



**Seismic
Vulnerability
Assessment**

**Owens Corning
Trumbull Asphalt Plant**
11910 NW St. Helens Road
Portland, OR 97231

**1543_MEM103
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TABLE OF CONTENTS

SECTION	PAGE NO.
Table of Contents	i
Report Disclaimer	iv
Errata Sheet for Norwest Engineering Seismic Vulnerability Assessment	v
Seismic Vulnerability Assessment	1
SECTION 1: Seismic Vulnerability Assessment	1
1.1 Facility Overview	1
1.2 Background	1
1.3 Oregon Laws 2022 Chapter 99.....	2
1.4 The Oregon Resilience Plan	2
1.5 Oregon Fuel Action Plan	2
SECTION 2: Tank Seismic Stability Rules	3
2.1 Summary of the Rules	3
2.2 Seismic Vulnerability Assessment (SVA)	3
2.3 SVA Implementation	3
2.4 Seismic Risk Mitigation Implementation Plan (SRMIP)	4
SECTION 3: Basis for Rules Development	5
SECTION 4: Assessment Methods and Approach	6
4.1 Summary of Evaluation Methods	6
4.1.1 Geotechnical	6
4.1.2 Structural	7
4.1.3 Safety/Mechanical/Fire	8
4.2 Facility Areas Evaluated	8
4.2.1 Process Area	8
4.2.2 Tank Farm	8
4.2.3 Rail Spur	8
4.2.4 Marine Facility	8
4.2.5 North Warehouse Area	8
4.2.6 South Warehouse Area	8

SECTION 5: Vulnerability Assessments	9
5.1 Summary of Evaluation Methods	9
5.1.1 Geotechnical Assessment (Site Wide)	9
5.1.1.1 Site Conditions Assessment	9
5.1.1.1.1 Site surface conditions, topography, shoreline topography....	9
5.1.1.1.2 Description of regional and site geology including soil stress history, deposition environment, and bedrock and soil units.....	9
5.1.1.1.3 Description of field explorations and laboratory testing.....	10
5.1.1.1.4 Description of site subsurface conditions, including soil and rock units encountered, extents and properties of those units, and groundwater conditions.	10
5.1.1.1.5 Description of methods, analyses, assumptions, and judgments.	11
5.1.1.2 Seismic Hazard Evaluation.....	11
5.1.1.2.1 Description of seismic hazards at the site, including seismic evaluation criteria (expected ground shaking), liquefaction, settlement, surface effects, loss of strength, lateral spread, and slope stability as appropriate.	11
5.1.1.2.2 Liquefaction/lateral spreading	12
5.1.1.2.3 Seismic settlement.....	13
5.1.1.2.4 Slope stability.....	14
5.1.1.2.5 Miscellany, Such as Surface Effects	14
5.1.1.3 Geotechnical Evaluation	14
5.1.1.3.1 Seismic design parameters	15
5.1.1.3.2 Estimated vertical settlement.....	15
5.1.1.3.3 Lateral ground deformations.....	15
5.1.1.3.4 Foundation design parameters	15
5.1.2 Structural Assessment	17
5.1.2.1 Seismic Performance Expectations	17
5.1.2.1.1 Process Area	17
5.1.2.1.2 Tank Farm	19
5.1.2.1.3 Rail Spur	20
5.1.2.1.4 Marine Facility	21
5.1.2.1.5 North Warehouse Area	21
5.1.2.1.6 South Warehouse Area	22

5.1.3 Safety Assessment	22
5.1.3.1 Description of fire control system	22
5.1.3.1.1 General system description	22
5.1.3.1.2 City water supply, vulnerability of the feed and the onsite U/G lines to liq/lat spreading damage.	22
5.1.3.2 Description of spill containment systems equipment, procedures	23
5.1.3.2.1 Risks in the event of a catastrophic failure.....	24
5.1.3.2.2 Prior 3 rd party acknowledgment of low risk	24
5.1.3.3 Mechanical-specific items	25
5.1.3.4 Description of onsite emergency equipment, ops safety measures, personnel policies, and procedures	25
5.1.4 Case for Tank Seismic Stability Rules Exemption	26
5.1.4.1 Asphalt behavior in the event of a spill	27
5.1.4.2 Asphalt storage vs. fuel storage in other states	27
5.1.4.3 Conclusions	28

SECTION 6: Appendices

6.1 Appendix A: Geotechnical Exhibits

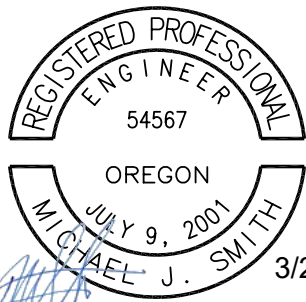
6.2 Appendix B: Site Plans

6.3 Appendix C: Photographs

REPORT DISCLAIMER

This report has been prepared by the undersigned. The contents of this report reflect the views of the author, who is solely responsible for the accuracy of the material and information presented herein, and does not constitute a standard, specification, or regulation.

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ERRATA SHEET FOR NORWEST ENGINEERING SEISMIC VULNERABILITY ASSESSMENT

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SEISMIC VULNERABILITY ASSESSMENT

SECTION 1: Seismic Vulnerability Assessment

1.1 Facility Overview

The Owens Corning Trumbull Plant in Linnton Oregon receives asphaltic petroleum fractions and processes them to produce modified asphalt binders. These asphalt binders have a variety of uses including asphalt pavement, the manufacture of fiberglass composite shingles, binders for built-up roofing, and binders for sealing pavement and other waterproofing applications.

Asphalt is delivered by rail and offloaded then stored in the tank farm. The facility does not refine asphalt; processing is limited to modifying asphalt to meet client specifications. Asphalt is loaded onto trucks for local distribution. The remainder of the site is used as storage and distribution of finished palleted shingle products.

1.2 Background

Per the State, a Cascadia Subduction Zone earthquake impacting the large capacity fuel handling facilities in Oregon could create widespread environmental damage, fires, endanger health and safety of surrounding communities and place impossible demands on the state's emergency response capabilities. The purpose of this act is to protect public health, life safety and environmental safety against fires and release of fuel products from large fuel storage facilities.

Oregon Laws 2022 Chapter 99 addresses the Oregon Resilience Plan written by the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) issued February 2013 and the Oregon Fuel Action Plan written by the Oregon Department of Energy (ODOE) issued October 2017. The two plans bring the recovery of basic infrastructure from a Cascadia earthquake event into sharp relief: The projected recovery for inland areas is expected to require up to 3 months. The projected recovery for coastal areas is expected to exceed 3 to 6 months.

Continued operation of existing fuel unloading and distribution terminals in Oregon will be essential in the recovery effort. Liquid fuels (gasoline, diesel, and jet fuel) will be a critical part of the recovery process ranging from fueling emergency and public safety vehicles to construction equipment required for restoration of transportation and utilities. Liquid fuels will need to be sourced from outside of the Cascadia impact areas. but there needs to be functioning local distribution terminals (with unloading and loading capabilities) to receive and distribute that fuel.

Based on the above, it is important to note that **this facility does not meet the intent of Oregon Resilience Plan nor the Oregon Fuel Action Plan and is not an essential facility for energy supporting emergency efforts.** An appeal for exemption from the Tank Seismic Stability Rules is discussed in Section 5.1.4 of this report.

1.3 Oregon Laws 2022 Chapter 99

The 2022 Oregon legislature adopted Senate Bill 1567 enacted as Chapter 99 of Oregon Laws 2022. The law authorizes the Oregon Department of Environmental Quality (ODEQ) to adopt requirements for Seismic Vulnerability Assessments (SVA) and the Risk Mitigation Implementation Plans (RMIP) for large capacity bulk fuels terminals in Columbia, Lane, and Multnomah counties.

Oregon Department of Environmental Quality (ODEQ) requires a Seismic Vulnerability Assessment (SVA) be submitted to the ODEQ by June 1, 2024. Within 180 days following ODEQ acceptance of the SVA, a facility-wide Seismic Risk Mitigation Implementation Plan must be submitted to the ODEQ.

The law applies to owners and operators of bulk fuel terminals or industrial facilities in Oregon with at least 2-million-gallon oil or liquid fuel products storage capacity. It is important to note that **asphalt is not a liquid fuel** and cannot be used as such.

1.4 The Oregon Resilience Plan

A Cascadia earthquake and tsunami will affect both Oregon and Washington. A particular vulnerability is Oregon's liquid fuel supply. Oregon depends primarily on liquid fuels transported into the state by pipeline and barges from Washington state refineries. Both states share common challenges, among them the interstate bridges and the Columbia River navigation channel as well as the regional power grid and liquid fuel supply. Once here, fuels are stored temporarily at Oregon's critical energy infrastructure hub, a six-mile stretch of the lower Willamette River where industrial facilities occupy liquefiable riverside soils. Disrupting the transportation, storage, and distribution of liquid fuels would rapidly disrupt most, if not all, sectors of the economy critical to emergency response and economic recovery.

1.5 Oregon Fuel Action Plan

As a result of a Cascadia earthquake Oregon can expect to lose most of the normal incoming supply of fuel. The Oregon Department of Geology and Mineral Industries (DOGAMI) 2013 Seismic Study found that the region's refineries and petroleum distribution terminals are expected to sustain moderate to significant damage. Existing facilities will have tank farm failures, marine dock failures, pipeline system breaks, hazardous material spills, fires, and structural damages onsite. Restoring the region's petroleum infrastructure will likely take months if not longer. In addition, the Olympic Pipeline that transports most of the gasoline, diesel, and jet fuel used in Oregon from refineries in Washington state is projected to be disabled for an extended period.

It is estimated that the existing petroleum terminals currently average a one-week fuel inventory at normal rates of consumption. So even if the terminals remain capable of distribution, they must also be capable of unloading product via barge and/or ship deliveries and/or tanker truck and/or rail car deliveries.

SECTION 2: Tank Seismic Stability Rules

2.1 Summary of the Rules

The owners and operators of bulk fuel terminals or industrial facilities with at least 2-million-gallon liquid fuel products storage capacity located in Columbia, Multnomah and Lane counties must provide a facility wide Seismic Vulnerability Assessment to ODEQ. The Oregon Department of Environmental Quality (ODEQ) Chapter 340 Division 300 Fuel Tank Seismic Stability provides the process criteria for the SVA. As noted in Section 1.3 above, **asphalt is not a fuel** and thus the inclusion for facilities subjected of the Rules should not apply to this facility.

2.2 Seismic Vulnerability Assessment (SVA)

The owners and operators of bulk fuel terminals or industrial facilities must:

- (A) Prepare and submit to Oregon Department of Environmental Quality (DEQ) a facility-wide Seismic Vulnerability Assessment (SVA) by June 1, 2024.
- (B) Be conducted and verified by an Assessment Team of qualified professionals.
- (C) Evaluate the existing site structures and facilities potential to maintain safe operating conditions, or safe shutdown procedures, to protect public health, life safety and environmental safety against releases of oils or liquid fuel products, including information about operational procedures during disasters.
- (D) Describe each facility component including fuel stored or handled, maximum and minimum storage volume, type of construction, age, inspection records, (if applicable), routine maintenance performed and when, and current normal operation.
- (E) Summarize currently implemented spill prevention and mitigation measures and their ability to achieve the performance objective defined in 340-300-0002;
- (F) Develop the Design Level Earthquake for the site in accordance with ASCE 7.

2.3 SVA Implementation

The SVA shall use the Codes and Standards as defined by OAR 340-300-0002(4) and the Design Level Earthquake determined using ASCE 7 to evaluate the potential for a spill greater than the Maximum Allowable Uncontained Spill during or after the Design Level Earthquake of all components including:

- (A) Existing buildings, structures, and ancillary components.
- (B) Tanks, pipes, and piping systems.
- (C) Spill containment measures and structures.
- (D) Transloading facilities, including wharves, berths, piers, moorings and

retaining structures; railcar unloading racks, and pipeline connections.

- (E) Truck Loading racks.
- (F) Control equipment; and
- (G) Any other structures related to or supporting facilities part of the bulk fuel terminal.
- (H) Evaluate soil's vulnerability to liquefaction, lateral spreading, and seismic-induced settlement.
- (I) Evaluate the safety of operating conditions, safe shutdown procedures, and potential spills.
- (J) Evaluate the availability and integrity of automated fire suppression systems and sufficient supplies of firewater and firefighting foam and other emergency response equipment located in seismically resilient locations that will be accessible after an earthquake or secondary effects to mitigate the risk of fire and explosions following an earthquake.
- (K) Evaluate the integrity of fire control measures such as firewalls surrounding the facility to limit fire spreading into surrounding communities; and
- (L) Evaluate the availability of day and night onsite personnel trained in emergency response and able to respond in the event of an earthquake.
- (M) Facility owner or operator must submit subsequent Seismic Vulnerability Assessment updates to DEQ.

2.4 Seismic Risk Mitigation Implementation Plan (SRMIP)

A seismic risk mitigation implementation plan must, at a minimum, identify actions, with timelines, to protect public health, life safety and environmental safety within the facility, in areas adjacent to the facility, and in other areas that may be affected because of damages to the facility. The Oregon Department of Environmental Quality (ODEQ) Chapter 340 Division 300 Fuel Tank Seismic Stability provides the process criteria for the SRMIP.

The SRMIP, as a risk-based assessment, must include consideration of the likelihood of a magnitude 9.0 Cascadia Subduction Zone earthquake or other seismic event that exceeds the impact of the Cascadia event, the potential consequences of that event and the resources needed to respond to that event.

Following acceptance of the SVA by the DEQ, the owners and operators of the regulated facilities shall prepare and submit to DEQ the facility-wide Seismic Risk Mitigation Implementation Plan (SRMIP) within 180 days which is designed to:

- (A) Mitigate earthquake-induced damage to reduce the potential of fuel spills and fires.
- (B) Address potential of facility to safely shut down during or immediately after a damaging earthquake, if needed, to minimize spills (as required by the

performance objective defined in 340-300-0002). Performance criteria must conform with the building codes in effect on September 1, 2023 as defined by OAR and may be based on the probabilistic or deterministic analysis or on an alternative analysis proposed by facility owner for DEQ's approval.

- (C) Provide risk mitigation measures implementation plans and timeline; and
- (D) Provide periodic reports of the ongoing implementation of mitigation measures.
- (E) Implement the risk minimization measures described in Risk Mitigation Implementation Plans when approved by DEQ within the approved timeline.
- (F) Prepare and submit to DEQ post-implementation reports documenting completion of mitigation work and addressing residual risks.
- (G) The Risk Mitigation Implementation Plan must outline interim mitigation actions that will be completed within 1, 3, & 5 years based on feasibility and order of importance.
- (H) All mitigation measures approved by DEQ must be completed within 10 years after the DEQ approves the Risk Mitigation Implementation Plan.
- (I) Annual Risk Mitigation Implementation Plan implementation status reports must be submitted by June 1st of each year, or on a schedule approved by DEQ in the Risk Mitigation Implementation Plan.

SECTION 3: Basis for Rules Development

The Environmental Quality Commission, in consultation with the State Department of Geology and Mineral Industries, shall adopt by rule a seismic risk mitigation implementation program for bulk oils or liquid fuels terminals that is based on risk. To the extent feasible and appropriate, the program adopted under this section shall be consistent and coordinated with the program established under ORS 468B.345 to 468B.415. Rules adopted under this section shall include, but not be limited to:

2 (a) Rules for the required content of seismic risk mitigation implementation plans and rules for approval by the Department of Environmental Quality of seismic risk mitigation implementation plans.

2 (b) Provisions for training, response exercises, external peer reviews, inspections, and tests to verify the ability of the facility to sustain safe conditions and respond to uncontrolled releases of hazardous materials from the bulk oils or liquid fuels terminal due to an earthquake.

2 (c) Requirements to minimize harmful impacts to local communities and natural resources due to uncontrolled releases of hazardous materials from the bulk oils or liquid fuels terminal due to an earthquake and its associated direct and indirect impacts, including fires and flooding.

2 (d) Requirements for the inspection of bulk storage tanks at bulk oils or liquid fuels terminals.

2 (e) Design and construction standards for new bulk storage tanks constructed at bulk oils or liquid fuels terminals.

2 (f) Design and construction standards for seismic mitigation of existing bulk storage tanks, piping and related structures constructed at bulk oils or liquid fuels terminals.

2 (g) Provisions requiring the proper installation of seismically certified generators to power critical operations, or at a minimum, the installation of electrical hookups for emergency generators.

2 (h) Provisions for the review of seismic vulnerability assessments required under section 2 of this 2022 Act and seismic risk mitigation implementation plans required under subsection (1) of this section by state agencies with expertise in earthquake hazards, risk mitigation or emergency preparedness or management.

2 (i) Provisions requiring the owner or operator of a bulk oils or liquid fuels terminal to submit seismic vulnerability mitigation implementation plan updates to the department:

(A) According to a schedule established by the commission.

(B) Upon the retrofit or reconstruction of all or a part of a bulk oils or liquid fuels terminal; and

(C) Based on new scientific or technical findings, but no more frequently than once every three years.

2 (j) Provisions establishing a fee calculated to cover the costs to the department of reviewing seismic risk mitigation implementation plans submitted under this section and seismic risk assessments submitted under section 2 of this 2022 Act, less any federal funds received by the department for those purposes. Fees received by the department under this paragraph shall be deposited in the Seismic Risk Mitigation Fund established under section 6 of this 2022 Act.

2 (k) Provisions establishing grants or other financial assistance to owners or operators of bulk oils or liquid fuels terminals for improvements to existing infrastructure, provided that federal funds are made available to the department for that purpose.

SECTION 4: Assessment Methods and Approach

4.1 Summary of Evaluation Methods

4.1.1 Geotechnical

The geotechnical assessment was prepared by Sage Geotechnical, LLC (Sage) under the direction of Daniel Simpson, PE, GE. Sage's geotechnical evaluation included:

- An assessment of site conditions, including the geotechnical properties of subsurface soil and groundwater.

- A seismic hazard evaluation. Strong ground motion hazards were defined in accordance with the response spectrum in the American Society of Civil Engineers' (ASCE) *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (2017). Soil liquefaction and potential liquefaction effects were evaluated in accordance with guidelines established by the National Academies of Sciences, Engineering, and Medicine (2021).
- A geotechnical evaluation in which the results of the site-condition assessment and seismic hazard evaluation were combined to estimate the effects that earthquakes could have on site soils and foundations.

Most of the infrastructure was constructed prior to the codification of contemporary seismic design standards; as such, even moderate lateral spreading could result in an exceedance of the performance threshold specified in Oregon Administrative Rule (OAR) 340-300. To account for this, Sage established an idealized site condition or geotechnical profile that could be used to assess seismic hazards (mainly, lateral spreading and liquefaction-induced settlement) and the horizontal extent of the site likely to be affected by significant lateral spreading.

4.1.2 Structural

Norwest conducted an on-site visual structural assessment of the facility to identify items which may be vulnerable in a design seismic event. The assessment was conducted by a team of licensed professional engineers. Efforts were focused on facility components including tanks, piping supports, loading facilities, containment structures, building structures, and other equipment identified as in-service and potentially impactful to the transportation of bulk oil or liquid fuels.

Our seismic performance expectations outlined below have been produced with consideration of sitewide liquefaction potential, as identified in the geotechnical evaluation. Some items identified as low risk in a design seismic event may be subject to additional lateral displacement, settlement, or residual stresses in a liquefaction or lateral spreading event, resulting in an exceedance of the performance requirement. As indicated above, potentially liquefiable soil is present at the site, but risk to specific items should be evaluated on a case-by-case basis.

Additionally, a distinction should be made between facility components which transport or hold asphalt, and components which transport or hold oil and fuel. While some items which transport or hold asphalt may be at risk of spill in a design seismic event, the spill of asphalt material does not have the same environmental implications as a spill of oil or fuel. In a spill scenario, asphalt will harden and become viscous at ambient temperature. This process helps mitigate contamination of the environment or adjacent properties, aid in cleaning of a spill, and differentiates an asphalt spill from an oil or fuel spill.

4.1.3 Safety/Mechanical/Fire

The safety assessment was limited to review of available documentation, drawings, reports, and procedures provided by Owens Corning. Many of the documents have been developed in accordance with Federal regulations. The information was reviewed and analyzed by a licensed professional engineer. Judgements and conclusions were drawn relative to the facility's safety of operating conditions, fire suppression systems, emergency response, and spill containment.

4.2 Facility Areas Evaluated

4.2.1 Process Area

The process area serves the truck rack, where asphalt product is loaded and shipped off site. This area contains multiple vessels and tanks, pumps, boilers, piping and conduit, and steel supports throughout this area. A small building for operations is located in this area, as well as a CMU building housing an MCC and boiler.

4.2.2 Tank Farm

The tank farm contains two large tanks and associated piping. The tank secondary containment is provided by soil embankments; the tank farm was constructed such that the tanks sit lower in elevation than the surrounding grades. A hot oil thermal system is also located in the tank farm.

4.2.3 Rail Spur

A single spur curves around the northern property, terminating adjacent to the tank farm. Multiple railcar unloading spots are located along the spur, where the railcars are unloaded from the underside of the cars. Small pumps, steam lines, and miscellaneous infrastructure supports the rail operations.

4.2.4 Marine Facility

A short pier and pier head structure is located on the river adjacent to the tank farm. It is a steel and concrete structure with two mooring/breasting dolphins and access walkways in addition to the pier/pier head. It has been out of service for some time and the service piping to/from the pier is disconnected.

4.2.5 North Warehouse Area

Two warehouses are located north of the process area. They are unoccupied structures that house materials and tools and some electrical equipment for the plant.

4.2.6 South Warehouse Area

The two-story administrative building located south of the main process area houses additional operations and administrative staff.

Two warehouses are located south of the administration building and are associated with the plant's asphalt shingle storage and distribution business. They are not associated with asphalt storage and distribution.

SECTION 5: Vulnerability Assessments

5.1 Summary of Evaluation Methods

5.1.1 Geotechnical Assessment (Site Wide)

5.1.1.1 *Site Conditions Assessment*

5.1.1.1.1 *Site surface conditions, topography, shoreline topography.*

Regional topography is depicted on Appendix A Figure A-1 Site topography and near-shore bathymetry are shown on Appendix A Figure A-2. Readily available light detection and ranging data (DNR, accessed February 19, 2024), bathymetric surveys of the Willamette River (City of Portland, accessed February 19, 2024), and site-specific survey data were used to evaluate the topography and bathymetry of the site and the surrounding area.

The site is bordered by the Portland Hills to the west and by the Willamette River to the east. As shown on Appendix A Figure A-2, the site is mostly level with 10 to 30 percent slopes near the riverbanks. The site is located approximately 20 to 30 feet (ft) above the average surface water elevation of the Willamette River. Local topographic relief includes secondary containment berms and railway embankments.

The site is surfaced with sod, soil, asphalt, and concrete. Tanks, mechanical equipment, buildings, and parking/drive aisles are present throughout the site.

5.1.1.1.2 *Description of regional and site geology including soil stress history, deposition environment, and bedrock and soil units.*

Geologic information for the site and the surrounding area was obtained from the Preliminary Geologic Map of the Linnton 7.5' Quadrangle, Multnomah and Washington Counties, Oregon (Madin et al. 2008). Near-surface deposits at the site are mapped as artificial fill (af), a man-made mixture of clay, silt, sand, gravel, debris, and rubble. Alluvium (Qal) is also mapped at the site and consists of clay, silt, and sand deposited by the Willamette River during the Holocene Epoch. The alluvium is underlain by a 130-ft-thick layer of Grande Ronde Basalt (Tsgb), an extrusive, igneous rock formed by the rapid cooling of dark gray or black lava. The condition of the artificial fill and alluvium likely ranges from normally consolidated to slightly overconsolidated.

Previous site operations—plywood manufacturing facility, sawmill, and log yard/log float—likely influence the constituents of the fill soils.

5.1.1.1.3 Description of field explorations and laboratory testing.

While at Landau Associates, Inc. (Landau), Sage Principal Engineer Daniel Simpson oversaw the site subsurface investigation, which included four cone penetration test soundings (CPT-1 through CPT-4) and two mud rotary borings (B-1 and B-2). The approximate locations of the explorations are shown on Appendix A Figure A-2b. Sage reviewed the site subsurface data reported by Landau (2022) when preparing this seismic vulnerability assessment (SVA). A complete copy of Landau's geotechnical engineering report is provided in Appendix A-1; exploration methods are described in Section 2.3 of the report.

Representative soil samples collected from the explorations were analyzed for grain size, plasticity, moisture content, and consolidation properties. Laboratory test methods and results are described in Appendix C of Landau's geotechnical engineering report (Appendix A-1).

5.1.1.1.4 Description of site subsurface conditions, including soil and rock units encountered, extents and properties of those units, and groundwater conditions.

Site subsurface conditions were characterized by generalizing soil with similar geotechnical behavior according to the following engineering stratigraphic units (ESUs):

ESU 1 Fill. ESU 1 consists of fill used to raise site grades. The fill observed in Landau's explorations primarily consisted of coarse-grained soils with variable wood debris and interbedded layers of wood waste.

ESU 2a Recent Alluvium. ESU 2a consists of very soft to soft, low-plasticity silt with interbeds of elastic silt.

ESU 2b Old Alluvium (loose). ESU 2b consists of loose to medium dense, silty sand to sandy silt with interbeds of low-plasticity and elastic silt.

ESU 2c Old Alluvium (dense). ESU 2c consists of medium dense to very dense, silty sand to sand with silt that may be remnants of the Troutdale Formation.

ESU 3 Basalt. ESU 3 consists of basalt. A CME-75 truck-mounted drill rig with a tricone bit was advanced approximately 1 to 3 ft into the basalt before encountering refusal.

On August 27, 2020, the groundwater elevation at the site was estimated to be approximately 10 ft below ground surface (bgs). This estimate was based on the results of pore pressure dissipation tests completed in cone penetration test soundings CPT-1 and CPT-3. Moisture content observations from borings B-1 and B-2, advanced in June 2021, indicate a site groundwater elevation of approximately 8.5 ft bgs.

A geotechnical cross section of the site is shown on Figure A-3.

5.1.1.1.5 *Description of methods, analyses, assumptions, and judgments.*

Analyses for the geotechnical portion of the SVA were completed in general accordance with current standards of practice and with methods described in peer-reviewed literature. The individual methods, analyses, assumptions, and judgments are described in the following sections.

5.1.1.2 *Seismic Hazard Evaluation*

The following were used to support the seismic hazard evaluation (see Appendix A-2):

- Site class determination (A-2-1).
- Building code seismic design parameters for the site (A-2-2).
- The U.S. Geological Survey (USGS) seismic hazard disaggregation for the site (A-2-3).
- Liquefaction and residual strength calculations (A-2-4).
- Empirical lateral spreading calculations (A-2-5).
- Seismic bearing capacity calculations (A-2-6).

5.1.1.2.1 *Description of seismic hazards at the site, including seismic evaluation criteria (expected ground shaking), liquefaction, settlement, surface effects, loss of strength, lateral spread, and slope stability as appropriate.*

Sage used the USGS 2014 National Seismic Hazard Model (v4.2.0) to review the peak ground acceleration (PGA) seismic hazard disaggregation for the site with a seismic site class of D. Based on this review, approximately 55 percent of the seismic hazard at the site stems from an interface rupture along the Cascadia subduction zone. The nearby Portland Hills fault constitutes approximately 9 percent of the seismic hazard at the site. The remaining hazard stems from other finite fault sources, random crustal events, and random deep intra-slab events. The mean moment magnitude from the PGA disaggregation, reproduced in Table G-1, was selected for liquefaction and lateral spreading analyses.

Table G-1. Seismic Parameters for Liquefaction and Lateral Spreading Analyses

Parameter	Value
Moment magnitude (M_w)	7.91
Peak ground acceleration (PGA_M)	0.486 g

g = force of gravity

Seismic evaluation criteria (expected ground shaking) were determined in accordance with ASCE 7, per OAR 340-300-0002(4)(a):

- The seismic site classification was determined using the shear wave velocity (V_s) measurements collected from cone penetration test sounding CPT-1 and the estimated shear wave velocities for soil and rock layers between CPT refusal (81 ft bgs) and 100 ft bgs. The V_s for the soil layers between CPT refusal and the bottom of ESU 2c was correlated with the standard penetration test N-value from the adjacent mud rotary boring (Wair et al. 2012). The V_s for the basalt layer between the bottom of ESU 2c and 100 ft bgs was determined by reviewing the V_s for similar materials in Sowers and Boyd (2019). The $V_{s,30}$ calculation is presented in Appendix A-2.
- Based on $V_{s,30}$ the site classifies as a seismic Site Class D; however, the presence of liquefiable soils results in modification to a seismic Site Class F. Per ASCE 7-16 and the 2022 Oregon Structural Specialty Code (hereafter, 2022 OSSC): For structures with a fundamental period of vibration of 0.5 seconds or less, a design response spectrum corresponding to the non-liquefied site class may be used where the presence of liquefiable soils would otherwise result in a Site Class F. For structures with a longer fundamental period of vibration, a site response analysis is required to determine the design response spectrum. The minimum response spectrum allowed at this site, following a seismic site response analysis, is 80 percent of the Site Class D response spectrum. Because this is a screening-level study, potentially vulnerable structures should be assessed using the Site Class D response spectrum, even if they have a fundamental period of vibration longer than 0.5 seconds. Additional analysis (e.g., a site response analysis) may be required if potentially vulnerable structures do not exceed the performance criteria for the Site Class D response spectrum and if the structures have a fundamental period of vibration longer than 0.5 seconds.
- The parameters in Table G-2 can be used to determine the Site Class D response spectrum. Structural analyses completed with this response spectrum are subject to the requirements in the notes following Table 11.4-2 in ASCE 7-16, Supplement 3 and to the corresponding limitations on the use of the site coefficient F_V .

Table G-2. Seismic Response Spectrum Parameters

S_s	F_a	S_1	F_v
0.898	1.141	0.413	1.887

F_a , F_v = acceleration (0.2-second period) and velocity (1.0-second period) site coefficients, respectively
 S_s , S_1 = 0.2-second and 1.0-second period spectral accelerations, respectively

Soil liquefaction hazards, including liquefaction-induced settlement, soil strength loss, and lateral spreading/flow failure, are also present at the site.

5.1.1.2.2 Liquefaction/lateral spreading

Sage used the following methods to complete liquefaction and lateral spreading analyses:

- **Liquefaction susceptibility** (i.e., whether soil will behave like sand or clay during dynamic loading) was determined in accordance with Boulanger and Idriss (2006) where Atterberg limits were available and with Robertson and Wride (1998) where CPT data were available. A soil behavior index of $I_c = 3.0$ was used as the cutoff for non-liquefiable soil (i.e., $I_c \geq 3.0$ is not susceptible to liquefaction).
- **Liquefaction triggering potential** (i.e., whether the earthquake cyclic stress ratio would exceed the cyclic resistance ratio of soil) was calculated in accordance with the procedure established by Boulanger and Idriss (2014). The calculations (Appendix A-2) were completed using cone penetration test data and CLiq software, version 3.5.2.22 (Geologismiki 2024). A groundwater elevation of 8 ft bgs was selected for the liquefaction triggering analysis, and soil layers above groundwater were assumed to be non-liquefiable.
- **Liquefaction/seismic strength loss:** Liquefied soil residual shear strength was computed using the procedure established by Boulanger and Idriss (2008), with void redistribution assumed to be significant. The residual shear strength of triggered, non-susceptible was calculated assuming the soils are susceptible. Residual strength calculations are provided in Appendix A-2.
- **Liquefaction-induced settlement** was estimated in accordance with the procedure established by Boulanger and Idriss (2008). Settlement calculations are provided in Appendix A-2. Liquefaction-induced settlement of dry sand was omitted from the calculations, as the site is underlain by little, if any, dry sand.
- **Lateral spreading** was calculated in accordance with the procedure established by Zhang et al. (2004). Lateral spreading calculations are provided in Appendix A-2.

Based on the results of the liquefaction calculations, the cyclic stress ratio for the design-level earthquake exceeds the cyclic resistance ratio for almost all soil layers.

Sage estimates that 10 to 30 inches of liquefaction-induced total settlement could occur following a seismic event; up to 30 inches of liquefaction-induced differential settlement could occur over 50-ft spans. Estimated lateral spreading contours are shown on Figure A-2a.

5.1.1.2.3 Seismic settlement

Free-field seismic settlement typically is caused by the reconsolidation of liquefied soils, ejection of liquefied soils, consolidation of dry sands. Because liquefaction is so severe, liquefaction-induced settlement was approximated with just reconsolidation settlement, based on the procedure established by Boulanger and Idriss (2008).; calculations are provided in Appendix A-2. Actual free-field, and structure settlement, is anticipated to be in excess of these estimates. Settlement caused by dry sand consolidation was omitted from the calculations, as the site is underlain by little, if any, dry sand.

Liquefaction-induced settlement and seismic bearing capacities are discussed in Section 5.1.1.3.

5.1.1.2.4 Slope stability

With the exception of the riverbank, the site is flat, and slope instability is not considered a seismic hazard. As noted, the riverbank and near-shore area are susceptible to flow failure.

5.1.1.2.5 Miscellany, Such as Surface Effects

The presence of seismic hazards, other than those discussed herein, is anticipated to be insignificant. No active faults are present at the site (USGS, accessed February 19, 2024).

5.1.1.3 Geotechnical Evaluation

Section 5.1.1.2 describes the methodology Sage used to evaluate seismic hazards at the site. Based on the results of its evaluation, Sage has identified the following potential hazards:

- During, or immediately after, a seismic event, a non-liquefied crust of variable thickness will be present at the site. The crust will be underlain by a laterally and vertically variable mixture of liquefied, sand-like soils and cyclically degraded, non-liquefied, clay-like soils (ESUs 2a and 2b). The sand- and clay-like soils will be underlain by a medium dense to dense, coarse-grained material that is generally not susceptible to liquefaction (ESU 2c) and a competent basalt layer (ESU 3).
- Following the onset of liquefaction, flow failure may occur within approximately 300 ft of the shoreline toe at the Willamette River. The seismic hazard transitions from flow failure to lateral spreading with distance from the shoreline; estimated lateral displacement decreases with distance from the shoreline.
- A significant percentage of the seismic hazard stems from large-magnitude sources, and seismic analysis should combine internal loading and liquefied soil conditions (WSDOT 2024), except where noted below (e.g., liquefaction downdrag loading).
- Sage made the following simplifying assumptions when completing its seismic hazard/geotechnical evaluation that lead to conservatism in estimating seismic demand:
 - When completing its lateral spreading analysis, Sage assumed that soils would strain to the maximum theoretical limit and that all soil layers strain in the same direction (Zhang et al. 2004).
 - When calculating the seismic bearing capacity, Sage assumed that all soils below the water table would reach an average residual strength to vertical effective stress ratio of 0.1.

5.1.1.3.1 Seismic design parameters

Seismic design parameters are provided in Section 5.1.1.2.

5.1.1.3.2 Estimated vertical settlement

Sage estimates that 10 to 30 inches of free-field liquefaction-induced total settlement could occur following a seismic event; up to 30 inches of liquefaction-induced differential settlement could occur over 50-ft spans. The effects of lateral spreading, ejecta, and structure rocking may increase these settlement estimates.

5.1.1.3.3 Lateral ground deformations

Flow failure is estimated to occur within approximately 300 ft of the toe of the Willamette riverbank. The flow failure zone shown on Figure A-2a was delineated by selecting areas with lateral displacements of more than 15 ft (Zhang et al. 2004).

The severity of lateral spreading is estimated to decrease with distance from the riverbank. The lateral spreading contours shown on Figure A-2a were developed in accordance with the procedure described in Section 5.1.1.2.2.

5.1.1.3.4 Foundation design parameters

5.1.1.3.4.1 Shallow Foundations

Liquefaction may affect the bearing capacity of shallow foundations wider than 4 ft or of foundations embedded more than 4 ft below grade. If seismic bearing pressures exceed those listed in Table G-3, foundations may experience a degree of settlement greater than that noted in Section 5.1.1.3.2. The values in Table G-3 include a safety factor of approximately 1.5.

Table G-3. Seismic (liquefied soil) Shallow Foundation Allowable Bearing Capacity

Foundation Width	4 ft	8 ft	16 ft	32 ft	64 ft	128 ft
Allowable Seismic Bearing Capacity	1.6 ksf	1.2 ksf	1.2 ksf	1.1 ksf	1.0 ksf	1.0 ksf

ft = feet

ksf = kips per square foot

5.1.1.3.4.2 Lateral Resistance of Shallow Foundations

If ground displacement occurs, shallow foundations will move laterally in accordance with the lateral spreading contours shown on Figure A-2. Lateral resistance to movement in excess of the lateral spreading, or in different directions, can be provided by passive pressure and basal friction.

Basal friction can be computed with a friction coefficient of 0.4 using dead loads. Passive pressure can be estimated with an allowable equivalent fluid density of 250 pounds per cubic foot. This includes a safety factor of at least 1.5. When computing passive resistance, the 2 feet of soil should be neglected. When combining passive resistance and basal friction, the passive component should not exceed one-third of the total resistance.

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5.1.2 Structural Assessment

5.1.2.1 *Seismic Performance Expectations*

Seismic performance was evaluated qualitatively based on condition assessment and structure type. The performance evaluation primarily considered gravity and inertial loading. Soil displacement due to liquefaction is anticipated to result in exceedances of the performance criteria for most structures.

5.1.2.1.1 *Process Area*

5.1.2.1.1a *Tanks*

Several tanks are provided at the Process Area near the center of the facility, including tanks labeled T-3 through T-18, T-51, T-60, C-1 through C-4, K-1, and K-2. Tanks are typically used for storage of asphalt, cooling water, and other mixing products as indicated by a placard at each tank.

Tall slender tanks have mechanical anchorage, and a foundation is provided. Other larger diameter tanks appear to be self-anchored. We believe storage tanks at the Process Area are of low risk in a design seismic event.

5.1.2.1.1b *Truck Loading Rack*

Several truck loading racks are provided around the Process Area. The racks are comprised of steel braced frames with a platform level and cantilevered awning. The truck racks appear to be well conceived, have a low seismic mass and are of low risk in a design seismic event.

5.1.2.1.1c Pipe Supports/Racks

Several pipe rack structures are provided at the Process Area supporting multiple pipes which run between tanks and process buildings. The pipe bridges typically consist of braced frames in the longitudinal direction and transverse moment frames. Piping is supported at approximately 20-feet above grade. At most locations, the pipe racks appear to be engineered and of low risk in a design seismic event. At a few isolated locations, deficiencies were observed including removed bracing and missing anchor rods. However, due to the infrequency of observed deficiencies, we believe the pipe racks are of low seismic risk.

A few pipe bridges are provided at the Process Area to cross over driving lanes. The pipe bridges are typically well braced and appear to be well conceived. We believe the pipe bridges are of low seismic risk.

Numerous individual pipe supports are provided around the Process Area in addition to the pipe racks and bridges. Pipe supports typically appear to be engineered and well-conceived, with a few exceptions.

One row of pipe supports between tanks T-3 and T-6 consists of a tall slender steel pipe with several added steel members to support piping. Based on the height and construction we believe this support type is at risk in a design level seismic event.

At one location adjacent to the MCC building, a long-span cantilever is provided at the end of a pipe rack. The cantilever is approximately 10 feet and supports large diameter piping close to the cantilever tip. We believe this support type is at risk in a design level seismic event.

5.1.2.1.1d Ancillary Equipment

Various ancillary tanks and equipment are provided in the Process Area, including smaller tanks, pumps, and electrical panel equipment. With a few exceptions, the in-service ancillary equipment appeared to be properly anchored and located on a foundation. We believe the anchored and founded equipment is of low risk in a design level seismic event.

The columns (equipment) are on concrete foundations and are connected to the columns with mechanical anchorage. We believe the columns are of low risk in a design level seismic event. The piping connected to the columns appear to be well engineered and supported. We believe the piping is of low risk in a design level seismic event.

At one location a horizontally oriented Patterson-Kelley pressure vessel is provided on saddle bases. The saddles are located on concrete piers and appear to be placed on shims without anchorage. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A horizontally oriented tank indicated as pre-heater #2 is provided toward the south end of the Process Area. The pre-heater is located on a steel skid which was not observed to

be anchored. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A small diameter vertically oriented tank indicated as the Loading Rack #1 Fiber Filter was observed without anchorage at the base. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

An RTO is located on a skid at the Process Area along with electrical equipment. No anchorage was observed at the base of the skid. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A boiler is also in the area. It sits on a concrete foundation and is anchored. We believe the boiler is of low risk in a design level seismic event. The pipe supports around the boiler appear to be in good condition and robust. The piping connections to the boiler and the surrounding piping is also of low risk in a design seismic event.

5.1.2.1.1e Canopies and Building Structures

Several buildings are located in the Process Area, including an administrative office building, operations center, boiler/MCC building, and numerous smaller canopy structures.

The boiler/MCC building is used for housing process equipment. The original building is two stories and constructed of cast-in-place concrete. Additions have been completed over time with masonry construction. Based on provided documents, the masonry additions appear to be reinforced and of low seismic risk. No information is available on the two-story concrete building. We believe the original two-story concrete building may be at risk in a design seismic event.

Several smaller canopy type structures are provided around the Process Area to cover mechanical and electrical equipment. The canopies are light framed and appear to be well conceived. Due to their low seismic mass the canopy buildings are of low risk in a design seismic event.

5.1.2.1.2 Tank Farm

5.1.2.1.2a Tanks

Two large diameter tanks are located in the tank farm area. The tanks are denoted T-1 and T-2. Both can be used for storing raw (flux) material and finished asphalt. The tanks are supported on shallow foundations. No anchorage bolting was observed at either tank. Based on the height and diameter, the tanks appear to be self-anchored. Self-anchored tanks perform well during seismic events and lateral spread is not expected to create significant differential settlement in the area. This minimizes the likelihood of the tank becoming unstable. The tanks generally appear to be well conceived and engineered. Based on our analysis we believe there is a low risk of tank overturning during the design seismic event but there is a concern with tank rupturing due to non-compliance with API 650 Appendix E.

5.1.2.1.2b Pipe Supports/Racks

Pipe supports at the tank farm area typically consist of steel tube and wide flange T-supports on a concrete pier foundation. The supports carry a few large diameter process pipes which are elevated approximately 12-feet above grade. The supports typically appear to be engineered and well-conceived and are likely at minimal risk in a design seismic event.

5.1.2.1.2c Ancillary Equipment

A few ancillary tanks and equipment are provided in the tank farm area, including smaller tanks, pumps, and electrical panel equipment. With a few exceptions, the in-service ancillary equipment appeared to be properly anchored and located on a foundation. We believe the anchored and founded equipment is of low risk in a design level seismic event.

At one location two CECO fume filters are provided on light framed bases. Due to the height and weight of the filters, and the slenderness of the bases, we believe these may be at risk in a design seismic event.

A hot oil expansion tank is located at the top level of a platform next to the hot oil heater building. The tank is located directly on beams framing the top level of the platform and no diaphragm bracing was observed. We believe this tank may be subject to lateral movement and may potentially compromise the platform framing in a design level seismic event, leading to failure of the tank.

5.1.2.1.2d Canopies and Building Structures

Structures provided at the Tank Farm area include the hot oil heater building and hot oil surge tank platform.

The hot oil heater building is a light-gage metal storage building which houses a hot oil storage drum and process equipment. The building has a low seismic mass and is of low risk in a design seismic event.

The hot oil surge tank platform is a two-story steel structure consisting of chevron braced frames. The platform houses an elevated tank at the top level, and various equipment and piping. The platform appears to be engineered and is of low risk in a design seismic event.

5.1.2.1.3 Rail Spur

5.1.2.1.3a Pipe Supports

Several active piping runs are supported on steel pipe supports at the Rail Spur. Piping at the Rail Spur is typically located 3-feet above grade or less with anchorage and a foundation provided. The pipe supports are well conceived, and of low seismic risk given the height of the supports.

5.1.2.1.3b Ancillary Equipment

Isolated pumps and other equipment are provided near the rail unloading area at the Rail Spur. The equipment is typically anchored and well-conceived, and of low seismic risk.

5.1.2.1.3c Containment Structure

Cast-in-place concrete containment walls are provided at the Rail Spur. The containment walls typically appear to be of adequate height and construction to resist hydrostatic loading in a spill event.

5.1.2.1.4 Marine Facility

5.1.2.1.4a Dock Structure

The dock structure consists of steel and concrete construction. The dock was permitted through the US Army Corps of Engineers and all repairs, modernizations and improvements have been permitted through federal and state agencies. The dock is currently in “caretaker status” with the United States Coast Guard and is no longer used for material transfers.

The dock and berthing dolphins consist of precast concrete battered piles, and the dock consists of approximately 220-feet of berthing. Limited information is available on the dock structure beyond what is visually available.

Battered piles are typically not recommended in new dock construction in seismic zones, due to their rigidity which may restrict seismic force dissipation. Based on the weight supported by the dock and the presence of a battered pile lateral resisting system, we believe the dock structure is at risk in a design level seismic event.

5.1.2.1.4b Pipe Supports

Numerous pipe supports are present within the Marine Facility area. Piping at the Marine Facility is typically located 3-feet above grade or less and anchored to the concrete dock structure. The pipe supports are well conceived, and of low seismic risk given the height of the supports provided the dock structure itself is adequate.

5.1.2.1.4c Canopies and Building Structures

An operations shack is located on the pier head. The shack is of light frame construction, appears to have a low seismic mass and poses minimal risk of impacting spill prevention.

5.1.2.1.5 North Warehouse Area

Several building structures are provided at the North warehouse area, including the pour building and materials storage buildings. The buildings are typically light framed buildings which are used for storage of solid materials and manufactured products. The buildings appear to be well conceived and pose minimal risk of impacting spill prevention.

5.1.2.1.6 *South Warehouse Area*

Several building structures are provided at the South warehouse area, including Building “C”, the shipping and receiving office, and warehouse buildings. The buildings are typically light framed buildings which are used for storage of solid materials and manufactured products. The buildings appear to be well conceived and pose minimal risk of impacting spill prevention.

The administrative office building is a two-story light framed structure used for plant operations. The building appears to be well conceived and poses minimal risk of impacting spill prevention.

The operations center and Obeya room is a single-story light framed structure for plant check-in and meetings. The building appears to be well conceived and poses minimal risk of impacting spill prevention.

5.1.3 Safety Assessment

5.1.3.1 *Description of fire control system*

5.1.3.1.1 *General system description*

The Owens Corning Trumbull Plant is served by a single 6-inch lateral originating from an 8-inch tap of the municipal water main in Old St. Helens Road (Hwy 30). Water is provided by the City of Portland. The size of the municipal main is unknown, as this information is typically classified for public safety reasons. The facility has five private fire hydrants, spaced throughout the site. The asphalt tanks are all equipped with steam snuffing systems which are considered an industry standard suppression technique for heavy oil.

The facility contains a fire access road stemming from Hwy 30 that encircles the processing equipment and storage facilities. The access road width and minimum turning radius for the access road are both compliant with Portland Fire Code.

Prior evaluations and industry best practice have concluded that steam snuffing is the preferred method of asphalt fire suppression. The tanks are fully insulated, making it difficult to apply cooling water to the shell and tank roof from fire suppression equipment. Furthermore, asphalt materials are stored at elevated temperatures and would react violently to water being introduced inside of the tank. Thus, internal tank suppression is determined to be the most effective. It should be noted that asphalt, despite being a petrochemical, is not flammable and has a flashpoint greater than 500°F.

5.1.3.1.2 *City water supply, vulnerability of the feed and the onsite U/G lines to liq/lat spreading damage.*

During a seismic event, underground pipes are at risk of being damaged including the fire protection water lines that serve the facility. This applies to both the water main in Hwy 30, which could be affected anywhere along its length upstream of this property,

and the onsite lines connecting the fire hydrants. Liquefaction-induced lateral spreading may create stress on the underground pipes, potentially causing damage. If a pipe in the system breaks, the network would lose pressure and no longer be effective. Therefore, the water feed is vulnerable in a design seismic event.

Additionally, the City water main in Hwy 30 has limited capacity in terms of flow and pressure. Many terminals along Hwy 30 have determined that any limitations in their fire suppression abilities are a result of the City water main flow and pressure and not the terminal infrastructure. It is reasonable to assume that the existing water supply is sufficient for the full range of suppression quantities recommended in the Bitumen Safety Code. This assumes that other terminals and properties upstream of this site are also not operating at maximum fire suppression capacity, simultaneously.

5.1.3.2 Description of spill containment systems equipment, procedures

Owens Corning maintains a Spill Prevention, Control, and Countermeasure (SPCC) Plan for the Trumbull Plant, in accordance with 40 CFR 112. It describes transfer operations, drainage, spill response and reporting, discharge prevention, security, inspections, and training. Aside from the two large tanks, other ancillary equipment tanks are of very low storage volume.

The two largest tanks containing asphalt are located inside the Tank Farm secondary containment structure. Earthen and concrete walls were used in the construction of the secondary containment perimeter, while the floor of the secondary containment is earth. The possibility of a leak through the containment walls or floor in the event product is released from the tanks is extremely low, provided differential settlement does not greatly affect the geometry of the system. The site-wide secondary containment system will provide additional backup in this case.

A catastrophic tank failure beyond design level would result in material flowing out of the main tank farm secondary containment into the plant wide secondary containment system. Within the plant wide containment system, there are smaller containment areas for the hot oil system, knockout tanks, and cutter stock storage tank. The material of construction of both the tank farm and the plant wide secondary containment systems are appropriate for the asphalt flux stored in the area.

The facility uses dikes, catch pans, sumps, sorbent materials and/or catch basins to provide secondary containment for petroleum products stored on-site. Secondary containment systems in these areas, including walls and floors, are capable of containing oil and have been constructed so that any discharge from a primary containment system, such as a tank, will not escape the containment system before cleanup occurs.

The secondary containment structures are sized to hold the contents of the largest container located in that structure and sufficient freeboard to contain precipitation. For containment areas not large enough to hold the tank contents and a rain event during a spill, the site-wide containment is large enough to hold the materials. Diked areas are sufficiently impervious to contain discharged oil.

A hot oil system is used to heat asphalt in stored tanks and in lines to keep it fluid. The hot oil system is self-contained and pumps hot oil through coils and lines. A leak in the system will result in a loss of pressure in the system, decreased hot oil flow and/or the expansion tank empties. If any of those conditions are detected, the system will automatically shut down. The hot oil heater and expansion tank are located in secondary containment.

5.1.3.2.1 Risks in the event of a catastrophic failure

The facility's spill prevention and secondary containment measures described above are adequate if an earthquake were to rupture the single largest tank in each containment area. In an extreme event where multiple tanks are ruptured simultaneously, the spill volume would exceed the containment capacity. However, it is not standard practice to design for this event and would require excessive infrastructure and space.

However, in such an event, the **risk to soil** is extremely low and the resulting cleanup has very low environmental risks. The **risk to groundwater** is equally low, given that asphalt does not emulsify easily, is highly viscous and cannot permeate soil. These risks are described further in Sections 5.1.3.2.2 and 5.1.4.1 below. The **risk of reaching the river** is possible. However, this risk is very difficult to assess analytically given the changing rates of asphalt viscosity as it cools, the unknown rate of release from either tank, and the presumptive ground effects (including potential ground deformation from the seismic event) on the asphalt pool as it moves over open areas of the plant. We judge the risk of reaching the river as low given the number of compounding failures that must occur for this event to materialize.

5.1.3.2.2 Prior 3rd party acknowledgment of low risk

The Owens Corning Trumbull Plant is prepared in the event a spill occurs. The facility has a strict procedure in place to properly contain, clean up, and dispose of spilled products while ensuring personnel and external safety.

Furthermore, the City of Portland, Oregon has granted Owens Corning a code exemption request to Section 1613.1 of the OSSC where it applies to ancillary structures. The appeal states that failures to the asphalt tanks pose minor risk to Life Safety and product release to nearby waters. As mentioned in previous sections, the spill of asphalt material does not have the same environmental implications as a spill of oil or fuel. Asphalt quickly solidifies and there is negligible outward running of the product and soil penetration. In a spill scenario, asphalt will harden and become viscous at ambient temperature. When solidified, it is easily rolled up on the ground. This process helps mitigate contamination of the environment or adjacent properties and aids in cleaning of a spill.

In a catastrophic event in which primary and secondary containment structures fail, the spilled asphalt product still does not pose a risk to Life Safety and product release to groundwater or the nearby river.

5.1.3.3 *Mechanical-specific items*

The material and construction of all bulk storage containers are compatible with the materials stored and conditions of storage such as pressure and temperature.

While the materials of construction of the secondary containment system are compatible with the asphalt stored in most of the tanks, there are several pieces of process equipment and tanks that contain materials that would soak into the soil. These tanks and pieces of process equipment are located inside their own secondary containment systems. These containment systems have concrete walls and floors, which are compatible with the materials stored in them.

The process oil and asphalt tanks are designed with automatic level gauges to monitor individual tank levels during filling. The gauges provide data to computers in the Control Room. An operator is present to monitor the gauges during filling to prevent overfilling of a tank. The system has a visual and audible alarm that will turn on if a tank is filled past its “safe fill” capacity. The operator will also monitor the overall filling of bulk storage containers.

Asphalt piping within the Tank Farm area is aboveground and constructed of minimum of Schedule 40 carbon steel, certified welded, and rated to operating pressures of 150 psig. Piping is wrapped with insulation and inspected on a monthly or transfer event basis with particular attention to connecting joints, valves, pumps, and pipe supports.

The mechanical-specific measures described above play a significant role to improve site safety and mitigate risk of damage during a seismic event.

5.1.3.4 *Description of onsite emergency equipment, ops safety measures, personnel policies, and procedures*

Lateral soil displacement and subsequent collapse would not be instantaneous during the maximum seismic event. This allows safe egress from the open tank farm area in the unlikely event of worker presence. This is based on standard safety training specifying immediate egress to safe muster points at the onset of ground shaking.

Plant personnel will promptly correct visible discharges that result in a loss of oil from a container, including but not limited to seams, gaskets, pumps and valves. Oil accumulated in a containment area will be promptly and properly removed. Two spill kit stations are located at the facility. The kits include shovels, pads, brooms, absorbent, drums, etc. and are located south of the Materials Storage Shed and south of the PPA tank.

Pursuant to 40 CFR Part 112, the Plant conducts required inspections of all tanks, pipelines, secondary containment, and associated equipment. A documented inspection of storage containers, pumps and piping systems containing petroleum products are performed monthly. As part of this inspection, the facility will inspect the outside of a container for signs of deterioration, discharges or accumulation of oil inside diked areas. As part of the plant daily operations, informal observations are made by personnel

working in areas around the plant, such as the truck unloading rack area. Personnel are trained to notify supervisors if any problems are observed.

The Trumball Plant maintains a Facility Response Plan that describes the facility's response to an onshore asphalt spill incident. It is consistent with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300) and is consistent with the Area Contingency Plan. It has been updated in accordance with the State of Oregon Department of Environmental Quality requirements in accordance with Administrative Code (OAR) 340-47-150 and 340-47-160.

Owens Corning orients, informs, and educates its employees so that they have the skills and knowledge to perform their work safely, productively, and efficiently. In order to accomplish this the training program includes orientation and general safety and health training, operational job training, specialized training, and refresher training. Oil-handling personnel will receive additional training on the following:

- Operation and maintenance equipment to prevent discharges
- Discharge procedure protocols
- Applicable pollution control laws, rules and regulations
- General facility operations
- Contents of the SPCC Plan

Owens Corning designates qualified individuals and alternates pursuant to 33 CFR Part 154.1026 Key attributes of the qualified individual are they are located in the U.S., available on a 24-hour basis, familiar with the facility response plan, trained in their responsibilities under the plan, speak English, and have full authority to implement the response plan.

The facility maintains spill response agreements with external contractors to facilitate a swift response to a release, when external support is required. Spill response contractor(s) and contact information is provided in the SPCC Plan.

With many procedures and policies in place, the Trumball Plant is adequately prepared to respond to any emergency, including an earthquake.

5.1.4 Case for Tank Seismic Stability Rules Exemption

The purpose of the Rules as summarized in Section 1 of this report is to limit the environmental impact and immediate risk to the public, while supporting the regional energy needs immediately after a design seismic event. This facility qualifies under the Rules based only on total volume of hazardous material storage, while not meeting the intent of the Rules on the other grounds previously stated. Asphalt spills would not impact public health or the environment relative to the intent of the Rules and Oregon Law Ch 99. City of Portland exemptions, along with experience with asphalt spills at the site and elsewhere, demonstrate the validity of this argument.

5.1.4.1 *Asphalt behavior in the event of a spill*

Asphalt does not behave like water OR fuel when exposed on the ground surface. The following distinguish asphalt from other stored petrochemical liquids:

- a. Asphalt is quite viscous, increasing with decreased temperature until it solidifies at 200°F.
- b. Asphalt presents a low risk of soil permeability given its viscosity characteristics. In fact, tank leaks are typically self-sealing, as the cooling asphalt solidifies and creates a seal.
- c. Asphalt does not emulsify easily. It is not flammable or combustible without a large, sustained ignition source. It does not evaporate or create air hazards once it reaches 200°F. The product with the largest volume by far onsite is less of a fire hazard than many other industrial chemicals found in other facilities throughout the State of Oregon.

Asphalt is found commonly within the local environment where runoff is collected in City stormwater systems: Paved roads and parking lots, in roofing shingles, for roof coverings, as pond liners, and other uses where all-weather surfaces and durable waterproofing are required. For this and other reasons, solidified asphalt is generally not considered hazardous to the environment. For instance, asphalt tank heels (remainder in the tank below the pump suction nozzle) removed for cleaning and maintenance are typically landfilled as non-hazardous solid waste.

Asphalt spilled on the ground will immediately begin to cool. It will bind with the surface soil and, as it cools, will form a surface seal. Asphalt will cool and harden in the catch basin or pipe, or on the ground before progressing any further in the event of a spill. The typical cleanup effort would require excavating the hardened asphalt and bound soil as necessary.

5.1.4.2 *Asphalt storage vs. fuel storage in other states*

There is relevant precedence in Federal EPA and other State environmental agencies that are useful examples here. They are based on the properties and characteristics of the product and the associated risk to the environment:

- A. The US Environmental Protection Agency (EPA) has published guidance documents for SPCC Regional Inspectors that specifically address containment for asphalt products. Below is an excerpt from the attached guidance document.
 - i. “The earthen floor of a secondary containment system may be considered *“capable of containing oil”* until cleanup occurs, or *“sufficiently impervious”* if there is no subsurface conduit to navigable waters allowing the oil to reach navigable waters before it is cleaned up. Should oil reach navigable waters or adjoining shorelines, it is a reportable discharge under 40 CFR part 110. The suitability of earthen material for secondary containment systems may depend on the properties of both the product stored and the soil. For example, compacted local soil may be suitable to

contain a viscous product, such as liquid asphalt cement, but may not be suitable to contain gasoline.”

- ii. Based on the above, asphalt on the ground is not considered a hazard so long as it does not reach navigable waters or shoreline before it has hardened.
- B. On the West Coast, California has its own Above-Ground Storage Tank (AST) program under the Aboveground Petroleum Storage Tank Act (APSA). Asphalt products that are not liquid (solidify) at 60°F and at absolute atmospheric pressure (psia) are exempt from this rule. Contrast with “petroleum”, which is crude oil or its fractions that are liquid at 60°F and 14.7 psia.
- C. Many States with AST programs also recognize the unique characteristics of asphalt and have certain exemptions for asphalt storage vs. petroleum storage. Some examples of these exemptions for asphalt storage tanks include the following:
 - i. Corrosion protection and corrosion protection monitoring
 - ii. Containment for substance transfer areas
 - iii. Overfill protection
 - iv. Leak detection
 - v. Internal inspections
 - vi. Soil or groundwater sampling during removal for possible contamination

5.1.4.3 *Conclusions*

Asphalt does not behave like fuel. It is much easier to remove in the event of a spill, does not contaminate groundwater, and is not combustible nor flammable like a fuel. A spill does poses neither a direct nor indirect risk to the public. Asphalt or asphalt products will not play a role in emergency fuel or energy plans at any level; thus Oregon Laws 2022 Chapter 99, the Oregon Resilience Plan, and the Oregon Fuel Action Plan are not relevant to this site. The Tank Seismic Stability Rules are intended for *fuel* storage facilities over 2 million gallons in stored volume, which disqualifies this facility. Therefore, **it is our opinion that this facility should be exempt from any further action relative to the requirements of the Rules.** This report addresses all required elements for assessment listed in Section 2.2 subpart A through F and Section 2.3 subpart A through M listed above and should conclude Owens Corning’s requirements relative to the Rules.

SECTION 6: APPENDICIES

6.1 Appendix A: Geotechnical Exhibits

Appendix A Figure A-1: Vicinity Map

Appendix A Figure A-2a: Overall Site Plan

Appendix A Figure A-2b: Detailed Site Plan

Appendix A Figure A-3: Geotechnical Cross Section

Appendix A-1: Historical Site Data

Appendix A-2: Geotechnical Calculations



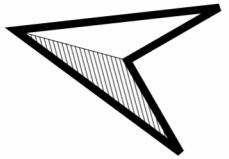
Vicinity Map

Owens Corning Linnton Asphalt Terminal SVA

Portland, Oregon

Figure A-1





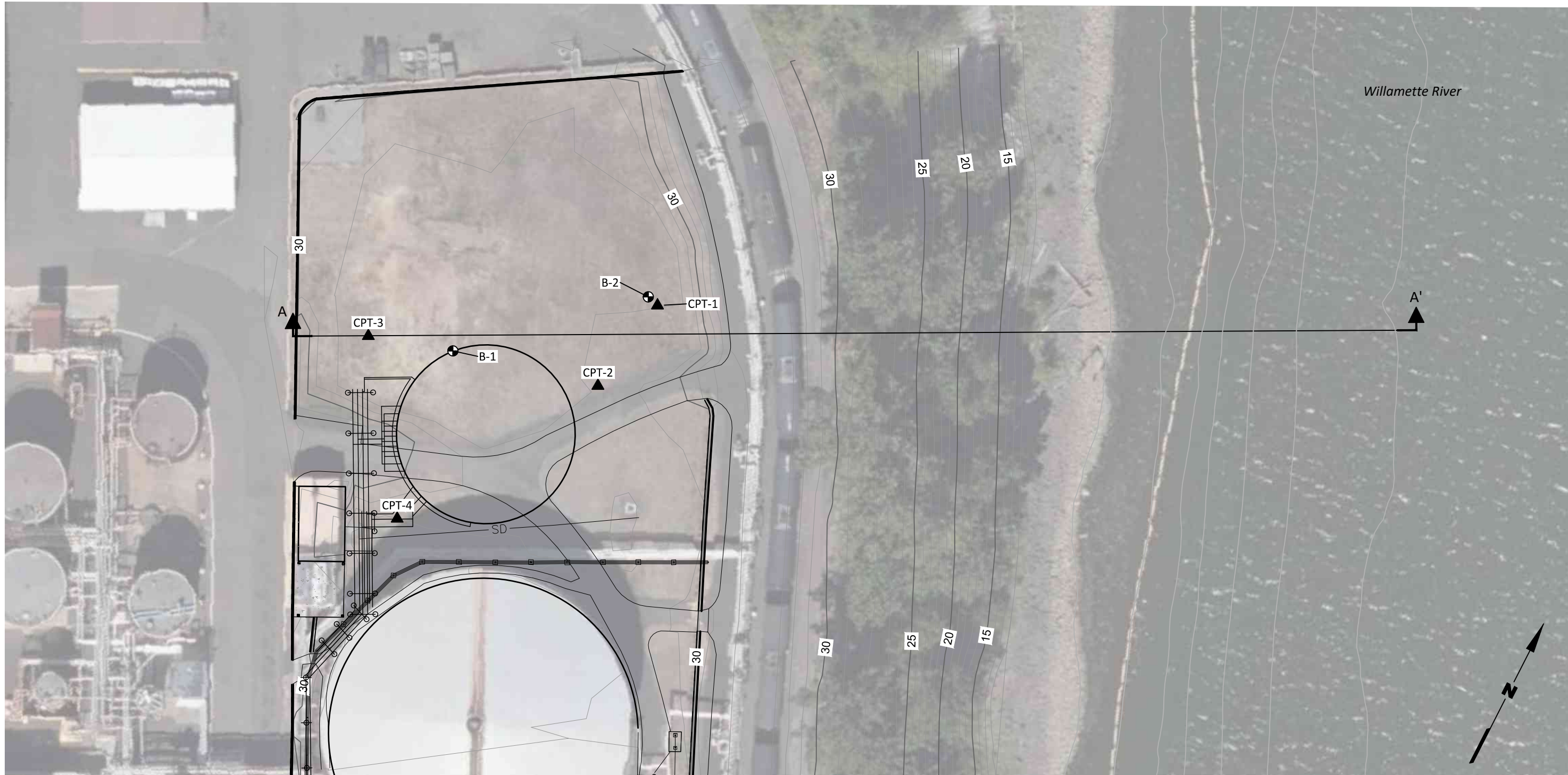
0 100 200 ft

Legend

- Contours from LIDAR
- Willamette_River_Bathymetry_(2005)
- Taxlot_Parcels
- Bing Maps Satellite Imagery
- Flow Failure Zone
- Lateral Spreading Contour



Site and Exploration Plan	
Owens Corning Linnton Asphalt Terminal SVA	
Portland, Oregon	Figure A-2a



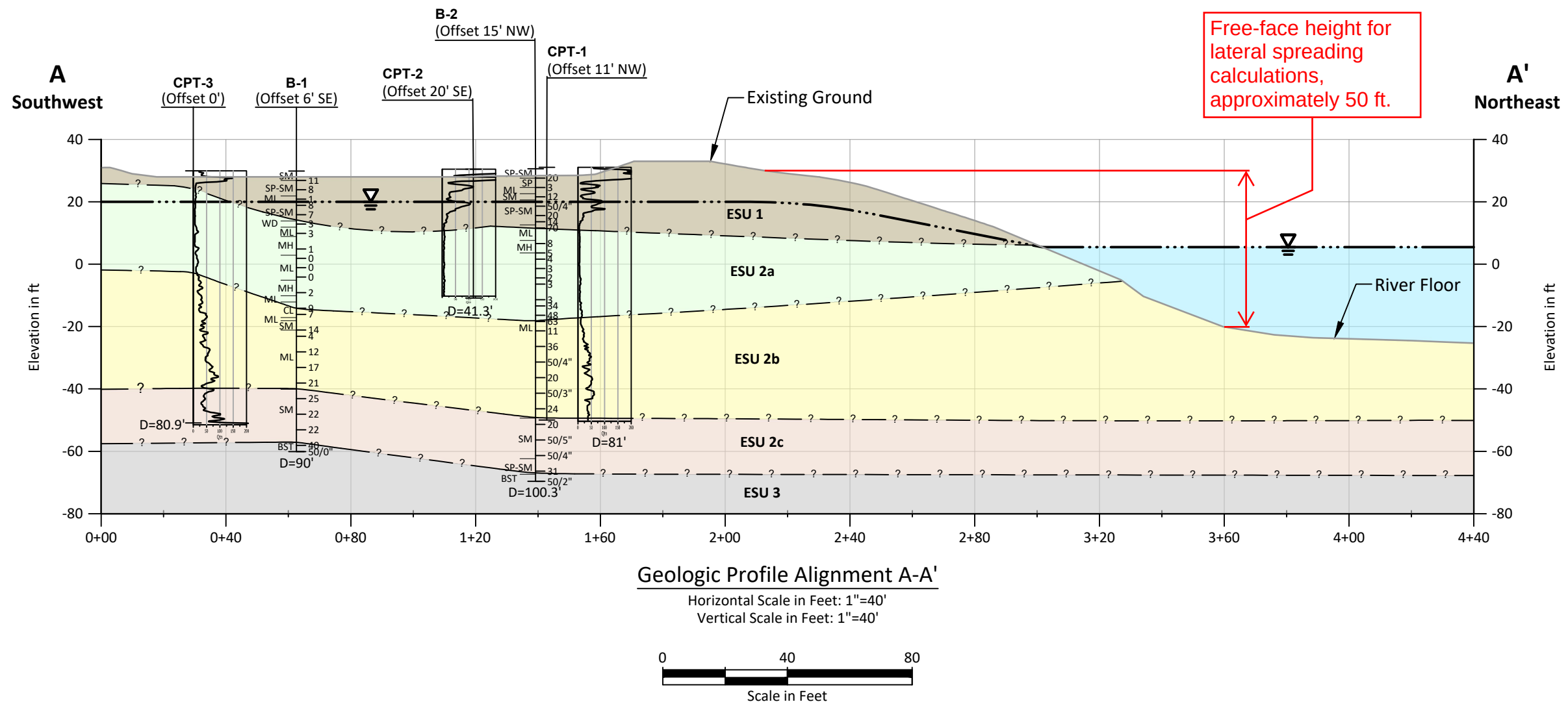
Notes

1. Ground surface survey by Norwest Engineering, Inc. dated 7/26/2021. Vertical Datum: City of Portland
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- B-1** Approximate Boring Location and Designation
- CPT-1** Approximate Cone Penetration Test Location and Designation
- 20— Elevation Contour
- A** **A'** Cross-Section View Location and Designation





Legend

B-1 — Project Exploration Designation
(Offset 6' SE) — Offset Distance in Feet and Direction

Top of Exploration

Seasonal High Groundwater (Landau Associates 2021)

ESU Average Blows per Foot (N)

USCS Soil Classification

Inferred Geologic Contact

Bottom of Exploration

Depth of Exploration

D = 90'

CPT-1 — Project Exploration Designation
(Offset 11' NW) — Offset Distance in Feet and Direction

Top of Exploration

Graphic Profile of Tip Resistance

Bottom of Exploration

Depth of Exploration

D = 81'

Notes:

1. Vertical Datum: City of Portland
2. ESU = Engineering Stratigraphic Unit
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Appendix A-1

Historic Geotechnical Data

**Geotechnical Engineering Report
Owens Corning Linnton Asphalt Terminal Final Design
11910 Northwest St. Helens Road
Portland, Oregon**

January 13, 2022

Prepared for

Norwest Engineering
4110 NE 122nd Avenue, Suite 207
Portland, Oregon 97230



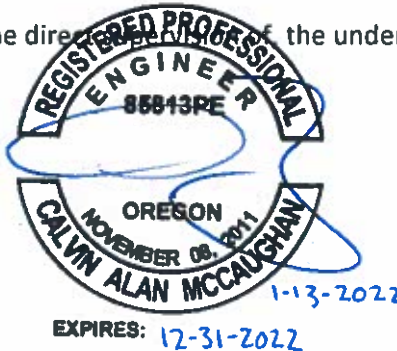
500 Columbia St NW, Ste 110
Olympia, WA
360.791.3178

**Geotechnical Engineering Report
Owens Corning Linnton Asphalt Terminal Final Design
11910 Northwest St. Helens Road
Portland, Oregon**

This document was prepared by, or under the direct supervision of, the undersigned, whose seal is affixed below.

Name: Calvin McCaughan, PE
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Date: January 13, 2022



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Date: January 13, 2022
Project No.: 1374018.020.021
File path: Y:\1374\018.020\R\Signature Page.docx
Project Coordinator: MCS

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1-1
1.1 Project Understanding.....	1-1
1.2 Scope of Work	1-1
2.0 SITE CONDITIONS	2-1
2.1 Geologic Setting.....	2-1
2.2 Surface Conditions.....	2-1
2.3 Subsurface Explorations	2-1
2.4 Subsurface Conditions.....	2-2
3.0 SEISMIC DESIGN CONSIDERATIONS	3-1
3.1 Seismic Setting.....	3-1
3.2 Ground Motion Hazard Analysis and Seismic Design Parameters	3-1
3.3 Liquefaction and Lateral Spreading.....	3-2
4.0 CONCLUSIONS AND RECOMMENDATIONS.....	4-1
4.1 Tank Foundation Recommendations	4-1
4.2 Ancillary Structure Foundation Recommendations	4-2
4.2.1 Monopole Column Supports	4-2
4.2.2 Pipe Rack Shallow Foundations and Equipment Slabs-On-Grade	4-3
4.2.2.1 Shallow Foundations.....	4-3
4.2.2.2 Equipment Slabs-on-Grade	4-4
4.3 Long-Term Settlement Potential	4-4
5.0 USE OF THIS REPORT	5-1
6.0 REFERENCES.....	6-1

FIGURES

<u>Figure</u>	<u>Title</u>
1	Vicinity Map
2	Site and Exploration Location Plan
3	Geologic Profile A-A'
4	Ground Motion Hazard Analysis

TABLES

<u>Table</u>	<u>Title</u>
1	Ground Motion Hazard Analysis Deterministic Source Summary
2	Seismic Design Parameters, 2 percent in 50-year probability of exceedance
3	Engineering Stratigraphic Unit Soil Properties
4	Shallow Foundation Design Parameters

APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Field Explorations
B	Sample Photograph Log
C	Laboratory Soil Testing

LIST OF ABBREVIATIONS AND ACRONYMS

AGI	Advanced Geosolutions, Inc.
ASCE	American Society of Civil Engineers
BC	British Columbia
bgs	below ground surface
City	City of Portland
CPT	cone penetration test
CSZ	Cascadia Subduction Zone
deg	degree(s)
ESU	engineering stratigraphic unit
ft	foot/feet
ft/ft	feet per foot
g	force of gravity
GMHA	ground motion hazard analysis
GMPE	ground motion prediction equation
H:V	horizontal to vertical
km	kilometer(s)
ksf	kips per square foot
LAI	Landau Associates, Inc.
M	moment magnitude
NAVD 88	North American Vertical Datum of 1988
NGA	Next Generation Attenuation
Norwest	Norwest Engineering
OSSC	Oregon Structural Specialty Code
PGA	peak ground acceleration
PPDT	pore water pressure dissipation test
PSHA	probabilistic seismic hazard analysis
R	hypocentral distance
SEI	Structural Engineering Institute
SPT	standard penetration test
USGS	US Geological Survey
V_s	shear wave velocity
Z_{TDR}	depth to top of rupture

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1.0 INTRODUCTION

This report summarizes the results of geotechnical engineering services provided by Landau Associates, Inc. (LAI) in support of the Linnton Asphalt Terminal expansion project, located at 11910 Northwest St Helens Road in Portland, Oregon (site; Figure 1).

This report has been prepared with information provided by Owens Corning (project owner) and Norwest Engineering (Norwest; prime engineer) and with data collected during LAI's geotechnical field exploration and laboratory testing programs.

1.1 Project Understanding

Owens Corning plans to improve the site by adding a new asphalt tank (Tank 11), associated piping, and ancillary equipment. The new tank will measure 70 feet (ft) in diameter and 42 ft tall. Based on the results of LAI's preliminary geotechnical services (2020), the project team has elected to use ground improvement to support the tank and mitigate the effects of seismically induced liquefaction.

1.2 Scope of Work

LAI provided the following geotechnical services to support design of the proposed improvements:

- Provided project management services and attended meetings, including a pre-application meeting with the City of Portland (City, authority having jurisdiction).
- Advanced two mud rotary borings at the site and collected representative soil samples.
- Completed geotechnical laboratory testing on select soil samples obtained from the borings. LAI's laboratory program included soil index testing and consolidation testing.
- Prepared this geotechnical engineering report, which includes:
 - A summary of the subsurface soil and groundwater conditions observed in LAI's explorations.
 - A summary of regional geologic conditions and recommended seismic design parameters.
 - Performance objectives for reinforcement-type ground improvement in accordance with the 2019 *Oregon Structural Specialty Code (2019 OSSC; ICC)* and the American Society of Civil Engineers' *Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE/SEI 7-16)*.
 - Geotechnical design recommendations for pipe rack and appurtenant foundations.
- Provided bid support by:
 - Reviewing the bid package for compliance with the performance objectives in this report) and preparing two schematic drawings.
 - Reviewing and responding to bidders' questions.
 - Assisting Norwest and Owens Corning with review of the bidders' proposals.

2.0 SITE CONDITIONS

The following sections describe the geologic setting of the site and the surrounding area and the surface and subsurface conditions observed in LAI's explorations. Interpretations of site conditions are based on LAI's review of available geologic information and on the results of the subsurface explorations and laboratory testing.

2.1 Geologic Setting

Geologic information for the site was obtained from the *Preliminary Geologic Map of the Linnton 7.5' Quadrangle, Multnomah and Washington Counties, Oregon* (Madin et al. 2008). Near-surface deposits at the site are mapped as artificial fill (af), a mixture of clay, silt, sand, gravel, debris, and rubble deposited by man. Alluvium (Qal) is also mapped at the site and consists of a mixture of clay, silt, and sand. This unit was deposited by the Willamette River during the Holocene Epoch. The alluvium is underlain by the Sentinel Bluffs Member of the Grande Ronde Basalt (Tsgb), an extrusive, igneous rock formed by the rapid cooling of dark gray or black lava. The layer of Grande Ronde Basalt measures up to 130 ft thick (Madin et al. 2008).

The subsurface conditions observed in LAI's explorations were consistent with the mapped geology for the site.

2.2 Surface Conditions

With the exception of secondary containment berms, the ground surface surrounding the proposed tank location is relatively flat. It is surfaced with grass and low scrub vegetation and located near paved access roads.

The Willamette River, flowing southeast to northwest, is located approximately 250 ft northeast of the site. The approximate surface elevation at the proposed tank location is 30 ft (North American Vertical Datum of 1988 [NAVD 88]). The riverbank slopes at approximately 3 horizontal to 1 vertical (3H:1V). Using bathymetric data provided by the City (accessed August 4, 2021), LAI estimated an approximate bottom-of-river-channel elevation of -25 ft NAVD 88.

2.3 Subsurface Explorations

Site subsurface conditions were explored on August 27, 2020 by advancing four cone penetration test (CPT) soundings (CPT-1 through CPT-4), and on June 24 through 29, 2021 by advancing and sampling two mud rotary borings (B-1 and B-2). The approximate locations of the explorations are shown on Figure 2.

Sounding CPT-1 included shear wave velocity measurements, and soundings CPT-1 and CPT-3 included pore pressure dissipation tests (PPDTs). Soil samples were collected from borings B-1 and B-2 using the standard penetration test (SPT) procedure and Shelby tube samplers. A description of LAI's field

investigation program, boring logs, and CPT data are provided in Appendix A; and photographs of SPT samples are provided in Appendix B.

Samples were transported to LAI's soils laboratory for further examination and testing. A summary of test methods and results are provided in Appendix C.

2.4 Subsurface Conditions

The site is generally underlain by fill over alluvium over basalt. Site subsurface conditions are characterized by the following engineering stratigraphic units (ESUs):

ESU 1 Fill. ESU 1 consists of fill used to raise site grades. The fill observed in LAI's explorations primarily consisted of coarse-grained soils (SP, SP-SM, and SM) with variable wood debris and interbedded layers of wood waste. LAI understands that, prior to 1990, the site was used as a plywood manufacturing facility, sawmill, and log yard.

ESU 2a Recent Alluvium. ESU 2a consists of very soft to soft, low-plasticity silt with interbeds of elastic silt.

ESU 2b Old Alluvium (loose). ESU 2b consists of loose to medium dense, silty sand to sandy silt with interbeds of low-plasticity and elastic silt.

ESU 2c Old Alluvium (dense). ESU 2c consists of medium dense to very dense, silty sand to sand with silt.

ESU 3 Basalt. ESU 3 consists of basalt. A CME-75 truck-mounted drill rig was advanced approximately 1 to 3 ft into the basalt before encountering refusal.

On August 27, 2020, the site groundwater elevation was estimated at approximately 10 ft below ground surface (bgs), based on the results of PPDTs completed in soundings CPT-1 and CPT-3. The moisture content observed in samples collected from borings B-1 and B-2 indicates a groundwater elevation of approximately 8.5 ft bgs. Site groundwater elevations are expected to fluctuate as a function of precipitation, river stage, and upgradient seepage.

Figure 3 shows a conceptual geologic cross section through the tank location.

3.0 SEISMIC DESIGN CONSIDERATIONS

The site is located in the seismically active Pacific Northwest and could be subject to ground shaking during a major seismic event. The following sections describe the seismic hazards present at the site. LAI prepared this section with the understanding that the proposed tank would have a fundamental period of vibration of less than 0.5 second and a sloshing period of more than 2 seconds.

3.1 Seismic Setting

The site is located on the North American tectonic plate near the convergent continental boundary known as the Cascadia Subduction Zone (CSZ). The CSZ is formed by the subduction of the oceanic Juan de Fuca Plate and Gorda Plate beneath the North American Plate, extending approximately from Vancouver Island, Canada to the Mendocino Escarpment off Northern California, United States (Goldfinger et al. 2012). This tectonic setting creates three potential seismic sources for the site: a subduction zone interface rupture, a deep intraslab rupture, and shallow crustal fault rupture. The CSZ lies approximately 80 miles west of the site.

The nearest shallow crustal fault is the Portland Hills fault, mapped approximately 1,000 ft southwest of the site (USGS 2021). The Portland Hills fault is a steeply dipping (approximately 70-degree) reverse fault. The fault dips to the southwest, and the site is situated on the footwall. Based on the US Geological Survey's (USGS) disaggregation for the site, the maximum considered event from the fault corresponds to a moment magnitude 7 event.

3.2 Ground Motion Hazard Analysis and Seismic Design Parameters

The seismic site class was determined in accordance with Section 20 of *ASCE/SEI 7-16*. The average shear wave velocity (V_s) in the top 30 meters (100 ft, denoted $V_{s,30}$) of the soil profile was computed using site-specific V_s measurements collected in sounding CPT-1 to a depth of 78.74 ft bgs, SPT N- V_s correlations (Wair et al. 2012) between 78.74 ft bgs and refusal at 90 ft bgs, and presumptive basalt V_s from 90 ft bgs to 100 ft bgs (Sowers and Boyd 2019). The computed $V_{s,30}$ is 685 feet per second, resulting in a **seismic site class D**.

The USGS has completed a countrywide probabilistic seismic hazard analysis (PSHA) that provides estimated strong motion at a given location, for a given probability of exceedance. The PSHA can be used to determine geotechnical and structural seismic design parameters for a given seismic site class. The 2019 OSSC requires completion of a ground motion hazard analysis (GMHA) for a seismic site class of D and a USGS-mapped, 1-second spectral ordinate (S_1) greater than 0.2g. Because the mapped S_1 for the subject site is 0.4g, LAI completed a GMHA.

The GMHA was completed in general accordance with the procedure outlined in Section 21.2, Method 1 of *ASCE 7-16*. The deterministic sources in Table 1 were used to complete the GMHA. To develop the

GMHA probabilistic spectrum, the uniform hazard spectrum in the USGS's PSHA was risk- and direction-adjusted in accordance with Federal Emergency Management Agency report P-1051.

Table 1. Ground Motion Hazard Analysis Deterministic Source Summary

ID	Source Type and Characteristics	GMPE
Source 1	Shallow Crustal/Portland Hills Fault M = 7.0, R = 1.4 km, Z_{TOR} = 0 km	NGA-West 2 weighted average
Source 2	Subduction intraslab M = 6.0, R = 12 km, Z_{TOR} = 30 km	Updated BC Hydro (Abrahamson et al. 2018)
Source 3	Subduction interface/Cascadia Subduction Zone M = 9.3, R = 70 km	Updated BC Hydro (Abrahamson et al. 2018)

BC = British Columbia

GMPE = ground motion prediction equation

ID = identifier

km = kilometer(s)

M = moment magnitude

NGA = Next Generation Attenuation

R = hypocentral distance

Z_{TOR} = depth to top of rupture

The results of the GMHA are presented on Figure 4 as a recommended site-specific design response spectrum. Based on the results of the GMHA and the USGS seismic hazard disaggregation for the site, LAI recommends the seismic design parameters provided in Table 2.

Table 2. Seismic Design Parameters, 2 percent in 50-year probability of exceedance

Site Class	Mean M	PGA _M	S _{DS}	S _{D1}
D	8.2	0.488g	0.776g	0.693g

g = force of gravity

M = moment magnitude

PGA = peak ground acceleration

S_{D1} = design short-period spectral ordinate

S_{DS} = design 1-second period spectral ordinate

3.3 Liquefaction and Lateral Spreading

Liquefaction is a phenomenon that occurs when strong ground motions cause saturated sand, gravel, and low-plasticity silt to lose shear strength. In LAI's opinion, seismically induced soil liquefaction is likely to occur at the subject site and could result in:

- ground surface settlement,
- lateral spreading (incremental, lateral movement of the ground surface toward the Willamette River during ground shaking), and
- flow failure (slope instabilities near the riverbank caused by loss of soil strength).

LAI used the methods noted to evaluate the:

- Potential for soils to be susceptible to liquefaction (Bray and Sancio 2006).
- Potential for susceptible soils to liquefy at design-level earthquake intensity (Boulanger and Idriss 2014).
- Shear strength loss (i.e., the residual shear strength of liquefied soils) and liquefaction-induced free-field vertical ground settlements (Idriss and Boulanger 2008).
- Estimated lateral spreading and flow failure, developed using a limit-equilibrium analysis and Bray et al.'s (2019) empirical Newmark's sliding block analysis.

Based on the results of the liquefaction analysis, LAI estimates that the site could be subject to 8 to 16 inches of liquefaction-induced settlement, more than 10 ft of lateral spreading displacement, and flow failure near the proposed tank.

4.0 CONCLUSIONS AND RECOMMENDATIONS

A design-level seismic event is estimated to cause liquefaction and significant vertical and lateral ground deformation. Based on the results of LAI's geotechnical explorations and engineering analyses, shallow and deep foundations would not be able to withstand the estimated ground deformation. As a result, the design team has selected ground improvement to mitigate liquefaction-induced settlement and lateral spreading to within tolerable limits for shallow foundation support.

Advanced Geosolutions, Inc. (AGI) will complete ground improvement design and construction.

4.1 Tank Foundation Recommendations

LAI understands that the desired tank foundation consists of a gravel pad and concrete ring wall system. LAI, Norwest, and Owens Corning developed the performance specification that AGI will use to design ground improvement. Key performance criteria are provided below:

- Provide static and seismic allowable bearing capacity of 6 kips per square foot (ksf) beneath the ring wall.
- Provide static and seismic allowable bearing capacity of 2.6 ksf in the area beneath the tank.
- Limit static total settlement to 4 inches and static differential settlement to 0.003 feet per foot (ft/ft) in any horizontal direction.
- Limit seismic differential settlement to 0.006 ft/ft in any horizontal direction.
- Limit seismic lateral foundation deformation to 12 inches.
- Provide a load transfer platform or equivalent to achieve uniform bearing capacities.

Ground improvement design should account for the following soil engineering properties. ESU designations correspond to the ESUs delineated on Figure 3 and described in Section 2.4.

Table 3. Engineering Stratigraphic Unit Soil Properties

Material Name	Description	Unit Weight	Static Strength ^(a)	Seismic (Liquefied/Cyclically Softened) Strength ^(a)
ESU 1	Fill	120 pcf	$\phi = 35 \text{ deg}$ $c = 0$	$S_{u,r}/\sigma'_v = 0.1$ $S_{u,r,min} = 100 \text{ psf}$
ESU 2a	Recent Alluvium	115 pcf	$\phi = 0 \text{ deg}$ $c = 800 \text{ psf}$	$S_{u,r}/\sigma'_v = 0.07$ $S_{u,r,min} = 100 \text{ psf}$
ESU 2b	Old Alluvium (loose)	120 pcf	$\phi = 0 \text{ deg}$ $c = 1,000 \text{ psf}$	$S_{u,r}/\sigma'_v = 0.14$ $S_{u,r,min} = 300 \text{ psf}$
ESU 2c	Old Alluvium (dense)	120 pcf	$\phi = 38 \text{ deg}$ $c = 0$	N/A

(a) = Strength parameters should be used with a linear Mohr-Coulomb failure envelope.

ϕ = internal angle of friction; c = cohesion intercept; deg = degree(s); ESU = engineering stratigraphic unit; N/A = not applicable; pcf = pounds per cubic foot; psf = pounds per square foot

The volume beneath the tank within the concrete ring wall should be backfilled with well-compacted, 2-inch minus, dense-graded aggregate conforming to the requirements for structural fill in Section 02630 of the Oregon Department of Transportation's 2021 *Oregon Standard Specifications for Construction (2021 ODOT Standard Specifications)*. A horizontal earth pressure coefficient of 0.3 may be used to compute hoop stress.

4.2 Ancillary Structure Foundation Recommendations

LAI understands that ancillary structure foundation design will not consider the effects of liquefaction. Ancillary structures include:

- Monopole pipe supports founded on piers cast in drilled holes or in excavations with a cylindrical form for a new 10-inch asphalt transfer line.
- Rectangular pipe rack foundations on the order of 4 ft to 8 ft wide and 10 ft to 12 ft long, with static bearing pressures less than 0.5 ksf and seismic earth pressures less than 1.5 ksf.
- Slab-on-grade for mechanical equipment with applied bearing pressures less than 0.25 ksf.

4.2.1 Monopole Column Supports

Monopole column supports will be used for the 10-inch transfer line running from the rail offload pipe rack to proposed Tank 11. Depending on the contractor's preference, pipe supports may be cast in a drilled hole or in an excavated hole with a cylindrical concrete form.

The contractor should complete the excavation with a smooth bladed bucket or a cleanout auger to limit bottom disturbance and leave a clean excavation. Owens Corning's representative should observe the bottom of excavations prior to placement of formwork or reinforcement to check that the contractor has sufficiently removed slough and loose soil from the bottom of the excavation.

Excavations below 4 ft bgs to 5 ft bgs may be unstable, depending on the excavation side slope and the presence of loose sand or groundwater. The contractor should be responsible for excavation stability and the maintenance of safe working conditions.

Excavations should be backfilled with controlled low-strength material in accordance with Section 00442 of the 2021 *ODOT Standard Specifications*.

Because the site contains a potentially compressible soil layer from approximately 7 ft bgs to 10 ft bgs, LAI recommends two types of monopole foundations:

- **Type 1:** Embedded 3 ft or less, designed with an allowable bearing capacity of 3 ksf. The maximum diameter of Type 1 foundations should be 24 inches.
- **Type 2:** Embedded 10 ft bgs, designed with an allowable lateral bearing capacity of 7 ksf. The maximum diameter of Type 2 foundations should be 30 inches.

Lateral resistance of monopile column foundations can be computed with an allowable passive equivalent fluid density of 250 pounds per cubic foot. The top 2 ft of soil should be neglected when computing lateral resistance. Allowable bearing pressured and passive resistance may be increased by one-third for seismic loading.

4.2.2 Pipe Rack Shallow Foundations and Equipment Slabs-On-Grade

LAI recommends that shallow foundations and equipment slabs-on-grade bear on compacted structural fill, as detailed in the following sections. For the purposes of this section, subgrade is defined as the native soil at the elevation where structural fill is placed and compacted below foundation elements.

Subgrade soils can be recompact to a firm, unyielding condition. If soft or loose soil encountered at subgrade elevation cannot be adequately recompact, the unsuitable soil should be overexcavated and replaced with structural fill or controlled low-strength material. Overexcavations need not extend more than 3 ft below subgrade elevation.

If unsuitable materials are encountered following a 3-ft overexcavation, a separation geotextile and structural fill should be placed. The geotextile should conform to the criteria in Table 02320-4 of the *2021 ODOT Standard Specifications*.

The subgrade should be inspected by an Owens Corning representative prior to placement of formwork.

4.2.2.1 Shallow Foundations

Cast-in-place shallow foundations should bear at least 2 ft below adjacent finished grade. Foundations should bear on a minimum of 1 ft of well-compacted, 2-inch minus, dense-graded aggregate conforming to the requirements for structural fill in Section 02630 of the *2021 ODOT Standard Specifications*. The structural fill should extend 1 ft beyond the edge of the foundation.

The parameters in Table 4 can be used to design shallow foundations.

Table 4. Shallow Foundation Design Parameters

Footing Width	Allowable Bearing Capacity	Estimated Settlement
4 ft	1 ksf	Immediate = 0.5 inch Consolidation = < 0.5 inch
4 ft	3 ksf	Immediate = 1.5 inch Consolidation = 0.5 inch
8 ft	0.5 ksf	Immediate = 0.5 inch Consolidation = 0.5 inch

Footing Width	Allowable Bearing Capacity	Estimated Settlement
8 ft	1.5 ksf	Immediate = 1.5 inch Consolidation = 1 inch

Notes:

1. Values for intermediate-sized footings can be interpolated.
 2. Values can be increased by one-third for seismic loading.
 3. Lateral resistance can be computed assuming an allowable coefficient of friction of 0.5.
 4. Footing length is assumed to be one to two times the width.
 5. Immediate settlement should occur relatively quickly, as loads are applied.
 6. Consolidation settlement is estimated to occur over 3 to 6 weeks.
 7. Consolidation settlement need not be considered for short-term live loading.
 8. Total settlement is the sum of immediate and consolidation settlement.
 9. Differential settlement is estimated to be less than one-half of the values between similarly sized and loaded footings.
- ft = foot
ksf = kips per square foot

4.2.2.2 Equipment Slabs-on-Grade

Equipment slabs-on-grade should bear on at least 1 ft of structural fill, and subgrade should be prepared as described above. A subgrade modulus of 100 pounds per cubic inch can be used to design slabs-on-grade. This value is for a 1-ft by 1-ft loaded area and should be adjusted for the actual size of the slab.

4.3 Long-Term Settlement Potential

Subsurface explorations revealed deposits of wood waste and organic matter, which may decompose, causing long-term settlement of overlying structures. Much of the existing site infrastructure is likely underlain by wood waste and organic matter. Over a 50-year period, structures not supported by ground improvement may settle 1 to 2 inches. Long-term settlement of new, shallow foundation-supported structures is anticipated to be similar to that of existing, shallow foundation-supported structures.

5.0 USE OF THIS REPORT

Landau Associates has prepared this report for the exclusive use of Norwest Engineering and Owens Corning for the proposed Owens Corning Linnton Asphalt Terminal project in Portland, Oregon. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Reuse of the information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that, within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of skill and care ordinarily exercised by members of the profession currently practicing in the same locality, under similar conditions as this project. Landau Associates makes no other warranty, either express or implied.

6.0 REFERENCES

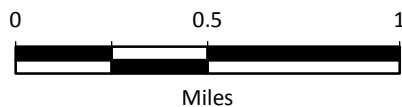
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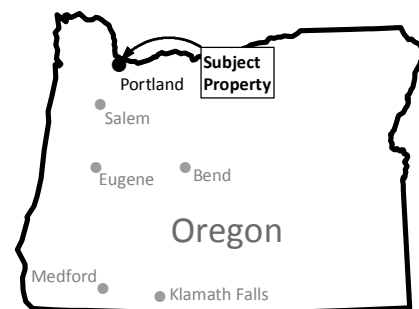
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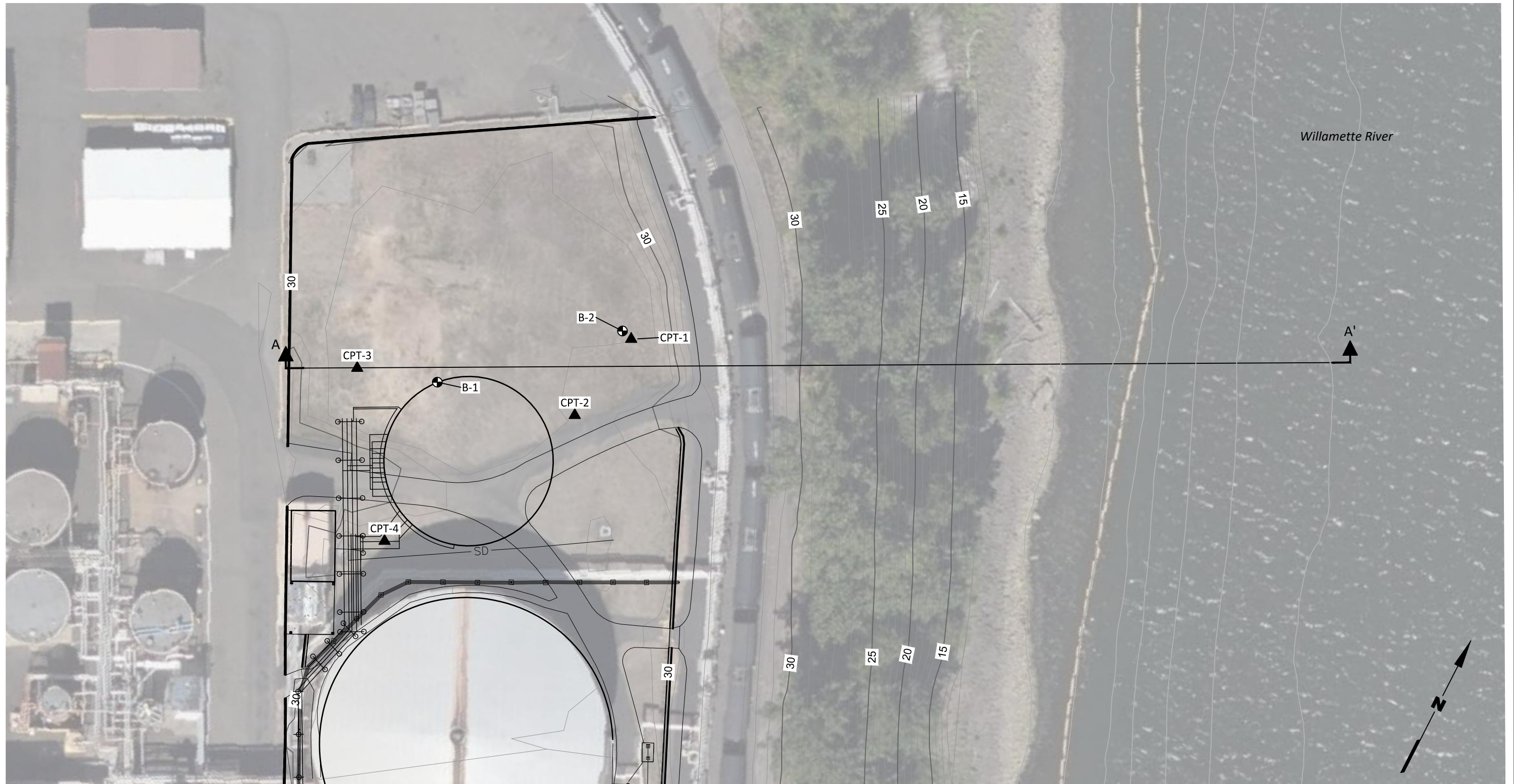


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Data Source: Esri.





Notes

1. Ground surface survey by Norwest Engineering, Inc. dated 7/26/2021. Vertical Datum: City of Portland
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- B-1  Approximate Boring Location and Designation
- CPT-1  Approximate Cone Penetration Test Location and Designation
-  -20- Elevation Contour
- A  A'  Cross-Section View Location and Designation

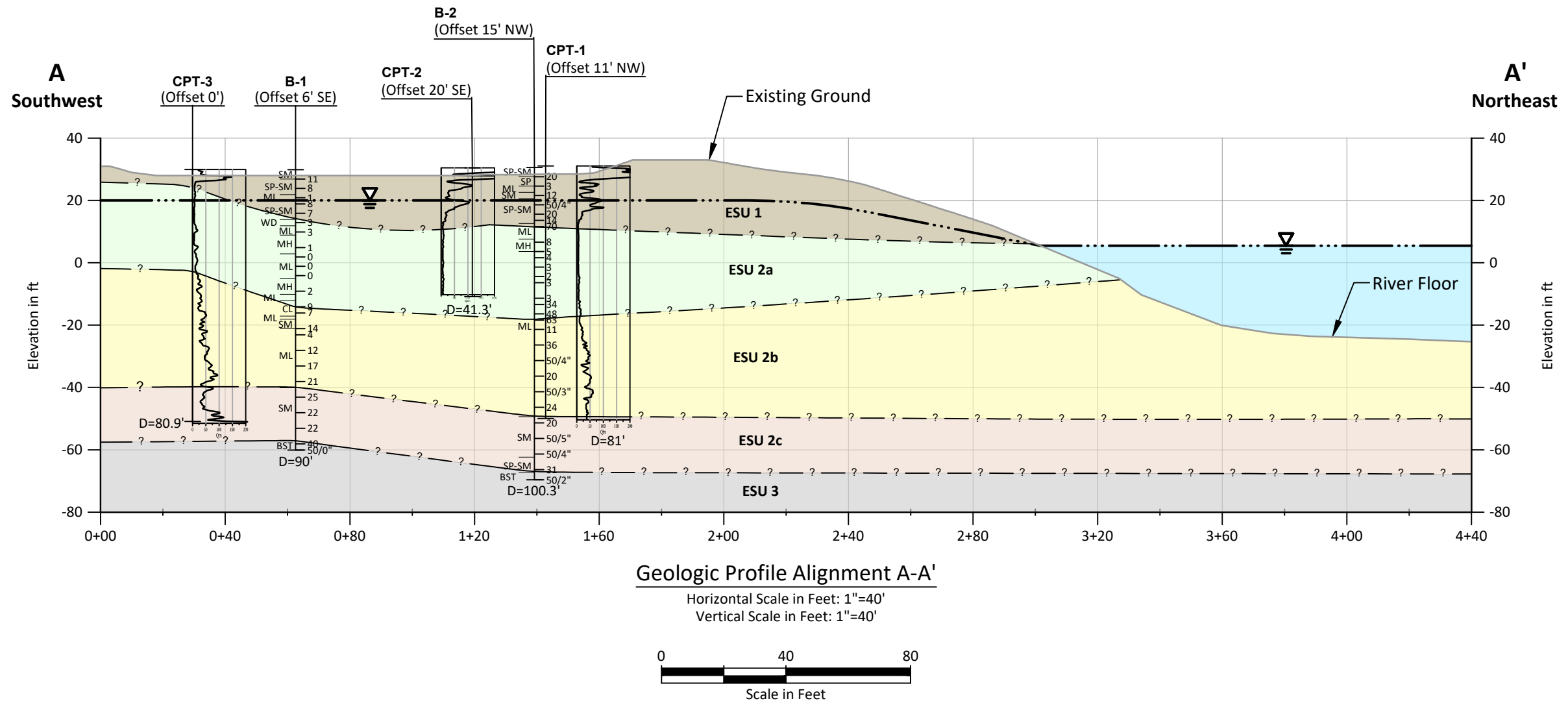


Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

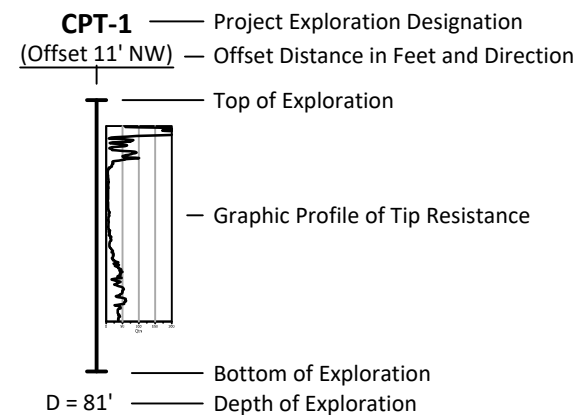
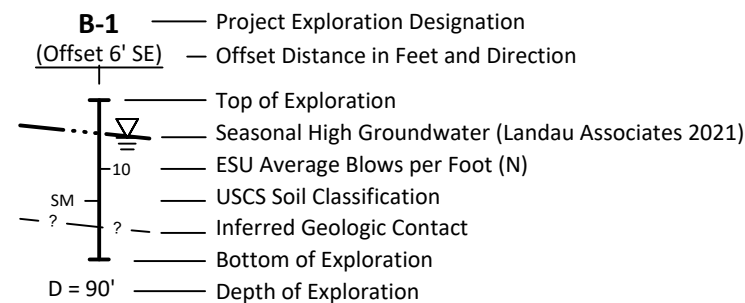
Site and Exploration Location Plan

Figure
2

Landau Associates | G:\Projects\1374\018\020\021\Asphalt Terminal Final Design\F02-F03 PlanProfile.dwg | 1/11/2022 3:17 PM | jvalluzzi

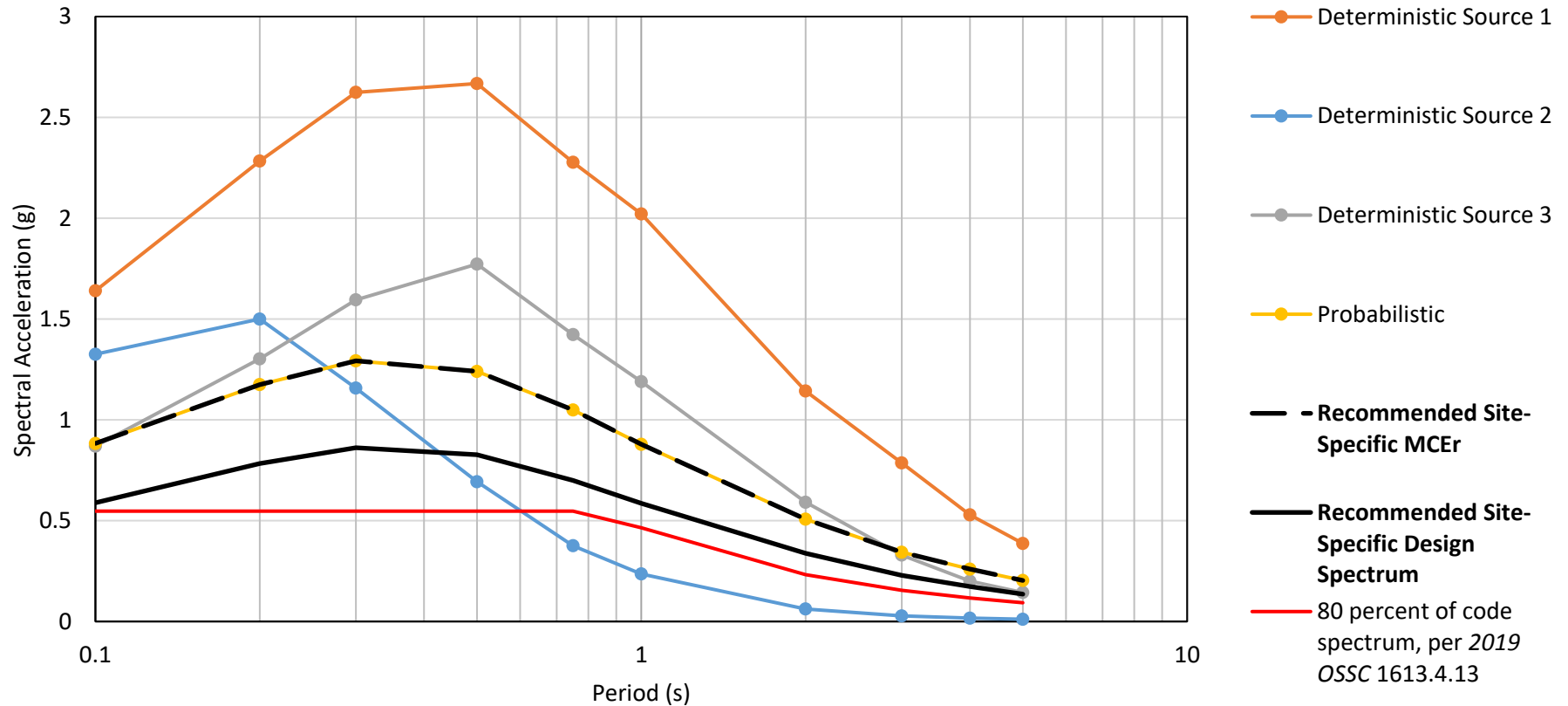


Legend



Notes:

1. Vertical Datum: City of Portland
2. ESU = Engineering Stratigraphic Unit
3. For cross-section location, see Figure 2.
4. See main text and boring logs for description of soil conditions encountered in the field explorations.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Notes:

1. Refer to main text for explanation of the ground motion hazard analysis and description of source parameters.
2. Black and white reproduction of this multicolor figure may lead to incorrect interpretation.
3. The 80 percent code spectrum is determined using a 65 percent contribution to total hazard by the Cascadia Subduction Zone, based on the 2014 US Geological Survey disaggregation for the site at the 1-second spectral ordinate, resulting in $F_v = 2.1$ (see Section 1613.4.13 of the 2019 OSSC).

Parameter	Calculation	Value (g)
S_{DS}	90% of S_{aD} [$T \geq 0.2s$]	0.776
S_{D1}	$\max\{T \times S_{aD} [1s \leq T \leq 5s]\}$	0.693
S_{MS}	$1.5 \times S_{DS}$	1.163
S_{M1}	$1.5 \times S_{D1}$	1.039

Field Explorations

APPENDIX A

FIELD EXPLORATIONS

Between June 24 and 29, 2021, Western States Soil Conservation, Inc., subcontracted by Landau Associates, Inc. (LAI), advanced two mud rotary borings (B-1 and B-2) at the approximate locations shown on Figure 2. Boring B-1 was advanced 90.5 feet (ft) below ground surface (bgs), and boring B-2 100.3 ft bgs. Hollow-stem auger drilling was used to advance the first 10 ft of borings B-1 and B-2.

LAI personnel monitored the field explorations, obtained representative soil samples, maintained a detailed record of the subsurface soil and groundwater conditions observed, and described the soil by visual and textural examination. Each representative soil type was described using the soil classification system shown on Figure A-1, in general accordance with ASTM International (ASTM) standard test method D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*. Summary logs of the explorations are presented on Figures A-2 and A-3. The stratigraphic contacts shown on the logs represent the approximate boundaries between soil types; actual transitions may be more gradual.

Disturbed soil samples were obtained at regular intervals using a 1.5-inch-inside-diameter, standard penetration test split-spoon sampler. A 140-pound automatic hammer, falling approximately 30 inches, was used to drive the sampler 18 inches (or a portion thereof) into the undisturbed soil. The number of blows required to drive the sampler for the final 12 inches of soil penetration (or a portion thereof) is noted on the boring logs, adjacent to the appropriate sample notation.

During advancement of boring B-2, the drill rig broke down at approximately 10 ft bgs and was replaced with a different rig. The automatic trip hammer on the new rig sporadically malfunctioned, delivering below-average energy that resulted in artificially inflated blow counts. Samples with blow counts presumed to be inflated are noted on the summary boring log.

Upon completion of fieldwork, the boreholes were decommissioned in general accordance with local requirements. Samples were sealed in plastic bags and transported to LAI's soils laboratory for further examination and testing.

Cone Penetration Tests

On August 27, 2020, Oregon Geotechnical Explorations, Inc., subcontracted by LAI, advanced four cone penetration test (CPT) soundings (CPT-1 through CPT-4) at the approximate locations shown on Figure 2. CPT soundings were advanced in general accordance with ASTM standard test method D5778, *Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils*. Cone tip pressure, sleeve friction, and pore water pressure measurements were collected at approximately 2-inch intervals. Seismic shear wave velocity measurements were collected at 1-meter (3.28 ft) intervals. CPT data are included at the end of this appendix.

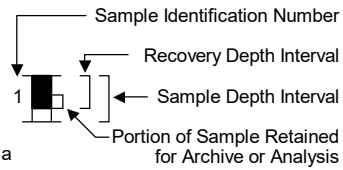
Soil Classification System

	MAJOR DIVISIONS		GRAPHIC SYMBOL	USCS LETTER SYMBOL ⁽¹⁾	TYPICAL DESCRIPTIONS ⁽²⁾⁽³⁾
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GP GM GC	Poorly graded gravel; gravel/sand mixture(s); little or no fines Silty gravel; gravel/sand/silt mixture(s) Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW SP	Well-graded sand; gravelly sand; little or no fines Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM SC	Silty sand; sand/silt mixture(s) Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

- Notes: 1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:
- Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
 - Secondary Constituents: > 30% and < 50% - "very gravelly," "very sandy," "very silty," etc.
> 15% and < 30% - "gravelly," "sandy," "silty," etc.
 - Additional Constituents: > 5% and < 15% - "with gravel," "with sand," "with silt," etc.
< 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key			Field and Lab Test Data	
SAMPLER TYPE	SAMPLE NUMBER & INTERVAL		Code	Description
Code	Description			
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon		PP = 1.0	Pocket Penetrometer, tsf
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon		TV = 0.5	Torvane, tsf
c	Shelby Tube		PID = 100	Photoionization Detector VOC screening, ppm
d	Grab Sample		W = 10	Moisture Content, %
e	Single-Tube Core Barrel		D = 120	Dry Density, pcf
f	Double-Tube Core Barrel		-200 = 60	Material smaller than No. 200 sieve, %
g	2.50-inch O.D., 2.00-inch I.D. WSDOT		GS	Grain Size - See separate figure for data
h	3.00-inch O.D., 2.375-inch I.D. Mod. California		AL	Atterberg Limits - See separate figure for data
i	Other - See text if applicable		GT	Other Geotechnical Testing
1	300-lb Hammer, 30-inch Drop		CA	Chemical Analysis
2	140-lb Hammer, 30-inch Drop			
3	Pushed			
4	Vibrocore (Rotasonic/Geoprobe)			
5	Other - See text if applicable			



Sample Identification Number

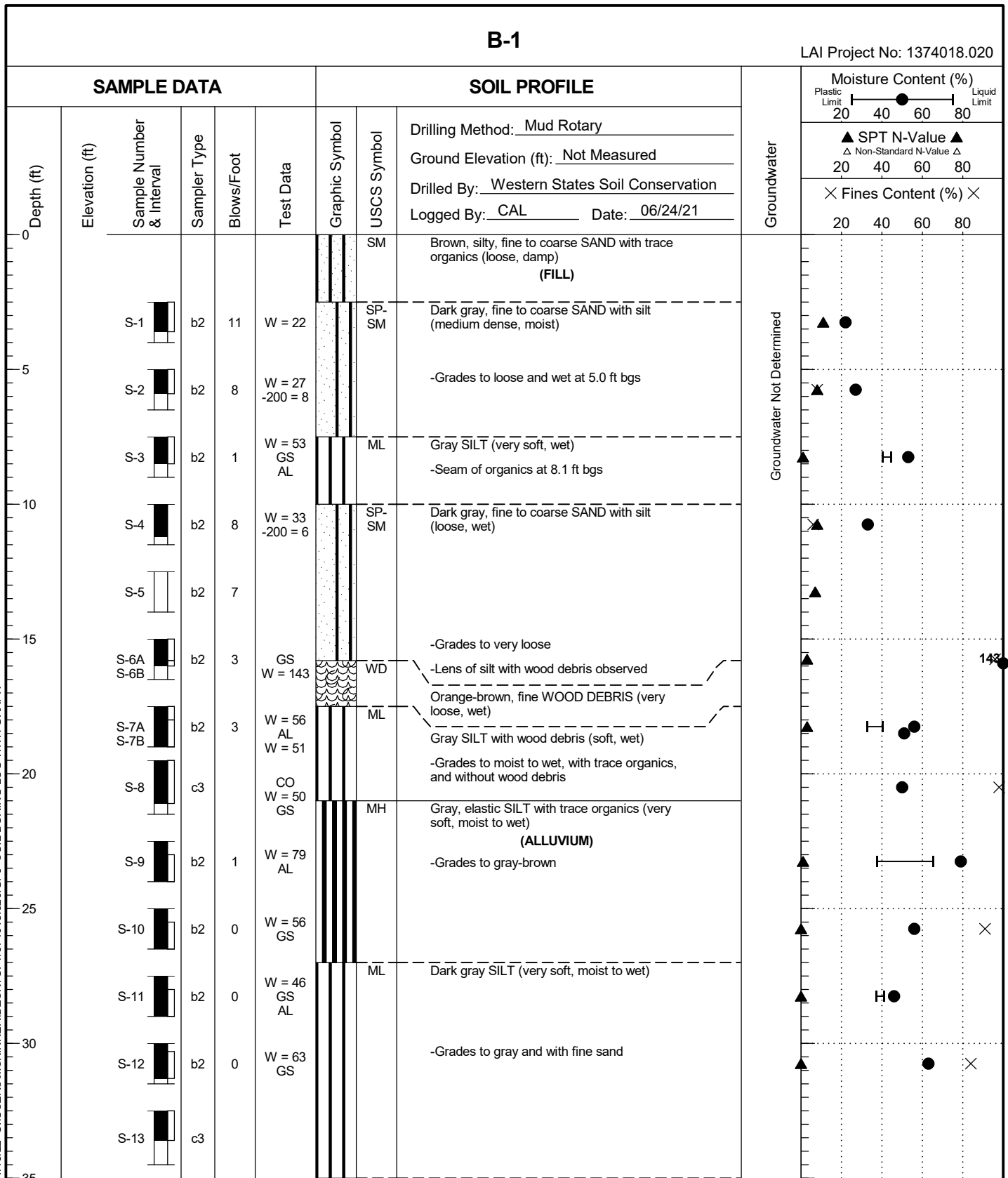
Recovery Depth Interval

Sample Depth Interval

Portion of Sample Retained for Archive or Analysis

Groundwater	
	Approximate water level at time of drilling (ATD)
	Approximate water level at time after drilling/excavation/well

1374018.02 1/13/22 C:\USERS\SKINNER\DESKTOP\1374018.020.GPJ SOIL BORING LOG WITH GRAPH



- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

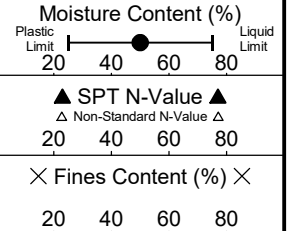
B-1

LAI Project No: 1374018.020

SAMPLE DATA

SOIL PROFILE

Groundwater



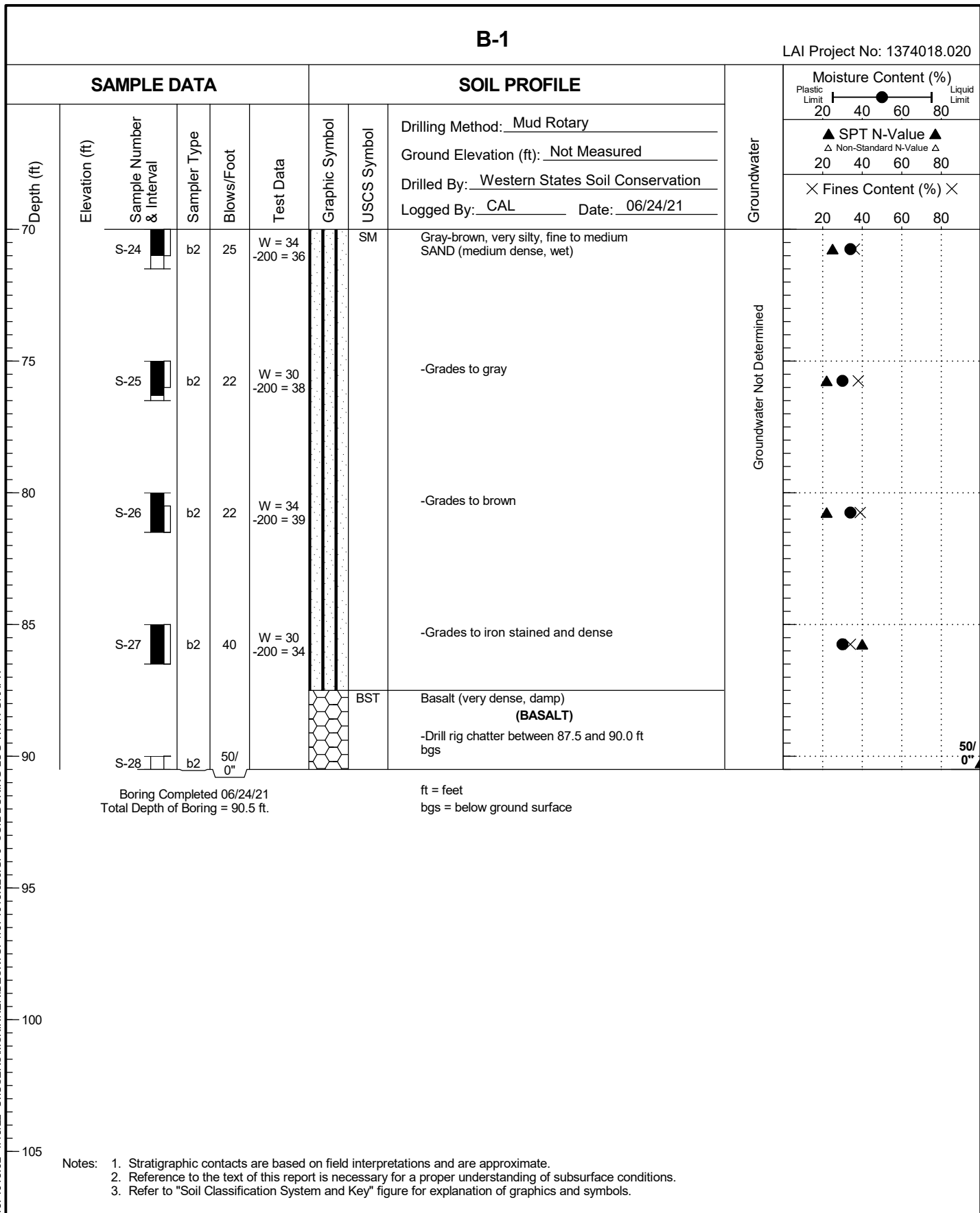
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Drilling Method: Mud Rotary	Ground Elevation (ft): Not Measured	Drilled By: Western States Soil Conservation	Logged By: CAL Date: 06/24/21
35		S-14	b2	2	W = 59 AL		MH	Gray, elastic SILT (very soft, moist)			
		S-15	b2								
40		S-16	b2	9	W = 35 GS AL		ML	Blue-gray to gray SILT (stiff, moist)			
		S-17A S-17B	b2	7	W = 39 GS AL W = 38 -200 = 98		CL	Gray-brown CLAY (medium stiff, moist)			
45		S-18	c3					-Observed minor iron staining -Grades to gray			
		S-19A S-19B	b2	14	W = 40 AL W = 34		SM	Gray-brown, silty, fine to coarse SAND (medium dense, wet)			
50		S-20A S-20B	b2	4	W = 43 W = 43 GS AL		ML	Gray-brown to brown SILT (soft, wet)			
55		S-21	b2	12	W = 40 GS			-Grades to stiff and with fine sand			
60		S-22	b2	17	W = 39 GS AL			-Grades to very stiff, moist to wet, and without sand -Observed vertical laminations between 60.0 and 60.5 ft			
65		S-23	b2	21	W = 35 GS						
70											

Groundwater Not Determined

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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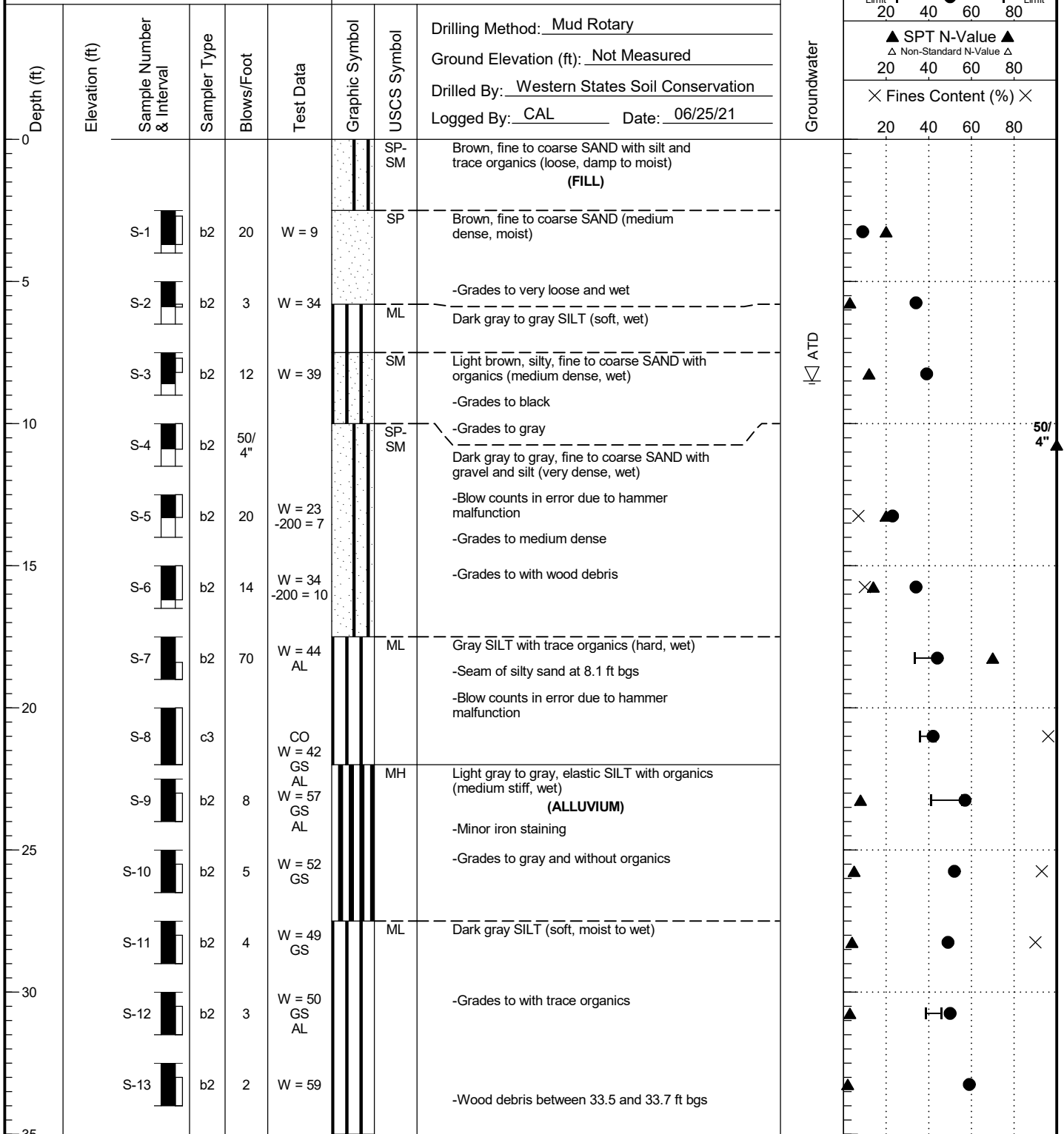


B-2

LAI Project No: 1374018.020

SAMPLE DATA

SOIL PROFILE



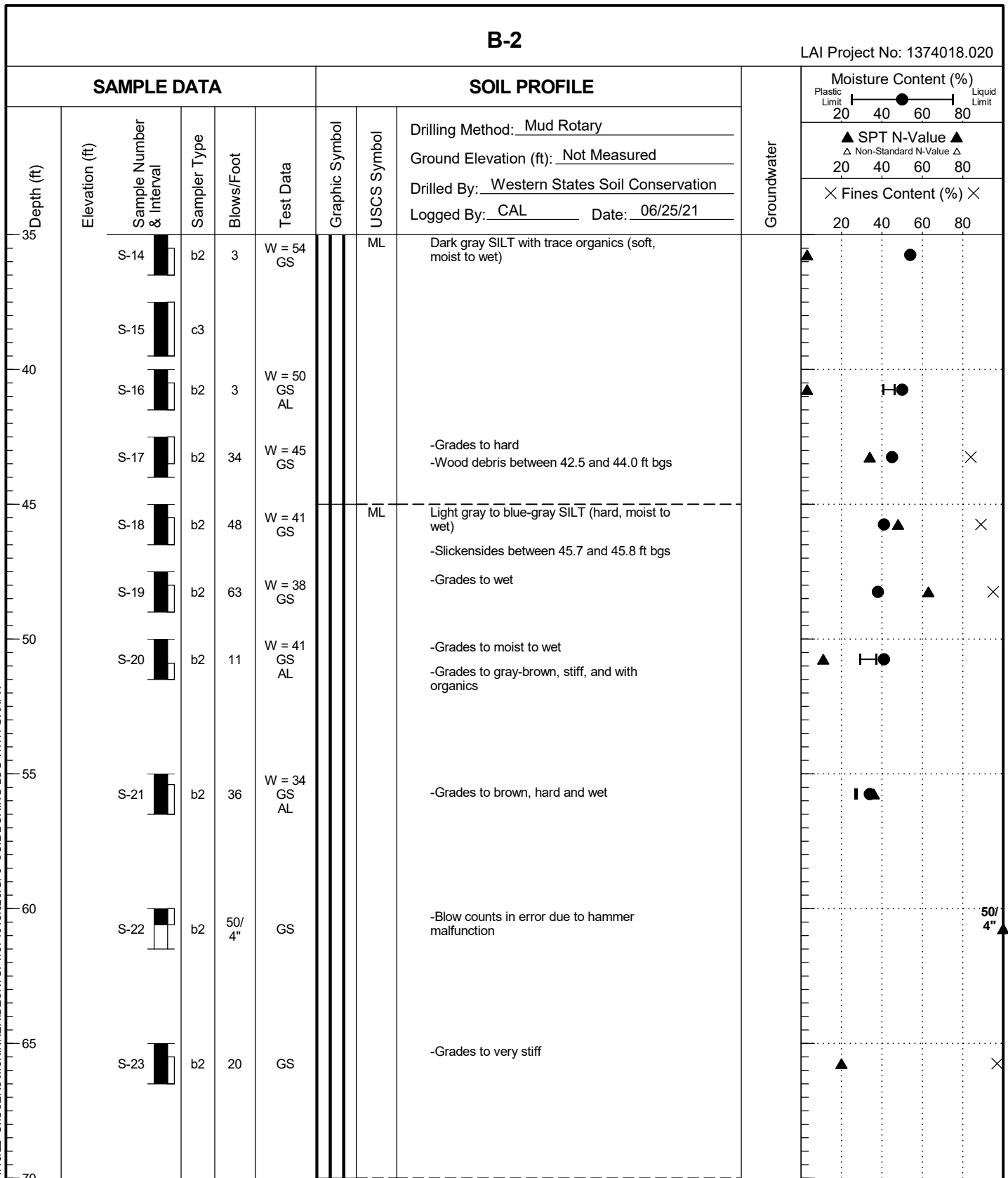
- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Boring B-2

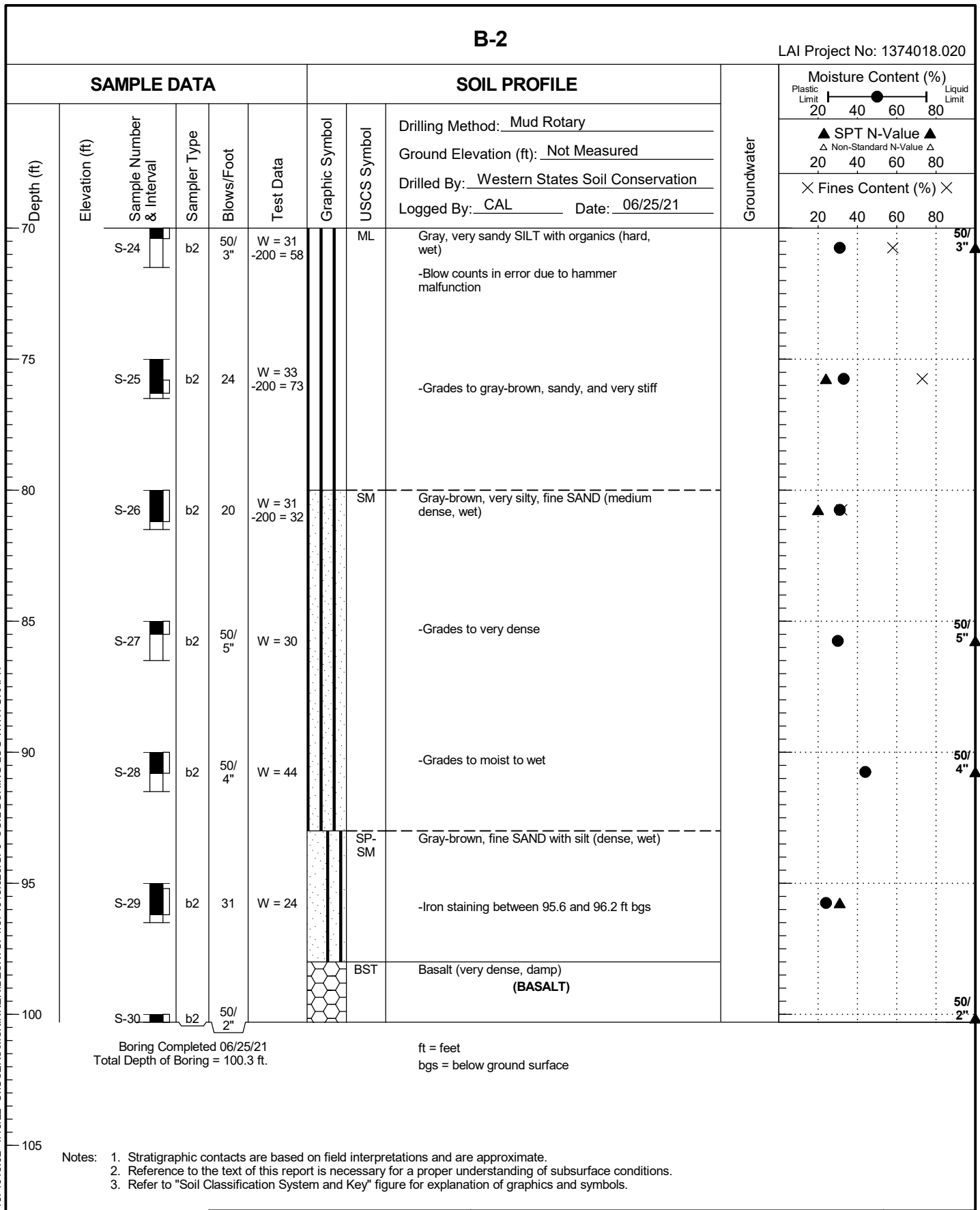
Figure
A-3
(1 of 3)

1374018.02 1/13/22 C:\USERS\SKINNER\DESKTOP\1374018.020.GPJ SOIL BORING LOG WITH GRAPH



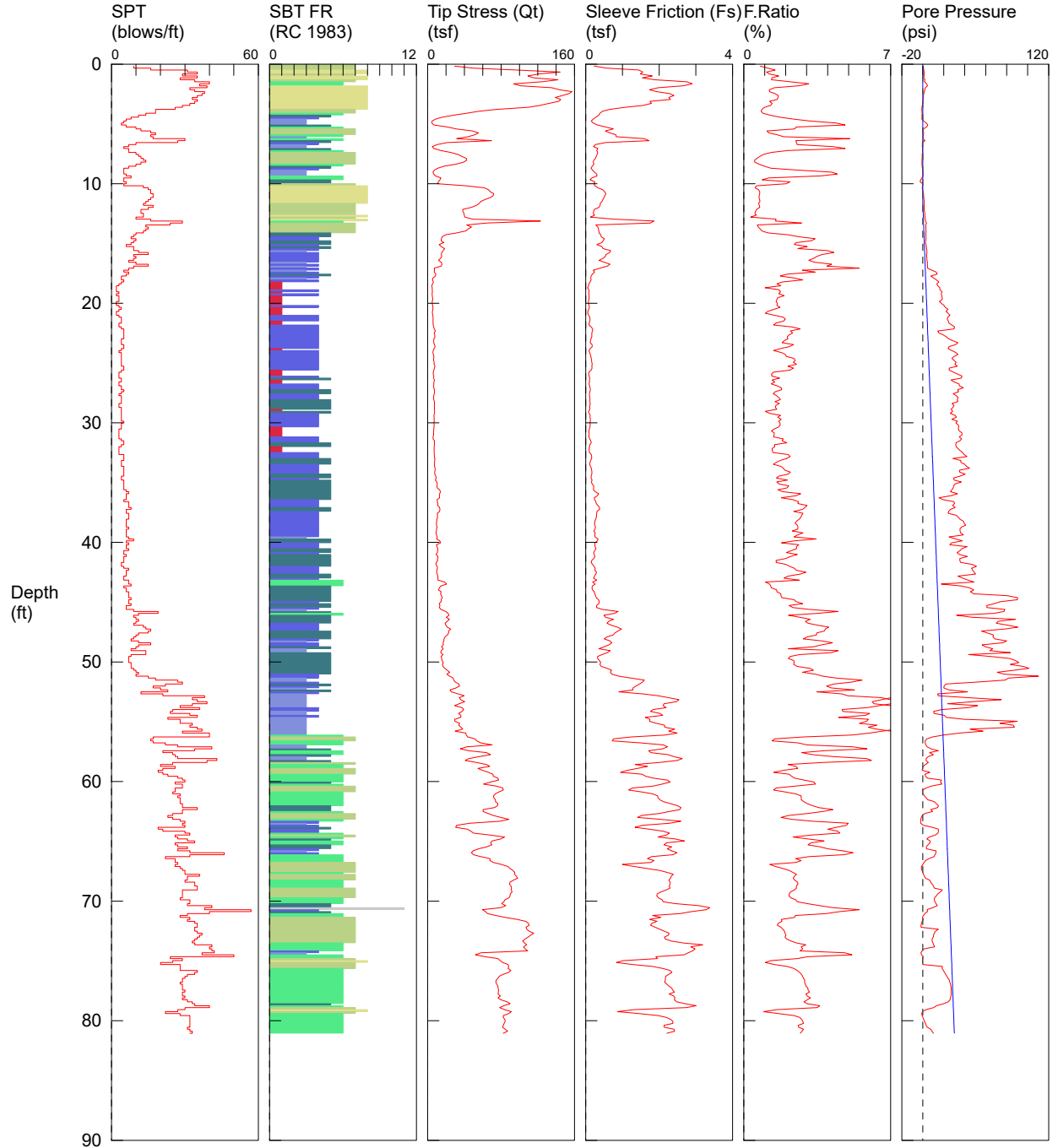
- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

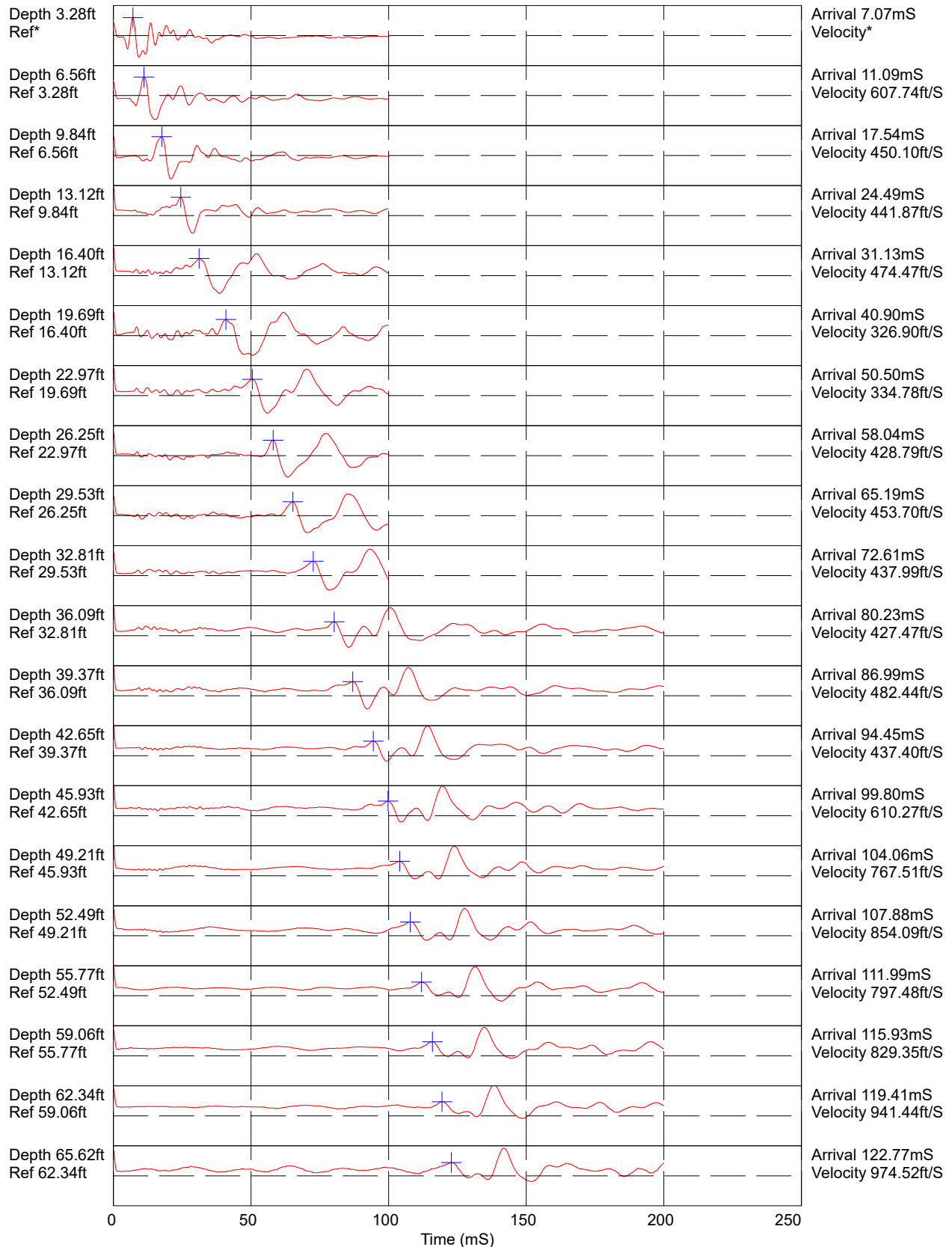
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 CONE ID: DDG1532
 HOLE NUMBER: CPT-1
 TEST DATE: 8/27/2020 9:56:01 AM
 TOTAL DEPTH: 81.037 ft



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

*SBT/SPT CORRELATION: UBC-1983

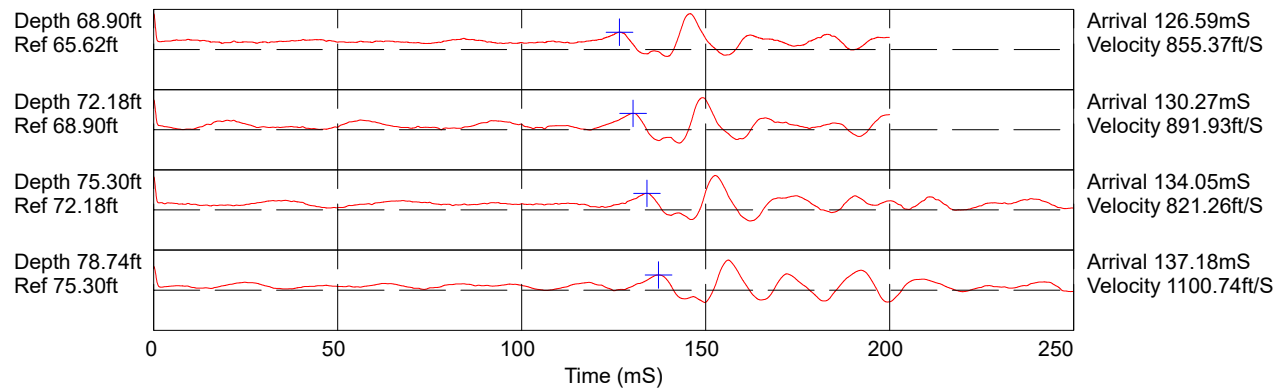
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Hammer to Rod String Distance (ft): 4.27

* = Not Determined

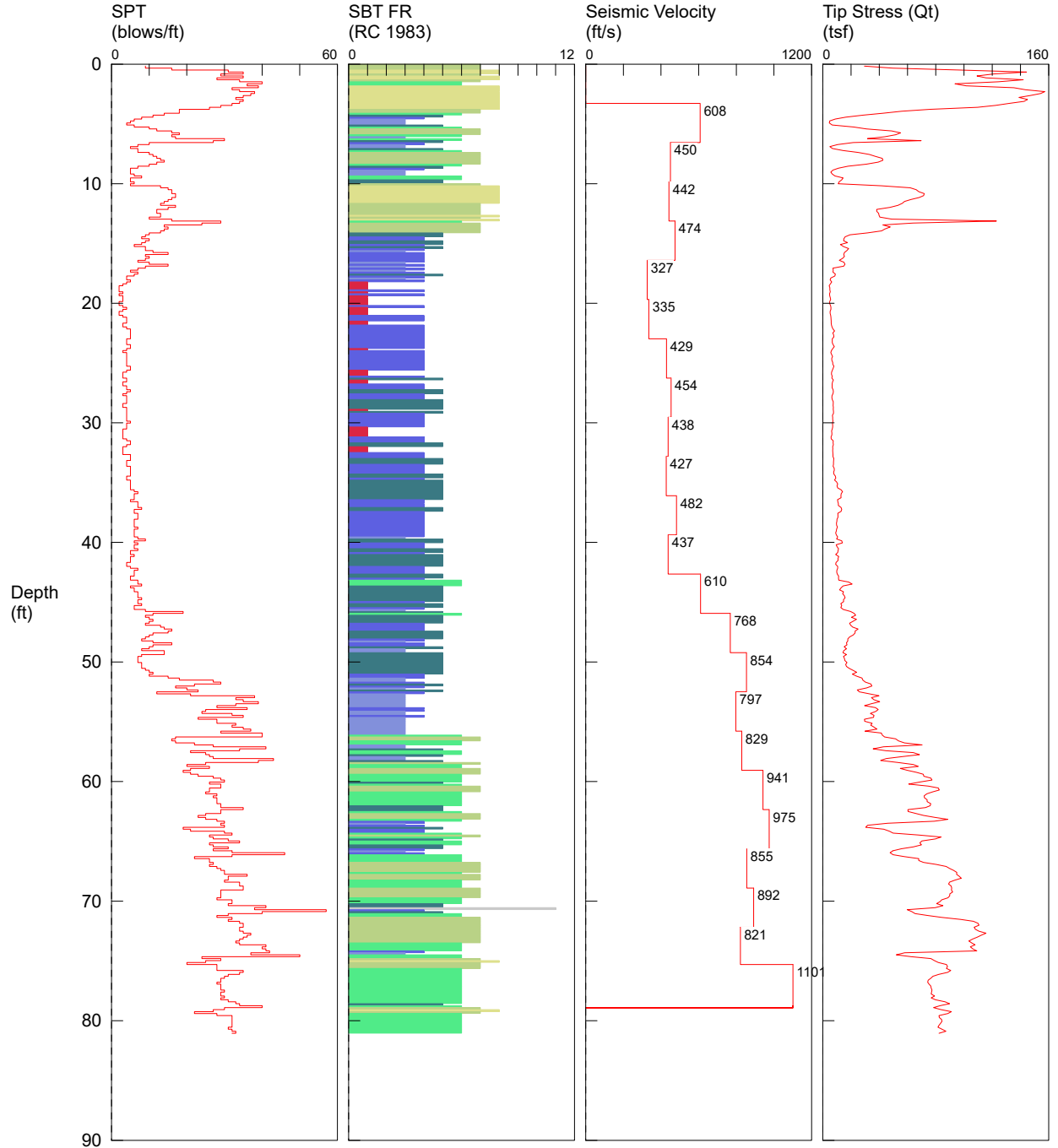
COMMENT: Landau Associates / CPT-1 / 1191 NW St. Helens Road Portland



Hammer to Rod String Distance (ft): 4.27
* = Not Determined

Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-1
 TEST DATE: 8/27/2020 9:56:01 AM
 TOTAL DEPTH: 81.037 ft

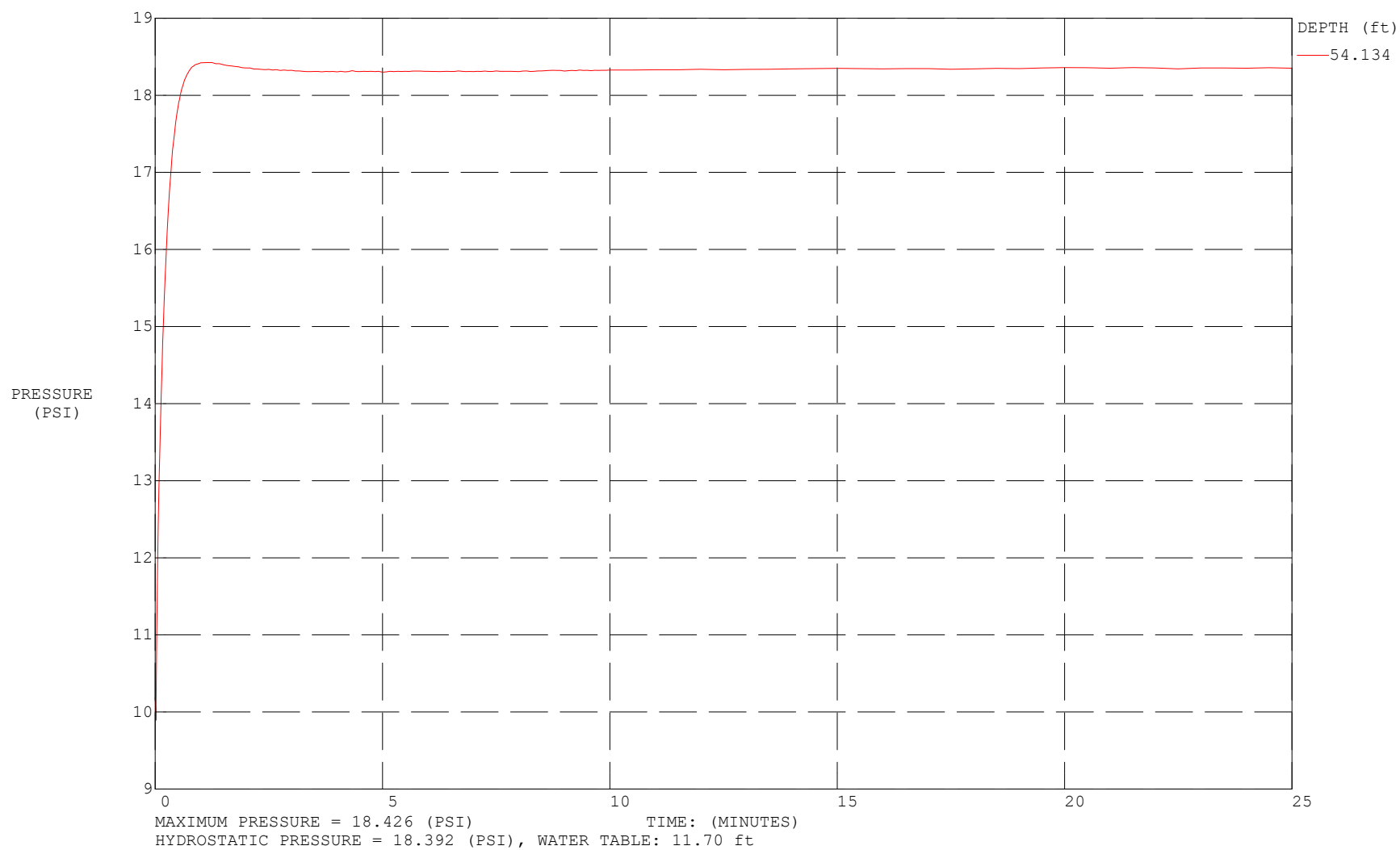


- | | | | |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 1 sensitive fine grained | 4 silty clay to clay | 7 silty sand to sandy silt | 10 gravelly sand to sand |
| 2 organic material | 5 clayey silt to silty clay | 8 sand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

*SBT/SPT CORRELATION: UBC-1983

COMMENT: Landau Associates / CPT-1 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 9:56:01 AM



Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-1
 TEST DATE: 8/27/2020 9:56:01 AM
 TOTAL DEPTH: 81.037 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	29.40	0.2305	0.784	0.287	9	7	silty sand to sandy silt
0.328	49.44	0.5667	1.146	0.444	16	7	silty sand to sandy silt
0.492	96.86	1.4463	1.493	0.908	31	7	silty sand to sandy silt
0.656	144.23	1.5526	1.076	1.038	35	8	sand to silty sand
0.820	121.07	1.4835	1.225	1.413	29	8	sand to silty sand
0.984	109.19	1.8084	1.656	1.091	35	7	silty sand to sandy silt
1.148	115.61	1.5459	1.337	0.820	28	8	sand to silty sand
1.312	141.95	1.8756	1.321	2.028	34	8	sand to silty sand
1.476	124.30	2.7545	2.216	1.557	40	7	silty sand to sandy silt
1.640	93.58	2.9001	3.099	3.545	36	6	sandy silt to clayey silt
1.804	101.54	2.6527	2.613	4.519	39	6	sandy silt to clayey silt
1.969	135.24	1.9738	1.460	2.350	32	8	sand to silty sand
2.133	143.52	1.7385	1.211	1.855	34	8	sand to silty sand
2.297	157.23	1.9252	1.224	1.488	38	8	sand to silty sand
2.461	154.22	2.2813	1.479	0.820	37	8	sand to silty sand
2.625	146.79	2.4006	1.635	0.570	35	8	sand to silty sand
2.789	138.97	2.2608	1.627	0.264	33	8	sand to silty sand
2.953	144.93	2.3063	1.591	0.189	35	8	sand to silty sand
3.117	142.64	1.7506	1.227	0.168	34	8	sand to silty sand
3.281	132.09	1.7885	1.354	0.104	32	8	sand to silty sand
3.445	122.28	1.5605	1.276	-0.596	29	8	sand to silty sand
3.609	109.60	1.0748	0.981	-0.663	26	8	sand to silty sand
3.773	75.94	0.6585	0.867	-1.075	18	8	sand to silty sand
3.937	55.89	0.4589	0.821	-0.937	18	7	silty sand to sandy silt
4.101	42.48	0.3860	0.909	-0.820	14	7	silty sand to sandy silt
4.265	28.57	0.3565	1.248	-0.860	11	6	sandy silt to clayey silt
4.429	16.23	0.2779	1.712	-0.921	8	5	clayey silt to silty clay
4.593	8.81	0.2067	2.346	-0.985	6	4	silty clay to clay
4.757	4.83	0.1508	3.124	0.546	5	3	clay
4.921	4.51	0.1978	4.388	3.306	4	3	clay
5.085	6.58	0.3179	4.834	4.655	6	3	clay
5.249	21.88	0.5459	2.495	3.553	10	5	clayey silt to silty clay
5.413	30.80	0.7473	2.426	0.399	12	6	sandy silt to clayey silt
5.577	48.73	0.5381	1.104	0.149	16	7	silty sand to sandy silt
5.741	55.07	0.6504	1.181	0.703	18	7	silty sand to sandy silt
5.906	51.57	0.8198	1.590	0.450	16	7	silty sand to sandy silt
6.070	43.86	0.8306	1.894	0.271	17	6	sandy silt to clayey silt
6.234	31.50	1.5902	5.049	0.133	30	3	clay
6.398	69.62	1.7234	2.475	2.041	27	6	sandy silt to clayey silt
6.562	21.48	0.5393	2.511	-0.474	10	5	clayey silt to silty clay
6.726	10.37	0.2632	2.539	-0.410	7	4	silty clay to clay
6.890	4.95	0.2100	4.245	-0.586	5	3	clay
7.054	6.79	0.3278	4.826	-0.274	7	3	clay
7.218	14.18	0.2989	2.107	-0.309	7	5	clayey silt to silty clay

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7.382	24.87	0.3252	1.308	-0.248	10	6	sandy silt to clayey silt
7.546	32.90	0.3068	0.933	-0.657	11	7	silty sand to sandy silt
7.710	37.07	0.2857	0.771	-0.516	12	7	silty sand to sandy silt
7.874	42.11	0.2648	0.629	-0.806	13	7	silty sand to sandy silt
8.038	42.49	0.2188	0.515	-0.889	14	7	silty sand to sandy silt
8.202	39.16	0.2029	0.518	-0.905	12	7	silty sand to sandy silt
8.366	30.87	0.2234	0.724	-0.916	10	7	silty sand to sandy silt
8.530	17.89	0.1745	0.975	-0.759	7	6	sandy silt to clayey silt
8.694	10.91	0.1401	1.284	-0.476	5	5	clayey silt to silty clay
8.858	7.17	0.1843	2.572	-0.210	5	4	silty clay to clay
9.022	5.59	0.2345	4.195	0.136	5	3	clay
9.186	6.65	0.2961	4.455	0.077	6	3	clay
9.350	8.42	0.3082	3.661	0.226	8	3	clay
9.514	14.33	0.1702	1.188	-0.878	5	6	sandy silt to clayey silt
9.678	13.43	0.1173	0.873	-2.209	5	6	sandy silt to clayey silt
9.843	11.52	0.2528	2.195	-2.555	6	5	clayey silt to silty clay
10.007	10.83	0.2189	2.022	-0.197	5	5	clayey silt to silty clay
10.171	41.37	0.2530	0.612	-0.293	13	7	silty sand to sandy silt
10.335	61.87	0.3298	0.533	-0.676	15	8	sand to silty sand
10.499	66.15	0.4625	0.699	-0.237	16	8	sand to silty sand
10.663	68.04	0.5153	0.757	0.189	16	8	sand to silty sand
10.827	71.87	0.5445	0.758	0.594	17	8	sand to silty sand
10.991	71.40	0.5217	0.731	0.761	17	8	sand to silty sand
11.155	68.23	0.4948	0.725	0.865	16	8	sand to silty sand
11.319	62.28	0.4666	0.749	1.019	15	8	sand to silty sand
11.483	57.91	0.4435	0.766	1.110	14	8	sand to silty sand
11.647	56.23	0.3940	0.701	1.206	13	8	sand to silty sand
11.811	53.18	0.3917	0.737	1.307	17	7	silty sand to sandy silt
11.975	47.52	0.3601	0.758	1.387	15	7	silty sand to sandy silt
12.139	38.12	0.2323	0.609	1.403	12	7	silty sand to sandy silt
12.303	38.15	0.2135	0.560	1.464	12	7	silty sand to sandy silt
12.467	39.46	0.2067	0.524	1.834	13	7	silty sand to sandy silt
12.631	39.82	0.2348	0.590	1.932	13	7	silty sand to sandy silt
12.795	40.39	0.1296	0.321	2.031	10	8	sand to silty sand
12.959	48.83	0.7499	1.536	2.177	16	7	silty sand to sandy silt
13.123	122.95	1.8547	1.508	2.515	29	8	sand to silty sand
13.287	63.89	1.7605	2.756	3.495	24	6	sandy silt to clayey silt
13.451	42.47	0.2733	0.644	2.659	14	7	silty sand to sandy silt
13.615	47.66	0.3275	0.687	2.824	15	7	silty sand to sandy silt
13.780	44.00	0.3451	0.784	2.885	14	7	silty sand to sandy silt
13.944	41.64	0.3551	0.853	2.936	13	7	silty sand to sandy silt
14.108	31.58	0.3635	1.151	2.920	10	7	silty sand to sandy silt
14.272	19.24	0.4072	2.116	2.901	9	5	clayey silt to silty clay
14.436	15.83	0.4192	2.648	2.981	8	5	clayey silt to silty clay
14.600	14.89	0.5058	3.398	2.946	10	4	silty clay to clay
14.764	14.70	0.4724	3.215	2.638	9	4	silty clay to clay
14.928	17.44	0.4343	2.491	2.454	8	5	clayey silt to silty clay
15.092	12.48	0.3000	2.405	2.986	6	5	clayey silt to silty clay
15.256	14.57	0.4407	3.024	3.348	9	4	silty clay to clay
15.420	18.25	0.4700	2.576	3.521	9	5	clayey silt to silty clay
15.584	16.97	0.6757	3.981	3.843	11	4	silty clay to clay
15.748	15.23	0.6540	4.294	3.915	15	3	clay
15.912	14.82	0.5528	3.730	3.532	9	4	silty clay to clay

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16.076	15.23	0.5308	3.485	3.641	10	4	silty clay to clay
16.240	14.07	0.4702	3.341	3.851	9	4	silty clay to clay
16.404	11.66	0.3613	3.098	3.979	7	4	silty clay to clay
16.568	14.91	0.5031	3.375	4.285	10	4	silty clay to clay
16.732	15.63	0.6553	4.194	4.272	15	3	clay
16.896	14.77	0.5847	3.960	4.413	9	4	silty clay to clay
17.060	7.10	0.3903	5.498	4.490	7	3	clay
17.224	7.31	0.2042	2.793	8.568	5	4	silty clay to clay
17.388	7.14	0.2424	3.396	12.632	7	3	clay
17.552	8.83	0.1836	2.080	13.660	6	4	silty clay to clay
17.717	8.46	0.1471	1.739	7.623	4	5	clayey silt to silty clay
17.881	5.59	0.1341	2.399	10.295	4	4	silty clay to clay
18.045	5.11	0.1435	2.810	12.965	5	3	clay
18.209	6.29	0.1162	1.847	15.249	4	4	silty clay to clay
18.373	5.35	0.0841	1.571	13.330	3	1	sensitive fine grained
18.537	4.47	0.0788	1.760	14.133	2	1	sensitive fine grained
18.701	4.94	0.0499	1.009	16.140	2	1	sensitive fine grained
18.865	4.95	0.0832	1.681	16.297	2	1	sensitive fine grained
19.029	5.18	0.0906	1.749	18.176	3	4	silty clay to clay
19.193	4.79	0.0796	1.662	17.609	2	1	sensitive fine grained
19.357	4.88	0.0939	1.924	18.001	3	4	silty clay to clay
19.521	5.30	0.0862	1.625	18.459	3	1	sensitive fine grained
19.685	5.49	0.0865	1.575	18.395	3	1	sensitive fine grained
19.849	4.89	0.0750	1.533	15.733	2	1	sensitive fine grained
20.013	4.75	0.0760	1.600	17.636	2	1	sensitive fine grained
20.177	5.42	0.0855	1.578	20.181	3	1	sensitive fine grained
20.341	5.69	0.0982	1.725	21.301	4	4	silty clay to clay
20.505	5.64	0.0810	1.436	24.067	3	1	sensitive fine grained
20.669	5.08	0.0582	1.145	22.081	2	1	sensitive fine grained
20.833	5.08	0.0525	1.033	24.067	2	1	sensitive fine grained
20.997	5.52	0.0810	1.468	25.861	3	1	sensitive fine grained
21.161	5.75	0.1079	1.877	23.808	4	4	silty clay to clay
21.325	5.85	0.1159	1.980	23.258	4	4	silty clay to clay
21.490	5.92	0.1120	1.891	24.186	4	4	silty clay to clay
21.654	5.90	0.0901	1.526	24.833	3	1	sensitive fine grained
21.818	6.05	0.0862	1.424	27.508	3	1	sensitive fine grained
21.982	6.48	0.1486	2.293	30.220	4	4	silty clay to clay
22.146	7.14	0.1915	2.683	29.675	5	4	silty clay to clay
22.310	8.32	0.1844	2.216	14.216	5	4	silty clay to clay
22.474	7.05	0.1643	2.330	15.206	5	4	silty clay to clay
22.638	7.66	0.1658	2.164	19.398	5	4	silty clay to clay
22.802	7.81	0.1615	2.067	22.528	5	4	silty clay to clay
22.966	6.74	0.1416	2.102	24.474	4	4	silty clay to clay
23.130	6.58	0.1264	1.920	28.573	4	4	silty clay to clay
23.294	6.60	0.1204	1.826	33.252	4	4	silty clay to clay
23.458	7.24	0.1714	2.367	31.216	5	4	silty clay to clay
23.622	8.08	0.1751	2.168	24.918	5	4	silty clay to clay
23.786	7.03	0.1242	1.767	24.037	4	4	silty clay to clay
23.950	6.02	0.0854	1.417	27.482	3	1	sensitive fine grained
24.114	5.60	0.1003	1.791	31.580	4	4	silty clay to clay
24.278	6.20	0.1228	1.982	33.332	4	4	silty clay to clay
24.442	6.86	0.1388	2.025	29.747	4	4	silty clay to clay
24.606	6.33	0.1512	2.390	27.673	4	4	silty clay to clay

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24.770	6.38	0.1565	2.453	29.725	4	4	silty clay to clay
24.934	6.94	0.1641	2.365	31.730	4	4	silty clay to clay
25.098	6.98	0.1754	2.512	30.444	4	4	silty clay to clay
25.262	7.84	0.1652	2.106	32.752	5	4	silty clay to clay
25.427	7.31	0.1726	2.362	25.211	5	4	silty clay to clay
25.591	6.75	0.1487	2.203	25.145	4	4	silty clay to clay
25.755	6.11	0.0863	1.412	29.073	3	1	sensitive fine grained
25.919	6.03	0.0796	1.320	33.361	3	1	sensitive fine grained
26.083	6.58	0.0879	1.337	37.364	3	1	sensitive fine grained
26.247	6.38	0.1085	1.701	36.728	4	4	silty clay to clay
26.411	7.39	0.1002	1.355	26.928	4	5	clayey silt to silty clay
26.575	6.85	0.1009	1.472	29.608	3	1	sensitive fine grained
26.739	6.51	0.0854	1.311	34.428	3	1	sensitive fine grained
26.903	6.57	0.1043	1.587	34.814	4	4	silty clay to clay
27.067	6.52	0.1166	1.788	38.501	4	4	silty clay to clay
27.231	7.25	0.1302	1.797	33.188	5	4	silty clay to clay
27.395	7.45	0.1113	1.494	33.952	4	5	clayey silt to silty clay
27.559	7.11	0.0996	1.401	28.852	3	5	clayey silt to silty clay
27.723	6.46	0.1008	1.560	31.817	4	4	silty clay to clay
27.887	6.42	0.1074	1.673	33.614	4	4	silty clay to clay
28.051	6.65	0.1159	1.743	32.685	4	4	silty clay to clay
28.215	7.33	0.1091	1.488	33.478	4	5	clayey silt to silty clay
28.379	7.30	0.1232	1.687	27.910	3	5	clayey silt to silty clay
28.543	7.25	0.1107	1.527	29.747	3	5	clayey silt to silty clay
28.707	7.41	0.1116	1.506	28.685	4	5	clayey silt to silty clay
28.871	7.33	0.1148	1.566	27.026	4	5	clayey silt to silty clay
29.035	7.47	0.0769	1.030	28.429	4	1	sensitive fine grained
29.199	7.52	0.0922	1.226	26.180	4	5	clayey silt to silty clay
29.364	6.75	0.1184	1.753	30.686	4	4	silty clay to clay
29.528	6.94	0.1120	1.614	31.956	4	4	silty clay to clay
29.692	6.97	0.1243	1.784	27.702	4	4	silty clay to clay
29.856	7.13	0.1187	1.664	32.682	5	4	silty clay to clay
30.020	6.78	0.1168	1.723	31.549	4	4	silty clay to clay
30.184	6.98	0.1207	1.730	33.893	4	4	silty clay to clay
30.348	6.93	0.1148	1.657	34.237	4	4	silty clay to clay
30.512	6.72	0.0972	1.446	33.758	3	1	sensitive fine grained
30.676	6.26	0.0828	1.323	34.644	3	1	sensitive fine grained
30.840	6.38	0.0925	1.450	37.290	3	1	sensitive fine grained
31.004	6.34	0.0918	1.447	37.287	3	1	sensitive fine grained
31.168	5.85	0.0830	1.419	34.620	3	1	sensitive fine grained
31.332	5.92	0.1113	1.879	36.898	4	4	silty clay to clay
31.496	7.31	0.1335	1.827	35.440	5	4	silty clay to clay
31.660	7.26	0.1489	2.050	31.676	5	4	silty clay to clay
31.824	7.41	0.1082	1.460	31.346	4	5	clayey silt to silty clay
31.988	6.94	0.1022	1.471	31.801	3	5	clayey silt to silty clay
32.152	7.03	0.0942	1.341	33.569	3	1	sensitive fine grained
32.316	6.94	0.0942	1.356	35.392	3	1	sensitive fine grained
32.480	6.99	0.0972	1.390	38.000	3	1	sensitive fine grained
32.644	7.10	0.1500	2.113	39.318	5	4	silty clay to clay
32.808	7.19	0.1586	2.205	42.073	5	4	silty clay to clay
32.972	7.77	0.1588	2.045	28.783	5	4	silty clay to clay
33.136	7.66	0.1329	1.734	36.230	4	5	clayey silt to silty clay
33.301	7.50	0.1159	1.545	36.244	4	5	clayey silt to silty clay

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33.465	7.46	0.1048	1.405	39.949	4	5	clayey silt to silty clay
33.629	7.23	0.1272	1.758	41.567	5	4	silty clay to clay
33.793	8.01	0.1510	1.884	44.479	5	4	silty clay to clay
33.957	8.14	0.1589	1.953	34.926	5	4	silty clay to clay
34.121	7.66	0.1697	2.217	35.091	5	4	silty clay to clay
34.285	7.79	0.1643	2.110	40.359	5	4	silty clay to clay
34.449	8.85	0.1473	1.664	35.424	4	5	clayey silt to silty clay
34.613	9.19	0.1430	1.556	29.180	4	5	clayey silt to silty clay
34.777	8.33	0.1725	2.070	29.821	5	4	silty clay to clay
34.941	9.77	0.1531	1.567	36.638	5	5	clayey silt to silty clay
35.105	10.44	0.1759	1.684	30.550	5	5	clayey silt to silty clay
35.269	10.04	0.2151	2.143	29.337	5	5	clayey silt to silty clay
35.433	10.43	0.2152	2.063	28.866	5	5	clayey silt to silty clay
35.597	12.86	0.2093	1.628	27.577	6	5	clayey silt to silty clay
35.761	13.96	0.2581	1.850	26.313	7	5	clayey silt to silty clay
35.925	12.99	0.3519	2.708	33.055	6	5	clayey silt to silty clay
36.089	12.75	0.3167	2.485	26.715	6	5	clayey silt to silty clay
36.253	12.91	0.2309	1.789	15.411	6	5	clayey silt to silty clay
36.417	10.33	0.2414	2.337	19.140	5	5	clayey silt to silty clay
36.581	10.60	0.2765	2.609	29.574	7	4	silty clay to clay
36.745	11.03	0.2839	2.573	30.258	7	4	silty clay to clay
36.909	11.00	0.3310	3.010	28.432	7	4	silty clay to clay
37.073	12.88	0.3757	2.917	30.771	8	4	silty clay to clay
37.238	13.42	0.3762	2.804	26.425	6	5	clayey silt to silty clay
37.402	12.90	0.3077	2.386	24.559	6	5	clayey silt to silty clay
37.566	10.58	0.2984	2.821	24.032	7	4	silty clay to clay
37.730	10.71	0.2956	2.760	31.908	7	4	silty clay to clay
37.894	10.65	0.2892	2.716	33.856	7	4	silty clay to clay
38.058	10.06	0.2660	2.643	35.272	6	4	silty clay to clay
38.222	9.85	0.2477	2.514	38.692	6	4	silty clay to clay
38.386	9.63	0.2349	2.440	39.374	6	4	silty clay to clay
38.550	9.74	0.2482	2.548	40.806	6	4	silty clay to clay
38.714	10.27	0.2652	2.581	36.768	7	4	silty clay to clay
38.878	9.71	0.2502	2.576	35.325	6	4	silty clay to clay
39.042	9.59	0.2215	2.309	35.493	6	4	silty clay to clay
39.206	9.05	0.2551	2.819	35.988	6	4	silty clay to clay
39.370	9.54	0.2447	2.564	38.695	6	4	silty clay to clay
39.534	10.49	0.2513	2.397	24.998	7	4	silty clay to clay
39.698	9.72	0.3345	3.440	31.250	9	3	clay
39.862	13.31	0.3200	2.404	37.503	6	5	clayey silt to silty clay
40.026	13.87	0.2487	1.793	27.346	7	5	clayey silt to silty clay
40.190	9.45	0.2473	2.617	25.621	6	4	silty clay to clay
40.354	10.06	0.2523	2.508	42.131	6	4	silty clay to clay
40.518	11.10	0.2792	2.516	37.010	7	4	silty clay to clay
40.682	10.80	0.2451	2.270	35.554	5	5	clayey silt to silty clay
40.846	10.55	0.2139	2.028	32.557	5	5	clayey silt to silty clay
41.011	9.04	0.2306	2.549	34.900	6	4	silty clay to clay
41.175	11.24	0.2487	2.212	42.472	5	5	clayey silt to silty clay
41.339	10.72	0.2143	1.998	35.144	5	5	clayey silt to silty clay
41.503	10.80	0.1657	1.534	35.208	5	5	clayey silt to silty clay
41.667	9.37	0.1448	1.545	36.039	4	5	clayey silt to silty clay
41.831	9.00	0.1797	1.997	47.007	4	5	clayey silt to silty clay
41.995	10.42	0.2282	2.190	51.114	5	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
42.159	10.55	0.2539	2.407	46.419	7	4	silty clay to clay
42.323	9.92	0.2483	2.504	47.455	6	4	silty clay to clay
42.487	9.83	0.2906	2.957	48.897	6	4	silty clay to clay
42.651	10.17	0.2748	2.702	50.180	6	4	silty clay to clay
42.815	11.13	0.2352	2.113	33.388	5	5	clayey silt to silty clay
42.979	11.05	0.2119	1.917	37.944	5	5	clayey silt to silty clay
43.143	11.27	0.2975	2.640	43.188	7	4	silty clay to clay
43.307	18.25	0.1885	1.033	48.753	7	6	sandy silt to clayey silt
43.471	20.75	0.2548	1.228	17.623	8	6	sandy silt to clayey silt
43.635	14.31	0.1825	1.275	36.395	5	6	sandy silt to clayey silt
43.799	12.81	0.1679	1.311	44.660	6	5	clayey silt to silty clay
43.963	11.78	0.1845	1.566	48.493	6	5	clayey silt to silty clay
44.127	14.56	0.2292	1.574	45.376	7	5	clayey silt to silty clay
44.291	14.00	0.2462	1.758	48.405	7	5	clayey silt to silty clay
44.455	15.13	0.2674	1.767	80.512	7	5	clayey silt to silty clay
44.619	15.73	0.2851	1.812	90.366	8	5	clayey silt to silty clay
44.783	14.61	0.3506	2.400	90.110	7	5	clayey silt to silty clay
44.948	14.64	0.3651	2.493	74.228	7	5	clayey silt to silty clay
45.112	12.65	0.3552	2.809	68.000	8	4	silty clay to clay
45.276	13.43	0.2906	2.165	60.893	6	5	clayey silt to silty clay
45.440	12.67	0.2960	2.336	61.202	6	5	clayey silt to silty clay
45.604	14.45	0.4535	3.138	78.239	9	4	silty clay to clay
45.768	19.57	0.8799	4.496	77.265	19	3	clay
45.932	22.17	0.7811	3.523	67.750	11	5	clayey silt to silty clay
46.096	23.21	0.4947	2.132	32.094	9	6	sandy silt to clayey silt
46.260	20.27	0.5409	2.669	46.901	10	5	clayey silt to silty clay
46.424	23.73	0.7505	3.163	88.236	11	5	clayey silt to silty clay
46.588	21.27	0.6242	2.935	71.782	10	5	clayey silt to silty clay
46.752	18.88	0.5782	3.062	69.916	9	5	clayey silt to silty clay
46.916	19.70	0.6963	3.535	81.242	13	4	silty clay to clay
47.080	21.23	0.8596	4.050	90.440	14	4	silty clay to clay
47.244	25.00	0.9714	3.885	77.816	16	4	silty clay to clay
47.408	22.79	0.8745	3.837	55.924	15	4	silty clay to clay
47.572	22.82	0.7938	3.478	61.338	11	5	clayey silt to silty clay
47.736	21.52	0.7452	3.464	67.422	10	5	clayey silt to silty clay
47.900	18.95	0.5753	3.036	66.767	9	5	clayey silt to silty clay
48.064	17.75	0.5027	2.833	68.532	8	5	clayey silt to silty clay
48.228	17.66	0.6600	3.738	79.967	11	4	silty clay to clay
48.392	16.72	0.7073	4.230	76.211	16	3	clay
48.556	17.05	0.6321	3.707	56.464	11	4	silty clay to clay
48.720	15.08	0.5035	3.340	59.557	10	4	silty clay to clay
48.885	16.76	0.3555	2.122	66.634	8	5	clayey silt to silty clay
49.049	14.82	0.6661	4.493	63.997	14	3	clay
49.213	14.21	0.5900	4.152	83.701	14	3	clay
49.377	16.70	0.4445	2.662	43.555	8	5	clayey silt to silty clay
49.541	14.59	0.3220	2.207	64.518	7	5	clayey silt to silty clay
49.705	15.20	0.3220	2.119	82.748	7	5	clayey silt to silty clay
49.869	15.54	0.3700	2.380	88.324	7	5	clayey silt to silty clay
50.033	17.04	0.4087	2.398	91.284	8	5	clayey silt to silty clay
50.197	16.14	0.3832	2.374	83.347	8	5	clayey silt to silty clay
50.361	16.68	0.4234	2.539	95.742	8	5	clayey silt to silty clay
50.525	18.70	0.5879	3.145	100.994	9	5	clayey silt to silty clay
50.689	21.22	0.7030	3.314	87.079	10	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
50.853	23.97	0.6711	2.800	70.930	11	5	clayey silt to silty clay
51.017	20.87	0.7093	3.398	77.342	10	5	clayey silt to silty clay
51.181	23.93	0.9003	3.762	109.987	15	4	silty clay to clay
51.345	27.78	1.2266	4.415	81.769	18	4	silty clay to clay
51.509	28.30	1.5963	5.642	78.495	27	3	clay
51.673	30.10	1.5440	5.129	51.027	29	3	clay
51.837	34.02	1.4643	4.304	22.065	22	4	silty clay to clay
52.001	34.68	1.3680	3.945	20.287	17	5	clayey silt to silty clay
52.165	30.93	1.2872	4.161	19.941	20	4	silty clay to clay
52.329	24.30	1.2835	5.283	24.900	23	3	clay
52.493	25.87	0.9021	3.486	42.560	12	5	clayey silt to silty clay
52.657	33.13	1.5460	4.666	14.125	21	4	silty clay to clay
52.822	39.79	1.9713	4.955	14.525	38	3	clay
52.986	34.35	2.2507	6.553	42.757	33	3	clay
53.150	36.12	2.5394	7.031	74.800	35	3	clay
53.314	40.25	2.4653	6.125	47.023	39	3	clay
53.478	34.42	2.1341	6.201	23.798	33	3	clay
53.642	29.48	2.1065	7.145	52.059	28	3	clay
53.806	37.27	2.1876	5.869	43.284	36	3	clay
53.970	39.24	1.8397	4.688	18.230	25	4	silty clay to clay
54.134	37.47	1.7680	4.718	10.122	24	4	silty clay to clay
54.298	33.65	2.0196	6.002	10.604	32	3	clay
54.462	36.17	2.0992	5.803	20.527	35	3	clay
54.626	35.93	1.6222	4.515	22.273	23	4	silty clay to clay
54.790	29.41	1.7452	5.934	38.881	28	3	clay
54.954	29.66	1.7361	5.853	90.100	28	3	clay
55.118	34.83	1.9211	5.515	73.331	33	3	clay
55.282	33.88	2.1470	6.338	86.261	32	3	clay
55.446	36.28	2.1515	5.930	87.291	35	3	clay
55.610	38.26	2.4209	6.327	45.112	37	3	clay
55.774	29.81	2.2602	7.583	57.409	29	3	clay
55.938	41.43	2.4915	6.014	35.387	40	3	clay
56.102	42.04	2.1576	5.132	19.523	40	3	clay
56.266	43.70	1.2406	2.839	9.151	17	6	sandy silt to clayey silt
56.430	51.51	0.7587	1.473	3.870	16	7	silty sand to sandy silt
56.594	53.54	0.7216	1.348	2.148	17	7	silty sand to sandy silt
56.759	57.74	1.4970	2.593	2.183	22	6	sandy silt to clayey silt
56.923	70.30	2.1152	3.009	2.763	27	6	sandy silt to clayey silt
57.087	42.87	2.2269	5.194	4.080	41	3	clay
57.251	35.60	2.0908	5.874	7.756	34	3	clay
57.415	44.63	1.7132	3.839	14.775	21	5	clayey silt to silty clay
57.579	64.11	1.7690	2.759	6.441	25	6	sandy silt to clayey silt
57.743	68.34	2.2394	3.277	9.973	26	6	sandy silt to clayey silt
57.907	56.73	2.3918	4.216	5.374	27	5	clayey silt to silty clay
58.071	44.92	2.6286	5.852	3.175	43	3	clay
58.235	40.90	2.4905	6.089	2.933	39	3	clay
58.399	53.13	2.0053	3.774	5.262	25	5	clayey silt to silty clay
58.563	63.99	1.3512	2.112	2.401	20	7	silty sand to sandy silt
58.727	67.53	1.6791	2.486	0.253	26	6	sandy silt to clayey silt
58.891	54.78	1.4065	2.567	-0.303	21	6	sandy silt to clayey silt
59.055	59.79	1.1362	1.900	-0.697	19	7	silty sand to sandy silt
59.219	66.27	0.9471	1.429	6.598	21	7	silty sand to sandy silt
59.383	71.03	1.5322	2.157	2.031	23	7	silty sand to sandy silt

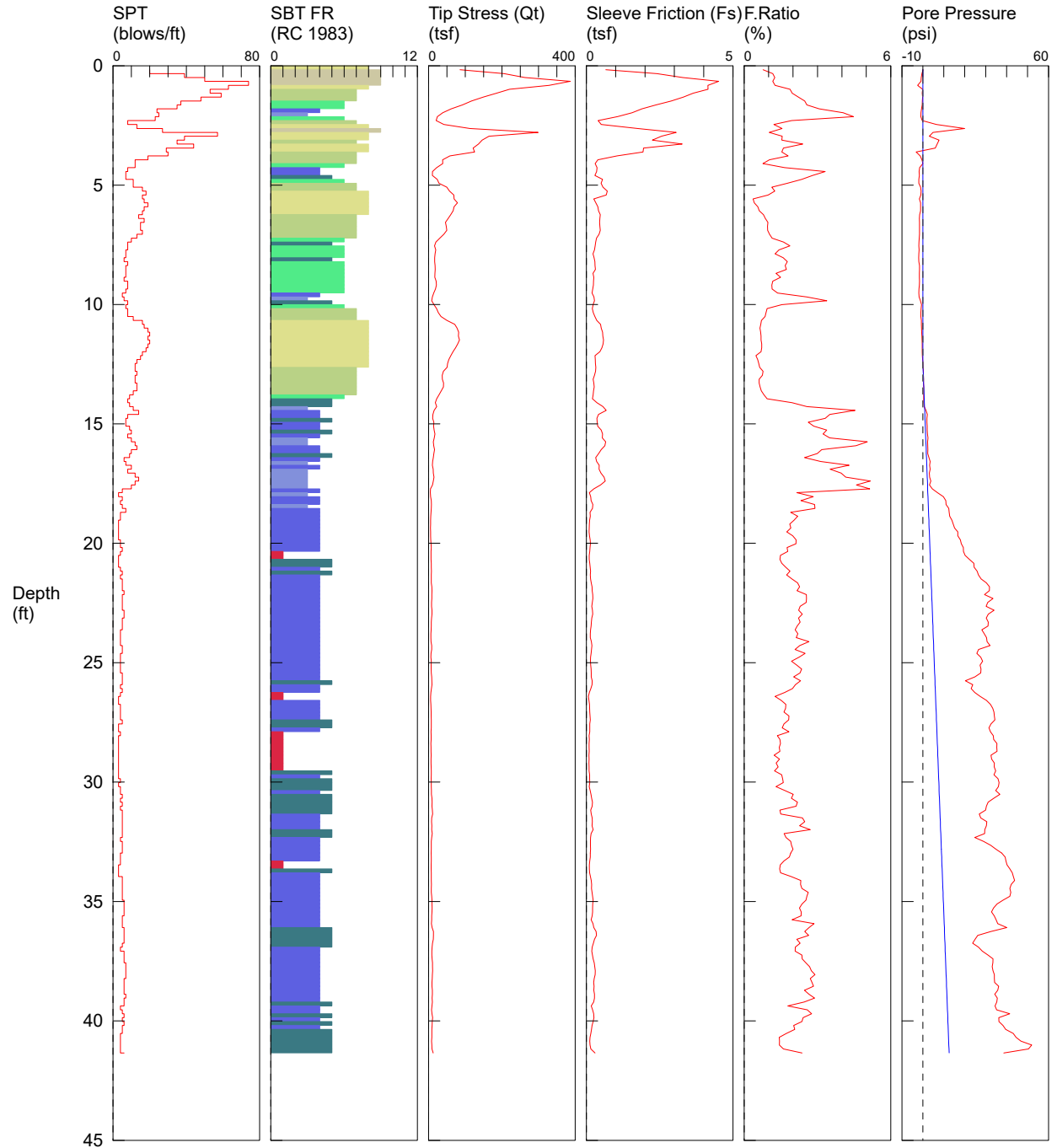
Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
59.547	71.58	1.6309	2.278	2.568	27	6	sandy silt to clayey silt
59.711	76.51	1.8447	2.411	4.251	29	6	sandy silt to clayey silt
59.875	77.27	2.2135	2.865	17.681	30	6	sandy silt to clayey silt
60.039	68.63	2.2967	3.347	16.806	26	6	sandy silt to clayey silt
60.203	60.84	2.0818	3.422	18.136	29	5	clayey silt to silty clay
60.367	74.74	1.8305	2.449	7.934	29	6	sandy silt to clayey silt
60.532	81.85	1.2673	1.548	2.816	26	7	silty sand to sandy silt
60.696	82.51	1.1686	1.416	0.008	26	7	silty sand to sandy silt
60.860	77.72	1.5167	1.951	-0.386	25	7	silty sand to sandy silt
61.024	73.73	1.8174	2.465	0.224	28	6	sandy silt to clayey silt
61.188	71.74	1.9572	2.728	1.480	27	6	sandy silt to clayey silt
61.352	71.91	1.9708	2.741	2.994	28	6	sandy silt to clayey silt
61.516	73.83	2.0155	2.730	4.645	28	6	sandy silt to clayey silt
61.680	73.89	2.1133	2.860	10.796	28	6	sandy silt to clayey silt
61.844	76.41	2.3105	3.024	12.848	29	6	sandy silt to clayey silt
62.008	76.10	2.4957	3.280	14.889	29	6	sandy silt to clayey silt
62.172	72.74	2.5910	3.562	13.928	35	5	clayey silt to silty clay
62.336	60.19	2.5593	4.252	7.679	29	5	clayey silt to silty clay
62.500	60.36	2.2752	3.769	9.236	29	5	clayey silt to silty clay
62.664	65.99	1.9979	3.027	1.876	25	6	sandy silt to clayey silt
62.828	71.23	1.5266	2.143	-0.570	23	7	silty sand to sandy silt
62.992	79.60	1.4082	1.769	-1.373	25	7	silty sand to sandy silt
63.156	88.45	2.0363	2.302	-2.121	28	7	silty sand to sandy silt
63.320	78.93	2.5878	3.279	-2.201	30	6	sandy silt to clayey silt
63.484	45.94	2.2856	4.975	-1.954	29	4	silty clay to clay
63.648	31.64	1.5506	4.900	0.314	30	3	clay
63.812	30.40	1.3440	4.420	9.044	19	4	silty clay to clay
63.976	43.15	1.7296	4.009	14.639	21	5	clayey silt to silty clay
64.140	47.12	2.1115	4.481	14.852	30	4	silty clay to clay
64.304	49.79	2.2769	4.573	14.320	32	4	silty clay to clay
64.469	67.64	2.2028	3.257	11.868	26	6	sandy silt to clayey silt
64.633	83.69	1.9665	2.350	6.037	27	7	silty sand to sandy silt
64.797	79.72	2.4262	3.043	3.764	31	6	sandy silt to clayey silt
64.961	70.22	2.6888	3.829	6.875	34	5	clayey silt to silty clay
65.125	68.64	2.1951	3.198	6.681	26	6	sandy silt to clayey silt
65.289	69.89	2.1339	3.053	4.818	27	6	sandy silt to clayey silt
65.453	64.13	2.3407	3.650	3.340	31	5	clayey silt to silty clay
65.617	55.56	2.2223	4.000	3.394	27	5	clayey silt to silty clay
65.781	49.54	2.3386	4.721	12.353	32	4	silty clay to clay
65.945	47.65	2.4809	5.207	12.499	46	3	clay
66.109	49.76	2.3770	4.777	11.589	32	4	silty clay to clay
66.273	57.70	1.7949	3.111	10.750	22	6	sandy silt to clayey silt
66.437	67.94	1.6815	2.475	5.656	26	6	sandy silt to clayey silt
66.601	67.90	1.8584	2.737	2.632	26	6	sandy silt to clayey silt
66.765	71.31	1.7766	2.492	1.171	27	6	sandy silt to clayey silt
66.929	80.33	0.9956	1.239	-0.165	26	7	silty sand to sandy silt
67.093	87.30	1.3147	1.506	-1.368	28	7	silty sand to sandy silt
67.257	89.82	1.6667	1.856	-1.437	29	7	silty sand to sandy silt
67.421	92.64	2.0017	2.161	-0.886	30	7	silty sand to sandy silt
67.585	94.91	2.2171	2.336	-0.101	30	7	silty sand to sandy silt
67.749	94.72	2.3819	2.515	0.559	36	6	sandy silt to clayey silt
67.913	96.54	2.3283	2.412	1.445	31	7	silty sand to sandy silt
68.077	98.01	2.3084	2.355	2.393	31	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
68.241	93.59	2.2643	2.419	6.558	30	7	silty sand to sandy silt
68.406	89.71	2.2966	2.560	7.418	34	6	sandy silt to clayey silt
68.570	89.11	2.3006	2.582	8.799	34	6	sandy silt to clayey silt
68.734	90.84	2.2738	2.503	10.080	35	6	sandy silt to clayey silt
68.898	91.26	2.2938	2.513	10.942	35	6	sandy silt to clayey silt
69.062	91.09	2.1928	2.407	18.514	29	7	silty sand to sandy silt
69.226	91.95	2.0429	2.222	16.532	29	7	silty sand to sandy silt
69.390	89.92	1.9444	2.162	14.242	29	7	silty sand to sandy silt
69.554	89.79	1.9370	2.157	12.850	29	7	silty sand to sandy silt
69.718	88.62	1.9817	2.236	11.139	28	7	silty sand to sandy silt
69.882	84.18	2.0818	2.473	10.785	32	6	sandy silt to clayey silt
70.046	82.93	2.1064	2.540	11.496	32	6	sandy silt to clayey silt
70.210	80.57	2.4323	3.019	12.478	31	6	sandy silt to clayey silt
70.374	85.00	3.0819	3.626	13.745	41	5	clayey silt to silty clay
70.538	79.63	3.3784	4.243	9.398	38	5	clayey silt to silty clay
70.702	59.72	3.2852	5.501	4.094	57	11	very stiff fine grained (*)
70.866	62.90	2.8847	4.586	4.362	40	4	silty clay to clay
71.030	65.30	2.5662	3.930	1.938	31	5	clayey silt to silty clay
71.194	74.28	1.8206	2.451	0.530	28	6	sandy silt to clayey silt
71.358	84.26	2.0444	2.426	-0.421	32	6	sandy silt to clayey silt
71.522	97.52	1.7426	1.787	0.575	31	7	silty sand to sandy silt
71.686	106.75	1.9420	1.819	-0.719	34	7	silty sand to sandy silt
71.850	109.88	1.7973	1.636	-1.320	35	7	silty sand to sandy silt
72.014	110.61	1.7660	1.597	-1.741	35	7	silty sand to sandy silt
72.178	107.14	1.8905	1.765	-1.746	34	7	silty sand to sandy silt
72.343	108.03	2.0194	1.869	14.668	34	7	silty sand to sandy silt
72.507	110.51	2.1396	1.936	12.020	35	7	silty sand to sandy silt
72.671	115.57	2.2708	1.965	10.923	37	7	silty sand to sandy silt
72.835	112.36	2.2560	2.008	10.205	36	7	silty sand to sandy silt
72.999	109.41	2.1442	1.960	9.981	35	7	silty sand to sandy silt
73.163	106.18	2.1646	2.039	8.797	34	7	silty sand to sandy silt
73.327	103.48	2.3279	2.250	8.786	33	7	silty sand to sandy silt
73.491	105.47	2.6454	2.508	9.547	34	7	silty sand to sandy silt
73.655	107.85	3.1863	2.954	10.125	41	6	sandy silt to clayey silt
73.819	104.51	2.8586	2.735	11.259	40	6	sandy silt to clayey silt
73.983	106.14	2.9804	2.808	1.288	41	6	sandy silt to clayey silt
74.147	109.13	2.9138	2.670	-0.793	42	6	sandy silt to clayey silt
74.311	58.02	2.7879	4.805	-1.900	37	4	silty clay to clay
74.475	51.98	2.6825	5.160	-1.248	50	3	clay
74.639	62.50	1.9091	3.054	0.354	24	6	sandy silt to clayey silt
74.803	76.60	1.9572	2.555	-0.298	29	6	sandy silt to clayey silt
74.967	79.03	1.0278	1.301	-0.476	25	7	silty sand to sandy silt
75.131	81.79	0.8333	1.019	-0.394	20	8	sand to silty sand
75.295	87.49	1.2678	1.449	-0.093	28	7	silty sand to sandy silt
75.459	88.28	1.8218	2.064	18.653	28	7	silty sand to sandy silt
75.623	87.51	2.0923	2.391	18.291	28	7	silty sand to sandy silt
75.787	90.62	2.3014	2.540	19.571	35	6	sandy silt to clayey silt
75.951	88.37	2.3464	2.655	20.487	34	6	sandy silt to clayey silt
76.115	82.09	2.2578	2.751	21.791	31	6	sandy silt to clayey silt
76.280	77.97	2.1790	2.795	22.858	30	6	sandy silt to clayey silt
76.444	76.39	2.1728	2.844	23.995	29	6	sandy silt to clayey silt
76.608	74.62	2.1660	2.903	25.318	29	6	sandy silt to clayey silt
76.772	74.25	2.1475	2.892	25.650	28	6	sandy silt to clayey silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
76.936	75.24	2.2049	2.930	26.310	29	6	sandy silt to clayey silt
77.100	76.38	2.2608	2.960	26.640	29	6	sandy silt to clayey silt
77.264	76.71	2.3401	3.050	26.925	29	6	sandy silt to clayey silt
77.428	77.30	2.3695	3.065	26.947	30	6	sandy silt to clayey silt
77.592	76.94	2.4126	3.136	26.883	29	6	sandy silt to clayey silt
77.756	76.74	2.2719	2.961	26.923	29	6	sandy silt to clayey silt
77.920	79.14	2.3944	3.026	26.787	30	6	sandy silt to clayey silt
78.084	76.73	2.4332	3.171	26.140	29	6	sandy silt to clayey silt
78.248	79.76	2.4127	3.025	25.996	31	6	sandy silt to clayey silt
78.412	86.53	2.4756	2.861	24.176	33	6	sandy silt to clayey silt
78.576	89.72	2.7065	3.017	19.797	34	6	sandy silt to clayey silt
78.740	82.96	3.0069	3.624	12.952	40	5	clayey silt to silty clay
78.904	78.43	2.7422	3.496	10.404	30	6	sandy silt to clayey silt
79.068	83.68	1.3138	1.570	3.013	27	7	silty sand to sandy silt
79.232	91.05	0.8580	0.942	-0.487	22	8	sand to silty sand
79.396	88.47	1.4458	1.634	-1.137	28	7	silty sand to sandy silt
79.560	82.33	1.9729	2.396	-0.772	32	6	sandy silt to clayey silt
79.724	82.44	2.1997	2.668	0.040	32	6	sandy silt to clayey silt
79.888	84.06	2.3184	2.758	0.791	32	6	sandy silt to clayey silt
80.052	84.38	2.3725	2.811	1.528	32	6	sandy silt to clayey silt
80.217	83.33	2.3728	2.847	2.406	32	6	sandy silt to clayey silt
80.381	82.29	2.1345	2.594	3.165	32	6	sandy silt to clayey silt
80.545	81.50	2.1316	2.615	4.197	31	6	sandy silt to clayey silt
80.709	84.40	2.4033	2.848	7.399	32	6	sandy silt to clayey silt
80.873	87.15	2.4207	2.777	8.616	33	6	sandy silt to clayey silt
81.037	82.25	2.2105	2.688	10.114	32	6	sandy silt to clayey silt

Landau Associates / CPT-2 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-2
 TEST DATE: 8/27/2020 12:13:29 PM
 TOTAL DEPTH: 41.339 ft



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

*SBT/SPT CORRELATION: UBC-1983

Landau Associates / CPT-2 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-2
 TEST DATE: 8/27/2020 12:13:29 PM
 TOTAL DEPTH: 41.339 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	85.53	0.6577	0.769	0.027	20	8	sand to silty sand
0.328	206.04	2.4057	1.168	-0.487	39	9	sand
0.492	262.72	3.2885	1.252	-0.796	50	9	sand
0.656	386.48	4.5128	1.168	-0.908	74	9	sand
0.820	328.62	4.1439	1.261	-2.539	63	9	sand
0.984	220.93	4.1505	1.879	-0.186	53	8	sand to silty sand
1.148	185.30	3.6440	1.967	-0.322	59	7	silty sand to sandy silt
1.312	148.96	3.3045	2.218	-0.202	48	7	silty sand to sandy silt
1.476	116.73	2.8921	2.478	-0.279	37	7	silty sand to sandy silt
1.640	92.35	2.3721	2.569	-0.418	35	6	sandy silt to clayey silt
1.804	61.65	1.8924	3.070	-0.668	24	6	sandy silt to clayey silt
1.969	38.49	1.5584	4.049	-0.913	25	4	silty clay to clay
2.133	23.71	1.0597	4.470	-0.972	23	3	clay
2.297	20.47	0.3973	1.941	-0.389	8	6	sandy silt to clayey silt
2.461	41.47	0.5043	1.216	6.439	13	7	silty sand to sandy silt
2.625	112.95	1.7514	1.551	19.821	27	8	sand to silty sand
2.789	298.71	3.0629	1.025	4.780	57	9	sand
2.953	164.63	2.5615	1.556	3.064	39	8	sand to silty sand
3.117	146.06	2.2461	1.538	7.724	35	8	sand to silty sand
3.281	136.33	3.2618	2.393	6.801	44	7	silty sand to sandy silt
3.445	121.43	1.9491	1.605	5.906	29	8	sand to silty sand
3.609	125.45	1.9269	1.536	-3.269	30	8	sand to silty sand
3.773	58.05	1.0445	1.799	-1.344	19	7	silty sand to sandy silt
3.937	37.92	0.3899	1.028	-0.484	12	7	silty sand to sandy silt
4.101	38.51	0.2948	0.766	-0.048	12	7	silty sand to sandy silt
4.265	21.80	0.3609	1.655	-1.562	8	6	sandy silt to clayey silt
4.429	10.46	0.3470	3.317	-1.860	7	4	silty clay to clay
4.593	10.24	0.2863	2.797	-1.746	7	4	silty clay to clay
4.757	23.22	0.5465	2.354	-1.943	11	5	clayey silt to silty clay
4.921	28.26	0.4984	1.763	-1.959	11	6	sandy silt to clayey silt
5.085	49.71	0.5630	1.133	-1.126	16	7	silty sand to sandy silt
5.249	56.95	0.7136	1.253	-0.854	18	7	silty sand to sandy silt
5.413	68.81	0.6753	0.981	-1.014	16	8	sand to silty sand
5.577	69.19	0.2511	0.363	-1.733	17	8	sand to silty sand
5.741	78.39	0.3195	0.408	-1.131	19	8	sand to silty sand
5.906	69.43	0.3880	0.559	-1.123	17	8	sand to silty sand
6.070	66.87	0.4131	0.618	-1.142	16	8	sand to silty sand
6.234	60.13	0.4732	0.787	-1.586	14	8	sand to silty sand
6.398	53.37	0.4612	0.864	-1.727	17	7	silty sand to sandy silt
6.562	46.11	0.4474	0.970	-1.706	15	7	silty sand to sandy silt
6.726	48.29	0.4601	0.953	-1.658	15	7	silty sand to sandy silt
6.890	49.36	0.4728	0.958	-1.674	16	7	silty sand to sandy silt
7.054	41.28	0.4282	1.037	-1.706	13	7	silty sand to sandy silt
7.218	30.22	0.3455	1.143	-1.802	10	7	silty sand to sandy silt

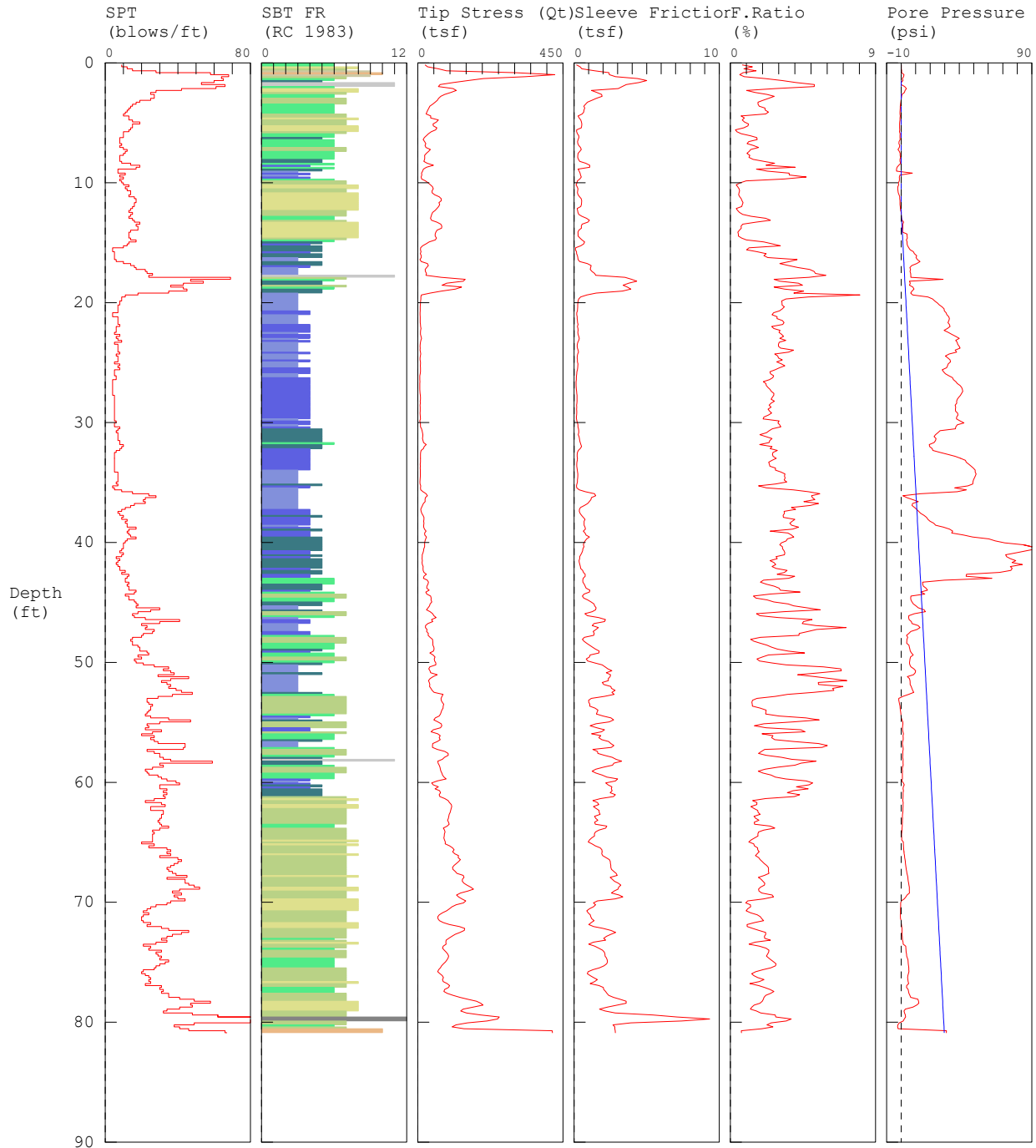
Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
7.382	19.67	0.3163	1.608	-1.908	8	6	sandy silt to clayey silt
7.546	15.98	0.2981	1.866	-2.004	8	5	clayey silt to silty clay
7.710	19.29	0.2741	1.421	-1.829	7	6	sandy silt to clayey silt
7.874	17.59	0.2218	1.261	-2.018	7	6	sandy silt to clayey silt
8.038	16.49	0.2624	1.591	-2.041	6	6	sandy silt to clayey silt
8.202	16.30	0.2878	1.765	-1.956	8	5	clayey silt to silty clay
8.366	17.52	0.2932	1.674	-1.706	7	6	sandy silt to clayey silt
8.530	17.81	0.3076	1.727	-1.703	7	6	sandy silt to clayey silt
8.694	17.13	0.2230	1.302	-1.754	7	6	sandy silt to clayey silt
8.858	16.84	0.2502	1.485	-1.711	6	6	sandy silt to clayey silt
9.022	20.65	0.2414	1.169	-1.666	8	6	sandy silt to clayey silt
9.186	21.16	0.2387	1.128	-1.722	8	6	sandy silt to clayey silt
9.350	18.80	0.2144	1.140	-1.906	7	6	sandy silt to clayey silt
9.514	13.94	0.1902	1.365	-1.930	5	6	sandy silt to clayey silt
9.678	9.97	0.2554	2.561	-1.855	6	4	silty clay to clay
9.843	8.15	0.2755	3.380	-1.203	8	3	clay
10.007	14.78	0.2270	1.536	-0.639	7	5	clayey silt to silty clay
10.171	21.53	0.2010	0.934	-0.860	8	6	sandy silt to clayey silt
10.335	26.38	0.2356	0.893	-1.057	8	7	silty sand to sandy silt
10.499	33.81	0.2894	0.856	-0.958	11	7	silty sand to sandy silt
10.663	49.98	0.3511	0.703	-0.775	16	7	silty sand to sandy silt
10.827	71.11	0.4818	0.677	-0.756	17	8	sand to silty sand
10.991	77.66	0.5010	0.645	-0.732	19	8	sand to silty sand
11.155	81.87	0.5511	0.673	-0.602	20	8	sand to silty sand
11.319	81.44	0.5607	0.688	-0.511	19	8	sand to silty sand
11.483	83.92	0.5811	0.692	-0.466	20	8	sand to silty sand
11.647	79.38	0.5658	0.713	-0.399	19	8	sand to silty sand
11.811	73.38	0.5279	0.719	-0.351	18	8	sand to silty sand
11.975	66.65	0.4601	0.690	-0.314	16	8	sand to silty sand
12.139	60.67	0.2901	0.478	-0.271	15	8	sand to silty sand
12.303	55.27	0.3035	0.549	-0.194	13	8	sand to silty sand
12.467	51.87	0.3080	0.594	0.061	12	8	sand to silty sand
12.631	50.20	0.3178	0.633	0.101	12	8	sand to silty sand
12.795	40.23	0.3107	0.772	0.184	13	7	silty sand to sandy silt
12.959	37.10	0.2757	0.743	0.224	12	7	silty sand to sandy silt
13.123	37.56	0.2299	0.612	0.269	12	7	silty sand to sandy silt
13.287	40.66	0.2488	0.612	0.319	13	7	silty sand to sandy silt
13.451	40.59	0.2637	0.650	0.373	13	7	silty sand to sandy silt
13.615	34.29	0.2399	0.700	0.378	11	7	silty sand to sandy silt
13.780	28.18	0.2276	0.808	0.354	9	7	silty sand to sandy silt
13.944	22.10	0.2071	0.937	0.370	8	6	sandy silt to clayey silt
14.108	18.26	0.3580	1.961	0.373	9	5	clayey silt to silty clay
14.272	21.99	0.5637	2.564	0.633	11	5	clayey silt to silty clay
14.436	14.89	0.6757	4.537	1.432	14	3	clay
14.600	11.78	0.4126	3.502	2.103	8	4	silty clay to clay
14.764	10.81	0.3585	3.315	1.863	7	4	silty clay to clay
14.928	13.97	0.3658	2.618	1.943	7	5	clayey silt to silty clay
15.092	13.40	0.3817	2.849	2.049	9	4	silty clay to clay
15.256	14.94	0.5044	3.377	2.041	10	4	silty clay to clay
15.420	17.12	0.5535	3.232	2.119	8	5	clayey silt to silty clay
15.584	15.43	0.5393	3.495	2.419	10	4	silty clay to clay
15.748	13.03	0.6564	5.039	2.196	12	3	clay
15.912	13.72	0.6276	4.575	2.316	13	3	clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
16.076	15.92	0.5046	3.169	2.350	10	4	silty clay to clay
16.240	14.01	0.4190	2.991	2.278	9	4	silty clay to clay
16.404	12.71	0.3142	2.471	2.821	6	5	clayey silt to silty clay
16.568	11.10	0.3472	3.129	3.436	7	4	silty clay to clay
16.732	10.15	0.4360	4.294	3.210	10	3	clay
16.896	12.24	0.4303	3.515	3.402	8	4	silty clay to clay
17.060	12.46	0.4943	3.967	3.069	12	3	clay
17.224	14.47	0.6013	4.155	3.189	14	3	clay
17.388	12.49	0.6441	5.157	3.721	12	3	clay
17.552	10.44	0.4793	4.590	3.090	10	3	clay
17.717	4.94	0.2537	5.140	4.416	5	3	clay
17.881	4.69	0.1008	2.151	6.915	3	4	silty clay to clay
18.045	5.18	0.1463	2.826	9.774	5	3	clay
18.209	7.01	0.1628	2.324	10.915	4	4	silty clay to clay
18.373	7.65	0.2202	2.880	11.022	5	4	silty clay to clay
18.537	7.13	0.2063	2.894	12.331	7	3	clay
18.701	6.55	0.1245	1.900	12.523	4	4	silty clay to clay
18.865	5.90	0.1294	2.191	12.755	4	4	silty clay to clay
19.029	5.32	0.1084	2.037	13.785	3	4	silty clay to clay
19.193	5.31	0.0989	1.862	14.402	3	4	silty clay to clay
19.357	4.95	0.0945	1.908	15.118	3	4	silty clay to clay
19.521	5.30	0.0924	1.745	16.606	3	4	silty clay to clay
19.685	5.26	0.1044	1.983	16.619	3	4	silty clay to clay
19.849	5.88	0.1250	2.125	17.868	4	4	silty clay to clay
20.013	6.53	0.1380	2.115	18.272	4	4	silty clay to clay
20.177	7.06	0.1239	1.755	19.276	5	4	silty clay to clay
20.341	6.48	0.1154	1.780	19.364	4	4	silty clay to clay
20.505	6.50	0.0964	1.484	20.103	3	1	sensitive fine grained
20.669	6.51	0.0950	1.459	22.203	3	1	sensitive fine grained
20.833	7.24	0.1114	1.539	24.288	3	5	clayey silt to silty clay
20.997	7.38	0.1253	1.699	24.463	4	5	clayey silt to silty clay
21.161	7.60	0.1421	1.871	25.882	5	4	silty clay to clay
21.325	7.48	0.1297	1.733	26.513	4	5	clayey silt to silty clay
21.490	7.26	0.1418	1.953	27.804	5	4	silty clay to clay
21.654	7.51	0.1642	2.185	30.292	5	4	silty clay to clay
21.818	8.53	0.1936	2.270	31.756	5	4	silty clay to clay
21.982	9.03	0.1954	2.164	31.714	6	4	silty clay to clay
22.146	8.49	0.2158	2.544	29.422	5	4	silty clay to clay
22.310	8.61	0.2194	2.547	33.449	5	4	silty clay to clay
22.474	7.90	0.2007	2.540	30.979	5	4	silty clay to clay
22.638	7.84	0.1792	2.286	30.157	5	4	silty clay to clay
22.802	9.08	0.2023	2.227	33.981	6	4	silty clay to clay
22.966	8.95	0.2130	2.380	31.181	6	4	silty clay to clay
23.130	8.11	0.1802	2.222	30.199	5	4	silty clay to clay
23.294	7.38	0.1693	2.293	31.203	5	4	silty clay to clay
23.458	7.17	0.1553	2.166	31.059	5	4	silty clay to clay
23.622	6.77	0.1413	2.086	28.115	4	4	silty clay to clay
23.786	6.03	0.1322	2.193	29.244	4	4	silty clay to clay
23.950	6.07	0.1291	2.129	30.356	4	4	silty clay to clay
24.114	6.41	0.1698	2.649	30.612	4	4	silty clay to clay
24.278	8.28	0.1883	2.274	32.036	5	4	silty clay to clay
24.442	8.23	0.1712	2.081	26.537	5	4	silty clay to clay
24.606	6.48	0.1616	2.492	25.698	4	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
24.770	6.28	0.1408	2.243	27.577	4	4	silty clay to clay
24.934	7.00	0.1357	1.937	28.501	4	4	silty clay to clay
25.098	6.84	0.1473	2.153	27.234	4	4	silty clay to clay
25.262	6.89	0.1621	2.353	27.761	4	4	silty clay to clay
25.427	7.28	0.1661	2.281	27.596	5	4	silty clay to clay
25.591	8.13	0.1646	2.023	24.849	5	4	silty clay to clay
25.755	8.46	0.1950	2.304	20.266	5	4	silty clay to clay
25.919	9.09	0.1908	2.099	23.814	4	5	clayey silt to silty clay
26.083	7.58	0.1495	1.972	23.007	5	4	silty clay to clay
26.247	6.03	0.0998	1.654	24.783	4	4	silty clay to clay
26.411	5.62	0.0708	1.261	27.348	3	1	sensitive fine grained
26.575	5.66	0.0855	1.510	30.324	3	1	sensitive fine grained
26.739	6.14	0.1047	1.704	32.257	4	4	silty clay to clay
26.903	6.38	0.1081	1.694	33.342	4	4	silty clay to clay
27.067	6.74	0.1096	1.627	33.904	4	4	silty clay to clay
27.231	6.62	0.1213	1.833	34.112	4	4	silty clay to clay
27.395	7.25	0.1322	1.823	34.330	5	4	silty clay to clay
27.559	7.11	0.1157	1.627	32.438	3	5	clayey silt to silty clay
27.723	7.09	0.1102	1.555	31.533	3	5	clayey silt to silty clay
27.887	6.32	0.1158	1.834	32.259	4	4	silty clay to clay
28.051	6.62	0.0897	1.356	33.606	3	1	sensitive fine grained
28.215	6.80	0.0996	1.464	33.766	3	1	sensitive fine grained
28.379	6.28	0.0930	1.482	35.288	3	1	sensitive fine grained
28.543	6.48	0.0930	1.434	35.238	3	1	sensitive fine grained
28.707	6.43	0.0939	1.460	35.429	3	1	sensitive fine grained
28.871	6.86	0.0840	1.225	32.493	3	1	sensitive fine grained
29.035	6.48	0.0935	1.443	32.792	3	1	sensitive fine grained
29.199	6.46	0.0844	1.307	34.120	3	1	sensitive fine grained
29.364	6.67	0.0926	1.390	34.005	3	1	sensitive fine grained
29.528	7.01	0.0871	1.243	34.764	3	1	sensitive fine grained
29.692	6.93	0.1062	1.532	33.928	3	5	clayey silt to silty clay
29.856	6.84	0.1078	1.576	35.868	4	4	silty clay to clay
30.020	7.28	0.1161	1.595	36.305	3	5	clayey silt to silty clay
30.184	7.32	0.0953	1.303	36.055	4	5	clayey silt to silty clay
30.348	7.69	0.1282	1.667	34.692	4	5	clayey silt to silty clay
30.512	7.72	0.1549	2.007	36.741	5	4	silty clay to clay
30.676	9.20	0.1773	1.927	33.870	4	5	clayey silt to silty clay
30.840	9.45	0.2055	2.174	31.131	5	5	clayey silt to silty clay
31.004	9.23	0.1960	2.123	30.306	4	5	clayey silt to silty clay
31.168	10.02	0.1467	1.465	29.917	5	5	clayey silt to silty clay
31.332	11.11	0.1660	1.494	26.896	5	5	clayey silt to silty clay
31.496	8.21	0.1957	2.384	27.577	5	4	silty clay to clay
31.660	8.00	0.1978	2.474	30.481	5	4	silty clay to clay
31.824	8.50	0.1927	2.268	30.324	5	4	silty clay to clay
31.988	8.31	0.2250	2.707	29.494	5	4	silty clay to clay
32.152	9.70	0.1587	1.636	29.470	5	5	clayey silt to silty clay
32.316	8.22	0.1406	1.711	24.724	4	5	clayey silt to silty clay
32.480	7.22	0.1375	1.904	28.911	5	4	silty clay to clay
32.644	7.19	0.1393	1.938	32.379	5	4	silty clay to clay
32.808	7.07	0.1411	1.996	34.852	5	4	silty clay to clay
32.972	6.87	0.1310	1.906	37.636	4	4	silty clay to clay
33.136	6.97	0.1289	1.849	39.227	4	4	silty clay to clay
33.301	6.94	0.1129	1.627	39.675	4	4	silty clay to clay

Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-3
 TEST DATE: 8/27/2020 12:54:59 PM
 TOTAL DEPTH: 80.873 ft

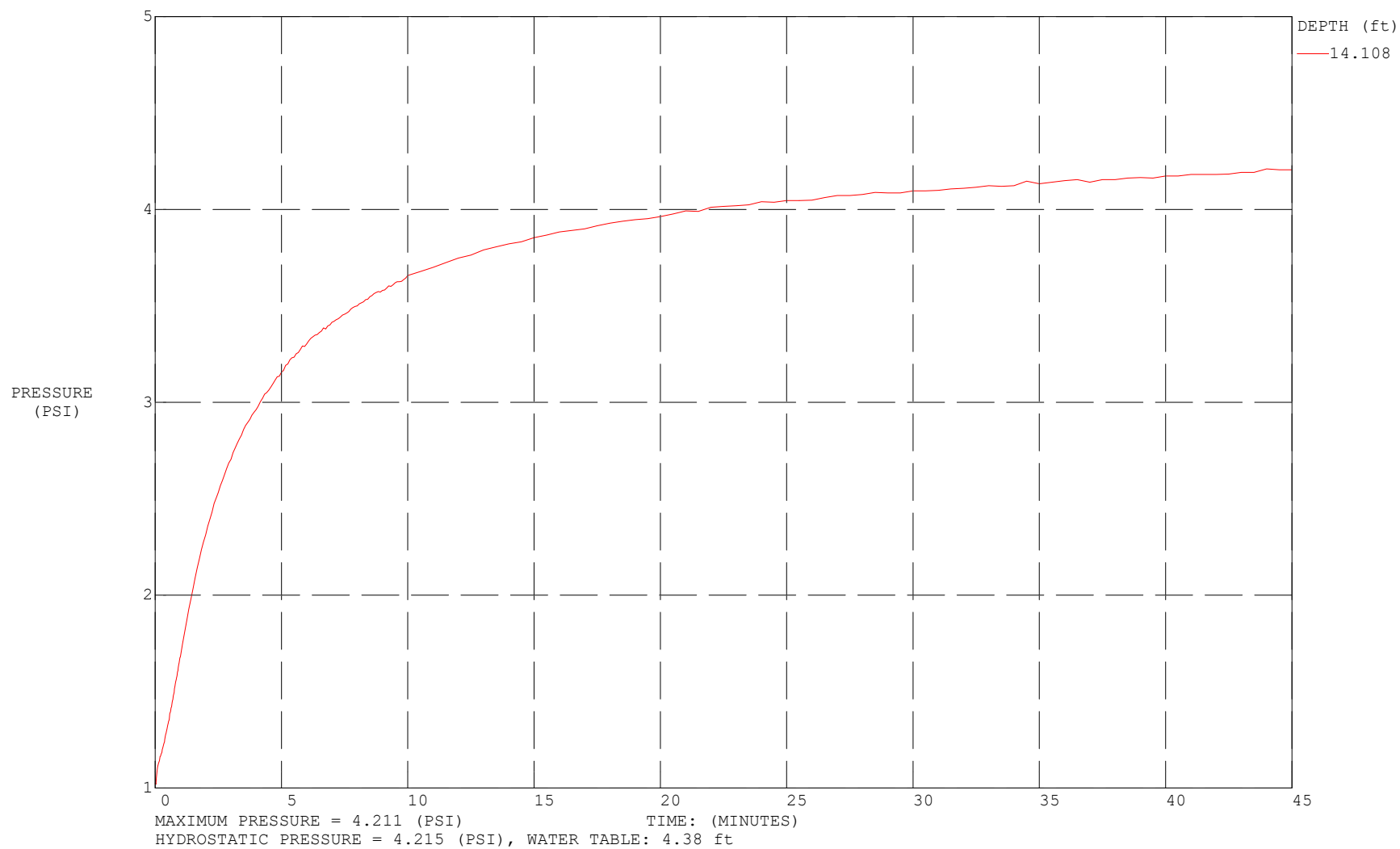


1 sensitive fine gr	4 silty clay to cl	7 silty sand to sandy	10 gravelly sand to sand
2 organic materia	5 clayey silt to silt	8 sand to silty sa	11 very stiff fine grained (*)
3 clay	6 sandy silt to claye	9 sand	12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

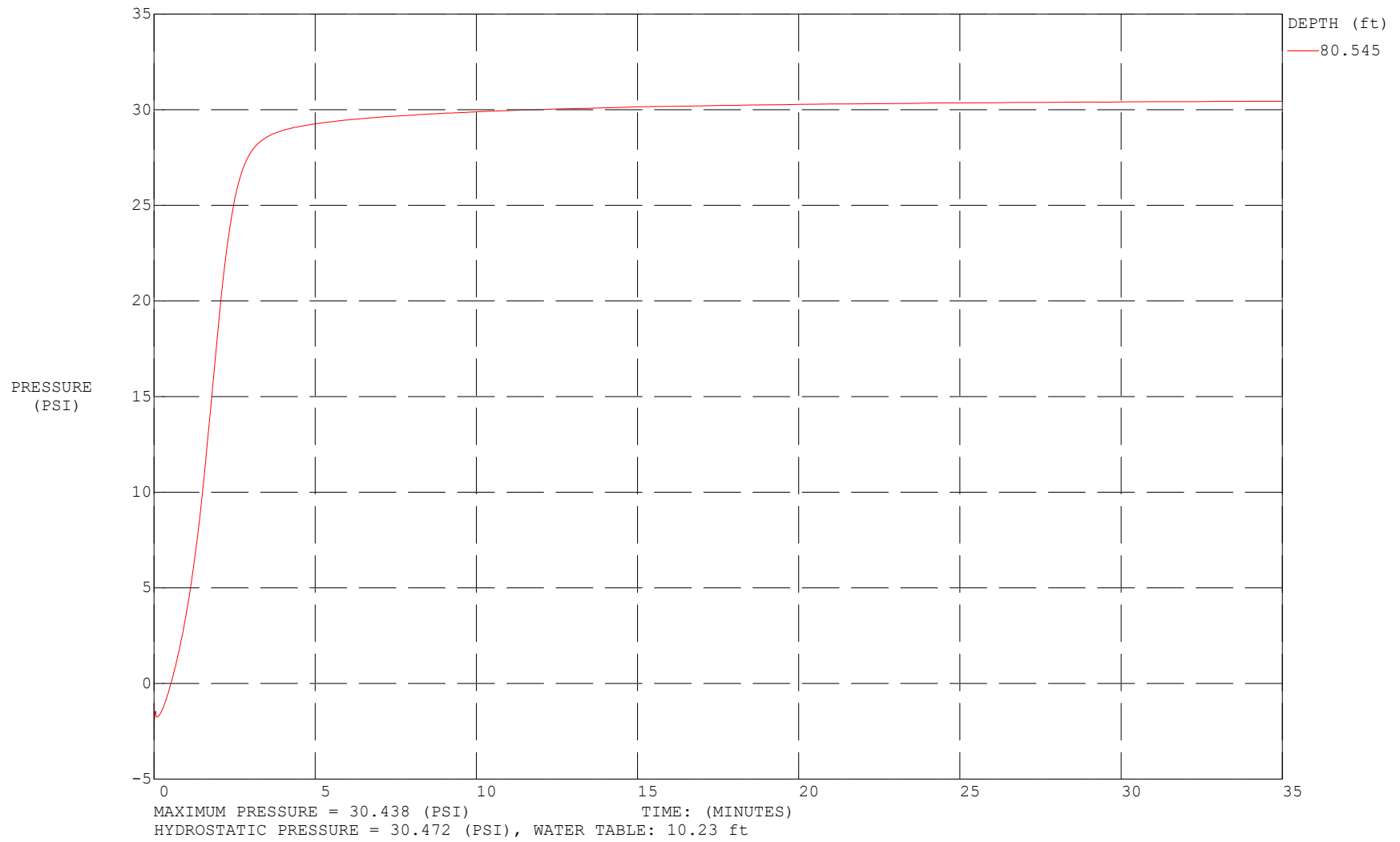
COMMENT: Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 12:54:59 PM



COMMENT: Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 12:54:59 PM



Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-3
 TEST DATE: 8/27/2020 12:54:59 PM
 TOTAL DEPTH: 80.873 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	22.94	0.1712	0.746	0.077	9	6	sandy silt to clayey silt
0.328	30.08	0.4101	1.363	0.037	12	6	sandy silt to clayey silt
0.492	63.36	0.5299	0.836	0.064	15	8	sand to silty sand
0.656	88.66	1.4152	1.596	0.325	28	7	silty sand to sandy silt
0.820	300.94	2.3976	0.797	0.245	58	9	sand
0.984	424.08	2.4262	0.572	1.919	68	10	gravelly sand to sand
1.148	333.55	2.8494	0.854	1.632	64	9	sand
1.312	203.75	4.3624	2.141	0.841	65	7	silty sand to sandy silt
1.476	155.62	4.9968	3.211	1.208	60	6	sandy silt to clayey silt
1.640	109.71	4.4637	4.069	-0.027	53	5	clayey silt to silty clay
1.804	69.10	3.5979	5.207	-0.011	66	11	very stiff fine grained (*)
1.969	63.56	3.3044	5.199	2.321	61	11	very stiff fine grained (*)
2.133	109.19	3.0462	2.790	3.599	42	6	sandy silt to clayey silt
2.297	118.91	1.1960	1.006	2.654	28	8	sand to silty sand
2.461	102.37	1.5570	1.521	2.164	25	8	sand to silty sand
2.625	83.22	1.8980	2.281	0.500	27	7	silty sand to sandy silt
2.789	71.01	1.9278	2.715	0.250	27	6	sandy silt to clayey silt
2.953	64.51	1.5328	2.376	0.112	25	6	sandy silt to clayey silt
3.117	60.32	1.2164	2.017	-0.088	19	7	silty sand to sandy silt
3.281	53.74	0.9201	1.712	-0.298	17	7	silty sand to sandy silt
3.445	45.97	0.7868	1.712	-0.522	15	7	silty sand to sandy silt
3.609	37.20	0.6645	1.786	-0.681	14	6	sandy silt to clayey silt
3.773	34.12	0.7301	2.140	-0.676	13	6	sandy silt to clayey silt
3.937	31.21	0.6747	2.162	-0.759	12	6	sandy silt to clayey silt
4.101	27.99	0.6581	2.351	-0.841	11	6	sandy silt to clayey silt
4.265	25.69	0.5634	2.193	-0.910	10	6	sandy silt to clayey silt
4.429	40.04	0.2647	0.661	-0.657	13	7	silty sand to sandy silt
4.593	39.72	0.3423	0.862	-0.825	13	7	silty sand to sandy silt
4.757	63.51	0.4635	0.730	-0.828	15	8	sand to silty sand
4.921	58.04	0.5019	0.865	-1.011	19	7	silty sand to sandy silt
5.085	46.84	0.5267	1.124	-1.121	15	7	silty sand to sandy silt
5.249	47.80	0.5223	1.093	-1.142	15	7	silty sand to sandy silt
5.413	59.10	0.4886	0.827	-1.083	14	8	sand to silty sand
5.577	55.37	0.1719	0.310	-1.062	13	8	sand to silty sand
5.741	41.84	0.1664	0.398	-1.168	10	8	sand to silty sand
5.906	32.76	0.2193	0.669	-0.703	10	7	silty sand to sandy silt
6.070	26.19	0.3225	1.231	-0.769	10	6	sandy silt to clayey silt
6.234	20.03	0.3277	1.636	-0.804	8	6	sandy silt to clayey silt
6.398	16.16	0.2693	1.666	-0.740	8	5	clayey silt to silty clay
6.562	20.99	0.2387	1.137	-1.480	8	6	sandy silt to clayey silt
6.726	24.65	0.2549	1.034	-1.538	9	6	sandy silt to clayey silt
6.890	21.99	0.3119	1.419	-1.046	8	6	sandy silt to clayey silt
7.054	25.18	0.4397	1.746	-1.248	10	6	sandy silt to clayey silt
7.218	38.58	0.4884	1.266	-2.281	12	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
7.382	33.53	0.3917	1.168	-1.294	11	7	silty sand to sandy silt
7.546	26.38	0.2701	1.024	-0.713	10	6	sandy silt to clayey silt
7.710	21.05	0.2543	1.208	-0.708	8	6	sandy silt to clayey silt
7.874	21.31	0.2444	1.147	-0.492	8	6	sandy silt to clayey silt
8.038	21.19	0.2961	1.398	-0.783	8	6	sandy silt to clayey silt
8.202	18.45	0.3836	2.079	-0.769	9	5	clayey silt to silty clay
8.366	28.99	0.7954	2.744	-0.258	14	5	clayey silt to silty clay
8.530	48.48	1.0714	2.210	-1.666	19	6	sandy silt to clayey silt
8.694	26.70	1.0721	4.015	-2.861	17	4	silty clay to clay
8.858	17.24	0.2781	1.613	-3.242	7	6	sandy silt to clayey silt
9.022	14.97	0.3419	2.284	-3.237	7	5	clayey silt to silty clay
9.186	11.34	0.4125	3.638	7.751	11	3	clay
9.350	12.02	0.4387	3.648	-0.809	8	4	silty clay to clay
9.514	10.43	0.4904	4.703	-1.341	10	3	clay
9.678	11.81	0.3929	3.328	-1.200	8	4	silty clay to clay
9.843	23.56	0.2297	0.975	-1.299	9	6	sandy silt to clayey silt
10.007	32.05	0.1900	0.593	-1.978	10	7	silty sand to sandy silt
10.171	39.30	0.1405	0.358	-1.797	13	7	silty sand to sandy silt
10.335	45.35	0.2035	0.449	-2.294	11	8	sand to silty sand
10.499	48.06	0.2597	0.540	-2.374	12	8	sand to silty sand
10.663	44.00	0.2486	0.565	-2.175	14	7	silty sand to sandy silt
10.827	44.17	0.2336	0.529	-1.991	14	7	silty sand to sandy silt
10.991	52.28	0.2656	0.508	-1.467	13	8	sand to silty sand
11.155	66.09	0.3781	0.572	-1.062	16	8	sand to silty sand
11.319	72.45	0.4851	0.670	-0.990	17	8	sand to silty sand
11.483	72.95	0.5228	0.717	-0.876	17	8	sand to silty sand
11.647	65.20	0.5110	0.784	-0.841	16	8	sand to silty sand
11.811	67.49	0.5005	0.742	-0.764	16	8	sand to silty sand
11.975	64.42	0.4530	0.703	-0.663	15	8	sand to silty sand
12.139	59.10	0.2108	0.357	-0.546	14	8	sand to silty sand
12.303	53.40	0.2364	0.443	-0.434	13	8	sand to silty sand
12.467	45.94	0.2573	0.560	-0.061	15	7	silty sand to sandy silt
12.631	42.68	0.3227	0.756	-0.008	14	7	silty sand to sandy silt
12.795	41.22	0.5284	1.282	0.061	13	7	silty sand to sandy silt
12.959	38.94	0.8499	2.182	0.226	15	6	sandy silt to clayey silt
13.123	42.48	1.0564	2.487	0.708	16	6	sandy silt to clayey silt
13.287	59.17	0.9407	1.590	1.648	19	7	silty sand to sandy silt
13.451	71.18	0.5472	0.769	1.110	17	8	sand to silty sand
13.615	74.53	0.4906	0.658	1.105	18	8	sand to silty sand
13.780	73.67	0.4970	0.675	1.107	18	8	sand to silty sand
13.944	59.19	0.3324	0.562	1.019	14	8	sand to silty sand
14.108	55.68	0.2574	0.462	1.022	13	8	sand to silty sand
14.272	53.84	0.2681	0.498	4.059	13	8	sand to silty sand
14.436	53.92	0.2692	0.499	4.062	13	8	sand to silty sand
14.600	57.99	0.3997	0.689	4.173	14	8	sand to silty sand
14.764	54.26	0.5343	0.985	3.607	17	7	silty sand to sandy silt
14.928	34.72	0.7183	2.069	4.016	13	6	sandy silt to clayey silt
15.092	25.13	0.6581	2.619	4.059	12	5	clayey silt to silty clay
15.256	14.92	0.4629	3.103	4.394	10	4	silty clay to clay
15.420	8.69	0.1002	1.152	5.270	4	5	clayey silt to silty clay
15.584	8.04	0.0813	1.011	6.202	4	5	clayey silt to silty clay
15.748	9.63	0.1581	1.642	8.320	5	5	clayey silt to silty clay
15.912	7.55	0.1674	2.216	9.124	5	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
16.076	10.74	0.2229	2.076	10.695	5	5	clayey silt to silty clay
16.240	10.87	0.2517	2.316	10.146	5	5	clayey silt to silty clay
16.404	6.71	0.2782	4.143	11.078	6	3	clay
16.568	10.53	0.3853	3.660	13.013	10	3	clay
16.732	29.72	0.9087	3.057	10.729	14	5	clayey silt to silty clay
16.896	32.58	1.1765	3.611	7.261	16	5	clayey silt to silty clay
17.060	27.11	1.1378	4.197	5.983	17	4	silty clay to clay
17.224	22.68	1.1141	4.912	6.444	22	3	clay
17.388	23.60	1.2251	5.190	6.090	23	3	clay
17.552	26.73	1.4089	5.271	6.462	26	3	clay
17.717	25.14	1.4882	5.919	6.659	24	3	clay
17.881	72.12	3.5080	4.864	6.662	69	11	very stiff fine grained (*)
18.045	146.66	3.9634	2.702	28.847	47	7	silty sand to sandy silt
18.209	140.80	4.3069	3.059	5.704	54	6	sandy silt to clayey silt
18.373	89.21	3.7614	4.216	6.239	43	5	clayey silt to silty clay
18.537	75.37	3.3705	4.472	5.717	36	5	clayey silt to silty clay
18.701	135.57	3.6659	2.704	7.996	43	7	silty sand to sandy silt
18.865	116.70	3.9089	3.350	8.810	45	6	sandy silt to clayey silt
19.029	73.37	3.3306	4.539	7.482	35	5	clayey silt to silty clay
19.193	38.45	1.5096	3.926	6.590	18	5	clayey silt to silty clay
19.357	11.02	0.8857	8.037	7.873	11	3	clay
19.521	9.22	0.4457	4.836	18.347	9	3	clay
19.685	9.29	0.3202	3.445	21.597	9	3	clay
19.849	8.62	0.2738	3.178	23.021	8	3	clay
20.013	7.97	0.2551	3.199	24.953	8	3	clay
20.177	7.62	0.2439	3.203	26.305	7	3	clay
20.341	7.29	0.2437	3.343	28.213	7	3	clay
20.505	7.36	0.2367	3.218	29.512	7	3	clay
20.669	7.25	0.2205	3.042	29.691	7	3	clay
20.833	6.95	0.1861	2.675	30.872	4	4	silty clay to clay
20.997	7.04	0.1815	2.580	31.477	4	4	silty clay to clay
21.161	7.12	0.2065	2.901	32.808	7	3	clay
21.325	7.19	0.2074	2.885	33.276	7	3	clay
21.490	7.16	0.2310	3.225	32.839	7	3	clay
21.654	7.16	0.2382	3.325	32.203	7	3	clay
21.818	8.18	0.2650	3.242	33.169	8	3	clay
21.982	8.78	0.2252	2.564	33.627	6	4	silty clay to clay
22.146	9.74	0.2623	2.694	31.833	6	4	silty clay to clay
22.310	8.76	0.2695	3.076	29.526	6	4	silty clay to clay
22.474	8.35	0.2515	3.010	32.403	5	4	silty clay to clay
22.638	8.42	0.2675	3.176	34.865	8	3	clay
22.802	9.71	0.3198	3.294	37.561	6	4	silty clay to clay
22.966	11.54	0.3533	3.063	39.997	7	4	silty clay to clay
23.130	9.32	0.3200	3.435	37.559	9	3	clay
23.294	8.28	0.2507	3.029	38.567	5	4	silty clay to clay
23.458	7.21	0.2142	2.972	38.948	7	3	clay
23.622	6.87	0.2051	2.985	39.941	7	3	clay
23.786	7.07	0.2205	3.116	40.540	7	3	clay
23.950	7.03	0.2750	3.914	37.127	7	3	clay
24.114	8.24	0.2973	3.607	38.171	8	3	clay
24.278	9.00	0.2474	2.749	33.002	6	4	silty clay to clay
24.442	7.45	0.2185	2.933	30.409	7	3	clay
24.606	6.94	0.2070	2.984	32.211	7	3	clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
24.770	7.00	0.2251	3.217	33.603	7	3	clay
24.934	8.01	0.2307	2.880	33.939	5	4	silty clay to clay
25.098	8.14	0.2574	3.162	32.416	8	3	clay
25.262	7.50	0.2531	3.375	31.929	7	3	clay
25.427	8.01	0.2439	3.044	31.285	8	3	clay
25.591	7.97	0.2213	2.775	28.293	5	4	silty clay to clay
25.755	7.82	0.1916	2.450	29.156	5	4	silty clay to clay
25.919	7.16	0.1781	2.489	30.524	5	4	silty clay to clay
26.083	6.08	0.1629	2.678	32.847	6	3	clay
26.247	5.93	0.1558	2.627	35.296	6	3	clay
26.411	6.30	0.1527	2.423	36.015	4	4	silty clay to clay
26.575	6.47	0.1322	2.044	37.625	4	4	silty clay to clay
26.739	6.34	0.1396	2.200	38.610	4	4	silty clay to clay
26.903	6.38	0.1416	2.220	40.651	4	4	silty clay to clay
27.067	6.23	0.1456	2.336	41.681	4	4	silty clay to clay
27.231	6.32	0.1553	2.456	42.142	4	4	silty clay to clay
27.395	6.59	0.1674	2.541	42.429	4	4	silty clay to clay
27.559	6.85	0.1848	2.697	41.588	4	4	silty clay to clay
27.723	7.54	0.2031	2.692	40.864	5	4	silty clay to clay
27.887	7.80	0.2025	2.595	39.600	5	4	silty clay to clay
28.051	7.88	0.1987	2.522	38.605	5	4	silty clay to clay
28.215	7.38	0.2017	2.733	38.184	5	4	silty clay to clay
28.379	7.62	0.1919	2.518	38.248	5	4	silty clay to clay
28.543	7.07	0.1693	2.395	37.186	5	4	silty clay to clay
28.707	7.22	0.1819	2.519	37.551	5	4	silty clay to clay
28.871	7.28	0.1701	2.336	37.407	5	4	silty clay to clay
29.035	7.10	0.1726	2.431	37.436	5	4	silty clay to clay
29.199	7.07	0.1806	2.554	38.818	5	4	silty clay to clay
29.364	7.29	0.1713	2.351	39.108	5	4	silty clay to clay
29.528	7.55	0.1568	2.076	38.141	5	4	silty clay to clay
29.692	7.79	0.1575	2.022	38.099	5	4	silty clay to clay
29.856	6.28	0.1899	3.023	40.580	6	3	clay
30.020	7.72	0.2277	2.948	43.201	5	4	silty clay to clay
30.184	8.44	0.2576	3.051	38.602	5	4	silty clay to clay
30.348	8.41	0.2628	3.124	37.596	8	3	clay
30.512	11.55	0.2995	2.593	37.415	7	4	silty clay to clay
30.676	13.25	0.3192	2.409	26.790	6	5	clayey silt to silty clay
30.840	14.19	0.3186	2.245	25.243	7	5	clayey silt to silty clay
31.004	15.37	0.2806	1.826	23.659	7	5	clayey silt to silty clay
31.168	15.28	0.3343	2.188	22.605	7	5	clayey silt to silty clay
31.332	14.31	0.3690	2.578	23.944	7	5	clayey silt to silty clay
31.496	15.74	0.3846	2.443	23.641	8	5	clayey silt to silty clay
31.660	17.51	0.4211	2.405	22.560	8	5	clayey silt to silty clay
31.824	25.86	0.4675	1.808	19.324	10	6	sandy silt to clayey silt
31.988	19.78	0.5105	2.580	19.638	9	5	clayey silt to silty clay
32.152	17.24	0.4243	2.462	21.354	8	5	clayey silt to silty clay
32.316	10.13	0.2951	2.913	21.831	6	4	silty clay to clay
32.480	8.59	0.2265	2.635	26.915	5	4	silty clay to clay
32.644	7.87	0.2055	2.611	32.262	5	4	silty clay to clay
32.808	7.92	0.2095	2.644	37.151	5	4	silty clay to clay
32.972	7.93	0.2251	2.837	40.936	5	4	silty clay to clay
33.136	8.21	0.2118	2.579	44.247	5	4	silty clay to clay
33.301	8.07	0.1916	2.375	44.857	5	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
33.465	7.41	0.1792	2.418	46.507	5	4	silty clay to clay
33.629	7.55	0.1853	2.454	48.200	5	4	silty clay to clay
33.793	7.15	0.1998	2.794	49.632	5	4	silty clay to clay
33.957	7.61	0.2122	2.790	50.941	5	4	silty clay to clay
34.121	7.50	0.2362	3.149	50.928	7	3	clay
34.285	7.49	0.2534	3.384	51.647	7	3	clay
34.449	7.57	0.2534	3.345	51.040	7	3	clay
34.613	7.28	0.2471	3.394	50.414	7	3	clay
34.777	6.86	0.2285	3.331	49.853	7	3	clay
34.941	6.56	0.2290	3.491	49.448	6	3	clay
35.105	6.83	0.1913	2.802	49.267	7	3	clay
35.269	9.08	0.1583	1.744	46.020	4	5	clayey silt to silty clay
35.433	8.06	0.1803	2.235	36.856	5	4	silty clay to clay
35.597	9.13	0.3561	3.898	44.822	9	3	clay
35.761	15.95	0.7720	4.841	38.565	15	3	clay
35.925	25.37	1.4068	5.545	13.234	24	3	clay
36.089	29.53	1.4863	5.033	1.227	28	3	clay
36.253	23.37	1.1865	5.077	3.870	22	3	clay
36.417	22.06	1.1557	5.238	7.961	21	3	clay
36.581	22.89	1.0432	4.556	11.757	22	3	clay
36.745	17.12	0.9344	5.457	7.812	16	3	clay
36.909	14.24	0.7039	4.944	7.442	14	3	clay
37.073	11.47	0.4336	3.782	9.207	11	3	clay
37.238	9.09	0.3674	4.043	10.665	9	3	clay
37.402	10.51	0.3494	3.324	12.108	7	4	silty clay to clay
37.566	12.14	0.4069	3.352	13.503	8	4	silty clay to clay
37.730	15.73	0.5140	3.266	15.792	10	4	silty clay to clay
37.894	19.09	0.6271	3.285	17.421	9	5	clayey silt to silty clay
38.058	18.83	0.7527	3.997	18.357	12	4	silty clay to clay
38.222	17.92	0.6868	3.833	19.891	11	4	silty clay to clay
38.386	18.82	0.6927	3.681	22.456	12	4	silty clay to clay
38.550	18.08	0.6869	3.798	23.777	12	4	silty clay to clay
38.714	17.83	0.7535	4.225	29.145	17	3	clay
38.878	20.36	0.7853	3.857	33.295	13	4	silty clay to clay
39.042	25.42	0.6258	2.462	35.459	12	5	clayey silt to silty clay
39.206	21.06	0.7509	3.566	34.809	13	4	silty clay to clay
39.370	21.46	0.8118	3.783	42.823	14	4	silty clay to clay
39.534	26.92	1.0571	3.926	49.182	17	4	silty clay to clay
39.698	24.29	0.8577	3.531	60.310	12	5	clayey silt to silty clay
39.862	22.06	0.7623	3.456	64.801	11	5	clayey silt to silty clay
40.026	21.05	0.6650	3.159	71.407	10	5	clayey silt to silty clay
40.190	20.95	0.6424	3.067	84.121	10	5	clayey silt to silty clay
40.354	20.88	0.6741	3.228	97.049	10	5	clayey silt to silty clay
40.518	18.73	0.6059	3.234	99.104	9	5	clayey silt to silty clay
40.682	17.45	0.5798	3.324	98.529	8	5	clayey silt to silty clay
40.846	15.75	0.5312	3.373	79.336	10	4	silty clay to clay
41.011	13.57	0.4553	3.356	71.952	9	4	silty clay to clay
41.175	13.57	0.3845	2.833	72.618	6	5	clayey silt to silty clay
41.339	13.09	0.3804	2.907	75.189	8	4	silty clay to clay
41.503	13.81	0.3392	2.456	78.950	7	5	clayey silt to silty clay
41.667	13.00	0.3511	2.700	76.371	6	5	clayey silt to silty clay
41.831	13.89	0.3914	2.818	83.493	7	5	clayey silt to silty clay
41.995	16.62	0.4294	2.583	75.210	8	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
42.159	15.75	0.4457	2.830	76.522	8	5	clayey silt to silty clay
42.323	16.65	0.5845	3.511	75.490	11	4	silty clay to clay
42.487	19.05	0.6395	3.357	67.755	9	5	clayey silt to silty clay
42.651	26.18	0.7565	2.890	44.966	13	5	clayey silt to silty clay
42.815	19.05	0.7595	3.988	44.769	12	4	silty clay to clay
42.979	17.21	0.6206	3.607	62.442	11	4	silty clay to clay
43.143	29.16	0.5980	2.050	29.741	11	6	sandy silt to clayey silt
43.307	32.73	0.6074	1.855	14.746	13	6	sandy silt to clayey silt
43.471	31.54	0.7001	2.220	14.756	12	6	sandy silt to clayey silt
43.635	28.12	0.7618	2.710	15.198	13	5	clayey silt to silty clay
43.799	27.52	0.8292	3.013	17.122	13	5	clayey silt to silty clay
43.963	34.97	1.0805	3.089	18.113	17	5	clayey silt to silty clay
44.127	24.45	1.0572	4.323	13.375	16	4	silty clay to clay
44.291	27.50	0.6792	2.469	16.316	11	6	sandy silt to clayey silt
44.455	39.53	0.5660	1.432	6.715	13	7	silty sand to sandy silt
44.619	41.50	0.6564	1.582	6.460	13	7	silty sand to sandy silt
44.783	40.81	0.9326	2.285	6.705	16	6	sandy silt to clayey silt
44.948	43.33	1.1659	2.691	7.466	17	6	sandy silt to clayey silt
45.112	38.09	1.3655	3.585	8.339	18	5	clayey silt to silty clay
45.276	36.09	1.4137	3.917	10.058	17	5	clayey silt to silty clay
45.440	31.81	1.5092	4.745	11.815	30	3	clay
45.604	26.58	1.4819	5.575	15.824	25	3	clay
45.768	37.83	1.2505	3.306	16.606	18	5	clayey silt to silty clay
45.932	45.92	0.7446	1.622	9.116	15	7	silty sand to sandy silt
46.096	49.72	0.9088	1.828	5.249	16	7	silty sand to sandy silt
46.260	56.56	1.6836	2.977	5.110	22	6	sandy silt to clayey silt
46.424	42.45	2.1512	5.068	5.390	41	3	clay
46.588	46.22	2.0967	4.536	6.982	30	4	silty clay to clay
46.752	30.65	1.3642	4.451	7.501	20	4	silty clay to clay
46.916	23.64	1.2509	5.291	11.701	23	3	clay
47.080	23.31	1.6733	7.177	12.949	22	3	clay
47.244	28.13	1.5044	5.347	10.942	27	3	clay
47.408	27.29	1.3144	4.816	6.620	26	3	clay
47.572	32.60	1.3908	4.266	5.281	21	4	silty clay to clay
47.736	31.81	1.3532	4.254	3.662	20	4	silty clay to clay
47.900	37.92	0.7075	1.866	4.488	15	6	sandy silt to clayey silt
48.064	45.30	0.5679	1.254	3.992	14	7	silty sand to sandy silt
48.228	46.37	0.6761	1.458	3.873	15	7	silty sand to sandy silt
48.392	46.55	0.8609	1.849	3.819	15	7	silty sand to sandy silt
48.556	46.59	1.0624	2.280	5.326	18	6	sandy silt to clayey silt
48.720	49.39	1.2542	2.540	5.637	19	6	sandy silt to clayey silt
48.885	50.34	1.4649	2.910	5.954	19	6	sandy silt to clayey silt
49.049	48.21	1.7259	3.580	6.271	23	5	clayey silt to silty clay
49.213	37.21	1.7123	4.602	7.093	24	4	silty clay to clay
49.377	46.98	1.1073	2.357	8.243	18	6	sandy silt to clayey silt
49.541	53.22	1.0569	1.986	6.399	20	6	sandy silt to clayey silt
49.705	50.86	0.8369	1.645	6.037	16	7	silty sand to sandy silt
49.869	52.15	0.9388	1.800	5.837	17	7	silty sand to sandy silt
50.033	55.43	1.4340	2.587	5.707	21	6	sandy silt to clayey silt
50.197	55.69	1.9231	3.453	5.927	27	5	clayey silt to silty clay
50.361	36.95	2.1294	5.762	6.686	35	3	clay
50.525	33.91	2.3226	6.850	8.746	32	3	clay
50.689	37.74	2.5972	6.882	9.968	36	3	clay

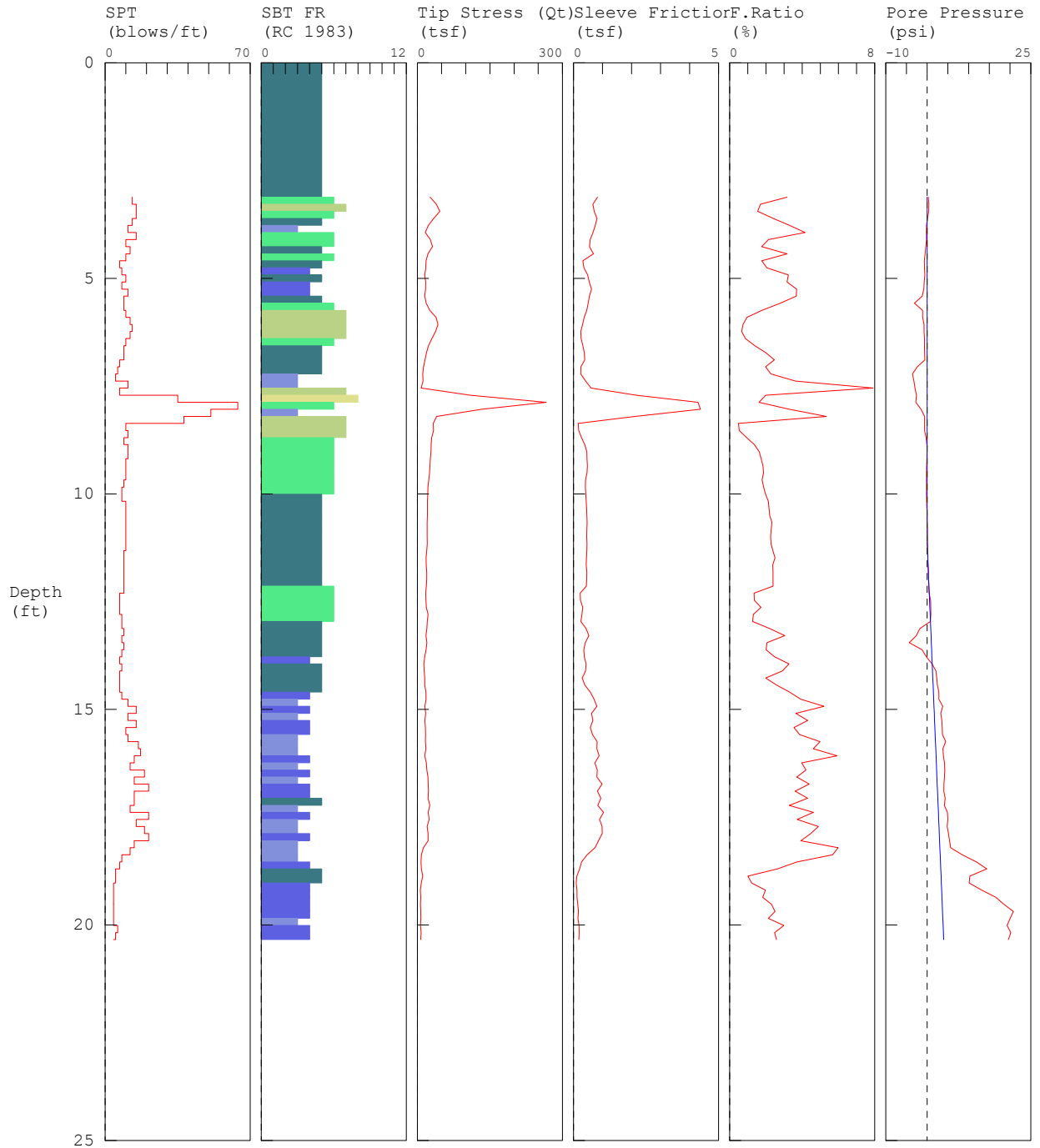
Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
50.853	39.75	2.2130	5.567	9.635	38	3	clay
51.017	60.07	2.5048	4.170	8.501	29	5	clayey silt to silty clay
51.181	47.53	2.4857	5.230	4.293	46	3	clay
51.345	37.83	2.3573	6.232	5.717	36	3	clay
51.509	32.76	2.3641	7.217	6.007	31	3	clay
51.673	35.66	1.9420	5.446	6.188	34	3	clay
51.837	37.40	2.0434	5.464	6.202	36	3	clay
52.001	36.21	2.5265	6.977	6.899	35	3	clay
52.165	40.51	2.5695	6.343	7.304	39	3	clay
52.329	44.01	2.8211	6.410	7.926	42	3	clay
52.493	50.45	2.6020	5.157	8.672	48	3	clay
52.657	78.05	2.7607	3.537	5.089	37	5	clayey silt to silty clay
52.822	75.00	2.0888	2.785	1.198	29	6	sandy silt to clayey silt
52.986	71.63	1.1783	1.645	-1.616	23	7	silty sand to sandy silt
53.150	72.46	0.9937	1.371	-1.677	23	7	silty sand to sandy silt
53.314	75.61	1.0053	1.330	-1.443	24	7	silty sand to sandy silt
53.478	80.04	1.0836	1.354	-1.081	26	7	silty sand to sandy silt
53.642	78.52	1.0708	1.364	-0.838	25	7	silty sand to sandy silt
53.806	78.08	1.4439	1.849	-0.705	25	7	silty sand to sandy silt
53.970	74.08	1.6422	2.217	-0.591	24	7	silty sand to sandy silt
54.134	72.01	1.5878	2.205	-0.402	23	7	silty sand to sandy silt
54.298	70.32	1.5346	2.182	-0.205	22	7	silty sand to sandy silt
54.462	66.35	1.9965	3.009	-0.096	25	6	sandy silt to clayey silt
54.626	54.35	2.5409	4.675	0.075	35	4	silty clay to clay
54.790	49.50	2.7221	5.500	0.490	47	3	clay
54.954	62.19	2.4161	3.885	1.142	30	5	clayey silt to silty clay
55.118	72.38	1.5017	2.075	1.230	23	7	silty sand to sandy silt
55.282	74.22	1.1029	1.486	1.041	24	7	silty sand to sandy silt
55.446	70.25	1.5579	2.218	0.924	22	7	silty sand to sandy silt
55.610	47.94	2.0931	4.366	0.921	31	4	silty clay to clay
55.774	40.85	1.8896	4.625	1.200	26	4	silty clay to clay
55.938	61.40	1.2041	1.961	1.565	20	7	silty sand to sandy silt
56.102	69.44	1.8308	2.637	1.294	27	6	sandy silt to clayey silt
56.266	66.32	1.6957	2.557	1.379	25	6	sandy silt to clayey silt
56.430	69.26	1.9042	2.749	1.315	27	6	sandy silt to clayey silt
56.594	60.32	2.3778	3.942	0.934	29	5	clayey silt to silty clay
56.759	46.33	2.5328	5.467	0.788	44	3	clay
56.923	45.52	2.7375	6.014	1.057	44	3	clay
57.087	45.12	2.5637	5.683	1.310	43	3	clay
57.251	60.45	1.2858	2.127	1.315	23	6	sandy silt to clayey silt
57.415	83.44	1.6067	1.926	1.105	27	7	silty sand to sandy silt
57.579	93.87	1.6370	1.744	1.113	30	7	silty sand to sandy silt
57.743	94.08	2.0802	2.211	1.086	30	7	silty sand to sandy silt
57.907	82.59	2.6113	3.162	1.057	32	6	sandy silt to clayey silt
58.071	75.95	2.8811	3.794	1.270	36	5	clayey silt to silty clay
58.235	61.70	3.2756	5.309	1.251	59	11	very stiff fine grained (*)
58.399	62.68	2.7411	4.373	1.251	30	5	clayey silt to silty clay
58.563	66.13	2.6479	4.004	1.387	32	5	clayey silt to silty clay
58.727	68.77	2.0232	2.942	0.876	26	6	sandy silt to clayey silt
58.891	69.73	1.4950	2.144	0.761	22	7	silty sand to sandy silt
59.055	71.60	1.2331	1.722	0.908	23	7	silty sand to sandy silt
59.219	74.41	1.4976	2.013	0.801	24	7	silty sand to sandy silt
59.383	76.26	1.9235	2.522	0.780	29	6	sandy silt to clayey silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
59.547	81.04	2.2565	2.784	0.777	31	6	sandy silt to clayey silt
59.711	87.68	2.9997	3.421	0.828	34	6	sandy silt to clayey silt
59.875	60.50	2.8418	4.697	0.450	39	4	silty clay to clay
60.039	42.68	2.1782	5.103	1.440	41	3	clay
60.203	47.64	2.3278	4.886	2.145	30	4	silty clay to clay
60.367	63.57	2.5980	4.087	1.517	30	5	clayey silt to silty clay
60.532	53.15	2.5630	4.822	1.299	34	4	silty clay to clay
60.696	67.38	2.6247	3.895	1.549	32	5	clayey silt to silty clay
60.860	70.48	2.4841	3.524	1.291	34	5	clayey silt to silty clay
61.024	66.22	2.8410	4.290	1.275	32	5	clayey silt to silty clay
61.188	68.34	2.7059	3.960	1.270	33	5	clayey silt to silty clay
61.352	83.67	1.8202	2.176	1.211	27	7	silty sand to sandy silt
61.516	93.85	1.2924	1.377	1.089	22	8	sand to silty sand
61.680	97.89	1.6108	1.645	1.347	31	7	silty sand to sandy silt
61.844	104.04	1.7041	1.638	1.267	33	7	silty sand to sandy silt
62.008	104.80	1.3281	1.267	1.235	25	8	sand to silty sand
62.172	103.14	1.5075	1.462	1.216	25	8	sand to silty sand
62.336	101.80	1.7213	1.691	1.171	32	7	silty sand to sandy silt
62.500	100.20	1.7233	1.720	1.102	32	7	silty sand to sandy silt
62.664	97.13	1.7910	1.844	0.876	31	7	silty sand to sandy silt
62.828	96.04	1.4046	1.462	0.806	31	7	silty sand to sandy silt
62.992	94.47	1.4868	1.574	0.897	30	7	silty sand to sandy silt
63.156	92.30	1.6318	1.768	0.785	29	7	silty sand to sandy silt
63.320	95.38	1.4116	1.480	0.798	30	7	silty sand to sandy silt
63.484	97.41	1.4603	1.499	0.737	31	7	silty sand to sandy silt
63.648	91.22	2.2490	2.465	0.719	35	6	sandy silt to clayey silt
63.812	78.98	2.1760	2.755	0.498	30	6	sandy silt to clayey silt
63.976	82.59	1.7114	2.072	0.538	26	7	silty sand to sandy silt
64.140	84.05	1.4661	1.744	0.439	27	7	silty sand to sandy silt
64.304	81.96	1.3993	1.707	0.303	26	7	silty sand to sandy silt
64.469	81.74	1.4010	1.714	0.290	26	7	silty sand to sandy silt
64.633	80.78	1.2070	1.494	0.330	26	7	silty sand to sandy silt
64.797	82.52	1.0619	1.287	0.373	26	7	silty sand to sandy silt
64.961	85.17	0.9711	1.140	1.509	20	8	sand to silty sand
65.125	84.50	1.2242	1.449	1.461	27	7	silty sand to sandy silt
65.289	98.42	1.4594	1.483	1.584	24	8	sand to silty sand
65.453	107.21	1.8053	1.684	1.618	34	7	silty sand to sandy silt
65.617	112.55	1.9130	1.700	1.765	36	7	silty sand to sandy silt
65.781	107.97	1.9250	1.783	1.922	34	7	silty sand to sandy silt
65.945	114.17	1.9025	1.666	2.044	36	7	silty sand to sandy silt
66.109	126.34	1.9635	1.554	2.286	30	8	sand to silty sand
66.273	125.04	2.1927	1.754	2.433	40	7	silty sand to sandy silt
66.437	131.67	2.4267	1.843	2.638	42	7	silty sand to sandy silt
66.601	126.53	2.4902	1.968	2.813	40	7	silty sand to sandy silt
66.765	119.49	2.4977	2.090	2.962	38	7	silty sand to sandy silt
66.929	112.17	2.5223	2.249	3.125	36	7	silty sand to sandy silt
67.093	107.41	2.5227	2.349	3.290	34	7	silty sand to sandy silt
67.257	108.56	2.5681	2.366	3.511	35	7	silty sand to sandy silt
67.421	115.63	2.7307	2.362	3.809	37	7	silty sand to sandy silt
67.585	121.01	2.8925	2.390	3.966	39	7	silty sand to sandy silt
67.749	140.82	2.9696	2.109	4.365	45	7	silty sand to sandy silt
67.913	143.30	2.4790	1.730	4.583	34	8	sand to silty sand
68.077	137.91	2.6311	1.908	4.645	44	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
68.241	137.54	2.7738	2.017	4.850	44	7	silty sand to sandy silt
68.406	143.18	3.0528	2.132	5.129	46	7	silty sand to sandy silt
68.570	152.18	3.2134	2.112	5.374	49	7	silty sand to sandy silt
68.734	164.06	3.0642	1.868	5.587	52	7	silty sand to sandy silt
68.898	172.71	3.0213	1.749	5.675	41	8	sand to silty sand
69.062	155.64	2.7529	1.769	5.589	37	8	sand to silty sand
69.226	132.23	2.5767	1.949	5.731	42	7	silty sand to sandy silt
69.390	119.60	3.0989	2.591	3.998	38	7	silty sand to sandy silt
69.554	125.80	3.3567	2.668	3.191	40	7	silty sand to sandy silt
69.718	136.48	2.8242	2.069	2.145	44	7	silty sand to sandy silt
69.882	148.29	1.6009	1.080	0.056	36	8	sand to silty sand
70.046	141.56	1.3355	0.943	-0.423	34	8	sand to silty sand
70.210	118.78	1.4769	1.243	-0.407	28	8	sand to silty sand
70.374	105.92	1.3309	1.257	-0.442	25	8	sand to silty sand
70.538	97.92	1.0484	1.071	-0.452	23	8	sand to silty sand
70.702	89.21	0.8709	0.976	-0.458	21	8	sand to silty sand
70.866	76.65	0.9578	1.250	-0.514	24	7	silty sand to sandy silt
71.030	66.68	1.1095	1.664	-0.551	21	7	silty sand to sandy silt
71.194	61.71	1.1416	1.850	-0.551	20	7	silty sand to sandy silt
71.358	62.44	1.2145	1.945	-0.516	20	7	silty sand to sandy silt
71.522	66.99	1.3767	2.055	-0.048	21	7	silty sand to sandy silt
71.686	78.66	1.1834	1.504	-0.021	25	7	silty sand to sandy silt
71.850	97.84	1.0029	1.025	0.189	23	8	sand to silty sand
72.014	128.67	1.3389	1.040	0.325	31	8	sand to silty sand
72.178	145.25	2.0012	1.378	0.556	35	8	sand to silty sand
72.343	143.84	2.5406	1.766	0.548	46	7	silty sand to sandy silt
72.507	130.84	2.8566	2.183	0.487	42	7	silty sand to sandy silt
72.671	115.80	2.5363	2.190	0.516	37	7	silty sand to sandy silt
72.835	105.67	2.2323	2.112	0.735	34	7	silty sand to sandy silt
72.999	96.01	2.0403	2.125	0.836	31	7	silty sand to sandy silt
73.163	87.51	2.1728	2.483	0.902	34	6	sandy silt to clayey silt
73.327	86.75	1.3237	1.526	1.254	28	7	silty sand to sandy silt
73.491	87.73	1.0137	1.155	1.312	21	8	sand to silty sand
73.655	78.61	1.4172	1.803	3.122	25	7	silty sand to sandy silt
73.819	76.67	1.6959	2.212	3.165	24	7	silty sand to sandy silt
73.983	81.77	1.9532	2.389	3.231	31	6	sandy silt to clayey silt
74.147	87.49	2.0790	2.376	3.415	28	7	silty sand to sandy silt
74.311	92.34	2.1264	2.303	3.628	29	7	silty sand to sandy silt
74.475	95.63	2.1329	2.230	3.788	31	7	silty sand to sandy silt
74.639	93.97	2.2244	2.367	4.221	30	7	silty sand to sandy silt
74.803	90.11	2.2754	2.525	4.700	35	6	sandy silt to clayey silt
74.967	85.54	2.2944	2.682	4.786	33	6	sandy silt to clayey silt
75.131	79.30	2.2425	2.828	4.889	30	6	sandy silt to clayey silt
75.295	73.57	2.0563	2.795	5.049	28	6	sandy silt to clayey silt
75.459	69.72	1.7459	2.504	5.297	27	6	sandy silt to clayey silt
75.623	64.37	1.2980	2.016	5.289	21	7	silty sand to sandy silt
75.787	61.51	0.9654	1.570	5.363	20	7	silty sand to sandy silt
75.951	68.67	0.9087	1.323	4.961	22	7	silty sand to sandy silt
76.115	75.44	1.0954	1.452	4.551	24	7	silty sand to sandy silt
76.280	79.26	1.3397	1.690	4.437	25	7	silty sand to sandy silt
76.444	76.62	1.5972	2.084	4.581	24	7	silty sand to sandy silt
76.608	78.65	1.4122	1.796	4.826	25	7	silty sand to sandy silt
76.772	91.19	1.0990	1.205	5.153	22	8	sand to silty sand

Landau Associates / CPT-4 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-4
 TEST DATE: 8/27/2020 3:54:20 PM
 TOTAL DEPTH: 20.341 ft



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

*SBT/SPT CORRELATION: UBC-1983

Landau Associates / CPT-4 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1532
 HOLE NUMBER: CPT-4
 TEST DATE: 8/27/2020 3:54:20 PM
 TOTAL DEPTH: 20.341 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
3.117	26.11	0.8257	3.163	0.256	13	5	clayey silt to silty clay
3.281	39.01	0.6640	1.702	0.399	15	6	sandy silt to clayey silt
3.445	46.30	0.7132	1.540	0.367	15	7	silty sand to sandy silt
3.609	33.64	0.8101	2.408	0.053	13	6	sandy silt to clayey silt
3.773	22.61	0.7469	3.304	-0.181	11	5	clayey silt to silty clay
3.937	16.16	0.6728	4.163	-0.240	15	3	clay
4.101	26.63	0.5698	2.140	-0.197	10	6	sandy silt to clayey silt
4.265	31.17	0.5485	1.760	-0.357	12	6	sandy silt to clayey silt
4.429	21.56	0.6837	3.170	-0.506	10	5	clayey silt to silty clay
4.593	17.86	0.3164	1.772	-0.713	7	6	sandy silt to clayey silt
4.757	17.34	0.3548	2.046	-0.681	8	5	clayey silt to silty clay
4.921	15.01	0.4855	3.235	-0.588	10	4	silty clay to clay
5.085	17.06	0.5390	3.160	-0.753	8	5	clayey silt to silty clay
5.249	16.72	0.6173	3.692	-0.809	11	4	silty clay to clay
5.413	14.88	0.5461	3.670	-1.216	9	4	silty clay to clay
5.577	18.18	0.5079	2.794	-3.109	9	5	clayey silt to silty clay
5.741	25.64	0.4543	1.772	-1.115	10	6	sandy silt to clayey silt
5.906	38.62	0.3668	0.950	-1.110	12	7	silty sand to sandy silt
6.070	42.23	0.3107	0.736	-0.761	13	7	silty sand to sandy silt
6.234	37.41	0.2461	0.658	-0.775	12	7	silty sand to sandy silt
6.398	30.02	0.2595	0.865	-0.673	10	7	silty sand to sandy silt
6.562	22.79	0.3167	1.389	-0.676	9	6	sandy silt to clayey silt
6.726	18.58	0.3708	1.996	-0.631	9	5	clayey silt to silty clay
6.890	15.54	0.3822	2.460	-0.570	7	5	clayey silt to silty clay
7.054	12.63	0.2497	1.977	-2.401	6	5	clayey silt to silty clay
7.218	10.85	0.2463	2.271	-3.567	5	5	clayey silt to silty clay
7.382	11.52	0.4185	3.635	-3.207	11	3	clay
7.546	7.61	0.6025	7.915	-2.968	7	3	clay
7.710	109.52	2.1682	1.980	-2.630	35	7	silty sand to sandy silt
7.874	266.07	4.2915	1.613	-2.781	64	8	sand to silty sand
8.038	133.14	4.3744	3.285	-1.522	51	6	sandy silt to clayey silt
8.202	39.65	2.1144	5.333	-0.644	38	3	clay
8.366	32.69	0.1577	0.483	-0.628	10	7	silty sand to sandy silt
8.530	33.43	0.1767	0.528	-0.644	11	7	silty sand to sandy silt
8.694	29.38	0.2758	0.939	-0.279	9	7	silty sand to sandy silt
8.858	28.26	0.3851	1.363	-0.090	11	6	sandy silt to clayey silt
9.022	28.08	0.4585	1.633	-0.059	11	6	sandy silt to clayey silt
9.186	26.77	0.4649	1.737	-0.104	10	6	sandy silt to clayey silt
9.350	25.71	0.4737	1.842	-0.144	10	6	sandy silt to clayey silt
9.514	24.99	0.4657	1.863	-0.168	10	6	sandy silt to clayey silt
9.678	23.22	0.4151	1.788	-0.176	9	6	sandy silt to clayey silt
9.843	21.67	0.4074	1.880	-0.173	8	6	sandy silt to clayey silt
10.007	21.40	0.4227	1.975	-0.176	8	6	sandy silt to clayey silt
10.171	20.59	0.4377	2.126	-0.146	10	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.335	20.69	0.4485	2.168	-0.090	10	5	clayey silt to silty clay
10.499	20.75	0.4573	2.204	-0.053	10	5	clayey silt to silty clay
10.663	20.04	0.4672	2.331	-0.016	10	5	clayey silt to silty clay
10.827	19.94	0.4560	2.287	0.035	10	5	clayey silt to silty clay
10.991	20.11	0.4538	2.257	0.045	10	5	clayey silt to silty clay
11.155	20.28	0.4622	2.279	0.069	10	5	clayey silt to silty clay
11.319	19.35	0.4609	2.382	0.109	9	5	clayey silt to silty clay
11.483	17.89	0.4467	2.496	0.154	9	5	clayey silt to silty clay
11.647	18.25	0.4330	2.373	0.200	9	5	clayey silt to silty clay
11.811	19.15	0.4576	2.389	0.237	9	5	clayey silt to silty clay
11.975	18.99	0.4529	2.385	0.269	9	5	clayey silt to silty clay
12.139	18.43	0.4401	2.388	0.327	9	5	clayey silt to silty clay
12.303	17.10	0.2301	1.345	0.431	7	6	sandy silt to clayey silt
12.467	17.48	0.2379	1.361	0.804	7	6	sandy silt to clayey silt
12.631	18.35	0.3162	1.723	0.854	7	6	sandy silt to clayey silt
12.795	22.05	0.2882	1.307	0.884	8	6	sandy silt to clayey silt
12.959	20.18	0.2544	1.261	0.727	8	6	sandy silt to clayey silt
13.123	19.45	0.4282	2.201	-1.762	9	5	clayey silt to silty clay
13.287	17.46	0.5301	3.036	-2.632	8	5	clayey silt to silty clay
13.451	19.59	0.4032	2.058	-4.341	9	5	clayey silt to silty clay
13.615	17.64	0.3535	2.004	-1.259	8	5	clayey silt to silty clay
13.780	15.08	0.3738	2.478	-0.229	7	5	clayey silt to silty clay
13.944	13.09	0.4290	3.278	1.171	8	4	silty clay to clay
14.108	14.09	0.4100	2.910	2.097	7	5	clayey silt to silty clay
14.272	14.85	0.2939	1.979	2.284	7	5	clayey silt to silty clay
14.436	15.06	0.3894	2.586	2.446	7	5	clayey silt to silty clay
14.600	17.50	0.5789	3.309	2.811	8	5	clayey silt to silty clay
14.764	17.94	0.7037	3.922	2.811	11	4	silty clay to clay
14.928	15.38	0.7995	5.199	3.737	15	3	clay
15.092	17.04	0.6219	3.650	3.261	11	4	silty clay to clay
15.256	15.53	0.6688	4.307	3.511	15	3	clay
15.420	16.28	0.5772	3.545	3.604	10	4	silty clay to clay
15.584	16.86	0.6500	3.854	3.681	11	4	silty clay to clay
15.748	16.34	0.8138	4.980	4.432	16	3	clay
15.912	17.48	0.8066	4.616	3.766	17	3	clay
16.076	14.92	0.8830	5.919	3.910	14	3	clay
16.240	18.47	0.7337	3.972	4.144	12	4	silty clay to clay
16.404	19.44	0.8186	4.211	4.227	19	3	clay
16.568	21.68	0.8025	3.702	4.181	14	4	silty clay to clay
16.732	22.35	0.9808	4.388	4.043	21	3	clay
16.896	22.66	0.8194	3.616	4.019	14	4	silty clay to clay
17.060	21.91	0.9403	4.291	4.309	14	4	silty clay to clay
17.224	25.46	0.8371	3.288	4.110	12	5	clayey silt to silty clay
17.388	22.34	1.0316	4.618	4.873	21	3	clay
17.552	24.08	0.8972	3.726	4.964	15	4	silty clay to clay
17.717	20.09	0.9826	4.892	4.823	19	3	clay
17.881	22.04	0.9855	4.471	5.102	21	3	clay
18.045	21.94	0.8600	3.919	5.369	14	4	silty clay to clay
18.209	12.40	0.7416	5.981	5.651	12	3	clay
18.373	8.27	0.4697	5.682	8.440	8	3	clay
18.537	7.32	0.2712	3.704	11.892	7	3	clay
18.701	7.99	0.2104	2.633	14.360	5	4	silty clay to clay
18.865	10.94	0.1102	1.007	10.258	5	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
19.029	7.73	0.0937	1.212	10.120	4	5	clayey silt to silty clay
19.193	6.07	0.1196	1.971	13.143	4	4	silty clay to clay
19.357	6.57	0.1199	1.825	16.582	4	4	silty clay to clay
19.521	6.27	0.1445	2.303	18.477	4	4	silty clay to clay
19.685	6.77	0.1689	2.494	20.780	4	4	silty clay to clay
19.849	7.02	0.1500	2.137	20.013	4	4	silty clay to clay
20.013	6.28	0.1875	2.985	19.262	6	3	clay
20.177	7.67	0.1900	2.478	20.175	5	4	silty clay to clay
20.341	6.97	0.1800	2.583	19.576	4	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
76.936	98.23	1.7202	1.751	3.750	31	7	silty sand to sandy silt
77.100	94.96	2.0107	2.117	3.649	30	7	silty sand to sandy silt
77.264	83.18	2.0435	2.457	4.815	32	6	sandy silt to clayey silt
77.428	80.43	2.1693	2.697	4.996	31	6	sandy silt to clayey silt
77.592	90.60	2.2606	2.495	5.326	35	6	sandy silt to clayey silt
77.756	108.94	2.3802	2.185	5.975	35	7	silty sand to sandy silt
77.920	129.95	2.7109	2.086	6.468	41	7	silty sand to sandy silt
78.084	154.25	3.1550	2.045	11.509	49	7	silty sand to sandy silt
78.248	181.36	3.5837	1.976	11.953	58	7	silty sand to sandy silt
78.412	195.00	3.5803	1.836	12.145	47	8	sand to silty sand
78.576	201.81	2.9669	1.470	10.737	48	8	sand to silty sand
78.740	171.55	2.2901	1.335	8.086	41	8	sand to silty sand
78.904	140.78	1.7482	1.242	2.907	34	8	sand to silty sand
79.068	132.73	2.1319	1.606	1.988	32	8	sand to silty sand
79.232	150.55	2.8277	1.878	2.249	48	7	silty sand to sandy silt
79.396	195.22	5.4304	2.782	2.776	62	7	silty sand to sandy silt
79.560	252.23	7.0811	2.807	3.000	81	7	silty sand to sandy silt
79.724	247.15	9.3378	3.778	2.143	118	12	sand to clayey sand (*)
79.888	214.40	7.4188	3.460	1.373	103	12	sand to clayey sand (*)
80.052	154.04	3.9026	2.533	-1.222	49	7	silty sand to sandy silt
80.217	118.27	2.6790	2.265	-2.361	38	7	silty sand to sandy silt
80.381	106.29	2.7989	2.633	-2.478	41	6	sandy silt to clayey silt
80.545	143.13	2.7974	1.954	-2.097	46	7	silty sand to sandy silt
80.709	416.64	2.8308	0.679	31.168	66	10	gravelly sand to sand
80.873	417.14	2.8407	0.681	31.139	67	10	gravelly sand to sand

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
33.465	6.82	0.1008	1.479	40.162	3	1	sensitive fine grained
33.629	6.84	0.0993	1.452	41.471	3	1	sensitive fine grained
33.793	7.19	0.1069	1.487	42.664	3	5	clayey silt to silty clay
33.957	7.15	0.1374	1.923	43.185	5	4	silty clay to clay
34.121	7.17	0.1659	2.314	43.739	5	4	silty clay to clay
34.285	7.61	0.1752	2.303	42.099	5	4	silty clay to clay
34.449	7.30	0.1723	2.360	41.476	5	4	silty clay to clay
34.613	7.31	0.1918	2.624	41.974	5	4	silty clay to clay
34.777	8.21	0.2108	2.566	41.556	5	4	silty clay to clay
34.941	9.03	0.2280	2.525	38.200	6	4	silty clay to clay
35.105	9.12	0.2158	2.366	35.365	6	4	silty clay to clay
35.269	9.36	0.2120	2.265	33.710	6	4	silty clay to clay
35.433	8.98	0.2096	2.334	32.728	6	4	silty clay to clay
35.597	8.40	0.1956	2.330	34.005	5	4	silty clay to clay
35.761	8.17	0.1601	1.960	34.910	5	4	silty clay to clay
35.925	7.73	0.2207	2.857	35.711	5	4	silty clay to clay
36.089	9.41	0.2499	2.655	40.031	6	4	silty clay to clay
36.253	13.31	0.3297	2.477	32.491	6	5	clayey silt to silty clay
36.417	13.15	0.3467	2.638	26.169	6	5	clayey silt to silty clay
36.581	12.83	0.2757	2.150	24.878	6	5	clayey silt to silty clay
36.745	10.46	0.2391	2.286	23.715	5	5	clayey silt to silty clay
36.909	9.36	0.1955	2.089	26.521	4	5	clayey silt to silty clay
37.073	8.68	0.1810	2.086	28.389	6	4	silty clay to clay
37.238	8.67	0.2049	2.362	31.056	6	4	silty clay to clay
37.402	9.62	0.2280	2.369	33.478	6	4	silty clay to clay
37.566	10.53	0.2653	2.519	33.377	7	4	silty clay to clay
37.730	10.53	0.2818	2.677	33.060	7	4	silty clay to clay
37.894	11.05	0.3036	2.747	33.444	7	4	silty clay to clay
38.058	10.25	0.2971	2.899	34.117	7	4	silty clay to clay
38.222	9.77	0.2646	2.707	34.056	6	4	silty clay to clay
38.386	8.90	0.2468	2.773	34.218	6	4	silty clay to clay
38.550	9.20	0.2607	2.833	36.182	6	4	silty clay to clay
38.714	10.08	0.2485	2.465	35.749	6	4	silty clay to clay
38.878	10.24	0.2712	2.648	34.269	7	4	silty clay to clay
39.042	9.59	0.2760	2.880	35.525	6	4	silty clay to clay
39.206	10.05	0.2469	2.456	35.240	6	4	silty clay to clay
39.370	9.27	0.1656	1.785	34.410	4	5	clayey silt to silty clay
39.534	8.10	0.2093	2.583	35.192	5	4	silty clay to clay
39.698	8.97	0.2472	2.755	41.421	6	4	silty clay to clay
39.862	10.70	0.2582	2.413	36.201	5	5	clayey silt to silty clay
40.026	9.80	0.2315	2.362	36.270	6	4	silty clay to clay
40.190	9.40	0.1902	2.023	38.184	5	5	clayey silt to silty clay
40.354	8.44	0.1743	2.065	39.496	5	4	silty clay to clay
40.518	8.64	0.1492	1.728	43.113	4	5	clayey silt to silty clay
40.682	8.53	0.1223	1.433	44.468	4	5	clayey silt to silty clay
40.846	8.05	0.1165	1.446	46.781	4	5	clayey silt to silty clay
41.011	8.48	0.1220	1.439	51.971	4	5	clayey silt to silty clay
41.175	9.34	0.1500	1.607	50.401	4	5	clayey silt to silty clay
41.339	12.26	0.2901	2.365	38.562	6	5	clayey silt to silty clay

Sample Photograph Log



1. Boring B-1 at 2.5 feet: Dark gray, fine to coarse SAND with silt.



2. Boring B-1 at 5 feet: Dark gray, fine to coarse SAND with silt.



3. Boring B-1 at 7.5 feet: Gray SILT.



4. Boring B-1 at 10 feet: Dark gray, fine to coarse SAND with silt.



5. Boring B-1 at 15 feet: Dark gray, fine to coarse SAND with silt.



6. Boring B-1 at 17.5 feet: Gray SILT with wood debris.



7. Boring B-1 at 22.5 feet: Gray, elastic SILT with trace organics.



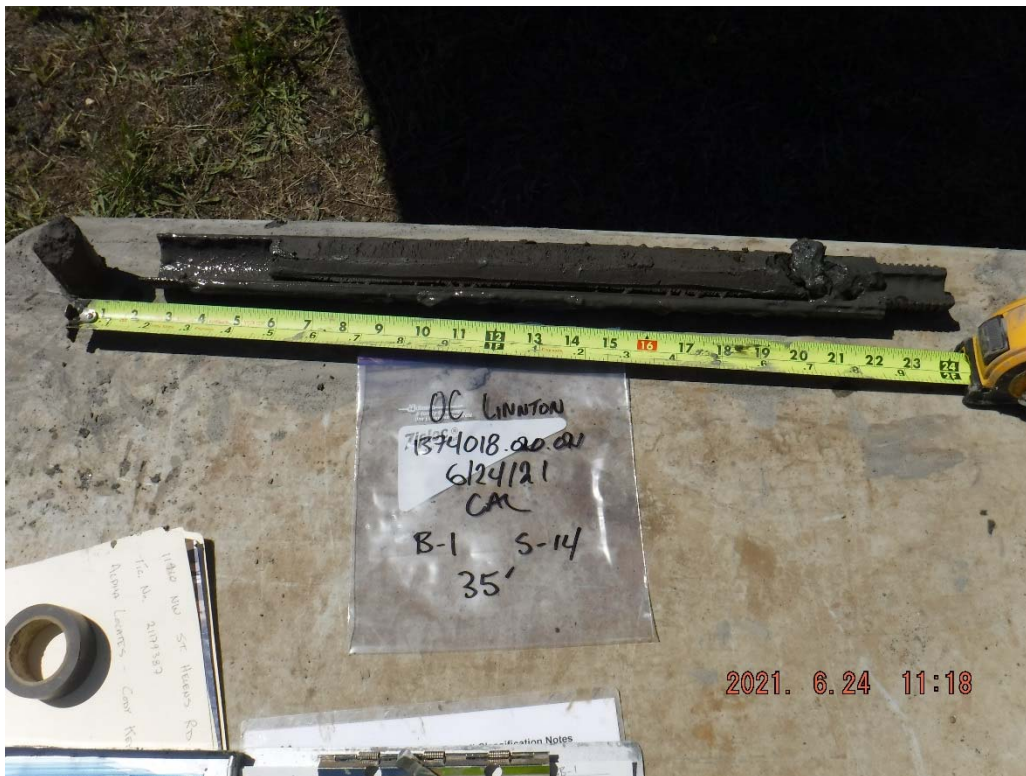
8. Boring B-1 at 25 feet: Gray, elastic SILT with trace organics.



9. Boring B-1 at 27.5 feet: Dark gray SILT.



10. Boring B-1 at 30 feet: Gray SILT with fine sand.



11. Boring B-1 at 35 feet: Gray, elastic SILT.



12. Boring B-1 at 40 feet: Blue-gray to gray SILT.



13. Boring B-1 at 42.5 feet: Gray-brown to gray CLAY.



14. Boring B-1 at 47.5 feet: Gray-brown SILT and gray-brown, silty, fine to coarse SAND.



15. Boring B-1 at 50 feet: Gray-brown to brown SILT.



16. Boring B-1 at 55 feet: Gray-brown to brown SILT with fine sand.



17. Boring B-1 at 60 feet: Gray-brown to brown SILT.



18. Boring B-1 at 65 feet: Gray-brown to brown SILT.



19. Boring B-1 at 70 feet: Gray-brown, very silty, fine to medium SAND.



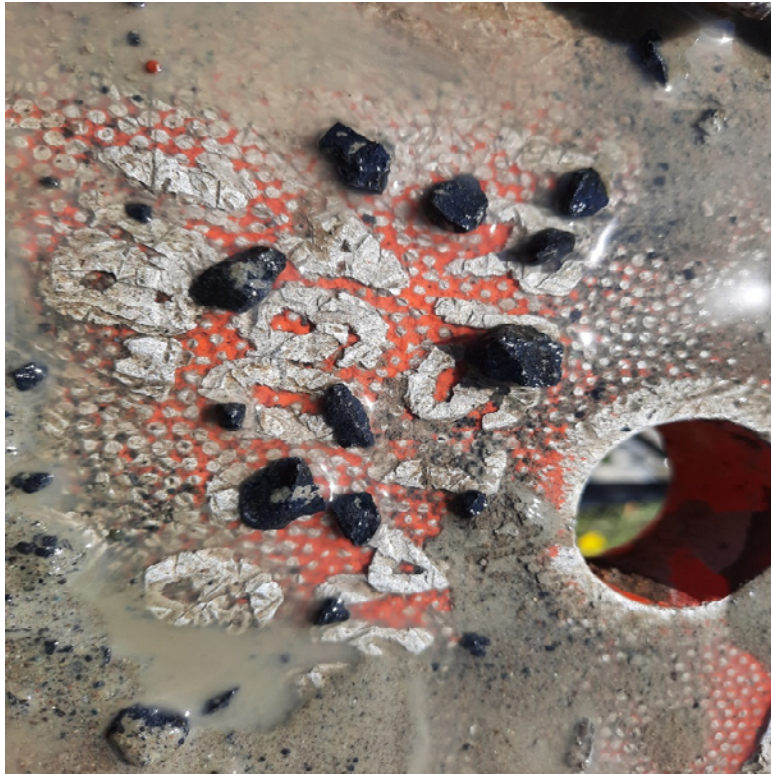
20. Boring B-1 at 75 feet: Gray, very silty, fine to medium SAND.



21. Boring B-1 at 80 feet: Brown, very silty, fine to medium SAND.



22. Boring B-1 at 85 feet: Brown, very silty, fine to medium SAND.



23. Boring B-1 at 90 feet: Basalt pieces from drill cuttings.



24. Boring B-2 at 2.5 feet: Brown, fine to coarse SAND.



25. Boring B-2 at 5 feet: Brown, fine to coarse SAND.



26. Boring B-2 at 7.5 feet: Light brown, silty, fine to coarse SAND with organics.



27. Boring B-2 at 10 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.



28. Boring B-2 at 12.5 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.



29. Boring B-2 at 15 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.



30. Boring B-2 at 17.5 feet: Gray SILT with trace organics.



31. Boring B-2 at 22.5 feet: Light gray to gray, elastic SILT with organics.



32. Boring B-2 at 25 feet: Gray, elastic SILT.



33. Boring B-2 at 27.5 feet: Dark gray SILT.



34. Boring B-2 at 30 feet: Dark gray SILT with trace organics.



35. Boring B-2 at 32.5 feet: Dark gray SILT with trace organics.



36. Boring B-2 at 35 feet: Dark gray SILT with trace organics.



37. Boring B-2 at 40 feet: Dark gray SILT with trace organics.



38. Boring B-2 at 42.5 feet: Dark gray SILT with trace organics.



39. Boring B-2 at 45 feet: Light gray to blue-gray SILT with slickensides.



40. Boring B-2 at 47.5 feet: Light gray to blue-gray SILT.



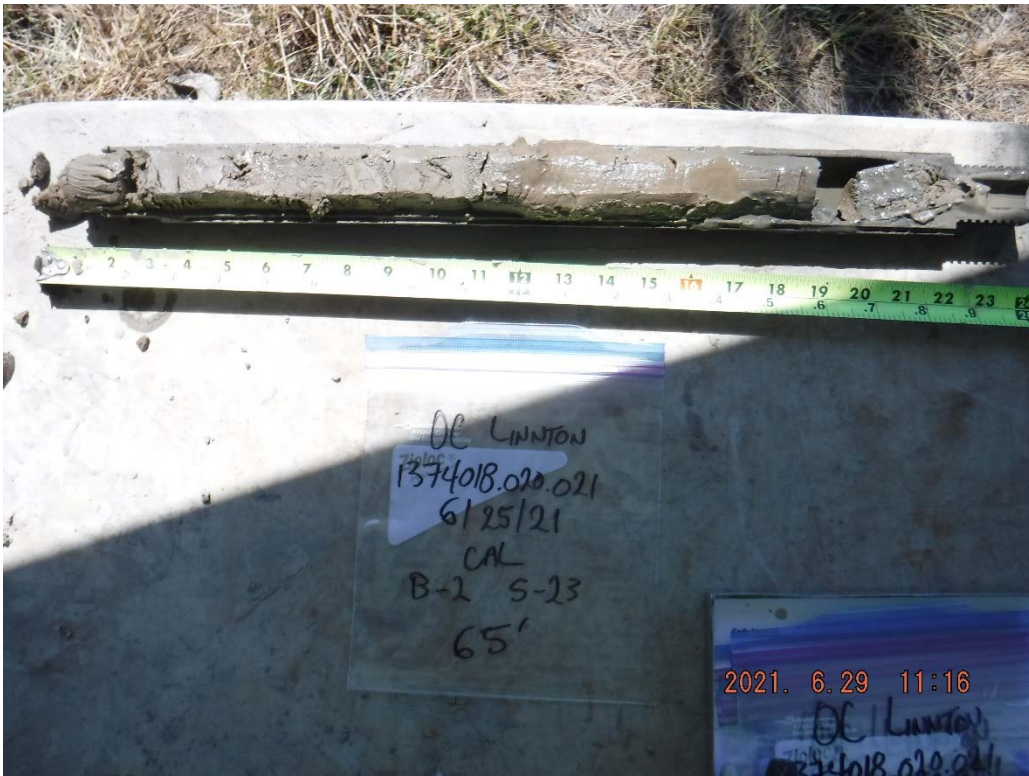
41. Boring B-2 at 50 feet: Gray to gray-brown SILT.



42. Boring B-2 at 55 feet: Gray-brown to brown SILT.



43. Boring B-2 at 60 feet: Gray-brown to brown SILT.



44. Boring B-2 at 65 feet: Gray-brown to brown SILT.



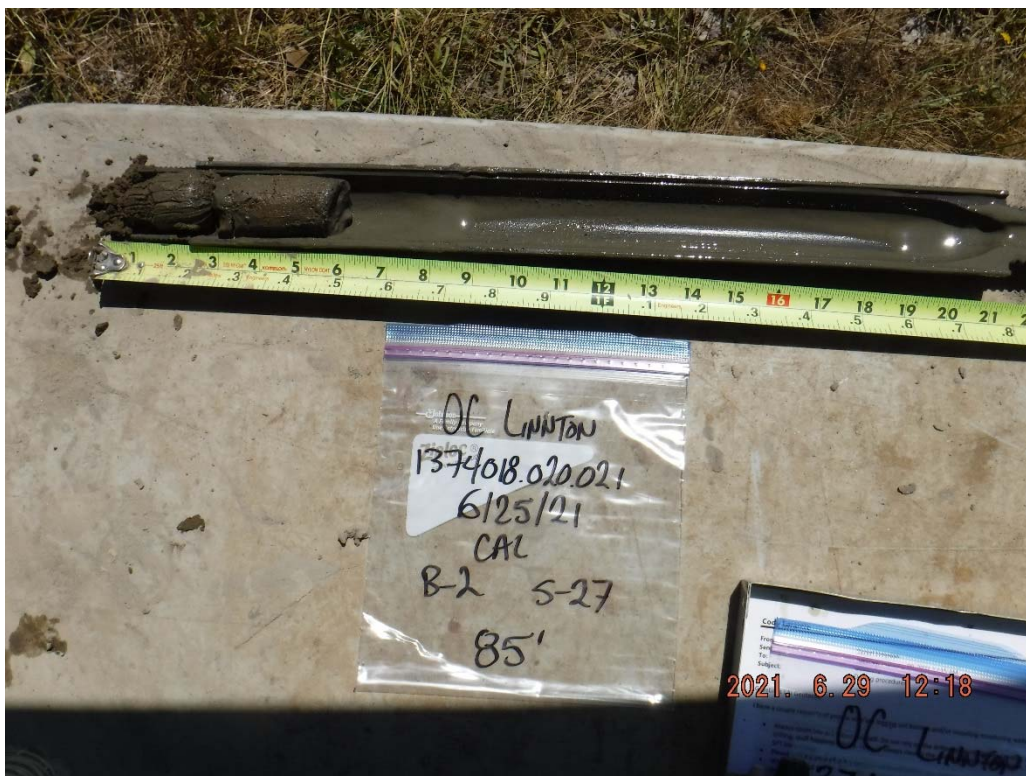
45. Boring B-2 at 70 feet: Gray, very sandy SILT with organics.



46. Boring B-2 at 75 feet: Gray-brown, sandy SILT with organics.



47. Boring B-2 at 80 feet: Gray-brown, very silty, fine SAND.



48. Boring B-2 at 85 feet: Gray-brown, very silty, fine SAND.



49. Boring B-2 at 90 feet: Gray-brown, very silty, fine SAND.



50. Boring B-2 at 95 feet: Gray-brown, fine SAND with silt.



51. Boring B-2 at 100 feet: Basalt.

Laboratory Soil Testing

APPENDIX C

LABORATORY SOIL TESTING

Samples obtained from the explorations were transported to Landau Associates, Inc.'s (LAI) soils laboratory for further examination and testing. Testing was performed in general accordance with the ASTM International (ASTM) standard test methods described below. Field log descriptions were checked against the samples and updated, where appropriate, in general accordance with ASTM standard D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*.

Soiltest Farm Consultants, subcontracted by LAI, completed cation exchange capacity (CEC) and soil pH measurements on two samples. Results are included at the end of Appendix C.

Natural Moisture Content

Natural moisture content determinations were performed on select soil samples in general accordance with ASTM standard test method D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*. The natural moisture content is shown as "W = xx" (i.e., percent of dry weight) in the "Test Data" column on the summary boring logs in Appendix A.

Grain Size Analyses

Grain size analyses were performed on select soil samples in general accordance with ASTM standard test method D7928, *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*. Samples selected for grain size analyses are designated with a "GS" in the "Test Data" column on the summary boring logs in Appendix A. The results of the grain size analyses are presented on Figures C-1 through C-6 in this appendix. Some hydrometer tests did not include a US No. 200 sieve wash.

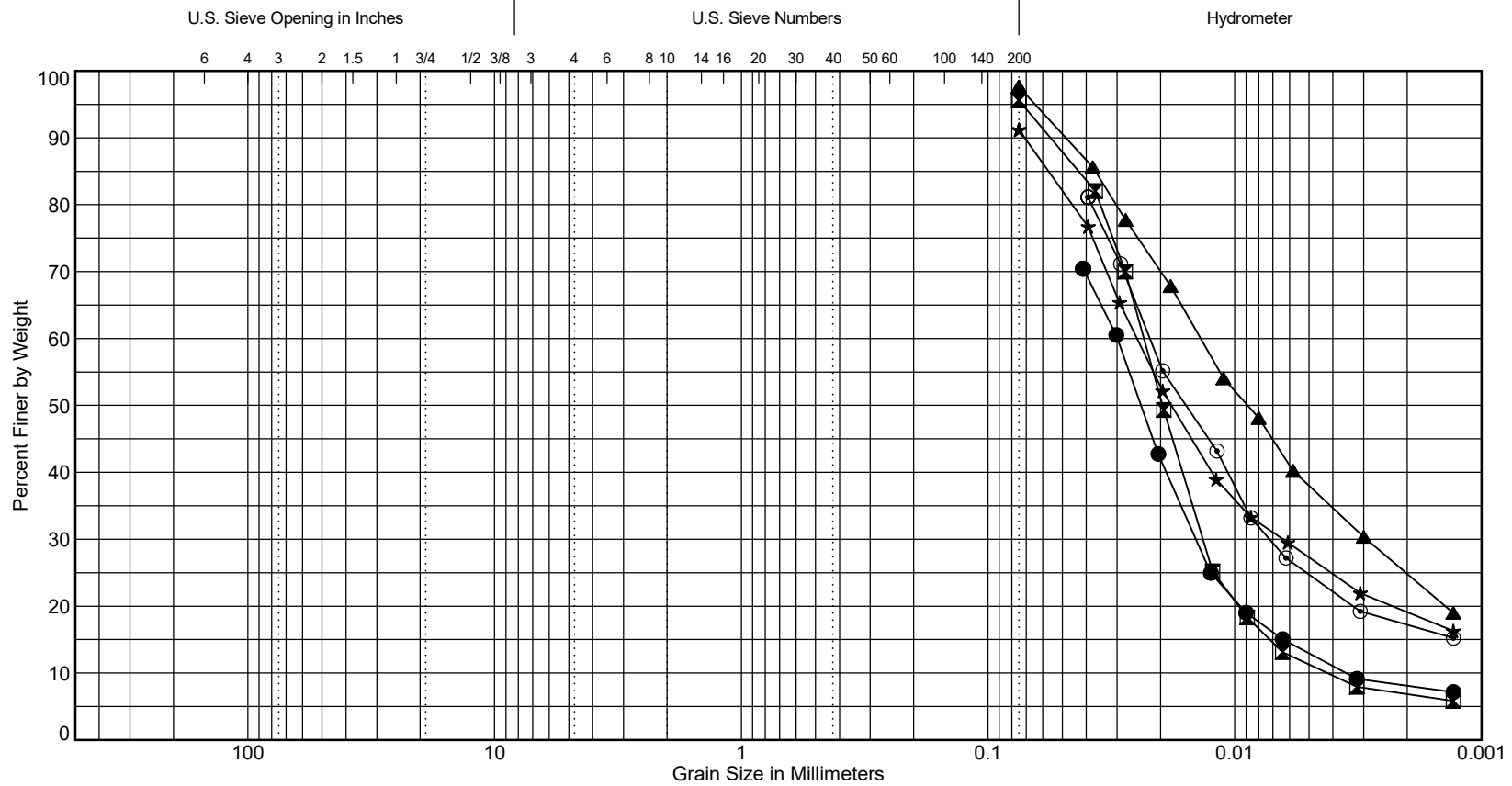
Atterberg Limits Determinations

Atterberg limits determinations were performed on select soil samples in general accordance with ASTM standard test method D4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*. Samples selected for Atterberg limits determinations are designated with an "AL" in the "Test Data" column on the summary boring logs in Appendix A. The results of the Atterberg limit tests are presented on Figures C-7 and C-8 in this appendix.

One-Dimensional Incremental Loading Consolidation Tests

Consolidation properties of subsurface site soils were evaluated with one-dimensional incremental loading consolidation tests. Tests were performed in general accordance with ASTM standard test method D2435, *Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading*. A load increment ratio of 2 was used with a 24-hour load duration.

The purpose of the test was to measure the coefficient of consolidation, the compression index, and the recompression index. Testing was performed on relatively undisturbed soil samples obtained with a Shelby tube sampler. Shelby tube samples were cut, extruded, and trimmed in general accordance with the Massachusetts Institute of Technology procedure (Germaine and Germaine 2009). The results of the consolidation tests are presented on Figures C-9 through C-12 in this appendix.



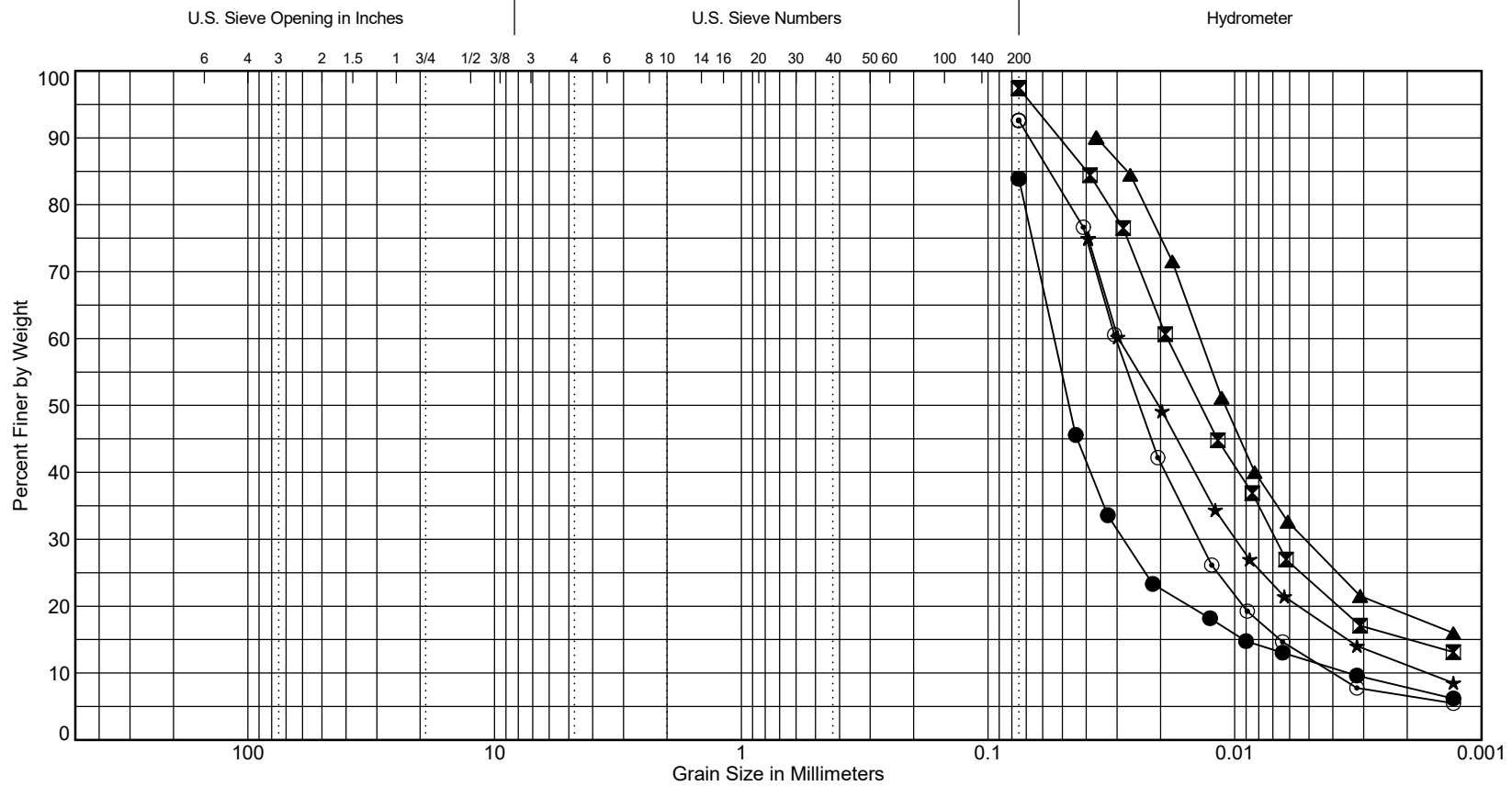
Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-3	7.5	53	SILT	ML
⊠	B-1	S-6A	15.0		SILT	ML
▲	B-1	S-8	19.0	50	SILT	ML
★	B-1	S-10	25.0	56	SILT with sand	ML
⊙	B-1	S-11	27.5	46	SILT	ML

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Grain Size Distribution

Figure
C-1



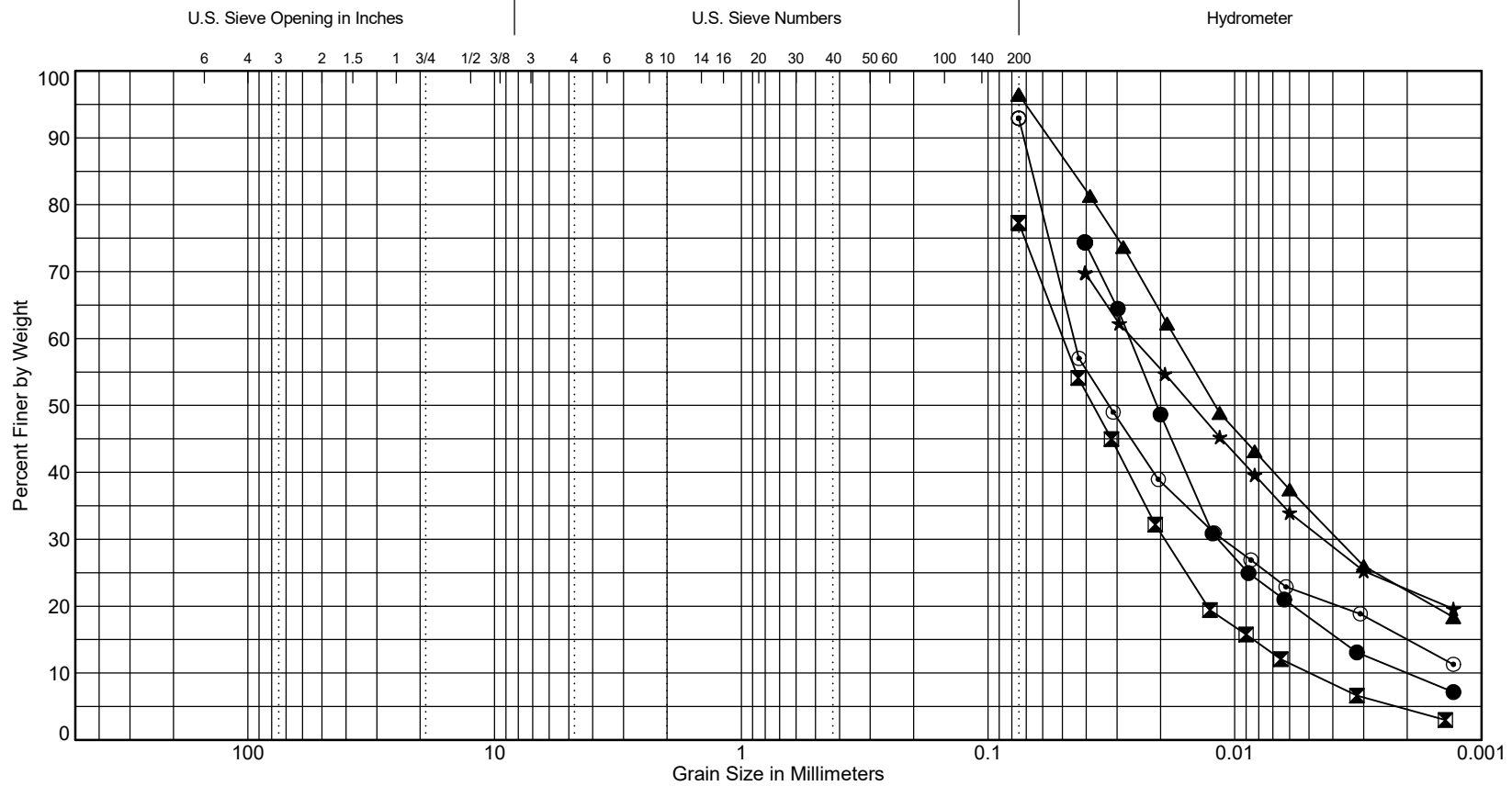
Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-12	30.0	63	SILT with sand	ML
⊠	B-1	S-16	40.0	35	SILT	ML
▲	B-1	S-17A	42.5	39	CLAY	CL
★	B-1	S-20B	50.5	43	SILT	ML
⊙	B-1	S-21	55.0	40	SILT	ML

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Grain Size Distribution

Figure
C-2



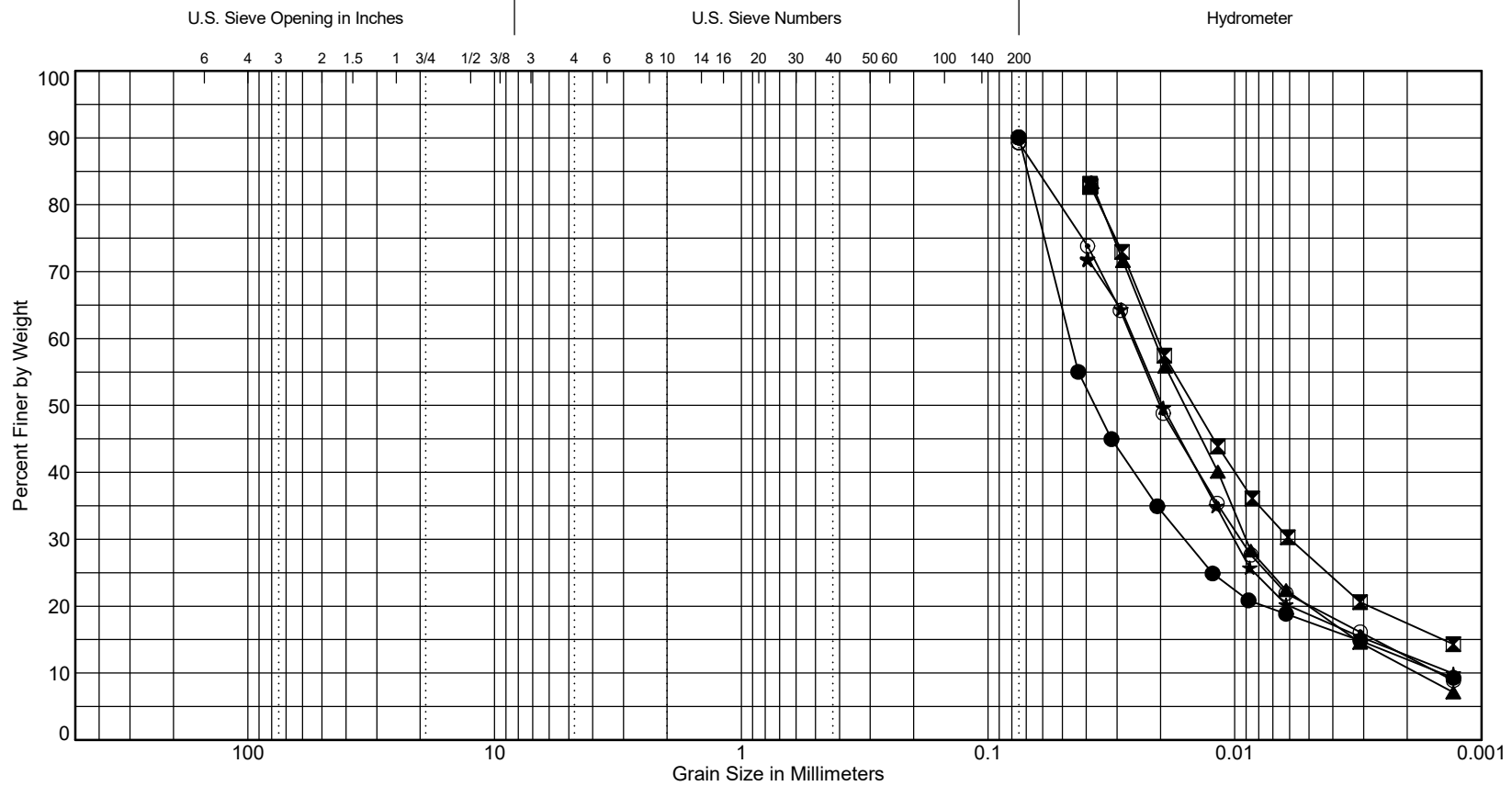
Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

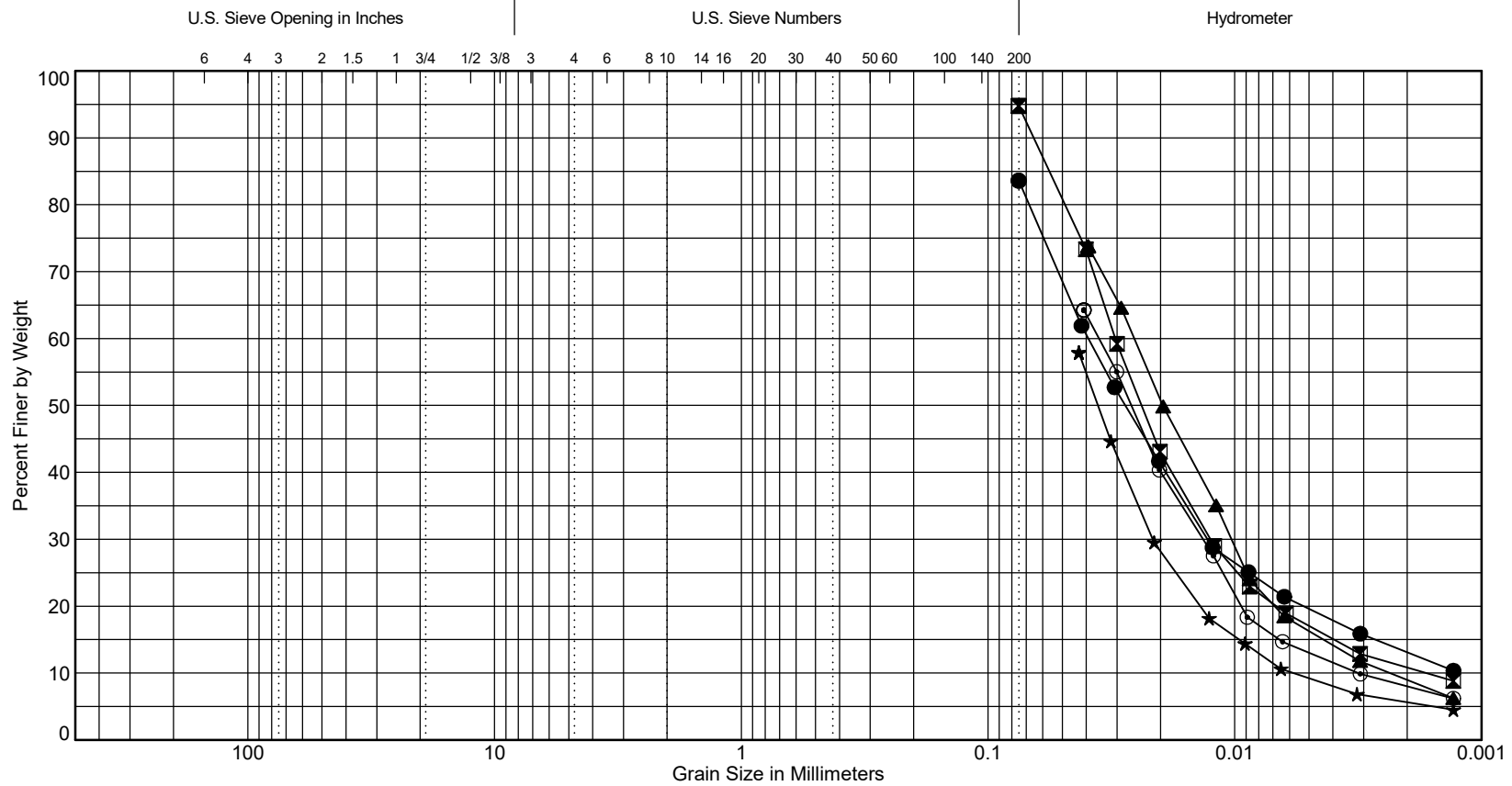
Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-22	60.0	39	SILT	ML
⊠	B-1	S-23	65.0	35	SILT with sand	ML
▲	B-2	S-8	21.0	42	SILT	ML
★	B-2	S-9	22.5	57	Elastic SILT	MH
⊙	B-2	S-10	25.0	52	SILT	ML

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Portland, Oregon

Grain Size Distribution

Figure
C-3





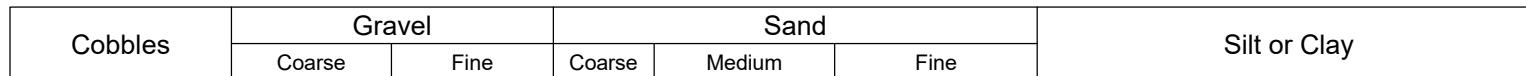
Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-17	42.5	45	SILT with sand	ML
⊠	B-2	S-19	47.5	38	SILT	ML
▲	B-2	S-20	50.0	41		
★	B-2	S-21	55.0	34		
⊙	B-2	S-22	60.0			

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Grain Size Distribution

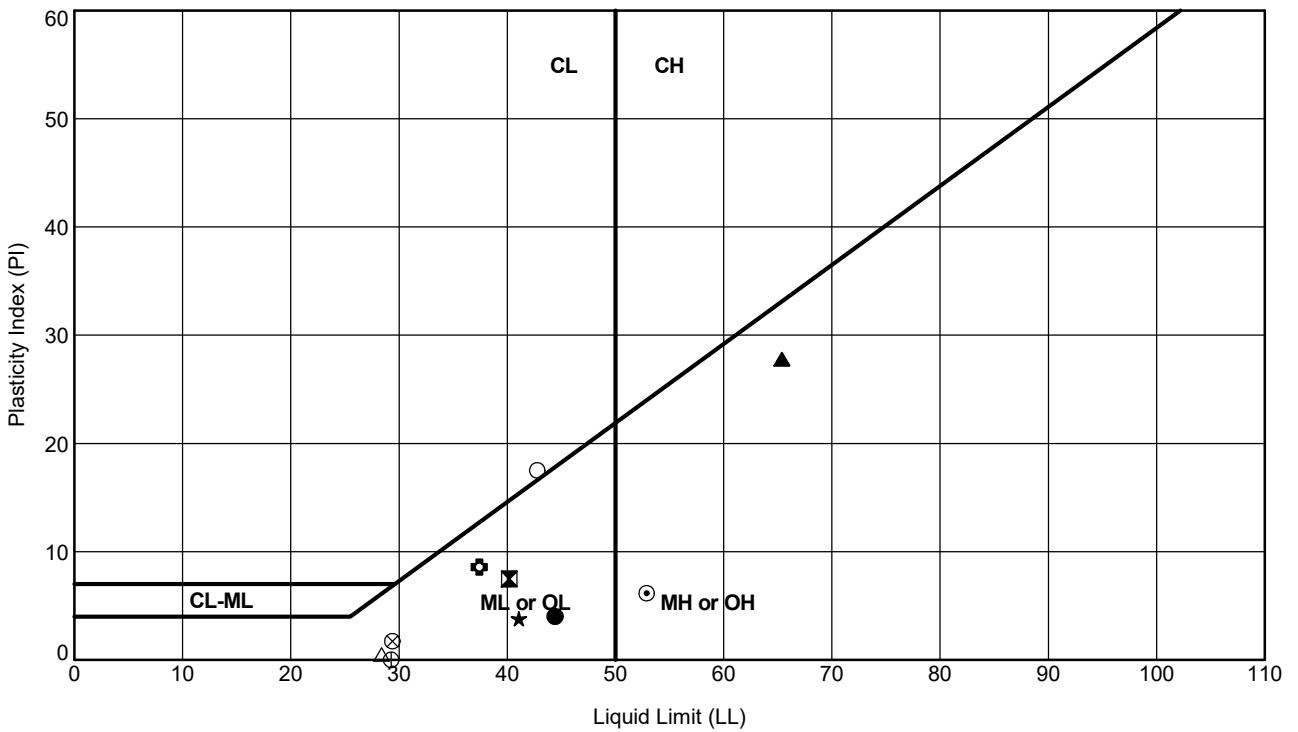
Figure
C-5



Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-23	65.0		SILT	ML

Grain Size Distribution

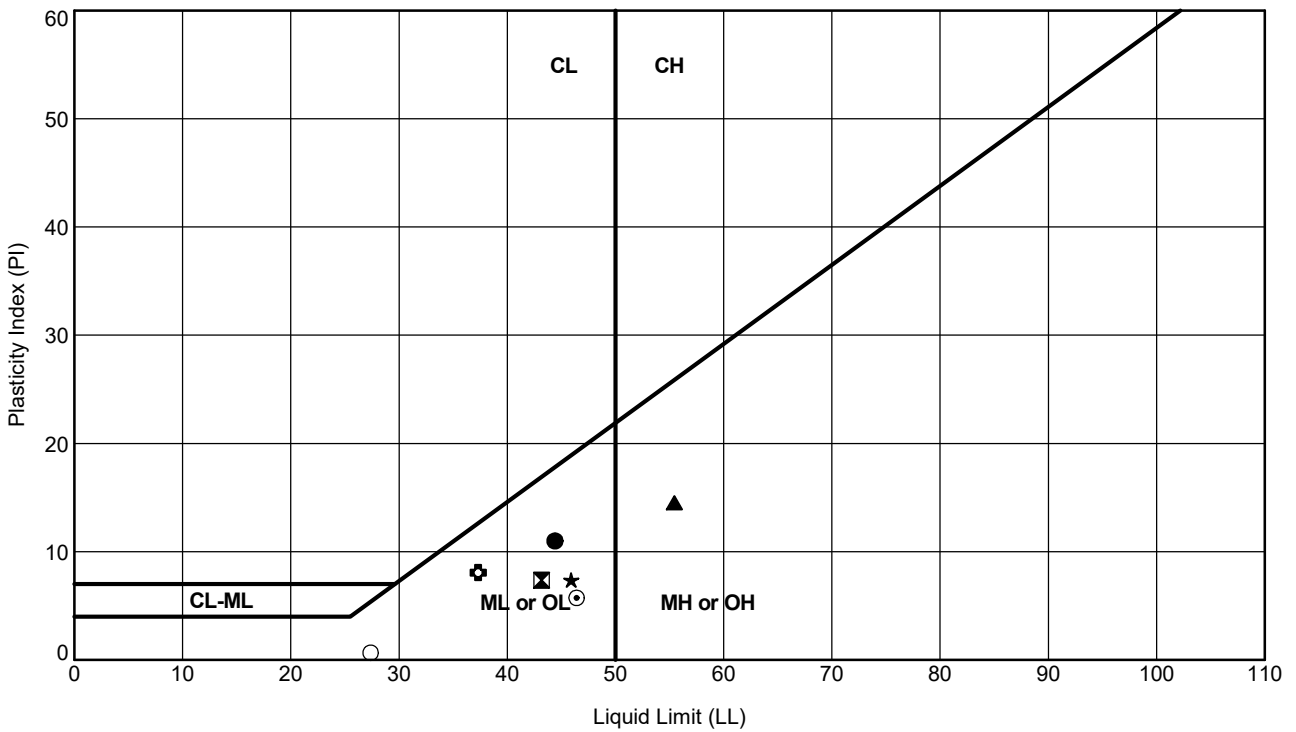
Figure
C-6



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-3	7.5	44	40	4	53	SILT	ML
⊠	B-1	S-7A	17.5	40	33	7	56	SILT	ML
⊙	B-1	S-9	22.5	65	38	27	79	Elastic SILT	MH
★	B-1	S-11	27.5	41	37	4	46	SILT	ML
⊙	B-1	S-14	35.0	53	47	6	59	Elastic SILT	MH
⊕	B-1	S-16	40.0	37	29	8	35	SILT	ML
○	B-1	S-17A	42.5	43	25	18	39	CLAY	CL
△	B-1	S-19A	47.5	28	28	0	40	SILT	ML
⊗	B-1	S-20B	50.5	29	28	1	43	SILT	ML
⊕	B-1	S-22	60.0	29	30	-1	39	SILT	ML

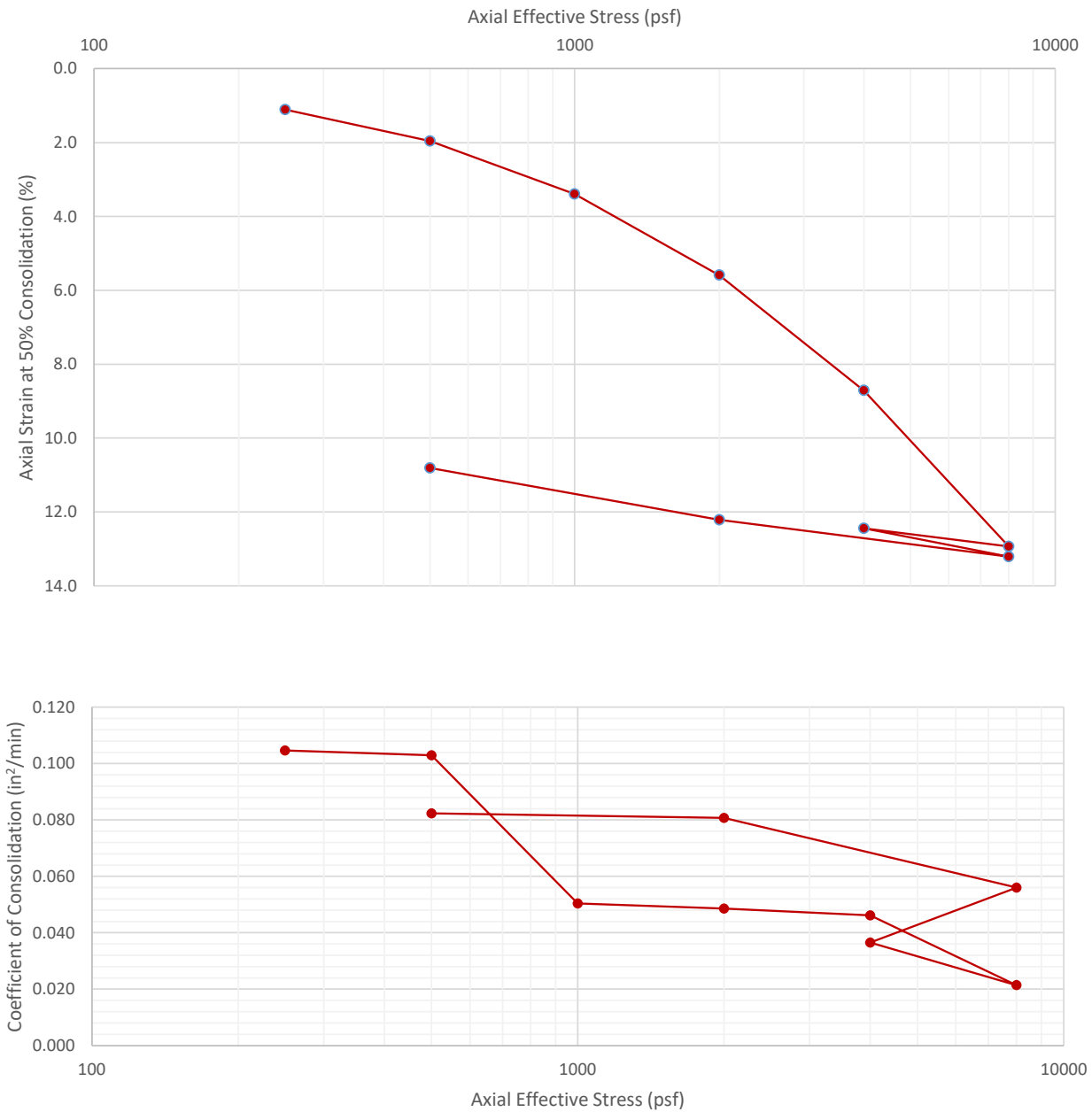
ASTM D 4318 Test Method



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-7	17.5	44	33	11	44	SILT	ML
⊠	B-2	S-8	21.0	43	36	7	42	SILT	ML
▲	B-2	S-9	22.5	55	41	14	57	Elastic SILT	MH
★	B-2	S-12	30.0	46	39	7	50		
⊙	B-2	S-16	40.0	46	41	5	50		
⊕	B-2	S-20	50.0	37	29	8	41		
○	B-2	S-21	55.0	27	27	0	34		

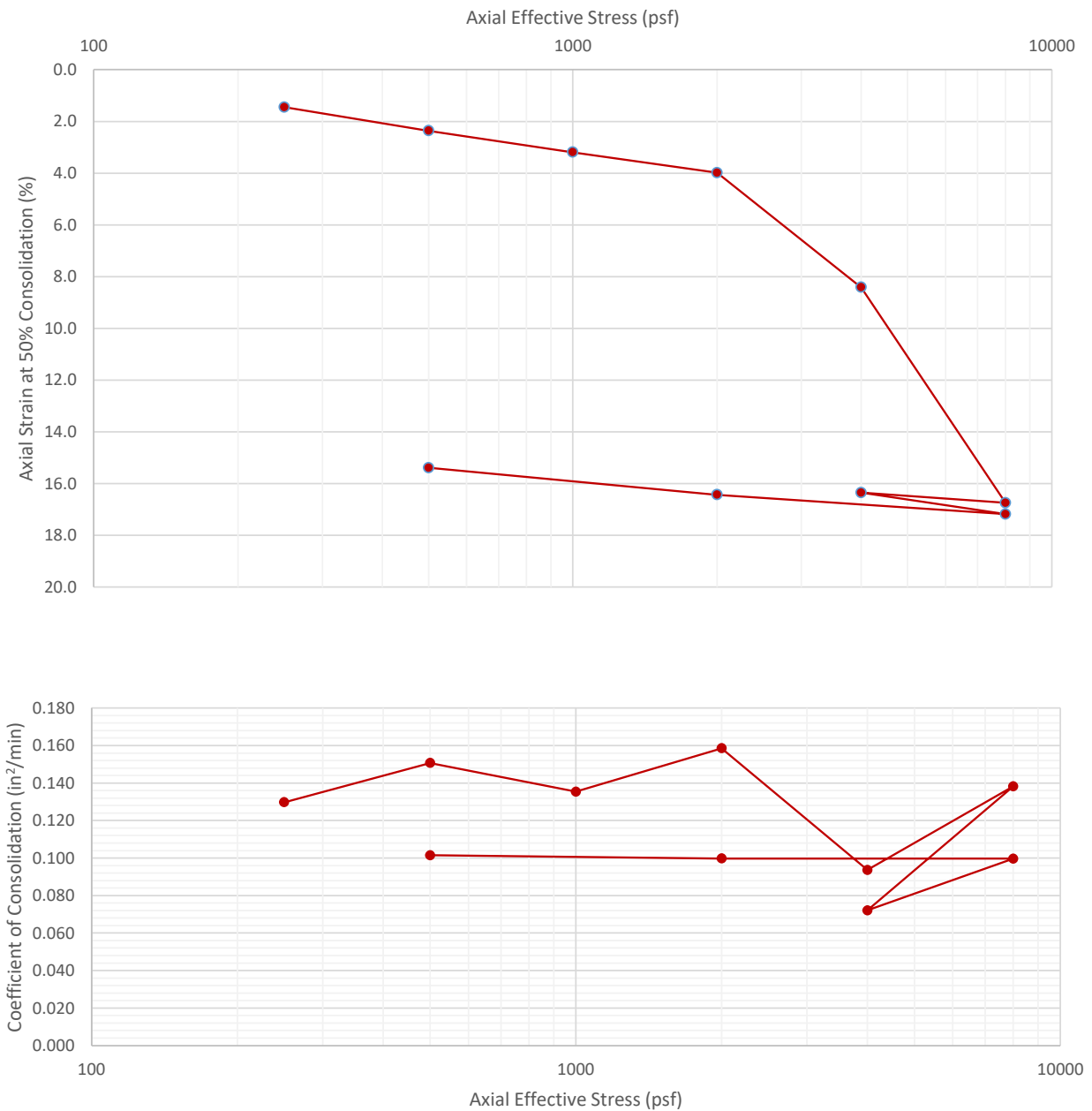
ASTM D 4318 Test Method



B-1, S-8 at 19.8 Feet Below Ground Surface

Sample Description: Gray SILT with trace organics
 Specific Gravity: 2.65

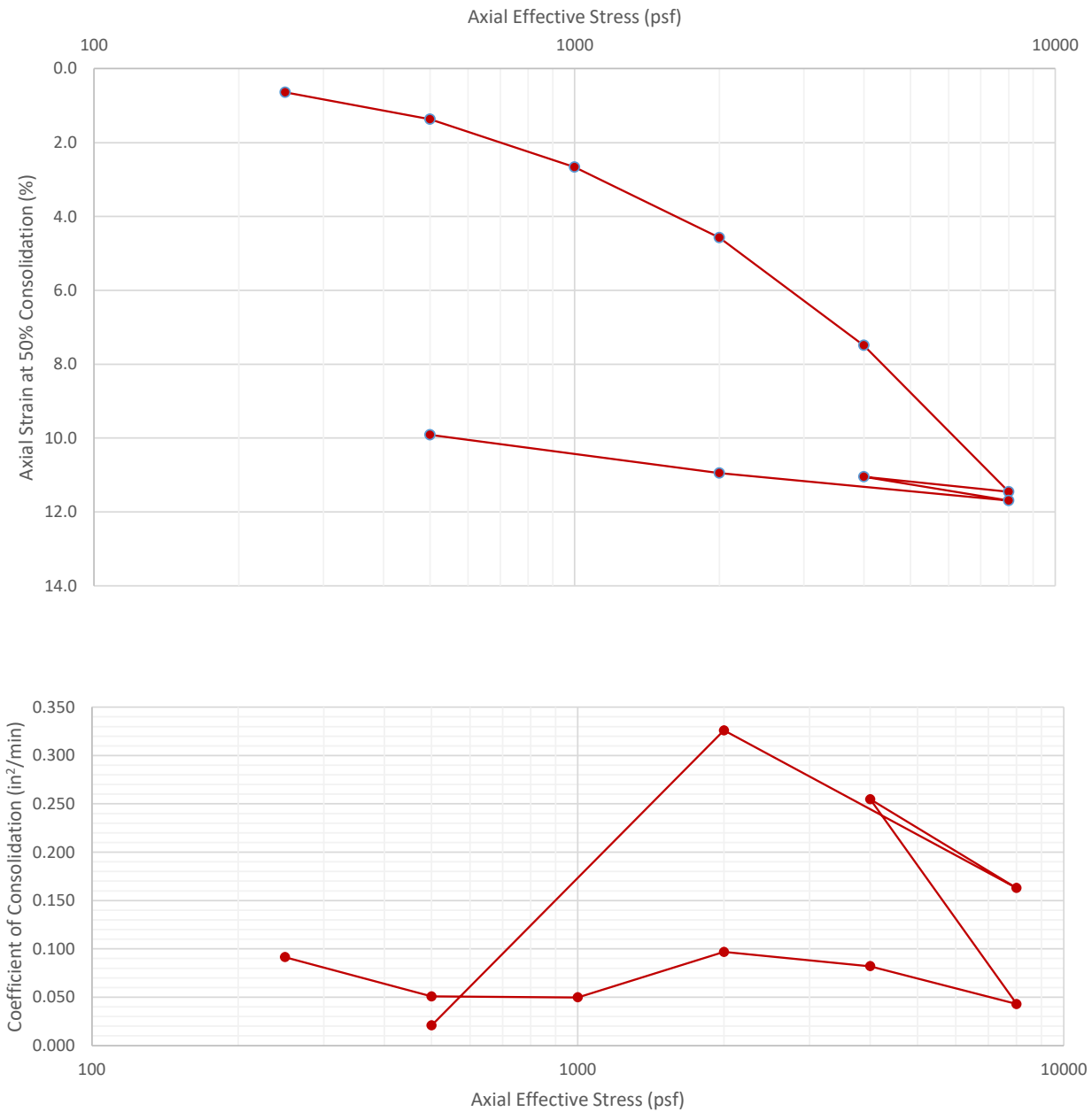
	Initial	Final	Comments:
Moisture (%):	45	43	
Dry Density (pcf):	71.1	77.0	
Saturation (%):	100	100	
Void Ratio:	1.32	1.14	



B-1, S-13 at 34 Feet Below Ground Surface

Sample Description: Gray SILT
Specific Gravity: 2.65

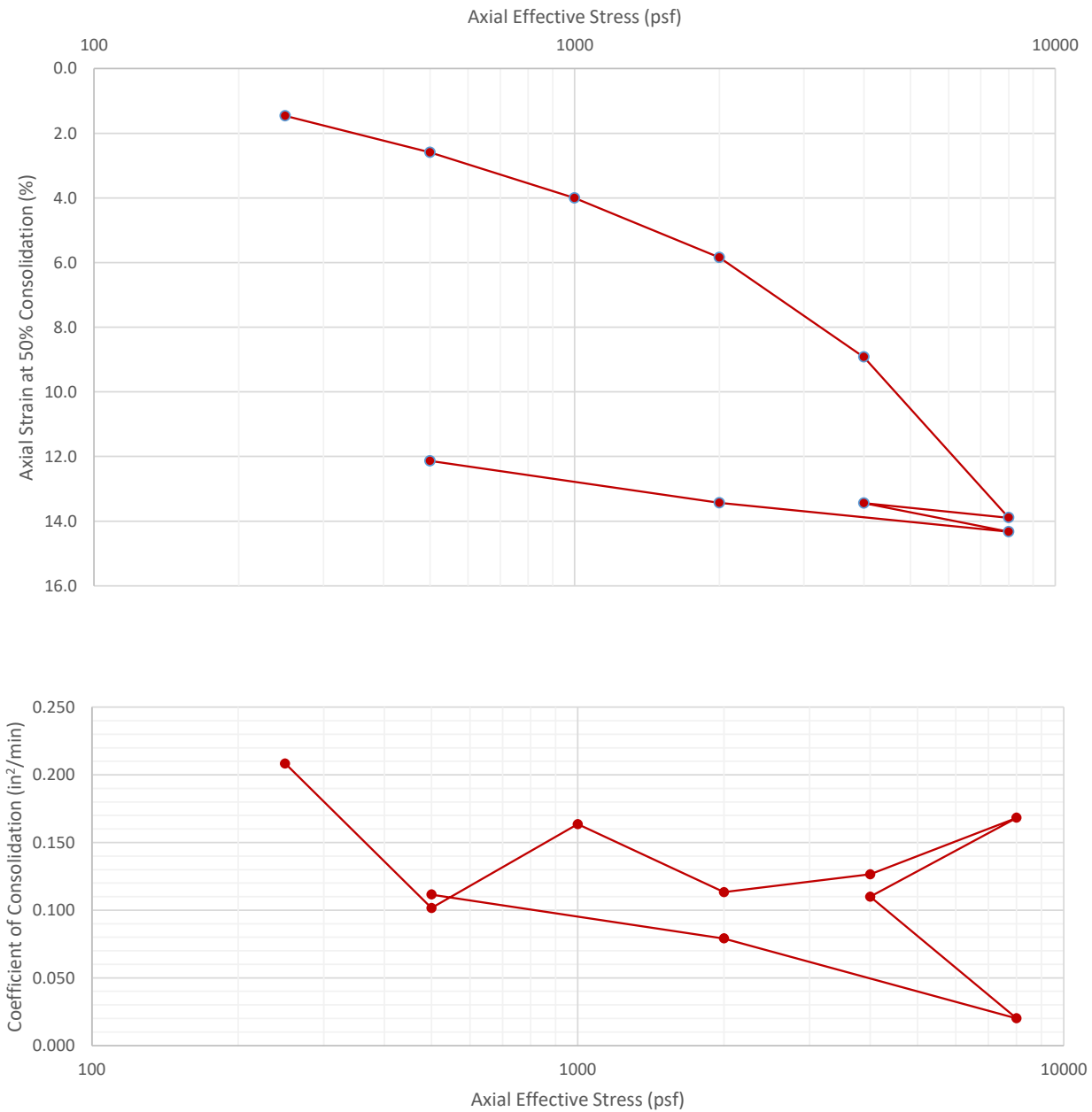
	Initial	Final	Comments:
Moisture (%):	64	53	
Dry Density (pcf):	60.5	68.3	
Saturation (%):	109	99	
Void Ratio:	1.72	1.42	



B-2, S-8 at 20.7 Feet Below Ground Surface

Sample Description: Gray SILT with trace organics
 Specific Gravity: 2.65

	Initial	Final	Comments:
Moisture (%):	43	39	
Dry Density (pcf):	76.6	83.1	
Saturation (%):	109	105	
Void Ratio:	1.15	0.99	



B-2, S-15 at 37.5 Feet Below Ground Surface

Sample Description: Dark gray SILT
 Specific Gravity: 2.65

	Initial	Final	Comments:
Moisture (%):	58	53	
Dry Density (pcf):	62.4	69.4	
Saturation (%):	98	102	
Void Ratio:	1.65	1.38	



soiltest
farm consultants, inc.

2925 Driggs Dr., Moses Lake, Wa 98837 • www.soiltestlab.com
Office: (509)765-1622 • Fax: (509)765-0314 • (800)764-1622



LANDAU ASSOC - TUMWATER

955 MALIN LANE SW STE B

TUMWATER, WA 98501

Laboratory #: S21-15919

Date Received: 8/16/2021

Grower: OC LINNTON

Field: B-2 S-6

Sampled By:

Customer Account #:

Customer Sample ID:

Soil Test Results

Cation Exchange	CEC	meq/100g	7.2	pH 1:1	5.9
-----------------	-----	----------	-----	--------	-----

E.C. 1:1 m.mhos/cm

Est Sat Paste E.C. m.mhos/cm

Effervescence

Ammonium - N mg/kg

Organic Matter W.B. %

Other Tests:

We make every effort to provide an accurate analysis of your sample. For reasonable cause we will repeat tests, but because of factors beyond our control in sampling procedures and the inherent variability of soil, our liability is limited to the price of the tests. Recommendations are to be used as general guides and should be modified for specific field conditions and situations. Note: "u" indicates that the element was analyzed for but not detected

This is your Invoice #: S21-15919 Account #: 227500 Reviewed by: K. Bair, PhD, C List Cost: \$26.00



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farm consultants, inc.

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LANDAU ASSOC - TUMWATER

955 MALIN LANE SW STE B

TUMWATER, WA 98501

Laboratory #: S21-15920

Date Received: 8/16/2021

Grower: OC LINNTON

Field: B-2 S-14

Sampled By:

Customer Account #:

Customer Sample ID:

Soil Test Results

Cation Exchange	CEC	meq/100g	18.8	pH 1:1	6.1
-----------------	-----	----------	------	--------	-----

E.C. 1:1 m.mhos/cm

Est Sat Paste E.C. m.mhos/cm

Effervescence

Ammonium - N mg/kg

Organic Matter W.B. %

Other Tests:

We make every effort to provide an accurate analysis of your sample. For reasonable cause we will repeat tests, but because of factors beyond our control in sampling procedures and the inherent variability of soil, our liability is limited to the price of the tests. Recommendations are to be used as general guides and should be modified for specific field conditions and situations. Note: "u" indicates that the element was analyzed for but not detected

This is your Invoice #: S21-15920 Account #: 227500 Reviewed by: K. Bair, PhD, C List Cost: \$26.00

Appendix A-2

Geotechnical Calculations

Contents:

- A-2-1 Site Class Determination
- A-2-2 Building Code Seismic Design Parameters
- A-2-3 Seismic Hazard Disaggregation
- A-2-4 Liquefaction and Residual Strength Calculations
- A-2-5 Empirical Lateral Spreading Calculations
- A-2-6 Seismic Bearing Capacity Calculations

A-2-1

Site Class Calculation

Owens Corning Linnton Asphalt Terminal SVA
Site Class Calculation

	A	B	C	D	E
1	CPT-1 Shear Wave Vel. for Layer i Layer Thickness				
2	CPT Measurement Depth (ft)	Vs,i (ft/s)	di (ft)	di/vsi	Notes
3	6.56	607.74	6.56	0.010794	Measured
4	9.84	450.1	3.28	0.007287	Measured
5	13.12	441.87	3.28	0.007423	Measured
6	16.4	474.47	3.28	0.006913	Measured
7	19.69	326.9	3.29	0.010064	Measured
8	22.97	334.78	3.28	0.009797	Measured
9	26.25	428.79	3.28	0.007649	Measured
10	29.53	453.7	3.28	0.007229	Measured
11	32.81	437.99	3.28	0.007489	Measured
12	36.09	427.47	3.28	0.007673	Measured
13	39.37	482.44	3.28	0.006799	Measured
14	42.65	437.4	3.28	0.007499	Measured
15	45.93	610.27	3.28	0.005375	Measured
16	49.21	767.51	3.28	0.004274	Measured
17	52.49	854.09	3.28	0.00384	Measured
18	55.77	797.48	3.28	0.004113	Measured
19	59.06	829.35	3.29	0.003967	Measured
20	62.34	941.44	3.28	0.003484	Measured
21	65.62	974.52	3.28	0.003366	Measured
22	68.9	855.37	3.28	0.003835	Measured
23	72.18	891.93	3.28	0.003677	Measured
24	75.3	821.26	3.12	0.003799	Measured
25	78.74	1100.74	3.44	0.003125	Measured
26	80	999.1	1.26	0.001261	SPT N to Vs Correlation (Wair et al 2012)
27	85	2234.0	5	0.002238	SPT N to Vs Correlation (Wair et al 2012)
28	90	2234.0	5	0.002238	SPT N to Vs Correlation (Wair et al 2012)
29	95	12000.0	5	0.000417	Sowers and Boyd (2019)
30	100	12000.0	5	0.000417	Sowers and Boyd (2019)
31	=SUM(D3:D30) 0.146043 Sum =100/D32 684.7314 (ft/s) Vs,30 208.7596 (m/s)				
32					
33					
34					
35					

A-2-2

Building Code Seismic Design Parameters

 This is a beta release of the new ATC Hazards by Location website. Please [contact us](#) with feedback.

 The ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

ATC Hazards by Location

Search Information

Coordinates: 45.609, -122.791

Elevation: 32 ft

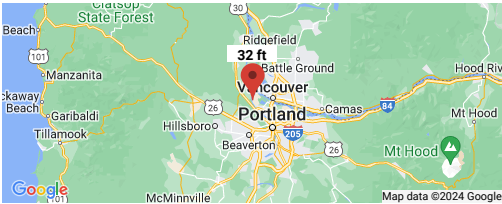
Timestamp: 2024-02-19T16:59:30.531Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: III

Site Class: D



Basic Parameters

Name	Value	Description
S _S	0.898	MCE _R ground motion (period=0.2s)
S ₁	0.413	MCE _R ground motion (period=1.0s)
S _{MS}	1.024	Site-modified spectral acceleration value
S _{M1}	* null	Site-modified spectral acceleration value
S _{DS}	0.683	Numeric seismic design value at 0.2s SA
S _{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

▼Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F _a	1.141	Site amplification factor at 0.2s
F _v	* null	Site amplification factor at 1.0s
CR _S	0.89	Coefficient of risk (0.2s)
CR ₁	0.87	Coefficient of risk (1.0s)
PGA	0.408	MCE _G peak ground acceleration
F _{PGA}	1.192	Site amplification factor at PGA
PGA _M	0.486	Site modified peak ground acceleration
T _L	16	Long-period transition period (s)
SsRT	0.898	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.009	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.413	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.475	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.611	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

Disclaimer

Hazard loads are provided by the U.S. Geological Survey [Seismic Design Web Services](#).

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A-2-3

PGA Disaggregation


```

1  *** Deaggregation of Seismic Hazard at OnePeriod of Spectral Acceleration ***
2  *** Data from Dynamic: Conterminous U.S. 2014 (update) (4.2.0) ****
3  PSHA Deaggregation. %contributions.
4  site: Test
5  longitude: 122.786°W
6  latitude: 45.603°E
7  imt: Peak Ground Acceleration
8  vs30 = 360 m/s (C/D boundary)
9  return period: 2475 yrs.
10 #This deaggregation corresponds to: Total
11 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
12 Deaggregation targets:
13   Return period: 2475 yrs
14   Exceedance rate: 0.0004040404 yr-1
15   PGA ground motion: 0.5326147 g
16 Recovered targets:
17   Return period: 2476.0286 yrs
18   Exceedance rate: 0.00040387255 yr-1
19 Totals:
20   Binned: 100 %
21   Residual: 0 %
22   Trace: 0.51 %
23 Mean (over all sources):
24   m: 7.78
25   r: 55.05 km
26   ε□: 0.94 σ
27 Mode (largest m-r bin):
28   m: 9.34
29   r: 70.18 km
30   ε□: 0.59 σ
31   Contribution: 12.47 %
32 Mode (largest m-r-ε□ bin):
33   m: 9.01
34   r: 70.14 km
35   ε□: 0.68 σ
36   Contribution: 8.04 %
37 Discretization:
38   r: min = 0.0, max = 1000.0, Δ = 20.0 km
39   m: min = 4.4, max = 9.4, Δ = 0.2
40   ε: min = -3.0, max = 3.0, Δ = 0.5 σ
41 Epsilon keys:
42   ε0: [-∞ .. -2.5)
43   ε1: [-2.5 .. -2.0)
44   ε2: [-2.0 .. -1.5)
45   ε3: [-1.5 .. -1.0)
46   ε4: [-1.0 .. -0.5)
47   ε5: [-0.5 .. 0.0)
48   ε6: [0.0 .. 0.5)
49   ε7: [0.5 .. 1.0)
50   ε8: [1.0 .. 1.5)
51   ε9: [1.5 .. 2.0)
52   ε10: [2.0 .. 2.5)
53   ε11: [2.5 .. +∞]
54 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
   ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
   ε=[2,2.5) ε=[2.5,∞)
55 270 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
56 250 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
57 250 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
58 250 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
59 250 8.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
60 230 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
   0.000 0.000 0.000
61 230 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

```

		0.000	0.000	0.000								
62	230	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
63	230	8.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
64	230	8.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
65	230	8.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.006								
66	230	8.7	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.007								
67	210	7.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
68	210	7.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.001								
69	210	7.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
70	210	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
71	210	8.1	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.001								
72	210	8.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.001								
73	210	8.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.002								
74	190	7.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
75	190	7.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.001								
76	190	7.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.001	0.002								
77	190	7.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.001	0.000								
78	190	7.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.001	0.001								
79	190	8.1	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.002								
80	190	8.3	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.001								
81	190	8.5	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.005	0.003								
82	170	7.1	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.007								
83	170	7.3	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.001	0.006								
84	170	7.5	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.006	0.003								
85	170	7.7	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.002	0.000								
86	170	7.9	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.001	0.003	0.002								
87	170	8.1	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.003	0.002								
88	170	8.3	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.003	0.001								
89	170	8.5	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.017	0.003								
90	170	8.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.001	0.000								
91	150	6.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.002								
92	150	7.1	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.003	0.043								
93	150	7.3	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.012	0.003								
94	150	7.5	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.003	0.013	0.001								
95	150	7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.002	0.002	0.000								

96	150	7.9	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.005	0.008	0.001							
97	150	8.1	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.016	0.003							
98	150	8.3	0.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.187	0.010							
99	150	8.5	0.115	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.013	0.101	0.000							
100	150	8.7	0.173	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.107	0.066	0.000							
101	130	6.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.001							
102	130	6.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.002	0.019							
103	130	7.1	0.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.078	0.025							
104	130	7.3	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.007	0.017	0.002							
105	130	7.5	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.019	0.005	0.001							
106	130	7.7	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
			0.006	0.001	0.000							
107	130	7.9	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
			0.005	0.018	0.002							
108	130	8.1	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.012	0.037	0.002							
109	130	8.3	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.024	0.029	0.000							
110	130	8.5	0.354	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.292	0.062	0.000							
111	130	8.7	1.528	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			1.528	0.000	0.000							
112	130	9.1	1.129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			1.126	0.000	0.003							
113	110	6.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.001							
114	110	6.7	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.001	0.014							
115	110	6.9	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.044	0.017							
116	110	7.1	0.182	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.049	0.118	0.015							
117	110	7.3	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
			0.027	0.009	0.001							
118	110	7.5	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
			0.017	0.003	0.000							
119	110	7.7	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
			0.002	0.000	0.000							
120	110	7.9	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.009
			0.024	0.009	0.000							
121	110	8.1	0.085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.060	0.025	0.000							
122	110	8.3	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.038	0.018	0.000							
123	110	8.5	0.778	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.274
			0.499	0.000	0.005							
124	110	8.7	3.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320
			3.103	0.000	0.016							
125	110	8.9	3.836	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.211
			1.573	0.020	0.032							
126	110	9.1	5.187	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.012
			0.000	0.175	0.000							
127	90	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
128	90	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
129	90	6.5	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.010	0.014							
130	90	6.7	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

		0.003	0.076	0.020								
131	90	6.9	0.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.097	0.144	0.013								
132	90	7.1	0.478	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052
		0.338	0.085	0.002								
133	90	7.3	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.049
		0.028	0.002	0.000								
134	90	7.5	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.040
		0.006	0.000	0.000								
135	90	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.004
		0.000	0.000	0.000								
136	90	7.9	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.007	0.005
		0.012	0.000	0.000								
137	90	8.1	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
		0.022	0.000	0.000								
138	90	8.3	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
		0.006	0.000	0.000								
139	90	8.5	0.246	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.237
		0.002	0.003	0.004								
140	90	8.7	0.223	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.216
		0.001	0.002	0.004								
141	90	8.9	0.251	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.239
		0.000	0.012	0.000								
142	70	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
143	70	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
144	70	6.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
145	70	6.5	0.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.068	0.090	0.006								
146	70	6.7	0.576	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
		0.412	0.130	0.006								
147	70	6.9	1.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.501
		0.474	0.044	0.000								
148	70	7.1	1.637	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.277	1.153
		0.207	0.000	0.000								
149	70	7.3	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.142	0.072
		0.003	0.000	0.000								
150	70	7.5	0.138	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.098	0.014
		0.000	0.000	0.001								
151	70	7.7	0.027	0.000	0.000	0.000	0.000	0.000	0.003	0.014	0.009	0.000
		0.000	0.000	0.001								
152	70	7.9	0.163	0.000	0.000	0.000	0.000	0.002	0.011	0.010	0.004	0.118
		0.007	0.011	0.000								
153	70	8.1	0.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.281
		0.013	0.014	0.000								
154	70	8.3	0.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167
		0.015	0.002	0.000								
155	70	8.5	0.828	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.380	0.360
		0.086	0.002	0.000								
156	70	8.7	1.265	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.079	0.078
		0.107	0.000	0.000								
157	70	8.9	7.975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.780	1.195
		0.000	0.000	0.000								
158	70	9.1	9.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.039	1.761
		0.000	0.000	0.000								
159	70	9.3	12.468	0.000	0.000	0.000	0.000	0.000	0.000	5.575	6.893	0.000
		0.000	0.000	0.000								
160	50	5.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
161	50	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
162	50	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
163	50	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
164	50	6.5	0.344	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073
		0.265	0.005	0.001								

165	50	6.7	1.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.760
		0.247	0.000	0.003								
166	50	6.9	1.595	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.572	1.003
		0.012	0.000	0.008								
167	50	7.1	2.395	0.000	0.000	0.000	0.000	0.000	0.000	0.088	2.105	0.186
		0.000	0.003	0.014								
168	50	7.3	0.326	0.000	0.000	0.000	0.000	0.000	0.000	0.187	0.108	0.000
		0.000	0.018	0.013								
169	50	7.5	0.202	0.000	0.000	0.000	0.000	0.000	0.024	0.151	0.004	0.000
		0.000	0.019	0.005								
170	50	7.7	0.035	0.000	0.000	0.000	0.000	0.003	0.014	0.013	0.000	0.000
		0.001	0.003	0.000								
171	50	7.9	0.027	0.000	0.000	0.000	0.000	0.013	0.003	0.009	0.000	0.000
		0.001	0.001	0.000								
172	30	5.1	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.002								
173	30	5.3	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.007								
174	30	5.5	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.002	0.028								
175	30	5.7	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.015	0.044								
176	30	5.9	0.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.062	0.051								
177	30	6.1	0.266	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.202	0.063								
178	30	6.3	0.335	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.022	0.243	0.070								
179	30	6.5	0.263	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.062	0.161	0.041								
180	30	6.7	0.214	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
		0.062	0.119	0.029								
181	30	6.9	0.164	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
		0.058	0.078	0.015								
182	30	7.1	0.189	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021
		0.101	0.063	0.004								
183	30	7.3	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.048
		0.118	0.050	0.003								
184	30	7.5	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.047
		0.071	0.019	0.001								
185	30	7.7	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.012
		0.010	0.001	0.000								
186	30	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
		0.002	0.000	0.000								
187	10	5.1	1.779	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.934
		0.410	0.351	0.082								
188	10	5.3	1.978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.429	0.630
		0.524	0.334	0.062								
189	10	5.5	2.180	0.000	0.000	0.000	0.000	0.000	0.000	0.477	0.363	0.502
		0.515	0.289	0.035								
190	10	5.7	1.912	0.000	0.000	0.000	0.000	0.000	0.000	0.364	0.511	0.379
		0.445	0.195	0.019								
191	10	5.9	1.643	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.410	0.398
		0.424	0.133	0.009								
192	10	6.1	2.650	0.000	0.000	0.000	0.000	0.000	0.000	0.600	0.666	0.864
		0.359	0.146	0.014								
193	10	6.3	2.871	0.000	0.000	0.000	0.000	0.000	0.000	0.734	0.903	0.843
		0.349	0.040	0.002								
194	10	6.5	4.278	0.000	0.000	0.000	0.000	0.000	0.392	1.900	1.241	0.519
		0.200	0.025	0.000								
195	10	6.7	5.631	0.000	0.000	0.000	0.000	0.000	0.947	3.311	0.978	0.269
		0.118	0.008	0.000								
196	10	6.9	5.619	0.000	0.000	0.000	0.000	0.470	1.917	2.567	0.388	0.221
		0.057	0.001	0.000								
197	10	7.1	3.797	0.000	0.000	0.000	0.000	1.072	0.806	1.492	0.239	0.166
		0.022	0.000	0.000								
198	10	7.3	0.992	0.000	0.000	0.000	0.000	0.166	0.158	0.344	0.189	0.120
		0.015	0.000	0.000								
199	10	7.5	0.277	0.000	0.000	0.000	0.000	0.013	0.032	0.089	0.094	0.046

	0.004	0.000	0.000									
200	10	7.7	0.041	0.000	0.000	0.000	0.000	0.001	0.006	0.013	0.015	0.005
			0.000	0.000	0.000							
201	10	7.9	0.009	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.003	0.001
			0.000	0.000	0.000							
202	Principal Sources (faults, subduction, random seismicity having > 3% contribution											
203	sub0_ch_bot.in:											
204	Percent Contributed: 29.7											
205	Distance (km): 70.179382											
206	Magnitude: 9.1055834											
207	Epsilon (mean values): 0.72309455											
208	Cascadia Megathrust - whole CSZ Characteristic:											
209	Percent Contributed: 29.7											
210	Distance (km): 70.179382											
211	Magnitude: 9.1055834											
212	Epsilon (mean values): 0.72309455											
213	Azimuth: 260.19218											
214	Latitude: 45.50147											
215	Longitude: -123.59924											
216	sub0_ch_mid.in:											
217	Percent Contributed: 11.34											
218	Distance (km): 118.71992											
219	Magnitude: 8.9254869											
220	Epsilon (mean values): 1.453965											
221	Cascadia Megathrust - whole CSZ Characteristic:											
222	Percent Contributed: 11.34											
223	Distance (km): 118.71992											
224	Magnitude: 8.9254869											
225	Epsilon (mean values): 1.453965											
226	Azimuth: 264.55326											
227	Latitude: 45.48932											
228	Longitude: -124.32961											
229	Geologic Model Partial Rupture:											
230	Percent Contributed: 8.12											
231	Distance (km): 2.6307074											
232	Magnitude: 6.7417979											
233	Epsilon (mean values): 0.084527773											
234	Portland Hills:											
235	Percent Contributed: 8.06											
236	Distance (km): 2.463229											
237	Magnitude: 6.7427124											
238	Epsilon (mean values): 0.06892305											
239	Azimuth: 153.40008											
240	Latitude: 45.58227											
241	Longitude: -122.77095											
242	coastalOR_deep.in:											
243	Percent Contributed: 6.48											
244	Distance (km): 58.997177											
245	Magnitude: 6.9341436											
246	Epsilon (mean values): 1.1568256											
247	Geologic Model Full Rupture:											
248	Percent Contributed: 3.8											
249	Distance (km): 1.0705765											
250	Magnitude: 6.9956517											
251	Epsilon (mean values): -0.10232568											
252	Portland Hills:											
253	Percent Contributed: 3.76											
254	Distance (km): 0.76905363											
255	Magnitude: 6.9988433											
256	Epsilon (mean values): -0.13052881											
257	Azimuth: 153.40008											
258	Latitude: 45.58227											
259	Longitude: -122.77095											
260	WUSmap_2014_fixSm.ch.in (opt):											
261	Percent Contributed: 3.72											
262	Distance (km): 10.593647											
263	Magnitude: 6.0309203											
264	Epsilon (mean values): 1.2076221											
265	PointSourceFinite: -122.786, 45.616:											

266 Percent Contributed: 1.01
267 Distance (km): 5.4362135
268 Magnitude: 5.5854201
269 Epsilon (mean values): 0.76675699
270 Azimuth: 0
271 Latitude: 45.616417
272 Longitude: -122.78573
273 noPuget_2014_fixSm.ch.in (opt):
274 Percent Contributed: 3.72
275 Distance (km): 10.592672
276 Magnitude: 6.0308705
277 Epsilon (mean values): 1.2075827
278 PointSourceFinite: -122.786, 45.616:
279 Percent Contributed: 1.01
280 Distance (km): 5.4362135
281 Magnitude: 5.5854201
282 Epsilon (mean values): 0.76675699
283 Azimuth: 0
284 Latitude: 45.616417
285 Longitude: -122.78573
286 WUSmap_2014_fixSm.gr.in (opt):
287 Percent Contributed: 3.52
288 Distance (km): 10.507784
289 Magnitude: 5.9931315
290 Epsilon (mean values): 1.2138064
291 PointSourceFinite: -122.786, 45.616:
292 Percent Contributed: 1.01
293 Distance (km): 5.4362135
294 Magnitude: 5.5854201
295 Epsilon (mean values): 0.76675699
296 Azimuth: 0
297 Latitude: 45.616417
298 Longitude: -122.78573
299 noPuget_2014_fixSm.gr.in (opt):
300 Percent Contributed: 3.52
301 Distance (km): 10.506752
302 Magnitude: 5.9930769
303 Epsilon (mean values): 1.2137653
304 PointSourceFinite: -122.786, 45.616:
305 Percent Contributed: 1.01
306 Distance (km): 5.4362135
307 Magnitude: 5.5854201
308 Epsilon (mean values): 0.76675699
309 Azimuth: 0
310 Latitude: 45.616417
311 Longitude: -122.78573
312 coastalOR_deep.in:
313 Percent Contributed: 2.5
314 Distance (km): 68.719381
315 Magnitude: 6.9730829
316 Epsilon (mean values): 1.5306657
317 sub0_ch_top.in:
318 Percent Contributed: 2.39
319 Distance (km): 136.64542
320 Magnitude: 8.83072
321 Epsilon (mean values): 1.7334477
322 Cascadia Megathrust - whole CSZ Characteristic:
323 Percent Contributed: 2.39
324 Distance (km): 136.64542
325 Magnitude: 8.83072
326 Epsilon (mean values): 1.7334477
327 Azimuth: 265.16041
328 Latitude: 45.48466
329 Longitude: -124.54931
330 Geologic Model Small Mag:
331 Percent Contributed: 1.71
332 Distance (km): 12.879756
333 Magnitude: 6.3293065
334 Epsilon (mean values): 1.0909879

335 Helvetia:
336 Percent Contributed: 1.19
337 Distance (km): 9.9278244
338 Magnitude: 6.3726484
339 Epsilon (mean values): 0.62045469
340 Azimuth: 223.99764
341 Latitude: 45.52135
342 Longitude: -122.89808
343 Zeng Model Partial Rupture:
344 Percent Contributed: 1.49
345 Distance (km): 2.6254197
346 Magnitude: 6.7417933
347 Epsilon (mean values): 0.084136407
348 Portland Hills:
349 Percent Contributed: 1.48
350 Distance (km): 2.463229
351 Magnitude: 6.7427124
352 Epsilon (mean values): 0.06892305
353 Azimuth: 153.40008
354 Latitude: 45.58227
355 Longitude: -122.77095
356 subl_ch_bot.in:
357 Percent Contributed: 1.32
358 Distance (km): 69.53628
359 Magnitude: 8.860661
360 Epsilon (mean values): 0.85495506
361 Cascadia Megathrust - Goldfinger Case B Characteristic:
362 Percent Contributed: 1.32
363 Distance (km): 69.53628
364 Magnitude: 8.860661
365 Epsilon (mean values): 0.85495506
366 Azimuth: 260.19218
367 Latitude: 45.50147
368 Longitude: -123.59924
369 WUSmap_2014_fixSm_M8.in (opt):
370 Percent Contributed: 1.09
371 Distance (km): 11.276305
372 Magnitude: 6.2920663
373 Epsilon (mean values): 1.1161568
374 noPuget_2014_fixSm_M8.in (opt):
375 Percent Contributed: 1.09
376 Distance (km): 11.273728
377 Magnitude: 6.2919703
378 Epsilon (mean values): 1.1160721
379 sub2_ch_bot.in:
380 Percent Contributed: 1.03
381 Distance (km): 102.21559
382 Magnitude: 8.7415072
383 Epsilon (mean values): 1.3724691
384 Cascadia Megathrust - Goldfinger Case C Characteristic:
385 Percent Contributed: 1.03
386 Distance (km): 102.21559
387 Magnitude: 8.7415072
388 Epsilon (mean values): 1.3724691
389 Azimuth: 227.24299
390 Latitude: 45
391 Longitude: -123.70227
392 PSHA Deaggregation. %contributions.
393 site: Test
394 longitude: 122.786°W
395 latitude: 45.603°E
396 imt: Peak Ground Acceleration
397 vs30 = 360 m/s (C/D boundary)
398 return period: 2475 yrs.
399 #This deaggregation corresponds to: GMM: Abrahamson, Silva & Kamai (2014)
400 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
401 Deaggregation targets:
402 Return period: 2475 yrs
403 Exceedance rate: 0.0004040404 yr⁻¹

```

404     PGA ground motion: 0.5326147 g
405 Recovered targets:
406     Return period: 2476.0286 yrs
407     Exceedance rate: 0.00040387255 yr-1
408 Totals:
409     Binned: 9.71 %
410     Residual: 0 %
411     Trace: 0.09 %
412 Mean (over all sources):
413     m: 6.3
414     r: 7.92 km
415      $\epsilon$ : 0.9  $\sigma$ 
416 Mode (largest m-r bin):
417     m: 6.69
418     r: 4.4 km
419      $\epsilon$ : 0.34  $\sigma$ 
420     Contribution: 1.35 %
421 Mode (largest m-r- $\epsilon$  bin):
422     m: 6.87
423     r: 1.35 km
424      $\epsilon$ : 0.05  $\sigma$ 
425     Contribution: 1.16 %
426 Discretization:
427     r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
428     m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
429      $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
430 Epsilon keys:
431      $\epsilon_0$ :  $[-\infty \dots -2.5)$ 
432      $\epsilon_1$ :  $[-2.5 \dots -2.0)$ 
433      $\epsilon_2$ :  $[-2.0 \dots -1.5)$ 
434      $\epsilon_3$ :  $[-1.5 \dots -1.0)$ 
435      $\epsilon_4$ :  $[-1.0 \dots -0.5)$ 
436      $\epsilon_5$ :  $[-0.5 \dots 0.0)$ 
437      $\epsilon_6$ :  $[0.0 \dots 0.5)$ 
438      $\epsilon_7$ :  $[0.5 \dots 1.0)$ 
439      $\epsilon_8$ :  $[1.0 \dots 1.5)$ 
440      $\epsilon_9$ :  $[1.5 \dots 2.0)$ 
441      $\epsilon_{10}$ :  $[2.0 \dots 2.5)$ 
442      $\epsilon_{11}$ :  $[2.5 \dots +\infty)$ 
443 Closest Distance, rRup (km) Magnitude (Mw) ALL  $\epsilon$ 
 $\epsilon=[-1.5,-1)$   $\epsilon=[-1,-0.5)$   $\epsilon=[-0.5,0)$   $\epsilon=[0,0.5)$   $\epsilon=[0.5,1)$   $\epsilon=[1,1.5)$   $\epsilon=[1.5,2)$ 
 $\epsilon=[2,2.5)$   $\epsilon=[2.5,\infty)$ 
444 110 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
445 90 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
446 90 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
447 70 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
448 70 7.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
449 70 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
450 70 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
451 50 6.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
452 50 6.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
453 50 6.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
454 50 6.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.002
455 50 7.1 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.005
456 50 7.3 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.006 0.005
457 50 7.5 0.008 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000

```



```
494     Magnitude: 6.7407248
495     Epsilon (mean values): 0.18185032
496 Portland Hills:
497     Percent Contributed: 1.93
498     Distance (km): 2.5131818
499     Magnitude: 6.7419801
500     Epsilon (mean values): 0.16144947
501     Azimuth: 153.40008
502     Latitude: 45.58227
503     Longitude: -122.77095
504 WUSmap_2014_fixSm.ch.in (opt):
505     Percent Contributed: 1.04
506     Distance (km): 10.868336
507     Magnitude: 5.9418069
508     Epsilon (mean values): 1.3413844
509 noPuget_2014_fixSm.ch.in (opt):
510     Percent Contributed: 1.04
511     Distance (km): 10.867227
512     Magnitude: 5.9417499
513     Epsilon (mean values): 1.3413442
514 PSHA Deaggregation. %contributions.
515 site: Test
516 longitude: 122.786°W
517 latitude: 45.603°E
518 imt: Peak Ground Acceleration
519 vs30 = 360 m/s (C/D boundary)
520 return period: 2475 yrs.
521 #This deaggregation corresponds to: GMM: Boore, Stewart, Seyhan & Atkinson (2014)
522 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
523 Deaggregation targets:
524     Return period: 2475 yrs
525     Exceedance rate: 0.0004040404 yr-1
526     PGA ground motion: 0.5326147 g
527 Recovered targets:
528     Return period: 2476.0286 yrs
529     Exceedance rate: 0.00040387255 yr-1
530 Totals:
531     Binned: 12.38 %
532     Residual: 0 %
533     Trace: 0.11 %
534 Mean (over all sources):
535     m: 6.28
536     r: 8.48 km
537     ε□: 0.73 σ
538 Mode (largest m-r bin):
539     m: 6.69
540     r: 4.8 km
541     ε□: 0.29 σ
542     Contribution: 1.48 %
543 Mode (largest m-r-ε□ bin):
544     m: 6.69
545     r: 3.19 km
546     ε□: 0.12 σ
547     Contribution: 1.17 %
548 Discretization:
549     r: min = 0.0, max = 1000.0, Δ = 20.0 km
550     m: min = 4.4, max = 9.4, Δ = 0.2
551     ε: min = -3.0, max = 3.0, Δ = 0.5 σ
552 Epsilon keys:
553     ε0: [-∞ .. -2.5)
554     ε1: [-2.5 .. -2.0)
555     ε2: [-2.0 .. -1.5)
556     ε3: [-1.5 .. -1.0)
557     ε4: [-1.0 .. -0.5)
558     ε5: [-0.5 .. 0.0)
559     ε6: [0.0 .. 0.5)
560     ε7: [0.5 .. 1.0)
561     ε8: [1.0 .. 1.5)
562     ε9: [1.5 .. 2.0)
```

563	ε10: [2.0 .. 2.5)											
564	ε11: [2.5 .. +∞]											
565	Closest Distance, rRup (km) Magnitude (Mw) ALL_ε											
	ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5)			ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)		ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)						
	ε=[2,2.5) ε=[2.5,∞)											
566	90	7.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
567	90	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
568	70	7.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
569	70	7.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.001											
570	70	7.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
571	70	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
572	50	6.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
573	50	6.7	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.002											
574	50	6.9	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.005											
575	50	7.1	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.003 0.006											
576	50	7.3	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.008 0.004											
577	50	7.5	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.007 0.002											
578	50	7.7	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.001 0.000											
579	50	7.9	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.000											
580	30	5.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.000 0.001											
581	30	5.5	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.002 0.016											
582	30	5.7	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.012 0.023											
583	30	5.9	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.051 0.020											
584	30	6.1	0.155	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000 0.144 0.011											
585	30	6.3	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.015 0.137 0.015											
586	30	6.5	0.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.048 0.061 0.009											
587	30	6.7	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
	0.037 0.050 0.005											
588	30	6.9	0.068	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009
	0.028 0.029 0.											

598	10	5.9	0.696	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.120	0.123
		0.157	0.027	0.000								
599	10	6.1	1.044	0.000	0.000	0.000	0.000	0.000	0.000	0.512	0.141	0.277
		0.069	0.045	0.000								
600	10	6.3	1.038	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.197	0.193
		0.102	0.000	0.000								
601	10	6.5	1.272	0.000	0.000	0.000	0.000	0.000	0.002	0.879	0.211	0.127
		0.054	0.000	0.000								
602	10	6.7	1.480	0.000	0.000	0.000	0.000	0.000	0.004	1.169	0.217	0.062
		0.028	0.000	0.000								
603	10	6.9	1.412	0.000	0.000	0.000	0.000	0.000	0.805	0.411	0.128	0.058
		0.008	0.000	0.000								
604	10	7.1	0.953	0.000	0.000	0.000	0.000	0.000	0.783	0.047	0.078	0.044
		0.001	0.000	0.000								
605	10	7.3	0.260	0.000	0.000	0.000	0.000	0.000	0.122	0.044	0.058	0.035
		0.000	0.000	0.000								
606	10	7.5	0.074	0.000	0.000	0.000	0.000	0.000	0.010	0.025	0.029	0.010
		0.000	0.000	0.000								
607	10	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.005	0.001
		0.000	0.000	0.000								
608	10	7.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
		0.000	0.000	0.000								
609	Principal Sources (faults, subduction, random seismicity having > 3% contribution											
610	Geologic Model Partial Rupture:											
611	Percent Contributed: 2.04											
612	Distance (km): 2.8096351											
613	Magnitude: 6.7381876											
614	Epsilon (mean values): 0.13958118											
615	Portland Hills:											
616	Percent Contributed: 2.02											
617	Distance (km): 2.5223492											
618	Magnitude: 6.7396868											
619	Epsilon (mean values): 0.11479336											
620	Azimuth: 153.40008											
621	Latitude: 45.58227											
622	Longitude: -122.77095											
623	WUSmap_2014_fixSm.ch.in (opt):											
624	Percent Contributed: 1.38											
625	Distance (km): 10.699143											
626	Magnitude: 5.9811048											
627	Epsilon (mean values): 1.0434387											
628	noPuget_2014_fixSm.ch.in (opt):											
629	Percent Contributed: 1.38											
630	Distance (km): 10.698072											
631	Magnitude: 5.9810523											
632	Epsilon (mean values): 1.0433888											
633	WUSmap_2014_fixSm.gr.in (opt):											
634	Percent Contributed: 1.32											
635	Distance (km): 10.586956											
636	Magnitude: 5.9471806											
637	Epsilon (mean values): 1.0429062											
638	noPuget_2014_fixSm.gr.in (opt):											
639	Percent Contributed: 1.31											
640	Distance (km): 10.58583											
641	Magnitude: 5.9471237											
642	Epsilon (mean values): 1.042854											
643	PSHA Deaggregation. %contributions.											
644	site: Test											
645	longitude: 122.786°W											
646	latitude: 45.603°E											
647	imt: Peak Ground Acceleration											
648	vs30 = 360 m/s (C/D boundary)											
649	return period: 2475 yrs.											
650	#This deaggregation corresponds to: GMM: Campbell & Bozorgnia (2014)											
651	Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:											
652	Deaggregation targets:											
653	Return period: 2475 yrs											
654	Exceedance rate: 0.0004040404 yr ⁻¹											
655	PGA ground motion: 0.5326147 g											

```

656 Recovered targets:
657   Return period: 2476.0286 yrs
658   Exceedance rate: 0.00040387255 yr-1
659 Totals:
660   Binned: 5.42 %
661   Residual: 0 %
662   Trace: 0.1 %
663 Mean (over all sources):
664   m: 6.59
665   r: 5.81 km
666   ε□: 0.82 σ
667 Mode (largest m-r bin):
668   m: 6.69
669   r: 4.23 km
670   ε□: 0.52 σ
671   Contribution: 1.09 %
672 Mode (largest m-r-ε□ bin):
673   m: 6.87
674   r: 1.33 km
675   ε□: 0.28 σ
676   Contribution: 0.93 %
677 Discretization:
678   r: min = 0.0, max = 1000.0, Δ = 20.0 km
679   m: min = 4.4, max = 9.4, Δ = 0.2
680   ε: min = -3.0, max = 3.0, Δ = 0.5 σ
681 Epsilon keys:
682   ε0: [-∞ .. -2.5)
683   ε1: [-2.5 .. -2.0)
684   ε2: [-2.0 .. -1.5)
685   ε3: [-1.5 .. -1.0)
686   ε4: [-1.0 .. -0.5)
687   ε5: [-0.5 .. 0.0)
688   ε6: [0.0 .. 0.5)
689   ε7: [0.5 .. 1.0)
690   ε8: [1.0 .. 1.5)
691   ε9: [1.5 .. 2.0)
692   ε10: [2.0 .. 2.5)
693   ε11: [2.5 .. +∞]
694 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
ε=[2,2.5) ε=[2.5,∞)
695 70 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
696 50 7.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
697 50 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
698 50 7.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
699 50 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
700 50 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
701 30 5.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
702 30 6.1 0.008 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.008
703 30 6.3 0.026 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.006 0.019
704 30 6.5 0.030 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.022 0.008
705 30 6.7 0.024 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.001 0.014 0.008
706 30 6.9 0.016 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.002 0.009 0.005
707 30 7.1 0.017 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.004 0.011 0.003
708 30 7.3 0.019 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.006 0.010 0.003

```

709	30	7.5	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.004	0.006	0.001						
710	30	7.7	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.001	0.001	0.000						
711	30	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000						
712	10	5.1	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.010	0.041	0.010						
713	10	5.3	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.059	0.021	0.008						
714	10	5.5	0.128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027
			0.059	0.030	0.012						
715	10	5.7	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076
			0.028	0.028	0.011						
716	10	5.9	0.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073
			0.045	0.031	0.007						
717	10	6.1	0.338	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.154
			0.085	0.026	0.008						
718	10	6.3	0.457	0.000	0.000	0.000	0.000	0.000	0.000	0.171	0.192
			0.067	0.024	0.002						
719	10	6.5	0.842	0.000	0.000	0.000	0.000	0.000	0.279	0.377	0.127
			0.043	0.015	0.000						
720	10	6.7	1.091	0.000	0.000	0.000	0.000	0.000	0.606	0.375	0.077
			0.028	0.006	0.000						
721	10	6.9	1.057	0.000	0.000	0.000	0.000	0.000	0.932	0.049	0.052
			0.024	0.001	0.000						
722	10	7.1	0.692	0.000	0.000	0.000	0.000	0.000	0.611	0.030	0.033
			0.018	0.000	0.000						
723	10	7.3	0.165	0.000	0.000	0.000	0.000	0.000	0.101	0.027	0.027
			0.010	0.000	0.000						
724	10	7.5	0.042	0.000	0.000	0.000	0.000	0.000	0.011	0.015	0.011
			0.004	0.000	0.000						
725	10	7.7	0.006	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002
			0.000	0.000	0.000						
726	10	7.9	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
			0.000	0.000	0.000						
727	Principal Sources (faults, subduction, random seismicity having > 3% contribution										
728	Geologic Model Partial Rupture:										
729	Percent Contributed: 1.58										
730	Distance (km): 2.5834073										
731	Magnitude: 6.7376899										
732	Epsilon (mean values): 0.3802706										
733	Portland Hills:										
734	Percent Contributed: 1.58										
735	Distance (km): 2.4779336										
736	Magnitude: 6.7383079										
737	Epsilon (mean values): 0.37044835										
738	Azimuth: 153.40008										
739	Latitude: 45.58227										
740	Longitude: -122.77095										
741	PSHA Deaggregation. %contributions.										
742	site: Test										
743	longitude: 122.786°W										
744	latitude: 45.603°E										
745	imt: Peak Ground Acceleration										
746	vs30 = 360 m/s (C/D boundary)										
747	return period: 2475 yrs										

```

760     Trace: 0.08 %
761 Mean (over all sources):
762     m: 6.47
763     r: 6.53 km
764      $\varepsilon$ : 0.47  $\sigma$ 
765 Mode (largest m-r bin):
766     m: 6.87
767     r: 2.57 km
768      $\varepsilon$ : -0.28  $\sigma$ 
769     Contribution: 1.81 %
770 Mode (largest m-r- $\varepsilon$  bin):
771     m: 6.84
772     r: 1.5 km
773      $\varepsilon$ : -0.4  $\sigma$ 
774     Contribution: 1.11 %
775 Discretization:
776     r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
777     m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
778      $\varepsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
779 Epsilon keys:
780      $\varepsilon_0$ :  $[-\infty \dots -2.5)$ 
781      $\varepsilon_1$ :  $[-2.5 \dots -2.0)$ 
782      $\varepsilon_2$ :  $[-2.0 \dots -1.5)$ 
783      $\varepsilon_3$ :  $[-1.5 \dots -1.0)$ 
784      $\varepsilon_4$ :  $[-1.0 \dots -0.5)$ 
785      $\varepsilon_5$ :  $[-0.5 \dots 0.0)$ 
786      $\varepsilon_6$ :  $[0.0 \dots 0.5)$ 
787      $\varepsilon_7$ :  $[0.5 \dots 1.0)$ 
788      $\varepsilon_8$ :  $[1.0 \dots 1.5)$ 
789      $\varepsilon_9$ :  $[1.5 \dots 2.0)$ 
790      $\varepsilon_{10}$ :  $[2.0 \dots 2.5)$ 
791      $\varepsilon_{11}$ :  $[2.5 \dots +\infty)$ 
792 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\varepsilon$   $\varepsilon=(-\infty, -2.5)$   $\varepsilon=[-2.5, -2)$   $\varepsilon=[-2, -1.5)$ 
 $\varepsilon=[-1.5, -1)$   $\varepsilon=[-1, -0.5)$   $\varepsilon=[-0.5, 0)$   $\varepsilon=[0, 0.5)$   $\varepsilon=[0.5, 1)$   $\varepsilon=[1, 1.5)$   $\varepsilon=[1.5, 2)$ 
 $\varepsilon=[2, 2.5)$   $\varepsilon=[2.5, \infty)$ 
793 110 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
794 90 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
795 90 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
796 70 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
797 70 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
798 70 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
799 70 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
800 50 6.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
801 50 7.1 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.002
802 50 7.3 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.004 0.004
803 50 7.5 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.005 0.002
804 50 7.7 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.001 0.001 0.000
805 50 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
806 30 5.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
807 30 5.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
808 30 5.7 0.004 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.004
809 30 5.9 0.011 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.002 0.009

```

810	30	6.1	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.014	0.016							
811	30	6.3	0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.001	0.021	0.016							
812	30	6.5	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.005	0.015	0.011							
813	30	6.7	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.009	0.015	0.007							
814	30	6.9	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
			0.012	0.014	0.005							
815	30	7.1	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
			0.028	0.013	0.002							
816	30	7.3	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.025
			0.031	0.012	0.000							
817	30	7.5	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.021
			0.019	0.004	0.000							
818	30	7.7	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.005
			0.002	0.000	0.000							
819	30	7.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
			0.000	0.000	0.000							
820	10	5.1	0.423	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.236
			0.090	0.066	0.031							
821	10	5.3	0.461	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.229
			0.135	0.077	0.019							
822	10	5.5	0.452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.105	0.145
			0.111	0.084	0.006							
823	10	5.7	0.418	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.172	0.088
			0.084	0.068	0.006							
824	10	5.9	0.381	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.143	0.101
			0.095	0.039	0.002							
825	10	6.1	0.638	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.253	0.203
			0.108	0.026	0.006							
826	10	6.3	0.698	0.000	0.000	0.000	0.000	0.000	0.000	0.086	0.357	0.183
			0.055	0.016	0.000							
827	10	6.5	1.177	0.000	0.000	0.000	0.000	0.000	0.390	0.272	0.352	0.113
			0.040	0.010	0.000							
828	10	6.7	1.706	0.000	0.000	0.000	0.000	0.000	0.940	0.491	0.192	0.053
			0.026	0.003	0.000							
829	10	6.9	1.814	0.000	0.000	0.000	0.000	0.470	1.106	0.067	0.112	0.050
			0.009	0.000	0.000							
830	10	7.1	1.270	0.000	0.000	0.000	0.000					

```

854 Portland Hills:
855 Percent Contributed: 1.26
856 Distance (km): 0.76905363
857 Magnitude: 7.0008807
858 Epsilon (mean values): -0.53453986
859 Azimuth: 153.40008
860 Latitude: 45.58227
861 Longitude: -122.77095
862 PSHA Deaggregation. %contributions.
863 site: Test
864 longitude: 122.786°W
865 latitude: 45.603°E
866 imt: Peak Ground Acceleration
867 vs30 = 360 m/s (C/D boundary)
868 return period: 2475 yrs.
869 #This deaggregation corresponds to: GMM: Atkinson & Macias (2009) : Interface
870 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
871 Deaggregation targets:
872 Return period: 2475 yrs
873 Exceedance rate: 0.0004040404 yr-1
874 PGA ground motion: 0.5326147 g
875 Recovered targets:
876 Return period: 2476.0286 yrs
877 Exceedance rate: 0.00040387255 yr-1
878 Totals:
879 Binned: 6.73 %
880 Residual: 0 %
881 Trace: 0.03 %
882 Mean (over all sources):
883 m: 9.12
884 r: 72.01 km
885 ε□: 1.15 σ
886 Mode (largest m-r bin):
887 m: 9.34
888 r: 70.18 km
889 ε□: 0.82 σ
890 Contribution: 3.19 %
891 Mode (largest m-r-ε□ bin):
892 m: 9.34
893 r: 70.18 km
894 ε□: 0.82 σ
895 Contribution: 3.19 %
896 Discretization:
897 r: min = 0.0, max = 1000.0, Δ = 20.0 km
898 m: min = 4.4, max = 9.4, Δ = 0.2
899 ε: min = -3.0, max = 3.0, Δ = 0.5 σ
900 Epsilon keys:
901 ε0: [-∞ .. -2.5)
902 ε1: [-2.5 .. -2.0)
903 ε2: [-2.0 .. -1.5)
904 ε3: [-1.5 .. -1.0)
905 ε4: [-1.0 .. -0.5)
906 ε5: [-0.5 .. 0.0)
907 ε6: [0.0 .. 0.5)
908 ε7: [0.5 .. 1.0)
909 ε8: [1.0 .. 1.5)
910 ε9: [1.5 .. 2.0)
911 ε10: [2.0 .. 2.5)
912 ε11: [2.5 .. +∞]
913 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
ε=[2,2.5) ε=[2.5,∞)
914 130 8.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
915 130 9.1 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.003
916 110 8.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
917 110 8.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

```


	0.000	0.000	0.000									
918	110	8.5	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.005									
919	110	8.7	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.016									
920	110	8.9	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.020	0.032									
921	110	9.1	0.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.175	0.000									
922	90	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
923	90	8.1	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
924	90	8.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
925	90	8.5	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.003	0.004									
926	90	8.7	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.001	0.002	0.004									
927	90	8.9	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.012	0.000									
928	70	7.9	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.011	0.000									
929	70	8.1	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.011	0.014	0.000									
930	70	8.3	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.015	0.002	0.000									
931	70	8.5	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.086	0.002	0.000									
932	70	8.7	0.165	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058
	0.107	0.000	0.000									
933	70	8.9	1.195	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.195
	0.000	0.000	0.000									
934	70	9.1	1.761	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.761
	0.000	0.000	0.000									
935	70	9.3	3.193	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.193	0.000
	0.000	0.000	0.000									
936	Principal Sources (faults, subduction, random seismicity having > 3% contribution											
937	sub0_ch_bot.in:											
938	Percent Contributed: 6.04											
939	Distance (km): 70.179382											
940	Magnitude: 9.1527281											
941	Epsilon (mean values): 1.05749											
942	Cascadia Megathrust - whole CSZ Characteristic:											
943	Percent Contributed: 6.04											
944	Distance (km): 70.179382											
945	Magnitude: 9.1527281											
946												

```

968     Residual: 0 %
969     Trace: 0.07 %
970 Mean (over all sources):
971     m: 8.93
972     r: 92.56 km
973      $\epsilon$ : 1.16  $\sigma$ 
974 Mode (largest m-r bin):
975     m: 9.34
976     r: 70.18 km
977      $\epsilon$ : 0.72  $\sigma$ 
978     Contribution: 3.7 %
979 Mode (largest m-r- $\epsilon$  bin):
980     m: 9.34
981     r: 70.18 km
982      $\epsilon$ : 0.72  $\sigma$ 
983     Contribution: 3.7 %
984 Discretization:
985     r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
986     m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
987      $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
988 Epsilon keys:
989      $\epsilon_0$ : [- $\infty$  .. -2.5)
990      $\epsilon_1$ : [-2.5 .. -2.0)
991      $\epsilon_2$ : [-2.0 .. -1.5)
992      $\epsilon_3$ : [-1.5 .. -1.0)
993      $\epsilon_4$ : [-1.0 .. -0.5)
994      $\epsilon_5$ : [-0.5 .. 0.0)
995      $\epsilon_6$ : [0.0 .. 0.5)
996      $\epsilon_7$ : [0.5 .. 1.0)
997      $\epsilon_8$ : [1.0 .. 1.5)
998      $\epsilon_9$ : [1.5 .. 2.0)
999      $\epsilon_{10}$ : [2.0 .. 2.5)
1000     $\epsilon_{11}$ : [2.5 .. + $\infty$ )
1001 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\epsilon$   $\epsilon=(-\infty,-2.5)$   $\epsilon=[-2.5,-2)$   $\epsilon=[-2,-1.5)$ 
       $\epsilon=[-1.5,-1)$   $\epsilon=[-1,-0.5)$   $\epsilon=[-0.5,0)$   $\epsilon=[0,0.5)$   $\epsilon=[0.5,1)$   $\epsilon=[1,1.5)$   $\epsilon=[1.5,2)$ 
       $\epsilon=[2,2.5)$   $\epsilon=[2.5,\infty)$ 
1002 250 8.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.000
1003 230 8.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.000
1004 230 8.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.000
1005 230 8.5 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.006
1006 230 8.7 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.007
1007 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.000
1008 210 8.1 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.001
1009 210 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.001
1010 210 8.5 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.002
1011 190 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.001
1012 190 8.1 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.002
1013 190 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.001
1014 190 8.5 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.005 0.001
1015 170 7.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.000 0.002
1016 170 8.1 0.005 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.003 0.002
1017 170 8.3 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.003 0.000
1018 170 8.5 0.015 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

```


1054 Percent Contributed: 9.75
1055 Distance (km): 70.179382
1056 Magnitude: 9.0876546
1057 Epsilon (mean values): 0.80695799
1058 Cascadia Megathrust - whole CSZ Characteristic:
1059 Percent Contributed: 9.75
1060 Distance (km): 70.179382
1061 Magnitude: 9.0876546
1062 Epsilon (mean values): 0.80695799
1063 Azimuth: 260.19218
1064 Latitude: 45.50147
1065 Longitude: -123.59924
1066 sub0_ch_mid.in:
1067 Percent Contributed: 5.06
1068 Distance (km): 118.71992
1069 Magnitude: 8.9099098
1070 Epsilon (mean values): 1.497474
1071 Cascadia Megathrust - whole CSZ Characteristic:
1072 Percent Contributed: 5.06
1073 Distance (km): 118.71992
1074 Magnitude: 8.9099098
1075 Epsilon (mean values): 1.497474
1076 Azimuth: 264.55326
1077 Latitude: 45.48932
1078 Longitude: -124.32961
1079 sub0_ch_top.in:
1080 Percent Contributed: 1.2
1081 Distance (km): 136.64542
1082 Magnitude: 8.8158252
1083 Epsilon (mean values): 1.74205
1084 Cascadia Megathrust - whole CSZ Characteristic:
1085 Percent Contributed: 1.2
1086 Distance (km): 136.64542
1087 Magnitude: 8.8158252
1088 Epsilon (mean values): 1.74205
1089 Azimuth: 265.16041
1090 Latitude: 45.48466
1091 Longitude: -124.54931
1092 PSHA Deaggregation. %contributions.
1093 site: Test
1094 longitude: 122.786°W
1095 latitude: 45.603°E
1096 imt: Peak Ground Acceleration
1097 vs30 = 360 m/s (C/D boundary)
1098 return period: 2475 yrs.
1099 #This deaggregation corresponds to: GMM: BC Hydro (2012) : Slab
1100 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
1101 Deaggregation targets:
1102 Return period: 2475 yrs
1103 Exceedance rate: 0.0004040404 yr⁻¹
1104 PGA ground motion: 0.5326147 g
1105 Recovered targets:
1106 Return period: 2476.0286 yrs
1107 Exceedance rate: 0.00040387255 yr⁻¹
1108 Totals:
1109 Binned: 6.67 %
1110 Residual: 0 %
1111 Trace: 0.12 %
1112 Mean (over all sources):
1113 m: 7
1114 r: 68.97 km
1115 ε□: 1.3 σ
1116 Mode (largest m-r bin):
1117 m: 7.1
1118 r: 54.05 km
1119 ε□: 0.76 σ
1120 Contribution: 1.19 %
1121 Mode (largest m-r-ε□ bin):
1122 m: 7.11

```

1123     r: 53.82 km
1124      $\epsilon_{\square}$ : 0.75  $\sigma$ 
1125     Contribution: 1.13 %
1126 Discretization:
1127     r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
1128     m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
1129      $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
1130 Epsilon keys:
1131      $\epsilon_0$ :  $[-\infty \dots -2.5)$ 
1132      $\epsilon_1$ :  $[-2.5 \dots -2.0)$ 
1133      $\epsilon_2$ :  $[-2.0 \dots -1.5)$ 
1134      $\epsilon_3$ :  $[-1.5 \dots -1.0)$ 
1135      $\epsilon_4$ :  $[-1.0 \dots -0.5)$ 
1136      $\epsilon_5$ :  $[-0.5 \dots 0.0)$ 
1137      $\epsilon_6$ :  $[0.0 \dots 0.5)$ 
1138      $\epsilon_7$ :  $[0.5 \dots 1.0)$ 
1139      $\epsilon_8$ :  $[1.0 \dots 1.5)$ 
1140      $\epsilon_9$ :  $[1.5 \dots 2.0)$ 
1141      $\epsilon_{10}$ :  $[2.0 \dots 2.5)$ 
1142      $\epsilon_{11}$ :  $[2.5 \dots +\infty)$ 
1143 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\epsilon$   $\epsilon=(-\infty, -2.5)$   $\epsilon=[-2.5, -2)$   $\epsilon=[-2, -1.5)$ 
 $\epsilon=[-1.5, -1)$   $\epsilon=[-1, -0.5)$   $\epsilon=[-0.5, 0)$   $\epsilon=[0, 0.5)$   $\epsilon=[0.5, 1)$   $\epsilon=[1, 1.5)$   $\epsilon=[1.5, 2)$ 
 $\epsilon=[2, 2.5)$   $\epsilon=[2.5, \infty)$ 
1144 270 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1145 250 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1146 250 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1147 250 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1148 230 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1149 230 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1150 230 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1151 210 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1152 210 7.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1153 210 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1154 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1155 190 7.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1156 190 7.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1157 190 7.5 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.001 0.002
1158 190 7.7 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.001 0.000
1159 190 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.001 0.000
1160 170 7.1 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.007
1161 170 7.3 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.001 0.006
1162 170 7.5 0.009 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.006 0.003
1163 170 7.7 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.002 0.000
1164 170 7.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.001 0.002 0.000
1165 150 6.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.002
1166 150 7.1 0.045 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.003 0.043

```

1167	150	7.3	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.012	0.003								
1168	150	7.5	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003		0.013	0.000								
1169	150	7.7	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.002		0.001	0.000								
1170	150	7.9	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003		0.000	0.000								
1171	130	6.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.001								
1172	130	6.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.002	0.019								
1173	130	7.1	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.078	0.023								
1174	130	7.3	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.007		0.016	0.000								
1175	130	7.5	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.019		0.002	0.000								
1176	130	7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.004		0.000	0.000								
1177	130	7.9	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
	0.003		0.000	0.000								
1178	110	6.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.001								
1179	110	6.7	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.001	0.014								
1180	110	6.9	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.044	0.015								
1181	110	7.1	0.155	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.049		0.105	0.000								
1182	110	7.3	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
	0.026		0.002	0.000								
1183	110	7.5	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011
	0.012		0.000	0.000								
1184	110	7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
	0.001		0.000	0.000								
1185	110	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
	0.000		0.000	0.000								
1186	90	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.000								
1187	90	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.000								
1188	90	6.5	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.010	0.013								
1189	90	6.7	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003		0.073	0.010								
1190	90	6.9	0.198	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.095		0.103	0.000								
1191	90	7.1	0.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052
	0.277		0.011	0.000								
1192	90	7.3	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.042
	0.009		0.000	0.000								
1193	90	7.5	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.026
	0.000		0.000	0.000								
1194	90	7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002
	0.000		0.000	0.000								
1195	90	7.9	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.001
	0.000		0.000	0.000								
1196	70	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.000								
1197	70	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.000								
1198	70	6.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000	0.000								
1199	70	6.5	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.065		0.049	0.000								
1200	70	6.7	0.383	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
	0.307		0.049	0.000								
1201	70	6.9	0.635	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.379

	0.255	0.000	0.000									
1202	70	7.1	0.951	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.173	0.730
	0.048	0.000	0.000									
1203	70	7.3	0.118	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.085	0.034
	0.000	0.000	0.000									
1204	70	7.5	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.059	0.002
	0.000	0.000	0.000									
1205	70	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.006	0.000
	0.000	0.000	0.000									
1206	70	7.9	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.004	0.000
	0.000	0.000	0.000									
1207	50	5.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1208	50	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1209	50	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1210	50	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1211	50	6.5	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073
	0.128	0.000	0.000									
1212	50	6.7	0.566	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.477
	0.089	0.000	0.000									
1213	50	6.9	0.843	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.334	0.509
	0.000	0.000	0.000									
1214	50	7.1	1.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.135	0.057
	0.000	0.000	0.000									
1215	50	7.3	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.078	0.062	0.000
	0.000	0.000	0.000									
1216	50	7.5	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.078	0.004	0.000
	0.000	0.000	0.000									
1217	50	7.7	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000
	0.000	0.000	0.000									
1218	50	7.9	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000
	0.000	0.000	0.000									
1219	Principal Sources (faults, subduction, random seismicity having > 3% contribution											
1220	coastalOR_deep.in:											
1221	Percent Contributed: 3.6											
1222	Distance (km): 60.262693											
1223	Magnitude: 6.9251684											
1224	Epsilon (mean values): 1.1662481											
1225	coastalOR_deep.in:											
1226	Percent Contributed: 1.6											
1227	Distance (km): 70.678731											
1228	Magnitude: 6.963448											
1229	Epsilon (mean values): 1.5215149											
1230	PSHA Deaggregation. %contributions.											
1231	site: Test											
1232	longitude: 122.786°W											
1233	latitude: 45.603°E											
1234	imt: Peak Ground Acceleration											
1235	vs30 = 360 m/s (C/D boundary)											
1236	return period: 2475 yrs											

```

1253     ε□: 0.9 σ
1254 Mode (largest m-r bin):
1255     m: 9.34
1256     r: 70.18 km
1257     ε□: 0.37 σ
1258     Contribution: 5.58 %
1259 Mode (largest m-r-ε□ bin):
1260     m: 9.34
1261     r: 70.18 km
1262     ε□: 0.37 σ
1263     Contribution: 5.58 %
1264 Discretization:
1265     r: min = 0.0, max = 1000.0, Δ = 20.0 km
1266     m: min = 4.4, max = 9.4, Δ = 0.2
1267     ε: min = -3.0, max = 3.0, Δ = 0.5 σ
1268 Epsilon keys:
1269     ε0: [-∞ .. -2.5)
1270     ε1: [-2.5 .. -2.0)
1271     ε2: [-2.0 .. -1.5)
1272     ε3: [-1.5 .. -1.0)
1273     ε4: [-1.0 .. -0.5)
1274     ε5: [-0.5 .. 0.0)
1275     ε6: [0.0 .. 0.5)
1276     ε7: [0.5 .. 1.0)
1277     ε8: [1.0 .. 1.5)
1278     ε9: [1.5 .. 2.0)
1279     ε10: [2.0 .. 2.5)
1280     ε11: [2.5 .. +∞]
1281 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
ε=[2,2.5) ε=[2.5,∞)
1282 210 8.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1283 190 8.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1284 190 8.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1285 170 8.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1286 170 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1287 170 8.5 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.003 0.003
1288 170 8.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1289 150 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1290 150 8.1 0.004 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.003
1291 150 8.3 0.055 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.045 0.010
1292 150 8.5 0.040 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.040 0.000
1293 150 8.7 0.071 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.005 0.065 0.000
1294 130 7.9 0.004 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.002 0.002
1295 130 8.1 0.014 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.012 0.002
1296 130 8.3 0.018 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.018 0.000
1297 130 8.5 0.146 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.085 0.061 0.000
1298 130 8.7 0.706 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.706 0.000 0.000
1299 130 9.1 0.607 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.607 0.000 0.000
1300 110 7.9 0.009 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.009 0.000

```



```

1350 Distance (km): 136.64542
1351 Magnitude: 8.845435
1352 Epsilon (mean values): 1.7217898
1353 Cascadia Megathrust - whole CSZ Characteristic:
1354 Percent Contributed: 1.18
1355 Distance (km): 136.64542
1356 Magnitude: 8.845435
1357 Epsilon (mean values): 1.7217898
1358 Azimuth: 265.16041
1359 Latitude: 45.48466
1360 Longitude: -124.54931
1361 PSHA Deaggregation. %contributions.
1362 site: Test
1363 longitude: 122.786°W
1364 latitude: 45.603°E
1365 imt: Peak Ground Acceleration
1366 vs30 = 360 m/s (C/D boundary)
1367 return period: 2475 yrs.
1368 #This deaggregation corresponds to: GMM: Zhao et al. (2006) : Slab
1369 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
1370 Deaggregation targets:
1371 Return period: 2475 yrs
1372 Exceedance rate: 0.0004040404 yr-1
1373 PGA ground motion: 0.5326147 g
1374 Recovered targets:
1375 Return period: 2476.0286 yrs
1376 Exceedance rate: 0.00040387255 yr-1
1377 Totals:
1378 Binned: 4.66 %
1379 Residual: 0 %
1380 Trace: 0.08 %
1381 Mean (over all sources):
1382 m: 7.02
1383 r: 61.35 km
1384 ε̄: 1.18 σ
1385 Mode (largest m-r bin):
1386 m: 7.1
1387 r: 53.87 km
1388 ε̄: 0.75 σ
1389 Contribution: 1.19 %
1390 Mode (largest m-r-ε̄ bin):
1391 m: 7.1
1392 r: 53.59 km
1393 ε̄: 0.73 σ
1394 Contribution: 0.97 %
1395 Discretization:
1396 r: min = 0.0, max = 1000.0, Δ = 20.0 km
1397 m: min = 4.4, max = 9.4, Δ = 0.2
1398 ε: min = -3.0, max = 3.0, Δ = 0.5 σ
1399 Epsilon keys:
1400 ε0: [-∞ .. -2.5)
1401 ε1: [-2.5 .. -2.0)
1402 ε2: [-2.0 .. -1.5)
1403 ε3: [-1.5 .. -1.0)
1404 ε4: [-1.0 .. -0.5)
1405 ε5: [-0.5 .. 0.0)
1406 ε6: [0.0 .. 0.5)
1407 ε7: [0.5 .. 1.0)
1408 ε8: [1.0 .. 1.5)
1409 ε9: [1.5 .. 2.0)
1410 ε10: [2.0 .. 2.5)
1411 ε11: [2.5 .. +∞]
1412 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
ε=[2,2.5) ε=[2.5,+∞)
1413 230 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1414 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000

```

1415	190	7.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1416	190	7.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1417	170	7.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1418	170	7.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1419	170	7.9	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.001	0.000									
1420	150	7.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1421	150	7.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.001									
1422	150	7.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.001	0.000									
1423	150	7.9	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.002	0.001	0.000									
1424	130	7.1	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.002									
1425	130	7.3	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.002									
1426	130	7.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.003	0.001									
1427	130	7.7	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.002	0.001	0.000									
1428	130	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
	0.002	0.000	0.000									
1429	110	6.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1430	110	6.9	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.002									
1431	110	7.1	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.012	0.015									
1432	110	7.3	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.001	0.007	0.001									
1433	110	7.5	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.005	0.003	0.000									
1434	110	7.7	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
	0.002	0.000	0.000									
1435	110	7.9	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004
	0.000	0.000	0.000									
1436	90	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1437	90	6.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.002									
1438	90	6.7	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.003	0.010									
1439	90	6.9	0.057	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003	0.041	0.013									
1440	90	7.1	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
	0.060	0.074	0.002									
1441	90	7.3	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
	0.019	0.002	0.000									
1442	90	7.5	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.013
	0.006	0.000	0.000									
1443	90	7.7	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.002
	0.000	0.000	0.000									
1444	90	7.9	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003	0.000
	0.000	0.000	0.000									
1445	70	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1446	70	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1447	70	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000									
1448	70	6.5	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003	0.041	0.006									
1449	70	6.7	0.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1450	70	6.9	0.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.122
1451	70	7.1	0.686	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.104	0.423
1452	70	7.3	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.058	0.039
1453	70	7.5	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.039	0.012
1454	70	7.7	0.015	0.000	0.000	0.000	0.000	0.000	0.003	0.009	0.003	0.000
1455	70	7.9	0.017	0.000	0.000	0.000	0.000	0.002	0.011	0.004	0.000	0.000
1456	50	5.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1457	50	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1458	50	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1459	50	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1460	50	6.5	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1461	50	6.7	0.441	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.284
1462	50	6.9	0.745	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.238	0.494
1463	50	7.1	1.186	0.000	0.000	0.000	0.000	0.000	0.000	0.088	0.970	0.129
1464	50	7.3	0.155	0.000	0.000	0.000	0.000	0.000	0.000	0.109	0.046	0.000
1465	50	7.5	0.097	0.000	0.000	0.000	0.000	0.000	0.024	0.073	0.000	0.000
1466	50	7.7	0.018	0.000	0.000	0.000	0.000	0.003	0.014	0.001	0.000	0.000
1467	50	7.9	0.016	0.000	0.000	0.000	0.000	0.013	0.002	0.000	0.000	0.000
1468	Principal Sources (faults, subduction, random seismicity having > 3% contribution											
1469	coastalOR_deep.in:											
1470	Percent Contributed: 2.88											
1471	Distance (km): 57.412881											
1472	Magnitude: 6.9453795											
1473	Epsilon (mean values): 1.1450295											
1474	PSHA Deaggregation. %contributions.											
1475	site: Test											
1476	longitude: 122.786°W											
1477	latitude: 45.603°E											
1478	imt: Peak Ground Acceleration											
1479	vs30 = 360 m/s (C/D boundary)											
1480	return period: 2475 yrs.											
1481	#This deaggregation corresponds to: Source Type: Grid											
1482	Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:											
1483	Deaggregation targets:											
1484	Return period: 2475 yrs											
1485	Exceedance rate: 0.0004040404 yr ⁻¹											
1486	PGA ground motion: 0.5326147 g											
1487	Recovered targets:											
1488	Return period: 2476.0286 yrs											
1489	Exceedance rate: 0.00040387255 yr ⁻¹											
1490	Totals:											
1491	Binned: 20.07 %											
1492	Residual: 0 %											
1493	Trace: 0.14 %											
1494	Mean (over all sources):											
1495	m: 6.06											
1496	r: 10.77 km											
1497	ε□: 1.2 σ											
1498	Mode (largest m-r bin):											
1499	m: 6.1											


```

1500     r: 9.57 km
1501      $\epsilon$ : 1.04  $\sigma$ 
1502     Contribution: 2.25 %
1503 Mode (largest m-r- $\epsilon$  bin):
1504     m: 5.1
1505     r: 5.15 km
1506      $\epsilon$ : 1.18  $\sigma$ 
1507     Contribution: 0.93 %
1508 Discretization:
1509     r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
1510     m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
1511      $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
1512 Epsilon keys:
1513      $\epsilon_0$ :  $[-\infty \dots -2.5)$ 
1514      $\epsilon_1$ :  $[-2.5 \dots -2.0)$ 
1515      $\epsilon_2$ :  $[-2.0 \dots -1.5)$ 
1516      $\epsilon_3$ :  $[-1.5 \dots -1.0)$ 
1517      $\epsilon_4$ :  $[-1.0 \dots -0.5)$ 
1518      $\epsilon_5$ :  $[-0.5 \dots 0.0)$ 
1519      $\epsilon_6$ :  $[0.0 \dots 0.5)$ 
1520      $\epsilon_7$ :  $[0.5 \dots 1.0)$ 
1521      $\epsilon_8$ :  $[1.0 \dots 1.5)$ 
1522      $\epsilon_9$ :  $[1.5 \dots 2.0)$ 
1523      $\epsilon_{10}$ :  $[2.0 \dots 2.5)$ 
1524      $\epsilon_{11}$ :  $[2.5 \dots +\infty]$ 
1525 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\epsilon$   $\epsilon=(-\infty, -2.5)$   $\epsilon=[-2.5, -2)$   $\epsilon=[-2, -1.5)$ 
 $\epsilon=[-1.5, -1)$   $\epsilon=[-1, -0.5)$   $\epsilon=[-0.5, 0)$   $\epsilon=[0, 0.5)$   $\epsilon=[0.5, 1)$   $\epsilon=[1, 1.5)$   $\epsilon=[1.5, 2)$ 
 $\epsilon=[2, 2.5)$   $\epsilon=[2.5, \infty)$ 
1526 110 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1527 90 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1528 90 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1529 70 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1530 70 7.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1531 70 7.7 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1532 70 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1533 50 6.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000
1534 50 6.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.001
1535 50 6.7 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.002
1536 50 6.9 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.006
1537 50 7.1 0.016 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.003 0.013
1538 50 7.3 0.031 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.018 0.013
1539 50 7.5 0.024 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.019 0.005
1540 50 7.7 0.005 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.001 0.003 0.000
1541 50 7.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.001 0.001 0.000
1542 30 5.1 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.002
1543 30 5.3 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.007
1544 30 5.5 0.031 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.002 0.028
1545 30 5.7 0.058 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.014 0.044
1546 30 5.9 0.082 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000

```



```
1590     Epsilon (mean values): 1.2075827
1591 PointSourceFinite: -122.786, 45.616:
1592     Percent Contributed: 1.01
1593     Distance (km): 5.4362135
1594     Magnitude: 5.5854201
1595     Epsilon (mean values): 0.76675699
1596     Azimuth: 0
1597     Latitude: 45.616417
1598     Longitude: -122.78573
1599 WUSmap_2014_fixSm.gr.in (opt):
1600     Percent Contributed: 3.52
1601     Distance (km): 10.507784
1602     Magnitude: 5.9931315
1603     Epsilon (mean values): 1.2138064
1604 PointSourceFinite: -122.786, 45.616:
1605     Percent Contributed: 1.01
1606     Distance (km): 5.4362135
1607     Magnitude: 5.5854201
1608     Epsilon (mean values): 0.76675699
1609     Azimuth: 0
1610     Latitude: 45.616417
1611     Longitude: -122.78573
1612 noPuget_2014_fixSm.gr.in (opt):
1613     Percent Contributed: 3.52
1614     Distance (km): 10.506752
1615     Magnitude: 5.9930769
1616     Epsilon (mean values): 1.2137653
1617 PointSourceFinite: -122.786, 45.616:
1618     Percent Contributed: 1.01
1619     Distance (km): 5.4362135
1620     Magnitude: 5.5854201
1621     Epsilon (mean values): 0.76675699
1622     Azimuth: 0
1623     Latitude: 45.616417
1624     Longitude: -122.78573
1625 WUSmap_2014_fixSm_M8.in (opt):
1626     Percent Contributed: 1.09
1627     Distance (km): 11.276305
1628     Magnitude: 6.2920663
1629     Epsilon (mean values): 1.1161568
1630 noPuget_2014_fixSm_M8.in (opt):
1631     Percent Contributed: 1.09
1632     Distance (km): 11.273728
1633     Magnitude: 6.2919703
1634     Epsilon (mean values): 1.1160721
1635 PSHA Deaggregation. %contributions.
1636 site: Test
1637 longitude: 122.786°W
1638 latitude: 45.603°E
1639 imt: Peak Ground Acceleration
1640 vs30 = 360 m/s (C/D boundary)
1641 return period: 2475 yrs.
1642 #This deaggregation corresponds to: Source Type: Slab
1643 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
1644 Deaggregation targets:
1645     Return period: 2475 yrs
1646     Exceedance rate: 0.0004040404 yr-1
1647     PGA ground motion: 0.5326147 g
1648 Recovered targets:
1649     Return period: 2476.0286 yrs
1650     Exceedance rate: 0.00040387255 yr-1
1651 Totals:
1652     Binned: 11.33 %
1653     Residual: 0 %
1654     Trace: 0.13 %
1655 Mean (over all sources):
1656     m: 7.01
1657     r: 65.84 km
1658     ε: 1.25 σ
```

```

1659 Mode (largest m-r bin):
1660   m: 7.1
1661   r: 53.96 km
1662    $\epsilon$ : 0.76  $\sigma$ 
1663   Contribution: 2.38 %
1664 Mode (largest m-r- $\epsilon$  bin):
1665   m: 7.11
1666   r: 53.71 km
1667    $\epsilon$ : 0.74  $\sigma$ 
1668   Contribution: 2.1 %
1669 Discretization:
1670   r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
1671   m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
1672    $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
1673 Epsilon keys:
1674    $\epsilon_0$ :  $[-\infty \dots -2.5)$ 
1675    $\epsilon_1$ :  $[-2.5 \dots -2.0)$ 
1676    $\epsilon_2$ :  $[-2.0 \dots -1.5)$ 
1677    $\epsilon_3$ :  $[-1.5 \dots -1.0)$ 
1678    $\epsilon_4$ :  $[-1.0 \dots -0.5)$ 
1679    $\epsilon_5$ :  $[-0.5 \dots 0.0)$ 
1680    $\epsilon_6$ :  $[0.0 \dots 0.5)$ 
1681    $\epsilon_7$ :  $[0.5 \dots 1.0)$ 
1682    $\epsilon_8$ :  $[1.0 \dots 1.5)$ 
1683    $\epsilon_9$ :  $[1.5 \dots 2.0)$ 
1684    $\epsilon_{10}$ :  $[2.0 \dots 2.5)$ 
1685    $\epsilon_{11}$ :  $[2.5 \dots +\infty]$ 
1686 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\epsilon$ 
 $\epsilon=[-1.5,-1)$   $\epsilon=[-1,-0.5)$   $\epsilon=[-0.5,0)$   $\epsilon=[0,0.5)$   $\epsilon=[0.5,1)$   $\epsilon=[1,1.5)$   $\epsilon=[1.5,2)$ 
 $\epsilon=[2,2.5)$   $\epsilon=[2.5,\infty)$ 
1687 270 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1688 250 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1689 250 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1690 250 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1691 230 7.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1692 230 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1693 230 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1694 210 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1695 210 7.5 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1696 210 7.7 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1697 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1698 190 7.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1699 190 7.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1700 190 7.5 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1701 190 7.7 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1702 190 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1703 170 7.1 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1704 170 7.3 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1705 170 7.5 0.009 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1706 170 7.7 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

```

	0.000	0.002	0.000									
1707	170 7.9	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.001	0.002	0.000									
1708	150 6.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.002									
1709	150 7.1	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.003	0.043									
1710	150 7.3	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.012	0.003									
1711	150 7.5	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003	0.013	0.001									
1712	150 7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.002	0.002	0.000									
1713	150 7.9	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.005	0.001	0.000									
1714	130 6.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.001									
1715	130 6.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.002	0.019									
1716	130 7.1	0.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.078	0.025									
1717	130 7.3	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.007	0.017	0.002									
1718	130 7.5	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.019	0.005	0.001									
1719	130 7.7	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
	0.006	0.001	0.000									
1720	130 7.9	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
	0.005	0.000	0.000									
1721	110 6.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.001									
1722	110 6.7	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.001	0.014									
1723	110 6.9	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.044	0.017									
1724	110 7.1	0.182	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.049	0.118	0.015									
1725	110 7.3	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
	0.027	0.009	0.001									
1726	110 7.5	0.032	0.000	0.00								

1741	70	6.3	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000								
1742	70	6.5	0.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.068	0.090	0.006							
1743	70	6.7	0.576	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
			0.412	0.130	0.006							
1744	70	6.9	1.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.501
			0.474	0.044	0.000							
1745	70	7.1	1.637	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.277	1.153
			0.207	0.000	0.000							
1746	70	7.3	0.219	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.142	0.072
			0.003	0.000	0.000							
1747	70	7.5	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.098	0.014
			0.000	0.000	0.000							
1748	70	7.7	0.026	0.000	0.000	0.000	0.000	0.000	0.003	0.014	0.009	0.000
			0.000	0.000	0.000							
1749	70	7.9	0.027	0.000	0.000	0.000	0.000	0.002	0.011	0.010	0.004	0.000
			0.000	0.000	0.000							
1750	50	5.7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
1751	50	5.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
1752	50	6.1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
1753	50	6.3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000							
1754	50	6.5	0.343	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073
			0.265	0.005	0.000							
1755	50	6.7	1.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.760
			0.247	0.000	0.000							
1756	50	6.9	1.587	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.572	1.003
			0.012	0.000	0.000							
1757	50	7.1	2.378	0.000	0.000	0.000	0.000	0.000	0.000	0.088	2.105	0.186
			0.000	0.000	0.000							
1758	50	7.3	0.296	0.000	0.000	0.000	0.000	0.000	0.000	0.187	0.108	0.000
			0.000	0.000	0.000							
1759	50	7.5	0.178	0.000	0.000	0.000	0.000	0.000	0.024	0.151	0.004	0.000
			0.000	0.000	0.000							
1760	50	7.7	0.030	0.000	0.000	0.000	0.000	0.003	0.014	0.013	0.000	0.000
			0.000	0.000	0.000							
1761	50	7.9	0.025	0.000	0.000	0.						


```

1789 Totals:
1790   Binned: 50.88 %
1791   Residual: 0 %
1792   Trace: 0.14 %
1793 Mean (over all sources):
1794   m: 8.98
1795   r: 88.02 km
1796    $\epsilon_{\square}$ : 1.03  $\sigma$ 
1797 Mode (largest m-r bin):
1798   m: 9.34
1799   r: 70.18 km
1800    $\epsilon_{\square}$ : 0.59  $\sigma$ 
1801   Contribution: 12.47 %
1802 Mode (largest m-r- $\epsilon_{\square}$  bin):
1803   m: 9.01
1804   r: 70.14 km
1805    $\epsilon_{\square}$ : 0.68  $\sigma$ 
1806   Contribution: 8.04 %
1807 Discretization:
1808   r: min = 0.0, max = 1000.0,  $\Delta$  = 20.0 km
1809   m: min = 4.4, max = 9.4,  $\Delta$  = 0.2
1810    $\epsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
1811 Epsilon keys:
1812    $\epsilon_0$ :  $[-\infty \dots -2.5)$ 
1813    $\epsilon_1$ :  $[-2.5 \dots -2.0)$ 
1814    $\epsilon_2$ :  $[-2.0 \dots -1.5)$ 
1815    $\epsilon_3$ :  $[-1.5 \dots -1.0)$ 
1816    $\epsilon_4$ :  $[-1.0 \dots -0.5)$ 
1817    $\epsilon_5$ :  $[-0.5 \dots 0.0)$ 
1818    $\epsilon_6$ :  $[0.0 \dots 0.5)$ 
1819    $\epsilon_7$ :  $[0.5 \dots 1.0)$ 
1820    $\epsilon_8$ :  $[1.0 \dots 1.5)$ 
1821    $\epsilon_9$ :  $[1.5 \dots 2.0)$ 
1822    $\epsilon_{10}$ :  $[2.0 \dots 2.5)$ 
1823    $\epsilon_{11}$ :  $[2.5 \dots +\infty]$ 
1824 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\epsilon$ 
 $\epsilon=[-1.5,-1)$   $\epsilon=[-1,-0.5)$   $\epsilon=[-0.5,0)$   $\epsilon=[0,0.5)$   $\epsilon=[0.5,1)$   $\epsilon=[1,1.5)$   $\epsilon=[1.5,2)$ 
 $\epsilon=[2,2.5)$   $\epsilon=[2.5,\infty)$ 
1825 250 8.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1826 230 8.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1827 230 8.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1828 230 8.5 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1829 230 8.7 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1830 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1831 210 8.1 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1832 210 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1833 210 8.5 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1834 190 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1835 190 8.1 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1836 190 8.3 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1837 190 8.5 0.008 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1838 170 7.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1839 170 8.1 0.005 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1840 170 8.3 0.004 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

```

	0.000	0.003	0.001									
1841	170 8.5	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.017	0.003									
1842	170 8.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.001	0.000									
1843	150 7.9	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.007	0.001									
1844	150 8.1	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.016	0.003									
1845	150 8.3	0.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.187	0.010									
1846	150 8.5	0.115	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.013	0.101	0.000									
1847	150 8.7	0.173	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.107	0.066	0.000									
1848	130 7.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.018	0.002									
1849	130 8.1	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.012	0.037	0.002									
1850	130 8.3	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.024	0.029	0.000									
1851	130 8.5	0.354	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.292	0.062	0.000									
1852	130 8.7	1.528	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1.528	0.000	0.000									
1853	130 9.1	1.129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1.126	0.000	0.003									
1854	110 7.9	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.024	0.009	0.000									
1855	110 8.1	0.085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.060	0.025	0.000									
1856	110 8.3	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.038	0.018	0.000									
1857	110 8.5	0.778	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.274
	0.499	0.000	0.005									
1858	110 8.7	3.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.320
	3.103	0.000	0.016									
1859	110 8.9	3.836	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.211
	1.573	0.020	0.032									
1860	110 9.1	5.187	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.012
	0.000	0.175	0.000									
1861	90 7.9	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
	0.012	0.000	0.000									
1862	90 8.1	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
	0.022	0.000	0.000									
1863	90 8.3	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
	0.006	0.000	0.000									
1864	90 8.5	0.246	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.237
	0.002	0.003	0.004									
1865	90 8.7	0.223	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.216
	0.001	0.002	0.004									
1866	90 8.9	0.251	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.239
	0.000	0.012	0.000									
1867	70 7.9	0.136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.118
	0.007	0.011	0.000									
1868	70 8.1	0.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.281
	0.013	0.014	0.000									
1869	70 8.3	0.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167
	0.015	0.002	0.000									
1870	70 8.5	0.828	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.380	0.360
	0.086	0.002	0.000									
1871	70 8.7	1.265	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.079	0.078
	0.107	0.000	0.000									
1872	70 8.9	7.975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.780	1.195
	0.000	0.000	0.000									
1873	70 9.1	9.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.039	1.761
	0.000	0.000	0.000									
1874	70 9.3	12.468	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.575	6.893	0.000
	0.000	0.000	0.000									

1875 Principal Sources (faults, subduction, random seismicity having > 3% contribution
1876 sub0_ch_bot.in:
1877 Percent Contributed: 29.7
1878 Distance (km): 70.179382
1879 Magnitude: 9.1055834
1880 Epsilon (mean values): 0.72309455
1881 Cascadia Megathrust - whole CSZ Characteristic:
1882 Percent Contributed: 29.7
1883 Distance (km): 70.179382
1884 Magnitude: 9.1055834
1885 Epsilon (mean values): 0.72309455
1886 Azimuth: 260.19218
1887 Latitude: 45.50147
1888 Longitude: -123.59924
1889 sub0_ch_mid.in:
1890 Percent Contributed: 11.34
1891 Distance (km): 118.71992
1892 Magnitude: 8.9254869
1893 Epsilon (mean values): 1.453965
1894 Cascadia Megathrust - whole CSZ Characteristic:
1895 Percent Contributed: 11.34
1896 Distance (km): 118.71992
1897 Magnitude: 8.9254869
1898 Epsilon (mean values): 1.453965
1899 Azimuth: 264.55326
1900 Latitude: 45.48932
1901 Longitude: -124.32961
1902 sub0_ch_top.in:
1903 Percent Contributed: 2.39
1904 Distance (km): 136.64542
1905 Magnitude: 8.83072
1906 Epsilon (mean values): 1.7334477
1907 Cascadia Megathrust - whole CSZ Characteristic:
1908 Percent Contributed: 2.39
1909 Distance (km): 136.64542
1910 Magnitude: 8.83072
1911 Epsilon (mean values): 1.7334477
1912 Azimuth: 265.16041
1913 Latitude: 45.48466
1914 Longitude: -124.54931
1915 sub1_ch_bot.in:
1916 Percent Contributed: 1.32
1917 Distance (km): 69.53628
1918 Magnitude: 8.860661
1919 Epsilon (mean values): 0.85495506
1920 Cascadia Megathrust - Goldfinger Case B Characteristic:
1921 Percent Contributed: 1.32
1922 Distance (km): 69.53628
1923 Magnitude: 8.860661
1924 Epsilon (mean values): 0.85495506
1925 Azimuth: 260.19218
1926 Latitude: 45.50147
1927 Longitude: -123.59924
1928 sub2_ch_bot.in:
1929 Percent Contributed: 1.03
1930 Distance (km): 102.21559
1931 Magnitude: 8.7415072
1932 Epsilon (mean values): 1.3724691
1933 Cascadia Megathrust - Goldfinger Case C Characteristic:
1934 Percent Contributed: 1.03
1935 Distance (km): 102.21559
1936 Magnitude: 8.7415072
1937 Epsilon (mean values): 1.3724691
1938 Azimuth: 227.24299
1939 Latitude: 45
1940 Longitude: -123.70227
1941 PSHA Deaggregation. %contributions.
1942 site: Test
1943 longitude: 122.786°W

```

1944 latitude: 45.603°E
1945 imt: Peak Ground Acceleration
1946 vs30 = 360 m/s (C/D boundary)
1947 return period: 2475 yrs.
1948 #This deaggregation corresponds to: Source Type: Fault
1949 Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
1950 Deaggregation targets:
1951   Return period: 2475 yrs
1952   Exceedance rate: 0.0004040404 yr-1
1953   PGA ground motion: 0.5326147 g
1954 Recovered targets:
1955   Return period: 2476.0286 yrs
1956   Exceedance rate: 0.00040387255 yr-1
1957 Totals:
1958   Binned: 17.72 %
1959   Residual: 0 %
1960   Trace: 0.05 %
1961 Mean (over all sources):
1962   m: 6.75
1963   r: 3.63 km
1964   ε□: 0.17 σ
1965 Mode (largest m-r bin):
1966   m: 6.87
1967   r: 1.26 km
1968   ε□: -0.08 σ
1969   Contribution: 4.74 %
1970 Mode (largest m-r-ε□ bin):
1971   m: 6.69
1972   r: 2.92 km
1973   ε□: 0.17 σ
1974   Contribution: 3.12 %
1975 Discretization:
1976   r: min = 0.0, max = 1000.0, Δ = 20.0 km
1977   m: min = 4.4, max = 9.4, Δ = 0.2
1978   ε: min = -3.0, max = 3.0, Δ = 0.5 σ
1979 Epsilon keys:
1980   ε0: [-∞ .. -2.5)
1981   ε1: [-2.5 .. -2.0)
1982   ε2: [-2.0 .. -1.5)
1983   ε3: [-1.5 .. -1.0)
1984   ε4: [-1.0 .. -0.5)
1985   ε5: [-0.5 .. 0.0)
1986   ε6: [0.0 .. 0.5)
1987   ε7: [0.5 .. 1.0)
1988   ε8: [1.0 .. 1.5)
1989   ε9: [1.5 .. 2.0)
1990   ε10: [2.0 .. 2.5)
1991   ε11: [2.5 .. +∞)
1992 Closest Distance, rRup (km) Magnitude (Mw) ALL_ε
    ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
    ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0) ε=[0,0.5) ε=[0.5,1) ε=[1,1.5) ε=[1.5,2)
    ε=[2,2.5) ε=[2.5,∞)
1993 50 6.7 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.000 0.001
1994 50 6.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.000 0.002
1995 50 7.1 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.000 0.001
1996 50 7.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.000 0.000
1997 30 5.7 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.001 0.000
1998 30 5.9 0.031 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.024 0.007
1999 30 6.1 0.124 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.097 0.026
2000 30 6.3 0.166 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.000 0.136 0.030
2001 30 6.5 0.114 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
    0.024 0.073 0.016

```

[illegible]

2057 Percent Contributed: 1.49
2058 Distance (km): 2.6254197
2059 Magnitude: 6.7417933
2060 Epsilon (mean values): 0.084136407
2061 Portland Hills:
2062 Percent Contributed: 1.48
2063 Distance (km): 2.463229
2064 Magnitude: 6.7427124
2065 Epsilon (mean values): 0.06892305
2066 Azimuth: 153.40008
2067 Latitude: 45.58227
2068 Longitude: -122.77095

A-2-4

Liquefaction and
Residual Strength
Calculations

TABLE OF CONTENTS

CPT-4 results	
Summary data report	1
CPT-1 results	
Summary data report	8
CPT-2 results	
Summary data report	15
CPT-3 results	
Summary data report	22

LIQUEFACTION ANALYSIS REPORT

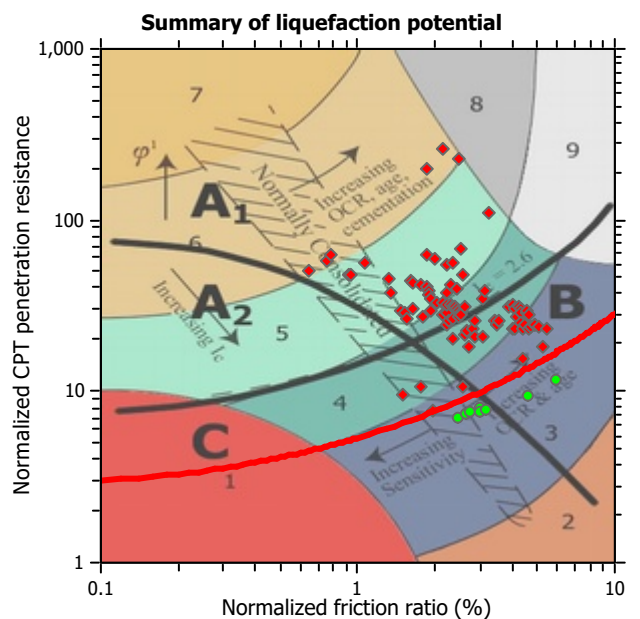
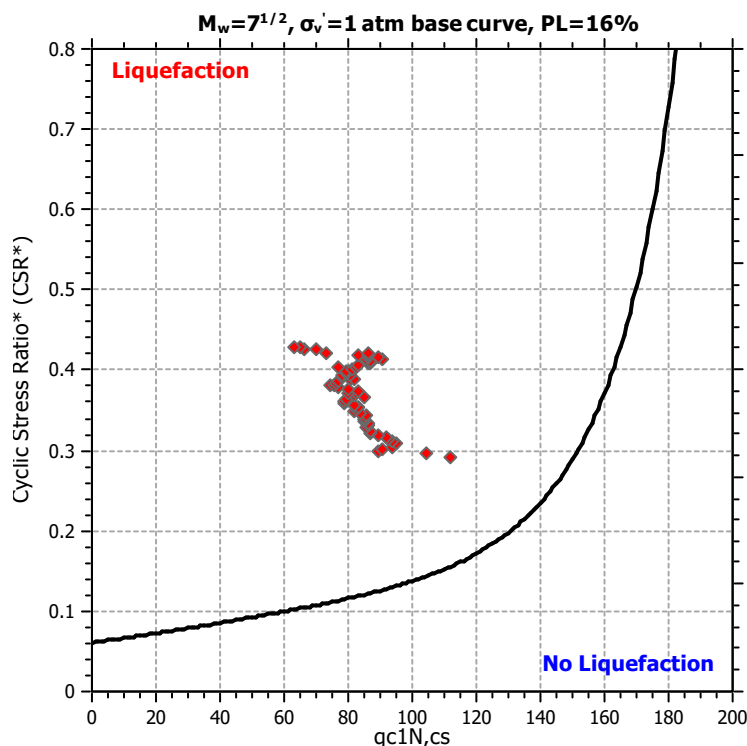
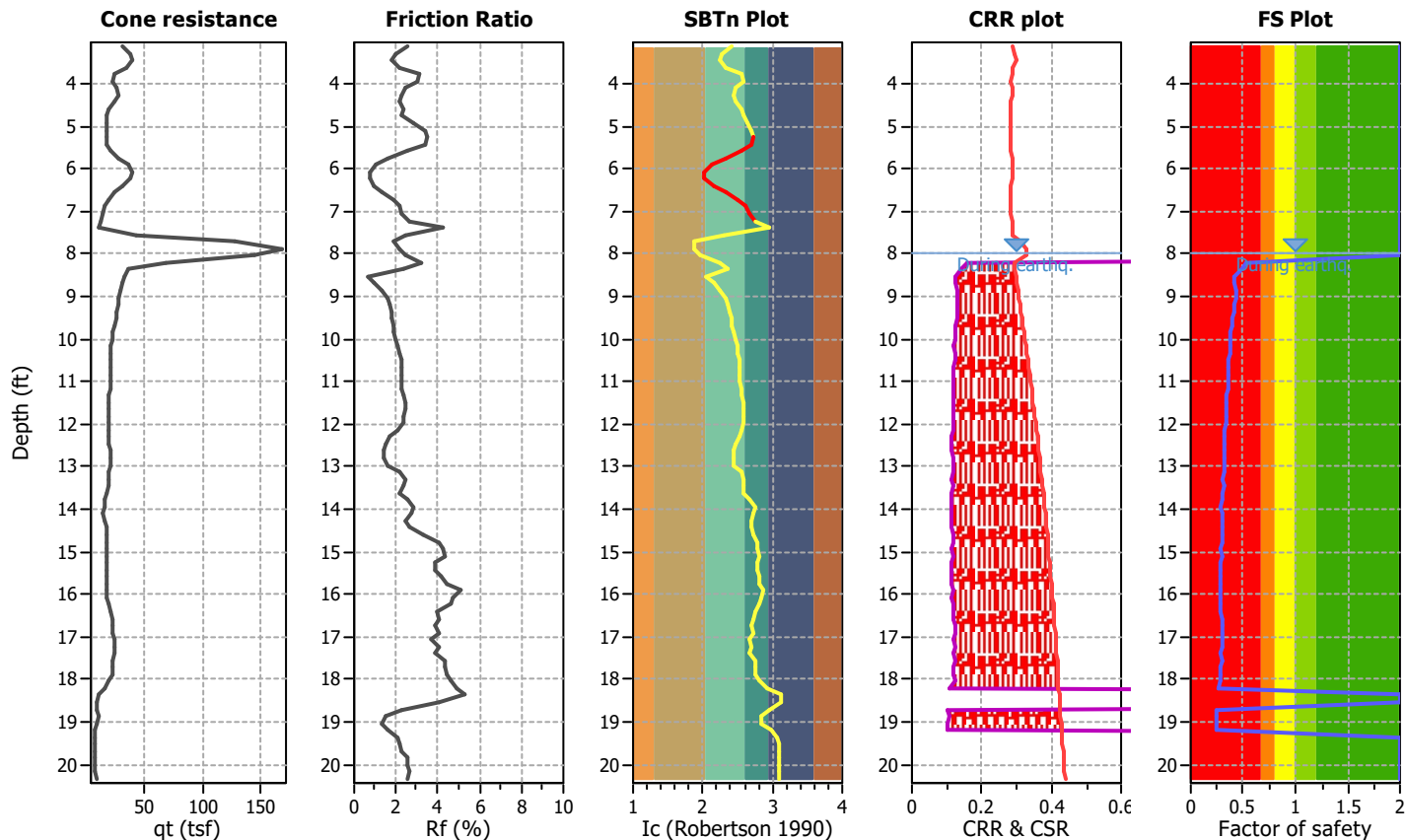
Project title : Owens Corning Linnton

Location : Portland

CPT file : CPT-4

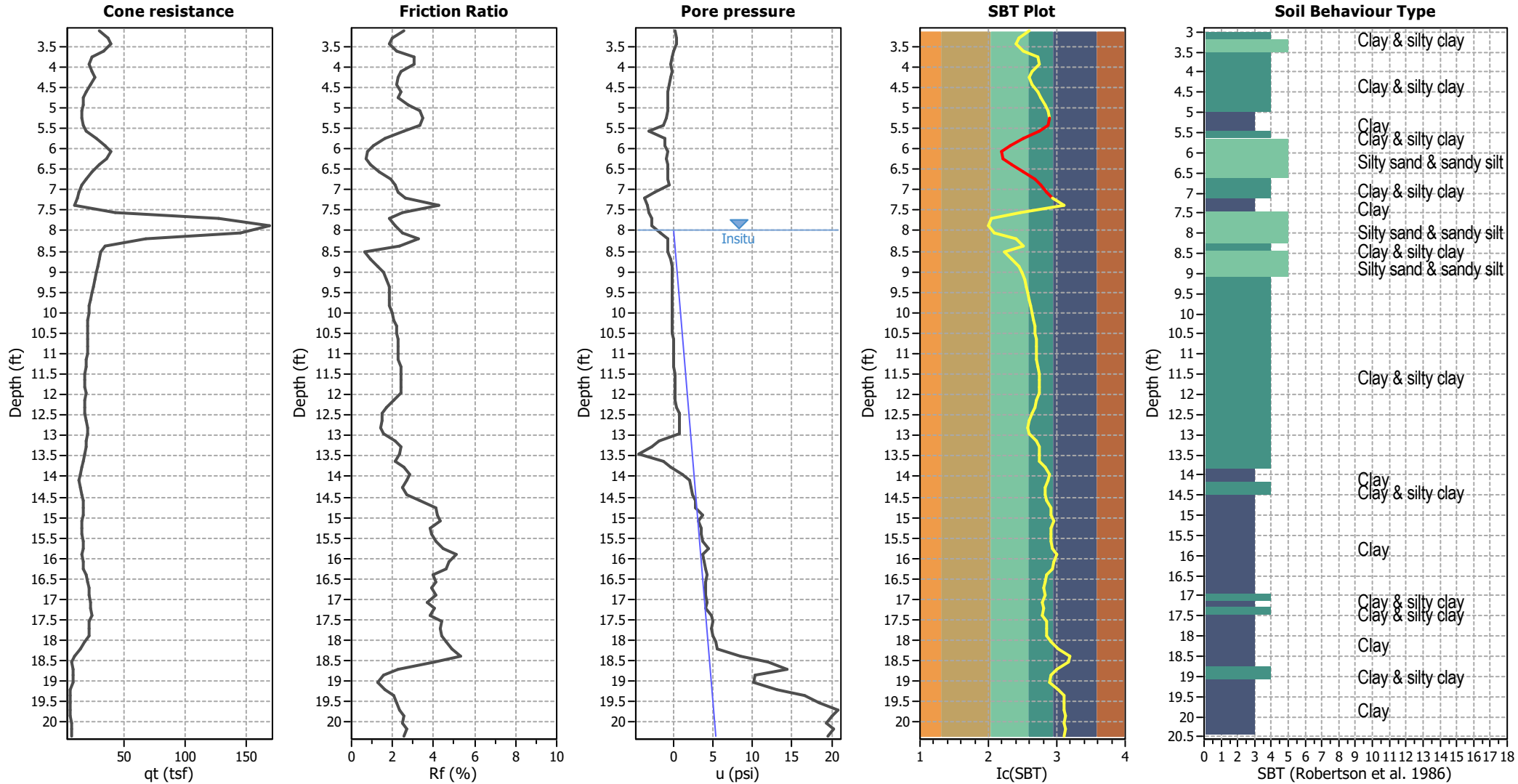
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w :	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: 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 plots



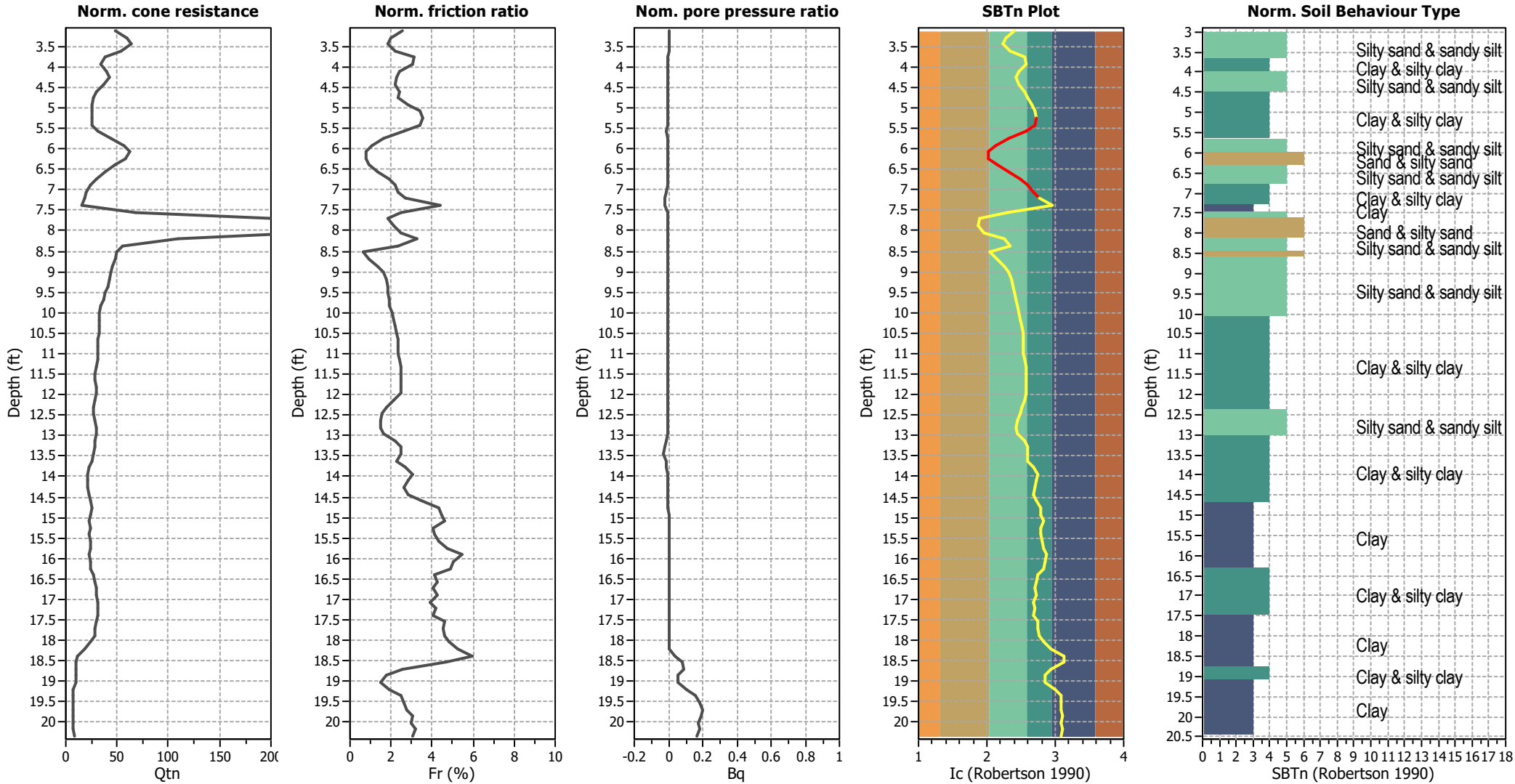
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K ₀ applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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 (normalized)



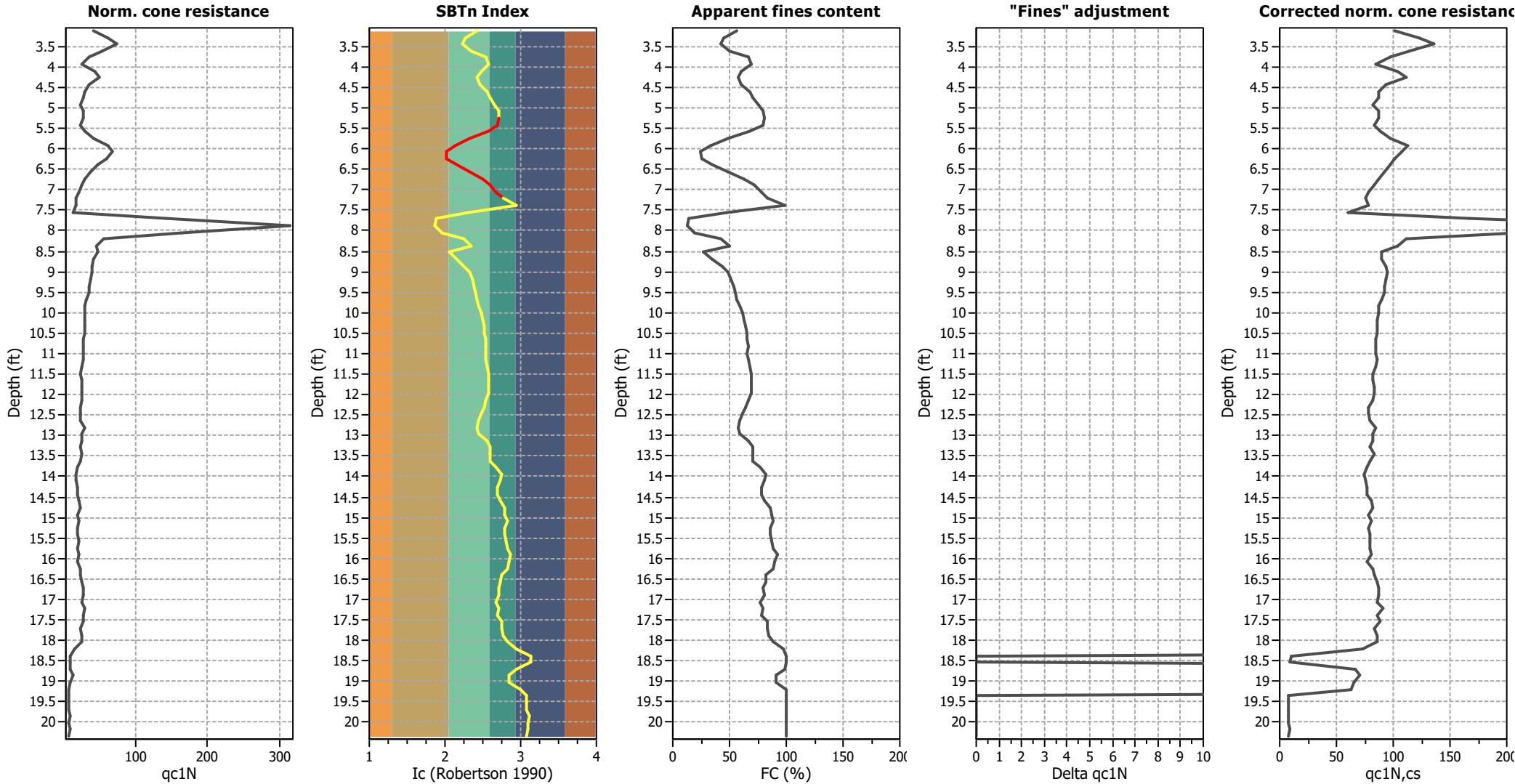
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _o applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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

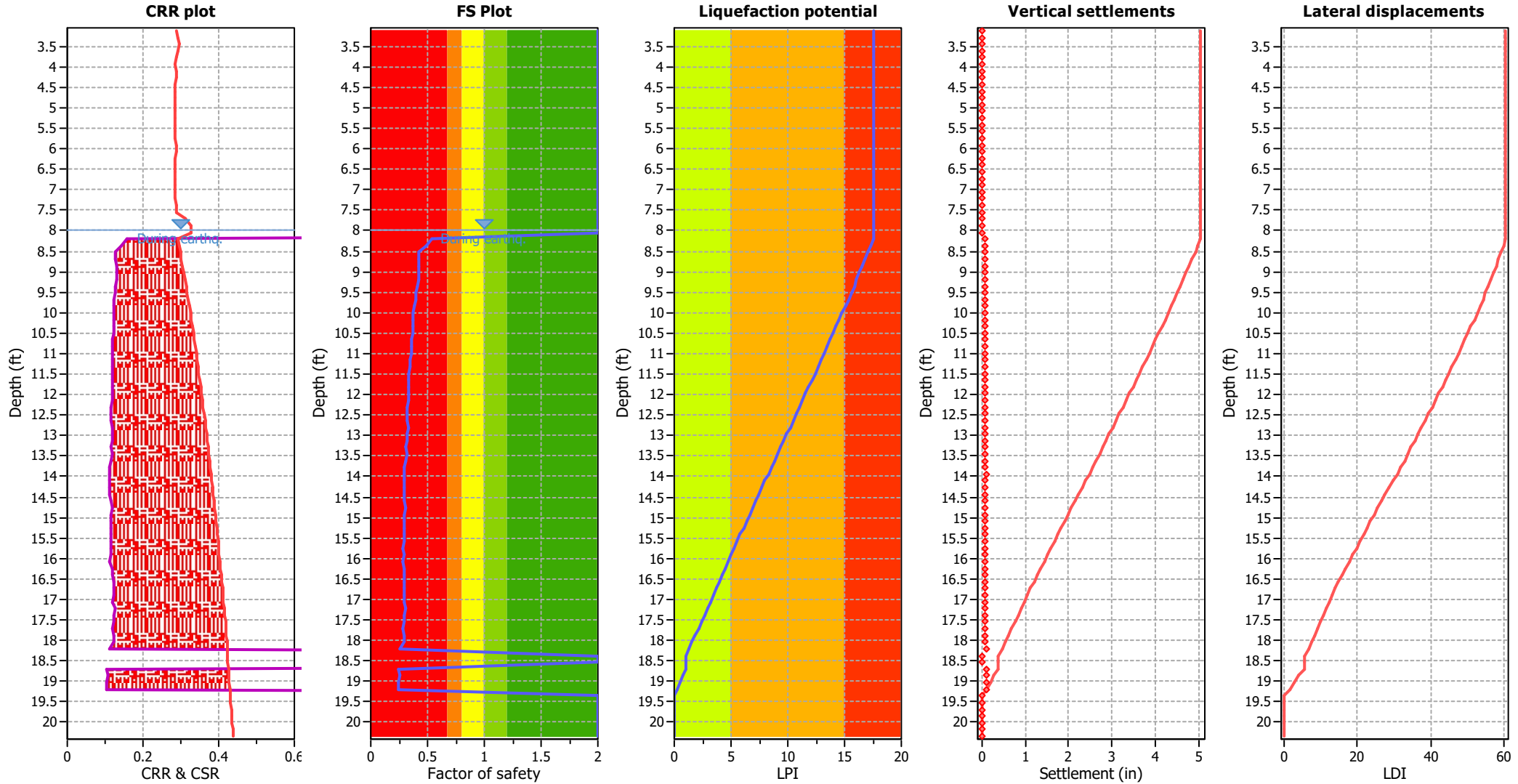
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K ₀ applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

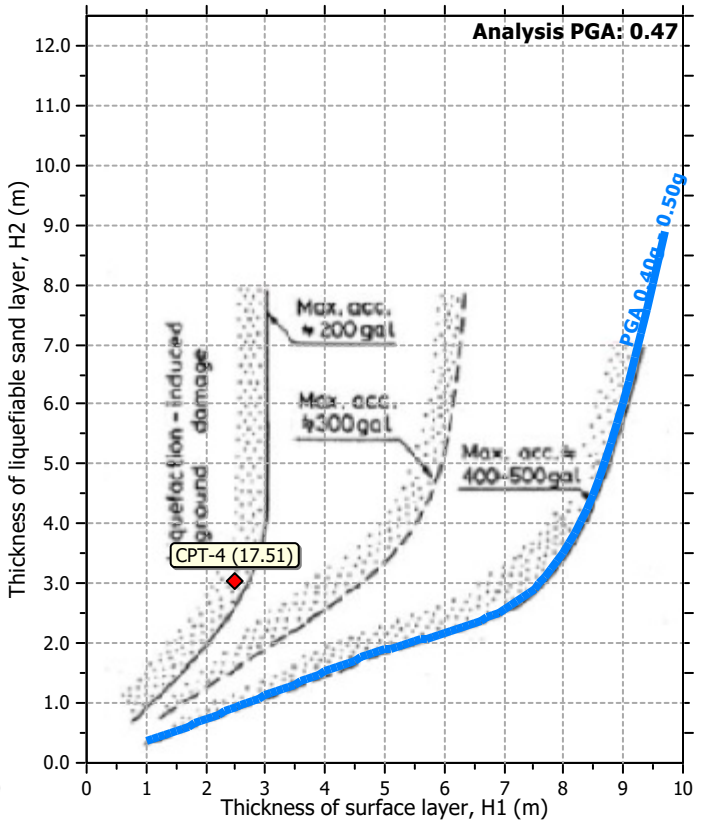
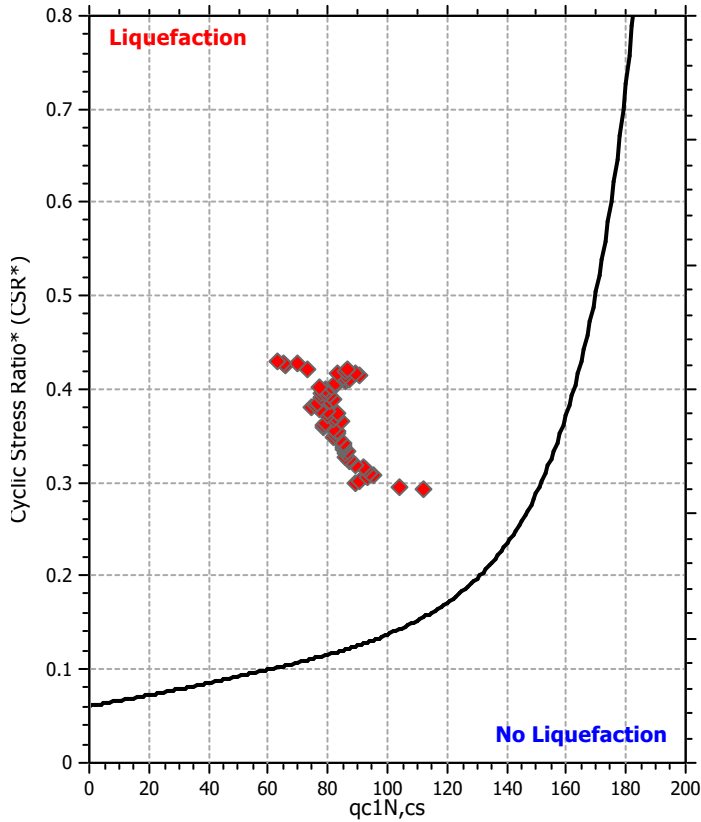
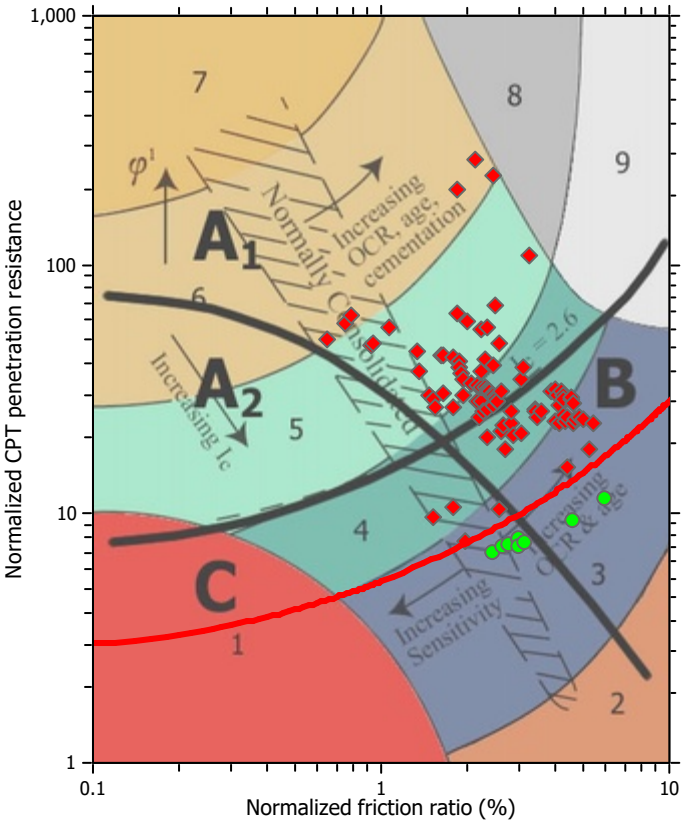
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

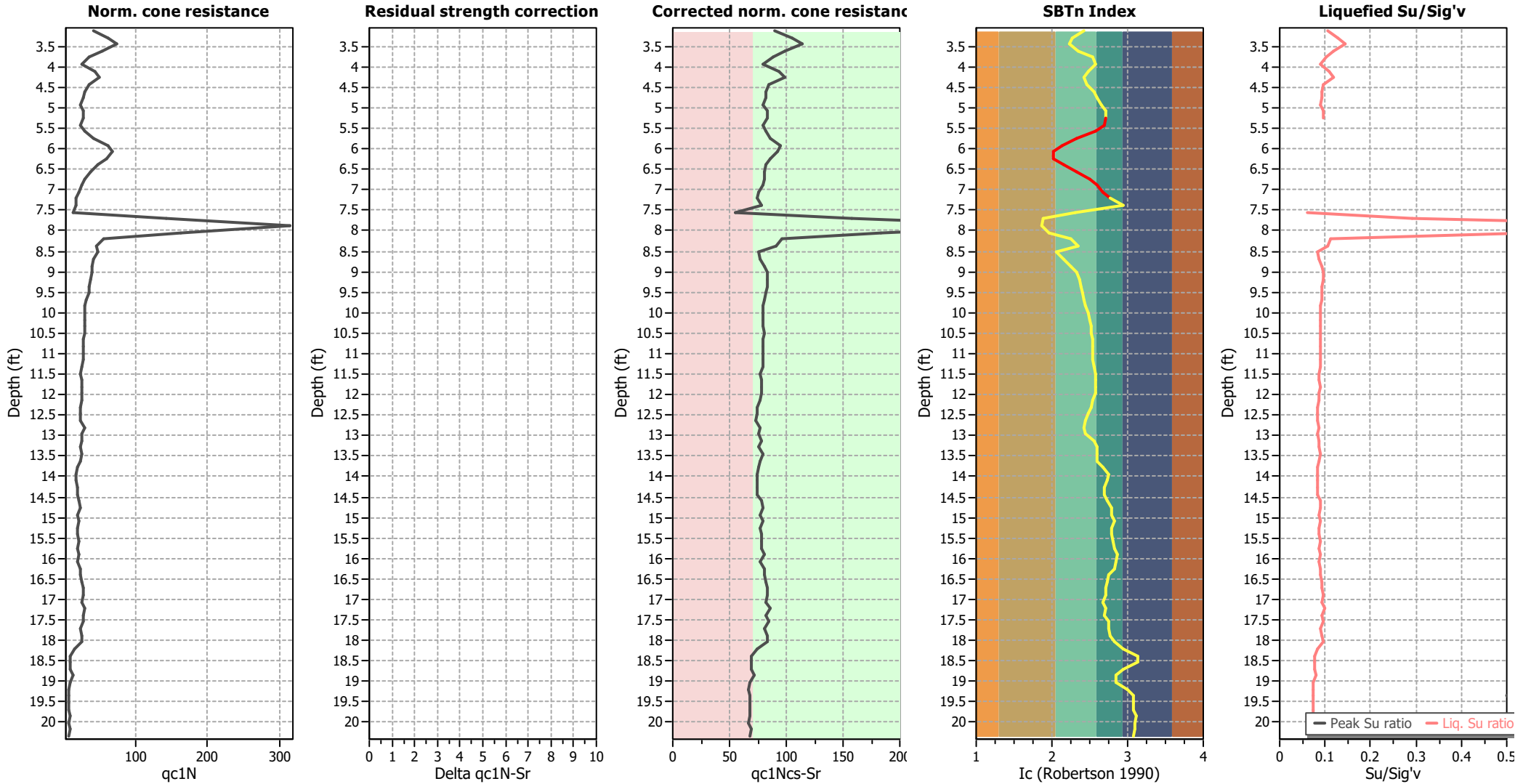
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	3.00	K_{ϕ} applied:	Yes
Earthquake magnitude M_w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

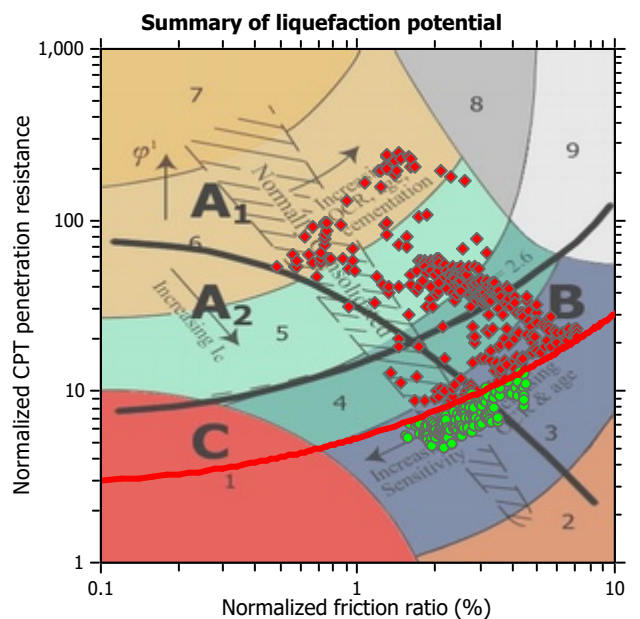
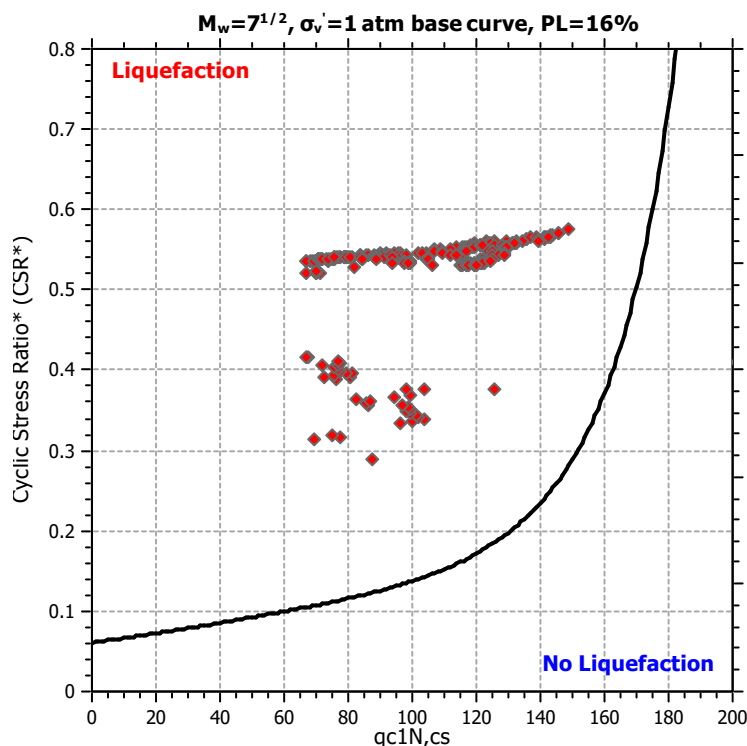
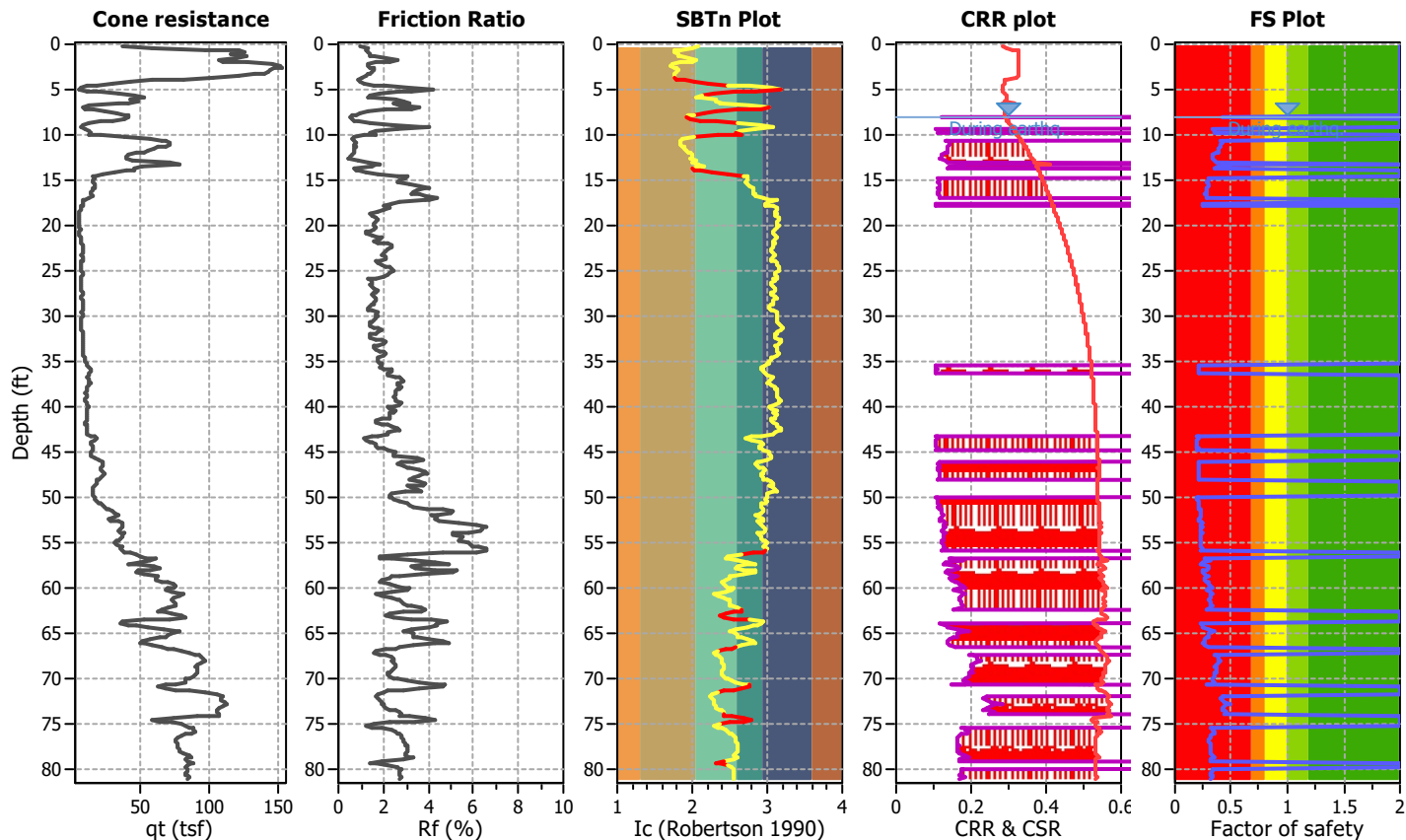
Project title : Owens Corning Linnton

Location : Portland

CPT file : CPT-1

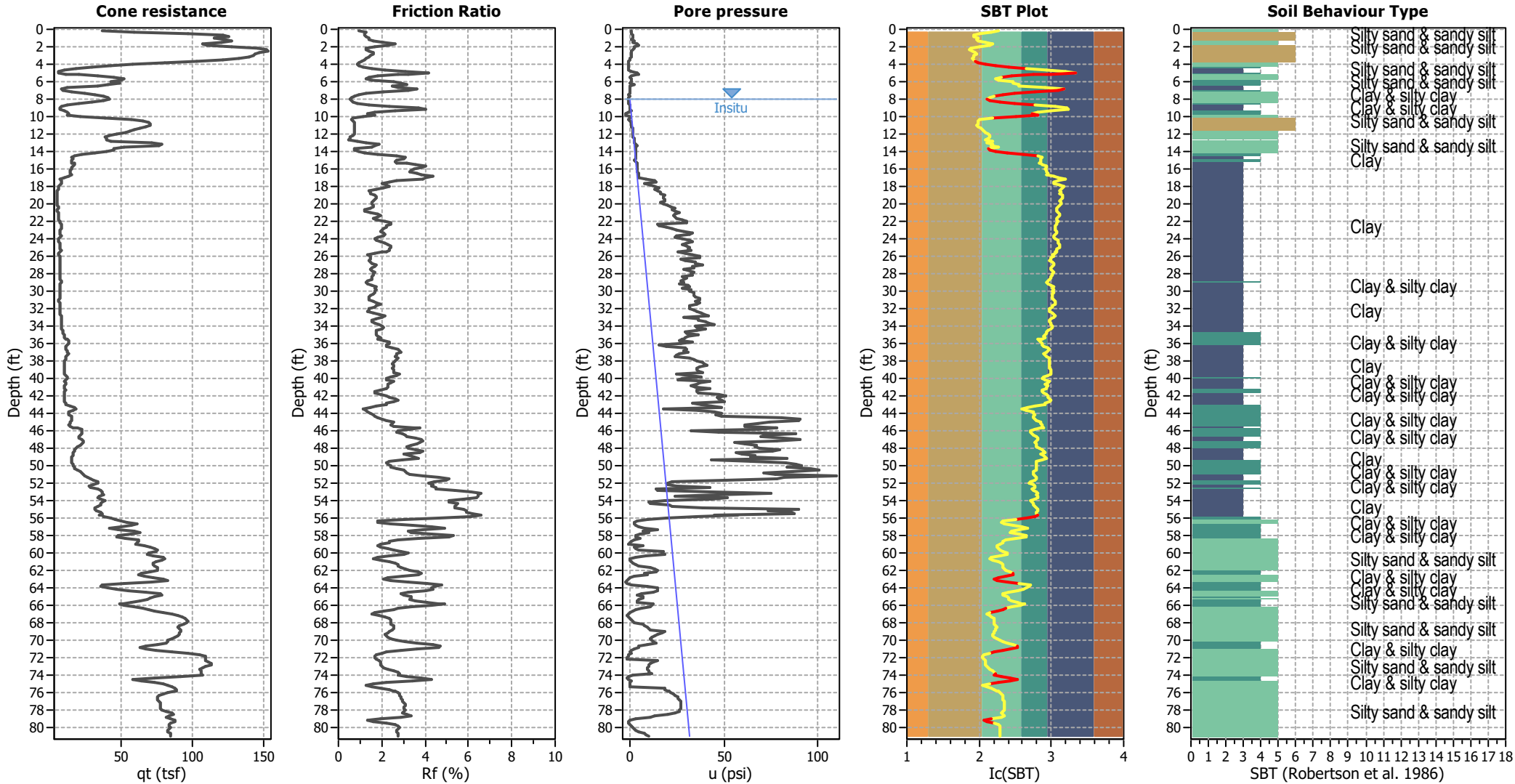
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w :	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based



Zone A1: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A2: 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 plots



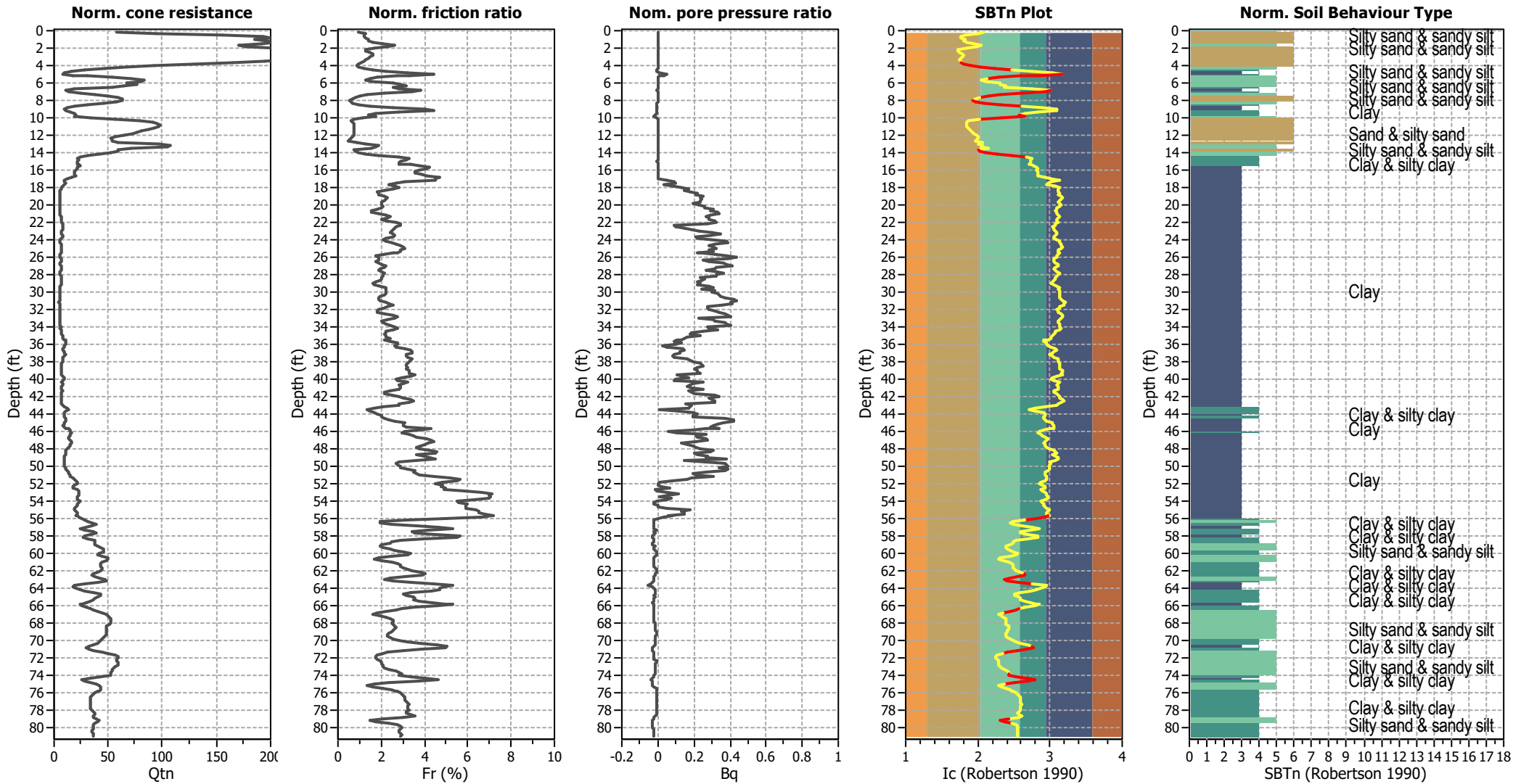
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _o applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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 (normalized)



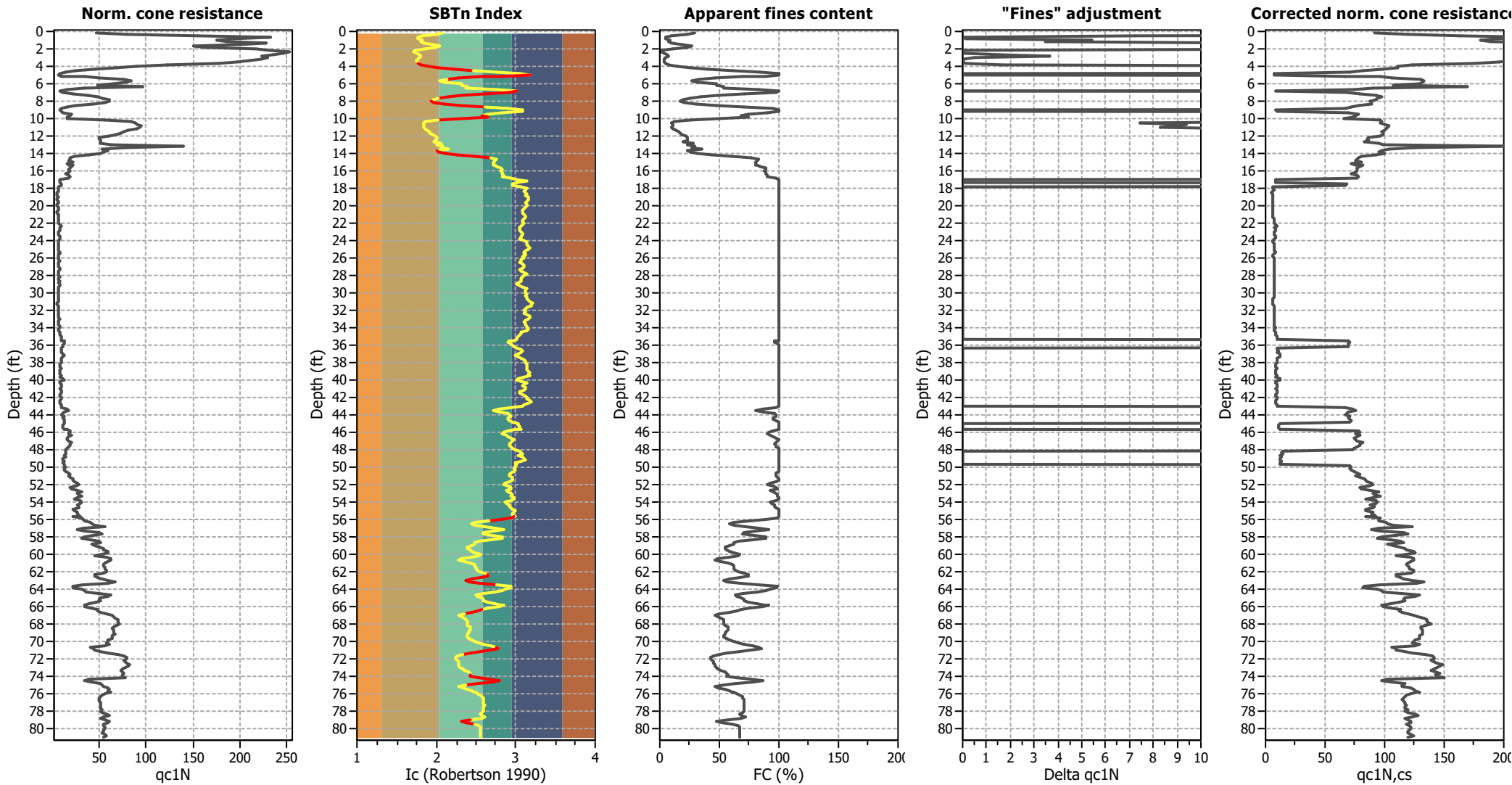
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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

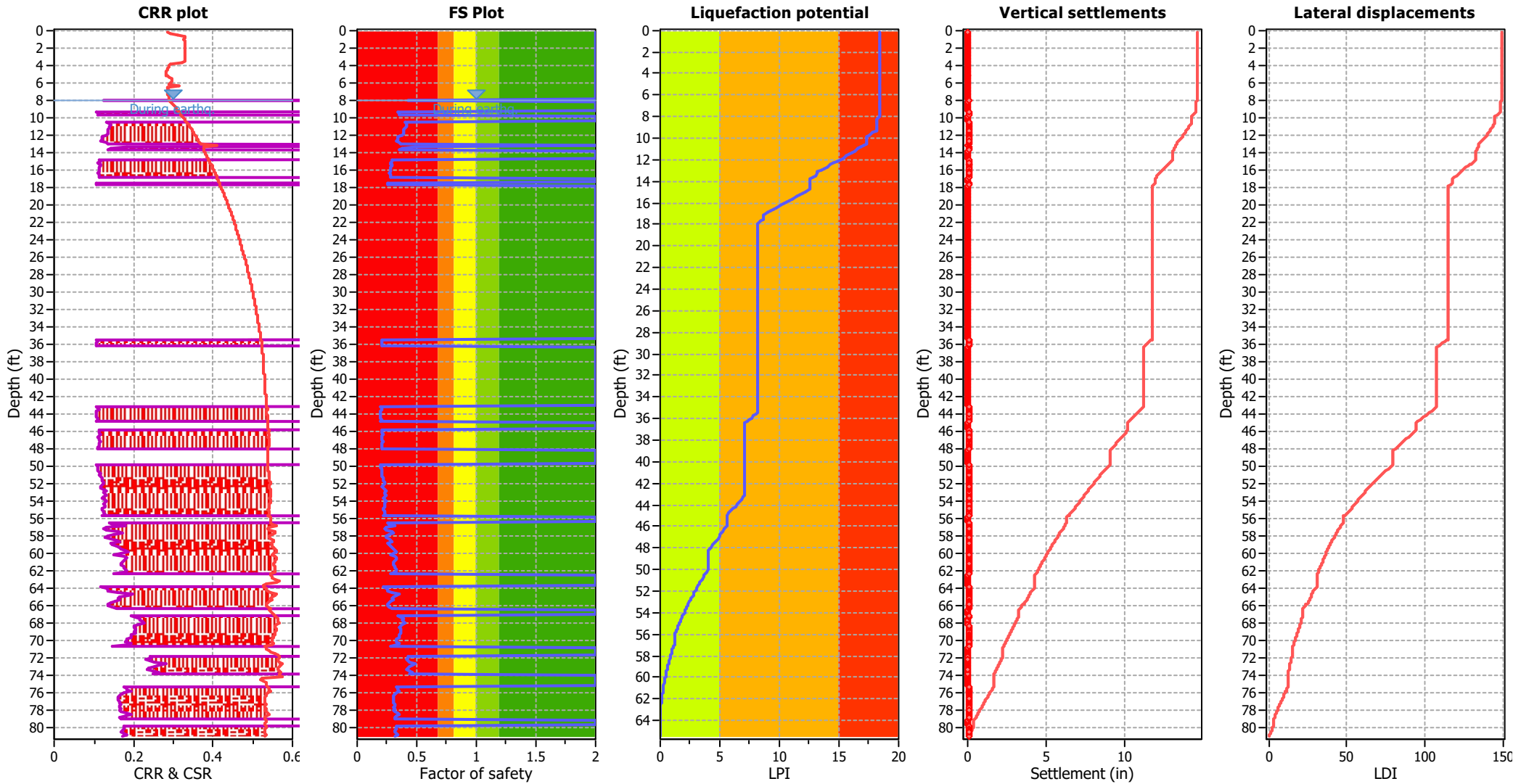
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

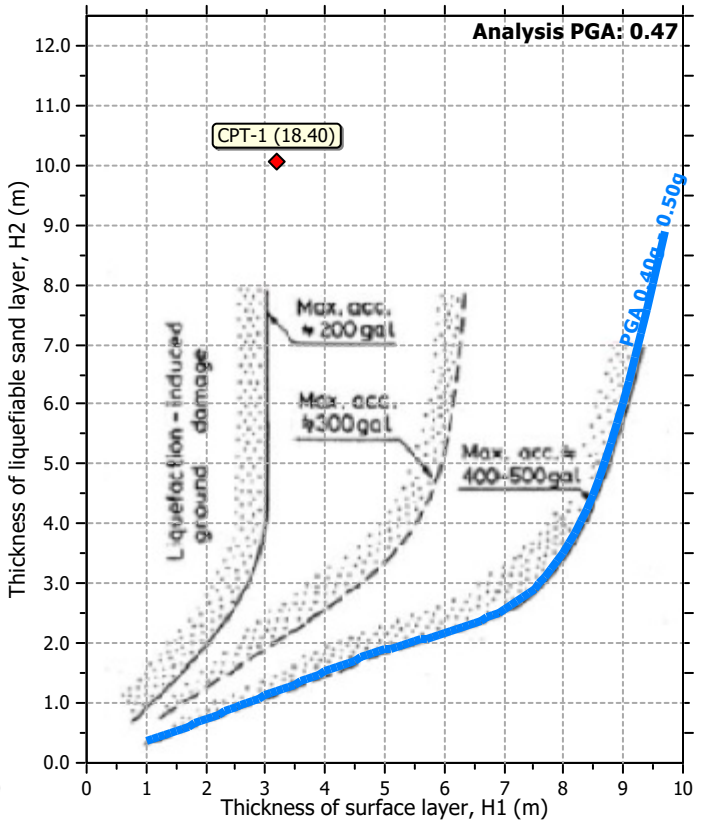
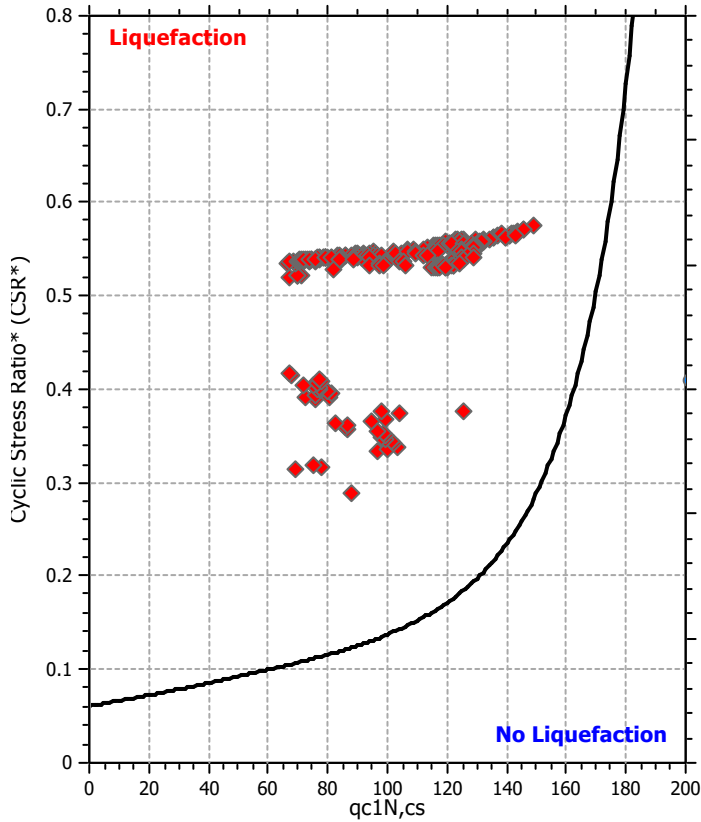
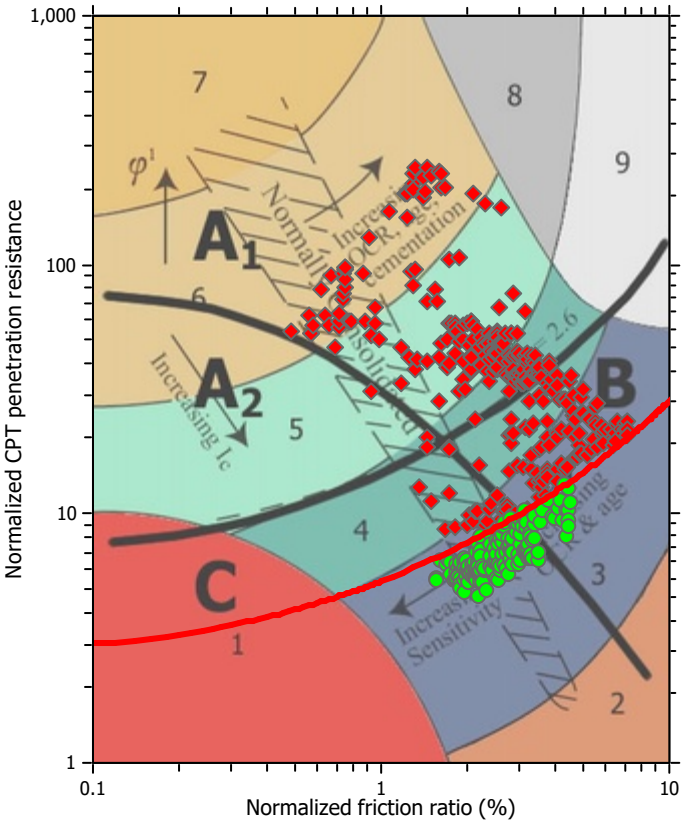
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

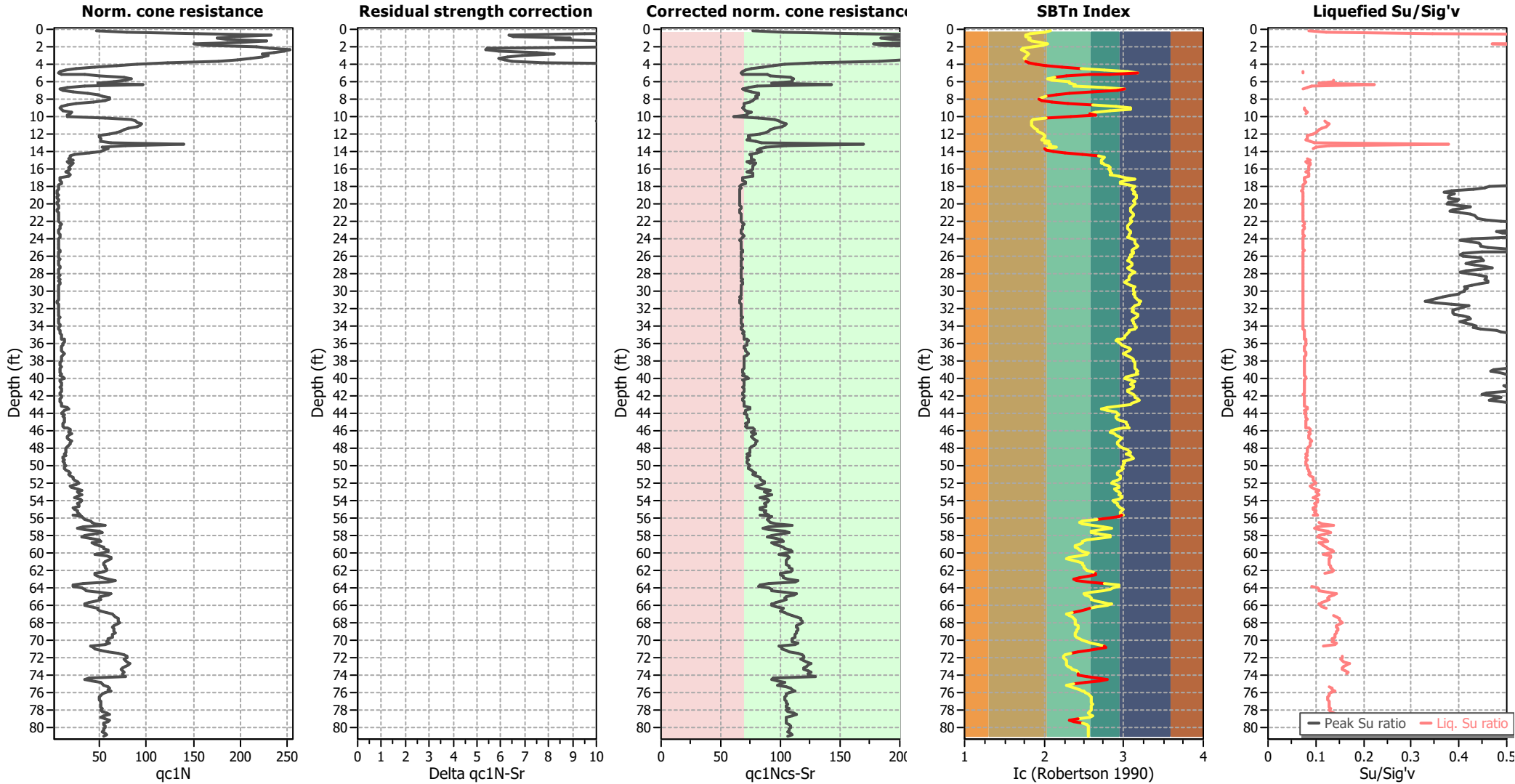
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_{ϕ} applied:	Yes
Earthquake magnitude M_w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

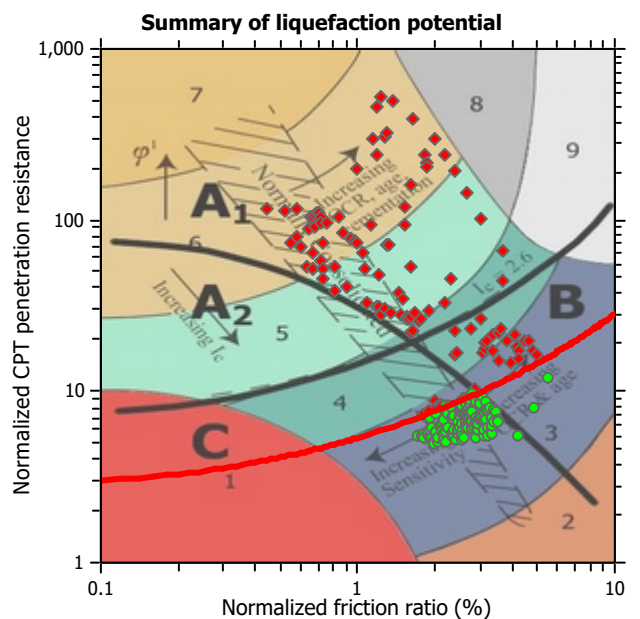
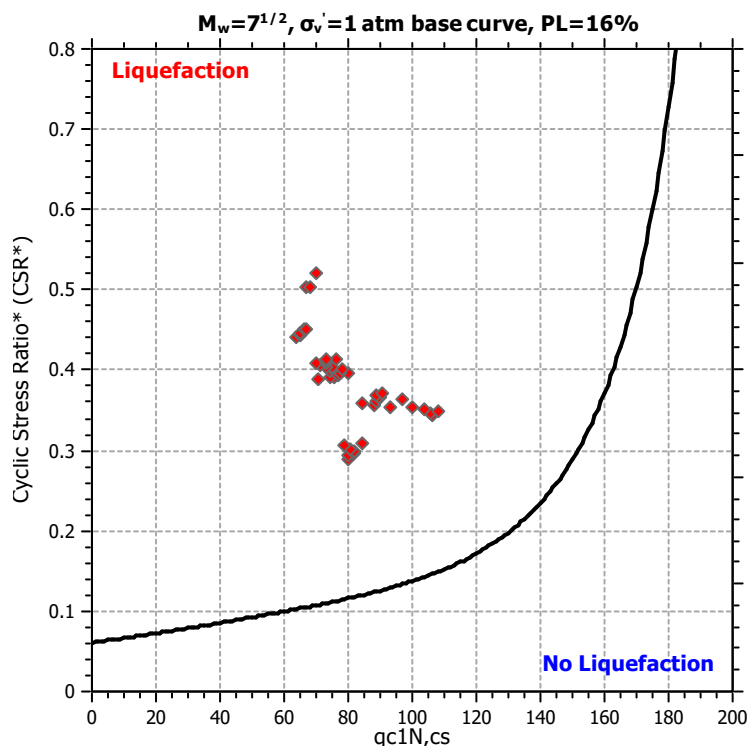
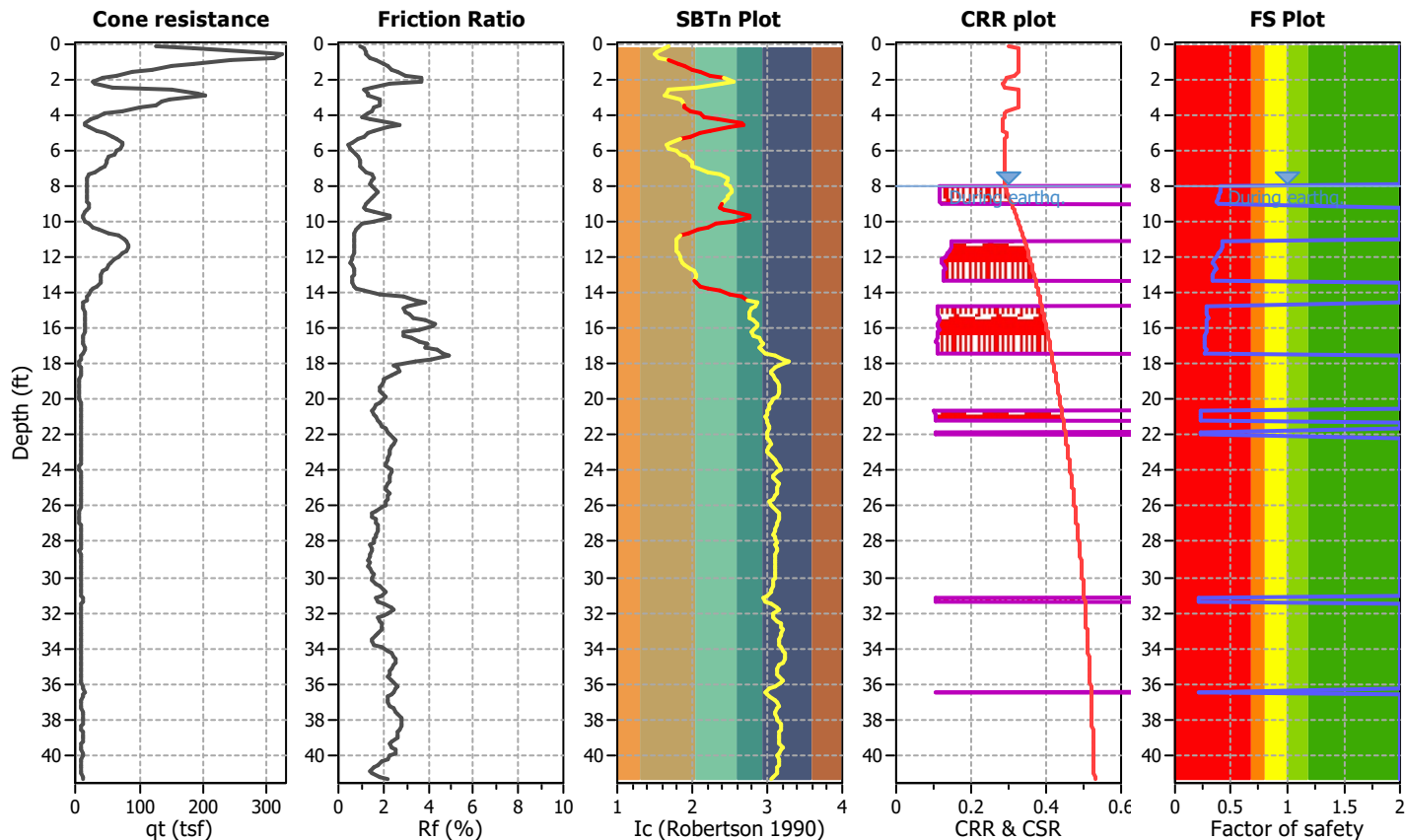
Project title : Owens Corning Linnton

Location : Portland

CPT file : CPT-2

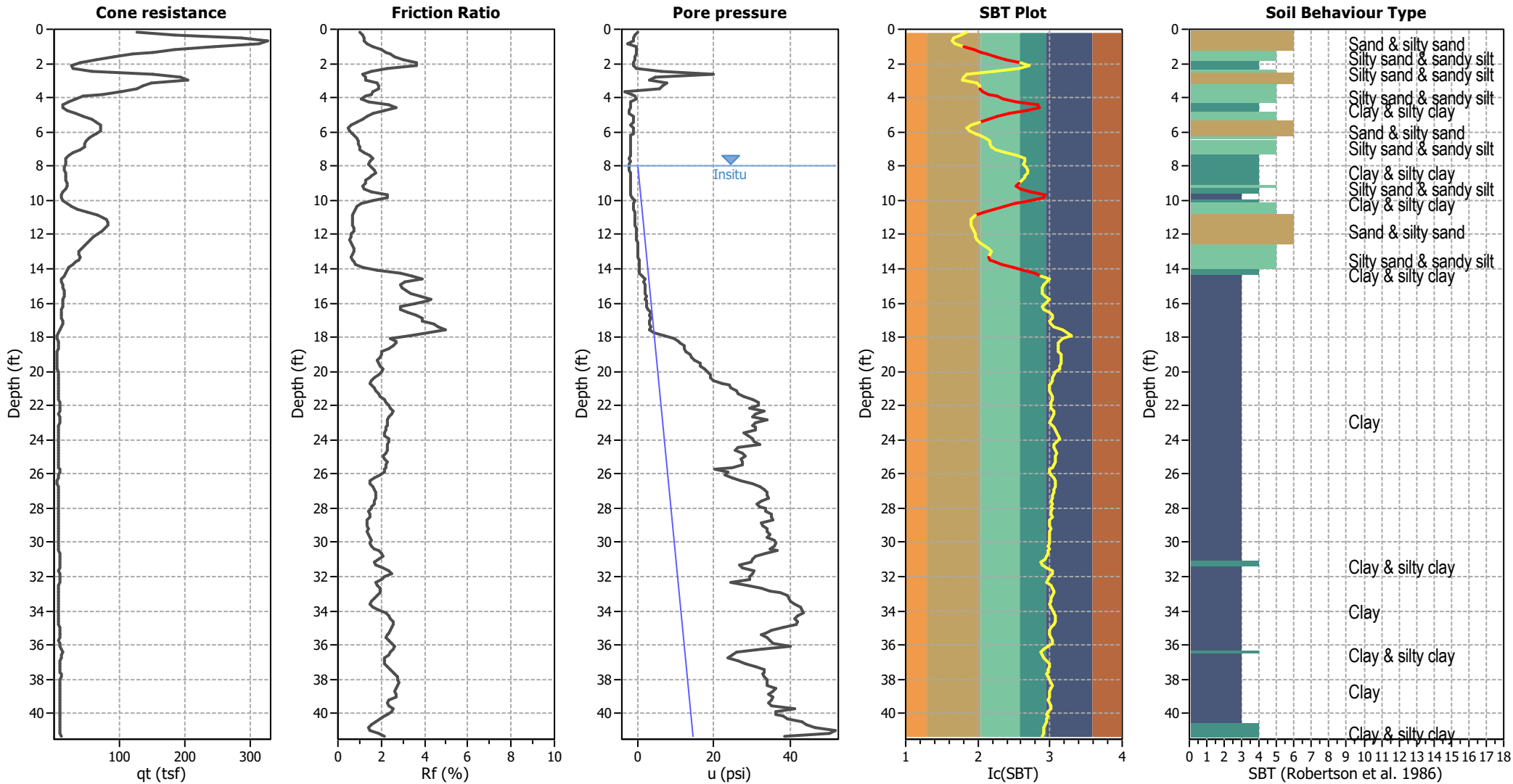
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w :	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based



Zone A1: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A2: 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 plots



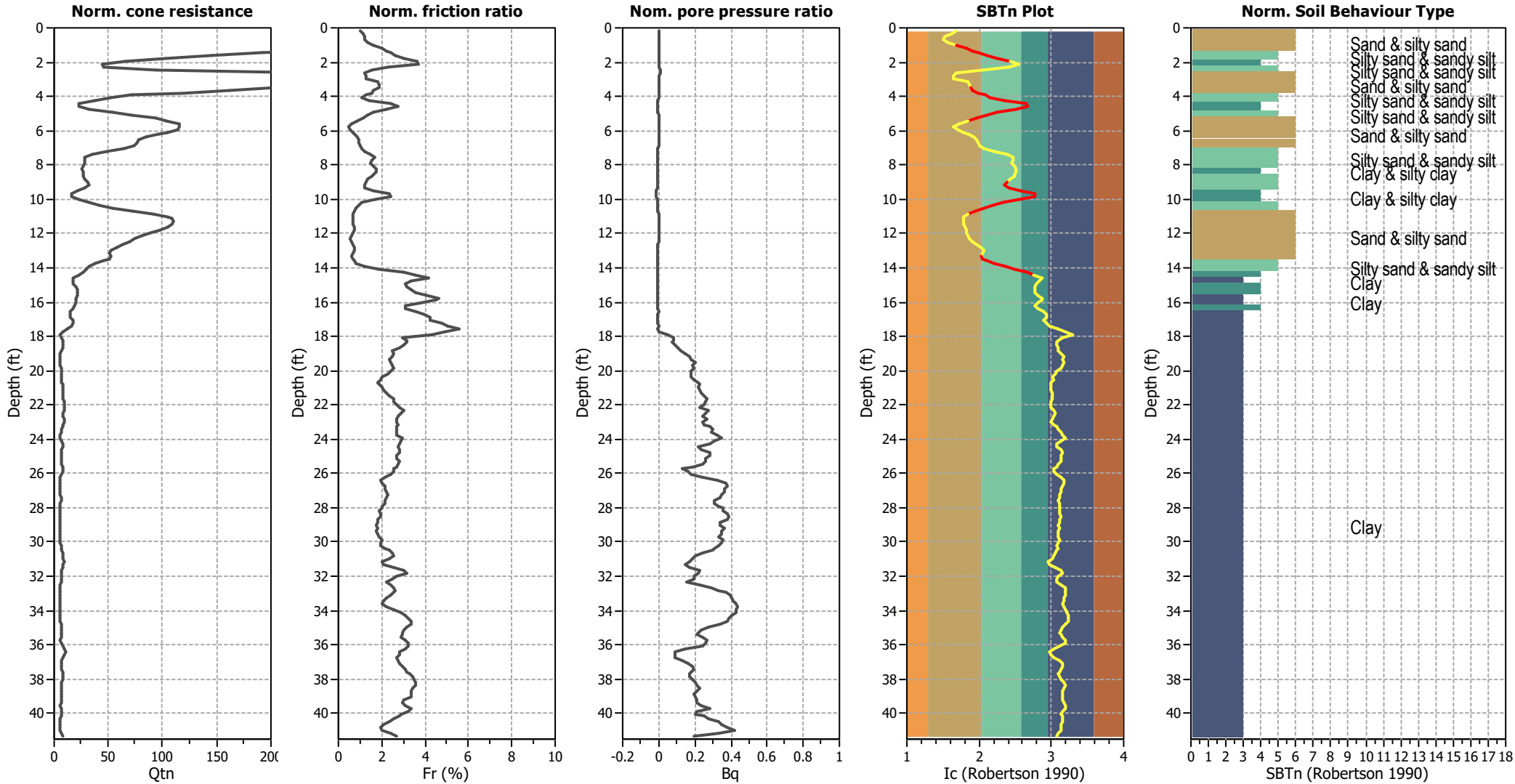
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K ₀ applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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 (normalized)



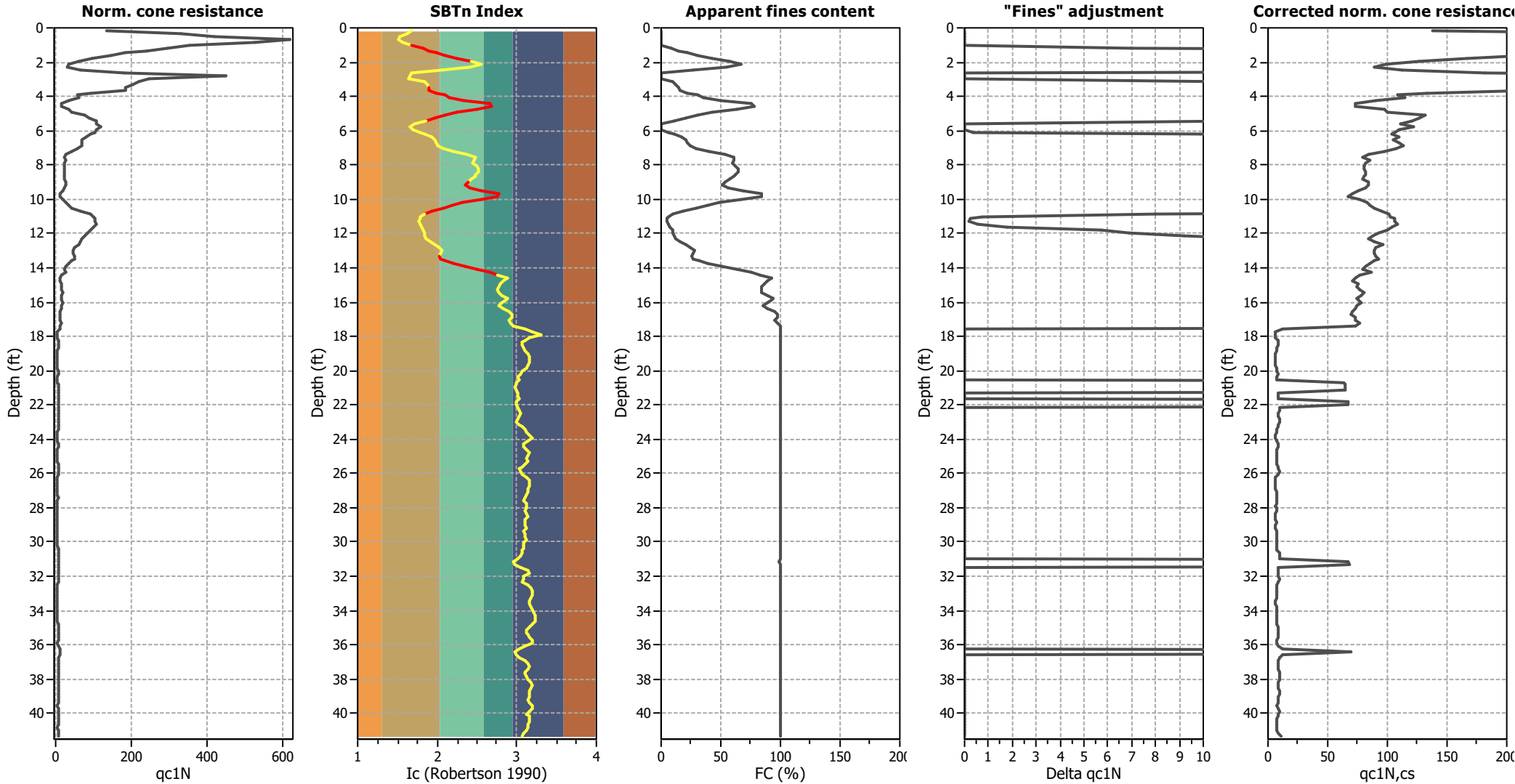
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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

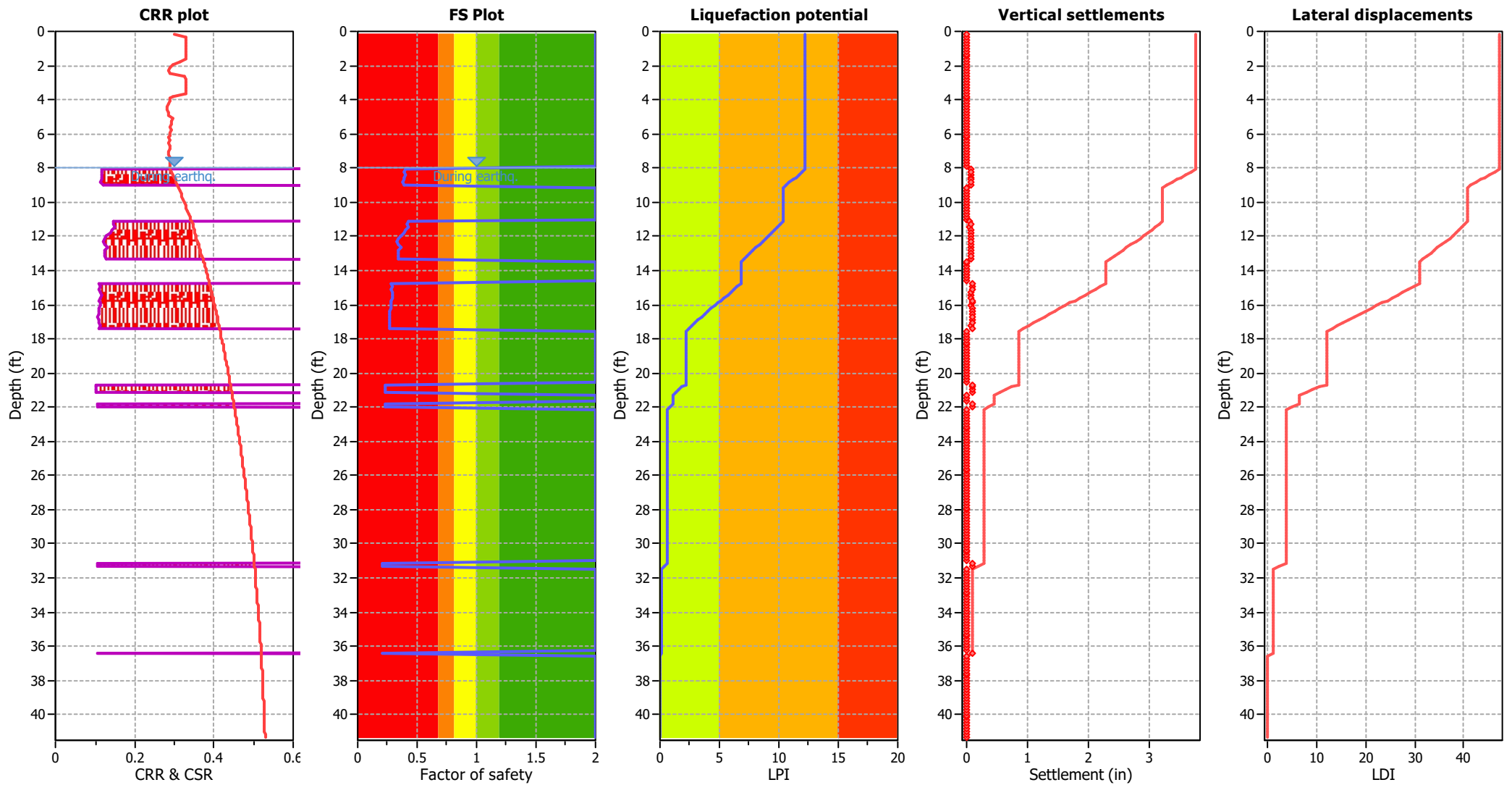
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K ₀ applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

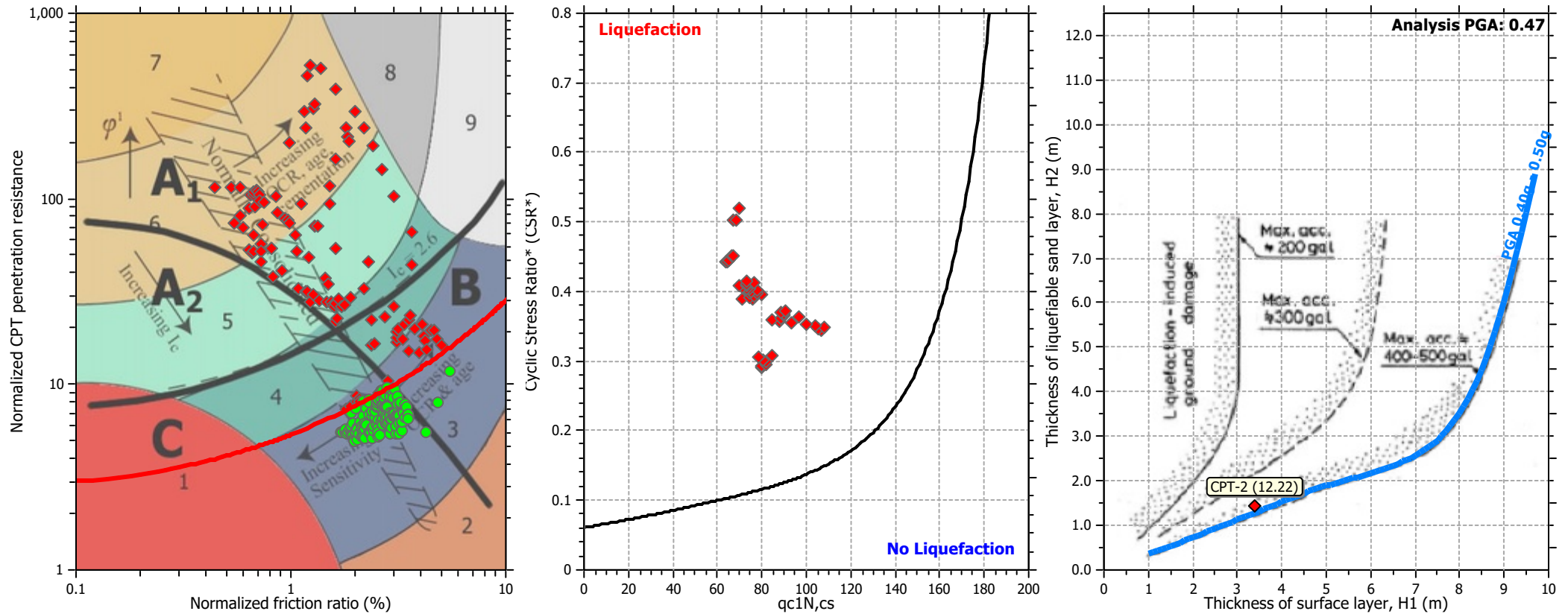
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

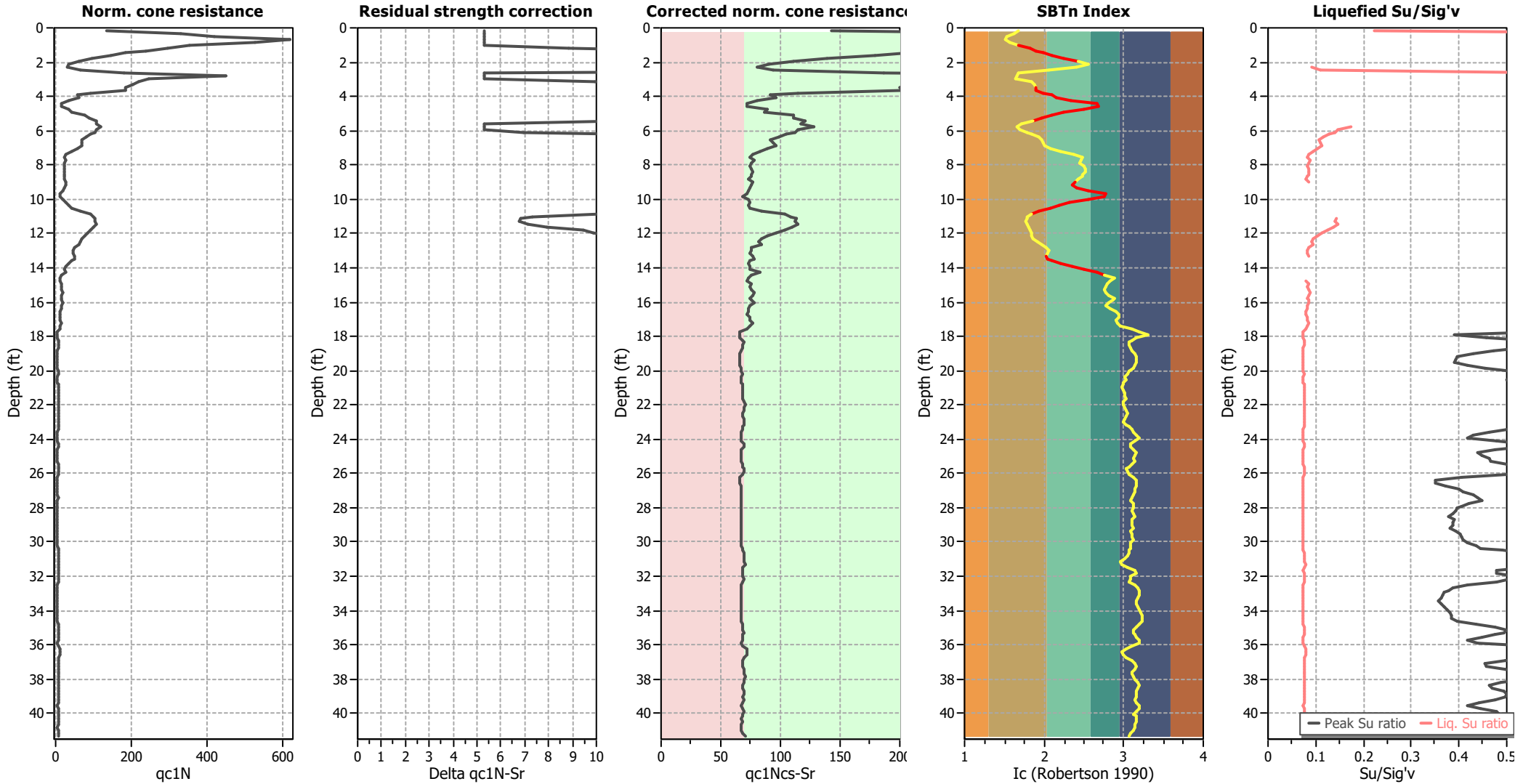
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	3.00	K_{σ} applied:	Yes
Earthquake magnitude M_w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

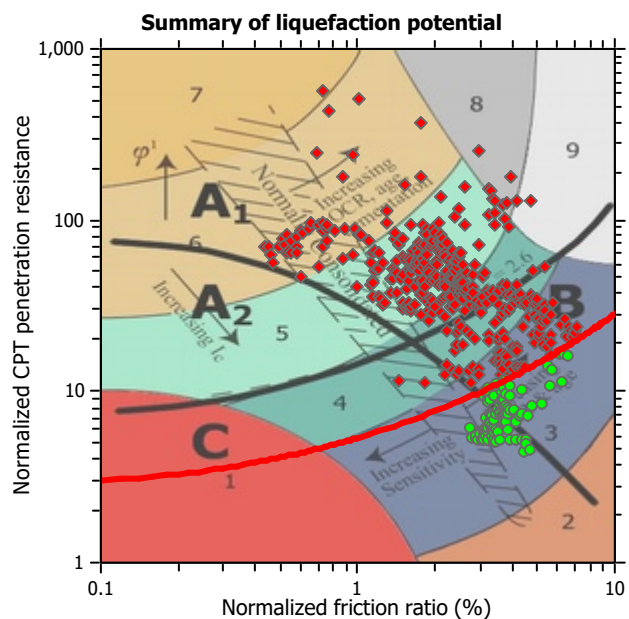
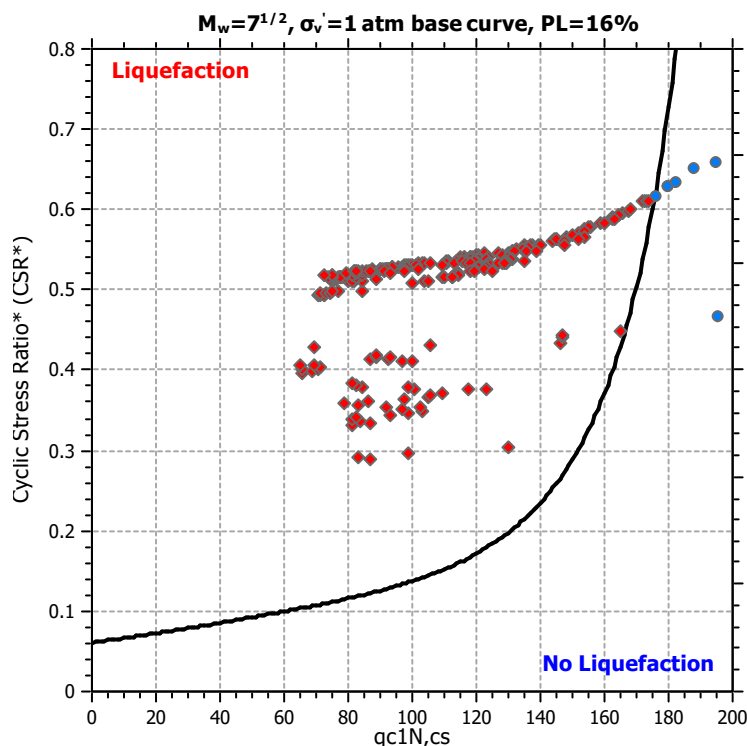
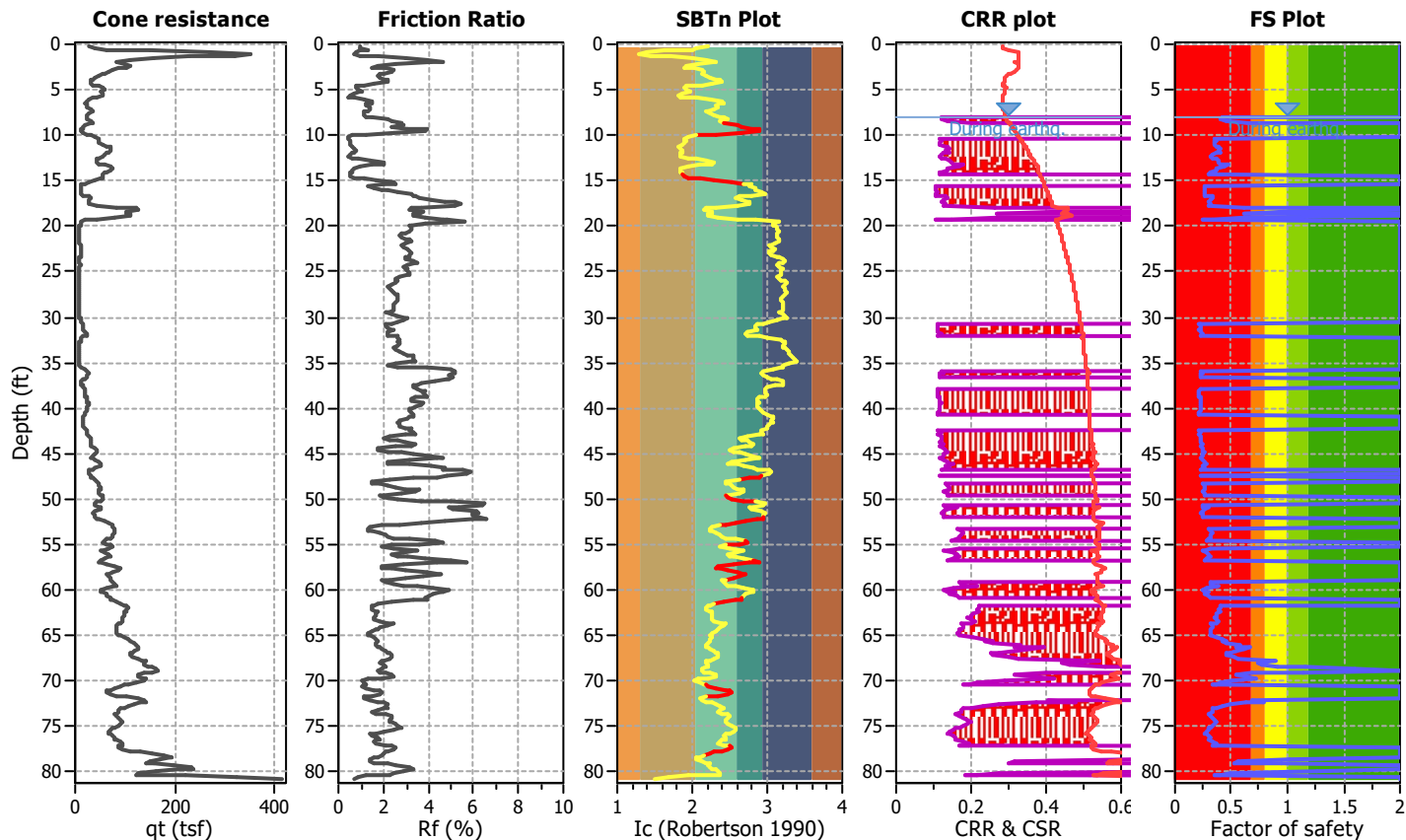
Project title : Owens Corning Linnton

Location : Portland

CPT file : CPT-3

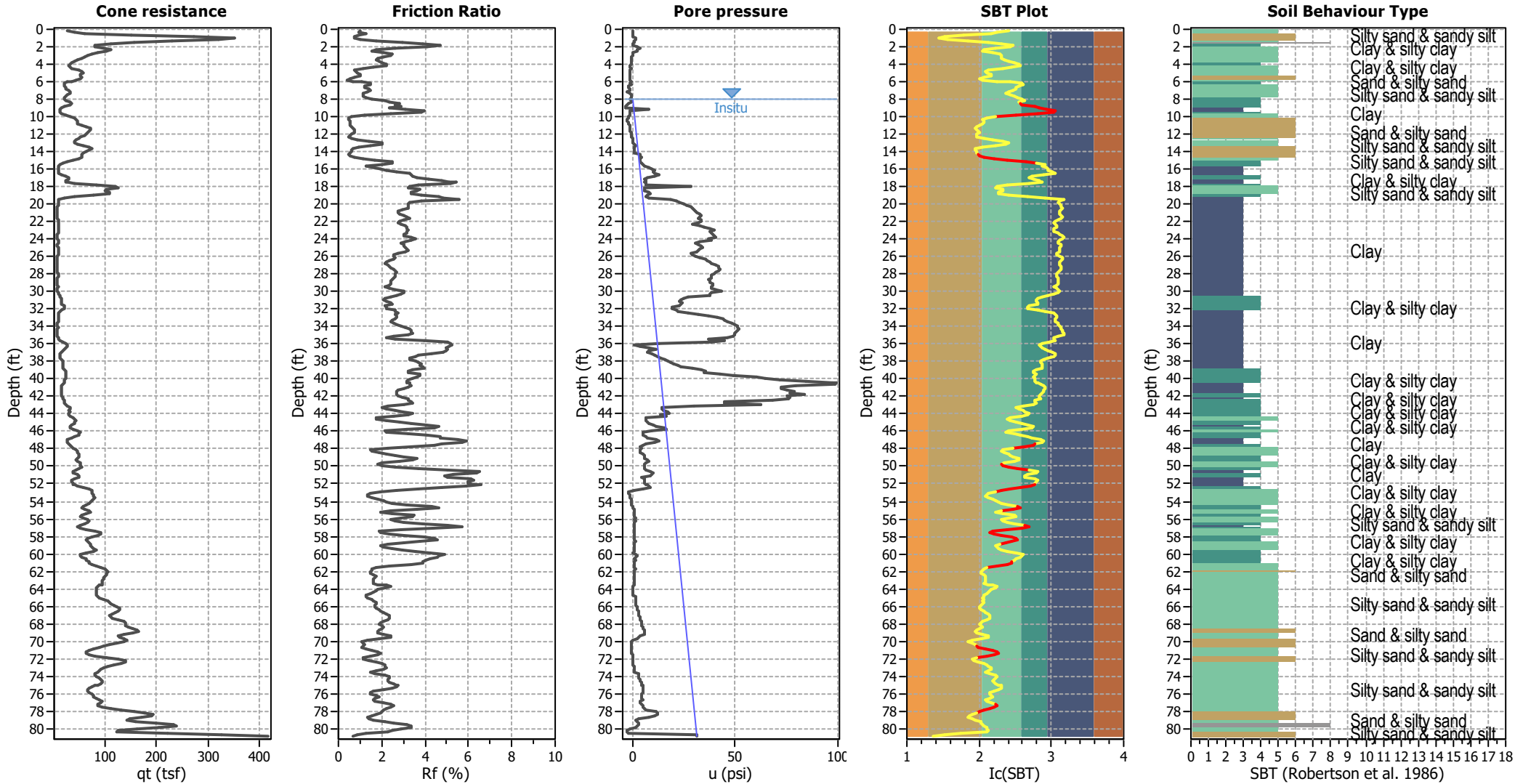
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w :	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based



Zone A1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A2: 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 plots



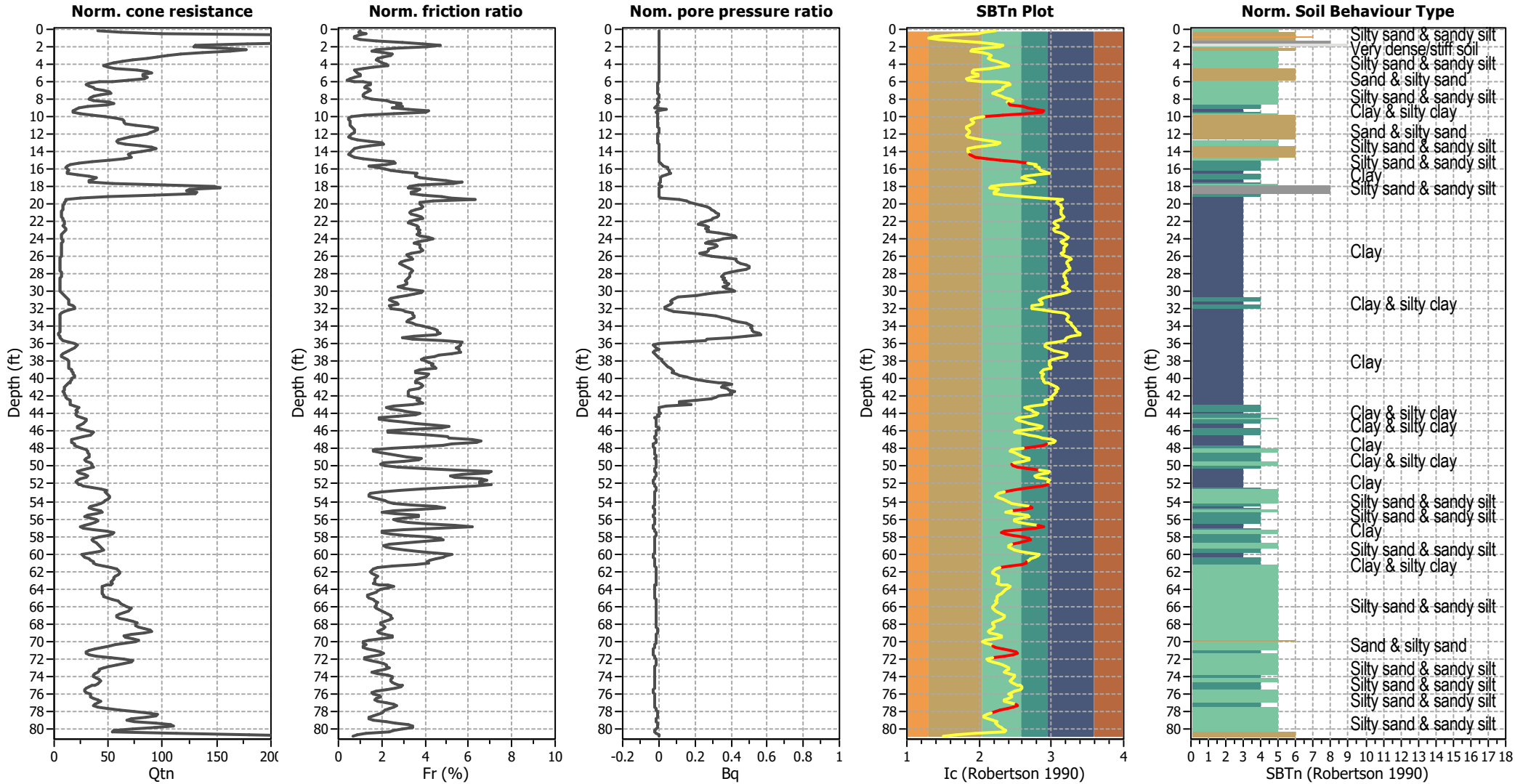
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _o applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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 (normalized)



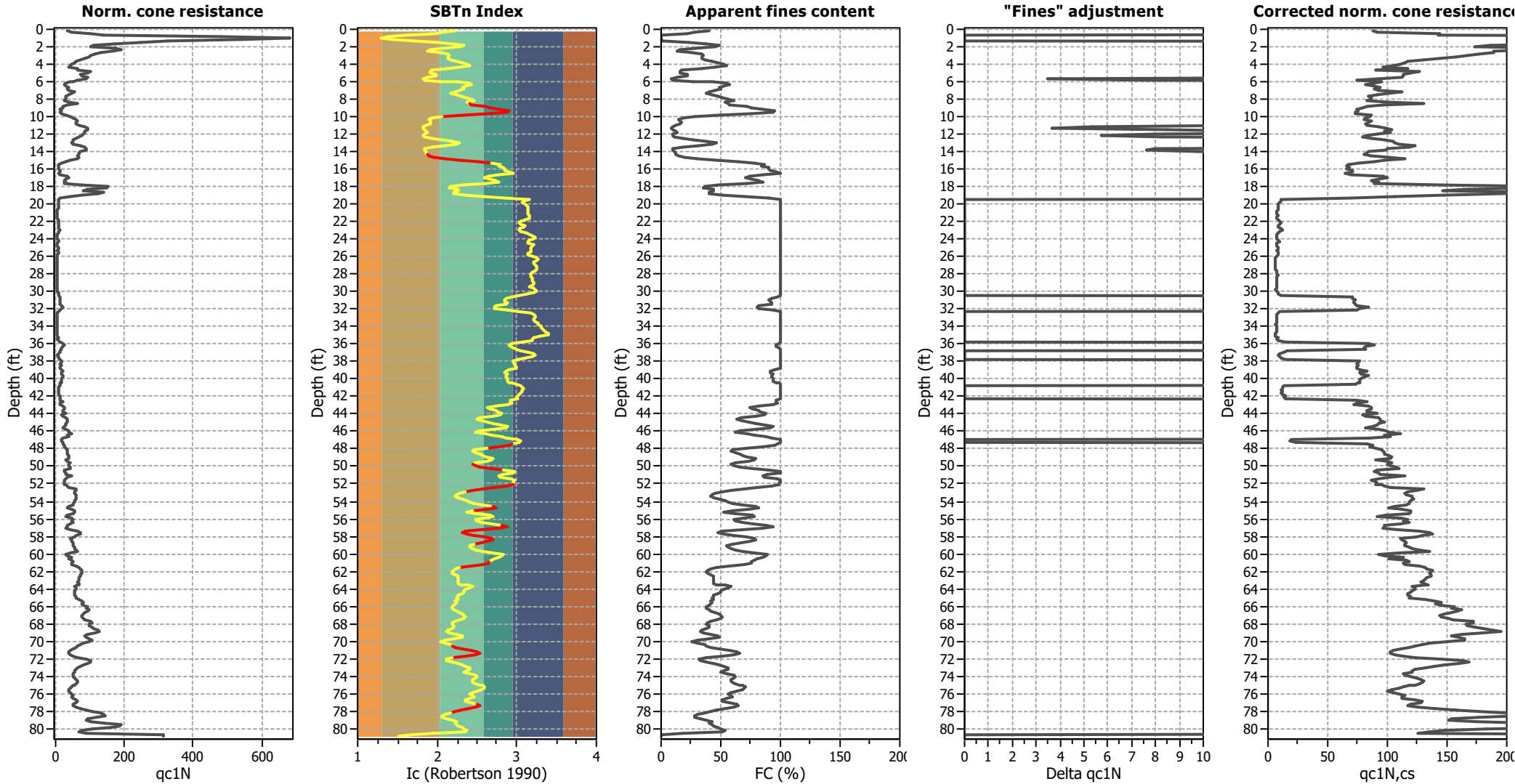
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

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

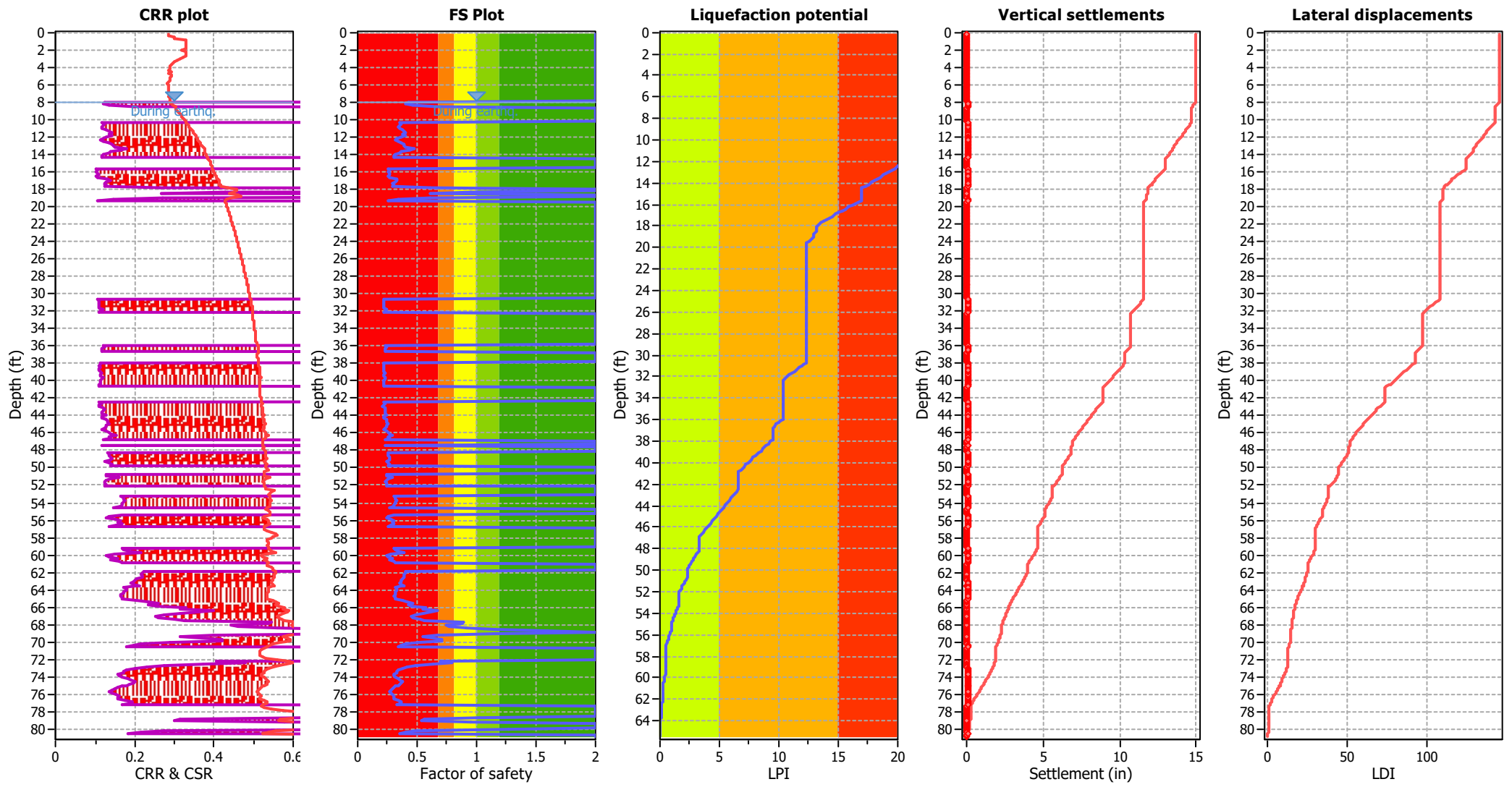
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

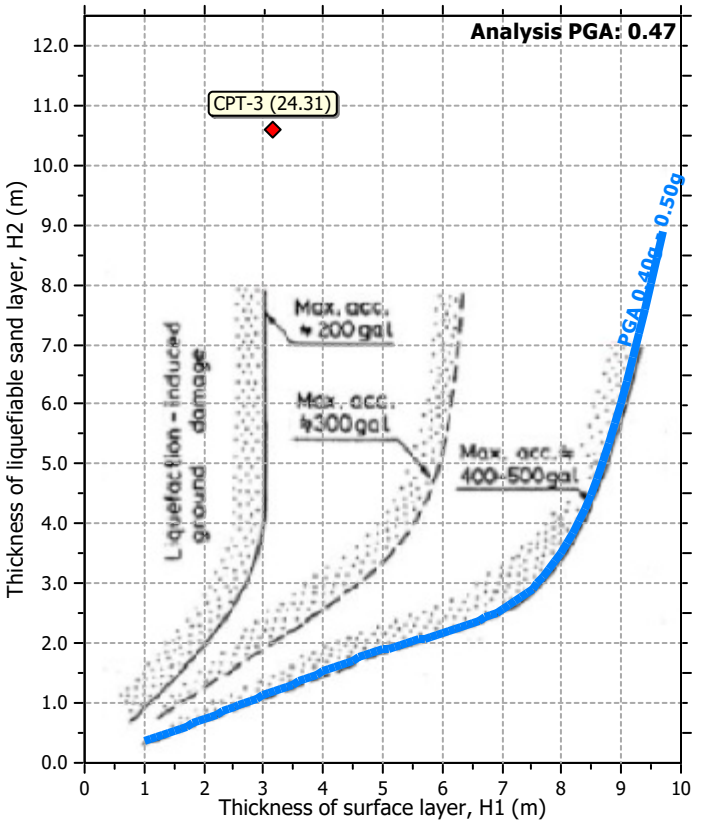
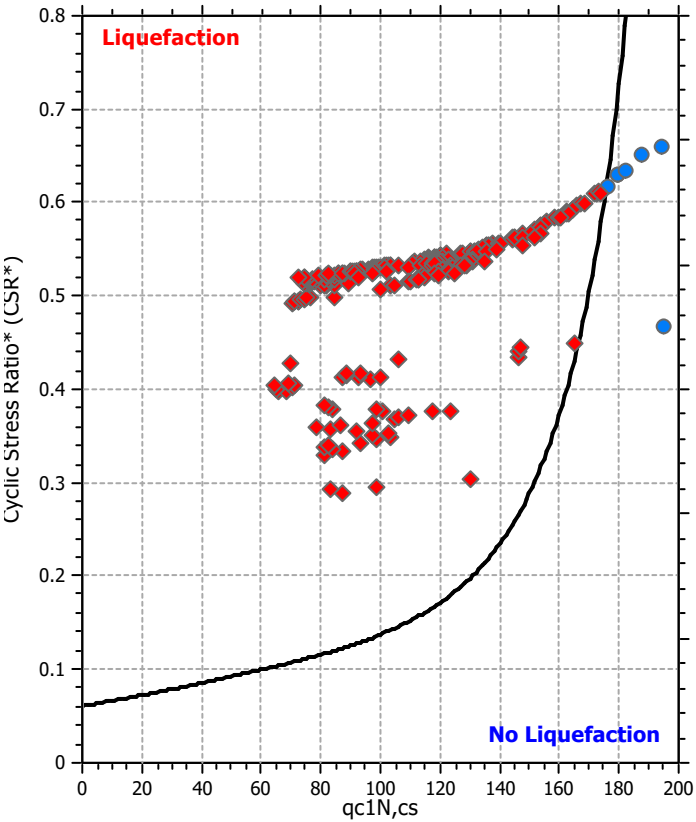
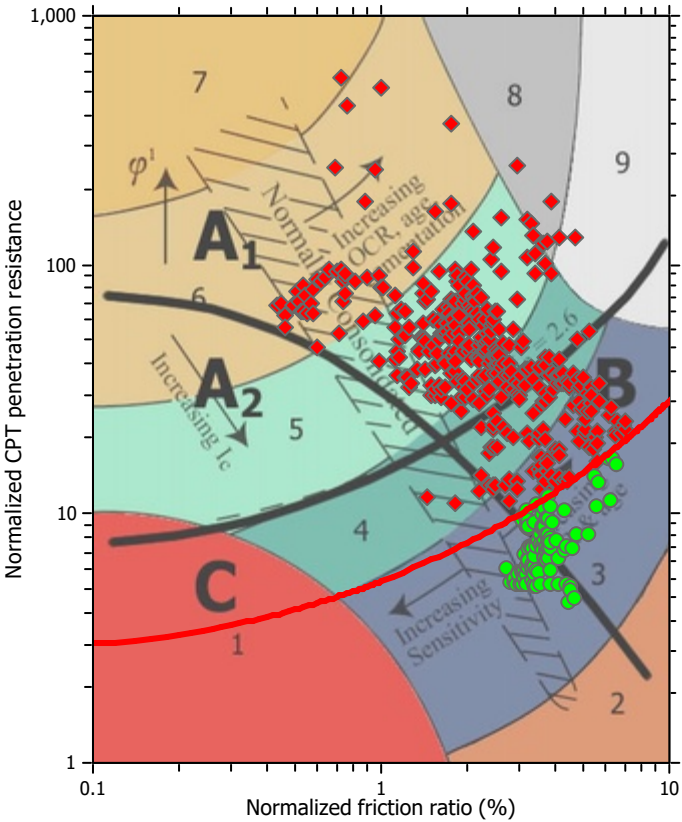
F.S. color scheme

- 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

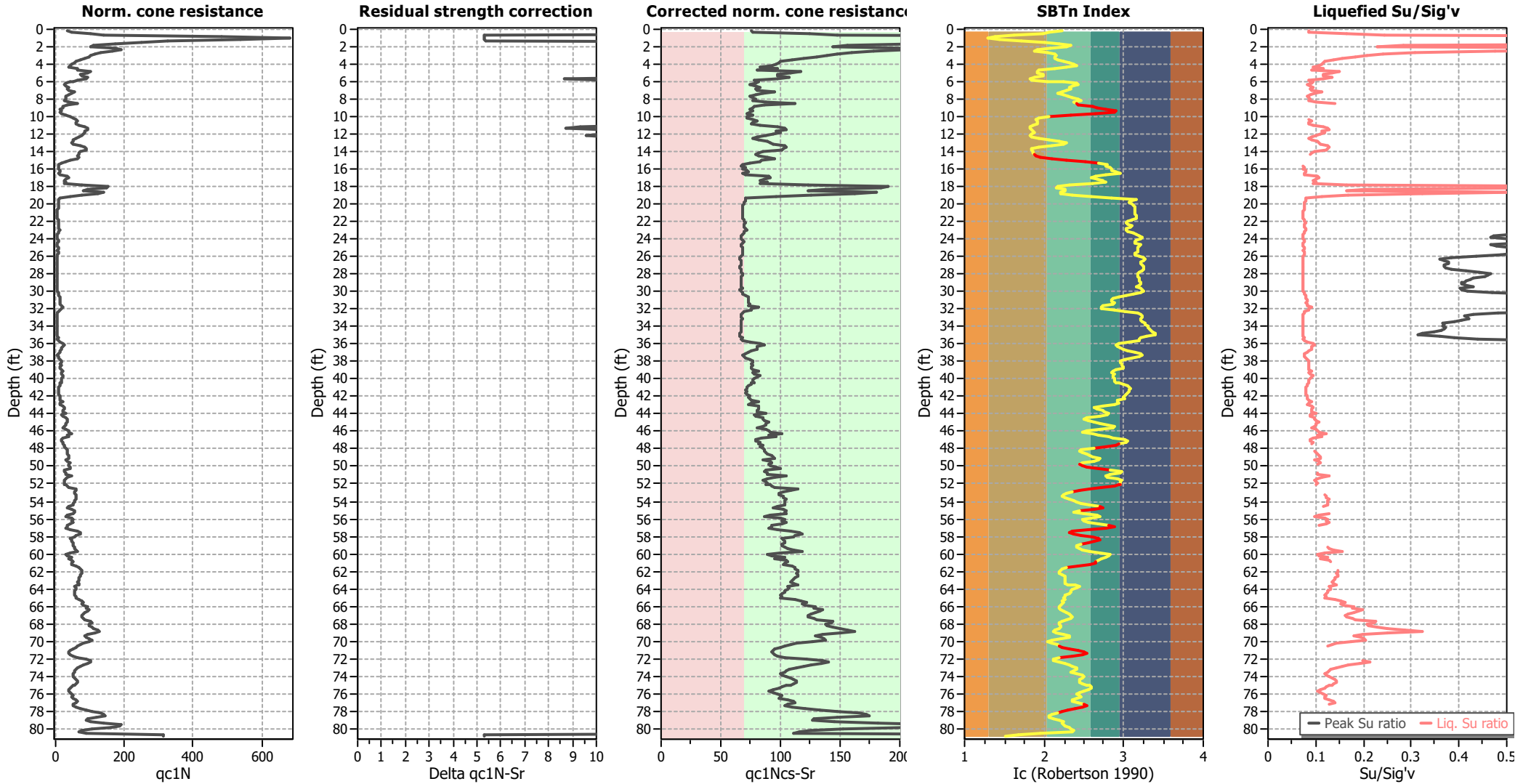
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	3.00	K_{ϕ} applied:	Yes
Earthquake magnitude M_w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K _s applied:	Yes
Earthquake magnitude M _w :	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

A-2-5
Lateral Spreading
Calculations

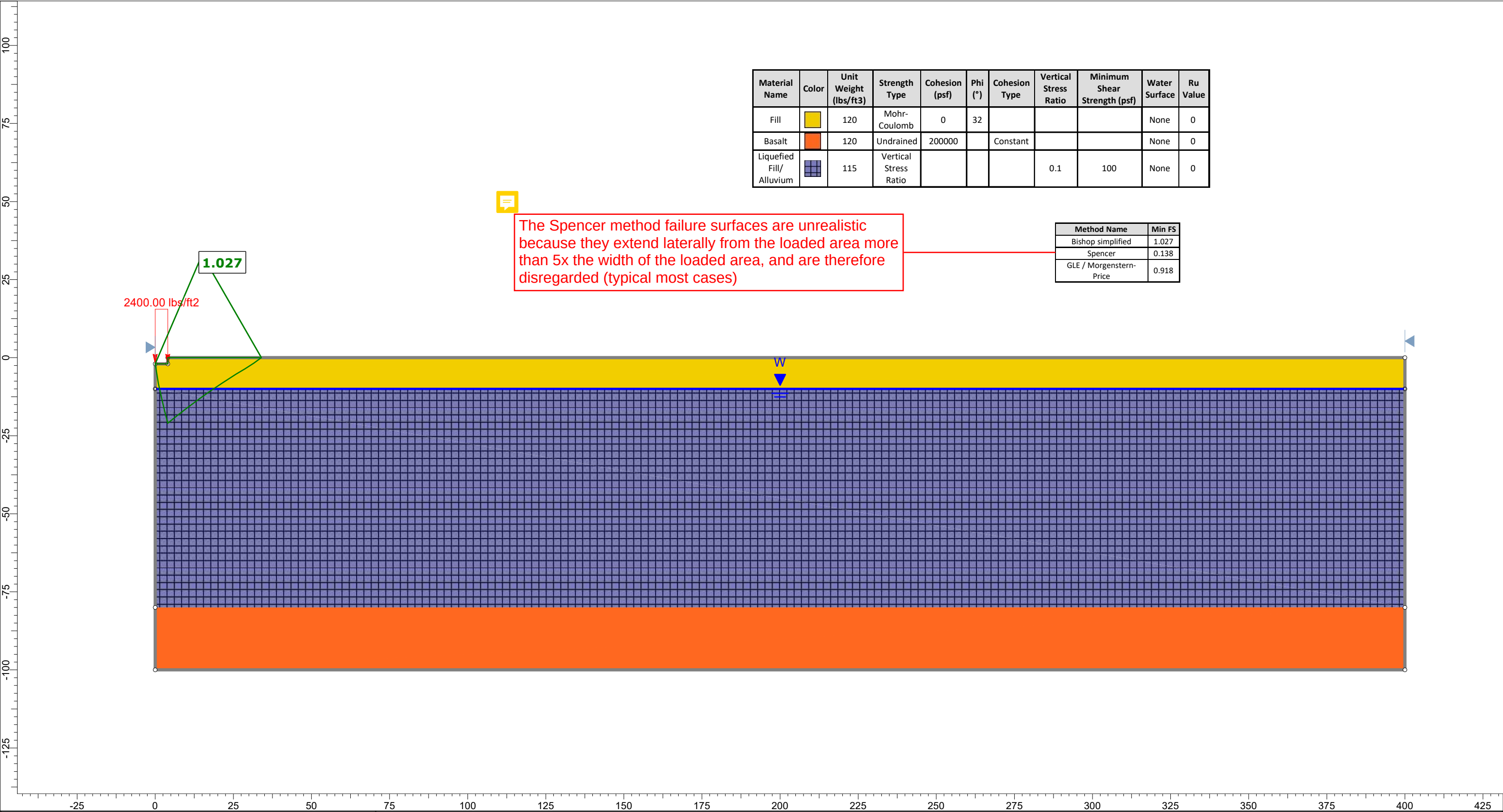
Owens Corning Linnton Asphalt Terminal SVA

Zhang et al. (2004) Lateral Spreading

	A	B	C	D	E
1					
2	H=	50 ft			
3		CPT-1	CPT-3		
4	LDI	148	140	(from Cliq output)	
5	Lateral spreading (in.)				Lat. Spread
6	L (ft)	CPT-1	CPT-3	avg	(ft)
7	100	510.0221	482.4533	496.2377	41.35314078
8	200	292.9308	277.0967	285.0137	23.75114239
9	400	168.2445	159.1502	163.6974	13.6414491
10	600	121.6376	115.0626	118.3501	9.862510977
11					
12		exempl calculation, formual in cell B7:			
13		=6*(A7/50)^-0.8*\$B\$4			

A-2-6

Seismic Bearing
Capacity Calculations



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio				0.1	100	None	0

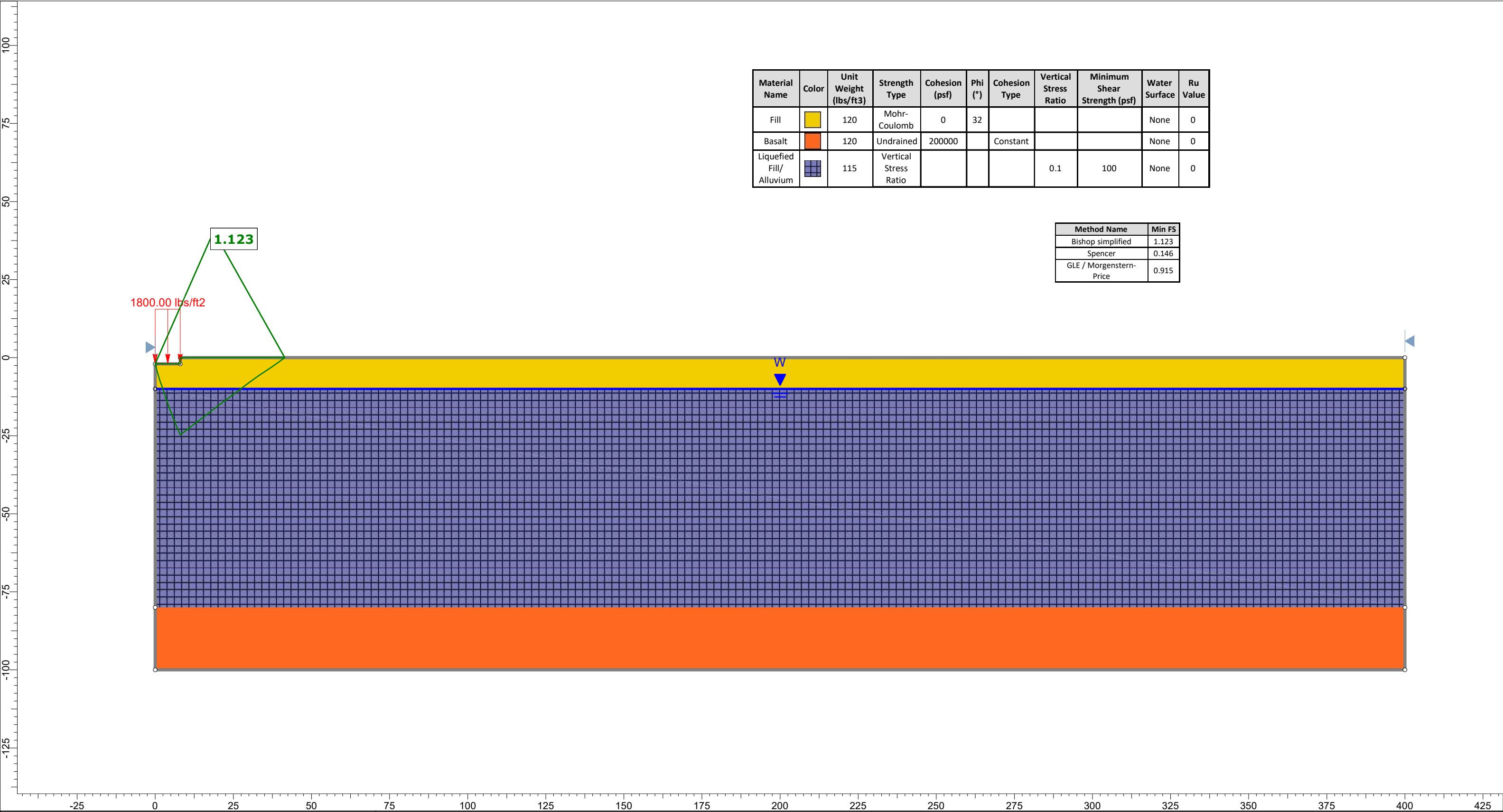
The Spencer method failure surfaces are unrealistic because they extend laterally from the loaded area more than 5x the width of the loaded area, and are therefore disregarded (typical most cases)

Method Name	Min FS
Bishop simplified	1.027
Spencer	0.138
GLE / Morgenstern-Price	0.918



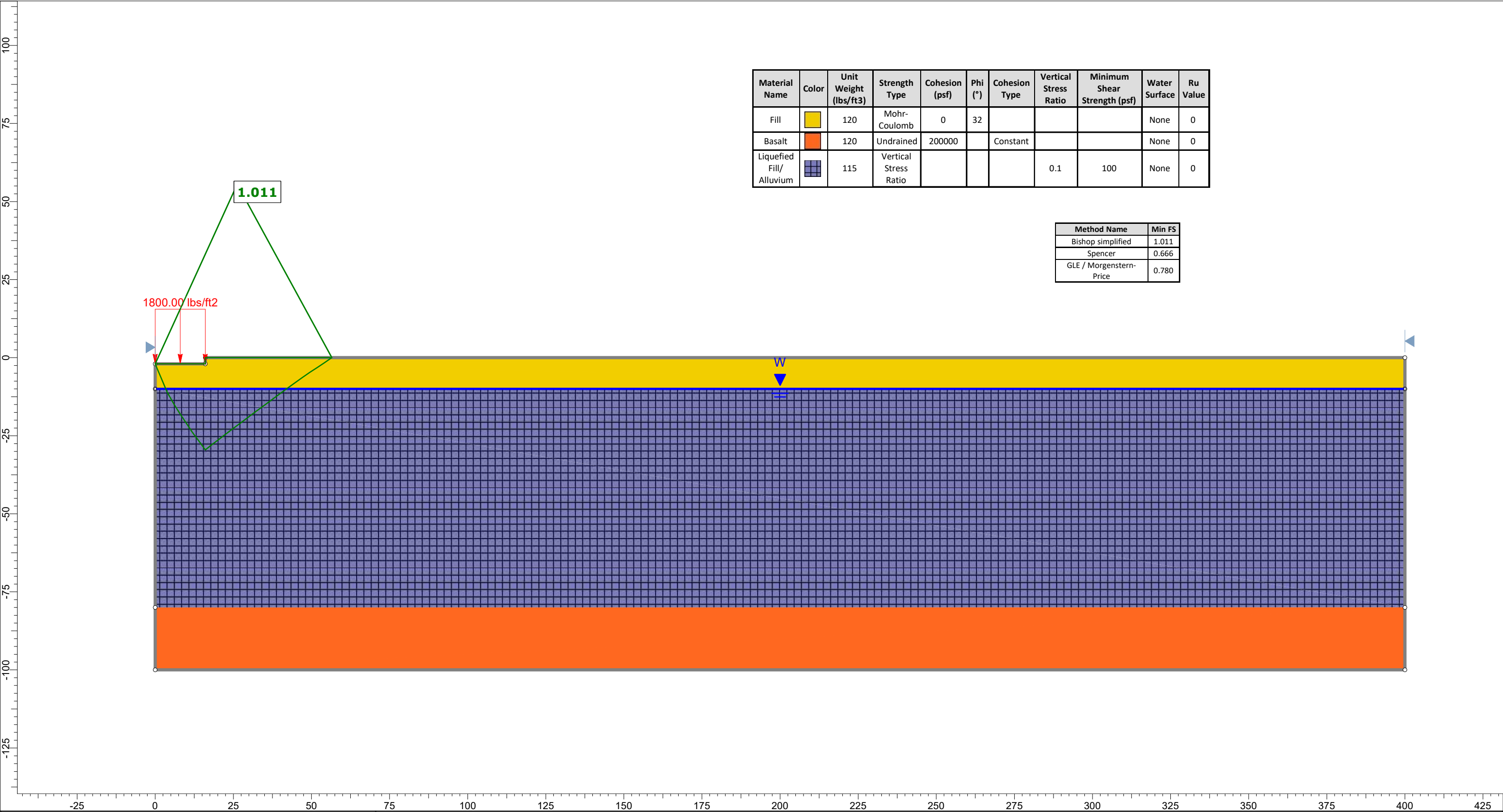
SLIDEINTERPRET 9.028

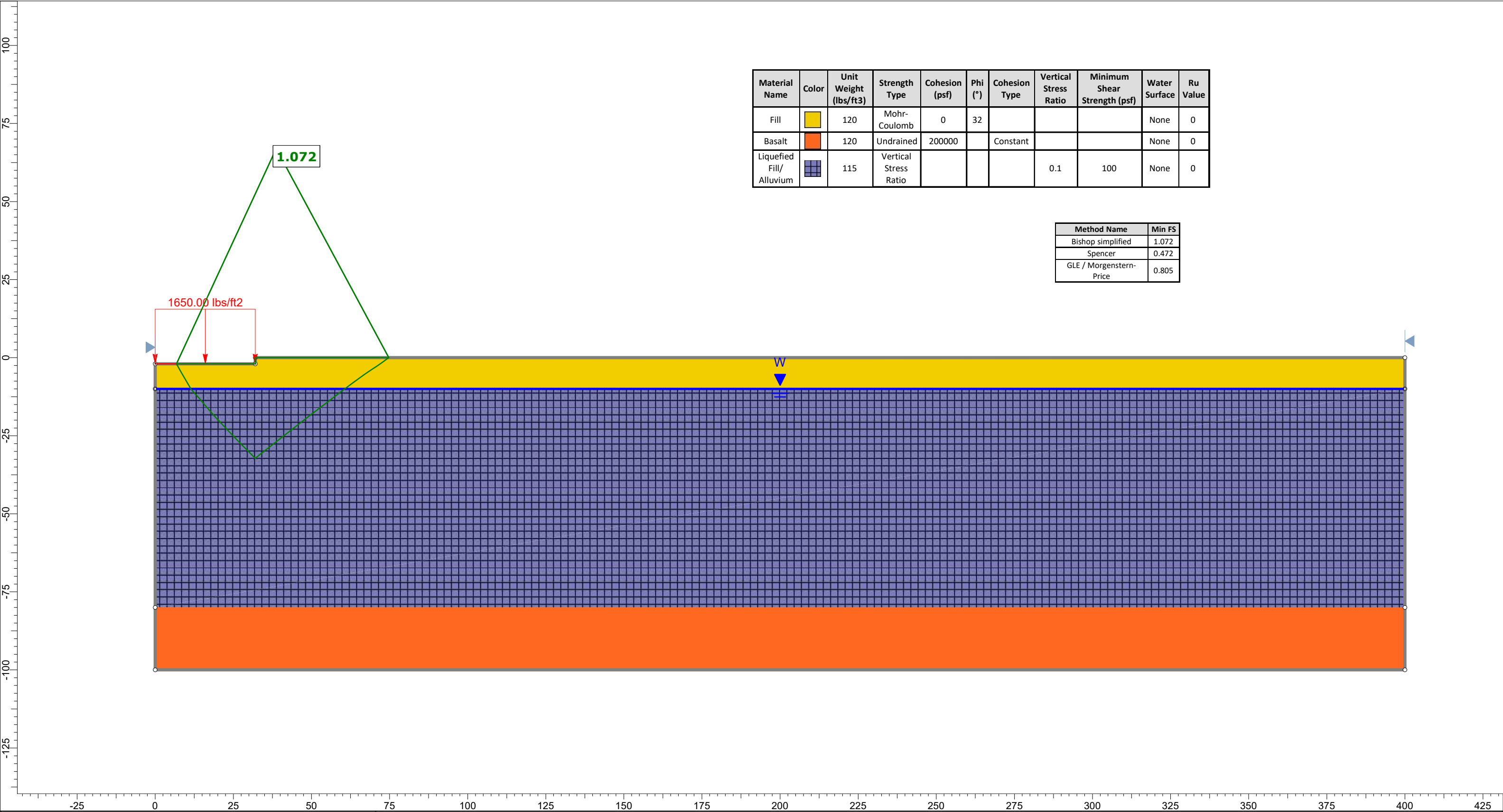
Project				Slide2 - An Interactive Slope Stability Program			
Group		4ft wide		Scenario		Master Scenario	
Drawn By				Checked By			
Date		3/25/2024, 10:09:55 AM		File Name		OC Linnton Bearing Cap.slmd	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio				0.1	100	None	0

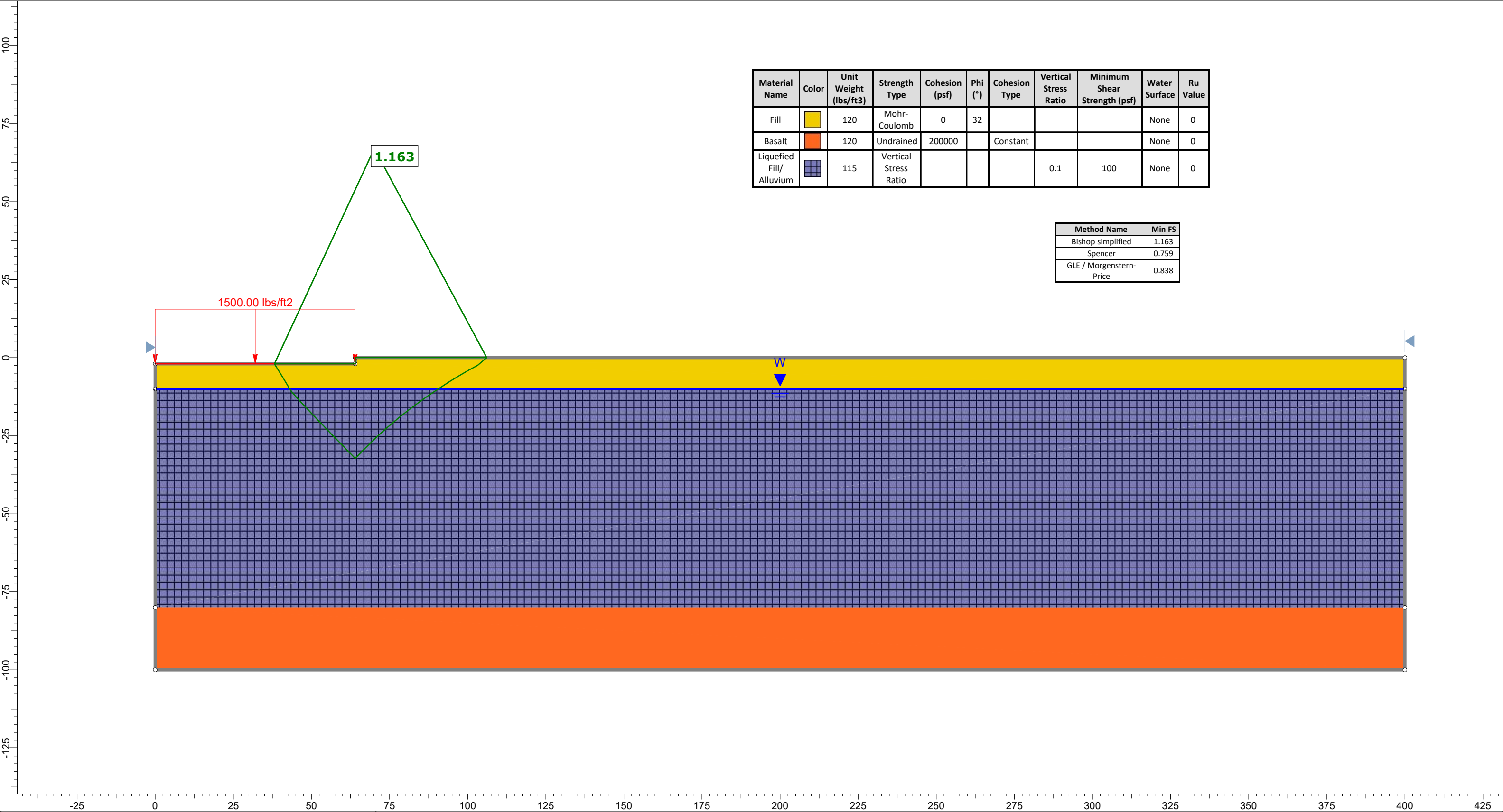
Method Name	Min FS
Bishop simplified	1.123
Spencer	0.146
GLE / Morgenstern-Price	0.915





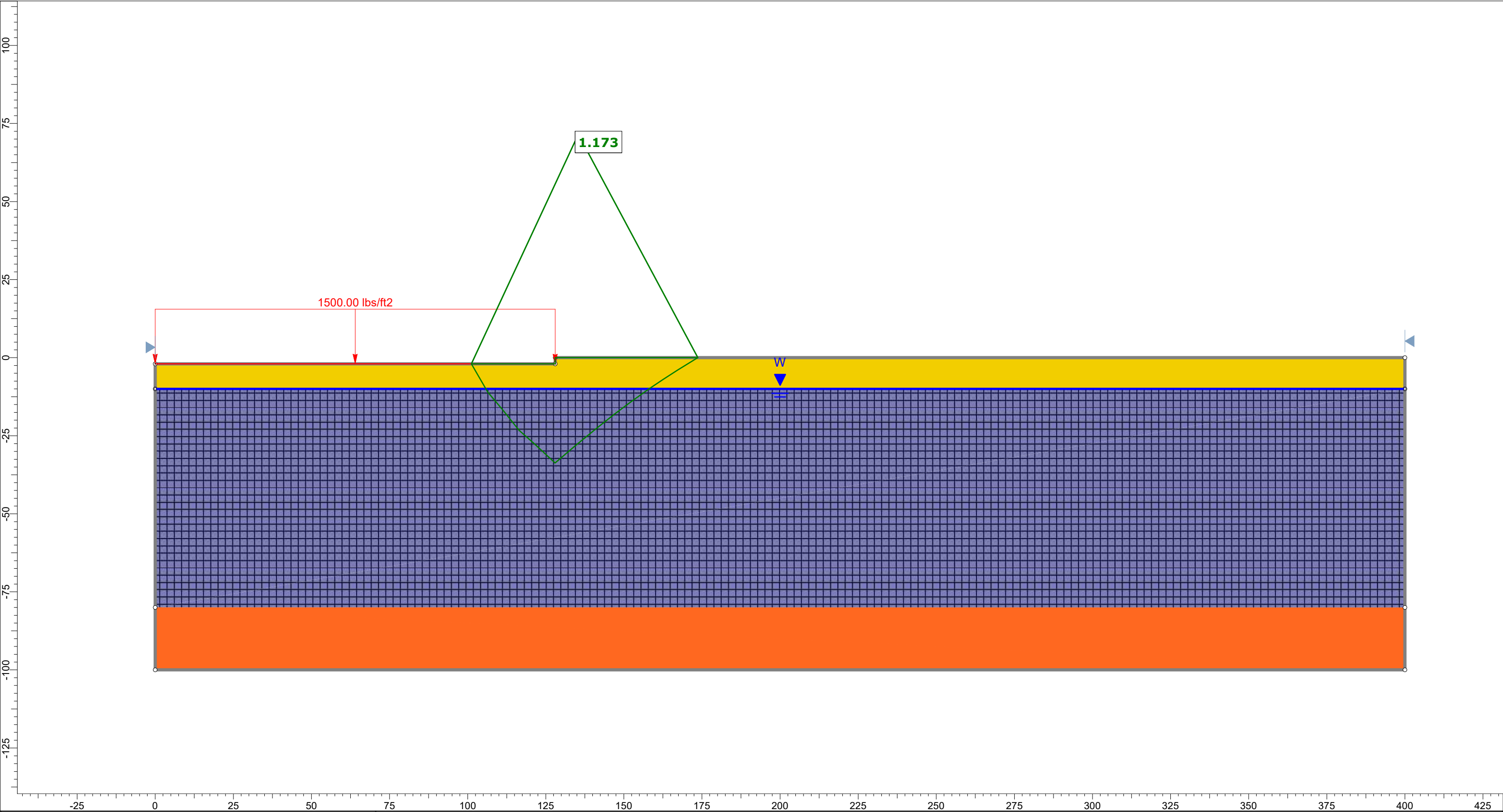
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.072
Spencer	0.472
GLE / Morgenstern-Price	0.805



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.163
Spencer	0.759
GLE / Morgenstern-Price	0.838



 SLIDEINTERPRET 9.028	Project		Slide2 - An Interactive Slope Stability Program	
	Group	128ft wide	Scenario	Master Scenario
	Drawn By		Checked By	
	Date	3/25/2024, 10:09:55 AM	File Name	OC Linnton Bearing Cap.slmd

6.2 Appendix B: Site Plans

Figure B-1 Site Map

Figure B-2 Evacuation Plan

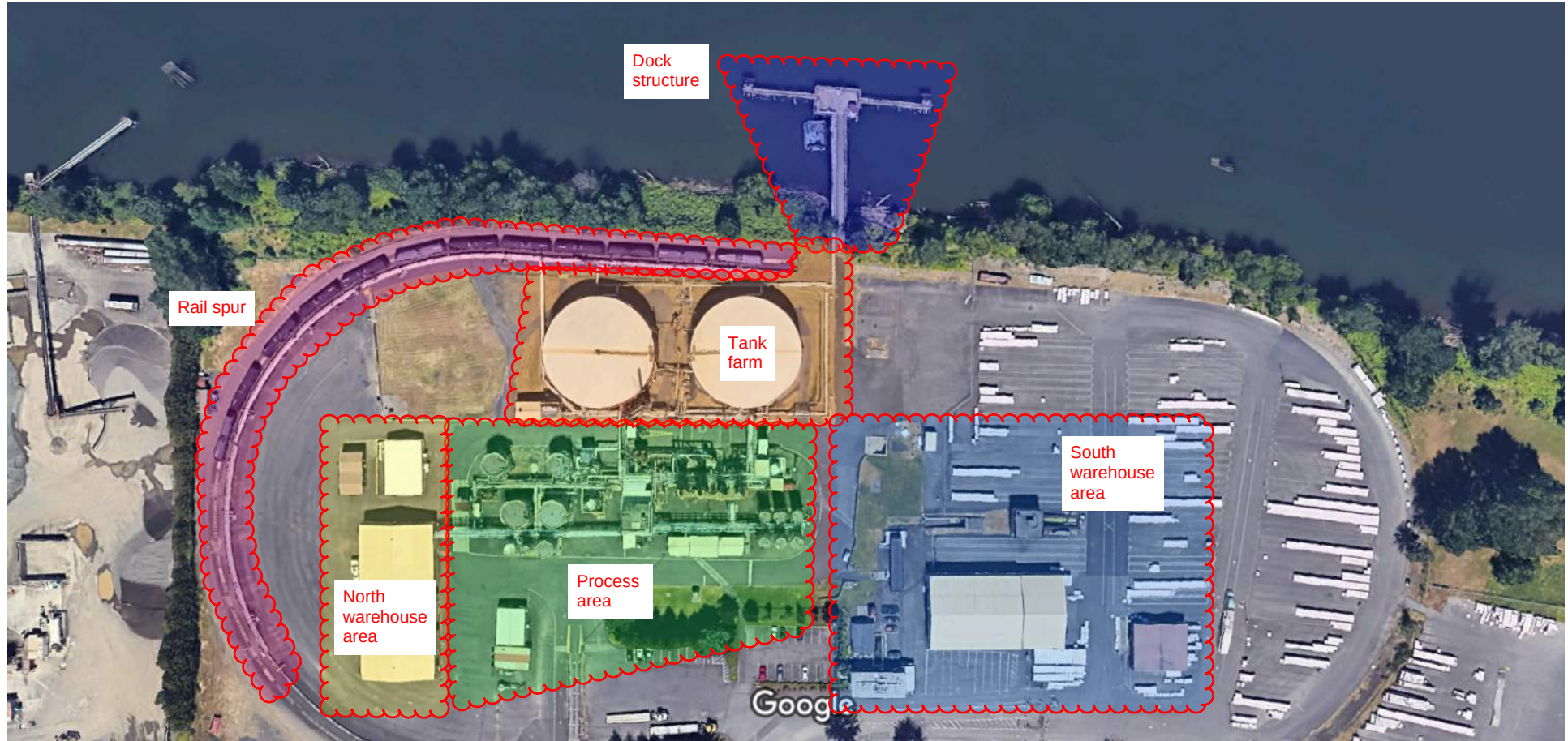


FIGURE B-1: SITE MAP

6.3 Appendix C: Photographs



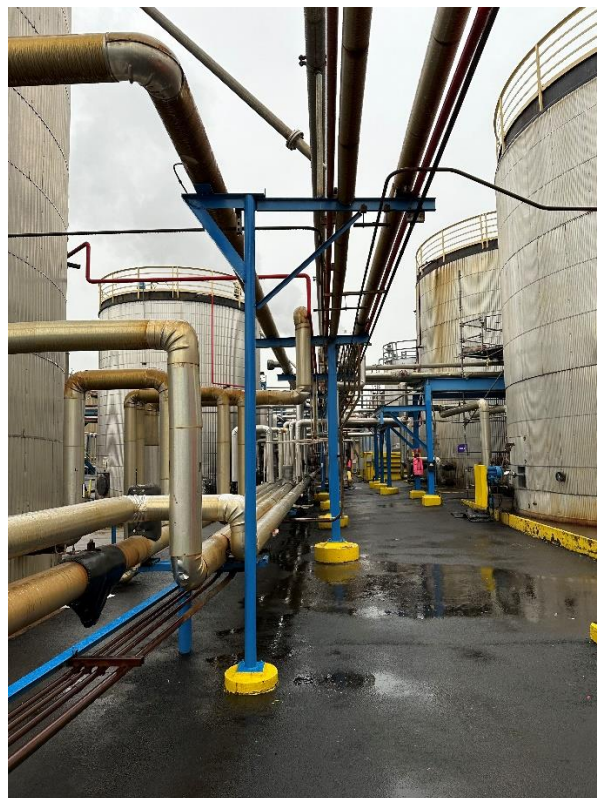
Picture 1. Typical view of Process area.



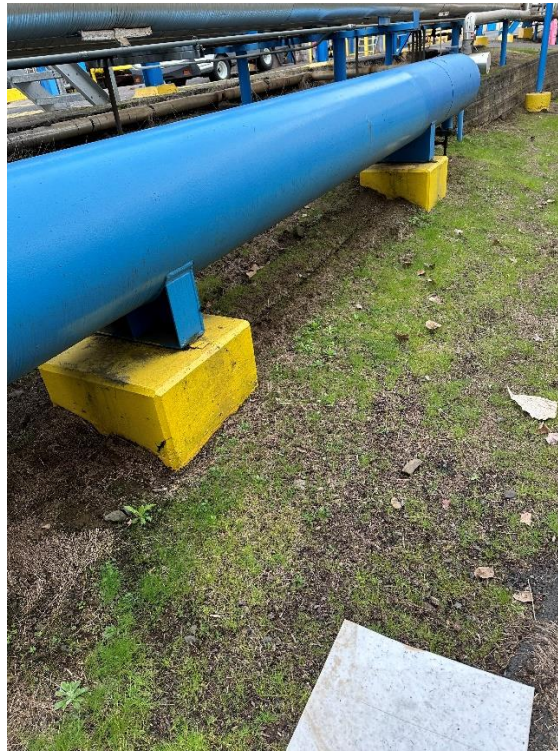
Picture 2. View of tanks at Process Area.



Picture 3. Typical view of truck loading rack.



Picture 4. Typical view of slender pipe support at Process Area.



Picture 5. View of unanchored pressure vessel at Process Area.



Picture 6. View of anchorage provided at smaller tank.



Picture 7. Typical view of light-framed storage building.



Picture 8. Anchorage not observed at pipe base of Process Area pipe rack.



Picture 9. View of large tank at tank farm area.



Picture 10. View of hot oil heater building and platform.



Picture 11. Typical view of Rail Spur.



Picture 12. View of dock structure.



Picture 13. View of piping at dock structure.