Exhibit K

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THOMPSON
WILDLAND MANAGEMENT
Environmental Management & Conservation Services
International Society of Arboriculture Certified Arborist # WE-7468A
Department of Pesticide Regulation Qualified Applicator Lic. #QL50949 B
Environmental & Arborist Assessments, Protection, Restoration, Monitoring & Reporting
Wildland Fire Property Protection, Fuel Reduction & Vegetation Management
Invasive Weed Control, and Habitat Restoration & Management
Soil Erosion & Sedimentation Control Specialist
Resource Ecologist

February 21, 2017

Pick-N-Pull Auto & Truck Dismantlers
Attention: Ms. Kelly Lam, Terraphase Engineering Inc.
516B Dolan Road
Moss Landing, CA. 95039
Monterey County A.P.N: 131-054-002-000

Subject: Tree impact assessment for vegetation management areas at the Moss Landing *Pick-N-Pull* facility

An arborist assessment was recently conducted to assess the impacts of potential vegetation management activities on several mature Monterey cypress trees and other vegetation that is located along the outer perimeter of the Moss Landing *Pick-N-Pull* facility (APN: 131-054-002). More specifically, trees and large shrubby vegetation that are located within 20 feet of the perimeter fenceline of the facility in the areas identified as *Outfall 1B* and *Outfall 2B* (refer to corresponding site plans) were identified and assessed. The "potential vegetation management areas" outlined on the site plans are located within a 20 foot "area of interest" from the outside perimeter of the fenceline. The purpose of the site evaluation and report is to identify habitat and vegetation characteristics of the site, the general health and condition of trees and vegetation that are located in this 20 foot area of interest (i.e., the area 20 feet away from the outside perimeter of the fence), evaluate the impacts of potential vegetation management activities on nearby trees and large shrubs, and provide tree protection and preservation recommendations that will satisfy Monterey County Planning Department permit conditions.

Where possible the characteristics and conditions described in this report are depicted in the accompanying photographs located at the end of the report (refer to *Figures 1-6*). Trees and shrubs assessed during the field assessment are identified on the *Exhibit A* tree inventory spreadsheet. The location of trees, potential vegetation management areas, and the area of interest that is a 20 foot distance from the perimeter fenceline of *Outfall 1B &*

Outfall 2B are identified on the *Exhibit B* site maps. Findings and recommendations are provided herein.

I. SITE DESCRIPTION & TREE CHARACTERISTICS

The Pick-N-Pull auto dismantler facility is located in a rural open space area at 516B Dolan Road in Moss Landing, California (A.P.N. 131-054-002-000). This facility is surrounded by agricultural lands, coastal grasslands, tidal marsh habitat, and a portion of the *Elkhorn Slough Estuarine Reserve* is less than one-quarter mile to the north, west and east of the facility.

The area of interest that was assessed is a distance of 20 feet from the outside of the perimeter fencing of *Outfall 1B* and *Outfall 2B*. This area of interest is composed of 25 mature upper canopy Monterey cypress (*Cupressus macrocarpa*) trees that are 6 inch diameter at breast height (DBH) or larger and 2 young cypress trees, one of which is larger than 6 inch DBH (refer to the corresponding *Exhibit A* tree inventory spreadsheet and *Exhibit B* site maps). Lower growing understory vegetation primarily consist of non-native annual grasses and invasive broadleaf weeds, with large shrubs (e.g., native coyote brush [*Baccharis pilularis*]) occurring to a lesser extent.

The subject Monterey cypress trees are generally in fair to good physiological health. Biotic disorders, such as disease and insect pests, appear to absent in levels that are detrimental to tree health and viability. These upper canopy cypress trees that dominate the perimeter of the facility are not naturally occurring and were planted decades ago along the outer fenceline of the property for the purpose of providing a vegetation screen for the facility. These trees are located in close proximity to one another and have dense and broad spanning canopies and relatively compact growth habits that collectively form a dense vegetation barrier along the outer perimeter of the facility.

It should be noted, that recent powerful winter storms have felled several large cypress trees in and around this area of interest along the outer perimeter of the facility. These large and aging trees fell due to structural deficiencies, such as decay and excessive canopy weight and mass that compromised structural integrity and increased the probability of structural failure during recent extreme weather events.

II. IMPACT ASSESSMENT

In regards to impacts associated with proposed vegetation management operations, most of the trees are not located within 20 feet of the outside of the perimeter fence (i.e., the area of interest) and all of trees are located outside of the potential vegetation management areas (refer to Exhibit B site maps). However, numerous tree limbs do encroach into the 20 foot area of interest and into the potential vegetation management areas, and some limbs cross over the perimeter fenceline into the auto dismantling facility (refer to *Figures 1-5*). Based on the location of perimeter trees related to proposed vegetation management operations, tree removal should not be required; however it will likely be necessary to perform substantial pruning and stem reduction of several mature cypress trees. Properly executed pruning operations should be utilized and will assist in minimizing stress and harmful affects to impacted trees (refer to pruning guidelines provided under tree protection recommendations).

In regards to vegetation removal, there are 3 relatively large coyote brush shrubs that may need to be removed for proposed vegetation management operations (refer to *Exhibit A* tree inventory spreadsheet and *Exhibit B* site maps). In addition to pruning several nearby trees, it will be necessary to remove a few storm fallen trees prior to the commencement of proposed vegetation management activities (refer to *Figures 3 & 6*). Per the location of subject trees in relation to potential vegetation management operations, soil disturbance or grading associated with project operations is not anticipated to have an adverse affect on large primary roots or the critical root zones of nearby trees.

It should be noted that nesting birds, sensitive habitat and/or special status species are not occurring on the subject property or in the proposed project area. However, an additional nesting bird assessment should be conducted if tree operations occur during the nesting season, which in Monterey County may begin as early as February and continue through August. Oak woodland or any other woodland or forest habitat is not occurring on the subject property. Consequently, woodland habitat and/or forest continuity will not be affected by proposed project operations.

Based on the impact assessment that was conducted for the areas of interest (which includes the potential vegetation management areas), there is no evidence that project operations (e.g., tree pruning and some grading) will compromise the health and welfare of nearby trees.

III. **TREE PROTECTION & PRESERVATION RECOMMENDATIONS**

Per Monterey County requirements and resource preservation best management practices (BMP's), the following tree and resource protection measures shall be implemented for proposed vegetation management operations. Proper execution of tree and resource preservation BMP's and regular project site monitoring will assist in protecting and sustaining the health and welfare of trees on the property. The location of tree protection measures will be determined on-site by the project arborist and other involved parties, and tree and resource preservation measures will be regularly inspected and properly maintained for the duration of the project to ensure they are functioning effectively:

1) Prior to commencing with grading and construction activities install high visibility exclusionary fencing that clearly defines the work area, limits unnecessary disturbance to

surrounding areas, and protects the critical root zone (i.e., canopy dripline) of individual trees and tree groupings. Perform necessary repairs, modifications and maintenance on a as needed basis.

2) Install appropriate sedimentation control measures (e.g., silt fence) along downslope perimeter of site, and if necessary apply soil stabilization and source control measures (e.g., rice straw mulch, erosion control blankets, all-weather surfaces) to exposed soil surfaces to prevent erosion problems and sediment runoff during rain events. Perform routine monitoring as well as necessary maintenance and improvements to ensure that erosion & sedimentation control measures are functioning effectively. It should be noted, that erosion problems and sediment deposition around trees can adversely affect tree health and stability.

3) Where grading and construction activities are occurring within 3 feet of trees install necessary trunk and stem protection measures (e.g., 2”x4” lumber forming protective barrier around circumference of lower stem of tree). Tree protection measures should be securely installed to trees with rope and high visibility exclusionary fencing. If it is necessary to perform any pruning use proper tree pruning practices to minimize stress and maximize wound healing.

4) Where possible avoid damaging or severing roots located within the critical root zone (i.e., canopy dripline) of trees, especially roots that are 2 inches diameter or larger. Construction footings should be designed and excavation cuts performed in a manner to minimize impacts to primary roots. If significant roots are encountered efforts should be made to carefully excavate (e.g., tunnel or dig) under or around primary lateral roots. Trenching operations that may occur within the critical root zone of retained trees should be performed under the guidance and monitoring of the project arborist. Tree roots severed or significantly damaged during grading and excavating operations should be cleanly cut and promptly covered with moist burlap fabric or equivalent until roots are permanently covered with backfill material or until the exposed grading cut and soil profile is permanently stabilized and protected. If burlap covered cut roots are exposed to the outside environment for an extended period of time a project attendant shall be assigned the task of regularly wetting burlap covered roots to prevent root desiccation.

5) Avoid storing construction tools, materials and equipment within the critical root zone (i.e., canopy dripline) of trees, and do not wash out or dispose of excess materials (e.g., paint, plaster, concrete, or other potentially harmful substances) within critical root zone areas. If it is unavoidable and necessary to temporarily store or stockpile materials and equipment within the dripline of trees, apply 3-5 inches of clean and properly sourced woodchip mulch to prevent significant soil compaction and root zone disturbance.

6) Where possible avoid altering the natural grade within the critical root zone of trees to reduce the likelihood of causing stress, decline or mortality. Lowering natural grade can

result in significant root damage and raising the grade (i.e., introducing fill material, particularly around the lower trunk and root crown) can lead to trunk and root decay disorders that are detrimental to the health and structural integrity of trees.

7) If tree pruning is necessary it is important to utilize proper pruning BMP's that will assist in minimizing harmful impacts to trees. Tree pruning should ideally be performed during the fall through early winter months. A general principal to follow is that it is important to make proper pruning cuts, keeping them as small as possible while removing as few living branches as necessary to achieve the objective. Excessive pruning stresses trees by depleting energy reserves and reducing food making processes (i.e., photosynthesis), which compromises a trees ability to replenish essential energy reserves, particularly during periods of stress (e.g. root disturbance, soil compaction, altering grade and drought conditions). Additionally, it creates an abundance of exposed wounds providing entry points for potentially harmful biotic disorders (e.g., disease, decay and/or insect pests) that can adversely affect the health and structural integrity of trees. It should be noted that pruning involving the removal of 30% or more living canopy material requires a County permit. Additional pruning BMP's and guidelines are available upon request.

8) Regularly perform construction site inspections for the duration of the project to monitor the condition of tree and resource protection measures, and to determine if any repairs, adjustments or modifications are necessary. Additionally, trees impacted by site development should be periodically monitored and assessed during and following the project to determine if any tree care and management actions are necessary, and to make certain trees do not present a hazard to property and/or nearby structures.

IV. **CONCLUSION**

Per the site assessment, there is no evidence that proposed vegetation management operations at the Moss Landing *Pick-N-Pull Auto & Truck Dismantlers* is going to have an adverse affect on the health and viability of Monterey cypress trees located in proximity to *Outfall 1B* and *Outfall 2B*. Additionally, prior to project operations commencing the necessary tree and resource protection measures shall be installed and properly maintained for the duration of the project.

Thank you and please let me know if you have any questions or need additional information.

Best regards,

Rob Thompson ______________________ 2-21-17 ____________

Rob Thompson
ISA Certified Arborist
Resource Ecologist

Date

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CLIENT ACKNOWLEDGES THAT THIS REPORT, AND ANY OPINIONS, ADVICE OR RECOMMENDATIONS EXPRESSED OR GIVEN IN IT, ARE BASED ON THE INFORMATION SUPPLIED BY CLIENT AND ON THE DATA, INSPECTIONS, MEASUREMENTS AND ANALYSIS CARRIED OUT OR OBTAINED BY TWM.

THIS REPORT IS BASED ON A LIMITED VISUAL INSPECTION FOR OBVIOUS DEFECTS AND OF TREE CONDITION FROM GROUND LEVEL. IT IS NOT A COMPLETE HEALTH AND HAZARD EVALUATION, AS SOME HEALTH AND HAZARD CONDITIONS ARE NOT VISIBLE AND CANNOT BE CONFIRMED BY SUCH LIMITED INSPECTION. A COMPREHENSIVE HEALTH AND HAZARD ASSESSMENT WOULD INCLUDE OTHER INVESTIGATION MEASURES INCLUDING, BUT NOT LIMITED TO, CORE SAMPLES, TISSUE ANALYSIS, ROOT COLLAR EXCAVATION, SOIL ANALYSIS, AND VISUAL INSPECTION OF THE ENTIRE TREE VIA CLIMBING. ESTIMATES FOR THIS WORK ARE AVAILABLE UPON REQUEST.

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Figure 1. Portion of area identified as *Outfall 1B* is visible in this photo. "Area of interest" that was assessed is 20 feet distance outside of the perimeter fence seen in this photo. Mature cypress tree in background will be retained but may require some pruning back of limbs. Young cypress tree right of center is not within "potential vegetation management area" and will be retained.

Figure 2. View of fenceline along portion of area identified as *Outfall 1B.* No cypress trees are proposed for removal in any of the potential vegetation management areas located in *Outfall 1B* or *Outfall 2B*.

Figure 3. Another view of *Outfall 1B* section where tree limbs may require trimming back. Cypress tree visible right of center has fallen through perimeter fence during recent storm and obviously will require removal.

Figure 4. Cypress trees along area identified as *Outfall 2B* will not require removal but may need to be pruned back in preparation for potential vegetation management activities.

Figure 5. Another view of perimeter fenceline along *Outfall 2B*. A few coyote brush shrubs visible along fence will likely need to be removed and cypress tree limbs originating from large trees located over 20 feet behind the fence and down the slope will likely need to be trimmed back.

Figure 6. Large cypress tree that was also visible in *Figure 3* has fallen into perimeter fence and will obviously require removal. No standing and living trees will require removal for potential vegetation management operations.

Exhibit A: Tree inventory spreadsheet

Date: February 18, 2017

Prepared by: Rob Thompson, ISA Certified Arborist

None of the Monterey Cypress trees recorded in this spreadsheet are proposed for removal.

A majority of the cypress trees are mature multi-stem trees with relatively compact growth forms.

GPS coordinates are in latitude/longitude in map datum NAD83.

	GPS Waypoint Name	Tree Specie	DBH (inches)	Coordinates	Project Area
1	T01	Monterey Cypress	40	N36° 48.320' W121° 45.061'	Outfall 2B
2	T02	Monterey Cypress	36	N36° 48.321' W121° 45.068'	Outfall 2B
3	T03	Monterey Cypress	46	N36° 48.322' W121° 45.071'	Outfall 2B
4	T04	Monterey Cypress	44	N36° 48.325' W121° 45.074'	Outfall 2B
5	T05	Monterey Cypress	35	N36° 48.325' W121° 45.077'	Outfall 2B
6	T06	Monterey Cypress	25	N36° 48.323' W121° 45.080'	Outfall 2B
7	T07	Monterey Cypress	48	N36° 48.318' W121° 45.082'	Outfall 2B
8	T08	Monterey Cypress	30	N36° 48.317' W121° 45.086'	Outfall 2B
9	T09	Monterey Cypress	40	N36° 48.314' W121° 45.090'	Outfall 2B
10	T10	Monterey Cypress	43	N36° 48.306' W121° 45.103'	Outfall 2B
11	T11	Monterey Cypress	45	N36° 48.300' W121° 45.110'	Outfall 2B
12	T12	Monterey Cypress	47	N36° 48.299' W121° 45.117'	Outfall 2B
13	T13	Monterey Cypress	23	N36° 48.275' W121° 45.133'	Outfall 1B
14	T14	Monterey Cypress	48	N36° 48.266' W121° 45.137'	Outfall 1B
15	T15	Monterey Cypress	24	N36° 48.264' W121° 45.137'	Outfall 1B
16	T16	Monterey Cypress	44	N36° 48.260' W121° 45.138'	Outfall 1B
17	T17	Monterey Cypress	46	N36° 48.259' W121° 45.138'	Outfall 1B
18	T18	Monterey Cypress	42	N36° 48.250' W121° 45.140'	Outfall 1B
19	T19	Monterey Cypress	39	N36° 48.248' W121° 45.139'	Outfall 1B
20	T20	Monterey Cypress	41	N36° 48.245' W121° 45.140'	Outfall 1B
21	T21	Monterey Cypress	38	N36° 48.242' W121° 45.141'	Outfall 1B
22	T22	Monterey Cypress	38	N36° 48.239' W121° 45.142'	Outfall 1B
23	T23	Monterey Cypress	48	N36° 48.238' W121° 45.143'	Outfall 1B
24	T24	Monterey Cypress	31	N36° 48.228' W121° 45.144'	Outfall 1B
25	T25	Monterey Cypress	7	N36° 48.225' W121° 45.143'	Outfall 1B
26	T26	Monterey Cypress	41	N36° 48.219' W121° 45.149'	Outfall 1B
27	T27	Monterey Cypress	4	N36° 48.215' W121° 45.146'	Outfall 1B
28	B01	Coyote Brush	6	N36° 48.316' W121° 45.057'	Outfall 2B
29	B02	Coyote Brush	5	N36° 48.312' W121° 45.082'	Outfall 2B
30	B03	Coyote Brush	5	N36° 48.309' W121° 45.087'	Outfall 2B

Geotechnical Design and Geological Report
Proposed Stormwater Management Improvements
516 Dolan Road
Moss Landing, California

Prepared for

Schnitzer Steel Industries, Inc.
1101 Embarcadero West
Oakland, CA 94607

Prepared by

Terraphase Engineering Inc.
1404 Franklin Street, Suite 600
Oakland, California 94612

March 17, 2017

Project Number: 0055.005.004

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terraphase
engineering

March 17, 2017 0055.005.0004

Robert Ellsworth
Regional Environmental Manager, Pacific Southwest Region
Schnitzer Steel Industries, Inc.
1101 Embarcadero West
Oakland, CA 94607

Subject: Geotechnical Design and Geological Report, Stormwater Management Improvements, Schnitzer Steel Industries, Inc., Moss Landing, California

Dear Mr. Ellsworth:

Terraphase Engineering Inc. (Terraphase) is pleased to present the attached Geotechnical Design Report for the Stormwater Management Improvements, to be located at 516 Dolan Road, in Moss Landing ("the Site"). Design recommendations for rigid pavement and site grading are presented, along with other pertinent findings and conclusions regarding slope stability and geologic hazards.

Terraphase observed and logged the installation of four Cone Penetration Test (CPT) probes at the Site to depths up to 85 feet below the ground surface (bgs) to assess the subsurface soil conditions at the Site. The results of our assessment indicate that, with proper preparation, the Site will be suitable to support the proposed development, provided that the Site is prepared in accordance with the recommendations contained within the attached report.

We appreciate the opportunity to provide this service for Schnitzer Steel Industries, Inc., and look forward to being of further assistance as the project proceeds. If you have any questions concerning the contents of the attached report, please feel free to call Jeff Raines at (510) 645-1850 x 32 or Chris Alger at (510) 645-1850 x 58 at any time.

Sincerely,

REGISTERED PROFESSIONAL ENGINEER
JEFFERY R RAINES
2762
EXP 9-30-17
GEOTECHNICAL
STATE OF CALIFORNIA

CERTIFIED ENGINEERING GEOLOGIST
CHRISTOPHER S. ALGER
NO. 1564
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Jeff Raines, P.E. (C51120), G.E. (2762)
Principal Geotechnical Engineer

Christopher Alger, P.G. (5020), C.E.G. (1564)
Principal Engineering Geologist

Attachment

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CONTENTS

TABLES

FIGURES

APPENDICES

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1. INTRODUCTION

1.1 General

Terraphase Inc. (Terraphase) has prepared this report to present the results of our geotechnical engineering investigation and design study for the proposed Stormwater Management Improvements to be located at 516 Dolan Road in Moss Landing, California ("the Site"; Figure 1). This Geotechnical Investigation and Design Report is based on the proposal prepared for the Schnitzer Steel Industries, Inc. by Terraphase dated January 12, 2017.

There was no available pre-existing geotechnical data for the Site other than published materials (e.g., Natural Resources Conservation Service [NRCS] soil maps).

1.2 PROJECT DESCRIPTION

The proposed project consists of the installation of four stormwater management ponds and the paving of the car crushing area with reinforced concrete pavement. The stormwater management ponds will be constructed at four corners of the Site near or at the tops of existing embankment slopes. The project will include the placement of some additional soil fill at the tops of the slopes. The stormwater management ponds will be lined to reduce the likelihood that stormwater will infiltrate into the slopes. The ponds will be drained to either below the toe of the adjacent slope or to a location unlikely to lead to slope instability.

1.3 SCOPE OF STUDY

Based on our understanding of the client project, the following scope of services was developed and completed:

- Terraphase observed and logged the installation of four cone penetration test (CPT) probes.
- Terraphase performed percolation tests to assess how well stormwater would infiltrate into the subsurface at each of the proposed pond areas.
- Terraphase assessed geological hazards applicable to the Site and their potential impacts to the proposed work.
- The following engineering analyses were performed to develop geotechnical engineering criteria for the proposed project:
    - Required reinforced concrete slab thicknesses and reinforcement to support large forklifts (Volvo L-90s loaders)
    - Slope stability analyses of Site embankment slopes
    - Percolation rates
- Recommendations were developed for:

- Site preparation and grading
  - Rigid pavement design and construction

This report summarizes our study results and presents our design and construction recommendations and design criteria, as well as the subsurface data on which they are based.

2. SUBSURFACE EXPLORATION AND LABORATORY TESTING

2.1 Subsurface Exploration

On April 26, 2016, California Push Technologies Inc. of San Leandro, California, advanced four cone penetration test (CPT) probes. Figure 2 illustrates the approximate locations of subsurface probes, designated CPT-01A, CPT-01B, CPT-02A and CPT-02B. The subsurface locations were selected based on proposed locations of the four ponds.

The Cone Penetration Tests were completed using a 30 Ton CPT Rig. The soundings were conducted in accordance with ASTM standard D 5778 – 12 - *Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils*. The cone used by California Push Technologies Inc. of San Leandro, California had the following properties:

Cone Penetrometers Used for this Project						
Contractor	Cone Number	Cross Sectional Area (cm_2)	Sleeve Area (cm_2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
California Push Technologies Inc.	AD391	15	225	1500	15	500

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8[1] and cone tips with a 60 degree apex. Pore pressures are recorded directly behind the cone tip in the "u^2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

Cone penetration testing consists of pushing a steel cone into the ground. Strain gauges in the cone detect the amount of force being applied to both the tip of the cone (tip resistance) and the side of the cone (side friction). Numerous correlations have been developed between the two types of cone resistance and material types (sands, silts, clays) and to the material properties of these soils (e.g., Robertson et al. 1986, Robertson 1990). In addition, the cone used at the Site included a pressure meter for assessing porewater pressures. Once the excess porewater pressures generated by installing the cone dissipated, the porewater pressure at depth can be used to evaluate the depth of the groundwater table (for unconfined aquifers). In addition, the time required to dissipate the excess pore pressures correlates with the consolidation properties of the soil.

[1] A constant developed from laboratory testing to correct measured tip resistance to account for pore water pressures.

The advantages of CPT testing include the following:

- Soil data are essentially continuous.
- Higher quality data are obtained due to reduced equipment and operator error, which produces less scatter in the data.
- No spoils requiring characterization and disposal are produced.

A disadvantage of CPT testing is that no soil samples are recovered for visual description or for laboratory testing.

Appendix A is the report prepared by the CPT contractor.

2.2 Percolation Testing

Percolation testing was conducted at the Site at the locations shown on Figure 2. Percolation testing was done in general accordance with USEPA (1990) guidance. Percolation test results are presented in Appendix B.

3. SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The Site is located along Via Tanques Road in Moss Landing, California approximately 2,800 feet north of Dolan Road. The site consists of two parcels on either side of Via Tanques Road. The western parcel is approximately 8.2 acres in area with elevations ranging from 60 to 74 above mean sea level (MSL) (WGS84 EGM96). The eastern parcel is approximately 6.4 acres in area with elevations ranging from 44 to 71 feet above MSL. The Site is currently used as an -end-of-useful-life automobile recycling yard.

3.2 Regional Geology

The Site is situated along the central section of the Monterey Bay, within the Coast Ranges geomorphic province of California. The Coast Ranges are generally characterized by rugged, northwest-trending mountains and intervening valleys. The ancestral confluence of the Pajaro and Salinas Rivers and their tributaries formed a broad basin of sediments that are exposed along the central Monterey Bay coastline (Greene, et al, 1977; Wagner et al., 2002). These Quaternary Age (1.6 million years ago to recent) deposits are composed of eolian and dune sands, flood plain and alluvial fan deposits, as well as marine terrace, beach, and shallow marine deposits.

The broad sedimentary basin is flanked by Pliocene and Miocene marine deposits of the Aromas, Purisima and Monterey bedrock formations. The basin lies on the west side of the San Andreas Fault Zone that forms a major tectonic boundary with the North American continent to the east. West of the San Andreas lies the Salinian Block and Pacific Plate. The Salinian Block is bounded by the Sur-Nacimiento Fault to the west. Bedrock within the Block consists of Paleozoic high grade metamorphic rocks and Cretaceous granitic rocks overlain by Tertiary and Quaternary sedimentary rocks (Wagner et al., 2002).

The site is located on an upland terrace formed primarily from old dune and alluvial fan deposits associated with historical deposition from the ancestral Salinas River and shaped by erosion along the adjacent Elkhorn Slough. The site is located upstream approximately two miles from the current Monterey Bay shoreline.

Centrally located along the Monterey Bay coastline, the Elkhorn Slough marks the head of the much larger Monterey Submarine Canyon. The 50- mile long submarine canyon is approximately 13 miles wide and a mile deep and has cut deep into the continental shelf forming a submarine feature of dimensions comparable to the Grand Canyon. In general, the onshore sedimentary basin geology is continued onto the continental shelf as exposed in the submarine canyon walls (Wagner et al., 2002).

The San Andreas Fault Zone is the major active fault in the area and is composed of lesser faults cutting the near shore areas. The Monterey Bay and San Gregorio Fault zones trend northwest offshore of the site, approximately 10.7 and 19 miles respectively, and are traceable on land west of Santa Cruz. The Zayante-Vergales fault is about 8 miles northeast of the site. The San Andreas fault lies approximately 11.5 miles northeast of the site.

3.3 Seismicity

The study area is located in a seismically active region of coastal California. The seismic sources include the San Andreas, San Gregorio, Monterey Bay, and Zayante-Vergales faults. For each of the active faults, the distance from the site and estimated maximum moment magnitude (Mw) earthquake are summarized in Table 1. The Site is located approximately equidistant between the San Andreas and Monterey Bay-Tularcitos Fault Zones. These structures are part of the San Andreas Fault System which forms the North American/Pacific plate boundary. In the Monterey Bay area, seismic stress is partitioned onto structures subsidiary to the main trace of the San Andreas fault, such as the Zayante-Vergeles and Monterey Bay-Tularcitos, and San Gregario faults. Movement along this plate boundary is primarily translational, resulting in mostly right-lateral strike-slip along the San Andreas Fault System.

Since 1800, four major earthquakes have been recorded on the San Andreas fault. In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale occurred east of Monterey Bay on the San Andreas fault (Toppozada and Borchardt, 1998). This earthquake was previously thought to have occurred on the northern portion of the Hayward fault. In 1838, an earthquake occurred with an estimated MM intensity of about VIII-IX. Faulting probably extended from San Francisco to San Juan Bautista (Toppozada and Borchardt, 1998).

The San Francisco earthquake of 1906 caused the most significant damage in the history of the San Francisco Bay area in terms of loss of lives and property damage. This earthquake created a 430-kilometer surface rupture along the San Andreas fault from Shelter Cove to San Juan Bautista. It had a maximum intensity of XI, a moment magnitude of about 7.9, and was felt 560 kilometers away in Oregon, Nevada and Los Angeles.

In October 1926, two moment-magnitude 6.1 earthquakes occurred near the town of Monterey southwest of the site that caused severe shaking at Santa Cruz (Stover and Coffman, 1993). In Santa Cruz many chimneys were knocked down. A few chimneys were knocked down in Carmel and Monterey. The second earthquake occurred one hour after, apparently causing stronger shaking in towns north of Monterey Bay.

The Loma Prieta earthquake of 17 October 1989 was a magnitude 6.9 event and was the largest earthquake to hit the San Francisco and Monterey Bay region since the 1906 San Francisco earthquake. Damage was extensive within a 70-mile radius. The epicenter was located approximately 31 miles northeast of the Site and generated a peak horizontal ground acceleration estimated at 0.25g at nearby Moss Landing (Greene, et al., 1991).

The U.S. Geological Survey's Working Group on California Earthquake Probabilities has compiled the Third Uniform California Earthquake Rupture Forecast (USERF3) for the San Francisco Bay area in order to estimate the probability of fault segment rupture. UCERF3 set the overall probability of a moment magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Region during the next 30 years at 72 percent. The highest probabilities are assigned to the Hayward/Rodgers Creek Fault and the northern segment of the San Andreas Fault. These probabilities are 14.3 and 6.4 percent, respectively (Field et al. 2014).

The expected design peak ground acceleration for the Site is 0.5 g based on the USGS Seismic Design Map tool (USGS 2017). Output from the Seismic Design Map tool is appended to this report in Appendix C.

Table 1
Known Active Earthquake Faults within 50 Kilometers of the Site
Schnitzer Steel Products
Moss Landing, California

Abbreviated Fault Name	Approx. Distance, miles (km)	Maximum Earthquake Mag. (Mw)	Peak Ground Accel. (g)	Est. Site Intensity, Modified Mercalli
ZAYANTE-VERGELES	6.3 (10.1)	6.8	0.288	IX
RINCONADA	8.9 (14.4)	7.3	0.255	IX
SAN ANDREAS (1906)	9.9 (15.9)	7.9	0.279	IX
SAN ANDREAS (Pajaro)	9.9 (15.9)	6.8	0.208	VIII
SAN ANDREAS (Santa Cruz Mtn.)	10.8 (17.4)	7	0.205	VIII
MONTEREY BAY - TULARCITOS	12.6 (20.2)	7.1	0.232	IX
SAN ANDREAS (Creeping)	13.5 (21.8)	6.5	0.148	VIII
SARGENT	13.9 (22.4)	6.8	0.159	VIII
CALAVERAS (So.of Calaveras Res)	18.8 (30.3)	6.2	0.089	VII
PALO COLORADO - SUR	20.6 (33.1)	7	0.123	VII
SAN GREGORIO	21.3 (34.3)	7.3	0.134	VIII
QUIEN SABE	22.9 (36.9)	6.4	0.089	VII
MONTE VISTA - SHANNON	26.3 (42.3)	6.8	0.115	VII
SAN ANDREAS (Peninsula)	29.3 (47.1)	7.1	0.096	VII

Notes: The expected peak ground acceleration (PGA) is the mean plus one standard deviation value
PGA = peak ground acceleration

Table 2
Applicable Portions of Modified Mercalli Intensity Scale
Schnitzer Steel Products
Moss Landing, California

Intensity	Shaking	Summary	Description
VII	Strong	Nonstructural Damage	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII	Very Strong	Moderate Damage	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	Violent	Heavy Damage	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Very Violent	Extreme Damage	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Table 3
Historical Earthquakes within 30 Miles of the Site Magnitude > 6
Schnitzer Steel Products
Moss Landing, California

Latitude	Longitude	Date	Magnitude	PGA (g)	MM	Distance in miles (km)
36.8300	121.57	10/18/1800	7.00	0.546	X	10.1
36.9000	121.6	04/24/1890	6.00	0.388	X	10.6
37.0360	121.883	10/18/1989	7.00	0.266	IX	17.6
37.0000	121.5	06/20/1897	6.20	0.204	VIII	19.3
36.5700	122.17	10/22/1926	6.10	0.136	VIII	28.3

Notes: Source: Blake 2000c
Latitude and Longitude are the locations of the assumed epicenters
MM – Mercalli Magnitude (please see Table 2)
Acceleration is the mean plus one standard deviation expected acceleration at the Site due to the historical earthquake calculated using the Abrahamson & Silva (1997) attenuation relationship.
Loma Prieta earthquake was on October 18, 1989

3.4 Site Geology

The site is located in a dynamic coastal environment that has been subject to historic alignment changes in the nearby Salinas River channel and Elkhorn Slough. Griggs (1990) documented abrupt changes in the Salinas River mouth from well north of Elkhorn Slough to its approximate present position. Despite these ancestral changes in the Salinas River channel, their effect on the nearest reach of the Elkhorn Slough has been relatively minor based on the comparison of an 1854 Coast and Geodetic Survey map and a present day topographic survey (Griggs, 1990). Landform morphology on and around the Site are consistent with a relatively stable landscape for the projected life of the Subject Project.

To investigate subsurface conditions and assess material geotechnical parameters, Cone penetrometer (CPT) borings were advanced on the four corners of the site to characterize soil types to depths ranging from 70 to 85 feet below ground surface (bgs). Based on interpretation of the CPT data, the eastern side of the Site is underlain by silty sand to sand to approximately 24 feet bgs overlaying a sequence of silty to clayey fines to 50 feet bgs. In contrast, the western side of the Site is underlain by a continuous sequence of sandy silt to clayey fines to a depth of 85 feet bgs.

4. GEOLOGIC HAZARDS

4.1 General

Geologic hazards evaluated for the site have included fault rupture, seismic ground shaking, liquefaction, lateral spreading, cyclic densification, and slope failure, among others. These hazards are discussed in the following sections.

The results of our geologic hazards evaluation of the site are presented in Table 2, below. The potential for occurrence of the identified hazard is rated on a scale of increasing probability: negligible, low, moderate, high.

Table 4
Summary of Potential Geologic Hazards
Schnitzer Steel Products
Moss Landing, California

Possible Geologic Hazard	Potential Occurrence
Fault Rupture	Negligible to Low
Seismic Ground Shaking	High
Liquefaction	Low
Lateral Spreading	Low
Cyclic Densification	High
Slope Failure	Low
Tsunamis and Seiches	Low
Flooding	Low to Moderate
Slope Failure	Low
Volcanic Eruption	Negligible
Naturally-Occurring Asbestos	Negligible to Low
Expansive Soil	Low
Collapsible Soil	Negligible
Climate and Sea Level Change	Moderate

Table 4 indicates that there are two geologic hazards with high potential and two geologic hazards with moderate potential for occurrence. Those with a high potential are seismic ground shaking and cyclic densification. Hazards with a moderate potential are flooding, climate and sea level change.

4.2 Fault Rupture

Historically, ground surface displacements closely follow the trace of geologically active faults. The site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults exist on the Site (CGS 2017).

The risk of fault offset at the site from a known active fault is negligible to low. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed; however, the risk of surface faulting and consequent secondary ground failure from previously unknown faults is also negligible.

4.3 Seismic Ground Shaking

Ground shaking from future major earthquakes on the San Andreas, San Gregorio, Monterey Bay-Tularcitos, or Zayante-Vergeles faults will likely be strong at the site. The intensity of the ground shaking will depend on the distance of the earthquake epicenter from the site and the magnitude of the earthquake.

Damage noted in nearby Moss Landing during the 1906 and 1989 earthquakes are indicators that strong shaking is to expected in the area during future large earthquakes. (Youd and Hoose, 1978).

4.4 Liquefaction

Liquefaction is the transformation of soil from a solid to a liquid state as a consequence of increased pore-water pressures, usually in response to strong ground shaking, such as those generated during a seismic event. Loose, granular soils are most susceptible to these effects while more stable silty clay and clay materials are generally somewhat less affected. The site has not been mapped as being within zones of predicted liquefaction susceptibility (Monterey County, 2004). However, given that the groundwater elevation is approximately 48 feet below the ground surface, liquefaction is unlikely to occur at the Site (see also Section 6 of this report).

4.5 Lateral Spreading

Given that the groundwater table, and hence any liquefiable soil strata, are below the toes of the slopes at the Site, lateral spreading cannot occur at the Site.

4.6 Cyclic Densification

Cyclic densification (also referred to as differential compaction) of non-saturated sand (sand above the groundwater table) can occur during an earthquake, resulting in settlement of the ground surface and overlying improvements. Loose sand was encountered above the groundwater table in some of the CPT probes. Settlement resulting from cyclic densification of these layers during the design-level earthquake has a high potential of occurrence (see also Section 6 of this report).

4.7 Tsunamis and Seiches

Tsunamis are seismic sea waves that are typically an open ocean phenomenon caused by underwater landslides, volcanic eruptions or seismic events. They primarily impact low-lying coastal areas. The Tsunami Inundation Map for Emergency Planning (California Emergency Management Agency, et al., 2009) shows potential tsunami inundation near the site on the west, north, and eastern sides. The Site itself is not identified as being within the tsunami inundation area.

Seiches are earthquake-generated waves or oscillations (sloshing) of the water surface in restricted bodies of water, such as a bay, lake or reservoir. Surface displacement on any of the local submarine fault strands has the potential to create a seiche in the Monterey Bay resulting in run-up into the Elkhorn Slough comparable with that shown on the Tsunami Inundation map (California Emergency Management Agency, et al., 2009).

4.8 Slope Failure

The site is essentially flat; however, the site is elevated above the surrounding estuary and localized slope failures could occur. Slope stability is discussed in Section 5 of this report.

4.9 Volcanic Eruption

The Monterey Bay Area lies outside of any known localized volcanic hazards. Clear Lake is the closest potential source of phreatic and phreatomagmatic vents and is approximately 230 miles northwest of the site. Other larger potential sources of far traveled tephra eruptions pose a low hazard to the San Francisco Bay and Monterey Bay areas because of their distance and predominant wind directions; they are Lassen Peak, Mt. Shasta, and Medicine Lake Highlands to the north, and Mono Lake - Long Valley Caldera sources to the east-southeast.

4.10 Naturally-Occurring Asbestos

The site is located on sediments derived from erosion of the Salinian bedrock. Since the San Andreas fault zone is also a source of sediment there is the slight potential for serpentinite detritus to have been transported historically by the ancestral Salinas River. However, because of the large area of the contributing drainage basin and the natural mixture of the other dominant units exposed within the Salinas River drainage there is little chance of the accumulation of significant deposits of serpentinite and its associated serpentine minerals that contribute to the asbestos hazard in site soils.

4.11 Collapsible Soil

Hydro-collapse of alluvial fan soils is a phenomenon that results in near-surface subsidence of alluvial materials from loading as a result of water percolating through the deposits for the first time. Early studies of this effect (U.S. Geological Survey, 1964) indicate that it is associated with soils or alluvial deposits containing less than 15% clay. Soils and alluvial deposits at the Site are dominated by sand. However, they lie close to or within the perennial water table fluctuations, thus reducing the potential of collapse to little or nil.

4.12 Expansive Soil

Expansive soils shrink and swell as a result of moisture changes. This can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Structures or improvements built atop expansive soils may be subject to damage from soil shrinkage and swelling, associated with wetting and drying. A soil with a higher plasticity index is generally more prone to shrinkage or swelling in response to seasonal rainfall. The project site soils are classified as silty sand and poorly graded sand, which are considered to be non-plastic. Review of the Soil Survey of Monterey County indicates the project Site to be underlain by Santa Ynez fine sandy loam soils, which are not considered expansive. We conclude the near-surface soils at the Site have very low expansion potential.

4.13 Climate and Sea Level Change

Between 1900 and 2000, sea level in the San Francisco Bay area rose 7 inches as the result of global temperature changes (San Francisco Bay Conservation and Development Commission (BCDC), 2008). This trend is expected to continue as the result of ongoing changes in the global climate, including a rising global surface temperature. Wide ranging estimates of an additional 3 inches to 5 feet of sea level rise by the end of this century suggest that the causative factors are not well constrained by the available data. Nevertheless, the BCDC is taking action (San Francisco Bay Conservation and Development Commission, 2008) to address the issues arising from future changes in sea level that will certainly impact near shore developments that are now close to, or within flooding, tsunami and tidal influences. The impact of rising sea level on the Site and vicinity over the next 50 years is poorly constrained and probably poses a moderate level of hazard.

5. SLOPE STABILITY

5.1 Topography

The steepest slope section at the Site project areas is located above CPT probe location 2A. The slope there is 2.1 horizontal to 1.0 vertical (2.1H:1V). This slope lies above the Union Pacific Railroad tracks and is hence also the most critical surface for analysis. A cross-sectional model was developed for analysis using this critical slope modified to reflect the proposed sediment pond.

The ponds were modeled as a 3.3 foot high berm with 2H:1V outer slopes and 3H:1V inside slopes with a 3.3 foot wide crest. As the ponds will be excavated into the existing surface, there will be some unloading of the slopes, however, this was conservatively neglected from the analysis.

5.2 Material Properties

The slope was divided into 4 material types for analysis. The material properties were selected based on a review of the CPT data. The material properties are listed in Table 5 below.

Table 5
Material Properties Used in the Slope Stability Analyses
Schnitzer Steel Products
Moss Landing, California

Top Depth (ft)	Bottom Depth (ft)	Moist Unit Weight (pcf)	Saturated Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)
0	8	116	135	11,000	0
8	22	121	138	50	42
22	48	115	135	3,600	0
48	62	117	136	50	38
BERM		135	147	11,000	38

NOTES: ft – feet; pcf – pounds per cubic foot, psf – pounds per square foot.

While the groundwater surface is below the toe of the slope, the analysis was performed assuming the slope and berms were completely saturated to account of the retention ponds being installed at the tops of the slope. While the ponds are lined, we do not assume that they will not leak. It is, nonetheless, extremely conservative to assume the slope is fully saturated.

5.3 Analysis

Slope stability was analyzed using STB2010, a slope stability program developed by Professor Arnold Verruijt of the Delft University of Technology. STB2010 implements the simplified Bishop slope stability analysis method.

In Bishop's method, the safety factor of a slope is determined by comparing the moment of the weight of a soil wedge about the center of a slip circle, with the resisting moment provided by the shear stresses along the slip surface. The two moments are calculated by subdividing the sliding wedge into a large number of vertical slices. It is assumed only horizontal (normal) stresses are acting on the vertical side planes of the slices with no shear stresses

5.4 Results

The results of the analysis indicated the slope had a factor of safety of 5.1 under static conditions and 1.8 under seismic loading using a horizontal acceleration of 0.25g (one half the peak ground acceleration for the Site).

During large seismic events there may be raveling of surface soils on the slope.

6. Liquefaction

Liquefaction is the loss of shear strength experienced by soil during dynamic loadings. As the soil shakes (e.g., during an earthquake) a loose soil will naturally densify. If the soil is saturated, the tendency toward densification will cause the pressure of the water to increase. If the water pressure increases to the point where it is equal to the weight of soil above the soil subject to liquefaction, the shear strength of the soil drops to zero and the soil liquefies. So, the requirements for a soil to liquefy are that it be loose, that it not have a lot of clay in it, that it be saturated, and that it not be so deep that the water pressure can't rise far enough to overcome the weight of the overlying soil.

At the Site, the groundwater level is at about 5 feet above sea level while the ground surface of the new ponds varies between 47 and 66 feet. Liquefaction is commonly considered to not be possible at depths greater than 50 feet below the ground surface (Southern California Earthquake Center 1999). Because the Site is sloped above the liquefiable layers, 60 feet was used as the cut-off for this Site.

Liquefaction was assessed using the computer program CLiq (Geologismiki 2017). CLiq uses CPT probe tip and side resistance and pore water pressure generation to assess liquefaction susceptibility. A Peak Ground Acceleration of 0.50g from a Magnitude 6.7 earthquake was used as the design event. Groundwater was assumed at 5 feet above mean sea level. The maximum vertical settlement predicted by CLiq due to liquefaction was 0.08 inches.

C-Liq output is appended to this report in Appendix D.

C-Liq implements the method of Robertson and Shao (2010) to calculate dry settlements (seismic shakedown). The maximum settlement due to seismic shakedown was found to be 0.26 inches.

7. DESIGN RECOMMENDATIONS

7.1 Berm Construction

The pond berms should be sloped 2H:1V or less unless otherwise approved by the geotechnical engineer. Surfaces to receive fill should be scarified to a minimum of 6 inches below grade, moisture condition to +/- 3% of optimum water content (ASTM D1557) and be recompacted to 90% of the maximum dry density (ASTM D 1557). Berm fill soil must contain at least 20% by weight soils finer than a No. 200 sieve and must have a plasticity index greater than 12 (ASTM D 4318). Berms should be compacted in lifts no greater than 10 inches thick in the loose condition prior to compaction. Berms should be compacted to 90% of the maximum dry density (ASTM D 1557).

Between 4 and 6 inches of topsoil should be track-walked onto exterior slopes to provide a substrate for plant growth. The exterior slopes should be seeded with native grasses. Large trees and shrubs should not be allowed to grow on the exterior berm slopes.

7.2 Rigid Pavement

This design is applicable to the large paved area at the car crusher and for the equipment pad. Rigid pavement design was performed in accordance with Packard (1996). We assumed a subgrade modulus of 200 pounds per cubic inch (pci) and designed the pavement for a Volvo L90 Loader. We assumed the entire weight of the loader, plus the bucket load, was put on the loader's front wheels (i.e., the loader tipped).

Recommendation:

Concrete Compressive Strength	5,000 pounds per square inch
Reinforcement	Number 3 bars on 24 inch centers both ways, 60 kips per square inch (ksi) yield strength
Construction joints	25 feet each way
Dowels	18-inch-long, 1.25 inch diameter, 12 inches on center each construction joint
Subbase	8 inches of Caltrans cement treated permeable base per Section 29-3 of the Caltrans 2015 Standard Specifications – compaction in accordance with Section 29-3.03

Scarify the subgrade to a depth of eight inches and compact to a minimum of 2% below the optimum water content (ASTM D1557) to at least 90% of the maximum dry density of the subgrade soil (ASTM D1557). Geotechnical engineer must approve subgrade to verify it is sufficiently stiff (subgrade modulus > 200 pci).

7.3 Forebays

Soil to receive concrete for the pond forebays should be scarified to a minimum depth of six inches and the be recompacted to 90% of the soil's maximum dry density.

8. Design Review and Construction Monitoring

Terraphase recommends that earthwork performed during construction be monitored by a qualified representative from our office, including:

- site preparation (stripping and grading)
- placement of compacted fill and backfill
- construction of slab, roadway, and/or parking-area subgrade

Terraphase's representative should be present to observe the soil conditions encountered during construction to evaluate the applicability of the recommendations presented in this report to the soil conditions encountered and to recommend appropriate changes in design or construction procedures, if conditions differ from those described herein.

9. Limitations

9.1 General

The opinions and recommendations presented in this report are based upon the scope of services, information obtained through the performance of the services, and the schedule as agreed upon by Terraphase and the party for whom this report was originally prepared. This report is an instrument of professional service and was prepared in accordance with the generally accepted standards and level of skill and care under similar conditions and circumstances established by the geotechnical consulting industry. No representation, warranty, or guarantee, express or implied, is intended or given. To the extent that Terraphase relied upon any information prepared by other parties not under contract to Terraphase, Terraphase makes no representation as to the accuracy or completeness of such information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared for a particular purpose and only in it's entirely. Only the party for whom this report was originally prepared and/or other specifically named parties have the right to make use of and rely upon this report. Reuse of this report or any portion thereof for other than its intended purpose, or if modified, or if used by third parties, shall be at the user's sole risk.

Furthermore, nothing contained in this report shall relieve any other party of its responsibility to abide by contract documents and applicable laws, codes, regulations, or standards.

9.2 Subsurface Explorations and Testing

Results of any observations, subsurface exploration or testing, and any findings presented in this report apply solely to conditions existing at the time when Terraphase's exploratory work was performed. It must be recognized that any such observations and exploratory or testing activities are inherently limited and do not represent a conclusive or complete characterization. Conditions in other parts of the project site may vary from those at the locations where data were collected and conditions can change with time. Terraphase's ability to interpret exploratory and test results is related to the availability of the data and the extent of the exploratory and testing activities.

The findings and recommendations submitted in this report are based, in part, on data obtained from subsurface CPT probes made at discrete sampling locations. The nature and extent of variation between these test locations, which may be widely spaced, may not become evident until construction. If variations are subsequently encountered, it will be necessary to re-evaluate the conclusions and recommendations of this report.

Correlations and descriptions of subsurface conditions presented in CPT logs are approximate only. Subsurface conditions may vary significantly from those encountered in borings and sampling locations and transitions between subsurface materials may be gradual or highly variable.

Conditions at the time water level measurements and other subsurface observations were made are presented in the boring logs or other sampling forms. This field data have been reviewed and interpretations provided in this report. However, groundwater levels may be variable and may fluctuate due to variations in precipitation, temperature, and other factors. Therefore, groundwater levels at the site at any time may be different than stated in this report.

9.3 Review

In the event that any change in the nature, design, or location of the proposed structure(s) is planned, the conclusions and recommendations in this report shall not be considered valid nor relied upon unless the changes are reviewed and the conclusions and recommendations of this report are modified or verified in writing.

9.4 Construction

To verify conditions presented in this report and modify recommendations based on field conditions encountered in the field, Terraphase should be retained to provide geotechnical engineering services during the construction phase of the project. This is to observe compliance with design concepts, specifications, and recommendations contained in this report, and to verify and refine our recommendations as necessary in the event that subsurface conditions differ from those anticipated prior to the start of construction.

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0 3.5 7

Scale in Miles

N

SAFETY FIRST	CLIENT: Schnitzer Steel Industries	**SITE LOCATION**
terraphase engineering	PROJECT: Stormwater Improvements	
	PROJECT NUMBER: 0055.004.002	FIGURE 1

File Name: figure 1 site location map usgs aerial.docx drawn by: jrr checked by: ptz

LEGEND

CPT and Percolation Test Location

0' 125' 250' 500'
Approximate Scale in Feet

Safety First	CLIENT:	Schnitzer Steel Industries	SITE PLAN
terraphase engineering	PROJECT:	Stormwater Improvements	
	PROJECT NO.:	0055.004.001	FIGURE 2

J:\CADD FILES\0055 Schnitzer Steel\005 Moss Landing\fIGURE 2 sITE pLAN.dwg

APPENDIX A

CPT Probe Logs

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PRESENTATION OF SITE INVESTIGATION RESULTS

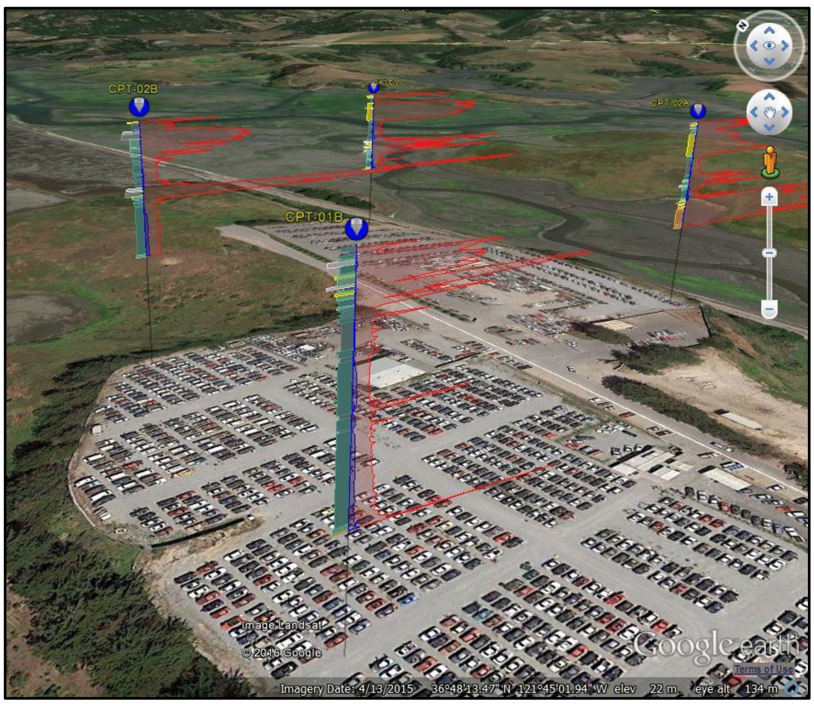
Moss Landing Pick-n-Pull

Prepared for:

Terraphase

CPT Inc. Job No: 16-56021

Project Start Date: 26-Apr-2016
Project End Date: 26-Apr-2016
Report Date: 28-Apr-2016



Prepared by:

California Push Technologies Inc.
820 Aladdin Avenue
San Leandro, CA 94577

Tel: (510) 357-3677

Email: cpt@cptinc.com
www.cptinc.com

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

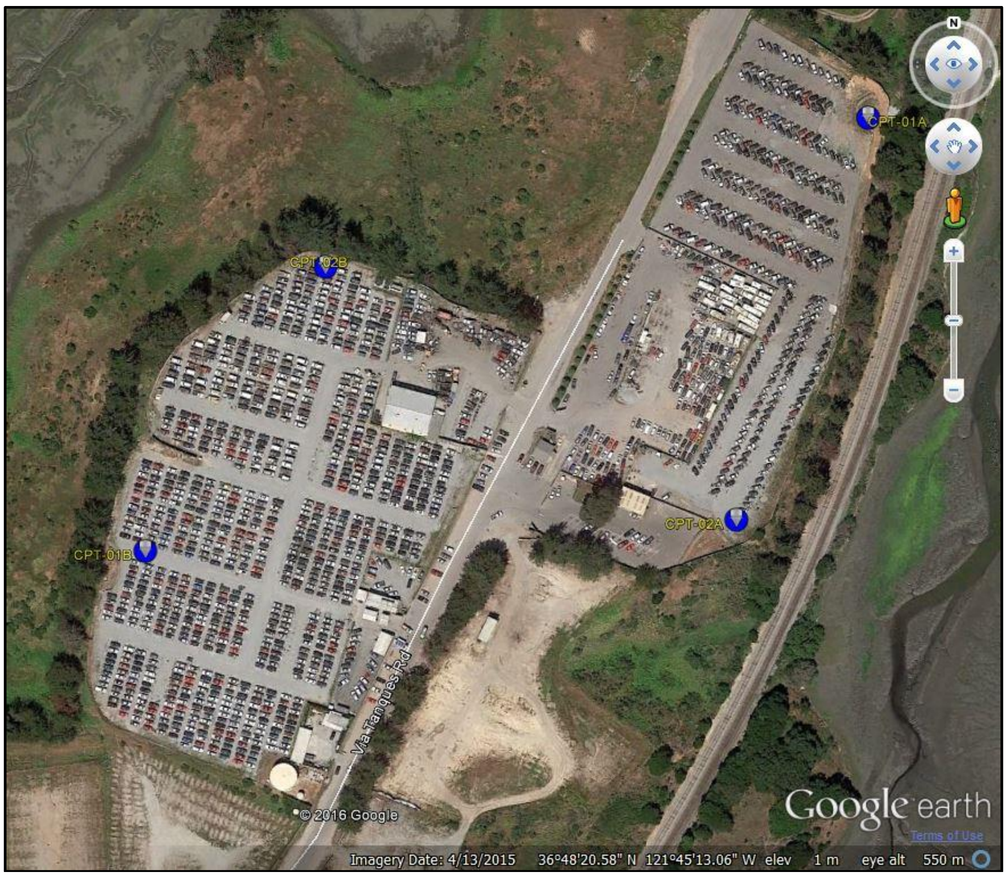
Introduction

The enclosed report presents the results of the site investigation program conducted by CPT Inc. for Terraphase at the Pick-N-Pull in Moss Landing, CA. The program consisted of four cone penetration tests (CPT).

Project Information

Project	
Client	Terraphase
Project	Moss Landing Pick-n-Pull
CPT Inc. project number	16-56021

A map from Google earth including the CPT test locations is presented below.



Rig Description	Deployment System	Test Type
CPT truck rig (C15)	30 ton rig cylinder	SCPT

Coordinates		
Test Type	Collection Method	EPSG Reference
CPT	Consumer grade GPS	26910

Cone Penetration Test (CPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	Advanced plots with Ic, Su(Nkt) and N1(60).

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
391:T1500F15U500	AD391	15	225	1500	15	500
Cone AD391 was used for all CPT soundings.						

Interpretation Tables	
Additional information	The Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986) was used to classify the soil for this project. A detailed set of CPT interpretations were generated and are provided in Excel format files in the release folder. The calculated parameters are based on values of corrected tip (q_t), sleeve friction (f_s) and pore pressure (u_2). Soils were classified as either drained or undrained based on the Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986). Calculations for both drained and undrained parameters were included for materials that classified as silt (Zone 6) and sandy silt (zone 7).

Limitations

This report has been prepared for the exclusive use of Terraphase (Client) for the project titled "Moss Landing Pick-n-Pull". The report's contents may not be relied upon by any other party without the express written permission of CPT Inc. CPT Inc. has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to CPT Inc. by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

CPT Inc.'s piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

The penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. Our calibration criteria also meet or exceed those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

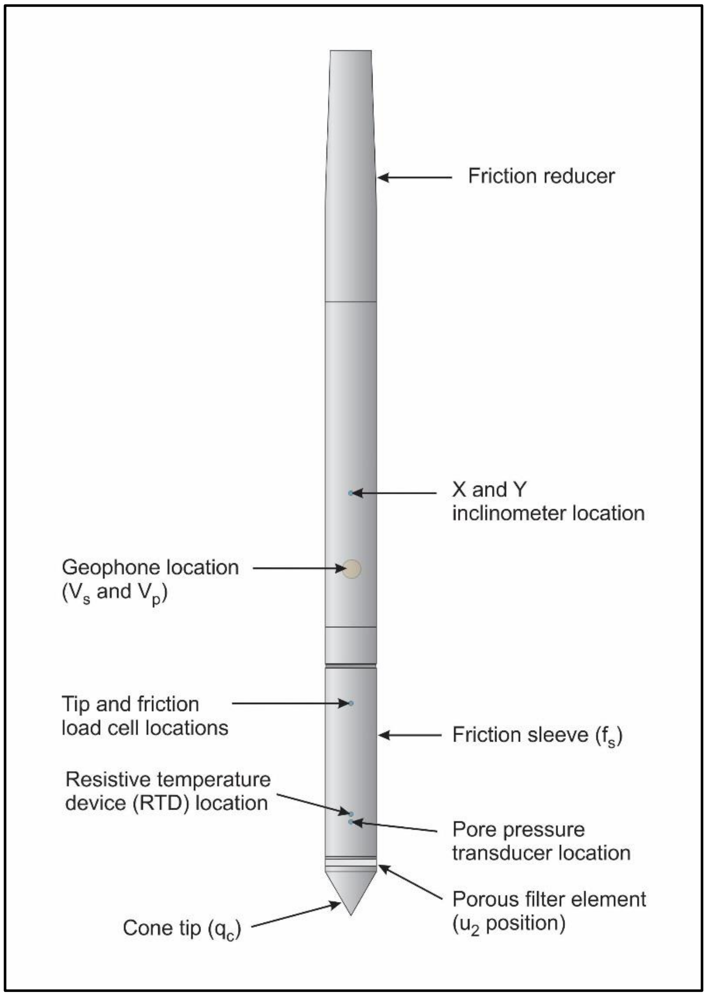


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to CPT Inc.'s CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerin or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to CPT Inc.'s cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerin under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of the piezocone data and associated calculated parameters for this report are based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for CPT Inc. probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all CPT Inc. piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

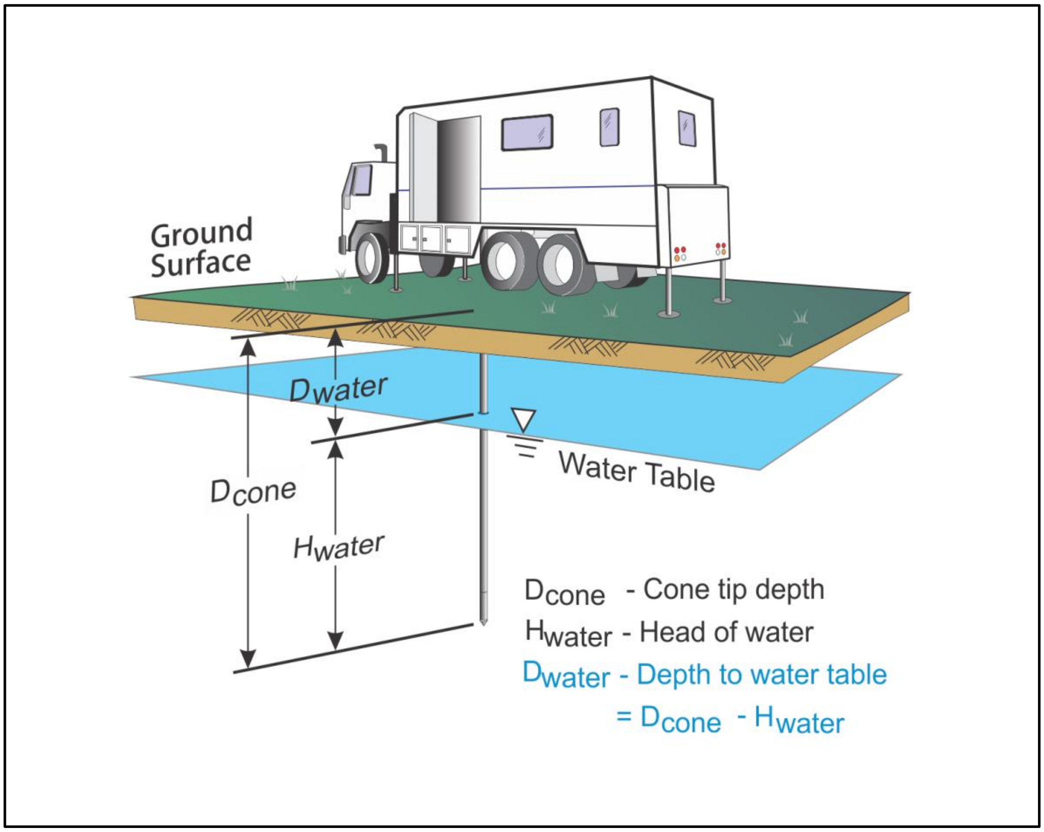


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

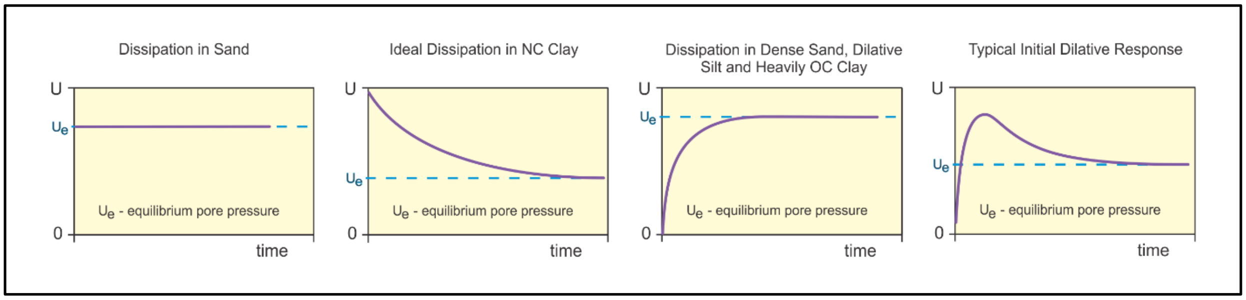


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T* is the dimensionless time factor (Table Time Factor)

a is the radius of the cone

I_r is the rigidity index

t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Burns, S.E. and Mayne, P.W., 1998, “Monotonic and dilatory pore pressure decay during piezocone tests”, Canadian Geotechnical Journal 26 (4): 1063-1073.

Burns, S.E. and Mayne, P.W., 2002, “Analytical cavity expansion-critical state model cone dissipation in fine-grained soils”, Soils & Foundations, Vol. 42(2): 131-137.

Jones, G.A. and Van Zyl, D.J.A., 1981, “The piezometer probe: a useful investigation tool”, Proceedings, 10th International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic and Professional.

Mayne, P.W., 2013, “Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests”, Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420.

Mayne, P.W., 2014, “Interpretation of geotechnical parameters from seismic piezocone tests”, CPT’14 Keynote Address, Las Vegas, NV, May 2014.

Mayne, P.W. and Peuchen, J., 2012, “Unit weight trends with cone resistance in soft to firm clays”, Geotechnical and Geophysical Site Characterization *4,* Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Robertson, P.K., 1990, “Soil Classification Using the Cone Penetration Test”, Canadian Geotechnical Journal, Volume 27: 151-158.

Robertson, P.K., 2009, “Interpretation of cone penetration tests – a unified approach”, Canadian Geotechnical Journal, Volume 46: 1337-1355.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, “Use of Piezometer Cone Data”, Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, “Estimating coefficient of consolidation from piezocone tests”, Canadian Geotechnical Journal, 29(4): 551-557.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, “An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils”, Canadian Geotechnical Journal, 36(2): 369-381.

Teh, C.I., and Houlsby, G.T., 1991, “An analytical study of the cone penetration test in clay”, Geotechnique, 41(1): 17-34.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots with Ic, Su(Nkt) and N1(60)
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and
Standard Cone Penetration Test Plots

CALIFORNIA PUSH
TECHNOLOGIES
INCORPORATED

Job No: 16-56021
Client: Terraphase
Project: Moss Landing Pick-n-Pull
Start Date: 26-Apr-2016
End Date: 26-Apr-2016

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (ft)	Final Depth (ft)	Northing[2] (m)	Easting (m)	Refer to Notation Number
CPT-01A	16-56021_CP01A	26-Apr-2016	391:T1500F15U500	46.7	68.24	4074065	611656	
CPT-02A	16-56021_CP02A	26-Apr-2016	391:T1500F15U500	54.0	70.21	4073878	611599	
CPT-01B	16-56021_CP01B	26-Apr-2016	391:T1500F15U500	66.8	85.63	4073859	611322	3
CPT-02B	16-56021_CP02B	26-Apr-2016	391:T1500F15U500	70.0	70.37	4073993	611405	3

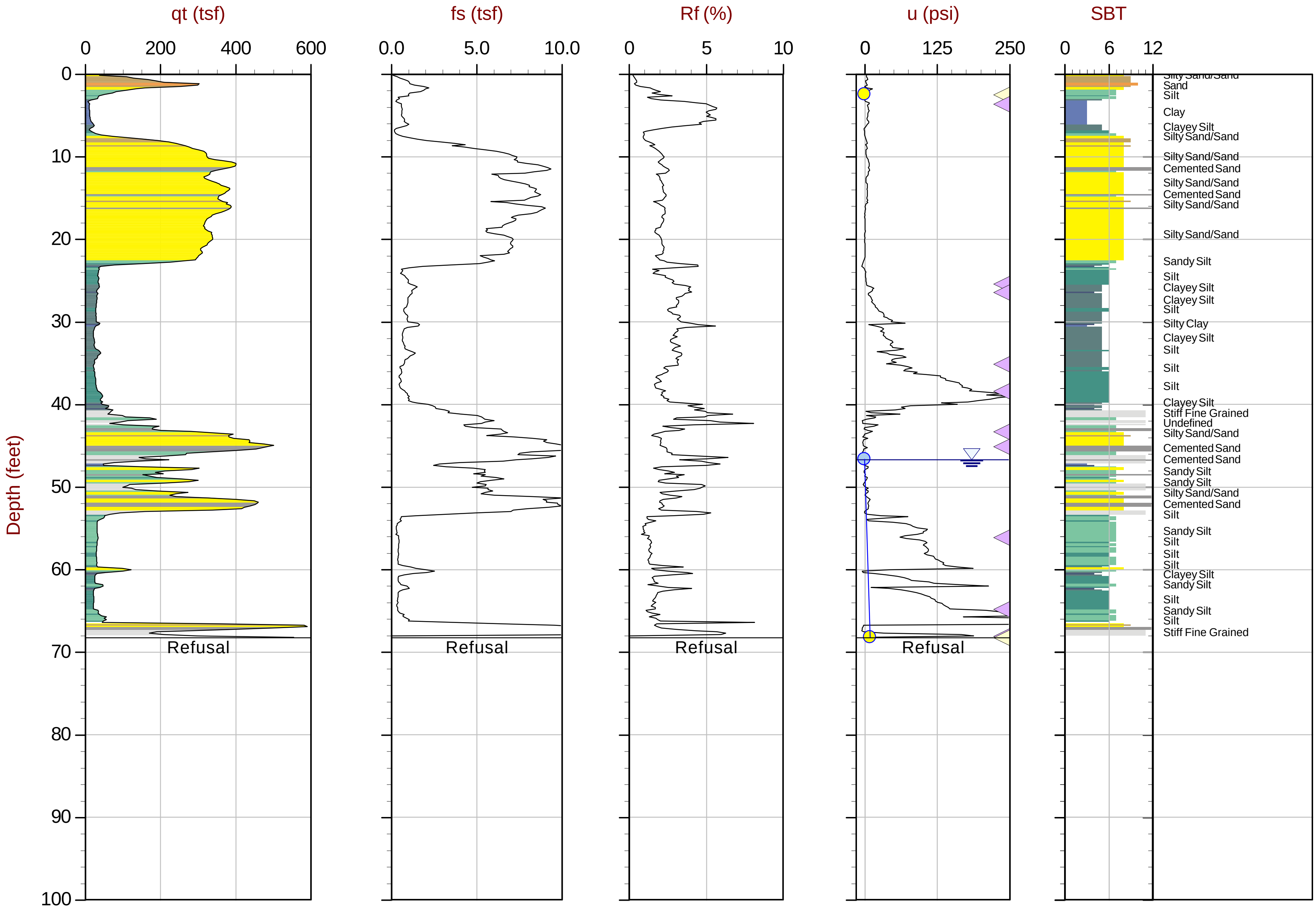
1. The assumed phreatic surface was based on pore pressure dissipation tests unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device with datum NAD83/UTM Zone 10 North.
3. The assumed phreatic surface was based the assumed phreatic surfaces of nearby CPT holes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 14:12
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01A
Cone: 391:T1500F15U500



Max Depth: 20.800 m / 68.24 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 16-56021_CP01A.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4074065m E: 611656m

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

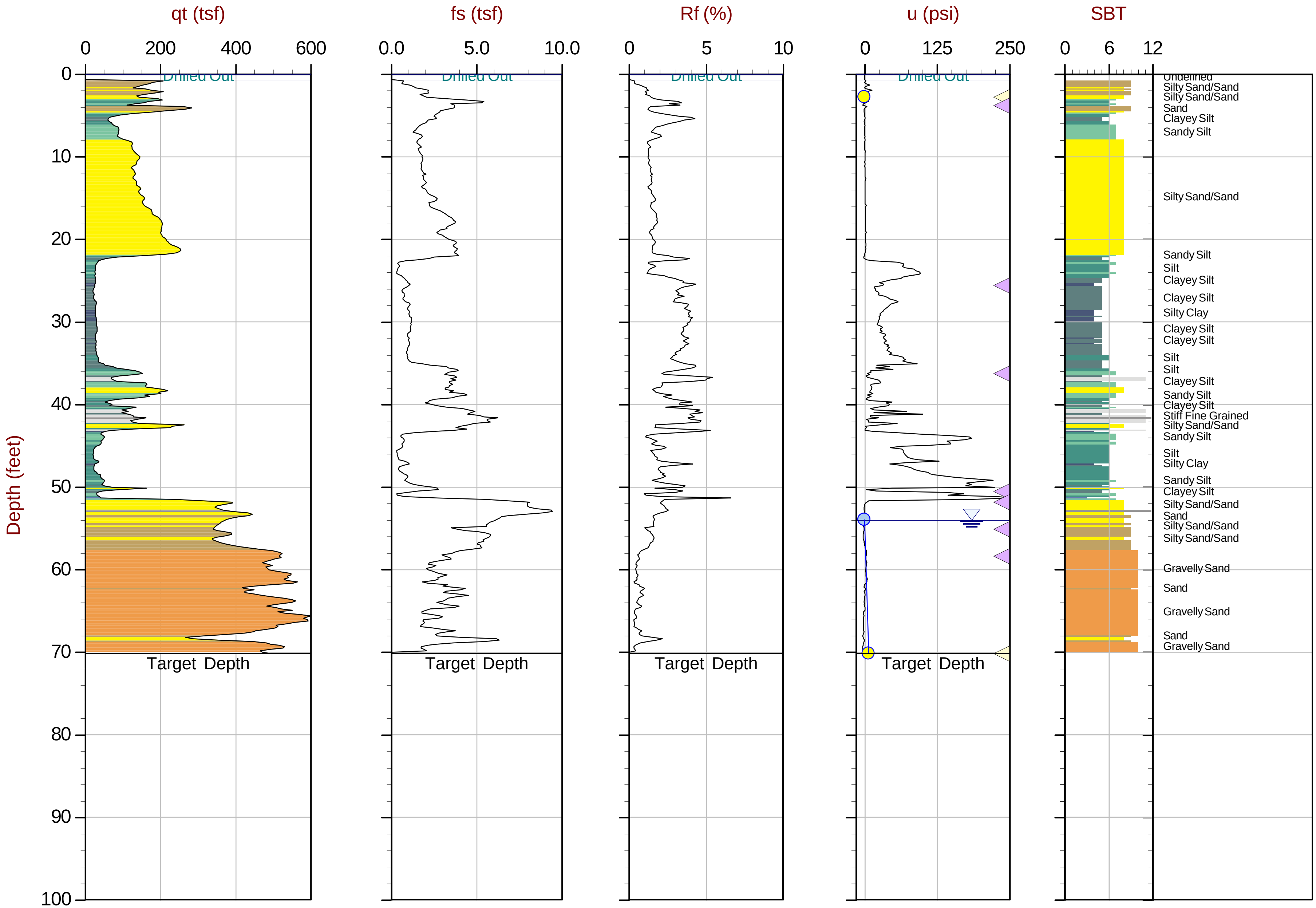
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 12:55
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02A
Cone: 391:T1500F15U500



Max Depth: 21.400 m / 70.21 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 16-56021_CP02A.COR
Unit Wt: SBT Zones

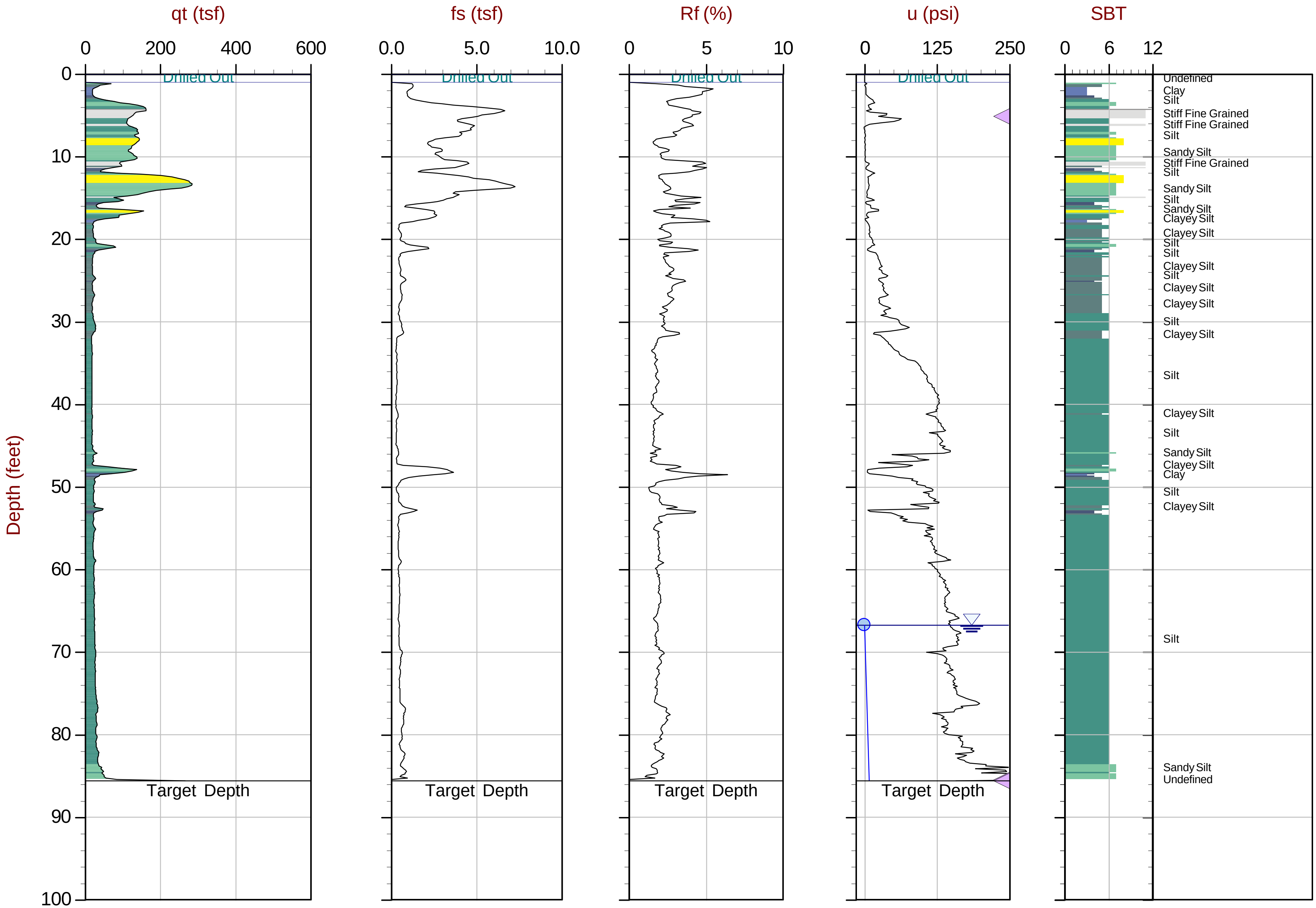
SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073878m E: 611599m

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-01B
	Date: 04:26:16 09:11	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	



Max Depth: 26.100 m / 85.63 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 16-56021_CP01B.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073859m E: 611322m

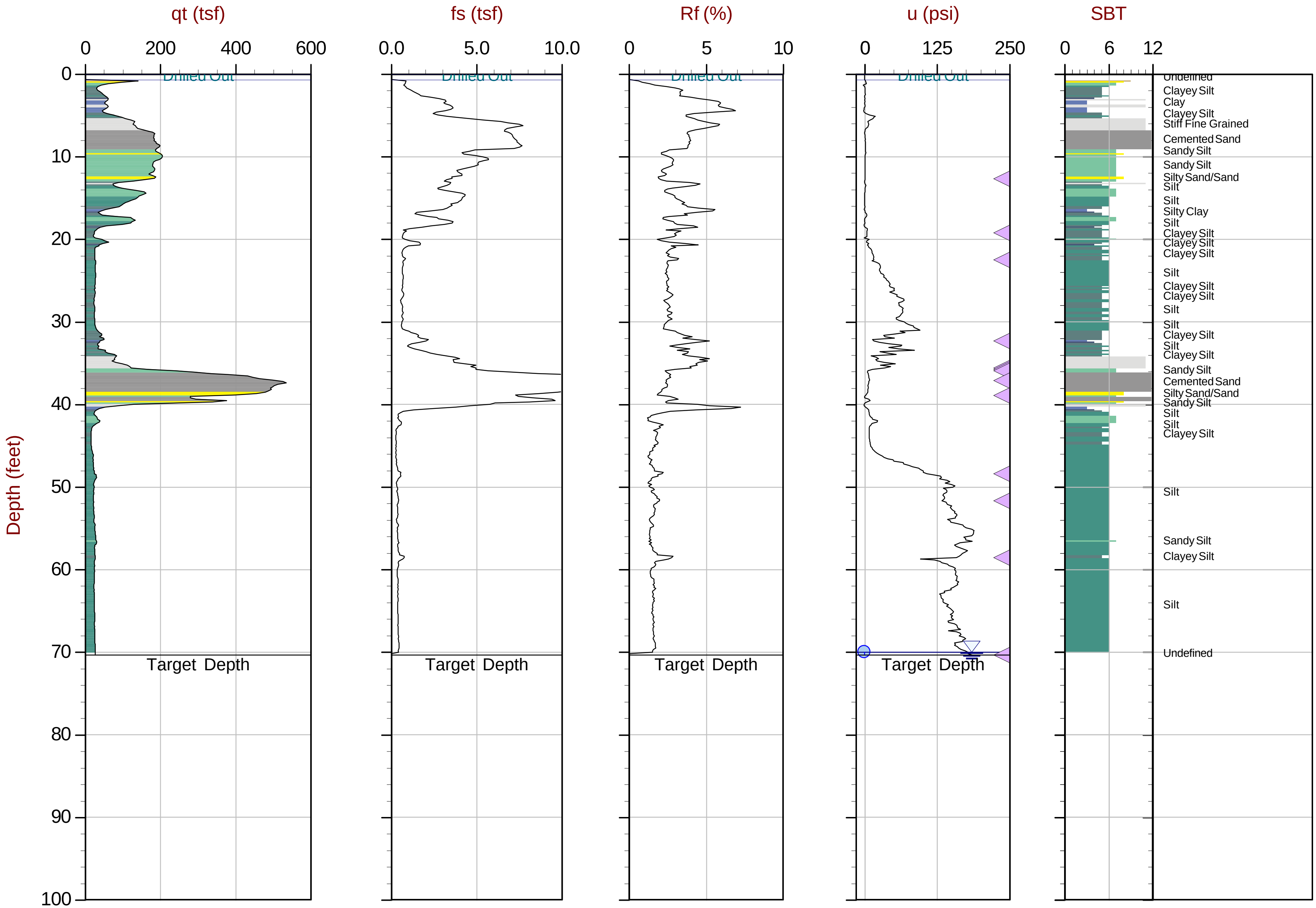
Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 10:47
Site: Moss Landing Pick-n-Pull
Sounding: CPT-02B
Cone: 391:T1500F15U500



Max Depth: 21.450 m / 70.37 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 16-56021_CP02B.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073993m E: 611405m

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

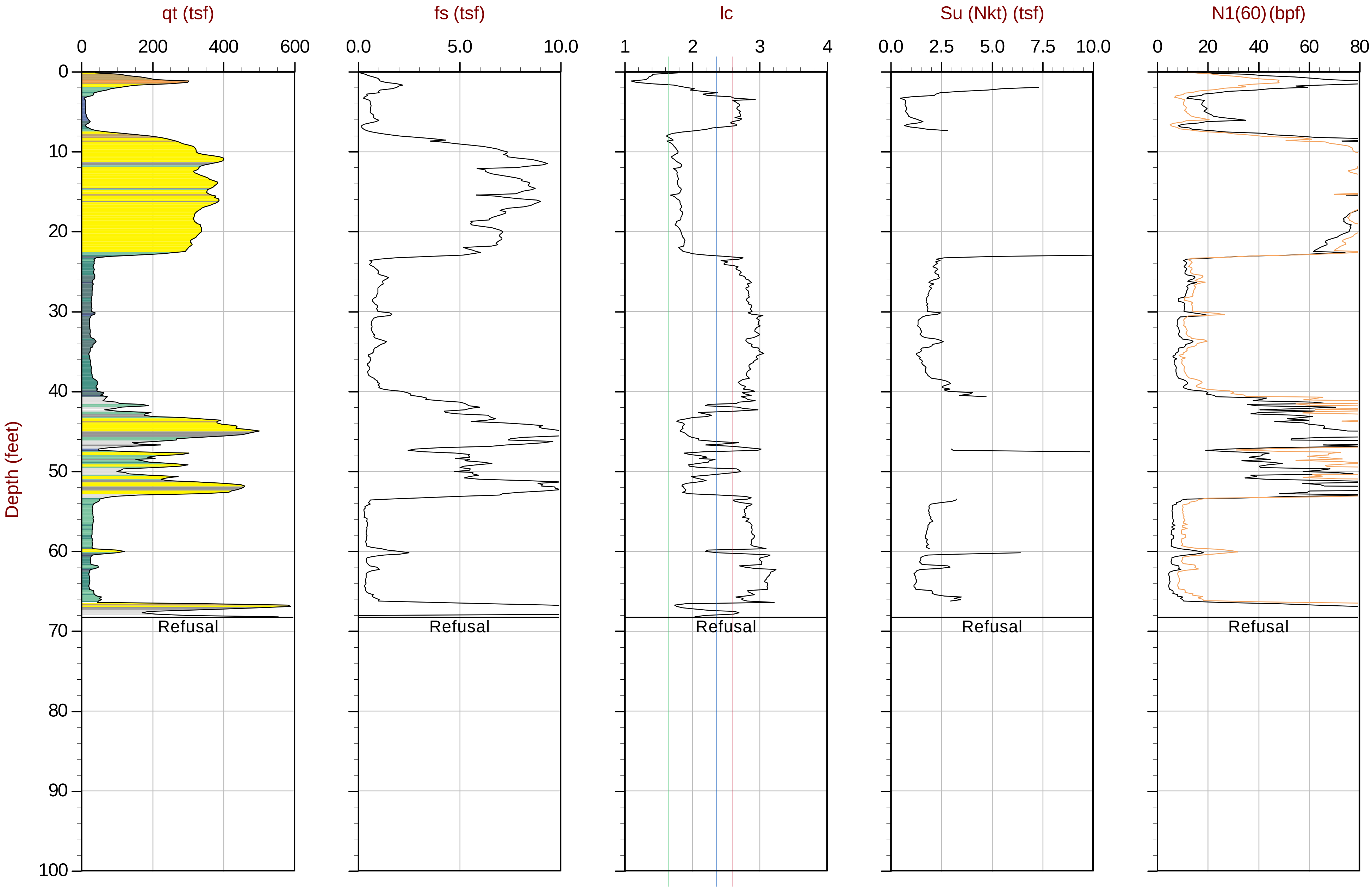
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Advanced Cone Penetration Test Plots with Ic, Su(Nkt) and N1(60)

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 14:12
Site: Moss Landing Pick-n-Pull
Sounding: CPT-01A
Cone: 391:T1500F15U500



Max Depth: 20.800 m / 68.24 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
N(60) (bpf)

File: 16-56021_CP01A.COR
Unit Wt: SBT Zones
Su Nkt: 15.0

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4074065m E: 611656m

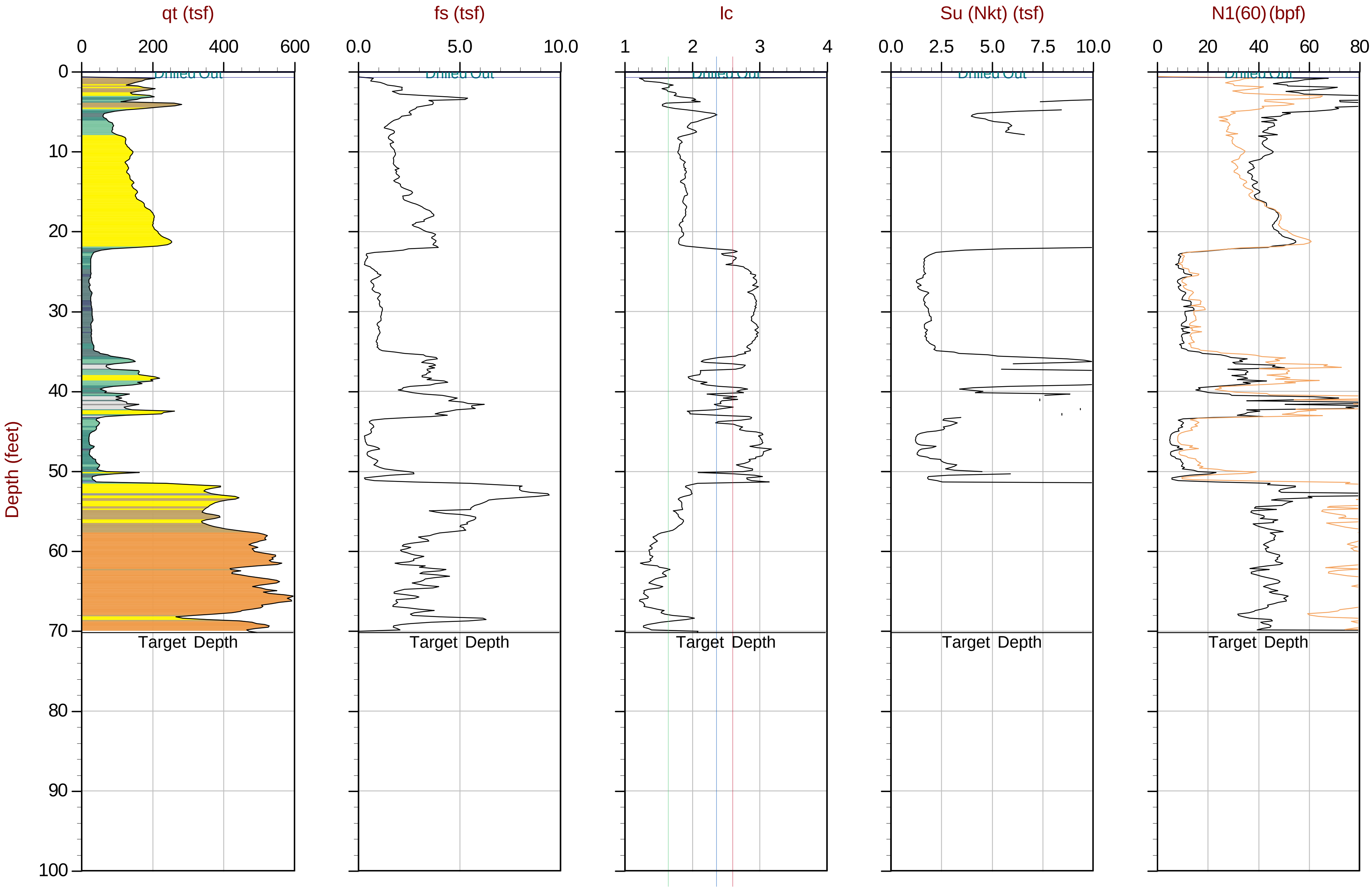
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 12:55
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02A
Cone: 391:T1500F15U500



Max Depth: 21.400 m / 70.21 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
N(60) (bpf)

File: 16-56021_CP02A.COR
Unit Wt: SBT Zones
Su Nkt: 15.0

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073878m E: 611599m

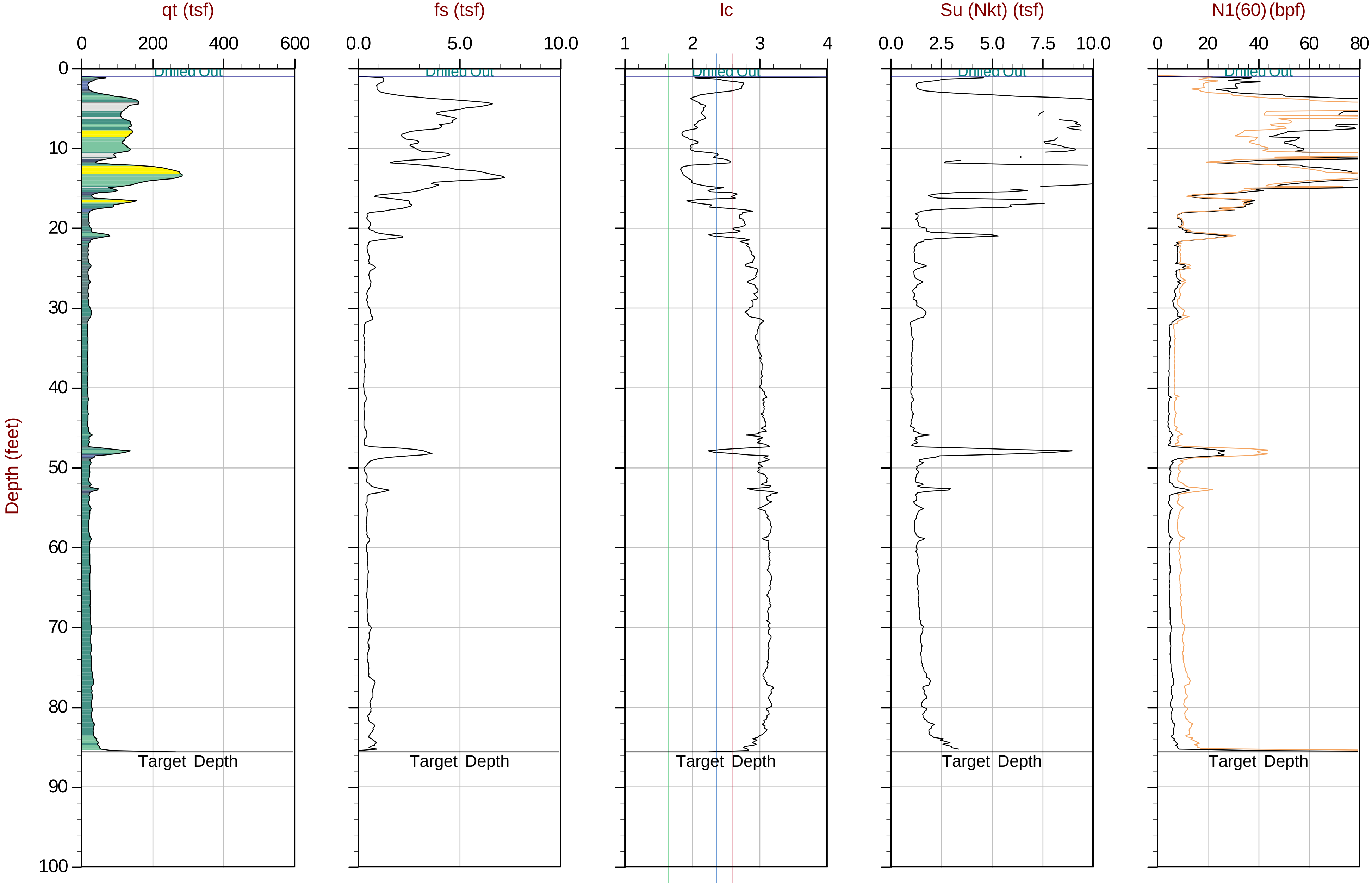
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 09:11
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01B
Cone: 391:T1500F15U500



Max Depth: 26.100 m / 85.63 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
N(60) (bpf)

File: 16-56021_CP01B.COR
Unit Wt: SBT Zones
Su Nkt: 15.0

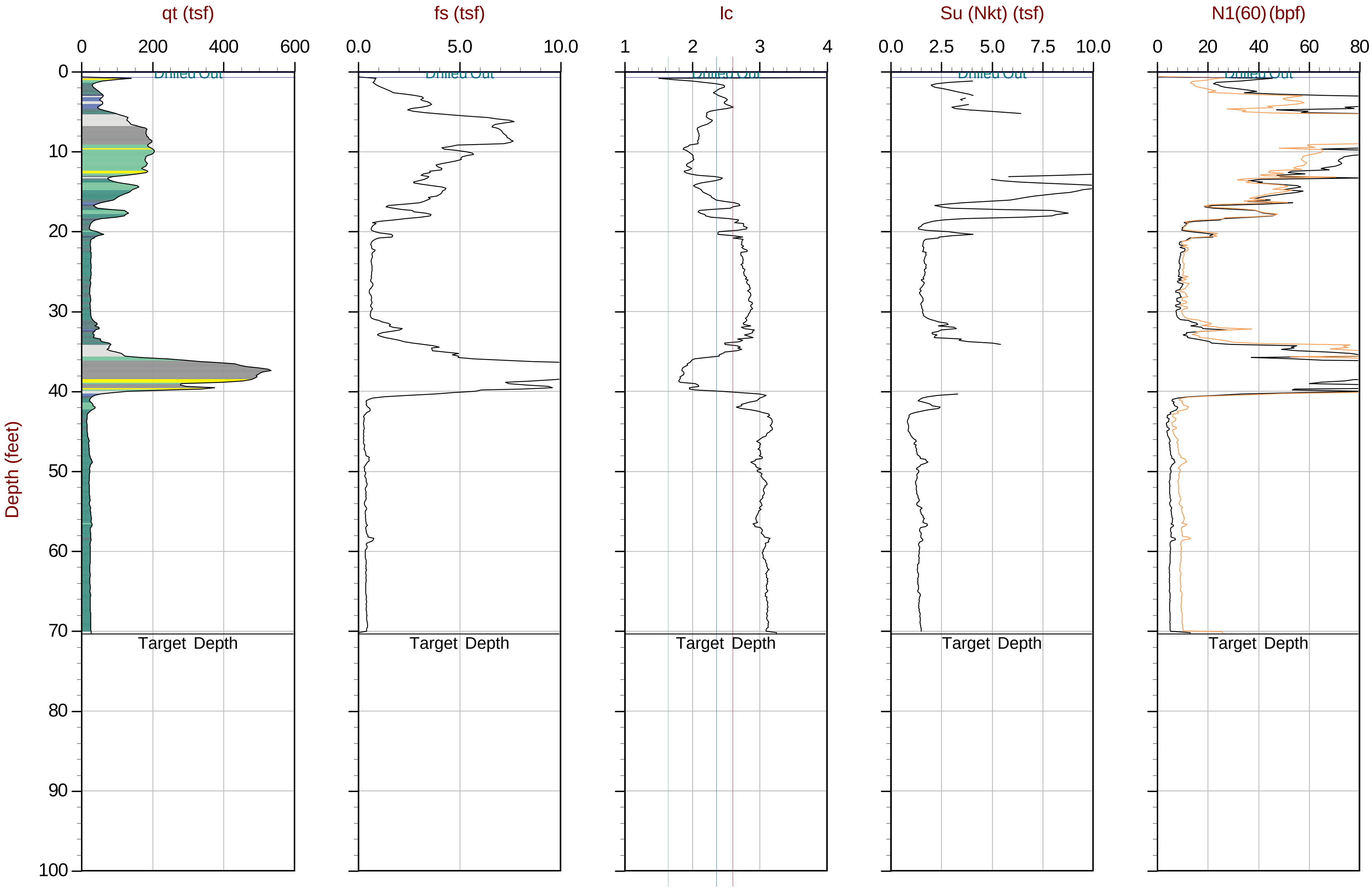
SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073859m E: 611322m

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04:26:16 10:47
Site: Moss Landing Pick-n-Pull
Sounding: CPT-02B
Cone: 391:T1500F15U500



Max Depth: 21.450 m / 70.37 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
N(60) (bpf)

File: 16-56021_CP02B.COR
Unit Wt: SBT Zones
Su Nkt: 15.0

SBT: Robertson and Campanella, 1986
Coords: UTM 10N N: 4073993m E: 611405m

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Pore Pressure Dissipation Summary and
Pore Pressure Dissipation Plots

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INCORPORATED

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Job No:	16-56021
Client:	Terraphase
Project:	Moss Landing Pick-n-Pull
Start Date:	26-Apr-2016
End Date:	26-Apr-2016

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (psi)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50}[a] (s)	Assumed Rigidity Index (I_r)	c_h[b] (cm^2/min)
CPT-01A	16-56021_CP01A	15	35	2.5	0.0					
CPT-01A	16-56021_CP01A	15	160	3.6						
CPT-01A	16-56021_CP01A	15	30	25.4						
CPT-01A	16-56021_CP01A	15	240	26.4						
CPT-01A	16-56021_CP01A	15	70	35.1						
CPT-01A	16-56021_CP01A	15	45	38.4						
CPT-01A	16-56021_CP01A	15	100	43.3						
CPT-01A	16-56021_CP01A	15	140	45.1						
CPT-01A	16-56021_CP01A	15	140	56.1						
CPT-01A	16-56021_CP01A	15	190	64.8						
CPT-01A	16-56021_CP01A	15	65	68.1						
CPT-01A	16-56021_CP01A	15	600	68.2	9.4	46.7				
CPT-02A	16-56021_CP02A	15	35	2.8	0.0					
CPT-02A	16-56021_CP02A	15	35	3.8						
CPT-02A	16-56021_CP02A	15	200	25.6						
CPT-02A	16-56021_CP02A	15	70	36.3						
CPT-02A	16-56021_CP02A	15	35	50.5						
CPT-02A	16-56021_CP02A	15	60	51.8						
CPT-02A	16-56021_CP02A	15	65	55.1						

Job No: 16-56021
Client: Terraphase
Project: Moss Landing Pick-n-Pull
Start Date: 26-Apr-2016
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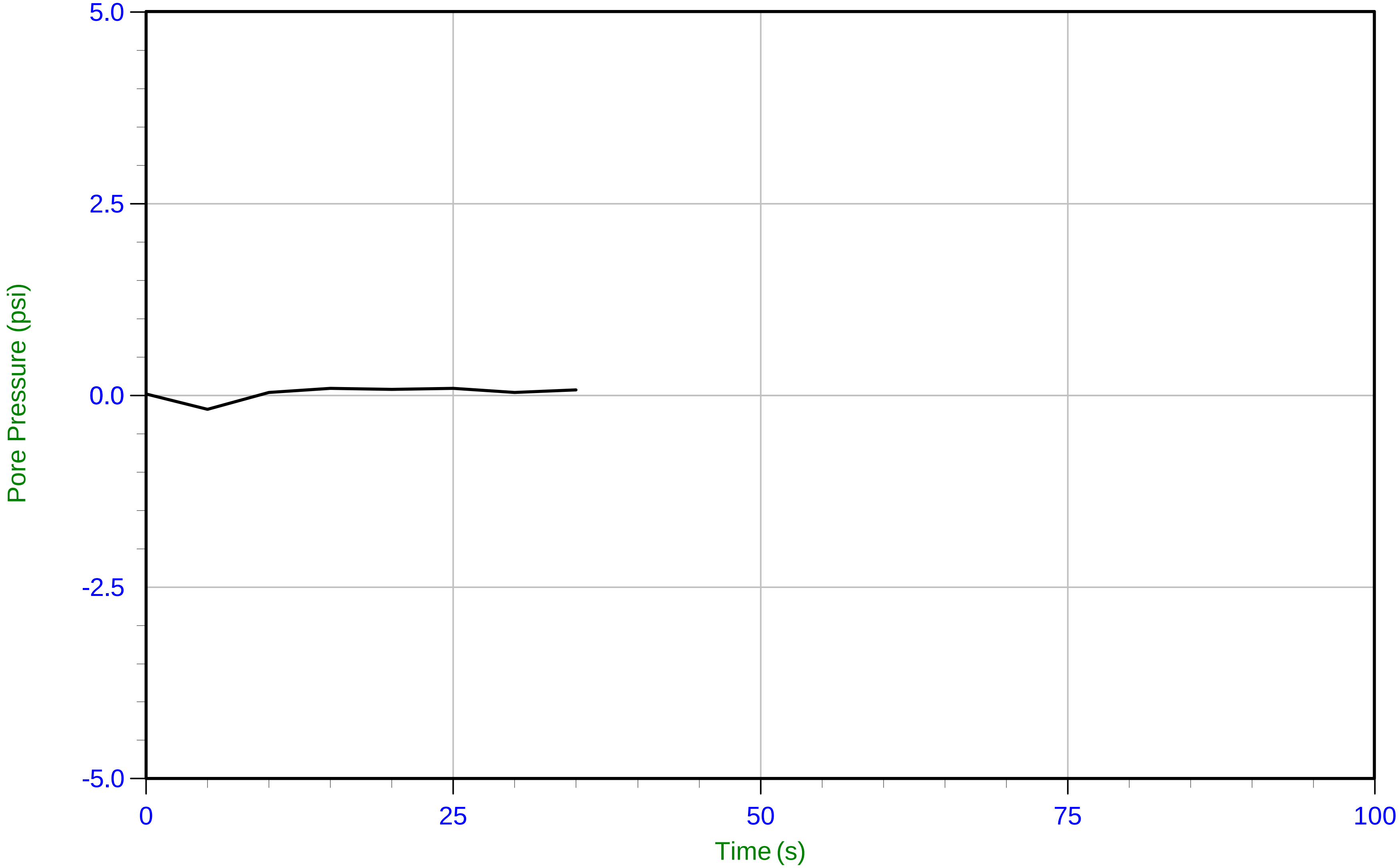
CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (psi)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
CPT-02A	16-56021_CP02A	15	25	58.4						
CPT-02A	16-56021_CP02A	15	405	70.2	7.0	54.0				
CPT-01B	16-56021_CP01B	15	30	5.1						
CPT-01B	16-56021_CP01B	15	360	85.5			66.8	127	100	5.5
CPT-01B	16-56021_CP01B	15	170	85.6			66.8	119	100	5.9
CPT-02B	16-56021_CP02B	15	40	12.6						
CPT-02B	16-56021_CP02B	15	125	19.2						
CPT-02B	16-56021_CP02B	15	120	22.5						
CPT-02B	16-56021_CP02B	15	450	32.3						
CPT-02B	16-56021_CP02B	15	25	35.6						
CPT-02B	16-56021_CP02B	15	1000	35.8						
CPT-02B	16-56021_CP02B	15	450	35.9						
CPT-02B	16-56021_CP02B	15	35	37.1						
CPT-02B	16-56021_CP02B	15	140	38.9						
CPT-02B	16-56021_CP02B	15	55	48.4						
CPT-02B	16-56021_CP02B	15	25	51.7						
CPT-02B	16-56021_CP02B	15	925	58.6						
CPT-02B	16-56021_CP02B	15	170	70.4						

a. Time is relative to where umax occurred
b. Houlsby and Teh, 1991

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

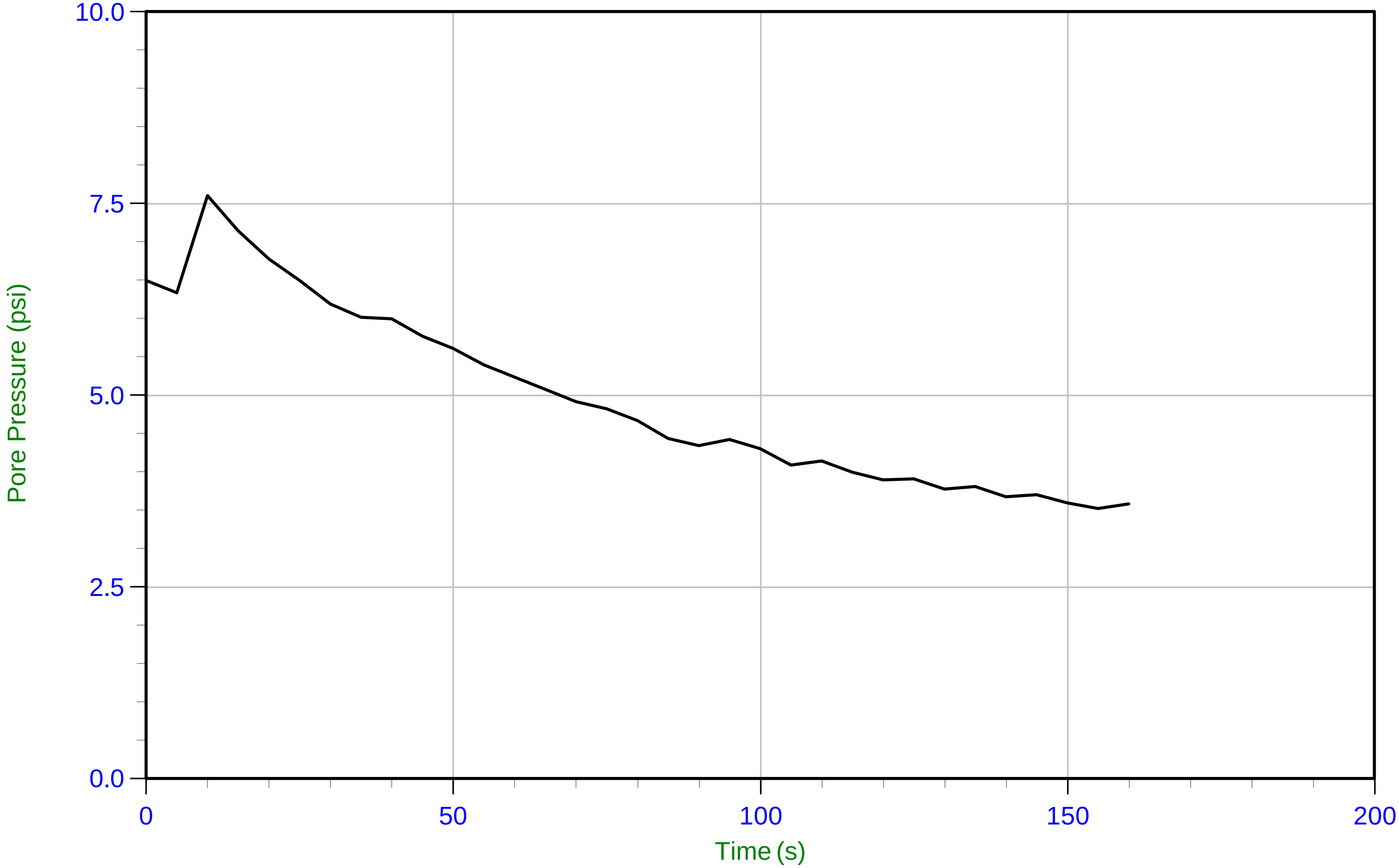
Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP01A.PPF	U Min: -0.2 psi	WT: 0.750 m / 2.461 ft
Depth: 0.750 m / 2.461 ft	U Max: 0.1 psi	Ueq: 0.0 psi
Duration: 35.0 s		

Terraphase	Job No: 16-56021 Date: 04/26/2016 14:12 Site: Moss Landing Pick-n-Pull	Sounding: CPT-01A Cone: 391:T1500F15U500 Cone Area: 15 sq cm



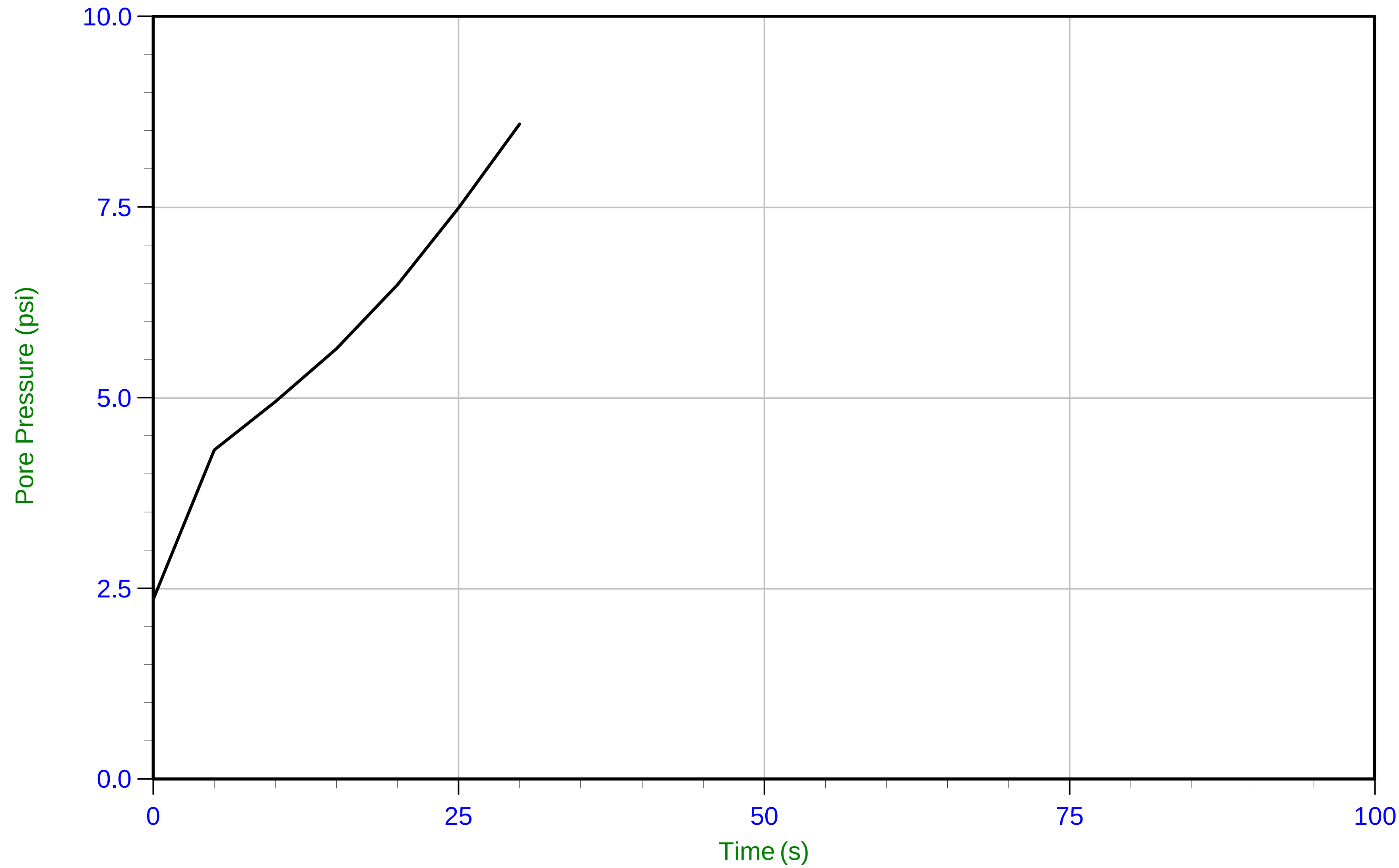
Trace Summary:

Filename: 16-56021_CP01A.PPF	U Min: 3.5 psi
Depth: 1.100 m / 3.609 ft	U Max: 7.6 psi
Duration: 160.0 s	

Terraphase

Job No: 16-56021
Date: 04/26/2016 14:12
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



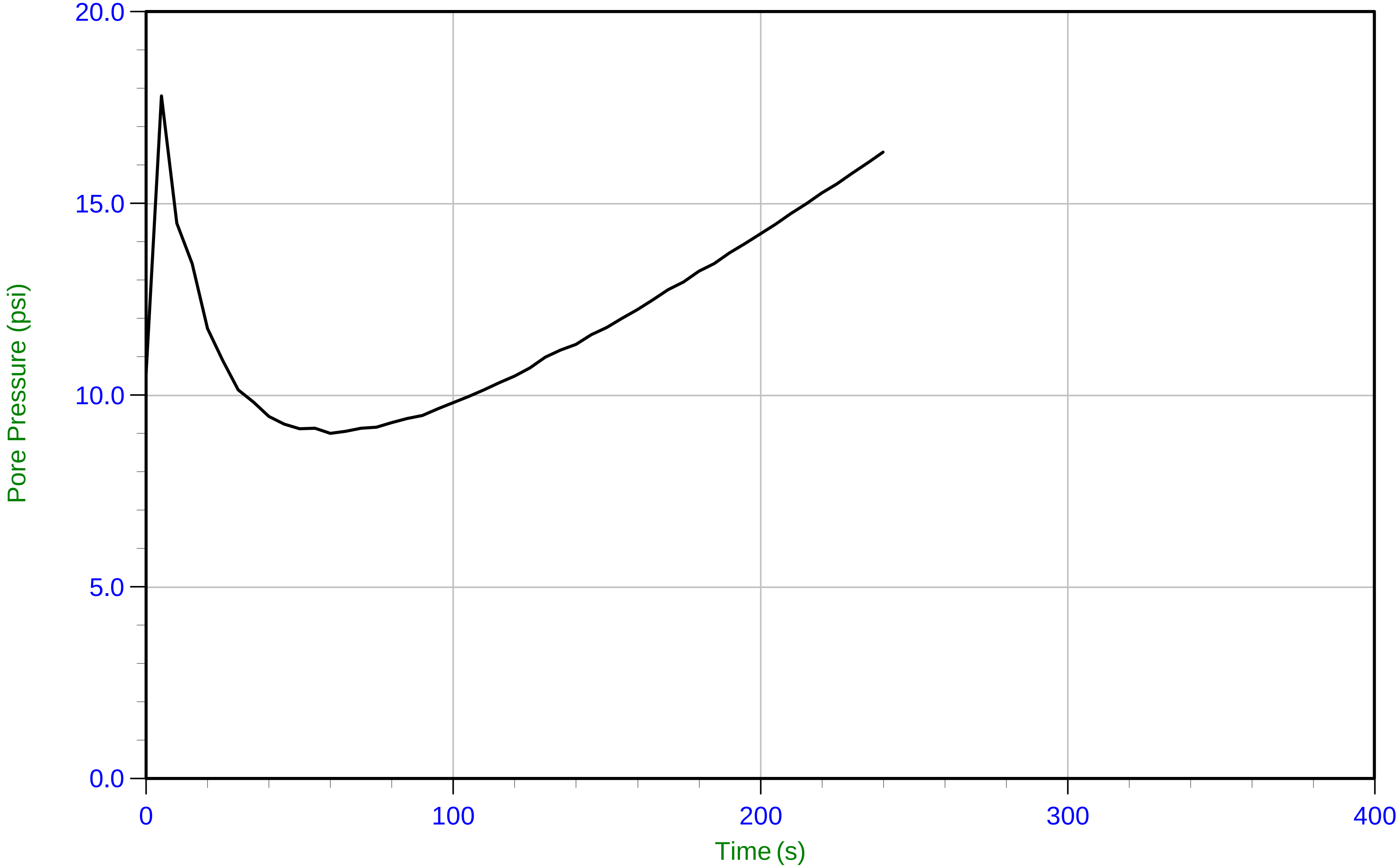
Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 7.750 m / 25.426 ft
Duration: 30.0 s

U Min: 2.4 psi
U Max: 8.6 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

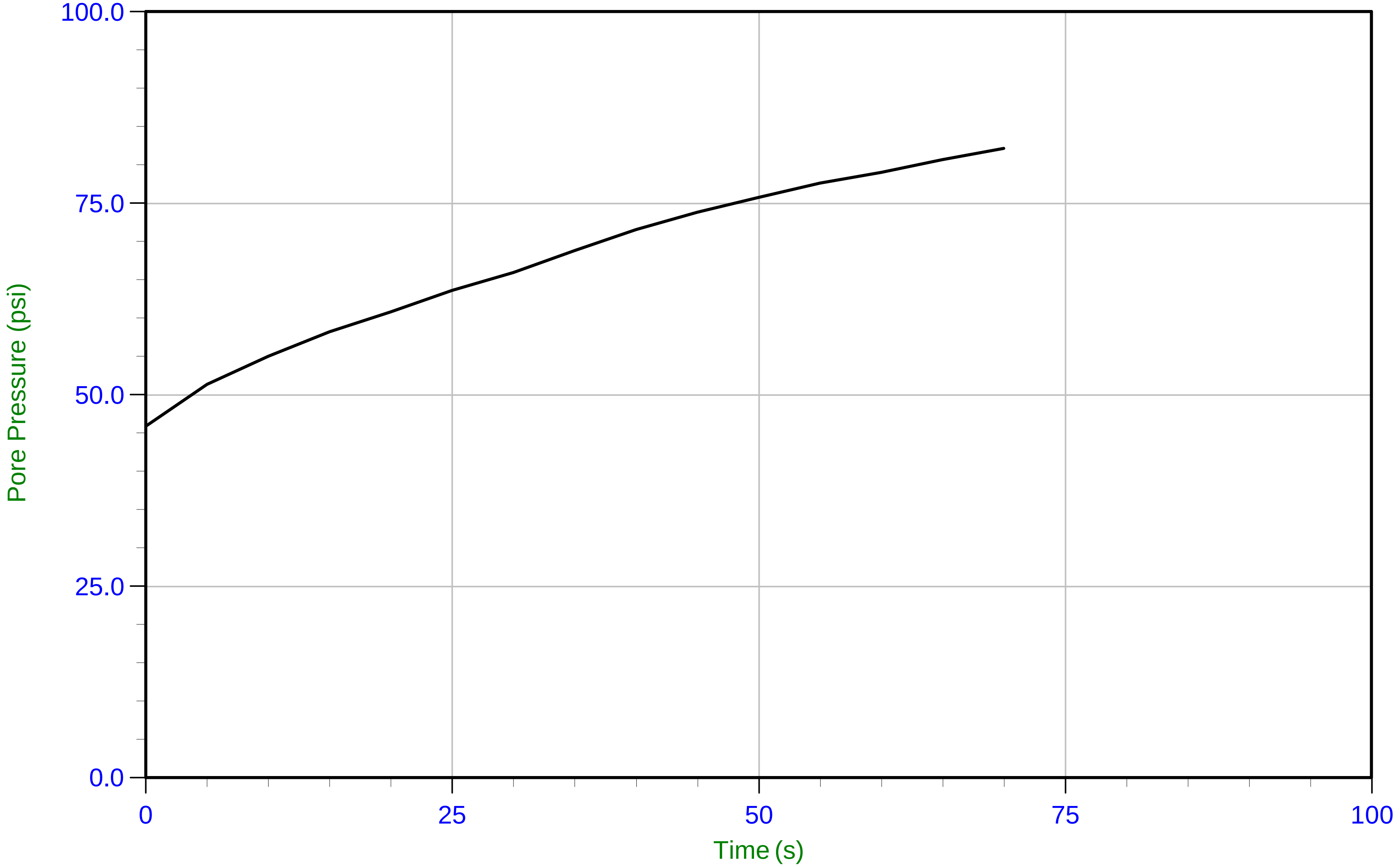


Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 8.050 m / 26.410 ft
Duration: 240.0 s

U Min: 9.0 psi
U Max: 17.8 psi

Terraphase	Job No: 16-56021 Date: 04/26/2016 14:12 Site: Moss Landing Pick-n-Pull	Sounding: CPT-01A Cone: 391:T1500F15U500 Cone Area: 15 sq cm



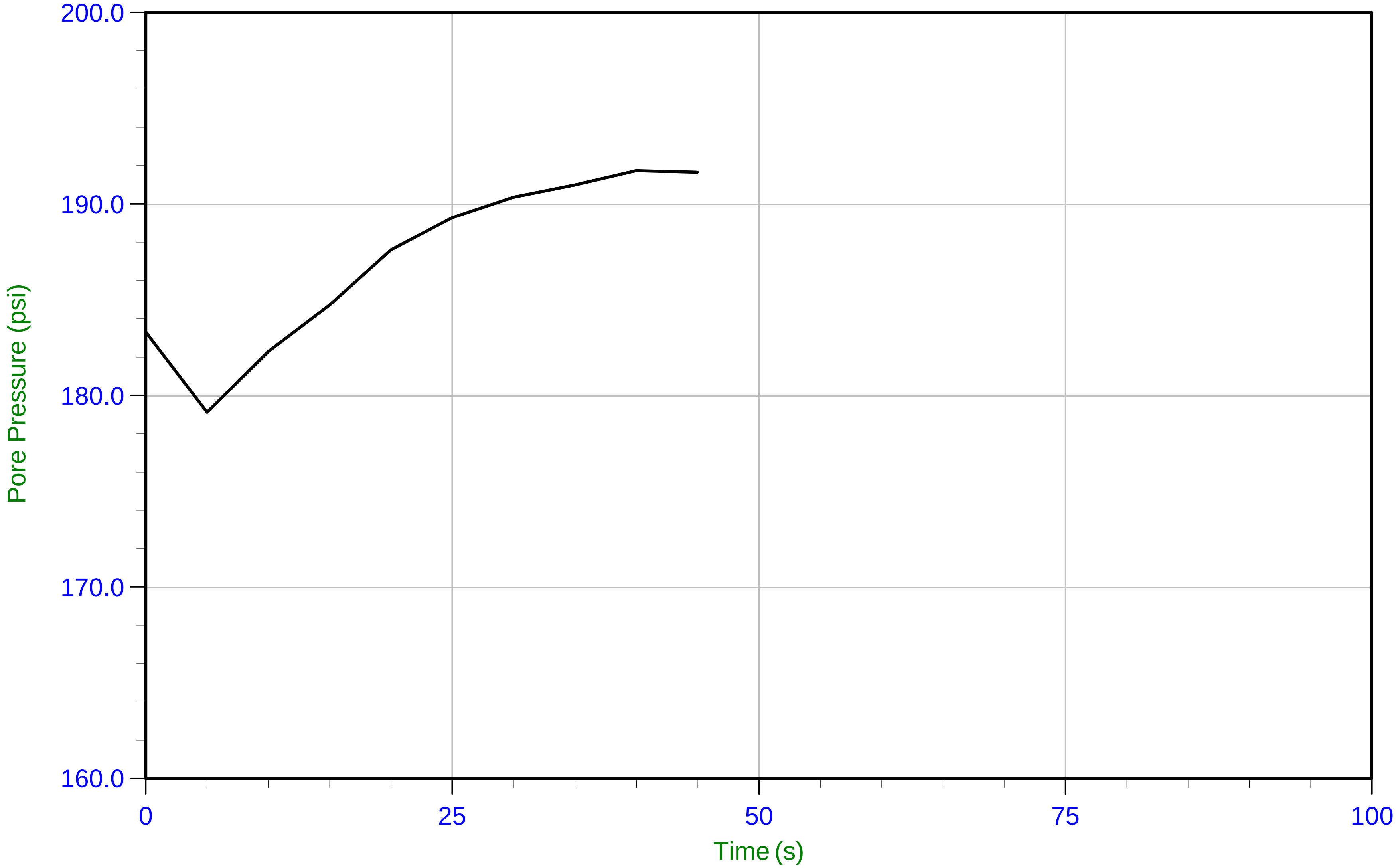
Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 10.700 m / 35.105 ft
Duration: 70.0 s

U Min: 45.9 psi
U Max: 82.1 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



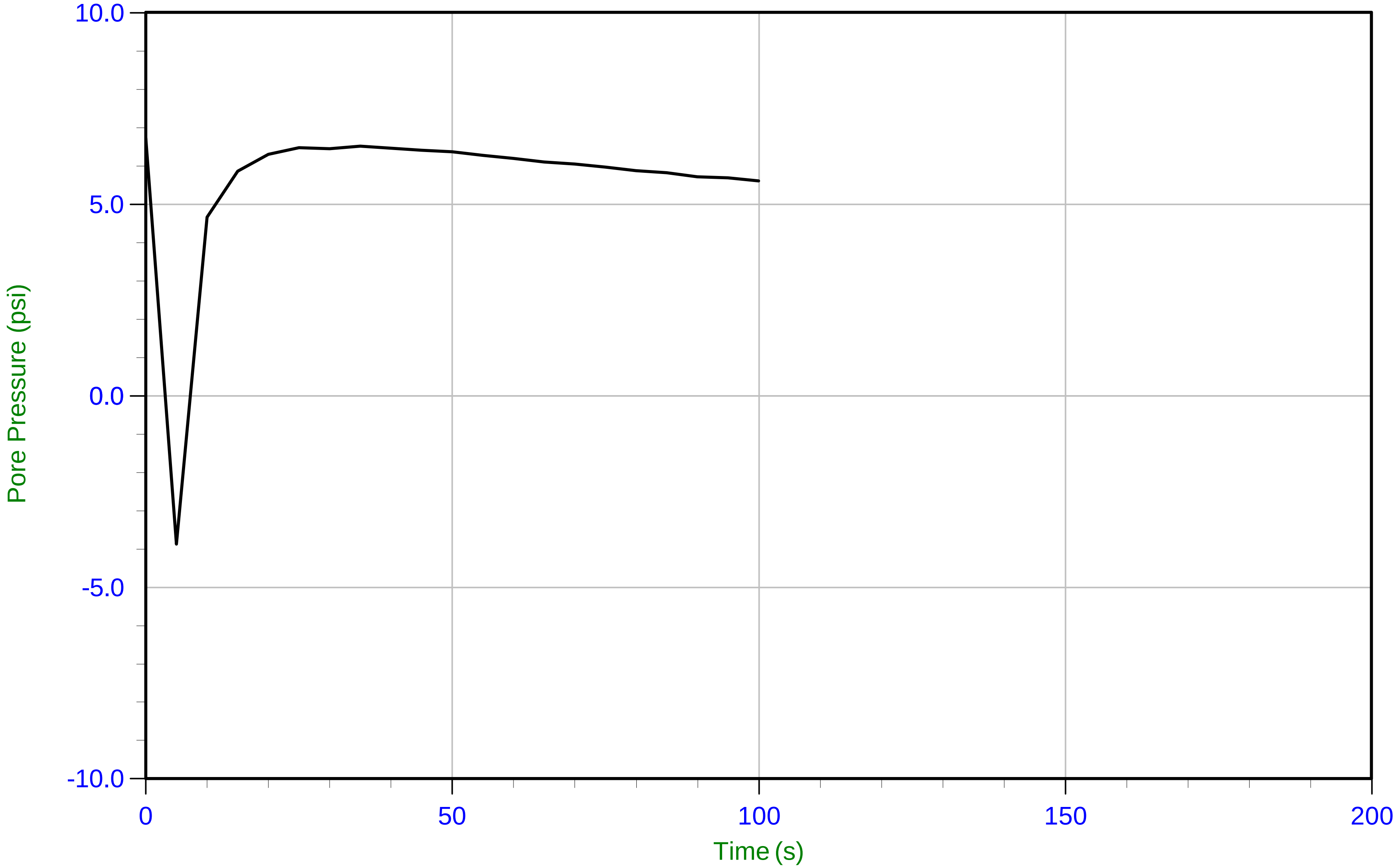
Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 11.700 m / 38.385 ft
Duration: 45.0 s

U Min: 179.1 psi
U Max: 191.7 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

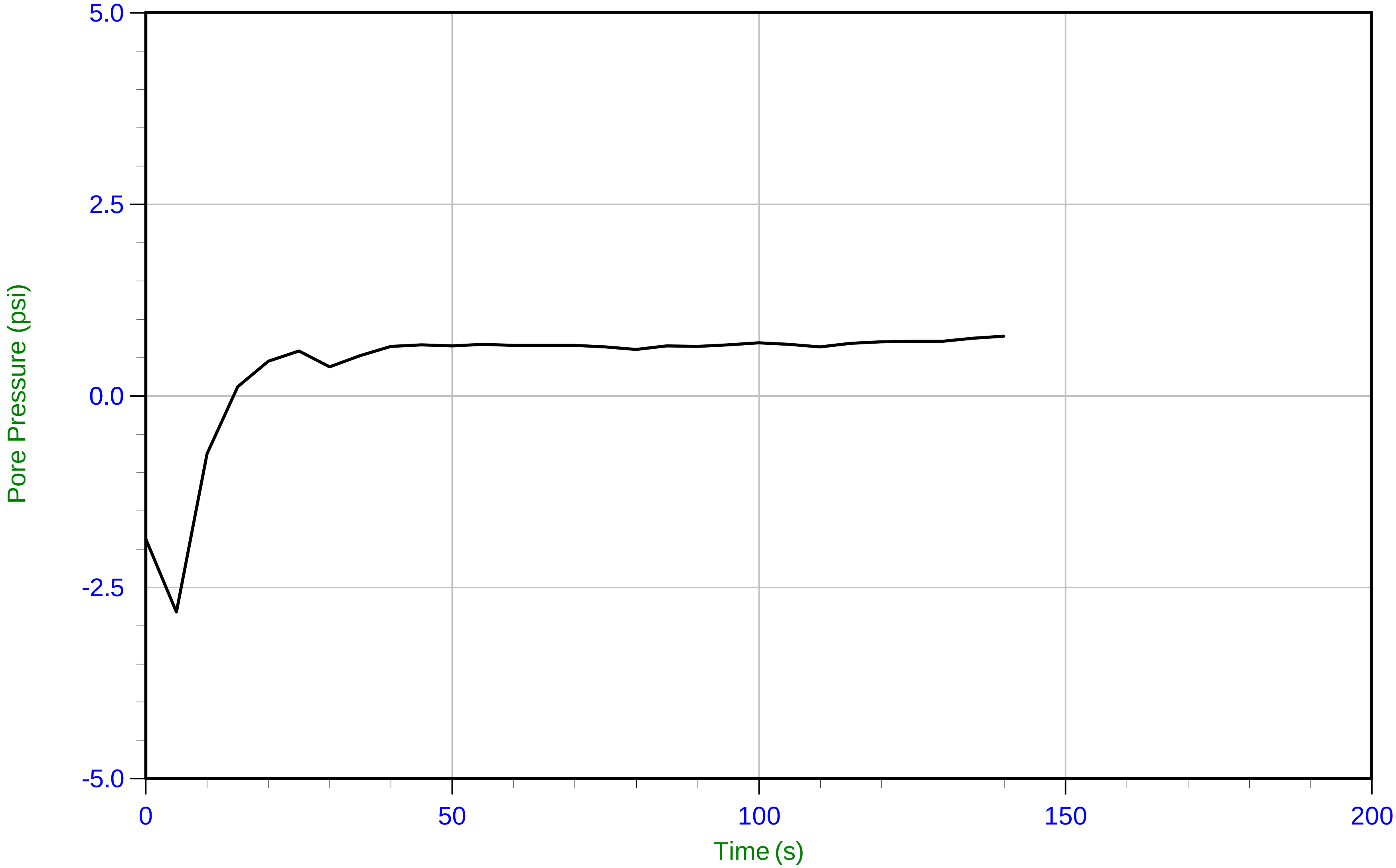
Filename: 16-56021_CP01A.PPF
Depth: 13.200 m / 43.307 ft
Duration: 100.0 s

U Min: -3.9 psi
U Max: 6.7 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 14:12
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

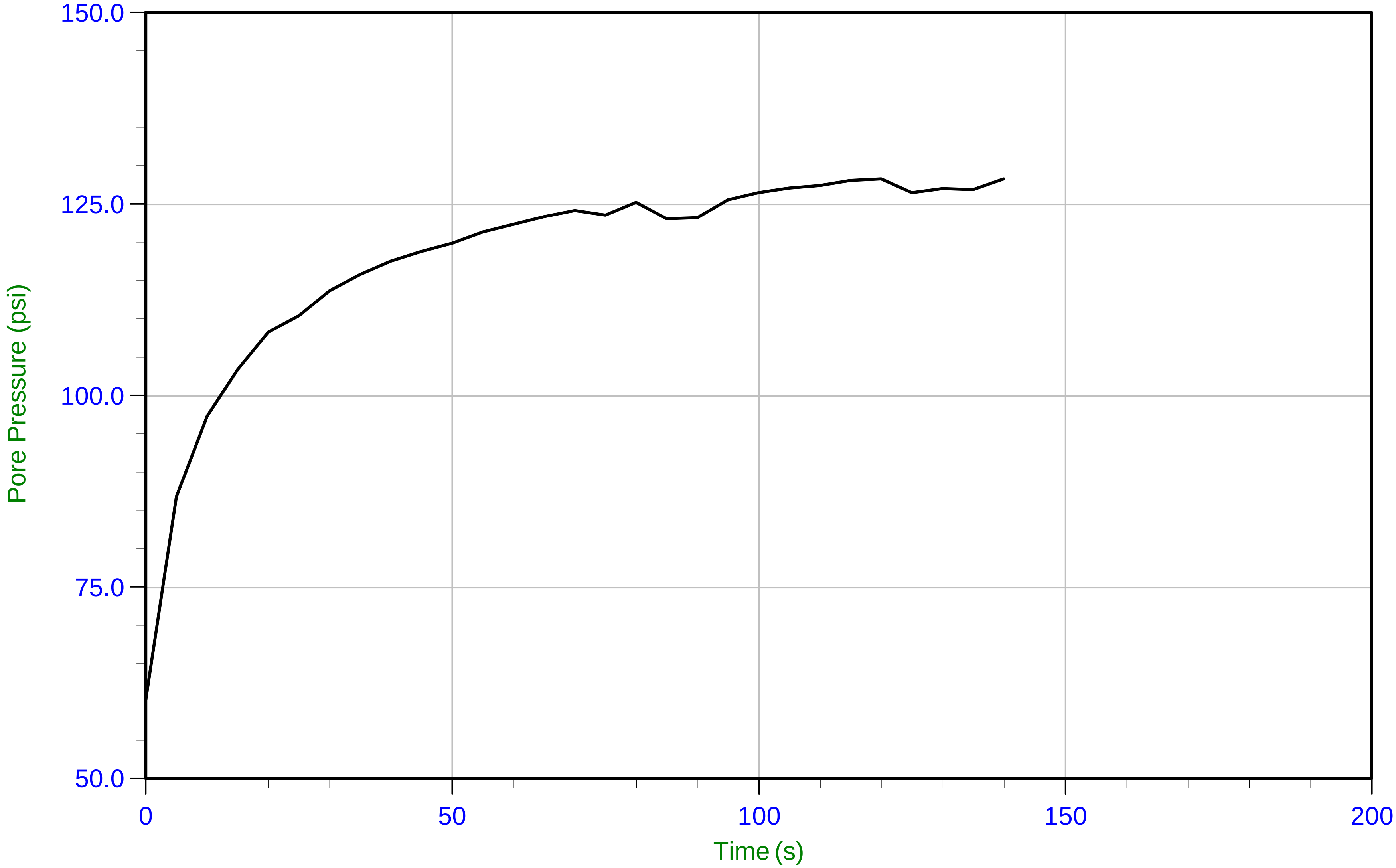
Filename: 16-56021_CP01A.PPF
Depth: 13.750 m / 45.111 ft
Duration: 140.0 s

U Min: -2.8 psi
U Max: 0.8 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 14:12
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



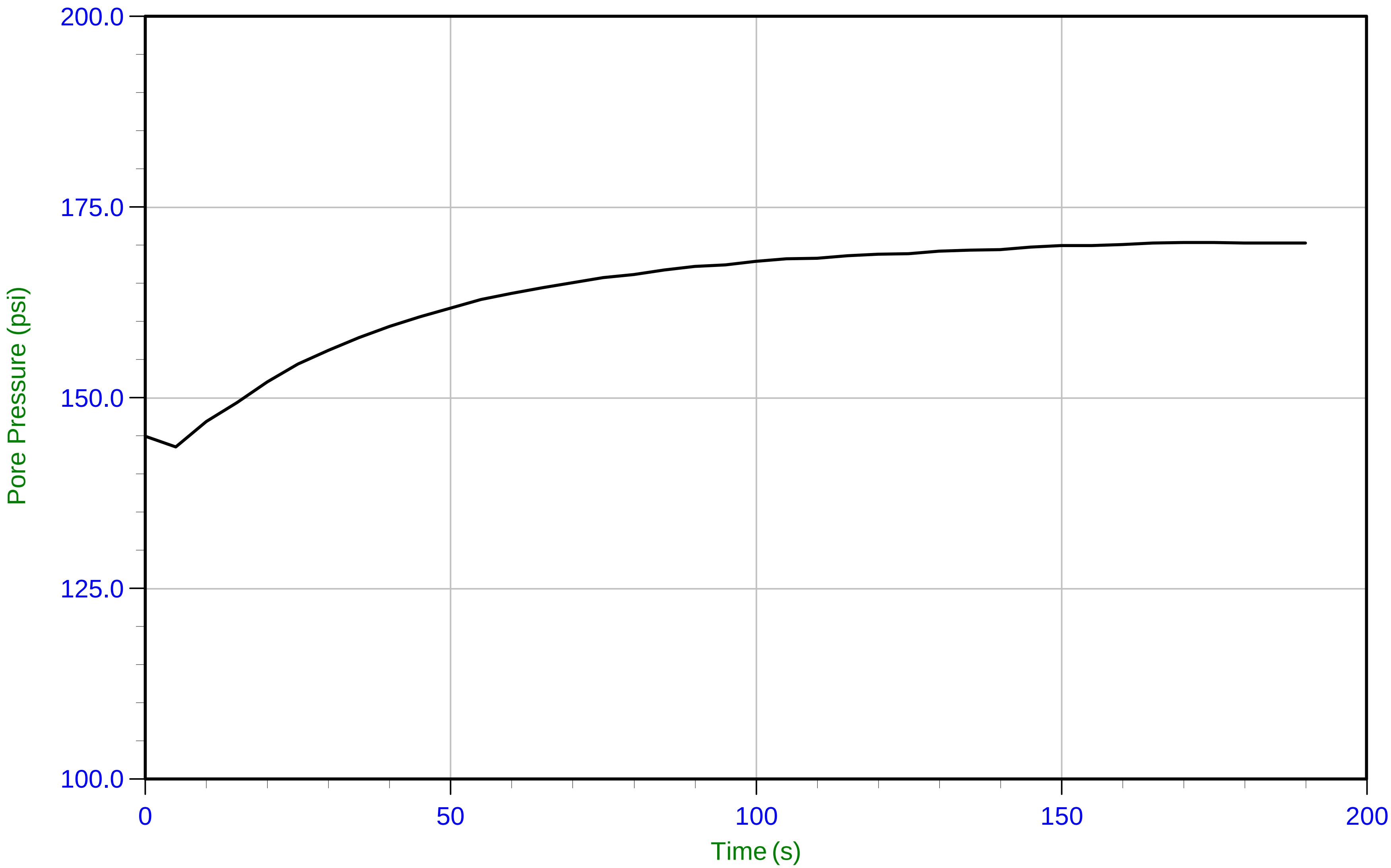
Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 17.100 m / 56.102 ft
Duration: 140.0 s

U Min: 60.3 psi
U Max: 128.3 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

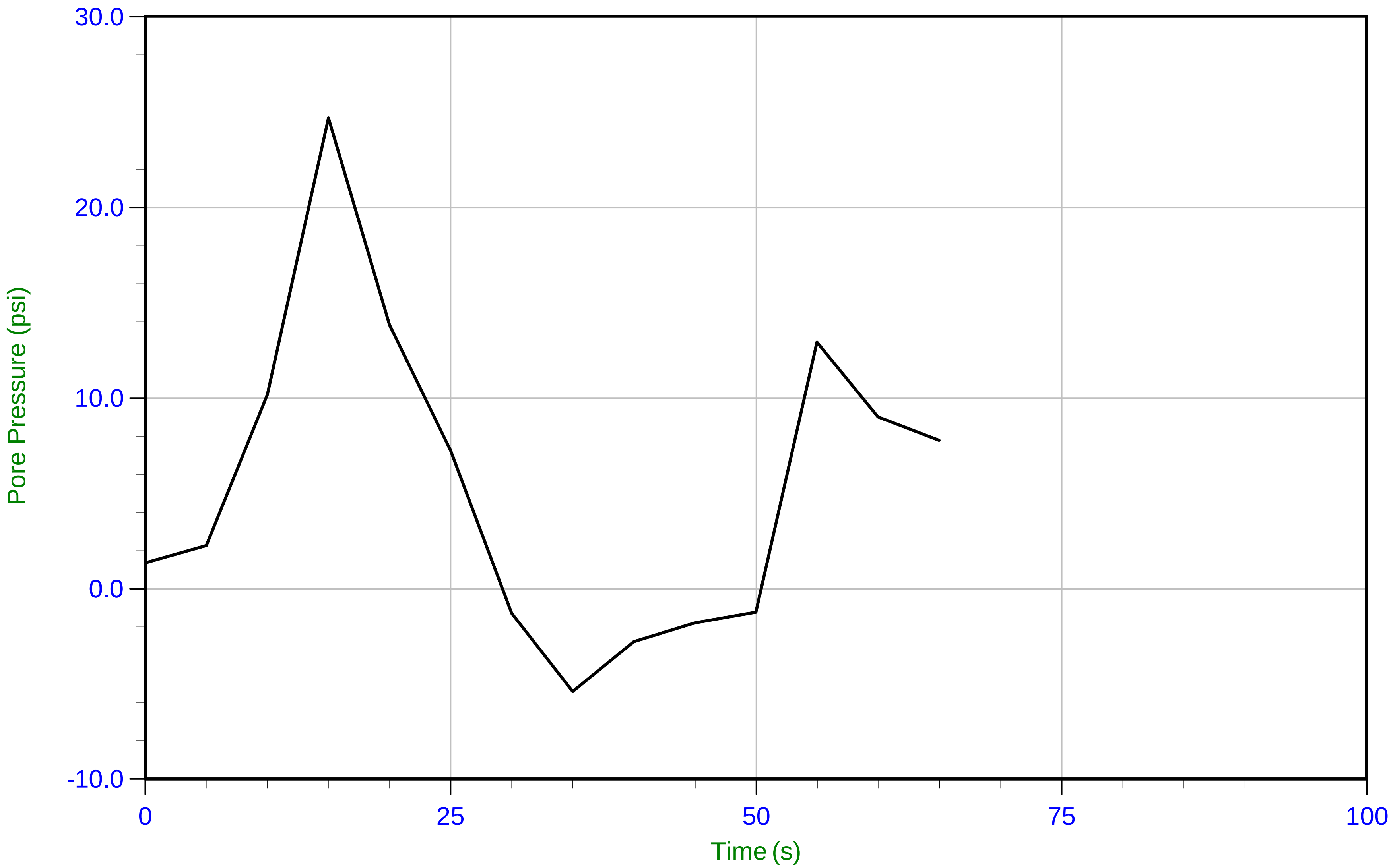


Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 19.750 m / 64.796 ft
Duration: 190.0 s

U Min: 143.6 psi
U Max: 170.4 psi

Terraphase	Job No: 16-56021	Sounding: CPT-01A
	Date: 04/26/2016 14:12	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

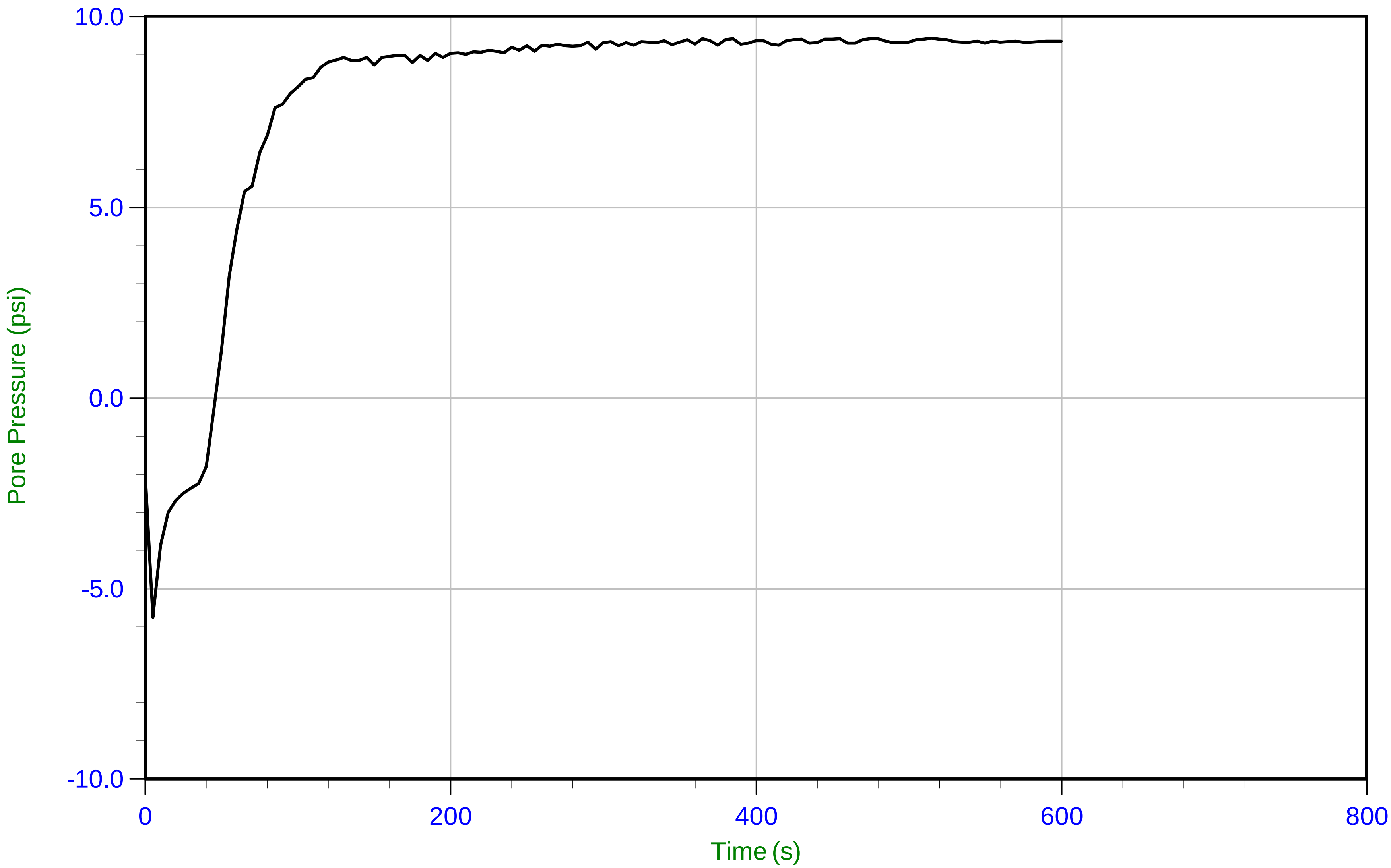
Filename: 16-56021_CP01A.PPF
Depth: 20.750 m / 68.077 ft
Duration: 65.0 s

U Min: -5.4 psi
U Max: 24.7 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 14:12
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP01A.PPF
Depth: 20.800 m / 68.241 ft
Duration: 600.0 s

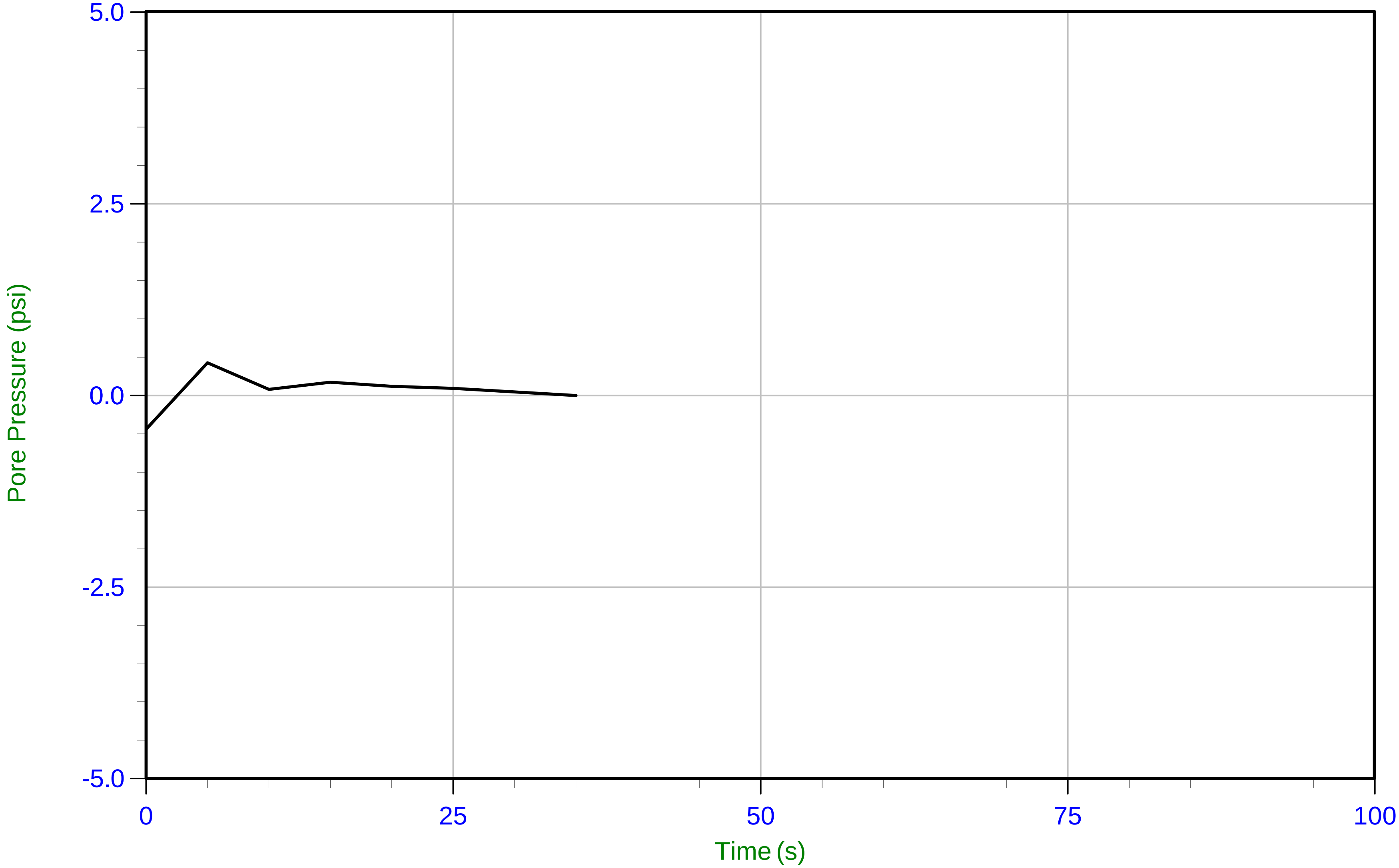
U Min: -5.8 psi
U Max: 9.4 psi

WT: 14.226 m / 46.673 ft
Ueq: 9.4 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 12:55
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

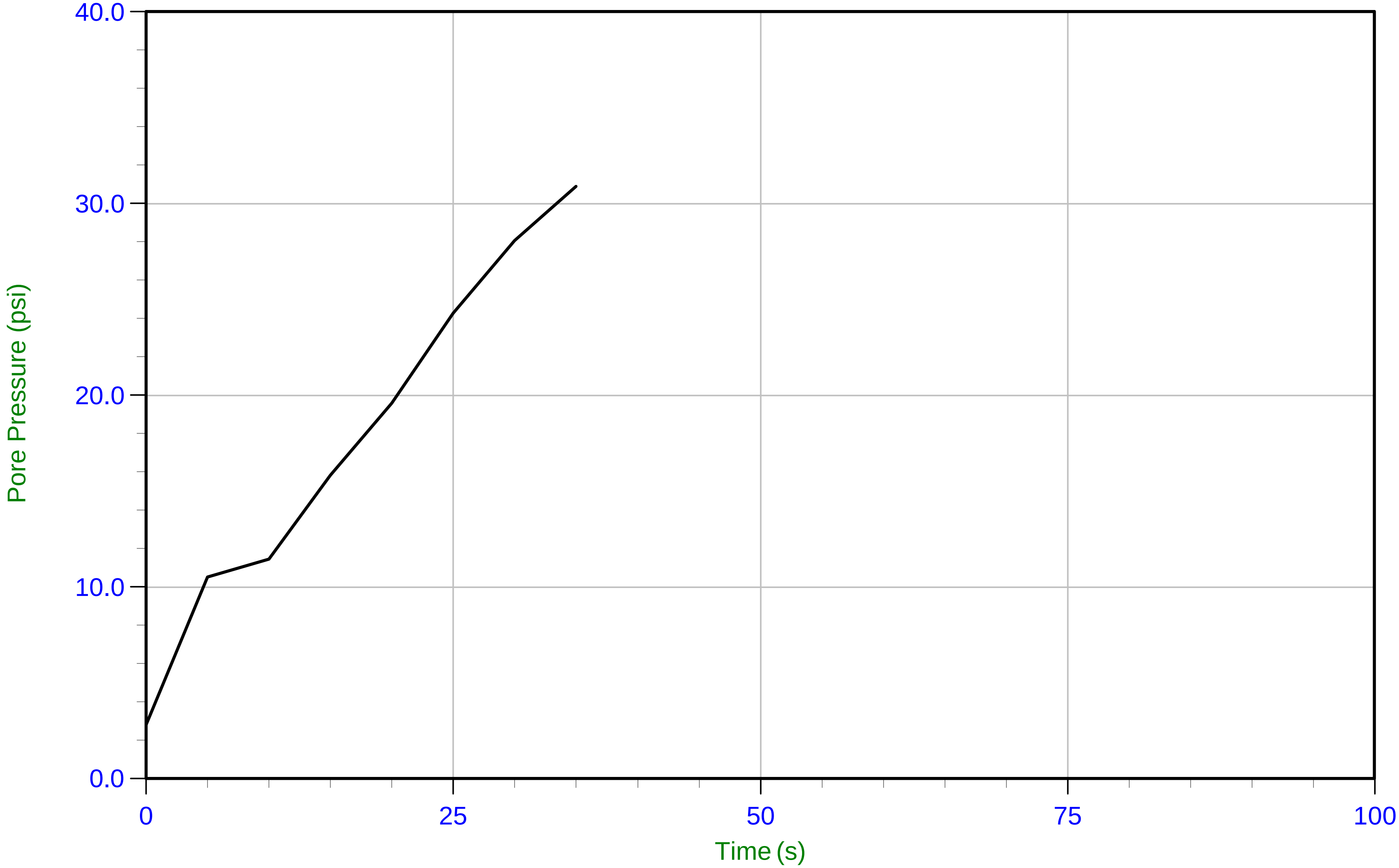
Filename: 16-56021_CP02A.PPF
Depth: 0.850 m / 2.789 ft
Duration: 35.0 s

U Min: -0.4 psi
U Max: 0.4 psi

WT: 0.850 m / 2.789 ft
Ueq: 0.0 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02A
	Date: 04/26/2016 12:55	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

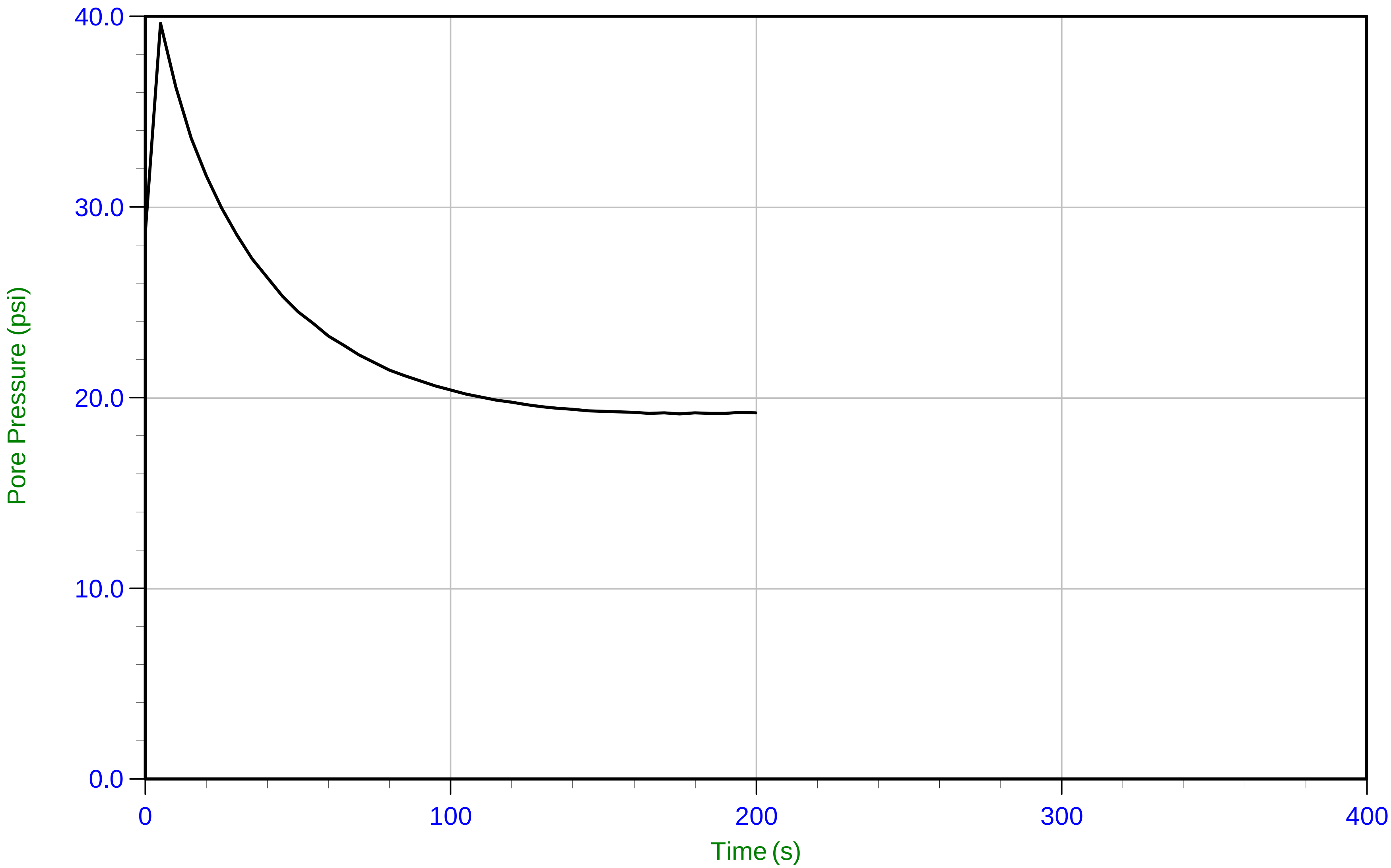


Trace Summary:

Filename: 16-56021_CP02A.PPF
Depth: 1.150 m / 3.773 ft
Duration: 35.0 s

U Min: 2.8 psi
U Max: 30.9 psi

Terraphase	Job No: 16-56021 Date: 04/26/2016 12:55 Site: Moss Landing Pick-n-Pull	Sounding: CPT-02A Cone: 391:T1500F15U500 Cone Area: 15 sq cm



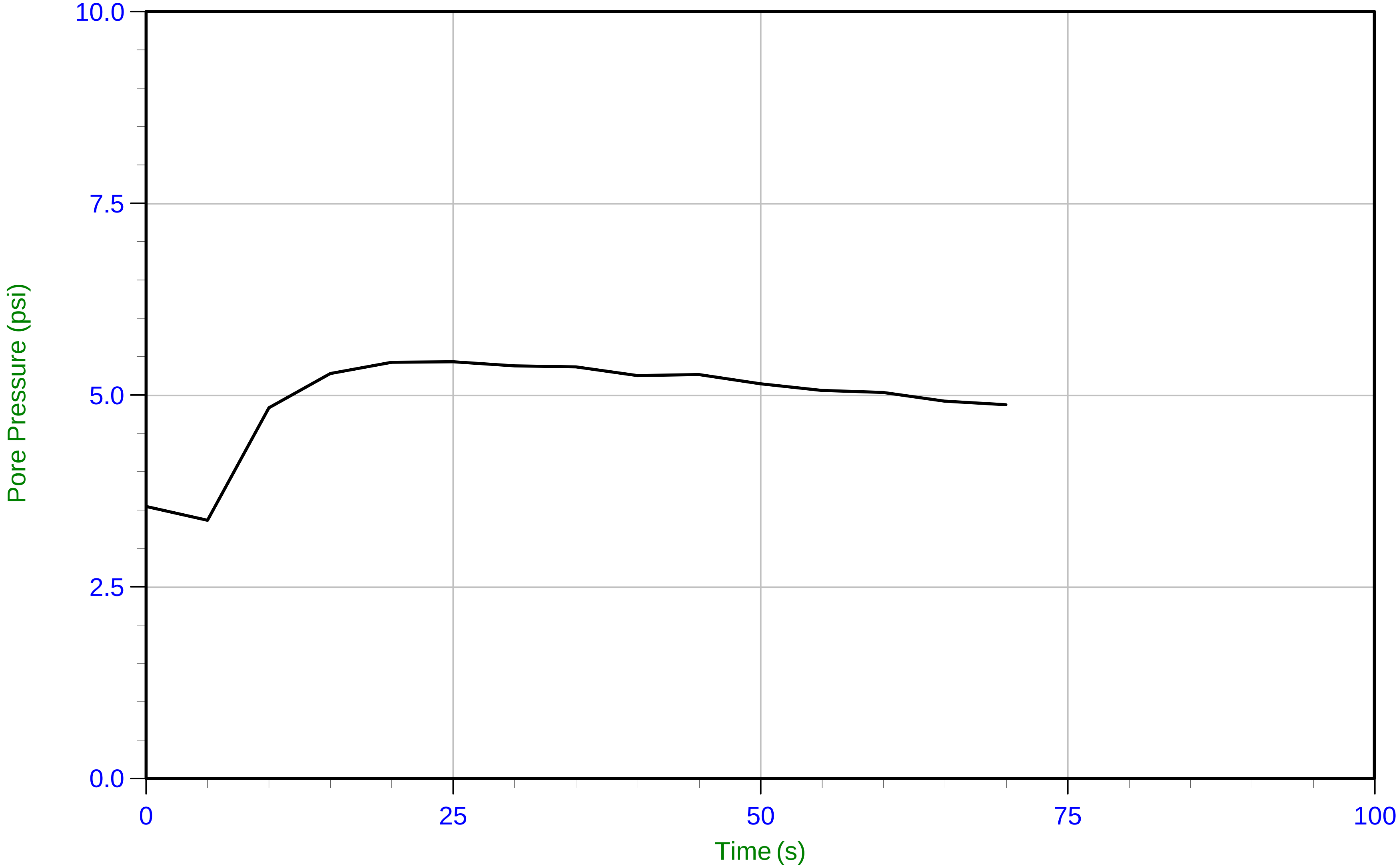
Trace Summary:

Filename: 16-56021_CP02A.PPF
Depth: 7.800 m / 25.590 ft
Duration: 200.0 s

U Min: 19.2 psi
U Max: 39.6 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02A
	Date: 04/26/2016 12:55	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

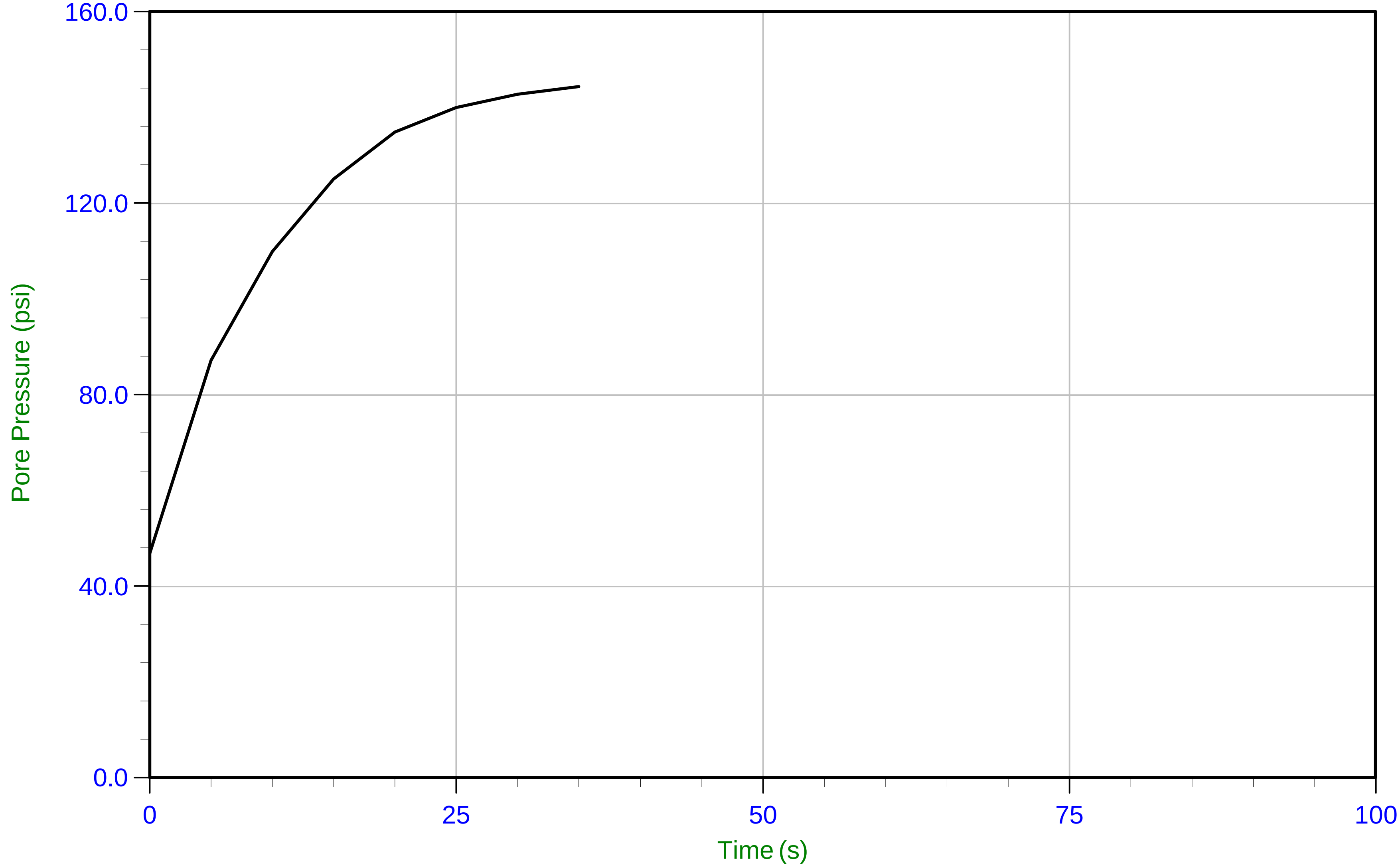
Filename: 16-56021_CP02A.PPF
Depth: 11.050 m / 36.253 ft
Duration: 70.0 s
U Min: 3.4 psi
U Max: 5.4 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04/26/2016 12:55
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm

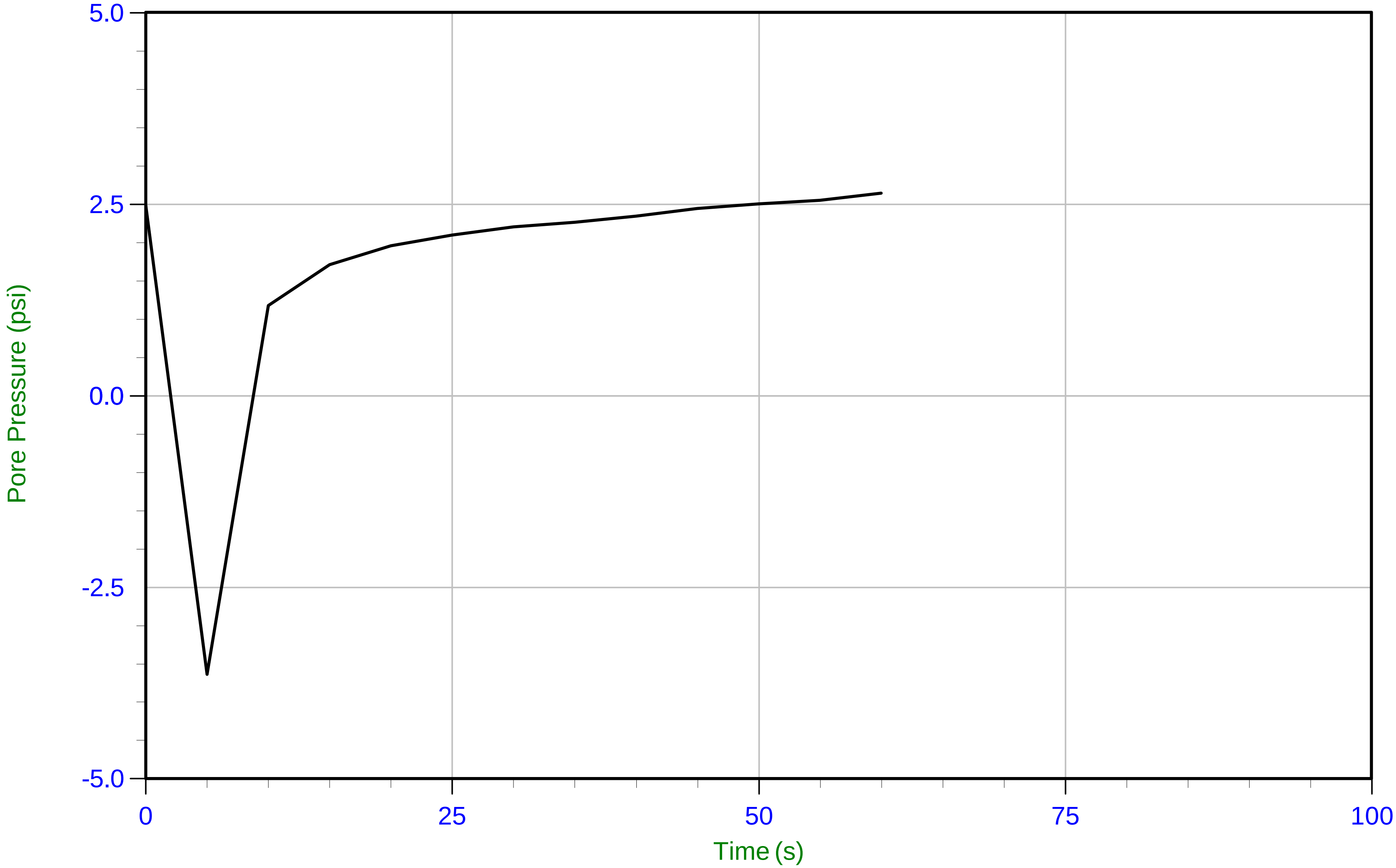


Trace Summary:

Filename: 16-56021_CP02A.PPF
Depth: 15.400 m / 50.524 ft
Duration: 35.0 s

U Min: 46.9 psi
U Max: 144.4 psi

Terraphase	Job No: 16-56021	Sounding: CPT-02A
	Date: 04/26/2016 12:55	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



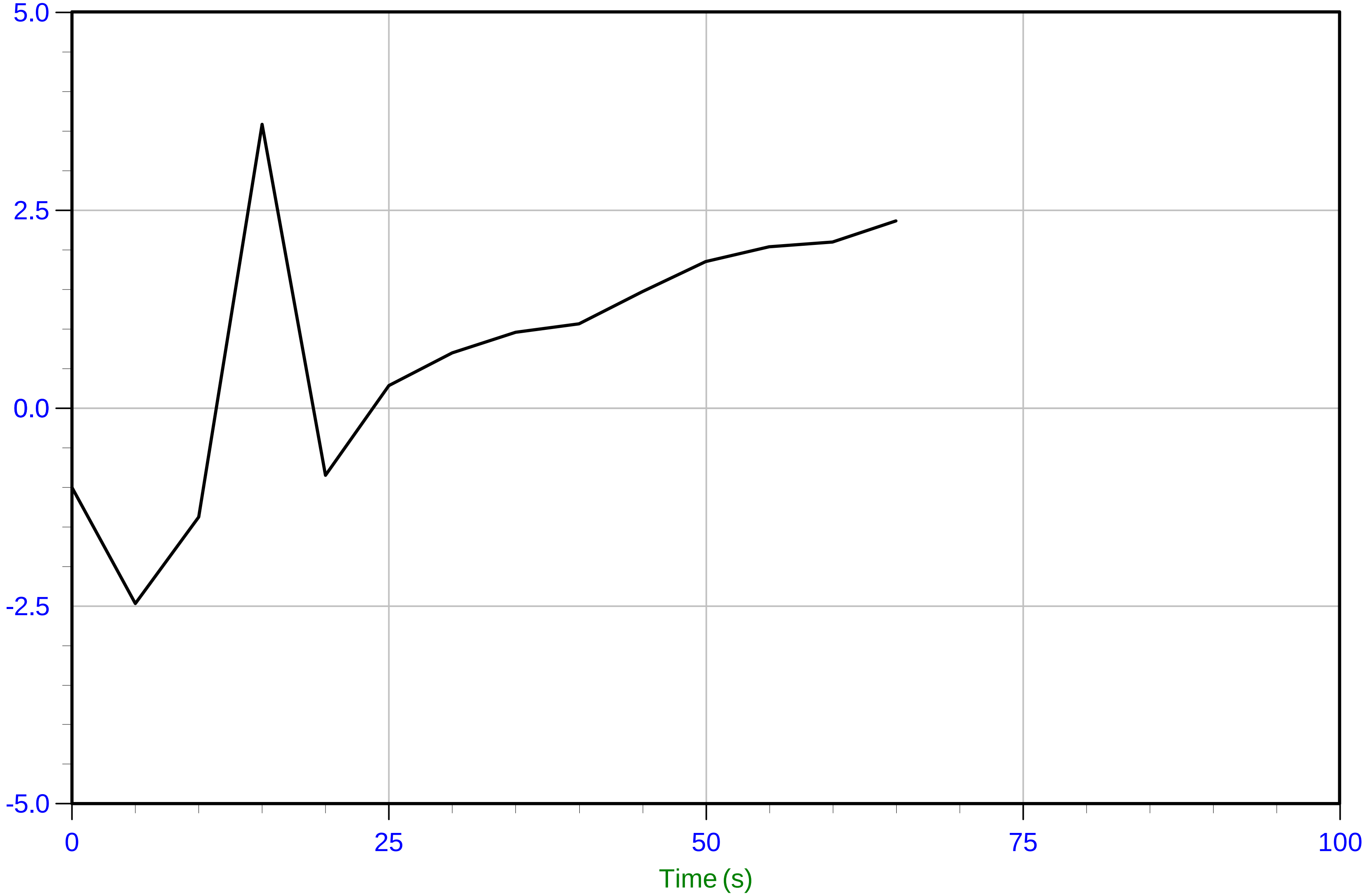
Trace Summary:

Filename: 16-56021_CP02A.PPF
Depth: 15.800 m / 51.837 ft
Duration: 60.0 s

U Min: -3.6 psi
U Max: 2.6 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02A
	Date: 04/26/2016 12:55	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

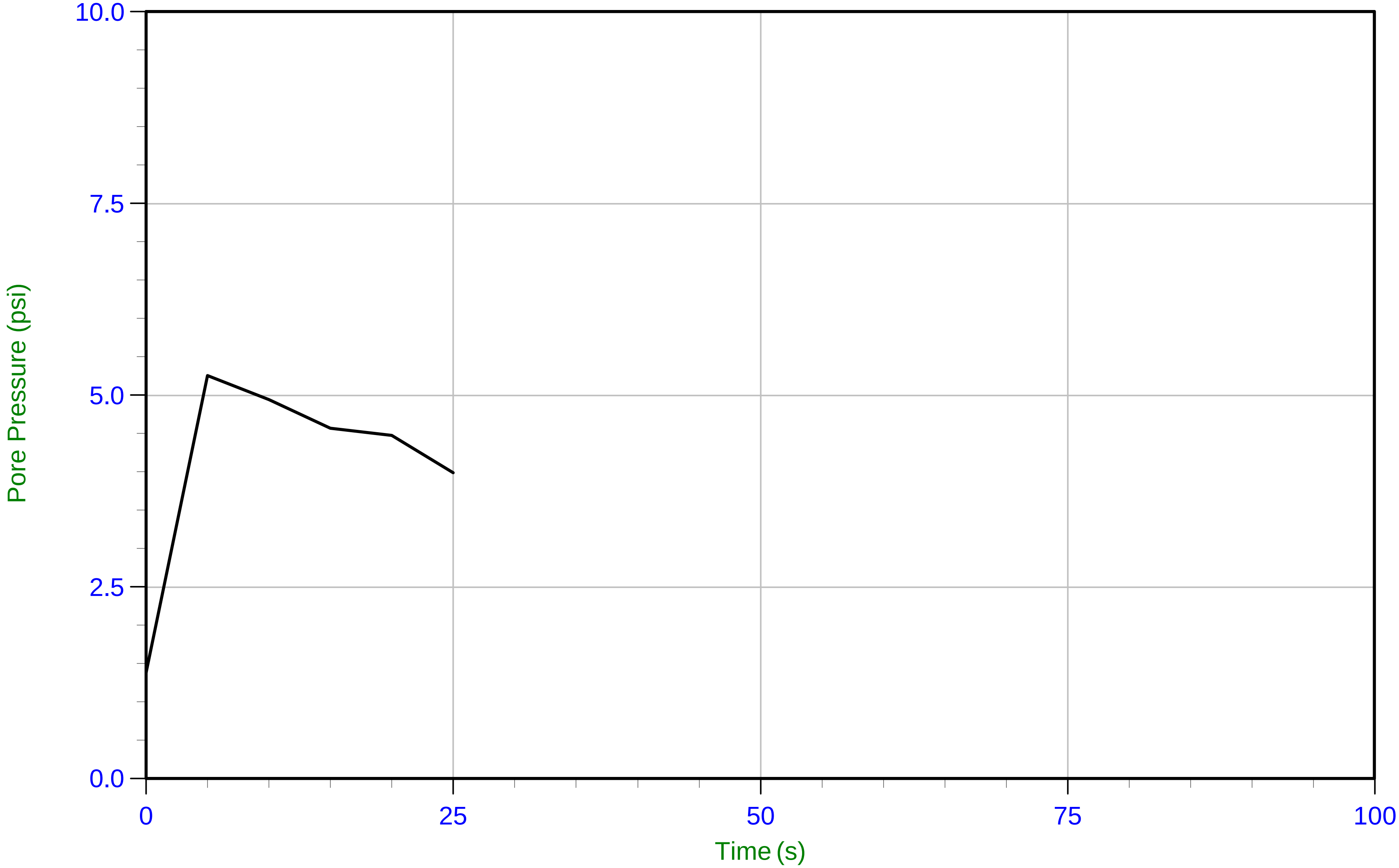


Trace Summary:

Filename: 16-56021_CP02A.PPF	U Min: -2.5 psi
Depth: 16.800 m / 55.117 ft	U Max: 3.6 psi
Duration: 65.0 s	

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02A
	Date: 04/26/2016 12:55	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

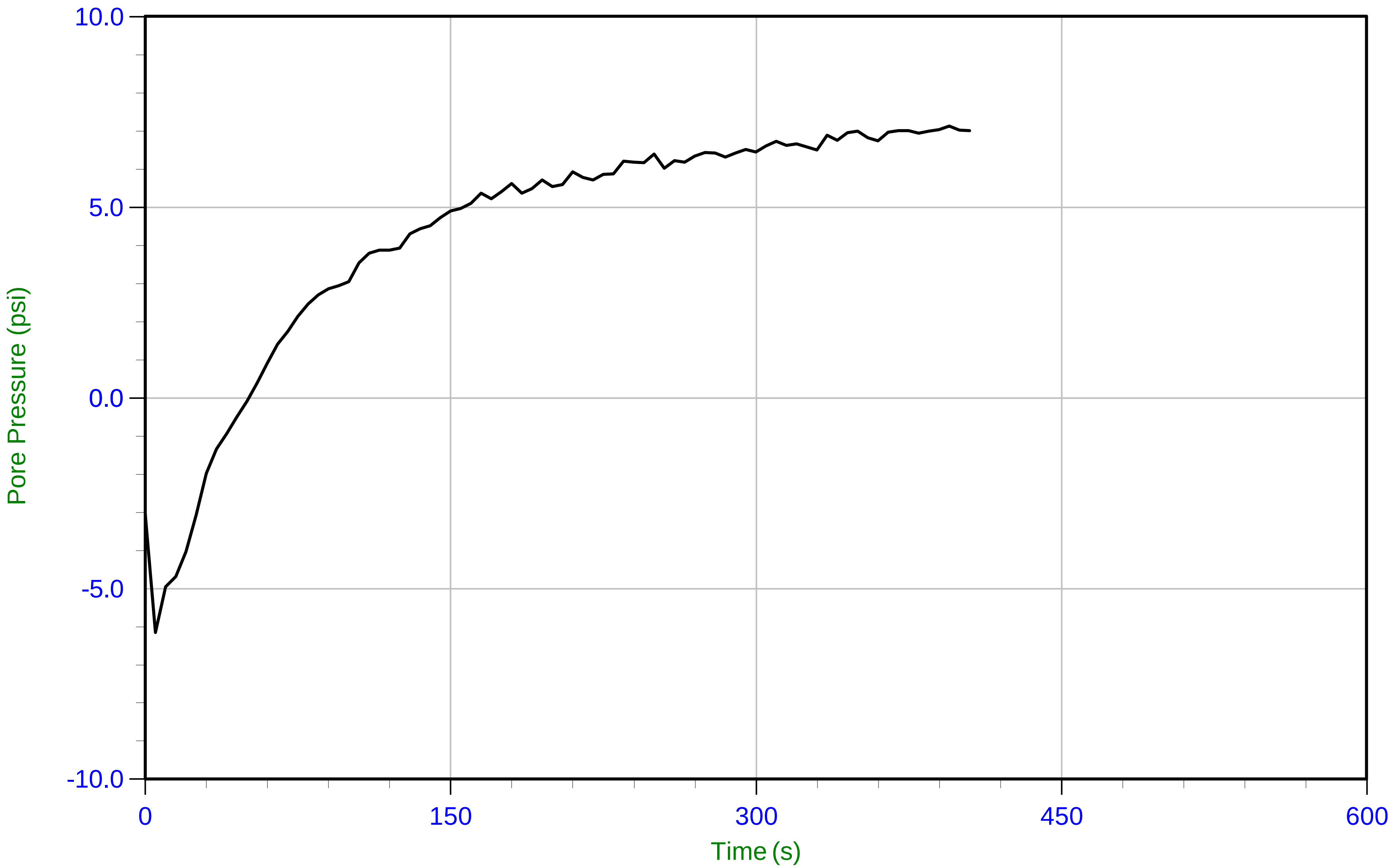
Filename: 16-56021_CP02A.PPF	U Min: 1.4 psi
Depth: 17.800 m / 58.398 ft	U Max: 5.3 psi
Duration: 25.0 s	

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase

Job No: 16-56021
Date: 04/26/2016 12:55
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02A
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP02A.PPF
Depth: 21.400 m / 70.209 ft
Duration: 405.0 s

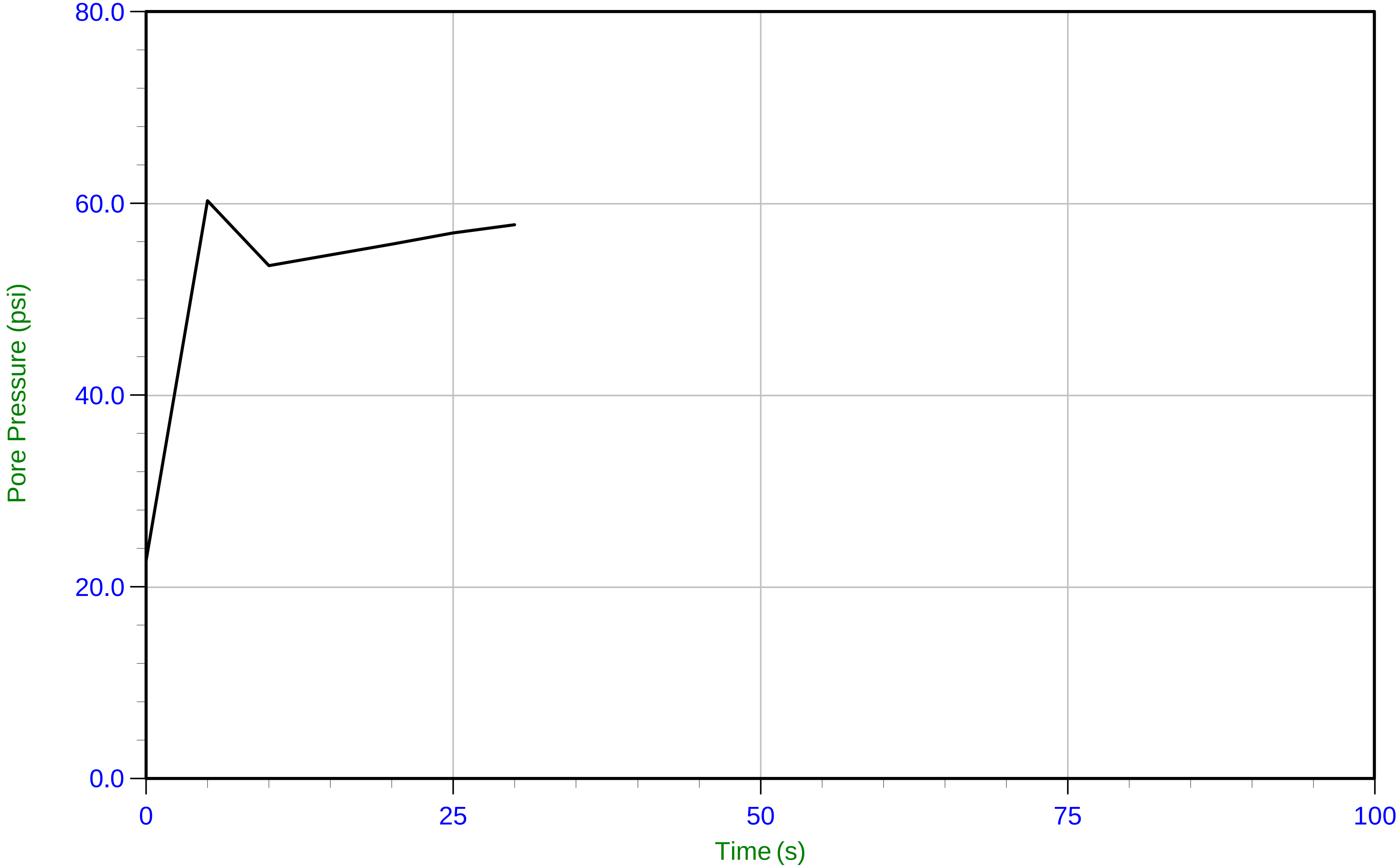
U Min: -6.2 psi
U Max: 7.1 psi

WT: 16.469 m / 54.031 ft
Ueq: 7.0 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 09:11
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

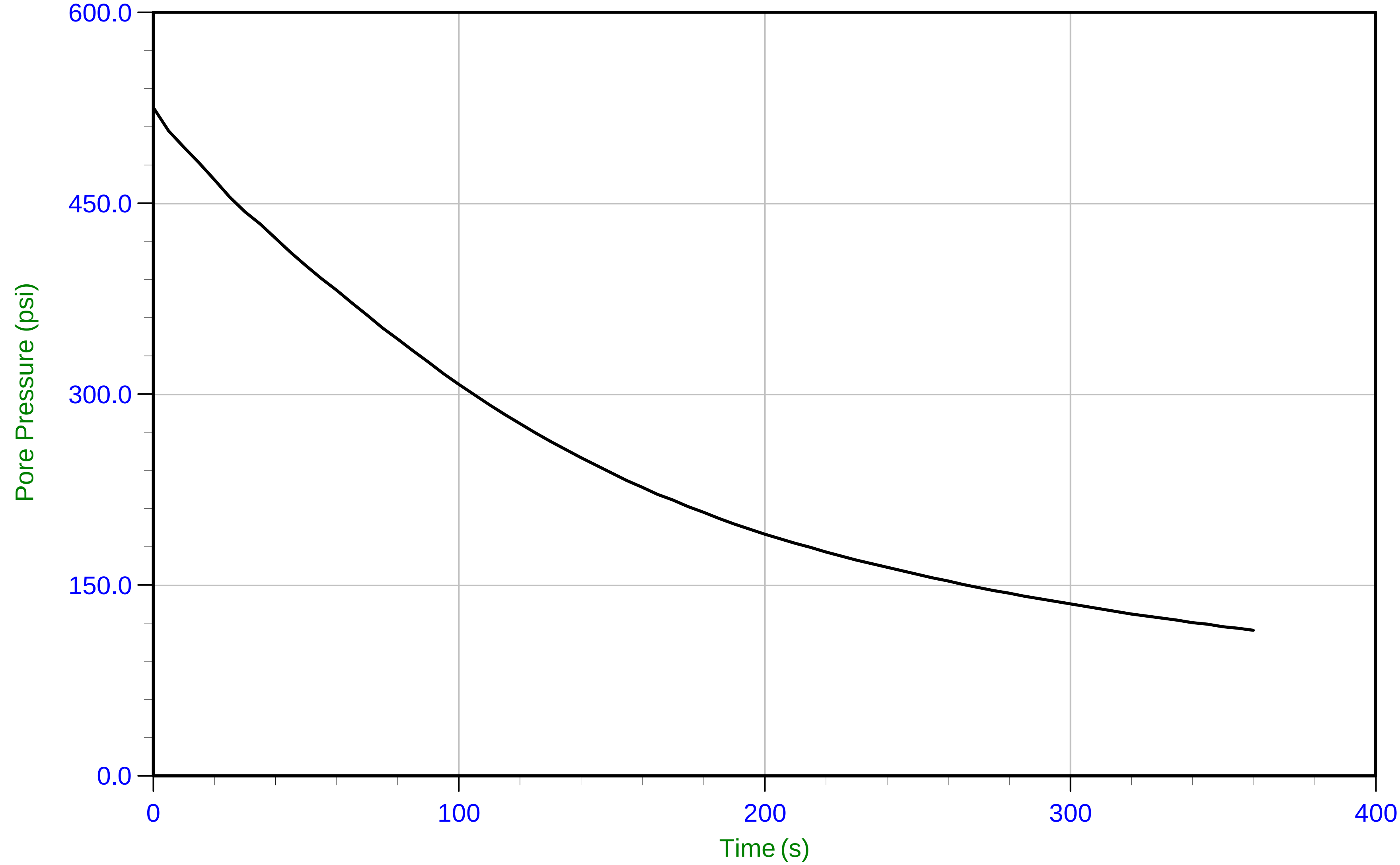
Filename: 16-56021_CP01B.PPF
Depth: 1.550 m / 5.085 ft
Duration: 30.0 s

U Min: 22.8 psi
U Max: 60.3 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 09:11
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP01B.PPF
Depth: 26.050 m / 85.465 ft
Duration: 360.0 s

U Min: 114.6 psi
U Max: 525.5 psi

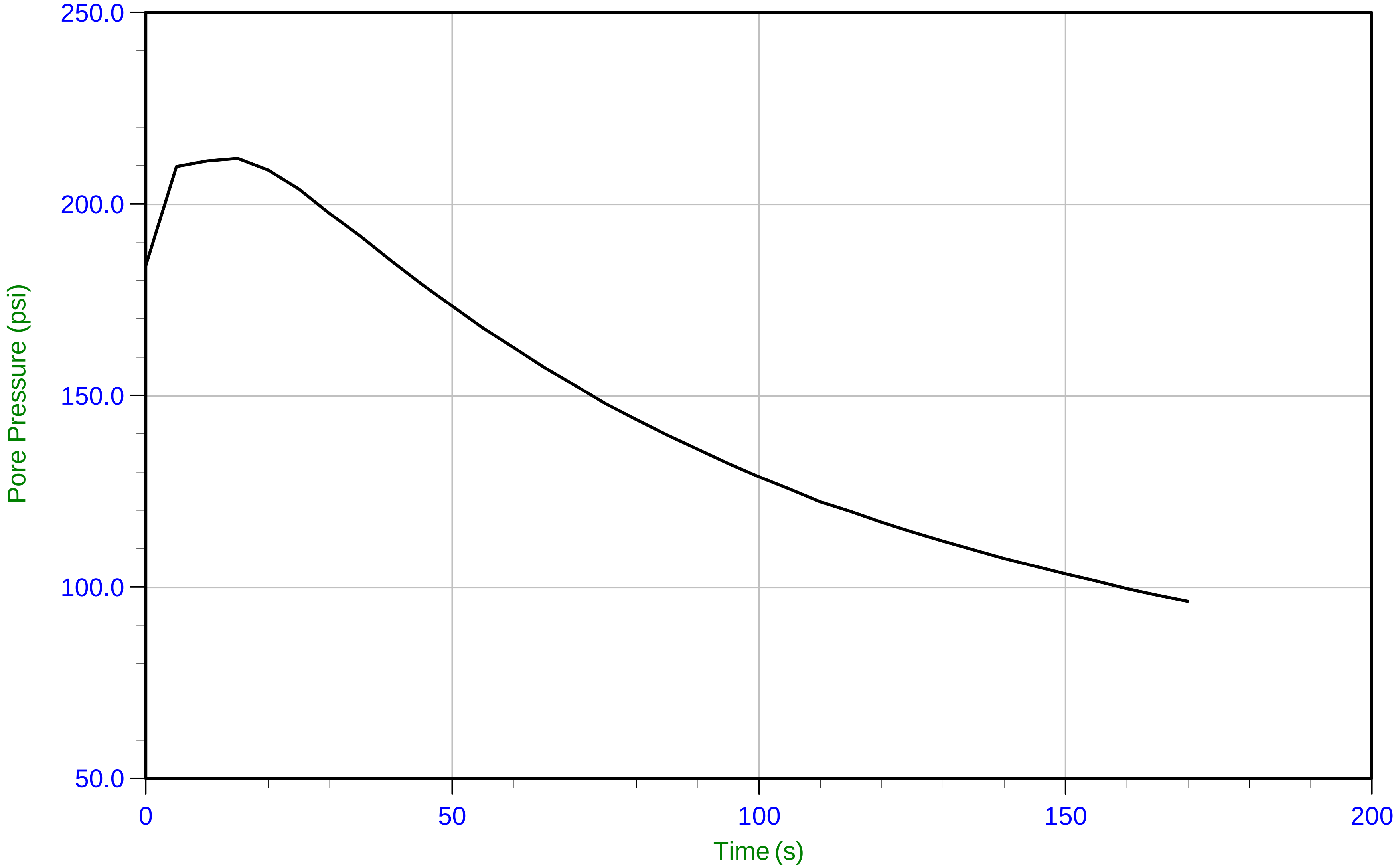
WT: 20.347 m / 66.754 ft
Ueq: 8.1 psi
U(50): 266.80 psi

T(50): 127.3 s
Ir: 100
Ch: 5.5 sq cm/min

Terraphase

Job No: 16-56021
Date: 04/26/2016 09:11
Site: Moss Landing Pick-n-Pull

Sounding: CPT-01B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP01B.PPF
Depth: 26.100 m / 85.629 ft
Duration: 170.0 s

U Min: 96.3 psi
U Max: 211.9 psi

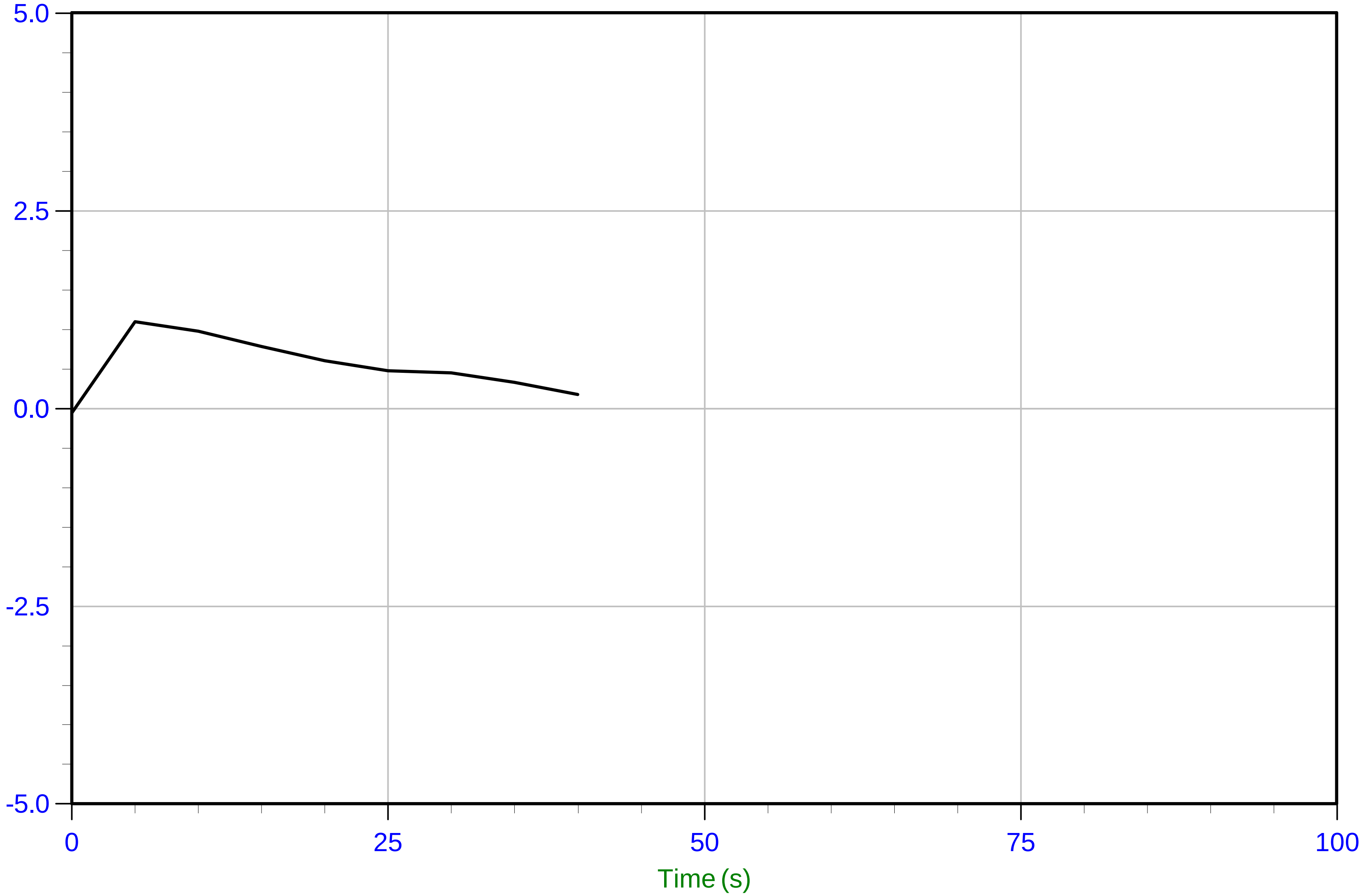
WT: 20.347 m / 66.754 ft
Ueq: 8.2 psi
U(50): 110.06 psi

T(50): 119.3 s
Ir: 100
Ch: 5.9 sq cm/min

Terraphase

Job No: 16-56021
Date: 04/26/2016 10:47
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

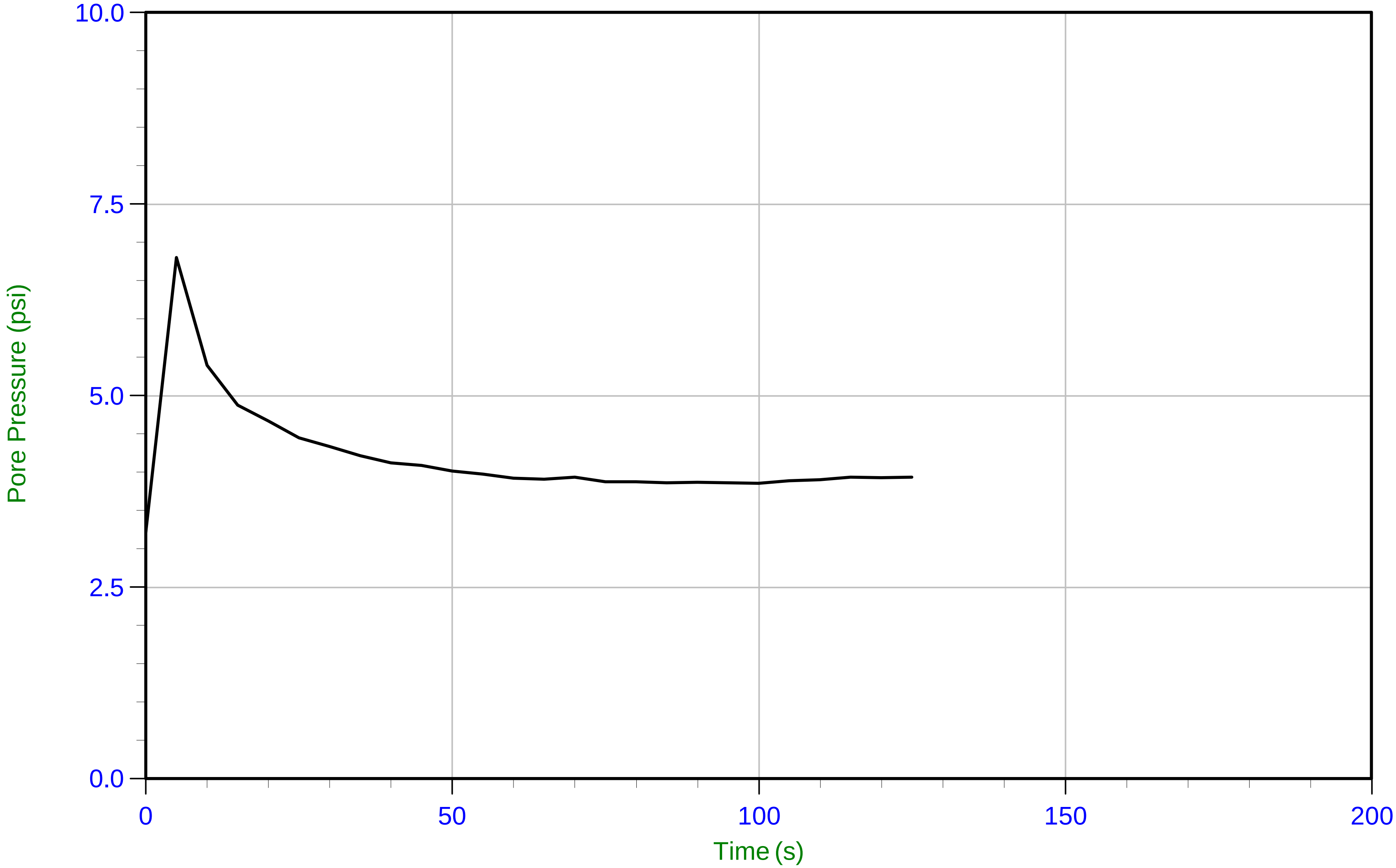
Filename: 16-56021_CP02B.PPF
Depth: 3.850 m / 12.631 ft
Duration: 40.0 s

U Min: -0.1 psi
U Max: 1.1 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 10:47
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

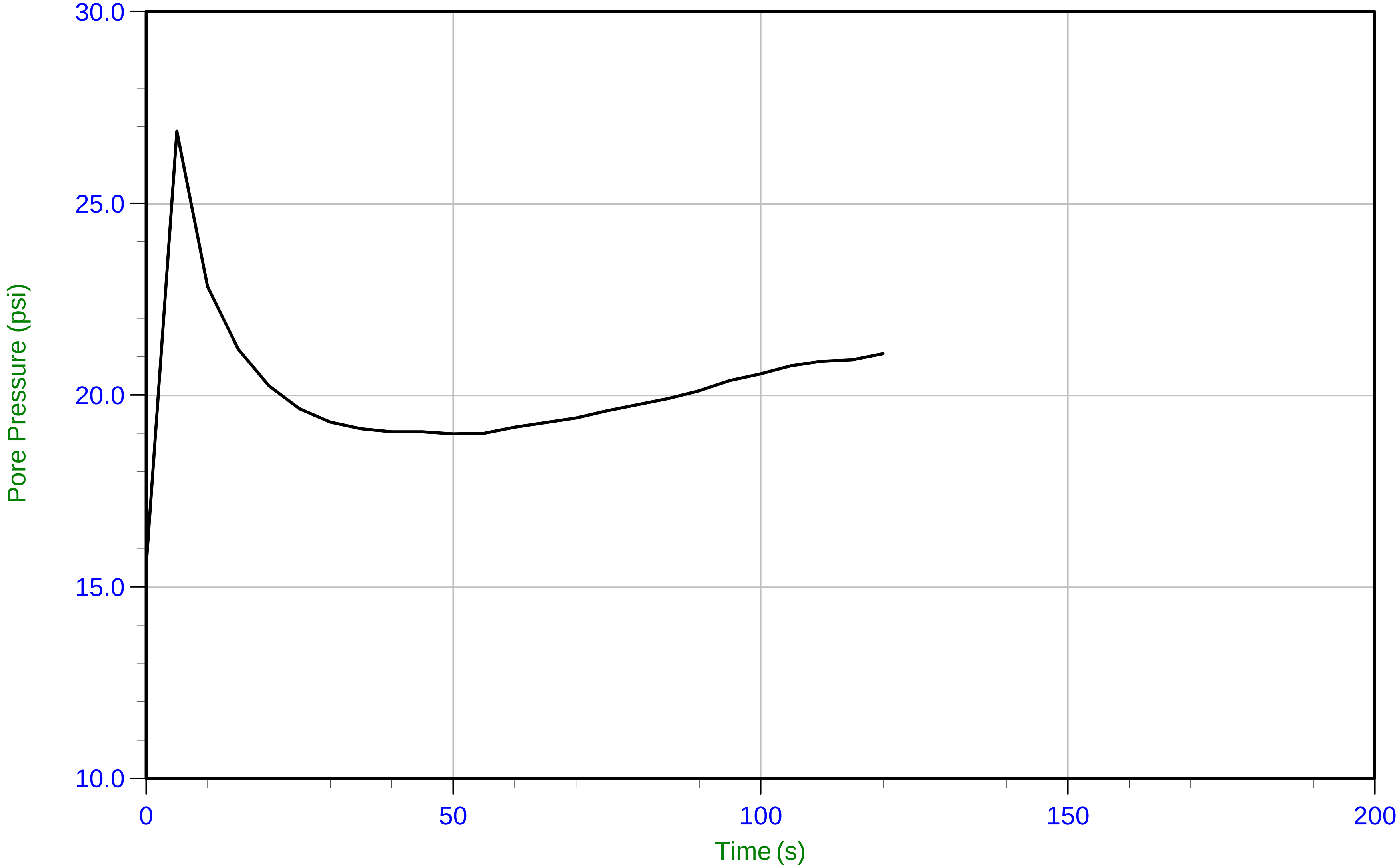
Filename: 16-56021_CP02B.PPF
Depth: 5.850 m / 19.193 ft
Duration: 125.0 s

U Min: 3.2 psi
U Max: 6.8 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 10:47
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



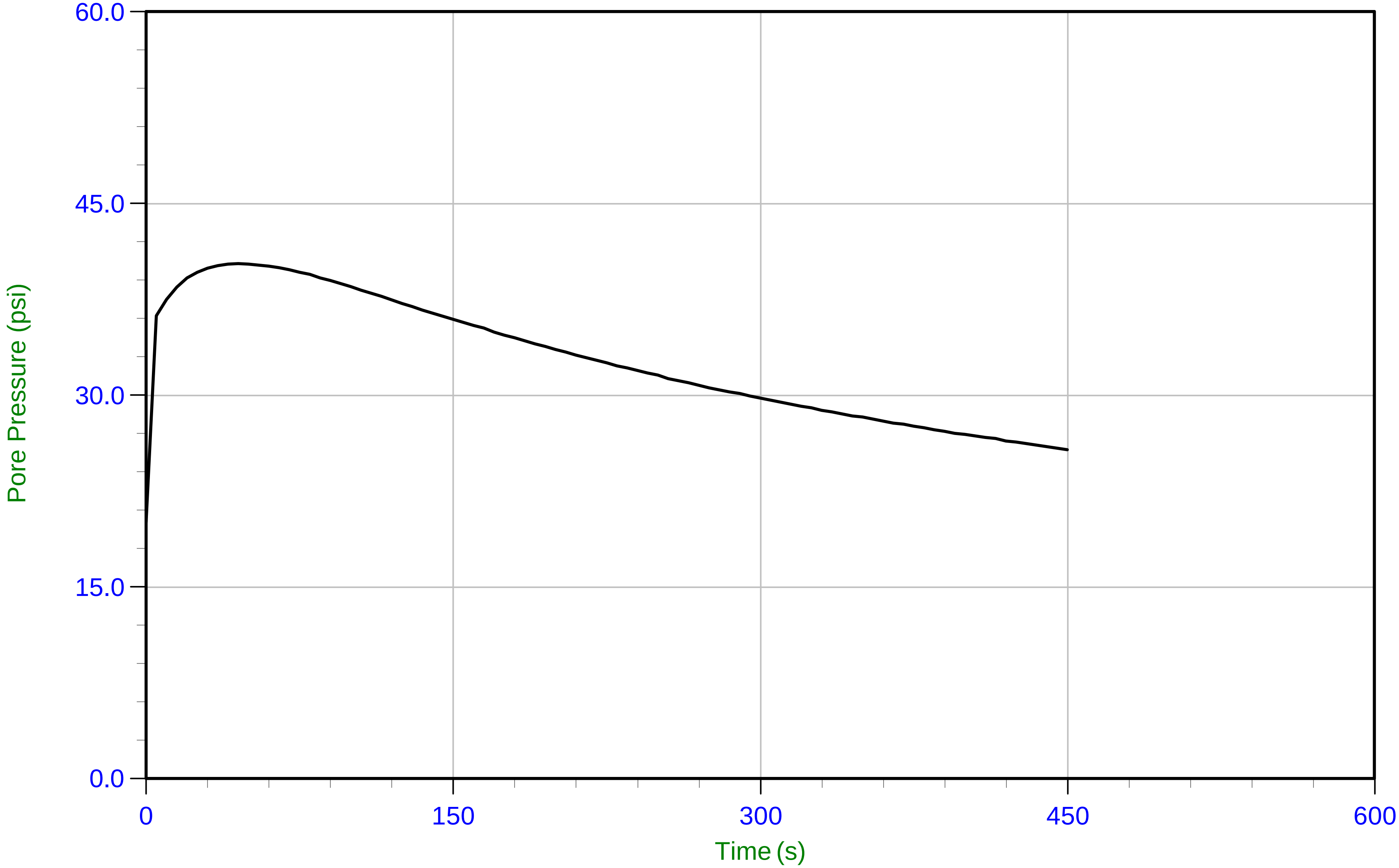
Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 6.850 m / 22.473 ft
Duration: 120.0 s

U Min: 15.5 psi
U Max: 26.9 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 9.850 m / 32.316 ft
Duration: 450.0 s

U Min: 20.1 psi
U Max: 40.3 psi

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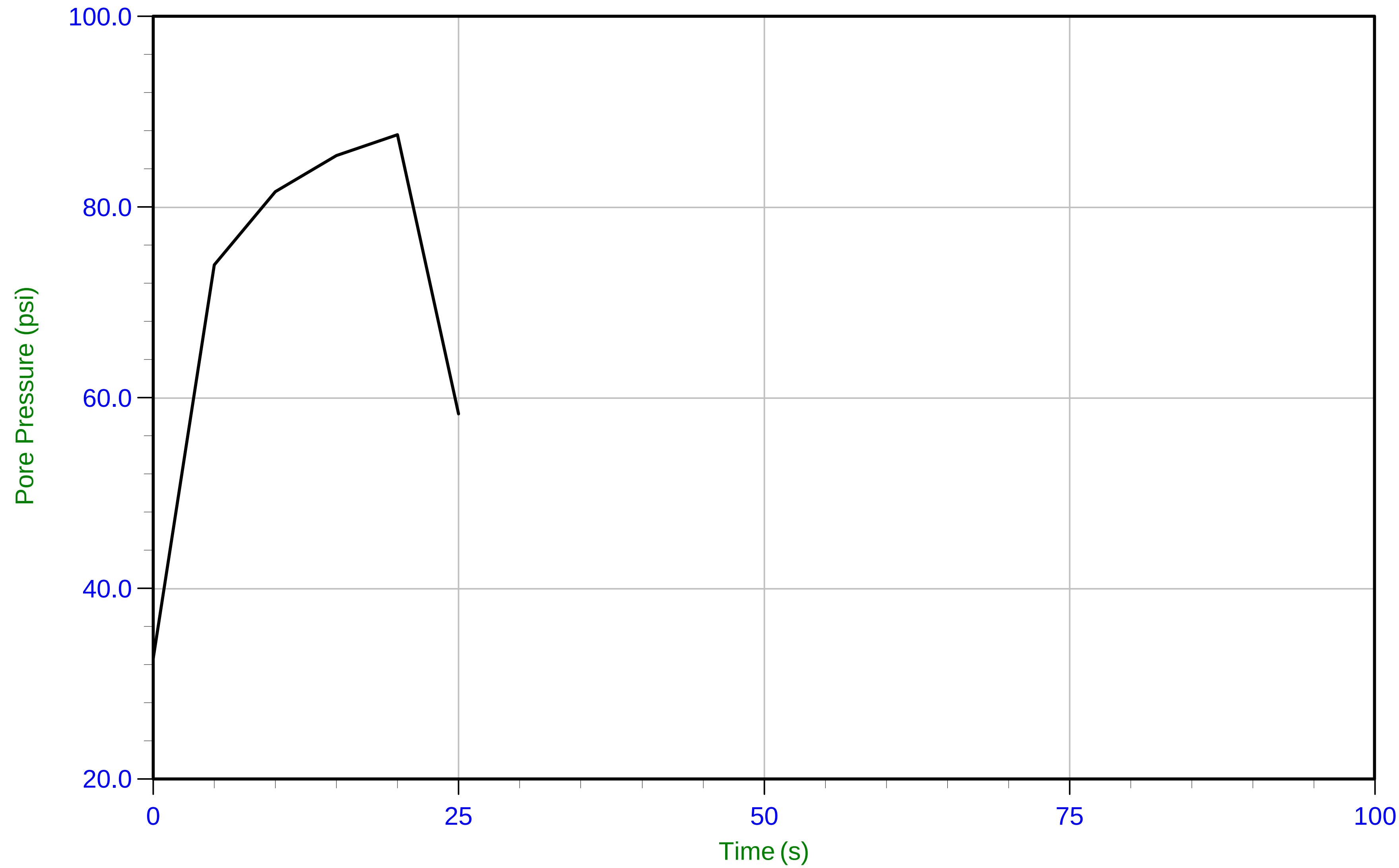
Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



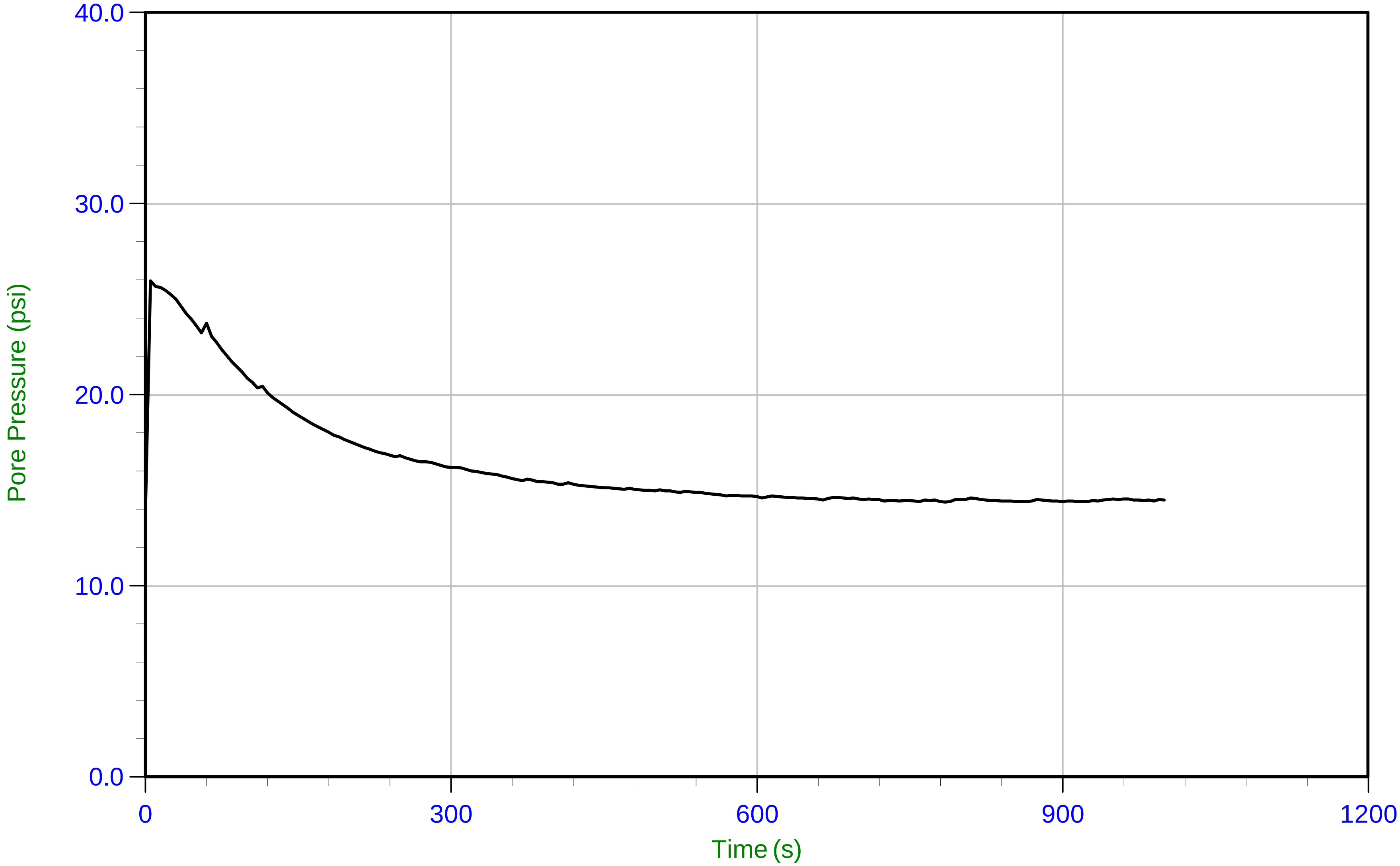
Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 10.850 m / 35.597 ft
Duration: 25.0 s

U Min: 32.7 psi
U Max: 87.6 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

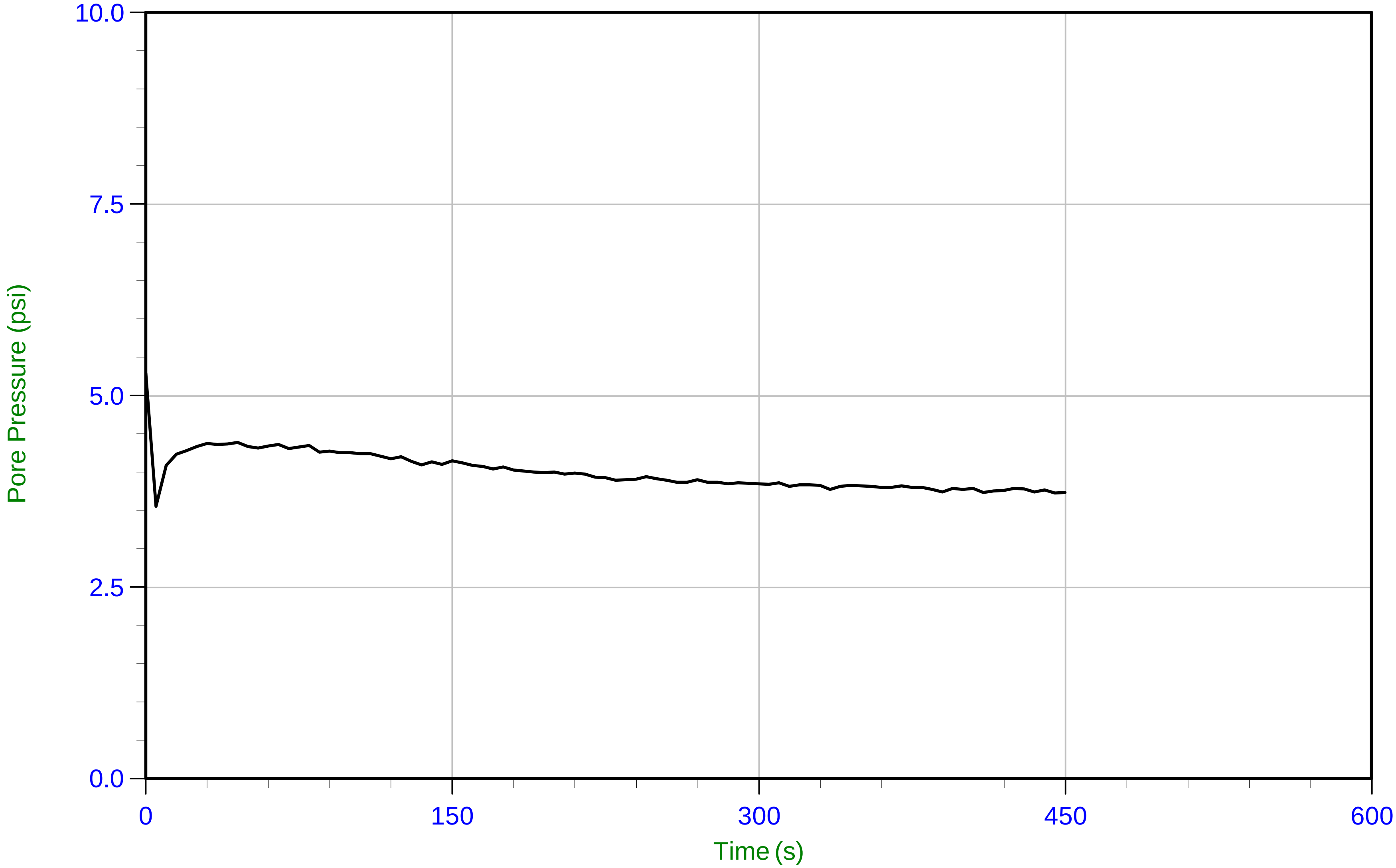
Filename: 16-56021_CP02B.PPF
Depth: 10.900 m / 35.761 ft
Duration: 1000.0 s

U Min: 13.7 psi
U Max: 25.9 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 10:47
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



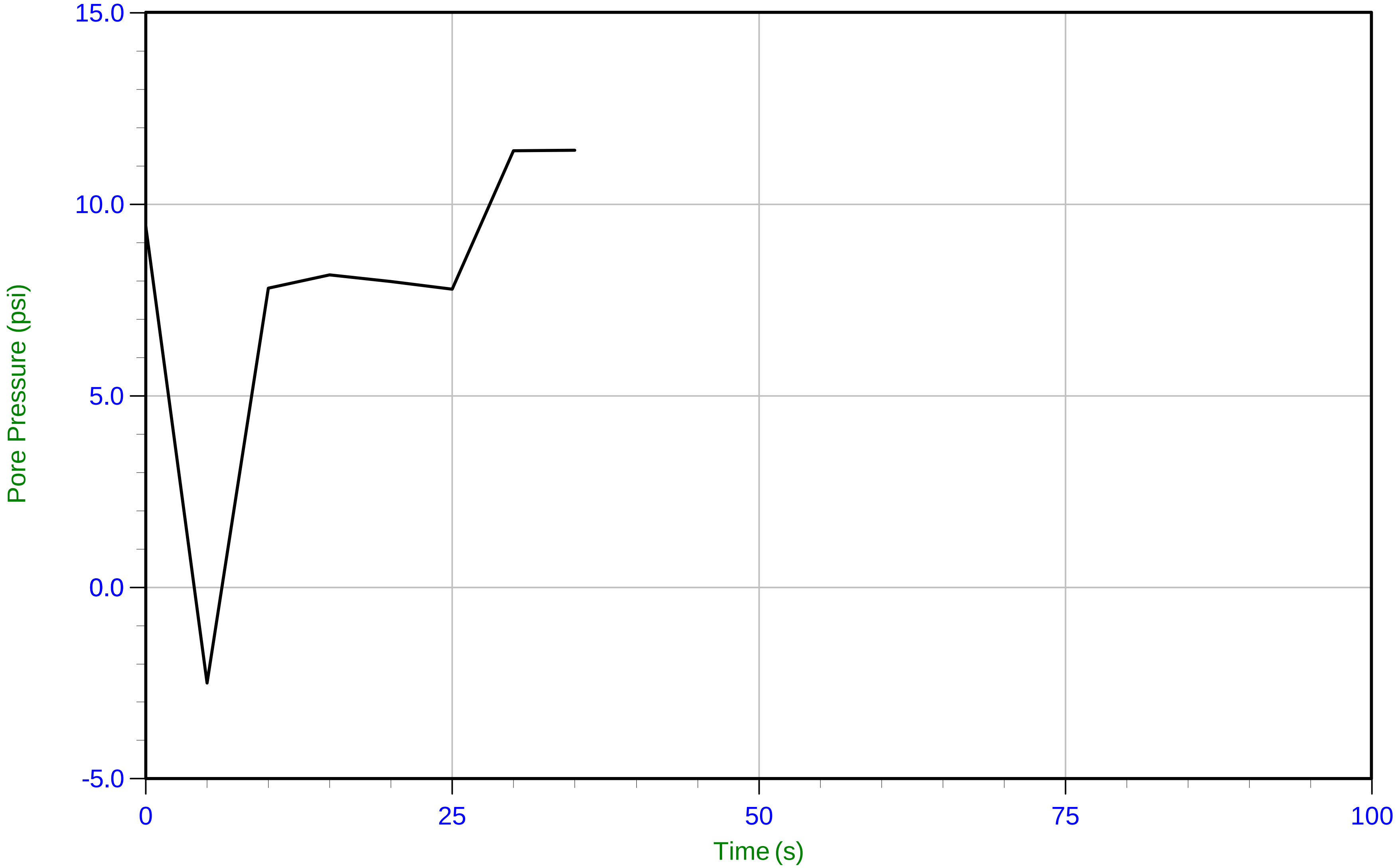
Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 10.950 m / 35.925 ft
Duration: 450.0 s

U Min: 3.6 psi
U Max: 5.3 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

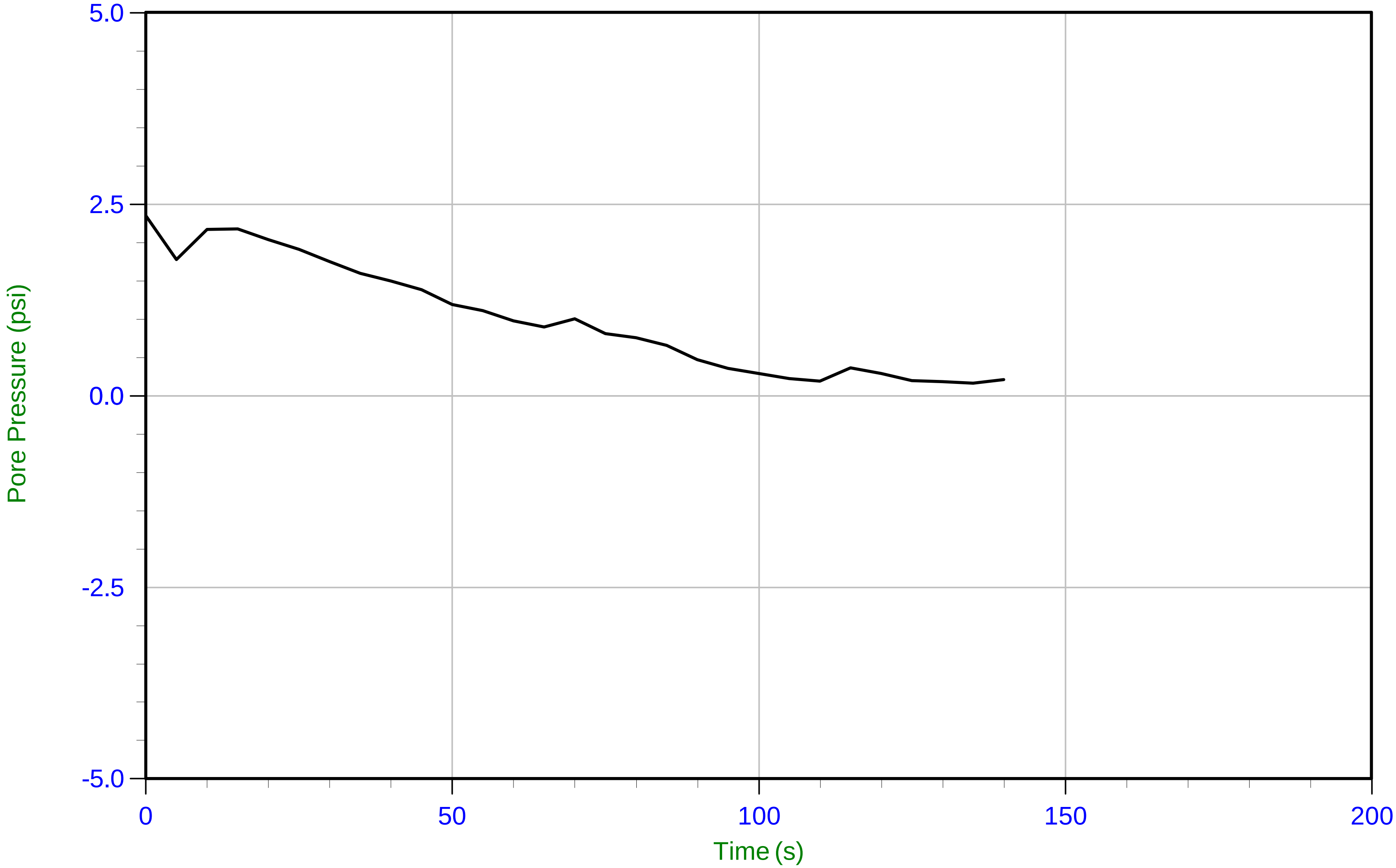


Trace Summary:

Filename: 16-56021_CP02B.PPF	U Min: -2.5 psi
Depth: 11.300 m / 37.073 ft	U Max: 11.4 psi
Duration: 35.0 s	

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



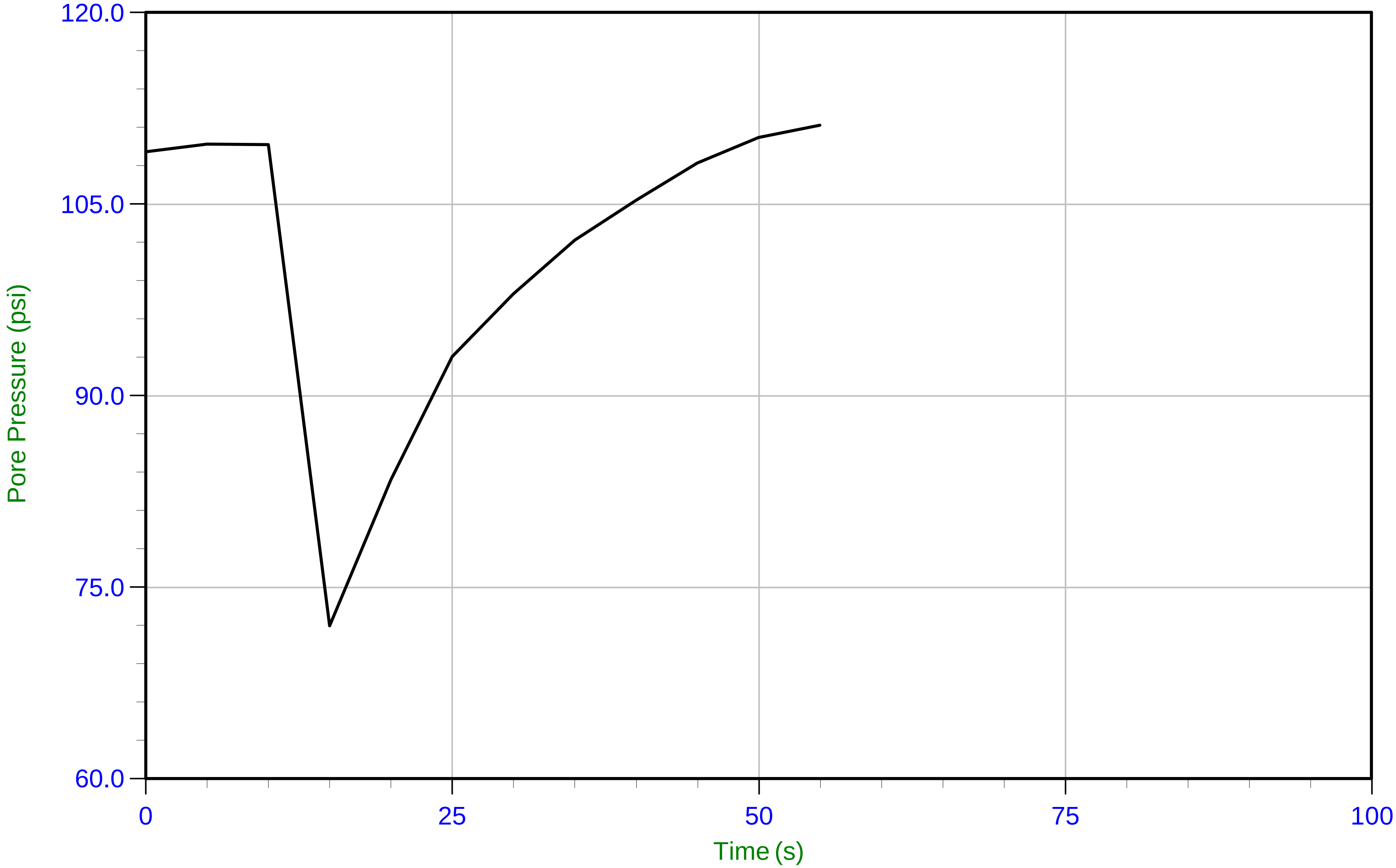
Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 11.850 m / 38.877 ft
Duration: 140.0 s

U Min: 0.2 psi
U Max: 2.3 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm

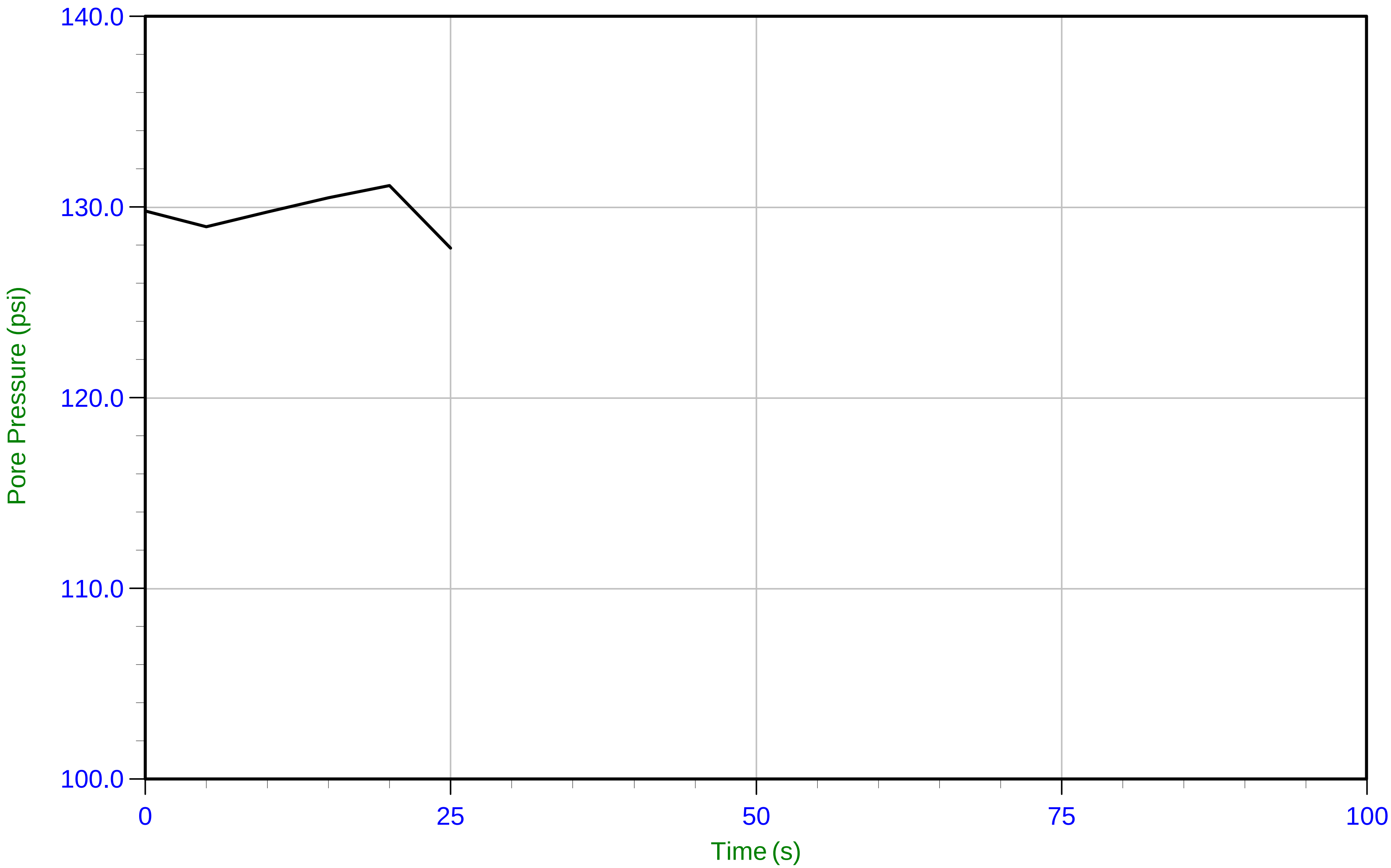


Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 14.750 m / 48.392 ft
Duration: 55.0 s

U Min: 72.0 psi
U Max: 111.2 psi

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



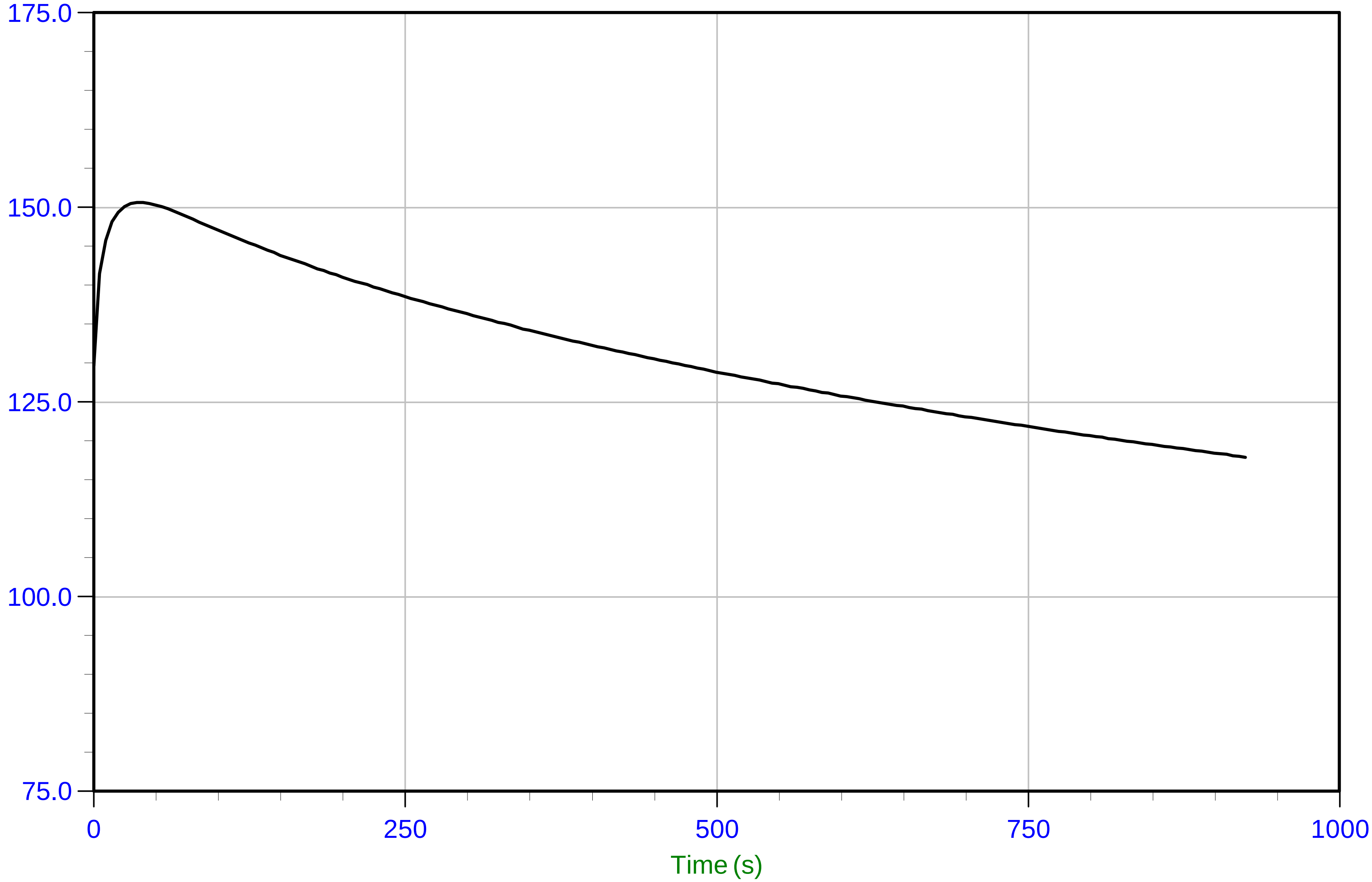
Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 15.750 m / 51.673 ft
Duration: 25.0 s

U Min: 127.9 psi
U Max: 131.1 psi

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Terraphase	Job No: 16-56021	Sounding: CPT-02B
	Date: 04/26/2016 10:47	Cone: 391:T1500F15U500
	Site: Moss Landing Pick-n-Pull	Cone Area: 15 sq cm



Trace Summary:

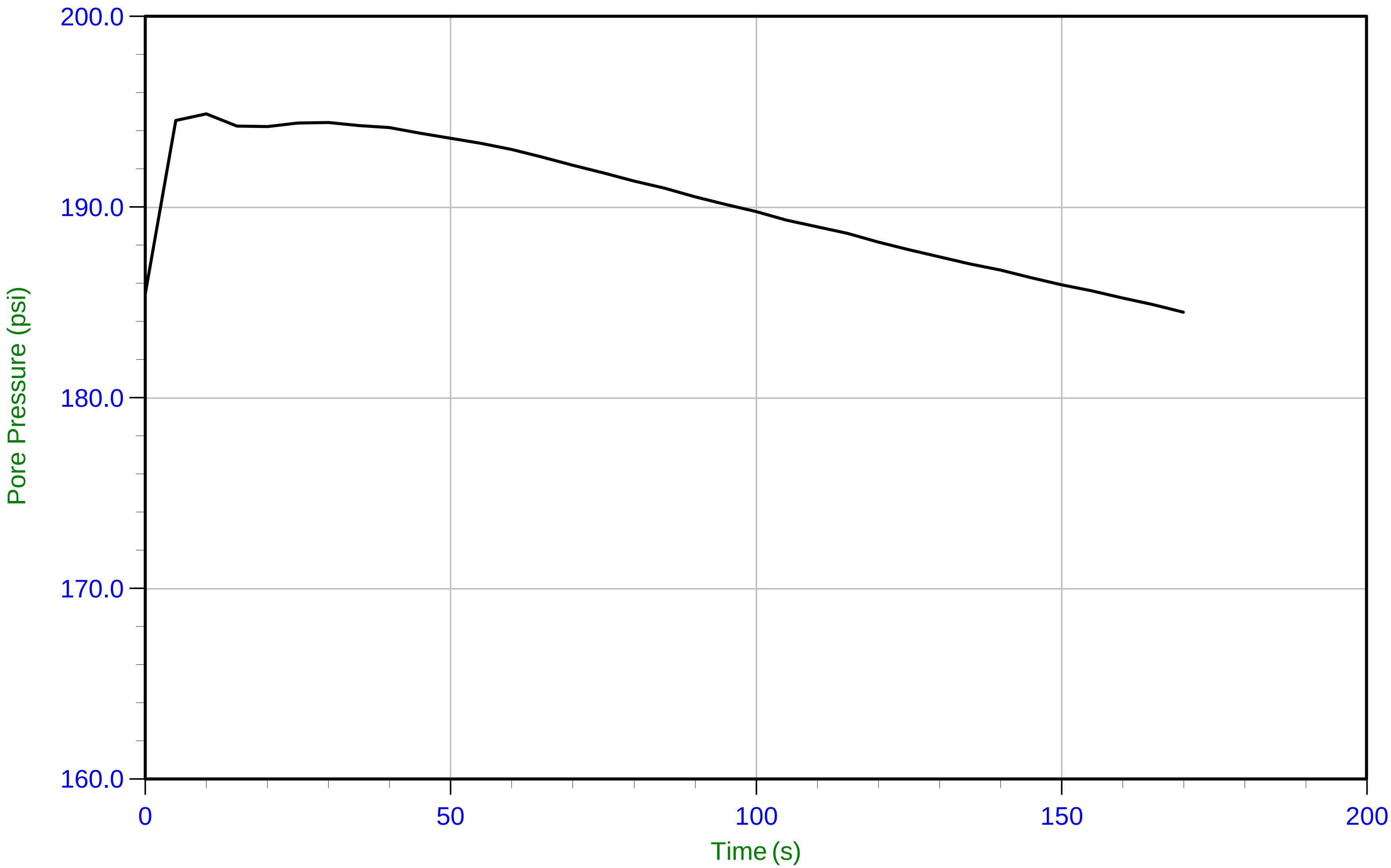
Filename: 16-56021_CP02B.PPF
Depth: 17.850 m / 58.562 ft
Duration: 925.0 s

U Min: 117.9 psi
U Max: 150.7 psi

Terraphase

Job No: 16-56021
Date: 04/26/2016 10:47
Site: Moss Landing Pick-n-Pull

Sounding: CPT-02B
Cone: 391:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-56021_CP02B.PPF
Depth: 21.450 m / 70.373 ft
Duration: 170.0 s

U Min: 184.5 psi
U Max: 194.9 psi

APPENDIX B

Percolation Test Logs

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Falling Head Percolation Field Log

Test ID:	1A
Date:	4/26/16
Measured Diameter:	6 inches
Gravel Thickness:	2 inches

Project Number:	0055.004.001
Site Location:	Moss Landing CA
Monitored Soaking Period:	2hr13min/1hr51min hours
Start Time for Soaking Period:	Date 4/26/16 Time 1410/1435

Measured By:	Chris J.
Weather:	Partly Cloudy
Testing Interval:	1.5 hours
Time Elapsed Since Soaking Period Began:	2hr13min/1hr51min hours

Start Soaking @ 1410

Test Number:	1	
Measured Depth:	36	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1623	30	28	28 1/16	1/16	0.125 in/hr
1653	60	28	28 1/16	1/16	0.0625 in/hr
1723	90	28	28 3/32	3/32	0.0625 in/hr

Test Number:		
Measured Depth:		inches bgs
Depth to top of 12 inches of water (as measured from perc test device):		inches bgs
Depth to top of 8 inches of water (as measured from perc test device):		inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1624	30	28	28	0	–
1654	60	28	28	0	–
1724	90	28	28 1/16	1/16	
			0.042 in/hr		

Test Number:		
Measured Depth:		inches bgs
Depth to top of 12 inches of water (as measured from perc test device):		inches bgs
Depth to top of 8 inches of water (as measured from perc test device):		inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate

Stability parameter:	If clay soils are present then the test is run with 30min intervals until there are two constant percolation rates (minimum of three intervals). If sandy soils are present or 6in of water seeps away in less than 30min then the test is run with 10min intervals for a 1hr period and the last water level drop is used to calculate the percolation rate.

Average Percolation Rate:		in/min	-->	0.052	in/hr

Notes:

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Falling Head Percolation Field Log

Page______ of ______

Test ID:	2A
Date:	4/26/16
Measured Diameter:	6 inches
Gravel Thickness:	2 inches

Project Number:	0055.004.001
Site Location:	Moss Landing CA
Monitored Soaking Period:	3hr 22min hours
Start Time for Soaking Period:	Date 4/26/16 Time 1255

Measured By:	Chris J.
Weather:	Partly Cloudy
Testing Interval:	0.5 hours
Time Elapsed Since Soaking Period Began:	3hr 22min hours

Test Number:	1
Measured Depth:	36 inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24 inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28 inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1618	30	28	28 14/16	14/16	1.75 in/hr
1650	30	28	29 -	1	2.0 in/hr
1723	30	28	28 14/16	14/16	1.75 in/hr

Test Number:	2
Measured Depth:	36 inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24 inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28 inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1617	30	28	29 1/2	1 1/2	3.0 in/hr
1648	30	28	29 12/16	1 12/16	3.5 in/hr
1722	30	28	29 1/2	1 1/2	3.0 in/hr

Test Number:	
Measured Depth:	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate

Stability parameter:	If clay soils are present then the test is run with 30min intervals until there are two constant percolation rates (minimum of three intervals). If sandy soils are present or 6in of water seeps away in less than 30min then the test is run with 10min intervals for a 1hr period and the last water level drop is used to calculate the percolation rate.

Average Percolation Rate: ______ in/min --> 2.375 in/hr

Notes:

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Falling Head Percolation Field Log

Test ID:	1B
Date:	4/26/16

Measured Diameter:	6	inches
Gravel Thickness:	2	inches

Project Number:	0055.004.001
Site Location:	Moss Landing CA

Monitored Soaking Period:	4	hours
Start Time for Soaking Period:	Date 4/26/16	Time 1110

Measured By:	Chris J
Weather:	Partly Cloudy

Testing Interval:	180	~~hours~~ min
Time Elapsed Since Soaking Period Began:	4	hours

Test Number:	1	
Measured Depth:	36	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1510	30	28	28	0	–
1540	60	28	28	0	–
1610	90	28	28	0	–
1640	120	28	28	0	–
1710	150	28	28 1/16	1/16	0.025 in/hr
1740	180	28	28 1/16	1/16	0.021 in/hr

Test Number:	2	
Measured Depth:	36	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1511	30	28	~~28~~ 28	0	–
1541	60	28	28	0	–
1611	90	28	28	0	–
1641	120	28	28	0	–
1711	150	28	28 1/16	1/16	0.025 in/hr
1741	180	28	28 1/16	1/16	0.021 in/hr

Test Number:		
Measured Depth:		inches bgs
Depth to top of 12 inches of water (as measured from perc test device):		inches bgs
Depth to top of 8 inches of water (as measured from perc test device):		inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate

Stability parameter:	If clay soils are present then the test is run with 30min intervals until there are two constant percolation rates (minimum of three intervals). If sandy soils are present or 6in of water seeps away in less than 30min then the test is run with 10min intervals for a 1hr period and the last water level drop is used to calculate the percolation rate.

Average Percolation Rate: ______ in/min --> 0.021 in/hr

Notes:

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Falling Head Percolation Field Log

Test ID:	2B
Date:	4/26/16
Measured Diameter:	6 inches
Gravel Thickness:	2 inches

Project Number:	0055.004.001
Site Location:	Moss Landing CA
Monitored Soaking Period:	4 hours
Start Time for Soaking Period:	Date 4/26/16 Time 1128

Measured By:	Chris J.
Weather:	Partly Cloudy
Testing Interval:	0.5 hours
Time Elapsed Since Soaking Period Began:	4 hours

Test Number:	1	
Measured Depth:	36	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1529	30	28	28 3/16	3/16	0.375 in/hr
1601	30	28	28 3/16	3/16	0.375 in/hr
1633	30	28	28 3/16	3/16	0.375 in/hr

Test Number:	2	
Measured Depth:	36	inches bgs
Depth to top of 12 inches of water (as measured from perc test device):	24	inches bgs
Depth to top of 8 inches of water (as measured from perc test device):	28	inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate
1529	30	28	28 2/16	2/16	0.25 in/hr
1400	30	28	28 1/16	1/16	0.125 in/hr
1633	30	28	28 1/16	1/16	0.125 in/hr

Test Number:		
Measured Depth:		inches bgs
Depth to top of 12 inches of water (as measured from perc test device):		inches bgs
Depth to top of 8 inches of water (as measured from perc test device):		inches bgs

Time	Interval	Initial depth to water	Final Depth to Water	Change in Water Level	Percolation Rate

Stability parameter:	If clay soils are present then the test is run with 30min intervals until there are two constant percolation rates (minimum of three intervals). If sandy soils are present or 6in of water seeps away in less than 30min then the test is run with 10min intervals for a 1hr period and the last water level drop is used to calculate the percolation rate.

Average Percolation Rate: ______ in/min --> 0.25 in/hr

Notes:

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APPENDIX C

USGS Seismic Design Map Output

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Design Maps Detailed Report

ASCE 7-10 Standard (36.8046°N, 121.7502°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1]	S_S = 1.500 g
From Figure 22-2 [2]	S_1 = 0.600 g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content $w \geq$ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient F_a

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.500 g, F_a = 1.000

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.600 g, F_v = 1.500

Equation (11.4–1): $S_{MS} = F_a S_S = 1.000 \times 1.500 = 1.500$ g

Equation (11.4–2): $S_{M1} = F_v S_1 = 1.500 \times 0.600 = 0.900$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

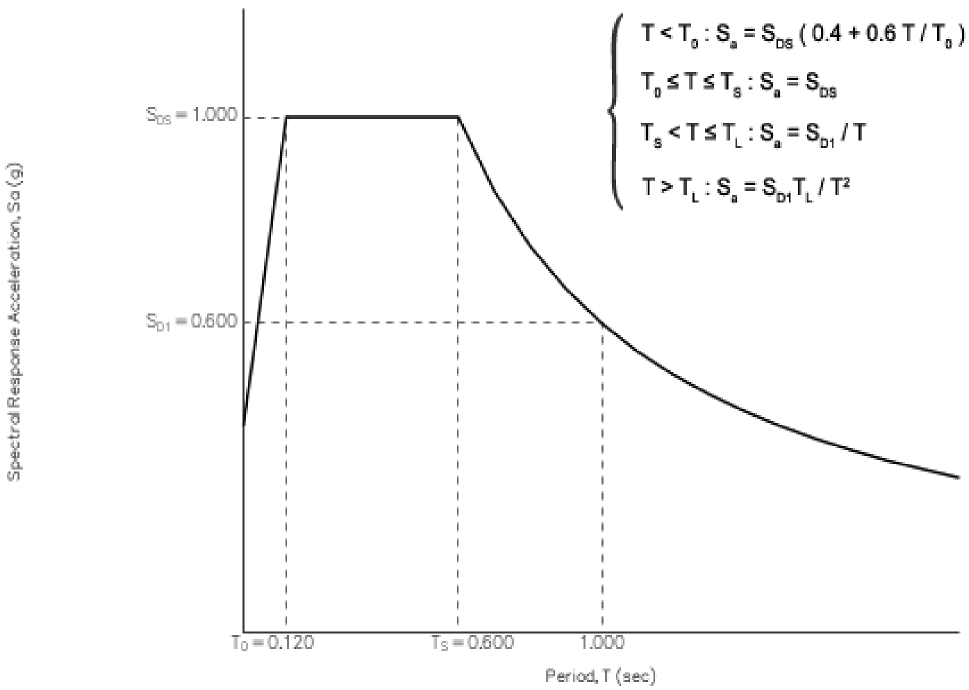
Equation (11.4–3): $S_{DS} = ⅔ S_{MS} = ⅔ \times 1.500 = 1.000$ g

Equation (11.4–4): $S_{D1} = ⅔ S_{M1} = ⅔ \times 0.900 = 0.600$ g

Section 11.4.5 — Design Response Spectrum

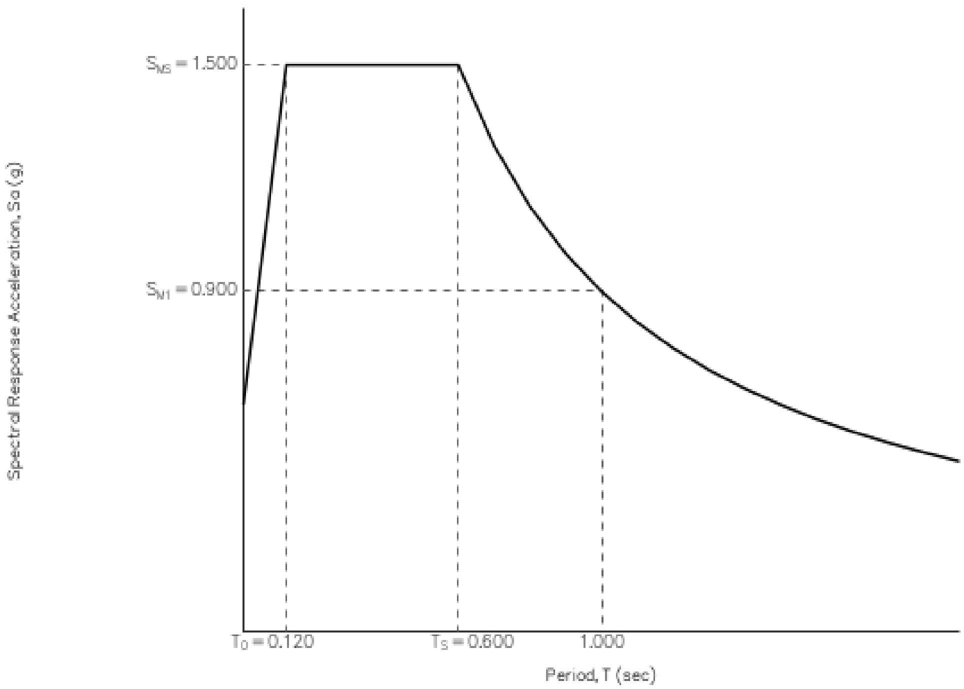
From Figure 22-12 [3] $T_L = 12$ seconds

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.500

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.500 = 0.5$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.500 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 1.048

From Figure 22-18 [6] C_{R1} = 0.981

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.000 g, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.600 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ “the more severe design category in accordance with Table 11.6-1 or 11.6-2” = D

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

APPENDIX D

C-Liq Output

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T A B L E   O F   C O N T E N T S

Terraphase Engineering Inc.
1404 Franklin Street, Sixth Floor
Oakland, California 94612
www.terraphase.com

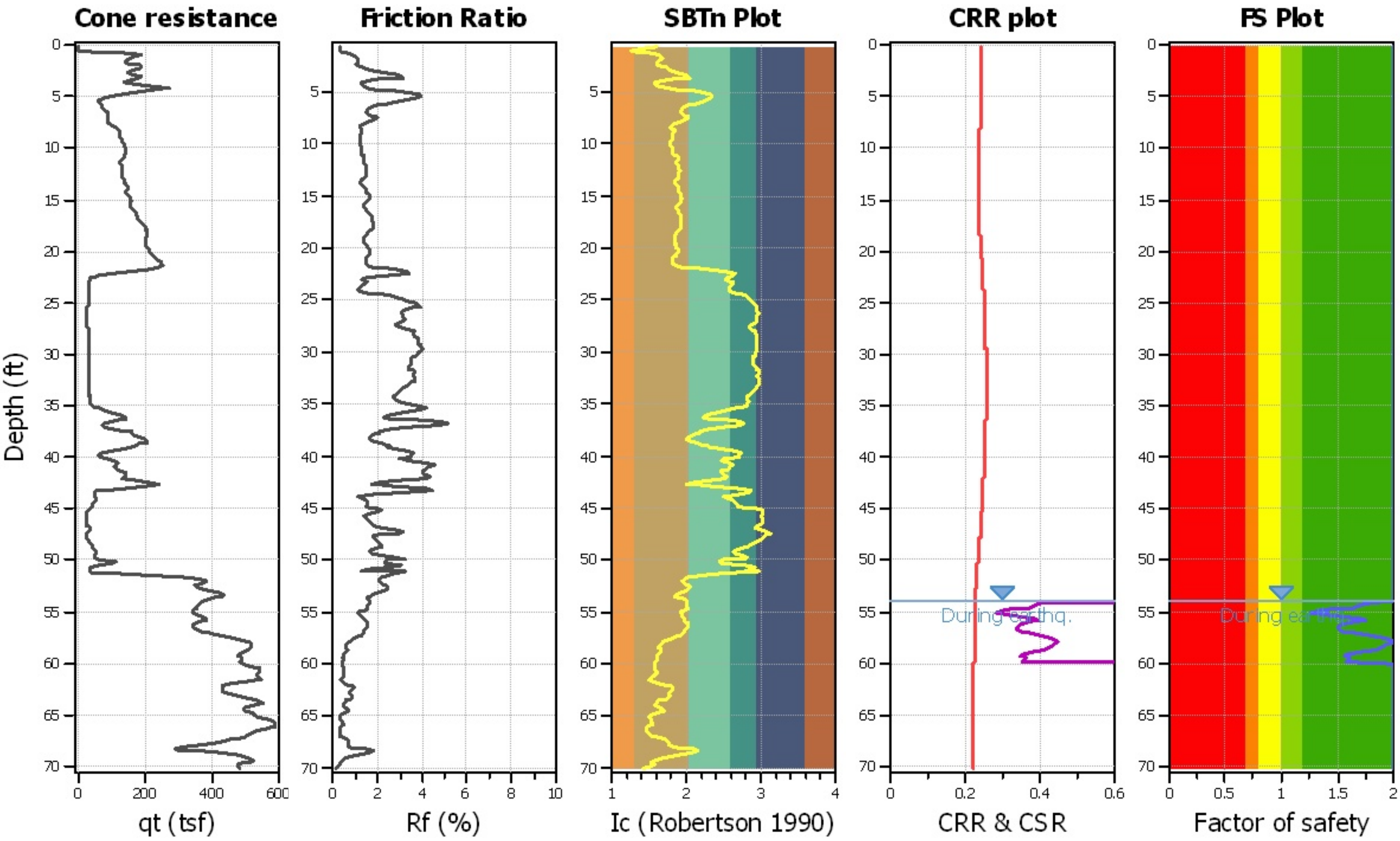
LIQUEFACTION ANALYSIS REPORT

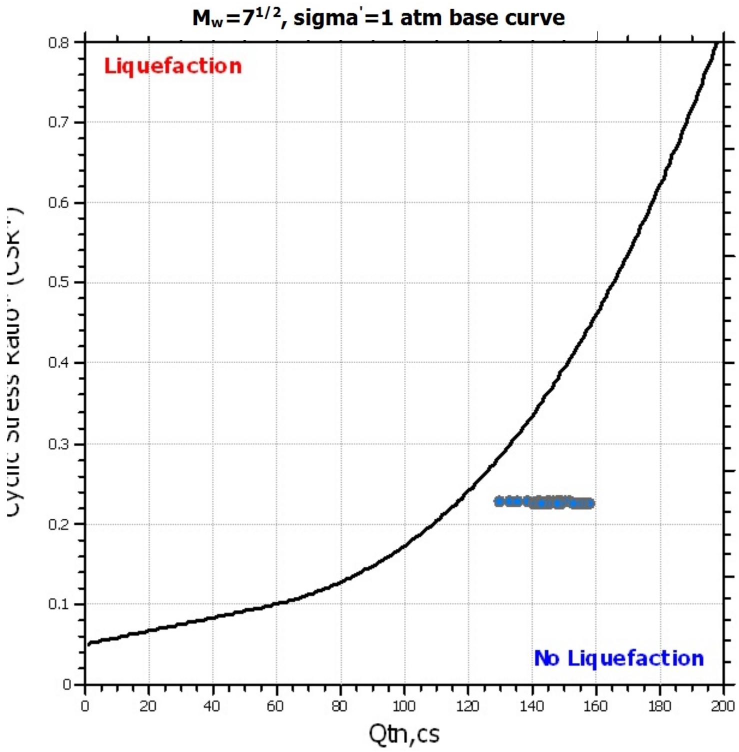
Project title : Moss Landing **Location : Monterey County, California**

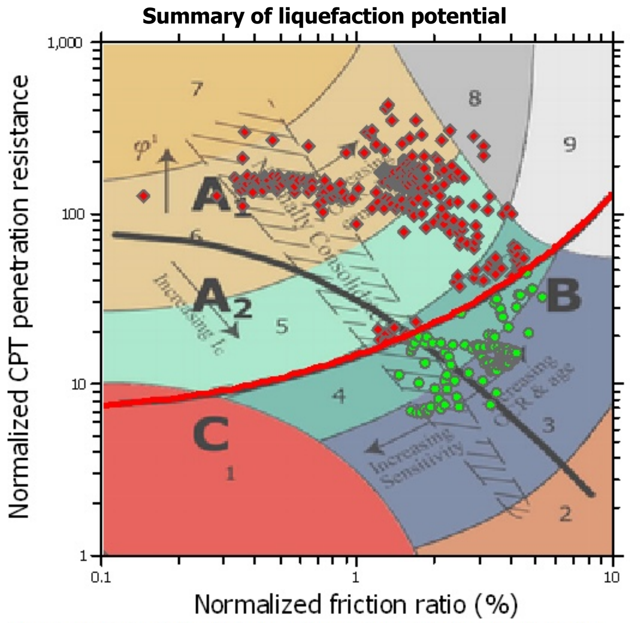
CPT file : CPT-2A

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	47.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	54.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.50	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

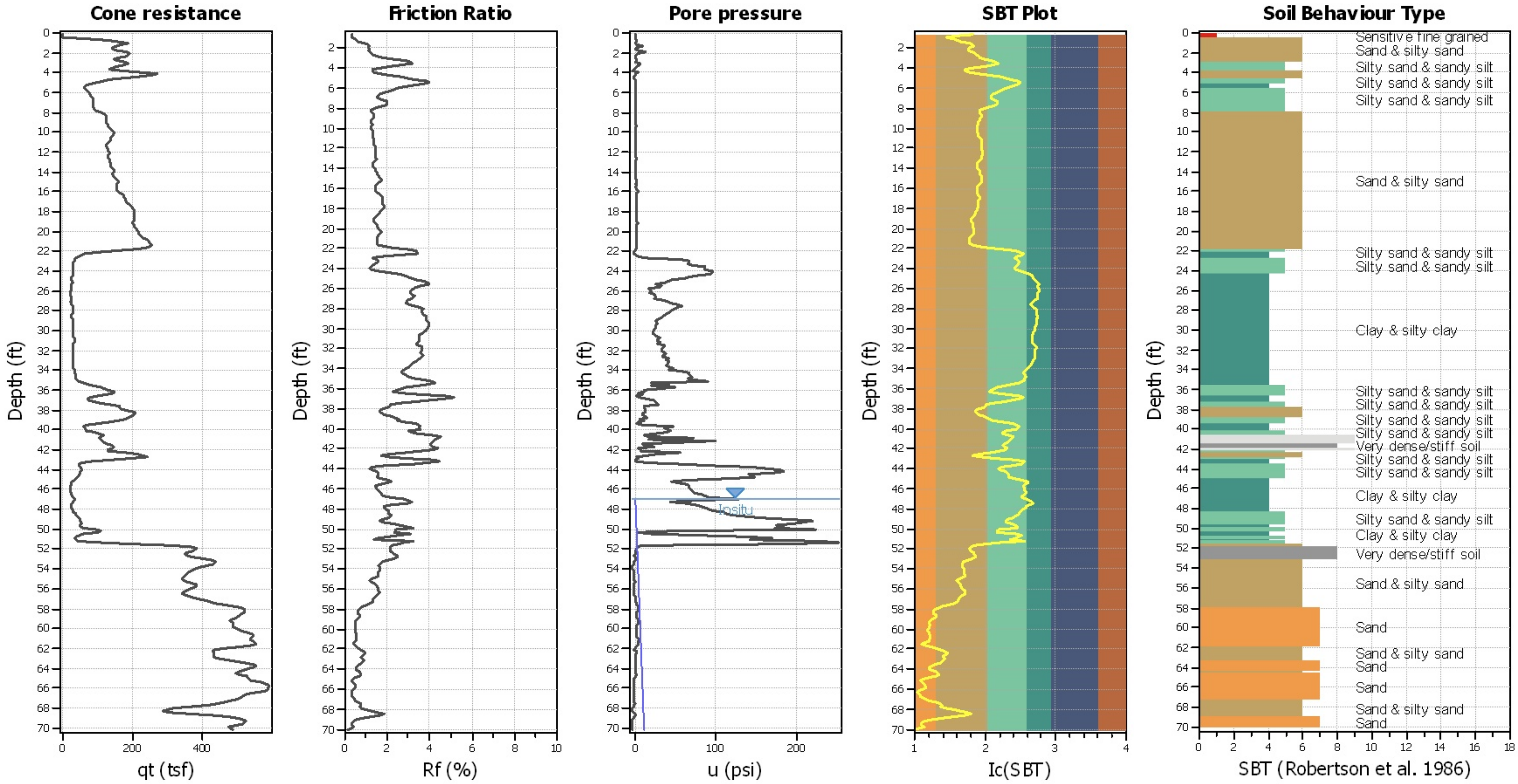






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plo



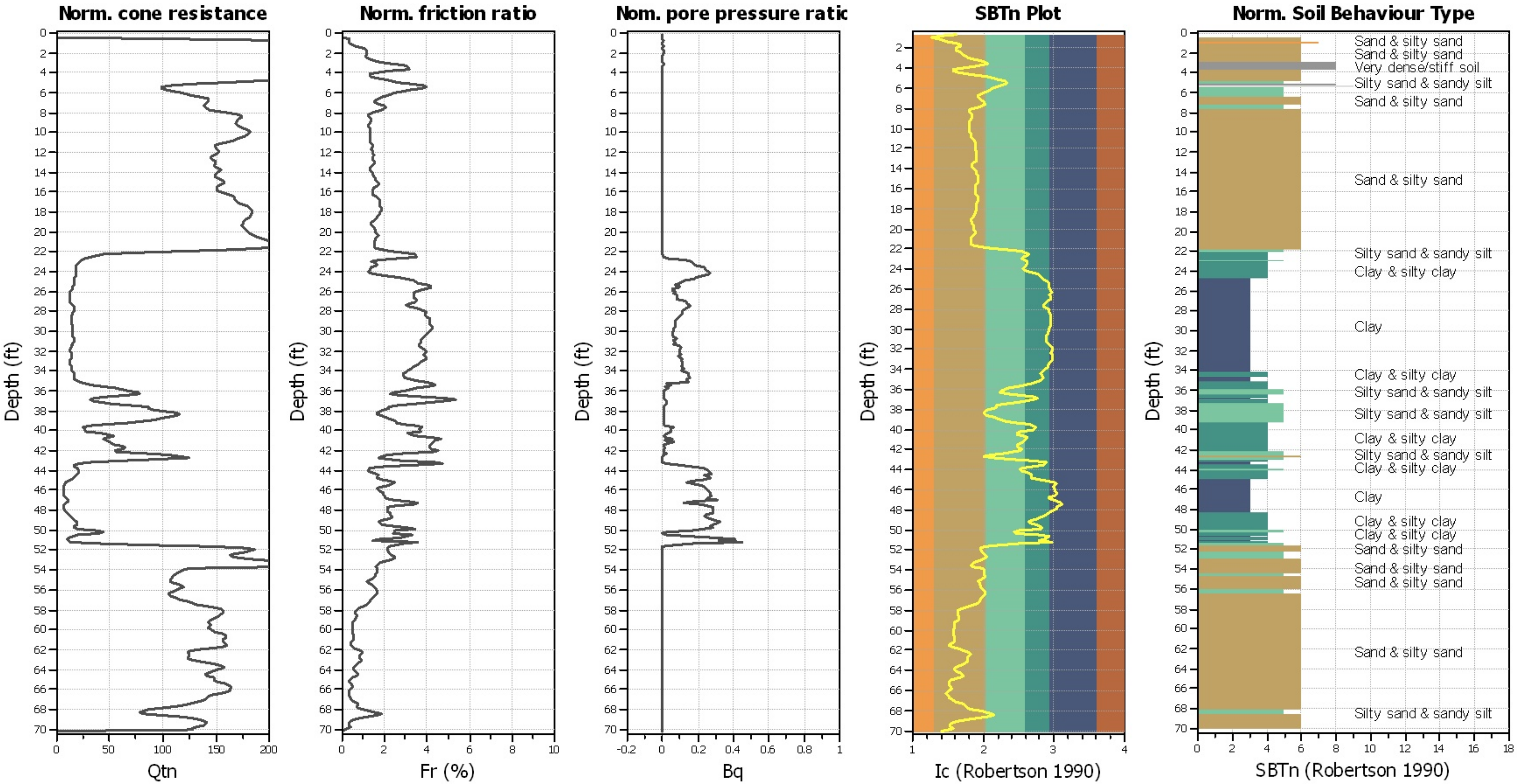
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normaliz



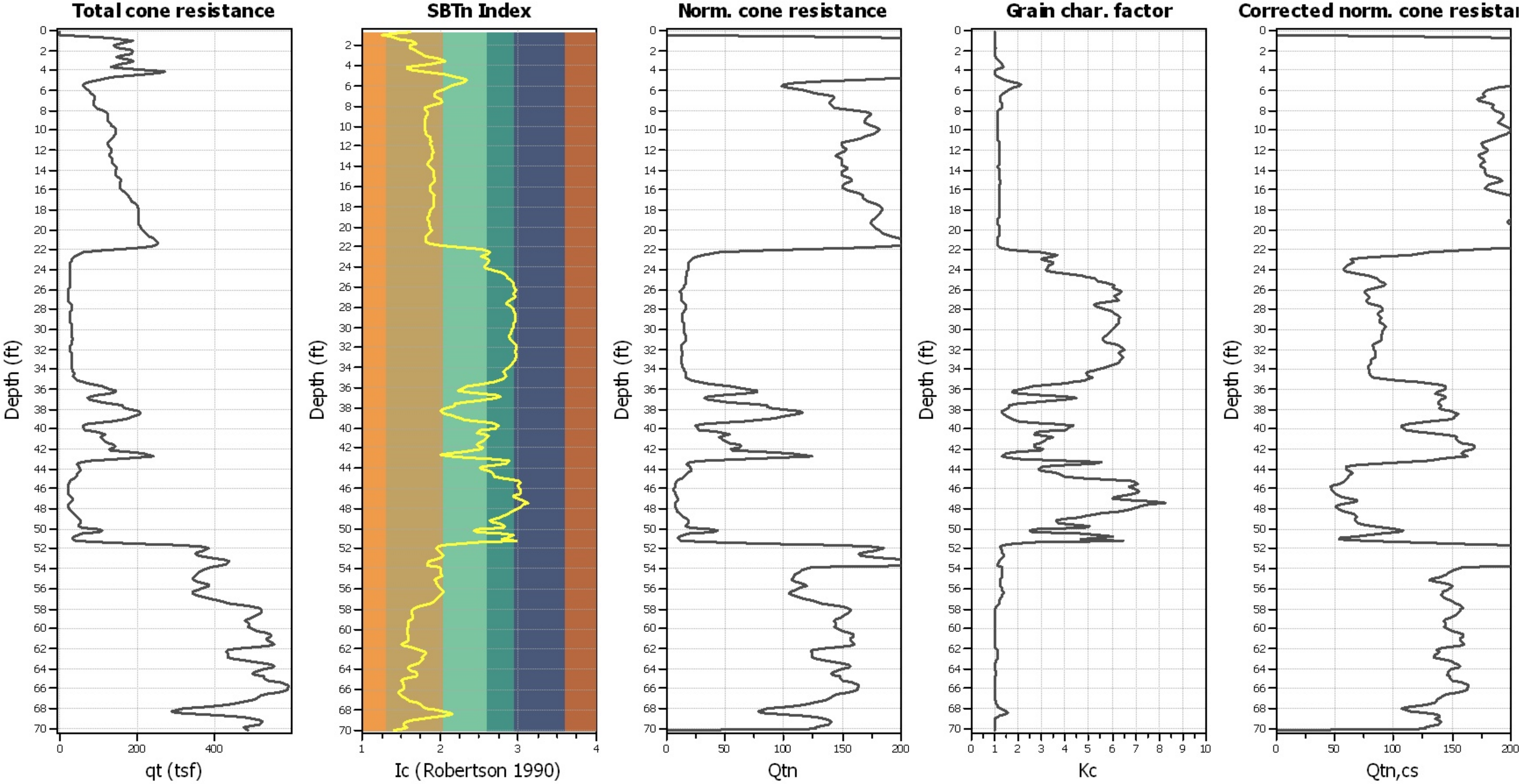
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBTn legend

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

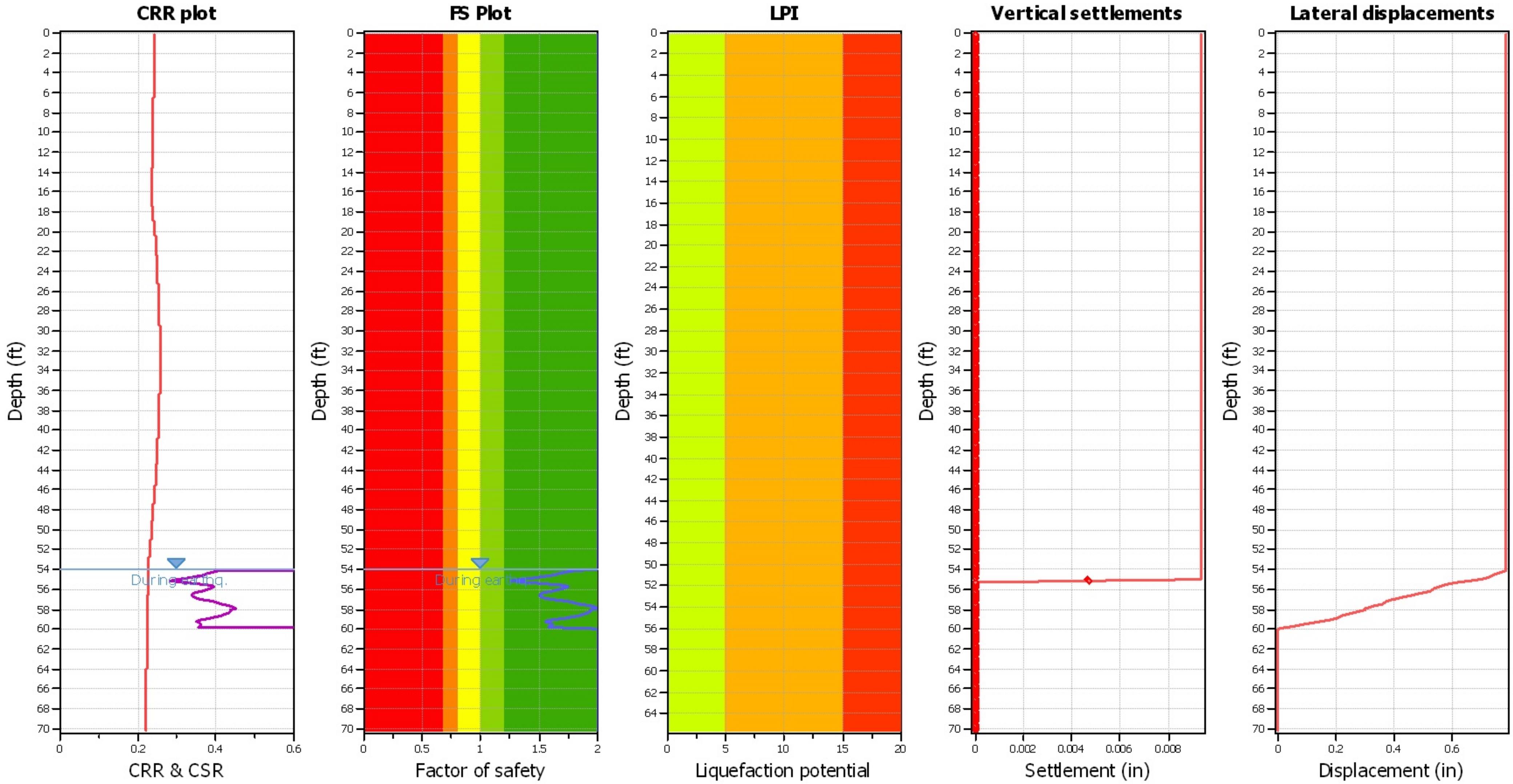
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

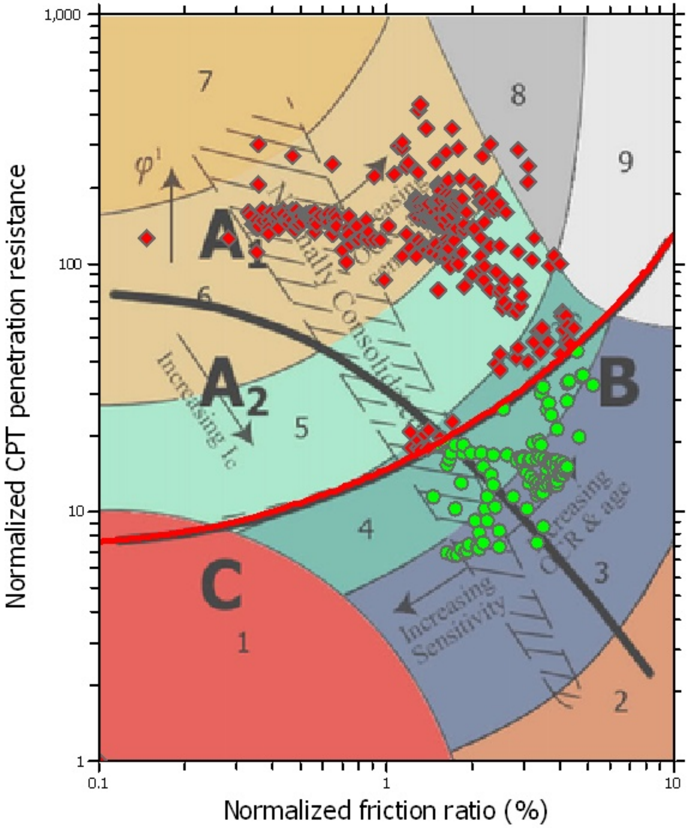
F.S. color scheme

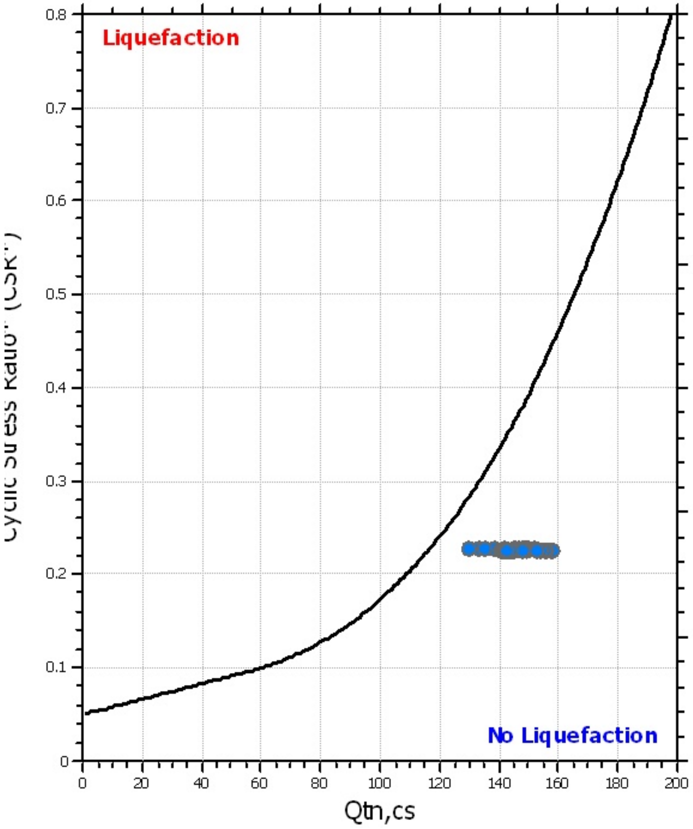
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

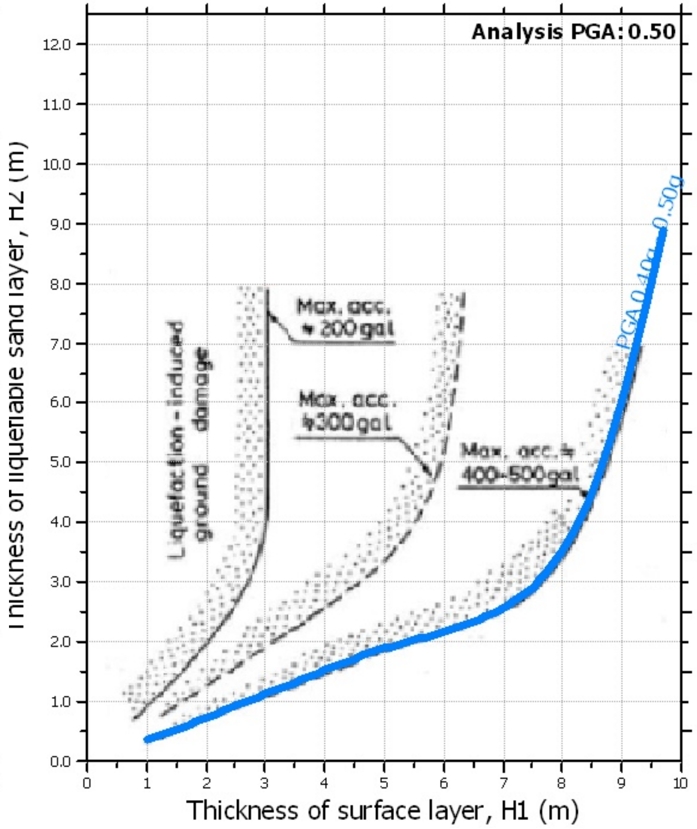
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plo



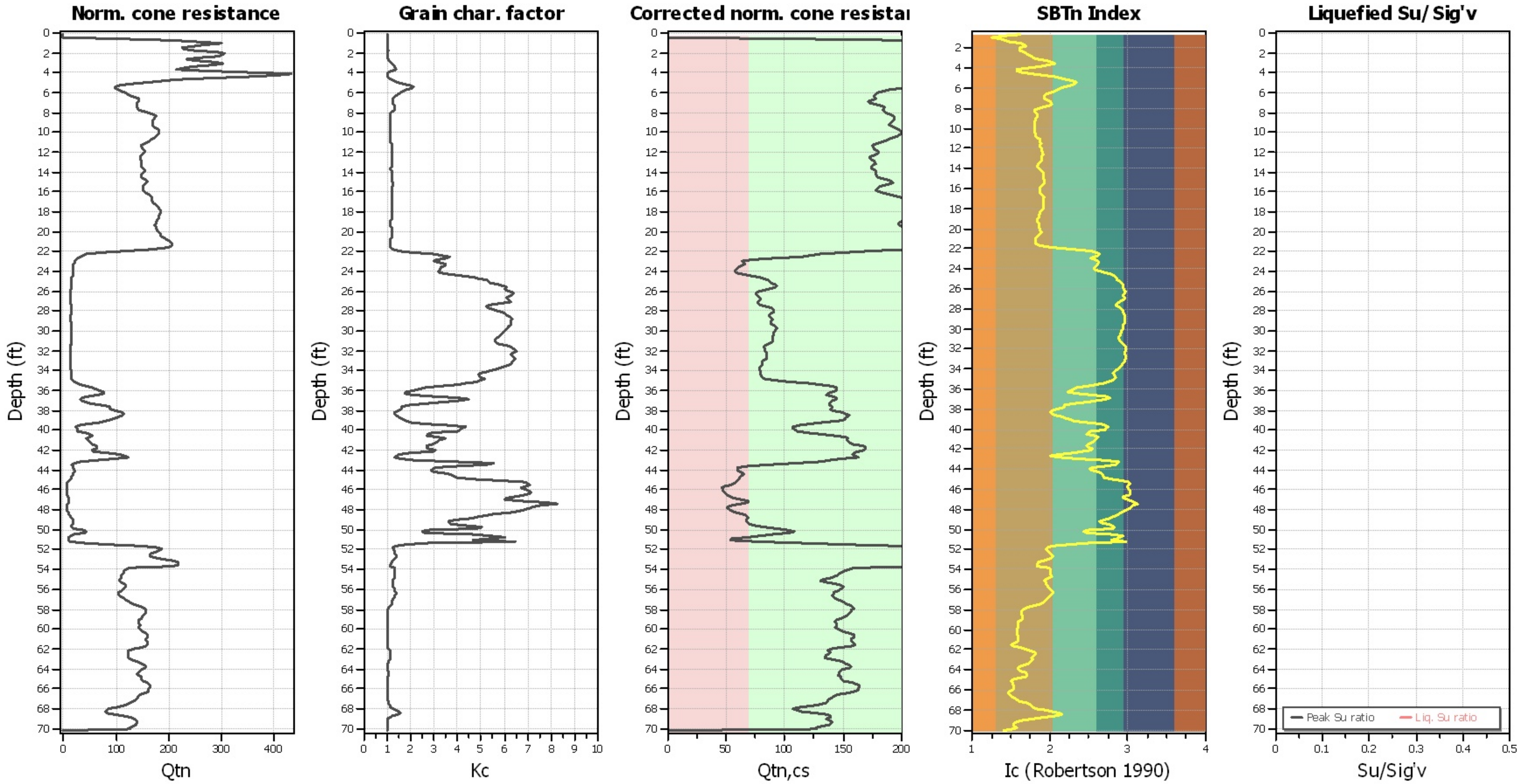




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	54.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_W:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	47.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

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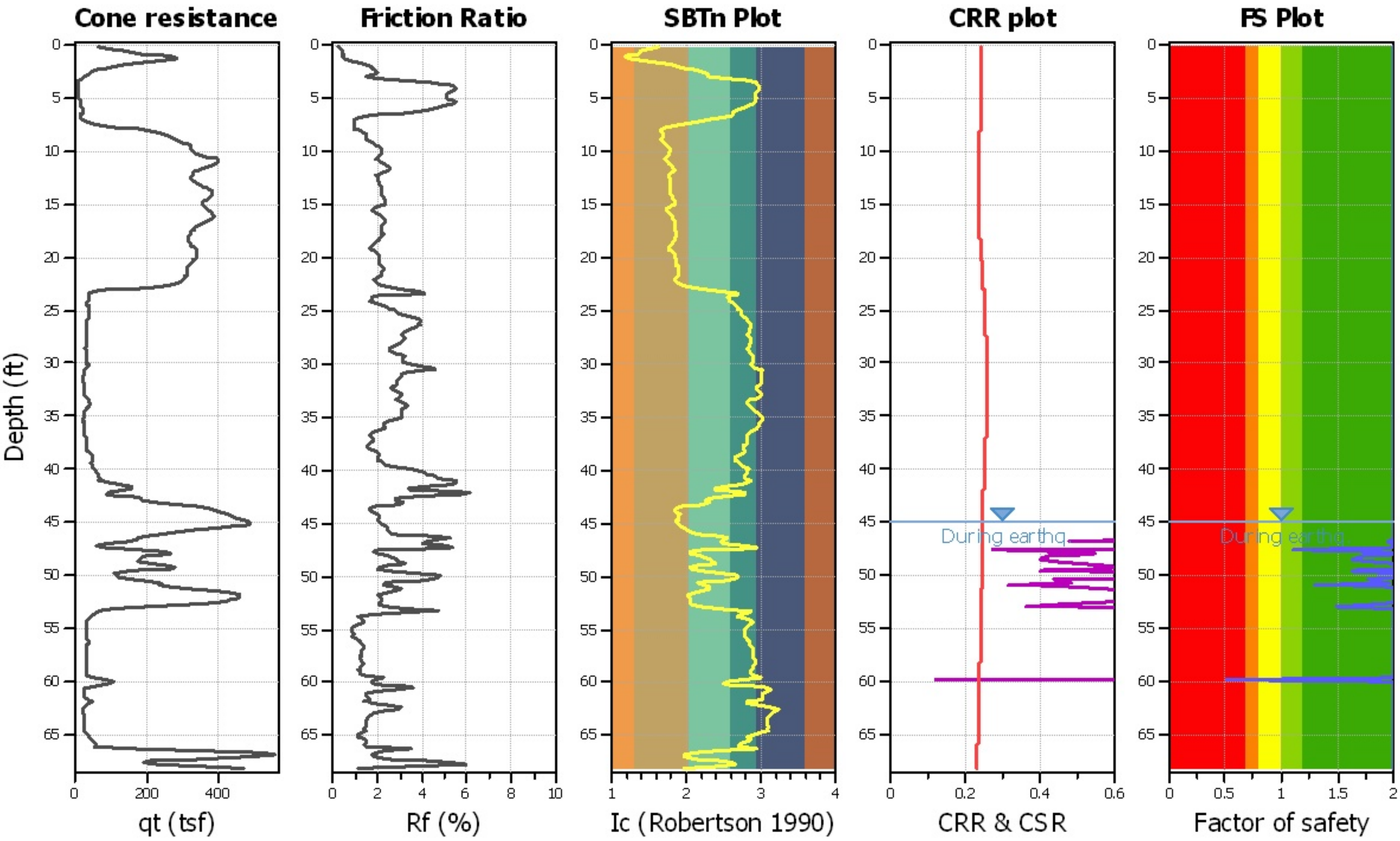
LIQUEFACTION ANALYSIS REPORT

Project title : Moss Landing **Location : Monterey County, California**

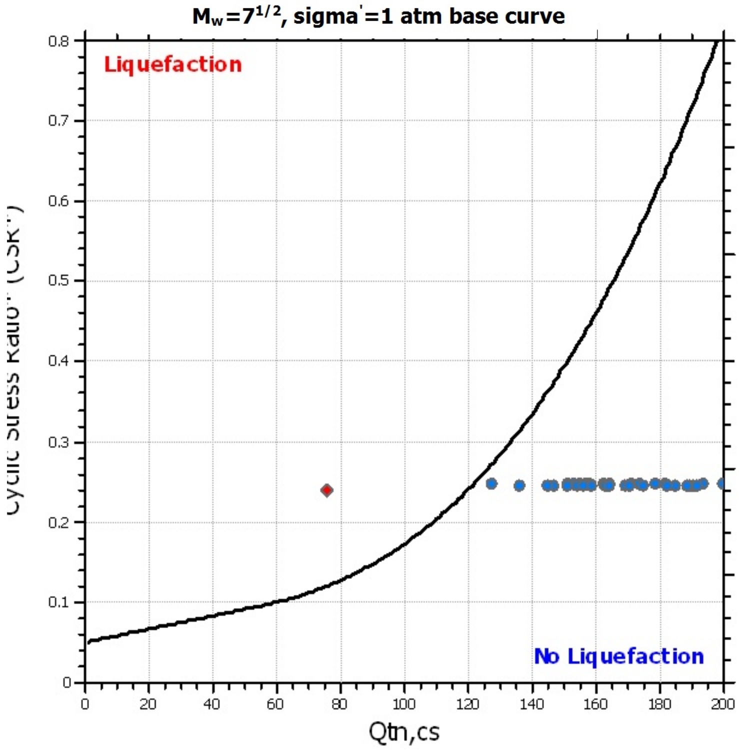
CPT file : CPT-1A

Input parameters and analysis data

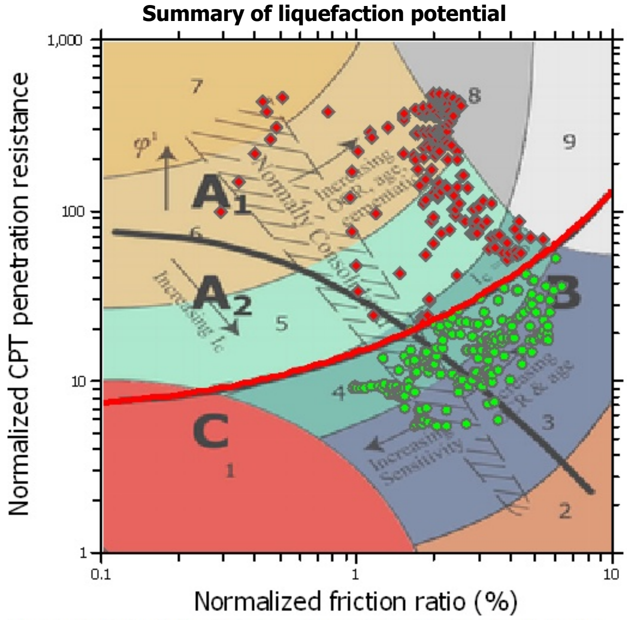
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	48.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	45.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.50	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



$M_w=7^{1/2}$, sigma'=1 atm base curve

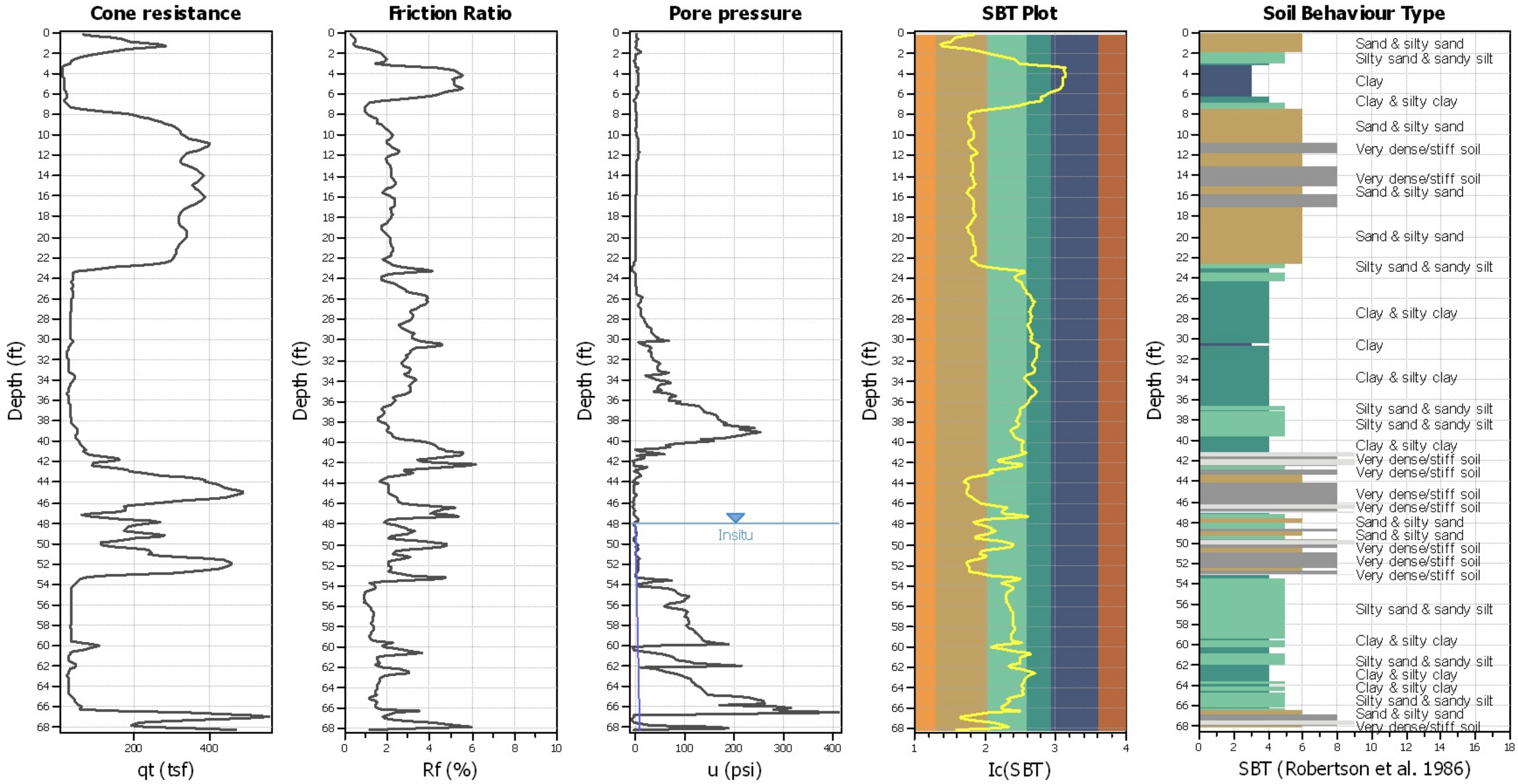


Summary of liquefaction potential



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

CPT basic interpretation plo



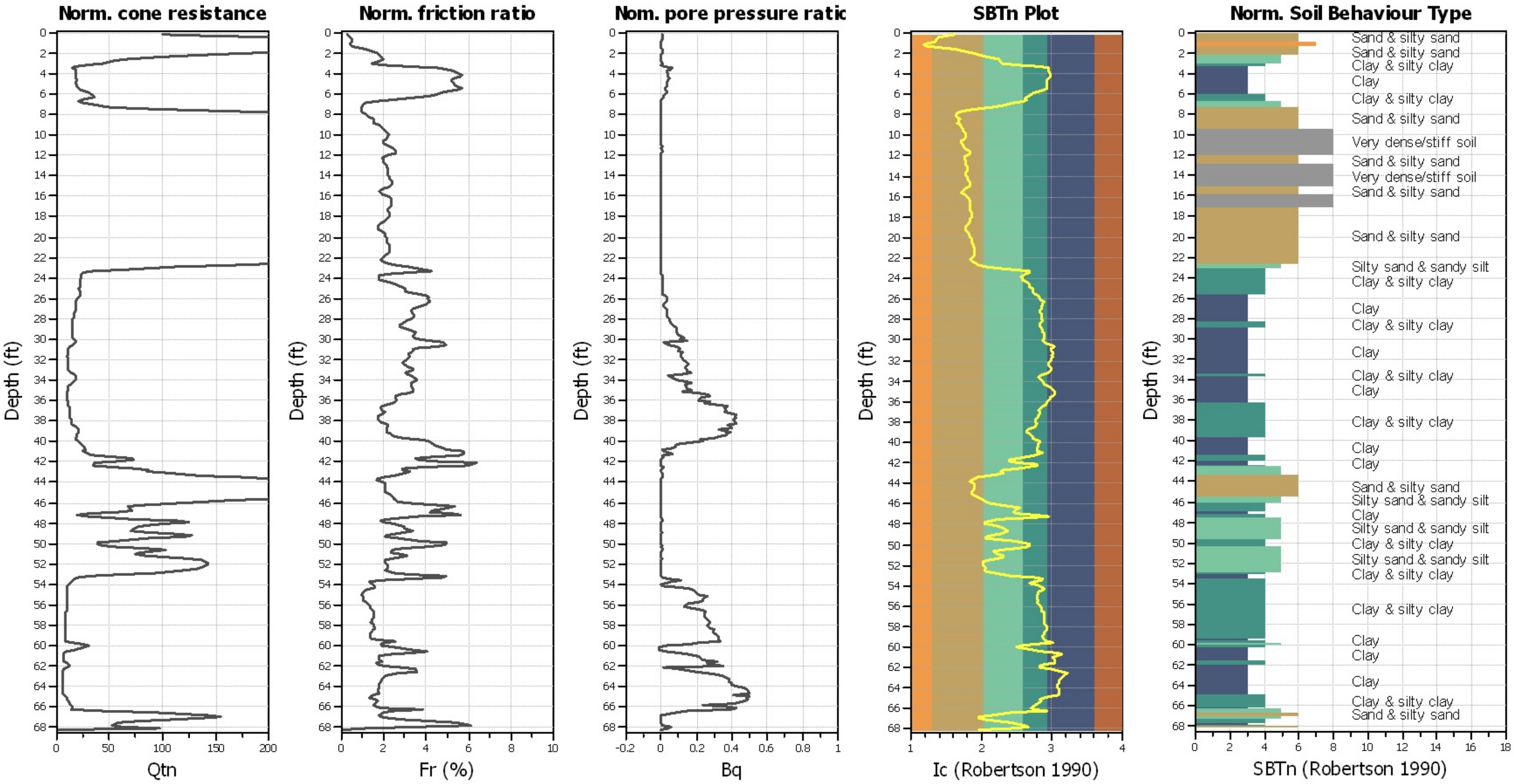
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normaliz



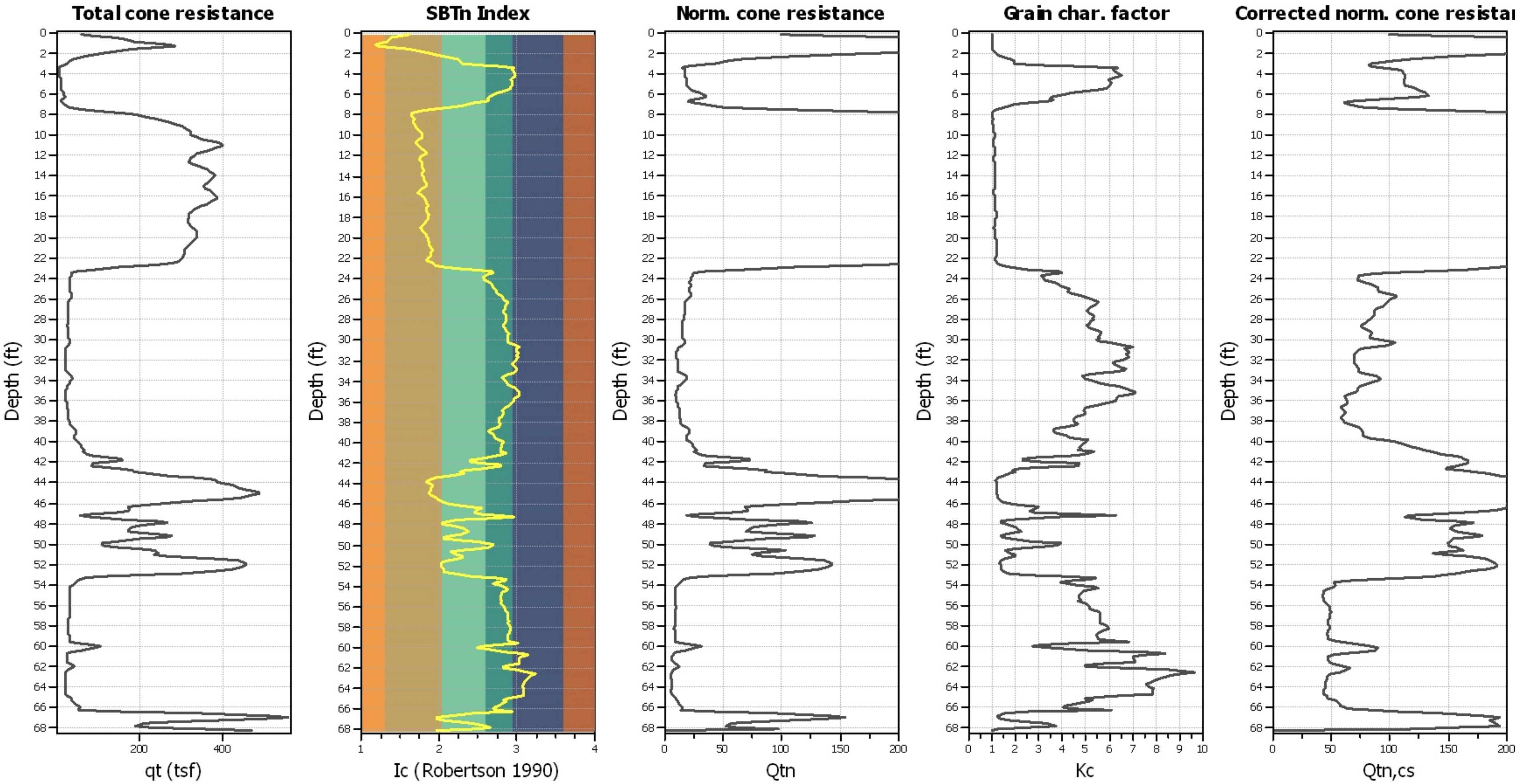
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBTn legend

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

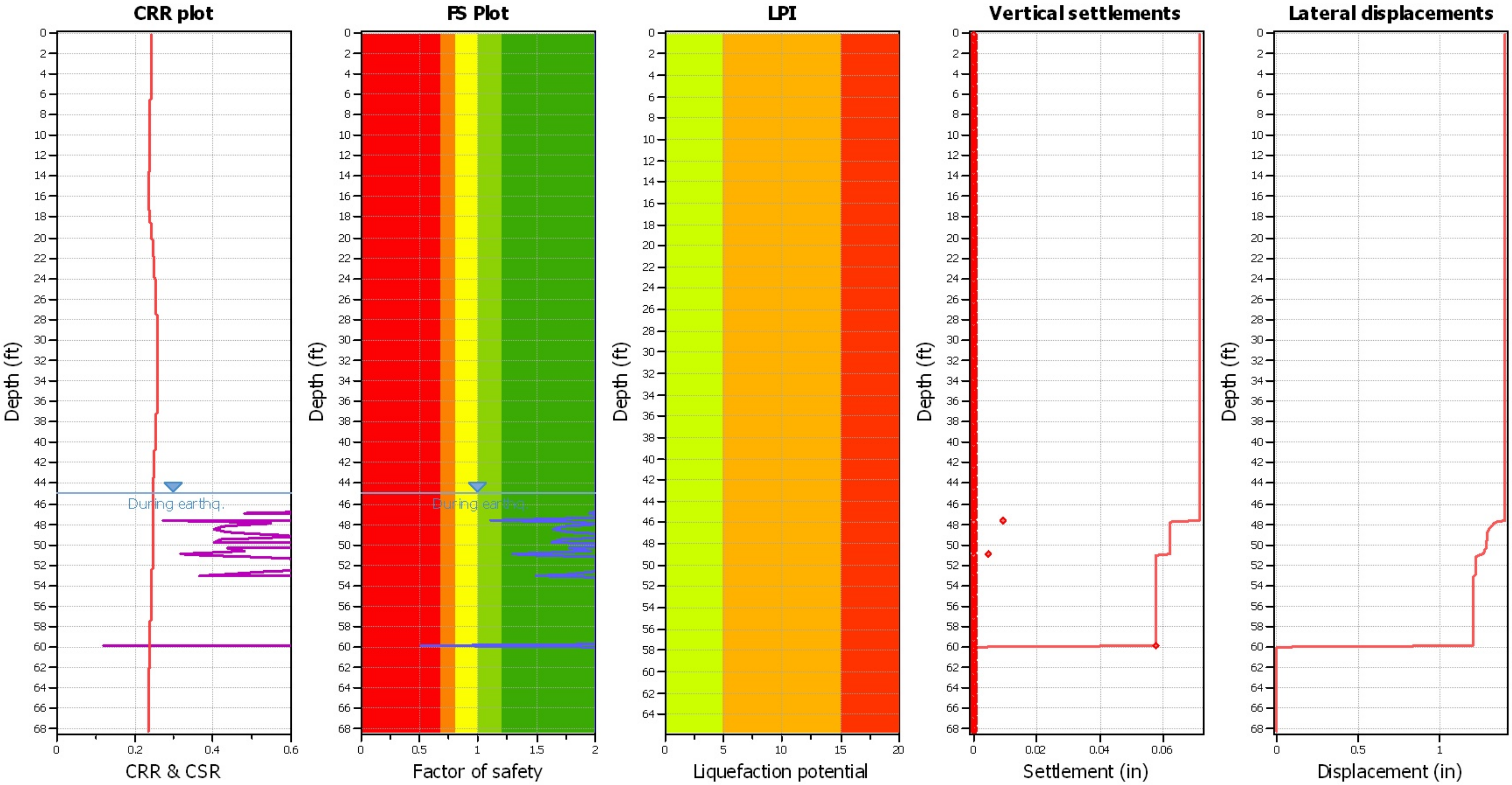
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

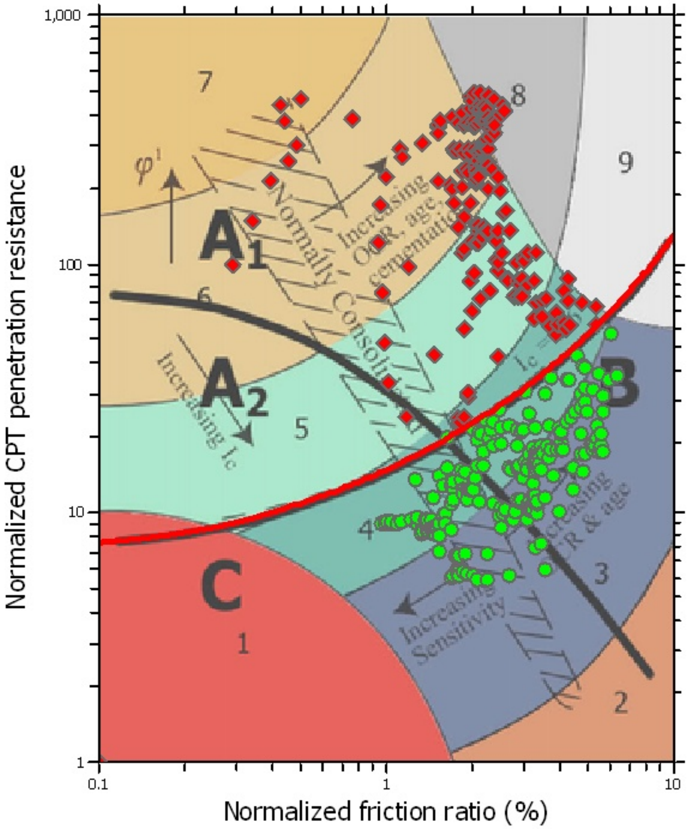
F.S. color scheme

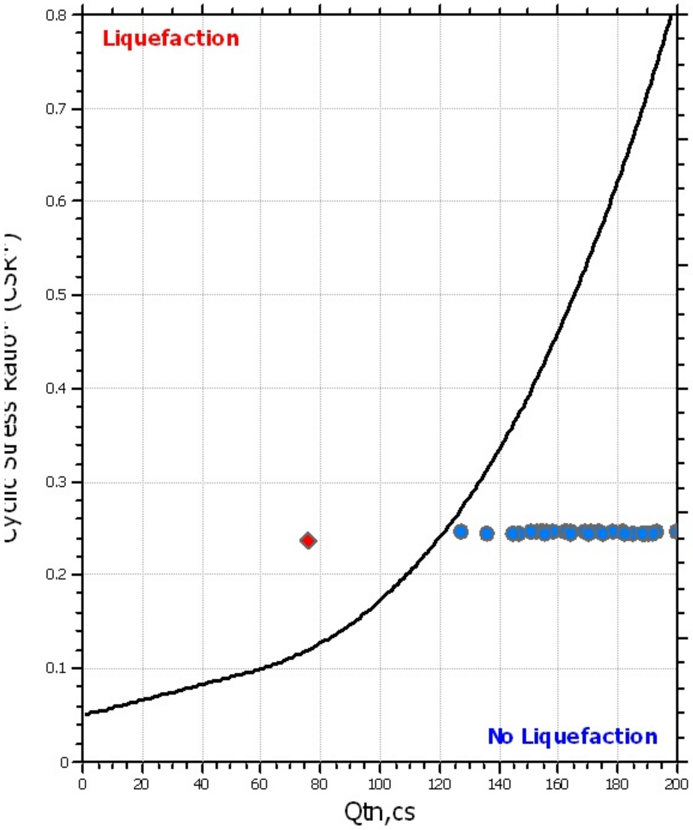
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

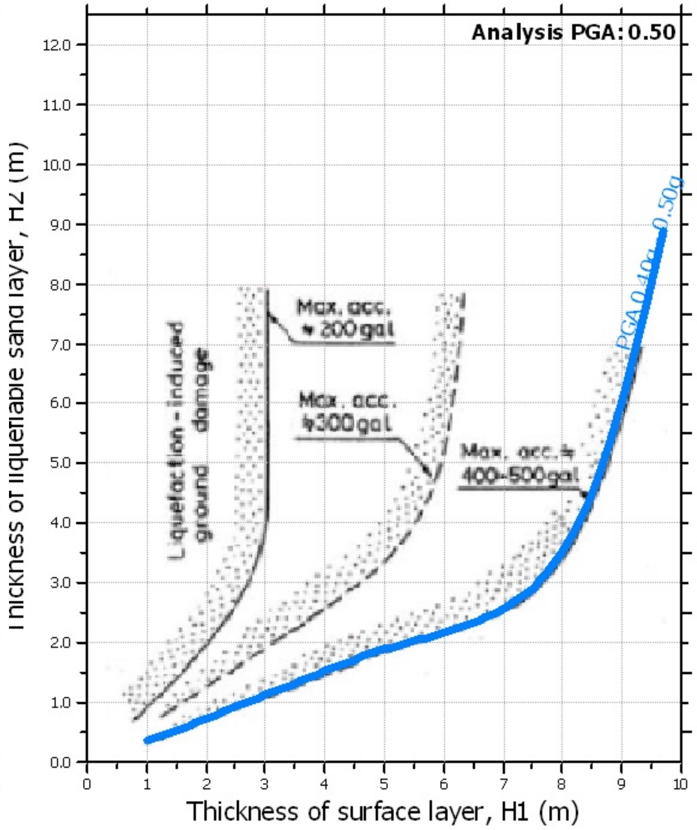
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plo



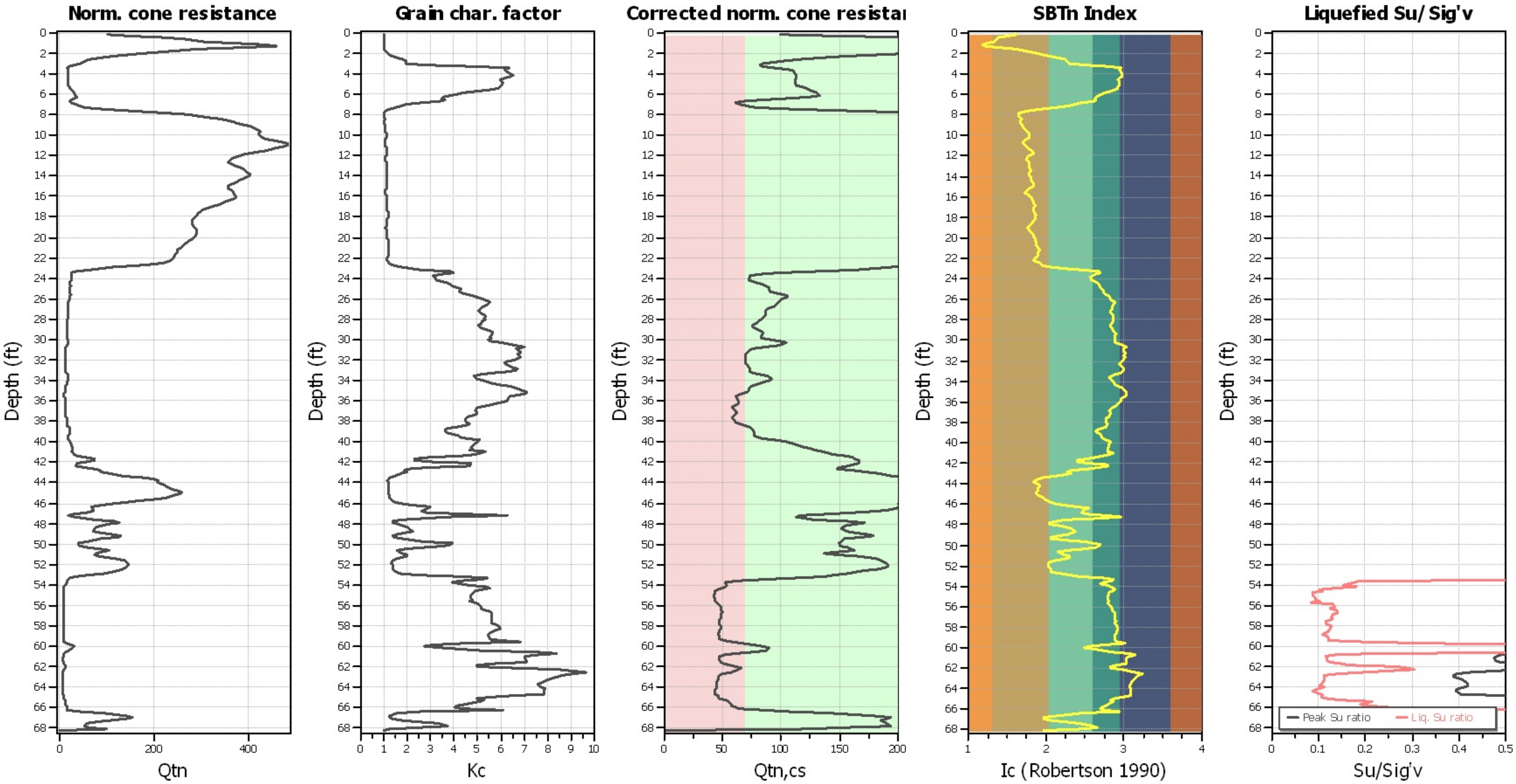




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	48.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

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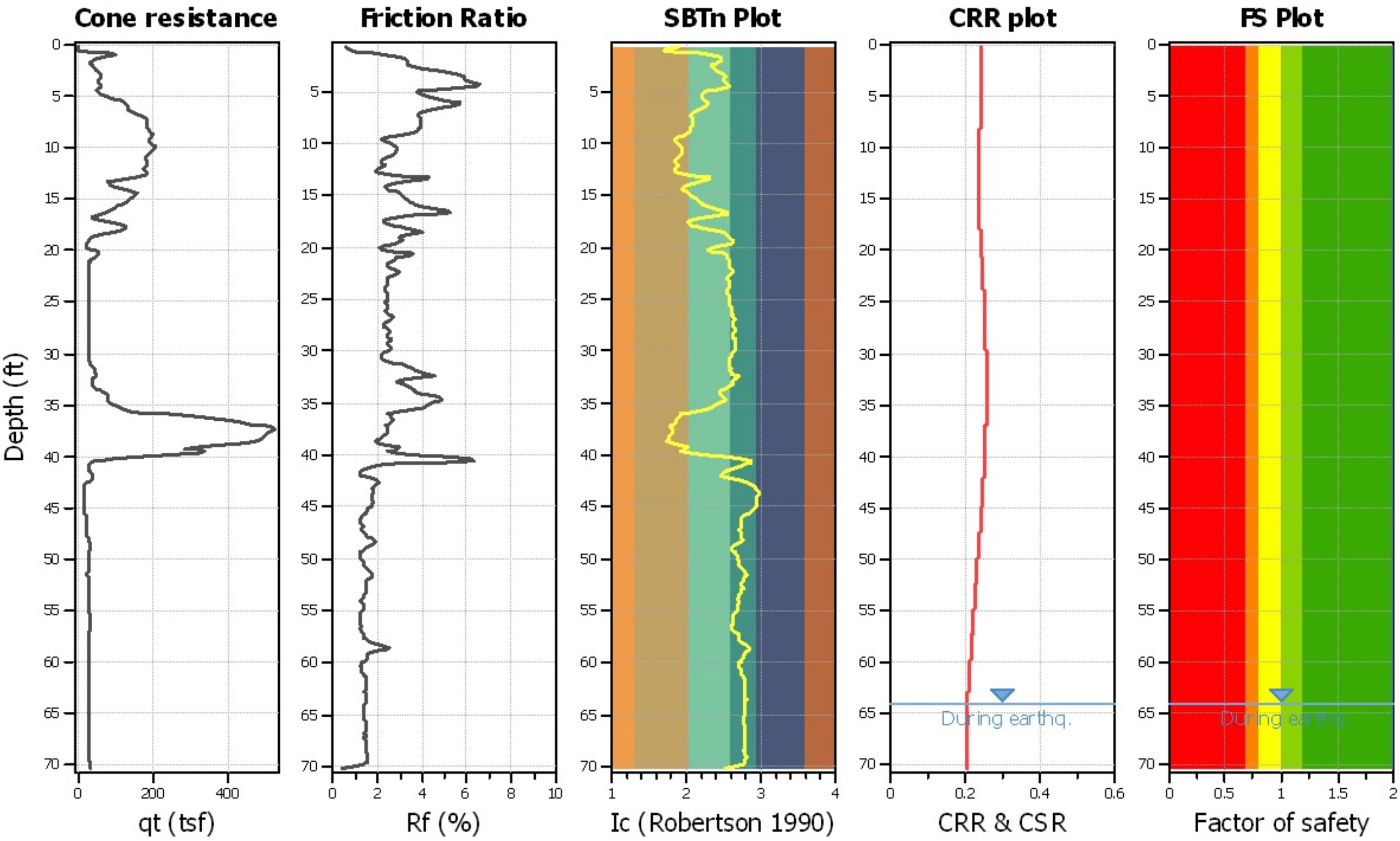
LIQUEFACTION ANALYSIS REPORT

Project title : Moss Landing **Location : Monterey County, California**

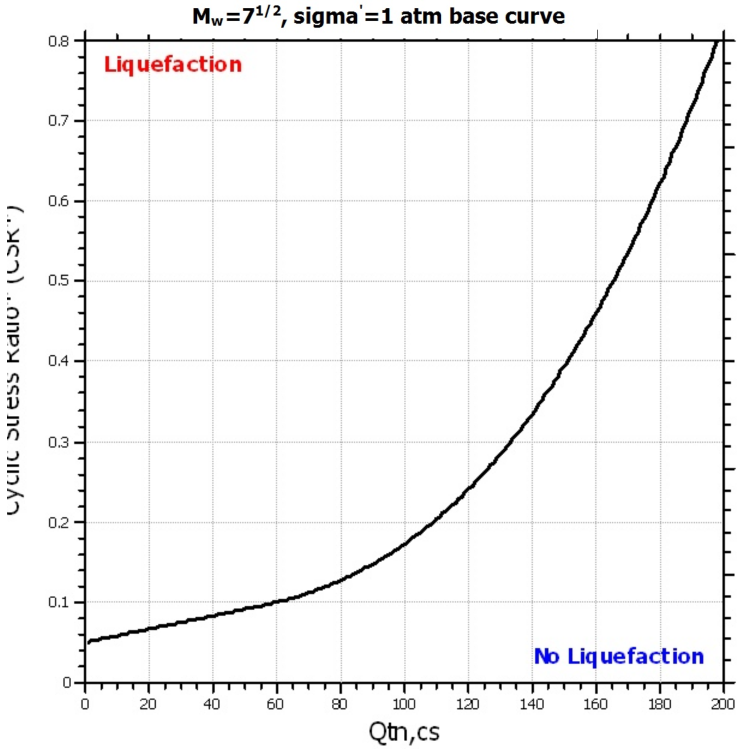
CPT file : CPT-2B

Input parameters and analysis data

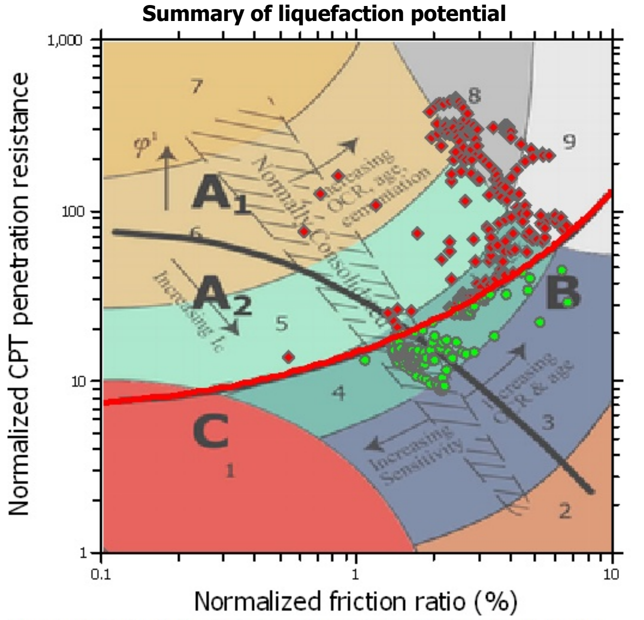
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	1.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	64.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.50	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



$M_w=7^{1/2}$, sigma'=1 atm base curve

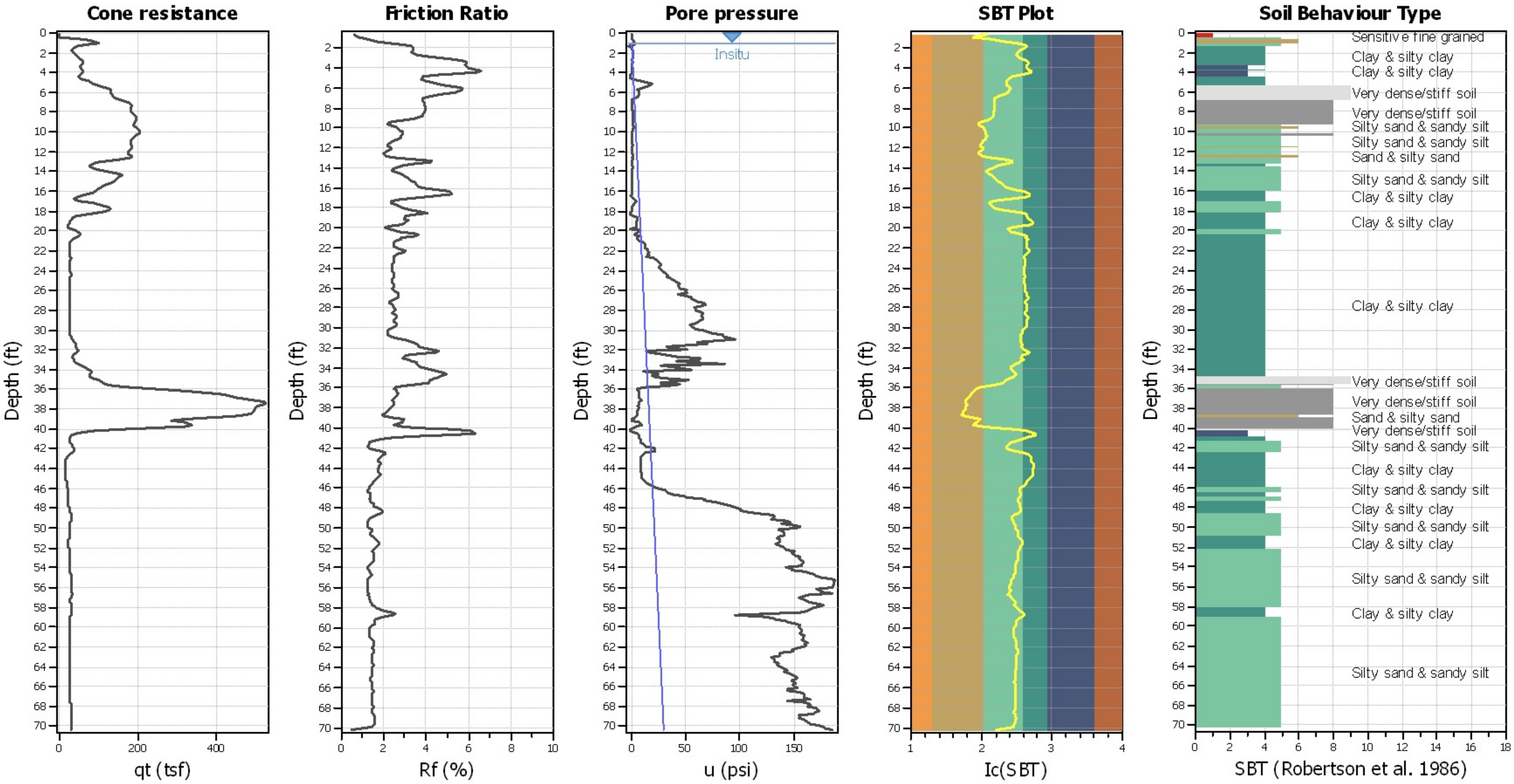


Summary of liquefaction potential



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

CPT basic interpretation plo



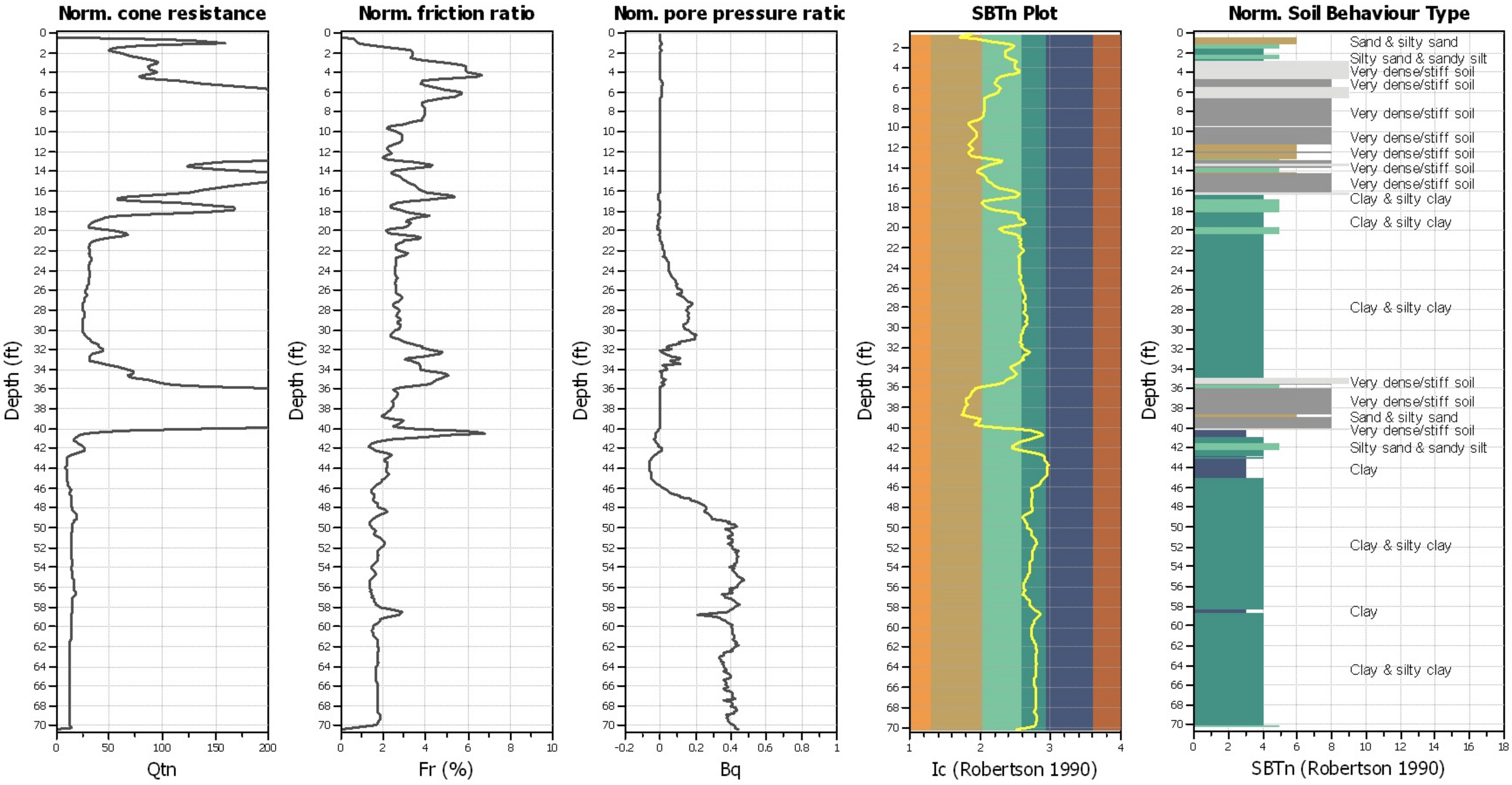
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normaliz



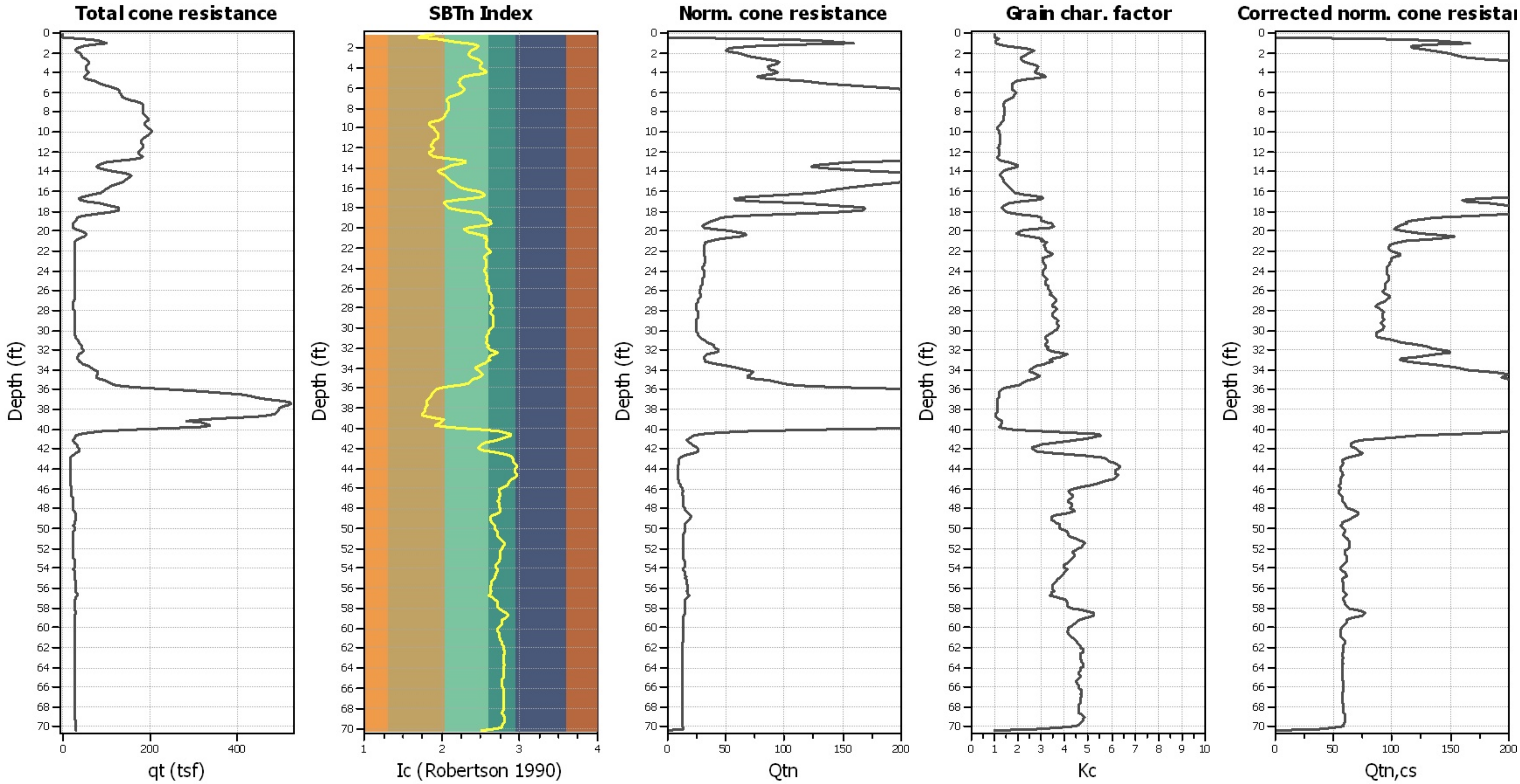
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBTn legend

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

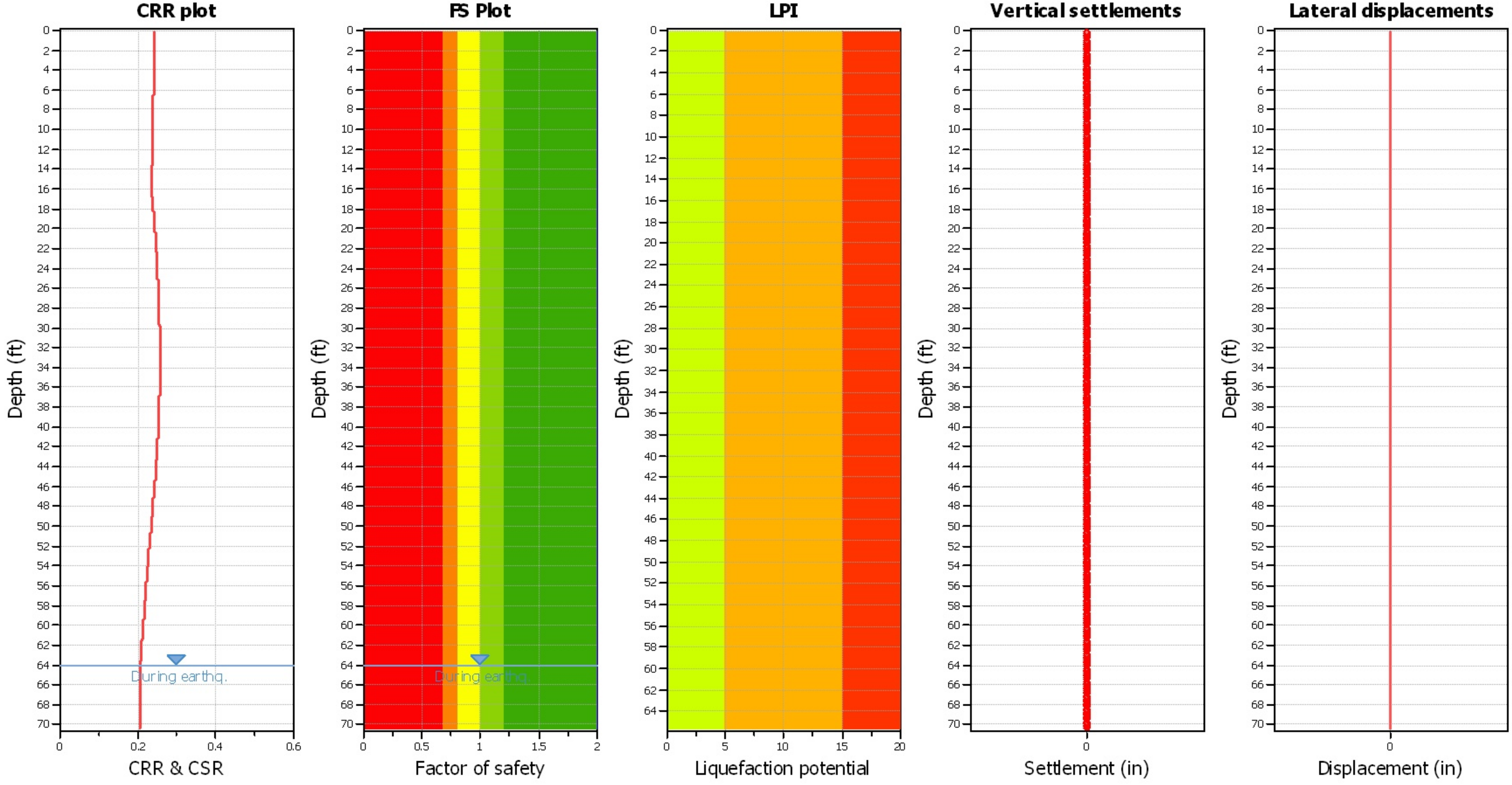
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

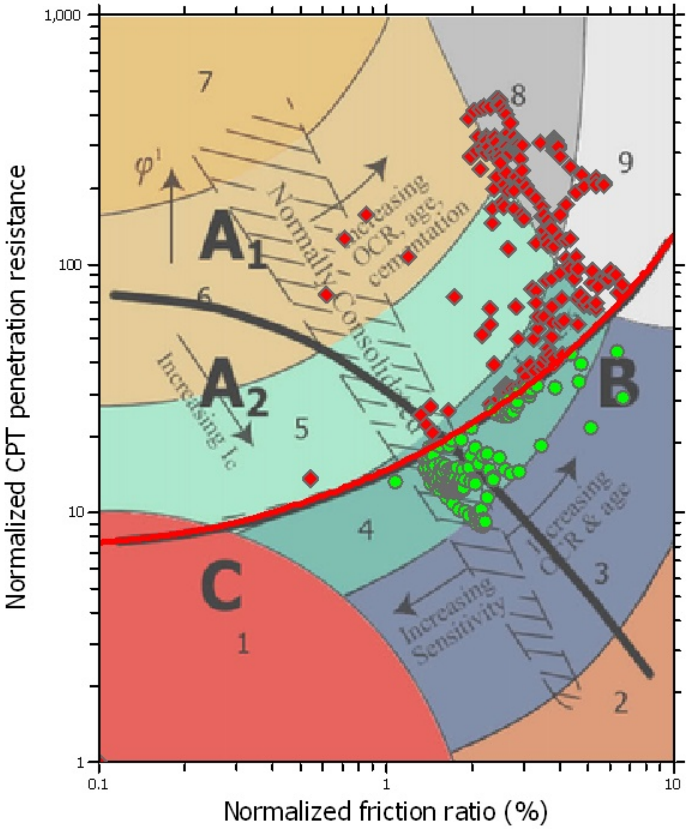
F.S. color scheme

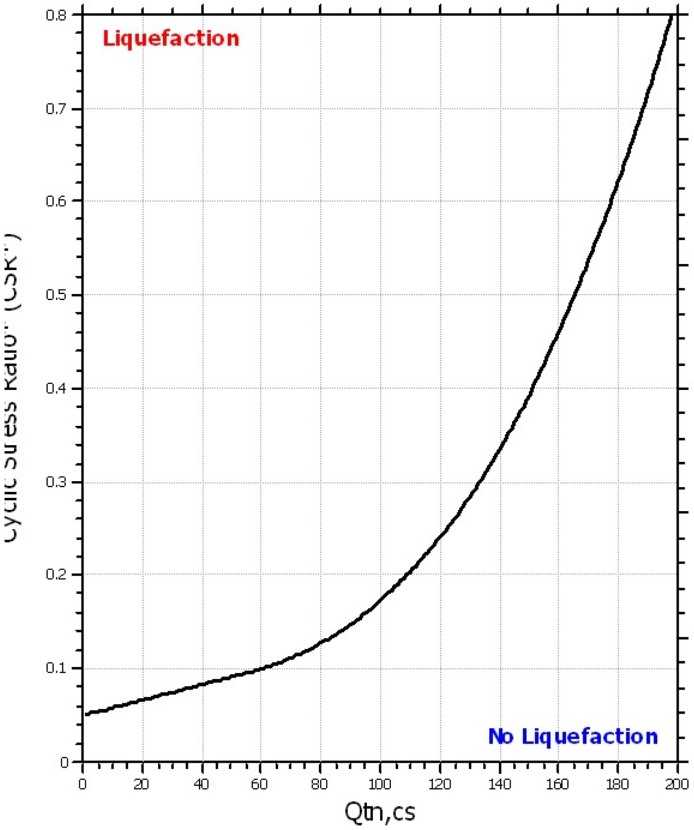
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

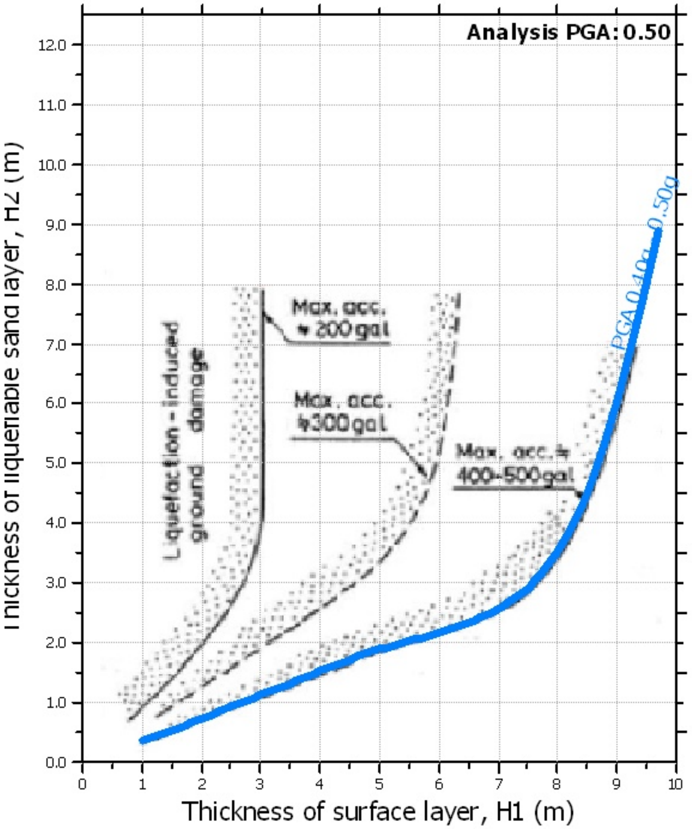
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plo



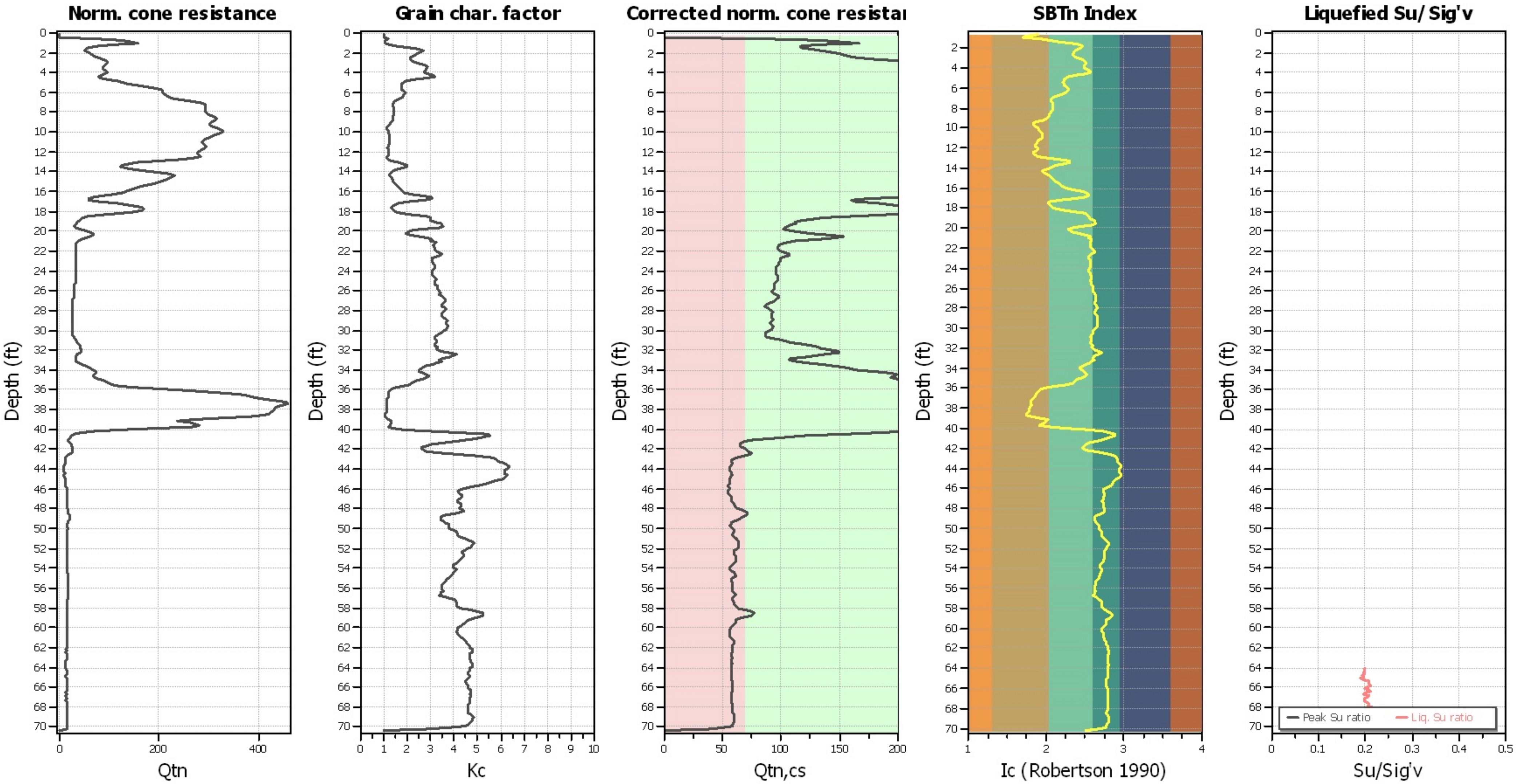




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	64.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Terraphase Engineering Inc.
1404 Franklin Street, Sixth Floor
Oakland, California 94612
www.terraphase.com

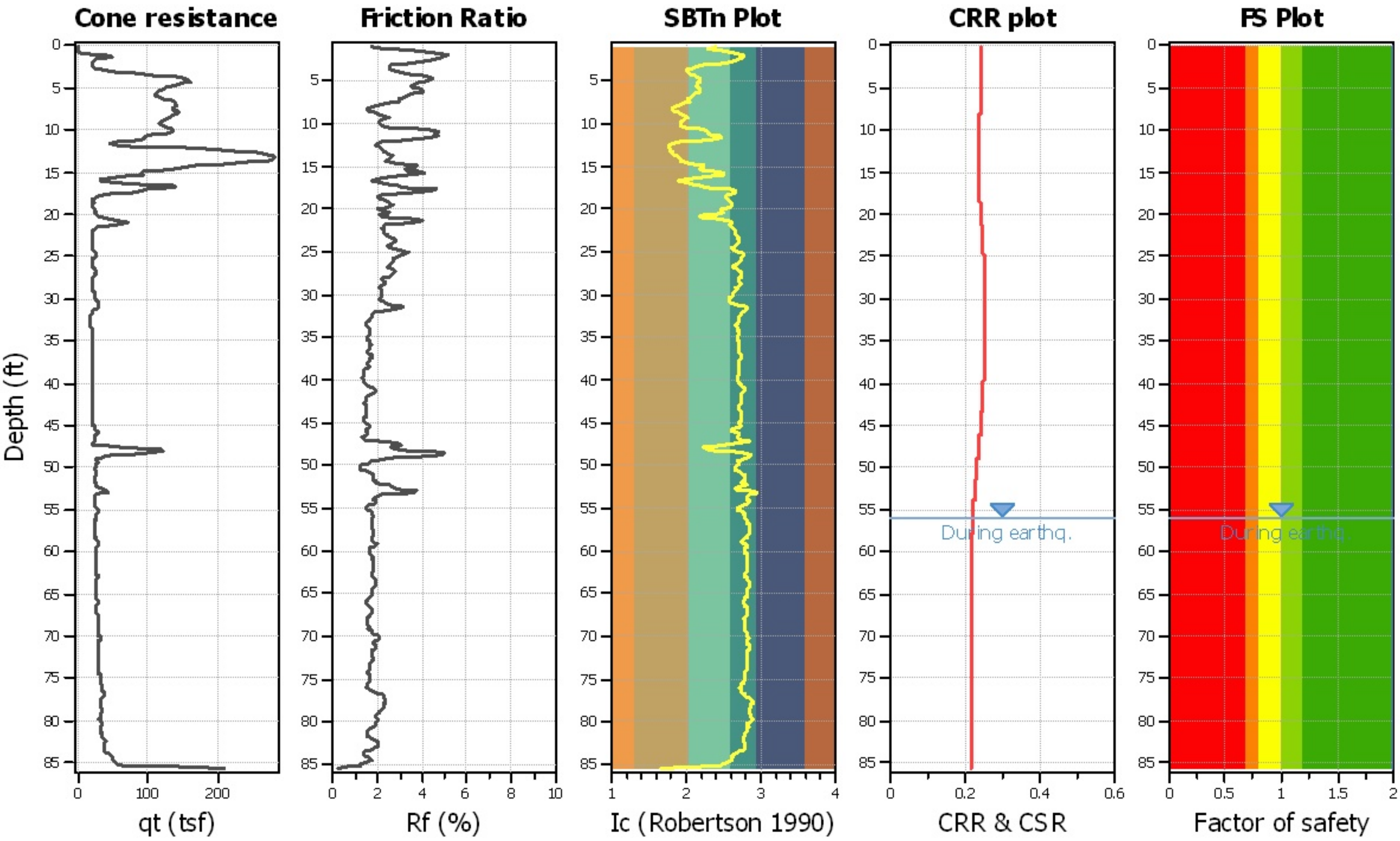
LIQUEFACTION ANALYSIS REPORT

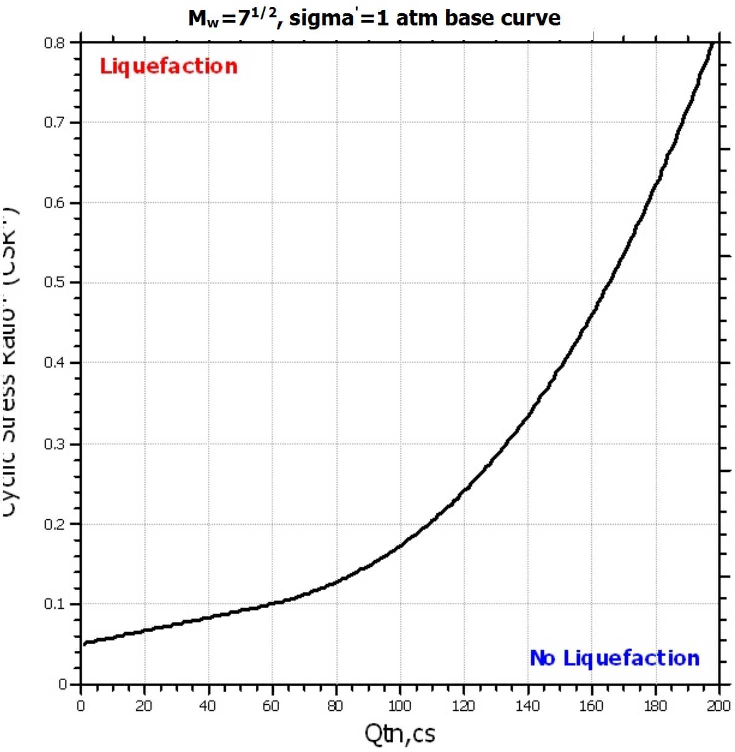
Project title : Moss Landing **Location : Monterey County, California**

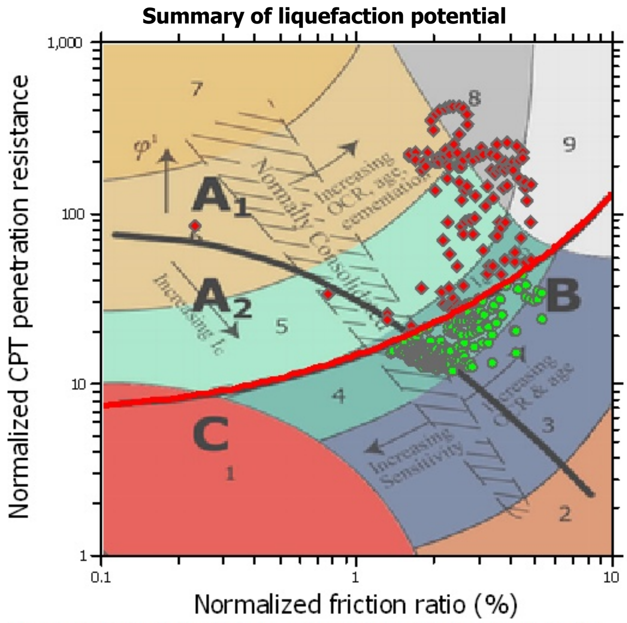
CPT file : CPT-1B

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	1.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	56.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.50	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

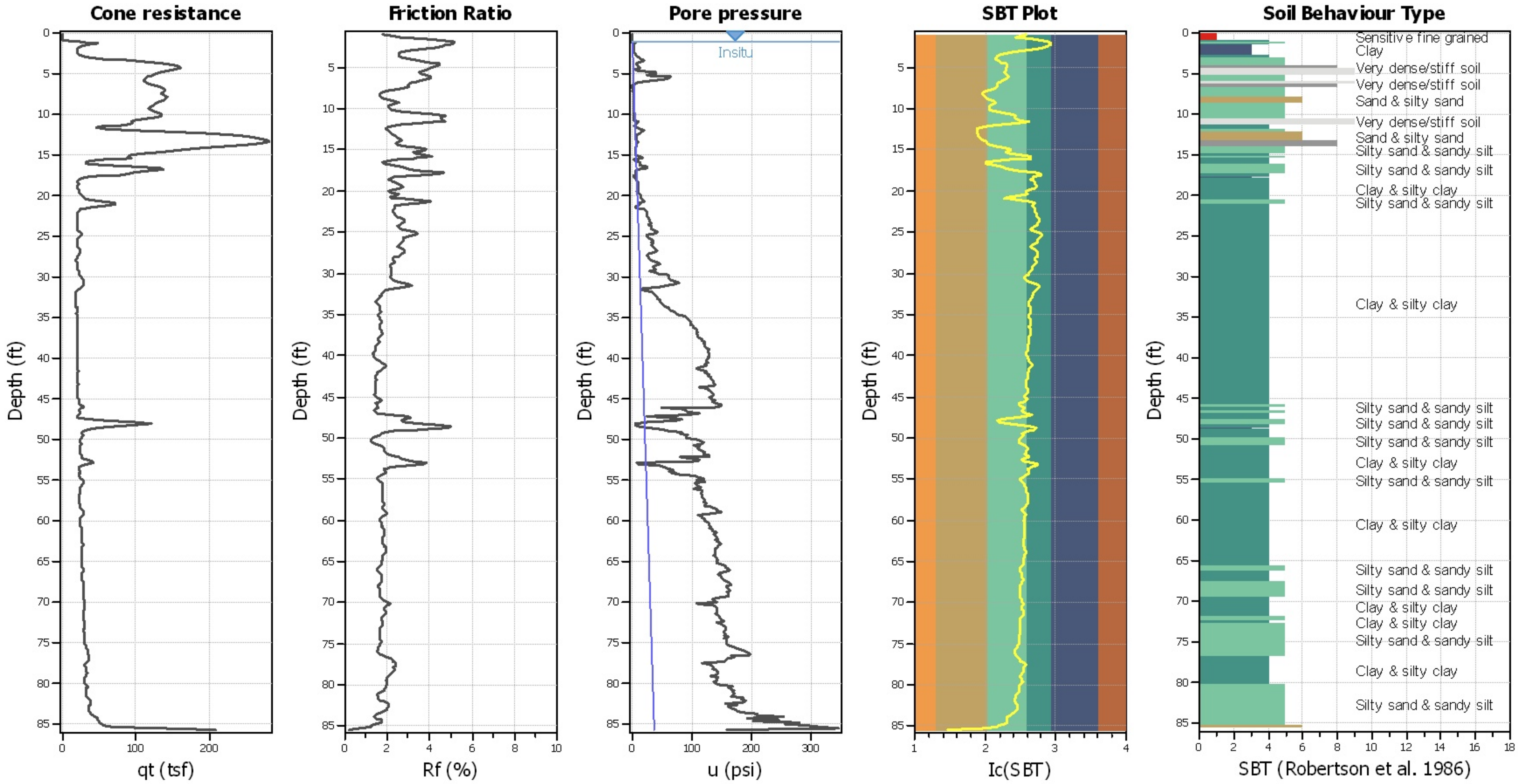






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plo



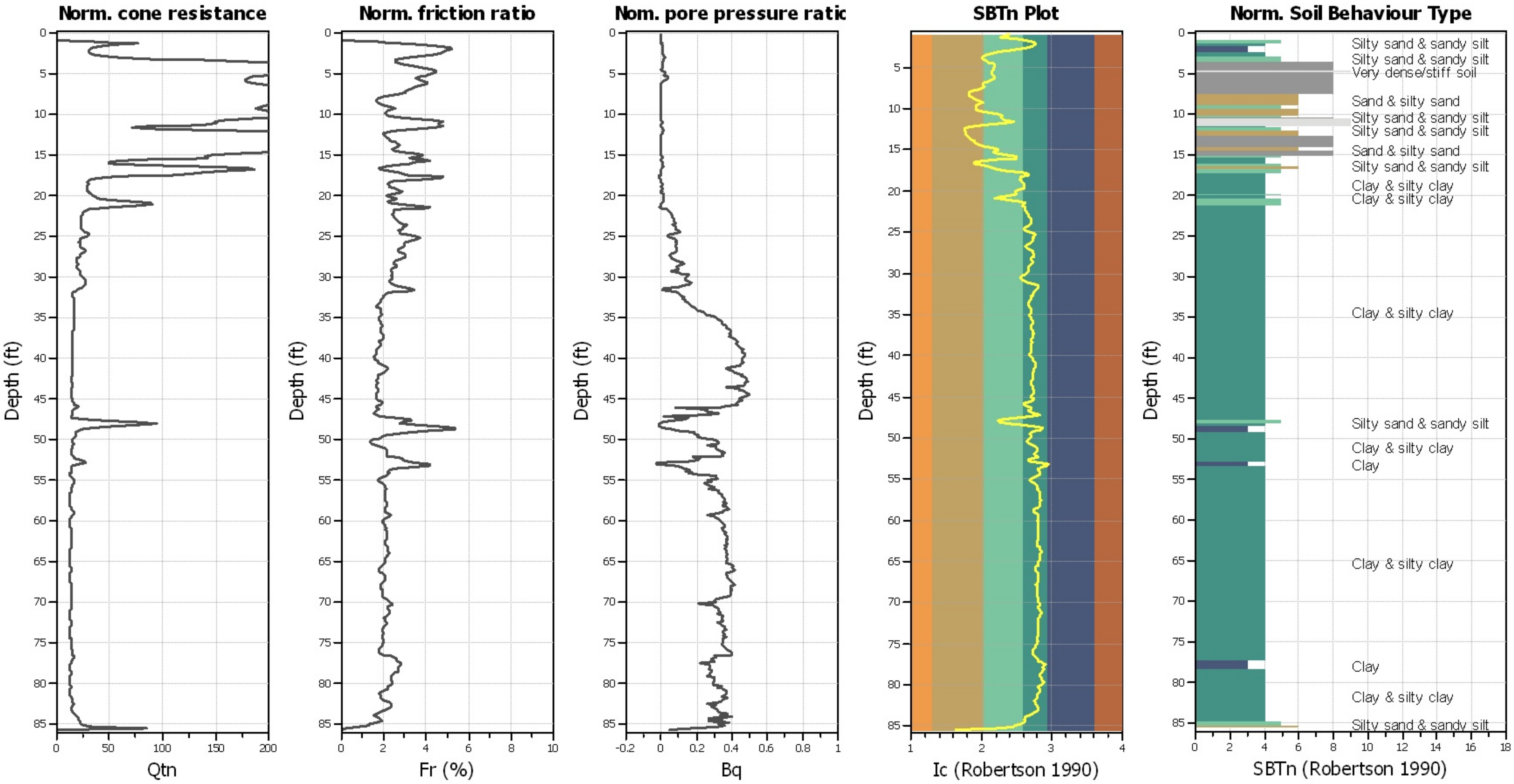
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	56.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normaliz



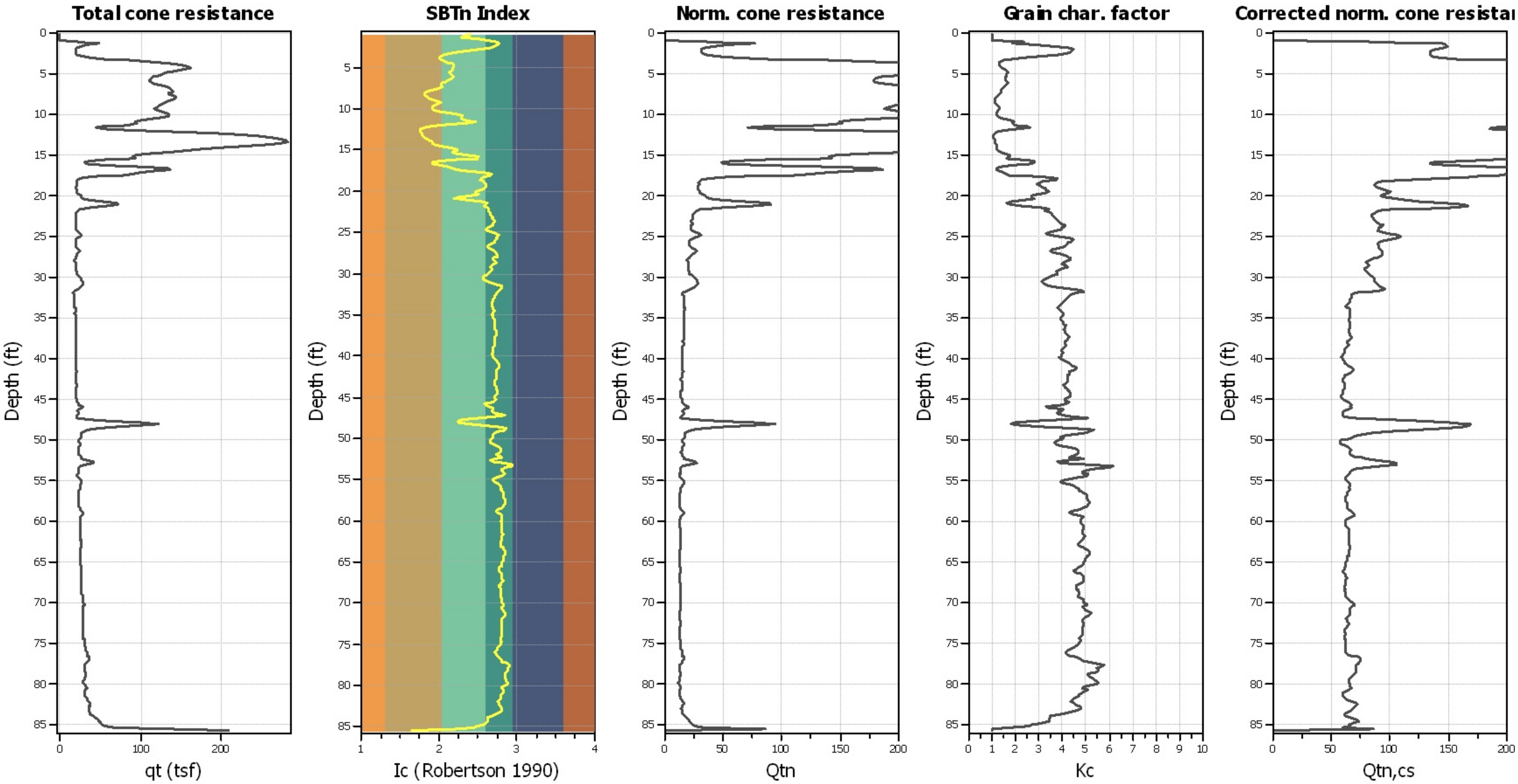
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	56.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBTn legend

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

Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

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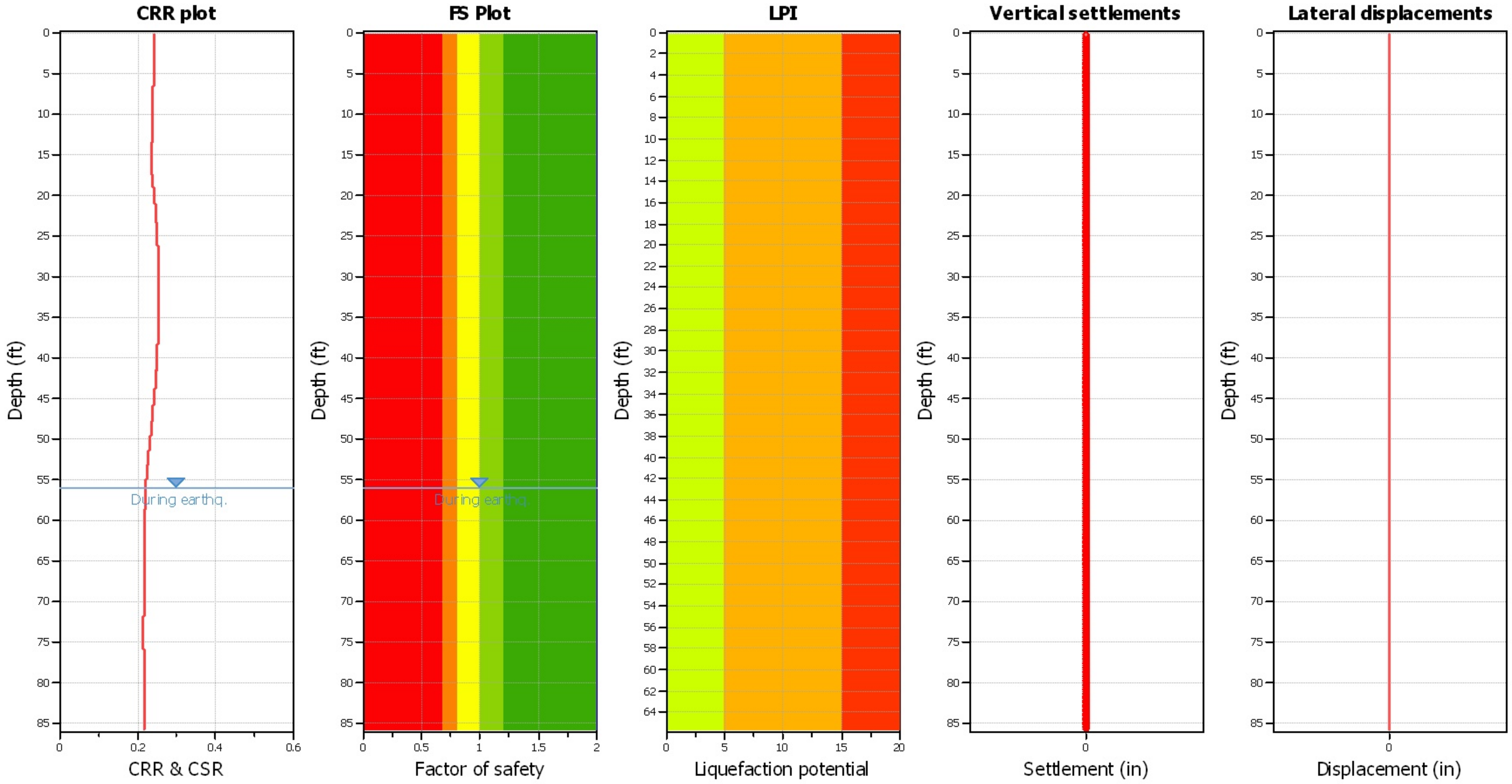
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plot



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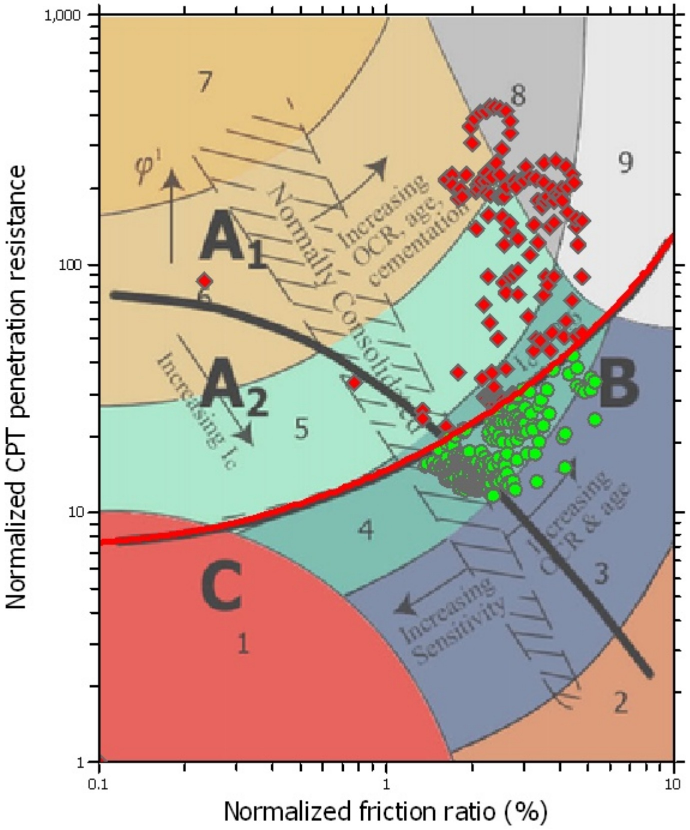
F.S. color scheme

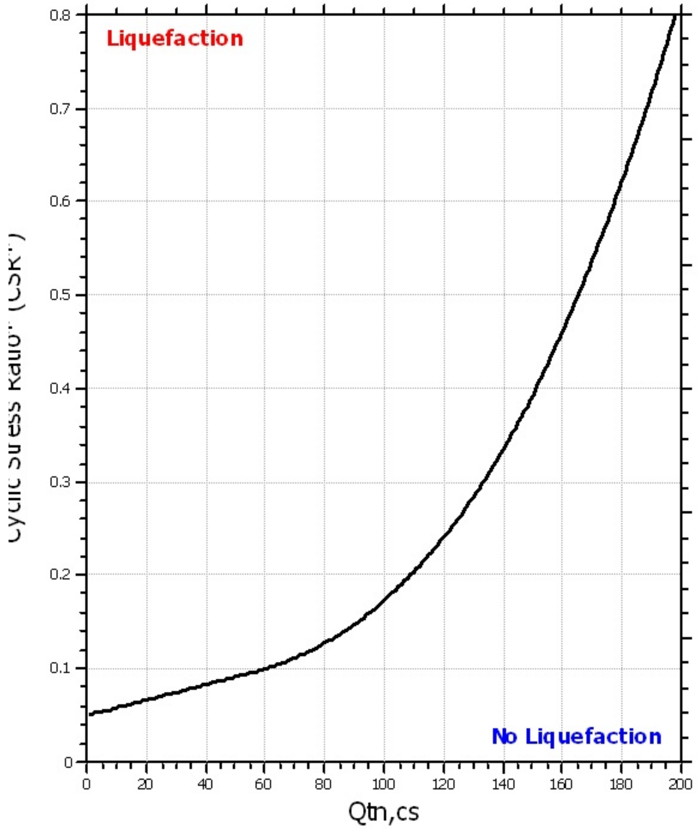
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

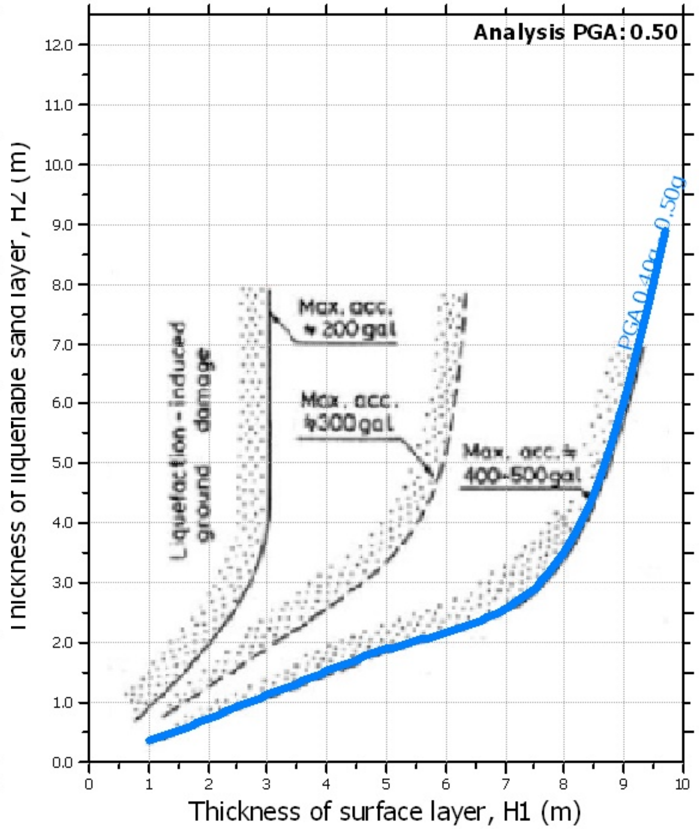
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plo







Input parameters and analysis data

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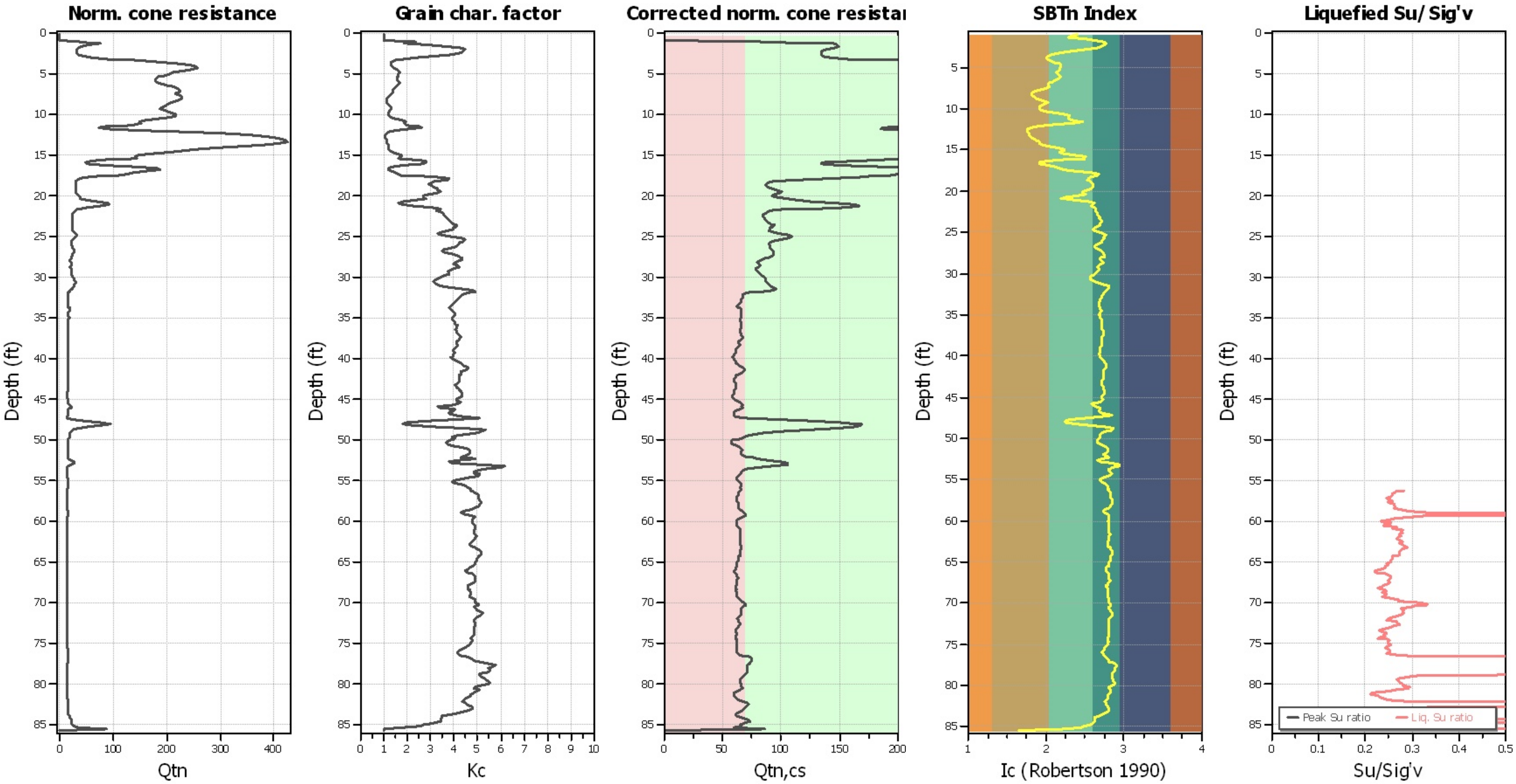
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

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Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
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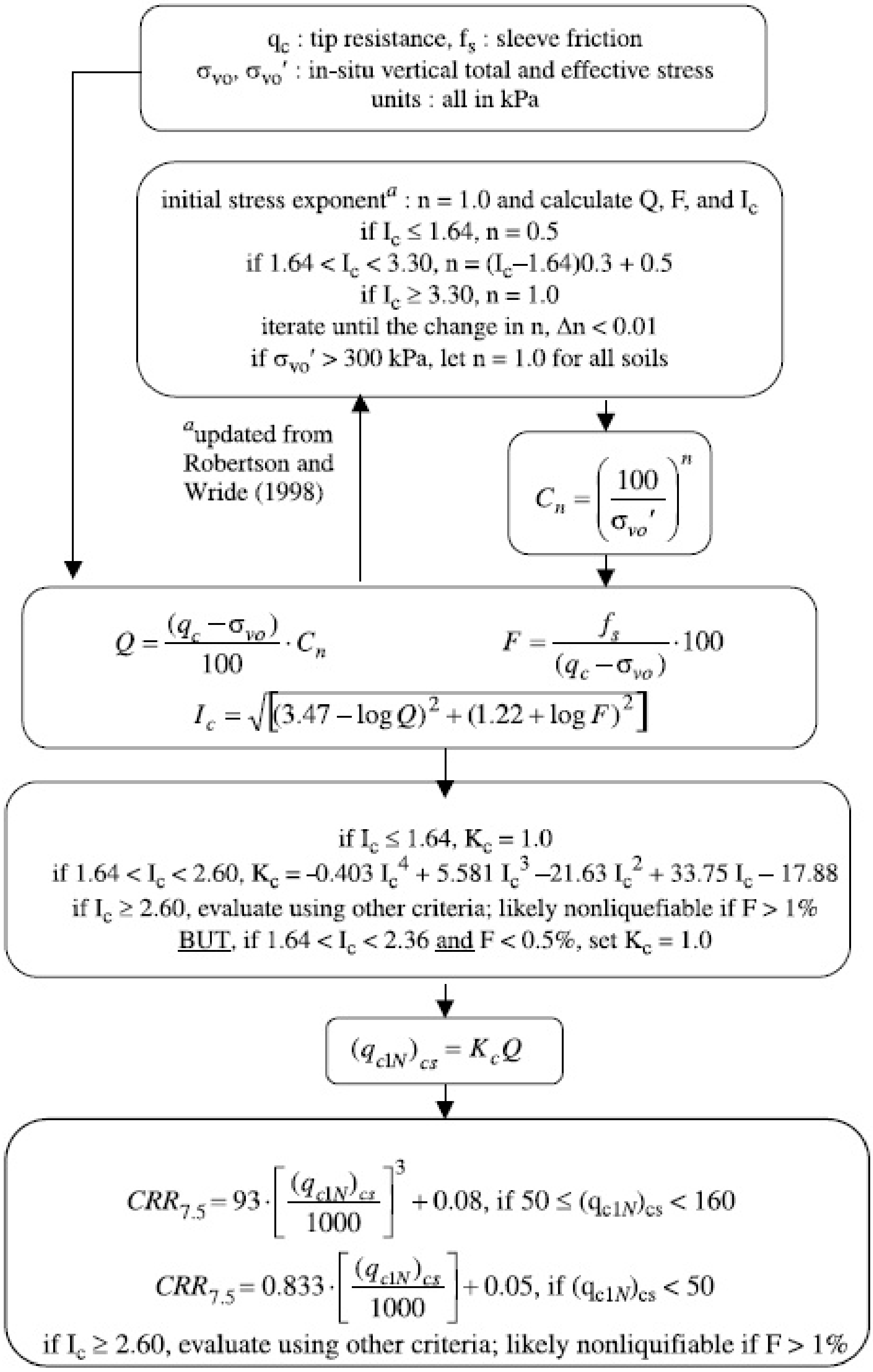
Earthquake magnitude M_w:	6.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.50	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

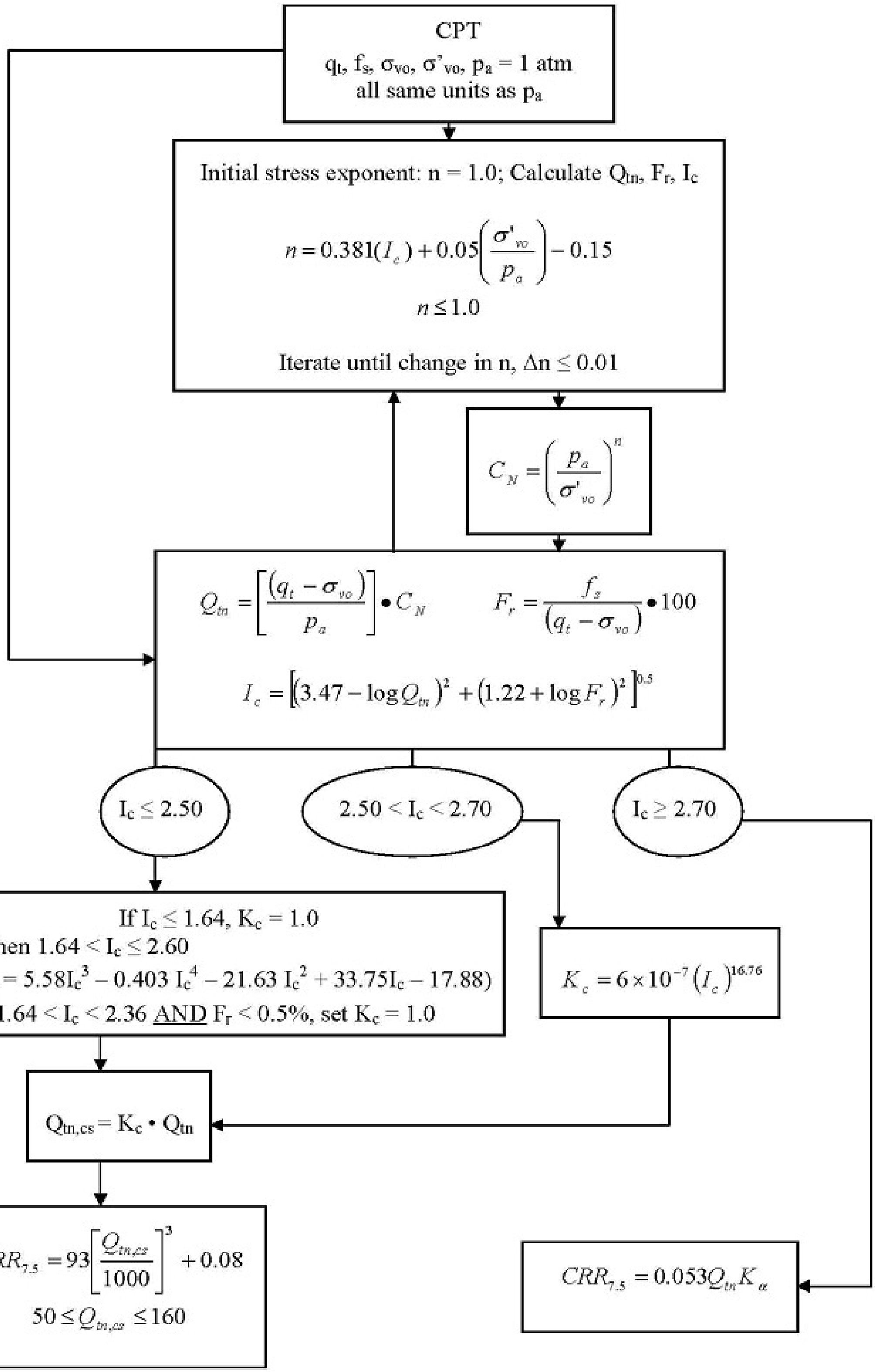
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)

q_c: tip resistance, f_s: sleeve friction
σ_{vo}, σ_{vo}': in situ vertical total and effective stress

$m = 1.338 - 0.249 \times (q_{c1N})^{0.264}$
iterate until change in m, $\Delta m < 0.01$

$$C_N = \left(\frac{P_a}{\sigma'_{vo}}\right)^m \leq 1.7$$

$$q_{c1N} = \frac{C_N \times q_c}{P_a}$$

$I_c < 2.60$

$I_c > 2.60$

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

where :

$$\Delta q_{c1N} = \left(5.4 + \frac{q_{c1N}}{16}\right) \times e^{\left(1.63 + \frac{9.7}{FC+0.01} - \left(\frac{15.7}{FC+0.01}\right)^2\right)}$$

$$CRR_{M=7.5,\sigma'_{vo}=1} = e^{\left(\frac{q_{c1Ncs}}{540} + \left(\frac{q_{c1Ncs}}{67}\right)^2 - \left(\frac{q_{c1Ncs}}{80}\right)^3 + \left(\frac{q_{c1Ncs}}{114}\right)^4 - 3\right)}$$

$$CRR_{M=7.5,\sigma'_{vo}=1} = 0.80 \times \frac{s_u}{\sigma'_{vo}} \times K_a$$

Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)

CPT

q_t, f_s, I_c

$I_c < I_c$ cut-off

Initial estimate using raw tip measurements, friction ratio. Calculate $q_{t,1}$. Repeat until an acceptable convergence tolerance is achieved.

$$c = f_1 \cdot \left(\frac{R_f}{f_3}\right)^{f_2}$$

$$C_q = \left(\frac{P_a}{\sigma'_v}\right)^{c}$$

$$q_{t,1} = C_q \cdot q_t$$

$$CRR = \exp\left[\frac{q_{t,1}^{1.045} + q_{t,1} \cdot (0.110 \cdot R_f) + (0.001 \cdot R_f) + c \cdot (1 + 0.850 \cdot R_f) - 0.848 \cdot \ln(M_w) - 0.002 \cdot \ln(\sigma'_v) - 20.923 + 1.632 \cdot \Phi^{-1}(P_L)}{7.177}\right]$$

Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65\frac{\sigma_v}{\sigma'_v}\frac{a_{\max}}{g}r_d\frac{1}{MSF}\frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z)+\beta(z)\cdot M\right]$$

$$\alpha(z) = -1.012 - 1.126\sin\left(\frac{z}{11.73}+5.133\right)$$

$$\beta(z) = 0.106 + 0.118\sin\left(\frac{z}{11.28}+5.142\right)$$

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \le 1.1$$

$$C_\sigma = \frac{1}{37.3 - 8.27\left(q_{c1Ncs}\right)^{0.264}} \le 0.3$$

$$MSF = 1 + (MSF_{max} - 1)\left(8.64\exp\left(\frac{-M}{4}\right) - 1.325\right)$$

$$MSF_{max} = 1.09 + \left(\frac{q_{c1Ncs}}{180}\right)^3 \le 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113} + \left(\frac{q_{c1Ncs}}{1000}\right)^2 - \left(\frac{q_{c1Ncs}}{140}\right)^3 + \left(\frac{q_{c1Ncs}}{137}\right)^4 - 2.80\right)$$

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9 + \frac{q_{c1N}}{14.6}\right)\exp\left(1.63 - \frac{9.7}{FC+2} - \left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_{N\sigma}\frac{q_c}{P_a}$$

$$C_{N\sigma} = \left(\frac{P_a}{\sigma'_v}\right)^m \le 1.7$$

$$m = 1.338 - 0.249\left(q_{c1Ncs}\right)^{0.264} \quad with \quad 0.264 \le m \le 0.782$$

$$FC = 80\left(I_C + C_{FC}\right) - 137 \quad with \quad 0\% \le FC \le 100\%$$

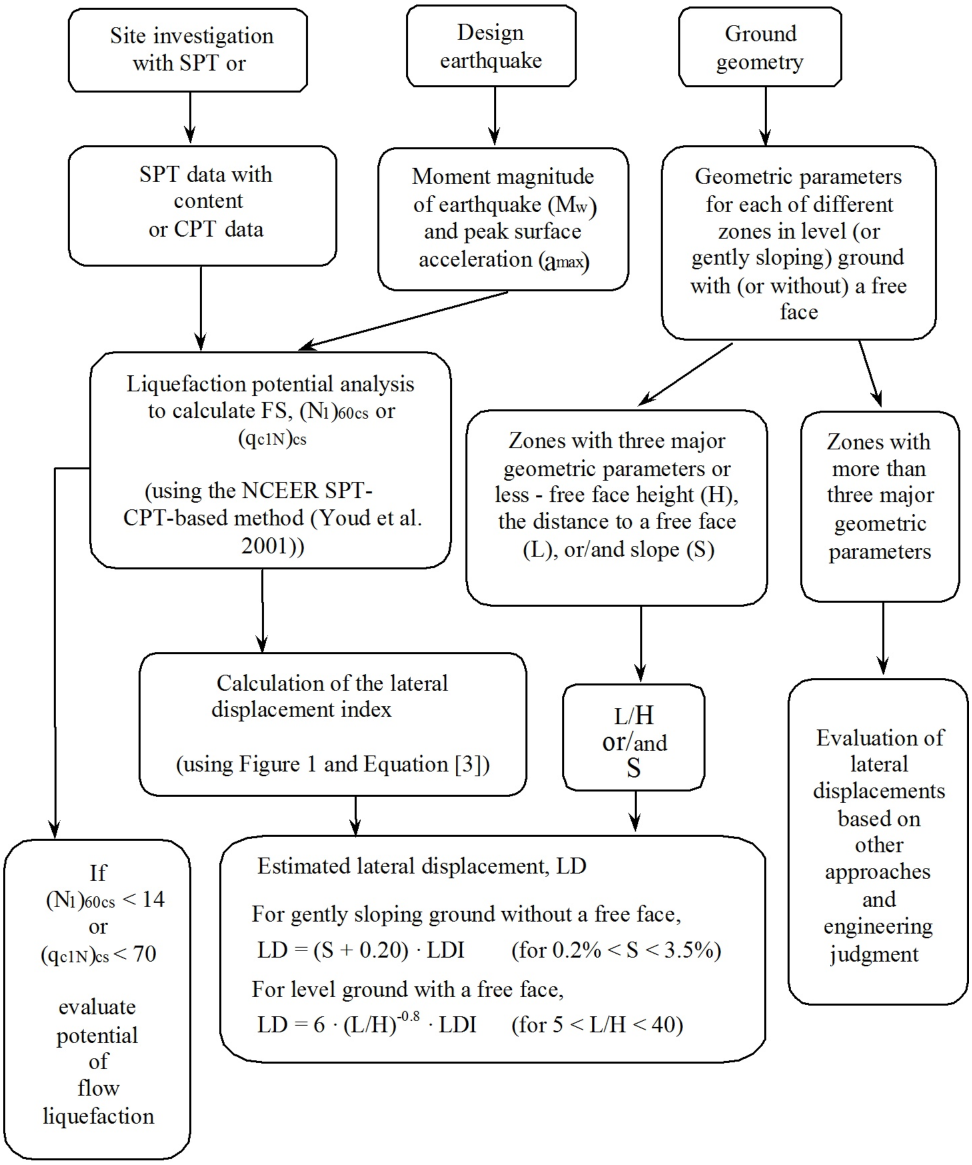
$$I_c = \left[\left(3.47 - \log(Q)\right)^2 + \left(1.22 + \log(F)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c - \sigma_{vc}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vc}}\right)^n \text{ with } 0.5 \le n \le 1.0 \text{ per Robertson \& Wride (1998)}$$

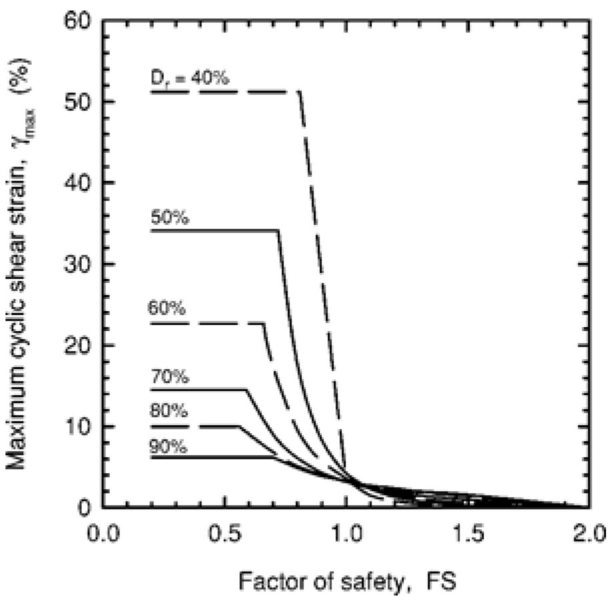
$$F = \left(\frac{f_s}{q_c - \sigma_{vc}}\right)\cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max} dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{\alpha_{max}}{g} \cdot \sigma_{v0} \cdot \tau_d$$

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0}\ \text{(Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

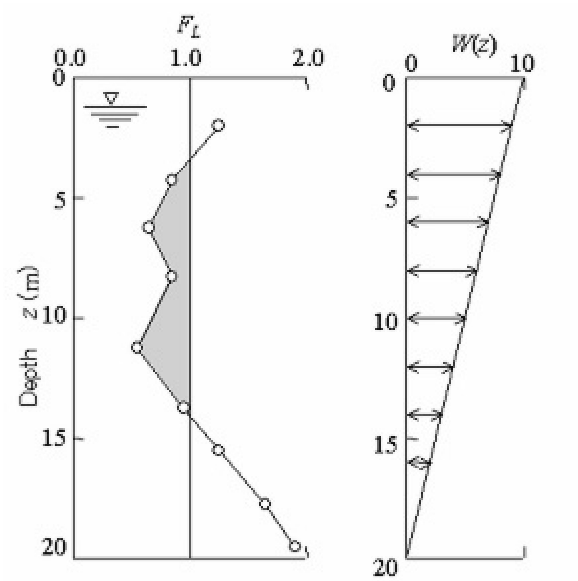
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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