March 17, 2017
File: 1911.027altr.doc

Alameda Unified School District
2060 Challenger Drive
Alameda, California 94501

Attention: Chad Pimentel, Legal Counsel for AUSD

Re: Geotechnical Engineering Investigation
Evaluation of Liquefaction Risk and Liquefaction Induced Settlement Potential
Donald D. Lum Elementary School Campus
1801 Sandcreek Way
Alameda, California

Introduction

This letter summarizes our geotechnical investigation of the Donald D. Lum Elementary School Campus located at 1801 Sandcreek Way in Alameda, California. The approximate site location is presented on Figure 1, Site Location Map. The purpose of our geotechnical investigation is to evaluate the site soil and groundwater conditions and to assess the liquefaction risk and liquefaction induced settlement potential across the school campus. Our scope includes exploring the subsurface conditions with seven Cone Penetration Tests (CPTs), conducting engineering analyses to evaluate the liquefaction risk and liquefaction induced settlement potential, and presentation of our geotechnical conclusions in this brief letter report.

Site Description

The Donald D. Lum Elementary School campus is located on the westerly side of Sandcreek Way, south of Otis Drive, in Alameda, as shown on the Site Location Map, Figure 1. The campus consists of numerous permanent and portable buildings, paved driveways, parking areas, and play areas, and landscaping improvements, as shown on the Site Plan, Figure 2. The ground surface at the project site and the surrounding area is characterized by nearly level to slightly sloping terrain.

Regional Geology

The site is located within the Coast Range Geomorphic Province of California. The regional bedrock geology consists of complexly folded, faulted, sheared, and altered sedimentary, igneous, and metamorphic rock of the Franciscan Complex. Bedrock is characterized by a diverse assemblage of greenstone, sandstone, shale, chert, and melange, with lesser amounts of conglomerate, calc-silicate rock, schist and other metamorphic rocks.

The regional topography is characterized by northwest-southeast trending mountain ridges and intervening valleys that were formed by movement between the North American and the Pacific Plates. Continued deformation and erosion during the late Tertiary and Quaternary Age (the last several million years) formed the prominent coastal ridges and the inland depression that is now the San Francisco Bay. The more recent seismic activity within the Coast Range

Geomorphic Province is concentrated along the San Andreas Fault zone, a complex group of generally north to northwest trending faults.

Geologic mapping[1] indicates the site is located in an area underlain by artificial fill sands, as shown on Figure 3. These artificial (manmade) fills were placed over older dune sands and soft clay (Bay Mud).

Surface Conditions

The site is currently developed as an elementary school campus. The attached Site Plan, Figure 2, shows the locations of existing buildings, driveways, and play areas. Most of the ground surface around the existing buildings consists of asphalt paved surfaces.

Seismicity

The San Francisco Bay Region is located in a seismically active area and the proposed improvements will therefore experience the effects of future earthquakes. Such earthquakes could occur on any of several active faults within the region. The active faults are classified into two types. Type A faults are capable of large magnitude earthquakes and have a high rate of seismic activity. Type B faults are also capable of large magnitude earthquakes but with a low rate of seismic activity or are smaller faults with a high rate of seismic activity. These faults are shown on the Active Fault Map, Figure 4.

Subsurface Exploration and Laboratory Testing

We explored the subsurface soil and groundwater conditions with seven Cone Penetration Tests (CPTs) at the approximate locations shown on the Site Plan, Figure 2. The CPTs were conducted with truck-mounted equipment on February 14, 2017. The CPTs were extended to depths of 49 feet to 70 feet below the ground surface. A schematic of the CPT apparatus is provided on Figure A-1 and a CPT Soil Interpretation Chart is provided on Figure A-2. CPT logs are shown on Figures A-3 through A-9.

Subsurface Conditions

The subsurface conditions are consistent with the mapped geology. Review of subsurface data collected from the CPTs conducted at the site indicate that the campus is generally underlain by approximately fifteen feet of loose to medium-dense sandy fill over a relatively thin layer of soft clay and organic material, interpreted as Bay Mud or similar marsh deposits. Beneath the soft clay, each CPT encountered predominantly loose to medium-dense silty sand and sandy silt extending to a depth of 50 feet or more.

Groundwater was measured at approximately six feet below the ground surface during our CPT investigation. It is anticipated that the groundwater level beneath the site is influenced by tidal activity in the nearby San Francisco Bay.

[1] Graymer, R. W., "Geologic Map and Map Database of the Oakland Metropolitan Area, Alameda, Contra Costa, and San Francisco Counties, California", 2000, USGS, MF-2342 Version 1.0., Scale 1:50,000.

Given the low site elevations and proximity to San Francisco Bay, the highest historic groundwater elevation is assumed to coincide with the ground surface.

Liquefaction Risk and Liquefaction Induced Settlement Potential

The project site lies within a California Seismic Hazard Zone of Required Investigation for Liquefaction, as mapped by CGS (2003).

Liquefaction refers to the sudden, temporary loss of soil shear strength during strong ground shaking. Liquefaction-related phenomena include liquefaction-induced settlement, flow failure, and lateral spreading. These phenomena can occur where there are saturated, loose, granular deposits. Recent advances in liquefaction studies indicate that liquefaction can occur in granular materials with a high fines content (35 to 50% clayey and silty materials that pass the #200 sieve) provided the fines exhibit a plasticity less than 7. Granular layers with a potential for liquefaction were observed during our subsurface exploration.

To evaluate soil liquefaction, the seismic energy from an earthquake is compared with the ability of the soil to resist pore pressure generation. The earthquake energy is termed the cyclic stress ratio (CSR) and is a function of the maximum credible earthquake peak ground acceleration (PGA) and depth. The soil resistance to liquefaction is based on the relative density, and the amount and plasticity of the fines (silts and clays). The relative density of cohesionless soil is correlated with Cone Penetration Test data measured in the field.

We analyzed the potential for liquefaction utilizing the CPT Liquefaction Assessment software program CLiq (2007, ver. 1.7.6.49), and the procedures outlined by Idriss and Boulanger (2014). The design seismic conditions consisted of a magnitude 7.3 earthquake producing a PGA of 0.52 g, which corresponds to the PGA_M per ASCE 7-10 Section 11.8.3. The results of our liquefaction analyses are presented on Figures 5 through 11, and indicate numerous granular soil layers observed between roughly the ground surface and 50 feet below the ground surface classify as liquefiable during the design seismic event. Therefore, we judge the risk of liquefaction at the site is high.

Potential liquefaction of sandy layers between the ground surface and a depth of 50 feet may result in ground surface settlement of between roughly 5-inches (CPT-7) to 10-inches (CPTs 1-6), based on the liquefaction analyses discussed above, and as shown on Figures 5 through 11. Potential liquefaction induced differential settlement within a given building footprint area is estimated to be approximately two-thirds of the total settlement (approximately 3 to 7 inches).

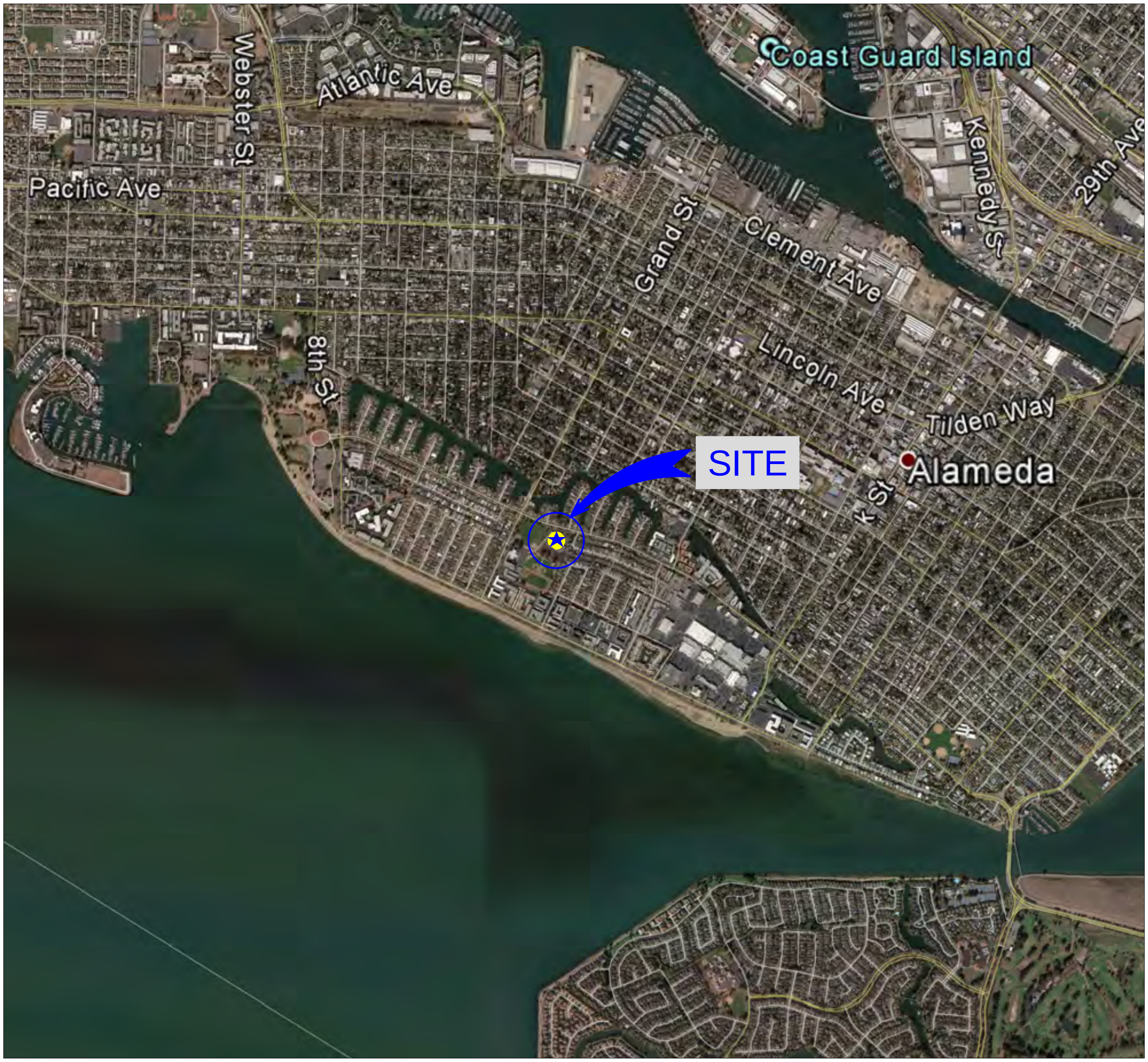
We also evaluated the liquefaction induced settlement potential at the Lum Elementary School Campus for a seismic event producing a PGA of 0.28 g, which corresponds to an expected return interval of approximately 90 to 100 years. Our analyses indicate that numerous granular soil layers between the ground surface and a depth of 50 feet still classify as liquefiable during this smaller seismic event, producing a predicted potential ground surface settlement of between roughly 4-inches (CPT-7) to 8-inches (CPTs 1-6). In this case, potential liquefaction induced differential settlement within a given building footprint area is estimated to be approximately 3 to 5 inches.

If you have any questions, or if we can be of further assistance, please call us at your convenience.

Yours very truly,
MILLER PACIFIC ENGINEERING GROUP

Daniel S. Caldwell
Geotechnical Engineer #2006
(Expires 9/30/17)

Attachments: Figures 1 through 11, A-1 through A-9



SITE: LATITUDE, 37.7618°
LONGITUDE, -122.2601°

SITE LOCATION

N.T.S.

NORTH

REFERENCE: Google Earth, 2017

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SITE LOCATION MAP

Lum Elementary School
1801 Sandcreek Way
Alameda, California

Project No. 1911.027 Date: 2/24/17

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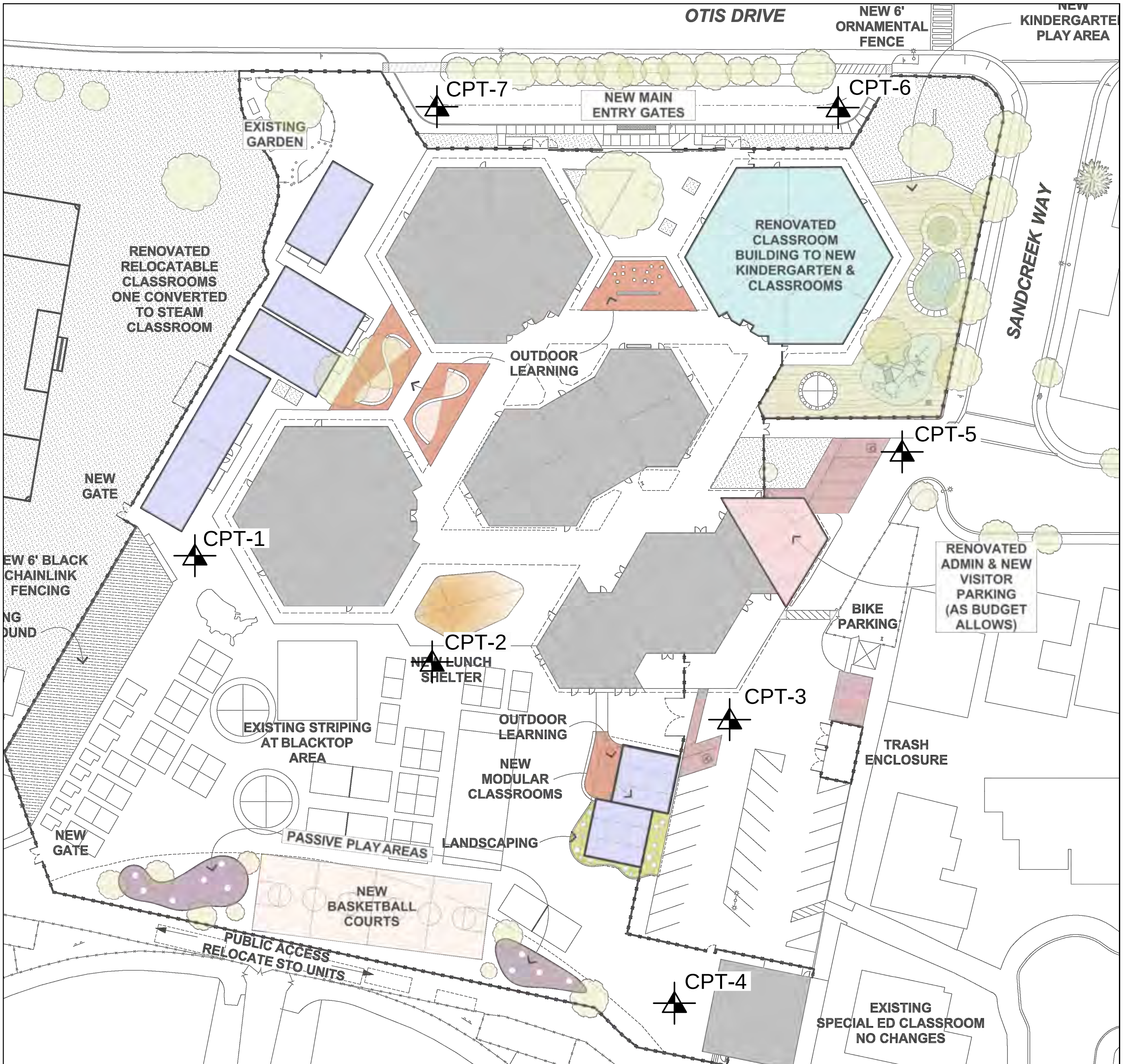
1
FIGURE



SITE PLAN

SCALE

0 40 80 160 FEET

Approximate location of CPT completed by MPEG, 2017

REFERENCE: Site Plan provided by QKA.

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SITE PLAN

Lum Elementary School
1801 Sandcreek Way
Alameda, California

Project No. 1911.027 Date: 2/24/17

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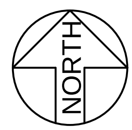
2
FIGURE

REGIONAL GEOLOGIC MAP

(NOT TO SCALE)



LEGEND

af — ARTIFICIAL FILL (HOLOCENE)
Man made deposit of various materials and ages. Some are compacted and quite firm, but fills made before 1865 are nearly everywhere not compacted and consist simply of dumped materials.

Qds — DUNE SAND (HOLOCENE AND PLEISTOCENE)
Fine-grained, very well sorted, well-drained, eolian deposits.They occur mainly in large sheets, as well as many small hills, most displaying Barchan morphology.Dunes display as much as 30 m of erosional relief and are presently being buried by basin deposits (Qhb) and bay mud (Qhbm). They probably began accumulating after the last interglacial high stand of sea level began to recede about 71 ka, continued to form when sea level dropped to its Wisconsin minimum about 18 ka, and probably ceased to accumulate after sea level reached its present elevation (about 6 ka). Atwater (1982) recognized buried paleosols in the dunes, indicating periods of nondeposition

REFERENCE: Graymer, R.W. (2000), "Geologic Map of the Oakland Metropolitan Area, Alameda, Contra Costa, and San Francisco Counties, California", United States Geological Survey Miscellaneous Field Studies Map MF-2342, Version 1.0, Map Scale 1:50,000.

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REGIONAL GEOLOGIC MAP

Lum Elementary School
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Alameda, California

Project No. 1911.027 Date: 2/24/17

Drawn MMT
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3
FIGURE

SITE COORDINATES: LAT. 37.7618° LON. -122.2601°

SCALE

0 12.5 25 50 MILES

NORTH

DATA SOURCE:
1) U.S. Geological Survey, U.S. Department of the Interior, "Earthquake Outlook for the San Francisco Bay Region 2014-2043", Map of Known Active Faults in the San Francisco Bay Region, Fact Sheet 2016-3020, Revised August 2016 (ver. 1.1).

MPEG MILLER PACIFIC ENGINEERING GROUP	504 Redwood Blvd. Suite 220 Novato, CA 94947 T 415 / 382-3444 F 415 / 382-3450 www.millerpac.com	ACTIVE FAULT MAP		
		Lum Elementary School 1801 Sandcreek Way Alameda, California Project No. 1911.027 Date: 2/24/17	Drawn MMT Checked	4 FIGURE

FILE: 1911.027 FM.dwg

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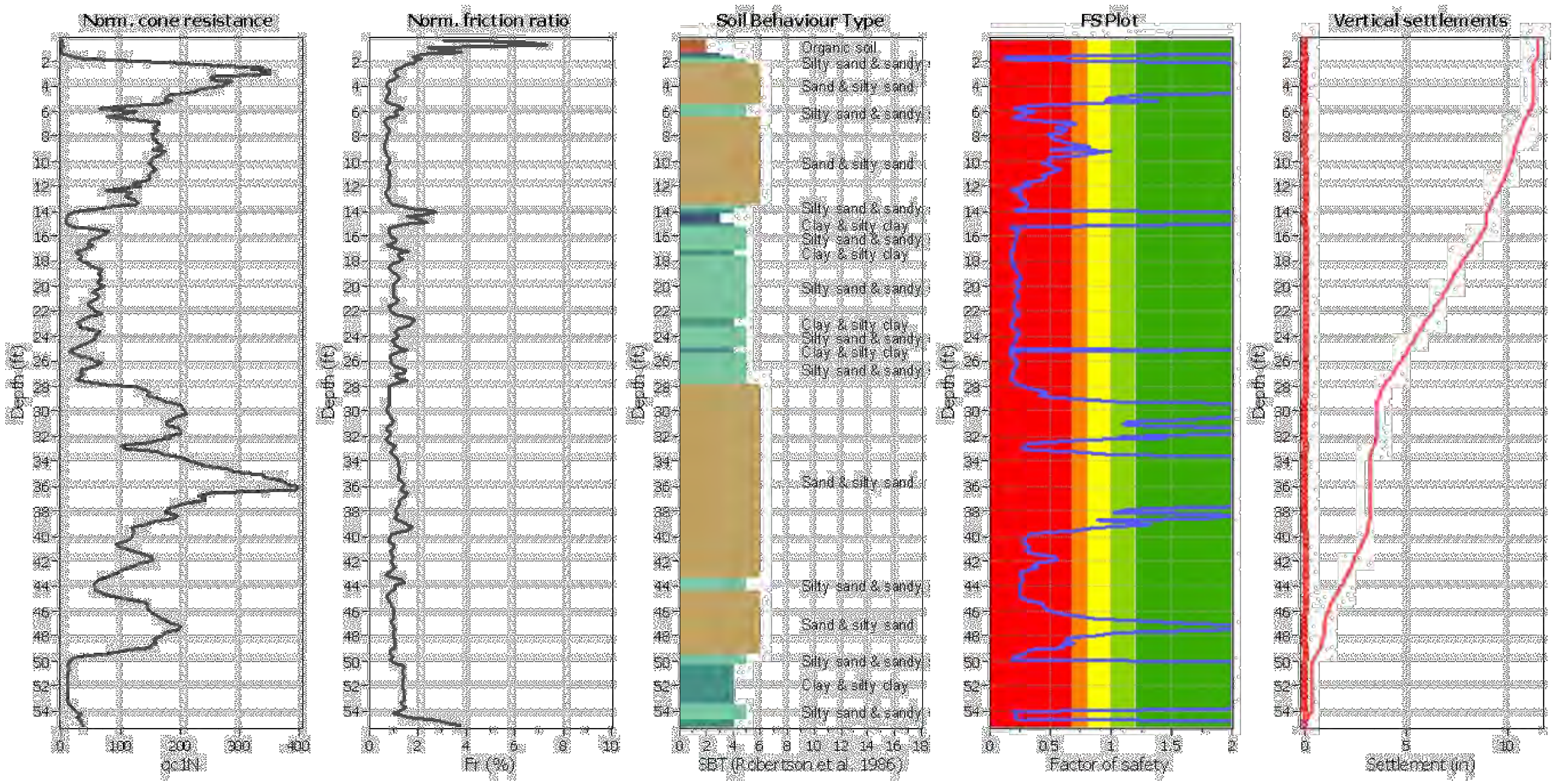
Project: **1911.027 Donald Lum Elementary**
Location: **Alameda, California**

CPT: CPT-01
Total depth: 55.12 ft



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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 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:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	.		

CPeT-IT v.2.0.6.94 - CPTU data presentation & interpretation software - Report created on: 2/23/2017, 11:27:00 AM
Project file: H:\Jobs\1900-1999\1911.027 Lum School\Liq\1911.027 Cliq.clq

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CPT-1 LIQUEFACTION ANALYSIS

Lum Elementary School
1801 Sandcreek Way
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Project No. 1911.027 Date: 2/24/17

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5
FIGURE

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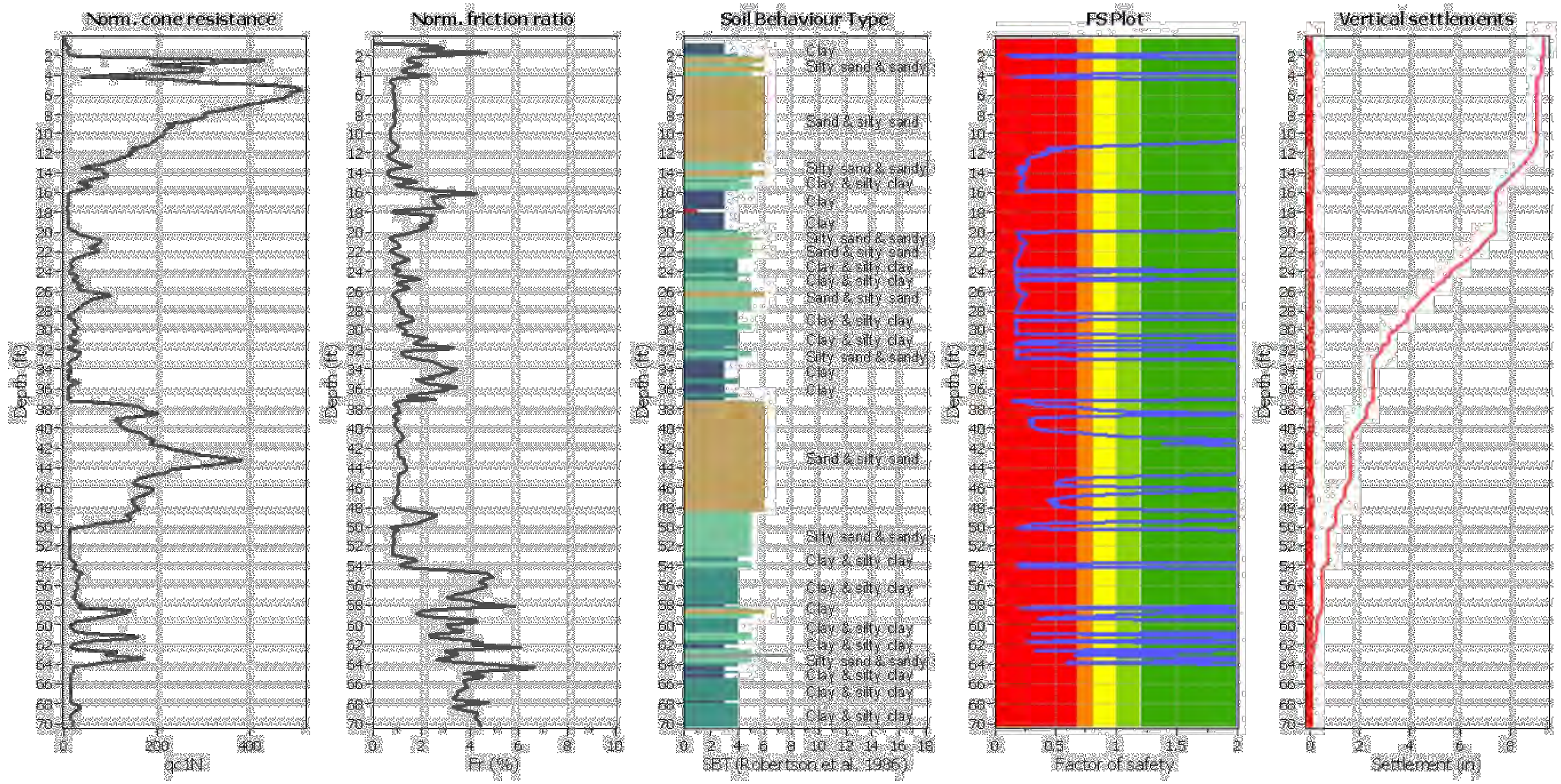
Project: 1911.027 Donald Lum Elementary
Location: Alameda, California

CPT: CPT-02
Total depth: 70.21 ft



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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:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	.		

CPeT-IT v.2.0.6.94 - CPTU data presentation & interpretation software - Report created on: 2/23/2017, 11:27:01 AM
Project file: H:\Jobs\1900-1999\1911.027 Lum School\Liq\1911.027 Cliq.clq

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CPT-2 LIQUEFACTION ANALYSIS

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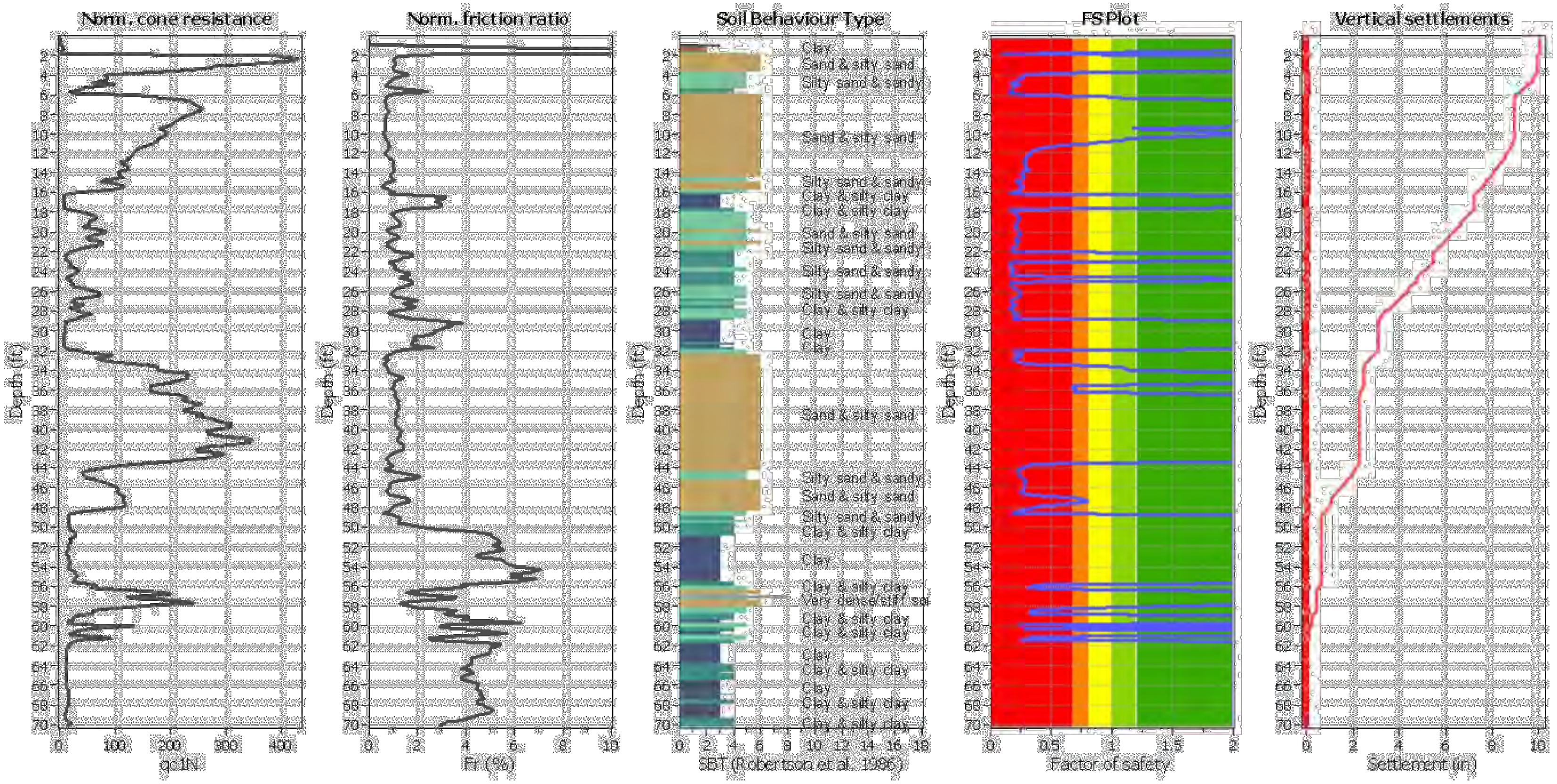
Project: 1911.027 Donald Lum Elementary
Location: Alameda, California

CPT: CPT-03
Total depth: 70.05 ft



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 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:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	.		

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CPT-3 LIQUEFACTION ANALYSIS

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7
FIGURE

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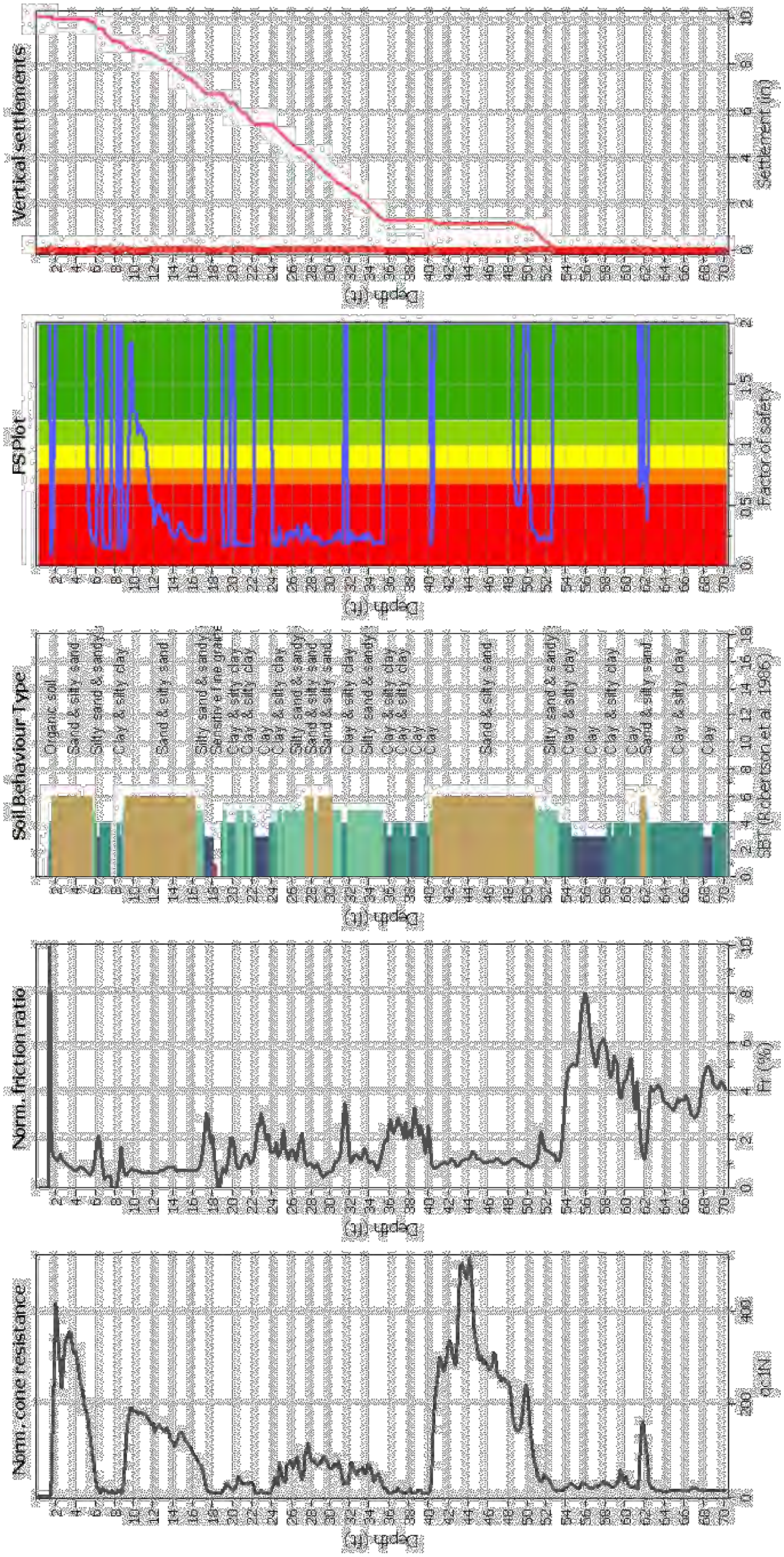
Project: 1911.027 Donald Lum Elementary
Location: Alameda, California

CPT: CPT-04
Total depth: 70.21 ft



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.52

G.W.T. (in-situ): 0.00 ft
G.W.T. (earthq.): 0.00 ft
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: .

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

CPeT-IT v.2.0.6.94 - CPTU data presentation & interpretation software - Report created on: 2/23/2017, 11:27:03 AM
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			8 FIGURE

FILE: 1911.027 Figures.dwg

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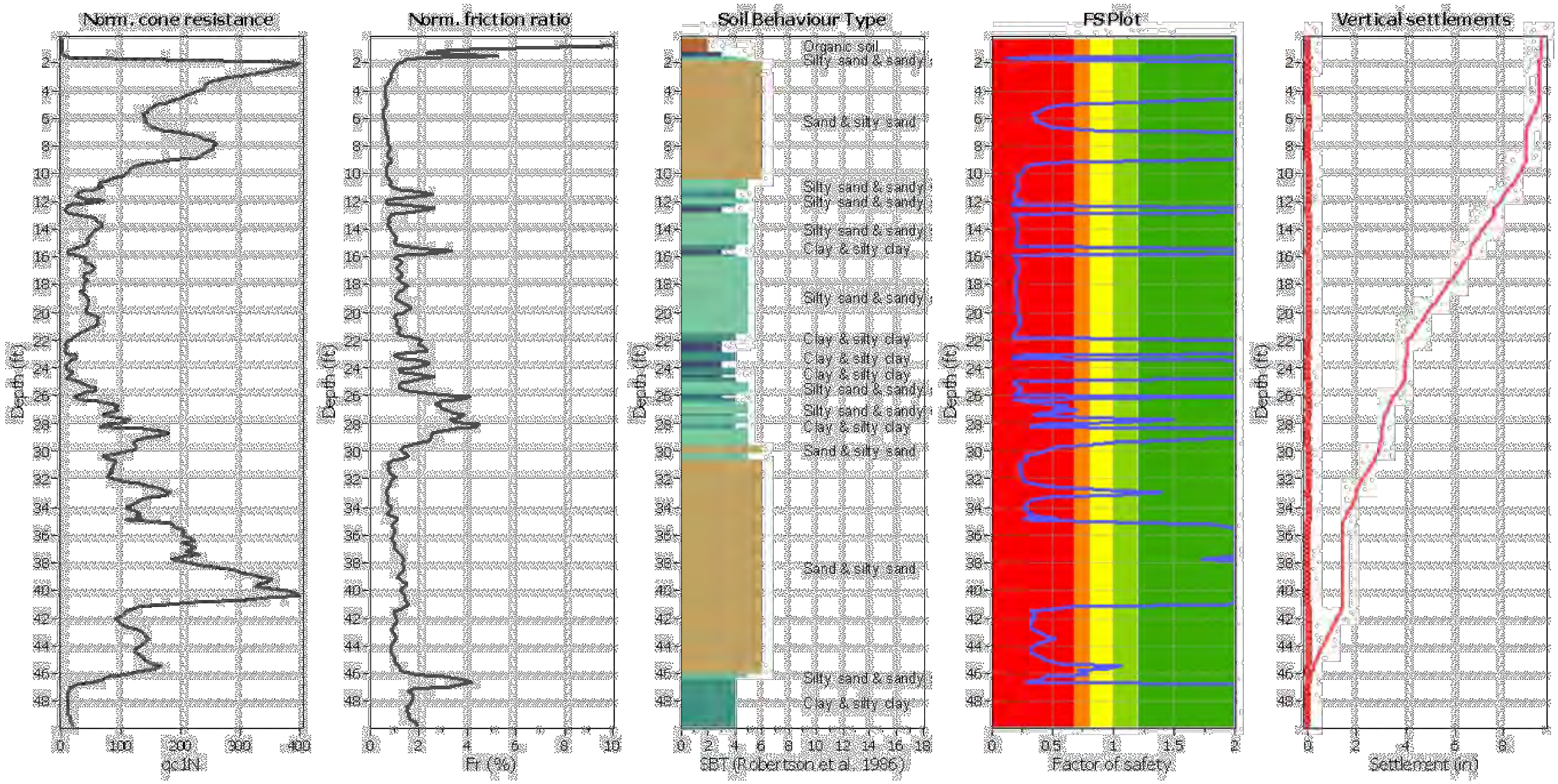
Project: **1911.027 Donald Lum Elementary**
Location: **Alameda, California**

CPT: CPT-05
Total depth: 49.71 ft



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 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:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	.		

CPeT-IT v.2.0.6.94 - CPTU data presentation & interpretation software - Report created on: 2/23/2017, 11:27:04 AM
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CPT-5 LIQUEFACTION ANALYSIS

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9
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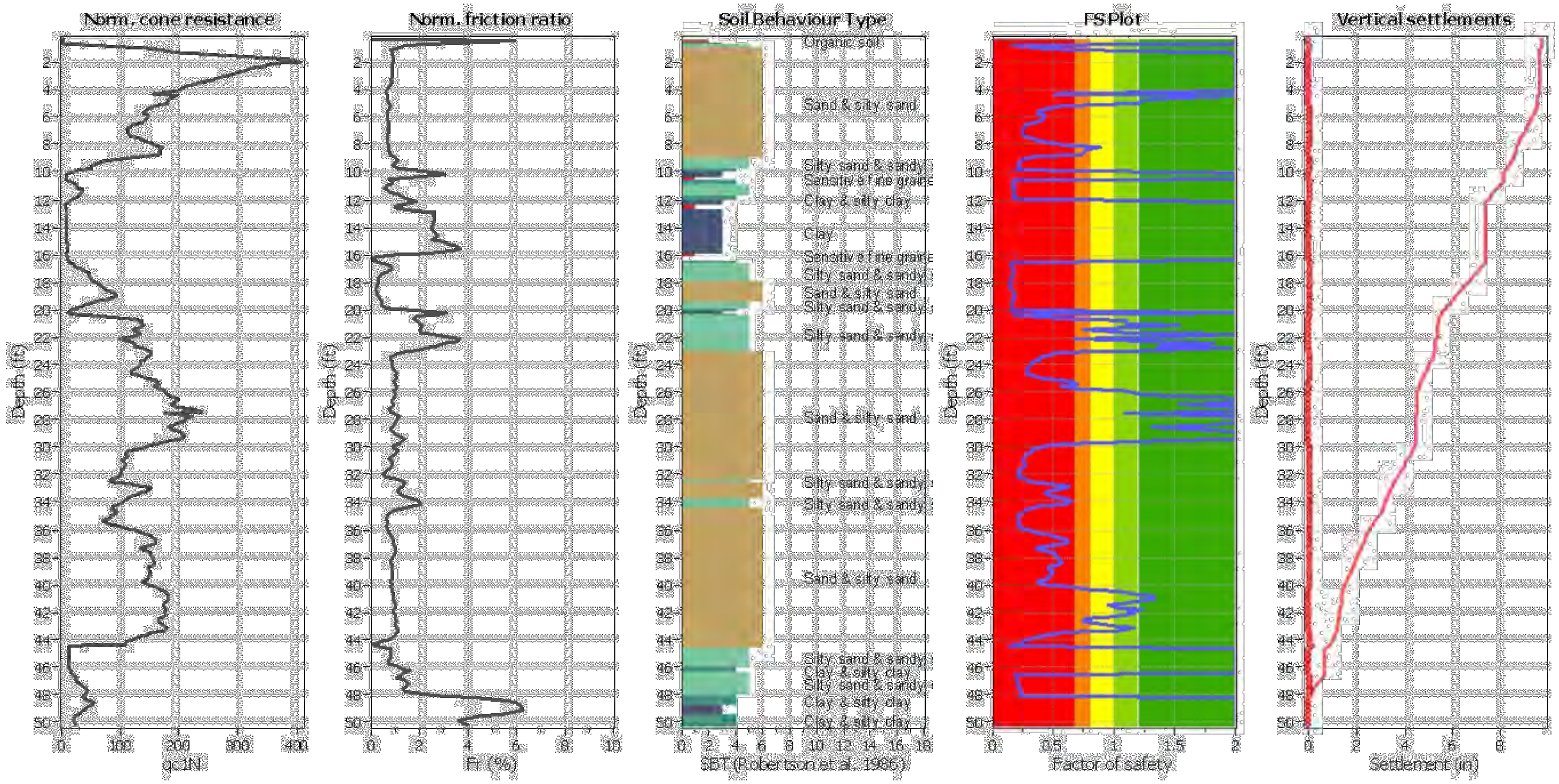
Project: 1911.027 Donald Lum Elementary
Location: Alameda, California

CPT: CPT-06
Total depth: 50.20 ft



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 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:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.52	Unit weight calculation:	Based on SBT	K_σ applied:	.		

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CPT-6 LIQUEFACTION ANALYSIS

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FIGURE

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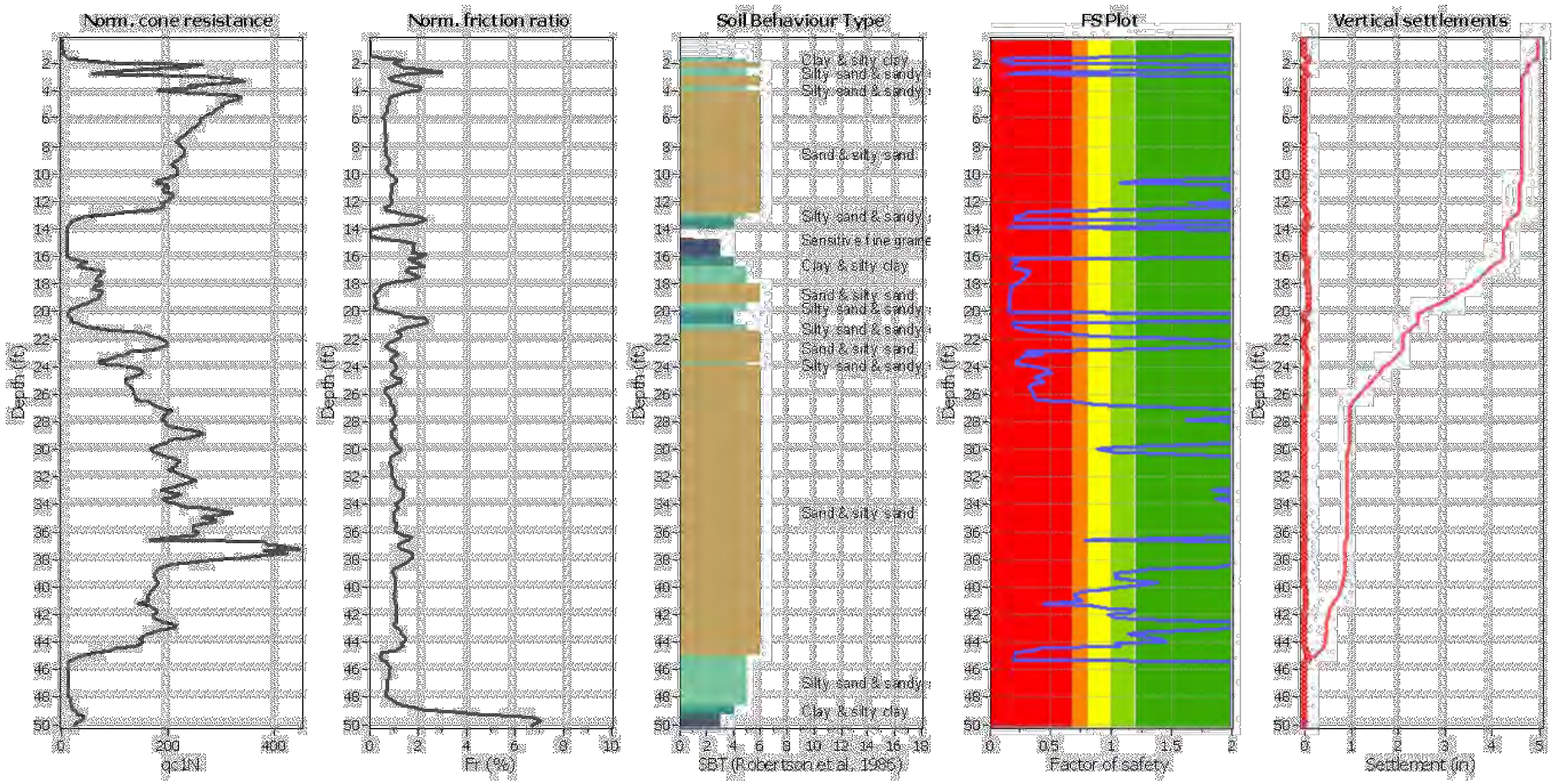
Project: 1911.027 Donald Lum Elementary
Location: Alameda, California

CPT: CPT-07
Total depth: 50.04 ft



Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	7.30
Peak ground acceleration:	0.52

G.W.T. (in-situ):	0.00 ft
G.W.T. (earthq.):	0.00 ft
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT

Use fill:	No
Fill height:	N/A
Fill weight:	N/A
Trans. detect. applied:	No
K_σ applied:	.

Clay like behavior applied:	.
Limit depth applied:	No
Limit depth:	N/A
MSF method:	Method based

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CPT-7 LIQUEFACTION ANALYSIS

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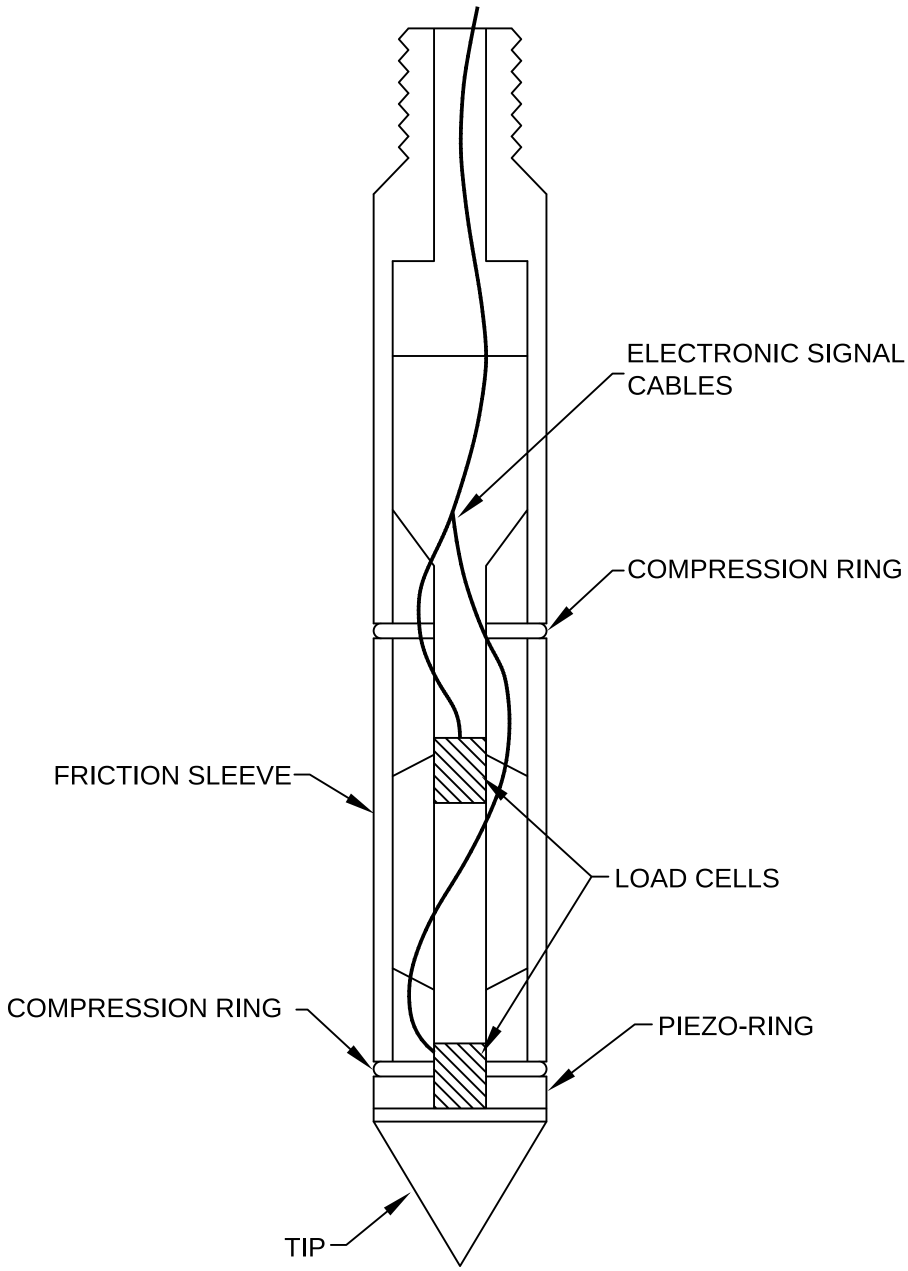
11
FIGURE

FILE: 1911.027 Figures.dwg

APPENDIX A



CONE PENETROMETER

(NO SCALE)

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FILENAME: 1911.027 CPT.dwg

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CONE PENETROMETER

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1801 Sandcreek Way
Alameda, California

Project No. 1911.027 Date: 2/24/17

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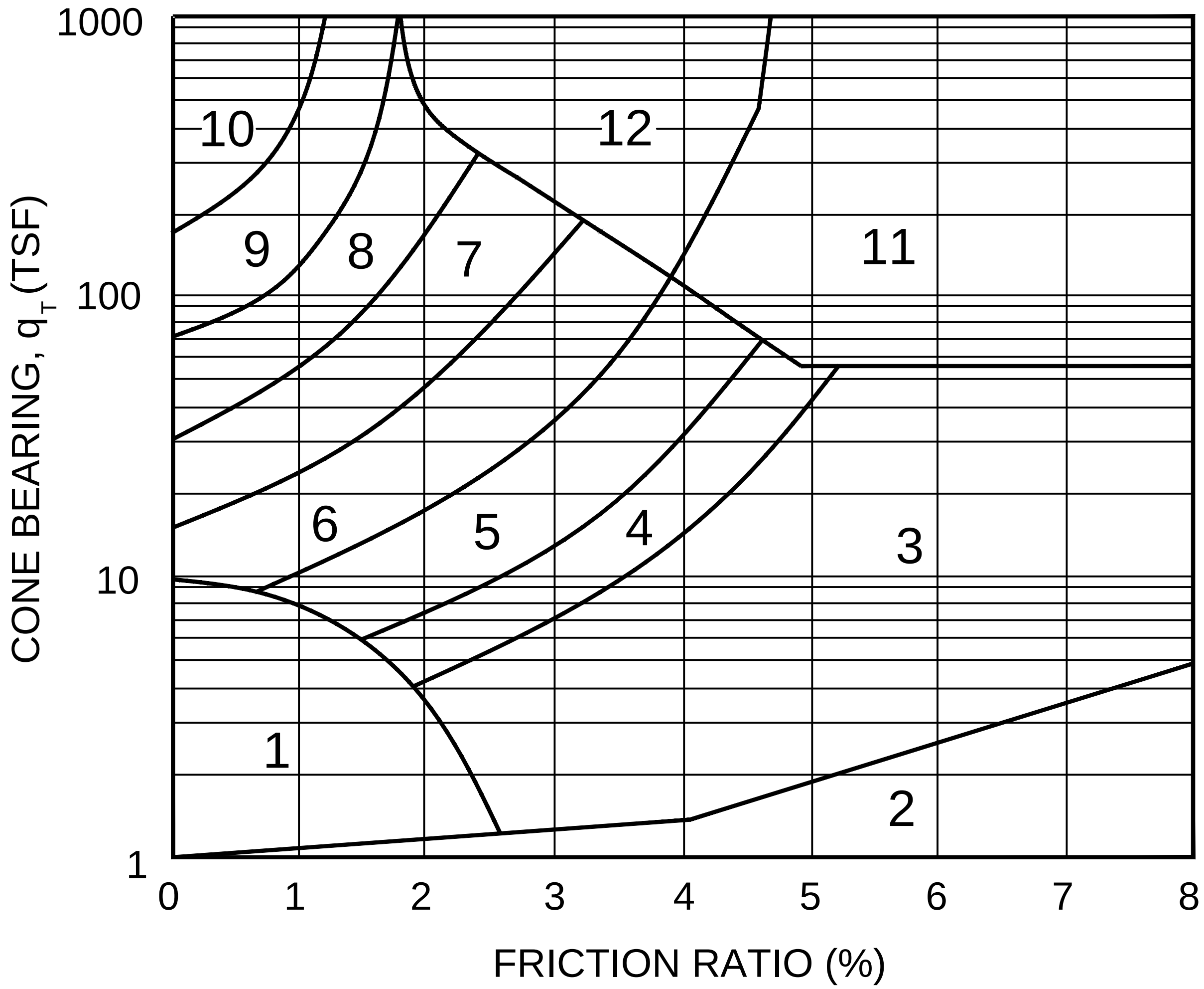
A-1
FIGURE



Zone:	Qc/N	Soil Behavior Type:
1)	2	Sensitive Fine Grained
2)	1	Organic Material
3)	1	Clay
4)	1.5	Silty Clay to Clay
5)	2	Clayey Silt to Silty Clay
6)	2.5	Sandy Silt to Clayey Silt
7)	3	Silty Sand to Sandy Silt
8)	4	Sand to Silty Sand
9)	5	Sand
10)	6	Gravelly Sand to Sand
11)	1	Very Stiff Fine Grained (*)
12)	2	Sand to Clayey Sand (*)

(*) Overconsolidated or Cemented

Reference: Robertson, P.K. (1986), "In-Situ Testing and Its Application to Geotechnical Engineering," Canadian Geotechnical Journal, Vol. 23; No. 23; No. 4, pp. 573-594

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FILENAME: 1911.027 CPT.dwg

CPT SOIL INTERPRETATION CHART

Lum Elementary School
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Alameda, California

Project No. 1911.027 Date: 2/24/17

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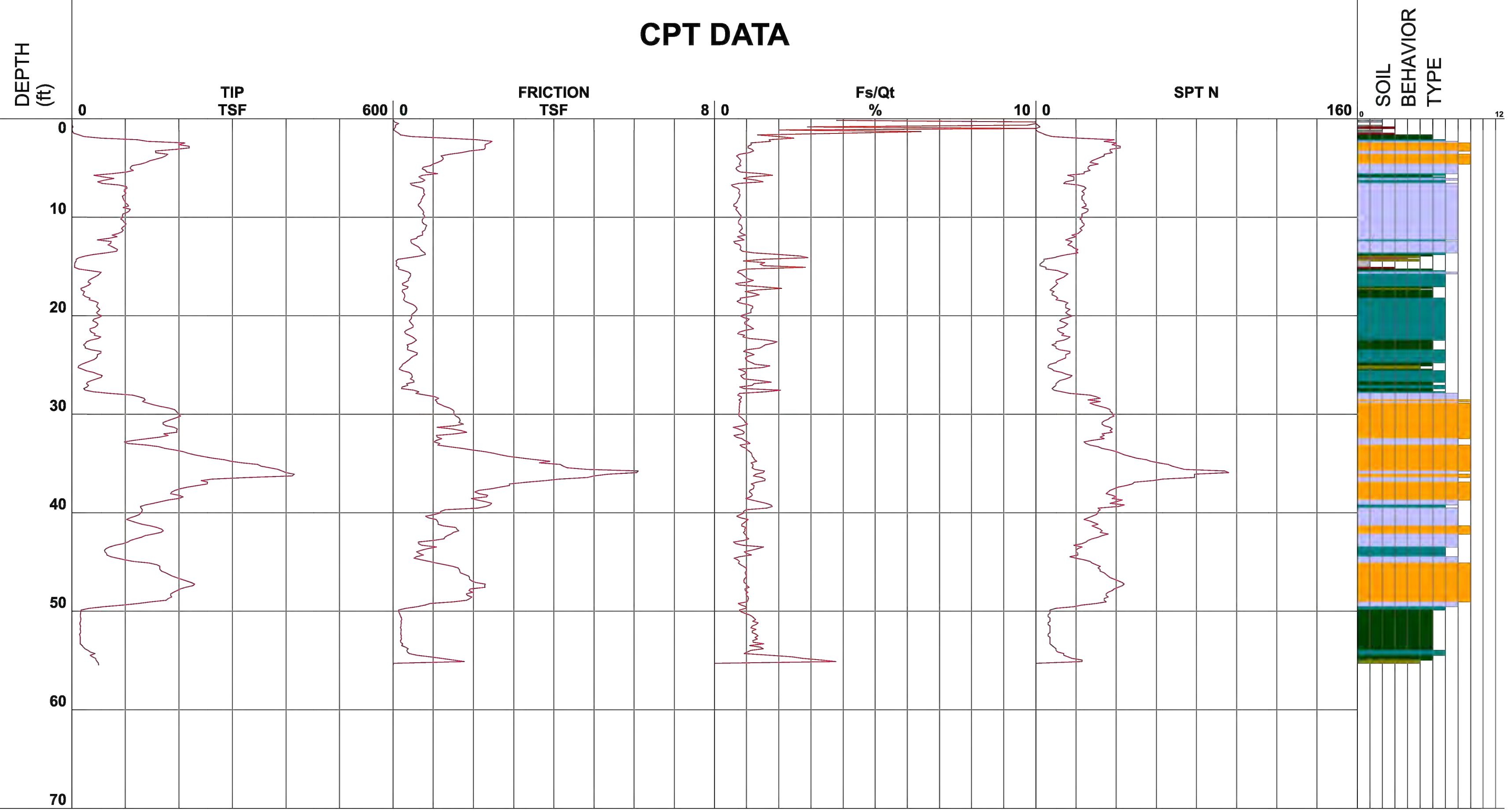
A-2
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(105).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-01	Date and Time	2/14/2017 9:44:45 AM	Maximum Depth	55.45 ft
EST GW Depth During Test			6.00 ft		

Net Area Ratio .8



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

MPEG MILLER PACIFIC ENGINEERING GROUP

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CPT-1 PLOT

Lum Elementary School
1801 Sandcreek Way
Alameda, California

Project No. 1911.027 Date: 2/24/17

Drawn MMT
Checked

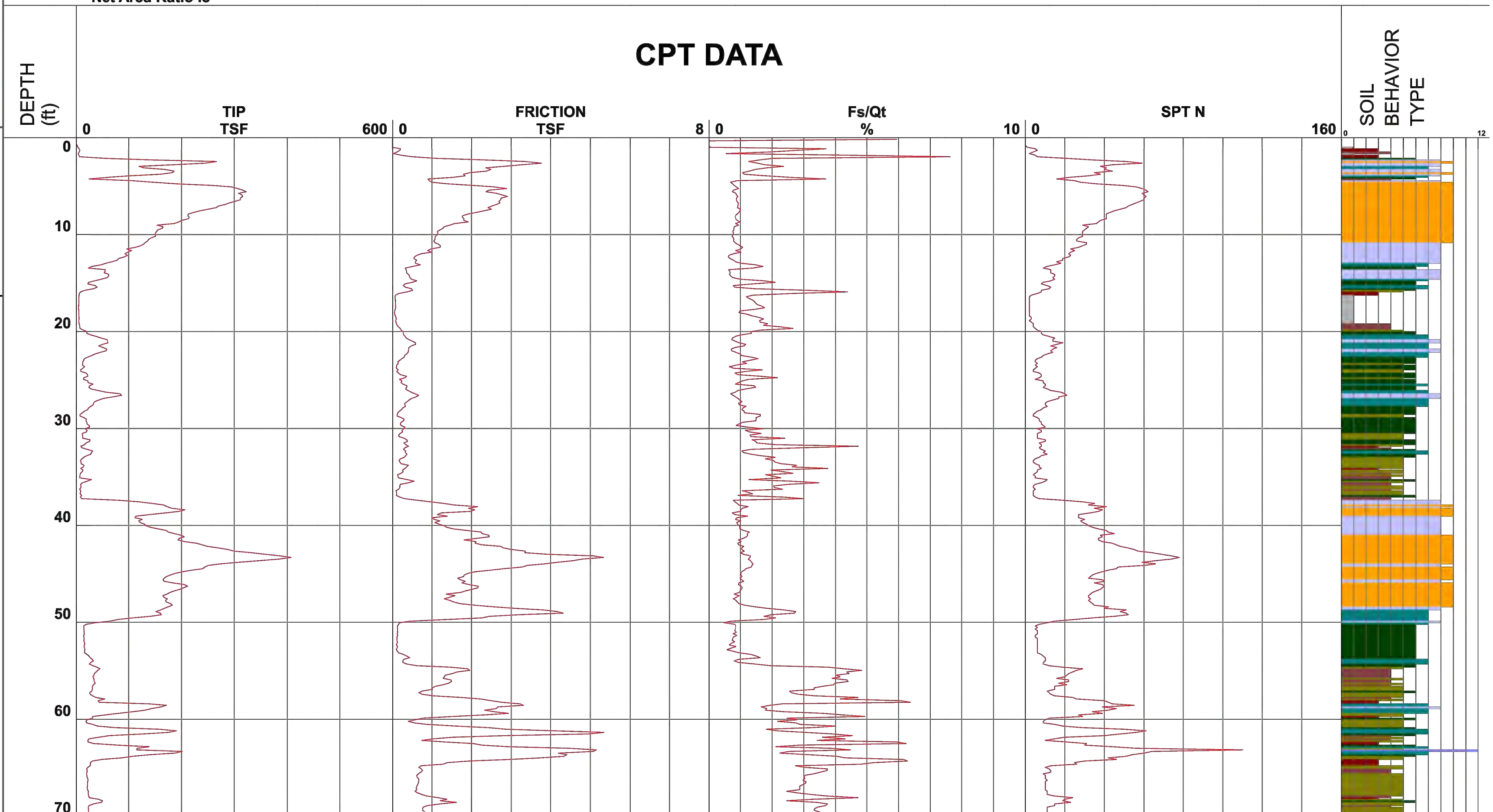
A-3
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(106).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-02	Date and Time	2/14/2017 11:19:05 AM	Maximum Depth	70.54 ft
EST GW Depth During Test		6.30 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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CPT-2 PLOT

Lum Elementary School
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Project No. 1911.027 Date: 2/24/17

Drawn MMT
Checked

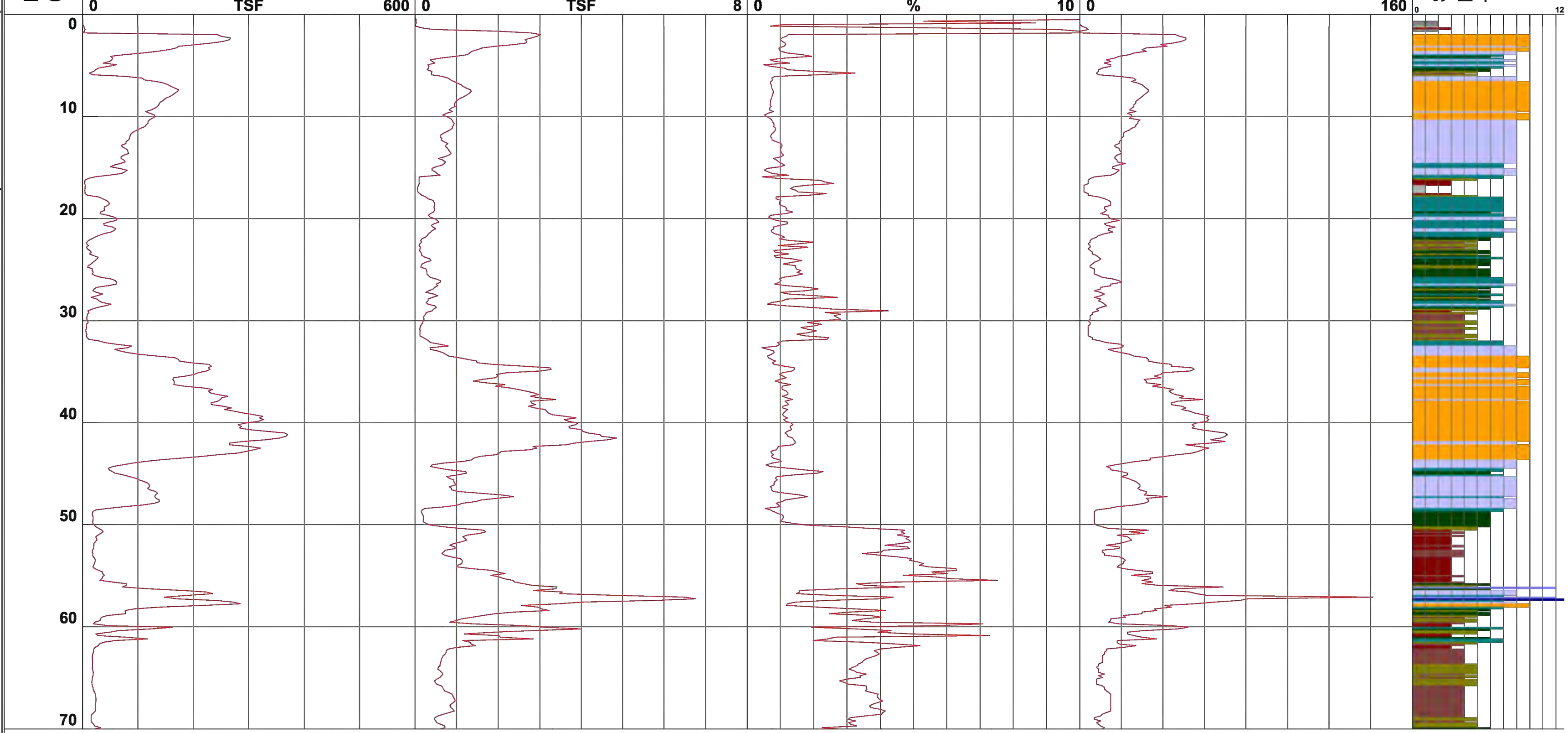
A-4
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(110).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-03	Date and Time	2/14/2017 3:19:13 PM	Maximum Depth	70.37 ft
EST GW Depth During Test		6.00 ft			

Net Area Ratio .8

CPT DATA



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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CPT-3 PLOT

Lum Elementary School
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Project No. 1911.027 Date: 2/24/17

Drawn MMT
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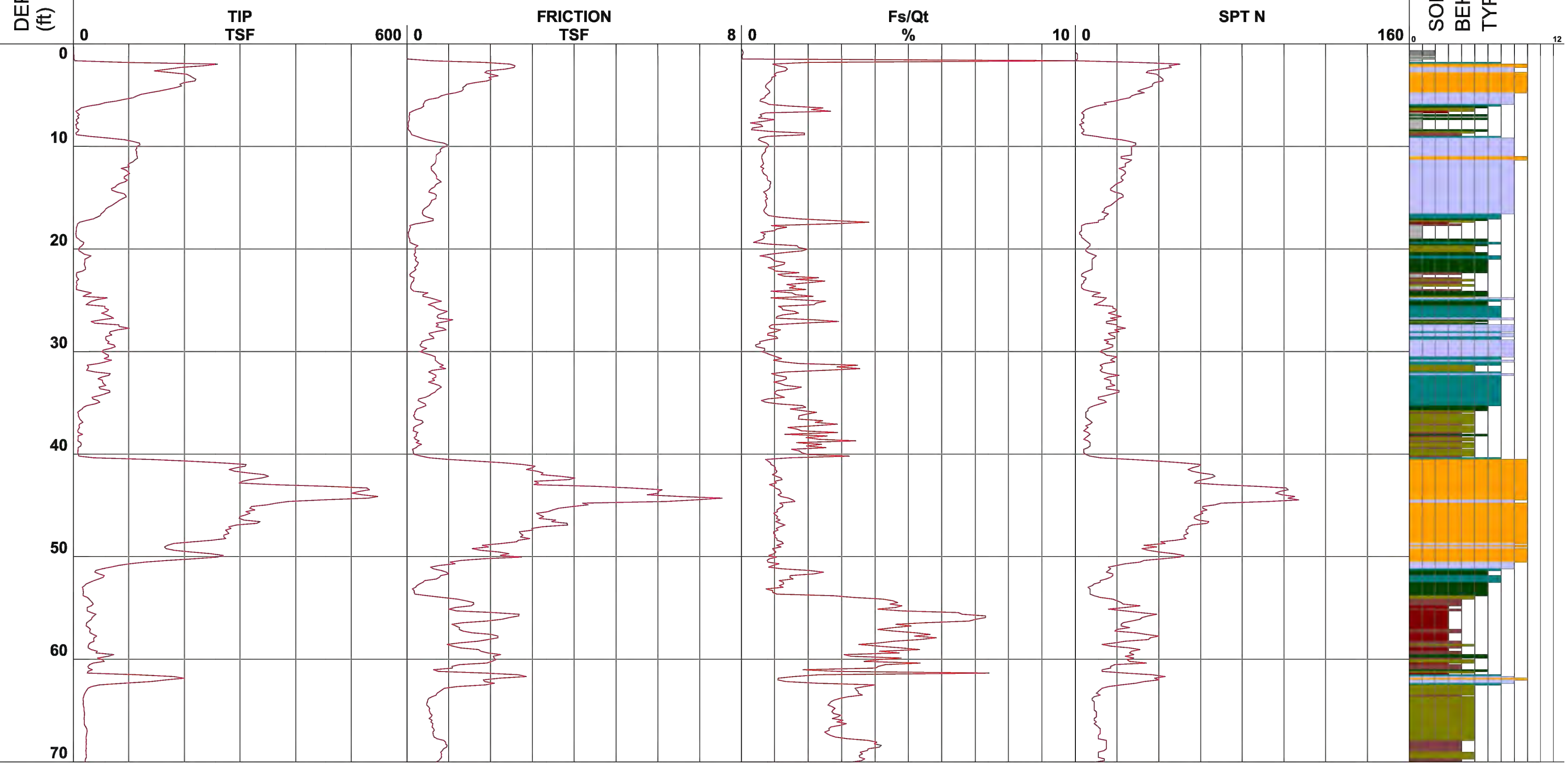
A-5
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(109).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-04	Date and Time	2/14/2017 2:21:08 PM	Maximum Depth	70.54 ft
EST GW Depth During Test			6.00 ft		

Net Area Ratio .8

CPT DATA



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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CPT-4 PLOT

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Project No. 1911.027 Date: 2/24/17

Drawn MMT
Checked

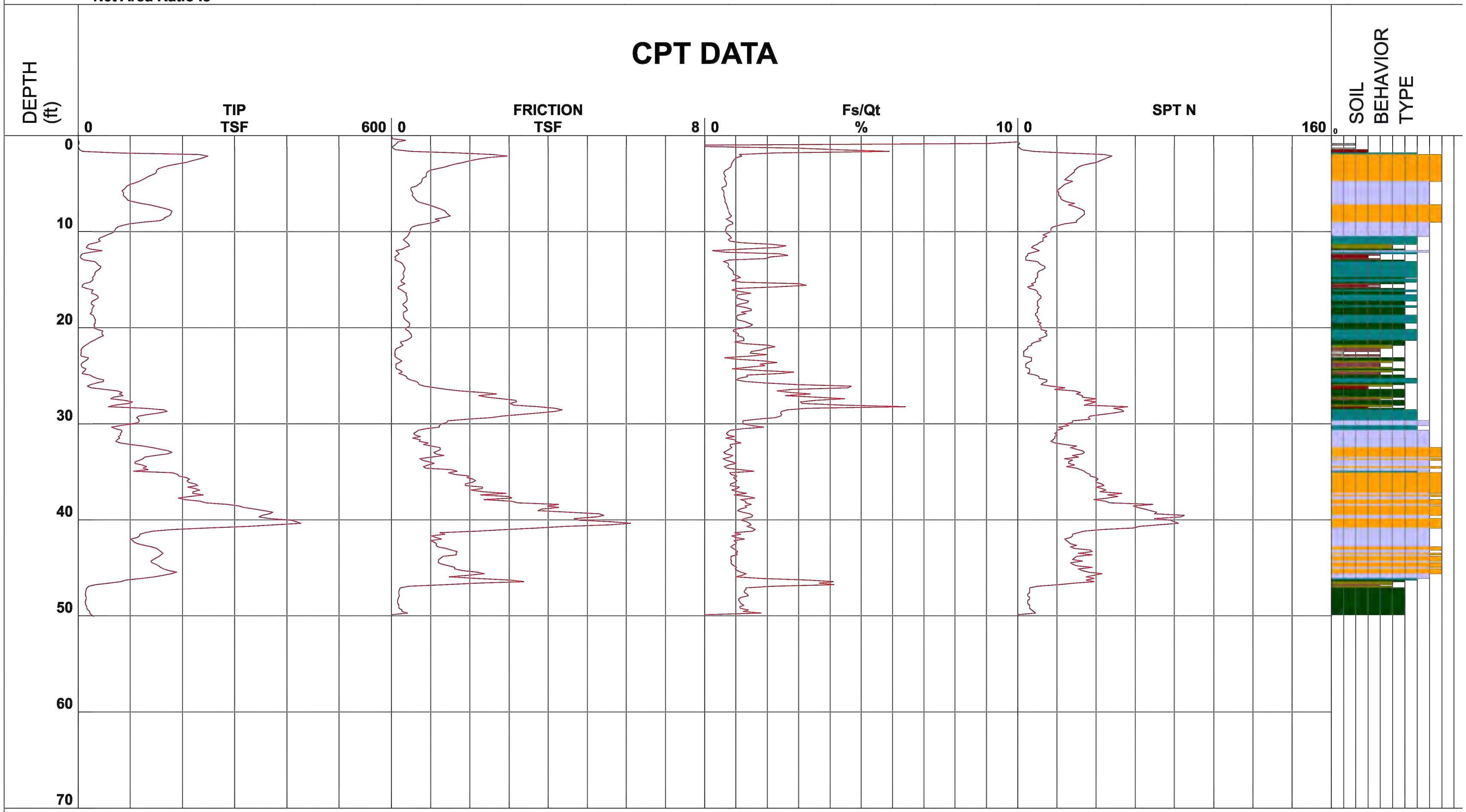
A-6
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(111).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-05	Date and Time	2/14/2017 4:16:07 PM	Maximum Depth	50.03 ft
EST GW Depth During Test			6.00 ft		

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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CPT-5 PLOT

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Project No. 1911.027 Date: 2/24/17

Drawn MMT
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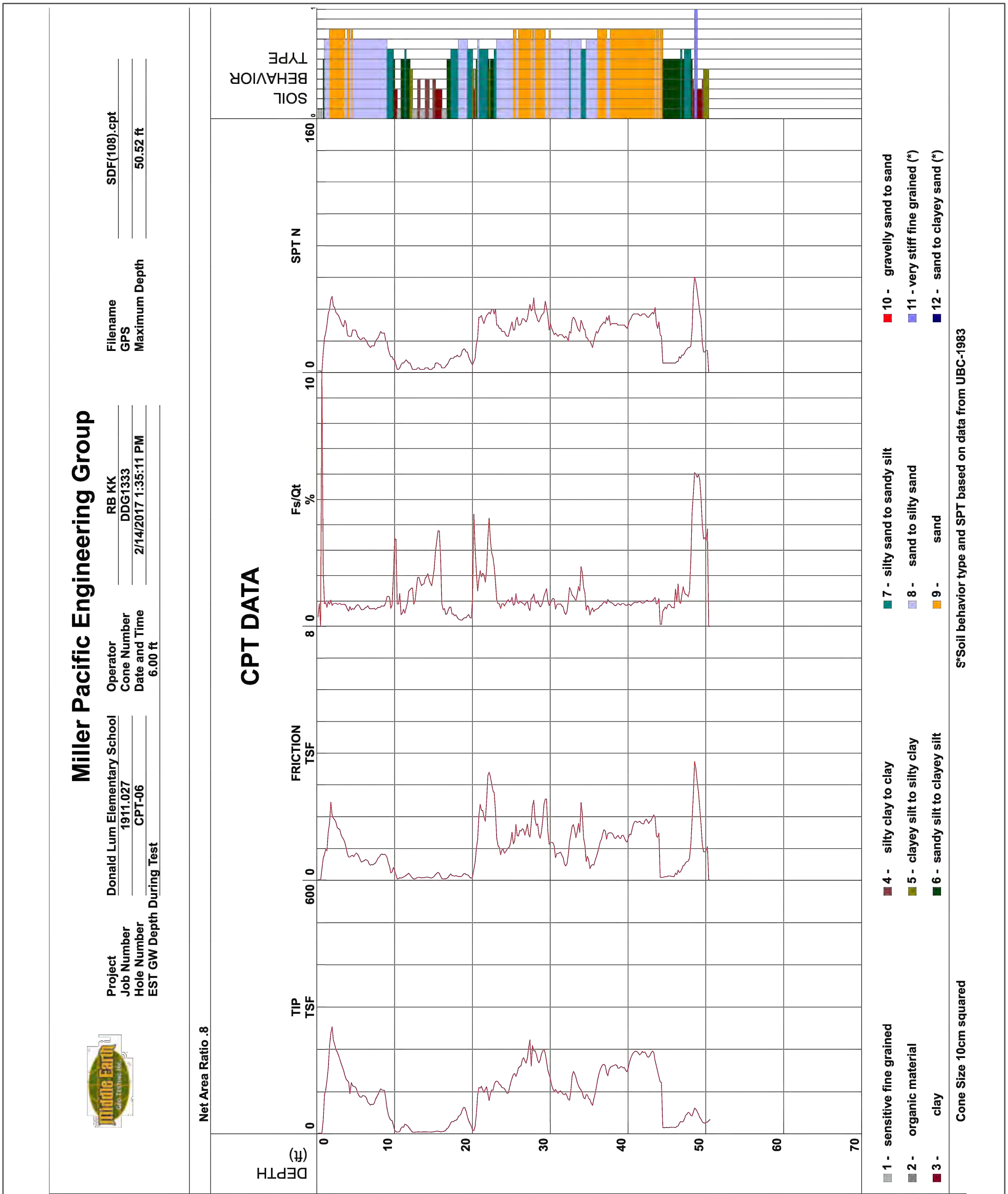
A-7
FIGURE



MPEG MILLER PACIFIC ENGINEERING GROUP

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CPT-6 PLOT

Lum Elementary School
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Project No. 1911.027 Date: 2/24/17

Drawn MMT
Checked

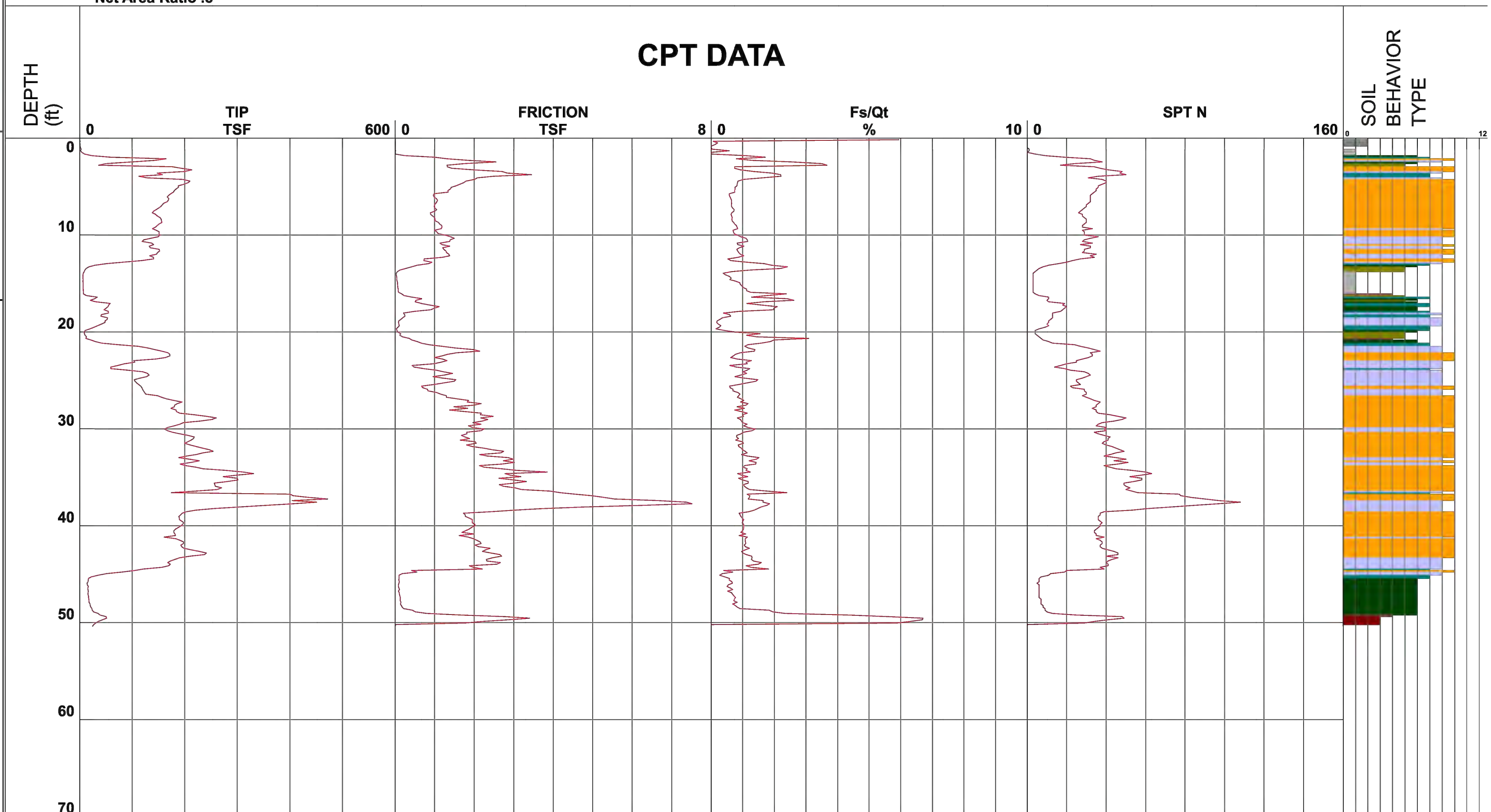
A-8
FIGURE

Miller Pacific Engineering Group

Project	Donald Lum Elementary School	Operator	RB KK	Filename	SDF(107).cpt
Job Number	1911.027	Cone Number	DDG1333	GPS	
Hole Number	CPT-07	Date and Time	2/14/2017 12:52:40 PM	Maximum Depth	50.36 ft
EST GW Depth During Test		6.00 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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CPT-7 PLOT

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A-9
FIGURE