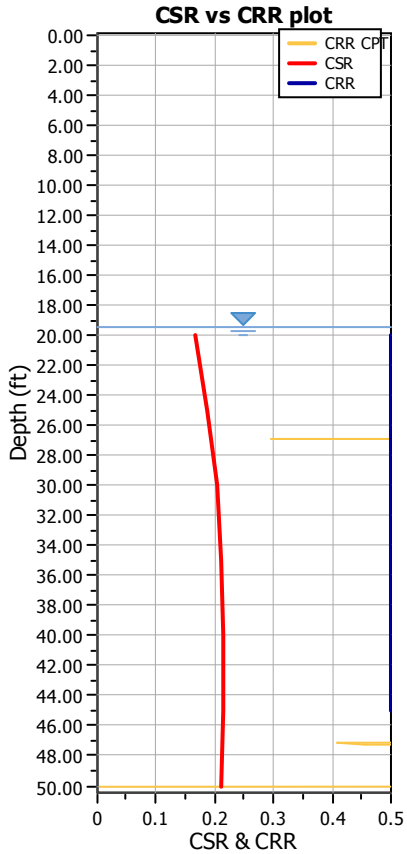
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

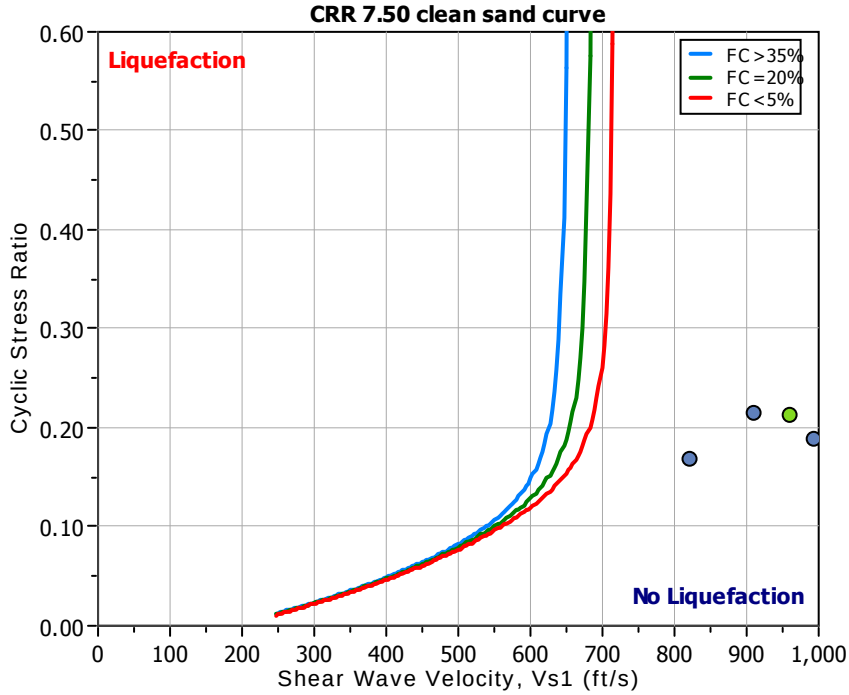
CPT file : 1-CPT-15

:: Input parameters and analysis properties ::

Calculation m;ethod:	NCEER (1998)
G.W.T. (in-situ):	20.00 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	133.18	0.00	1.33	1.33	0.95	0.207	0.96	1.28	0.168	Yes
2	25.00	131.10	0.16	1.66	1.50	0.94	0.225	0.93	1.28	0.188	Yes
3	30.00	125.42	0.31	1.97	1.66	0.93	0.239	0.92	1.28	0.203	Yes
4	35.00	128.12	0.47	2.29	1.83	0.89	0.242	0.90	1.28	0.210	Yes
5	40.00	132.63	0.62	2.62	2.00	0.85	0.241	0.88	1.28	0.213	Yes
6	45.00	126.58	0.78	2.94	2.16	0.81	0.238	0.87	1.28	0.213	Yes
7	50.00	117.41	0.94	3.23	2.30	0.77	0.233	0.86	1.28	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	V_{s1c} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	871.50	33.60	0.25	822.79	658.46	0.500	2.97	Yes
2	25.00	1,087.00	43.01	0.25	995.59	656.17	0.500	2.66	Yes
3	30.00	1,708.00	47.72	0.25	1525.88	656.17	0.500	2.46	Yes
4	35.00	1,219.00	39.72	0.25	1063.65	656.17	0.500	2.38	Yes
5	40.00	1,347.00	55.23	0.25	1148.66	656.17	0.500	2.35	Yes
6	45.00	1,089.00	74.35	0.25	910.91	656.17	0.500	2.34	Yes
7	50.00	1,167.00	35.31	0.25	961.22	656.17	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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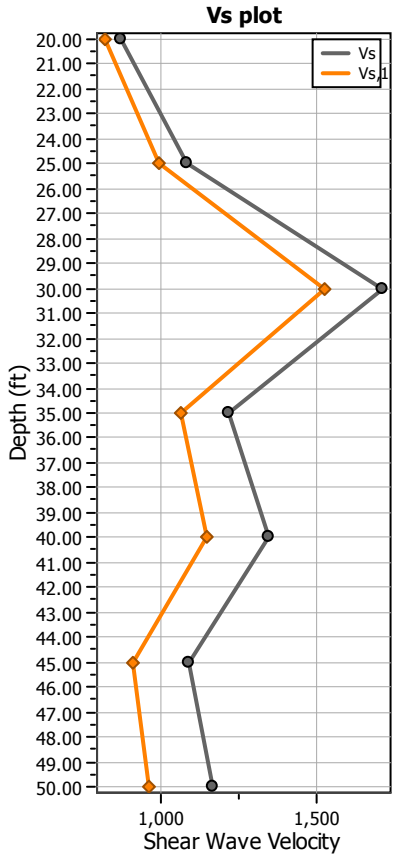
Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

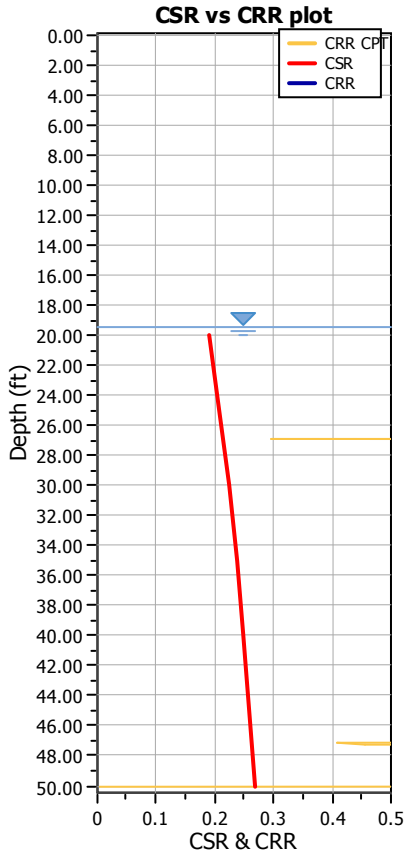
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

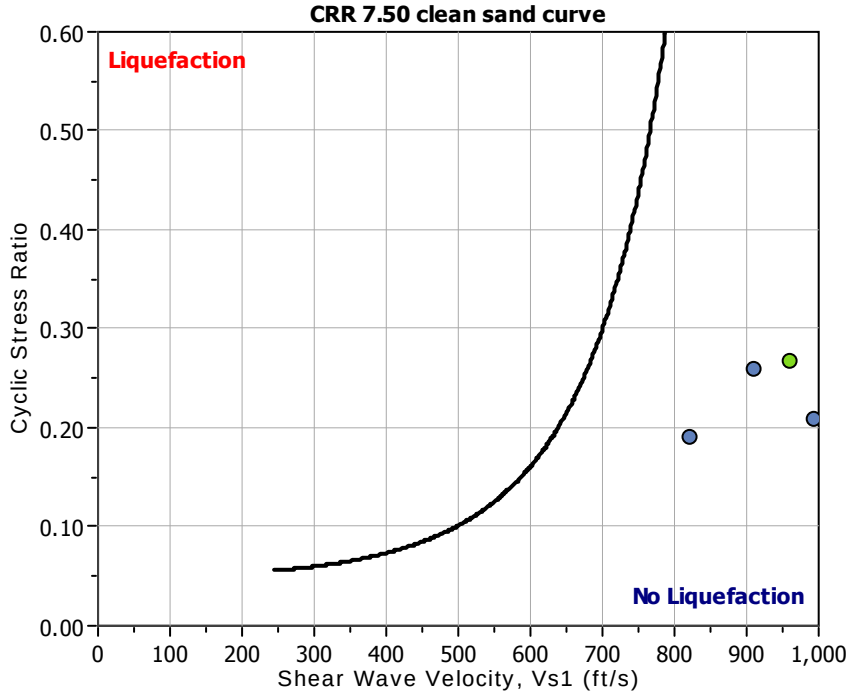
CPT file : 1-CPT-15

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	20.00 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	133.18	0.00	1.33	1.33	1.00	0.217	1.00	1.15	0.190	Yes
2	25.00	131.10	0.16	1.50	1.66	1.00	0.239	1.00	1.15	0.209	Yes
3	30.00	125.42	0.31	1.66	1.97	1.00	0.257	1.00	1.15	0.225	Yes
4	35.00	128.12	0.47	1.83	2.29	1.00	0.272	1.00	1.15	0.238	Yes
5	40.00	132.63	0.62	2.00	2.62	1.00	0.284	1.00	1.15	0.248	Yes
6	45.00	126.58	0.78	2.16	2.94	1.00	0.295	1.00	1.15	0.258	Yes
7	50.00	117.41	0.94	2.30	3.23	1.01	0.306	1.00	1.15	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	871.50	33.60	0.94	822.79	1.947	10.27	Yes
2	25.00	1,087.00	43.01	0.92	995.59	14.192	67.90	Yes
3	30.00	1,708.00	47.72	0.89	1525.88	85707.1250	38127.1650	Yes
4	35.00	1,219.00	39.72	0.87	1063.65	37.272	156.80	Yes
5	40.00	1,347.00	55.23	0.85	1148.66	151.389	609.80	Yes
6	45.00	1,089.00	74.35	0.84	910.91	5.189	20.13	Yes
7	50.00	1,167.00	35.31	0.82	961.22	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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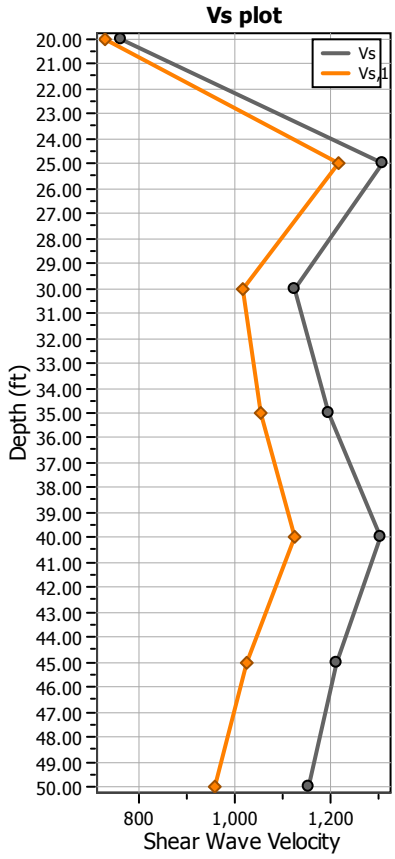
Vs BASED LIQUEFACTION ANALYSIS REPORT (NCEER 1998)

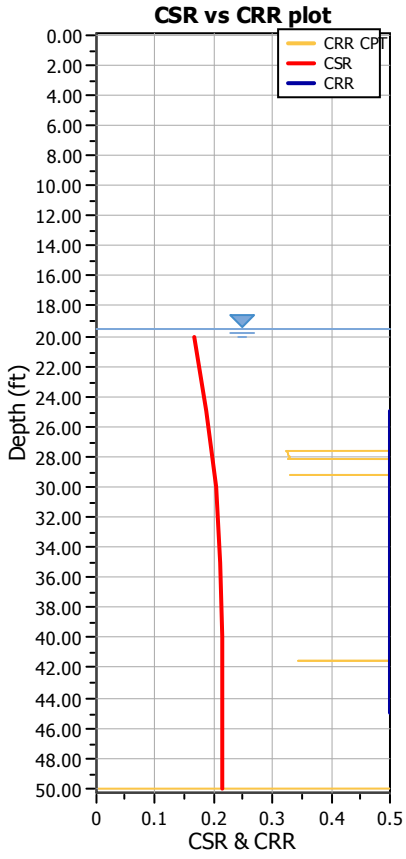
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

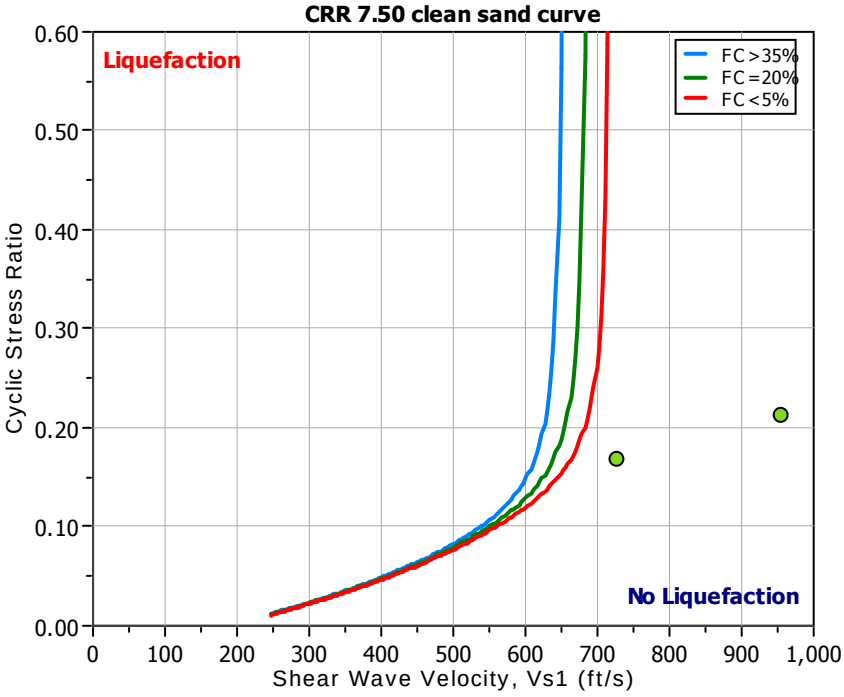
CPT file : 1-CPT-21

:: Input parameters and analysis properties ::

Calculation m;ethod:	NCEER (1998)
G.W.T. (in-situ):	20.50 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	127.33	0.00	1.27	1.27	0.95	0.207	0.97	1.28	2.000	No
2	25.00	116.28	0.14	1.56	1.42	0.94	0.227	0.95	1.28	0.187	Yes
3	30.00	130.63	0.30	1.89	1.59	0.93	0.241	0.92	1.28	0.203	Yes
4	35.00	126.38	0.45	2.21	1.75	0.89	0.245	0.91	1.28	0.210	Yes
5	40.00	123.25	0.61	2.51	1.91	0.85	0.244	0.89	1.28	0.213	Yes
6	45.00	130.35	0.76	2.84	2.08	0.81	0.241	0.88	1.28	0.214	Yes
7	50.00	123.89	0.92	3.15	2.23	0.77	0.236	0.86	1.28	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	V_{s1c} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	763.00	11.54	0.25	728.49	694.65	4.000	2.00	No
2	25.00	1,308.00	49.89	0.25	1214.49	656.17	0.500	2.68	Yes
3	30.00	1,124.00	40.10	0.25	1014.53	656.17	0.500	2.46	Yes
4	35.00	1,197.00	54.22	0.25	1054.90	656.17	0.500	2.38	Yes
5	40.00	1,305.00	45.87	0.25	1126.41	656.17	0.500	2.34	Yes
6	45.00	1,212.00	56.90	0.25	1024.05	656.17	0.500	2.34	Yes
7	50.00	1,152.00	45.93	0.25	956.13	656.17	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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2213 Plaza Drive
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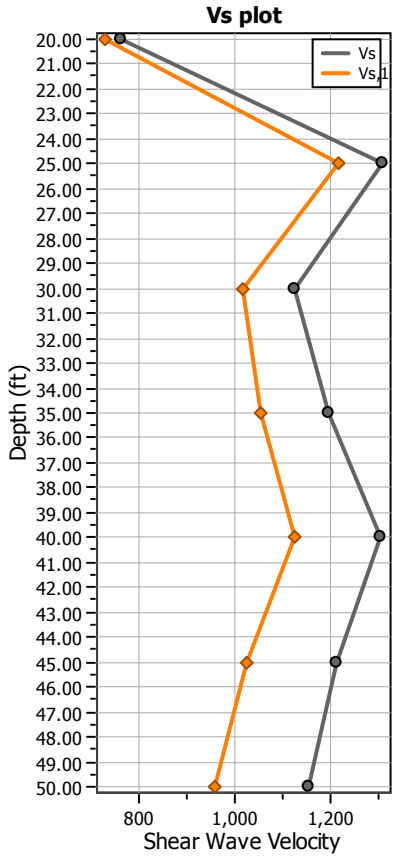
Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

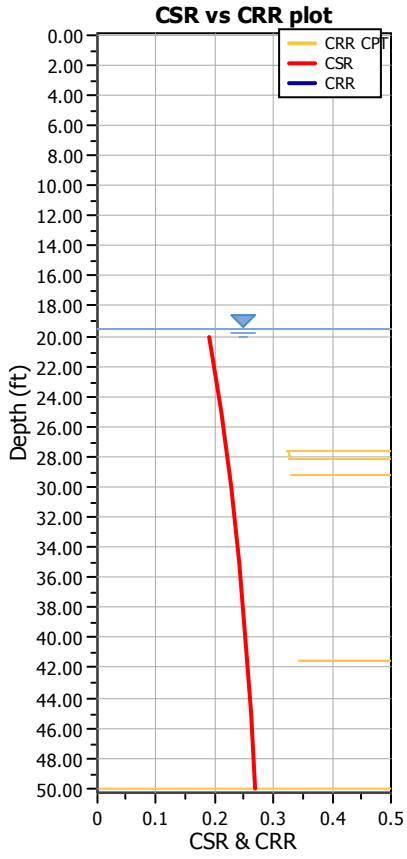
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

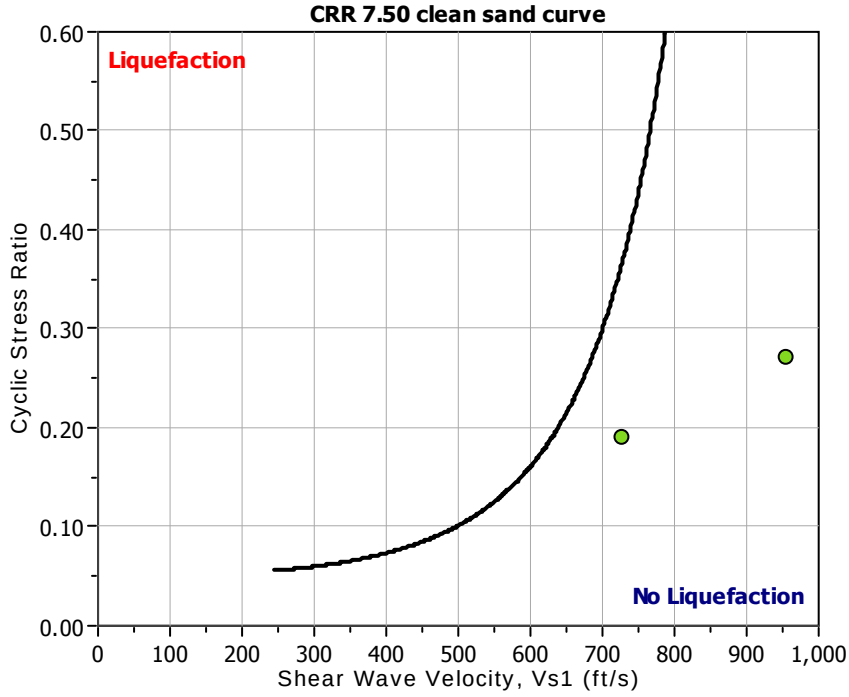
CPT file : 1-CPT-21

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	20.50 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	127.33	0.00	1.27	1.27	1.00	0.217	1.00	1.15	2.000	No
2	25.00	116.28	0.14	1.42	1.56	1.00	0.241	1.00	1.15	0.210	Yes
3	30.00	130.63	0.30	1.59	1.89	1.00	0.260	1.00	1.15	0.227	Yes
4	35.00	126.38	0.45	1.75	2.21	1.00	0.275	1.00	1.15	0.240	Yes
5	40.00	123.25	0.61	1.91	2.51	1.00	0.288	1.00	1.15	0.252	Yes
6	45.00	130.35	0.76	2.08	2.84	1.00	0.299	1.00	1.15	0.261	Yes
7	50.00	123.89	0.92	2.23	3.15	1.01	0.309	1.00	1.15	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	763.00	11.54	0.95	728.49	4.000	2.00	No
2	25.00	1,308.00	49.89	0.93	1214.49	500.119	2376.00	Yes
3	30.00	1,124.00	40.10	0.90	1014.53	18.301	80.71	Yes
4	35.00	1,197.00	54.22	0.88	1054.90	33.379	138.96	Yes
5	40.00	1,305.00	45.87	0.86	1126.41	102.207	405.99	Yes
6	45.00	1,212.00	56.90	0.84	1024.05	21.422	82.04	Yes
7	50.00	1,152.00	45.93	0.83	956.13	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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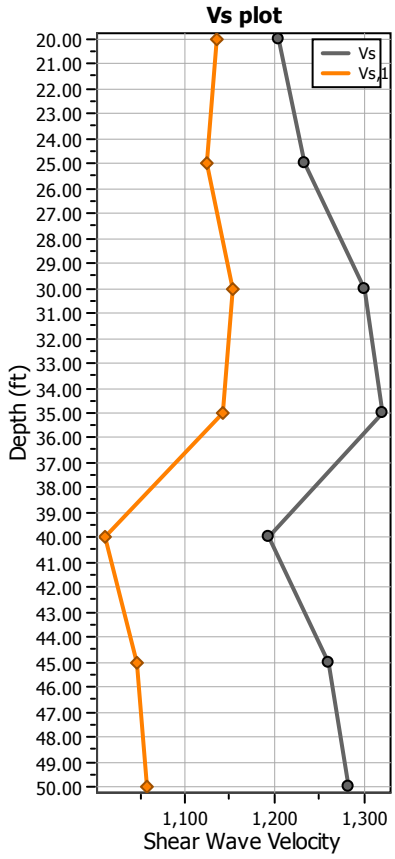
Vs BASED LIQUEFACTION ANALYSIS REPORT (NCEER 1998)

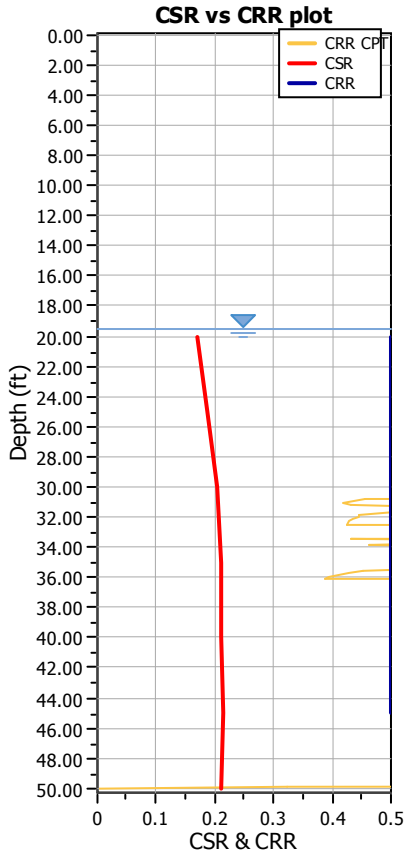
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

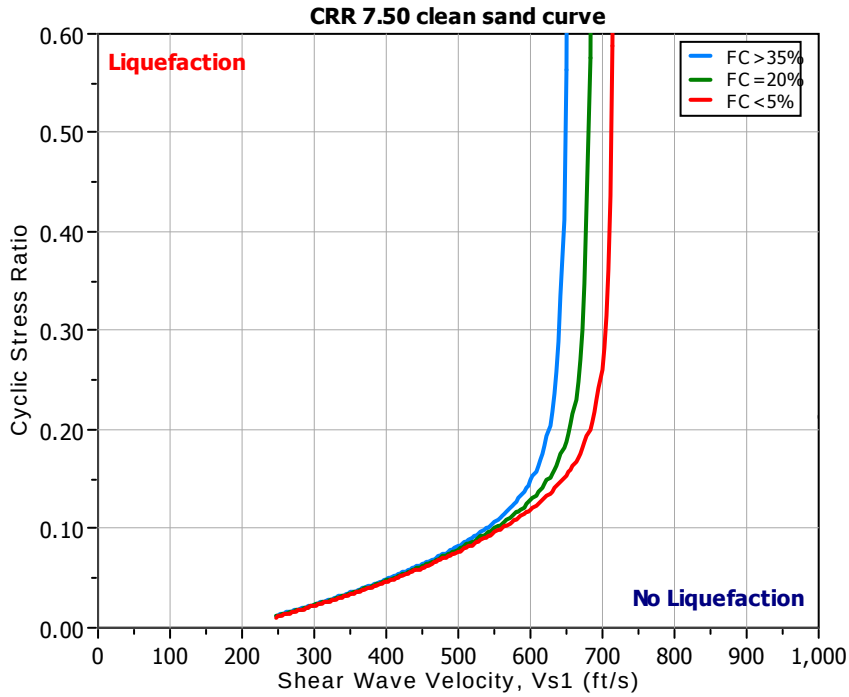
CPT file : 1-CPT-9

:: Input parameters and analysis properties ::

Calculation m;ethod:	NCEER (1998)
G.W.T. (in-situ):	20.00 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	133.88	0.00	1.34	1.34	0.95	0.207	0.96	1.28	0.168	Yes
2	25.00	137.28	0.16	1.68	1.53	0.94	0.225	0.93	1.28	0.188	Yes
3	30.00	134.15	0.31	2.02	1.71	0.93	0.238	0.91	1.28	0.204	Yes
4	35.00	134.75	0.47	2.35	1.89	0.89	0.240	0.89	1.28	0.210	Yes
5	40.00	126.42	0.62	2.67	2.05	0.85	0.240	0.88	1.28	0.212	Yes
6	45.00	130.18	0.78	3.00	2.22	0.81	0.236	0.86	1.28	0.213	Yes
7	50.00	87.36	0.94	3.21	2.28	0.77	0.234	0.86	1.28	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	V_{s1c} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	1,204.00	39.49	0.25	1135.22	656.17	0.500	2.97	Yes
2	25.00	1,233.00	11.20	0.25	1125.14	695.21	0.500	2.66	Yes
3	30.00	1,299.00	44.20	0.25	1152.89	656.17	0.500	2.46	Yes
4	35.00	1,319.00	36.00	0.25	1141.50	656.17	0.500	2.39	Yes
5	40.00	1,193.00	55.55	0.25	1011.65	656.17	0.500	2.35	Yes
6	45.00	1,259.00	53.13	0.25	1046.59	656.17	0.500	2.35	Yes
7	50.00	1,281.00	100.00	0.25	1057.51	656.17	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

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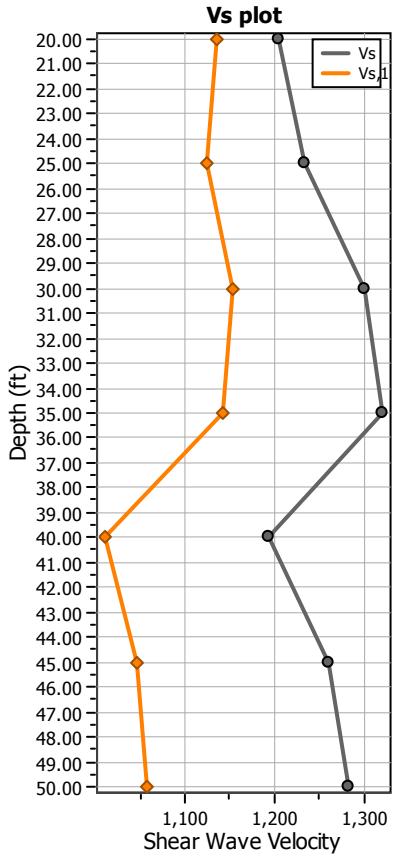
Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

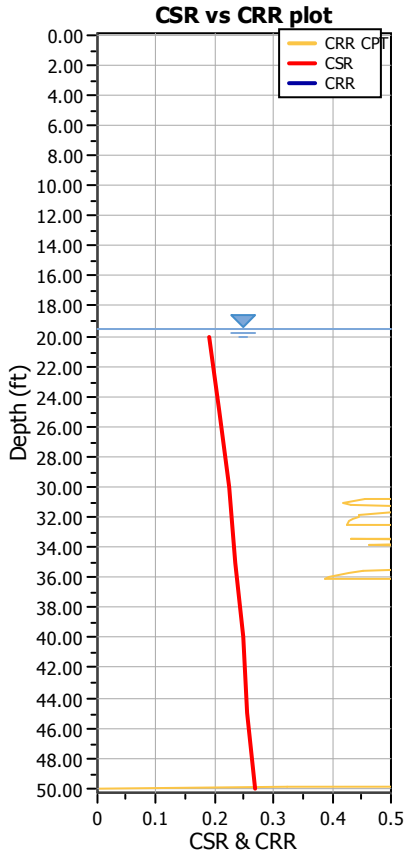
Project title : Elk Grove Hospital **Location : Elk Grove, CA**

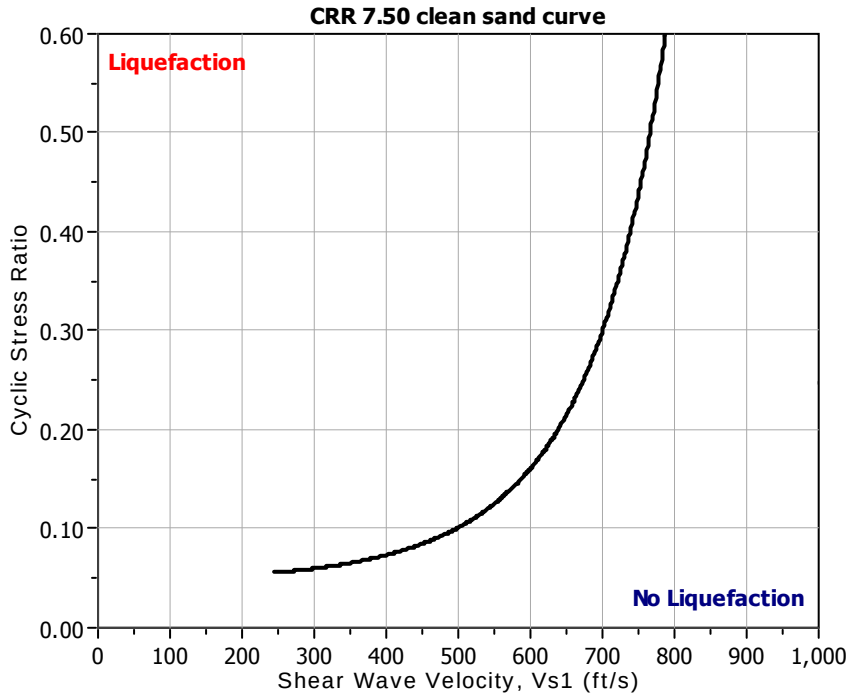
CPT file : 1-CPT-9

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	20.00 ft
G.W.T. (earthq.):	19.50 ft
Earthquake magnitude M_w:	6.80
Peak ground acceleration:	0.33g







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (ft)	Weight (pcf)	u_o (tsf)	σ_v (tsf)	σ'_v (tsf)	r_d	CSR	K_σ	MSF	CSR^*	Can Liquefy
1	20.00	133.88	0.00	1.34	1.34	1.00	0.217	1.00	1.15	0.190	Yes
2	25.00	137.28	0.16	1.53	1.68	1.00	0.239	1.00	1.15	0.209	Yes
3	30.00	134.15	0.31	1.71	2.02	1.00	0.256	1.00	1.15	0.224	Yes
4	35.00	134.75	0.47	1.89	2.35	1.00	0.270	1.00	1.15	0.236	Yes
5	40.00	126.42	0.62	2.05	2.67	1.00	0.283	1.00	1.15	0.247	Yes
6	45.00	130.18	0.78	2.22	3.00	1.00	0.293	1.00	1.15	0.256	Yes
7	50.00	87.36	0.94	2.28	3.21	1.01	0.307	1.00	1.15	2.000	No

Abbreviations

Depth: Depth from free surface where SPT was performed (ft)
u_0: Water pressure at test point (tsf)
σ_v: Total overburden pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio ()
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (ft)	V_s (ft/s)	Fines %	n	V_{s1} (ft/s)	$CRR_{7.5}$	F.S.	Can Liquefy
1	20.00	1,204.00	39.49	0.94	1135.22	117.499	619.82	Yes
2	25.00	1,233.00	11.20	0.91	1125.14	95.183	456.09	Yes
3	30.00	1,299.00	44.20	0.89	1152.89	160.402	716.68	Yes
4	35.00	1,319.00	36.00	0.87	1141.50	130.157	551.34	Yes
5	40.00	1,193.00	55.55	0.85	1011.65	17.981	72.83	Yes
6	45.00	1,259.00	53.13	0.83	1046.59	29.475	115.10	Yes
7	50.00	1,281.00	100.00	0.83	1057.51	4.000	2.00	No

Abbreviations

Depth: Depth from free surface where Vs was performed (ft)
V_s: Estimated Vs (ft/s)
n: Stress exponent normalization factor
V_{s1}: Normalized Vs (ft/s)
V_{s1c}: Critical value of Vs1, which separates contractive and dilative behavior (tsf)
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

APPENDIX G

AUGER CAST PILE ANALYSIS

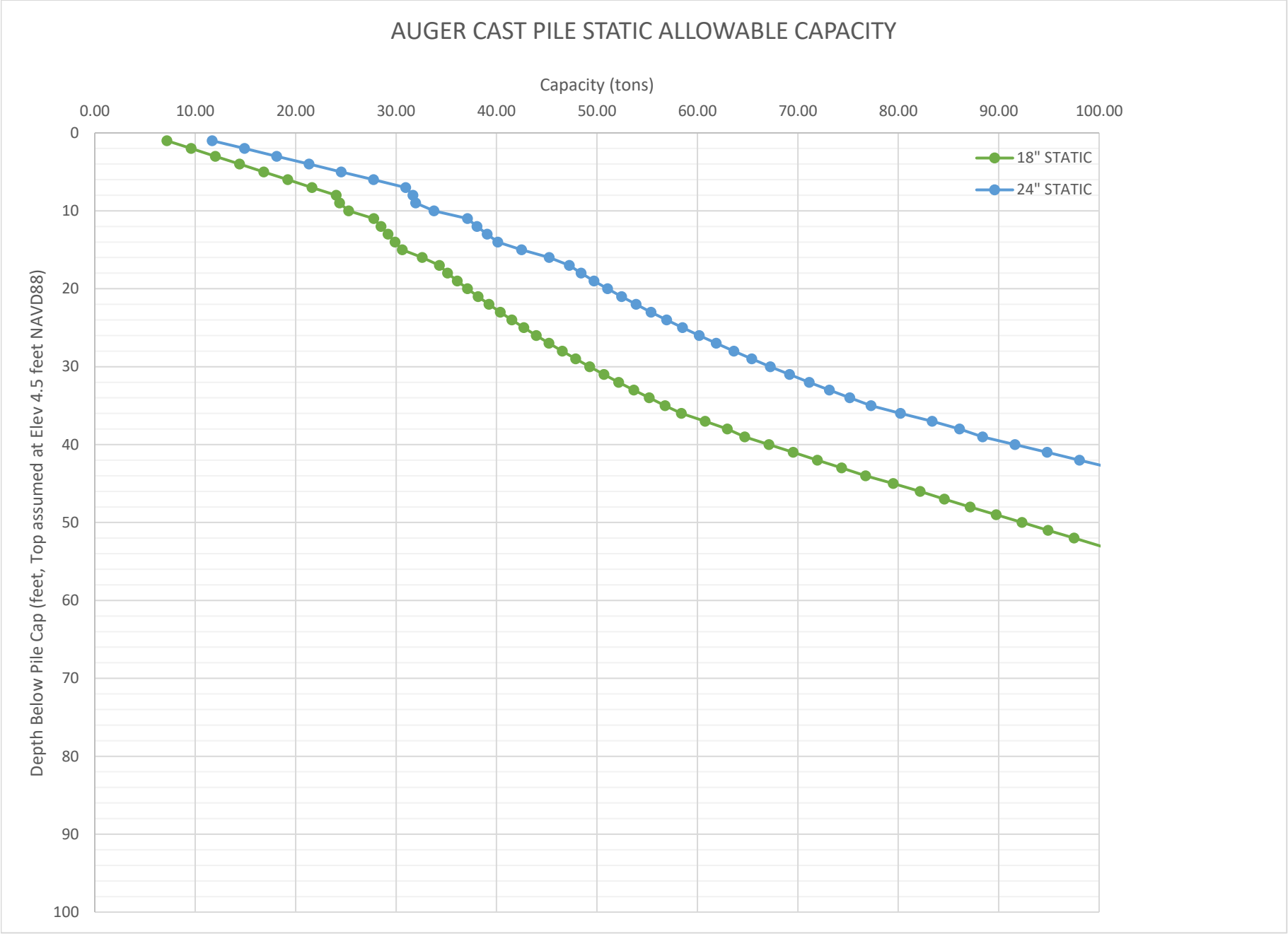


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TABLE G-1: Pile Properties

PILE TYPE	DIAMETER (in)	AREA (in^2)	UNCRAKED SECTION FOR EQUAL TO OR	I (in^4) CRACKED SECTION MORE THAN 1/2 INCH DEFLECTION	f'c (psi)	E (ksi)
Auger Cast	18	254	5,153	2,576	4,500	3824
Auger Cast	24	452	16,286	8,143	4,500	3824

TABLE G-2: Profile 1-B8/1-CPT4: Lateral Pile Analysis Parameters*

DEPTH (feet)	L-PILE SOIL TYPE	FRICTION ANGLE (Degrees)	UNDRAINED SHEAR STRENGHT (psf)	MODULUS OF SOIL REACTION, k (pci)	SOIL STRAIN PARAMETER E_{50}	EFFECTIVE UNIT WEIGHT (pcf)
0 to 6	stiff clay without	-	4,000	-	0.005	120
6 to 11	stiff clay with free water	-	4000	-	0.005	57.6
11 to 18	sand	32	-	125	-	57.6
18 to 22	sand	35		60	-	57.6
22 to 34	sand	35	-	125	-	57.6
34 to 39	sand	35	-	60	-	57.6
39 to 47	stiff clay with free water	-	4,000	-	0.005	57.6
47 +	stiff clay with free water	-	4,500	-	0.005	57.6

*Soil profile/pile head depth shown is assumed to begin at Elevation 4.5 Feet (NAVD88)

TABLE G-3: Lateral Pile Analysis Summary

PILE TYPE	DEFLECTION CHARACTERISTIC	PILE DEFLECTION FREE HEAD			PILE DEFLECTION FIXED HEAD		
		1/4" DEFLECTION	1/2" DEFLECTION	1" DEFLECTION	1/4" DEFLECTION	1/2" DEFLECTION	1" DEFLECTION
Profile 1-B8/1-CPT4: 100 Ton Axial Load							
18-Inch Diameter	Maximum Lateral Shear Capacities (kips)	31.80	45.00	50.12	38.21	100.13	110.41
	Maximum Bending Moment (in-kips)	981.41	1643.38	1803.32	2709.35	4495.15	4798.00
	Depth to Maximum bending Moment (feet)	4.8	5.8	5.3	0.0	0.0	0.0
Profile 1-B8/1-CPT4: 100 Ton Axial Load							
24-inch Diameter	Maximum Lateral Shear Capacities (kips)	52.44	76.89	86.52	119.43	174.16	189.89
	Maximum Bending Moment (in-kips)	2109.45	3620.09	4011.14	5900.25	9578.49	10160.49
	Depth to Maximum bending Moment (feet)	6.0	6.5	6.5	0.0	0.0	0.0

* Depths are below bottom of pile cap and assume top of pile is at Elevation 4.5 Feet

APPENDIX H

SUPPLEMENTAL RECOMMENDATIONS

SUPPLEMENTAL RECOMMENDATIONS

Prepared by
ENGEO Incorporated

ENGEO
Expect Excellence

TABLE OF CONTENTS

GENERAL INFORMATION

PREFACE

These supplemental recommendations are intended as a guide for earthwork and are in addition to any previous earthwork recommendations made by the Geotechnical Engineer. If there is a conflict between these supplemental recommendations and any previous recommendations, it should be immediately brought to the attention of ENGEO. Testing standards identified in this document shall be the most current revision (unless stated otherwise).

DEFINITIONS

BACKFILL	Soil, rock or soil-rock material used to fill excavations and trenches.
DRAWINGS	Documents approved for construction which describe the work.
THE GEOTECHNICAL ENGINEER	The project geotechnical engineering consulting firm, its employees, or its designated representatives.
ENGINEERED FILL	Fill upon which the Geotechnical Engineer has made sufficient observations and tests to confirm that the fill has been placed and compacted in accordance with geotechnical engineering recommendations.
FILL	Soil, rock, or soil-rock materials placed to raise the grades of the site or to backfill excavations.
IMPORTED MATERIAL	Soil and/or rock material which is brought to the site from offsite areas.
ONSITE MATERIAL	Soil and/or rock material which is obtained from the site.
OPTIMUM MOISTURE	Water content, percentage by dry weight, corresponding to the maximum dry density as determined by ASTM D-1557.
RELATIVE COMPACTION	The ratio, expressed as a percentage, of the in-place dry density of the fill or backfill material as compacted in the field to the maximum dry density of the same material as determined by ASTM D-1557.
SELECT MATERIAL	Onsite and/or imported material which is approved by the Geotechnical Engineer as a specific-purpose fill.

PART I - EARTHWORK

1.0 GENERAL

1.1 WORK COVERED

Supplemental recommendations for performing earthwork and grading. Activities include:

- ✓ Site Preparation and Demolition
- ✓ Excavation
- ✓ Grading
- ✓ Backfill of Excavations and Trenches
- ✓ Engineered Fill Placement, Moisture Conditioning, and Compaction

1.2 CODES AND STANDARDS

The contractor should perform their work complying with applicable occupational safety and health standards, rules, regulations, and orders. The Occupational Safety and Health Standards (OSHA) Board is the only agency authorized in the State to adopt and enforce occupational safety and health standards (Labor Code § 142 et seq.). The owner, their representative and contractor are responsible for site safety; ENGEO representatives are not responsible for site safety.

Excavating, trenching, filling, backfilling, shoring and grading work should meet the minimum requirements of the applicable Building Code, and the standards and ordinances of state and local governing authorities.

1.3 TESTING AND OBSERVATION

Site preparation, cutting and shaping, excavating, filling, and backfilling should be carried out under the testing and observation of ENGEO. ENGEO shall be retained to perform appropriate field and laboratory tests to check compliance with the recommendations. Any fill or backfill that does not meet the supplemental recommendations shall be removed and/or reworked, until the supplemental recommendations are satisfied.

Tests for compaction shall be made in accordance with test procedures outlined in ASTM D-1557, as applicable, unless other testing methods are deemed appropriate by ENGEO. These and other tests shall be performed in accordance with accepted testing procedures, subject to the engineering discretion of ENGEO.

2.0 MATERIALS

2.1 STANDARD

Materials, tools, equipment, facilities, and services as required for performing the required excavating, trenching, filling and backfilling should be furnished by the Contractor.

2.2 ENGINEERED FILL AND BACKFILL

Material to be used for engineered fill and backfill should be free from organic matter and other deleterious substances, and of such quality that it will compact thoroughly without excessive voids when watered and rolled.

Unless specified elsewhere by ENGEO, engineered fill and backfill shall be free of significant organics, or any other unsatisfactory material. In addition, engineered fill and backfill shall comply with the grading requirements shown in the following table:

TABLE 2.2-1: Engineered Fill and Backfill Requirements

US STANDARD SIEVE	PERCENTAGE PASSING
3"	100
No. 4	35–100
No. 30	20–100

Earth materials to be used as engineered fill and backfill shall be cleared of debris, rubble and deleterious matter. Rocks and aggregate exceeding the maximum allowable size shall be removed from the site. Rocks of maximum dimension in excess of two-thirds of the lift thickness shall be removed from any fill material to the satisfaction of ENGEO.

ENGEO shall be immediately notified if potential hazardous materials or suspect soils exhibiting staining or odor are encountered. Work activities shall be discontinued within the area of potentially hazardous materials. ENGEO shall be notified at least 72 hours prior to the start of filling and backfilling operations. Materials to be used for filling and backfilling shall be submitted to ENGEO no less than 10 days prior to intended delivery to the site. Unless specified elsewhere by ENGEO, where conditions require the importation of low expansive fill material, the material shall be an inert, low to non-expansive soil, or soil-rock material, free of organic matter and meeting the following requirements:

TABLE 2.2-2: Imported Fill Material Requirements

	SIEVE SIZE	PERCENT PASSING
GRADATION (ASTM D-421)	2-inch	100
	#200	15 - 70
PLASTICITY (ASTM D-4318)	Plasticity Index < 12	
ORGANIC CONTENT (ASTM D-2974)	Less than 2 percent	

A sample of the proposed import material should be submitted to ENGEO no less than 10 days prior to intended delivery to the site.

2.3 SUBDRAINS

A subdrain system is an underground network of piping used to remove water from areas that collect or retain surface water or subsurface water. Subsurface water is collected by allowing

water into the pipe through perforations. Subdrain systems may drain and discharge to an appropriate outlet such as storm drain, natural swales or drainage, etc.. Details for subdrain systems may vary depending on many items, including but not limited to site conditions, soil types, subdrain spacing, depth of the pipe and pervious medium, as well as pipe diameter.

2.4 PIPE

Subdrain pipe shall conform with these supplemental recommendations unless specified elsewhere by ENGEO. Perforated pipe for various depths shall be manufactured in accordance with the following requirements:

TABLE 2.4-1: Perforated Pipe Requirements

PIPE TYPE	STANDARD	TYPICAL SIZES (INCHES)	PIPE STIFFNESS (PSI)
PIPE STIFFNESS ABOVE 200 PSI (BELOW 50 FEET OF FINISHED GRADE)			
ABS SDR 15.3		4 to 6	450
PVC Schedule 80	ASTM D1785	3 to 10	530
PIPE STIFFNESS BETWEEN 100 PSI AND 150 PSI (BETWEEN 15 AND 50 FEET OF FINISHED GRADE)			
ABS SDR 23.5	ASTM D2751	4 to 6	150
PVC SDR 23.5	ASTM D3034	4 to 6	153
PVC Schedule 40	ASTM D1785	3 to 10	135
ABS Schedule 40/DWV	ASTM D1527 & D2661	3 to 10	
PIPE STIFFNESS BETWEEN 45 PSI AND 50 PSI* (BETWEEN 0 TO 15 FEET OF FINISHED GRADE)			
PVC A-2000	ASTM F949	4 to 10	50
PVC SDR 35	ASTM D3034	4 to 8	46
ABS SDR 35	ASTM D2751	4 to 8	45
Corrugated PE	AASHTO M294 Type S	4 to 10	45

***Pipe with a stiffness less than 45 psi should not be used.**

Other pipes not listed in the table above shall be submitted for review by the Geotechnical Engineer not less 72 hours before proposed use.

2.5 OUTLETS AND RISERS

Subdrain outlets and risers must be fabricated from the same material as the subdrain pipe. Outlet and riser pipe and fittings must not be perforated. Covers must be fitted and bolted into the riser pipe or elbow. Covers must seat uniformly and not be subject to rocking.

2.6 PERMEABLE MATERIAL

Permeable material shall generally conform to Caltrans Standard Specification unless specified otherwise by ENGEO. Class 2 permeable material shall comply with the gradation requirements shown in the following table.

TABLE 2.6-1: Class 2 Permeable Material Grading Requirements

SIEVE SIZES	PERCENTAGE PASSING
1"	100
3/4"	90 to 100
3/8"	40 to 100
No. 4	25 to 40
No. 8	18 to 33
No. 30	5 to 15
No. 50	0 to 7
No. 200	0 to 3

2.7 FILTER FABRIC

Filter fabric shall meet the following Minimum Average Roll Values unless specified elsewhere by ENGEO.

Grab Strength (ASTM D-4632) ..... 180 lbs
Mass per Unit Area (ASTM D-4751) ..... 6 oz/yd^2
Apparent Opening Size (ASTM D-4751) .....70-100 U.S. Std. Sieve
Flow Rate (ASTM D-4491)..... 80 gal/min/ft^2
Puncture Strength (ASTM D-4833) ..... 80 lbs

Areas to receive filter fabric must comply with the compaction and elevation tolerance specified for the material involved. Handle and place filter fabric under the manufacturer's instructions. Align and place filter fabric without wrinkles.

Overlap adjacent roll ends of filter fabric in accordance with manufacturer's recommendations. The preceding roll must overlap the following roll in the direction that the permeable material is being spread. Completely replace torn or punctured sections damaged during placement or repair by placing a piece of filter fabric that is large enough to cover the damaged area and comply with the overlap specified. Cover filter fabric with the thickness of overlying material shown within 72 hours of placing the fabric.

2.8 GEOCOMPOSITE DRAINAGE

Geocomposite drainage is a prefabricated material that includes filter fabric and plastic pipe. Filter fabric must be Class A. The drain shall be of composite construction consisting of a supporting structure or drainage core material surrounded by a geotextile. The geotextile shall encapsulate the drainage core and prevent random soil intrusion into the drainage structure. The drainage core material shall consist of a three-dimensional polymeric material with a structure that permits flow along the core laterally. The core structure shall also be constructed to permit flow regardless of the water inlet surface. The drainage core shall provide support to the geotextile.

A geotextile flap shall be provided along drainage core edges. This flap shall be of sufficient width for sealing the geotextile to the adjacent drainage structure edge to prevent soil intrusion into the structure during and after installation. The geotextile shall cover the full length of the

core. The geocomposite core shall be furnished with an approved method of constructing and connecting with outlet pipes. If the fabric on the geocomposite drain is torn or punctured, replace the damaged section completely. The specific drainage composite material and supplier shall be preapproved by ENGEO.

The Contractor shall submit a manufacturer's certification that the geocomposite meets the design properties and respective index criteria measured in full accordance with applicable test methods. The manufacturer's certification shall include a submittal package of documented test results that confirm the design values. In case of dispute over validity of design values, the Contractor will supply design property test data from a laboratory approved by ENGEO, to support the certified values submitted.

Geocomposite material suppliers shall provide a qualified and experienced representative onsite to assist the Contractor and ENGEO at the start of construction with directions on the use of drainage composite. If there is more than one application on a project, this criterion will apply to construction of the initial application only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining applications. The soil surface against which the geocomposite is to be placed shall be free of debris and inordinate irregularities that will prevent intimate contact between the soil surface and the drain.

Edge seams shall be formed by utilizing the flap of the geotextile extending from the geocomposite's edge and lapping over the top of the fabric of the adjacent course. The fabric flap shall be securely fastened to the adjacent fabric by means of plastic tape or non-water-soluble construction adhesive, as recommended by the supplier. To prevent soil intrusion, exposed edges of the geocomposite drainage core edge must be covered.

Approved backfill shall be placed immediately over the geocomposite drain. Backfill operations should be performed to not damage the geotextile surface of the drain. Also during operations, avoid excessive settlement of the backfill material. The geocomposite drain, once installed, shall not be exposed for more than 7 days prior to backfilling.

PART II - GEOGRID SOIL REINFORCEMENT

Geogrid soil reinforcement (geogrid) shall be submitted to ENGEO and should be approved before use. The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction to ultraviolet degradation and to chemical and biological degradation encountered in the soil being reinforced. The geogrids shall have an Allowable Tensile Strength (T_a) and Pullout Resistance, for the soil type(s) as specified on design plans.

The contractor shall submit a manufacturer's certification that the geogrids supplied meet plans and project specifications. The contractor shall check the geogrid upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geogrid will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geogrid damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geogrid material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project, for a minimum of three days, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). Geogrid reinforcement may be joined with mechanical connections or overlaps as recommended and approved by the manufacturer. Joints shall not be placed within 6 feet of the slope face, within 4 feet below top of slope, nor horizontally or vertically adjacent to another joint.

The geogrid reinforcement shall be installed in accordance with the manufacturer's recommendations. The geogrid reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed. The geogrid reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the manufacturer's approval. Only one joint per length of geogrid shall be allowed. This joint shall be made for the full width of the strip by using a similar material with similar strength. Joints in geogrid reinforcement shall be pulled and held taut during fill placement.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geogrid reinforcement shall be overlapped or mechanically connected where exposed in a wrap around face system, as applicable.

The Contractor may place only that amount of geogrid reinforcement required for immediately pending work to prevent undue damage. After a layer of geogrid reinforcement has been placed, the next succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geogrid reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geogrid reinforcement and soil. Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geogrid reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geogrid reinforcement in position until the subsequent soil layer can be placed.

Under no circumstances shall a track-type vehicle be allowed on the geogrid reinforcement before at least 6 inches of soil have been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geogrid reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided. During construction, the surface of the fill should be kept approximately horizontal. Geogrid reinforcement shall be placed directly on the compacted horizontal fill surface. Geogrid reinforcements are to be placed as shown on plans, and oriented correctly.

PART III - GEOTEXTILE SOIL REINFORCEMENT

The specific geotextile material and supplier shall be preapproved by ENGEO. The contractor shall submit a manufacturer's certification that the geotextiles supplied meet the respective index criteria set when geotextile was approved by ENGEO, measured in full accordance with specified test methods and standards.

The contractor shall check the geotextile upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geotextile shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geotextile will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geotextile damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geotextile material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project to assist the Contractor and ENGEO personnel at the start of construction. The geotextile reinforcement shall be installed in accordance with the manufacturer's recommendations. The geotextile reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed, secured with staples, pins, or small piles of backfill, placed without wrinkles, and aligned with the primary strength direction perpendicular to slope contours. Cover geotextile reinforcement with backfill within the same work shift. Place at least 6 inches of backfill on the geotextile reinforcement before operating or driving equipment or vehicles over it, except those used under the conditions specified below for spreading backfill.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geotextile reinforcement shall be overlapped or mechanically connected where exposed in a wraparound face system, as applicable.

The contractor may place only that amount of geotextile reinforcement required for immediately pending work to prevent undue damage. After a layer of geotextile reinforcement has been placed, the succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geotextile reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geotextile reinforcement and soil.

Geotextile reinforcement shall be placed to lay flat and be pulled tight prior to backfilling. After a layer of geotextile reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geotextile reinforcement in position until the subsequent soil layer can be placed. Under no circumstances shall a track-type vehicle be allowed on the geotextile reinforcement before at least six inches of soil has been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geotextile reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the

geotextile reinforcement as slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

During construction, the surface of the fill should be kept approximately horizontal. Geotextile reinforcement shall be placed directly on the compacted horizontal fill surface. Geotextile reinforcements are to be placed within three inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by ENGEO.

Replace or repair any geotextile reinforcement damaged during construction. Grade and compact backfill to ensure the reinforcement remains taut. Geotextile soil reinforcement must be tested to the required design values using the following ASTM test methods.

TABLE III-1: Geotextile Soil Reinforcements

PROPERTY	TEST
Elongation at break, percent	ASTM D 4632
Grab breaking load, lb, 1-inch grip (min) in each direction	ASTM D 4632
Wide width tensile strength at 5 percent strain, lb/ft (min)	ASTM D 4595
Wide width tensile strength at ultimate strength, lb/ft (min)	ASTM D 4595
Tear strength, lb (min)	ASTM D 4533
Puncture strength, lb (min)	ASTM D 6241
Permittivity, sec^{-1} (min)	ASTM D 4491
Apparent opening size, inches (max)	ASTM D 4751
Ultraviolet resistance, percent (min) retained grab break load, 500 hours	ASTM D 4355

PART IV - EROSION CONTROL MAT

Work shall consist of furnishing and placing a synthetic erosion control mat and/or degradable erosion control blanket for slope face protection and lining of runoff channels. The specific erosion control material and supplier shall be pre-approved by ENGEO.

The Contractor shall submit a manufacturer's certification that the erosion mat/blanket supplied meets the criteria specified when the material was approved by ENGEO. The manufacturer's certification shall include a submittal package of documented test results that confirm the property values. Jute mesh shall consist of processed natural jute yarns woven into a matrix, and netting shall consist of coconut fiber woven into a matrix. Erosion control blankets shall be made of processed natural fibers that are mechanically, structurally, or chemically bound together to form a continuous matrix that is surrounded by two natural nets.

The Contractor shall check the erosion control material upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140°F, mud, dirt, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be removed by cutting out a section of the mat. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the Contractor at no additional cost to the Owner.

Erosion control material suppliers shall provide a qualified and experienced representative onsite, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). The erosion control material shall be placed and anchored on a smooth graded, firm surface approved by the Engineer. Anchoring terminal ends of the erosion control material shall be accomplished through use of key trenches. The material in the trenches shall be anchored to the soil on maximum 1½ foot centers. Topsoil, if required by construction drawings, placed over final grade prior to installation of the erosion control material shall be limited to a depth not exceeding 3 inches.

Erosion control material shall be anchored, overlapped, and otherwise constructed to ensure performance until vegetation is well established. Anchors shall be as designated on the construction drawings, with a minimum of 12-inch length, and shall be spaced as designated on the construction drawings, with a maximum spacing of 4 feet.

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