



Seismic Vulnerability Assessment

**Kinder Morgan
Linnton Terminal**

**11400 NW St. Helens Road
Portland, OR 97231**

**1568_REP102_SVA LINNTON
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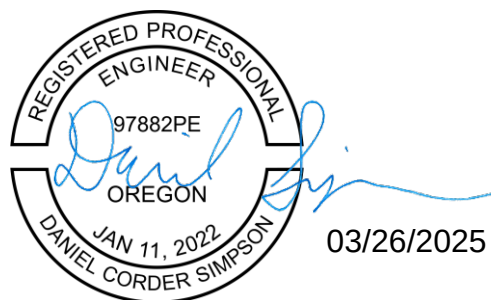
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ERRATA SHEET FOR NORWEST ENGINEERING SEISMIC VULNERABILITY ASSESSMENT

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SEISMIC VULNERABILITY ASSESSMENT

SECTION 1: Seismic Vulnerability Assessment

1.1 Facility Overview

The Linnton Terminal receives and distributes products including gasoline, ultra-low sulfur diesel (ULSD), and Biodiesel blend 5% (Oregon specification). Products are received via the Olympic pipeline and by tankers and barges. Products are distributed via tankers and barges and the SFPP pipeline to Eugene.

The terminal occupies 17 acres along the Willamette River. This terminal has Marine loading and unloading facilities including two berths each 740 feet long.

The Terminal Tank Farm has 20 tanks ranging from 11,000 to 72,000 barrels with a combined total storage capacity of 420,008 barrels.

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.

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.

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.

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 Pipeline Regulations & Marine Facilities

Where in conflict with Oregon law Chapter 99, the federal Pipeline Safety Improvement Act of 2002, 49 U.S.C. 60101 et seq. prevails.

Interstate petroleum and natural gas pipelines are not subject to Oregon regulations as they are subject to regulation by the United States Federal Energy Regulatory Commission (FERC).

Intrastate pipelines are regulated by the U.S. Department of Transportation (US DOT). The US DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) may delegate some authority to state agencies, usually the Public Utilities Commission (PUC).

The United States Army Corps of Engineers (USACE) and the United States Coast Guard (USCG) are responsible for in-water and shoreline infrastructure, operations, and safety. This includes spill prevention and control. It is not known at this time what the impact of new State regulations will be on the current jurisdictional practice.

2.5 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

Geotechnical assessments were completed by Sage Geotechnical LLC (Sage) under subcontract to Norwest. Sage's geotechnical engineering was completed under the supervision 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.

Much of the site 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 and visual-only walkdown. The walkdown is the critical first step in evaluation methodology. In the walkdown, a team of licensed professional engineers systematically reviewed the facility with focus on the terminal systems including tanks, piping support, loading racks, containment structures, building structures, and other equipment identified as in-service and potentially impactful to the transportation of bulk oil or liquid fuels.

4.1.3 Safety/Mechanical/Fire

The safety assessment was limited to review of available documentation, drawings, reports, and procedures provided by Kinder Morgan. 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 to be Evaluated

See Appendix B for the terminal site plan, referencing the areas below.

4.2.1 Area 1 (Truck Loading Rack)

Area 1 contains the truck loading rack, piping and ancillary equipment serving the rack, and five buildings including three warehouses, a maintenance shop, and an administrative building. The truck loading rack is no longer in service.

4.2.2 Area 2 (Tank Farm)

This area contains three large product tanks and two smaller tanks, piping and ancillary equipment serving the tanks, and additional buildings. Tank secondary containment is provided by free-standing concrete walls. A rail transfer area with two rail spurs is located along the western boundary of the area. The spurs and associated rack system are no longer in service.

4.2.3 Area 3 (Tank Farm)

This area contains the bulk of the terminal storage tanks, piping and ancillary equipment serving the tanks, and additional buildings. Tank secondary containment is provided by free-standing concrete walls.

4.2.4 Area 4 (Dock)

The marine facility (dock) consists of a single berth wharf primarily of timber construction with four steel and concrete mooring dolphins, and some steel piles from previous repairs. Product piping runs to the dock on a pier structure to the wharf service area.

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 *Description of surface conditions, topography, shoreline topography.*

Regional topography is depicted on Figure A-1. Site topography and near-shore bathymetry are shown on Figure A-2. Readily available light detection and ranging data (DNR, accessed February 19, 2024) and bathymetric surveys of the Willamette River (City of Portland, accessed February 19, 2024) 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 southwest and by the Willamette River to the northeast. As shown on 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 Quadrangle, Multnomah and Washington Counties, Oregon* (Madin et al. 2008). Near-surface deposits at the site are mapped as artificial fill. Madin et al. (2008) indicates the fill is underlain by Grande Ronde Basalt. Quaternary alluvium, possibly underlain by the Troutdale formation is likely situated between the fill and basalt. The artificial fill and alluvium are likely normally consolidated to slightly overconsolidated.

5.1.1.1.3 *Description of field explorations and laboratory testing.*

On March 4, 2024, Sage oversaw the completion of three cone penetration test (CPT) soundings (CPT-1 through CPT-3). Sage reviewed the resultant data as well as historical CPT, boring, and laboratory data collected by others (Delta 2009). The approximate locations of the recent and selected historical explorations are shown on Figure A-2.

The March 2024 CPT soundings were performed in general accordance with ASTM International standard test method D5778, *Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils*. Data from the recent CPT soundings are included in Appendix A-1; historical data collected by others are included in Appendix A-2.

Soundings CPT-1 through CPT-3 were advanced through 10-ft-deep, vacuum-excavated boreholes in accordance with Kinder Morgan's safety requirements. The vacuum excavations were backfilled with bentonite chips; the chips were placed around a 2-inch polyvinyl chloride (PVC) pipe to sleeve the CPT probe. The CPTs were advanced to refusal based on cone tip pressure, on a material presumed to be basalt.

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 into the following engineering stratigraphic units (ESUs):

ESU 1: Fill. ESU 1 consists of fill used to raise site grades. Coarse-grained fill (SP, SP-SM, and SM) and fine-grained fill (ML) was observed in Sage's 2024 vacuum excavations and Delta's 2009 soil borings.

ESU 2: Alluvium. ESU 2 consists of alluvium, a very soft to stiff or very loose to medium dense mixture of sand, silt, clay, and organic matter of varying proportions.

ESU 3: Basalt. ESU 3 consists of basalt.

Pore water pressure dissipation tests were completed during Sage's March 2024 field investigation in CPT-1 and CPT-3. The measured equilibrium pore pressure indicated that groundwater was present at approximately 14 to 20 ft below ground surface (bgs). A water level sensor was used to measure a depth to groundwater of approximately 15 ft in the hole left by the CPT-2 probe prior to grouting. Delta (2009) indicates that depth to groundwater typically varies from approximately 13 to 24 ft below ground surface. Groundwater for liquefaction analyses was set at 15 ft bgs and the groundwater profile shown on Figure A-3 was selected for yield acceleration calculations (discussed subsequently).

Figure A-3 shows a conceptual geotechnical cross section of the site as well as the engineering soil parameters selected for seismic geotechnical analyses.

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

Analyses for the geotechnical portion of the seismic vulnerability assessment (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-3):

- Site class determination (A-3-1).
- Building code seismic design parameters for the site (A-3-2).
- The U.S. Geological Survey (USGS) seismic hazard disaggregation for the site (A-3-3).

- Liquefaction and residual strength calculations (A-3-4).
- Yield acceleration calculations (A-3-5).
- Newmark sliding block results (A-3-6).
- Seismic bearing capacity calculations (A-3-7).

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 (Petersen et al. 2014). Based on this review, more than 50 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 11 percent of the seismic hazard at the site. The remaining seismic hazard stems from other finite fault sources, random crustal events, or 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)	7.78
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 sounding CPT-3 and the estimated shear wave velocities for rock layers between CPT refusal and 100 ft bgs. The V_s for the basalt layer between the bottom of ESU 2 and 100 ft bgs was determined by reviewing similar materials in Sowers and Boyd (2019).
- Based on the V_s , 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 components per OAR 340-300-003 (1) (f) do not exceed the performance objective per OAR 340-300-0002 (18) 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 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

CPT data were used to complete liquefaction calculations, as CPT results are more easily reproduced (less uncertain) than standard penetration test results (i.e., the other type of data available for this study). Data collected from historical soil borings were used to confirm Sage's interpretation of the CPT data.

- **Liquefaction susceptibility** (i.e., whether the soil will behave like sand or clay during dynamic loading) was determined in accordance with Robertson and Wride (1998). A soil behavior index of $I_c = 3.0$ was used as the cutoff for non-liquefiable soil (i.e., $I_c > 3.0$ is not susceptible to liquefaction). Additionally, soils must be saturated to be susceptible to liquefaction. A groundwater depth of 15 ft bgs was selected for liquefaction calculations. This depth is intended to account for variations in seasonal groundwater levels.
- **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). Liquefaction triggering

computations were performed using CLiq software, version 3.5.2.22 (Geologismiki 2024).

- **Liquefaction/seismic strength loss:** liquefied soil residual shear strength was computed using the procedure established by Idriss and Boulanger (2008), with void redistribution assumed to be significant. Calculations are provided in Appendix G-3. The CPT data indicate that approximately 60 to 75 percent of the measured soil layers are susceptible to strength loss. The CPT data suggest that zones of liquefied soil are discontinuous vertically and laterally (heterogeneous soil mixture) and interrupted by soils not susceptible to liquefaction. Geotechnical analyses captured the effect of this by averaging residual strengths as described below.
 - For lateral spreading analysis and analysis of shallow foundations 32 ft wide and wider, where potential failure surfaces would engage large quantities of soil, likely passing through both liquefied and non-liquefied soil: Residual strengths were averaged with non-liquefied soils (with a cap of $S_{u,r}/\sigma'_v = 0.6$ for non-liquefied soils) to characterize the subsurface condition. This resulted in an average $S_{u,r}/\sigma'_v = 0.14$. This ratio was applied to all soil in ESUs 1 and 2 below the design groundwater elevation.
 - For analysis of foundations less than 32 ft wide, where soil failure surfaces could be largely confined to a localized, liquefied, sand-like soil layer: The ratio $S_{u,r}/\sigma'_v = 0.1$ was used for calculations, approximately corresponding to the lower end of calculated residual shear strengths for all layers. This ratio is applied to all soil in ESUs 1 and 2 below the design groundwater elevation.
 - A minimum shear strength of 100 psf was applied to all soil layers modeled with the vertical stress ratio described above.
- **Lateral spreading potential** was determined using Newmark sliding block analyses. First, the limit equilibrium method, implemented with Rocscience Slide2, was used to estimate the distribution of seismic yield acceleration at the site. Appendix A-3-5 shows how the spatial distribution of seismic yield acceleration was calculated. Then, USGS' **Seismic LAndslide Movement Modeled using Earthquake Records (SLAMMER)** program was used to complete sliding block analyses. The results of the sliding block and seismic yield acceleration analyses were combined to estimate the magnitude and distribution of lateral spreading at the site, as represented by the lateral spreading contours and zone of potential flow failure shown on Figure A-2.
- **Ground motion selection for Newmark analyses** was based on the following screening criteria:
 - First, the Next-Generation Attenuation for Subduction Zone Regions project (NGA-SUB) and the Next Generation Attenuation-West 2 (NGA-West2) ground motion databases were used to generate a pool of ground motions representative of a subduction zone or shallow crustal event.

- Next, the pool was reduced to only ground motions from recording sites with a shear wave velocity of the top 30 meters between 180 meters per second (m/s) and 360m/s (i.e., site class D conditions).
- The pool was further reduced to only those ground motions that could be scaled to the design PGA by a factor of 0.25 to 4, or in the case of shallow crustal motions, by records with a PGA between 0.46g and 0.52g.
- According to Jibson (1993), the Arias intensity (I_a) correlates well with the distribution of earthquake-induced landslides, especially compared with other intensity measures (namely, PGA). Therefore, Sage used I_a as a screening parameter to select representative ground motions for the Newmark analysis.
- I_a ground motion prediction equations were used to predict I_a at the site resulting from a mean design-level earthquake originating from a subduction zone interface/intraslab event (Macedo et al. 2019) and for a shallow crustal event (Bahrapouri et al. 2021). The computed I_a were approximately 5 to 7 m/s for a subduction event and 0.8 m/s for a shallow crustal event.
- The estimated I_a were used to select the ground motions listed in Table G-3. The selected ground motions were imported to SLAMMER for the Newmark calculation.

Table G-3. Ground Motions Selected for Newmark Calculation

Event	Station/Record	Scale Factor	Scaled PGA (g)	Arias Intensity, after scale factor applied (m/s)	Event Type
Imperial Valley 1979	E04 140	1	0.49	1.34	Crustal
Imperial Valley 1979	E05 140	1	0.52	1.66	Crustal
Imperial Valley 1979	E07 230	1	0.46	1.70	Crustal
N. Palm Springs 1986	WWT 180	1	0.49	1.77	Crustal
Northridge 1994	LOS 270	1	0.48	1.98	Crustal
Northridge 1994	STN 020	1	0.47	1.12	Crustal
Parkfield 1966	C02 065	1	0.48	1.78	Crustal
Westmoreland 1981	WSM 180	1	0.50	1.91	Crustal
Tohoku 2011	IBRH20 S2	2.18	0.49	6.41	Subduction
Tohoku 2011	CHB004 EW	1.57	0.49	6.03	Subduction
Tohoku 2011	CHB004 NS	1.70	0.49	6.74	Subduction
Tohoku 2011	CHBH13 NS2	3.10	0.49	5.54	Subduction
Tohoku 2011	IBR018 NS	1.37	0.49	6.53	Subduction

Tokachi-Okii 2003	NMRH05 EW2	1.47	0.49	6.75	Subduction
Tokachi-Okii 2003	HKD068 EW	1.58	0.49	7.00	Subduction
Ibaraki 2011 (Tohoku 2011 aftershock)	CHB004 NS	3.26	0.49	8.04	Subduction
Tokachi-Okii 2003	51563 NS	0.94	0.49	5.07	Subduction
Kaikōura 2016	SEDS N00E	0.67	0.49	3.50	Subduction

g = force of gravity

m/s = meters per second

PGA = peak ground acceleration

5.1.1.2.3 Seismic settlement

Seismic settlement is the result of liquefied soil reconsolidation or ejection to the ground surface (liquefaction-induced settlement), dry sand consolidation, or reductions in seismic bearing capacity. Liquefaction-induced settlement was calculated in accordance with Boulanger and Idriss (2008); calculations are provided in Appendix A-3. Settlement caused by dry sand consolidation was not included in the calculations, because there is very little, if any, dry sand at the site.

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

No seismic hazards, other than those discussed herein, are anticipated to be significantly present at the site. According to the USGS National Seismic Hazard Model Fault database, no active faults are present at the site.

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 crustal layer 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 non-liquefied clay-like soils (ESU 2 alluvium) over a competent basalt layer (ESU 3).
- Following the onset of liquefaction, flow failure may occur within approximately 200 ft of the shoreline toe at the Willamette River. The seismic hazard transitions to

lateral spreading with distance from the shoreline, and lateral displacement will likely decrease with distance from the shoreline.

- Approximately 60 to 75 percent of saturated site soils are susceptible to liquefaction. Based on a review of subsurface information, these soils appear to be laterally and vertically discontinuous/heterogeneous. Sage has incorporated this heterogeneity as described in section 5.1.1.2.2.
- 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).
- Sage made the following simplifying assumptions when completing its seismic hazard/geotechnical evaluation that lead to conservatism in estimating seismic demand:
 - The lateral spreading analysis is based on the assumption that soils will be fully liquefied at the onset of ground shaking.
 - Newmark analyses are based on the assumption of a sliding rigid block, neglecting the seismic damping caused by the impedance contrast between the material above and below the potential failure surface.
 - The lateral spreading failure surfaces are between 300 and 1,200 ft long. Sage's evaluation did not account for the spatial incoherence of seismic waves acting on the sliding mass.

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 20 inches of liquefaction-induced total settlement could occur following a seismic event; as much as 20 inches of liquefaction-induced differential settlement could over 50-ft spans. The effects of lateral spreading may increase these settlement estimates.

5.1.1.3.3 Lateral ground deformations

Flow failure is estimated to occur within approximately 200 ft of the toe of the Willamette riverbank. The flow failure zone shown on Figure A-2 was delineated by selecting areas with a yield acceleration of less than 0.02g. (Yield accelerations were determined as part of the Newmark analysis described above.) Flow failure is estimated to result in ground deformations of more than 10 ft.

The severity of lateral spreading will likely decrease with distance from the riverbank. The lateral spreading displacement contours shown on Figure A-2 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

In addition to the settlement described in Section 5.1.1.3.2, liquefaction may affect the bearing capacity of shallow foundations wider than 4 ft. Table G-4 summarizes seismic bearing capacity with liquefaction. The values in Table G-4 include a safety factor of 1.5. When calculating the allowable bearing capacities, Sage assumed that the foundation would be embedded approximately 2 to 4 ft below surrounding site grades.

Table G-4. Seismic (liquefied soil) Shallow Foundation Allowable Bearing Capacity

Foundation Width	4 ft	8 ft	16 ft -128 ft
Allowable Seismic Bearing Capacity	2.7 ksf	2 ksf	1.4 ksf

ft = feet

ksf = kips per square foot

Where seismic bearing pressures are less than those listed in Table G-4, foundations will likely experience a degree of settlement equal to or less than the settlement noted in Section 5.1.1.3.2. Where seismic bearing pressures are greater than those listed in Table G-4, foundations will likely experience bearing capacity loss and settlement beyond that noted in Section 5.1.1.3.2.

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 foundation movements beyond the lateral spreading (or prior to the onset of lateral spreading) 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

As Identified in Section 5.1.1, this site is subject to liquefaction and liquefaction induced lateral spreading. The nature of this hazard, the analytical methods used to estimate it, and the conventional design historically used in the facility present us with a situation that is hopelessly complicated and beyond the analytical tools at our disposal. The expectation is that lateral spreading will result in an exceedance of the seismic performance objective outlined in OAR 340-300-0002(18). But tanks and piping are flexible structures and seismic performance under liquefaction settlement and seismic settlement are much better, well-conceived and maintained tanks and piping have performed well in past earthquakes. The seismic performance expectations outlined below have been formed based on the perceived structural response to the ground shaking hazard on Site Class D soils. [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.]

5.1.2.1 *Seismic Performance Expectations*

5.1.2.1.1 *Area 01*

5.1.2.1.1a *Truck Loading Rack*

A truck loading rack is provided near the main gate of the facility at Area 01. The loading rack is constructed of structural steel frames and purlins. The structure supports a roof and various piping and mechanical equipment. The truck loading rack is labeled out-of-service and is of minimal risk regarding spill prevention.

5.1.2.1.1b *Pipe Bridge and Supports*

A pipe bridge is provided adjacent to the truck loading rack, supporting multiple pipes running between the tank farm and truck loading rack. The pipe bridge consists of steel joists to support gravity loads and a cantilevered column lateral resisting system. The pipe bridge is labeled out-of-service and is of minimal risk regarding spill prevention.

Several inactive pipes are mounted to the exterior face of the Area 02 containment wall. In addition to the inactive pipes, one active foam fire pipe is included. The foam fire pipe is also mounted to the exterior of Warehouse D on fabricated steel supports. The supports are anchored to the exterior concrete wall of Warehouse D. We believe the anchored support type is of low risk in a design level seismic event.

5.1.2.1.1c *Ancillary Equipment*

Various ancillary tanks and equipment are provided in Area 01, including smaller tanks, pumps, and electrical panel equipment. Most ancillary equipment at Area 01 was labeled out-of-service. The few items of in-service ancillary equipment was properly anchored and of low seismic risk.

5.1.2.1.1d Canopies and Building Structures

Contained in Area 01 are several buildings including the Office, Warehouses A, B, and D, and the Shop. Limited information is available on the buildings beyond what is visually available.

The Office is of masonry construction with an unknown construction date. The building appears to be well maintained and conceived and is of minimal risk regarding spill prevention.

Warehouse A consists of cast-in-place concrete exterior walls. The roof framing consists of steel trusses and purlins, and a metal roof deck. The roof structure was reportedly replaced within the past 20 years, and the building is currently being used for storage of non-petroleum materials. The building appears to be well maintained and conceived and is of minimal risk regarding spill prevention.

Warehouse B consists of steel roof trusses and purlins, and metal roof deck and exterior walls. The building is mostly vacant with isolated non-petroleum materials being stored. The building appears to be well conceived with a low seismic mass and is of minimal risk regarding spill prevention.

Warehouse D consists of cast-in-place concrete walls, columns, and roof framing. The building is mostly vacant with isolated non-petroleum materials being stored. The building appears to be well conceived and is of minimal risk regarding spill prevention.

The Shop building consists of cast-in-place concrete walls, with steel roof framing supporting an apparent concrete roof slab. The building appears to be well conceived and is of minimal risk regarding spill prevention.

5.1.2.1.2 Area 02

5.1.2.1.2a Tank Farm

Five operational storage tanks are provided at Area 02 of the facility with various construction dates. The storage tanks vary in size, the largest being approximately 115-feet in diameter and 40-feet in height. The operational tanks appear to be well engineered (per API 650), conceived and maintained. The foundations of the tanks vary with more modern installation utilizing ground improvements or piles and some older tanks on mat gravel foundations. The tanks are also self-anchored. Self-Anchored Tanks are very common and perform well during seismic events. At many of the tanks, placards were provided which give a repair or alteration date in accordance with API 653. API 653, Tank Inspection, Repair, Alteration, and Reconstruction is a standard developed and published by the American Petroleum Institute (API) and covers the inspection, repair, alteration, and reconstruction of steel aboveground storage tanks used in the petroleum and chemical industries. All active tanks are required to undergo an API 653 inspection based on certain parameters. This inspection ensures the tank floors and shells have not deteriorated as well as ensuring the tank has not experienced differential settlement. Given the nature of the inspection requirements we can be sure the tanks are plumb and have not been corroded. All the tanks are regulated by the Department of Transportation

and Kinder Morgan complies with all inspection requirements. 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

Active piping runs are provided at a few locations at Area 02. The majority of pipe supports are located 3-feet above grade or less with anchorage and a foundation provided. Pipe supports are typically well conceived, and of low seismic risk given the height of the supports. One exception is highlighted below:

At one area outside the Fire Foam Building, a slender pipe support was observed at approximately 15-feet in height. The pipe support lateral resisting system appears to be a cantilevered column. Based on the height and slenderness of the support, we believe this support type is at risk in a design level seismic event.

5.1.2.1.2c Containment Structure

Containment walls are provided at the perimeter of Area 02 tank farm and consist of cast-in-place concrete. The walls generally appear to be in fair condition, with several previous spall repairs observed. No information has been provided regarding the foundation of the containment walls. Based on our observations, the containment walls appear to be of adequate height and construction to resist static surcharge loading in the event of a tank spill. However, based on the age of construction we believe it is unlikely the containment wall was designed for lateral movement in a seismic scenario. Further analysis or retrofitting may be warranted to ensure their efficacy under seismic stress, thereby fortifying the overall resilience of the tank farm infrastructure.

5.1.2.1.2d Rail Car Transfer Area

A rail car transfer area is provided at the west end of Area 02. The transfer area is constructed of structural steel braced frames and supports isolated piping and mechanical equipment. The rail car transfer area is labeled out-of-service and is of minimal risk regarding spill prevention.

5.1.2.1.2e Ancillary Equipment

Various ancillary tanks and equipment are provided in Area 02, including smaller tanks, pumps, and electrical equipment. Much of the ancillary equipment in Area 02 appeared to be in service. 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. A few exceptions are highlighted below:

At the east side of Area 02, a fire foam building is provided to house a vertically oriented cylindrical foam tank for fire suppression. The tank skirt was placed directly on a concrete pedestal, with no anchorage observed. We believe this tank may be subject to sliding or overturning in a design level seismic event.

Near the fire foam building, an electrical transformer is provided which is placed on a concrete slab. No anchorage was observed between the transformer and the slab. We believe this item may be subject to sliding or overturning in a design level seismic event.

Several vertically oriented cylindrical tanks and other equipment are provided at the area indicated Non-Haz Storage Drum. The equipment is typically anchored to the slab. Two water tanks, along with a horizontally oriented tank were observed without anchorage to the slab. We believe these items may be subject to sliding or overturning in a design level seismic event.

5.1.2.1.2f Canopies and Building Structures

Contained in Area 02 are several buildings including Warehouse C, the Boiler Room and Pump House, the Fire Foam Building, and a few smaller canopy structures. Limited information is available on the buildings beyond what is visually available.

Warehouse C consists of steel roof trusses and purlins, and metal roof deck and exterior walls. The building is mostly vacant with isolated non-petroleum materials being stored. The building appears to be well conceived with a low seismic mass and is of minimal risk regarding spill prevention.

The Boiler Room and Pump House consists of steel roof trusses and purlins, and metal roof deck and exterior walls. The building houses out-of-service mechanical and electrical equipment. The building appears to be well conceived with a low seismic mass and is of minimal risk regarding spill prevention.

The Fire Foam Building consists of clay tile masonry walls with steel roof trusses and a wood roof deck. The building houses a foam fire tank, pump, and various electrical equipment. The building appears to be well maintained and conceived and is of minimal risk in a design level seismic event.

Smaller canopy structures include an electrical closet canopy, a canopy at the Non-Haz Storage Drum area, and a guard shack near the Fire Foam Building. The canopy-type buildings are light framed and appear to be of varied age and condition. The canopies appear to have a low seismic mass and are of minimal risk regarding spill prevention.

5.1.2.1.3 Area 03

5.1.2.1.3a Tank Farm

Ten operational storage tanks are provided at Area 03 of the facility with various construction dates. The storage tanks vary in size, the largest being approximately 115-feet in diameter and 40-feet in height. The operational tanks appear to be well engineered (per API 650), conceived and maintained. The foundations of the tanks vary with more modern installation utilizing ground improvements or piles and some older tanks on mat gravel foundations. The tanks are also self-anchored. Self-Anchored Tanks are very common and perform well during seismic events. At many of the tanks, placards were provided which give a repair or alteration date in accordance with API 653. API 653, Tank Inspection, Repair, Alteration, and Reconstruction is a standard developed and

published by the American Petroleum Institute (API) and covers the inspection, repair, alteration, and reconstruction of steel aboveground storage tanks used in the petroleum and chemical industries. All active tanks are required to undergo an API 653 inspection based on certain parameters. This inspection ensures the tank floors and shells have not deteriorated as well as ensuring the tank has not experienced differential settlement. Given the nature of the inspection requirements we can be sure the tanks are plumb and have not been corroded. All the tanks are regulated by the Department of Transportation and Kinder Morgan complies with all inspection requirements. 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.

5.1.2.1.3b Pipe Supports

Active piping runs are provided at a few locations at Area 03. The majority of pipe supports are located 3-feet above grade or less with anchorage and a foundation provided. Pipe supports are typically well conceived, and of low seismic risk given the height of the supports.

5.1.2.1.3c Containment Structure

Containment walls are provided at the perimeter of Area 03 tank farm and consist of cast-in-place concrete. The walls generally appear to be in fair condition, with several previous spall repairs observed. No information has been provided regarding the foundation of the containment walls. Based on our observations, the containment walls appear to be of adequate height and construction to resist static surcharge loading in the event of a tank spill. However, based on the age of construction we believe it is unlikely the containment wall was designed for lateral movement in a seismic scenario. Further analysis or retrofitting may be warranted to ensure their efficacy under seismic stress, thereby fortifying the overall resilience of the tank farm infrastructure.

5.1.2.1.3d Ancillary Equipment

Various ancillary equipment is provided in Area 02, primarily consisting of pumps and electrical equipment. The ancillary equipment typically 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.

5.1.2.1.4 Area 04

5.1.2.1.4a Dock Structure

The dock structure consists of a steel and wooden dock structure, and concrete dolphins which are supported by battered steel pipe piles. The dock was permitted through the US Army Corps of Engineers and all repairs, modernizations and improvements have been permitted. The dock structure is currently in compliance with all requirements set forth by the US Coast Guard and the US Army Corps of Engineers. The dock contains

approximately 1,400-feet of berthing. The dock structure houses various piping and offloading equipment.

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

The pier structure carries pipes to the timber dock structure where the piping terminates. The pier structure is of the same style of construction as noted above and are therefore at risk in a design level event owing to the dock structural risk covered above in 5.1.2.1.3a.

5.1.2.1.4c Ancillary Equipment

Equipment such as pumps on the dock and piping running along the dock are at risk in a design level event owing to the dock structural risk covered above in 5.1.2.1.3a.

5.1.3 Safety Assessment

5.1.3.1 Description of fire control system

5.1.3.1.1 General system description

The Linnton Terminal has one fire pump and one foam pump. The tank fire pump system is a large Diesel Cat engine and pump. Located on the Linnton Dock, this engine pulls water up and out of the Willamette River and pressurizes the fire system. Water comes from the Willamette River and/or the Fire Department Connection (FDC) just inside the main entrance gate. FDC's are located throughout the terminal and on the marine dock. A fire pump test was conducted by West Coast Fire on October 19, 2023. The report concluded that the pump performed well.

There is one foam/water monitor located on the containment wall between tanks 55023 and 55022, pointing directly at tank 72021. This monitor will spray foam to cover any small flange, incipient or piping fire(s) between tanks. Once foam is injected into the system, the appropriate tank is then selected. The foam monitor will also discharge foam once the injection valve is opened.

The fire protection system is fed by two separate water systems, one off the Willamette River and the second from the City water supply main off Highway 30. The site has two taps off the 12" city water main. The northern lateral is 8" which enters the facility just south of the main entrance. The southern lateral is 4" which enters the facility just north of NW 112th Ave. The river pump is located on the dock and the highway FDC is just inside the front gate and to the right. Tank cooling water will be provided by the City of Portland, Fire Bureau pumper (Boats and/or Trucks) and not the Linnton facility pumps.

The facility has fire hydrants located throughout the terminal at safe distances at safe distances from storage tanks to maintain operability during a potential fire. The hydrants on site consist of double hydrants, single hydrants, truck rack hydrants, and foam hydrants and are all painted red. Hydrants are either connected to city water or river water and are marked as such.

The facility's fire control system as described above is capable of mitigating risk of fire and explosions following an earthquake, as long as the system remains undamaged. With multiple sources of water, the Willamette River and the city water main, the water supply is also sufficient.

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, not the terminal infrastructure. However, the Linnton facility's fire water supply first comes from the Willamette River and is not totally dependent on the City water main.

5.1.3.2 Description of spill containment systems equipment, procedures

5.1.3.2.1 Assembled from the SPCC plan

Kinder Morgan maintains a Spill Prevention, Control, and Countermeasure (SPCC) Plan for the Linnton facility, in accordance with 40 CFR 112. It describes personnel, training, and spill prevention procedures; inspections and records; facility drainage; bulk storage containers and operational equipment; transfer operations, pumping and in-plant processes; and security.

The facility has a secondary containment system for the bulk oil and oil product storage containers to prevent oil from reaching navigable waters. All bulk storage tank installations are constructed so that a secondary means of containment is provided for the entire contents of the largest single container plus sufficient freeboard to allow for precipitation. Containment areas are constructed of concrete walls with earthen floor except for the fire pump diesel tank, which is contained within a steel basin.

Based on the soils type, containment areas have some vertical permeability that may preclude a spill from being completely cleaned up before permeating the ground. However, containment areas can maintain a discharge within the boundaries of the

Facility provided that a discharge is timely detected and clean-up operations begin immediately after discovery of the discharge.

In addition to the containment system, the facility has a strong tank integrity program which significantly increases the chances of detecting corrosion or anomalies in the tank shell before it becomes compromised. Discharges would be detected during daily visual inspections and while conducting normal operations. In the event of a discharge, recovery would commence expeditiously by using contracted vacuum trucks and excavation equipment.

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.

5.1.3.2.1.1 Mechanical-specific items

Containers are constructed of a material that is compatible with the oil and oil products stored and the conditions of storage (including pressure and temperature). The facility has high, redundant high, and high-high liquid level alarms with an audible or visual signal at a constantly manned operation or surveillance station. Tank bottoms and associated buried appurtenances are cathodically protected.

The outside of all bulk storage containers and their associated supports and foundations are inspected during formal facility monthly inspections for signs of discharges or accumulation of oil inside secondary containment areas. Field-erected aboveground bulk containers are integrity tested on a regular schedule and when material repairs are made using API Standard 653 (Tanks 30,000 gallons and larger). Small shop-built containers, and those less than 30,000 gallons, may alternatively follow STI-SP001 testing standards set forth in STI-SP001.

All aboveground valves and pipes/pipelines are regularly examined during operating personnel rounds and formally monthly. During these examinations, operating personnel assess the general condition and necessity for corrective actions of items such as flange joints, valve glands and bodies, pipe supports, metal surfaces, expansion joints, catch pans, valve locks and other appurtenances. Periodic pressure testing may be warranted for piping in areas where facility drainage is such that a failure might lead to a spill event. Liquid level sensing devices on tanks are tested monthly to ensure proper operation.

The facility's buried piping installations are provided with corrosion protection. Buried piping installations are wrapped and coated to reduce corrosion. When a section of buried line is exposed for any reason, it is examined for deterioration. If corrosion damage is found, additional examination and corrective action will be taken as indicated by the magnitude of damage.

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

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

Kinder Morgan has placed six 20-lb dry chemical fire extinguishers on or near the dock. One located at the shore entrance to the dock, one located in the dock personnel shelter, one at each end of the dock, one inside the Boat House and one located near the dock transfer area. Fire extinguishers are located throughout the terminal and near the truck loading racks. Instructions for their use are printed on a label attached to the fire extinguisher. All are checked monthly and inspected annually.

The facility maintains notification and response procedures to be implemented immediately after discovering a discharge incident and securing the source. Oil-handling personnel must undergo minimum initial training including operation and maintenance of equipment, discharge procedure protocols, applicable oil spill prevention laws, rules, and regulation, general facility operations and the contents of the SPCC. Facility personnel maintain a high level of training and awareness on the Facility's Integrated Contingency Plan and can implement this contingency plan in the event of an emergency.

Kinder Morgan maintains a Fire Prevention and Protection Plan for the Linnton Terminal. The purpose of the plan is to provide employees with a minimum standard for fire protection and prevention and incorporate Kinder Morgan's policy on fire prevention, training and maintenance. The plan complies with the OSHA Fire Prevention Standard, Title 29 CFR 1910.39 and Cal-OSHA Title 8 Sec. 3221.

The facility also maintains an evacuation plan in the event of an emergency. The diagram includes primary and secondary emergency response command centers, a staging area, main exits, gates, stairs/ladders, and emergency panic bar exit gates.

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

SECTION 6: APPENDICIES

6.1 Appendix A: Geotechnical Data

Appendix A Figure A-1: Vicinity Map

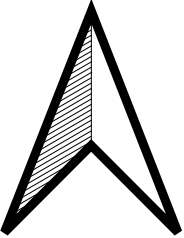
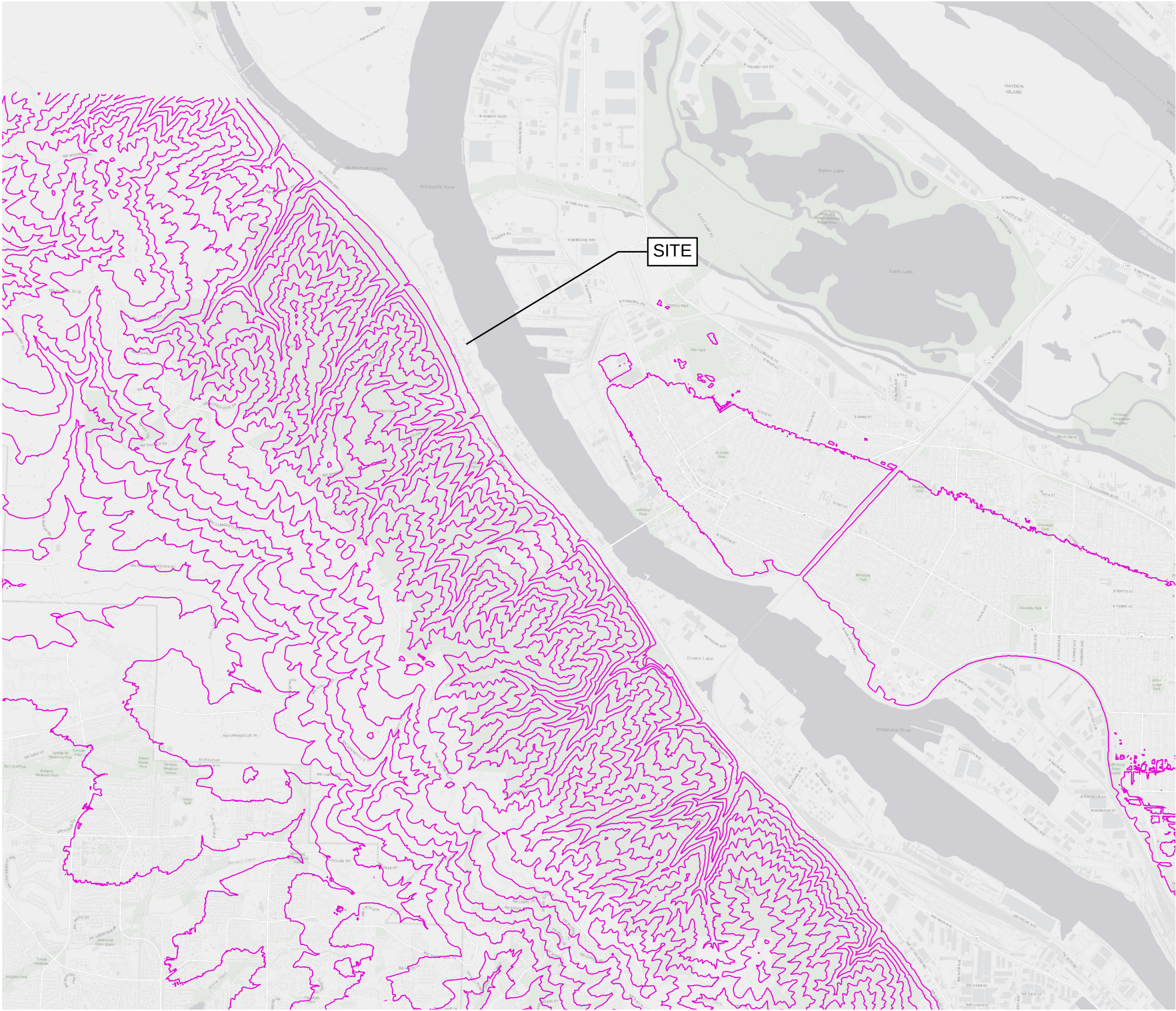
Appendix A Figure A-2: Site and Exploration Plan

Appendix A Figure A-3: Geotechnical Cross Section

Appendix A-1: CPT Data Collected for this Study

Appendix A-2: Historical Data

Appendix A-3: Geotechnical Calculations



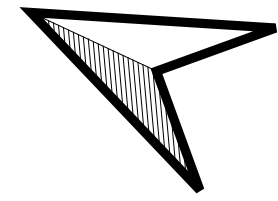
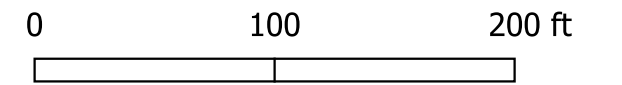
0 3,000 6,000 ft



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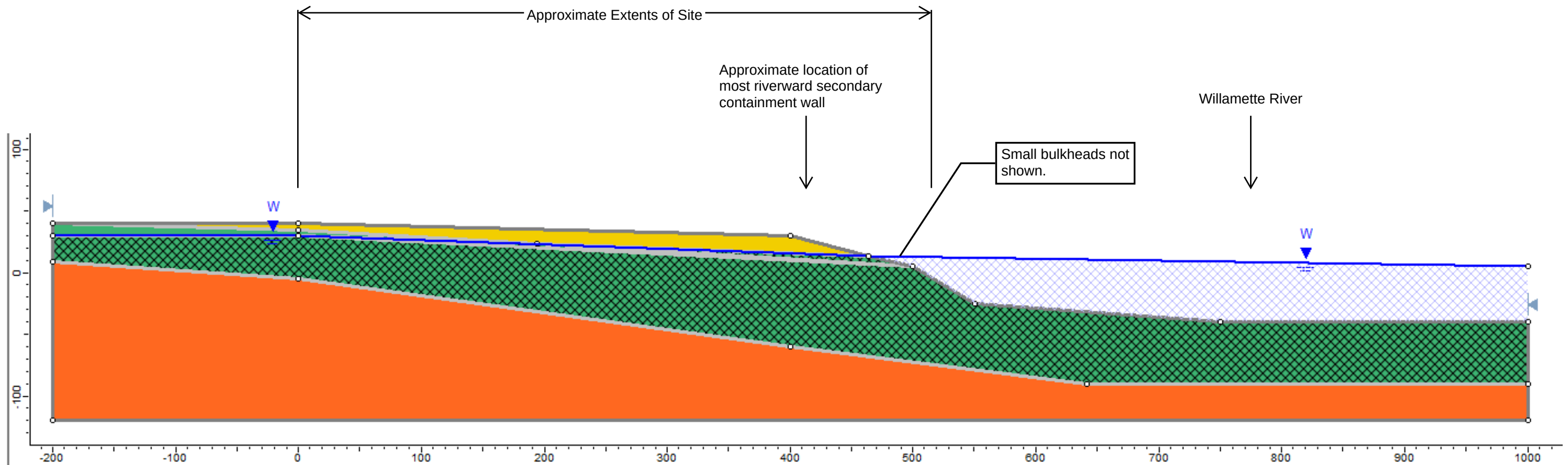


100' Contours from LIDAR



Legend

- Lateral Spread Displacement Contours
 - ▨ Flow Failure Zone
 - ▭ Site Boundary
 - ▭ Taxlot_Parcel
 - Metro 2014 LIDAR Contours
 - CPT Location and Designation
 - Delta (2009) Boring Location and Designation
 - Willamette_River_Bathymetry_(2005)
- Bing Maps Satellite Imagery



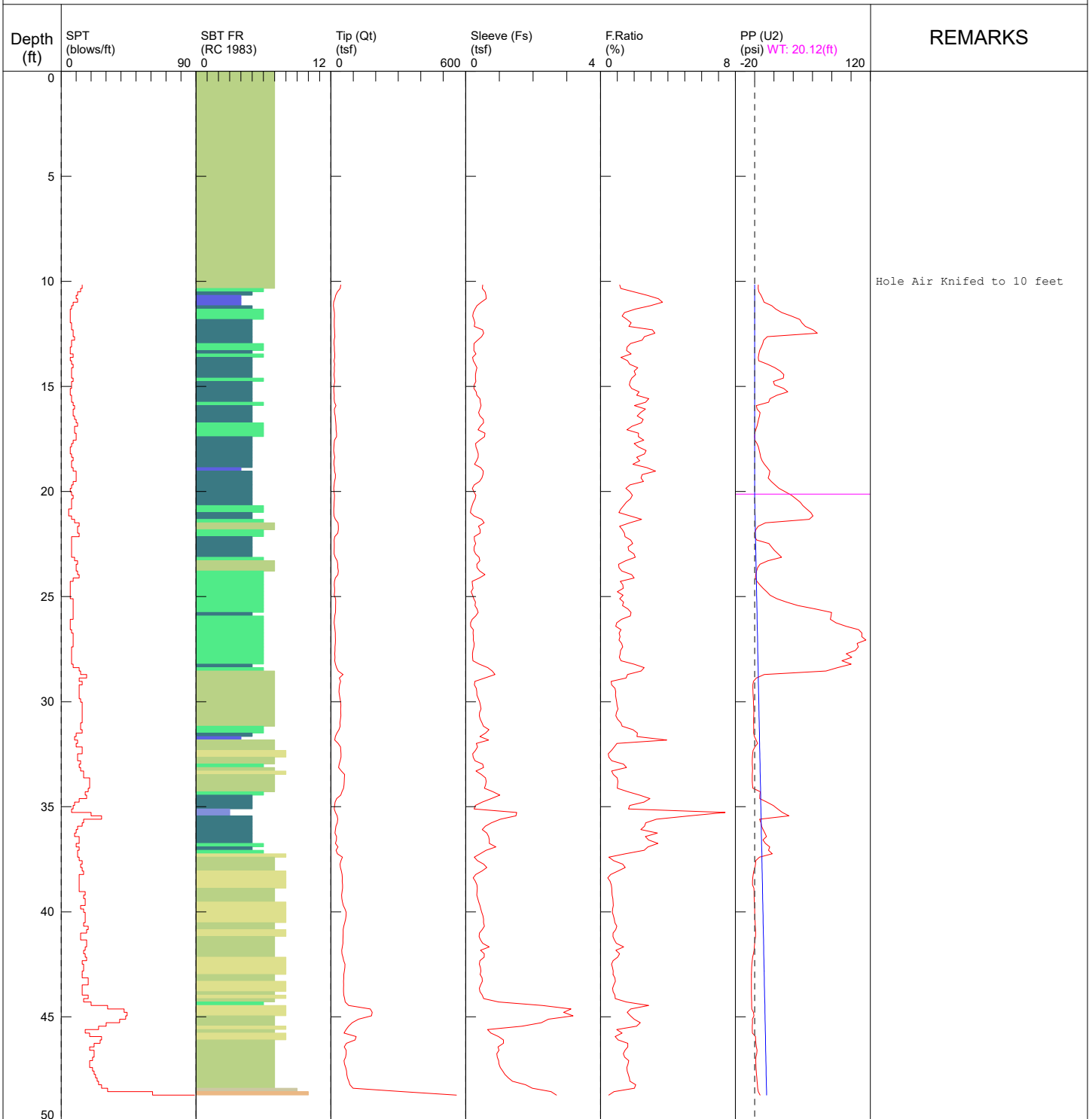
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	■	120	Mohr-Coulomb	0	32				None	0
Alluvium	■	115	Mohr-Coulomb	200	28				None	0
Basalt	■	120	Undrained	20000		Constant			None	0
Alluvium/ Fill Liquefied	■	115	Vertical Stress Ratio				0.14	100	None	0

Section 6.1: Appendix A - Geotechnical Data

Appendix A-1
CPT Data Collected for This Study

Sage Geotechnical / CPT-1 / 11400 NW St Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1654
 TEST DATE: 3/4/2024 10:23:53 AM
 TOTAL DEPTH: 48.720 ft

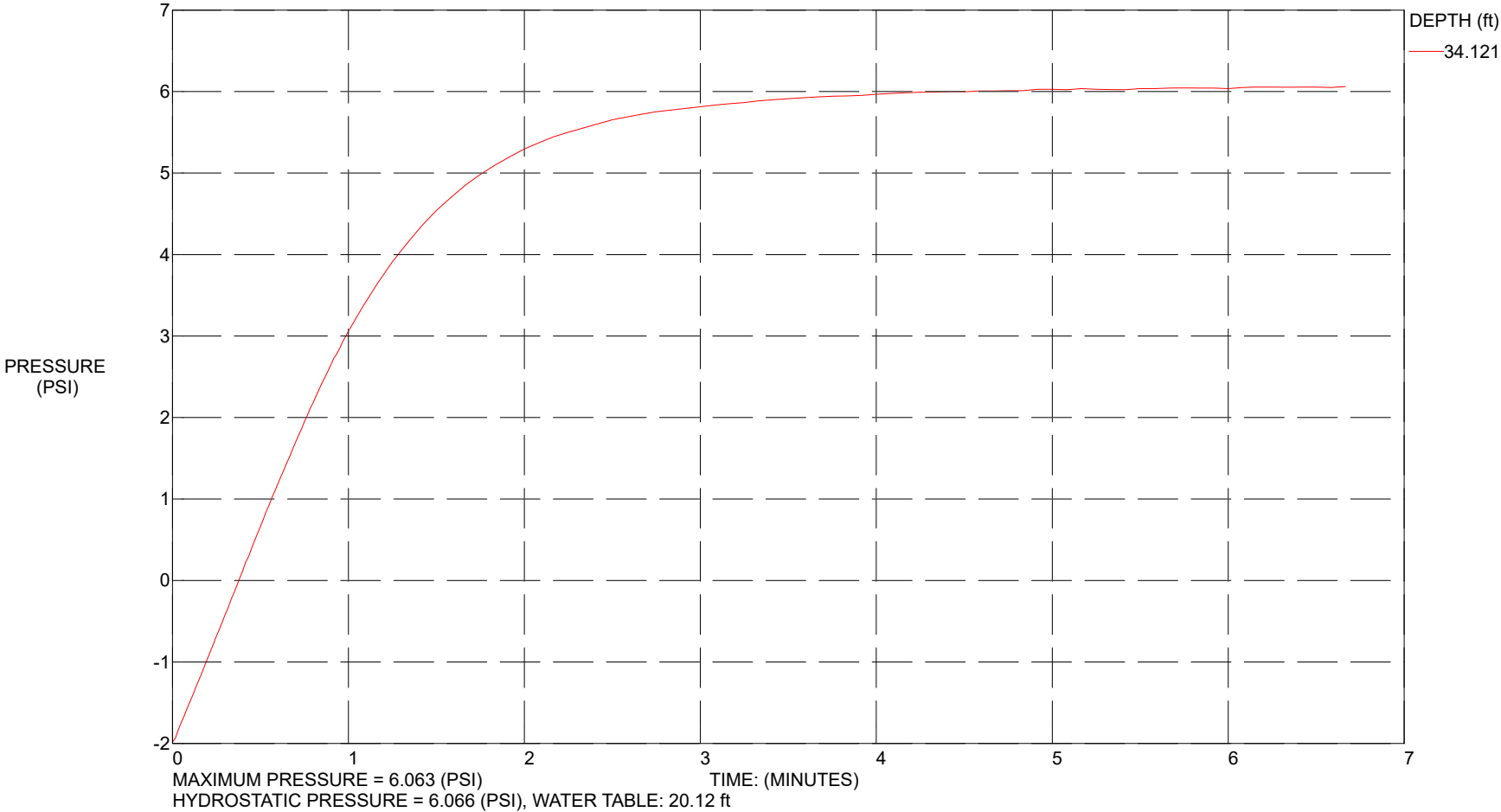


- | | | | |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 1 sensitive fine grained | 4 silty clay to clay | 7 silty sand to sandy silt | 10 gravelly sand to sand |
| 2 organic material | 5 clayey silt to silty clay | 8 sand 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: Sage Geotechnical / CPT-1 / 11400 NW St Helens Road Portland

CONE ID: DDG1654
TEST DATE:



Sage Geotechnical / CPT-1 / 11400 NW St Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1654
 TEST DATE: 3/4/2024 10:23:53 AM
 TOTAL DEPTH: 48.720 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	44.27	0.5031	1.136	3.796	14	7	silty sand to sandy silt
10.335	41.24	0.4941	1.198	3.591	13	7	silty sand to sandy silt
10.499	29.12	0.5741	1.971	4.389	11	6	sandy silt to clayey silt
10.663	21.60	0.5982	2.769	6.576	10	5	clayey silt to silty clay
10.827	17.70	0.6070	3.429	8.299	11	4	silty clay to clay
10.991	12.61	0.4623	3.666	9.720	8	4	silty clay to clay
11.155	11.29	0.3335	2.954	17.740	7	4	silty clay to clay
11.319	13.23	0.2737	2.069	21.927	6	5	clayey silt to silty clay
11.483	15.63	0.2227	1.425	28.146	6	6	sandy silt to clayey silt
11.647	16.00	0.2049	1.281	38.107	6	6	sandy silt to clayey silt
11.811	15.41	0.2408	1.563	46.754	6	6	sandy silt to clayey silt
11.975	14.99	0.2716	1.813	48.998	7	5	clayey silt to silty clay
12.139	15.01	0.2522	1.679	52.622	7	5	clayey silt to silty clay
12.303	16.27	0.4998	3.071	60.474	8	5	clayey silt to silty clay
12.467	16.53	0.5328	3.224	64.928	8	5	clayey silt to silty clay
12.631	18.04	0.4694	2.603	13.049	9	5	clayey silt to silty clay
12.795	14.41	0.3553	2.466	9.262	7	5	clayey silt to silty clay
12.959	13.98	0.2486	1.779	8.368	7	5	clayey silt to silty clay
13.123	15.43	0.2428	1.574	6.841	6	6	sandy silt to clayey silt
13.287	15.61	0.2411	1.544	5.158	6	6	sandy silt to clayey silt
13.451	16.80	0.3038	1.808	4.259	8	5	clayey silt to silty clay
13.615	16.83	0.2023	1.202	3.674	6	6	sandy silt to clayey silt
13.780	13.92	0.2230	1.602	4.079	7	5	clayey silt to silty clay
13.944	16.42	0.2835	1.726	13.321	8	5	clayey silt to silty clay
14.108	15.07	0.3327	2.207	21.013	7	5	clayey silt to silty clay
14.272	15.42	0.3065	1.988	26.628	7	5	clayey silt to silty clay
14.436	13.85	0.2879	2.078	30.285	7	5	clayey silt to silty clay
14.600	15.68	0.2894	1.845	29.724	8	5	clayey silt to silty clay
14.764	17.17	0.3002	1.748	19.287	7	6	sandy silt to clayey silt
14.928	14.79	0.2516	1.701	20.499	7	5	clayey silt to silty clay
15.092	13.03	0.2402	1.843	30.181	6	5	clayey silt to silty clay
15.256	13.52	0.3091	2.286	34.448	6	5	clayey silt to silty clay
15.420	15.34	0.3286	2.142	23.160	7	5	clayey silt to silty clay
15.584	14.73	0.4209	2.858	15.874	7	5	clayey silt to silty clay
15.748	16.19	0.4330	2.676	14.505	8	5	clayey silt to silty clay
15.912	22.49	0.4518	2.009	1.644	9	6	sandy silt to clayey silt
16.076	15.83	0.4212	2.661	2.511	8	5	clayey silt to silty clay
16.240	16.14	0.3823	2.369	5.512	8	5	clayey silt to silty clay
16.404	19.40	0.4208	2.169	5.062	9	5	clayey silt to silty clay
16.568	20.62	0.5212	2.528	4.007	10	5	clayey silt to silty clay
16.732	21.94	0.5313	2.422	3.197	11	5	clayey silt to silty clay
16.896	23.20	0.4316	1.860	2.269	9	6	sandy silt to clayey silt
17.060	23.21	0.3640	1.568	1.067	9	6	sandy silt to clayey silt
17.224	25.37	0.5713	2.252	0.152	10	6	sandy silt to clayey silt
17.388	24.90	0.5573	2.239	-0.231	10	6	sandy silt to clayey silt
17.552	16.17	0.4138	2.559	0.198	8	5	clayey silt to silty clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	14.59	0.2916	1.998	2.307	7	5	clayey silt to silty clay
17.881	13.56	0.3033	2.237	3.893	6	5	clayey silt to silty clay
18.045	12.72	0.3436	2.701	4.676	6	5	clayey silt to silty clay
18.209	14.28	0.3721	2.606	5.629	7	5	clayey silt to silty clay
18.373	17.25	0.3697	2.143	6.221	8	5	clayey silt to silty clay
18.537	13.87	0.3218	2.321	7.776	7	5	clayey silt to silty clay
18.701	13.60	0.2603	1.914	10.157	7	5	clayey silt to silty clay
18.865	16.12	0.4425	2.745	12.983	8	5	clayey silt to silty clay
19.029	16.01	0.5216	3.258	15.763	10	4	silty clay to clay
19.193	20.58	0.5079	2.468	15.135	10	5	clayey silt to silty clay
19.357	20.03	0.4803	2.398	14.035	10	5	clayey silt to silty clay
19.521	16.02	0.4075	2.543	17.209	8	5	clayey silt to silty clay
19.685	14.60	0.2536	1.737	21.079	7	5	clayey silt to silty clay
19.849	13.02	0.1952	1.499	25.277	6	5	clayey silt to silty clay
20.013	14.01	0.2442	1.743	31.906	7	5	clayey silt to silty clay
20.177	16.02	0.3020	1.885	38.020	8	5	clayey silt to silty clay
20.341	15.63	0.2775	1.776	42.749	7	5	clayey silt to silty clay
20.505	14.56	0.2226	1.530	47.224	7	5	clayey silt to silty clay
20.669	13.72	0.1881	1.371	50.009	7	5	clayey silt to silty clay
20.833	12.95	0.1567	1.210	53.933	5	6	sandy silt to clayey silt
20.997	12.93	0.1404	1.086	58.240	5	6	sandy silt to clayey silt
21.161	13.98	0.2460	1.760	60.522	7	5	clayey silt to silty clay
21.325	19.63	0.4779	2.435	56.657	9	5	clayey silt to silty clay
21.490	31.55	0.5464	1.732	11.211	12	6	sandy silt to clayey silt
21.654	33.65	0.3797	1.128	3.525	11	7	silty sand to sandy silt
21.818	33.26	0.4301	1.293	1.133	11	7	silty sand to sandy silt
21.982	30.16	0.4251	1.409	0.061	12	6	sandy silt to clayey silt
22.146	17.47	0.2526	1.446	-0.079	7	6	sandy silt to clayey silt
22.310	14.34	0.2565	1.789	2.061	7	5	clayey silt to silty clay
22.474	15.37	0.2934	1.909	14.744	7	5	clayey silt to silty clay
22.638	15.32	0.2488	1.623	17.458	7	5	clayey silt to silty clay
22.802	14.83	0.2471	1.666	20.431	7	5	clayey silt to silty clay
22.966	14.80	0.2925	1.976	24.268	7	5	clayey silt to silty clay
23.130	19.36	0.3976	2.054	27.884	9	5	clayey silt to silty clay
23.294	28.06	0.4168	1.485	13.806	11	6	sandy silt to clayey silt
23.458	30.52	0.3277	1.074	5.481	10	7	silty sand to sandy silt
23.622	31.02	0.3377	1.089	3.113	10	7	silty sand to sandy silt
23.786	32.93	0.4139	1.257	1.947	11	7	silty sand to sandy silt
23.950	31.08	0.5721	1.841	1.049	12	6	sandy silt to clayey silt
24.114	20.07	0.4008	1.997	0.724	8	6	sandy silt to clayey silt
24.278	16.08	0.1878	1.168	2.302	6	6	sandy silt to clayey silt
24.442	15.10	0.2000	1.325	5.382	6	6	sandy silt to clayey silt
24.606	16.32	0.2183	1.338	8.655	6	6	sandy silt to clayey silt
24.770	16.34	0.1612	0.987	12.406	6	6	sandy silt to clayey silt
24.934	15.20	0.2024	1.331	15.979	6	6	sandy silt to clayey silt
25.098	21.10	0.2395	1.135	22.913	8	6	sandy silt to clayey silt
25.262	21.33	0.2904	1.362	32.976	8	6	sandy silt to clayey silt
25.427	21.04	0.2734	1.300	45.097	8	6	sandy silt to clayey silt
25.591	20.81	0.3368	1.619	62.903	8	6	sandy silt to clayey silt
25.755	20.45	0.3691	1.805	79.786	8	6	sandy silt to clayey silt
25.919	16.90	0.2982	1.764	79.222	8	5	clayey silt to silty clay
26.083	15.61	0.1942	1.244	78.546	6	6	sandy silt to clayey silt
26.247	14.86	0.1426	0.960	84.393	6	6	sandy silt to clayey silt
26.411	16.32	0.1465	0.897	94.878	6	6	sandy silt to clayey silt
26.575	18.41	0.2233	1.213	107.858	7	6	sandy silt to clayey silt
26.739	19.84	0.2174	1.096	111.378	8	6	sandy silt to clayey silt
26.903	19.73	0.2280	1.155	111.121	8	6	sandy silt to clayey silt

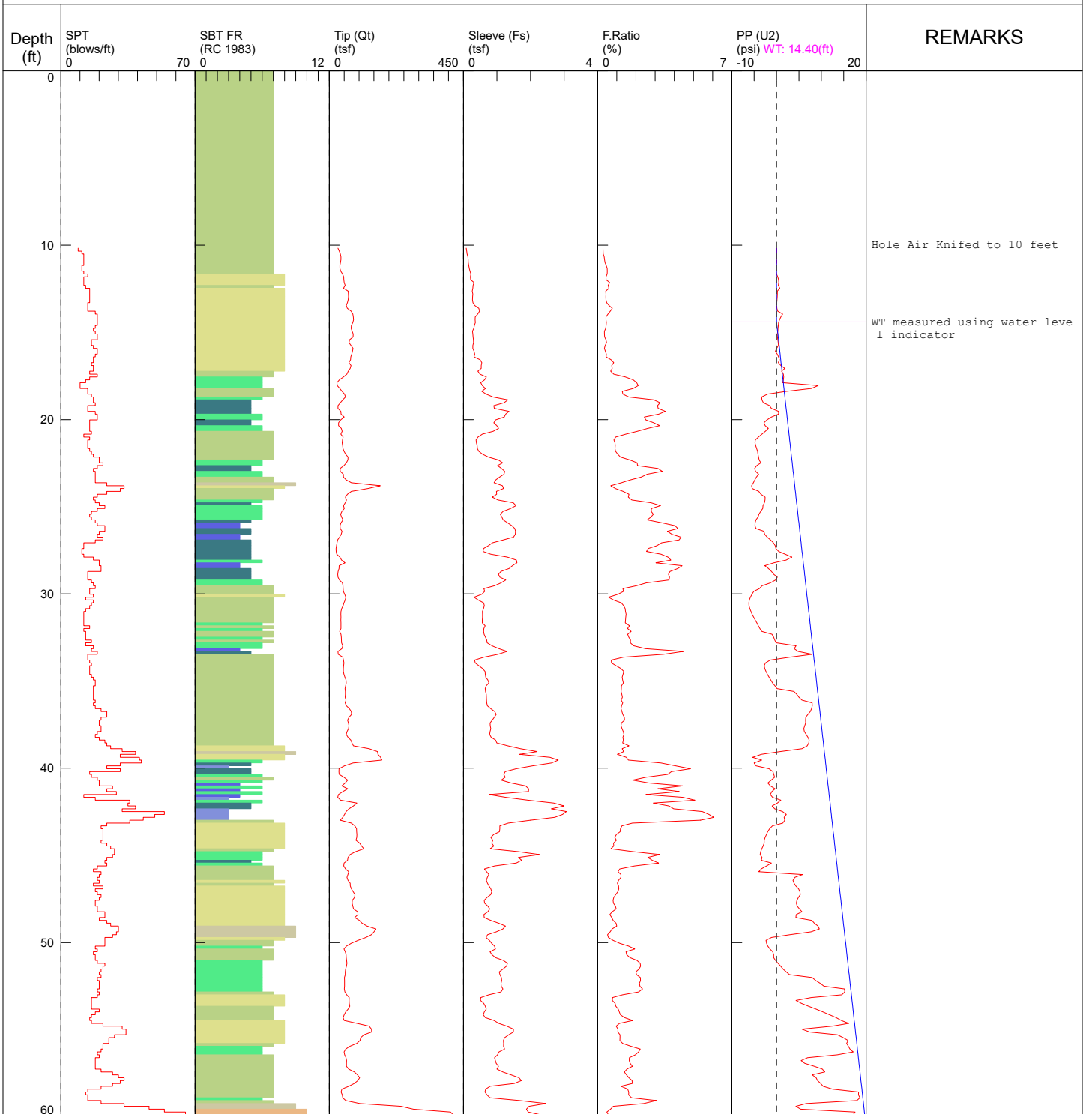
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	20.50	0.2241	1.093	115.385	8	6	sandy silt to clayey silt
27.231	19.93	0.2495	1.251	106.341	8	6	sandy silt to clayey silt
27.395	18.48	0.2423	1.311	107.569	7	6	sandy silt to clayey silt
27.559	18.10	0.2148	1.187	104.570	7	6	sandy silt to clayey silt
27.723	17.27	0.2002	1.159	95.102	7	6	sandy silt to clayey silt
27.887	18.12	0.2017	1.113	100.865	7	6	sandy silt to clayey silt
28.051	17.63	0.2144	1.216	90.451	7	6	sandy silt to clayey silt
28.215	20.45	0.4045	1.978	100.169	8	6	sandy silt to clayey silt
28.379	25.24	0.6528	2.586	86.043	12	5	clayey silt to silty clay
28.543	32.64	0.7853	2.406	74.064	13	6	sandy silt to clayey silt
28.707	54.08	0.8671	1.603	9.956	17	7	silty sand to sandy silt
28.871	37.61	0.5693	1.514	1.670	12	7	silty sand to sandy silt
29.035	43.12	0.2699	0.626	-1.314	14	7	silty sand to sandy silt
29.199	39.08	0.2560	0.655	-1.995	12	7	silty sand to sandy silt
29.364	36.94	0.3159	0.855	-1.939	12	7	silty sand to sandy silt
29.528	36.40	0.3266	0.897	-1.794	12	7	silty sand to sandy silt
29.692	37.85	0.3329	0.879	-1.603	12	7	silty sand to sandy silt
29.856	40.86	0.3758	0.920	-1.469	13	7	silty sand to sandy silt
30.020	43.29	0.4142	0.957	-1.321	14	7	silty sand to sandy silt
30.184	44.52	0.4360	0.979	-1.182	14	7	silty sand to sandy silt
30.348	43.55	0.4525	1.039	-1.065	14	7	silty sand to sandy silt
30.512	43.81	0.4118	0.940	-0.958	14	7	silty sand to sandy silt
30.676	44.55	0.4042	0.907	-1.011	14	7	silty sand to sandy silt
30.840	42.43	0.4304	1.015	-1.131	14	7	silty sand to sandy silt
31.004	40.10	0.4836	1.206	-1.083	13	7	silty sand to sandy silt
31.168	41.09	0.5246	1.277	-0.981	13	7	silty sand to sandy silt
31.332	36.05	0.6921	1.920	-1.042	14	6	sandy silt to clayey silt
31.496	26.89	0.5883	2.188	-1.151	10	6	sandy silt to clayey silt
31.660	19.49	0.4201	2.155	-0.285	9	5	clayey silt to silty clay
31.824	17.27	0.6777	3.924	1.428	11	4	silty clay to clay
31.988	32.32	0.3131	0.969	2.938	10	7	silty sand to sandy silt
32.152	43.02	0.3517	0.818	0.213	14	7	silty sand to sandy silt
32.316	44.42	0.2889	0.650	-1.695	14	7	silty sand to sandy silt
32.480	45.04	0.2074	0.461	-2.129	11	8	sand to silty sand
32.644	44.92	0.2197	0.489	-2.401	11	8	sand to silty sand
32.808	41.45	0.2733	0.659	-2.531	13	7	silty sand to sandy silt
32.972	36.91	0.5044	1.366	-2.541	12	7	silty sand to sandy silt
33.136	34.25	0.5267	1.538	-2.323	13	6	sandy silt to clayey silt
33.301	46.57	0.3046	0.654	-2.229	15	7	silty sand to sandy silt
33.465	61.33	0.4657	0.759	-2.526	15	8	sand to silty sand
33.629	59.86	0.5879	0.982	-2.617	19	7	silty sand to sandy silt
33.793	59.23	0.6083	1.027	-2.495	19	7	silty sand to sandy silt
33.957	58.61	0.5899	1.006	-2.234	19	7	silty sand to sandy silt
34.121	56.15	0.5538	0.986	-1.977	18	7	silty sand to sandy silt
34.285	49.79	0.8057	1.618	5.900	16	7	silty sand to sandy silt
34.449	43.69	1.0112	2.314	5.339	17	6	sandy silt to clayey silt
34.613	25.82	0.7563	2.929	5.273	12	5	clayey silt to silty clay
34.777	18.98	0.4894	2.579	12.657	9	5	clayey silt to silty clay
34.941	16.53	0.2860	1.730	19.173	8	5	clayey silt to silty clay
35.105	15.17	0.2516	1.659	23.841	7	5	clayey silt to silty clay
35.269	20.42	1.5088	7.389	28.699	20	3	clay
35.433	28.15	1.4897	5.292	35.627	27	3	clay
35.597	30.96	1.0268	3.317	5.103	15	5	clayey silt to silty clay
35.761	28.49	0.7629	2.678	6.505	14	5	clayey silt to silty clay
35.925	22.36	0.5837	2.611	7.059	11	5	clayey silt to silty clay
36.089	20.50	0.4888	2.384	8.731	10	5	clayey silt to silty clay
36.253	18.52	0.6245	3.372	10.657	9	5	clayey silt to silty clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	25.55	0.6784	2.655	12.258	12	5	clayey silt to silty clay
36.581	24.68	0.7009	2.840	8.528	12	5	clayey silt to silty clay
36.745	20.62	0.7010	3.400	11.013	10	5	clayey silt to silty clay
36.909	31.78	0.8923	2.808	15.613	12	6	sandy silt to clayey silt
37.073	23.41	0.6048	2.583	14.276	11	5	clayey silt to silty clay
37.238	29.17	0.4283	1.469	18.271	11	6	sandy silt to clayey silt
37.402	51.52	0.2525	0.490	5.031	12	8	sand to silty sand
37.566	45.17	0.3458	0.766	1.075	14	7	silty sand to sandy silt
37.730	40.47	0.5330	1.317	0.800	13	7	silty sand to sandy silt
37.894	42.59	0.6246	1.466	0.239	14	7	silty sand to sandy silt
38.058	46.67	0.4835	1.036	-0.877	15	7	silty sand to sandy silt
38.222	49.95	0.2982	0.597	-1.545	12	8	sand to silty sand
38.386	50.90	0.2194	0.431	-2.094	12	8	sand to silty sand
38.550	50.68	0.2869	0.566	-2.315	12	8	sand to silty sand
38.714	51.91	0.3311	0.638	-2.300	12	8	sand to silty sand
38.878	51.68	0.3417	0.661	-0.793	12	8	sand to silty sand
39.042	49.97	0.3357	0.672	-0.666	16	7	silty sand to sandy silt
39.206	47.94	0.3271	0.682	-0.579	15	7	silty sand to sandy silt
39.370	48.89	0.3561	0.728	-0.503	16	7	silty sand to sandy silt
39.534	51.39	0.3834	0.746	-0.366	16	7	silty sand to sandy silt
39.698	55.28	0.4186	0.757	-0.241	13	8	sand to silty sand
39.862	62.40	0.4458	0.714	-0.081	15	8	sand to silty sand
40.026	67.96	0.4728	0.696	0.053	16	8	sand to silty sand
40.190	67.42	0.5122	0.760	0.178	16	8	sand to silty sand
40.354	65.06	0.5289	0.813	0.274	16	8	sand to silty sand
40.518	61.77	0.5269	0.853	0.435	15	8	sand to silty sand
40.682	57.34	0.5549	0.968	0.612	18	7	silty sand to sandy silt
40.846	54.45	0.4897	0.899	0.844	17	7	silty sand to sandy silt
41.011	55.14	0.4083	0.741	0.996	13	8	sand to silty sand
41.175	54.13	0.3956	0.731	0.874	13	8	sand to silty sand
41.339	53.57	0.4413	0.824	0.376	17	7	silty sand to sandy silt
41.503	53.58	0.5027	0.938	0.005	17	7	silty sand to sandy silt
41.667	50.98	0.6971	1.367	-0.417	16	7	silty sand to sandy silt
41.831	48.43	0.4372	0.903	-0.663	15	7	silty sand to sandy silt
41.995	49.03	0.5517	1.125	-1.365	16	7	silty sand to sandy silt
42.159	53.80	0.5438	1.011	-2.188	17	7	silty sand to sandy silt
42.323	56.90	0.4229	0.743	-2.508	14	8	sand to silty sand
42.487	62.50	0.4065	0.650	-2.874	15	8	sand to silty sand
42.651	62.11	0.4362	0.702	-3.161	15	8	sand to silty sand
42.815	59.85	0.4494	0.751	-3.316	14	8	sand to silty sand
42.979	57.43	0.4290	0.747	-3.382	14	8	sand to silty sand
43.143	57.06	0.4856	0.851	-3.438	18	7	silty sand to sandy silt
43.307	56.46	0.4930	0.873	-3.456	18	7	silty sand to sandy silt
43.471	56.58	0.4440	0.785	-3.466	14	8	sand to silty sand
43.635	56.49	0.4029	0.713	-3.476	14	8	sand to silty sand
43.799	56.40	0.4215	0.747	-3.474	14	8	sand to silty sand
43.963	57.33	0.4891	0.853	-3.410	18	7	silty sand to sandy silt
44.127	61.15	0.5320	0.870	-3.329	15	8	sand to silty sand
44.291	64.09	0.9757	1.522	-3.263	20	7	silty sand to sandy silt
44.455	79.71	2.2738	2.853	-3.171	31	6	sandy silt to clayey silt
44.619	175.08	3.1250	1.785	-2.999	42	8	sand to silty sand
44.783	184.03	2.9050	1.579	-1.220	44	8	sand to silty sand
44.948	180.30	3.1851	1.766	-0.816	43	8	sand to silty sand
45.112	122.94	2.4524	1.995	-2.343	39	7	silty sand to sandy silt
45.276	95.12	2.2451	2.360	-2.239	30	7	silty sand to sandy silt
45.440	78.46	1.6732	2.133	-2.528	25	7	silty sand to sandy silt
45.604	67.63	0.6452	0.954	-2.447	16	8	sand to silty sand

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
45.768	58.60	0.7476	1.276	-2.358	19	7	silty sand to sandy silt
45.932	112.39	0.9724	0.865	0.856	27	8	sand to silty sand
46.096	107.52	1.1195	1.041	1.001	26	8	sand to silty sand
46.260	69.34	1.1174	1.611	1.212	22	7	silty sand to sandy silt
46.424	59.30	0.9568	1.613	1.634	19	7	silty sand to sandy silt
46.588	68.11	0.9860	1.448	2.429	22	7	silty sand to sandy silt
46.752	68.02	0.9211	1.354	2.119	22	7	silty sand to sandy silt
46.916	65.43	0.9346	1.428	1.248	21	7	silty sand to sandy silt
47.080	58.64	0.9775	1.667	1.065	19	7	silty sand to sandy silt
47.244	60.76	0.9866	1.624	1.192	19	7	silty sand to sandy silt
47.408	65.96	1.0248	1.554	1.400	21	7	silty sand to sandy silt
47.572	69.53	1.0964	1.577	1.596	22	7	silty sand to sandy silt
47.736	70.60	1.1615	1.645	1.855	23	7	silty sand to sandy silt
47.900	74.13	1.2656	1.707	2.185	24	7	silty sand to sandy silt
48.064	79.80	1.3882	1.740	2.475	25	7	silty sand to sandy silt
48.228	85.04	1.7746	2.087	2.805	27	7	silty sand to sandy silt
48.392	98.55	1.9784	2.008	3.181	31	7	silty sand to sandy silt
48.556	317.46	2.5306	0.797	3.819	61	9	sand
48.720	558.34	2.6907	0.482	5.588	89	10	gravelly sand to sand

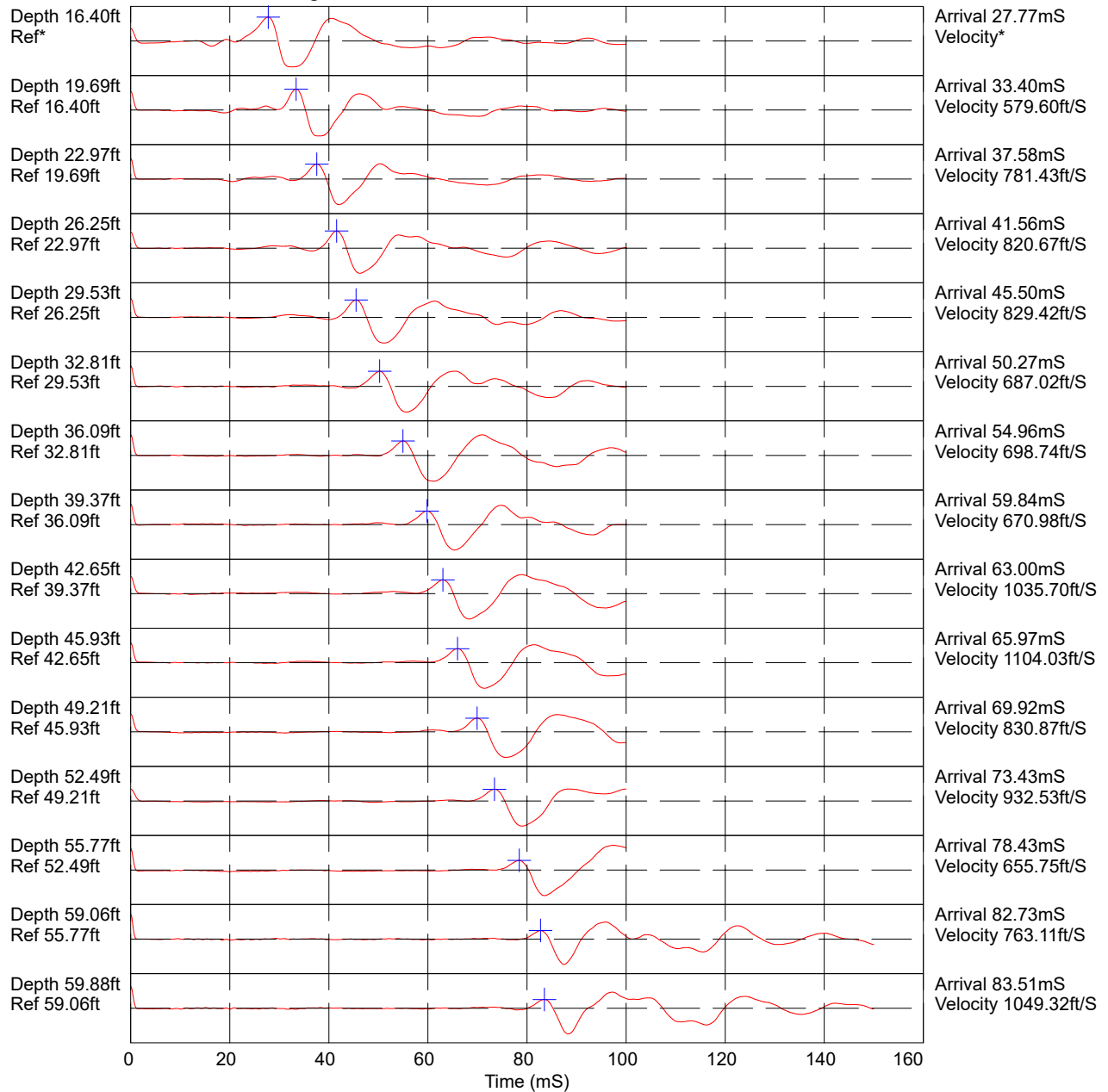
Sage Geotechnical / CPT-2 / 11400 NW St Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1654
 TEST DATE: 3/4/2024 11:34:46 AM
 TOTAL DEPTH: 59.875 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: Sage Geotechnical / CPT-2 / 11400 NW St Helens Road Portland

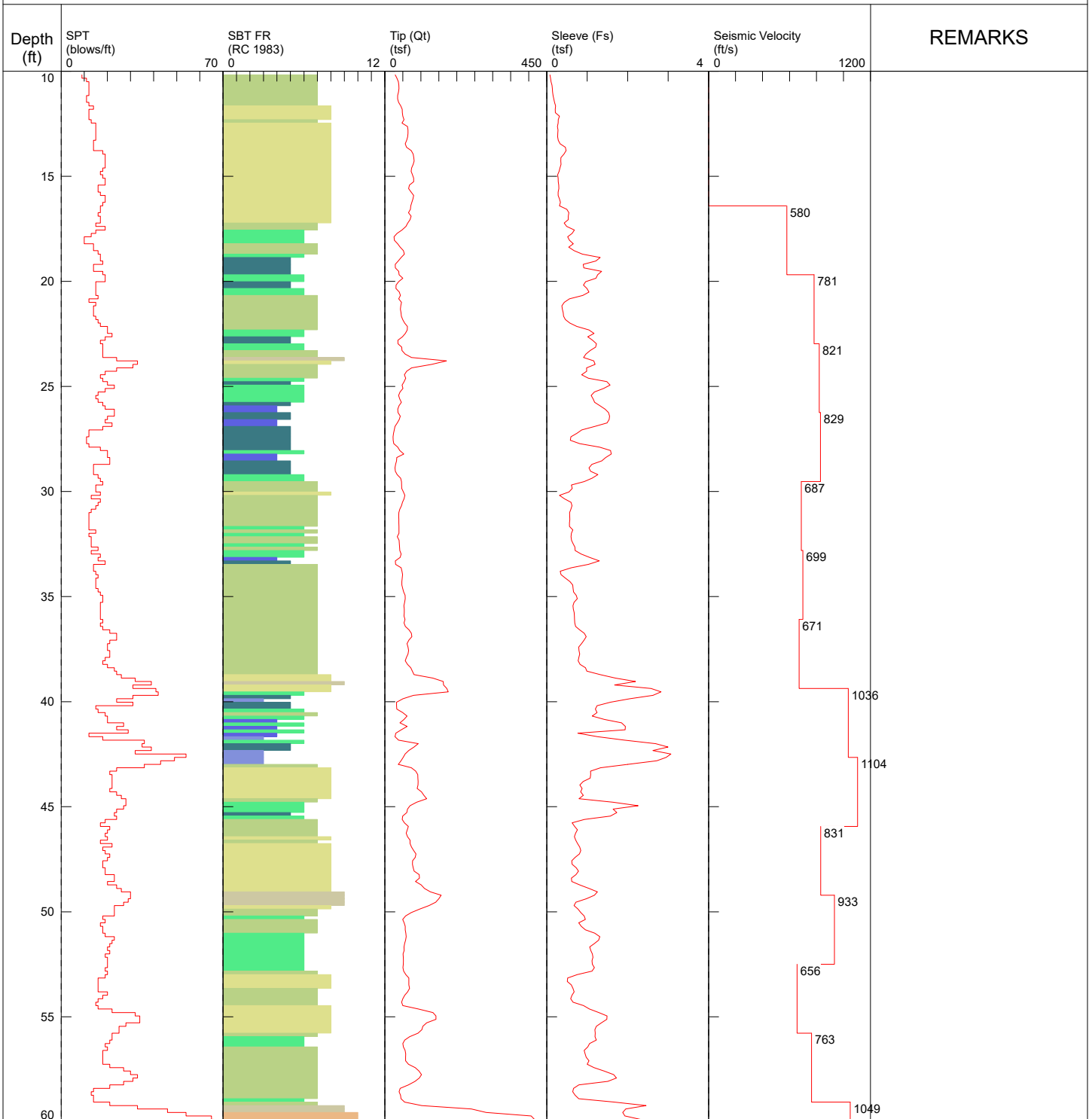


Hammer to Rod String Distance (ft): 2.03

* = Not Determined

Sage Geotechnical / CPT-2 / 11400 NW St Helens Road Portland

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OPERATOR: OGE BAK
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Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	28.77	0.0793	0.276	0.036	9	7	silty sand to sandy silt
10.335	33.52	0.0951	0.284	0.061	11	7	silty sand to sandy silt
10.499	37.28	0.1067	0.286	0.028	12	7	silty sand to sandy silt
10.663	38.78	0.1300	0.335	0.038	12	7	silty sand to sandy silt
10.827	39.14	0.1394	0.356	0.048	12	7	silty sand to sandy silt
10.991	37.61	0.1429	0.380	0.036	12	7	silty sand to sandy silt
11.155	35.52	0.1573	0.443	-0.112	11	7	silty sand to sandy silt
11.319	35.53	0.1734	0.488	-0.094	11	7	silty sand to sandy silt
11.483	38.36	0.1923	0.501	-0.097	12	7	silty sand to sandy silt
11.647	44.08	0.2194	0.498	-0.013	14	7	silty sand to sandy silt
11.811	48.37	0.2079	0.430	0.262	12	8	sand to silty sand
11.975	48.63	0.2137	0.439	0.462	12	8	sand to silty sand
12.139	50.01	0.3132	0.626	0.508	12	8	sand to silty sand
12.303	52.93	0.2857	0.540	0.384	13	8	sand to silty sand
12.467	47.51	0.2793	0.588	0.691	15	7	silty sand to sandy silt
12.631	62.90	0.2627	0.418	0.196	15	8	sand to silty sand
12.795	64.14	0.2779	0.433	0.183	15	8	sand to silty sand
12.959	64.17	0.2722	0.424	0.135	15	8	sand to silty sand
13.123	62.98	0.2694	0.428	0.089	15	8	sand to silty sand
13.287	60.50	0.2834	0.468	0.053	14	8	sand to silty sand
13.451	56.53	0.3297	0.583	0.041	14	8	sand to silty sand
13.615	60.40	0.4584	0.759	0.064	14	8	sand to silty sand
13.780	73.14	0.4791	0.655	0.262	18	8	sand to silty sand
13.944	78.83	0.4245	0.538	1.354	19	8	sand to silty sand
14.108	80.39	0.3490	0.434	0.943	19	8	sand to silty sand
14.272	81.28	0.3468	0.427	0.651	19	8	sand to silty sand
14.436	78.73	0.3534	0.449	0.460	19	8	sand to silty sand
14.600	74.20	0.3239	0.437	0.376	18	8	sand to silty sand
14.764	72.89	0.3054	0.419	0.323	17	8	sand to silty sand
14.928	76.56	0.2668	0.348	0.267	18	8	sand to silty sand
15.092	79.92	0.2799	0.350	0.137	19	8	sand to silty sand
15.256	79.91	0.2862	0.358	0.155	19	8	sand to silty sand
15.420	68.03	0.2942	0.432	0.274	16	8	sand to silty sand
15.584	66.01	0.3012	0.456	0.371	16	8	sand to silty sand
15.748	72.84	0.2799	0.384	0.401	17	8	sand to silty sand
15.912	79.90	0.2806	0.351	0.018	19	8	sand to silty sand
16.076	77.75	0.3138	0.404	-0.277	19	8	sand to silty sand
16.240	74.90	0.3365	0.449	0.140	18	8	sand to silty sand
16.404	72.03	0.3154	0.438	0.432	17	8	sand to silty sand
16.568	70.97	0.4965	0.700	0.615	17	8	sand to silty sand
16.732	65.52	0.5466	0.834	0.381	16	8	sand to silty sand
16.896	72.85	0.5304	0.728	0.953	17	8	sand to silty sand
17.060	69.96	0.5304	0.758	1.830	17	8	sand to silty sand
17.224	63.58	0.4292	0.675	1.110	15	8	sand to silty sand
17.388	58.74	0.4943	0.842	1.502	19	7	silty sand to sandy silt
17.552	47.48	0.6828	1.438	1.601	15	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	33.90	0.6278	1.852	1.494	13	6	sandy silt to clayey silt
17.881	25.31	0.5151	2.035	1.354	10	6	sandy silt to clayey silt
18.045	26.58	0.5612	2.111	9.295	10	6	sandy silt to clayey silt
18.209	35.32	0.6541	1.852	7.783	14	6	sandy silt to clayey silt
18.373	42.39	0.5438	1.283	2.198	14	7	silty sand to sandy silt
18.537	51.34	0.6751	1.315	-2.023	16	7	silty sand to sandy silt
18.701	54.21	0.8783	1.620	-3.342	17	7	silty sand to sandy silt
18.865	45.17	1.3210	2.925	-3.276	17	6	sandy silt to clayey silt
19.029	37.26	1.2125	3.254	-2.953	18	5	clayey silt to silty clay
19.193	28.86	0.9014	3.124	-1.583	14	5	clayey silt to silty clay
19.357	29.11	0.9164	3.148	-1.166	14	5	clayey silt to silty clay
19.521	38.52	1.3585	3.527	0.445	18	5	clayey silt to silty clay
19.685	39.49	1.2577	3.185	0.427	19	5	clayey silt to silty clay
19.849	49.90	1.2150	2.435	-1.126	19	6	sandy silt to clayey silt
20.013	38.30	0.9598	2.506	-2.168	15	6	sandy silt to clayey silt
20.177	31.02	0.9057	2.920	-2.836	15	5	clayey silt to silty clay
20.341	30.73	0.9926	3.230	-2.554	15	5	clayey silt to silty clay
20.505	40.07	1.0451	2.608	-1.819	15	6	sandy silt to clayey silt
20.669	42.99	0.8890	2.068	-2.521	16	6	sandy silt to clayey silt
20.833	38.43	0.5605	1.458	-3.273	12	7	silty sand to sandy silt
20.997	46.09	0.4322	0.938	-4.053	15	7	silty sand to sandy silt
21.161	44.18	0.3740	0.847	-4.754	14	7	silty sand to sandy silt
21.325	42.94	0.3845	0.895	-4.838	14	7	silty sand to sandy silt
21.490	44.64	0.4068	0.911	-4.691	14	7	silty sand to sandy silt
21.654	45.88	0.4147	0.904	-4.460	15	7	silty sand to sandy silt
21.818	49.49	0.4590	0.928	-4.264	16	7	silty sand to sandy silt
21.982	54.76	0.5697	1.040	-4.178	17	7	silty sand to sandy silt
22.146	62.53	0.7420	1.187	-4.043	20	7	silty sand to sandy silt
22.310	62.19	1.0389	1.671	-3.901	20	7	silty sand to sandy silt
22.474	56.83	1.1678	2.055	-3.512	22	6	sandy silt to clayey silt
22.638	48.90	1.0156	2.077	-4.437	19	6	sandy silt to clayey silt
22.802	36.06	1.1327	3.141	-4.912	17	5	clayey silt to silty clay
22.966	36.57	1.2294	3.362	-4.696	18	5	clayey silt to silty clay
23.130	46.90	1.2095	2.579	-4.020	18	6	sandy silt to clayey silt
23.294	47.48	1.0745	2.263	-4.500	18	6	sandy silt to clayey silt
23.458	56.39	0.9659	1.713	-4.864	18	7	silty sand to sandy silt
23.622	73.89	0.9115	1.234	-5.184	24	7	silty sand to sandy silt
23.786	171.02	1.1625	0.680	-5.578	33	9	sand
23.950	130.23	1.1953	0.918	-5.451	31	8	sand to silty sand
24.114	74.13	0.9827	1.326	-3.979	24	7	silty sand to sandy silt
24.278	60.57	0.9886	1.632	-3.509	19	7	silty sand to sandy silt
24.442	54.05	0.8608	1.592	-2.567	17	7	silty sand to sandy silt
24.606	57.75	1.0282	1.780	-2.577	18	7	silty sand to sandy silt
24.770	53.47	1.4846	2.777	-2.716	20	6	sandy silt to clayey silt
24.934	47.67	1.5625	3.278	-3.042	23	5	clayey silt to silty clay
25.098	50.21	1.4050	2.798	-3.103	19	6	sandy silt to clayey silt
25.262	42.27	1.1790	2.789	-3.535	16	6	sandy silt to clayey silt
25.427	37.87	1.0970	2.897	-3.939	15	6	sandy silt to clayey silt
25.591	41.15	1.1430	2.778	-4.137	16	6	sandy silt to clayey silt
25.755	45.81	1.1830	2.583	-4.627	18	6	sandy silt to clayey silt
25.919	39.10	1.3186	3.372	-4.818	19	5	clayey silt to silty clay
26.083	35.82	1.4426	4.028	-4.836	23	4	silty clay to clay
26.247	36.55	1.5271	4.179	-4.625	23	4	silty clay to clay
26.411	42.70	1.5521	3.635	-2.831	20	5	clayey silt to silty clay
26.575	39.81	1.5414	3.872	-2.673	19	5	clayey silt to silty clay
26.739	34.27	1.4899	4.348	-2.112	22	4	silty clay to clay
26.903	27.93	1.1855	4.245	-1.344	18	4	silty clay to clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	25.93	0.8633	3.330	-0.712	12	5	clayey silt to silty clay
27.231	24.07	0.7433	3.088	-0.297	12	5	clayey silt to silty clay
27.395	22.59	0.5945	2.632	-0.150	11	5	clayey silt to silty clay
27.559	22.88	0.5824	2.545	0.475	11	5	clayey silt to silty clay
27.723	24.69	0.8150	3.301	1.924	12	5	clayey silt to silty clay
27.887	35.65	1.3057	3.663	3.420	17	5	clayey silt to silty clay
28.051	41.27	1.5753	3.817	2.124	20	5	clayey silt to silty clay
28.215	52.50	1.5933	3.035	-0.633	20	6	sandy silt to clayey silt
28.379	33.14	1.4574	4.397	-2.640	21	4	silty clay to clay
28.543	32.51	1.3610	4.186	-1.819	21	4	silty clay to clay
28.707	29.59	1.1149	3.768	-1.141	14	5	clayey silt to silty clay
28.871	28.31	1.0439	3.688	-0.638	14	5	clayey silt to silty clay
29.035	28.90	1.0831	3.748	0.165	14	5	clayey silt to silty clay
29.199	33.94	1.2638	3.723	-0.231	16	5	clayey silt to silty clay
29.364	43.96	1.1165	2.540	-1.370	17	6	sandy silt to clayey silt
29.528	45.93	0.9255	2.015	-3.222	18	6	sandy silt to clayey silt
29.692	46.29	0.6076	1.313	-3.863	15	7	silty sand to sandy silt
29.856	46.90	0.6310	1.345	-5.103	15	7	silty sand to sandy silt
30.020	51.70	0.5492	1.062	-5.499	17	7	silty sand to sandy silt
30.184	55.62	0.3160	0.568	-5.834	13	8	sand to silty sand
30.348	53.44	0.4398	0.823	-6.086	17	7	silty sand to sandy silt
30.512	48.78	0.6000	1.230	-6.195	16	7	silty sand to sandy silt
30.676	46.14	0.6230	1.350	-6.175	15	7	silty sand to sandy silt
30.840	41.56	0.5965	1.435	-5.979	13	7	silty sand to sandy silt
31.004	38.89	0.5641	1.450	-5.733	12	7	silty sand to sandy silt
31.168	38.39	0.5680	1.480	-5.479	12	7	silty sand to sandy silt
31.332	38.91	0.5696	1.464	-5.141	12	7	silty sand to sandy silt
31.496	38.68	0.5612	1.451	-4.772	12	7	silty sand to sandy silt
31.660	39.04	0.5608	1.437	-4.419	12	7	silty sand to sandy silt
31.824	38.97	0.6451	1.655	-4.076	15	6	sandy silt to clayey silt
31.988	38.95	0.6069	1.558	-3.743	12	7	silty sand to sandy silt
32.152	34.46	0.6008	1.743	-3.288	13	6	sandy silt to clayey silt
32.316	39.23	0.6138	1.565	-1.049	13	7	silty sand to sandy silt
32.480	40.25	0.6511	1.617	-0.673	13	7	silty sand to sandy silt
32.644	40.69	0.6953	1.709	-0.424	16	6	sandy silt to clayey silt
32.808	41.28	0.7019	1.700	-0.127	13	7	silty sand to sandy silt
32.972	45.24	0.8482	1.875	4.361	17	6	sandy silt to clayey silt
33.136	42.34	1.0580	2.499	3.926	16	6	sandy silt to clayey silt
33.301	28.99	1.2958	4.469	4.813	19	4	silty clay to clay
33.465	29.98	1.0280	3.429	7.982	14	5	clayey silt to silty clay
33.629	45.31	0.6078	1.342	2.960	14	7	silty sand to sandy silt
33.793	47.47	0.3335	0.702	-1.418	15	7	silty sand to sandy silt
33.957	49.01	0.3526	0.720	-2.470	16	7	silty sand to sandy silt
34.121	48.05	0.4584	0.954	-2.765	15	7	silty sand to sandy silt
34.285	47.14	0.5731	1.216	-2.648	15	7	silty sand to sandy silt
34.449	47.31	0.6425	1.358	-2.373	15	7	silty sand to sandy silt
34.613	49.34	0.6507	1.319	-2.046	16	7	silty sand to sandy silt
34.777	52.11	0.6628	1.272	-1.670	17	7	silty sand to sandy silt
34.941	56.04	0.7270	1.297	-1.293	18	7	silty sand to sandy silt
35.105	56.52	0.7551	1.336	-0.889	18	7	silty sand to sandy silt
35.269	54.74	0.6757	1.234	-0.371	17	7	silty sand to sandy silt
35.433	52.67	0.6476	1.230	0.107	17	7	silty sand to sandy silt
35.597	53.97	0.6570	1.217	3.865	17	7	silty sand to sandy silt
35.761	53.91	0.6785	1.258	4.528	17	7	silty sand to sandy silt
35.925	52.97	0.6827	1.289	5.009	17	7	silty sand to sandy silt
36.089	55.84	0.6850	1.227	5.657	18	7	silty sand to sandy silt
36.253	53.19	0.6934	1.304	7.931	17	7	silty sand to sandy silt

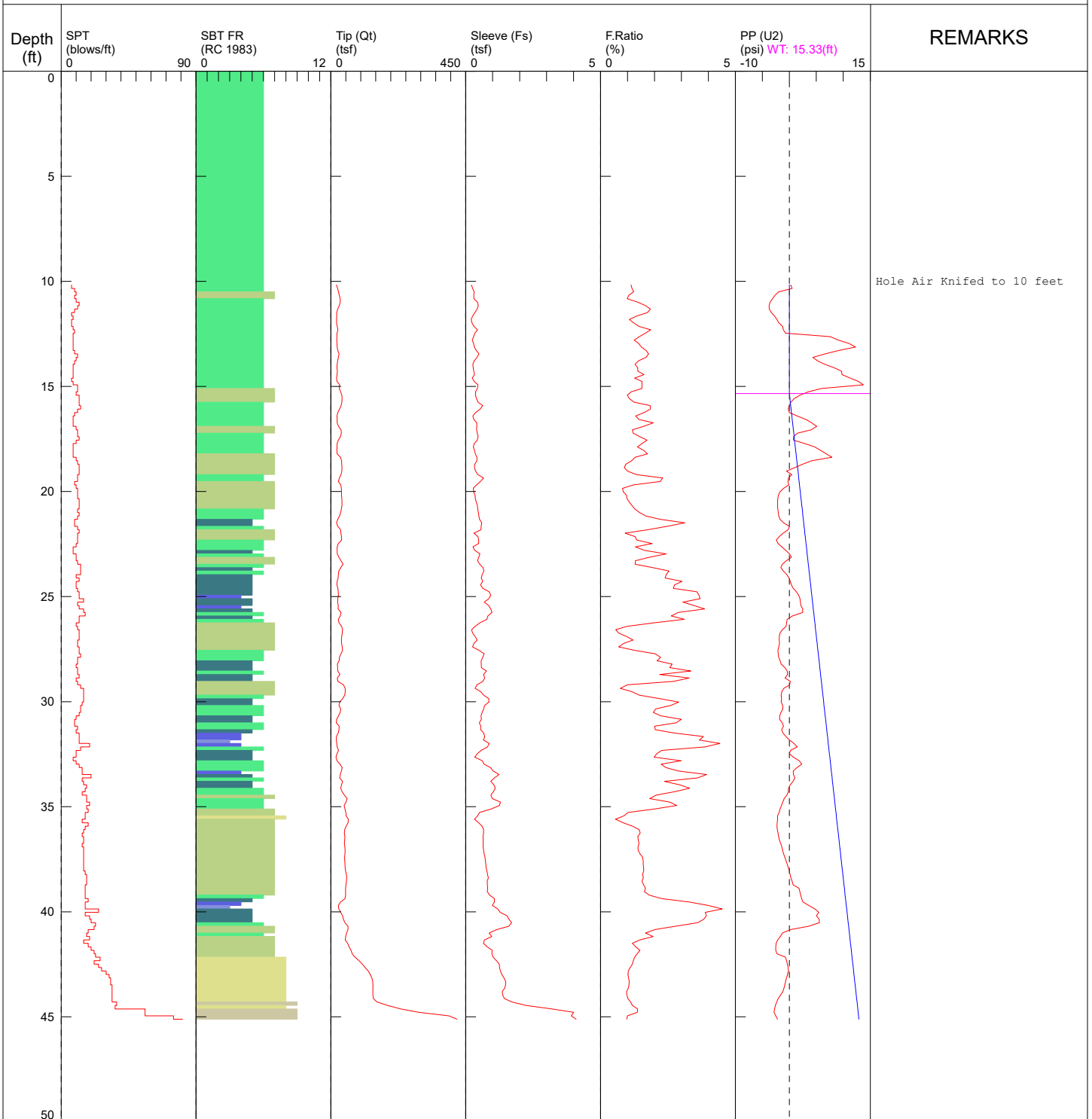
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	57.00	0.7111	1.248	7.972	18	7	silty sand to sandy silt
36.581	67.04	0.8108	1.209	7.814	21	7	silty sand to sandy silt
36.745	73.74	0.9285	1.259	7.532	24	7	silty sand to sandy silt
36.909	74.79	0.9757	1.305	7.031	24	7	silty sand to sandy silt
37.073	66.37	0.9217	1.389	6.523	21	7	silty sand to sandy silt
37.238	61.44	0.8578	1.396	6.472	20	7	silty sand to sandy silt
37.402	64.07	0.7910	1.235	6.513	20	7	silty sand to sandy silt
37.566	65.87	0.7973	1.210	6.282	21	7	silty sand to sandy silt
37.730	64.28	0.8146	1.267	6.081	21	7	silty sand to sandy silt
37.894	59.77	0.7937	1.328	6.223	19	7	silty sand to sandy silt
38.058	56.63	0.7768	1.372	6.622	18	7	silty sand to sandy silt
38.222	62.72	0.8241	1.314	7.011	20	7	silty sand to sandy silt
38.386	71.95	0.9583	1.332	7.280	23	7	silty sand to sandy silt
38.550	76.19	0.9905	1.300	7.191	24	7	silty sand to sandy silt
38.714	80.91	1.3194	1.631	6.833	26	7	silty sand to sandy silt
38.878	133.54	1.6979	1.271	5.677	32	8	sand to silty sand
39.042	161.89	2.1941	1.355	0.790	39	8	sand to silty sand
39.206	163.11	1.6756	1.027	-3.420	31	9	sand
39.370	172.08	2.5769	1.497	-5.357	41	8	sand to silty sand
39.534	176.27	2.8249	1.603	-3.347	42	8	sand to silty sand
39.698	79.68	2.6262	3.296	-5.026	31	6	sandy silt to clayey silt
39.862	50.61	2.0571	4.064	-4.594	24	5	clayey silt to silty clay
40.026	32.51	1.5725	4.837	-1.682	31	3	clay
40.190	32.32	1.2429	3.845	-0.821	15	5	clayey silt to silty clay
40.354	32.89	1.2002	3.649	-0.633	16	5	clayey silt to silty clay
40.518	49.40	1.2425	2.515	-0.429	19	6	sandy silt to clayey silt
40.682	61.73	1.1244	1.822	-1.202	20	7	silty sand to sandy silt
40.846	53.29	1.4244	2.673	-1.985	20	6	sandy silt to clayey silt
41.011	41.78	1.8486	4.424	-1.387	27	4	silty clay to clay
41.175	62.06	1.9436	3.132	-0.320	24	6	sandy silt to clayey silt
41.339	45.54	1.9374	4.254	-1.060	29	4	silty clay to clay
41.503	30.51	0.7659	2.510	-1.395	12	6	sandy silt to clayey silt
41.667	28.27	1.2531	4.432	-0.892	18	4	silty clay to clay
41.831	37.95	1.9249	5.072	0.935	36	3	clay
41.995	92.58	2.6890	2.904	0.178	35	6	sandy silt to clayey silt
42.159	80.83	2.9980	3.709	-0.991	39	5	clayey silt to silty clay
42.323	66.06	2.6194	3.965	-0.409	32	5	clayey silt to silty clay
42.487	56.20	3.0668	5.457	1.326	54	3	clay
42.651	50.85	2.9513	5.803	2.203	49	3	clay
42.815	44.89	2.7185	6.055	1.690	43	3	clay
42.979	37.32	2.0000	5.358	1.832	36	3	clay
43.143	73.63	1.3307	1.807	1.370	24	7	silty sand to sandy silt
43.307	85.77	1.0828	1.262	-0.935	21	8	sand to silty sand
43.471	91.34	1.0836	1.186	-1.560	22	8	sand to silty sand
43.635	91.78	1.0724	1.168	-2.002	22	8	sand to silty sand
43.799	92.44	0.9004	0.974	-2.282	22	8	sand to silty sand
43.963	92.15	0.8171	0.887	-2.551	22	8	sand to silty sand
44.127	89.57	0.8747	0.977	-2.767	21	8	sand to silty sand
44.291	102.03	0.8387	0.822	-2.755	24	8	sand to silty sand
44.455	108.38	0.9044	0.834	-3.019	26	8	sand to silty sand
44.619	116.00	0.7977	0.688	-3.303	28	8	sand to silty sand
44.783	88.24	1.6343	1.852	-3.542	28	7	silty sand to sandy silt
44.948	69.76	2.2590	3.238	-3.672	27	6	sandy silt to clayey silt
45.112	62.76	1.6392	2.612	-3.263	24	6	sandy silt to clayey silt
45.276	60.91	1.7330	2.845	-3.400	23	6	sandy silt to clayey silt
45.440	49.49	1.5721	3.177	-1.149	24	5	clayey silt to silty clay
45.604	48.37	0.9300	1.923	-2.216	19	6	sandy silt to clayey silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
45.768	54.28	0.6251	1.152	-3.466	17	7	silty sand to sandy silt
45.932	65.32	0.6894	1.055	-3.984	21	7	silty sand to sandy silt
46.096	62.31	0.7556	1.213	5.773	20	7	silty sand to sandy silt
46.260	59.06	0.7131	1.207	4.106	19	7	silty sand to sandy silt
46.424	62.71	0.6824	1.088	3.672	20	7	silty sand to sandy silt
46.588	70.10	0.7159	1.021	3.901	17	8	sand to silty sand
46.752	70.20	0.7625	1.086	4.297	22	7	silty sand to sandy silt
46.916	73.98	0.8128	1.099	4.917	18	8	sand to silty sand
47.080	80.22	0.8424	1.050	5.202	19	8	sand to silty sand
47.244	86.24	0.8095	0.939	5.308	21	8	sand to silty sand
47.408	84.28	0.7013	0.832	4.866	20	8	sand to silty sand
47.572	77.18	0.6167	0.799	4.538	18	8	sand to silty sand
47.736	76.52	0.6279	0.821	4.419	18	8	sand to silty sand
47.900	78.74	0.7264	0.923	4.610	19	8	sand to silty sand
48.064	81.34	0.7831	0.963	5.095	19	8	sand to silty sand
48.228	95.41	0.7230	0.758	5.692	23	8	sand to silty sand
48.392	96.05	0.6074	0.632	4.381	23	8	sand to silty sand
48.556	85.01	0.6191	0.728	4.287	20	8	sand to silty sand
48.720	100.80	0.8117	0.805	7.883	24	8	sand to silty sand
48.885	109.91	1.0478	0.953	8.434	26	8	sand to silty sand
49.049	126.34	1.2519	0.991	9.257	30	8	sand to silty sand
49.213	156.40	1.1770	0.753	9.560	30	9	sand
49.377	150.02	0.9804	0.654	7.717	29	9	sand
49.541	141.17	0.7191	0.509	2.948	27	9	sand
49.705	122.55	0.6740	0.550	-1.141	23	9	sand
49.869	96.55	0.7720	0.800	-2.371	23	8	sand to silty sand
50.033	73.18	0.8409	1.149	-2.223	23	7	silty sand to sandy silt
50.197	57.48	0.9267	1.612	-1.982	18	7	silty sand to sandy silt
50.361	49.35	0.9529	1.931	-1.499	19	6	sandy silt to clayey silt
50.525	53.54	0.7897	1.475	-0.874	17	7	silty sand to sandy silt
50.689	56.42	0.8524	1.511	-0.673	18	7	silty sand to sandy silt
50.853	56.75	0.9517	1.677	-0.656	18	7	silty sand to sandy silt
51.017	58.08	1.1865	2.043	-0.254	19	7	silty sand to sandy silt
51.181	59.28	1.3100	2.210	0.313	23	6	sandy silt to clayey silt
51.345	57.48	1.2840	2.234	0.900	22	6	sandy silt to clayey silt
51.509	54.58	1.1781	2.158	1.428	21	6	sandy silt to clayey silt
51.673	53.46	1.0620	1.987	2.145	20	6	sandy silt to clayey silt
51.837	53.69	1.0867	2.024	2.894	21	6	sandy silt to clayey silt
52.001	50.61	1.1274	2.228	7.949	19	6	sandy silt to clayey silt
52.165	51.14	1.1420	2.233	8.736	20	6	sandy silt to clayey silt
52.329	51.40	1.1182	2.176	9.755	20	6	sandy silt to clayey silt
52.493	51.15	1.1260	2.201	10.566	20	6	sandy silt to clayey silt
52.657	50.30	1.1770	2.340	15.183	19	6	sandy silt to clayey silt
52.822	52.26	1.1181	2.139	15.242	20	6	sandy silt to clayey silt
52.986	58.15	0.7530	1.295	14.573	19	7	silty sand to sandy silt
53.150	66.75	0.5151	0.772	7.745	16	8	sand to silty sand
53.314	66.37	0.5066	0.763	4.330	16	8	sand to silty sand
53.478	66.70	0.6048	0.907	5.522	16	8	sand to silty sand
53.642	68.68	0.6484	0.944	7.100	16	8	sand to silty sand
53.806	63.42	0.6779	1.069	8.818	20	7	silty sand to sandy silt
53.970	55.41	0.6224	1.123	10.297	18	7	silty sand to sandy silt
54.134	49.87	0.5903	1.184	11.791	16	7	silty sand to sandy silt
54.298	46.35	0.6504	1.403	13.321	15	7	silty sand to sandy silt
54.462	49.86	0.9104	1.826	14.454	16	7	silty sand to sandy silt
54.626	92.81	1.0527	1.134	16.139	22	8	sand to silty sand
54.790	133.81	1.2882	0.963	12.472	32	8	sand to silty sand
54.954	141.78	1.4906	1.051	5.692	34	8	sand to silty sand

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
55.118	141.99	1.4850	1.046	7.351	34	8	sand to silty sand
55.282	116.24	1.3502	1.162	13.575	28	8	sand to silty sand
55.446	105.56	1.2268	1.162	14.894	25	8	sand to silty sand
55.610	102.86	1.1891	1.156	15.991	25	8	sand to silty sand
55.774	92.11	1.1973	1.300	15.643	22	8	sand to silty sand
55.938	68.83	1.1935	1.734	16.047	22	7	silty sand to sandy silt
56.102	55.24	1.2254	2.218	16.385	21	6	sandy silt to clayey silt
56.266	49.66	1.0586	2.132	17.127	19	6	sandy silt to clayey silt
56.430	51.73	1.0150	1.962	13.549	20	6	sandy silt to clayey silt
56.594	56.04	0.9250	1.651	6.935	18	7	silty sand to sandy silt
56.759	57.85	0.9489	1.640	5.474	18	7	silty sand to sandy silt
56.923	57.53	0.9746	1.694	6.294	18	7	silty sand to sandy silt
57.087	57.57	1.0426	1.811	8.444	18	7	silty sand to sandy silt
57.251	65.49	0.9973	1.523	10.223	21	7	silty sand to sandy silt
57.415	84.20	1.1692	1.389	10.754	27	7	silty sand to sandy silt
57.579	94.51	1.4180	1.500	7.946	30	7	silty sand to sandy silt
57.743	101.87	1.6542	1.624	8.833	33	7	silty sand to sandy silt
57.907	95.88	1.7211	1.795	9.153	31	7	silty sand to sandy silt
58.071	83.88	1.5094	1.800	9.852	27	7	silty sand to sandy silt
58.235	65.64	0.7942	1.210	10.398	21	7	silty sand to sandy silt
58.399	42.30	0.6615	1.564	12.477	14	7	silty sand to sandy silt
58.563	39.45	0.6396	1.621	18.327	13	7	silty sand to sandy silt
58.727	43.44	0.6991	1.609	18.309	14	7	silty sand to sandy silt
58.891	44.76	0.7890	1.763	18.606	14	7	silty sand to sandy silt
59.055	54.79	1.6721	3.052	17.938	21	6	sandy silt to clayey silt
59.219	102.38	2.4538	2.397	6.592	33	7	silty sand to sandy silt
59.383	240.48	1.9533	0.812	4.295	46	9	sand
59.547	281.71	1.8762	0.666	5.377	54	9	sand
59.711	406.54	1.9305	0.475	17.534	65	10	gravelly sand to sand
59.875	415.57	2.3106	0.556	17.120	66	10	gravelly sand to sand

Sage Geotechnical / CPT-3 / 11400 NW St Helens Road Portland

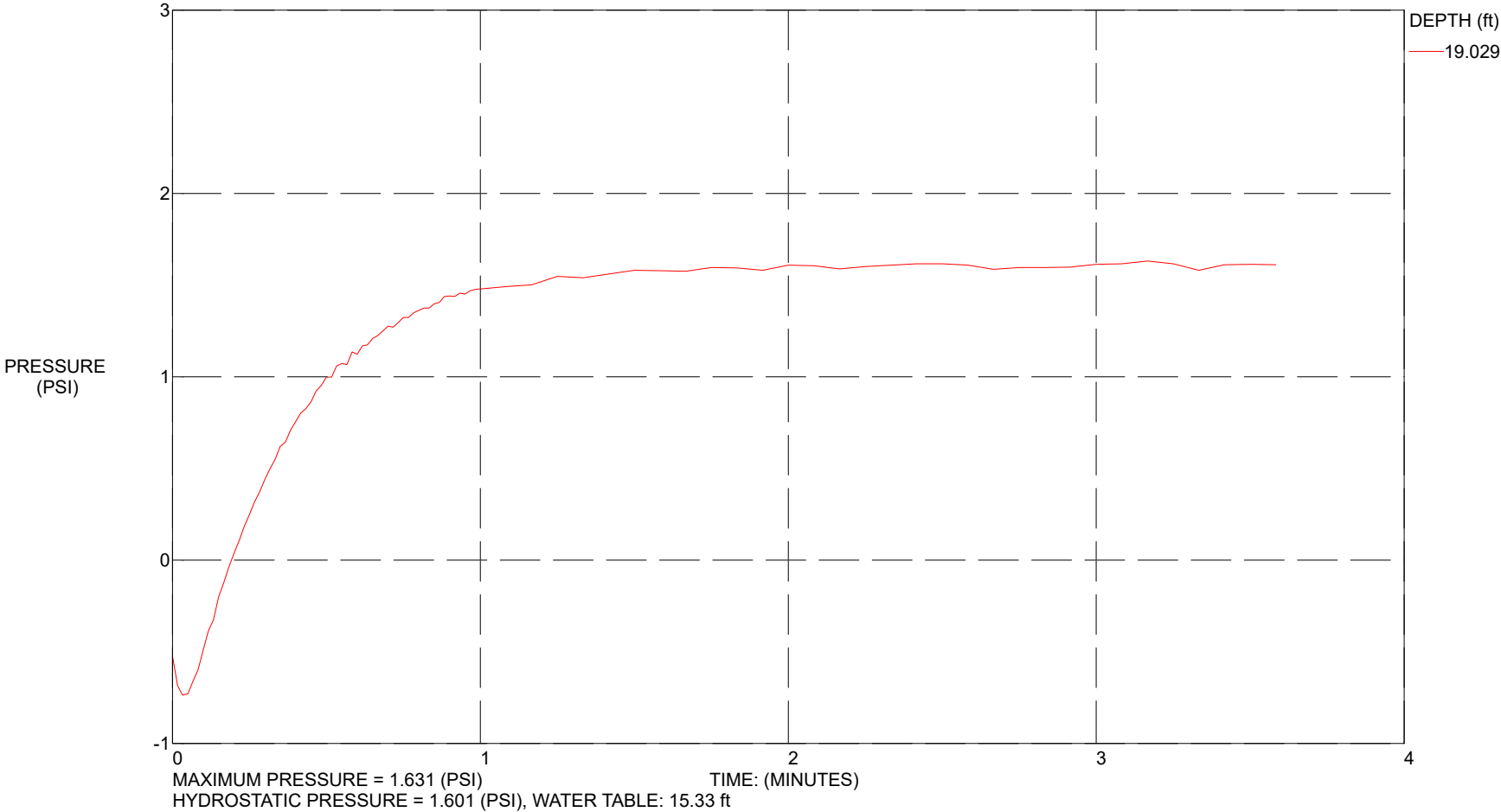
OPERATOR: OGE BAK
 CONE ID: DDG1654
 TEST DATE: 3/4/2024 12:56:09 PM
 TOTAL DEPTH: 45.112 ft



- | | | | |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 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: Sage Geotechnical / CPT-3 / 11400 NW St Helens Road Portland

CONE ID: DDG1654
TEST DATE:



Sage Geotechnical / CPT-3 / 11400 NW St Helens Road Portland

OPERATOR: OGE BAK
 CONE ID: DDG1654
 TEST DATE: 3/4/2024 12:56:09 PM
 TOTAL DEPTH: 45.112 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	18.38	0.2070	1.126	0.264	7	6	sandy silt to clayey silt
10.335	22.43	0.2611	1.164	0.518	9	6	sandy silt to clayey silt
10.499	25.33	0.3116	1.230	-1.995	10	6	sandy silt to clayey silt
10.663	28.31	0.2966	1.048	-2.689	9	7	silty sand to sandy silt
10.827	30.76	0.3035	0.987	-3.123	10	7	silty sand to sandy silt
10.991	31.65	0.4375	1.382	-3.570	12	6	sandy silt to clayey silt
11.155	27.89	0.4661	1.671	-3.743	11	6	sandy silt to clayey silt
11.319	22.99	0.4241	1.845	-3.730	9	6	sandy silt to clayey silt
11.483	19.54	0.3399	1.740	-3.334	7	6	sandy silt to clayey silt
11.647	19.64	0.2617	1.332	-2.739	8	6	sandy silt to clayey silt
11.811	18.85	0.2014	1.068	-2.320	7	6	sandy silt to clayey silt
11.975	18.98	0.2317	1.220	-1.964	7	6	sandy silt to clayey silt
12.139	21.57	0.3069	1.423	-1.248	8	6	sandy silt to clayey silt
12.303	23.43	0.4351	1.857	-1.116	9	6	sandy silt to clayey silt
12.467	20.33	0.3377	1.661	-0.704	8	6	sandy silt to clayey silt
12.631	20.18	0.2899	1.437	7.601	8	6	sandy silt to clayey silt
12.795	19.72	0.2448	1.242	9.118	8	6	sandy silt to clayey silt
12.959	20.58	0.2911	1.415	11.069	8	6	sandy silt to clayey silt
13.123	21.17	0.3208	1.515	12.266	8	6	sandy silt to clayey silt
13.287	23.26	0.3926	1.688	9.146	9	6	sandy silt to clayey silt
13.451	27.59	0.4915	1.782	6.602	11	6	sandy silt to clayey silt
13.615	25.02	0.4209	1.682	4.345	10	6	sandy silt to clayey silt
13.780	22.49	0.3176	1.412	5.202	9	6	sandy silt to clayey silt
13.944	20.84	0.2660	1.276	6.546	8	6	sandy silt to clayey silt
14.108	20.14	0.2768	1.374	8.279	8	6	sandy silt to clayey silt
14.272	21.67	0.2982	1.376	9.679	8	6	sandy silt to clayey silt
14.436	20.39	0.3283	1.611	9.755	8	6	sandy silt to clayey silt
14.600	19.22	0.2424	1.261	11.300	7	6	sandy silt to clayey silt
14.764	20.56	0.3162	1.538	12.828	8	6	sandy silt to clayey silt
14.928	29.54	0.4543	1.538	13.712	11	6	sandy silt to clayey silt
15.092	28.24	0.4318	1.529	5.961	11	6	sandy silt to clayey silt
15.256	32.36	0.3660	1.131	3.517	10	7	silty sand to sandy silt
15.420	36.59	0.3627	0.991	1.924	12	7	silty sand to sandy silt
15.584	37.63	0.4038	1.073	0.877	12	7	silty sand to sandy silt
15.748	36.54	0.4542	1.243	0.300	12	7	silty sand to sandy silt
15.912	34.30	0.6308	1.839	-0.084	13	6	sandy silt to clayey silt
16.076	29.05	0.5358	1.845	-0.206	11	6	sandy silt to clayey silt
16.240	22.63	0.3658	1.617	-0.028	9	6	sandy silt to clayey silt
16.404	20.41	0.2654	1.301	1.438	8	6	sandy silt to clayey silt
16.568	21.06	0.2987	1.419	3.042	8	6	sandy silt to clayey silt
16.732	20.91	0.4079	1.951	4.132	8	6	sandy silt to clayey silt
16.896	25.45	0.4083	1.604	5.070	10	6	sandy silt to clayey silt
17.060	33.98	0.4006	1.179	4.071	11	7	silty sand to sandy silt
17.224	35.20	0.4264	1.211	1.502	11	7	silty sand to sandy silt
17.388	31.73	0.4602	1.451	0.785	12	6	sandy silt to clayey silt
17.552	24.82	0.4274	1.722	0.755	10	6	sandy silt to clayey silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	20.63	0.3165	1.534	2.828	8	6	sandy silt to clayey silt
17.881	20.59	0.2811	1.366	4.681	8	6	sandy silt to clayey silt
18.045	20.20	0.3248	1.608	5.827	8	6	sandy silt to clayey silt
18.209	20.65	0.3592	1.740	6.871	8	6	sandy silt to clayey silt
18.373	32.23	0.4129	1.281	7.893	10	7	silty sand to sandy silt
18.537	35.79	0.4118	1.150	4.117	11	7	silty sand to sandy silt
18.701	36.10	0.3355	0.929	2.442	12	7	silty sand to sandy silt
18.865	37.04	0.3250	0.878	1.004	12	7	silty sand to sandy silt
19.029	36.44	0.3632	0.997	-0.536	12	7	silty sand to sandy silt
19.193	34.00	0.4519	1.329	0.445	11	7	silty sand to sandy silt
19.357	28.61	0.6591	2.304	-0.160	11	6	sandy silt to clayey silt
19.521	24.65	0.5449	2.211	-0.272	9	6	sandy silt to clayey silt
19.685	32.74	0.4023	1.229	-0.107	10	7	silty sand to sandy silt
19.849	35.05	0.2839	0.810	-1.080	11	7	silty sand to sandy silt
20.013	35.47	0.2986	0.842	-1.736	11	7	silty sand to sandy silt
20.177	35.66	0.3420	0.959	-2.041	11	7	silty sand to sandy silt
20.341	36.39	0.3578	0.983	-2.142	12	7	silty sand to sandy silt
20.505	36.83	0.3932	1.068	-2.193	12	7	silty sand to sandy silt
20.669	37.02	0.4310	1.164	-2.198	12	7	silty sand to sandy silt
20.833	35.26	0.4481	1.271	-2.152	11	7	silty sand to sandy silt
20.997	32.58	0.4705	1.444	-2.043	12	6	sandy silt to clayey silt
21.161	29.19	0.4892	1.676	-1.952	11	6	sandy silt to clayey silt
21.325	23.27	0.5127	2.203	-1.728	9	6	sandy silt to clayey silt
21.490	18.97	0.5925	3.124	-1.085	9	5	clayey silt to silty clay
21.654	23.23	0.5748	2.475	-0.003	11	5	clayey silt to silty clay
21.818	32.15	0.5667	1.763	-0.231	12	6	sandy silt to clayey silt
21.982	33.55	0.3044	0.907	-1.146	11	7	silty sand to sandy silt
22.146	35.42	0.4543	1.283	-1.906	11	7	silty sand to sandy silt
22.310	35.82	0.4806	1.342	-2.450	11	7	silty sand to sandy silt
22.474	25.05	0.4782	1.909	-2.089	10	6	sandy silt to clayey silt
22.638	20.69	0.2675	1.293	-1.375	8	6	sandy silt to clayey silt
22.802	20.70	0.3380	1.633	-0.666	8	6	sandy silt to clayey silt
22.966	21.55	0.5246	2.434	0.010	10	5	clayey silt to silty clay
23.130	26.67	0.4803	1.801	0.361	10	6	sandy silt to clayey silt
23.294	33.84	0.4360	1.289	-0.579	11	7	silty sand to sandy silt
23.458	40.70	0.5213	1.281	-1.288	13	7	silty sand to sandy silt
23.622	32.84	0.6366	1.938	-1.586	13	6	sandy silt to clayey silt
23.786	26.50	0.6724	2.537	-1.118	13	5	clayey silt to silty clay
23.950	25.06	0.6099	2.433	-0.460	10	6	sandy silt to clayey silt
24.114	24.16	0.5788	2.395	-0.051	12	5	clayey silt to silty clay
24.278	20.80	0.6278	3.018	0.180	10	5	clayey silt to silty clay
24.442	20.14	0.5519	2.740	0.368	10	5	clayey silt to silty clay
24.606	23.46	0.6334	2.700	0.704	11	5	clayey silt to silty clay
24.770	24.31	0.8657	3.561	1.301	12	5	clayey silt to silty clay
24.934	25.52	0.9306	3.647	1.728	12	5	clayey silt to silty clay
25.098	23.19	0.8557	3.691	1.964	15	4	silty clay to clay
25.262	22.59	0.6885	3.048	2.061	11	5	clayey silt to silty clay
25.427	24.54	0.8523	3.473	2.137	12	5	clayey silt to silty clay
25.591	24.04	0.9276	3.859	2.465	15	4	silty clay to clay
25.755	33.72	0.9712	2.880	2.450	16	5	clayey silt to silty clay
25.919	31.40	0.8235	2.623	0.579	12	6	sandy silt to clayey silt
26.083	25.25	0.7845	3.107	-0.386	12	5	clayey silt to silty clay
26.247	26.67	0.5286	1.982	-0.513	10	6	sandy silt to clayey silt
26.411	35.86	0.3537	0.986	-0.600	11	7	silty sand to sandy silt
26.575	39.03	0.2191	0.561	-1.306	12	7	silty sand to sandy silt
26.739	37.77	0.2534	0.671	-1.738	12	7	silty sand to sandy silt
26.903	36.30	0.3541	0.976	-1.886	12	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	35.25	0.4245	1.204	-1.875	11	7	silty sand to sandy silt
27.231	35.77	0.3061	0.856	-1.822	11	7	silty sand to sandy silt
27.395	37.79	0.2543	0.673	-1.952	12	7	silty sand to sandy silt
27.559	38.78	0.4957	1.278	-2.135	12	7	silty sand to sandy silt
27.723	33.75	0.6824	2.022	-2.094	13	6	sandy silt to clayey silt
27.887	28.49	0.6334	2.223	-1.959	11	6	sandy silt to clayey silt
28.051	27.45	0.5741	2.092	-1.715	11	6	sandy silt to clayey silt
28.215	21.81	0.5778	2.649	-1.537	10	5	clayey silt to silty clay
28.379	22.59	0.5791	2.564	-0.826	11	5	clayey silt to silty clay
28.543	22.95	0.7677	3.344	-0.409	11	5	clayey silt to silty clay
28.707	30.21	0.6629	2.194	-0.341	12	6	sandy silt to clayey silt
28.871	21.45	0.7053	3.289	-0.803	10	5	clayey silt to silty clay
29.035	23.41	0.6337	2.706	0.183	11	5	clayey silt to silty clay
29.199	42.16	0.4175	0.990	0.061	13	7	silty sand to sandy silt
29.364	47.91	0.3508	0.732	-1.019	15	7	silty sand to sandy silt
29.528	47.84	0.5588	1.168	-1.413	15	7	silty sand to sandy silt
29.692	46.35	0.6623	1.429	-1.522	15	7	silty sand to sandy silt
29.856	38.75	0.8544	2.205	-1.454	15	6	sandy silt to clayey silt
30.020	29.56	0.8562	2.897	-1.504	14	5	clayey silt to silty clay
30.184	26.94	0.6996	2.597	-1.225	13	5	clayey silt to silty clay
30.348	32.68	0.6665	2.040	-1.217	13	6	sandy silt to clayey silt
30.512	31.04	0.6062	1.953	-1.573	12	6	sandy silt to clayey silt
30.676	25.40	0.5676	2.234	-1.791	10	6	sandy silt to clayey silt
30.840	19.37	0.5808	2.998	-1.812	9	5	clayey silt to silty clay
31.004	18.06	0.5057	2.800	-1.326	9	5	clayey silt to silty clay
31.168	27.97	0.5599	2.001	-1.108	11	6	sandy silt to clayey silt
31.332	27.29	0.5539	2.030	-1.438	10	6	sandy silt to clayey silt
31.496	24.30	0.6654	2.738	-1.192	12	5	clayey silt to silty clay
31.660	18.45	0.7038	3.815	-0.645	12	4	silty clay to clay
31.824	18.13	0.6641	3.663	0.010	12	4	silty clay to clay
31.988	19.70	0.8718	4.426	0.861	19	3	clay
32.152	20.94	0.8097	3.868	1.451	13	4	silty clay to clay
32.316	25.31	0.5738	2.267	0.198	10	6	sandy silt to clayey silt
32.480	20.52	0.4274	2.083	0.013	10	5	clayey silt to silty clay
32.644	16.80	0.3341	1.988	0.737	8	5	clayey silt to silty clay
32.808	20.51	0.6136	2.991	1.819	10	5	clayey silt to silty clay
32.972	30.12	0.6763	2.245	2.300	12	6	sandy silt to clayey silt
33.136	37.85	0.9148	2.417	1.436	14	6	sandy silt to clayey silt
33.301	35.26	1.0182	2.888	0.704	14	6	sandy silt to clayey silt
33.465	31.43	1.2353	3.930	0.762	20	4	silty clay to clay
33.629	29.57	1.0647	3.600	1.022	14	5	clayey silt to silty clay
33.793	39.13	0.9264	2.368	0.671	15	6	sandy silt to clayey silt
33.957	35.65	1.0477	2.939	0.137	17	5	clayey silt to silty clay
34.121	33.14	1.0933	3.299	-0.193	16	5	clayey silt to silty clay
34.285	37.38	1.0226	2.736	-0.168	14	6	sandy silt to clayey silt
34.449	45.33	0.9342	2.061	-0.473	17	6	sandy silt to clayey silt
34.613	54.12	0.9852	1.820	-0.971	17	7	silty sand to sandy silt
34.777	50.24	1.2870	2.562	-1.227	19	6	sandy silt to clayey silt
34.941	44.27	1.2498	2.823	-1.448	17	6	sandy silt to clayey silt
35.105	47.21	0.9472	2.007	-1.710	18	6	sandy silt to clayey silt
35.269	50.08	0.5123	1.023	-1.911	16	7	silty sand to sandy silt
35.433	51.09	0.4423	0.866	-2.196	16	7	silty sand to sandy silt
35.597	58.33	0.3223	0.552	-2.173	14	8	sand to silty sand
35.761	57.18	0.4817	0.843	-2.264	18	7	silty sand to sandy silt
35.925	51.35	0.6071	1.182	-2.300	16	7	silty sand to sandy silt
36.089	46.08	0.6587	1.429	-2.241	15	7	silty sand to sandy silt
36.253	44.83	0.6576	1.467	-2.109	14	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	46.46	0.6402	1.378	-1.987	15	7	silty sand to sandy silt
36.581	46.40	0.6484	1.397	-1.855	15	7	silty sand to sandy silt
36.745	45.37	0.6444	1.420	-1.606	14	7	silty sand to sandy silt
36.909	46.56	0.6462	1.388	-1.426	15	7	silty sand to sandy silt
37.073	47.43	0.6599	1.391	-1.255	15	7	silty sand to sandy silt
37.238	46.75	0.6818	1.458	-1.083	15	7	silty sand to sandy silt
37.402	45.85	0.7157	1.561	-0.833	15	7	silty sand to sandy silt
37.566	46.10	0.7291	1.581	-0.623	15	7	silty sand to sandy silt
37.730	47.18	0.7441	1.577	-0.414	15	7	silty sand to sandy silt
37.894	47.42	0.7552	1.593	-0.206	15	7	silty sand to sandy silt
38.058	49.20	0.7850	1.595	-0.030	16	7	silty sand to sandy silt
38.222	51.80	0.8079	1.560	0.122	17	7	silty sand to sandy silt
38.386	52.75	0.8361	1.585	0.287	17	7	silty sand to sandy silt
38.550	51.78	0.7950	1.535	0.511	17	7	silty sand to sandy silt
38.714	50.35	0.8031	1.595	0.678	16	7	silty sand to sandy silt
38.878	48.80	0.8122	1.664	1.789	16	7	silty sand to sandy silt
39.042	49.25	0.7995	1.623	1.957	16	7	silty sand to sandy silt
39.206	49.12	0.8854	1.803	2.096	16	7	silty sand to sandy silt
39.370	46.96	1.0623	2.262	2.295	18	6	sandy silt to clayey silt
39.534	32.49	1.0648	3.278	2.493	16	5	clayey silt to silty clay
39.698	24.68	0.9872	4.000	3.608	16	4	silty clay to clay
39.862	26.37	1.1878	4.505	4.721	25	3	clay
40.026	32.96	1.2785	3.879	5.458	16	5	clayey silt to silty clay
40.190	39.04	1.5307	3.920	5.019	19	5	clayey silt to silty clay
40.354	41.93	1.6047	3.827	5.522	20	5	clayey silt to silty clay
40.518	47.29	1.7030	3.601	5.557	23	5	clayey silt to silty clay
40.682	57.39	1.5969	2.782	3.613	22	6	sandy silt to clayey silt
40.846	57.10	1.1490	2.012	0.244	18	7	silty sand to sandy silt
41.011	52.12	0.8718	1.673	-1.283	17	7	silty sand to sandy silt
41.175	49.55	0.9645	1.947	-1.687	19	6	sandy silt to clayey silt
41.339	47.77	0.6963	1.458	-2.170	15	7	silty sand to sandy silt
41.503	55.88	0.6564	1.175	-2.467	18	7	silty sand to sandy silt
41.667	61.36	0.8013	1.306	-2.518	20	7	silty sand to sandy silt
41.831	67.38	0.9824	1.458	-2.508	22	7	silty sand to sandy silt
41.995	71.27	0.9675	1.357	-2.315	23	7	silty sand to sandy silt
42.159	80.50	1.0167	1.263	-0.757	26	7	silty sand to sandy silt
42.323	93.82	1.1389	1.214	-0.521	22	8	sand to silty sand
42.487	105.02	1.2405	1.181	-0.379	25	8	sand to silty sand
42.651	114.16	1.2552	1.100	-0.224	27	8	sand to silty sand
42.815	124.76	1.2832	1.029	-0.170	30	8	sand to silty sand
42.979	131.77	1.3394	1.016	-0.338	32	8	sand to silty sand
43.143	136.62	1.4151	1.036	-0.539	33	8	sand to silty sand
43.307	139.45	1.4791	1.061	-0.689	33	8	sand to silty sand
43.471	140.51	1.4798	1.053	-0.861	34	8	sand to silty sand
43.635	140.24	1.4414	1.028	-1.014	34	8	sand to silty sand
43.799	140.09	1.3534	0.966	-1.212	34	8	sand to silty sand
43.963	140.47	1.3696	0.975	-1.664	34	8	sand to silty sand
44.127	142.08	1.4366	1.011	-2.061	34	8	sand to silty sand
44.291	154.27	1.7088	1.108	-2.353	37	8	sand to silty sand
44.455	189.88	2.2480	1.184	-2.592	36	9	sand
44.619	233.54	3.2025	1.371	-2.750	56	8	sand to silty sand
44.783	293.67	4.0024	1.363	-2.838	56	9	sand
44.948	393.69	3.9110	0.993	-2.513	75	9	sand
45.112	421.27	4.0910	0.971	-2.208	81	9	sand

Section 6.1: Appendix A - Geotechnical Data

Appendix A-2
Historical Site Data

Impermeable Barrier Geotechnical Study

Kinder Morgan
Linnton Terminal

Portland, Oregon
Delta Project No. KMLIN-09-05

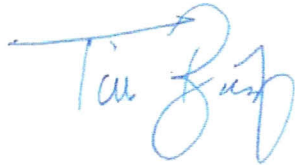
November 5, 2009

Prepared For:

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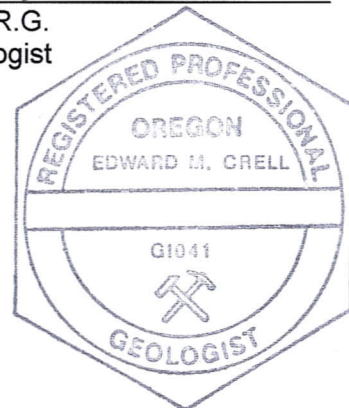


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Appendix A	Geotechnical Boring Logs
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Appendix C	RSV Geotechnical Report

IMPERMEABLE BARRIER GEOTECHNICAL STUDY

KINDER MORGAN LINNTON TERMINAL

11400 NW ST. HELENS ROAD

PORTLAND, OREGON

DELTA PROJECT NO. KMLIN-09-05

1.0 INTRODUCTION & BACKGROUND

Delta Consultants, Inc. (Delta) has prepared this report to present the findings of the geotechnical investigation performed at the Linnton Terminal (site), owned by Kinder Morgan Liquids Terminals, LLC (KMLT). The site is located at 11400 NW St. Helens Road, Portland, Oregon (see Figure 1). The purpose of the study was to collect sufficient data on which to base the design of an impermeable barrier wall at the site. The intent of the proposed barrier is to provide an impermeable impediment between the on-site light non-aqueous phase liquid (LNAPL) and the Willamette River (see Figure 2). The study was conducted in July through September 2009. Tasks performed in this study included geotechnical evaluation of subsurface conditions, confirming the extent of LNAPL, reviewing geology and hydrogeology, and identifying the existence of any utilities or facilities which may affect construction.

The Linnton Terminal currently consists of 34 above ground petroleum storage tanks and associated pipes and equipment. A seawall runs the length of the site along the Willamette River. This seawall consists of up to five tiers of old wooden bulkheads, pilings, and rip rap walls; some of which are visible only during lower river water elevations. Historical groundwater monitoring and river observation has shown that a LNAPL plume exists on the southern end of the site along the terminal frontage with the Willamette River. An interim remedial action measure (IRAM) system, consisting of five total-fluid recovery wells and associated aboveground treatment components, was installed at the site in 2004 to mitigate localized seepage of LNAPL through the seawall. This network has successfully reduced the occurrence for LNAPL to seep into the river, however, localized seasonal sheens continue to occur in the Willamette near recovery wells 3 and 4 (see Figures 2 and 3).

The purpose of the proposed impermeable barrier is to provide a more reliable long term solution to the seasonal migration of LNAPL to the Willamette River. The following work was completed in order to collect sufficient data to develop a conceptual design for an impermeable barrier to mitigate LNAPL migration to the Willamette River:

- Use of Laser-Induced Fluorescence (LIF) technology to confirm the vertical and horizontal extent of the LNAPL plume. The LNAPL at the site contains significant amounts of diesel oils

and other polyaromatic hydrocarbons that will fluoresce when exposed to ultraviolet light. This data was used to confirm the presence of LNAPL measured in nearby monitoring wells.

- Further evaluate the site stratigraphy using cone penetrometer soundings which were collected in conjunction with the LIF study.
- Complete exploratory/geotechnical soil borings and sampling in the vicinity of the proposed impermeable barrier. Exploratory/geotechnical borings were completed using mud rotary drilling techniques. Soil samples recovered from the borings were classified in the field using the Unified Soil Classification System (USCS, see Appendix A). Coarse-grained and fine-grained soil samples were collected using a 2.5-foot split spoon sampler in conjunction with Standard Penetration Testing (SPT) to obtain the consistency of cohesive soils and relative density of granular materials. Fine-grained soils were also collected with Shelby Tube samplers. Penetrometer estimates of the unconfined compressive strength were also collected in the field.
- Complete a geotechnical evaluation to assess soil mechanics relevant to constructing the impermeable barrier. This assessment included static and dynamic settlement evaluation, deep foundation design, and seismic studies completed in accordance with 2007 Oregon Structural Specialty Code.
- Evaluating existing surface and subsurface utilities and facilities that may influence barrier design and construction

All work described above was completed in accordance with Delta's *Linnton Barrier Wall Design Study Bid Response Request* dated July 20, 2009.

2.0 GEOLOGY & HYDROGEOLOGY

2.1 Geology

2.1.1 Regional Geology

The Willamette River is located centrally in a structural downwarp between the Cascade Range and the Coast Range. The base of the Tualatin Mountains lies about 600 feet west of the Site. The Tualatin Mountains trend to the northwest and reach an elevation of approximately 1,100 feet.

The Willamette River region is underlain by Holocene terrace, flood plain and fluvial sand and silt. The Holocene sediments are underlain by late Pleistocene fluvio-lacustrine sand and gravel. The alluvium ranges up to several thousand feet thick. The alluvium is underlain by early Pliocene conglomerates of the Troutdale Formation, early Pliocene siltstone of the Sandy River Formation, Miocene to Pliocene Columbia River Basalt and Tertiary marine sediments of the Scappoose Formation.

Throughout most of the area, elevations below about 350 feet are mantled with sand, silt and gravel of late-Pleistocene age. These sediments were transported to the Portland area and deposited as a large delta by catastrophic floods of glacial melt water that coursed down the Columbia River about 10,000 to 13,000 years ago. The glacial-fluvial flood deposits have largely been removed from the Site by erosion.

In the Portland area, the Columbia River Basalts are overlain by the Troutdale Formation. The Troutdale Formation consists of sandstone and conglomerate of Pliocene age. Most of the Troutdale Formation in the Site area has been removed by erosion; only a few thin remnants are known along the Tualatin Mountains. Local remnants of the Troutdale formation may underlie the alluvium at the Site.

In the Portland area, the Columbia River Basalt consists of 12 to 14 flows of hard basalt. The flows, which date from the Miocene age, are jointed and usually have rubbly or vesicular tops which contain most of the groundwater. Often they are separated by a few inches or feet of sedimentary deposits (siltstone and sandstone). Some of the flows are weathered to a depth of a few feet. The basalt is estimated to be in excess of 500 feet thick beneath the Site. The basalt underlies the anticlinal Tualatin Mountains, immediately west and south of the Site. The Columbia River Basalt dips to the northeast from the Tualatin Mountain anticline into the Portland Basin. Basalt outcrops are found in many areas along the flanks of the hills. Basalt outcrops at the base of the hills to the west of the Site at about 50 feet msl. On-site drilling encountered basalt at approximately 50 to 60 feet below ground surface.

2.1.2 Site Geology

The Site geology is typified by a layer of fill covering alluvium to basalt bedrock. The source of the fill (silt and sand) is likely from dredging activities on the Willamette and Columbia Rivers. The fill material has been identified to an approximate depth of 30 feet below ground surface (the maximum depth explored on-site during previous Remedial Investigation activities) near the river and only 1 foot below grade in the borings furthest from the river near the western property boundary. Holocene alluvial deposits underlie the fill material. The alluvium extends to approximately 50 to 60 feet below ground surface near the Willamette River.

The sediments beneath the Site consist of alternating layers of sandy silt, silt, silty sand, sand with occasional layers of sandy gravel, gravelly sand, or clayey silt containing organics to the total depth explored (see Figures 4 and 5, Appendix A and B). Vesicular basalt bedrock was encountered at approximately 50 to 60 feet below ground surface.

2.2 Hydrogeology

2.2.1 Regional Hydrogeology

Four units that act as aquifers are present within the Portland area. These are the Columbia River Basalt, the Troutdale formation, late Pleistocene glacial flood deposits, and Holocene alluvium. The Columbia River Basalts and underlying units, have been downwarped to form the Willamette Lowland. The Tualatin Mountains form a structural high separating the eastern (Portland Basin) and western (Tualatin Valley) parts of the Willamette Lowland. The basin was filled with deposits of the Sandy River Mudstone, Troutdale formation and Pleistocene flood deposits. These deposits were subsequently incised by the Willamette River and Columbia River. When sea levels rose at the end of the Pleistocene, these canyons were backfilled with sand, gravel, silt and clay filled silt.

The Columbia River Basalts form the main regional aquifer. Recharge for the aquifer comes from the uplands adjacent to the Portland Basin. The basalt outcrops in these uplands, exposing the edges of the individual flows. Discharge from this aquifer is largely from water wells, slow leakage to the Sandy River Mudstone and river alluvium where the rivers have incised to the basalt.

The Troutdale formation likely does not occur beneath the Site. The Troutdale formation receives its recharge from the adjacent uplands, where it outcrops and strata are exposed. Local artesian conditions may occur within the Troutdale, where there are discontinuous lower permeability lenses.

The majority of discharge is to the Columbia River and water wells. Pleistocene flood deposits are not present at or near the Site.

The Holocene alluvial deposits are internally complex and consist of many individual aquifers and aquitards. Hydrologic conditions within the alluvium are localized and seasonal. These deposits line the Willamette River and are recharged largely through precipitation, bank storage and discharge from the underlying units. Discharge from this unit is largely to the Willamette River, water wells and leakage to underlying units.

2.2.2 Site Hydrogeology

The fill and the alluvium stratigraphic units are hydraulically connected. These units discharge to the Willamette River and the direction of groundwater flow at the Site, as inferred from the elevation contours, is generally toward the river (see Figures 6 and 7).

Water levels beneath the Site are influenced by annual precipitation cycles and by river stage fluctuations. The effect of river stage fluctuations is most pronounced on water levels in wells along the riverfront. The depths to water typically range from 13 feet to 24 feet below ground surface. Groundwater elevation ranges from about 8 to 16 feet above mean sea level (msl). The direction of shallow groundwater flow is generally to the east, toward the Willamette River, at an average gradient of 0.03 to 0.04. Hydraulic conductivities at the site are typically between 20 and 35 feet per day. Using this as the typical gradient, and using typical values for the effective porosity (40 percent) and hydraulic conductivity (35 feet per day for sandy zones), the flow velocity within the Site's upper sandy fill material is estimated to be about 400 feet per year. However, inter-fingering lenses of clayey material significantly affect the hydraulic conductivity of the unit. The units are thought to be generally unconfined, although due to the lenses and bedding, there may be locally confined areas within the aquifers.

2.2.3 IRAM Hydrogeology

Since 2004, LNAPL has been managed by a five recovery well IRAM (RW-1 through RW-5 on Figures 6 and 7). The IRAM currently removes total fluids to maintain the designed hydraulic drawdown and capture. Pneumatic pump intakes are approximately 25 to 30 feet below ground surface. Total recovery averages 10 to 12 gallons per minute (gpm) to maintain approximately 6 feet of drawdown. Recovery rates to maintain drawdown range from less than 1 gpm in RW-3 to 3 gpm in RW-5.

Analytical modeling from pump test results identified the following hydraulic capture data. Details can be found in Delta's *IRAM Design Report* dated November 13, 2003.

Wet Season/High Tide

- Hydraulic Conductivity = 19.4 feet/day
- Rate = 5.75 gpm
- Drawdown = 13 feet
- Capture Zone = 55 feet
- Stagnation Point = 17 feet
- Optimal Well Spacing = 35 feet

Dry Season

- Hydraulic Conductivity = 19.4 feet/day
- Rate = 2.5 gpm
- Drawdown = 6 feet
- Capture Zone = 69 feet
- Stagnation Point = 22 feet
- Optimal Well Spacing = 44 feet

3.0 GEOTECHNICAL INVESTIGATION

Delta Consultants teamed with RSV Engineering Inc. to assist with geotechnical engineering services and recommendations. RSV conducted numerical analysis to evaluate the seismic response of the proposed barrier wall and also evaluated the following components:

- Slope stability analysis
- Liquefaction analysis
- Static and dynamic settlement
- Static consolidation characteristics
- Deep foundation design

Triaxial testing of a Shelby Tube sample recovered during drilling, sampling, and testing in the field, was performed in the soil mechanics laboratory as planned. A consolidated isotropic undrained (CIU) triaxial test was performed with pore pressure measurements. The testing was performed at three selected horizontal confining pressures yielding three points enabling a plot of three Mohr's circles for both effective and total stress conditions. The test requires saturation of the samples followed by consolidation of the samples at the confining pressures prior to loading and failing by shearing of the samples. This sophisticated test provides data which allows an evaluation of the shear strength of the soil in conjunction with other testing data.

This CIU triaxial test provides important information regarding soil strength, which in turn is critical to the geotechnical evaluation, including the stability analysis. Details of all geotechnical analytical testing is presented in the report prepared by RSV. The geotechnical analytical report is presented in Appendix C and the following is a summary of RSV's findings.

Soil mechanics laboratory tests were conducted on selected soil samples recovered during drilling and sampling of the soil borings in order to obtain properties of in-situ soils in the vicinity of the proposed wall. Seven unconfined compression tests, 18 density determinations, 39 moisture content tests, six Atterberg Limits tests, four sieve and hydrometer tests, four specific gravity tests, a permeability test, a consolidation test, and a triaxial shear test were conducted on selected samples.

Moisture contents of upper granular soils were approximately 10 percent and results of fine grained soils were generally 30 to 48 percent except for one test result of 22 percent and another of 60 percent. Moist density of a sample of upper coarse grained soil was determined to be 97 pcf. Saturated or moist densities of fine grained soils ranged from 101 to 122 pcf. Liquid limits ranged from 30 to 41 percent, plastic limits 26 to 32 percent, and plasticity indices 0 to 10 percent. Moisture contents of liquid limit test samples were above liquid limit values except for one sample which was approximately equal to the liquid limit. Specific

gravity of representative soil samples ranged from 2.72 for coarse grained soil to 2.66, 2.67, and 2.71 for fine grained soil. Calibrated penetrometer estimates of unconfined compressive strength ranged from 0.2 to 1.5 tsf. Unconfined compression test strengths ranged from 0.3 to 1.4 tsf. Permeability of a sample of fine grained soil was approximately 1.6×10^{-6} cm./sec. Groundwater was encountered during drilling at depths of approximately 16 to 28 feet.

A slope stability analysis was performed in order to evaluate the stability of the riverbank and determine the factor of safety against a slope shear failure of existing slope conditions and of existing slope conditions with new sheet piling installed. A widely used program, XSTABL© version 5.204, was used for slope stability calculations. Circular surface search and simplified Bishop method of analysis options were used. Soil properties were based upon field and laboratory testing data and results. Cross-section conditions were determined based upon available information. Surface loading accounted for tanks located behind the proposed sheet piling. Cross-sections, soil properties, phreatic surface, ground surface loading, other conditions, and critical failure surfaces are shown on the sections and output in the attachments. The factor of safety against a slope shear surface slide failure for the existing slope was approximately 1.1 for total and effective strength cases. This calculated factor of safety is below a generally accepted standard of approximately 1.6 to 1.3 depending upon loading conditions. The calculated factor of safety against a slope shear failure for the slope with an assumed new sheet piling installation (considering that the sheet piling wall design has not been completed) was approximately 1.2 for total and effective strength cases (i.e. greater factor of safety than existing conditions).

With respect to settlement, new sheet piling installed behind the existing bulkheads and assumed to be essentially approximately flush with the existing ground surface would not add load of consequence that would cause material settlement along the affected riverbank. This flush with ground surface assumption is a key assumption in connection with settlement in that such an installation would not be a cantilever sheet pile with unequal lateral earth pressure load and resistance or new vertical load which could cause settlement. Rather, under this assumption, the proposed sheet piling would be essentially inserted into existing subsurface soils and their stress field assumed to be in equilibrium.

Liquefaction of the riverbank soils was also evaluated. Gradations of riverbank soils were analyzed. The particle size distribution of the sand (SM) tested was within the range of particle size distributions for the category most liquefiable soil. The particle size distributions of ML soils tested were partially within the range of particle size distributions for the category potentially liquefiable soil. Such soils with cohesion would have a lower tendency to liquefaction. Liquefaction was also analyzed for cyclic stress and cyclic resistance ratio. The factor of safety against liquefaction for deep clean sands was estimated at less than 1.0 for a magnitude 7.5 earthquake. The factor of safety against liquefaction for deep sands with fines

was estimated to be greater than 1.0 for a magnitude 7.5 earthquake. Accordingly in such an event, settlement and ground flow could occur in and above the deep clean sands depending upon the ground motion duration and intensity.

4.0 EXISTING SURFACE & SUBSURFACE UTILITIES

Subsurface utilities were located using electromagnetic pipe and cable locators, electromagnetic induction metal detectors, and ground penetrating radar. Two maps were created from the results of these locating efforts, discussion with terminal personnel, and field verification/vacuum clearance (see Figures 8 and 9).

Along with the tiered old wooden bulkheads, pilings, and rip rap running along the water front, the following underground and above ground piping and facilities were identified in the study area,

- Electrical utilities
- Water lines
- Storm water lines
- Above ground piping associated with the site IRAM
- Miscellaneous petroleum piping
- Cathodic protection wiring
- Former boar/ship tie off (with concrete footing)
- Oil and water separator #2.

Aboveground facilities and obstructions identified in this investigation should also be considered when designing the barrier wall and construction activities.

5.0 SUMMARY OF EXTENT OF LNAPL

Historical groundwater data and river-sheen observation indicate that LNAPL is localized around the southern edge of the river frontage, particularly in the area near IRAM recovery wells R-3 and R-4. The greatest amounts of measureable LNAPL measured in upgradient monitoring wells is in this area (see Figures 6 and 7).

Aromatic hydrocarbons, those containing one or more benzene rings, are known to fluoresce under ultraviolet light. Typically, the greater the number of benzene rings in a compound the stronger the fluorescent response, making the heavy petroleum at the Linnton Terminal ideal for assessment using laser-induced fluorescence (LIF). Aromatic compounds with one or two benzene rings (BTEX and naphthalene, for instance) tend to fluoresce most strongly when exposed to ultraviolet wavelengths below 300 nanometers (nm), while the polyaromatic hydrocarbons (PAHs) are more responsive to wavelengths above 300 nm. The aromatic hydrocarbons have emission (response) wavelengths that range from under 300 nm (UV) for single benzene-ring compounds to 400, 450 and 500 nm (violet, blue and green visible light range) for various PAHs.

The UVOST[®] system used for this investigation had an adsorption wavelength of around 300 nm and used four emission wavelength detectors, which allowed for a qualitative determination of product type. In general, the more complex the PAH compound, the greater the response at the longer wavelengths. The UVOST[®] system recorded the total and individual wavelength responses as a percentage of the response compared to a standard product mixture used to calibrate the instrumentation in the field. The emission response obtained from the standard is designated as a Reference Emitter (RE) and it is the sum of the responses obtained for each of the four detected wavelengths. The response obtained in the field while advancing the CPT-LIF probe may be less or more than the Reference Emitter, so that readings can be greater than 100%.

As the CPT probe is advanced to the target depth, the fluorescence response is measured about every 2 inches. The response of the four detected wavelengths are summed to provide a composite total response (%RE). The response for each of the four detected wavelengths is also retained in the dataset which allows for comparisons and analysis of individual wavelengths or derived values. CPT and LIF logs are presented in Appendix B.

A two-dimensional section of a derived %RE value is shown on Figure 10. This adjustment emphasizes the presence of the product typically found in monitoring wells near CPT-A, which tends to be a heavy, viscous petroleum. Based upon the accumulation of product in monitoring wells at the site, the section

depicted in Figure 10 suggests that a derived fluorescent response (490 – 390 nM) greater than 10% is indicative of product saturations that can readily accumulate in an adjacent monitoring well. This observation is most notable from about 12 to 16 feet below ground surface (bgs) at CPT-A, as evidenced by product accumulations greater than 1 foot having commonly occurred in recovery wells RW-3 and RW-4 prior to the start-up of the IRAM. On the other hand, the %RE values shown at CPT-E correlate with the observation that product accumulations in monitoring well MW-1 have been rare over 7 years of gauging events.

Based on this LIF investigation, areas where soil is more saturated with LNAPL will tend to fluoresce at %RE levels greater than 10. LIF data collected during this investigation confirm the LNAPL is localized in the area where LNAPL has been observed, primarily localized between recovery wells R-3 and R-4. Additionally, it is apparent that the vertical extent of LNAPL does not significantly extend beyond 30 feet bgs. This finding corresponds with a zone of clay and silty clay observed between 30 to 35 feet bgs (Figure 5).

6.0 PROPOSED POSITION OF IMPERMEABLE BARRIER

When considering the free LNAPL as a potential source of hydrocarbons that may migrate to the Willamette River and using the historical data observed in monitoring wells as well as LIF data collected in this investigation, it appears that the horizontal extent of LNAPL barrier should extend approximately 450 linear feet along the Willamette River between monitoring wells MW-1 and MW-8 in order to provide adequate LNAPL containment (see Figure 11). Water levels beneath the Site are influenced by annual precipitation cycles and by river stage fluctuations. The effect of river stage fluctuations is most pronounced on water levels in wells along the riverfront. The depths to water typically range from 13 feet to 24 feet below ground surface. Groundwater elevation ranges from about 8 to 16 feet above mean sea level (msl).

From this investigation, it was determined that the vertical extent of LNAPL is localized to the water table at approximately 15 to 25 feet below ground surface (Figure 10). Additionally, seasonal variation in ground water levels in monitoring wells near the Willamette approximate 10 feet and groundwater levels are also influenced by tide. Inter-fingering lenses of clayey material significantly affect the hydraulic conductivity of the unit and the units are thought to be generally unconfined.

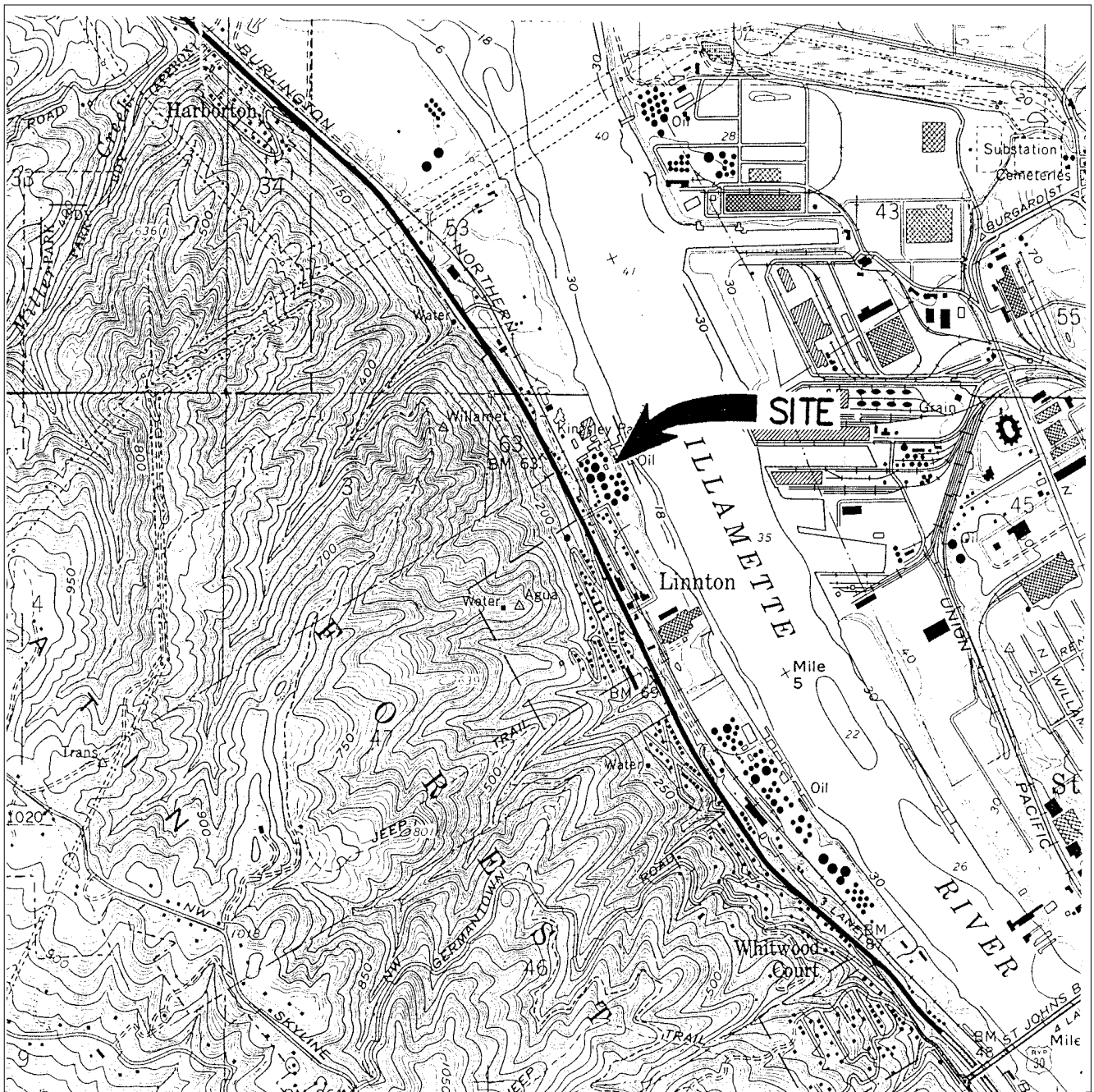
Previous risk screening of dissolved hydrocarbon constituents show that petroleum contamination along waterfront attenuate with depth and concentrations above applicable risk-based standards do not extend below 35 feet below ground surface. The vertical extent of the proposed barrier should allow for tidal and seasonal changes and prevent migration of dissolved constituents above risk-based screening levels to the Willamette River.

7.0 REMARKS

The recommendations contained in this report represent Delta's professional opinions based upon the currently available information and are arrived at in accordance with currently acceptable professional standards. This report is based upon a specific scope of work requested by the client. The Contract between Delta and its client outlines the scope of work, and only those tasks

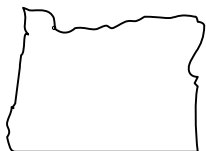
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FIGURES



REFERENCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP
LINNTON, OREGON, 1961
PHOTOREVISED 1984

SCALE 1 : 25,000



QUADRANGLE LOCATION

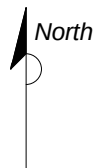


FIGURE 1

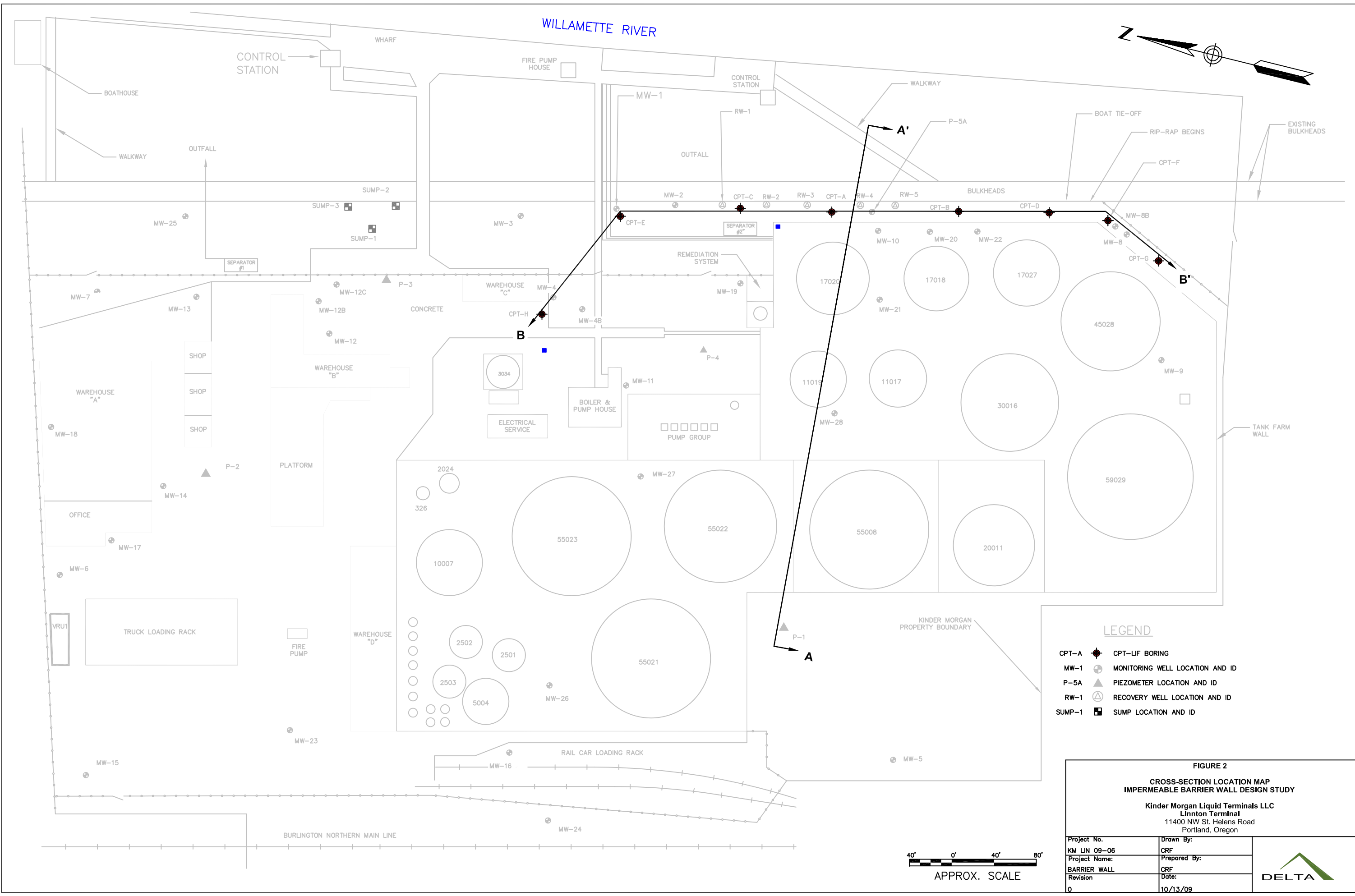
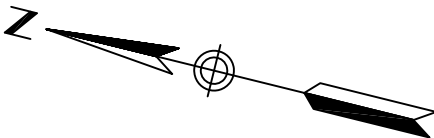
SITE LOCATION MAP

**Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon**

PROJECT NO. KM LIN 09-02	DRAWN BY CRF 5/19/09
FILE NO. Barrier Study	PREPARED BY CRF 5/19/09
REVISION NO. 0	REVIEWED BY DL 5/20/09



WILLAMETTE RIVER



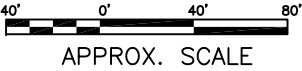
LEGEND

- CPT-A CPT-LIF BORING
- MW-1 MONITORING WELL LOCATION AND ID
- P-5A PIEZOMETER LOCATION AND ID
- RW-1 RECOVERY WELL LOCATION AND ID
- SUMP-1 SUMP LOCATION AND ID

FIGURE 2
CROSS-SECTION LOCATION MAP
IMPERMEABLE BARRIER WALL DESIGN STUDY

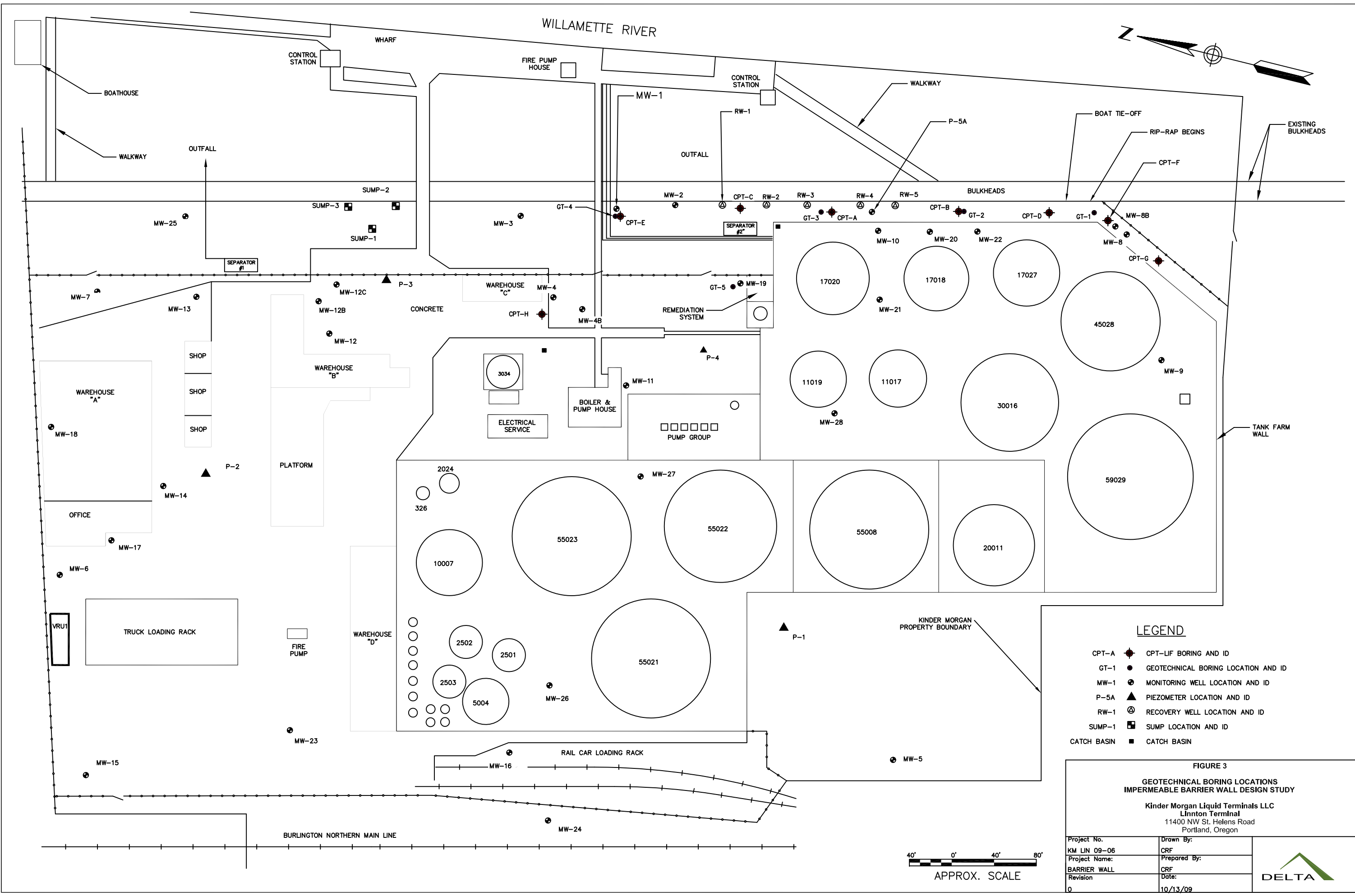
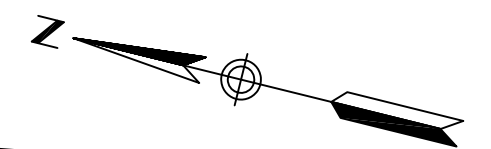
Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No.	Drawn By:	
KM LIN 09-06	CRF	
Project Name:	Prepared By:	
BARRIER WALL	CRF	
Revision	Date:	
0	10/13/09	



APPROX. SCALE

WILLAMETTE RIVER



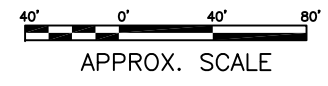
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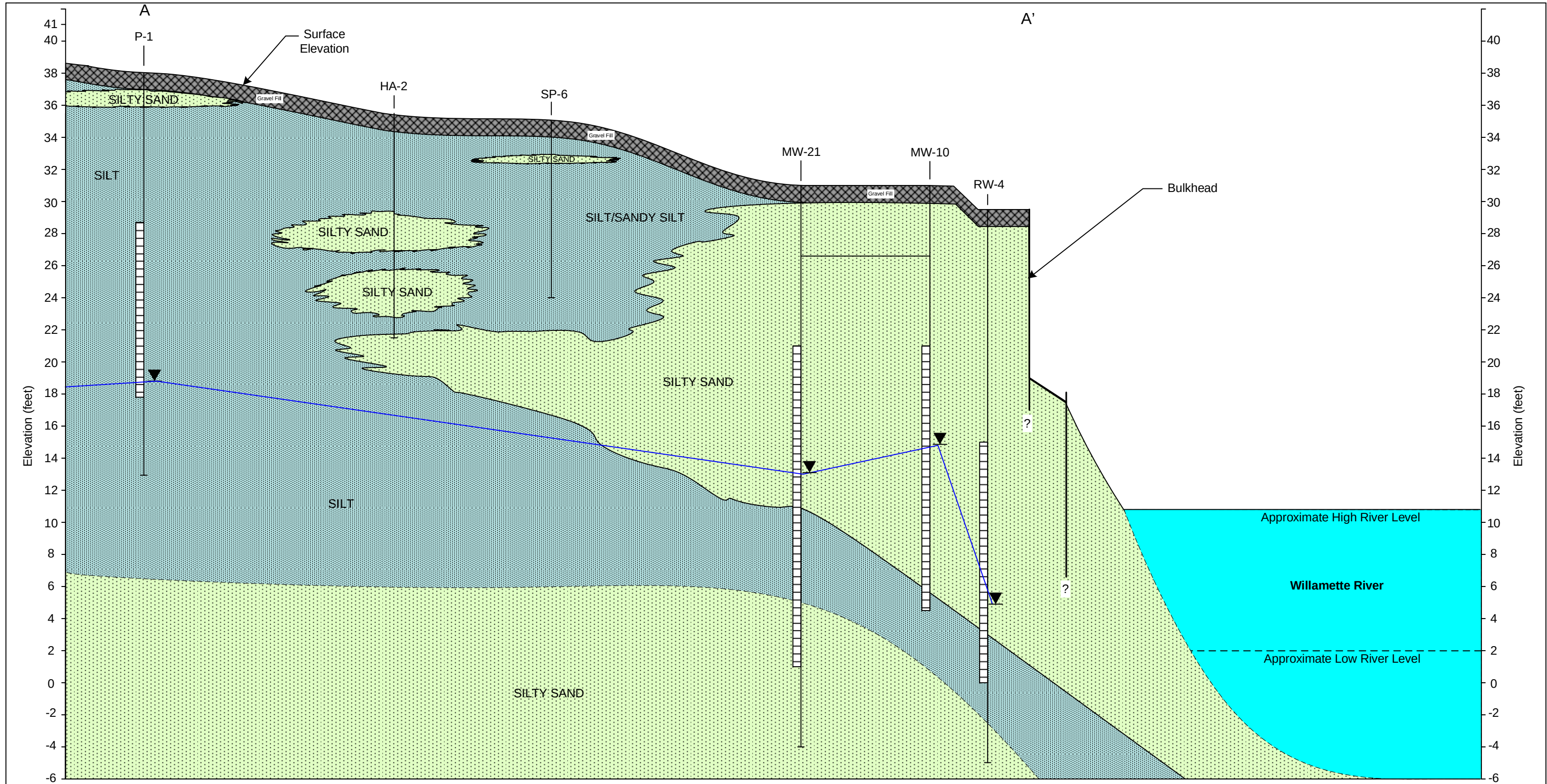
- CPT-A CPT-LIF BORING AND ID
- GT-1 GEOTECHNICAL BORING LOCATION AND ID
- MW-1 MONITORING WELL LOCATION AND ID
- P-5A PIEZOMETER LOCATION AND ID
- RW-1 RECOVERY WELL LOCATION AND ID
- SUMP-1 SUMP LOCATION AND ID
- CATCH BASIN CATCH BASIN

FIGURE 3
GEOTECHNICAL BORING LOCATIONS
IMPERMEABLE BARRIER WALL DESIGN STUDY

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No.	Drawn By:	
KM LIN 09-06	CRF	
Project Name:	Prepared By:	
BARRIER WALL	CRF	
Revision	Date:	
0	10/13/09	





LEGEND

▼ Typical Static Groundwater Levels During Groundwater Extraction (April)

MW-5 Boring/Well Identification

← Borehole

← Well Screen Interval

Bottom of Well/Boring

Approximate Horizontal Scale in Feet



Approximate Vertical Scale in Feet

FIGURE 4

CROSS-SECTION A-A' - CONCEPTUAL

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
Portland, Oregon

PROJECT NO. KMLIN-0906	DRAWN BY CRF 10/13/09
FILE NO. BARRIER WALL	PREPARED BY CRF 10/13/09
REVISION NO.	REVIEWED BY



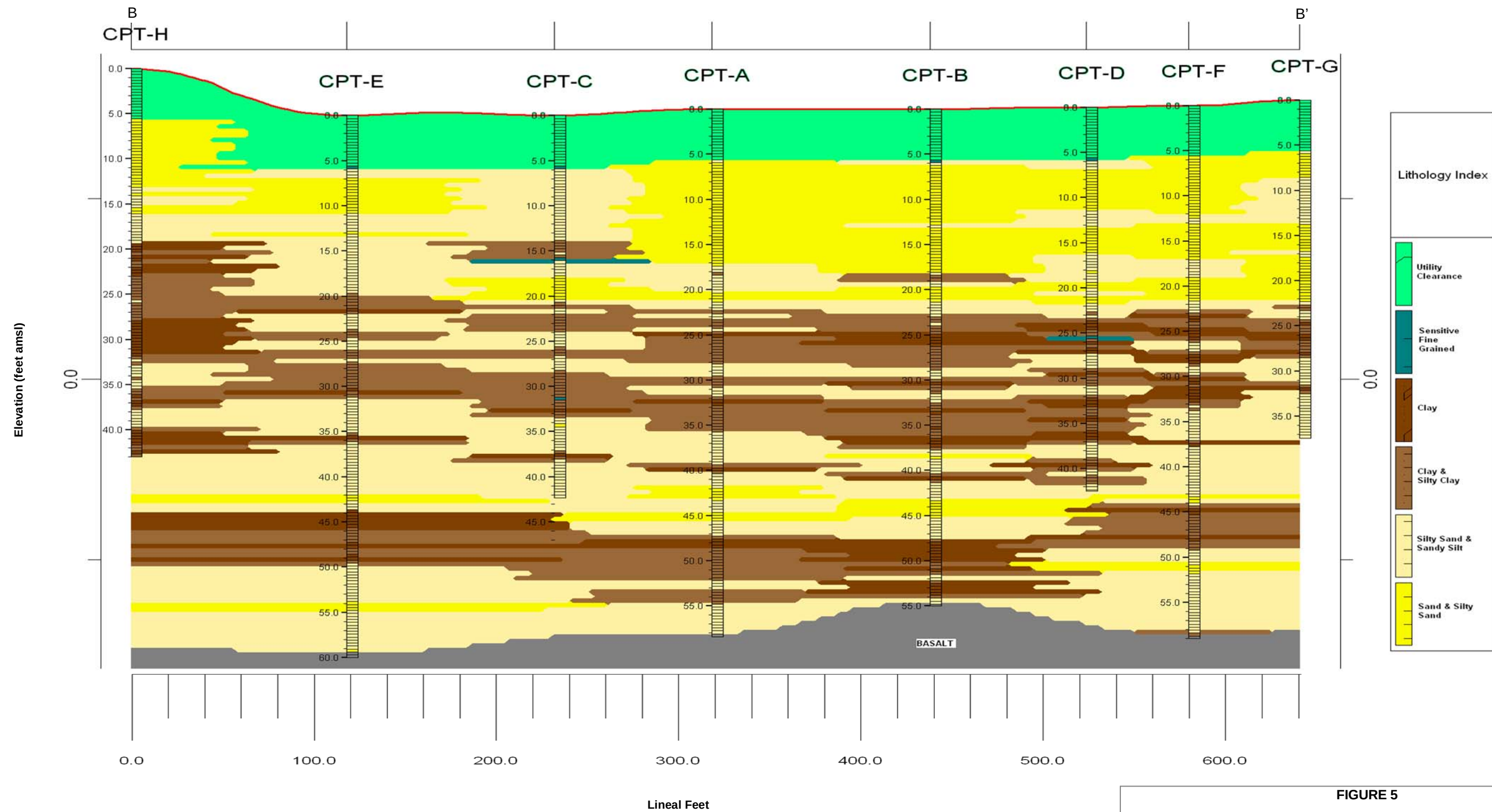
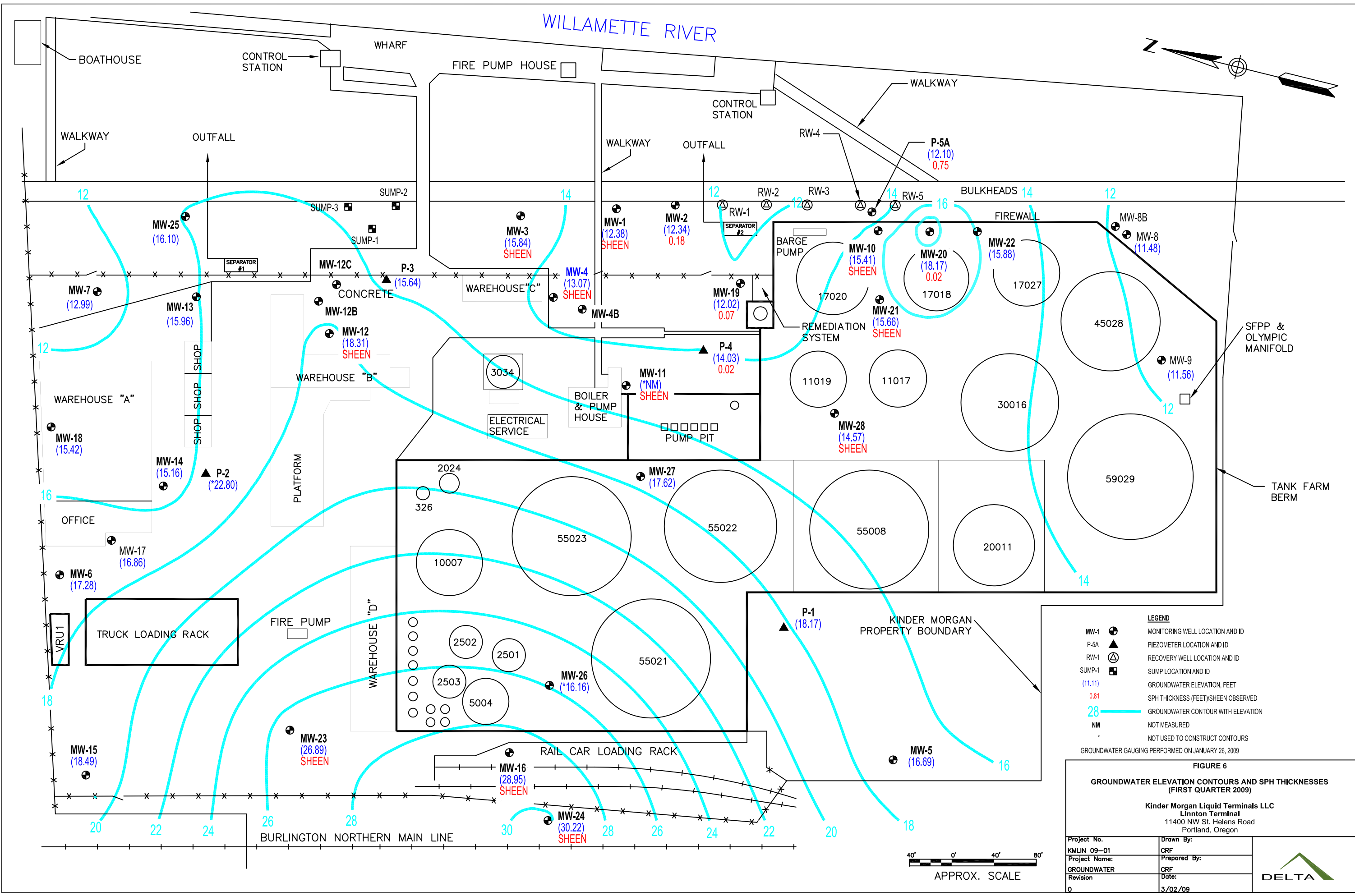
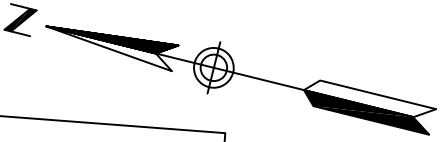


FIGURE 5
CROSS-SECTION B-B'
BARRIER WALL DESIGN INVESTIGATION
 Kinder Morgan Liquid Terminals LLC
 Linnton Terminal
 11400 NW St. Helens Road
 Portland, Oregon

PROJECT NO. KM LIN 09-09	DRAWN BY WH
FILE NO. BARRIER WALL	PREPARED BY CRF 10/29/09
REVISION NO. 0	REVIEWED BY TB 10/29/09



WILLAMETTE RIVER



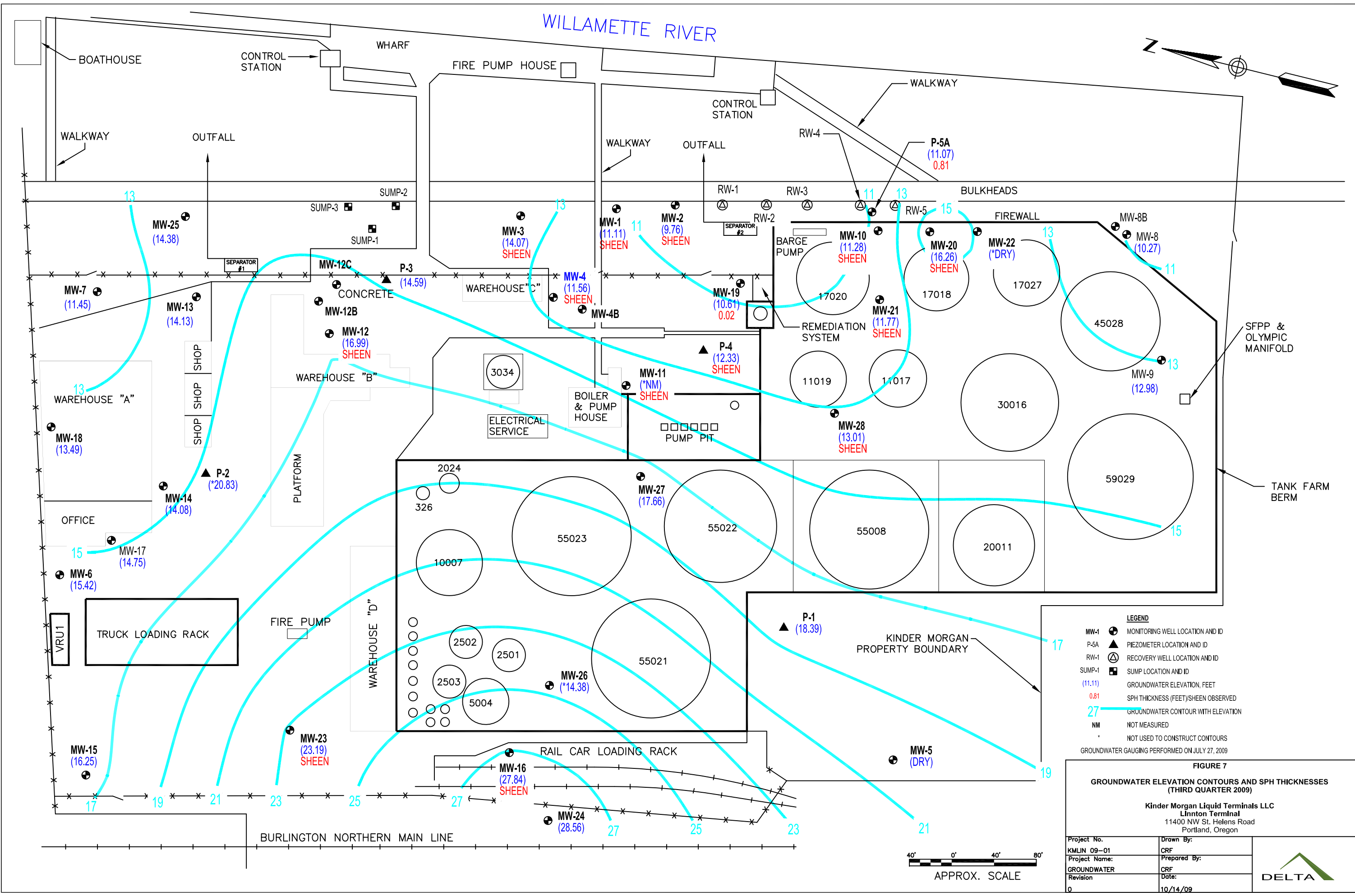
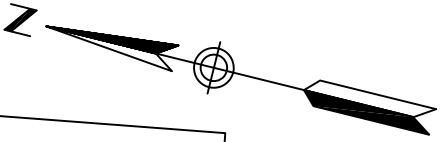
- LEGEND**
- MW-1 (Symbol) MONITORING WELL LOCATION AND ID
 - P-5A (Symbol) PIEZOMETER LOCATION AND ID
 - RW-1 (Symbol) RECOVERY WELL LOCATION AND ID
 - SUMP-1 (Symbol) SUMP LOCATION AND ID
 - (11.11) GROUNDWATER ELEVATION, FEET
 - 0.81 SPH THICKNESS (FEET)/SHEEN OBSERVED
 - 28 GROUNDWATER CONTOUR WITH ELEVATION
 - NM NOT MEASURED
 - * NOT USED TO CONSTRUCT CONTOURS
- GROUNDWATER GAUGING PERFORMED ON JANUARY 26, 2009

FIGURE 6
GROUNDWATER ELEVATION CONTOURS AND SPH THICKNESSES
(FIRST QUARTER 2009)

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No. KMLIN 09-01	Drawn By: CRF
Project Name: GROUNDWATER	Prepared By: CRF
Revision 0	Date: 3/02/09

WILLAMETTE RIVER



LEGEND

- MW-1 MONITORING WELL LOCATION AND ID
- P-5A PIEZOMETER LOCATION AND ID
- RW-1 RECOVERY WELL LOCATION AND ID
- SUMP-1 SUMP LOCATION AND ID
- (11.11) GROUNDWATER ELEVATION, FEET
- 0.81 SPH THICKNESS (FEET)/SHEEN OBSERVED
- 27 GROUNDWATER CONTOUR WITH ELEVATION
- NM NOT MEASURED
- * NOT USED TO CONSTRUCT CONTOURS

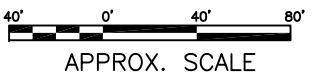
GROUNDWATER GAUGING PERFORMED ON JULY 27, 2009

FIGURE 7

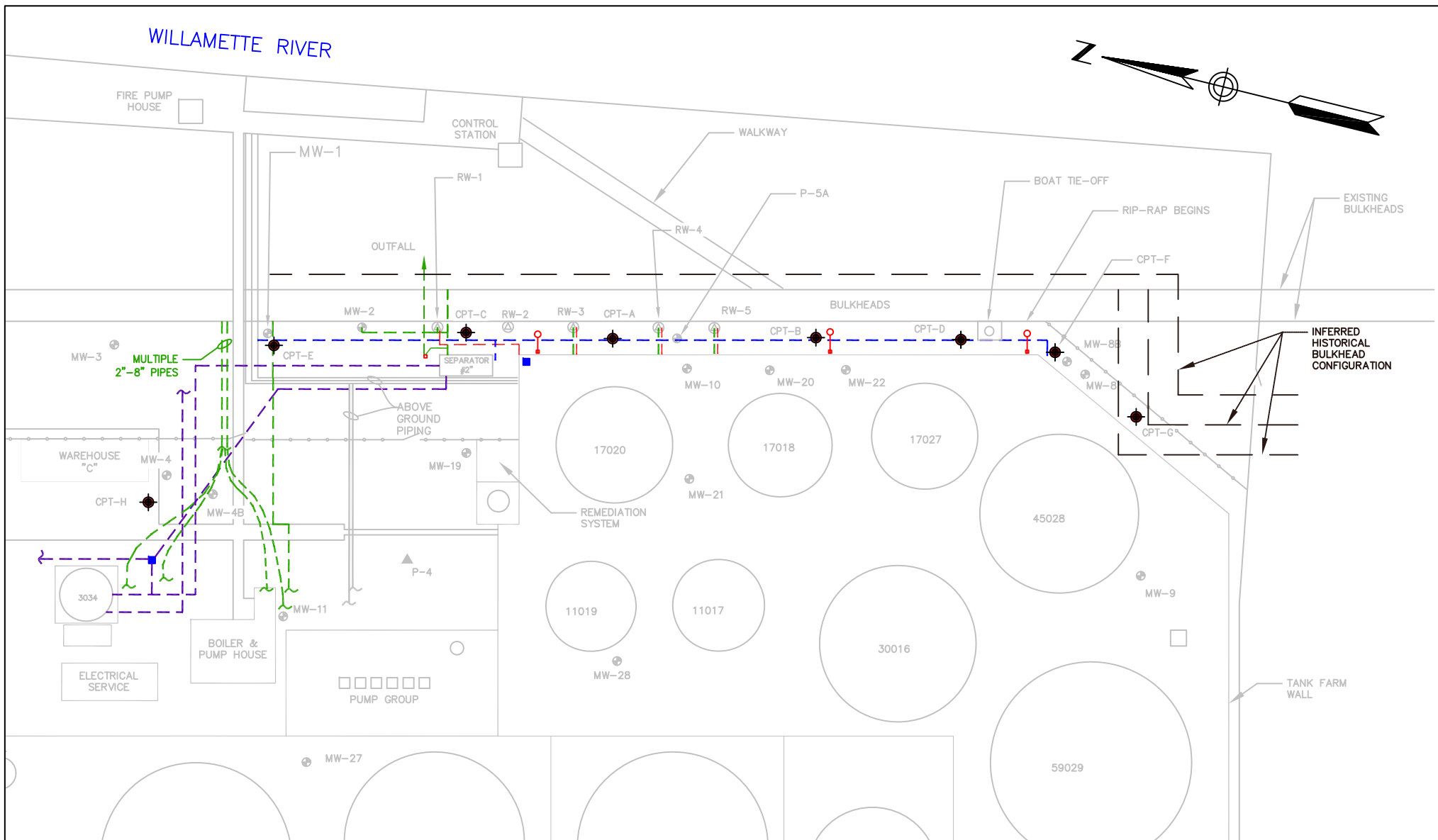
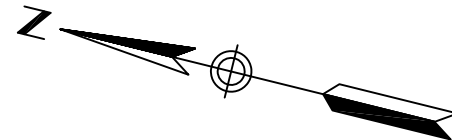
GROUNDWATER ELEVATION CONTOURS AND SPH THICKNESSES
(THIRD QUARTER 2009)

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No. KMLIN 09-01	Drawn By: CRF
Project Name: GROUNDWATER	Prepared By: CRF
Revision 0	Date: 10/14/09



WILLAMETTE RIVER



LEGEND

- MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- RECOVERY WELL LOCATION
- CATHODIC PROTECTION
- CATCH BASIN

KNOWN OR REASONABLY LIKELY PIPING CONFIGURATIONS

- ELECTRICAL UTILITY
- MISCELLANEOUS PIPING
- WATER LINE
- STORMWATER CONVEYANCE



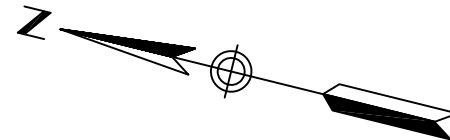
FIGURE 8

UTILITY MAP OVERVIEW IMPERMEABLE BARRIER WALL DESIGN STUDY

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No.	Drawn By:	
KM LIN 09-06	CRF	
Project Name:	Prepared By:	
BARRIER WALL	CRF	
Revision	Date:	
0	10/13/09	

WILLAMETTE RIVER



FIRE PUMP HOUSE

CONTROL STATION

WALKWAY

OUTFALL

BOAT TIE-OFF

RIP-RAP BEGINS

BULKHEADS

RW-2

RW-3

RW-4

RW-5

MW-1

MW-2

RW-1

OUTFALL BASIN

SEPARATOR #2

MW-10

MW-20

MW-22

MW-8B

MW-8

MW-3

WAREHOUSE "C"

MW-4

MW-4B

MW-19

FENCE

17020

17018

17027

11019

11017

30016

45028

MW-9

3034

BOILER & PUMP HOUSE

P-4

MW-11

PUMP PIT

ELECTRICAL SERVICE

MW-21

MW-28

MW-27

TANK FARM WALL

REMEDATION SYSTEM

LEGEND

⊕ MONITORING WELL LOCATION

▲ PIEZOMETER LOCATION

⊗ RECOVERY WELL LOCATION

■ CATCH BASIN

⊙ FIRE HYDRANT

— ABOVE GROUND IRAM PIPING

— MISCELLANEOUS ABOVE GROUND PRODUCT PIPING

*NOTE:

PIPING NOT TO SCALE

LOCATIONS ARE APPROXIMATE

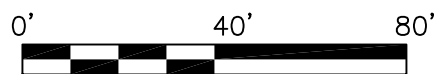


FIGURE 9

EXISTING SURFACE FACILITIES IMPERMEABLE BARRIER WALL DESIGN STUDY

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

Project No.

KM LIN 09-06

Project Name:

BARRIER WALL

Revision

0

Drawn By:

CRF

Prepared By:

CRF

Date:

10/12/09



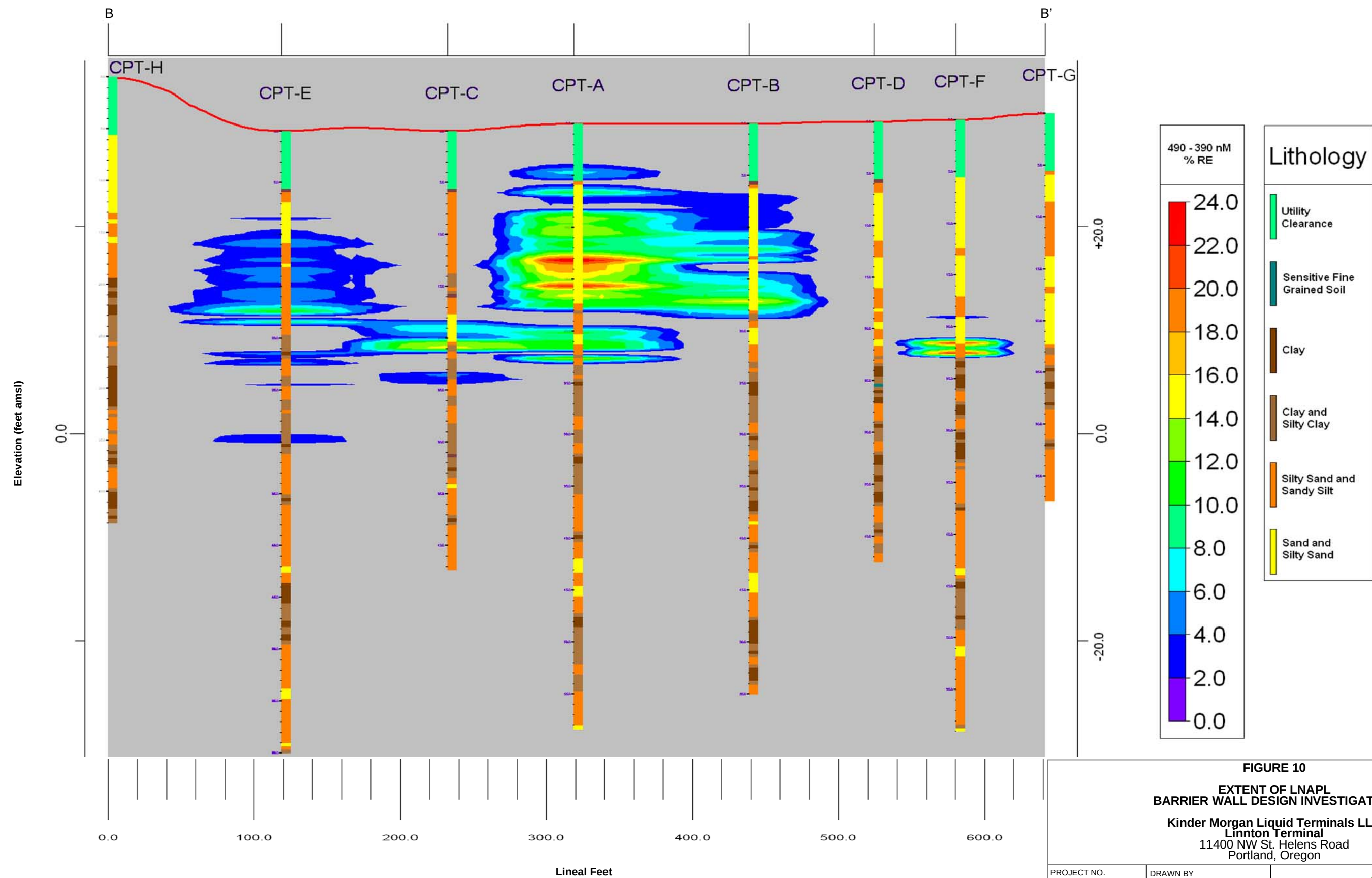
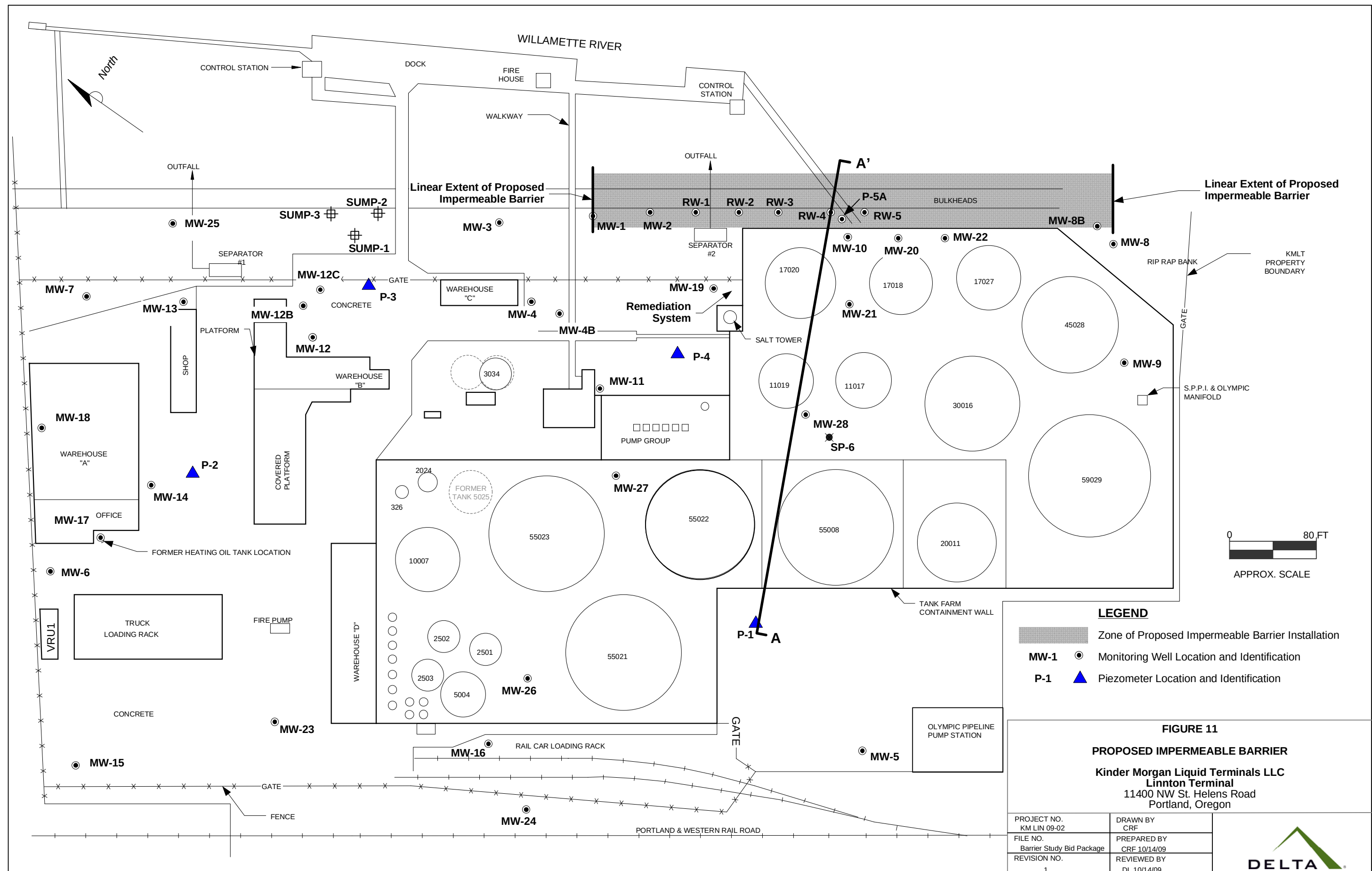


FIGURE 10
EXTENT OF LNAPL
BARRIER WALL DESIGN INVESTIGATION
Kinder Morgan Liquid Terminals LLC
Linnton Terminal
 11400 NW St. Helens Road
 Portland, Oregon

PROJECT NO. KM LIN 09-09	DRAWN BY WH
FILE NO. BARRIER WALL	PREPARED BY CRE 10/29/09
REVISION NO. 0	REVIEWED BY TB 10/29/09





APPENDIX A

Geotechnical Boring Logs



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-1

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM/NWH**

Drilling Date(s): **9/2-9/3/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **4**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **59**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0		Dry				SM		Poorly graded SAND; Dark brown, fine-medium grained, loose, no odor. 10YR;4/3 (hand auger), dry	0		0
					3,3,3	SP		Poorly graded SAND; Dark brown, fine-grained, loose, no odor, no staining. 10yr;4/3, slightly moist	0		
					2,2,1			As above, 12" recovery	0		5
					2,1,3			As above, 12" recovery	0		
					2,2,2			As above, brown in color, very loose, moist, 15" recovery.	0		10
					1,2,2			As above, top=10yr 4/3 brown, Bottom is getting contaminated 10yr 2/1 dark gray, odor, trace mica at bottom, 12" recovery	0		
					2,3,4			As above, 15" recovery	0		15
					1,1,2			Top=10yr 4/3 brown, becoming stained, strong odor at 16'8"; 10yr 2/1 very dark gray, very loose, moist, 13" recovery	0		
					2,3,4			Top=10yr 4/3 brown; Bottom=10yr 2/1 black. Bottom has strong odor. Moist, 12" recovery.	0		20
					2,3,2			10yr 2/1 black, strong odor, sheen, staining, very loose, moist, 16" recovery	0		
					1 for 12"; 1 for 6"	ML		Clayey SILT; Brown (10yr 4/3), low plasticity, very soft, dilatancy, no odor, 16" recovery.	0		25
					NA			As above, 22" recovery	1.0		
					1,1,4	SM		Silty fine SAND; Very dark gray (10yr 3/1), very loose, no odor. (Shoe contains clayey silt), wet.	0		30

Bentonite



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-1

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM/NWH**

Drilling Date(s): **9/2-9/3/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **4**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **59**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30					NA	ML		Clayey SILT; Brown (10yr 4/3), low plasticity, soft, dilatancy, no odor, no staining, wet.	1.25		30
35					1,1,1	SM		Silty SAND; Brown (10yr 4/3), very loose, no odor, no staining. 60% fine sand, 30% silt. Switch to mud rotary with tri-cone bit.	0		35
					1;1 for 12"	ML		Sandy SILT; Brown, (10yr 4/3), very soft, no odor, no staining. 60% silt, 40% very fine sand. Some clayey silt in shoe, wet, 18" recovery.	0		
40					NA	SM		Silty SAND; Brown, (10yr 4/3), loose, no odor, no staining. Shelby tube sample collected, wet 16" recovery.	0		40
					2,2,3	SP		Poorly graded SAND; Brown (10yr 4/3), fine-grained, very loose, no odor, no staining, wet 12" recovery. Grades dark gray at 43.5 feet bgs	0		
45					6,2,1	ML		Clayey SILT; Brown (10yr 4/3), none to low plasticity, very soft, dilatancy, no odor, no staining, wet. Shelby tube sample collected.	0.25		45
					2,3,6	SP		Organic woody material for 4". Poorly graded SAND; Gray (10yr 4/1), fine-grained, loose, no odor, no staining. Bentonite slough, wet, 14" recovery.	0		
50					2,3,6			As above, 12" recovery	0		50
55					6,8,7	SM		Silty SAND; Gray (10yr 4/1), loose, no odor, no staining, fine-grained, wet, 12" recovery. Bentonite slough.	0		55
					50 for 1"	BASALT		Refusal at 56'1". No recovery. Resume drilling with tri-cone bit on 9-3-09. Drilled 3' into basalt with black basalt chips present in cutting fluid.			
60								Bottom of Boring at 59 feet bgs			60



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-2

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM/NWH**

Drilling Date(s): **9/2/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **36**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0						SW		Gravelly SILTY SAND; Dark brown (7.5yr 3/2), 20% small-medium, angular-subangular gravel, loose, no odor. 60% fine sand, 20% silt, slightly moist. (Hand auger)	0		0
								As above, 12" recovery	0		
						SP		Poorly graded SAND; Dark gray (10yr 3/1), fine-grained, very loose, strong odor, staining, slightly moist, 12" recovery.	0		
5								As above, 12" recovery	0		5
								As above, 12" recovery	0		
10								As above, 12" recovery	0		10
								Black (10yr 2/1), very loose, sheen, strong odor, staining, with some anomalous pea gravel, moist, 12" recovery.	0		
								As above, with no pea gravel, no sheen, 14" recovery.	0		
15								As above, 12" recovery	0		15
								Black (10yr 2/1), loose, sheen, strong odor, staining, moist, 12" recovery.	0		
20									0		20

BORING LOG

Client: **Kinder Morgan**

Boring/Well No.

Project Number: **KMLIN-0906**

GT-2

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: MM/NWH

Drilling Date(s): 9/2/09

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **36**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: CME 75

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content Boring Interval Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSE Reading (ppm)	Boring Completion	Depth (ft.)
20		<-->							20
	Wet	3,2,3		ML		Clayey SILT; Very dark gray (10yr 3/1), low plasticity, soft, dilatancy, odor, 10" recovery.	0		
				SP		Poorly graded SAND; Shelby tube sample	0.75		
	Moist			ML		Sandy Clayey SILT; Dark brown (10yr 3/3), low plasticity, dilatancy, soft, odor, some gray staining; Shelby tube sample, 22" recovery.	0.5		
25						Clayey SILT; Dark brown (10yr 3/3), low plasticity, dilatancy, odor, gray staining, moist, 18" recovery.	1.25		
	Wet	1,1,1				Clayey SILT with sand; Dark brown (10yr 3/3), low plasticity, dilatancy, very soft, mild odor, no staining, with woody organic debris, transitioning to fine sand material at very bottom.	0.5		
				SM		Silty SAND; Brown (10yr 4/3), no odor, no staining, fine-grained, wet, 18" recovery.	0.5		
	Moist	1,2,2		ML		Clayey SILT; Brown (10yr 4/3), low plasticity, dilatancy, no odor, wet, 24" recovery.	0		
	Wet			SP		Fine SAND microlense; no odor, no staining, wet			
30				ML		Clayey SILT microlense; no odor, no staining, wet			
				SP		Fine SAND microlense; no odor, no staining, wet			
						Bottom of Boring at 36 feet bgs			
35		1,2,4							
40									



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0						SW		Gravelly SILTY SAND; Dark brown (7.5yr 3/3), 60% fine sand, 20% silt, 20% pea-ping pong sized gravel (subrounded to subangular). Dry, no odor, no staining. (Hand auger)	N/A		0
						SP		Fine sand with silt; 90% fine sand with 10% silt. 5yr 3/3 dark reddish brown. Gray staining and odor in shoe, loose. 15" recovery. Dry.	0		
						SM		Silty Sand; 70% fine sand, 30% silt, fill material. 10yr 3/1, very dark gray, strong odor, staining, sheen, very loose. 8" recovery, moist, woody debris	0		
5						SP		Fine sand; 10yr 3/1 dark gray, odor, staining, sheen, very loose, moist. Brass sleeve, fill material. 4" recovery	0		
								As above, 12" recovery, very dark gray	0		
10											10



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
10								As above	0		10
				2,3,3							
								Fine sand; fill material, 10yr 2/1 black, odor, staining, moist, loose, brass sleeves, 12" recovery.	0		
15				3,4,4					0		15
								Fine sand; 10yr 2/1 black, odor, staining, moist, loose, brass sleeves, 8" recovery.	0		
				3,3,3							
								Fine sand; 10yr 2/1 black, odor, staining, sheen, moist, very loose, brass sleeves, 15" recovery.	0		
20				2,3,2					0	Bentonite	20



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
20											20
						ML		Sandy Silt; 10yr 3/1 very dark gray. 60% silt, 40% sand, no plasticity; odor, staining, wet. 18" recovery. brass sleeves	0.25		
						SM		Silty Sand; 10yr 3/1 very dark gray, 60% fine sand, 40% silt, loose, mild odor - shelby tube			
						ML		Clayey Silt; Dark brown (10yr 3/1 and 10yr 4/2) dark gray and dark grayish-brown. Glistens when tapped. Soft, wet. No odor, no staining. Low plasticity - can't quite roll 1/8" thread.	0.75		
25											25
								Clayey Silt with Sand; 10yr 4/2 dark grayish brown, soft, low plasticity, glistens when tapped, no odor, no staining. 18" recovery.			
						SM		Silty Sand; 60% fine sand, 40% silt, 10yr 4/2 dark grayish brown, very loose, wet, no odor.			
						SP		Fine sand; 10yr 4/2 dark grayish brown, very loose, wet, no odor, no staining. 18" recovery.			
30						ML		Clayey Silt; 10yr 4/2 dark grayish brown, soft, low plasticity,	0.8		30



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30						SM		no odor, no staining, glistens when tapped.			30
						ML		Silty Sand; 10yr 4/3 brown, loose, moist, no odor, no staining. Grades to clayey SILT at bottom, fairly soft. Shelby tube sample, 24" recovery.			
						SM					
								Clayey SILT microlense; no odor, no staining			
								Silty Sand; 10yr 4/3 brown, loose, moist, no odor, no staining.			
						ML		Clayey Silt (possibly silty clay), 10yr 4/3 brown, low plasticity, glistens when tapped,	1.0		
						ML		Clayey Silt with Sand; 10yr 4/2 brown, wet, some density in shoe. Little-no plasticity, gives up water readily, no odor, no staining. 18" recovery.			
35					1,2,1				1.25		35
						SP		Fine sand; 10yr 3/1 dark gray, loose, wet, no odor, no staining. 18" recovery.			
					1,2,4						
								Bottom of Boring at 37.5 feet bgs			



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0		Moist				ML		Clayey Silt; 10yr 3/2 very dark grayish brown, little-no plasticity, slightly moist, soft, no staining, no odor (hand auger)			0
						SM		Silty fine SAND; 10yr3/3 dark brown, loose, no odor, no staining, dry, disturbed bag sample, 9" recovery	0		
		Dry			3,3,5						
								As above, 70% fine sand, 30% silt, loose, slightly moist, no odor, disturbed bag sample, 10" recovery	0		
5					3,3,2						5
								As above, 10yr 3/1 very dark gray, moist, staining, strong odor, disturbed bag sample, 8" recovery	0		
					1,2,3						
								As above, 80% fine sand, 20% silt, loose, disturbed bag sample, 10" recovery	0		
					2,1,2						
10		Moist									10

BORING LOG

Client: **Kinder Morgan**

Boring/Well No.

Project Number: **KMLIN-0906**

GT-4

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: MM

Drilling Date(s): 8/31/09

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **63.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**Screen slot size: **N/A**

Sand Pack: **N/A**

[illegible]



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30								Switch to mud rotary. Sandy Silt; dark brown 7.5yr 3/2, ~80% silt, 20% fine sand, no odor, wet, soft, 18" recovery.	0	Bentonite	30
				1,3,4		SP		Fine Sand; dark gray 10yr 3/1, dark gray, no odor, loose, no staining.			
								Fine Sand; black 2.5yr 2.5/1, wet, loose, no staining, no odor, 10" recovery.	0		
35				2,3,2							35
						ML		Sandy Silt; Dark brown 7.5yr 3/2, wet, soft, no odor. 65% silt, 35% fine sand	0		
						SP		Fine Sand; 2.5yr 2.5/1 black, wet, loose, no odor, no staining, 12" recovery.	0		
				1,3,5							
								Fine Sand; 2.5yr 3/2 very dark grayish brown, wet, loose, no odor, no staining, 16" recovery.	0		
40				4,7,7							40



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
50								Very loose, 4" recovery	0		50
				4,3,2							
						SM		Silty Sand; 10yr 3/1 very dark gray, 70% fine sand, 30% silt, wet, no staining, no odor, loose, 18" recovery, bag sample.	0		
					2,5,6						
55								As above	0		55
						SP		Fine Sand; Very dark gray 10yr 3/1, very loose, no odor, no staining, wet, 10" recovery, bag sample	0		
				1,2,0							
								As above, 12" recovery			
				0,6, 50 for 4"		BASALT		Bedrock-Vesicular Basalt - switch to tri-cone at 2:57 pm.	0		60



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
60											60
65								Bottom of Boring at 63.5 feet bgs (3:10 pm). Hole backfilled with hydrated bentonite chips. mud flushed out and original surface restored.			65



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-5

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **9/1/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **32.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
20								Shelby tube sample collected from 20-22 feet bgs. Same as above.			20
				N/A					1.5		
								Sandy Silt; 10yr 3/1 very dark gray, no plasticity, odor, sheen, loose, soft. 60% silt, 40% fine sand. 18" recovery.			
				2,3,4					0.5		25
25											
								Clayey Silt; Color change at 26.5 from very dark gray to 10yr 4/3 brown, little plasticity, glistens when shaken, odor diminishes, sheen on top. 18" recovery.			
				2,2,1					0.3		
								Shelby tube sample collected from 27.5 to 29.5 bgs. Clayey Silt; 10yr 4/3 low plasticity, gives up water, no odor, no staining, wet, very soft, gooey. 24" recovery.			
				N/A					0		
30											30



BORING LOG

Client: **Kinder Morgan**

Boring/Well No.

Project Number: **KMLIN-0906**

GT-5

Site Address:

11400 NW St. Helens Rd

Portland, OR

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **32.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

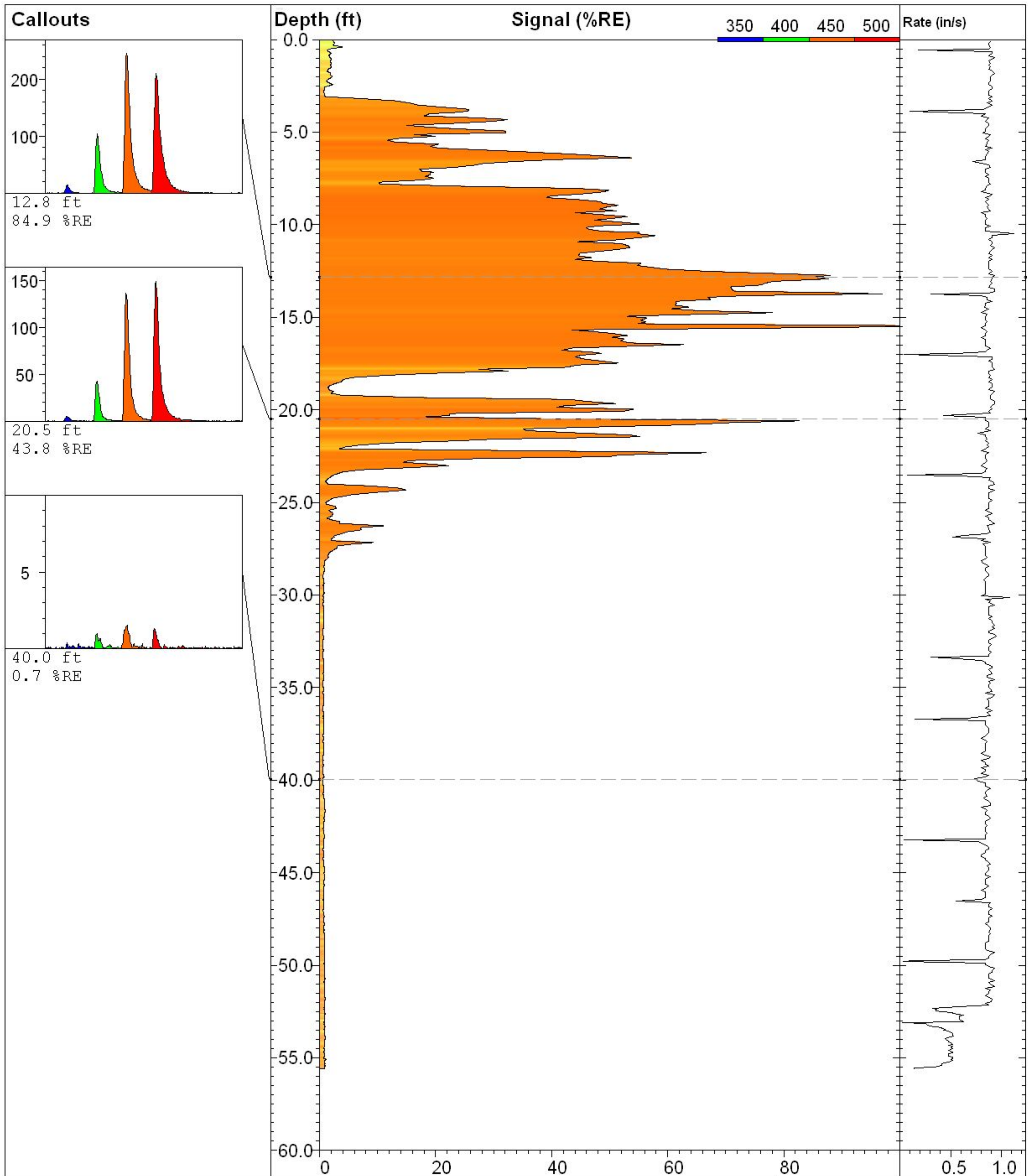
Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30						SP		Fine Sand; gray, very loose, wet, no odor, no staining. 18" recovery.			30
						SM		Silty Sand; 85% fine sand, 15% silt, no plasticity, 10yr 4/1 gray, wet, loose/soft, no odor, no staining.	0		
								Bottom of Boring at 32.5 feet bgs			
35											35

APPENDIX B

CPT / LIF Logs



www.greggdrilling.com

CPT-A

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

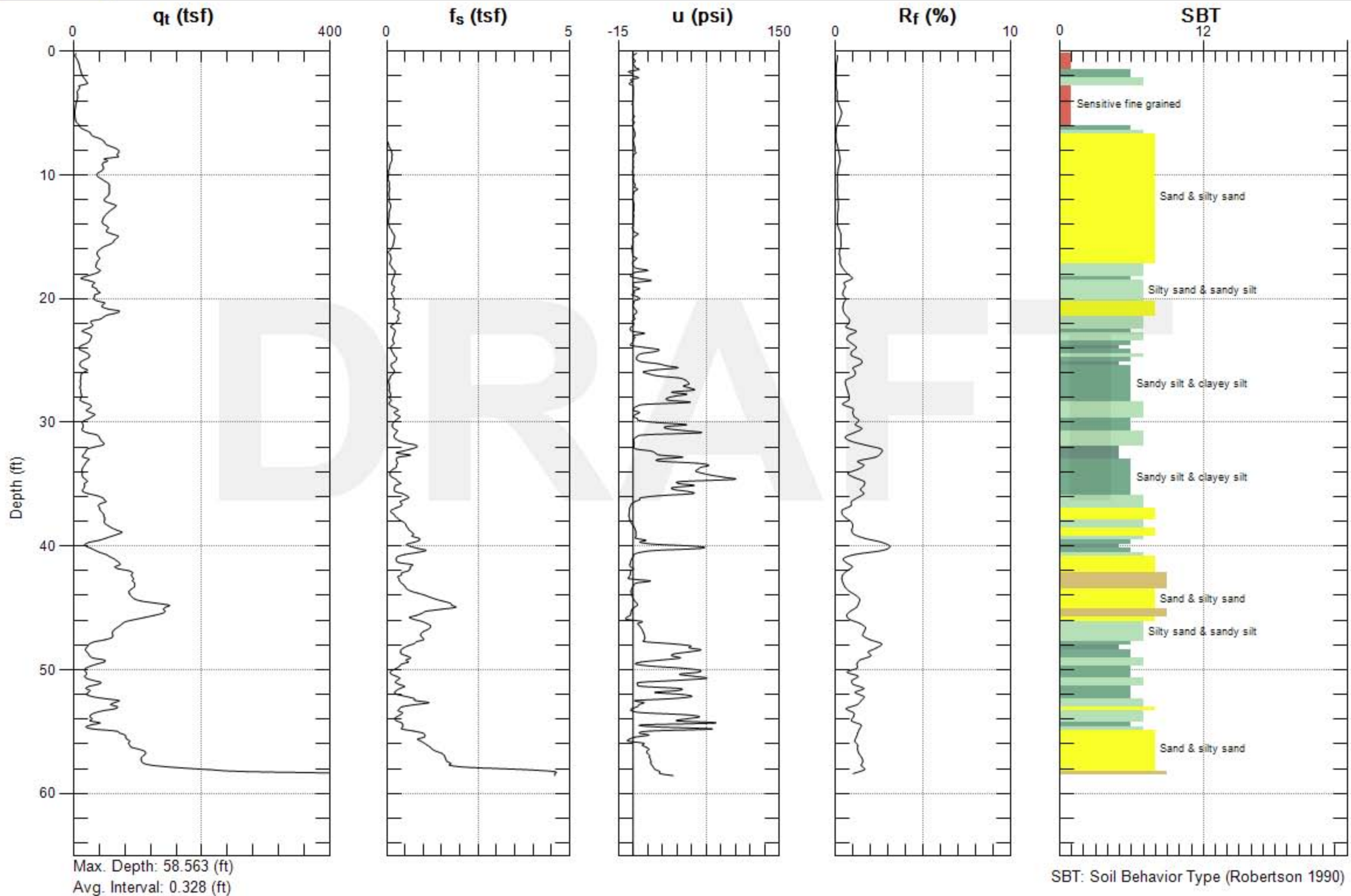
UVOST By Dakota

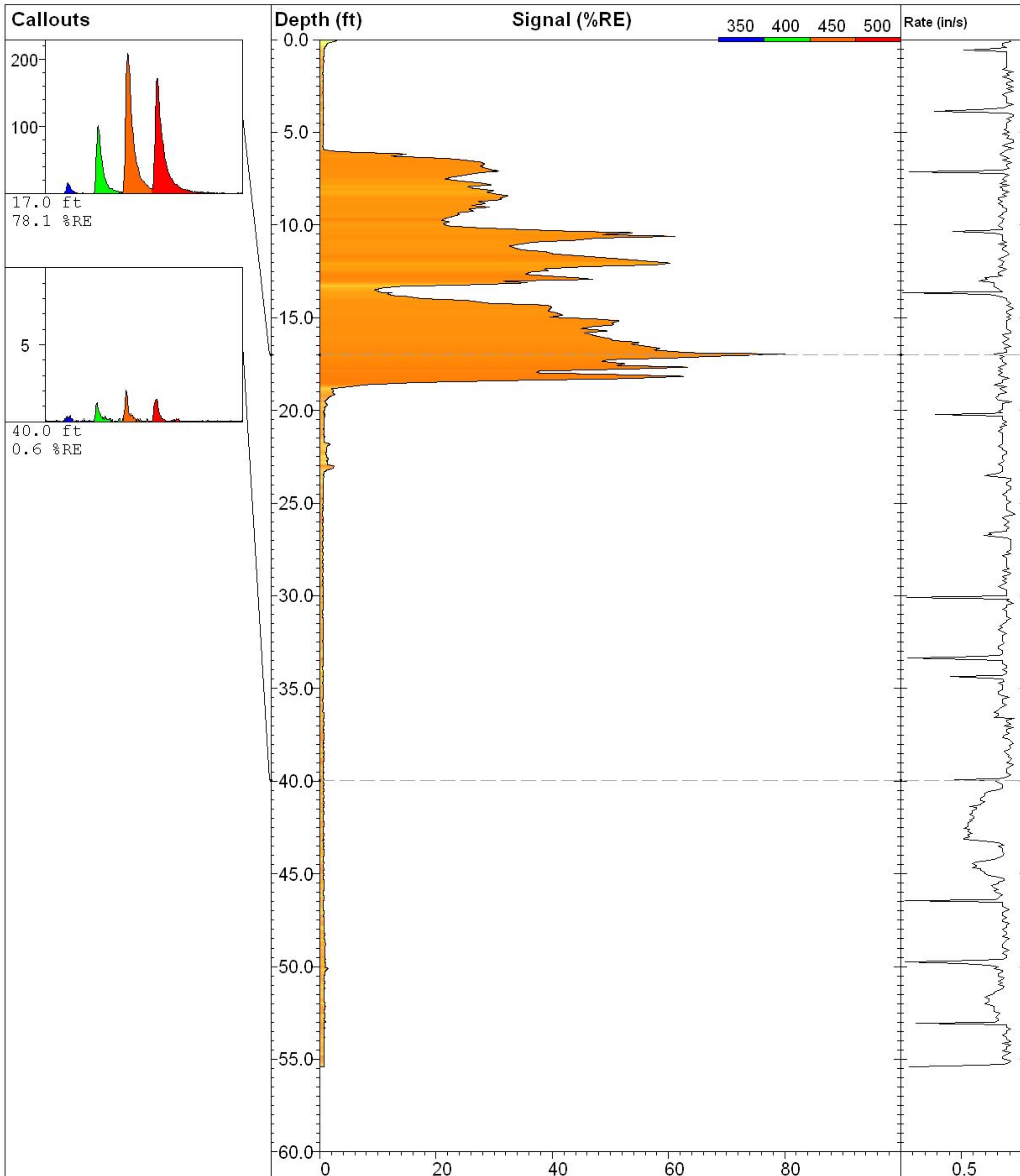
www.DakotaTechnologies.com

Final depth:
55.60 ft

Max signal:
109.5 % @ 15.46 ft

Date & Time:
2009-08-25 14:04 PDT





www.greggdrilling.com

CPT-B

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

UVOST By Dakota

www.DakotaTechnologies.com

Final depth:
55.41 ft

Max signal:
80.2 % @ 16.96 ft

Date & Time:
2009-08-25 12:00 PDT



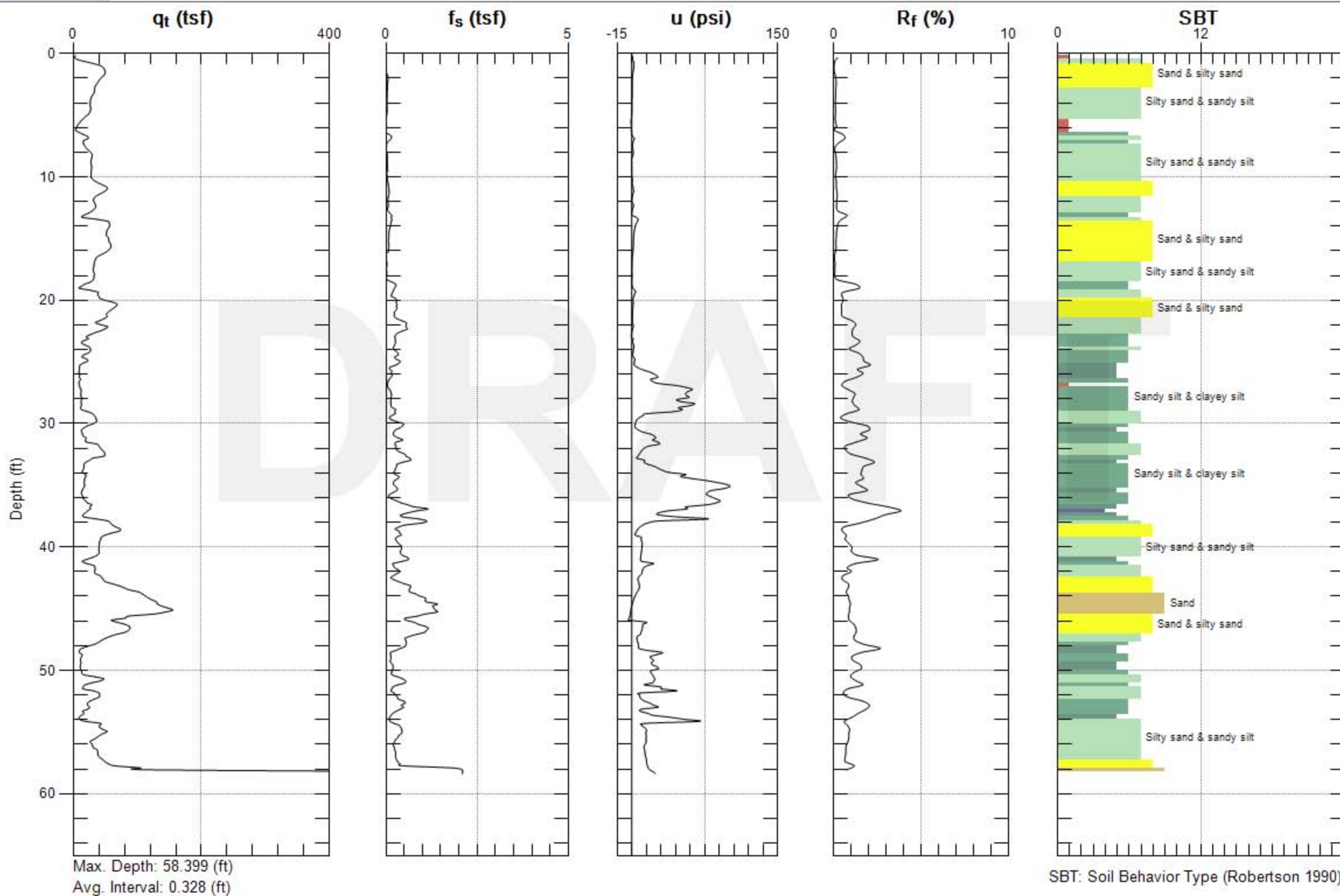
DELTA

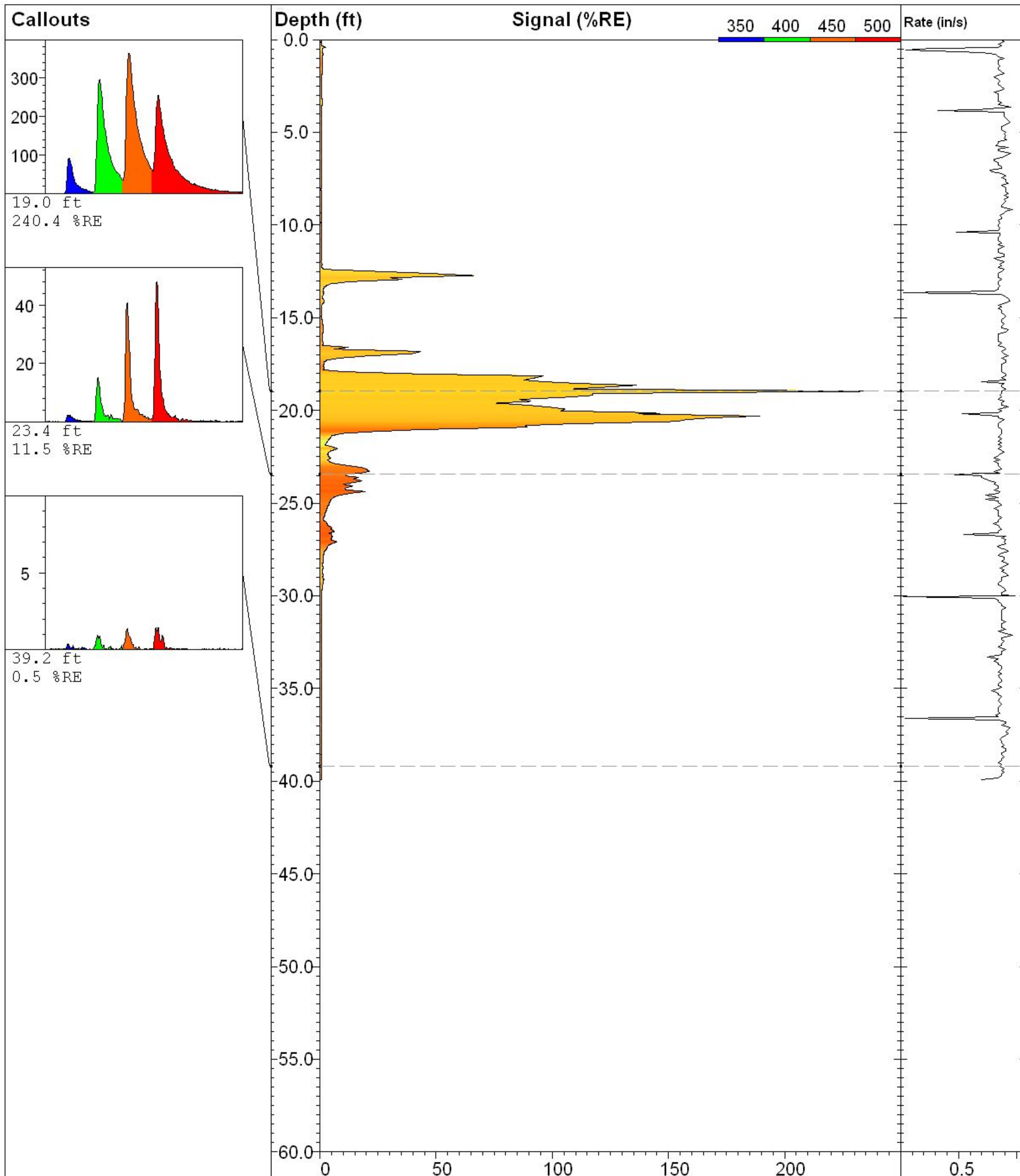
Site: Linnton Terminal

Sounding: UCPT-B

Engineer: M. Hemphill

Date: 8/25/2009 11:45





www.greggdrilling.com

CPT-C

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

UVOST By Dakota

www.DakotaTechnologies.com

Final depth:
39.92 ft

Max signal:
240.4 % @ 18.96 ft

Date & Time:
2009-08-25 15:25 PDT



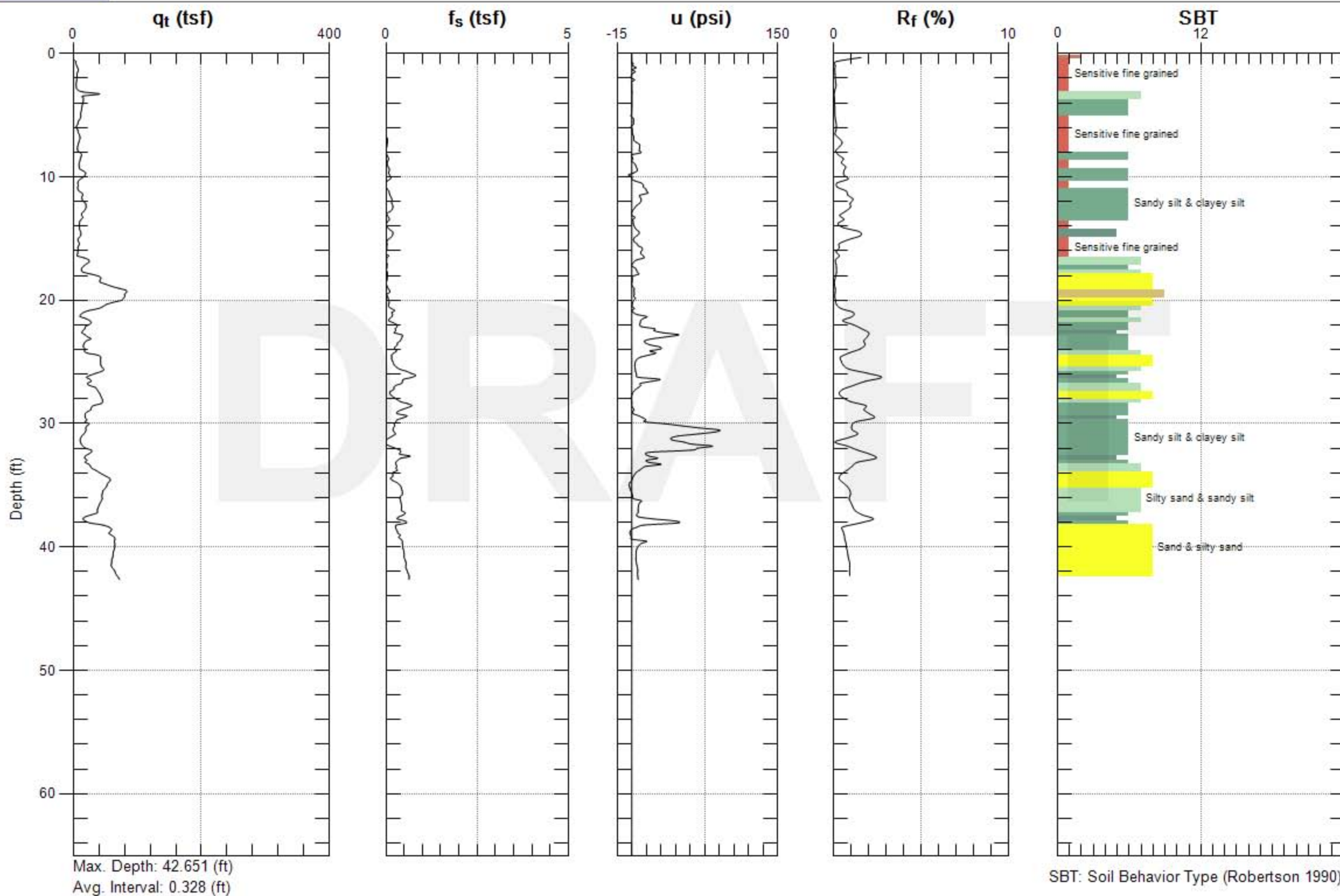
DELTA

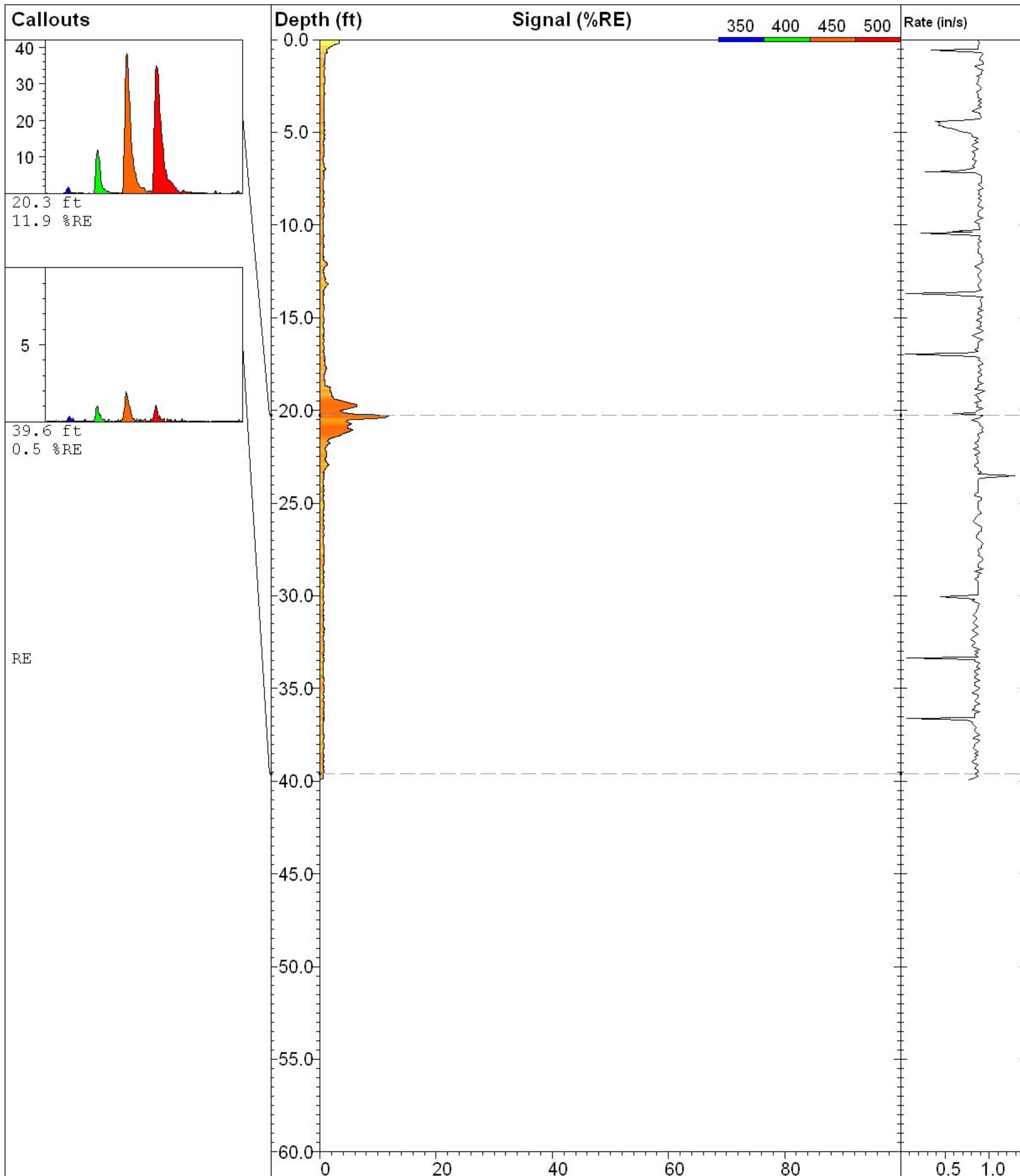
Site: Linnton Terminal

Sounding: UCPT-C

Engineer: N. Hemphill

Date: 8/25/2009 03:22





www.greggdrilling.com

CPT-D

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

UVOST By Dakota

www.DakotaTechnologies.com

Final depth:
39.90 ft

Max signal:
11.9 % @ 20.27 ft

Date & Time:
2009-08-26 09:30 PDT



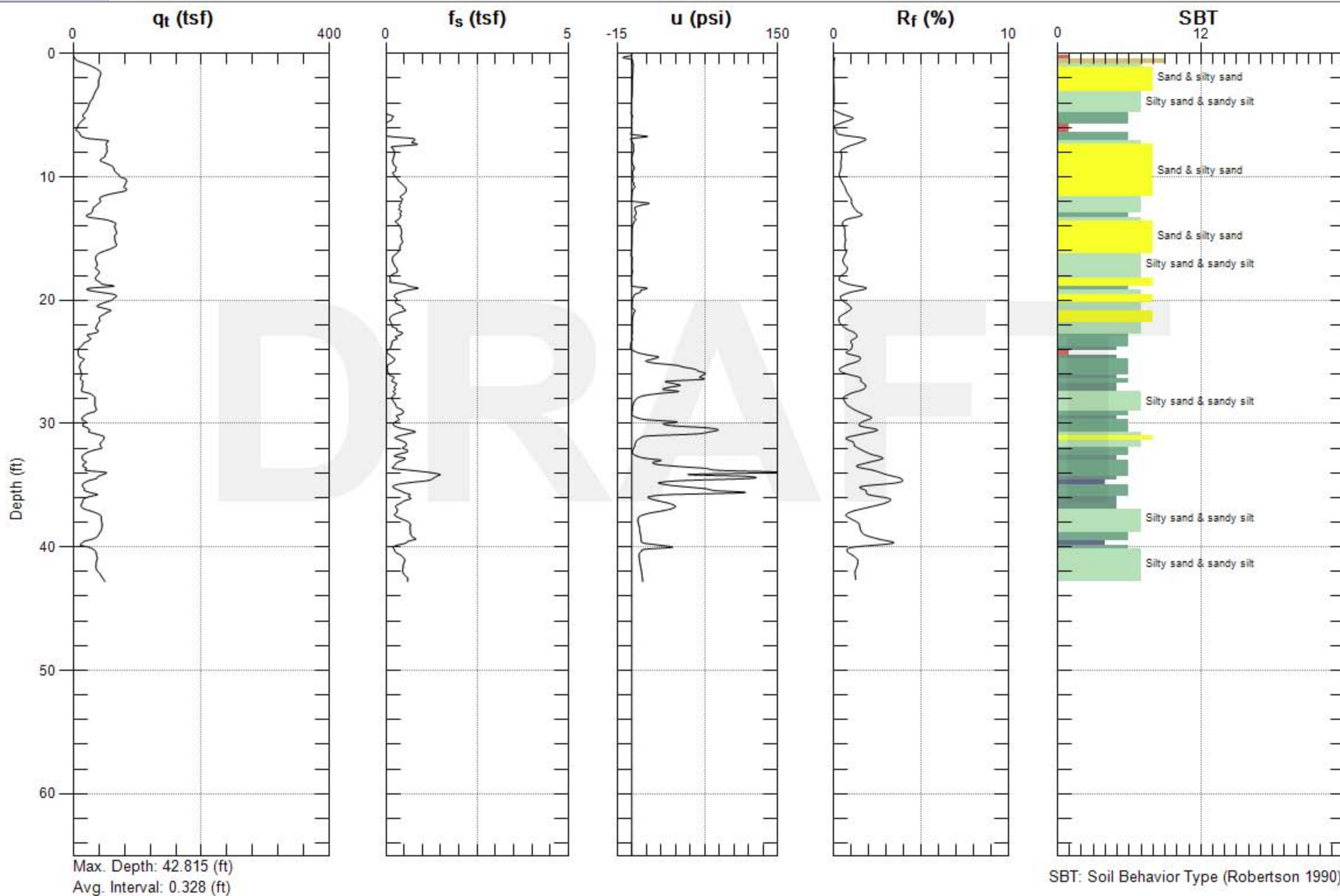
DELTA

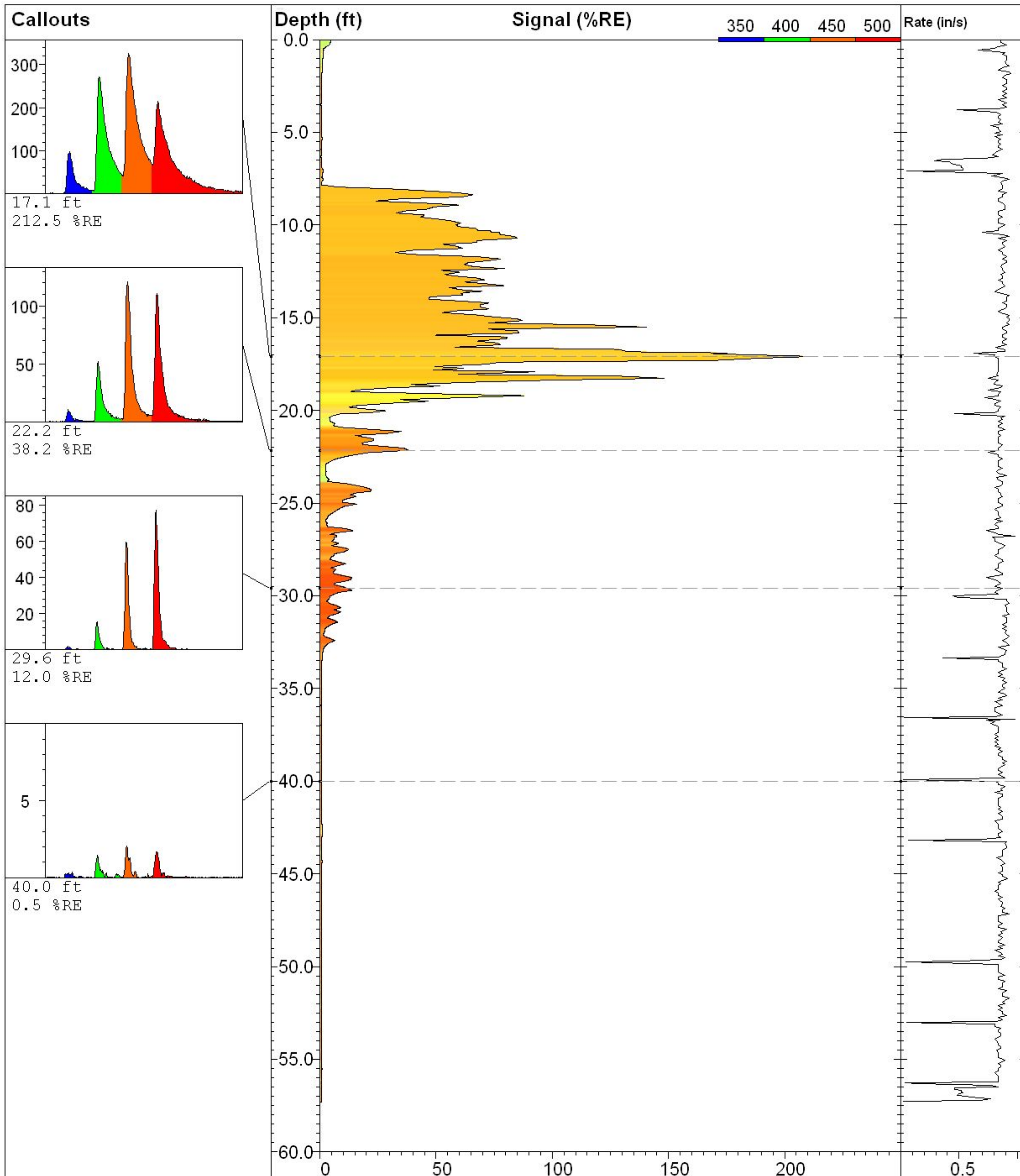
Site: Linnton Terminal

Sounding: UCPT-D

Engineer: N. Hemphill

Date: 8/26/2009 09:28





CPT-E

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

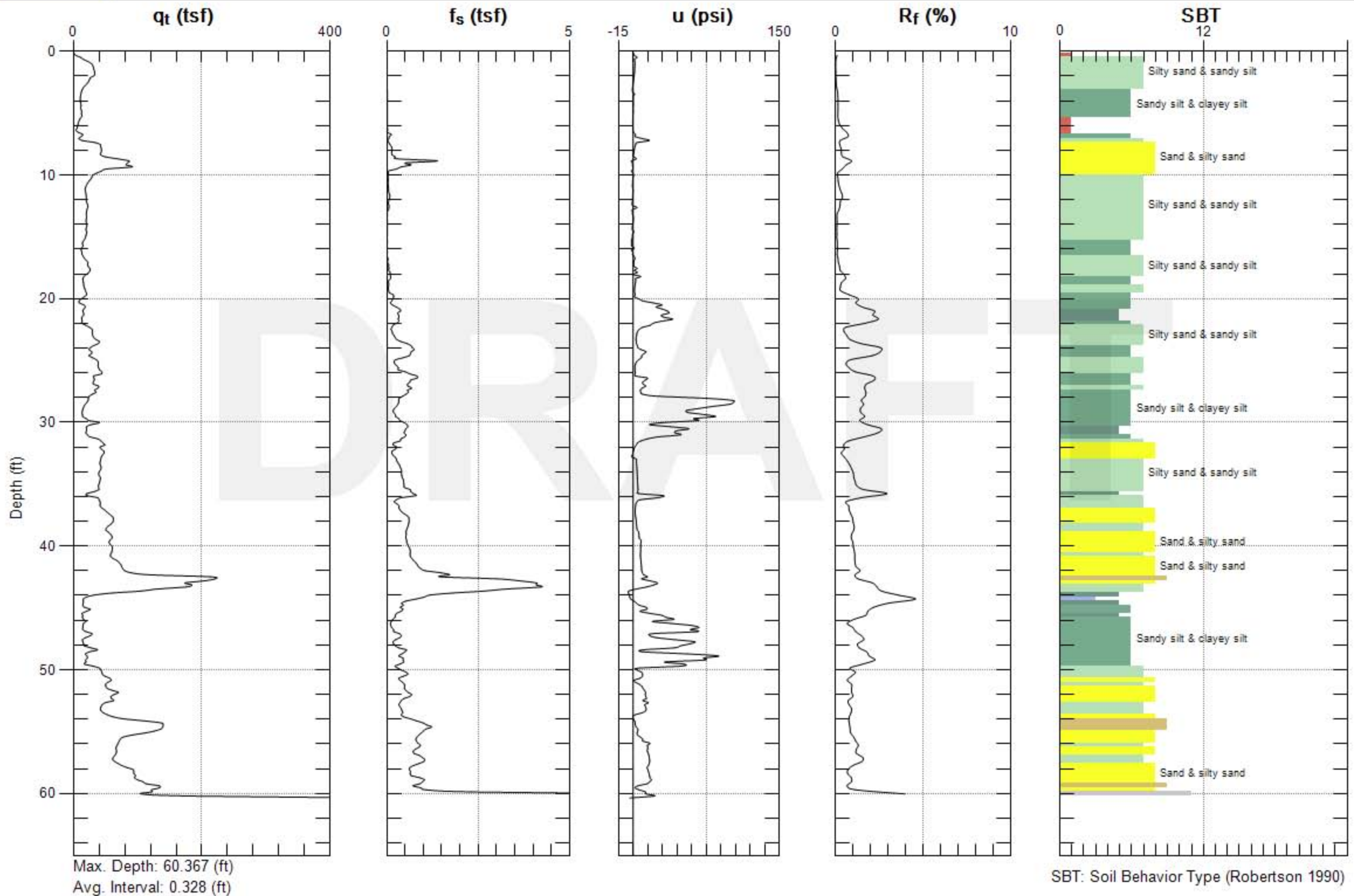
UVOST By Dakota

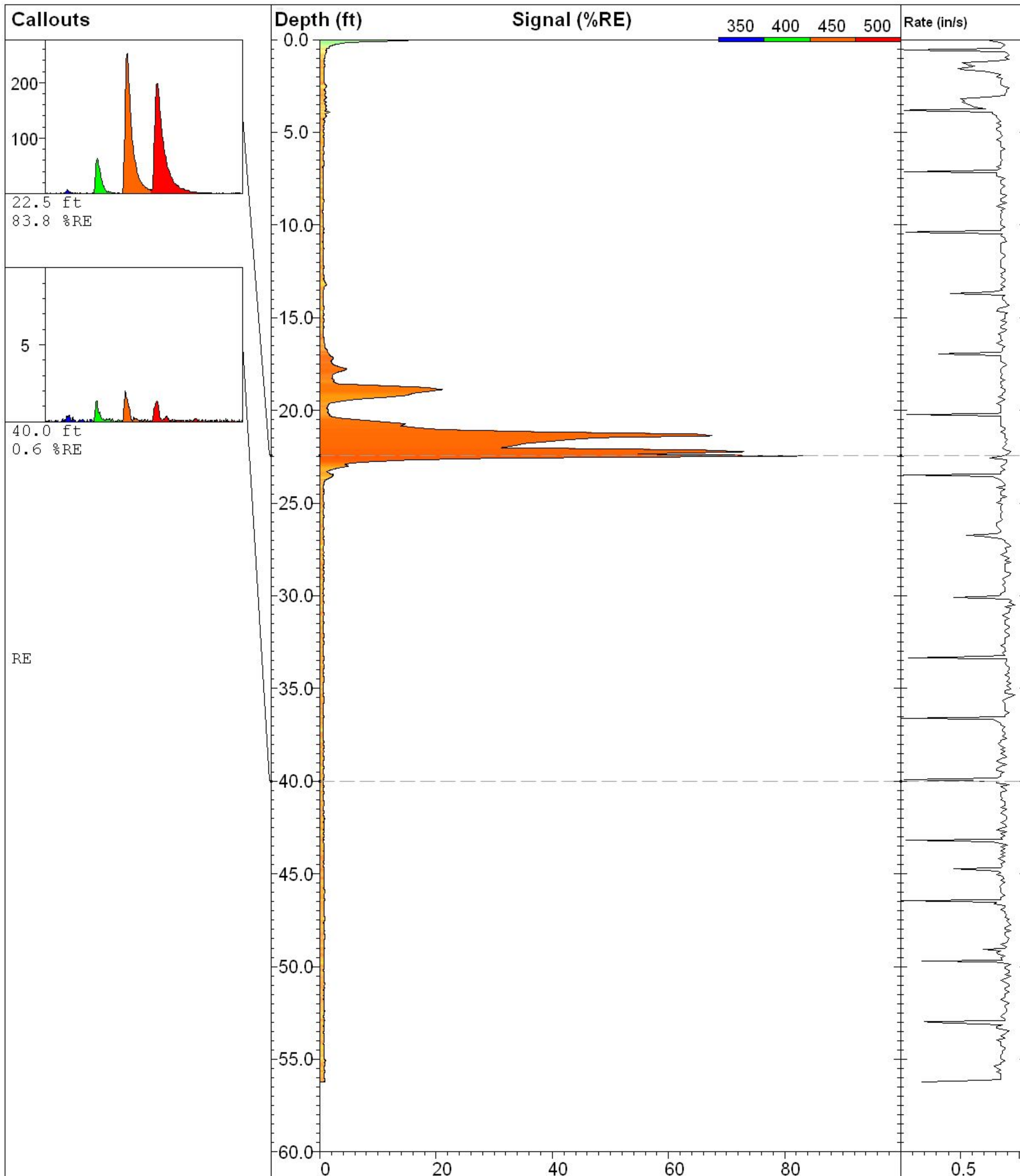
www.DakotaTechnologies.com

Final depth:
57.30 ft

Max signal:
212.5 % @ 17.09 ft

Date & Time:
2009-08-26 07:52 PDT





www.greggdrilling.com

CPT-F

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

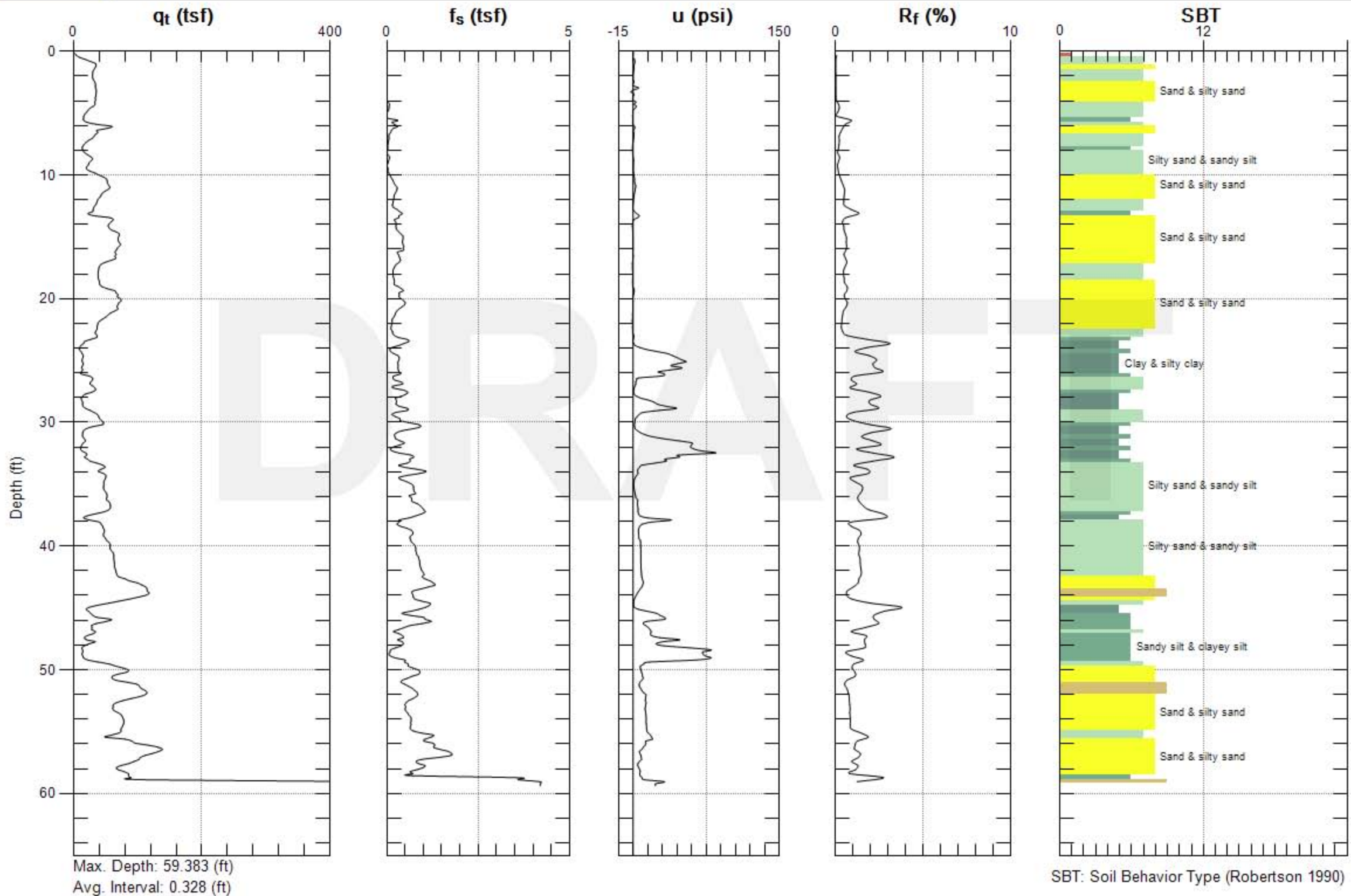
UVOST By Dakota

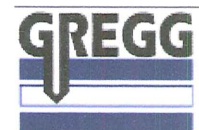
www.DakotaTechnologies.com

Final depth:
56.21 ft

Max signal:
83.8 % @ 22.45 ft

Date & Time:
2009-08-26 10:40 PDT





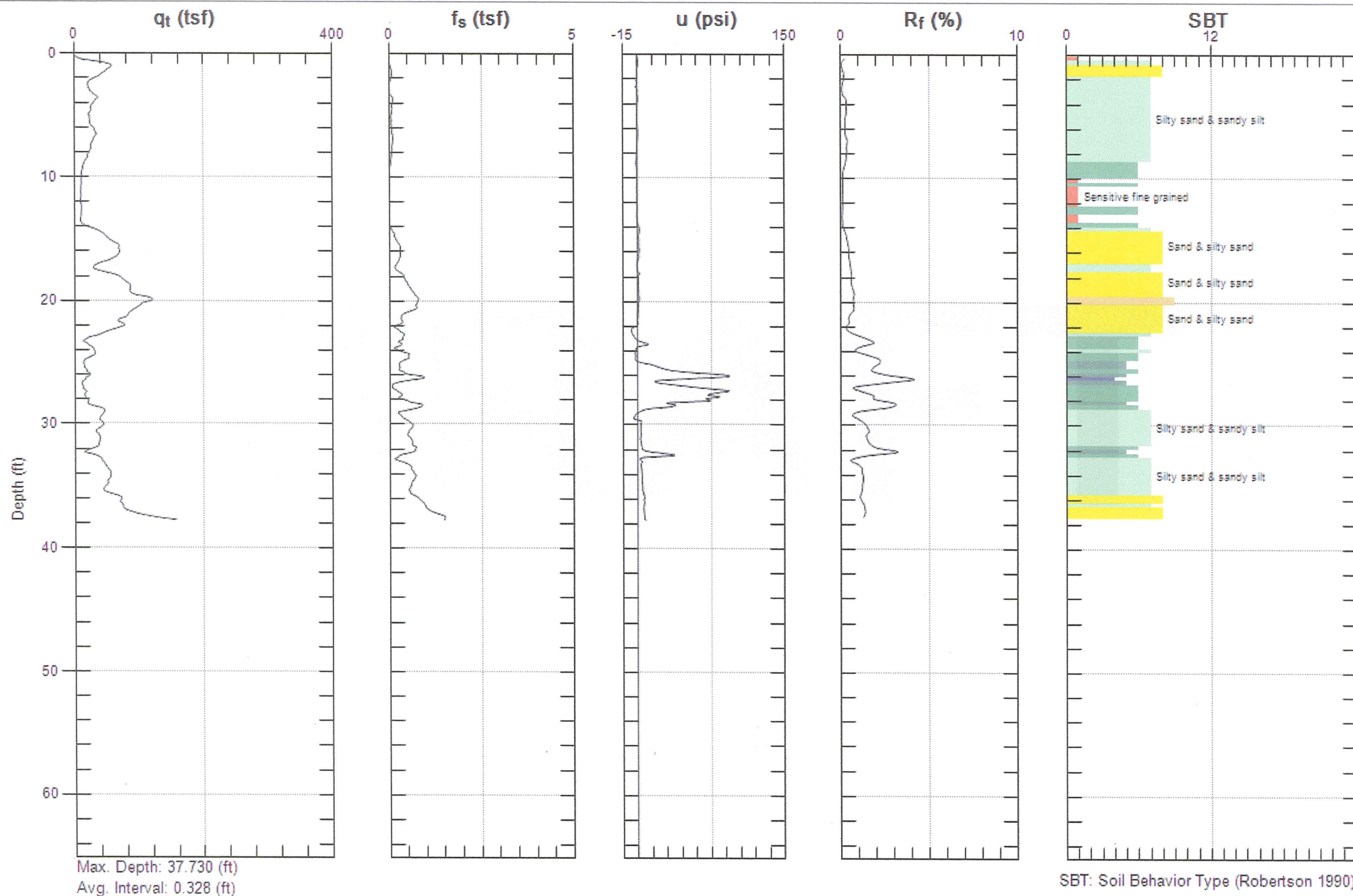
DELTA

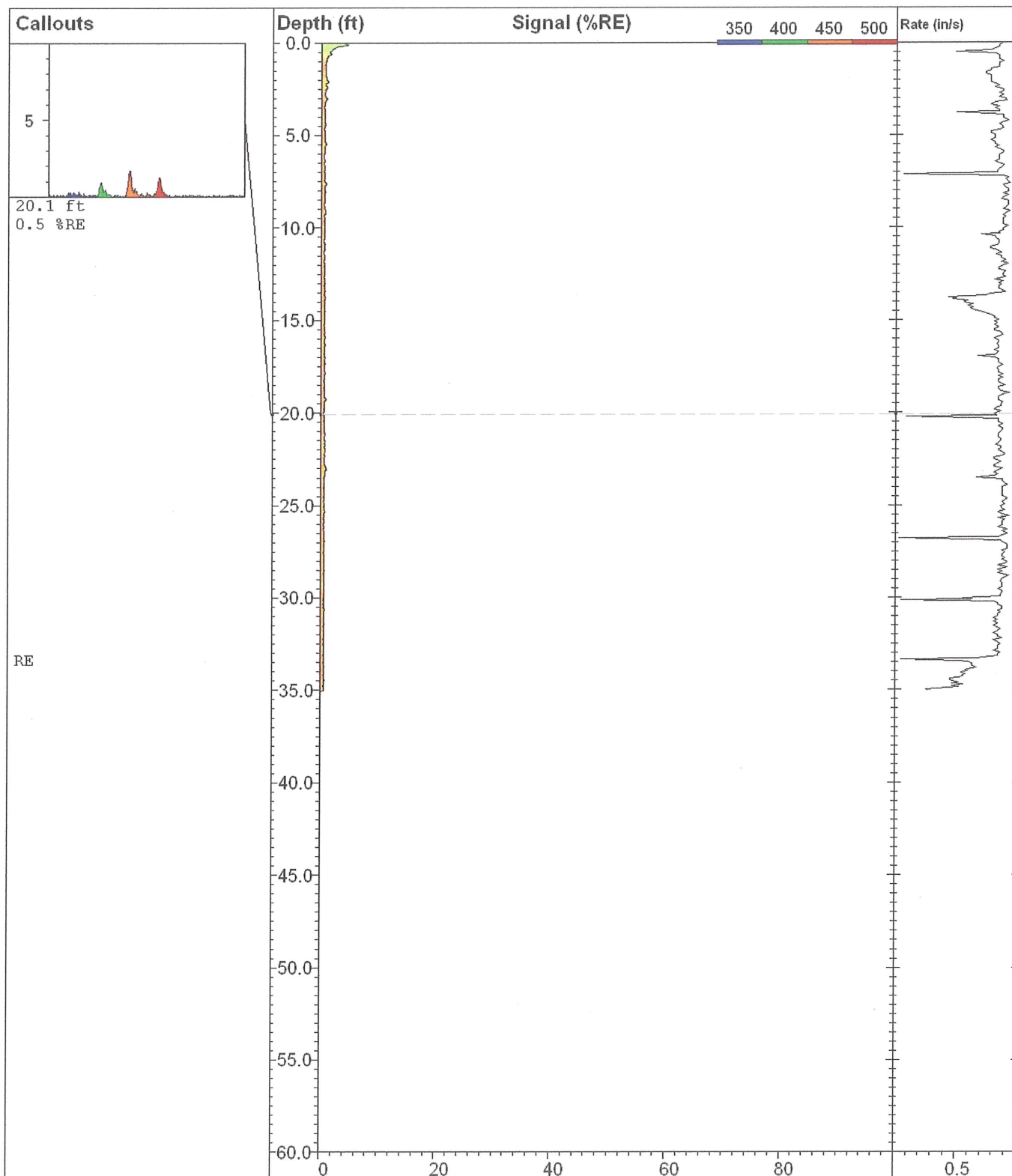
Site: Linnton Terminal

Sounding: UCPT-G

Engineer: N. Hemphill

Date: 8/26/2009 12:09





www.greggdrilling.com

CPT-G

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

UVOST By Dakota

www.DakotaTechnologies.com

Final depth:
35.04 ft

Max signal:
4.6 % @ 0.13 ft

Date & Time:
2009-08-26 12:39 PDT



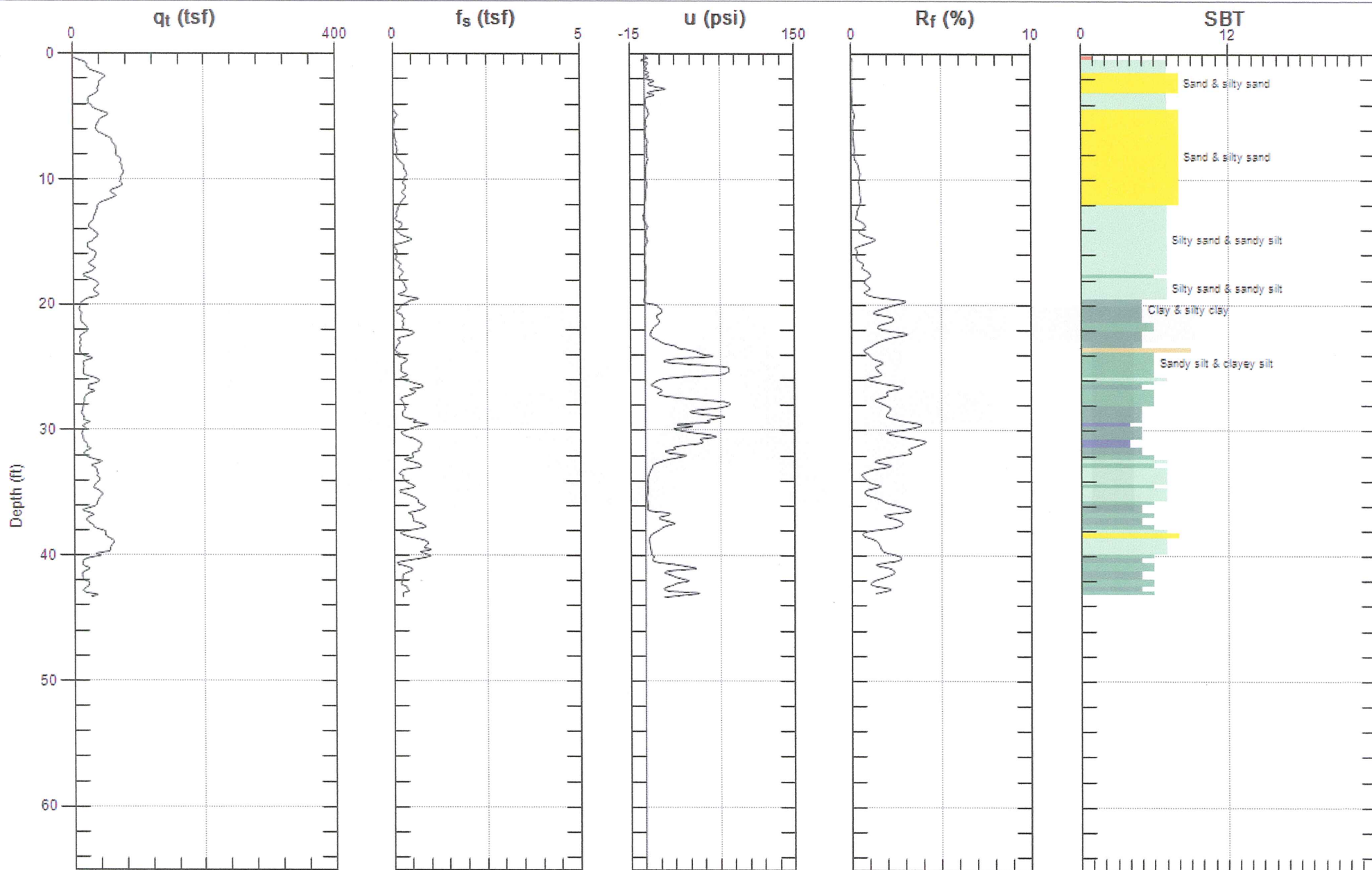
DELTA

Site: Linnton Terminal

Sounding: UCPT-H

Engineer: N. Hemphill

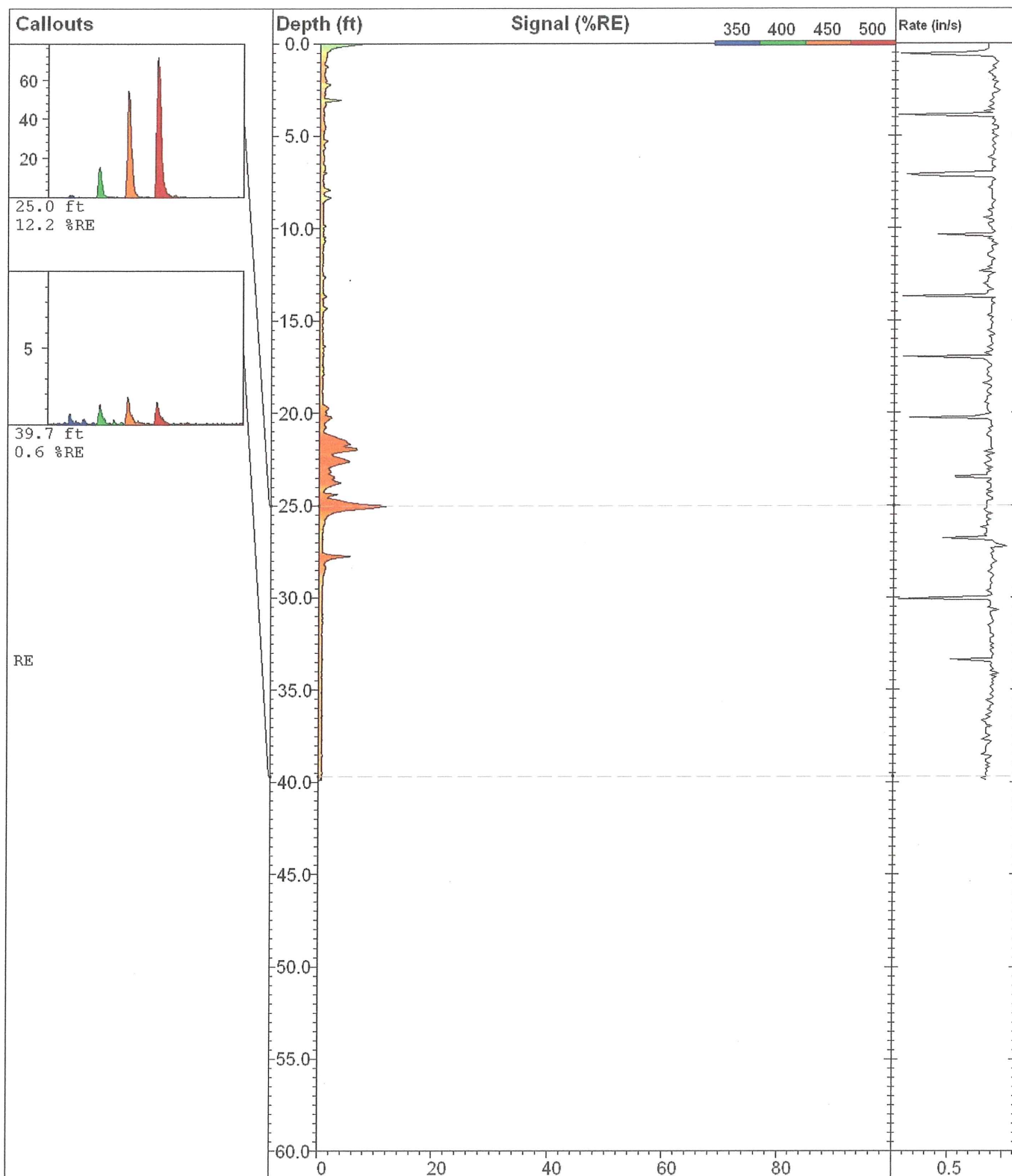
Date: 8/26/2009 02:14



Max. Depth: 43.307 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



CPT-H

Site:
Linnton Terminal

Client:
Delta

Job:
09-142ma

Latitude / Datum:
Unavailable / NA

Longitude / Fix:
Unavailable / NA

Operator/Unit:
D. Tidwell/UVOST1009

UVOST By Dakota
www.DakotaTechnologies.com

Final depth:
39.90 ft

Max signal:
12.2 % @ 25.02 ft

Date & Time:
2009-08-26 14:15 PDT

DAKOTA TECHNOLOGIES UVOST LOG REFERENCE

Main Plot :

Signal (total fluorescence) versus depth where signal is relative to the Reference Emitter (RE). The total area of the waveform is divided by the total area of the Reference Emitter yielding the %RE. This %RE scales with the NAPL fluorescence. The fill color is based on relative contribution of each channel's area to the total waveform area (see callout waveform). The channel-to-color relationship and corresponding wavelengths are given in the upper right corner of the main plot.

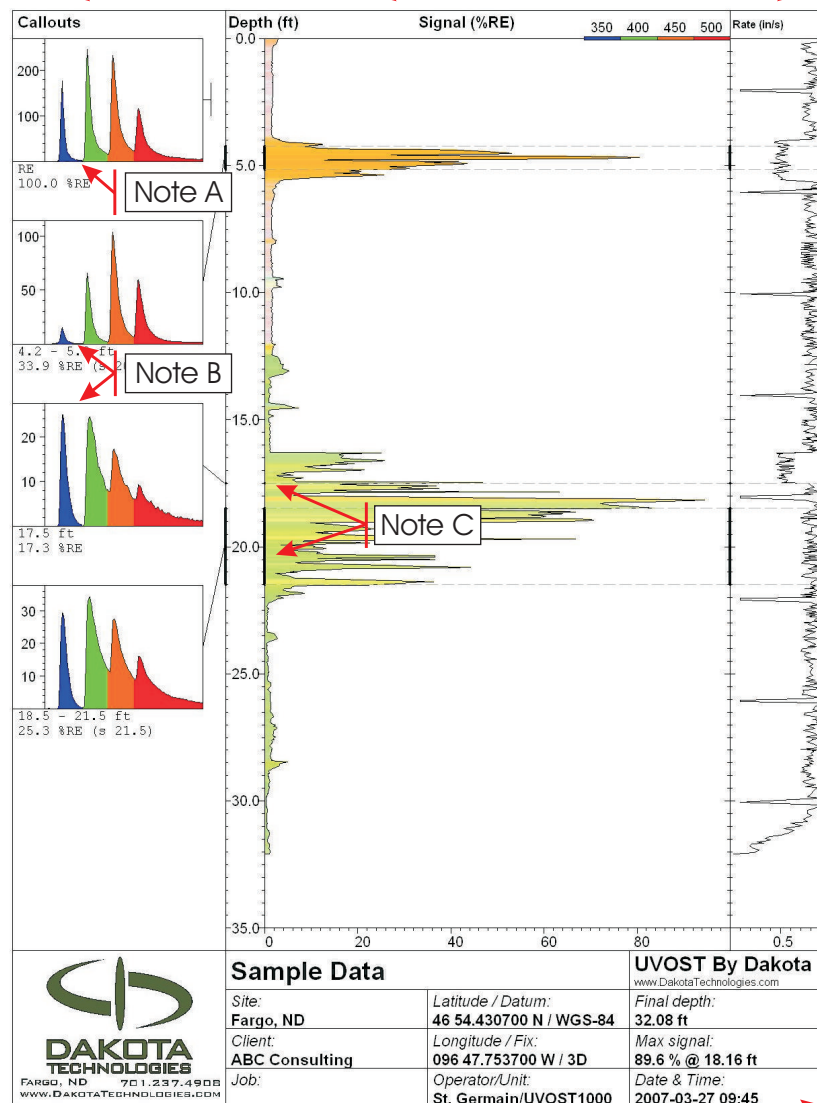
Callouts :

Waveforms from selected depths or depth ranges showing the multi-wavelength waveform for that depth.

The four peaks are due to fluorescence at four wavelengths and referred to as "channels". Each channel is assigned a color.

Various NAPLs will have a unique waveform "fingerprint" due to the relative amplitude of the four channels and/or broadening of one or more channels.

Basic waveform statistics and any operator notes are given below the callout.



Rate Plot :

The rate of probe advancement. ~ 0.8in (2cm) per second is preferred.

A noticeable decrease in the rate of advancement may be indicative of difficult probing conditions (gravel, angular sands, etc.) such as that seen here at ~5 ft.

Notice that this log was not terminated arbitrarily, but due to "refusal", as indicated by the sudden advancement rate drop at final depth.

Info Box :

Contains pertinent log info including name and location.

Note A :

Time is along the x axis. No scale is given, but it is a consistent 320ns wide.

The y axis is in mV and directly corresponds to the amount of light striking the photodetector.

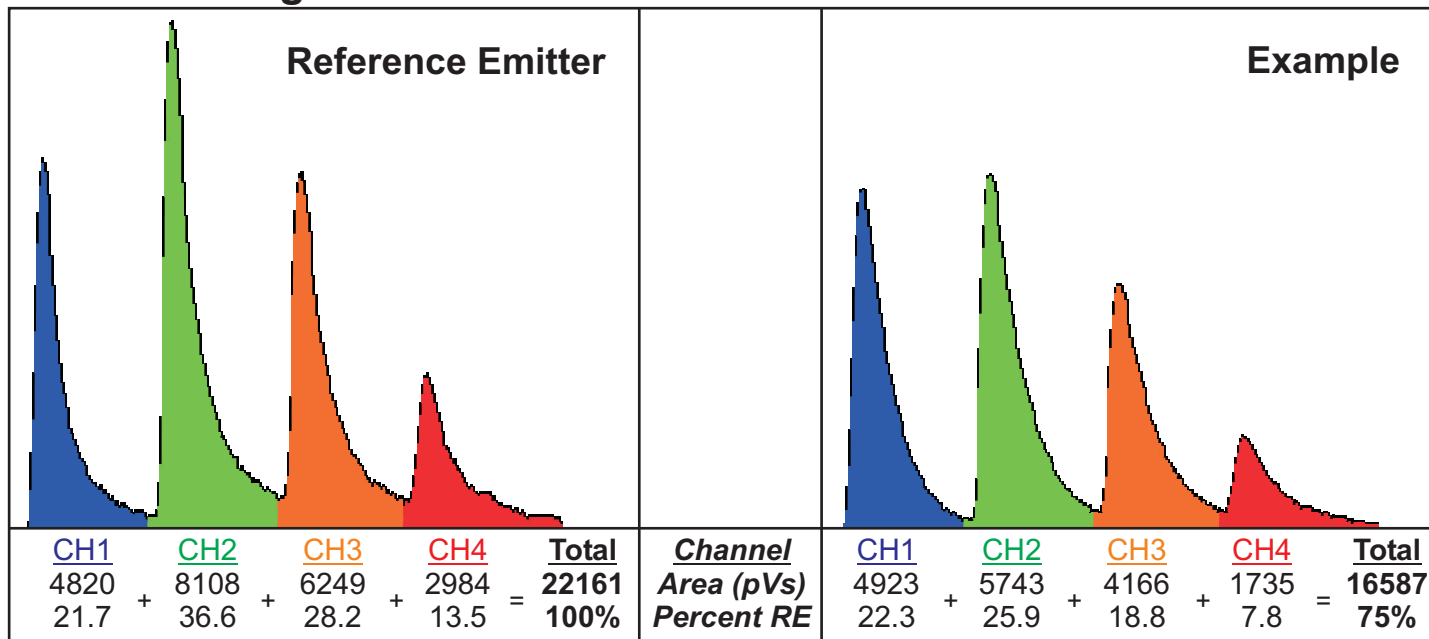
Note B :

These two waveforms show two different products, each with a unique waveform. The first is used motor oil and the second is diesel.

Note C :

Callouts can be a single depth (see 3rd callout) or a range (see 4th callout). The range is noted on the depth axis by a bold line. When the callout is a range, the average and standard deviation in %RE is given below the callout.

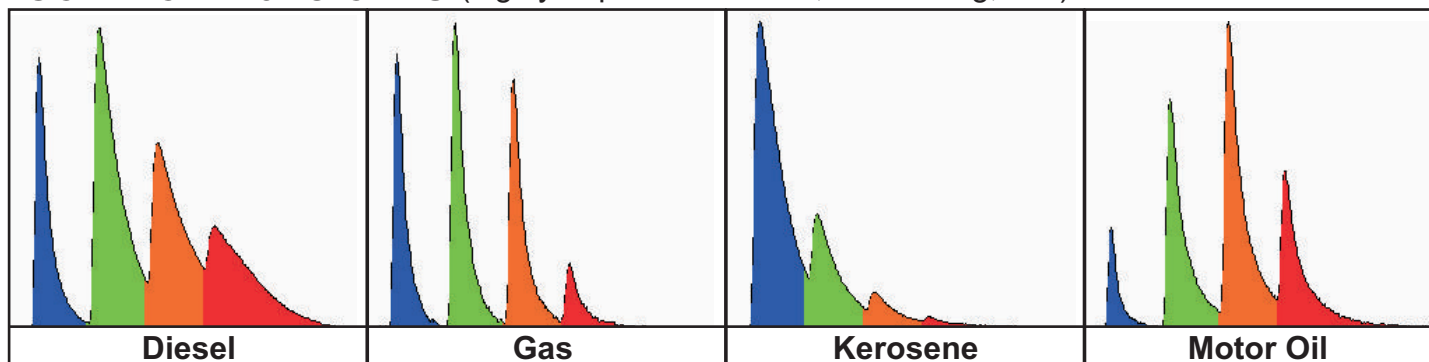
Waveform Signal Calculation



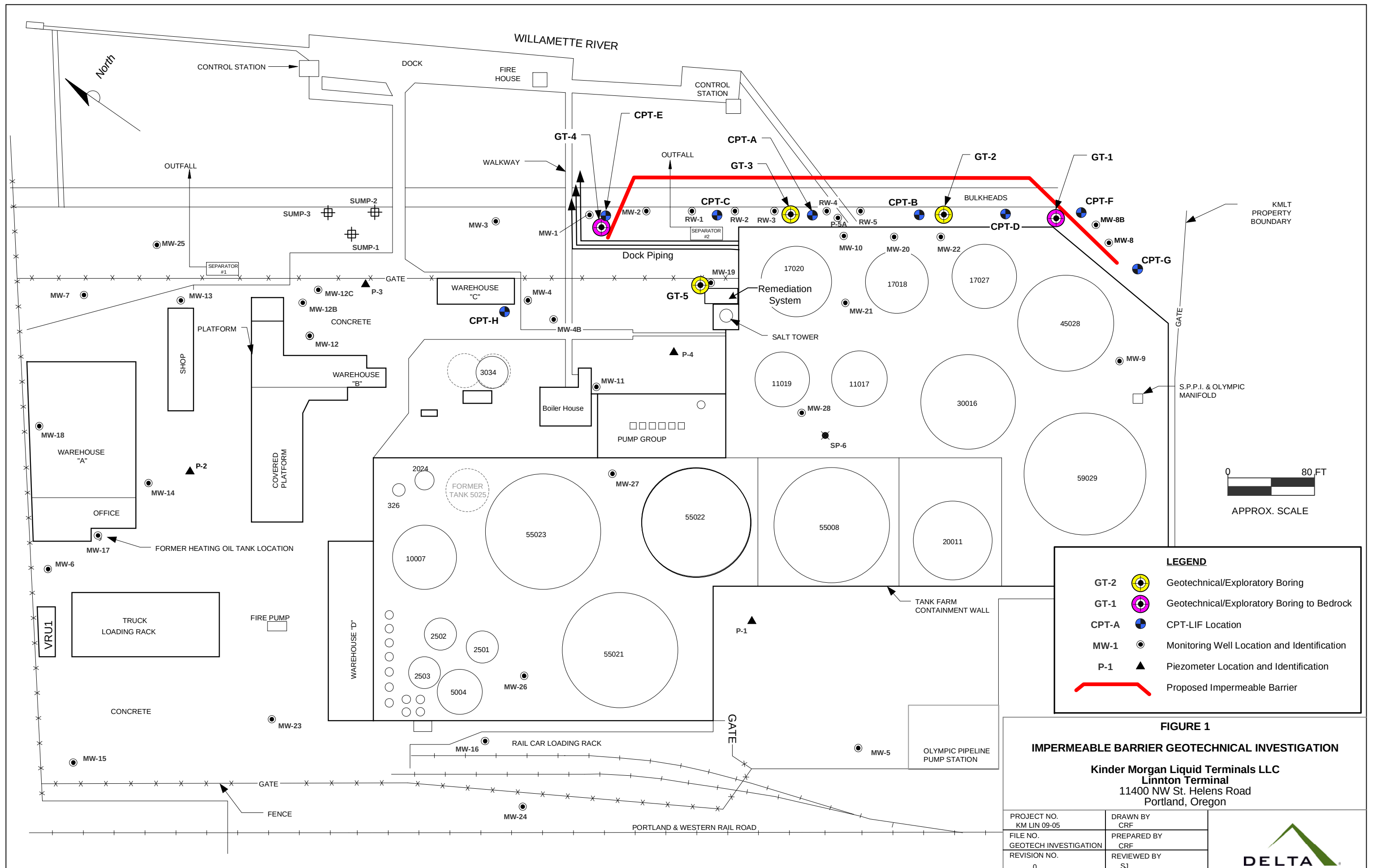
Data Files

*.lif.raw.bin	Raw data file. Header is ASCII format and contains information stored when the file was initially written (e.g. date, total depth, max signal, gps, etc., and any information entered by the operator). All raw waveforms are appended to the bottom of the file in a binary format.
*.lif.plt	Stores the plot scheme history (e.g. callout depths) for associated Raw file. Transfer along with the Raw file in order to recall previous plots.
*.lif.jpg	A jpg image of the OST log including the main signal vs. depth plot, callouts, information, etc.
*.lif.dat.txt	Data export of a single Raw file. ASCII tab delimited format. No string header is provided for the columns (to make importing into other programs easier). Each row is a unique depth reading. The columns are: Depth, Total Signal (%RE), Ch1%, Ch2%, Ch3%, Ch4%, Rate, Conductivity Depth, Conductivity Signal. Summing channels 1 to 4 yields the Total Signal.
*.lif.sum.txt	A summary file for a number of Raw files. ASCII tab delimited format. The file contains a string header. The summary includes one row for each Raw file and contains information for each file including: the file name, gps coordinates, max depth, max signal, and depth at which the max signal occurred.
*.lif.log.txt	An activity log generated automatically located in the OST application directory in the 'log' subfolder. Each OST unit the computer operates will generate a separate log file per month. A log file contains much of the header information contained within each separate Raw file, including: date, total depth, max signal, etc.

Common Waveforms (highly dependent on soil, weathering, etc.)



**PROPOSED IMPERMEABLE BARRIER SUBSURFACE INVESTIGATION
BORING LOCATION PLAN**



BORING LOCATIONS SURVEY COORDINATES

Boring Locations Survey Coordinates

Linnton Terminal Proposed Impermeable Barrier Wall Geotechnical Report
Kinder Morgan Liquid Terminals, LLC

Boring/Well ID	X	Y	Z
GT-1	13115.983	7951.686	30.3
GT-2	11638.661	7966.219	30.0
GT-3	10018.758	7959.424	29.7
GT-4	7684.422	7911.294	29.1
GT-5	9018.829	7112.226	30.7
CPT-A	10139.69	7959.424	29.9
CPT-B	11578.661	7966.219	29.9
CPT-C	9101.983	8001.857	29.2
CPT-D	12605.437	7951.686	30.1
CPT-E	7741.203	7911.294	29.2
CPT-F	13272.078	7862.552	30.3
CPT-G	13846.211	7405.136	30.9
CPT-H	6851.983	6800.226	34.4



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-1

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM/NWH**

Drilling Date(s): **9/2-9/3/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **4**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **59**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0		Dry				SM		Poorly graded SAND; Dark brown, fine-medium grained, loose, no odor. 10YR;4/3 (hand auger), dry	0		0
						SP		Poorly graded SAND; Dark brown, fine-grained, loose, no odor, no staining. 10YR;4/3, slightly moist	0		
					3,3,3						
								As above, 12" recovery	0		5
					2,2,1						
								As above, 12" recovery	0		
					2,1,3				0		
								As above, brown in color, very loose, moist, 15" recovery.	0		10
					2,2,2				0		
								As above, top=10yr 4/3 brown, Bottom is getting contaminated 10yr 2/1 dark gray, odor, trace mica at bottom, 12" recovery	0		
					1,2,2				0		15
								As above, 15" recovery	0		
					2,3,4				0		
								Top=10yr 4/3 brown, becoming stained, strong odor at 16'8"; 10yr 2/1 very dark gray, very loose, moist, 13" recovery	0		20
					1,1,2				0		
								Top=10yr 4/3 brown; Bottom=10yr 2/1 black. Bottom has strong odor. Moist, 12" recovery.	0		
					2,3,4				0		25
								10yr 2/1 black, strong odor, sheen, staining, very loose, moist, 16" recovery	0		
					2,3,2				0		
						ML		Clayey SILT; Brown (10yr 4/3), low plasticity, very soft, dilatancy, no odor, 16" recovery.	0		30
					1 for 12"; 1 for 6"						
								As above, 22" recovery	1.0		
					NA						
						SM		Silty fine SAND; Very dark gray (10yr 3/1), very loose, no odor. (Shoe contains clayey silt), wet.	0		
					1,1,4				0		30



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-1

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM/NWH**

Drilling Date(s): **9/2-9/3/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **4**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **59**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30					NA	ML		Clayey SILT; Brown (10yr 4/3), low plasticity, soft, dilatancy, no odor, no staining, wet.	1.25		30
						SM		Silty SAND; Brown (10yr 4/3), very loose, no odor, no staining. 60% fine sand, 30% silt. Switch to mud rotary with tri-cone bit.	0		35
					1;1 for 12"	ML		Sandy SILT; Brown, (10yr 4/3), very soft, no odor, no staining. 60% silt, 40% very fine sand. Some clayey silt in shoe, wet, 18" recovery.	0		
					NA	SM		Silty SAND; Brown, (10yr 4/3), loose, no odor, no staining. Shelby tube sample collected, wet 16" recovery.	0		40
					2,2,3	SP		Poorly graded SAND; Brown (10yr 4/3), fine-grained, very loose, no odor, no staining, wet 12" recovery. Grades dark gray at 43.5 feet bgs	0		
					6,2,1	ML		Clayey SILT; Brown (10yr 4/3), none to low plasticity, very soft, dilatancy, no odor, no staining, wet. Shelby tube sample collected.	0.25		45
					2,3,6	SP		Organic woody material for 4". Poorly graded SAND; Gray (10yr 4/1), fine-grained, loose, no odor, no staining. Bentonite slough, wet, 14" recovery.	0		50
					2,3,6			As above, 12" recovery	0		
					6,8,7	SM		Silty SAND; Gray (10yr 4/1), loose, no odor, no staining, fine-grained, wet, 12" recovery. Bentonite slough.	0		55
					50 for 1"	BASALT		Refusal at 56'1". No recovery. Resume drilling with tri-cone bit on 9-3-09. Drilled 3' into basalt with black basalt chips present in cutting fluid.			
								Bottom of Boring at 59 feet bgs			60



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-2

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM/NWH**

Drilling Date(s): **9/2/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **36**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0						SW		Gravelly SILTY SAND; Dark brown (7.5yr 3/2), 20% small-medium, angular-subangular gravel, loose, no odor. 60% fine sand, 20% silt, slightly moist. (Hand auger)	0		0
				3,3,4				As above, 12" recovery	0		
						SP		Poorly graded SAND; Dark gray (10yr 3/1), fine-grained, very loose, strong odor, staining, slightly moist, 12" recovery.	0		
5				2,3,2				As above, 12" recovery	0		5
				2,2,2				As above, 12" recovery	0		
				2,1,3				As above, 12" recovery	0		10
10				1,2,2				Black (10yr 2/1), very loose, sheen, strong odor, staining, with some anomalous pea gravel, moist, 12" recovery.	0		
				1,3,4				As above, with no pea gravel, no sheen, 14" recovery.	0		15
15				1,2,5				As above, 12" recovery	0		
				2,3,4				Black (10yr 2/1), loose, sheen, strong odor, staining, moist, 12" recovery.	0		20

Bentonite



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0						SW		Gravelly SILTY SAND; Dark brown (7.5yr 3/3), 60% fine sand, 20% silt, 20% pea-ping pong sized gravel (subrounded to subangular). Dry, no odor, no staining. (Hand auger)	N/A		0
						SP		Fine sand with silt; 90% fine sand with 10% silt. 5yr 3/3 dark reddish brown. Gray staining and odor in shoe, loose. 15" recovery. Dry.	0		
						SM		Silty Sand; 70% fine sand, 30% silt, fill material. 10yr 3/1, very dark gray, strong odor, staining, sheen, very loose. 8" recovery, moist, woody debris	0		
5						SP		Fine sand; 10yr 3/1 dark gray, odor, staining, sheen, very loose, moist. Brass sleeve, fill material. 4" recovery	0		
								As above, 12" recovery, very dark gray	0		
10											10



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-3

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **9/1/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **37.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
10								As above	0		10
				2,3,3							
								Fine sand; fill material, 10yr 2/1 black, odor, staining, moist, loose, brass sleeves, 12" recovery.	0		
15				3,4,4							15
								Fine sand; 10yr 2/1 black, odor, staining, moist, loose, brass sleeves, 8" recovery.	0		
				3,3,3							
								Fine sand; 10yr 2/1 black, odor, staining, sheen, moist, very loose, brass sleeves, 15" recovery.	0		
20				2,3,2							20



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
20											20
						ML		Sandy Silt; 10yr 3/1 very dark gray. 60% silt, 40% sand, no plasticity; odor, staining, wet. 18" recovery. brass sleeves	0.25		
						SM		Silty Sand; 10yr 3/1 very dark gray, 60% fine sand, 40% silt, loose, mild odor - shelby tube			
						ML		Clayey Silt; Dark brown (10yr 3/1 and 10yr 4/2) dark gray and dark grayish-brown. Glistens when tapped. Soft, wet. No odor, no staining. Low plasticity - can't quite roll 1/8" thread.	0.75		
25											25
								Clayey Silt with Sand; 10yr 4/2 dark grayish brown, soft, low plasticity, glistens when tapped, no odor, no staining. 18" recovery.			
						SM		Silty Sand; 60% fine sand, 40% silt, 10yr 4/2 dark grayish brown, very loose, wet, no odor.			
						SP		Fine sand; 10yr 4/2 dark grayish brown, very loose, wet, no odor, no staining. 18" recovery.			
30						ML		Clayey Silt; 10yr 4/2 dark grayish brown, soft, low plasticity,	0.8		30



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-3

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **9/1/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **37.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30						SM		no odor, no staining, glistens when tapped.			30
						ML		Silty Sand; 10yr 4/3 brown, loose, moist, no odor, no staining. Grades to clayey SILT at bottom, fairly soft. Shelby tube sample, 24" recovery.			
						SM					
								Clayey SILT microlense; no odor, no staining			
								Silty Sand; 10yr 4/3 brown, loose, moist, no odor, no staining.			
						ML		Clayey Silt (possibly silty clay), 10yr 4/3 brown, low plasticity, glistens when tapped,	1.0		
						ML		Clayey Silt with Sand; 10yr 4/2 brown, wet, some density in shoe. Little-no plasticity, gives up water readily, no odor, no staining. 18" recovery.			
35					1,2,1				1.25		35
						SP		Fine sand; 10yr 3/1 dark gray, loose, wet, no odor, no staining. 18" recovery.			
					1,2,4						
								Bottom of Boring at 37.5 feet bgs			



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
0		Moist				ML		Clayey Silt; 10yr 3/2 very dark grayish brown, little-no plasticity, slightly moist, soft, no staining, no odor (hand auger)			0
						SM		Silty fine SAND; 10yr3/3 dark brown, loose, no odor, no staining, dry, disturbed bag sample, 9" recovery	0		
		Dry			3,3,5						
								As above, 70% fine sand, 30% silt, loose, slightly moist, no odor, disturbed bag sample, 10" recovery	0		
5					3,3,2						5
								As above, 10yr 3/1 very dark gray, moist, staining, strong odor, disturbed bag sample, 8" recovery	0		
					1,2,3						
								As above, 80% fine sand, 20% silt, loose, disturbed bag sample, 10" recovery	0		
					2,1,2						
10		Moist									10



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-4

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **8/31/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **63.5**

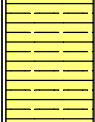
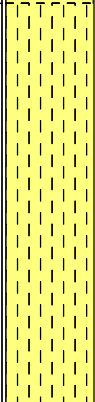
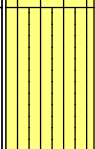
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
10											10
						SP		Fine Sand; very dark gray (10yr 3/1), moist, strong odor, sheen, staining, very loose, disturbed bag sample, 6" recovery.	0		
					0,1,1						
								Fine sand with silt, 10yr 2/1 black, sheen, moist, strong odor, staining, woody organic debris, anomalous pea-sized rounded gravel, very loose, disturbed bag sample.	0		
					1,1,1						
15						SM		Silty fine SAND; Very dark gray (10yr 3/1), strong odor, staining, wet. ~70% fine sand, 30% silt, woody organic debris, loose, disturbed bag sample, 8" recovery	0		15
					1,2,2						
						ML		SILT with fine sand; very dark gray (10yr 3/1), no plasticity, wet, strong odor, staining, very loose, disturbed bag sample, 18" recovery. 90% silt, 10% fine sand.	0		
					1 for 12"						
20											20



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.

GT-4

Site Address:

**11400 NW St. Helens Rd
Portland, OR**

Logged By: **MM**

Drilling Date(s): **8/31/09**

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **63.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
20											20
						SP		Fine sand; Brown (10yr 3/1), very loose, wet, strong odor, staining.			
						ML		SILT; Brown, (10yr 3/1), very loose, slightly cohesive, little-no plasticity, wet.	0.2		
						SP		Fine sand; Brown, (10yr 3/1), very loose, wet, odor, sheen.			
						SP		Fine sand; Dark gray, (10yr 3/1), loose, odor, sheen, staining.			
						ML		Sandy SILT; Dark gray (10yr 3/1), no plasticity, loose, wet, odor, staining, excretes oil on squeezing.	0.75		
						SP		Fine Sand; Dark gray (10yr 3/1), loose, odor, sheen, staining, disturbed bag sample, 18" recovery. Shelby tube collected from >25' to 27' bgs, wet, 24" recovery.			
25						ML		Sandy SILT; Dark gray (10yr 3/1), 80% silt, 20% fine sand, no plasticity, soft, less odor, gray.			
								Same as bottom of Shelby tube sample above from 28-28.5' bgs.			
								Pockets/veins of oil (black) materials (picture). Dark grayish brown 10yr 4/2, no odor, wet, soft, non-plastic, 18" recovery.	0.4		
30											30



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30								Switch to mud rotary. Sandy Silt; dark brown 7.5yr 3/2, ~80% silt, 20% fine sand, no odor, wet, soft, 18" recovery.	0	Bentonite	30
			1,3,4			SP		Fine Sand; dark gray 10yr 3/1, dark gray, no odor, loose, no staining.			
								Fine Sand; black 2.5yr 2.5/1, wet, loose, no staining, no odor, 10" recovery.	0		
35			2,3,2								35
						ML		Sandy Silt; Dark brown 7.5yr 3/2, wet, soft, no odor. 65% silt, 35% fine sand	0		
						SP		Fine Sand; 2.5yr 2.5/1 black, wet, loose, no odor, no staining, 12" recovery.	0		
			1,3,5								
								Fine Sand; 2.5yr 3/2 very dark grayish brown, wet, loose, no odor, no staining, 16" recovery.	0		
40			4,7,7								40

BORING LOG

Client: **Kinder Morgan**

Boring/Well No.

Project Number: **KMLIN-0906**

GT-4

Site Address:

11400 NW St. Helens Rd
Portland, OR

Logged By: MM

Drilling Date(s): 8/31/09

Drilling Company: **Cascade Drilling**

Drilling Method: **Mud Rotary**

Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**

Casing Diameter (in.): **N/A**

Boring Depth (ft): **63.5**

Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**

Rig: **CME 75**

Screen slot size: **N/A**

Sand Pack: **N/A**

[illegible]



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
50								Very loose, 4" recovery	0		50
				4,3,2							
						SM		Silty Sand; 10yr 3/1 very dark gray, 70% fine sand, 30% silt, wet, no staining, no odor, loose, 18" recovery, bag sample.	0		
					2,5,6						
55								As above	0		55
						SP		Fine Sand; Very dark gray 10yr 3/1, very loose, no odor, no staining, wet, 10" recovery, bag sample	0		
				1,2,0							
								As above, 12" recovery			
				0,6, 50 for 4"		BASALT		Bedrock-Vesicular Basalt - switch to tri-cone at 2:57 pm.	0		60



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-4

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **8/31/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **63.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
60											60
65								Bottom of Boring at 63.5 feet bgs (3:10 pm). Hole backfilled with hydrated bentonite chips. mud flushed out and original surface restored.			65



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-5

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **9/1/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **32.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
10								dark gray, moist, loose, odor, 7" recovery.			10
						SP		Fine sand; 10yr 3/1 very dark gray, strong odor, loose, oily. 16" recovery	0		
					2,4,6						
								As above, 12" recovery	0		
					3,3,3						
15						ML		Clayey Silt; 10yr 3/1 very dark gray. Chunks of grape-sized weathered rock. Sheen, oily, odor, organic woody debris.	0.25	Bentonite	15
					1,1,4						
								As above, cracks with product, strong odor, little-no plasticity, moist, glistens when shaken, soft, organic debris, 18" recovery.			
					2,1,3						
20									1.3		20



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-5

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

Drilling Date(s): **9/1/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **32.5**
Well Depth (ft.): **N/A**

Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
20								Shelby tube sample collected from 20-22 feet bgs. Same as above.			20
				N/A					1.5		
								Sandy Silt; 10yr 3/1 very dark gray, no plasticity, odor, sheen, loose, soft. 60% silt, 40% fine sand. 18" recovery.			
				2,3,4					0.5		25
25								Clayey Silt; Color change at 26.5 from very dark gray to 10yr 4/3 brown, little plasticity, glistens when shaken, odor diminishes, sheen on top. 18" recovery.			
				2,2,1					0.3		
								Shelby tube sample collected from 27.5 to 29.5 bgs. Clayey Silt; 10yr 4/3 low plasticity, gives up water, no odor, no staining, wet, very soft, gooey. 24" recovery.			
				N/A					0		
30											30



BORING LOG

Client: **Kinder Morgan**
Project Number: **KMLIN-0906**

Boring/Well No.
GT-5

Site Address:
11400 NW St. Helens Rd
Portland, OR
Logged By: **MM**

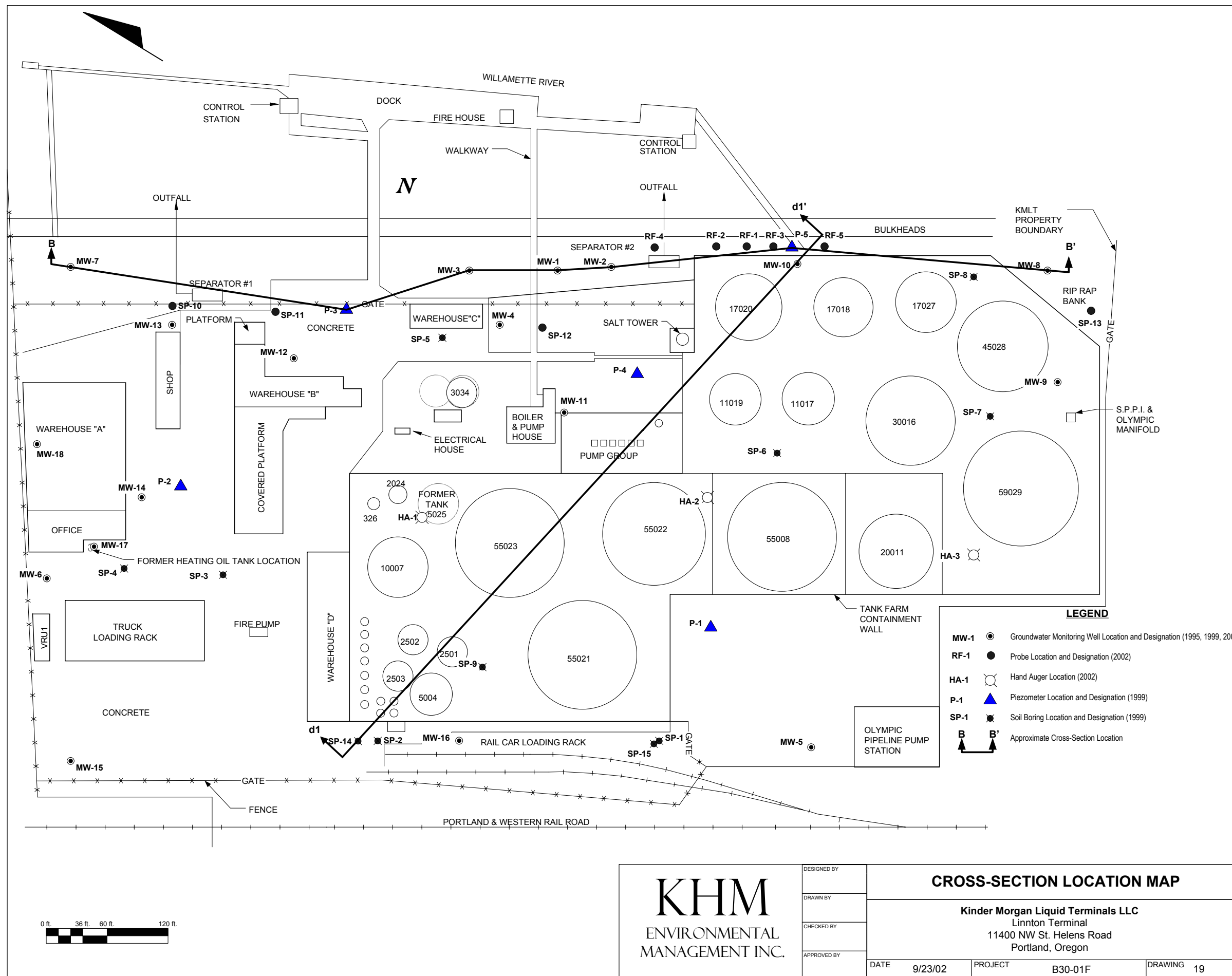
Drilling Date(s): **9/1/09**
Drilling Company: **Cascade Drilling**
Drilling Method: **Mud Rotary**
Sampling Method: **SPT/Shelby Tube**

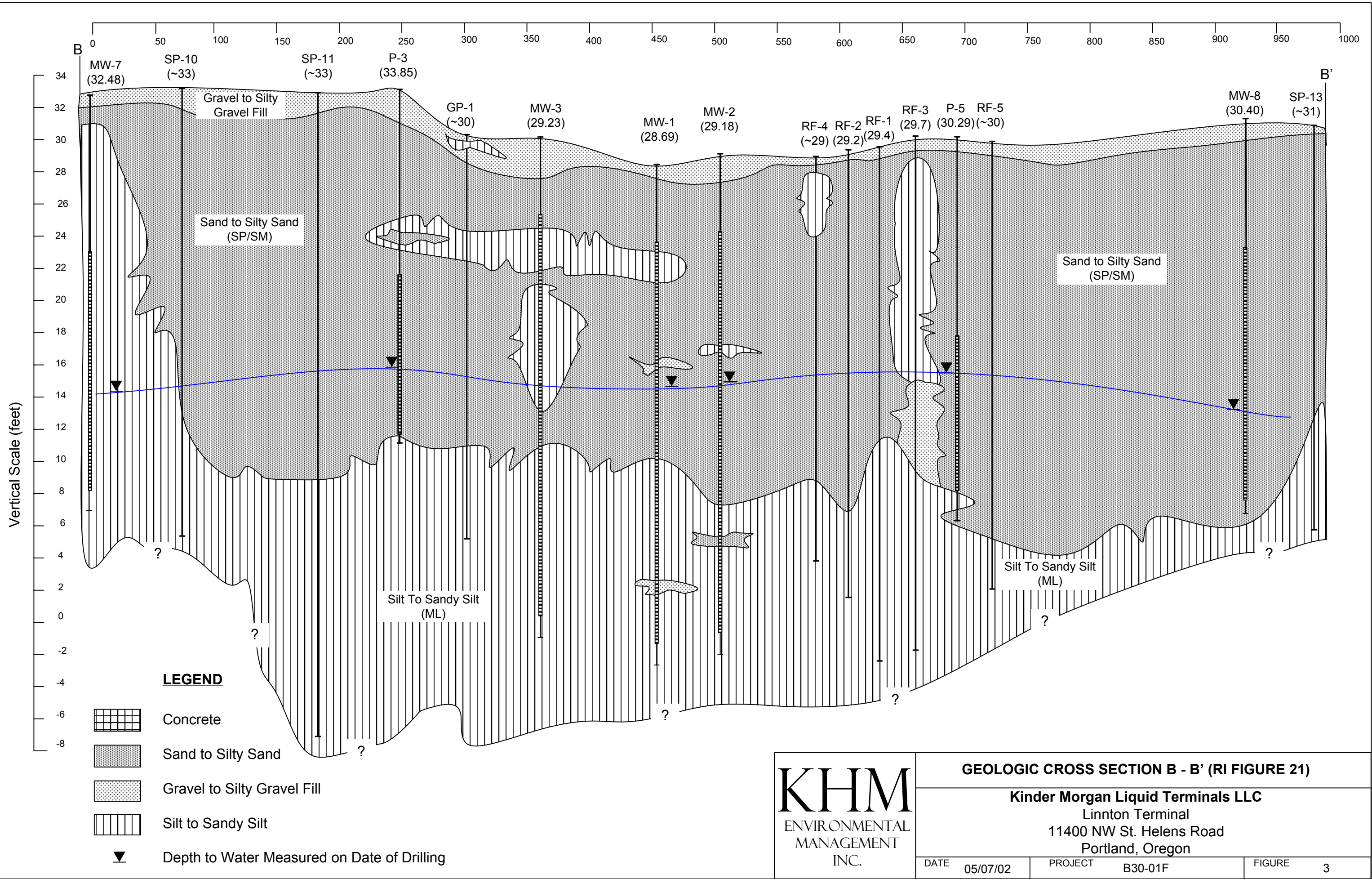
Boring diameter (in.): **8.25**
Casing Diameter (in.): **N/A**
Boring Depth (ft): **32.5**
Well Depth (ft.): **N/A**

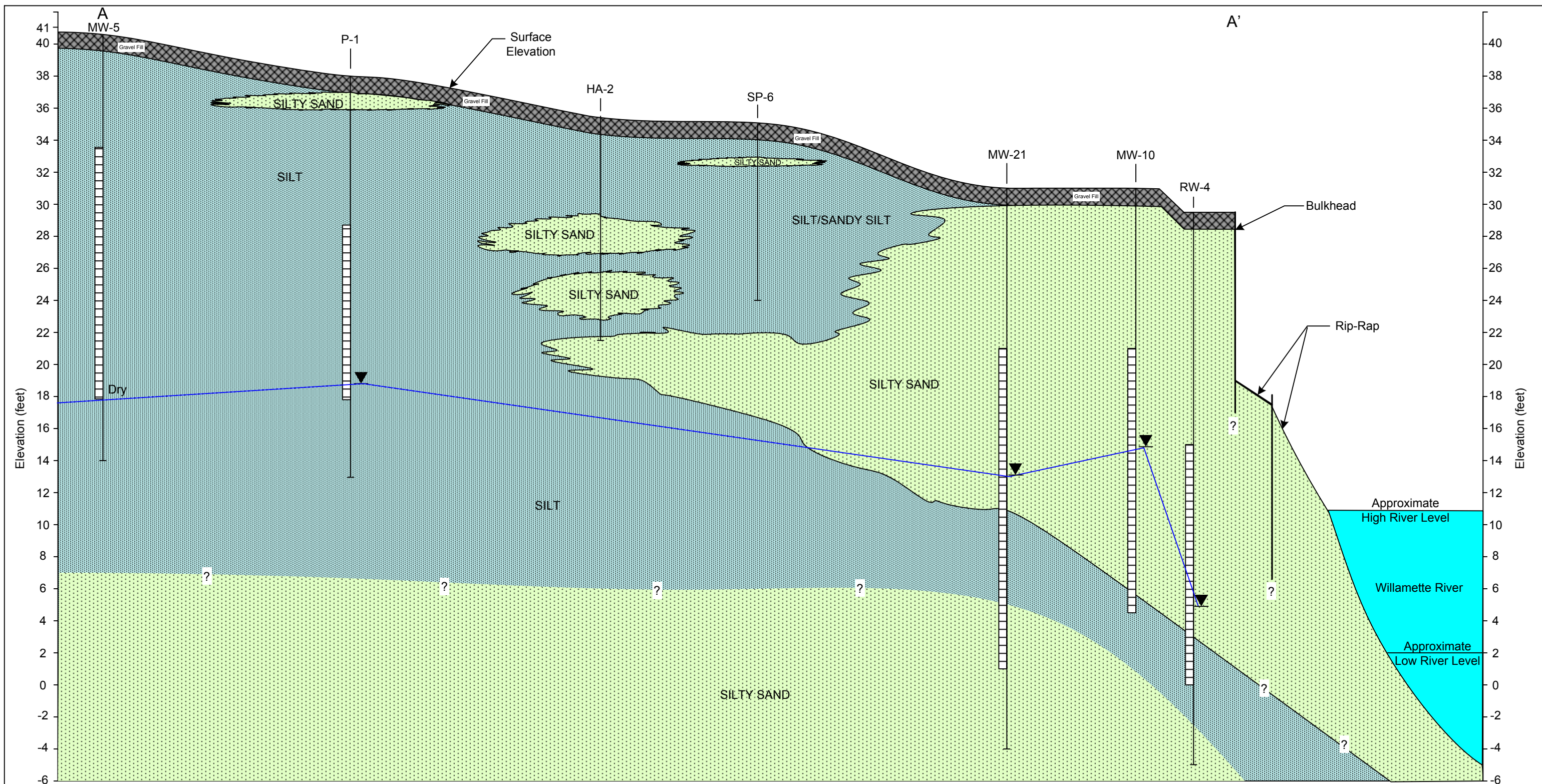
Hammer: **140 lb Auto**
Rig: **CME 75**
Screen slot size: **N/A**
Sand Pack: **N/A**

Depth (ft.)	Water Level	Moisture Content	Boring Interval	Recovery	Blow Count	USCS Symbol	Soil/Rock Graphic	Soil/Rock Visual Description	TSF Reading (ppm)	Boring Completion	Depth (ft.)
30						SP		Fine Sand; gray, very loose, wet, no odor, no staining. 18" recovery.	0		30
					0,1,2	SM		Silty Sand; 85% fine sand, 15% silt, no plasticity, 10yr 4/1 gray, wet, loose/soft, no odor, no staining.			
								Bottom of Boring at 32.5 feet bgs			
35											35

Pages from "Barrier Design Bid
Package"
Provided to Sage by Kinder Morgan







LEGEND

▼ Static Groundwater Level Measured on April 28, 2005

MW-5 Boring/Well Identification

← Borehole
 ← Well Screen Interval
 Bottom of Well/Boring

Approximate Horizontal Scale in Feet



Approximate Vertical Scale in Feet
Vertical Exaggeration x 10

FIGURE 4

CROSS-SECTION A-A'

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
Portland, Oregon

PROJECT NO. PTKM-010-4	DRAWN BY CRF 7/7/05	
FILE NO.	PREPARED BY CRF 7/7/05	
REVISION NO.	REVIEWED BY	

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/22/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/VEIL NO: RW-5
PAGE 1 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion

Backfill
Casing

Water
Level

Moisture
Content

PID Reading
(ppm)

Penetration
(blows/6")

Depth (feet)

Sample
Recovery
Interval

Soil Type

LITHOLOGY / DESCRIPTION

Bentonite			Moist			1			GP	Poorly graded GRAVEL; Brown 100% gravel
						2			SP	Poorly graded SAND; Brown 95% medium sand, 5% silt
						3				(Grades gray)
						4				
						5				
						6				(Grades brown)
						7				(Grades gray)
						8				
						9				
						10				
						11				
						12				
						13				
						14				
						15				
						16				
						17				
						18				
						19				
						20				(Grades finer)
						21				(Encountered wood debris)
						22				

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/22/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-5
PAGE 2 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion

Backfill
Casing

Water
Level

Moisture
Content

PID Reading
(ppm)

Penetration
(blows/6")

Depth (feet)

Sample
Interval

Soil Type

LITHOLOGY / DESCRIPTION

10x20 Sand		Wet		2 1 2	23			SP	
					24				
					25				
					26				CL
					27				
					28				
					29				
					30				
					31				
					32				
					33				
					34				
					35				
					36				(Grades finer sand)
					37				Bottom of boring at 36.5 feet
					38				
					39				
					40				
					41				
					42				
					43				
					44				

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/22/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-4
PAGE 1 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion

Backfill
Casing

Water
Level

Moisture
Content

PID Reading
(ppm)

Penetration
(blows/6")

Depth (feet)

Sample
Recovery
Interval

Soil Type

LITHOLOGY / DESCRIPTION

Bentonite			Moist			1			GP	Poorly graded GRAVEL; Brown 100% gravel
						2			SP	Poorly graded SAND; Brown 95% medium sand, 5% silt
						3				
						4				(Grades gray)
						5				
						6				(Encountered wood debris)
						7				
						8				
						9				
						10				(Grades brown)
						11				(Grades gray)
						12				
						13				
						14				
						15				(Grades brown)
						16				(Grades gray)
						17				
						18				
						19				
						20				(Silt lens)
						21				
						22				

10x20 Sand

▽

Moist

Wet

3
2
3

3
2
3

5
5
6

5
7
8

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/22/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-4
PAGE 2 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion		Water Level	Moisture Content	PID Reading (ppm)	Penetration (blows/6")	Depth (feet)	Sample		Soil Type	LITHOLOGY / DESCRIPTION
Backfill	Casing						Recover	y Interval		
10x20 Sand			Wet		3 5 6	23			SP	
						24				
						25			CL	CLAY; Brown 60% clay, 35% silt, 5% fine sand, trace mica
						26				
						27				
						28				
						29				
						30				
						31				
						32				
						33				
						34				
						35			SM	Silty SAND; Brown 80% medium sand, 15% silt, 5% clay
						36				
						37				Bottom of Boring at 36.5 feet
						38				
						39				
						40				
						41				
						42				
						43				
						44				

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/21/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-3
PAGE 1 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion

Backfill
Casing

Water
Level

Moisture
Content

PID Reading
(ppm)

Penetration
(blows/6")

Depth (feet)

Sample
Recovery
Interval

Soil Type

LITHOLOGY / DESCRIPTION

Bentonite		Moist			4 4 4	1			GP	Poorly graded GRAVEL; Brown 100% gravel
						2			SP- SM	Poorly graded SAND with silt; Brown 90% medium sand, 10% silt
						3				
						4				
						5				
						6				(Grades gray)
						7				
						8				
						9				
						10				
						11				
						12				
						13				
						14				
						15			CL	Sandy CLAY; Gray 60% clay, 30% sand, 10% silt
						16			SC	Clayey SAND; Gray 70% sand, 25% clay, 5% silt
						17				
						18				
						19				
						20				
						21				(Wood debris)
						22				

10x20 Sand

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-Inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/21/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-3
PAGE 2 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion

Backfill
Casing

Water
Level

Moisture
Content

PID Reading
(ppm)

Penetration
(blows/6")

Depth (feet)

Sample
Interval

Soil Type

LITHOLOGY / DESCRIPTION

10x20 Sand		Wet			23			SC	SILT; Gray 80% silt, 15% clay, 5% fine sand (Grades brown and more clay)			
					24							
					25					ML	(Grades more silt and less clay)	
					26							
					27							
					28							
					29							
					30							
					31							
					32							
					33							
					34							
					35							
					36							
					37							Bottom of boring at 36.5 feet
					38							
					39							
					40							
					41							
					42							
					43							
					44							

KHM

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

PROJECT NO: B30-011
LOGGED BY: K. Thordarson
DRILLER: Cascade
DRILLING METHOD: HSA
SAMPLING METHOD: SPT
CASING TYPE: PVC
SLOT SIZE: 0.02-inch
GRAVEL PACK: 10x20

CLIENT: Kinder Morgan
LOCATION: Portland, OR
DATE DRILLED: 10/21/2002
HOLE DIAMETER: 12.75-inch OD
HOLE DEPTH: 36.5 feet
WELL DIAMETER: 4-inch
WELL DEPTH: 35 feet
CASING STICKUP: Flush

BORING/WELL NO: RW-2
PAGE 2 OF 2

LOCATION MAP

See Figure 2

ELEVATION

NORTHING

EASTING

Well Completion		Water Level	Moisture Content	PID Reading (ppm)	Penetration (blows/6")	Depth (feet)	Sample Recovery Interval	Soil Type	LITHOLOGY / DESCRIPTION
Backfill	Casing								
10x20 Sand			Wet		4 4 4	23		ML	
						24			
						25		SP-SM	Poorly graded SAND with silt; Gray
						26			90% medium to fine sand, 10% silt, trace mica
						27			
						28			
						29			
						30			
						31		CL	(Grades brown)
						32			CLAY; Brown
			Wet	3 5 7		33			60% clay, 35% silt, 5% fine sand
						34			
						35		SM	Silty SAND; Brown
						36			75% medium to fine sand, 15% silt, 10% clay
						37			Bottom of Boring at 36.5 feet
						38			
						39			
						40			
						41			
						42			
						43			
						44			



PROJECT NO:	B30-011	CLIENT:	Kinder Morgan	BORING/WELL NO:	RW-1
LOGGED BY:	K. Thordarson	LOCATION:	Portland, OR	PAGE 2 OF 2	
DRILLER:	Cascade	DATE DRILLED:	10/12/2002	LOCATION MAP See Figure 2	
DRILLING METHOD:	HSA	HOLE DIAMETER:	12.75-inch OD		
SAMPLING METHOD:	SPT	HOLE DEPTH:	36.5 feet		
CASING TYPE:	PVC	WELL DIAMETER:	4-inch		
SLOT SIZE:	0.02-inch	WELL DEPTH:	35 feet		
GRAVEL PACK:	10x20	CASING STICKUP:	Flush		

ELEVATION	NORTHING	EASTING
-----------	----------	---------

Well Completion		Water Level	Moisture Content	PID Reading (ppm)	Penetration (blows/6")	Depth (feet)	Recovery	Sample Interval	Soil Type	LITHOLOGY / DESCRIPTION
Backfill	Casing									
10x20 Sand			Wet		2 2 2	23			CL	
						24				
						25				
						26			ML	(Grades brown) Sandy SILT; Brown 70% silt, 30% fine sand, trace mica
						27				
						28				
						29				
						30				
						31				
						32				
			Moist Wet		3 3 3	33				
						34				
						35				
						36				
			Wet		2 2 4	37				Bottom of boring at 36.5 feet
						38				
						39				
						40				
						41				
						42				
						43				
						44				

Monitoring Well ID: MW-4B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 50

Date: September 10, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 50

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
1				Airknife to 5'							
2											
3											
4											
5			SW	Brown SILTY SAND with little GRAVEL	0		Dry				
6				No gravel							
7											
8											
9											
10					0		Mst				
11											
12			CL	Gray green SILTY CLAY. Stiff, organic material, no odor							
13											
14			ML	Gray green CLAYEY SILT. Soft, low plasticity.							
15	MW-4B-15				1.7		Mst				
16				same as above							
17											
18											
19				Hydrocarbon odor, SPH visible on core							
20					10		Wet				
21											
22				Strong hydrocarbon odor, SPH visible in pore space of sediment (21-27)	28						
23											
24											
25					41.5		Sat				
26	MW-4B-26										
27											

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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 1 of 2

Monitoring Well ID: MW-4B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 50

Date: September 10, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 50

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
27											
28				Color change to gray green and brown. Brown and green mottling, medium stiff.							
29											
30					0		Mst				
31			SW	Brown fine SILTY SAND. Medium stiff.							
32											
33											
34				Decrease silt							
35					0		Mst				
36											
37											
38											
39											
40				Red mottling	0		Mst				
41			ML	Brown CLAYEY SILT. Medium stiff, low plasticity, some red mottling							
42											
43											
44											
45					0		Mst				
46											
47			SP	Brown fine SAND with some red mottling. Loose.							
48											
49											
50											

0.010-inch
slotted
screen

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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 2 of 2

Monitoring Well ID: MW-8B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 46

Date: September 11, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 46

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
1				Airknife to 5'							
2											
3											
4											
5			SW	Light Brown Fine to Coarse SAND. Loose, no odor	0		Dry				
6											
7											
8											
9											
10					0		Dry				
11											
12											
13											
14					1.2						
15				Grey staining, hydrocarbon odor			Mst				
16					19						
17				Color change to grey, hydrocarbon staining, strong hydrocarbon odor							
18					128						
19	MW-8B-19				450						
20					150		Mst				
21					183						
22											
23			ML	Brown CLAYEY SILT. Medium stiff, low plasticity							
24											
25											
26					0		Wet				
27											

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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 1 of 2

Monitoring Well ID: MW-8B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 46

Date: September 11, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 46

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
27											
28				Missing 8' of core.							
29											
30					0		Wet				
31											
32											
33											
34					0						
35											
36			SP	Brown fine SAND. Loose, no odor							
37											
38							Mst				
39				Color change to grey							
40					0						
41			ML	Gray green CLAYEY SILT. Medium stiff, low plasticity							
42											
43				Some coarse gravel (43-43.3)							
44											
45					0		Mst				
46											

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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 2 of 2

Monitoring Well ID: MW-12B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 51

Date: September 10, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 51

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
1				Airknife to 5'							
2											
3											
4											
5			SW	Brown well graded GRAVELLY SAND with SILT. Loose, hydrocarbon odor.	0		Dry				
6					7.8		Dry				
7			ML	Gray CLAYEY SILT. Soft, low plasticity, strong hydrocarbon odor.	75		Mst				
8											
9			SP	Gray brown medium SAND with SILT. Loose, gray staining, very stron hydrocarbon odor.	210		Mst				
10											
11					490		Mst				
12											
13	MW-12B -12.5										
14											
15					320		Mst				
16			SW	Gray and brown SILTY SAND with CLAY. Medium-fine sand, low plasticity, hydrocarbon odor.							
17					0		Mst				
18											
19			ML	Brown SILT with CLAY. Medium stiff, low plasticity, no odor.	0		Mst				
20											
21											
22											
23											
24											
25					0		Mst				
26											
27											

Surface casing (temporary)

2-inch PVC riser

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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 1 of 2

Monitoring Well ID: MW-12B

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal**Drilling Method:** Sonic**Well Depth:** 51**Date:** September 10, 2008**Casing Type:** PVC**Well Diameter:** 2 in.**Contractor:** Boart Longyear**Slot Size:** 0.010**Elevation:** 0**Logged By:** Christopher Sheridan**Hole Depth:** 51**Coordinates:** 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery Interval	Well Construction	Notes
28										
29				Color change to dark brown, high amount of organics and woody debris, increase stiffness	0		Mst			
30										
31										
32										
33										
34				Moderate stiffness	0		Mst			
35										
36										
37										
38										
39										
40					0		Mst			
41										
42										
43				High amount of woody debris						
44										
45			ML	Gray Green CLAYEY SILT. Soft, moderate plasticity, no odor.	0		Mst			
46										
47				Color change to light brown, woody debris						
48										
49			ML	50-50.2= Medium GRAVELLY with SILT; 50.2-50.4= Brown SILT with CLAY; 50.4-50.7= Brown fine SAND with CLAY; 50.7-51: Brown CLAYEY SILT.						
50					0		Mst			
51										

0.010-inch
slotted
screen

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**Client** Kinder Morgan**Project** Linnton IRAM Evaluation**Page** 2 of 2

Monitoring Well ID: MW-12C

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal**Drilling Method:** Sonic**Well Depth:** 66**Date:** September 10, 2008**Casing Type:** PVC**Well Diameter:** 2 in.**Contractor:** Boart Longyear**Slot Size:** 0.010**Elevation:** 0**Logged By:** Christopher Sheridan**Hole Depth:** 66**Coordinates:** 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
1				Airknife to 5'							
2											
3											
4											
5			SW	Brown well graded fine to coarse SAND. Loose, hydrocarbon odor	14.2		Dry				
6											
7											
8					7.4		Dry				
9											
10				Color change to dark brown and gray staining							
11				Very strong hydrocarbon odor	212		Mst				
12											
13					490		Mst				
14	MW-12C -13.5										
15					315		Mst				
16											
17				High amount of woody debris	13		Sat				Surface casing (temporary)
18											
19											
20					0		Wet				
21			ML	Gray green CLAYEY SILT. Medium stiff, low plasticity							
22			SP	Gray green fine SAND with SILT. Loose, no odor.							
23			ML	Gray green CLAYEY SILT. Medium stiff, low plasticity, red mottling.	0		Mst				
24			SP								
25											
26				No mottling							
27											

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**Client** Kinder Morgan**Project** Linnton IRAM Evaluation**Page** 1 of 3

Monitoring Well ID: MW-12C

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal**Drilling Method:** Sonic**Well Depth:** 66**Date:** September 10, 2008**Casing Type:** PVC**Well Diameter:** 2 in.**Contractor:** Boart Longyear**Slot Size:** 0.010**Elevation:** 0**Logged By:** Christopher Sheridan**Hole Depth:** 66**Coordinates:** 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
27					0		Mst				
28				Grades to brown color							
29											
30											
31											
32					0		Mst				
33				Gray green fine SAND with SILT. Loose, no odor							
34				Color change to dark brown, increase stiffness							
35											
36											
37				No recovery from 36' to 39'							
38											
39											
40					0		Mst				
41											
42											
43				Color change to very dark brown, organics							
44											
45											
46				Color change to gray green, no organics	0		Mst				
47											
48											
49											
50											
51											
52					0		Mst				
53											
54											

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**Client** Kinder Morgan**Project** Linnton IRAM Evaluation**Page 2 of 3**

Monitoring Well ID: MW-12C

Project No. PTKM-01-17

Location: Kinder Morgan Linnton Terminal

Drilling Method: Sonic

Well Depth: 66

Date: September 10, 2008

Casing Type: PVC

Well Diameter: 2 in.

Contractor: Boart Longyear

Slot Size: 0.010

Elevation: 0

Logged By: Christopher Sheridan

Hole Depth: 66

Coordinates: 0

Depth (ft.)	Sample No.	Lithology	USCS	LITHOLOGIC DESCRIPTION	PID	Water Level	Moisture Content	Recovery	Interval	Well Construction	Notes
54											
55											
56											
57											
58	MW-12C			Same as above	0						
59	-58										
60											
61											
62			Bdrk	Fractured BASALT bedrock.							
63											
64											
65					0						
66											

0.010-inch
slotted
screen

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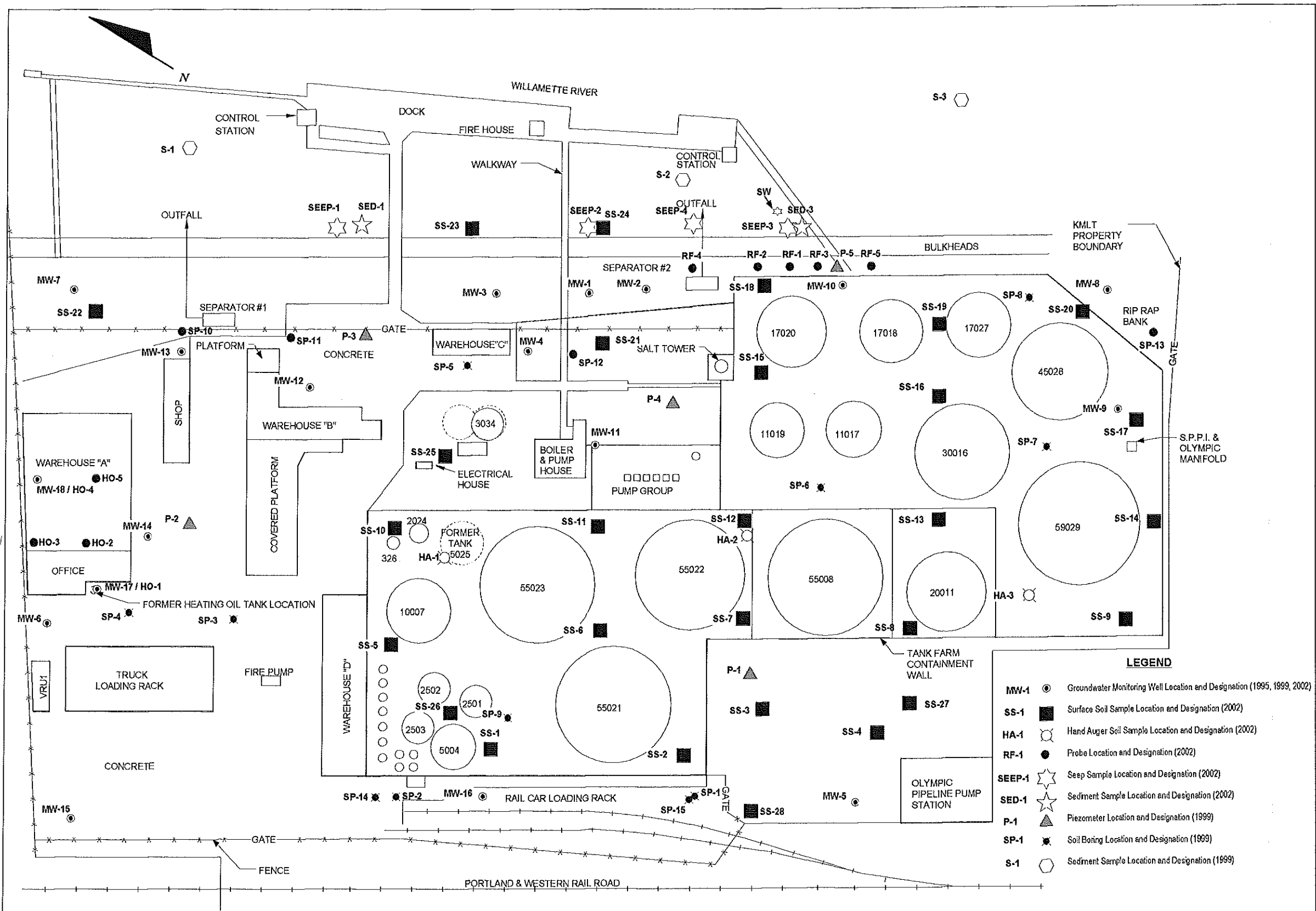
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Client Kinder Morgan

Project Linnton IRAM Evaluation

Page 3 of 3



DRAFT

KHM ENVIRONMENTAL MANAGEMENT INC.	DESIGNED BY	SITE MAP WITH SAMPLE LOCATIONS Kinder Morgan Liquid Terminals LLC Linnton Terminal 11400 NW St. Helens Road Portland, Oregon		
	DRAWN BY			
	CHECKED BY	DATE 8/28/02	PROJECT B30-01F	DRAWING 5
	APPROVED BY			

DRAFT

TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	HA-1 (8)	HA-1 (14)	HA-2 (10)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)	HO-1 (11)	HO-1 (24)	HO-1 (28)	HO-2 (11)	HO-2 (21)	HO-2 (40)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	2/7/02	2/7/02	2/7/02	2/7/02	2/7/02	2/7/02	1/21/02	1/21/02	1/22/02	1/21/02	1/21/02	1/21/02
DEPTH (feet)	8	14	10	10	10	10	11	24	28	11	21	40
CONSTITUENT												
Benzene	0.200 U	NA	NA	NA	NA	NA	0.500 U	0.0500 U	0.0500 U	5.00 U	5.00 U	0.0500 U
Diesel	1940	4060	1180	1180	1180	25.0 U	17400	101	25.0 U	243	3230	25.0 U
Ethylbenzene	0.200 U	NA	NA	NA	NA	NA	1.1	0.0500 U	0.0500 U	5.00 U	5.00 U	0.0500 U
Fuel oil no. 2	1360	2970	50.0 U	50.0 U	50.0 U	50.0 U	2000 U	50.0 U	50.0 U	50.0 U	244	50.0 U
Gasoline	240	533	110	137	1460	1460	383	21.5	2.00 U	328	322	2.00 M
Naphthalene	0.200 U	NA	NA	NA	NA	NA	10.5	0.15	0.0591 R	164	156	0.0939
Toluene	0.200 U	NA	NA	NA	NA	NA	0.500 M	0.500 M	0.0500 U	5.00 U	5.00 U	0.0500 U
Xylene (total)	0.200 U	NA	NA	NA	NA	NA	0.500 M	0.500 M	0.0500 U	5.00 U	5.00 U	0.0500 U

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TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
Kinder Morgan Liquid Terminals
Linnton Terminal
Portland, Oregon

SAMPLE ID	HO-3 (16)	HO-3 (16) DUP	HO-3 (32)	HO-4 (16)	HO-4 (24)	HO-5(12)	HO-5 (20)	MW-9Y(15)	MW-9Z(20)	MW-10Y(10)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	4/15/02	4/15/02	4/15/02	4/15/02	4/15/02	4/15/02	4/15/02	1/15/02	1/15/02	1/15/02
DEPTH (feet)	16	16	32	16	24	12	20	15	20	10
CONSTITUENT										
Benzene	0.0500 U	0.0500 U	0.0500 M	0.0500 U	0.0500 U	0.0500 M	0.0500 U	0.0500 U	0.316 J	1.00 U
Diesel	25.0 U	25.0 M	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	6590
Ethylbenzene	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 U	0.0500 U	1.00 U
Fuel oil no. 2	50.0 U	50.7	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	250 U
Gasoline	2.50 M	2.99	2.50 M	2.50 M	2.50 M	2.89	2.50 M	3.32	4.09	1450
Naphthalene	0.0555 R	0.0647 R	0.0500 M	0.0500 U	0.0500 U	0.0574 R	0.0500 U	0.0500 U	0.0500 U	1.00 U
Toluene	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 U	0.0500 M	1.00 U
Xylene (total)	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 M	0.0500 U	0.0500 M	1.00 U

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TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEXN
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	MW-10Z(15)	MW-10(25)	MW-11Y(20)	MW-11Z(25)	MW-11Z(25)DUP	MW-11(30)	MW-12Y(10)	MW-12Z(15)	MW-12Z(15)DUP	MW-12(25)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	1/15/02	1/15/02	1/17/02	1/17/02	1/17/02	1/17/02	1/16/02	1/16/02	1/16/02	1/16/02
DEPTH (feet)	15	25	20	25	25	30	10	15	15	25
CONSTITUENT										
Benzene	1.00 U	0.0500 M	0.200 M	0.200 M	0.200 M	0.0500 U	0.500 U	1.00 M	1.00 M	0.100 M
Diesel	10700	25.0 U	11600	5990	4850	809	8030	13800	13400	900
Ethylbenzene	1.00 U	0.0500 U	0.200 U	0.200 U	0.100 U	0.0500 U	0.500 U	1.00 U	1.00 U	0.100 U
Fuel oil no. 2	250 U	50.0 U	8120	4250	3420	746	1330	1030	983	114
Gasoline	1070	2.02	320	189	49.2	22	1090	980	1030	130
Naphthalene	1.00 U	0.0500 U	0.200 U	0.200 U	0.100 U	0.0500 U	0.500 U	1.00 U	1.00 U	0.100 U
Toluene	1.00 U	0.0500 U	0.200 U	0.200 M	0.200 M	0.0500 M	0.500 U	1.00 U	1.00 U	0.100 U
Xylene (total)	1.00 U	0.0500 U	0.200 U	0.200 U	0.100 U	0.0500 M	0.500 U	1.00 U	1.00 U	0.100 U

TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

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SAMPLE ID	MW-13Y(10)	MW-13Z(20)	MW-13(30)	MW-14Y(10)	MW-14Z(15)	MW-15Y(15)	MW-15Z(20)	MW-15Z(20)DUP	MW-16Y(5.5)	MW-16Z(10.5)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	1/14/02	1/14/02	1/14/02	1/14/02	1/16/02	1/16/02	1/16/02	1/16/02	1/14/02	1/14/02
DEPTH (feet)	10	20	30	10	15	15	20	20	5.5	10.5
CONSTITUENT										
Benzene	0.200 M	0.0500 M	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.500 U
Diesel	745	191	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U	7100
Ethylbenzene	0.200 U	0.127	0.0500 U	0.0500 U	0.0500 M	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.500 U
Fuel oil no. 2	115	184	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U	2410
Gasoline	362	53.3	2.00 U	2.00 U	2.00 U	2.00 M	2.00 U	2.00 U	4.06	852
Naphthalene	0.200 U	0.0500 U	0.0659 R	0.0500 U	0.0500 U	0.0627 R	0.0500 U	0.0500 U	0.0500 U	0.500 U
Toluene	0.200 U	0.0500 U	0.0500 U	0.0500 U	0.0500 M	0.0500 M	0.0500 U	0.0500 U	0.0500 U	0.500 U
Xylene (total)	0.200 U	0.103	0.0500 U	0.0500 U	0.0500 M	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.500 U

TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

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SAMPLE ID	MW-16(21)	RF-1 X(10.5)	RF-1 Y(14)	RF-1 Y(19)	RF-1 Z(32)	RF-2 X(10)	RF-2 Y(20)	RF-2 Z(28)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	1/14/02	1/21/02	1/21/02	1/21/02	1/21/02	1/21/02	1/21/02	1/21/02
DEPTH (feet)	21	10.5	14	19	32	10	20	28
CONSTITUENT								
Benzene	0.0500 U	0.0500 U	1.00 U	0.200 M	0.0500 U	0.500 U	0.200 U	0.0500 U
Diesel	37.1	25.0 U	9850	1910	25.0 U	8960	9420	25.0 U
Ethylbenzene	0.0500 U	0.0500 U	1.00 U	0.200 U	0.0500 U	0.500 U	0.200 U	0.0500 M
Fuel oil no. 2	50.0 M	50.0 U	2920	118	50.0 U	521	602	50.0 U
Gasoline	2.00 M	2.00 M	850	232	8.03	818	436	2.63
Naphthalene	0.0500 U	0.0500 U	1.00 U	0.200 U	0.0500 U	0.500 U	0.200 U	0.0500 M
Toluene	0.0500 M	0.0500 U	1.00 U	0.200 M	0.0500 U	0.500 U	0.200 U	0.0500 U
Xylene (total)	0.0500 M	0.0500 U	1.00 U	0.200 U	0.0500 U	0.500 U	0.200 U	0.0500 M

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TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	RF-3 X(15)	RF-3 Y(24)	RF-3 Z(32)	RF-4 (19)	RF-4 (32)	RF-5 (15)	RF-5 (28)	SP-10 (15)	SP-10 (28)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	1/21/02	1/21/02	1/21/02	4/17/02	4/17/02	4/17/02	4/17/02	4/16/02	4/16/02
DEPTH (feet)	15	24	32	19	32	15	28	15	28
CONSTITUENT									
Benzene	0.200 M	0.100 U	0.0500 U	0.500 U	0.0500 U	5.00 M	0.0500 U	0.0500 U	0.0500 U
Diesel	109	2850	25.0 U	14300	162	12300	25.0 U	25.0 M	25.0 U
Ethylbenzene	0.200 U	0.100 U	0.0500 U	0.500 M	0.0500 M	5.00 M	0.0500 U	0.0500 U	0.0500 U
Fuel oil no. 2	50.0 U	1030	50.0 U	500 U	135	500 U	50.0 U	50.0 U	50.0 U
Gasoline	144	190	4.22	408	10.2	1510	3.15	19.7	2.50 U
Naphthalene	0.200 U	0.100 U	0.0500 M	10.5	0.0500 U	5.00 U	0.0500 M	0.0500 U	0.0500 U
Toluene	0.200 M	0.100 U	0.0500 M	0.500 U	0.0500 U	5.00 M	0.0500 U	0.0500 M	0.0500 U
Xylene (total)	0.200 M	0.100 U	0.0500 M	0.941	0.0500 M	5.00 U	0.0500 U	0.0500 M	0.0500 U

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TABLE 10
SUBSURFACE SOIL ANALYTICAL RESULTS - TPH, BTEX/N
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	SP-11 (15)	SP-11 (38)	SP-12 (15)	SP-12 (32)	SP-13 (18)	SP-13 (24)	SP-14 (14.5)	SP-14 (22)	SP-15 (12)	SP-15 (16)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	4/16/02	4/16/02	4/16/02	4/16/02	4/16/02	4/16/02	4/17/02	4/17/02	4/17/02	4/17/02
DEPTH (feet)	15	38	15	32	18	24	14.5	22	12	16
CONSTITUENT										
Benzene	0.200 U	0.0500 U	0.500 U	0.0500 U	0.0500 M	0.0500 U	0.500 U	0.0500 U	0.0500 U	0.0500 U
Diesel	977	25.0 U	10100	60.8	25.0 U	25.0 U	1780	25.0 M	25.0 U	25.0 U
Ethylbenzene	0.200 U	0.0500 U	0.500 U	0.0500 M	0.0500 M	0.0500 M	0.500 U	0.0500 M	0.0500 U	0.0500 U
Fuel oil no. 2	50.0 U	50.0 U	500 U	51.4	50.0 U	50.0 U	585	50.0 U	50.0 U	50.0 U
Gasoline	736	2.50 M	592	7.33	2.84	2.51	890	13.4	2.50 M	2.50 M
Naphthalene	0.200 U	0.0500 U	4.73	0.0500 U	0.0500 U	0.0500 U	0.500 U	0.11	0.0500 U	0.0500 U
Toluene	0.0200 M	0.0500 M	0.0500 M	0.0500 U	0.0500 M	0.0500 M	0.500 U	0.0500 M	0.0500 U	0.0500 M
Xylene (total)	0.200 DU	0.0500 M	0.500 DU	0.0500 M	0.0500 M	0.0500 M	1.7	0.107	0.0500 U	0.0500 M

NOTES:

Gasoline Range Hydrocarbons analyzed by NW TPH-Gx Method

Diesel and Oil Range Hydrocarbons analyzed by NW TPH-Dx Method

Benzene, Toluene, Ethylbenzene, Xylene, and Naphthalene (BTEX/N) analyzed by USEPA Method 8021B

mg/kg = Milligrams per kilogram

NA = Not analyzed

J = Estimated Value

U = Analyte included in the analysis but not detected above laboratory method detection limits (MDLs)

M = Analyte included in the analysis but not detected above laboratory method reporting limits (MRLs)

R = Analyte detected below MRL in sample extract. Percent solids calculation raised result above MRL. Result reported as Estimated Value

Bold Face Font = Analyte detected above MRLs

TABLE 11
SUBSURFACE SOIL ANALYTICAL RESULTS - VOCs
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

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SAMPLE ID	HA-1 (14)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)	HO-2 (21)	MW-9Z(20)	MW-10Y(10)	MW-10Z(15)	MW-11Y(20)	MW-12Y(10)	MW-14Z(15)	MW-15Y(15)	MW-16Z(10.5)
UNITS	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
SAMPLE DATE	2/7/02	2/7/02	2/7/02	2/7/02	1/21/02	1/15/02	1/15/02	1/15/02	1/17/02	1/16/02	1/14/02	1/16/02	1/14/02
DEPTH (feet)	14	10	10	10	21	20	10	15	20	10	15	15	10.5
CONSTITUENT													
Acetone	2500 U	2500 U	2500 U	25000 U	25000 U	2500 U	25000 U	2500 U	2500 U	2500 U	2500 U	2500 U	2500 U
Benzene	100 U	100 U	100 U	1000 U	1000 U	672	1000 U	100 M	100 U	100 U	100 U	100 U	100 M
Bromobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Chlorobromomethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Bromodichloromethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Bromoform	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Methyl bromide	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
Methyl ethyl ketone	1000 U	1000 U	1000 U	10000 U	10000 U	1000 U	10000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
n-Butylbenzene	500 M	500 U	500 M	5460	5000 U	500 M	5000 M	10300	712	10600	500 M	500 M	5940
sec-Butylbenzene	424	100 M	100 M	3250	1000 U	100 U	2830	7550	1020	7560	100 M	209	2310
tert-Butylbenzene	100 M	100 U	100 M	1000 U	1000 U	100 U	1000 U	268	100 U	100 U	100 U	100 U	100 U
Carbon disulfide	1000 U	1000 U	1000 U	10000 U	10000 U	1000 U	10000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Carbon tetrachloride	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Chlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Chloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Chloroform	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Methyl chloride	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
o-Chlorotoluene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
p-Chlorotoluene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
DBCP	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
Dibromochloromethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
EDB	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Methylene bromide	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
o-Dichlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
m-Dichlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
p-Dichlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Dichlorodifluoromethane	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
1,1-Dichloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,2-Dichloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1-Dichloroethylene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
cis-1,2-Dichloroethylene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Ethene, 1,2-dichloro-, (E)-	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,2-Dichloropropane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,3-Dichloropropane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
sec-Dichloropropane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1-Dichloropropene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
cis-1,3-Dichloropropene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
trans-1,3-Dichloropropene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U

TABLE 11
SUBSURFACE SOIL ANALYTICAL RESULTS - VOCs
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

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SAMPLE ID	HA-1 (14)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)	HO-2 (21)	MW-9Z(20)	MW-10Y(10)	MW-10Z(15)	MW-11Y(20)	MW-12Y(10)	MW-14Z(15)	MW-15Y(15)	MW-16Z(10.5)
UNITS	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
SAMPLE DATE	2/7/02	2/7/02	2/7/02	2/7/02	1/21/02	1/15/02	1/15/02	1/15/02	1/17/02	1/16/02	1/14/02	1/16/02	1/14/02
DEPTH (feet)	14	10	10	10	21	20	10	15	20	10	15	15	10.5
CONSTITUENT													
Ethylbenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 M	100 U	100 M	100 U	100 U	100 M
Hexachlorobutadiene	200 U	200 U	200 U	2000 U	2000 U	200 U	2000 U	200 U	200 U	200 U	100 M	200 U	200 U
2-Hexanone	1000 U	1000 U	1000 U	10000 U	10000 U	1000 U	10000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Isopropylbenzene	200 M	200 M	200 M	3350	2000 U	200 U	4420	8410	586	8460	200 U	200 M	6630
p-Isopropyltoluene	200 U	200 U	200 U	2000 U	2000 U	200 U	2000 U	200 U	200 U	200 U	200 U	200 U	838
Methyl isobutyl ketone (MIBK)	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
Methyl tert-butyl ether	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Methylene chloride	500 U	500 U	500 U	5000 U	5000 U	500 U	5000 U	500 U	500 U	500 U	500 U	500 U	500 U
Naphthalene	200 M	200 U	200 U	2000 U	163000	200 U	2000 U	200 U	200 U	200 U	200 U	200 U	200 U
n-Propylbenzene	158	100 M	100 M	5960	1000 U	100 M	7450	14300	480	14900	131	143 R	9480
Styrene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1,1,2-Tetrachloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1,2,2-Tetrachloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Tetrachloroethylene	100 U	100 U	100 U	1000 M	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Toluene	100 U	100 M	100 U	1000 U	1000 U	100 U	1000 U	100 M	100 U	100 M	100 U	100 U	100 M
1,2,3-Trichlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,2,4-Trichlorobenzene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1,1-Trichloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,1,2-Trichloroethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Trichloroethylene	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Trichlorofluoromethane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
1,2,3-Trichloropropane	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Benzene, 1,2,4-trimethyl	100 M	100 U	100 U	1000 U	1000 M	100 U	1290	100 U	100 U	100 U	100 U	100 U	100 U
Benzene, 1,3,5-trimethyl-	100 U	100 U	100 M	1000 U	1000 U	100 U	1000 M	100 U	100 U	100 U	100 U	100 U	100 U
Vinyl chloride	100 U	100 U	100 U	1000 U	1000 U	100 U	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
o-Xylene	100 U	100 M	100 M	1000 U	1000 U	100 U	1000 U	100 U	100 M	100 U	100 U	100 U	100 U
m/p-xylene	200 U	200 M	200 M	2000 U	2000 U	200 U	2000 U	200 M	200 U	200 U	200 U	200 U	200 M

NOTES:

Volatile Organic Compounds (VOCs) analyzed by USEPA Method 8260B

µg/kg = Micrograms per kilogram

U = Estimated Value

M = Analyte included in the analysis but not detected above laboratory method detection limits (MDLs)

R = Analyte detected below MRL in sample extract. Percent solids calculation raised result above MRL. Result reported as Estimated Value.

Bold Face Font = Analyte detected above MRLs

EDB = 1,2-Dibromoethane

DBCP = 1,2-Dibromo-3-Chloropropane

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TABLE 12
SUBSURFACE SOIL ANALYTICAL RESULTS - PAH's
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	HA-1 (8)	HO-1 (11)	HO-1 (24)	HO-1 (28)	HO-2 (11)	HO-2 (21)	HO-2 (40)	MW-10Y(10)	MW-10Z(15)	MW-11Y(20)	MW-12Y(10)	MW-12Z(15)
UNITS	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
SAMPLE DATE	2/7/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	1/15/2002	1/15/2002	1/17/2002	1/16/2002	1/16/2002
DEPTH (feet)	8	11	24	28	11	21	40	10	15	20	10	15
CONSTITUENT												
Acenaphthene	268	1330	13.4 U	13.4 U	1220	163000	13.4 U	2010	3180	654	2080	1200
Acenaphthylene	67.0 U	670 U	13.4 U	13.4 U	67.0 M	6700 M	13.4 U	1340 U	1340 U	268 U	335 U	670 U
Anthracene	141	783	13.4 U	13.4 U	360	48400	13.4 U	1340 M	1340 M	454	1060	763
Benzo(a)anthracene	101	67.0 U	13.4 U	13.4 U	67.0 M	26300	13.4 U	345	379	268 M	171	134 M
Benzo(a)pyrene	67.0 M	67.0 U	13.4 U	13.4 U	67.0 U	4790	13.4 U	350	390	268 M	123	134 U
Benzo(b)fluoranthene	67.0 M	67.0 U	13.4 U	13.4 U	67.0 U	6980	13.4 U	237	235	536 U	78.9	134 U
Benzo(ghi)perylene	67.0 M	67.0 U	13.4 U	13.4 U	67.0 U	1030	13.4 U	279	327	268 U	67.0 M	134 U
Benzo(k)fluoranthene	94.7	67.0 U	13.4 U	13.4 U	67.0 U	4860	13.4 U	182	220	536 U	74.5	134 U
Chrysene	251	103	13.4 U	13.4 U	67.0 M	23000	13.4 U	427	504	963	324	134 M
Dibenzo(a,h)anthracene	67.0 U	67.0 U	13.4 U	13.4 U	67.0 U	602	13.4 U	134 M	134 M	268 U	67.0 U	134 U
Fluoranthene	107	153	13.4 U	13.4 U	448	169000	13.4 U	1340 M	1340 M	373	411	670 U
Fluorene	881	6700 U	13.4 U	13.4 U	1500	152000	13.4 U	2330	4010	3070	5730	3400
Indeno(1,2,3-cd)pyrene	67.0 U	67.0 U	13.4 U	13.4 U	67.0 U	1230	13.4 U	206	236	268 U	67.0 M	134 U
Naphthalene	670 U	10100	13.4 U	13.4 U	33200	582000	13.4 U	6700 U	13400 U	1340 U	6700 U	6700 U
Phenanthrene	1660	6910	13.4 U	13.4 U	3610	384000	13.4 M	3330	4610	5650	9800	6220
Pyrene	254	495	13.4 M	13.4 U	263	103000	13.4 U	1610	1700	566	667	387

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TABLE 12
SUBSURFACE SOIL ANALYTICAL RESULTS - PAH's
Kinder Morgan Liquid Terminals
Linnton Terminal
Portland, Oregon

SAMPLE ID	MW-12Z(15)DUP	MW-13Y(10)	MW-13Z(20)	MW-16Z(10.5)	RF-1 Y(14)	RF-1 Y(19)	RF-2 X(10)	RF-2 Y(20)	RF-3 X(15)	RF-3 Y(24)	SP-10 (15)
UNITS	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
SAMPLE DATE	1/16/2002	1/14/2002	1/14/2002	1/14/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	1/21/2002	4/16/2002
DEPTH (feet)	15	10	20	10.5	14	19	10	20	15	24	15
CONSTITUENT											
Acenaphthene	1370	670 U	45	1860	1550	671	1440	1550	134 U	268 U	26.8 U
Acenaphthylene	670 U	670 U	26.8 U	335 U	670 U	268 U	268 U	134 U	134 M	134 U	26.8 U
Anthracene	774	670 U	53.6 U	2760	1240	704	473	716	136	137	26.8 M
Benzo(a)anthracene	134 M	61	26.8 M	1750	670 M	134 M	307	310	697	134 U	67.3
Benzo(a)pyrene	134 M	30.1	26.8 M	1280	670 M	134 M	312	350	962	134 U	78.8
Benzo(b)fluoranthene	134 U	26.8 M	26.8 M	533	670 M	134 U	268 M	228	2380	134 U	64.9
Benzo(ghi)perylene	134 U	26.8 M	26.8 M	841	670 M	134 U	268 M	356	1700	134 U	76.4
Benzo(k)fluoranthene	134 U	26.8 M	26.8 M	335 M	670 U	134 U	268 M	198	134 U	134 U	50.3
Chrysene	149	63.1	31.9	2260	973	134 M	448	487	1070	134 M	82.3
Dibenzo(a,h)anthracene	134 U	26.8 U	26.8 U	335 M	670 U	134 U	268 U	134 M	326	134 U	26.8 M
Fluoranthene	670 U	670 U	57.2	1210	670 M	202	687	696	1090	134 M	120
Fluorene	3660	670 M	121	4940	3640	2450	2100	2870	134 U	670 U	26.8 U
Indeno(1,2,3-cd)pyrene	134 U	26.8 M	26.8 M	343	670 U	134 U	268 M	240	1280	134 U	57.6
Naphthalene	6700 U	670 U	268 U	3350 U	6700 U	1340 U	1340 U	6700 U	134 U	670 U	26.8 U
Phenanthrene	6010	26.8 M	168	8640	5770	4670	2980	4320	379	917	56.9
Pyrene	443	206	59	5730	1490	527	1180	1360	1080	134 M	131
NOTES: Polynuclear Aromatic Compounds (PAHs) analyzed by USEPA Method 8270M-SIM µg/l = Micrograms per kilogram J = Estimated Value U = Analyte included in the analysis but not detected above laboratory method detection limits (MDLs) M = Analyte included in the analysis but not detected above laboratory method reporting limits (MRLs) Bold Face Font = Analyte detected above MRLs											

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TABLE 13
SUBSURFACE SOIL ANALYTICAL RESULTS - TOTAL METALS
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

SAMPLE ID	HA-1 (8)	HA-1 (14)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	2/7/2002	2/7/2002	2/7/2002	2/7/2002	2/7/2002
DEPTH (feet)	8	14	10	10	10
CONSTITUENT					
Arsenic	12.4	12	13.3	13.9	10.4
Barium	205	165	177	180	184
Cadmium	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
Chromium	30.7	28.2	28.6	28.3	27.5
Copper	33.1	35.5	36.7	40.5	35.7
Lead	23.2	15.4	15.7	15.4	13
Mercury	0.100 M	0.100 M	0.100 U	0.100 M	0.100 M
Selenium	0.500 U	0.500 U	0.500 U	0.500 M	0.500 M
Silver	0.500 M	0.500 M	0.500 M	0.500 M	0.500 M
Zinc	101	95.5	107	115	96.9
NOTES: Total Metals analyzed by USEPA 6000/7000 Series Methods mg/kg = Milligrams per kilogram U = Analyte included in the analysis but not detected above laboratory method detection limits (MDLs) M = Analyte included in the analysis but not detected above laboratory method reporting limits (MRLs) Bold Face Font = Analyte detected above MRLs					

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TABLE 14
SUBSURFACE SOIL ANALYTICAL RESULTS - SVOCs
Kinder Morgan Liquid Terminals
Linnton Terminal
Portland, Oregon

SAMPLE ID	HA-1 (14)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)	MW-10Z(15)	MW-11Y(20)	MW-12Z(15)	MW-12Z(15)DUP	MW-13(30)	MW-14Y(10)	MW-15Y(15)	MW-15Y(15)	MW-16Z(10.5)	MW-16(21)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	2/7/2002	2/7/2002	2/7/2002	2/7/2002	1/15/2002	1/17/2002	1/16/2002	1/16/2002	1/14/2002	1/14/2002	1/16/2002	1/16/2002	1/14/2002	1/14/2002
DEPTH (feet)	14	10	10	10	15	20	15	15	30	10	15	15	10.5	21
CONSTITUENT														
Acenaphthene	1.65 U	0.358	0.343	0.330 U	3.56	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Acenaphthylene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Anthracene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzo(a)anthracene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzo(a)pyrene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzo(b)fluoranthene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzo(ghi)perylene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzo(k)fluoranthene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Benzoic acid	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Benzyl alcohol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
4-Bromophenyl phenyl ether	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Butyl benzyl phthalate	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
p-Chloro-m-cresol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
p-Chloroaniline	10.0 U	2.00 U	2.00 U	2.00 U	20.0 U	20.0 U	20.0 U	20.0 U	2.00 U	2.00 U	2.00 U	2.00 U	20.0 U	2.00 U
Bis(2-chloroethoxy)methane	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Bis(2-chloroethyl)ether	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Bis(2-chloroisopropyl)ether	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2-Chloronaphthalene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2-Chlorophenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
4-Chlorophenyl phenyl ether	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Chrysene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Di-n-butyl phthalate	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Di-n-octyl phthalate	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Dibenzo(a,h)anthracene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Dibenzofuran	1.65 U	0.330 M	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
o-Dichlorobenzene	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
m-Dichlorobenzene	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
p-Dichlorobenzene	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
3,3-Dichlorobenzidine	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
2,4-Dichlorophenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Diethyl phthalate	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2,4-Dimethylphenol	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Dimethyl phthalate	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
4,6-Dinitro-o-cresol	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
2,4-Dinitrophenol	10.0 U	2.00 U	2.00 U	2.00 U	20.0 U	20.0 U	20.0 U	20.0 U	2.00 U	2.00 U	2.00 U	2.00 U	20.0 U	2.00 U
2,4-Dinitrotoluene	2.50 U	0.500 U	0.500 U	0.500 U	5.00 U	5.00 U	5.00 U	5.00 U	0.500 U	0.500 U	0.500 U	0.500 U	5.00 U	0.500 U
2,6-Dinitrotoluene	2.50 U	0.500 U	0.500 U	0.500 U	5.00 U	5.00 U	5.00 U	5.00 U	0.500 U	0.500 U	0.500 U	0.500 U	5.00 U	0.500 U
Bis(2-ethylhexyl)phthalate (BEHP)	10.0 U	2.00 U	2.00 U	2.00 U	20.0 U	20.0 U	20.0 U	20.0 U	2.00 U	2.00 U	2.00 U	2.00 U	20.0 U	2.00 U
Fluoranthene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U

TABLE 14
SUBSURFACE SOIL ANALYTICAL RESULTS - SVOCs
 Kinder Morgan Liquid Terminals
 Linnton Terminal
 Portland, Oregon

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SAMPLE ID	HA-1 (14)	HA-2 (10)	HA-2 (10) DUP	HA-3 (10)	MW-10Z(15)	MW-11Y(20)	MW-12Z(15)	MW-12Z(15)DUP	MW-13(30)	MW-14Y(10)	MW-15Y(15)	MW-15Y(15)	MW-16Z(10.5)	MW-16(21)
UNITS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SAMPLE DATE	2/7/2002	2/7/2002	2/7/2002	2/7/2002	1/15/2002	1/17/2002	1/16/2002	1/16/2002	1/14/2002	1/14/2002	1/16/2002	1/16/2002	1/14/2002	1/14/2002
DEPTH (feet)	14	10	10	10	15	20	15	15	30	10	15	15	10.5	21
CONSTITUENT														
Fluorene	1.65 U	0.330 U	0.376	0.330 U	4.91	3.30 M	4.28	4.21	0.330 U	0.330 U	0.330 U	0.330 U	3.30 M	0.330 U
Hexachlorobenzene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Hexachlorobutadiene	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Hexachlorocyclopentadiene	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Hexachloroethane	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Indeno(1,2,3-cd)pyrene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Isophorone	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2-Methylnaphthalene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	19.1	0.330 U
o-Cresol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Cresols	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Naphthalene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
o-Nitroaniline	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
m-Nitroaniline	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
p-Nitroaniline	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Nitrobenzene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
o-Nitrophenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
p-Nitrophenol	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
N-Nitrosodiphenylamine	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
N-Nitrosodipropylamine	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
PCP	5.00 U	1.00 U	1.00 U	1.00 U	10.0 U	10.0 U	10.0 U	10.0 U	1.00 U	1.00 U	1.00 U	1.00 U	10.0 U	1.00 U
Phenanthrene	1.65 U	2.44	2.29	0.330 U	5.27	5.93	6.35	7.65	0.330 U	0.330 U	0.330 U	0.330 U	9.74	0.330 U
Phenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
Pyrene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 M	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	5.11	0.330 U
1,2,4-Trichlorobenzene	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2,4,5-Trichlorophenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U
2,4,6-Trichlorophenol	1.65 U	0.330 U	0.330 U	0.330 U	3.30 U	3.30 U	3.30 U	3.30 U	0.330 U	0.330 U	0.330 U	0.330 U	3.30 U	0.330 U

NOTES:

Semivolatile Organic Compounds (SVOCs) analyzed by USEPA Method 8270C

mg/kg = Milligrams per kilogram

J = Estimated Value

U = Analyte included in the analysis but not detected above laboratory method detection limits (MDLs)

M = Analyte included in the analysis but not detected above laboratory method reporting limits (MRLs)

Bold Face Font = Analyte detected above MRLs

Section 6.1: Appendix A - Geotechnical Data

Appendix A-3 Geotechnical Calculations

A-3-1

Site Class Calculation

Attachment 2
Site Class Calculation
Kinder Morgan Linnton Terminal SVA

	A	B	C	D	E
1	CPT-2	Shear Wave Vel. for Layer i	Layer Thickness		
2	CPT Measurement Depth (ft)	Vs,i (ft/s)	di (ft)	di/vsi	Notes
3	19.69	579.6	19.69	0.033972	Measured, required to Vac top 10'
4	22.97	781.43	3.28	0.004197	Measured
5	26.25	820.67	3.28	0.003997	Measured
6	29.53	829.42	3.28	0.003955	Measured
7	32.81	687.02	3.28	0.004774	Measured
8	36.09	698.74	3.28	0.004694	Measured
9	39.37	670.98	3.28	0.004888	Measured
10	42.65	1035.7	3.28	0.003167	Measured
11	45.93	1104.03	3.28	0.002971	Measured
12	49.21	830.87	3.28	0.003948	Measured
13	52.49	932.53	3.28	0.003517	Measured
14	55.77	655.75	3.28	0.005002	Measured
15	59.06	763.11	3.29	0.004311	Measured
16	59.88	1049.32	0.82	0.000781	Measured
17	100	12000.0	40.12	0.003343	Sowers and Boyd (2019)
18	=SUM(D3:D17) 0.087518 Sum Vs,30 =100/D19 1142.621 (ft/s) =D21/3.28 348.3601 (m/s)				
19					
20					
21					
22					

A-3-2

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

Address: 11400 NW St Helens Rd, Portland, OR 97231, USA

Coordinates: 45.6029267, -122.785729

Elevation: 31 ft

Timestamp: 2024-03-07T19:02:00.222Z

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}	1.025	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	0.474	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.608	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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TABLE 1613.2.3(2) VALUES OF SITE COEFFICIENT F_v^a

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE _R) SPECTRAL RESPONSE ACCELERATION PARAMETER AT 1-SECOND PERIOD					
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \geq 0.6$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	2.2 ^c	2.0 ^c	1.9 ^c	1.8 ^c	1.7 ^c
E	4.2	3.3 ^c	2.8 ^c	2.4 ^c	2.2 ^c	2.0 ^c
F	Note b	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1 .

b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.

c. See requirements for site-specific ground motions in Section 11.4.8 of ASCE 7.

$S_1 = 0.413g$
 $F_v =$
 $1.9 - 0.1 * (0.013 / 0.1)$
 $F_v = 1.887$

A-3-3
Seismic Hazard (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      $\epsilon_{\square}$ : 0.9  $\sigma$ 
416 Mode (largest m-r bin):
417     m: 6.69
418     r: 4.4 km
419      $\epsilon_{\square}$ : 0.34  $\sigma$ 
420 Contribution: 1.35 %
421 Mode (largest m-r- $\epsilon_{\square}$  bin):
422     m: 6.87
423     r: 1.35 km
424      $\epsilon_{\square}$ : 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_ $\epsilon$   $\epsilon=(-\infty, -2.5)$   $\epsilon=[-2.5, -2)$   $\epsilon=[-2, -1.5)$ 
 $\epsilon=[-1.5, -1)$   $\epsilon=[-1, -0.5)$   $\epsilon=[-0.5, 0)$   $\epsilon=[0, 0.5)$   $\epsilon=[0.5, 1)$   $\epsilon=[1, 1.5)$   $\epsilon=[1.5, 2)$ 
 $\epsilon=[2, 2.5)$   $\epsilon=[2.5, \infty)$ 
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=(-∞,-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,∞)											
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 0.002											

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											

709	30	7.5	0.012	0.000	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	0.000
			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	0.000							
712	10	5.1	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			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	0.000
			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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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: 45.58											

```

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

```

[illegible]

```

968 Residual: 0 %
969 Trace: 0.07 %
970 Mean (over all sources):
971 m: 8.93
972 r: 92.56 km
973  $\varepsilon_{\square}$ : 1.16  $\sigma$ 
974 Mode (largest m-r bin):
975 m: 9.34
976 r: 70.18 km
977  $\varepsilon_{\square}$ : 0.72  $\sigma$ 
978 Contribution: 3.7 %
979 Mode (largest m-r- $\varepsilon_{\square}$  bin):
980 m: 9.34
981 r: 70.18 km
982  $\varepsilon_{\square}$ : 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  $\varepsilon$ : min = -3.0, max = 3.0,  $\Delta$  = 0.5  $\sigma$ 
988 Epsilon keys:
989  $\varepsilon_0$ :  $[-\infty \dots -2.5)$ 
990  $\varepsilon_1$ :  $[-2.5 \dots -2.0)$ 
991  $\varepsilon_2$ :  $[-2.0 \dots -1.5)$ 
992  $\varepsilon_3$ :  $[-1.5 \dots -1.0)$ 
993  $\varepsilon_4$ :  $[-1.0 \dots -0.5)$ 
994  $\varepsilon_5$ :  $[-0.5 \dots 0.0)$ 
995  $\varepsilon_6$ :  $[0.0 \dots 0.5)$ 
996  $\varepsilon_7$ :  $[0.5 \dots 1.0)$ 
997  $\varepsilon_8$ :  $[1.0 \dots 1.5)$ 
998  $\varepsilon_9$ :  $[1.5 \dots 2.0)$ 
999  $\varepsilon_{10}$ :  $[2.0 \dots 2.5)$ 
1000  $\varepsilon_{11}$ :  $[2.5 \dots +\infty]$ 
1001 Closest Distance, rRup (km) Magnitude (Mw) ALL_ $\varepsilon$   $\varepsilon=(-\infty, -2.5)$   $\varepsilon=[-2.5, -2)$   $\varepsilon=[-2, -1.5)$ 
1002  $\varepsilon=[-1.5, -1)$   $\varepsilon=[-1, -0.5)$   $\varepsilon=[-0.5, 0)$   $\varepsilon=[0, 0.5)$   $\varepsilon=[0.5, 1)$   $\varepsilon=[1, 1.5)$   $\varepsilon=[1.5, 2)$ 
1003  $\varepsilon=[2, 2.5)$   $\varepsilon=[2.5, \infty)$ 
1004 250 8.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1005 0.000 0.000 0.000
1006 230 8.1 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1007 0.000 0.000 0.000
1008 230 8.3 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1009 0.000 0.000 0.000
1010 230 8.5 0.006 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1011 0.000 0.000 0.006
1012 230 8.7 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1013 0.000 0.000 0.007
1014 210 7.9 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1015 0.000 0.000 0.000
1016 210 8.1 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1017 0.000 0.000 0.001
1018 210 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1019 0.000 0.000 0.001
1020 210 8.5 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1021 0.000 0.000 0.002
1022 190 7.9 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1023 0.000 0.000 0.001
1024 190 8.1 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1025 0.000 0.000 0.002
1026 190 8.3 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1027 0.000 0.000 0.001
1028 190 8.5 0.007 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1029 0.000 0.005 0.001
1030 170 7.9 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1031 0.000 0.000 0.002
1032 170 8.1 0.005 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1033 0.000 0.003 0.002
1034 170 8.3 0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1035 0.000 0.003 0.000
1036 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=(-∞,-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,∞)
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

```

1301	110	8.1	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.003	0.025	0.000							
1302	110	8.3	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.004	0.018	0.000							
1303	110	8.5	0.362	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.136
			0.227	0.000	0.000							
1304	110	8.7	1.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167
			1.562	0.000	0.000							
1305	110	8.9	2.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.025
			0.000	0.000	0.000							
1306	110	9.1	2.901	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.901
			0.000	0.000	0.000							
1307	90	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.006	0.000	0.000							
1308	90	8.1	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
			0.013	0.000	0.000							
1309	90	8.3	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
			0.004	0.000	0.000							
1310	90	8.5	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.118
			0.002	0.000	0.000							
1311	90	8.7	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.113
			0.000	0.000	0.000							
1312	90	8.9	0.136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.136
			0.000	0.000	0.000							
1313	70	7.9	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044
			0.007	0.000	0.000							
1314	70	8.1	0.127	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125
			0.002	0.000	0.000							
1315	70	8.3	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.081
			0.000	0.000	0.000							
1316	70	8.5	0.390	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.265	0.125
			0.000	0.000	0.000							
1317	70	8.7	0.612	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.612	0.000
			0.000	0.000	0.000							
1318	70	8.9	3.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.880	0.000
			0.000	0.000	0.000							
1319	70	9.1	4.708	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.708	0.000
			0.000	0.000	0.000							
1320	70	9.3	5.575	0.000	0.000	0.000	0.000	0.000	0.000	5.575	0.000	0.000
			0.000	0.000	0.000							
1321	Principal Sources (faults, subduction, random seismicity having > 3% contribution											

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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

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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     ε□: 1.04 σ
1502     Contribution: 2.25 %
1503 Mode (largest m-r-ε□ bin):
1504     m: 5.1
1505     r: 5.15 km
1506     ε□: 1.18 σ
1507     Contribution: 0.93 %
1508 Discretization:
1509     r: min = 0.0, max = 1000.0, Δ = 20.0 km
1510     m: min = 4.4, max = 9.4, Δ = 0.2
1511     ε: min = -3.0, max = 3.0, Δ = 0.5 σ
1512 Epsilon keys:
1513     ε0: [-∞ .. -2.5)
1514     ε1: [-2.5 .. -2.0)
1515     ε2: [-2.0 .. -1.5)
1516     ε3: [-1.5 .. -1.0)
1517     ε4: [-1.0 .. -0.5)
1518     ε5: [-0.5 .. 0.0)
1519     ε6: [0.0 .. 0.5)
1520     ε7: [0.5 .. 1.0)
1521     ε8: [1.0 .. 1.5)
1522     ε9: [1.5 .. 2.0)
1523     ε10: [2.0 .. 2.5)
1524     ε11: [2.5 .. +∞]
1525 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,∞)
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

```

			0.000	0.038	0.044								
1547	30	6.1	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.105	0.037								
1548	30	6.3	0.169	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.022	0.107	0.040								
1549	30	6.5	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			0.037	0.087	0.025								
1550	30	6.7	0.128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
			0.042	0.062	0.020								
1551	30	6.9	0.138	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
			0.054	0.060	0.012								
1552	30	7.1	0.185	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021
			0.099	0.060	0.004								
1553	30	7.3	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.048
			0.118	0.049	0.003								
1554	30	7.5	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.047
			0.071	0.019	0.001								
1555	30	7.7	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.012
			0.010	0.001	0.000								
1556	30	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
			0.002	0.000	0.000								
1557	10	5.1	1.779	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.934
			0.410	0.351	0.082								
1558	10	5.3	1.978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.429	0.630
			0.524	0.334	0.062								
1559	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								
1560	10	5.7	1.911	0.000	0.000	0.000	0.000	0.000	0.000	0.364	0.511	0.379	
			0.445	0.194	0.019								
1561	10	5.9	1.617	0.000	0.000	0.000	0.000	0.000	0.000	0.263	0.410	0.395	
			0.423	0.118	0.008								
1562	10	6.1	2.253	0.000	0.000	0.000	0.000	0.000	0.000	0.430	0.641	0.730	
			0.359	0.090	0.004								
1563	10	6.3	2.118	0.000	0.000	0.000	0.000	0.000	0.000	0.437	0.704	0.676	
			0.277	0.025	0.000								
1564	10	6.5	1.309	0.000	0.000	0.000	0.000	0.000	0.006	0.198	0.489	0.426	
			0.172	0.018	0.000								
1565	10	6.7	1.040	0.000	0.000	0.000	0.000	0.000	0.016	0.192	0.463	0.245	
			0.116	0.008</									

```

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

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```

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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
	0.017	0.003	0.000									
1727	110 7.7	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
	0.002	0.000	0.000									
1728	110 7.9	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.009
	0.000	0.000	0.000									
1729	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	0.000									
1730	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	0.000									
1731	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
	0.000	0.010	0.014									
1732	90 6.7	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.003	0.076	0.020									
1733	90 6.9	0.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.097	0.144	0.013									
1734	90 7.1	0.478	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052
	0.338	0.085	0.002									
1735	90 7.3	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.049
	0.028	0.002	0.000									
1736	90 7.5	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.040
	0.006	0.000	0.000									
1737	90 7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.004
	0.000	0.000	0.000									
1738	90 7.9	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.007	0.001
	0.000	0.000	0.000									
1739	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	0.000									
1740	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	0.000									


```

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_ $\epsilon$   $\epsilon=(-\infty, -2.5)$   $\epsilon=[-2.5, -2)$   $\epsilon=[-2, -1.5)$ 
 $\epsilon=[-1.5, -1)$   $\epsilon=[-1, -0.5)$   $\epsilon=[-0.5, 0)$   $\epsilon=[0, 0.5)$   $\epsilon=[0.5, 1)$   $\epsilon=[1, 1.5)$   $\epsilon=[1.5, 2)$ 
 $\epsilon=[2, 2.5)$   $\epsilon=[2.5, \infty)$ 
1825 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
1826 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
1827 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
1828 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
1829 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
1830 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
1831 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
1832 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
1833 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
1834 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
1835 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
1836 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
1837 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
1838 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
1839 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
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 0.000 0.000

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	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

```

2002	30	6.7	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.020	0.057	0.010								
2003	30	6.9	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.004	0.018	0.003								
2004	30	7.1	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.002	0.002	0.000								
2005	30	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								
2006	10	5.7	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000								
2007	10	5.9	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.003
		0.001	0.014	0.002								
2008	10	6.1	0.397	0.000	0.000	0.000	0.000	0.000	0.000	0.170	0.025	0.134
		0.000	0.056	0.010								
2009	10	6.3	0.753	0.000	0.000	0.000	0.000	0.000	0.000	0.297	0.199	0.167
		0.072	0.015	0.002								
2010	10	6.5	2.969	0.000	0.000	0.000	0.000	0.000	0.386	1.703	0.752	0.094
		0.028	0.007	0.000								
2011	10	6.7	4.591	0.000	0.000	0.000	0.000	0.000	0.931	3.119	0.515	0.024
		0.002	0.001	0.000								
2012	10	6.9	4.743	0.000	0.000	0.000	0.000	0.468	1.879	2.393	0.002	0.000
		0.000	0.000	0.000								
2013	10	7.1	3.173	0.000	0.000	0.000	0.000	1.069	0.778	1.326	0.000	0.000
		0.000	0.000	0.000								
2014	10	7.3	0.480	0.000	0.000	0.000	0.000	0.164	0.119	0.198	0.000	0.000
		0.000	0.000	0.000								
2015	10	7.5	0.031	0.000	0.000	0.000	0.000	0.011	0.010	0.010	0.000	0.000
		0.000	0.000	0.000								
2016	Principal Sources (faults, subduction, random seismicity having > 3% contribution)											
2017	Geologic Model Partial Rupture:											
2018	Percent Contributed: 8.12											
2019	Distance (km): 2.6307074											
2020	Magnitude: 6.7417979											
2021	Epsilon (mean values): 0.084527773											
2022	Portland Hills:											
2023	Percent Contributed: 8.06											
2024	Distance (km): 2.463229											
2025	Magnitude: 6.7427124											

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-3-4

Liquefaction and
Residual Strength
Calculations

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LIQUEFACTION ANALYSIS REPORT

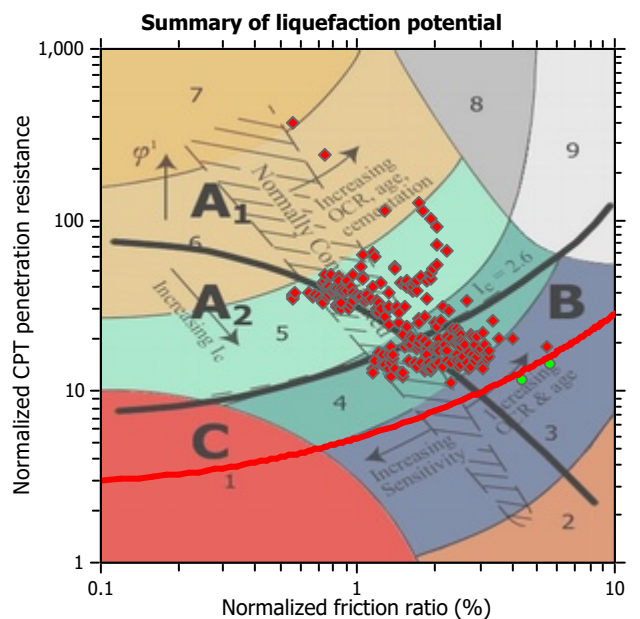
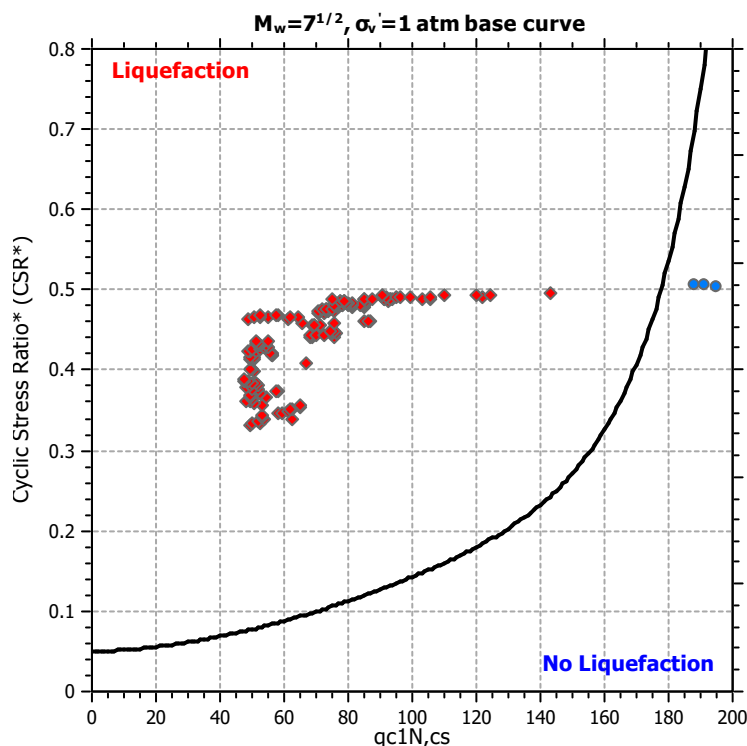
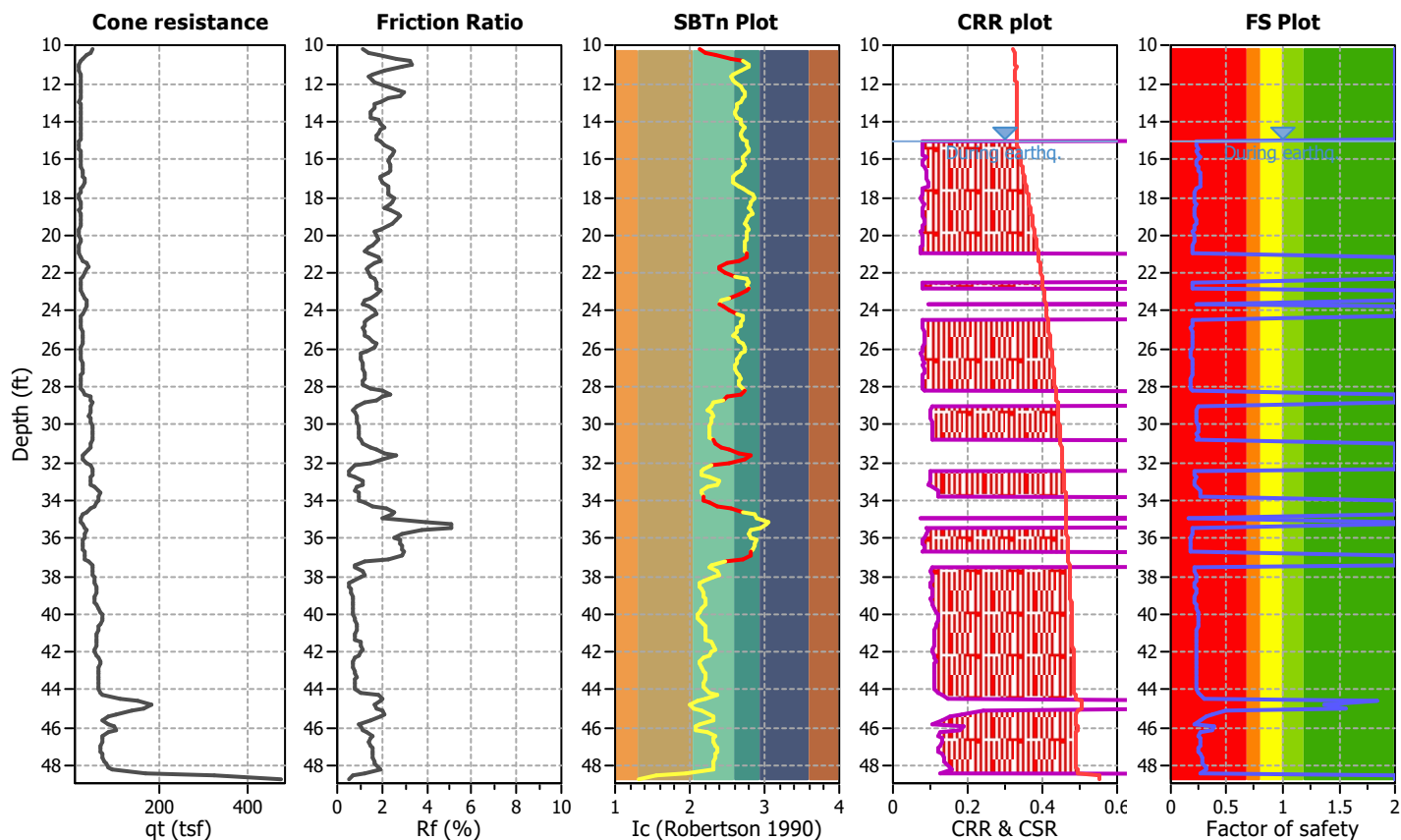
Project title : Kinder Morgan Linnton SVA

Location : Portland, Oregon

CPT file : CPT-01

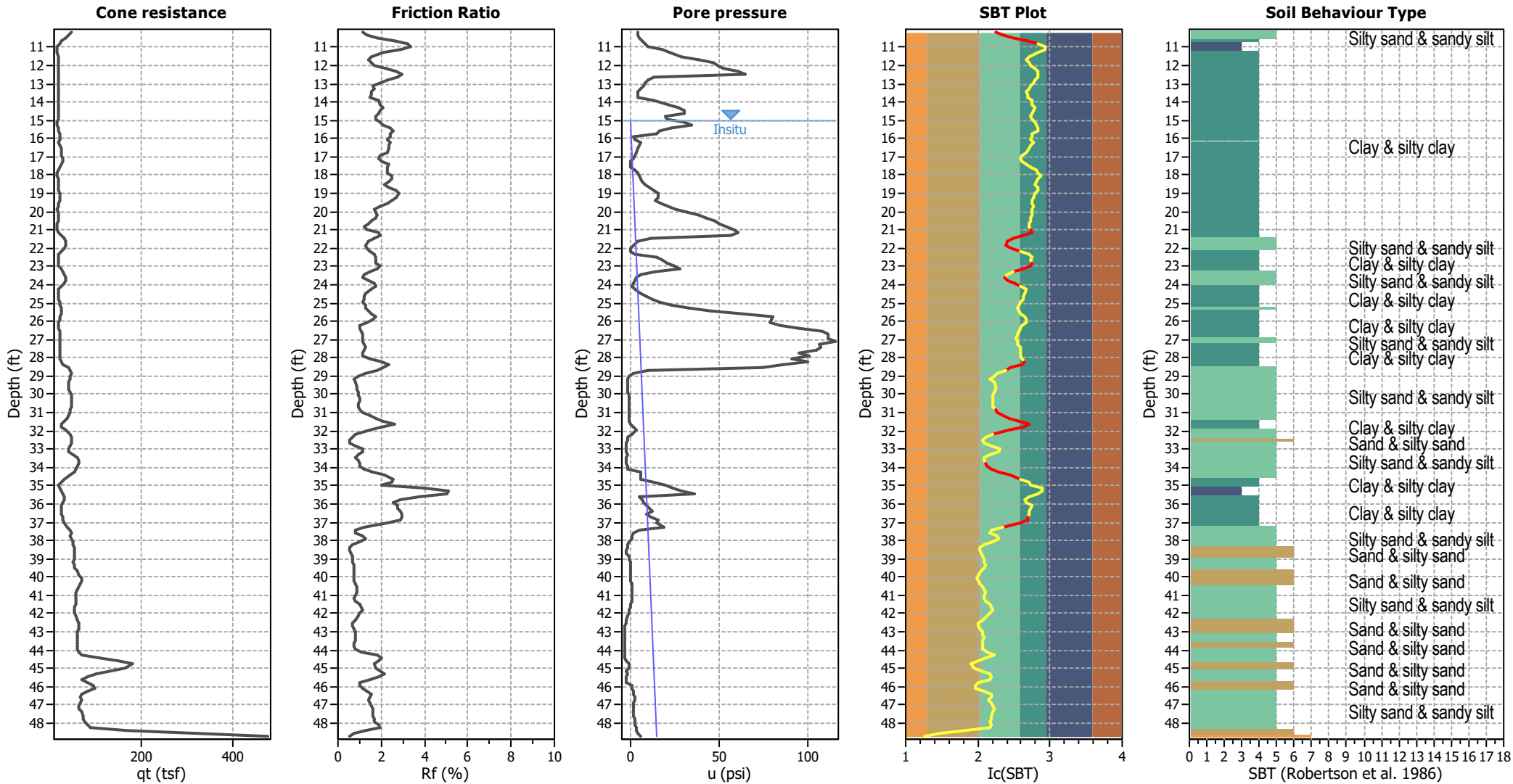
Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	R&W (1998)	G.W.T. (earthq.):	15.00 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:	Yes
Earthquake magnitude M_w :	7.78	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	80.00 ft
Peak ground acceleration:	0.49	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

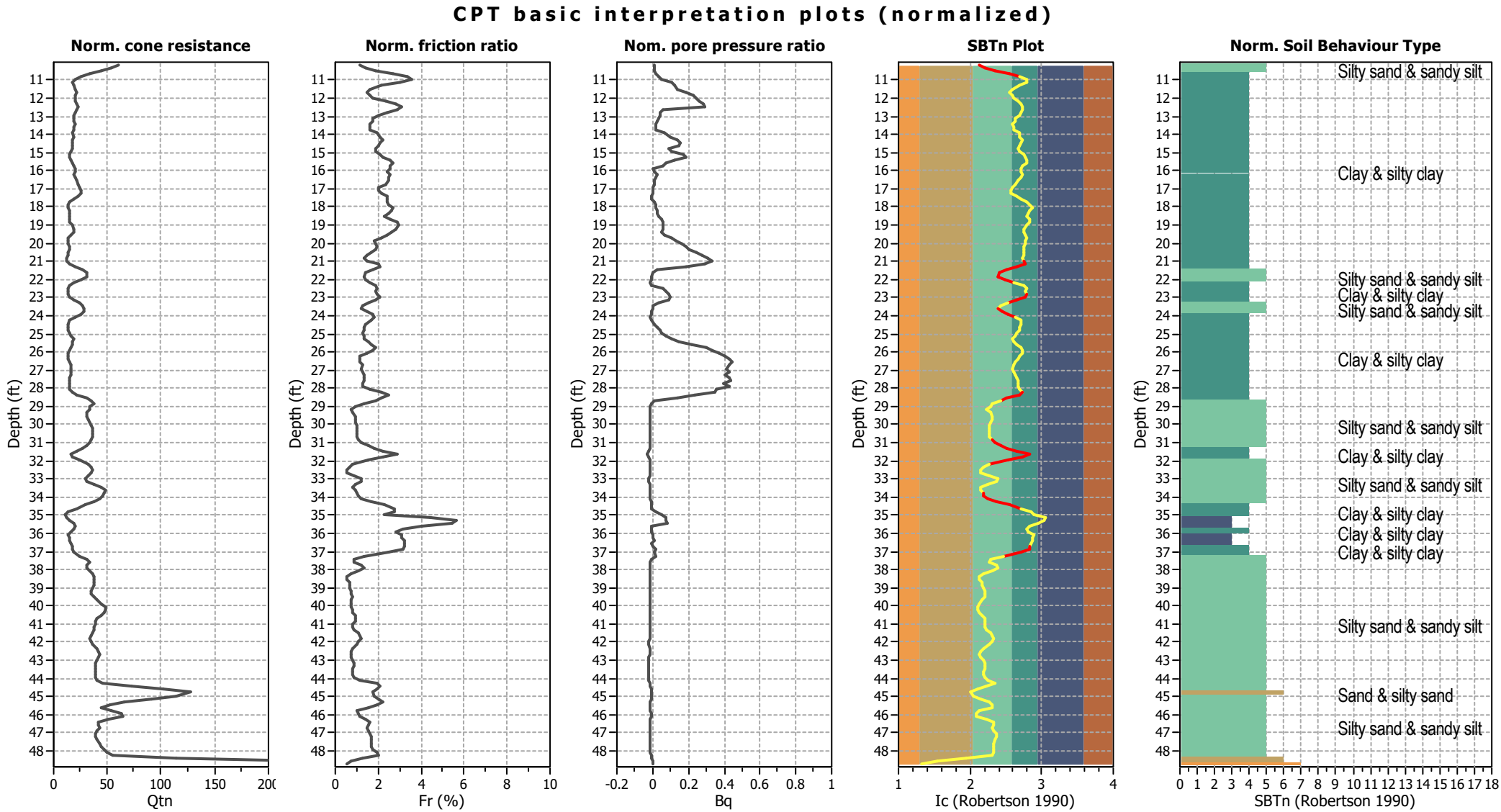


Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	3.00	K_0 applied:	Yes
Earthquake magnitude M_w :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBT legend

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



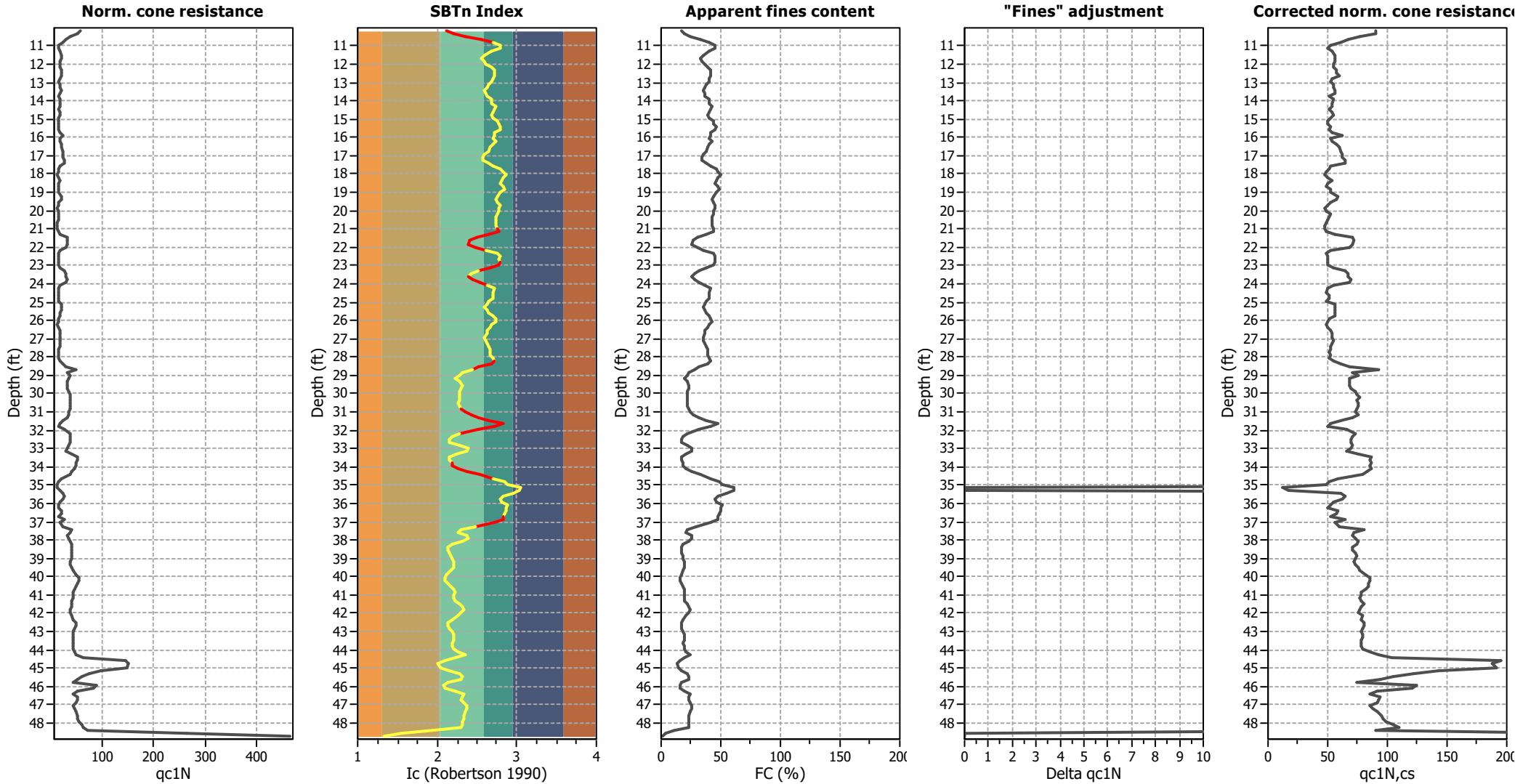
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBTn legend

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

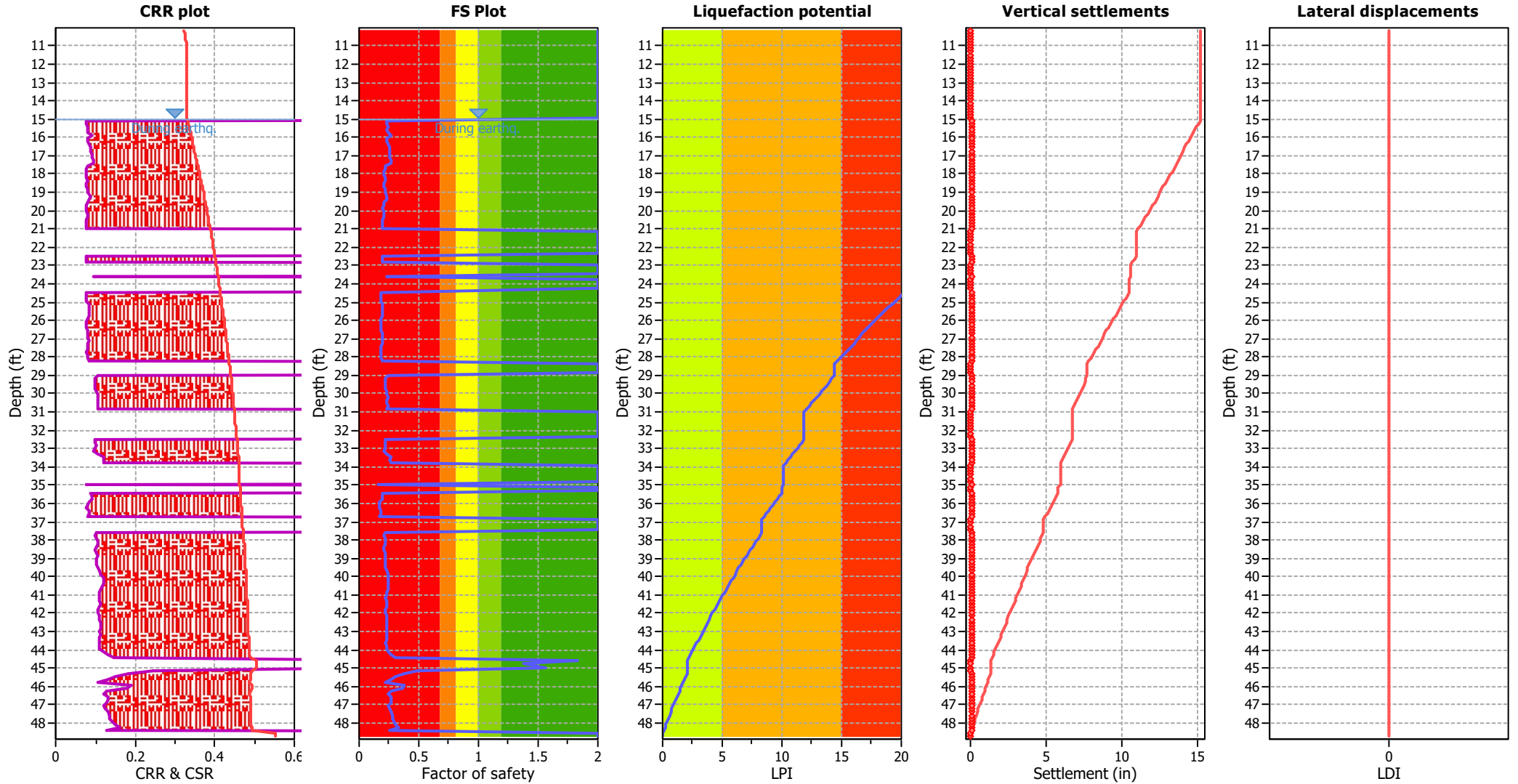
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (earthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

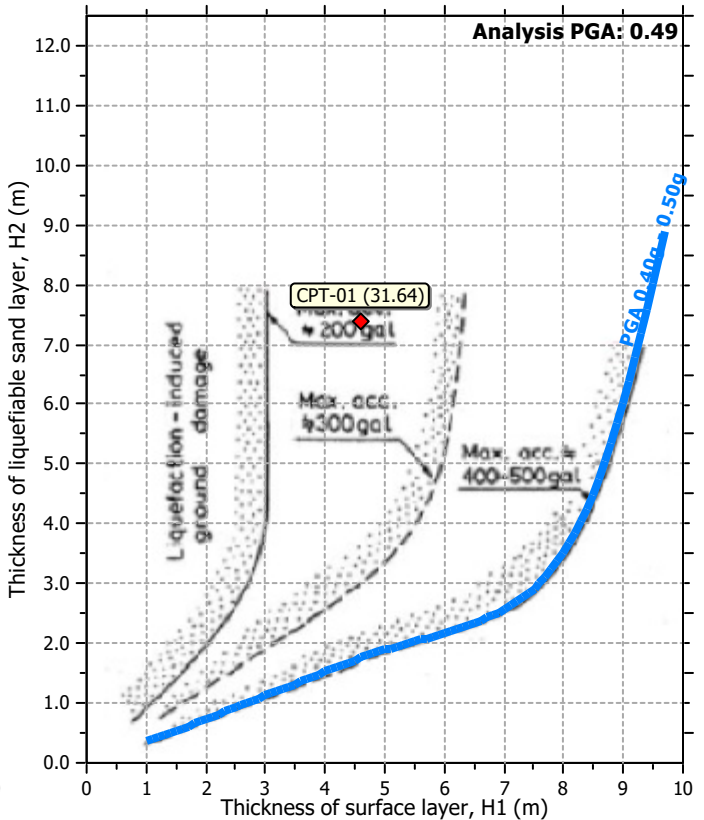
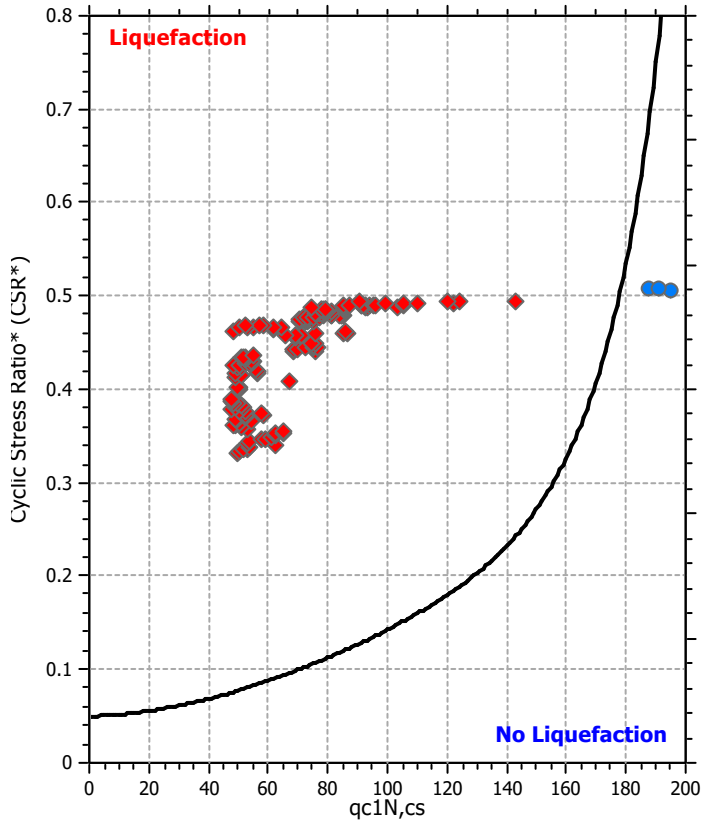
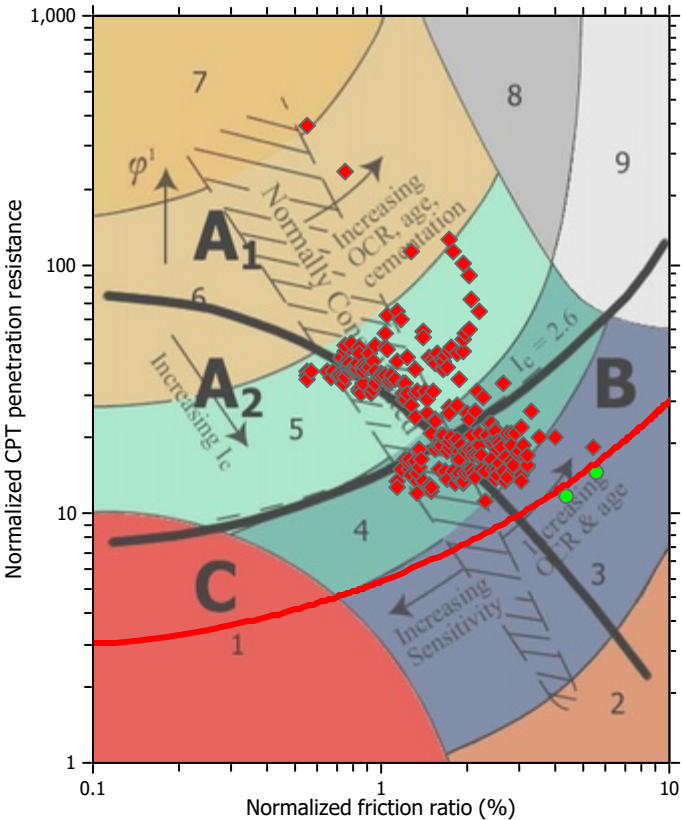
F.S. color scheme

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

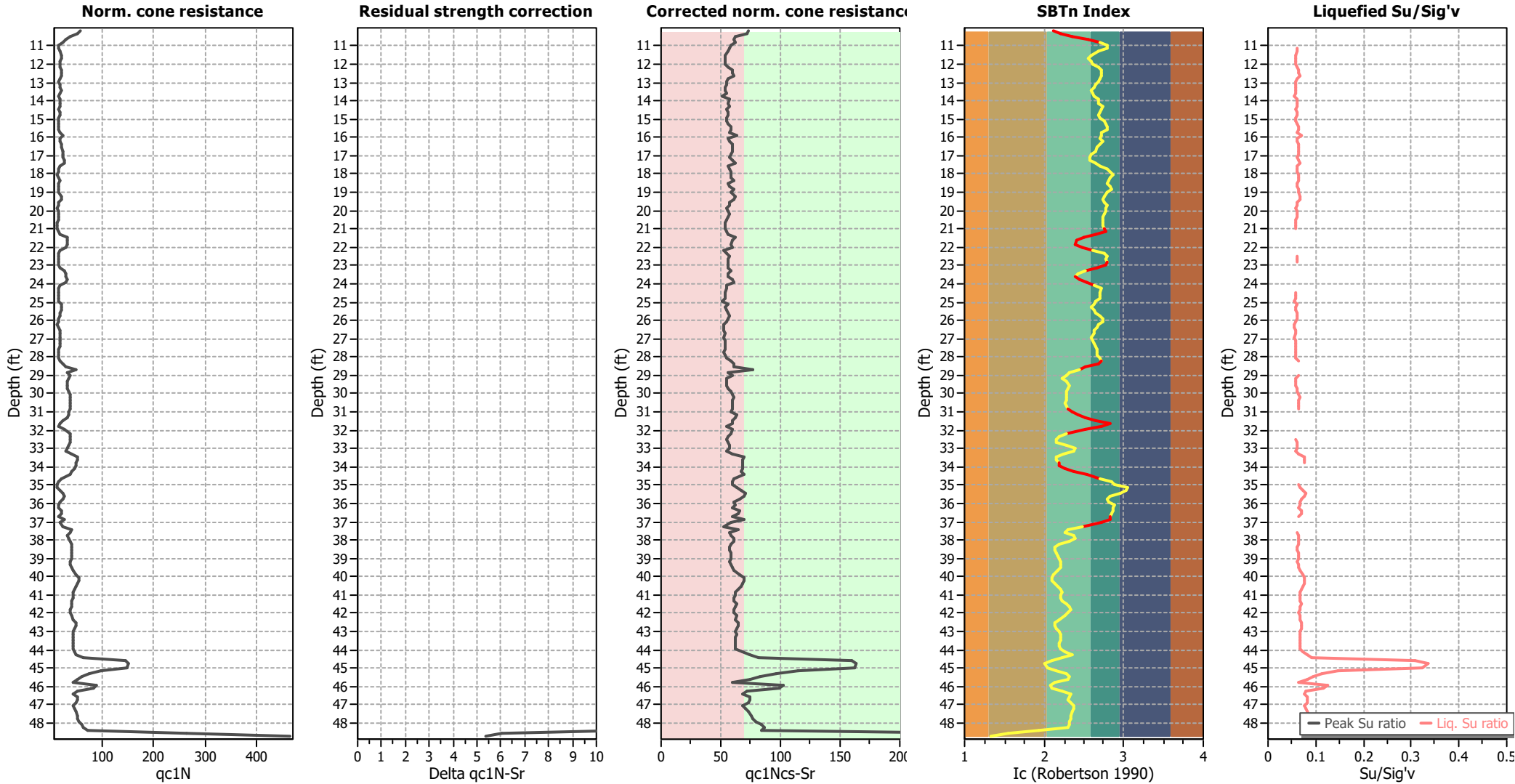
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	3.00	K_g applied:	Yes
Earthquake magnitude M_w :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

:: Field input data ::						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	44.27	0.50	3.80	16.49	114.39
2	10.34	41.24	0.49	3.59	19.28	114.42
3	10.50	29.12	0.57	4.39	24.60	114.32
4	10.66	21.60	0.60	6.58	32.89	114.08
5	10.83	17.70	0.61	8.30	40.40	112.93
6	10.99	12.61	0.46	9.72	45.46	111.12
7	11.15	11.29	0.33	17.74	45.70	108.86
8	11.32	13.23	0.27	21.93	39.99	107.20
9	11.48	15.63	0.22	28.15	34.91	106.23
10	11.65	16.00	0.20	38.11	33.26	106.00
11	11.81	15.41	0.24	46.75	34.59	106.48
12	11.97	14.99	0.27	49.00	36.13	106.90
13	12.14	15.01	0.25	52.62	39.28	109.08
14	12.30	16.27	0.50	60.47	41.45	110.82
15	12.47	16.53	0.53	64.93	41.82	112.11
16	12.63	18.04	0.47	13.05	41.86	111.28
17	12.79	14.41	0.36	9.26	40.66	109.43
18	12.96	13.98	0.25	8.37	39.71	107.56
19	13.12	15.43	0.24	6.84	37.34	106.56
20	13.29	15.61	0.24	5.16	36.53	107.24
21	13.45	16.80	0.30	4.26	35.27	106.93
22	13.62	16.83	0.20	3.67	36.22	106.66
23	13.78	13.92	0.22	4.08	36.33	106.43
24	13.94	16.42	0.28	13.32	39.69	107.58
25	14.11	15.07	0.33	21.01	40.03	108.35
26	14.27	15.42	0.31	26.63	42.16	108.25
27	14.44	13.85	0.29	30.29	41.29	107.93
28	14.60	15.68	0.29	29.72	40.14	107.97
29	14.76	17.17	0.30	19.29	39.17	107.71
30	14.93	14.79	0.25	20.50	40.48	107.13
31	15.09	13.03	0.24	30.18	43.63	107.01
32	15.26	13.52	0.31	34.45	44.48	107.71
33	15.42	15.34	0.33	23.16	45.76	109.18
34	15.58	14.73	0.42	15.87	45.31	110.13
35	15.75	16.19	0.43	14.51	41.80	111.21
36	15.91	22.49	0.45	1.64	41.21	111.26
37	16.08	15.83	0.42	2.51	40.80	110.97
38	16.24	16.14	0.38	5.51	42.53	110.64
39	16.40	19.40	0.42	5.06	40.68	111.43
40	16.57	20.62	0.52	4.01	38.98	112.45
41	16.73	21.94	0.53	3.20	37.27	112.65
42	16.90	23.20	0.43	2.27	34.76	111.93
43	17.06	23.21	0.36	1.07	33.75	112.26
44	17.22	25.37	0.57	0.15	34.19	112.96
45	17.39	24.90	0.56	-0.23	37.78	112.96
46	17.55	16.17	0.41	0.20	40.99	111.06
47	17.72	14.59	0.29	2.31	46.00	108.86
48	17.88	13.56	0.30	3.89	48.10	108.14

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	12.72	0.34	4.68	49.71	108.72
50	18.21	14.28	0.37	5.63	47.42	109.40
51	18.37	17.25	0.37	6.22	46.27	109.31
52	18.54	13.87	0.32	7.78	45.37	108.46
53	18.70	13.60	0.26	10.16	47.46	108.94
54	18.86	16.12	0.44	12.98	48.37	110.36
55	19.03	16.01	0.52	15.76	45.91	112.05
56	19.19	20.58	0.51	15.13	43.79	112.41
57	19.36	20.03	0.48	14.04	42.76	111.84
58	19.52	16.02	0.41	17.21	43.99	110.09
59	19.68	14.60	0.25	21.08	45.53	107.63
60	19.85	13.02	0.20	25.28	44.55	105.96
61	20.01	14.01	0.24	31.91	44.30	106.54
62	20.18	16.02	0.30	38.02	43.65	107.45
63	20.34	15.63	0.28	42.75	42.98	107.29
64	20.50	14.56	0.22	47.22	42.93	106.04
65	20.67	13.72	0.19	50.01	42.87	104.48
66	20.83	12.95	0.16	53.93	42.54	103.23
67	21.00	12.93	0.14	58.24	43.73	104.08
68	21.16	13.98	0.25	60.52	44.14	107.85
69	21.32	19.63	0.48	56.66	37.71	111.49
70	21.49	31.55	0.55	11.21	31.01	112.87
71	21.65	33.65	0.38	3.52	26.69	112.98
72	21.82	33.26	0.43	1.13	26.18	112.26
73	21.98	30.16	0.43	0.06	29.95	111.02
74	22.15	17.47	0.25	-0.08	35.97	109.12
75	22.31	14.34	0.26	2.06	43.35	107.34
76	22.47	15.37	0.29	14.74	45.08	107.19
77	22.64	15.32	0.25	17.46	44.62	107.13
78	22.80	14.83	0.25	20.43	45.16	107.10
79	22.97	14.80	0.29	24.27	44.39	108.57
80	23.13	19.36	0.40	27.88	38.33	110.37
81	23.29	28.06	0.42	13.81	31.81	111.15
82	23.46	30.52	0.33	5.48	27.46	111.10
83	23.62	31.02	0.34	3.11	26.13	111.20
84	23.79	32.93	0.41	1.95	28.06	112.71
85	23.95	31.08	0.57	1.05	32.05	112.76
86	24.11	20.07	0.40	0.72	36.86	110.91
87	24.28	16.08	0.19	2.30	41.27	107.42
88	24.44	15.10	0.20	5.38	40.82	105.31
89	24.61	16.32	0.22	8.65	40.19	104.99
90	24.77	16.34	0.16	12.41	40.24	105.03
91	24.93	15.20	0.20	15.98	37.53	105.52
92	25.10	21.10	0.24	22.91	36.81	107.16
93	25.26	21.33	0.29	32.98	34.86	108.07
94	25.43	21.04	0.27	45.10	36.37	108.90
95	25.59	20.81	0.34	62.90	37.89	109.48
96	25.75	20.45	0.37	79.79	40.61	109.49

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	16.90	0.30	79.22	42.03	108.14
98	26.08	15.61	0.19	78.55	42.32	105.64
99	26.25	14.86	0.14	84.39	39.68	103.61
100	26.41	16.32	0.15	94.88	38.42	104.18
101	26.57	18.41	0.22	107.86	36.80	105.41
102	26.74	19.84	0.22	111.38	36.32	106.51
103	26.90	19.73	0.23	111.12	35.27	106.61
104	27.07	20.50	0.22	115.39	35.80	106.95
105	27.23	19.93	0.25	106.34	36.77	107.05
106	27.39	18.48	0.24	107.57	38.07	106.85
107	27.56	18.10	0.21	104.57	38.94	106.21
108	27.72	17.27	0.20	95.10	38.51	105.72
109	27.89	18.12	0.20	100.86	38.88	105.70
110	28.05	17.63	0.21	90.45	40.32	107.93
111	28.21	20.45	0.40	100.17	41.85	111.43
112	28.38	25.24	0.65	86.04	39.57	114.66
113	28.54	32.64	0.79	74.06	31.26	117.17
114	28.71	54.08	0.87	9.96	27.93	117.16
115	28.87	37.61	0.57	1.67	23.16	115.42
116	29.04	43.12	0.27	-1.31	21.98	111.89
117	29.20	39.08	0.26	-2.00	20.06	109.95
118	29.36	36.94	0.32	-1.94	21.90	110.29
119	29.53	36.40	0.33	-1.79	22.88	110.86
120	29.69	37.85	0.33	-1.60	22.61	111.38
121	29.86	40.86	0.38	-1.47	21.98	112.12
122	30.02	43.29	0.41	-1.32	21.55	112.89
123	30.18	44.52	0.44	-1.18	21.64	113.39
124	30.35	43.55	0.45	-1.06	21.57	113.38
125	30.51	43.81	0.41	-0.96	21.39	113.20
126	30.68	44.55	0.40	-1.01	21.48	113.05
127	30.84	42.43	0.43	-1.13	22.68	113.39
128	31.00	40.10	0.48	-1.08	24.21	113.96
129	31.17	41.09	0.52	-0.98	27.31	115.06
130	31.33	36.05	0.69	-1.04	31.41	115.20
131	31.50	26.89	0.59	-1.15	38.09	114.20
132	31.66	19.49	0.42	-0.28	47.56	113.51
133	31.82	17.27	0.68	1.43	41.90	112.40
134	31.99	32.32	0.31	2.94	31.67	112.75
135	32.15	43.02	0.35	0.21	21.66	110.88
136	32.32	44.42	0.29	-1.70	18.59	110.26
137	32.48	45.04	0.21	-2.13	17.20	109.06
138	32.64	44.92	0.22	-2.40	17.54	108.85
139	32.81	41.45	0.27	-2.53	21.51	111.28
140	32.97	36.91	0.50	-2.54	26.19	113.02
141	33.14	34.25	0.53	-2.32	25.31	113.30
142	33.30	46.57	0.30	-2.23	20.55	113.55
143	33.47	61.33	0.47	-2.53	17.41	114.29
144	33.63	59.86	0.59	-2.62	17.53	115.94

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	59.23	0.61	-2.50	18.46	116.43
146	33.96	58.61	0.59	-2.23	18.79	116.24
147	34.12	56.15	0.55	-1.98	21.00	116.88
148	34.28	49.79	0.81	5.90	25.31	118.08
149	34.45	43.69	1.01	5.34	32.72	118.13
150	34.61	25.82	0.76	5.27	40.90	116.44
151	34.78	18.98	0.49	12.66	49.27	112.71
152	34.94	16.53	0.29	19.17	51.22	109.32
153	35.10	15.17	0.25	23.84	61.48	114.44
154	35.27	20.42	1.51	28.70	60.88	118.31
155	35.43	28.15	1.49	35.63	55.16	120.42
156	35.60	30.96	1.03	5.10	47.65	119.15
157	35.76	28.49	0.76	6.50	45.12	116.62
158	35.92	22.36	0.58	7.06	46.55	114.41
159	36.09	20.50	0.49	8.73	51.54	113.46
160	36.25	18.52	0.62	10.66	50.39	113.99
161	36.42	25.55	0.68	12.26	49.69	114.96
162	36.58	24.68	0.70	8.53	49.16	115.30
163	36.74	20.62	0.70	11.01	47.40	116.23
164	36.91	31.78	0.89	15.61	47.46	115.87
165	37.07	23.41	0.60	14.28	41.40	115.16
166	37.24	29.17	0.43	18.27	29.55	112.72
167	37.40	51.52	0.25	5.03	22.44	111.54
168	37.57	45.17	0.35	1.07	21.26	112.46
169	37.73	40.47	0.53	0.80	25.55	114.38
170	37.89	42.59	0.62	0.24	26.17	115.04
171	38.06	46.67	0.48	-0.88	22.91	114.09
172	38.22	49.95	0.30	-1.54	18.82	111.74
173	38.39	50.90	0.22	-2.09	16.79	110.21
174	38.55	50.68	0.29	-2.31	16.82	110.53
175	38.71	51.91	0.33	-2.30	17.67	111.54
176	38.88	51.68	0.34	-0.79	18.15	111.89
177	39.04	49.97	0.34	-0.67	18.71	111.80
178	39.21	47.94	0.33	-0.58	19.25	111.86
179	39.37	48.89	0.36	-0.50	19.42	112.22
180	39.53	51.39	0.38	-0.37	19.03	112.94
181	39.70	55.28	0.42	-0.24	17.85	113.69
182	39.86	62.40	0.45	-0.08	16.48	114.42
183	40.03	67.96	0.47	0.05	15.74	115.07
184	40.19	67.42	0.51	0.18	15.91	115.52
185	40.35	65.06	0.53	0.27	16.83	115.70
186	40.52	61.77	0.53	0.43	18.19	115.76
187	40.68	57.34	0.55	0.61	19.31	115.44
188	40.85	54.45	0.49	0.84	19.56	114.77
189	41.01	55.14	0.41	1.00	19.08	113.87
190	41.17	54.13	0.40	0.87	18.93	113.58
191	41.34	53.57	0.44	0.38	19.76	114.09
192	41.50	53.58	0.50	0.01	22.02	115.53

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	50.98	0.70	-0.42	22.84	115.43
194	41.83	48.43	0.44	-0.66	23.92	115.57
195	41.99	49.03	0.55	-1.36	22.59	114.92
196	42.16	53.80	0.54	-2.19	21.22	114.98
197	42.32	56.90	0.42	-2.51	18.59	114.45
198	42.49	62.50	0.41	-2.87	17.01	113.96
199	42.65	62.11	0.44	-3.16	16.86	114.15
200	42.81	59.85	0.45	-3.32	17.60	114.21
201	42.98	57.43	0.43	-3.38	18.52	114.41
202	43.14	57.06	0.49	-3.44	19.23	114.59
203	43.31	56.46	0.49	-3.46	19.46	114.66
204	43.47	56.58	0.44	-3.47	19.09	114.21
205	43.63	56.49	0.40	-3.48	18.70	113.81
206	43.80	56.40	0.42	-3.47	18.90	114.08
207	43.96	57.33	0.49	-3.41	19.09	114.83
208	44.13	61.15	0.53	-3.33	20.95	117.31
209	44.29	64.09	0.98	-3.26	24.69	122.27
210	44.45	79.71	2.27	-3.17	19.75	127.17
211	44.62	175.08	3.13	-3.00	15.75	129.88
212	44.78	184.03	2.90	-1.22	12.90	131.15
213	44.95	180.30	3.19	-0.82	14.07	130.34
214	45.11	122.94	2.45	-2.34	17.28	129.26
215	45.28	95.12	2.25	-2.24	21.62	126.99
216	45.44	78.46	1.67	-2.53	22.95	124.04
217	45.60	67.63	0.65	-2.45	22.76	120.73
218	45.77	58.60	0.75	-2.36	16.86	119.21
219	45.93	112.39	0.97	0.86	15.27	120.92
220	46.10	107.52	1.12	1.00	15.56	121.91
221	46.26	69.34	1.12	1.21	19.89	121.38
222	46.42	59.30	0.96	1.63	23.94	120.62
223	46.59	68.11	0.99	2.43	23.44	120.12
224	46.75	68.02	0.92	2.12	22.62	120.14
225	46.92	65.43	0.93	1.25	23.85	120.00
226	47.08	58.64	0.98	1.06	25.15	120.07
227	47.24	60.76	0.99	1.19	25.46	120.30
228	47.41	65.96	1.02	1.40	24.41	120.73
229	47.57	69.53	1.10	1.60	23.77	121.25
230	47.74	70.60	1.16	1.85	23.58	121.86
231	47.90	74.13	1.27	2.19	23.30	122.56
232	48.06	79.80	1.39	2.48	23.41	123.80
233	48.23	85.04	1.77	2.81	22.68	125.13
234	48.39	98.55	1.98	3.18	11.36	128.16
235	48.56	317.46	2.53	3.82	3.50	130.78
236	48.72	558.34	2.69	5.59	0.66	132.42

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)

Abbreviations

- Depth: Depth from free surface, at which CPT was performed (ft)
- q_c: Measured cone resistance (tsf)
- f_s: Sleeve friction resistance (tsf)
- u: Pore pressure (tsf)
- Fines content: Percentage of fines in soil (%)
- Unit weight: Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	43.26	60.80	1.45	88.39	2.12	0.08	0.73
10.34	38.21	54.05	1.64	88.40	2.21	0.08	0.73
10.50	30.65	44.07	2.15	94.82	2.35	0.07	0.70
10.66	22.81	33.52	3.33	111.64	2.55	0.07	0.68
10.83	17.30	25.65	4.69	120.43	2.70	0.07	0.66
10.99	13.87	20.46	5.74	117.37	2.79	0.06	0.63
11.15	12.38	17.92	5.79	103.76	2.79	0.06	0.63
11.32	13.38	18.83	4.61	86.89	2.69	0.06	0.64
11.48	14.95	20.51	3.67	75.34	2.59	0.06	0.65
11.65	15.68	21.17	3.39	71.79	2.56	0.06	0.65
11.81	15.47	20.72	3.62	74.99	2.58	0.06	0.64
11.97	15.14	20.13	3.89	78.32	2.62	0.06	0.64
12.14	15.42	20.49	4.48	91.75	2.68	0.06	0.64
12.30	15.94	21.08	4.90	103.39	2.72	0.06	0.65
12.47	16.95	22.23	4.98	110.69	2.73	0.06	0.65
12.63	16.33	21.12	4.99	105.34	2.73	0.07	0.65
12.79	15.48	19.67	4.75	93.39	2.70	0.06	0.64
12.96	14.61	18.25	4.56	83.26	2.69	0.06	0.63
13.12	15.01	18.46	4.11	75.89	2.64	0.06	0.64
13.29	15.95	19.42	3.96	76.96	2.62	0.06	0.64
13.45	16.41	19.74	3.74	73.76	2.60	0.06	0.64
13.62	15.85	18.87	3.91	73.72	2.62	0.06	0.64
13.78	15.72	18.53	3.93	72.74	2.62	0.06	0.63
13.94	15.14	17.74	4.56	80.87	2.69	0.06	0.64
14.11	15.64	18.18	4.62	84.05	2.69	0.06	0.64
14.27	14.78	17.02	5.05	85.90	2.73	0.06	0.64
14.44	14.98	17.06	4.87	83.10	2.72	0.06	0.63
14.60	15.57	17.54	4.65	81.46	2.69	0.06	0.64
14.76	15.88	17.70	4.46	78.86	2.68	0.06	0.64
14.93	15.00	16.53	4.71	77.87	2.70	0.06	0.63
15.09	13.78	15.07	5.35	80.64	2.76	0.06	0.62
15.26	13.96	15.23	5.53	84.25	2.77	0.06	0.63
15.42	14.53	15.84	5.80	91.93	2.80	0.06	0.63
15.58	15.42	16.78	5.70	95.74	2.79	0.06	0.63
15.75	17.80	19.34	4.97	96.22	2.73	0.06	0.64
15.91	18.17	19.65	4.86	95.44	2.71	0.07	0.66
16.08	18.15	19.53	4.78	93.24	2.71	0.06	0.64
16.24	17.12	18.32	5.12	93.85	2.74	0.06	0.64
16.40	18.72	19.98	4.75	94.92	2.70	0.06	0.65
16.57	20.65	21.99	4.42	97.21	2.67	0.06	0.65
16.73	21.92	23.24	4.10	95.25	2.64	0.06	0.66
16.90	22.78	24.01	3.65	87.61	2.59	0.06	0.66
17.06	23.93	25.13	3.47	87.29	2.57	0.06	0.66
17.22	24.49	25.65	3.55	91.05	2.58	0.07	0.67
17.39	22.15	23.09	4.19	96.80	2.65	0.07	0.67
17.55	18.55	19.15	4.81	92.19	2.71	0.06	0.64
17.72	14.77	15.04	5.85	88.05	2.80	0.06	0.63
17.88	13.62	13.75	6.31	86.82	2.84	0.06	0.62

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	13.52	13.59	6.68	90.75	2.86	0.06	0.62
18.21	14.75	14.83	6.16	91.39	2.82	0.06	0.63
18.37	15.13	15.16	5.91	89.62	2.80	0.07	0.64
18.54	14.91	14.83	5.72	84.81	2.79	0.06	0.62
18.70	14.53	14.39	6.17	88.83	2.83	0.06	0.62
18.86	15.24	15.09	6.38	96.22	2.84	0.07	0.63
19.03	17.57	17.45	5.83	101.82	2.80	0.06	0.63
19.19	18.87	18.71	5.38	100.76	2.76	0.07	0.65
19.36	18.88	18.62	5.17	96.25	2.74	0.07	0.65
19.52	16.88	16.47	5.43	89.36	2.76	0.06	0.63
19.68	14.55	13.99	5.75	80.48	2.79	0.06	0.63
19.85	13.88	13.23	5.54	73.33	2.77	0.06	0.62
20.01	14.35	13.66	5.49	75.00	2.77	0.06	0.62
20.18	15.22	14.49	5.36	77.59	2.76	0.06	0.63
20.34	15.40	14.61	5.22	76.18	2.75	0.06	0.63
20.50	14.64	13.77	5.21	71.66	2.75	0.06	0.62
20.67	13.74	12.80	5.19	66.50	2.74	0.06	0.62
20.83	13.20	12.20	5.12	62.53	2.74	0.06	0.62
21.00	13.29	12.25	5.37	65.79	2.76	0.06	0.62
21.16	15.51	14.44	5.46	78.80	2.77	0.06	0.62
21.32	21.72	20.55	4.18	85.89	2.65	0.06	0.64
21.49	28.28	26.91	3.03	81.52	2.51	0.07	0.68
21.65	32.82	31.24	2.41	75.31	2.41	0.06	0.69
21.82	32.36	30.66	2.34	71.88	2.39	0.06	0.69
21.98	26.96	25.30	2.87	72.54	2.48	0.06	0.68
22.15	20.66	19.07	3.86	73.65	2.61	0.06	0.63
22.31	15.73	14.21	5.29	75.19	2.75	0.06	0.62
22.47	15.01	13.46	5.66	76.11	2.78	0.06	0.63
22.64	15.17	13.56	5.56	75.36	2.78	0.06	0.63
22.80	14.98	13.32	5.67	75.58	2.79	0.06	0.62
22.97	16.33	14.57	5.51	80.27	2.77	0.06	0.62
23.13	20.74	18.74	4.30	80.51	2.66	0.06	0.64
23.29	25.98	23.68	3.15	74.69	2.52	0.06	0.67
23.46	29.87	27.29	2.51	68.58	2.43	0.06	0.68
23.62	31.49	28.74	2.34	67.19	2.39	0.06	0.68
23.79	31.68	28.82	2.59	74.79	2.44	0.06	0.68
23.95	28.03	25.27	3.19	80.69	2.53	0.07	0.68
24.11	22.41	19.87	4.02	79.94	2.63	0.06	0.64
24.28	17.08	14.79	4.87	72.00	2.72	0.06	0.63
24.44	15.83	13.57	4.78	64.83	2.71	0.06	0.62
24.61	15.92	13.60	4.65	63.30	2.70	0.06	0.63
24.77	15.95	13.58	4.67	63.36	2.70	0.06	0.63
24.93	17.55	15.02	4.15	62.25	2.64	0.05	0.62
25.10	19.21	16.51	4.01	66.26	2.63	0.06	0.65
25.26	21.16	18.25	3.66	66.89	2.59	0.06	0.65
25.43	21.06	18.09	3.93	71.15	2.62	0.06	0.65
25.59	20.77	17.75	4.21	74.79	2.65	0.06	0.64
25.75	19.39	16.41	4.74	77.75	2.70	0.06	0.64

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	17.65	14.76	5.02	74.16	2.73	0.06	0.63
26.08	15.79	13.02	5.08	66.13	2.73	0.06	0.62
26.25	15.60	12.81	4.56	58.35	2.69	0.06	0.62
26.41	16.53	13.61	4.31	58.72	2.66	0.06	0.63
26.57	18.19	15.07	4.01	60.47	2.63	0.06	0.63
26.74	19.33	16.05	3.92	62.97	2.62	0.06	0.64
26.90	20.02	16.62	3.74	62.14	2.60	0.06	0.64
27.07	20.05	16.59	3.83	63.56	2.61	0.06	0.64
27.23	19.64	16.15	4.01	64.72	2.63	0.06	0.64
27.39	18.84	15.38	4.25	65.30	2.65	0.06	0.63
27.56	17.95	14.53	4.41	64.12	2.67	0.06	0.63
27.72	17.83	14.38	4.33	62.29	2.66	0.06	0.63
27.89	17.67	14.19	4.40	62.45	2.67	0.06	0.63
28.05	18.73	15.06	4.68	70.48	2.70	0.06	0.63
28.21	21.11	17.06	4.98	85.04	2.73	0.06	0.64
28.38	26.11	21.37	4.53	96.89	2.68	0.07	0.66
28.54	37.32	31.20	3.07	95.72	2.51	0.07	0.68
28.71	41.44	34.78	2.58	89.61	2.44	0.09	0.73
28.87	44.94	37.87	1.99	75.40	2.32	0.06	0.68
29.04	39.94	33.44	1.87	62.57	2.29	0.07	0.70
29.20	39.71	33.22	1.70	56.41	2.23	0.06	0.68
29.36	37.47	31.12	1.86	57.97	2.28	0.06	0.68
29.53	37.06	30.64	1.96	60.09	2.31	0.06	0.68
29.69	38.37	31.68	1.93	61.26	2.30	0.06	0.68
29.86	40.67	33.59	1.87	62.85	2.29	0.06	0.69
30.02	42.89	35.42	1.83	64.80	2.27	0.06	0.70
30.18	43.79	36.08	1.84	66.31	2.28	0.07	0.70
30.35	43.96	36.13	1.83	66.17	2.27	0.06	0.70
30.51	43.97	36.04	1.81	65.41	2.27	0.06	0.70
30.68	43.60	35.61	1.82	64.92	2.27	0.07	0.70
30.84	42.36	34.40	1.94	66.78	2.30	0.06	0.69
31.00	41.21	33.25	2.11	70.04	2.34	0.06	0.69
31.17	39.08	31.23	2.49	77.83	2.42	0.07	0.70
31.33	34.68	27.31	3.09	84.44	2.52	0.07	0.69
31.50	27.48	21.09	4.25	89.69	2.65	0.07	0.66
31.66	21.22	15.74	6.20	97.51	2.83	0.07	0.63
31.82	23.03	17.25	5.00	86.16	2.73	0.06	0.63
31.99	30.87	23.83	3.13	74.66	2.52	0.06	0.67
32.15	39.92	31.64	1.84	58.20	2.28	0.06	0.69
32.32	44.16	35.27	1.58	55.89	2.19	0.06	0.69
32.48	44.79	35.81	1.49	53.51	2.15	0.06	0.68
32.64	43.80	34.87	1.51	52.82	2.16	0.06	0.68
32.81	41.09	32.28	1.83	58.92	2.27	0.06	0.69
32.97	37.54	29.02	2.35	68.06	2.39	0.06	0.68
33.14	39.24	30.37	2.24	67.90	2.37	0.06	0.67
33.30	47.38	37.21	1.74	64.70	2.25	0.06	0.70
33.47	55.92	44.37	1.51	66.86	2.15	0.08	0.72
33.63	60.14	47.69	1.51	72.20	2.16	0.07	0.72

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	59.23	46.72	1.58	73.62	2.18	0.08	0.72
33.96	58.00	45.55	1.60	72.82	2.19	0.07	0.72
34.12	54.85	42.66	1.78	75.87	2.26	0.08	0.72
34.28	49.88	38.19	2.24	85.38	2.37	0.07	0.71
34.45	39.77	29.62	3.30	97.82	2.54	0.08	0.70
34.61	29.50	21.22	4.80	101.77	2.71	0.07	0.65
34.78	20.44	14.03	6.58	92.28	2.86	0.07	0.63
34.94	16.89	11.30	7.02	79.37	2.89	0.06	0.62
35.10	17.37	11.62	9.55	110.98	3.04	0.07	0.83
35.27	21.25	14.48	9.40	136.06	3.04	0.07	1.03
35.43	26.51	18.36	7.96	146.12	2.95	0.08	0.66
35.60	29.20	20.34	6.21	126.37	2.83	0.08	0.67
35.76	27.27	18.90	5.66	107.06	2.78	0.07	0.66
35.92	23.78	16.20	5.97	96.76	2.81	0.07	0.64
36.09	20.46	13.62	7.10	96.73	2.89	0.07	0.63
36.25	21.52	14.36	6.83	98.12	2.87	0.07	0.63
36.42	22.92	15.33	6.67	102.29	2.86	0.07	0.65
36.58	23.62	15.79	6.55	103.42	2.85	0.07	0.65
36.74	25.69	17.28	6.16	106.45	2.82	0.06	0.63
36.91	25.27	16.91	6.17	104.39	2.83	0.08	0.67
37.07	28.12	19.13	4.90	93.63	2.72	0.06	0.64
37.24	34.70	24.48	2.81	68.75	2.47	0.06	0.66
37.40	41.95	30.39	1.92	58.25	2.30	0.07	0.71
37.57	45.72	33.29	1.80	59.99	2.27	0.06	0.69
37.73	42.74	30.57	2.27	69.24	2.38	0.06	0.69
37.89	43.24	30.81	2.34	72.18	2.39	0.07	0.69
38.06	46.40	33.38	1.96	65.59	2.31	0.07	0.70
38.22	49.17	35.83	1.60	57.37	2.19	0.06	0.69
38.39	50.51	37.02	1.47	54.43	2.13	0.06	0.69
38.55	51.16	37.43	1.47	55.10	2.13	0.06	0.69
38.71	51.42	37.43	1.52	57.00	2.16	0.06	0.69
38.88	51.19	37.10	1.55	57.66	2.17	0.06	0.69
39.04	49.86	35.94	1.59	57.26	2.19	0.06	0.69
39.21	48.93	35.09	1.63	57.32	2.21	0.06	0.69
39.37	49.41	35.34	1.65	58.19	2.21	0.06	0.69
39.53	51.85	37.13	1.62	60.03	2.20	0.06	0.70
39.70	56.36	40.57	1.53	62.26	2.17	0.07	0.70
39.86	61.88	44.84	1.45	65.15	2.12	0.07	0.71
40.03	65.93	47.91	1.42	67.81	2.10	0.08	0.72
40.19	66.81	48.43	1.42	68.96	2.10	0.08	0.72
40.35	64.75	46.60	1.47	68.62	2.13	0.07	0.72
40.52	61.39	43.75	1.56	68.11	2.18	0.07	0.72
40.68	57.85	40.86	1.64	66.92	2.21	0.07	0.71
40.85	55.64	39.10	1.66	64.79	2.22	0.07	0.70
41.01	54.57	38.29	1.62	62.06	2.20	0.07	0.70
41.17	54.28	38.01	1.61	61.18	2.20	0.07	0.70
41.34	53.76	37.42	1.67	62.62	2.22	0.07	0.70
41.50	52.71	36.26	1.87	67.95	2.29	0.07	0.71

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_c (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	51.00	34.83	1.96	68.17	2.31	0.07	0.70
41.83	49.48	33.53	2.07	69.53	2.34	0.07	0.70
41.99	50.42	34.27	1.93	66.19	2.30	0.07	0.70
42.16	53.24	36.38	1.80	65.46	2.26	0.07	0.71
42.32	57.73	39.91	1.58	63.24	2.19	0.07	0.70
42.49	60.50	42.09	1.48	62.42	2.14	0.07	0.71
42.65	61.49	42.73	1.47	63.00	2.13	0.07	0.71
42.81	59.80	41.28	1.52	62.68	2.16	0.07	0.71
42.98	58.11	39.82	1.58	62.91	2.19	0.07	0.70
43.14	56.98	38.80	1.63	63.33	2.21	0.07	0.71
43.31	56.70	38.47	1.65	63.47	2.21	0.07	0.70
43.47	56.51	38.31	1.62	62.10	2.20	0.07	0.70
43.63	56.49	38.27	1.59	60.94	2.19	0.07	0.70
43.80	56.74	38.32	1.61	61.60	2.20	0.07	0.70
43.96	58.29	39.30	1.62	63.70	2.20	0.07	0.70
44.13	60.86	40.67	1.77	72.16	2.26	0.07	0.72
44.29	68.32	45.06	2.16	97.41	2.36	0.08	0.73
44.45	106.29	72.30	1.67	120.94	2.22	0.09	0.75
44.62	146.27	101.77	1.42	144.10	2.10	0.31	0.88
44.78	179.80	127.09	1.31	165.95	2.00	0.34	0.87
44.95	162.42	113.58	1.34	152.76	2.04	0.32	0.88
45.11	132.79	90.76	1.50	136.03	2.15	0.15	0.82
45.28	98.84	65.58	1.84	120.42	2.28	0.11	0.79
45.44	80.40	52.58	1.97	103.50	2.31	0.09	0.76
45.60	68.23	44.28	1.95	86.33	2.31	0.08	0.74
45.77	79.54	53.23	1.47	78.49	2.13	0.07	0.69
45.93	92.84	62.81	1.39	87.53	2.08	0.12	0.79
46.10	96.42	65.04	1.41	91.52	2.09	0.12	0.78
46.26	78.72	51.50	1.68	86.69	2.23	0.08	0.73
46.42	65.58	41.72	2.08	86.63	2.34	0.08	0.72
46.59	65.14	41.42	2.02	83.72	2.32	0.08	0.74
46.75	67.19	42.82	1.93	82.83	2.30	0.08	0.73
46.92	64.03	40.40	2.07	83.45	2.34	0.08	0.73
47.08	61.61	38.48	2.22	85.29	2.37	0.08	0.72
47.24	61.79	38.44	2.25	86.63	2.38	0.08	0.72
47.41	65.42	40.87	2.13	87.04	2.35	0.08	0.73
47.57	68.70	43.03	2.06	88.53	2.33	0.08	0.74
47.74	71.42	44.73	2.04	91.09	2.33	0.09	0.74
47.90	74.84	46.89	2.01	94.05	2.32	0.09	0.75
48.06	79.66	49.86	2.02	100.61	2.32	0.10	0.76
48.23	87.80	55.18	1.94	107.09	2.30	0.10	0.77
48.39	167.02	113.43	1.26	143.23	1.94	0.10	0.73
48.56	324.78	238.14	1.00	238.14	1.55	0.96	0.95
48.72	478.05	365.16	1.00	365.16	1.32	1.03	1.09

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$

Abbreviations

- q_t :Total cone resistance
- K_c :Cone resistance correction factor due to fines
- $Q_{tn,cs}$:Adjusted and corrected cone resistance due to fines
- I_c :Soil behavior type index
- $S_{u(liq)}/\sigma'_v$:Calculated liquefied undrained strength ratio
- $S_{u(peak)}/\sigma'_v$:Calculated peak undrained strength ratio

LIQUEFACTION ANALYSIS REPORT

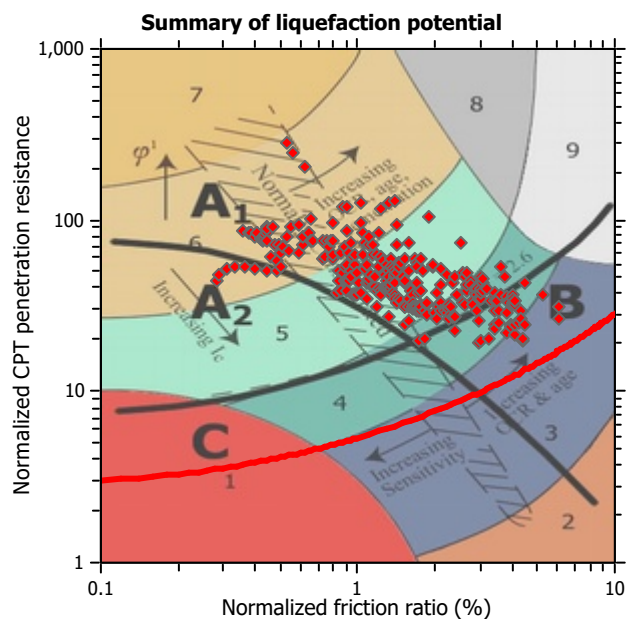
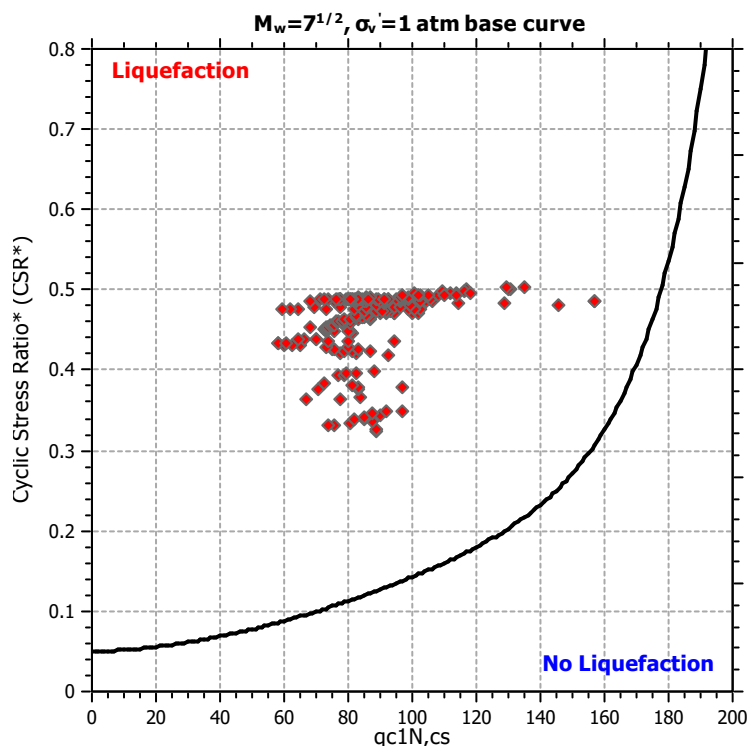
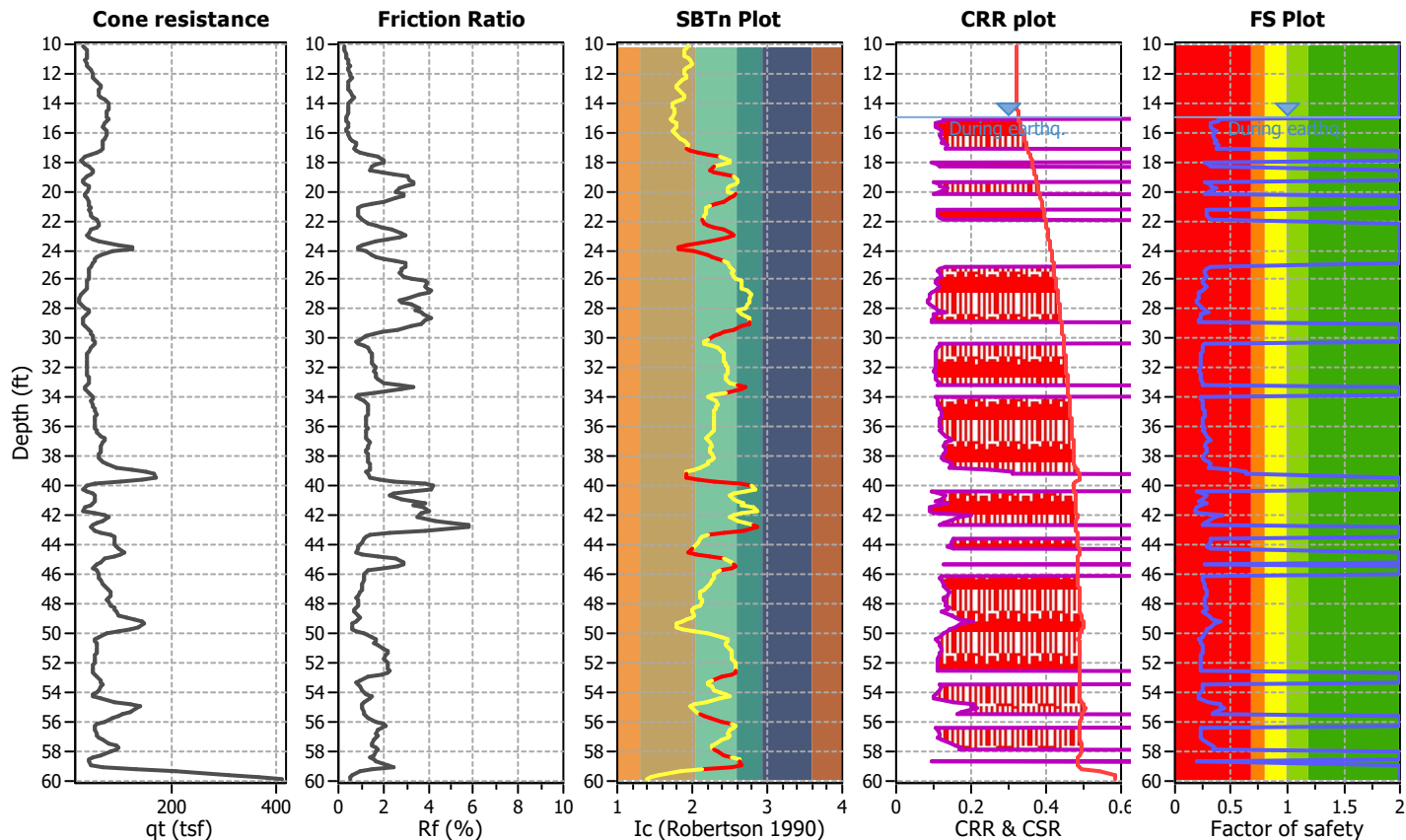
Project title : Kinder Morgan Linnton SVA

Location : Portland, Oregon

CPT file : CPT-02

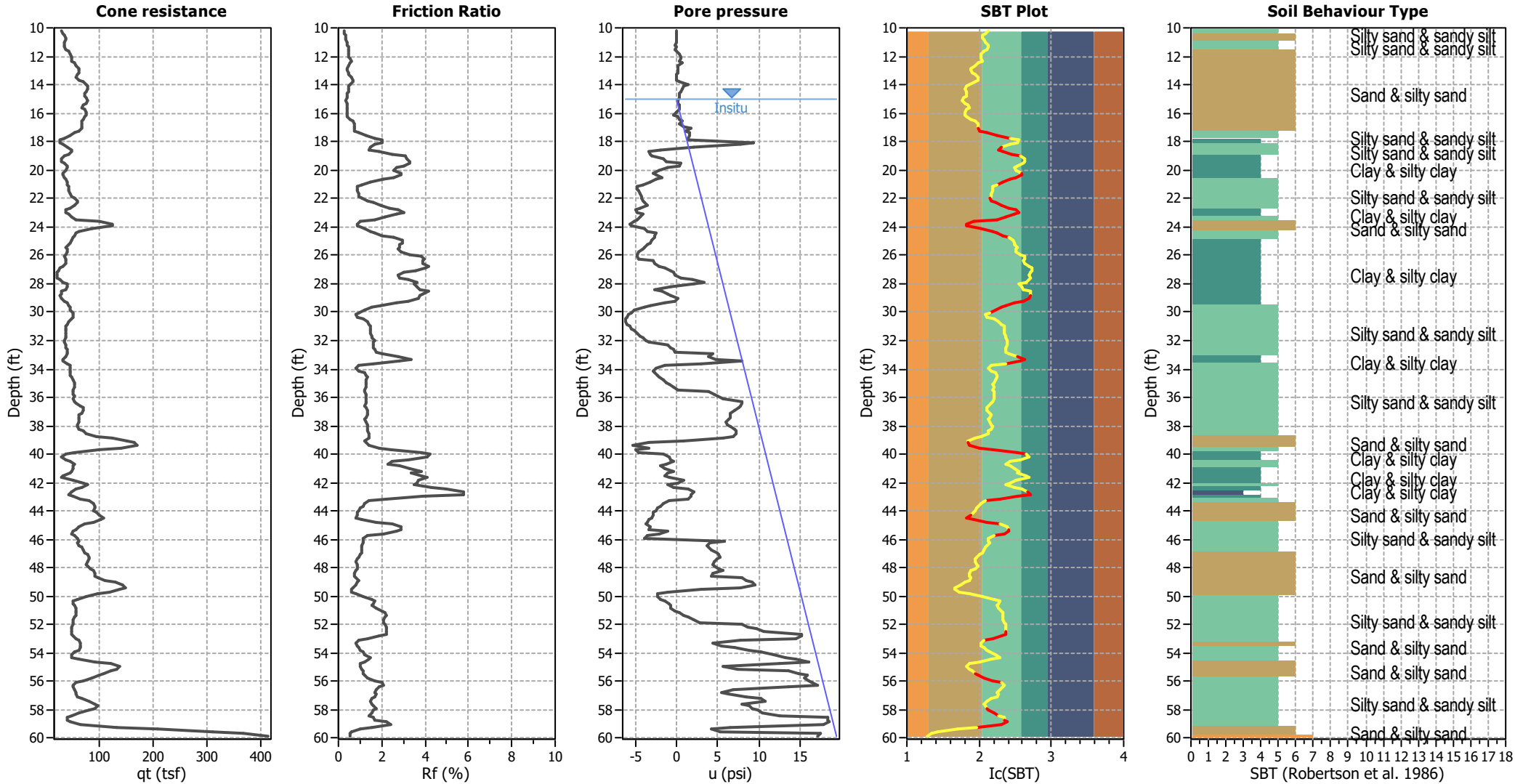
Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	R&W (1998)	G.W.T. (earthq.):	15.00 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:	Yes
Earthquake magnitude M_w :	7.78	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	80.00 ft
Peak ground acceleration:	0.49	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



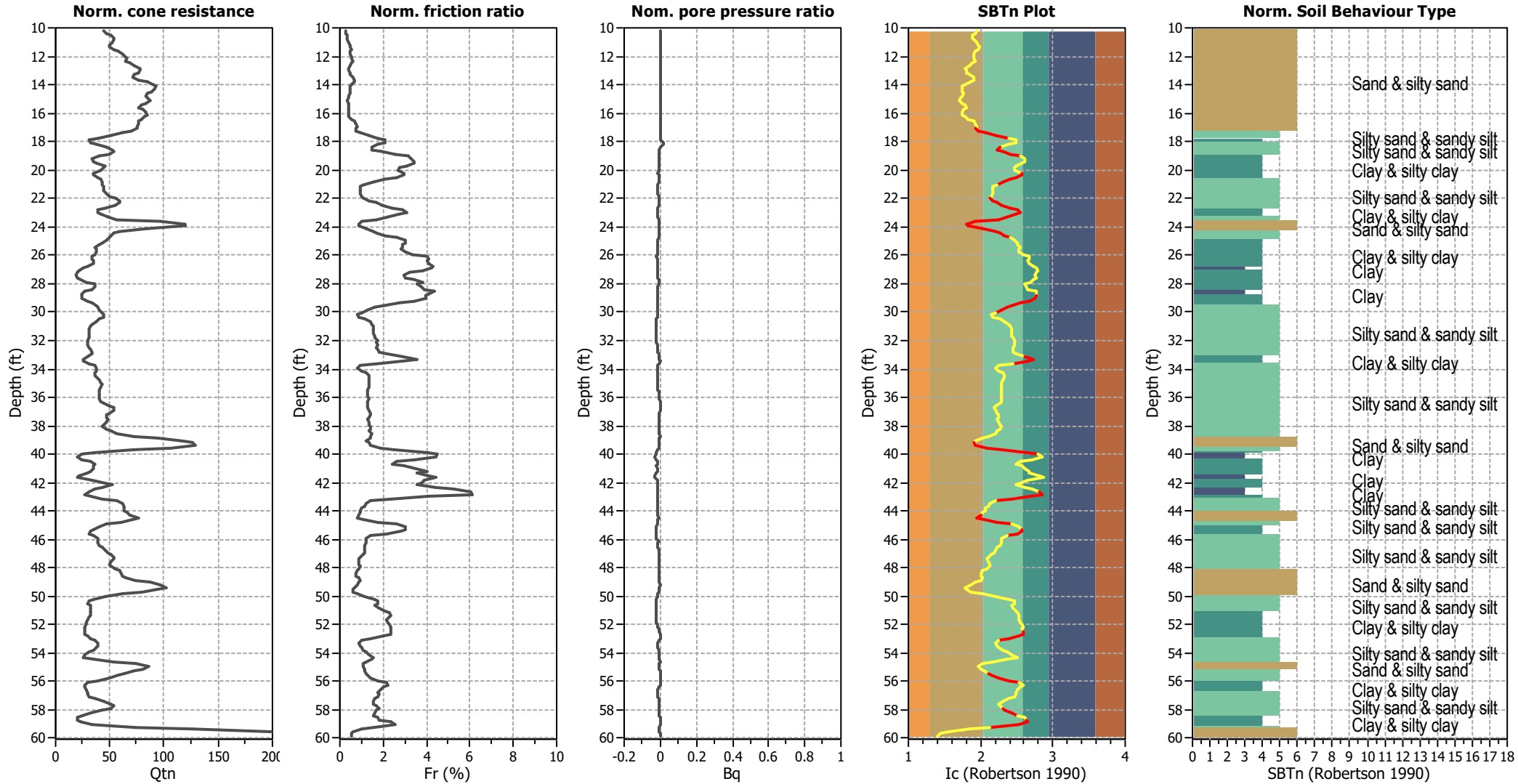
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



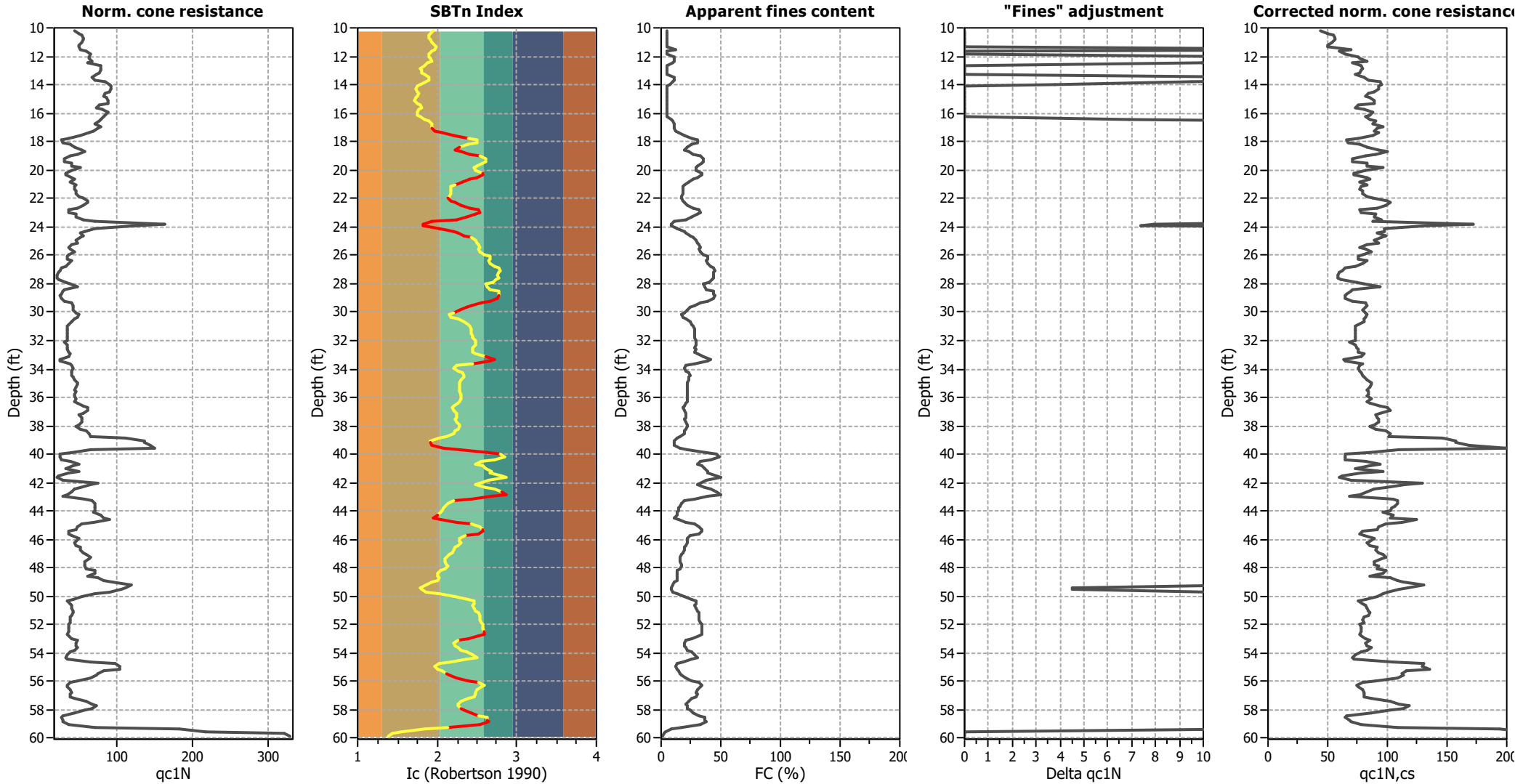
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBTn legend

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

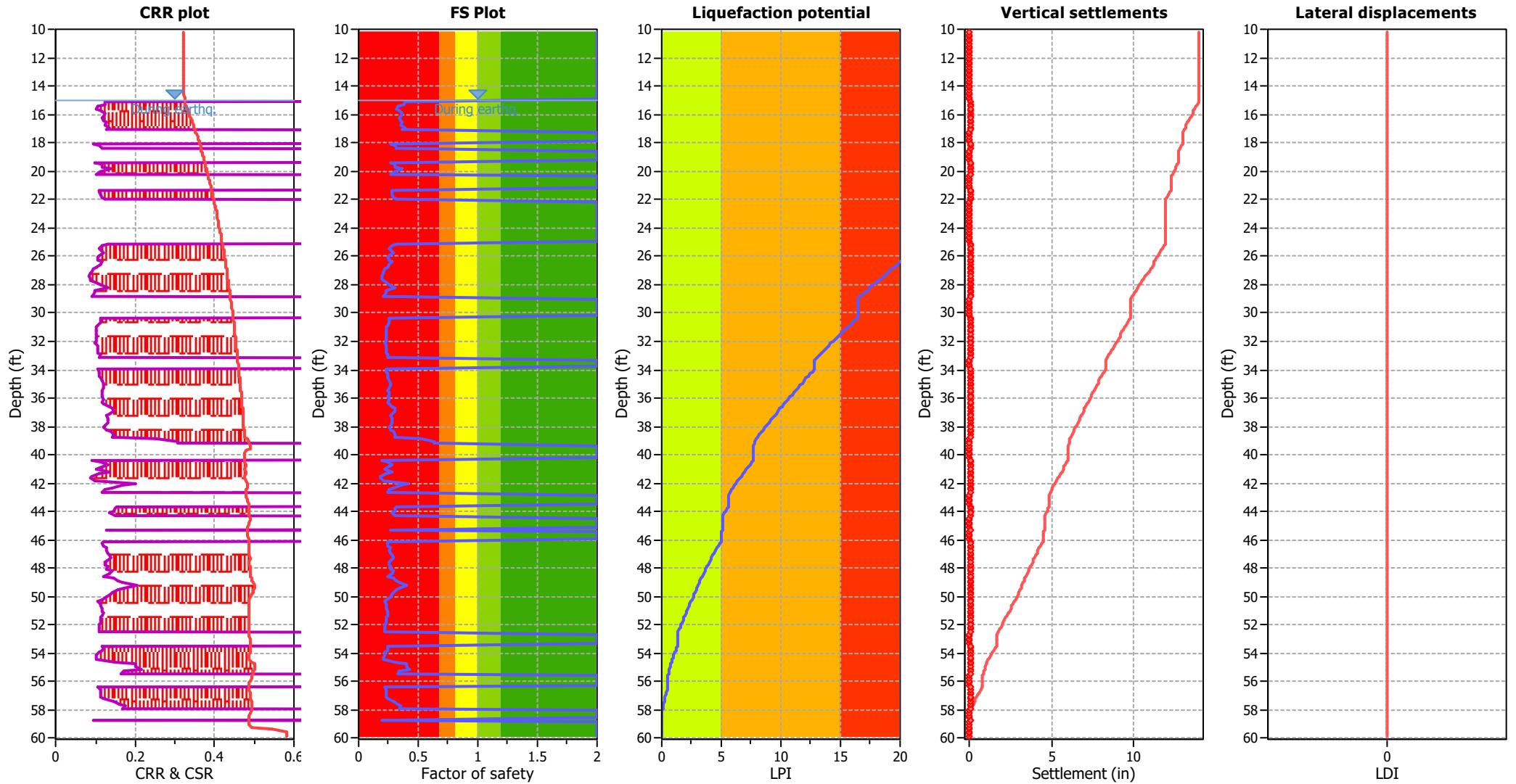
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

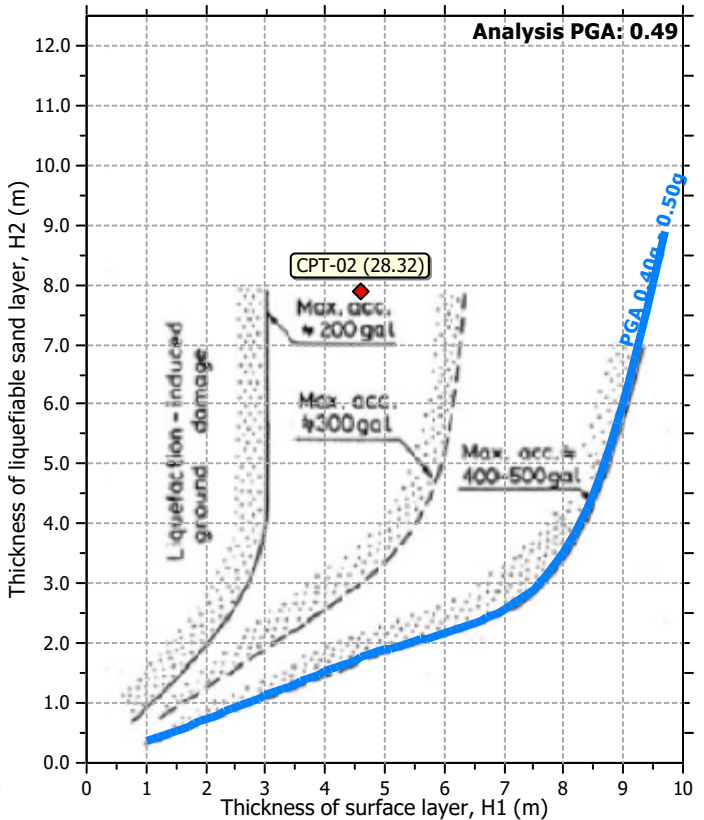
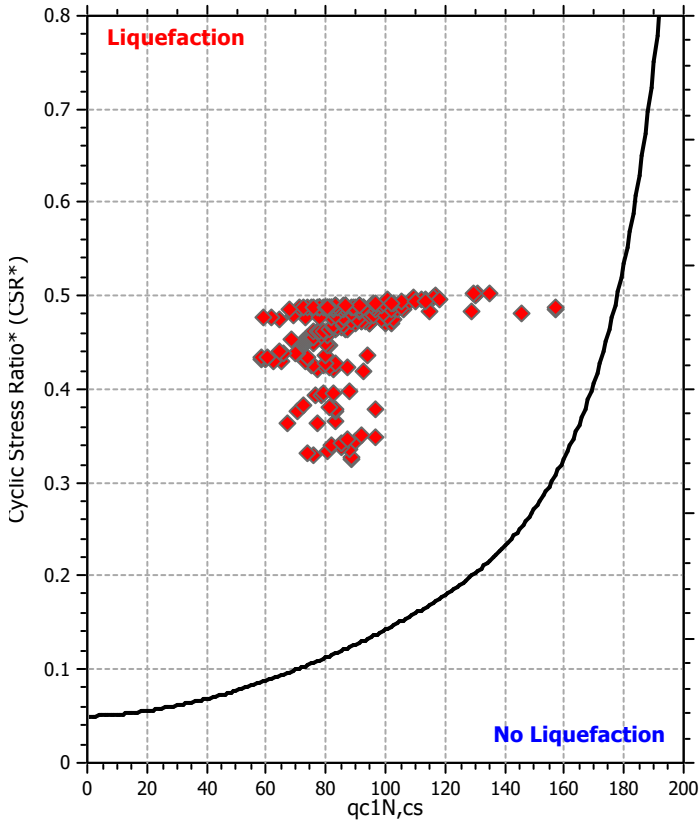
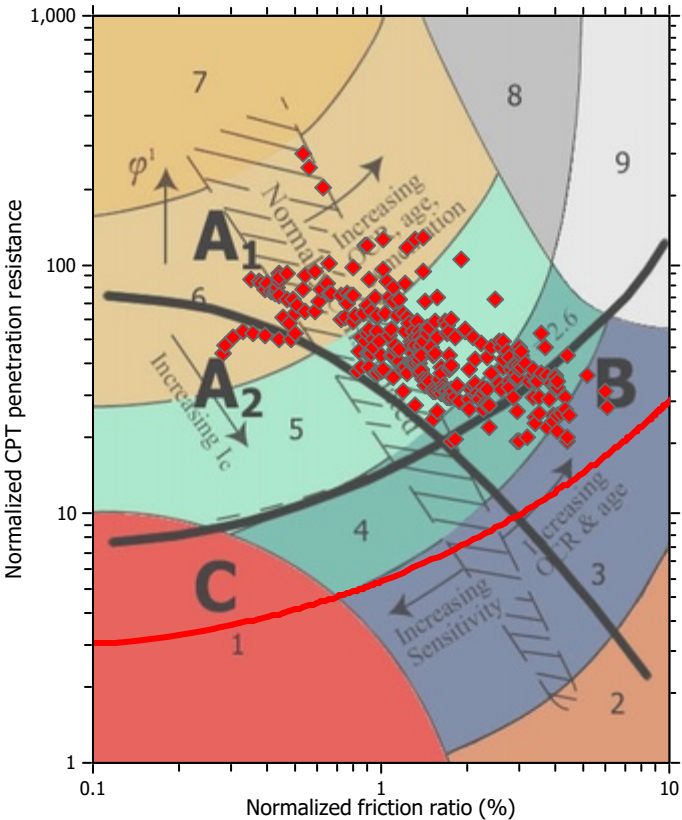
F.S. color scheme

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
Green	Low risk

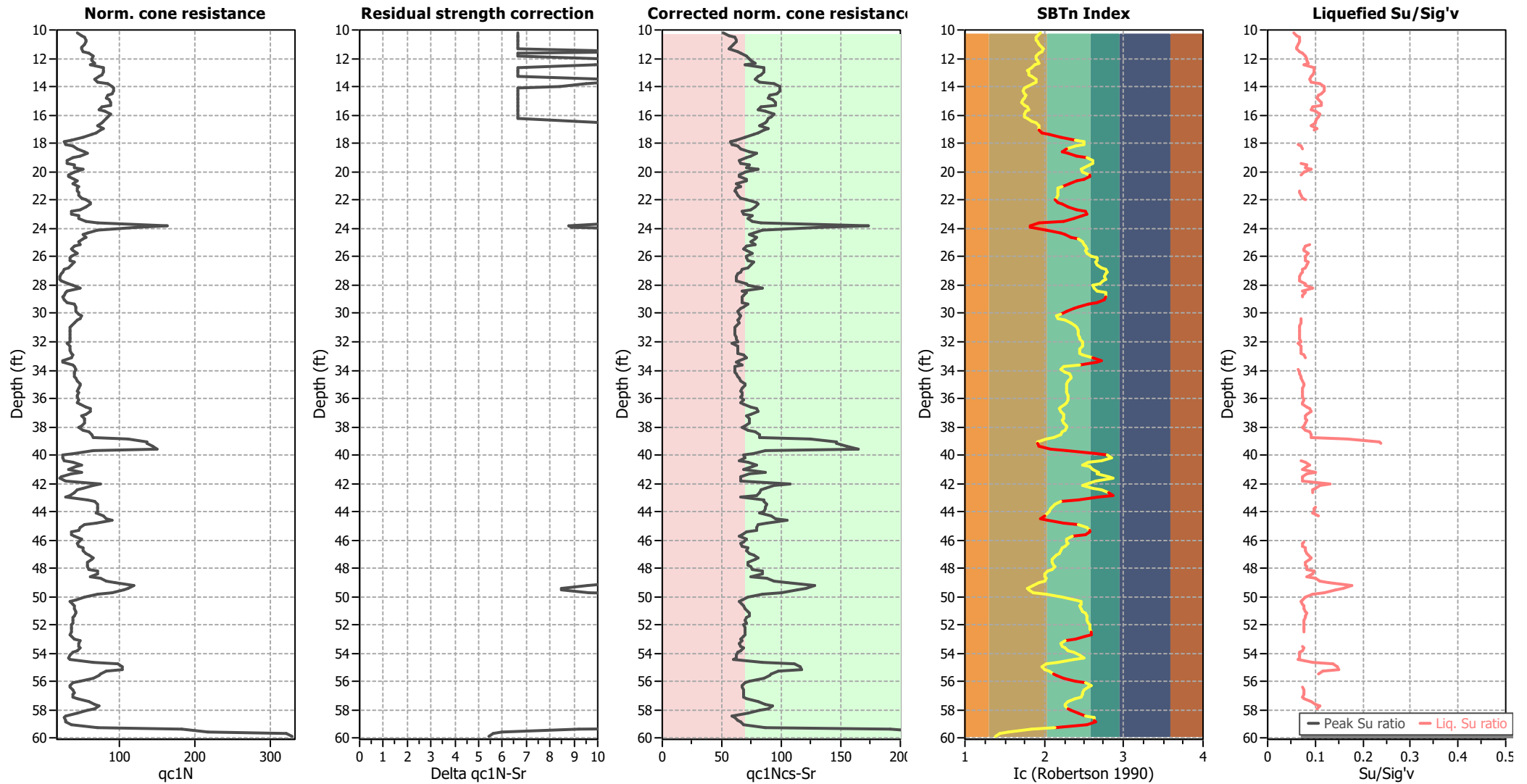
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

:: Field input data ::						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	28.77	0.08	0.04	5.00	100.52
2	10.34	33.52	0.10	0.06	5.00	101.49
3	10.50	37.28	0.11	0.03	5.00	102.94
4	10.66	38.78	0.13	0.04	5.00	103.98
5	10.83	39.14	0.14	0.05	5.00	104.65
6	10.99	37.61	0.14	0.04	5.00	105.05
7	11.15	35.52	0.16	-0.11	5.00	105.52
8	11.32	35.53	0.17	-0.09	5.00	106.26
9	11.48	38.36	0.19	-0.10	12.18	107.27
10	11.65	44.08	0.22	-0.01	5.00	107.94
11	11.81	48.37	0.21	0.26	5.00	108.37
12	11.97	48.63	0.21	0.46	10.47	109.47
13	12.14	50.01	0.31	0.51	10.62	110.28
14	12.30	52.93	0.29	0.38	11.19	110.83
15	12.47	47.51	0.28	0.69	9.86	110.60
16	12.63	62.90	0.26	0.20	5.00	110.69
17	12.79	64.14	0.28	0.18	5.00	110.85
18	12.96	64.17	0.27	0.14	5.00	110.91
19	13.12	62.98	0.27	0.09	5.00	110.91
20	13.29	60.50	0.28	0.05	5.00	111.30
21	13.45	56.53	0.33	0.04	10.45	112.69
22	13.62	60.40	0.46	0.06	10.46	114.08
23	13.78	73.14	0.48	0.26	9.41	114.88
24	13.94	78.83	0.42	1.35	7.91	114.49
25	14.11	80.39	0.35	0.94	5.00	113.76
26	14.27	81.28	0.35	0.65	5.00	113.28
27	14.44	78.73	0.35	0.46	5.00	113.04
28	14.60	74.20	0.32	0.38	5.00	112.64
29	14.76	72.89	0.31	0.32	5.00	111.95
30	14.93	76.56	0.27	0.27	5.00	111.64
31	15.09	79.92	0.28	0.14	5.00	111.55
32	15.26	79.91	0.29	0.15	5.00	111.69
33	15.42	68.03	0.29	0.27	5.00	111.72
34	15.58	66.01	0.30	0.37	5.00	111.58
35	15.75	72.84	0.28	0.40	5.00	111.61
36	15.91	79.90	0.28	0.02	5.00	111.84
37	16.08	77.75	0.31	-0.28	5.00	112.32
38	16.24	74.90	0.34	0.14	5.00	112.50
39	16.40	72.03	0.32	0.43	8.87	113.70
40	16.57	70.97	0.50	0.61	10.36	114.82
41	16.73	65.52	0.55	0.38	11.17	115.90
42	16.90	72.85	0.53	0.95	11.41	116.05
43	17.06	69.96	0.53	1.83	11.12	115.47
44	17.22	63.58	0.43	1.11	12.07	115.12
45	17.39	58.74	0.49	1.50	14.81	115.54
46	17.55	47.48	0.68	1.60	19.40	115.93
47	17.72	33.90	0.63	1.49	25.66	115.35
48	17.88	25.31	0.52	1.35	30.60	114.31

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	26.58	0.56	9.29	30.40	114.46
50	18.21	35.32	0.65	7.78	26.01	115.02
51	18.37	42.39	0.54	2.20	21.72	116.00
52	18.54	51.34	0.68	-2.02	19.88	117.16
53	18.70	54.21	0.88	-3.34	22.57	119.51
54	18.86	45.17	1.32	-3.28	26.87	120.53
55	19.03	37.26	1.21	-2.95	32.55	120.08
56	19.19	28.86	0.90	-1.58	35.51	118.78
57	19.36	29.11	0.92	-1.17	35.85	119.15
58	19.52	38.52	1.36	0.45	34.27	120.19
59	19.68	39.49	1.26	0.43	30.37	121.21
60	19.85	49.90	1.22	-1.13	29.09	120.41
61	20.01	38.30	0.96	-2.17	29.65	119.45
62	20.18	31.02	0.91	-2.84	33.72	118.47
63	20.34	30.73	0.99	-2.55	33.67	118.73
64	20.50	40.07	1.05	-1.82	30.49	118.96
65	20.67	42.99	0.89	-2.52	26.91	117.95
66	20.83	38.43	0.56	-3.27	22.84	116.00
67	21.00	46.09	0.43	-4.05	19.81	113.69
68	21.16	44.18	0.37	-4.75	18.06	112.76
69	21.32	42.94	0.38	-4.84	18.16	112.58
70	21.49	44.64	0.41	-4.69	18.20	112.86
71	21.65	45.88	0.41	-4.46	17.76	113.42
72	21.82	49.49	0.46	-4.26	17.35	114.46
73	21.98	54.76	0.57	-4.18	16.95	116.21
74	22.15	62.53	0.74	-4.04	17.90	118.47
75	22.31	62.19	1.04	-3.90	19.77	120.15
76	22.47	56.83	1.17	-3.51	22.42	120.61
77	22.64	48.90	1.02	-4.44	26.90	120.41
78	22.80	36.06	1.13	-4.91	31.36	120.17
79	22.97	36.57	1.23	-4.70	32.65	120.54
80	23.13	46.90	1.21	-4.02	29.91	120.64
81	23.29	47.48	1.07	-4.50	25.34	120.41
82	23.46	56.39	0.97	-4.86	20.54	120.11
83	23.62	73.89	0.91	-5.18	11.08	121.61
84	23.79	171.02	1.16	-5.58	8.43	122.68
85	23.95	130.23	1.20	-5.45	8.58	122.84
86	24.11	74.13	0.98	-3.98	13.56	121.60
87	24.28	60.57	0.99	-3.51	19.09	119.95
88	24.44	54.05	0.86	-2.57	21.25	119.85
89	24.61	57.75	1.03	-2.58	23.93	120.91
90	24.77	53.47	1.48	-2.72	27.16	122.19
91	24.93	47.67	1.56	-3.04	29.64	122.72
92	25.10	50.21	1.41	-3.10	30.92	122.02
93	25.26	42.27	1.18	-3.54	31.47	120.97
94	25.43	37.87	1.10	-3.94	32.66	120.25
95	25.59	41.15	1.14	-4.14	31.89	120.33
96	25.75	45.81	1.18	-4.63	32.51	120.81

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	39.10	1.32	-4.82	34.97	121.29
98	26.08	35.82	1.44	-4.84	38.84	121.70
99	26.25	36.55	1.53	-4.63	38.68	122.17
100	26.41	42.70	1.55	-2.83	37.97	122.41
101	26.57	39.81	1.54	-2.67	38.56	122.30
102	26.74	34.27	1.49	-2.11	41.92	121.36
103	26.90	27.93	1.19	-1.34	44.39	119.72
104	27.07	25.93	0.86	-0.71	45.17	117.69
105	27.23	24.07	0.74	-0.30	44.14	115.78
106	27.39	22.59	0.59	-0.15	43.74	114.67
107	27.56	22.88	0.58	0.47	44.05	114.96
108	27.72	24.69	0.81	1.92	42.59	117.61
109	27.89	35.65	1.31	3.42	40.50	120.39
110	28.05	41.27	1.58	2.12	35.49	122.38
111	28.21	52.50	1.59	-0.63	36.67	122.57
112	28.38	33.14	1.46	-2.64	38.36	122.05
113	28.54	32.51	1.36	-1.82	44.13	120.69
114	28.71	29.59	1.11	-1.14	44.30	119.75
115	28.87	28.31	1.04	-0.64	44.55	119.05
116	29.04	28.90	1.08	0.17	43.56	119.49
117	29.20	33.94	1.26	-0.23	38.43	120.04
118	29.36	43.96	1.12	-1.37	33.12	120.06
119	29.53	45.93	0.93	-3.22	27.69	118.67
120	29.69	46.29	0.61	-3.86	24.95	117.24
121	29.86	46.90	0.63	-5.10	22.11	115.94
122	30.02	51.70	0.55	-5.50	19.19	114.79
123	30.18	55.62	0.32	-5.83	17.30	113.89
124	30.35	53.44	0.44	-6.09	17.99	114.13
125	30.51	48.78	0.60	-6.20	21.07	115.47
126	30.68	46.14	0.62	-6.17	23.93	115.92
127	30.84	41.56	0.60	-5.98	25.68	115.59
128	31.00	38.89	0.56	-5.73	27.06	115.21
129	31.17	38.39	0.57	-5.48	27.55	115.04
130	31.33	38.91	0.57	-5.14	27.63	115.02
131	31.50	38.68	0.56	-4.77	27.48	115.01
132	31.66	39.04	0.56	-4.42	27.99	115.33
133	31.82	38.97	0.65	-4.08	28.26	115.52
134	31.99	38.95	0.61	-3.74	29.68	115.58
135	32.15	34.46	0.60	-3.29	29.47	115.46
136	32.32	39.23	0.61	-1.05	29.47	115.67
137	32.48	40.25	0.65	-0.67	28.59	116.16
138	32.64	40.69	0.70	-0.42	28.67	116.52
139	32.81	41.28	0.70	-0.13	28.66	117.29
140	32.97	45.24	0.85	4.36	30.12	118.42
141	33.14	42.34	1.06	3.93	35.95	119.67
142	33.30	28.99	1.30	4.81	41.63	119.73
143	33.47	29.98	1.03	7.98	38.53	118.76
144	33.63	45.31	0.61	2.96	28.42	116.24

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	47.47	0.33	-1.42	20.73	113.52
146	33.96	49.01	0.35	-2.47	19.35	112.67
147	34.12	48.05	0.46	-2.77	21.00	114.06
148	34.28	47.14	0.57	-2.65	23.04	115.42
149	34.45	47.31	0.64	-2.37	23.91	116.24
150	34.61	49.34	0.65	-2.05	23.58	116.66
151	34.78	52.11	0.66	-1.67	22.64	117.11
152	34.94	56.04	0.73	-1.29	22.10	117.59
153	35.10	56.52	0.76	-0.89	21.82	117.67
154	35.27	54.74	0.68	-0.37	21.99	117.34
155	35.43	52.67	0.65	0.11	21.94	116.95
156	35.60	53.97	0.66	3.87	22.11	116.95
157	35.76	53.91	0.68	4.53	22.27	117.08
158	35.92	52.97	0.68	5.01	22.17	117.21
159	36.09	55.84	0.69	5.66	22.39	117.25
160	36.25	53.19	0.69	7.93	21.97	117.41
161	36.42	57.00	0.71	7.97	21.03	118.00
162	36.58	67.04	0.81	7.81	19.53	119.01
163	36.74	73.74	0.93	7.53	18.62	119.97
164	36.91	74.79	0.98	7.03	19.09	120.25
165	37.07	66.37	0.92	6.52	20.19	119.92
166	37.24	61.44	0.86	6.47	20.81	119.28
167	37.40	64.07	0.79	6.51	20.43	118.91
168	37.57	65.87	0.80	6.28	19.97	118.82
169	37.73	64.28	0.81	6.08	20.52	118.77
170	37.89	59.77	0.79	6.22	21.64	118.59
171	38.06	56.63	0.78	6.62	21.92	118.60
172	38.22	62.72	0.82	7.01	21.06	119.24
173	38.39	71.95	0.96	7.28	19.64	120.07
174	38.55	76.19	0.99	7.19	19.39	121.47
175	38.71	80.91	1.32	6.83	16.30	123.55
176	38.88	133.54	1.70	5.68	13.71	126.10
177	39.04	161.89	2.19	0.79	10.90	127.06
178	39.21	163.11	1.68	-3.42	10.76	128.33
179	39.37	172.08	2.58	-5.36	11.06	129.08
180	39.53	176.27	2.82	-3.35	15.33	129.57
181	39.70	79.68	2.63	-5.03	21.80	128.27
182	39.86	50.61	2.06	-4.59	37.38	125.39
183	40.03	32.51	1.57	-1.68	45.78	122.72
184	40.19	32.32	1.24	-0.82	49.10	120.90
185	40.35	32.89	1.20	-0.63	41.56	120.66
186	40.52	49.40	1.24	-0.43	33.35	120.98
187	40.68	61.73	1.12	-1.20	30.16	121.75
188	40.85	53.29	1.42	-1.99	33.68	122.72
189	41.01	41.78	1.85	-1.39	36.16	123.97
190	41.17	62.06	1.94	-0.32	39.42	124.54
191	41.34	45.54	1.94	-1.06	38.91	122.81
192	41.50	30.51	0.77	-1.40	46.87	120.95

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	28.27	1.25	-0.89	49.89	120.74
194	41.83	37.95	1.92	0.94	37.92	124.86
195	41.99	92.58	2.69	0.18	32.66	127.46
196	42.16	80.83	3.00	-0.99	30.23	128.41
197	42.32	66.06	2.62	-0.41	36.08	128.33
198	42.49	56.20	3.07	1.33	41.57	127.90
199	42.65	50.85	2.95	2.20	46.78	127.67
200	42.81	44.89	2.72	1.69	49.61	126.39
201	42.98	37.32	2.00	1.83	39.51	125.04
202	43.14	73.63	1.33	1.37	27.67	123.30
203	43.31	85.77	1.08	-0.94	19.05	122.19
204	43.47	91.34	1.08	-1.56	16.87	121.80
205	43.63	91.78	1.07	-2.00	15.90	121.43
206	43.80	92.44	0.90	-2.28	15.12	120.77
207	43.96	92.15	0.82	-2.55	14.71	120.21
208	44.13	89.57	0.87	-2.77	13.91	120.12
209	44.29	102.03	0.84	-2.75	13.17	120.51
210	44.45	108.38	0.90	-3.02	11.52	120.49
211	44.62	116.00	0.80	-3.30	14.32	122.38
212	44.78	88.24	1.63	-3.54	20.27	124.55
213	44.95	69.76	2.26	-3.67	27.77	125.23
214	45.11	62.76	1.64	-3.26	31.97	125.04
215	45.28	60.91	1.73	-3.40	33.65	123.82
216	45.44	49.49	1.57	-1.15	34.30	122.47
217	45.60	48.37	0.93	-2.22	31.58	120.15
218	45.77	54.28	0.63	-3.47	24.90	117.97
219	45.93	65.32	0.69	-3.98	22.08	117.57
220	46.10	62.31	0.76	5.77	21.88	117.94
221	46.26	59.06	0.71	4.11	22.23	117.88
222	46.42	62.71	0.68	3.67	21.08	117.84
223	46.59	70.10	0.72	3.90	20.00	118.15
224	46.75	70.20	0.76	4.30	19.32	118.71
225	46.92	73.98	0.81	4.92	18.79	119.22
226	47.08	80.22	0.84	5.20	17.49	119.53
227	47.24	86.24	0.81	5.31	16.25	119.29
228	47.41	84.28	0.70	4.87	15.72	118.52
229	47.57	77.18	0.62	4.54	15.86	117.77
230	47.74	76.52	0.63	4.42	16.47	117.81
231	47.90	78.74	0.73	4.61	16.78	118.44
232	48.06	81.34	0.78	5.09	15.58	118.95
233	48.23	95.41	0.72	5.69	13.93	118.71
234	48.39	96.05	0.61	4.38	13.14	118.15
235	48.56	85.01	0.62	4.29	13.12	118.52
236	48.72	100.80	0.81	7.88	13.66	120.07
237	48.88	109.91	1.05	8.43	12.98	122.05
238	49.05	126.34	1.25	9.26	11.16	123.24
239	49.21	156.40	1.18	9.56	9.50	123.33
240	49.38	150.02	0.98	7.72	7.99	122.17

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	49.54	141.17	0.72	2.95	8.03	120.57
242	49.70	122.55	0.67	-1.14	9.56	119.56
243	49.87	96.55	0.77	-2.37	13.46	119.45
244	50.03	73.18	0.84	-2.22	19.55	119.61
245	50.20	57.48	0.93	-1.98	26.20	119.54
246	50.36	49.35	0.95	-1.50	29.36	119.12
247	50.52	53.54	0.79	-0.87	29.27	118.90
248	50.69	56.42	0.85	-0.67	27.96	119.01
249	50.85	56.75	0.95	-0.66	28.91	120.11
250	51.02	58.08	1.19	-0.25	30.23	121.20
251	51.18	59.28	1.31	0.31	31.34	121.88
252	51.34	57.48	1.28	0.90	32.00	121.81
253	51.51	54.58	1.18	1.43	32.23	121.23
254	51.67	53.46	1.06	2.15	32.26	120.75
255	51.84	53.69	1.09	2.89	32.90	120.58
256	52.00	50.61	1.13	7.95	33.76	120.72
257	52.16	51.14	1.14	8.74	34.44	120.75
258	52.33	51.40	1.12	9.76	34.36	120.76
259	52.49	51.15	1.13	10.57	34.74	120.82
260	52.66	50.30	1.18	15.18	34.60	120.83
261	52.82	52.26	1.12	15.24	31.65	120.10
262	52.99	58.15	0.75	14.57	25.88	118.54
263	53.15	66.75	0.52	7.75	20.99	116.56
264	53.31	66.37	0.51	4.33	19.23	116.03
265	53.48	66.70	0.60	5.52	19.71	116.63
266	53.64	68.68	0.65	7.10	20.91	117.28
267	53.81	63.42	0.68	8.82	22.48	117.20
268	53.97	55.41	0.62	10.30	25.00	116.72
269	54.13	49.87	0.59	11.79	27.92	116.35
270	54.30	46.35	0.65	13.32	30.73	117.31
271	54.46	49.86	0.91	14.45	25.42	119.37
272	54.63	92.81	1.05	16.14	18.20	121.89
273	54.79	133.81	1.29	12.47	13.73	123.79
274	54.95	141.78	1.49	5.69	12.30	124.88
275	55.12	141.99	1.49	7.35	13.22	124.88
276	55.28	116.24	1.35	13.57	14.53	124.19
277	55.45	105.56	1.23	14.89	16.20	123.36
278	55.61	102.86	1.19	15.99	17.50	122.87
279	55.77	92.11	1.20	15.64	20.42	122.48
280	55.94	68.83	1.19	16.05	25.72	122.07
281	56.10	55.24	1.23	16.39	31.81	121.25
282	56.27	49.66	1.06	17.13	34.57	120.61
283	56.43	51.73	1.01	13.55	33.15	119.93
284	56.59	56.04	0.93	6.93	31.08	119.78
285	56.76	57.85	0.95	5.47	29.87	119.76
286	56.92	57.53	0.97	6.29	30.14	120.08
287	57.09	57.57	1.04	8.44	29.06	120.30
288	57.25	65.49	1.00	10.22	25.82	121.09

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	57.41	84.20	1.17	10.75	22.67	122.30
290	57.58	94.51	1.42	7.95	21.01	123.87
291	57.74	101.87	1.65	8.83	21.34	124.87
292	57.91	95.88	1.72	9.15	22.51	124.92
293	58.07	83.88	1.51	9.85	23.96	123.16
294	58.23	65.64	0.79	10.40	27.36	120.33
295	58.40	42.30	0.66	12.48	31.35	117.14
296	58.56	39.45	0.64	18.33	36.35	116.41
297	58.73	43.44	0.70	18.31	36.52	116.91
298	58.89	44.76	0.79	18.61	38.00	120.08
299	59.05	54.79	1.67	17.94	32.48	124.15
300	59.22	102.38	2.45	6.59	16.93	127.36
301	59.38	240.48	1.95	4.29	8.99	128.70
302	59.55	281.71	1.88	5.38	3.49	129.03
303	59.71	406.54	1.93	17.53	2.12	129.89
304	59.88	415.57	2.31	17.12	1.44	130.68

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q _c :	Measured cone resistance (tsf)
f _s :	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	30.35	44.12	1.00	44.12	1.95	0.05	0.62
10.34	33.19	47.48	1.00	47.48	1.92	0.06	0.63
10.50	36.53	51.51	1.00	51.51	1.90	0.07	0.64
10.66	38.40	53.63	1.00	53.63	1.89	0.07	0.64
10.83	38.51	53.50	1.00	53.50	1.91	0.07	0.64
10.99	37.42	51.86	1.00	51.86	1.94	0.06	0.64
11.15	36.22	50.10	1.00	50.10	1.97	0.06	0.63
11.32	36.47	50.17	1.00	50.17	1.99	0.06	0.63
11.48	39.32	53.43	1.28	68.65	1.97	0.07	0.68
11.65	43.60	58.21	1.00	58.21	1.93	0.07	0.65
11.81	47.03	61.85	1.00	61.85	1.90	0.08	0.67
11.97	49.00	64.00	1.24	79.30	1.90	0.08	0.70
12.14	50.52	65.51	1.24	81.44	1.91	0.08	0.70
12.30	50.15	64.74	1.26	81.47	1.93	0.09	0.71
12.47	54.45	69.00	1.22	84.28	1.88	0.08	0.68
12.63	58.18	72.67	1.00	72.67	1.84	0.10	0.70
12.79	63.74	78.33	1.00	78.33	1.79	0.10	0.71
12.96	63.76	77.81	1.00	77.81	1.80	0.10	0.70
13.12	62.55	75.93	1.00	75.93	1.81	0.09	0.70
13.29	60.00	72.73	1.00	72.73	1.85	0.09	0.69
13.45	59.14	71.72	1.24	88.81	1.90	0.09	0.71
13.62	63.36	76.27	1.24	94.48	1.90	0.09	0.72
13.78	70.79	84.04	1.21	101.44	1.86	0.11	0.74
13.94	77.45	90.41	1.14	103.20	1.79	0.12	0.74
14.11	80.17	92.38	1.00	92.38	1.75	0.12	0.73
14.27	80.13	91.56	1.00	91.56	1.74	0.12	0.73
14.44	78.07	88.73	1.00	88.73	1.75	0.11	0.73
14.60	75.27	85.10	1.00	85.10	1.77	0.11	0.72
14.76	74.55	83.60	1.00	83.60	1.75	0.10	0.71
14.93	76.46	84.98	1.00	84.98	1.73	0.11	0.72
15.09	78.80	87.02	1.00	87.02	1.71	0.11	0.73
15.26	75.95	83.87	1.00	83.87	1.74	0.11	0.73
15.42	71.32	78.84	1.00	78.84	1.78	0.09	0.70
15.58	68.96	76.14	1.00	76.14	1.80	0.09	0.69
15.75	72.92	80.02	1.00	80.02	1.77	0.10	0.71
15.91	76.83	83.89	1.00	83.89	1.74	0.11	0.72
16.08	77.52	84.48	1.00	84.48	1.75	0.11	0.72
16.24	74.89	81.59	1.00	81.59	1.78	0.10	0.71
16.40	72.63	79.30	1.19	94.14	1.83	0.10	0.72
16.57	69.51	76.09	1.24	94.04	1.90	0.10	0.73
16.73	69.78	76.38	1.26	96.08	1.93	0.09	0.72
16.90	69.44	75.81	1.26	95.83	1.94	0.10	0.74
17.06	68.80	74.76	1.26	93.94	1.93	0.10	0.73
17.22	64.09	69.59	1.28	89.20	1.97	0.09	0.73
17.39	56.60	61.67	1.37	84.71	2.07	0.09	0.73
17.55	46.71	51.18	1.64	84.16	2.21	0.08	0.72
17.72	35.56	39.13	2.28	89.15	2.38	0.07	0.70
17.88	28.60	31.43	2.97	93.19	2.50	0.06	0.67

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	29.07	31.81	2.93	93.35	2.49	0.06	0.68
18.21	34.76	37.76	2.32	87.70	2.39	0.07	0.70
18.37	43.02	46.38	1.85	85.60	2.28	0.07	0.71
18.54	49.31	52.90	1.68	89.02	2.23	0.08	0.73
18.70	50.24	53.99	1.93	104.20	2.30	0.09	0.75
18.86	45.55	49.01	2.43	119.30	2.41	0.08	0.73
19.03	37.10	39.89	3.27	130.65	2.54	0.08	0.71
19.19	31.74	33.96	3.78	128.36	2.60	0.07	0.68
19.36	32.16	34.27	3.84	131.60	2.61	0.07	0.68
19.52	35.71	37.90	3.56	135.03	2.58	0.08	0.71
19.68	42.64	45.02	2.93	131.92	2.49	0.08	0.71
19.85	42.56	44.65	2.74	122.35	2.46	0.09	0.74
20.01	39.74	41.46	2.82	117.06	2.48	0.08	0.71
20.18	33.35	34.63	3.47	120.10	2.57	0.07	0.69
20.34	33.94	35.09	3.46	121.43	2.56	0.07	0.69
20.50	37.93	39.03	2.95	115.11	2.50	0.08	0.71
20.67	40.50	41.40	2.44	100.98	2.41	0.08	0.72
20.83	42.50	43.12	1.96	84.42	2.31	0.07	0.70
21.00	42.90	43.20	1.68	72.47	2.22	0.07	0.71
21.16	44.40	44.50	1.55	68.91	2.17	0.07	0.70
21.32	43.92	43.86	1.55	68.19	2.17	0.07	0.70
21.49	44.49	44.29	1.56	69.01	2.18	0.07	0.70
21.65	46.67	46.34	1.53	70.84	2.16	0.07	0.71
21.82	50.04	49.59	1.50	74.54	2.15	0.07	0.71
21.98	55.59	55.00	1.48	81.39	2.14	0.08	0.72
22.15	59.83	59.14	1.54	90.94	2.17	0.09	0.75
22.31	60.52	59.72	1.67	99.96	2.22	0.09	0.75
22.47	55.97	55.06	1.91	105.42	2.30	0.09	0.75
22.64	47.26	46.27	2.44	112.81	2.41	0.08	0.73
22.80	40.51	39.43	3.08	121.63	2.52	0.07	0.70
22.97	39.84	38.62	3.29	127.09	2.54	0.07	0.70
23.13	43.65	42.19	2.86	120.70	2.48	0.08	0.73
23.29	50.26	48.44	2.24	108.51	2.37	0.08	0.73
23.46	59.25	56.97	1.74	99.03	2.25	0.08	0.74
23.62	100.43	96.52	1.26	121.17	1.93	0.09	0.72
23.79	125.05	119.88	1.17	140.07	1.81	0.42	0.86
23.95	125.13	119.61	1.17	140.54	1.82	0.19	0.80
24.11	88.31	84.01	1.33	111.46	2.02	0.10	0.74
24.28	62.92	59.41	1.62	96.30	2.20	0.09	0.74
24.44	57.46	53.98	1.80	97.23	2.26	0.08	0.73
24.61	55.09	51.54	2.08	106.96	2.34	0.09	0.75
24.77	52.96	49.33	2.47	121.94	2.42	0.09	0.74
24.93	50.45	46.75	2.82	131.86	2.48	0.08	0.73
25.10	46.72	43.01	3.01	129.66	2.51	0.09	0.73
25.26	43.45	39.75	3.10	123.30	2.52	0.08	0.71
25.43	40.43	36.74	3.29	120.97	2.54	0.07	0.70
25.59	41.61	37.70	3.17	119.47	2.53	0.08	0.71
25.75	42.02	37.93	3.27	123.94	2.54	0.08	0.72

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_c (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	40.24	36.10	3.68	133.04	2.59	0.08	0.70
26.08	37.16	33.07	4.39	145.29	2.67	0.08	0.70
26.25	38.36	34.03	4.36	148.49	2.67	0.08	0.70
26.41	39.69	35.11	4.23	148.46	2.65	0.09	0.71
26.57	38.93	34.25	4.34	148.64	2.66	0.08	0.71
26.74	34.00	29.60	5.00	147.96	2.73	0.08	0.69
26.90	29.38	25.26	5.51	139.17	2.77	0.07	0.67
27.07	25.98	22.08	5.68	125.29	2.79	0.07	0.66
27.23	24.20	20.39	5.46	111.31	2.77	0.07	0.66
27.39	23.18	19.40	5.37	104.25	2.76	0.07	0.65
27.56	23.39	19.51	5.44	106.07	2.77	0.07	0.65
27.72	27.74	23.30	5.14	119.69	2.74	0.07	0.66
27.89	33.87	28.66	4.72	135.14	2.70	0.08	0.69
28.05	43.14	36.82	3.78	139.02	2.60	0.08	0.71
28.21	42.30	35.90	3.99	143.21	2.63	0.10	0.74
28.38	39.38	33.16	4.30	142.66	2.66	0.07	0.68
28.54	31.75	26.26	5.46	143.26	2.77	0.08	0.68
28.71	30.14	24.75	5.49	135.90	2.77	0.07	0.67
28.87	28.93	23.60	5.54	130.84	2.77	0.07	0.67
29.04	30.38	24.77	5.34	132.16	2.76	0.07	0.67
29.20	35.60	29.24	4.31	126.17	2.66	0.07	0.69
29.36	41.28	34.14	3.37	115.03	2.55	0.08	0.71
29.53	45.39	37.74	2.54	96.01	2.43	0.08	0.71
29.69	46.37	38.57	2.19	84.57	2.36	0.07	0.71
29.86	48.30	40.23	1.88	75.78	2.29	0.07	0.71
30.02	51.41	42.95	1.63	69.96	2.21	0.07	0.71
30.18	53.59	44.83	1.50	67.23	2.15	0.07	0.71
30.35	52.61	43.82	1.54	67.65	2.17	0.07	0.71
30.51	49.45	40.79	1.78	72.81	2.26	0.07	0.71
30.68	45.49	37.15	2.08	77.10	2.34	0.07	0.71
30.84	42.20	34.17	2.28	77.93	2.38	0.07	0.70
31.00	39.61	31.83	2.46	78.23	2.42	0.07	0.69
31.17	38.73	30.96	2.52	78.14	2.43	0.07	0.69
31.33	38.66	30.80	2.53	78.08	2.43	0.07	0.69
31.50	38.88	30.89	2.52	77.69	2.43	0.07	0.69
31.66	38.90	30.79	2.58	79.58	2.44	0.07	0.69
31.82	38.99	30.75	2.62	80.63	2.44	0.07	0.69
31.99	37.46	29.33	2.83	82.92	2.48	0.07	0.69
32.15	37.55	29.32	2.80	81.99	2.47	0.06	0.68
32.32	37.98	29.57	2.80	82.71	2.47	0.07	0.69
32.48	40.06	31.21	2.67	83.30	2.45	0.07	0.69
32.64	40.74	31.66	2.68	84.86	2.45	0.07	0.70
32.81	42.40	32.91	2.68	88.14	2.45	0.07	0.70
32.97	42.95	33.16	2.89	95.96	2.49	0.08	0.71
33.14	38.86	29.49	3.86	113.80	2.61	0.08	0.70
33.30	33.77	25.14	4.94	124.24	2.72	0.07	0.67
33.47	34.76	25.94	4.33	112.43	2.66	0.07	0.67
33.63	40.92	31.19	2.65	82.52	2.45	0.07	0.71

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	47.26	36.71	1.75	64.42	2.25	0.07	0.70
33.96	48.18	37.46	1.64	61.48	2.21	0.07	0.70
34.12	48.07	37.13	1.78	66.04	2.26	0.07	0.70
34.28	47.50	36.41	1.98	72.01	2.31	0.07	0.70
34.45	47.93	36.58	2.07	75.83	2.34	0.07	0.70
34.61	49.59	37.81	2.04	76.98	2.33	0.07	0.71
34.78	52.50	40.08	1.94	77.64	2.30	0.07	0.71
34.94	54.89	41.91	1.88	78.90	2.29	0.08	0.72
35.10	55.77	42.51	1.86	78.88	2.28	0.08	0.72
35.27	54.64	41.49	1.87	77.63	2.29	0.07	0.72
35.43	53.79	40.70	1.87	75.97	2.28	0.07	0.71
35.60	53.52	40.35	1.88	76.01	2.29	0.07	0.72
35.76	53.62	40.30	1.90	76.56	2.29	0.07	0.72
35.92	54.24	40.68	1.89	76.86	2.29	0.07	0.71
36.09	54.00	40.36	1.91	77.12	2.30	0.08	0.72
36.25	55.34	41.33	1.87	77.27	2.29	0.07	0.71
36.42	59.08	44.21	1.78	78.77	2.26	0.07	0.72
36.58	65.93	49.59	1.65	82.05	2.22	0.08	0.74
36.74	71.86	54.18	1.59	85.97	2.19	0.09	0.75
36.91	71.63	53.78	1.62	87.18	2.20	0.09	0.75
37.07	67.53	50.31	1.71	85.96	2.24	0.08	0.74
37.24	63.96	47.34	1.76	83.39	2.25	0.08	0.73
37.40	63.79	47.13	1.73	81.49	2.24	0.08	0.73
37.57	64.74	47.79	1.69	80.77	2.23	0.08	0.73
37.73	63.31	46.49	1.74	80.74	2.24	0.08	0.73
37.89	60.23	43.88	1.84	80.65	2.28	0.08	0.73
38.06	59.71	43.33	1.87	80.81	2.28	0.07	0.72
38.22	63.77	46.38	1.78	82.73	2.26	0.08	0.73
38.39	70.29	51.37	1.66	85.46	2.22	0.09	0.75
38.55	76.35	55.84	1.64	91.81	2.21	0.09	0.75
38.71	96.88	71.88	1.44	103.78	2.12	0.09	0.75
38.88	125.45	94.27	1.33	125.55	2.03	0.17	0.82
39.04	152.85	116.38	1.25	145.54	1.92	0.24	0.84
39.21	165.69	126.06	1.25	157.18	1.92	0.24	0.84
39.37	170.49	129.23	1.25	162.16	1.93	0.28	0.85
39.53	142.68	105.55	1.40	147.35	2.08	0.34	0.89
39.70	102.19	73.10	1.85	135.44	2.28	0.10	0.76
39.86	54.27	36.26	4.12	149.35	2.64	0.09	0.72
40.03	38.48	24.68	5.81	143.33	2.80	0.07	0.67
40.19	32.57	20.48	6.54	133.94	2.85	0.08	0.67
40.35	38.20	24.56	4.93	121.00	2.72	0.07	0.67
40.52	48.01	31.82	3.41	108.40	2.56	0.08	0.71
40.68	54.81	36.77	2.90	106.61	2.49	0.09	0.74
40.85	52.27	34.53	3.46	119.54	2.57	0.08	0.72
41.01	52.38	34.25	3.90	133.47	2.62	0.07	0.69
41.17	49.79	32.10	4.50	144.60	2.68	0.10	0.74
41.34	46.04	29.50	4.41	129.99	2.67	0.08	0.70
41.50	34.77	21.39	6.04	129.27	2.82	0.07	0.66

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	32.24	19.61	6.72	131.79	2.87	0.07	0.65
41.83	52.93	33.91	4.22	143.03	2.65	0.07	0.68
41.99	70.45	46.19	3.29	152.09	2.54	0.13	0.80
42.16	79.82	52.78	2.91	153.52	2.49	0.11	0.77
42.32	67.70	43.57	3.88	169.09	2.61	0.10	0.75
42.49	57.70	36.21	4.93	178.48	2.72	0.09	0.73
42.65	50.65	31.05	6.02	187.02	2.81	0.09	0.71
42.81	44.35	26.86	6.65	178.72	2.86	0.09	0.70
42.98	51.95	32.29	4.52	146.02	2.68	0.07	0.68
43.14	65.57	42.62	2.54	108.29	2.43	0.10	0.76
43.31	83.58	56.56	1.62	91.52	2.20	0.10	0.76
43.47	89.63	61.25	1.47	90.33	2.13	0.10	0.76
43.63	91.85	62.96	1.42	89.61	2.10	0.10	0.76
43.80	92.12	63.26	1.39	87.72	2.08	0.10	0.76
43.96	91.39	62.73	1.37	85.92	2.06	0.10	0.75
44.13	94.58	65.12	1.34	87.19	2.03	0.09	0.74
44.29	99.99	69.08	1.31	90.78	2.01	0.11	0.76
44.45	108.80	75.91	1.27	96.18	1.95	0.11	0.75
44.62	104.21	71.27	1.35	96.51	2.05	0.13	0.79
44.78	91.33	60.23	1.71	103.28	2.24	0.10	0.77
44.95	73.59	46.54	2.55	118.90	2.43	0.09	0.75
45.11	64.48	39.82	3.18	126.63	2.53	0.09	0.73
45.28	57.72	35.16	3.46	121.55	2.56	0.09	0.73
45.44	52.92	31.93	3.57	113.90	2.58	0.08	0.71
45.60	50.71	30.73	3.12	95.87	2.52	0.07	0.70
45.77	55.99	34.93	2.19	76.38	2.36	0.07	0.71
45.93	60.64	38.36	1.88	72.14	2.29	0.08	0.73
46.10	62.23	39.36	1.86	73.24	2.28	0.07	0.72
46.26	61.36	38.62	1.90	73.20	2.29	0.07	0.71
46.42	63.96	40.45	1.79	72.25	2.26	0.07	0.72
46.59	67.67	43.03	1.69	72.83	2.23	0.08	0.73
46.75	71.43	45.57	1.64	74.67	2.21	0.08	0.73
46.92	74.80	47.82	1.60	76.49	2.19	0.08	0.73
47.08	80.15	51.61	1.51	78.01	2.15	0.09	0.74
47.24	83.58	54.16	1.44	78.04	2.11	0.09	0.75
47.41	82.57	53.53	1.41	75.71	2.10	0.09	0.74
47.57	79.33	51.20	1.42	72.78	2.10	0.08	0.73
47.74	77.48	49.68	1.45	72.16	2.12	0.08	0.73
47.90	78.87	50.39	1.47	74.06	2.13	0.08	0.73
48.06	85.16	54.83	1.41	77.20	2.09	0.08	0.73
48.23	90.93	59.16	1.34	79.25	2.04	0.10	0.75
48.39	92.16	60.18	1.31	79.01	2.01	0.10	0.74
48.56	93.95	61.27	1.31	80.41	2.01	0.08	0.72
48.72	98.57	64.00	1.33	85.13	2.03	0.10	0.75
48.88	112.35	73.38	1.31	96.00	2.00	0.11	0.76
49.05	130.88	86.75	1.26	109.10	1.93	0.13	0.77
49.21	144.25	96.88	1.21	117.23	1.86	0.18	0.80
49.38	149.20	101.39	1.15	116.15	1.79	0.16	0.78

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
49.54	137.91	93.36	1.15	107.19	1.80	0.14	0.76
49.70	120.09	79.82	1.21	96.75	1.86	0.12	0.75
49.87	97.43	62.37	1.32	82.53	2.02	0.10	0.74
50.03	75.74	46.13	1.66	76.43	2.22	0.08	0.73
50.20	60.00	34.83	2.35	81.76	2.39	0.07	0.71
50.36	53.46	30.31	2.78	84.27	2.47	0.07	0.70
50.52	53.10	30.03	2.77	83.08	2.47	0.07	0.71
50.69	55.57	31.62	2.58	81.61	2.44	0.07	0.71
50.85	57.08	32.30	2.71	87.68	2.46	0.08	0.71
51.02	58.04	32.58	2.91	94.79	2.49	0.08	0.72
51.18	58.28	32.47	3.08	100.06	2.51	0.08	0.72
51.34	57.11	31.61	3.19	100.69	2.53	0.08	0.72
51.51	55.17	30.36	3.22	97.88	2.53	0.08	0.71
51.67	53.91	29.55	3.23	95.36	2.53	0.08	0.71
51.84	52.59	28.62	3.33	95.38	2.55	0.08	0.71
52.00	51.81	27.99	3.48	97.32	2.57	0.08	0.70
52.16	51.05	27.40	3.59	98.41	2.58	0.08	0.70
52.33	51.23	27.43	3.58	98.19	2.58	0.08	0.70
52.49	50.95	27.16	3.64	98.97	2.59	0.08	0.70
52.66	51.24	27.26	3.62	98.70	2.58	0.08	0.70
52.82	53.57	28.89	3.13	90.41	2.52	0.07	0.70
52.99	59.05	32.88	2.31	75.85	2.39	0.07	0.71
53.15	63.76	36.56	1.78	65.00	2.26	0.07	0.72
53.31	66.61	38.62	1.63	63.02	2.21	0.07	0.71
53.48	67.25	38.81	1.67	64.77	2.22	0.07	0.71
53.64	66.27	37.84	1.77	67.02	2.26	0.08	0.72
53.81	62.50	35.18	1.92	67.56	2.30	0.07	0.71
53.97	56.23	30.94	2.20	68.05	2.36	0.07	0.70
54.13	50.54	27.12	2.57	69.83	2.44	0.07	0.69
54.30	48.69	25.64	2.99	76.56	2.50	0.07	0.69
54.46	63.01	34.57	2.25	77.74	2.38	0.06	0.69
54.63	92.16	53.61	1.56	83.49	2.18	0.10	0.76
54.79	122.80	74.31	1.33	99.04	2.03	0.14	0.80
54.95	139.19	85.32	1.29	109.91	1.98	0.15	0.80
55.12	133.34	80.85	1.32	106.37	2.01	0.15	0.81
55.28	121.26	72.43	1.36	98.66	2.06	0.12	0.78
55.45	108.22	63.47	1.44	91.29	2.11	0.11	0.77
55.61	100.18	57.93	1.51	87.60	2.15	0.10	0.77
55.77	87.93	49.50	1.73	85.54	2.24	0.10	0.76
55.94	72.06	38.84	2.29	88.80	2.38	0.08	0.73
56.10	57.91	29.78	3.16	93.97	2.52	0.08	0.71
56.27	52.21	26.25	3.61	94.85	2.58	0.07	0.69
56.43	52.48	26.50	3.37	89.42	2.55	0.07	0.70
56.59	55.21	28.20	3.04	85.70	2.51	0.08	0.71
56.76	57.14	29.36	2.86	83.83	2.48	0.08	0.71
56.92	57.65	29.52	2.90	85.49	2.49	0.08	0.71
57.09	60.20	31.01	2.74	84.83	2.46	0.07	0.71
57.25	69.09	36.45	2.30	83.77	2.39	0.08	0.72

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
57.41	81.40	44.02	1.94	85.40	2.30	0.09	0.75
57.58	93.53	51.30	1.78	91.28	2.26	0.10	0.77
57.74	97.42	53.27	1.81	96.41	2.27	0.11	0.78
57.91	93.88	50.74	1.92	97.62	2.30	0.10	0.77
58.07	81.80	43.47	2.08	90.34	2.34	0.09	0.75
58.23	63.94	32.81	2.50	81.95	2.42	0.08	0.72
58.40	49.13	24.17	3.08	74.51	2.51	0.06	0.67
58.56	41.73	19.70	3.93	77.41	2.62	0.07	0.67
58.73	42.55	20.05	3.96	79.44	2.62	0.07	0.68
58.89	47.66	22.45	4.23	95.06	2.65	0.07	0.68
59.05	67.31	33.25	3.26	108.49	2.54	0.08	0.70
59.22	132.55	74.14	1.48	109.59	2.14	0.10	0.76
59.38	208.19	126.35	1.19	150.63	1.84	0.70	0.88
59.55	309.58	203.08	1.00	203.08	1.54	0.93	0.90
59.71	367.94	247.40	1.00	247.40	1.45	0.96	0.99
59.88	412.56	281.13	1.00	281.13	1.39	0.98	1.00

Abbreviations

q_t :	Total cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c :	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

LIQUEFACTION ANALYSIS REPORT

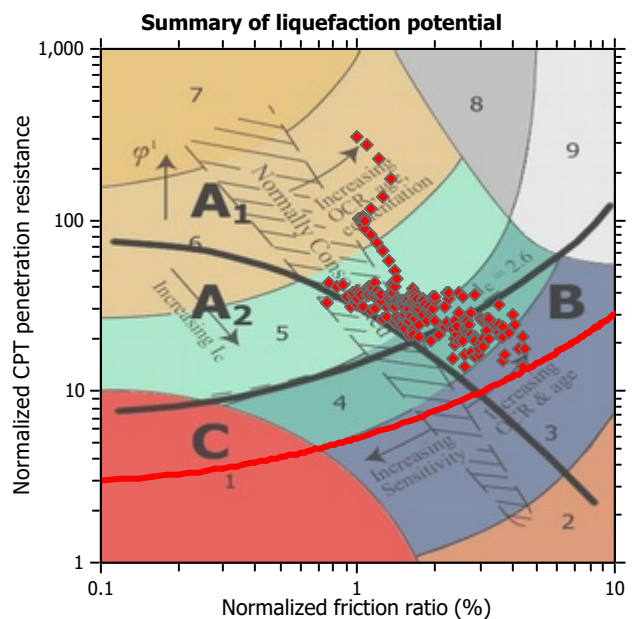
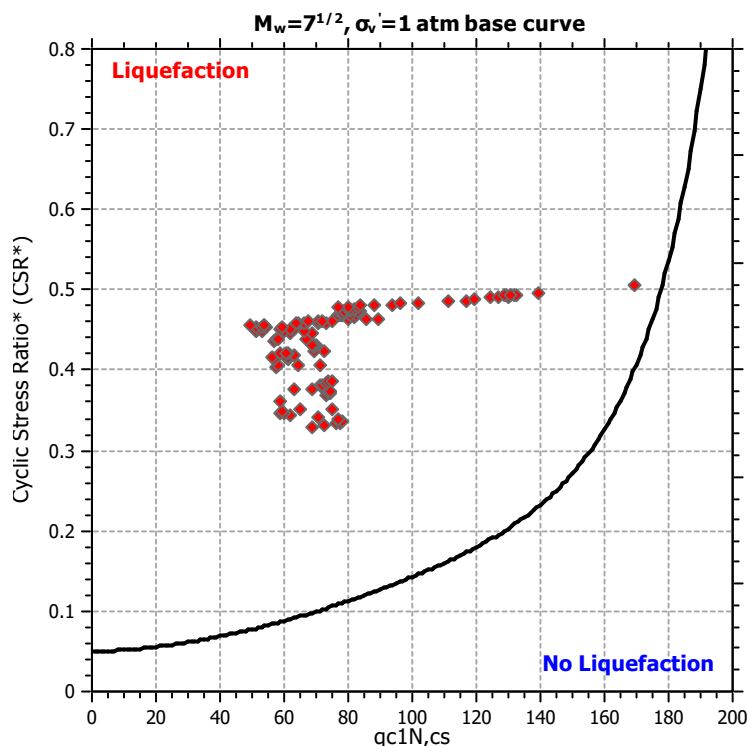
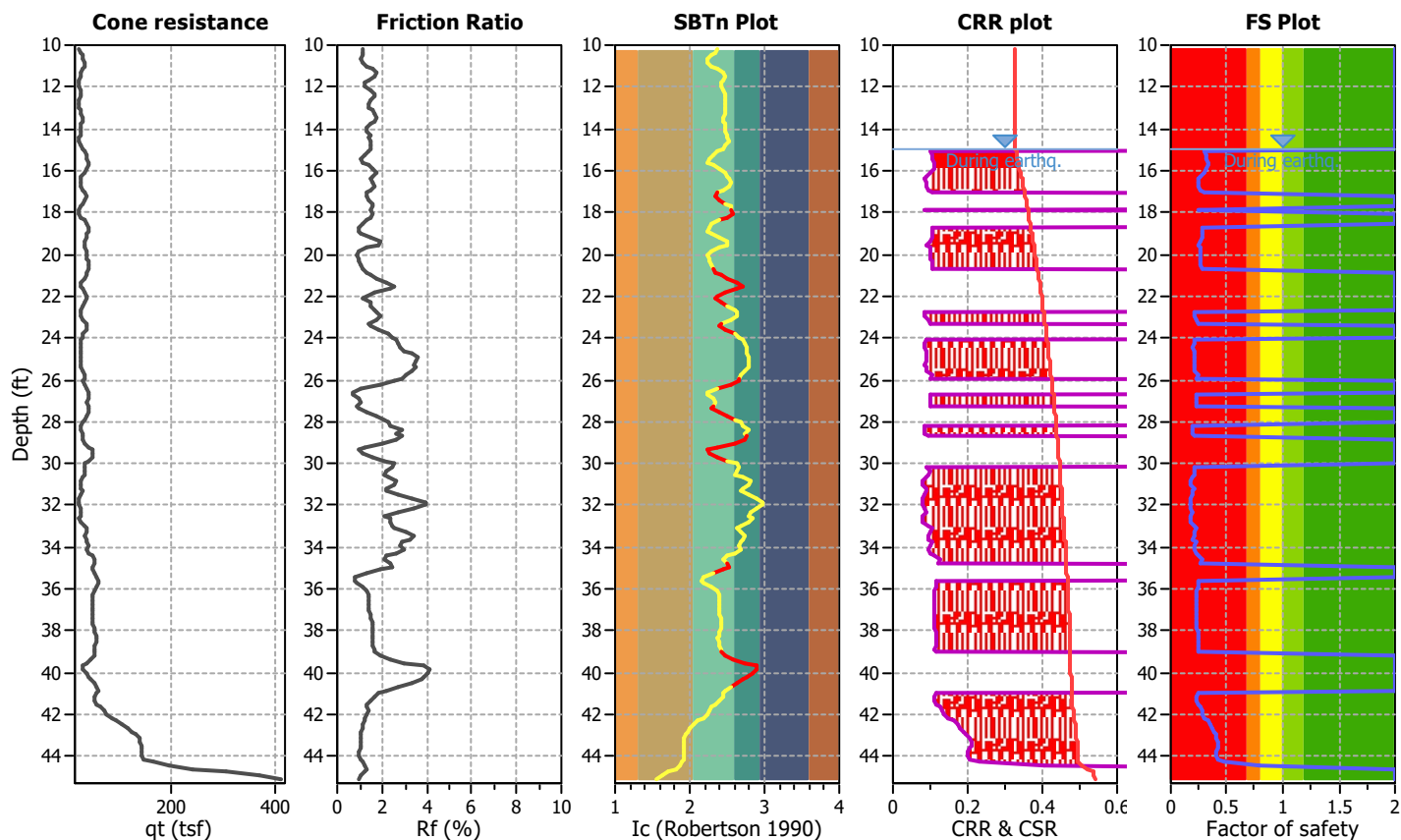
Project title : Kinder Morgan Linnton SVA

Location : Portland, Oregon

CPT file : CPT-03

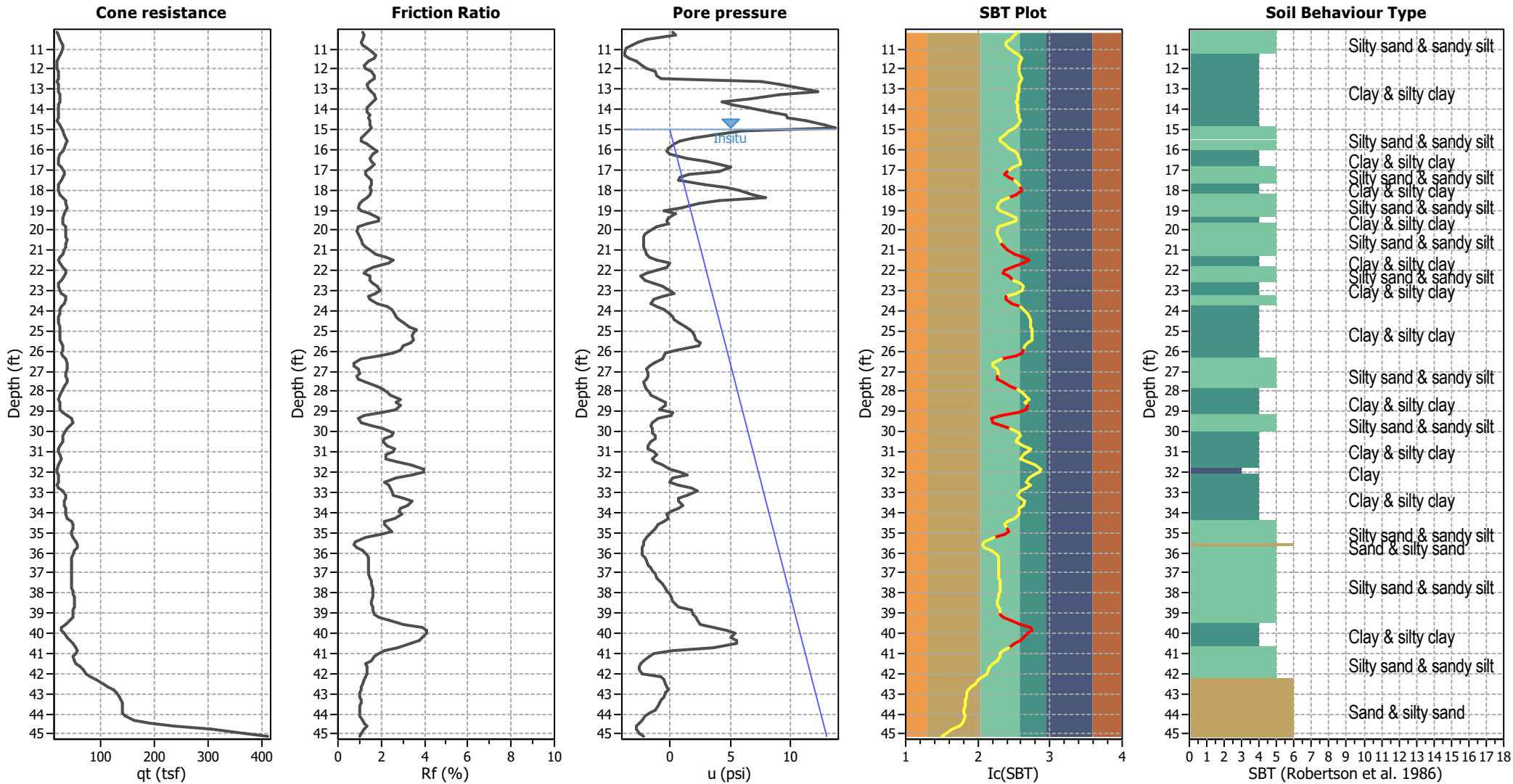
Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	R&W (1998)	G.W.T. (earthq.):	15.00 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:	Yes
Earthquake magnitude M_w :	7.78	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	80.00 ft
Peak ground acceleration:	0.49	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



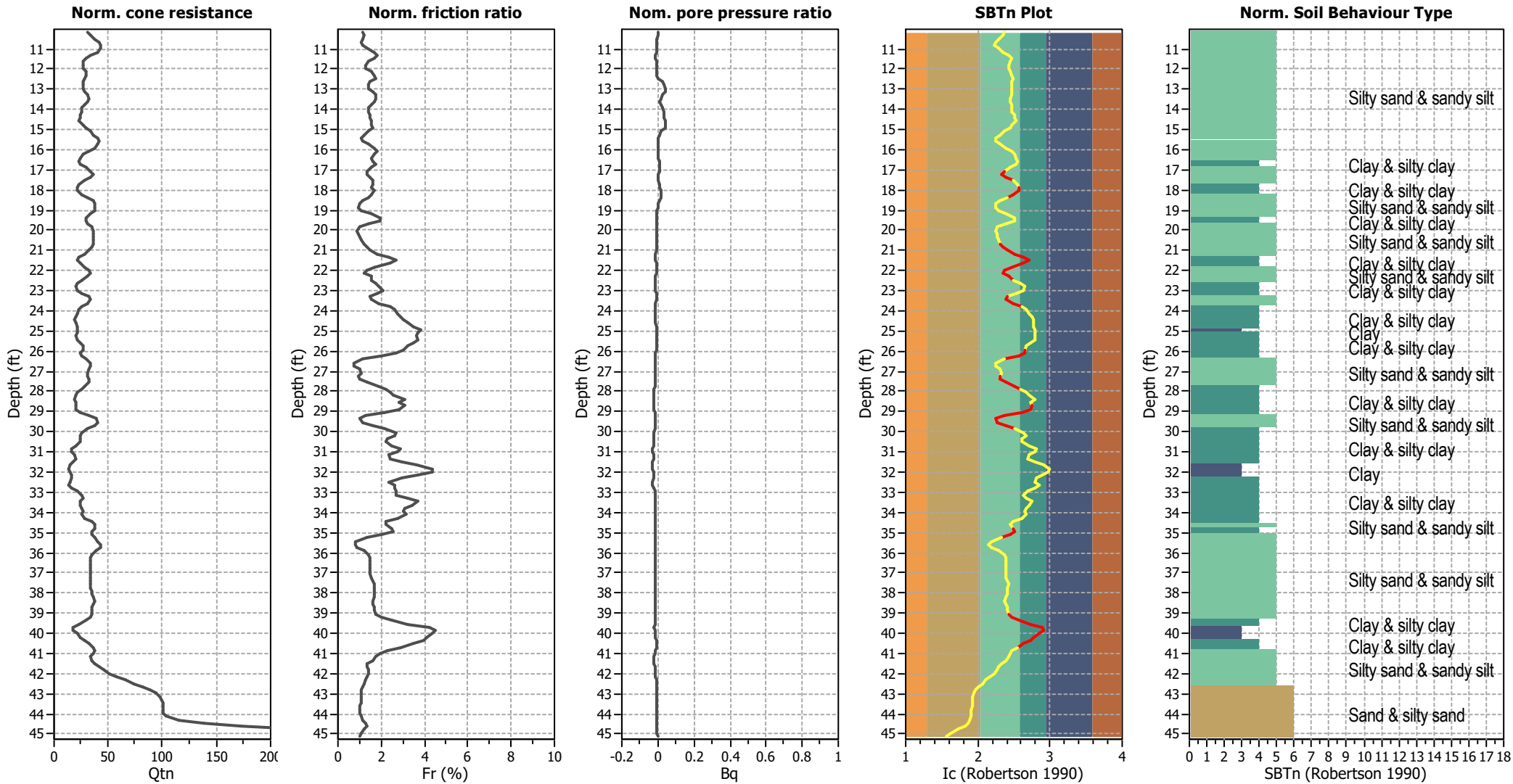
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



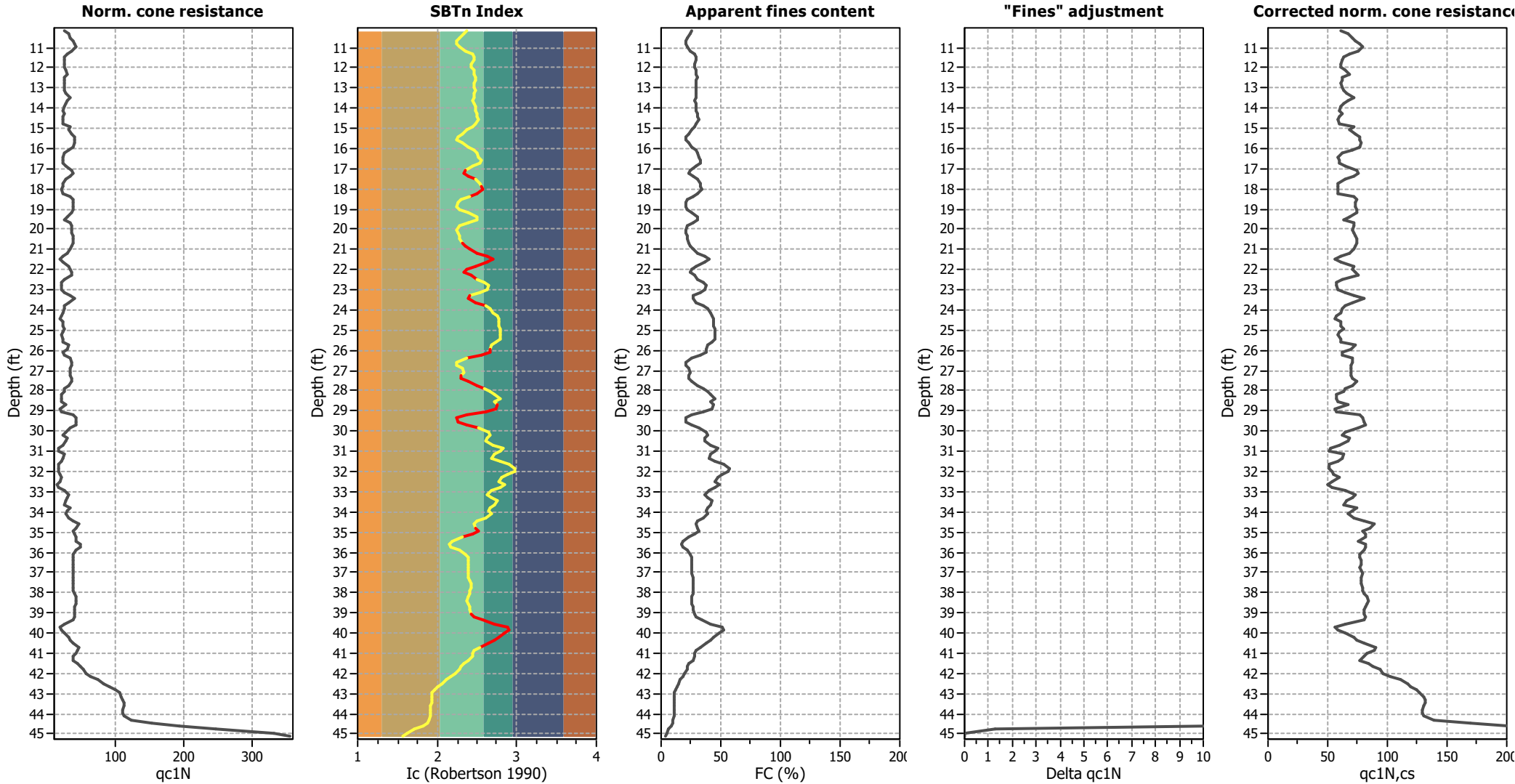
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBTn legend

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

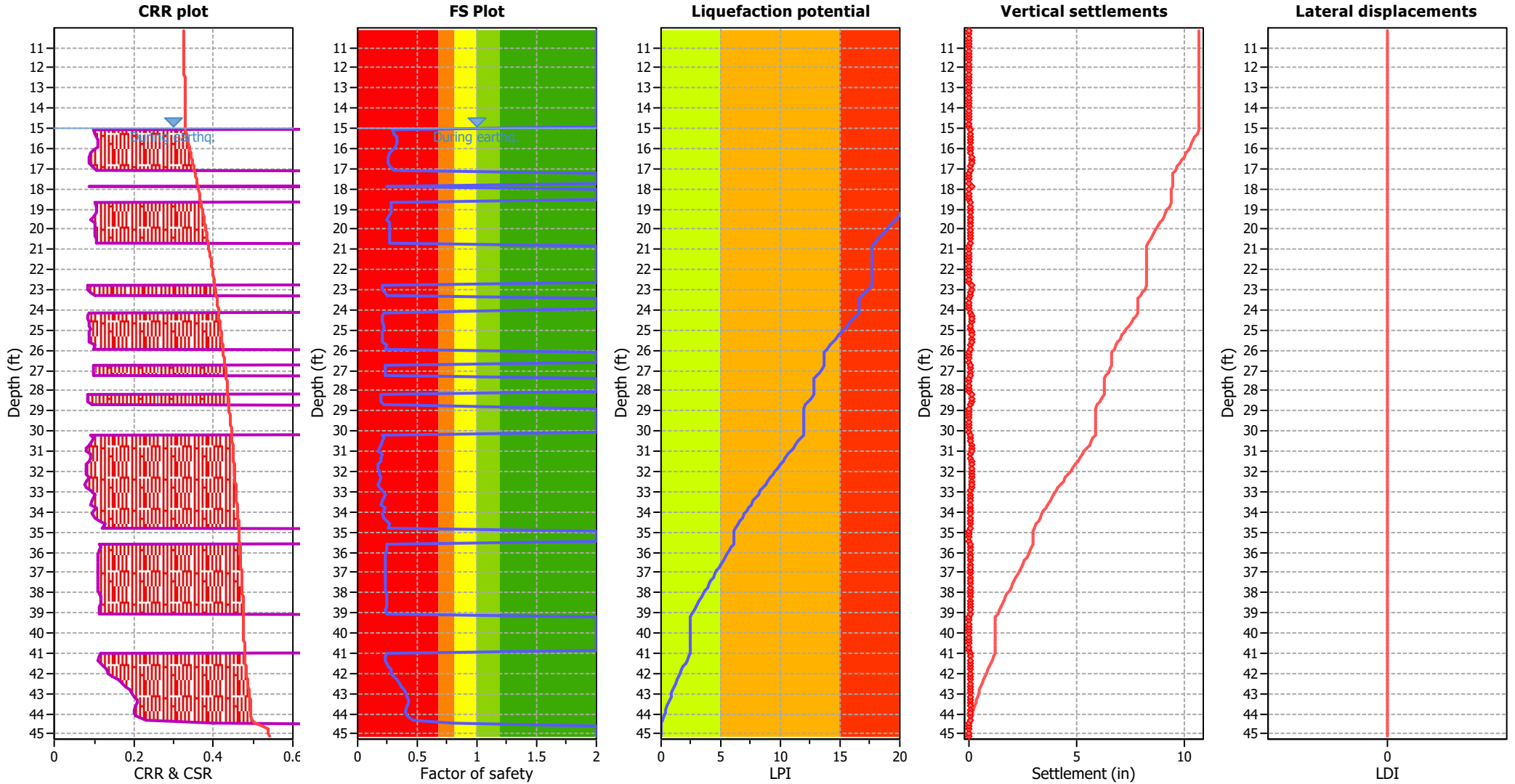
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (earthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

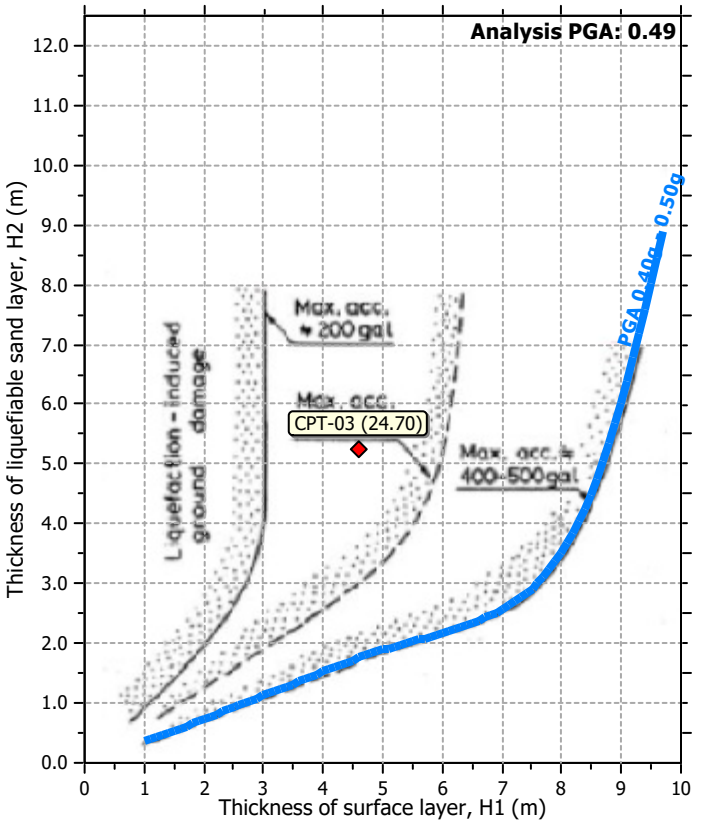
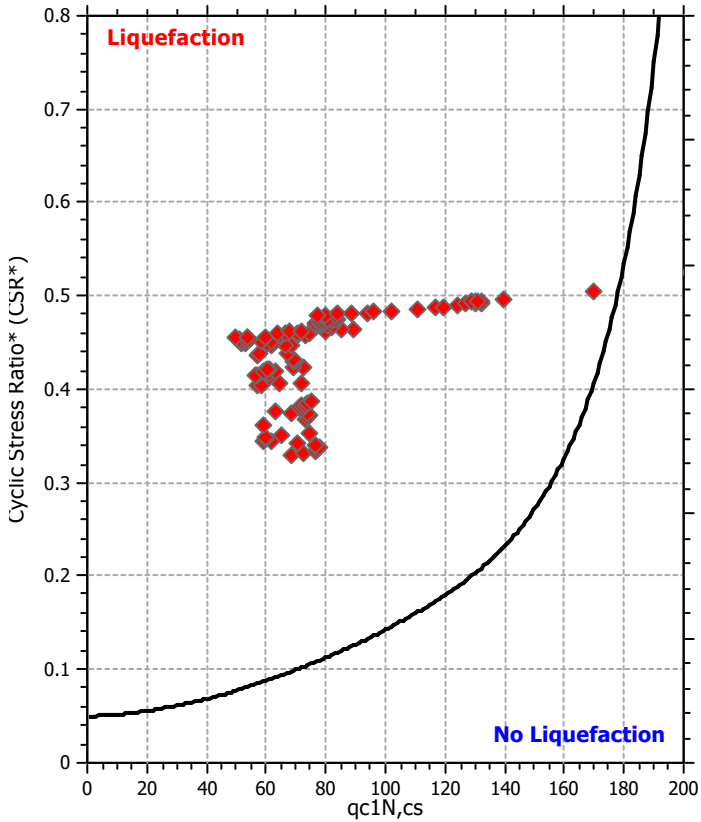
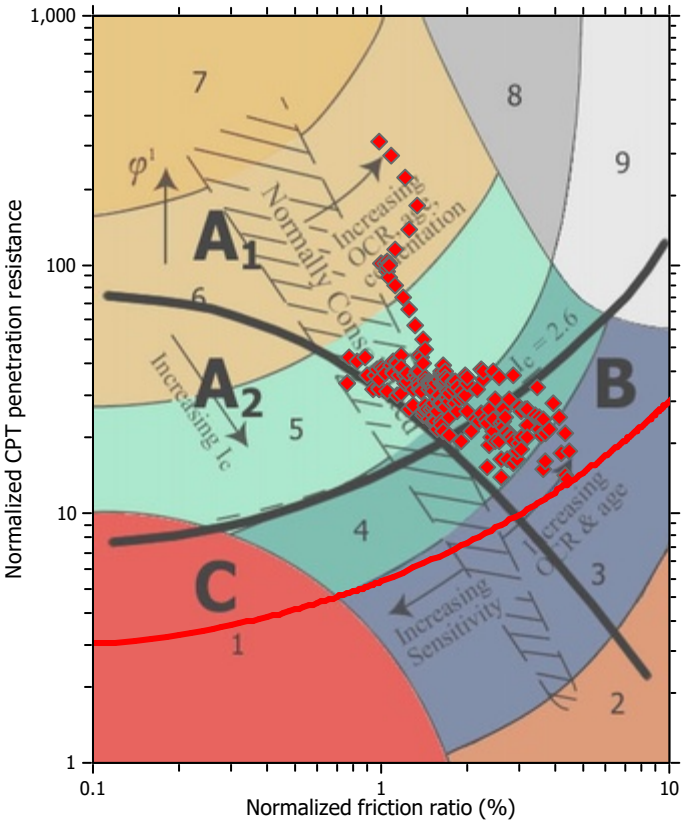
F.S. color scheme

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

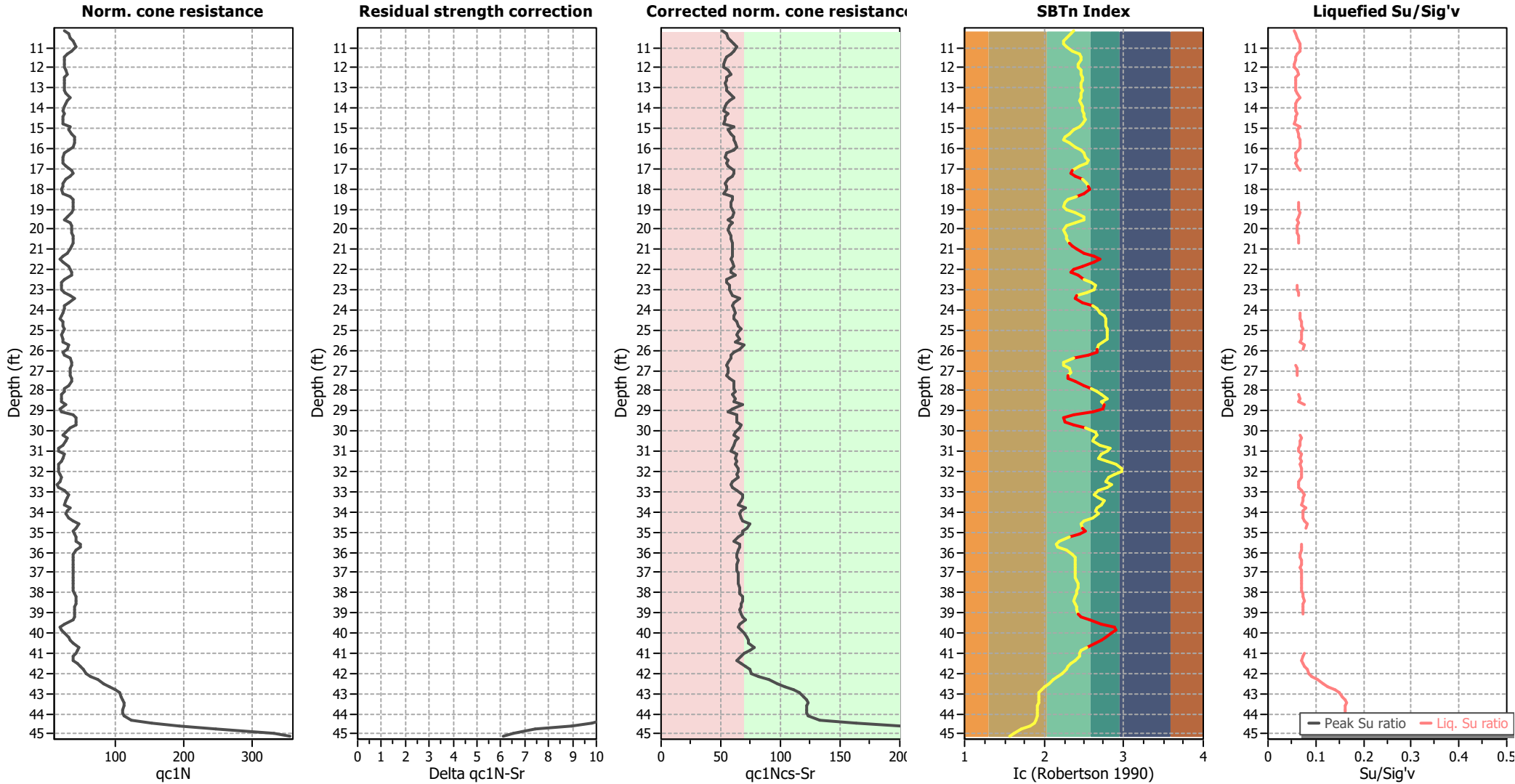
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	R&W (1998)	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 :	7.78	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	80.00 ft

:: Field input data ::

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	18.38	0.21	0.26	25.11	106.63
2	10.34	22.43	0.26	0.52	24.05	107.96
3	10.50	25.33	0.31	-2.00	22.13	109.09
4	10.66	28.31	0.30	-2.69	20.55	109.70
5	10.83	30.76	0.30	-3.12	20.28	110.82
6	10.99	31.65	0.44	-3.57	21.78	111.91
7	11.15	27.89	0.47	-3.74	24.76	112.39
8	11.32	22.99	0.42	-3.73	27.91	111.45
9	11.48	19.54	0.34	-3.33	29.31	109.81
10	11.65	19.64	0.26	-2.74	28.76	107.85
11	11.81	18.85	0.20	-2.32	27.80	106.77
12	11.97	18.98	0.23	-1.96	27.75	107.31
13	12.14	21.57	0.31	-1.25	28.74	109.50
14	12.30	23.43	0.44	-1.12	29.44	110.31
15	12.47	20.33	0.34	-0.70	30.00	110.14
16	12.63	20.18	0.29	7.60	29.68	108.55
17	12.79	19.72	0.24	9.12	29.19	108.16
18	12.96	20.58	0.29	11.07	29.30	108.47
19	13.12	21.17	0.32	12.27	29.64	109.77
20	13.29	23.26	0.39	9.15	29.06	111.35
21	13.45	27.59	0.49	6.60	28.73	112.06
22	13.62	25.02	0.42	4.34	28.52	111.60
23	13.78	22.49	0.32	5.20	28.99	109.89
24	13.94	20.84	0.27	6.55	29.50	108.58
25	14.11	20.14	0.28	8.28	29.77	108.38
26	14.27	21.67	0.30	9.68	30.85	108.88
27	14.44	20.39	0.33	9.76	31.01	108.56
28	14.60	19.22	0.24	11.30	31.89	108.67
29	14.76	20.56	0.32	12.83	29.62	109.99
30	14.93	29.54	0.45	13.71	28.36	111.54
31	15.09	28.24	0.43	5.96	25.39	112.18
32	15.26	32.36	0.37	3.52	23.00	111.80
33	15.42	36.59	0.36	1.92	20.83	111.85
34	15.58	37.63	0.40	0.88	20.70	112.49
35	15.75	36.54	0.45	0.30	22.96	113.90
36	15.91	34.30	0.63	-0.08	25.78	114.32
37	16.08	29.05	0.54	-0.21	29.04	113.54
38	16.24	22.63	0.37	-0.03	30.86	111.12
39	16.40	20.41	0.27	1.44	31.71	109.17
40	16.57	21.06	0.30	3.04	33.04	109.43
41	16.73	20.91	0.41	4.13	32.43	110.62
42	16.90	25.45	0.41	5.07	28.68	111.69
43	17.06	33.98	0.40	4.07	24.81	112.20
44	17.22	35.20	0.43	1.50	23.74	112.65
45	17.39	31.73	0.46	0.79	26.28	112.57
46	17.55	24.82	0.43	0.76	29.90	111.51
47	17.72	20.63	0.32	2.83	32.54	109.95
48	17.88	20.59	0.28	4.68	33.53	109.01

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	20.20	0.32	5.83	34.11	109.34
50	18.21	20.65	0.36	6.87	30.65	110.70
51	18.37	32.23	0.41	7.89	26.44	111.73
52	18.54	35.79	0.41	4.12	22.51	111.97
53	18.70	36.10	0.34	2.44	20.90	111.50
54	18.86	37.04	0.33	1.00	20.44	111.18
55	19.03	36.44	0.36	-0.54	21.80	111.92
56	19.19	34.00	0.45	0.45	26.16	113.60
57	19.36	28.61	0.66	-0.16	30.82	114.14
58	19.52	24.65	0.54	-0.27	30.94	113.89
59	19.68	32.74	0.40	-0.11	26.26	112.11
60	19.85	35.05	0.28	-1.08	21.70	110.75
61	20.01	35.47	0.30	-1.74	20.64	110.36
62	20.18	35.66	0.34	-2.04	21.03	110.95
63	20.34	36.39	0.36	-2.14	21.55	111.64
64	20.50	36.83	0.39	-2.19	21.99	112.25
65	20.67	37.02	0.43	-2.20	22.92	112.76
66	20.83	35.26	0.45	-2.15	24.45	113.09
67	21.00	32.58	0.47	-2.04	26.84	113.21
68	21.16	29.19	0.49	-1.95	30.92	113.22
69	21.32	23.27	0.51	-1.73	37.17	113.38
70	21.49	18.97	0.59	-1.08	40.83	113.55
71	21.65	23.23	0.57	0.00	37.16	114.09
72	21.82	32.15	0.57	-0.23	29.73	113.20
73	21.98	33.55	0.30	-1.15	25.54	112.87
74	22.15	35.42	0.45	-1.91	24.09	112.47
75	22.31	35.82	0.48	-2.45	27.54	113.22
76	22.47	25.05	0.48	-2.09	30.58	111.78
77	22.64	20.69	0.27	-1.38	35.27	110.38
78	22.80	20.70	0.34	-0.67	37.57	110.55
79	22.97	21.55	0.52	0.01	36.89	112.03
80	23.13	26.67	0.48	0.36	32.48	112.98
81	23.29	33.84	0.44	-0.58	26.76	113.47
82	23.46	40.70	0.52	-1.29	26.37	114.37
83	23.62	32.84	0.64	-1.59	29.81	115.21
84	23.79	26.50	0.67	-1.12	35.45	115.14
85	23.95	25.06	0.61	-0.46	38.60	114.65
86	24.11	24.16	0.58	-0.05	40.98	114.28
87	24.28	20.80	0.63	0.18	43.16	113.87
88	24.44	20.14	0.55	0.37	44.10	114.07
89	24.61	23.46	0.63	0.70	44.11	115.10
90	24.77	24.31	0.87	1.30	44.04	116.52
91	24.93	25.52	0.93	1.73	45.65	117.15
92	25.10	23.19	0.86	1.96	45.52	116.59
93	25.26	22.59	0.69	2.06	45.62	116.32
94	25.43	24.54	0.85	2.14	45.73	116.57
95	25.59	24.04	0.93	2.46	42.24	117.71
96	25.75	33.72	0.97	2.45	39.40	117.83

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	31.40	0.82	0.58	38.25	117.47
98	26.08	25.25	0.78	-0.39	38.36	115.90
99	26.25	26.67	0.53	-0.51	33.53	114.21
100	26.41	35.86	0.35	-0.60	25.13	111.53
101	26.57	39.03	0.22	-1.31	20.36	109.68
102	26.74	37.77	0.25	-1.74	20.32	109.69
103	26.90	36.30	0.35	-1.89	22.91	111.23
104	27.07	35.25	0.42	-1.88	23.83	111.55
105	27.23	35.77	0.31	-1.82	22.71	110.88
106	27.39	37.79	0.25	-1.95	22.61	111.47
107	27.56	38.78	0.50	-2.13	25.92	113.65
108	27.72	33.75	0.68	-2.09	30.92	115.16
109	27.89	28.49	0.63	-1.96	35.09	115.18
110	28.05	27.45	0.57	-1.72	39.07	114.41
111	28.21	21.81	0.58	-1.54	41.45	113.99
112	28.38	22.59	0.58	-0.83	45.48	114.61
113	28.54	22.95	0.77	-0.41	41.89	115.22
114	28.71	30.21	0.66	-0.34	43.42	115.62
115	28.87	21.45	0.71	-0.80	42.32	115.16
116	29.04	23.41	0.63	0.18	35.58	114.57
117	29.20	42.16	0.42	0.06	25.50	113.57
118	29.36	47.91	0.35	-1.02	20.41	113.64
119	29.53	47.84	0.56	-1.41	21.25	114.95
120	29.69	46.35	0.66	-1.52	25.61	116.82
121	29.86	38.75	0.85	-1.45	31.25	117.44
122	30.02	29.56	0.86	-1.50	37.28	117.10
123	30.18	26.94	0.70	-1.23	38.42	116.35
124	30.35	32.68	0.67	-1.22	36.32	115.52
125	30.51	31.04	0.61	-1.57	36.03	114.97
126	30.68	25.40	0.57	-1.79	40.94	114.22
127	30.84	19.37	0.58	-1.81	47.19	113.33
128	31.00	18.06	0.51	-1.33	45.64	113.40
129	31.17	27.97	0.56	-1.11	41.23	113.56
130	31.33	27.29	0.55	-1.44	39.74	114.44
131	31.50	24.30	0.67	-1.19	45.62	114.70
132	31.66	18.45	0.70	-0.65	52.25	114.77
133	31.82	18.13	0.66	0.01	57.42	115.28
134	31.99	19.70	0.87	0.86	56.43	115.73
135	32.15	20.94	0.81	1.45	50.95	115.72
136	32.32	25.31	0.57	0.20	46.99	114.15
137	32.48	20.52	0.43	0.01	45.00	111.76
138	32.64	16.80	0.33	0.74	48.69	111.78
139	32.81	20.51	0.61	1.82	45.19	113.37
140	32.97	30.12	0.68	2.30	39.76	116.27
141	33.14	37.85	0.91	1.44	36.97	117.88
142	33.30	35.26	1.02	0.70	39.42	119.33
143	33.47	31.43	1.24	0.76	43.15	119.47
144	33.63	29.57	1.06	1.02	41.36	119.36

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	39.13	0.93	0.67	39.07	119.02
146	33.96	35.65	1.05	0.14	38.13	119.17
147	34.12	33.14	1.09	-0.19	39.21	119.36
148	34.28	37.38	1.02	-0.17	35.82	119.30
149	34.45	45.33	0.93	-0.47	30.29	119.45
150	34.61	54.12	0.99	-0.97	28.83	120.29
151	34.78	50.24	1.29	-1.23	30.27	120.96
152	34.94	44.27	1.25	-1.45	31.58	120.77
153	35.10	47.21	0.95	-1.71	28.53	118.93
154	35.27	50.08	0.51	-1.91	23.50	116.45
155	35.43	51.09	0.44	-2.20	18.39	113.71
156	35.60	58.33	0.32	-2.17	17.34	113.64
157	35.76	57.18	0.48	-2.26	18.29	114.55
158	35.92	51.35	0.61	-2.30	21.85	115.93
159	36.09	46.08	0.66	-2.24	24.88	116.43
160	36.25	44.83	0.66	-2.11	26.02	116.47
161	36.42	46.46	0.64	-1.99	25.95	116.44
162	36.58	46.40	0.65	-1.85	25.82	116.40
163	36.74	45.37	0.64	-1.61	25.88	116.42
164	36.91	46.56	0.65	-1.43	25.79	116.48
165	37.07	47.43	0.66	-1.25	25.78	116.65
166	37.24	46.75	0.68	-1.08	26.32	116.89
167	37.40	45.85	0.72	-0.83	26.99	117.10
168	37.57	46.10	0.73	-0.62	27.27	117.32
169	37.73	47.18	0.74	-0.41	27.21	117.48
170	37.89	47.42	0.76	-0.21	26.93	117.72
171	38.06	49.20	0.79	-0.03	26.43	117.99
172	38.22	51.80	0.81	0.12	25.90	118.33
173	38.39	52.75	0.84	0.29	25.55	118.40
174	38.55	51.78	0.80	0.51	25.82	118.36
175	38.71	50.35	0.80	0.68	26.45	118.23
176	38.88	48.80	0.81	1.79	26.98	118.20
177	39.04	49.25	0.80	1.96	27.63	118.42
178	39.21	49.12	0.89	2.10	29.16	119.09
179	39.37	46.96	1.06	2.29	34.12	119.47
180	39.53	32.49	1.06	2.49	41.92	119.20
181	39.70	24.68	0.99	3.61	51.31	118.95
182	39.86	26.37	1.19	4.72	52.27	119.43
183	40.03	32.96	1.28	5.46	48.49	120.88
184	40.19	39.04	1.53	5.02	44.48	121.97
185	40.35	41.93	1.60	5.52	41.65	122.93
186	40.52	47.29	1.70	5.56	37.22	123.35
187	40.68	57.39	1.60	3.61	32.67	122.88
188	40.85	57.10	1.15	0.24	29.11	121.44
189	41.01	52.12	0.87	-1.28	28.18	119.92
190	41.17	49.55	0.96	-1.69	28.00	118.56
191	41.34	47.77	0.70	-2.17	26.35	117.97
192	41.50	55.88	0.66	-2.47	23.68	117.62

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	61.36	0.80	-2.52	22.18	118.81
194	41.83	67.38	0.98	-2.51	21.48	119.88
195	41.99	71.27	0.97	-2.31	20.11	120.66
196	42.16	80.50	1.02	-0.76	18.10	121.31
197	42.32	93.82	1.14	-0.52	16.20	122.24
198	42.49	105.02	1.24	-0.38	14.58	123.01
199	42.65	114.16	1.26	-0.22	13.19	123.53
200	42.81	124.76	1.28	-0.17	12.10	123.90
201	42.98	131.77	1.34	-0.34	11.43	124.34
202	43.14	136.62	1.42	-0.54	11.20	124.77
203	43.31	139.45	1.48	-0.69	11.11	125.06
204	43.47	140.51	1.48	-0.86	11.03	125.13
205	43.63	140.24	1.44	-1.01	10.82	124.92
206	43.80	140.09	1.35	-1.21	10.65	124.73
207	43.96	140.47	1.37	-1.66	10.59	124.73
208	44.13	142.08	1.44	-2.06	10.68	125.41
209	44.29	154.27	1.71	-2.35	10.29	126.97
210	44.45	189.88	2.25	-2.59	9.75	129.47
211	44.62	233.54	3.20	-2.75	8.64	132.03
212	44.78	293.67	4.00	-2.84	6.45	133.82
213	44.95	393.69	3.91	-2.51	4.78	134.84
214	45.11	421.27	4.09	-2.21	3.70	135.16

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q _c :	Measured cone resistance (tsf)
f _s :	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	19.73	30.50	2.21	67.45	2.37	0.05	0.66
10.34	22.05	33.53	2.09	70.03	2.34	0.06	0.68
10.50	25.36	37.75	1.89	71.19	2.29	0.06	0.68
10.66	28.13	41.03	1.74	71.35	2.25	0.06	0.69
10.83	30.24	43.57	1.72	74.78	2.24	0.07	0.70
10.99	30.10	43.28	1.85	80.12	2.28	0.07	0.71
11.15	27.51	39.70	2.17	86.16	2.36	0.07	0.70
11.32	23.47	33.90	2.57	87.22	2.44	0.06	0.68
11.48	20.72	29.66	2.77	82.24	2.47	0.06	0.66
11.65	19.34	27.23	2.69	73.33	2.46	0.06	0.66
11.81	19.16	26.53	2.56	67.86	2.43	0.06	0.66
11.97	19.80	27.13	2.55	69.21	2.43	0.06	0.66
12.14	21.33	29.08	2.69	78.23	2.46	0.06	0.67
12.30	21.78	29.46	2.79	82.25	2.47	0.06	0.68
12.47	21.31	28.55	2.87	82.08	2.48	0.06	0.66
12.63	20.08	26.51	2.83	74.93	2.48	0.06	0.66
12.79	20.16	26.28	2.76	72.41	2.47	0.06	0.66
12.96	20.49	26.45	2.77	73.32	2.47	0.06	0.66
13.12	21.67	27.76	2.82	78.32	2.48	0.06	0.66
13.29	24.01	30.46	2.74	83.35	2.46	0.06	0.67
13.45	25.29	31.76	2.69	85.39	2.46	0.07	0.69
13.62	25.03	31.08	2.66	82.63	2.45	0.06	0.68
13.78	22.78	27.95	2.73	76.22	2.46	0.06	0.67
13.94	21.16	25.67	2.80	71.89	2.47	0.06	0.66
14.11	20.88	25.09	2.84	71.27	2.48	0.06	0.66
14.27	20.73	24.73	3.00	74.29	2.50	0.06	0.66
14.44	20.43	24.11	3.03	73.04	2.51	0.06	0.66
14.60	20.06	23.48	3.17	74.36	2.53	0.06	0.65
14.76	23.11	26.77	2.82	75.46	2.48	0.06	0.66
14.93	26.11	30.00	2.64	79.09	2.45	0.07	0.69
15.09	30.05	34.17	2.25	76.74	2.37	0.06	0.68
15.26	32.40	36.54	1.97	72.12	2.31	0.06	0.69
15.42	35.53	39.77	1.76	70.14	2.25	0.07	0.70
15.58	36.92	41.18	1.75	72.15	2.25	0.07	0.70
15.75	36.16	40.39	1.97	79.57	2.31	0.07	0.70
15.91	33.30	37.21	2.29	85.36	2.38	0.07	0.70
16.08	28.66	31.98	2.73	87.43	2.46	0.07	0.68
16.24	24.03	26.63	3.01	80.04	2.50	0.06	0.66
16.40	21.37	23.51	3.14	73.82	2.52	0.06	0.65
16.57	20.79	22.81	3.36	76.52	2.55	0.06	0.66
16.73	22.47	24.60	3.25	80.07	2.54	0.06	0.66
16.90	26.78	29.18	2.68	78.23	2.45	0.06	0.67
17.06	31.54	34.15	2.18	74.31	2.36	0.07	0.70
17.22	33.64	36.26	2.05	74.48	2.33	0.07	0.70
17.39	30.58	32.90	2.36	77.54	2.40	0.06	0.69
17.55	25.73	27.58	2.86	78.87	2.48	0.06	0.67
17.72	22.01	23.45	3.27	76.73	2.54	0.06	0.65
17.88	20.47	21.67	3.44	74.51	2.56	0.06	0.65

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	20.48	21.61	3.53	76.38	2.57	0.06	0.65
18.21	24.36	25.67	2.97	76.33	2.50	0.06	0.65
18.37	29.56	31.04	2.38	73.80	2.40	0.06	0.69
18.54	34.71	36.26	1.92	69.72	2.30	0.06	0.69
18.70	36.31	37.74	1.77	66.78	2.26	0.06	0.69
18.86	36.53	37.80	1.73	65.40	2.24	0.06	0.69
19.03	35.83	37.01	1.85	68.58	2.28	0.06	0.69
19.19	33.02	34.11	2.34	79.90	2.39	0.07	0.69
19.36	29.09	29.98	3.00	89.94	2.50	0.07	0.68
19.52	28.67	29.41	3.02	88.79	2.51	0.06	0.67
19.68	30.81	31.39	2.35	73.91	2.40	0.06	0.69
19.85	34.42	34.86	1.84	64.28	2.28	0.06	0.69
20.01	35.39	35.70	1.75	62.36	2.25	0.06	0.69
20.18	35.84	36.06	1.78	64.23	2.26	0.06	0.69
20.34	36.29	36.43	1.83	66.63	2.27	0.06	0.69
20.50	36.75	36.79	1.87	68.83	2.29	0.06	0.69
20.67	36.37	36.30	1.97	71.36	2.31	0.06	0.70
20.83	34.95	34.78	2.13	74.21	2.35	0.06	0.69
21.00	32.34	32.05	2.43	77.86	2.41	0.06	0.69
21.16	28.35	27.93	3.01	84.20	2.51	0.06	0.68
21.32	23.81	23.29	4.08	95.01	2.64	0.06	0.66
21.49	21.82	21.20	4.78	101.37	2.71	0.06	0.64
21.65	24.78	24.08	4.08	98.17	2.64	0.06	0.66
21.82	29.64	28.78	2.84	81.58	2.48	0.07	0.69
21.98	33.71	32.66	2.26	73.96	2.38	0.06	0.69
22.15	34.93	33.74	2.09	70.60	2.34	0.06	0.69
22.31	32.10	30.86	2.52	77.87	2.43	0.07	0.70
22.47	27.19	25.90	2.96	76.73	2.50	0.06	0.66
22.64	22.15	20.84	3.74	77.90	2.60	0.06	0.65
22.80	20.98	19.62	4.15	81.48	2.64	0.06	0.65
22.97	22.97	21.51	4.03	86.63	2.63	0.06	0.65
23.13	27.35	25.70	3.26	83.87	2.54	0.06	0.67
23.29	33.74	31.79	2.42	76.92	2.41	0.06	0.69
23.46	35.79	33.68	2.37	79.74	2.40	0.07	0.71
23.62	33.35	31.21	2.85	88.84	2.48	0.07	0.69
23.79	28.13	26.07	3.77	98.24	2.60	0.07	0.67
23.95	25.24	23.18	4.35	100.74	2.66	0.07	0.66
24.11	23.34	21.26	4.81	102.27	2.71	0.07	0.66
24.28	21.70	19.59	5.25	102.95	2.75	0.07	0.65
24.44	21.47	19.29	5.45	105.09	2.77	0.07	0.65
24.61	22.64	20.32	5.45	110.78	2.77	0.07	0.66
24.77	24.43	21.93	5.44	119.23	2.77	0.07	0.66
24.93	24.34	21.75	5.78	125.68	2.79	0.07	0.66
25.10	23.77	21.11	5.75	121.42	2.79	0.07	0.66
25.26	23.44	20.71	5.77	119.54	2.79	0.07	0.65
25.43	23.72	20.89	5.80	121.06	2.80	0.07	0.66
25.59	27.43	24.26	5.06	122.84	2.73	0.07	0.66
25.75	29.72	26.28	4.50	118.31	2.68	0.08	0.69

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_c (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	30.12	26.55	4.28	113.67	2.66	0.07	0.68
26.08	27.77	24.28	4.30	104.45	2.66	0.07	0.66
26.25	29.26	25.58	3.44	87.94	2.56	0.06	0.66
26.41	33.85	29.77	2.21	65.94	2.37	0.06	0.69
26.57	37.55	33.13	1.72	57.08	2.24	0.06	0.69
26.74	37.70	33.17	1.72	57.03	2.24	0.06	0.68
26.90	36.44	31.88	1.96	62.64	2.31	0.06	0.68
27.07	35.77	31.16	2.06	64.32	2.33	0.06	0.68
27.23	36.27	31.54	1.94	61.31	2.31	0.06	0.68
27.39	37.45	32.50	1.93	62.84	2.30	0.06	0.69
27.56	36.77	31.73	2.31	73.34	2.39	0.07	0.69
27.72	33.67	28.76	3.01	86.71	2.51	0.07	0.68
27.89	29.90	25.23	3.70	93.47	2.59	0.07	0.67
28.05	25.92	21.56	4.44	95.67	2.67	0.07	0.67
28.21	23.95	19.72	4.91	96.74	2.72	0.06	0.65
28.38	22.45	18.29	5.74	104.99	2.79	0.07	0.65
28.54	25.25	20.70	4.99	103.33	2.73	0.07	0.65
28.71	24.87	20.26	5.31	107.56	2.75	0.07	0.68
28.87	25.02	20.33	5.08	103.27	2.73	0.06	0.64
29.04	29.01	23.81	3.79	90.26	2.60	0.06	0.65
29.20	37.83	31.62	2.26	71.43	2.38	0.07	0.70
29.36	45.97	38.81	1.73	67.04	2.24	0.07	0.71
29.53	47.37	39.88	1.80	71.82	2.26	0.07	0.71
29.69	44.31	36.92	2.27	83.89	2.38	0.07	0.71
29.86	38.22	31.36	3.07	96.17	2.51	0.07	0.70
30.02	31.75	25.58	4.10	104.88	2.64	0.07	0.67
30.18	29.73	23.75	4.31	102.42	2.66	0.07	0.66
30.35	30.22	24.12	3.92	94.65	2.62	0.07	0.68
30.51	29.71	23.61	3.87	91.42	2.61	0.07	0.67
30.68	25.27	19.70	4.80	94.64	2.71	0.07	0.66
30.84	20.94	15.94	6.11	97.41	2.82	0.07	0.64
31.00	21.80	16.61	5.78	95.91	2.79	0.06	0.63
31.17	24.44	18.80	4.86	91.38	2.71	0.07	0.66
31.33	26.52	20.47	4.57	93.48	2.69	0.07	0.66
31.50	23.35	17.68	5.77	102.05	2.79	0.07	0.65
31.66	20.29	15.06	7.26	109.38	2.90	0.07	0.63
31.82	18.76	13.76	8.52	117.18	2.98	0.07	0.63
31.99	19.59	14.37	8.27	118.86	2.97	0.07	0.64
32.15	21.98	16.24	6.96	113.01	2.88	0.07	0.64
32.32	22.26	16.44	6.07	99.77	2.82	0.07	0.66
32.48	20.88	15.31	5.64	86.33	2.78	0.06	0.64
32.64	19.28	13.91	6.45	89.70	2.85	0.06	0.62
32.81	22.48	16.47	5.68	93.54	2.79	0.06	0.64
32.97	29.49	22.13	4.57	101.14	2.69	0.07	0.67
33.14	34.41	26.06	4.04	105.34	2.63	0.08	0.69
33.30	34.85	26.22	4.50	118.11	2.68	0.07	0.68
33.47	32.09	23.82	5.25	125.10	2.75	0.07	0.67
33.63	33.38	24.80	4.89	121.17	2.72	0.07	0.67

:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_c (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	34.78	25.89	4.44	114.90	2.67	0.08	0.69
33.96	35.97	26.77	4.26	113.99	2.66	0.07	0.68
34.12	35.39	26.17	4.46	116.85	2.68	0.07	0.68
34.28	38.62	28.74	3.84	110.23	2.61	0.07	0.69
34.45	45.61	34.42	2.92	100.44	2.49	0.08	0.71
34.61	49.90	37.77	2.70	102.13	2.46	0.08	0.73
34.78	49.54	37.27	2.92	108.64	2.49	0.08	0.72
34.94	47.24	35.26	3.12	109.98	2.52	0.08	0.70
35.10	47.19	35.31	2.66	93.92	2.45	0.07	0.71
35.27	49.46	37.37	2.03	75.77	2.33	0.07	0.71
35.43	53.17	40.70	1.57	63.93	2.18	0.07	0.70
35.60	55.53	42.59	1.50	63.99	2.15	0.07	0.71
35.76	55.62	42.44	1.56	66.36	2.18	0.07	0.71
35.92	51.54	38.73	1.86	71.98	2.28	0.07	0.71
36.09	47.42	35.15	2.18	76.80	2.36	0.07	0.70
36.25	45.79	33.70	2.32	78.31	2.39	0.07	0.70
36.42	45.90	33.69	2.31	77.98	2.39	0.07	0.70
36.58	46.08	33.73	2.30	77.55	2.39	0.07	0.70
36.74	46.11	33.66	2.31	77.61	2.39	0.07	0.70
36.91	46.45	33.83	2.30	77.63	2.38	0.07	0.70
37.07	46.91	34.08	2.29	78.15	2.38	0.07	0.70
37.24	46.68	33.75	2.36	79.73	2.40	0.07	0.70
37.40	46.23	33.26	2.45	81.45	2.41	0.07	0.70
37.57	46.38	33.25	2.49	82.66	2.42	0.07	0.70
37.73	46.90	33.54	2.48	83.13	2.42	0.07	0.70
37.89	47.93	34.24	2.44	83.61	2.41	0.07	0.70
38.06	49.47	35.33	2.38	83.95	2.40	0.07	0.71
38.22	51.25	36.60	2.31	84.52	2.39	0.07	0.71
38.39	52.11	37.17	2.27	84.21	2.38	0.07	0.72
38.55	51.63	36.67	2.30	84.31	2.39	0.07	0.71
38.71	50.31	35.53	2.38	84.52	2.40	0.07	0.71
38.88	49.47	34.76	2.45	85.06	2.41	0.07	0.71
39.04	49.06	34.29	2.54	86.94	2.43	0.07	0.71
39.21	48.44	33.60	2.75	92.42	2.47	0.08	0.71
39.37	42.86	29.07	3.54	102.82	2.57	0.08	0.71
39.53	34.71	22.75	5.00	113.76	2.73	0.07	0.67
39.70	27.85	17.65	7.05	124.34	2.89	0.07	0.65
39.86	28.00	17.69	7.27	128.60	2.90	0.07	0.65
40.03	32.79	20.90	6.40	133.81	2.84	0.08	0.67
40.19	37.98	24.55	5.53	135.76	2.77	0.08	0.69
40.35	42.75	27.91	4.94	138.01	2.72	0.08	0.69
40.52	48.87	32.36	4.09	132.35	2.64	0.08	0.71
40.68	53.93	36.19	3.29	119.21	2.54	0.09	0.73
40.85	55.54	37.58	2.74	103.08	2.46	0.08	0.73
41.01	52.92	35.73	2.61	93.28	2.44	0.08	0.71
41.17	49.81	33.45	2.59	86.52	2.44	0.07	0.71
41.34	51.07	34.42	2.37	81.45	2.40	0.07	0.70
41.50	55.00	37.44	2.05	76.63	2.33	0.07	0.72

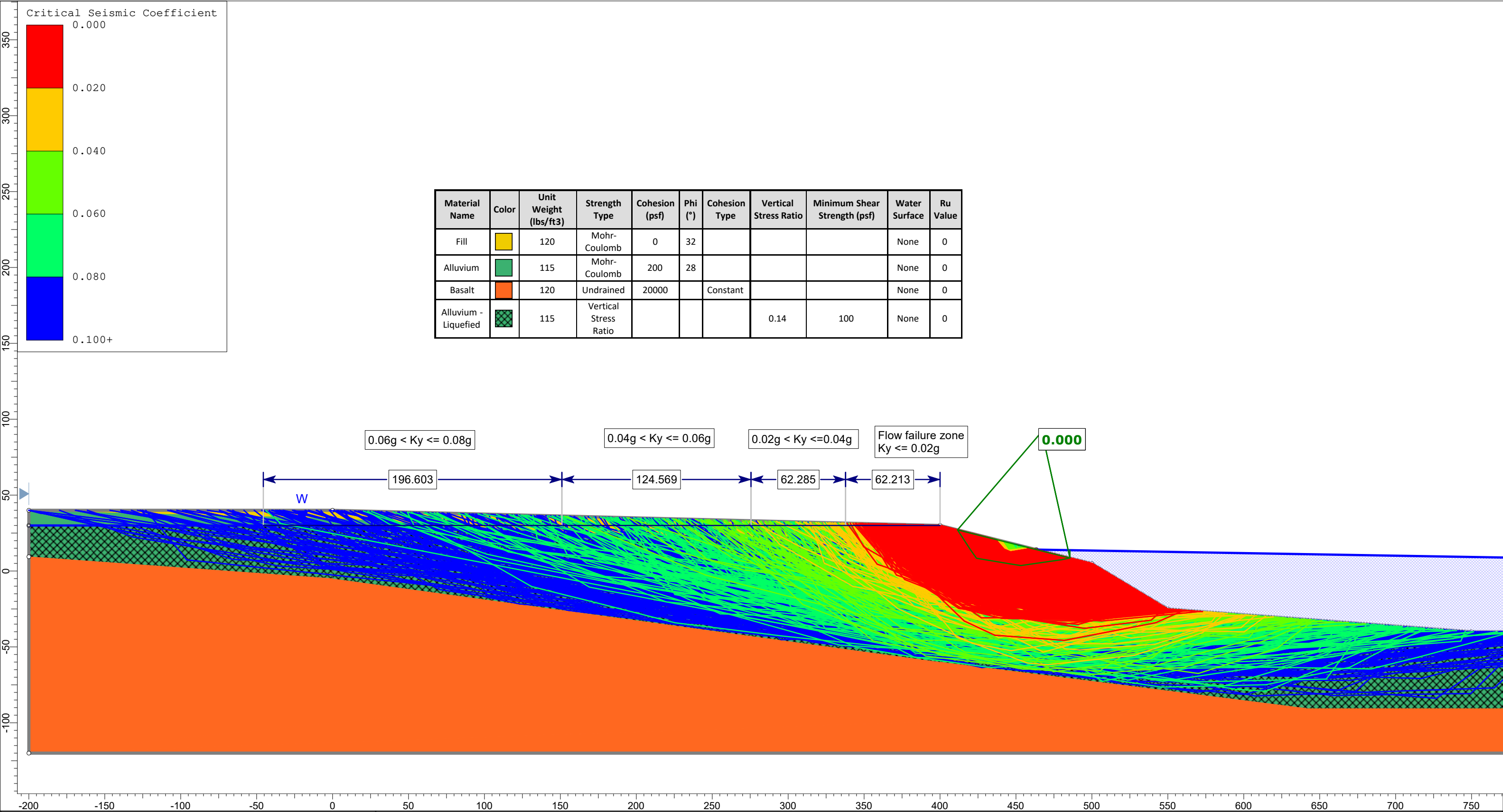
:: Strength loss calculation (Idriss & Boulanger (2008)) :: (continued)

Depth (ft)	q_c (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	61.54	42.19	1.89	79.75	2.29	0.08	0.73
41.83	66.67	45.85	1.82	83.56	2.27	0.08	0.74
41.99	73.05	50.53	1.70	86.01	2.23	0.08	0.74
42.16	81.86	57.16	1.55	88.66	2.17	0.09	0.75
42.32	93.11	65.63	1.44	94.40	2.11	0.10	0.77
42.49	104.33	74.12	1.36	101.13	2.06	0.12	0.78
42.65	114.65	82.00	1.31	107.79	2.01	0.13	0.78
42.81	123.56	88.82	1.28	113.91	1.97	0.14	0.79
42.98	131.05	94.43	1.26	119.42	1.94	0.15	0.79
43.14	135.95	97.93	1.26	123.24	1.93	0.16	0.80
43.31	138.86	99.88	1.26	125.47	1.93	0.16	0.80
43.47	140.07	100.58	1.25	126.14	1.93	0.16	0.80
43.63	140.28	100.63	1.25	125.64	1.92	0.16	0.80
43.80	140.27	100.49	1.24	125.02	1.91	0.16	0.80
43.96	140.88	100.75	1.24	125.18	1.91	0.16	0.80
44.13	145.61	103.90	1.24	129.32	1.91	0.16	0.80
44.29	162.08	115.86	1.23	143.00	1.90	0.19	0.81
44.45	192.56	138.17	1.22	168.30	1.87	0.34	0.85
44.62	239.03	172.86	1.18	203.58	1.82	0.91	0.89
44.78	306.97	225.76	1.02	231.26	1.72	0.95	0.94
44.95	369.54	275.60	1.00	275.60	1.63	0.98	1.00
45.11	412.08	310.22	1.00	310.22	1.56	1.00	1.02

Abbreviations

q_c :	Total cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c :	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

A-3-5
Yield Acceleration
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
Alluvium		115	Mohr-Coulomb	200	28				None	0
Basalt		120	Undrained	20000		Constant			None	0
Alluvium - Liquefied		115	Vertical Stress Ratio				0.14	100	None	0

A-3-6

Site Class Calculation

		Newmark Calculation Summary								
		Yield Acceleration = 0.02g								
Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	36.8	31.8	34.3	45.8	42	43.9	29.4	28.8	29.1
Imperial Valley 1979	E05-140	28.8	55.1	41.9	49.6	58.8	54.2	34.2	55.5	44.9
Imperial Valley 1979	E07-230	107.3	144.9	126.1	151.8	134.9	143.4	67.9	100.5	84.2
N. Palm Springs 1986	WWT-180	21.4	17.1	19.2	7.6	9	8.3	8	10.4	9.2
Northridge 1994	LOS-270	40.8	43.7	42.3	28.4	28.5	28.4	18.9	23	20.9
Northridge 1994	STN-020	26.2	17.2	21.7	18.3	13.2	15.8	15.2	10.7	13
Parkfield 1966	C02-065	48.5	69.3	58.9	35.5	34.3	34.9	25.6	27	26.3
Westmorland 1981	WSM-180	28.5	32	30.2	17.1	23.7	20.4	14.8	24.1	19.5
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	161.1	158.7	159.9	148.6	151.6	150.1	123.4	116.8	120.1
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	113.2	122.3	117.7	152.8	149.7	151.3	123.2	119.1	121.2
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	117.2	118.6	117.9	133.3	149.8	141.5	102.9	112.4	107.6
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	124	94.3	109.1	99.6	96	97.8	75.5	65.9	70.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	92.7	79.8	86.3	90.1	84.9	87.5	73.6	60.3	66.9
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	117.7	114.5	116.1	119.2	117.3	118.3	99.6	99.9	99.8
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	67.1	61	64.1	60.8	52	56.4	59.4	34.5	46.9
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	102.7	102.1	102.4	114.4	114.6	114.5	95.4	77.5	86.4
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	58.6	47.3	53	47.5	40	43.8	39.7	29.5	34.6
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	112.9	89.9	101.4	98.8	86.6	92.7	79.4	67.5	73.5
	Mean value	78.1	77.8	77.9	78.8	77.1	78	60.3	59.1	59.7
	Median value	79.9	74.6	75.2	75.5	71.8	72	63.7	57.9	56.9
	Standard deviation	41.8	41.9	41.1	48.7	48.5	48.5	37.4	36.7	36.5

		Newmark Calculation Summary								
		Yield Acceleration = 0.04g								
Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	18.7	14.9	16.8	25.2	18.4	21.8	16.9	13	15
Imperial Valley 1979	E05-140	13.1	25.5	19.3	15.7	30.3	23	13.2	27.3	20.2
Imperial Valley 1979	E07-230	67.9	78.6	73.3	86.7	77.6	82.1	46	54.8	50.4
N. Palm Springs 1986	WWT-180	12.8	10.7	11.7	2.6	5.1	3.8	3.8	4.9	4.3
Northridge 1994	LOS-270	21.3	25.6	23.5	12.5	15.4	13.9	8.3	13	10.7
Northridge 1994	STN-020	12	8	10	6.4	2.9	4.7	6.3	3.8	5.1
Parkfield 1966	C02-065	27.5	33.9	30.7	20	15.4	17.7	15.4	11.1	13.2
Westmorland 1981	WSM-180	18.2	17.5	17.9	5.1	11.2	8.2	6.1	10.7	8.4
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	71.7	68	69.9	53.6	41.2	47.4	45.7	37.9	41.8
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	43.1	48.5	45.8	47.4	43.6	45.5	42.1	37.8	40
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	45.5	47.9	46.7	44	50.4	47.2	36.1	38.7	37.4
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	57.8	46.7	52.2	35.8	29.5	32.6	27.5	23.4	25.5
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	44.4	41.2	42.8	32	28.4	30.2	28.5	21.5	25
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	47.1	50.6	48.9	33.6	25.4	29.5	32.8	23.3	28
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	31.2	30.1	30.7	26.5	17.3	21.9	23.6	12.3	18
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	52.7	47.8	50.3	51.8	40.5	46.2	43.8	32	37.9
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	27.4	22	24.7	19.5	12	15.7	16.5	10.4	13.4
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	64.4	45.5	54.9	42.2	43.2	42.7	35.2	32	33.6
	Mean value	37.6	36.8	37.2	31.1	28.2	29.7	24.9	22.7	23.8
	Median value	37.2	37.6	36.7	29.3	26.9	26.3	25.6	22.4	22.6
	Standard deviation	19.4	18.8	18.8	20.6	18.3	19.1	14.2	13.6	13.5

		Newmark Calculation Summary								
		Yield Acceleration = 0.08g								
Earthquake	Record	Rigid block	Rigid block	Rigid block	Decoupled	Decoupled	Decoupled	Coupled	Coupled	Coupled
		(in.)Normal	(in.)Inverse	(in.)Average	(in.)Normal	(in.)Inverse	(in.)Average	(in.)Normal	(in.)Inverse	(in.)Average
Imperial Valley 1979	E04-140	9.7	5.7	7.7	7.1	3.5	5.3	6.1	3.2	4.7
Imperial Valley 1979	E05-140	3.9	11.3	7.6	2.7	7.1	4.9	2.5	7.4	4.9
Imperial Valley 1979	E07-230	35.3	35.5	35.4	24.5	31.2	27.8	21.1	27.8	24.5
N. Palm Springs 1986	WWT-180	7.3	5.7	6.5	0.5	1.2	0.9	0.8	1.3	1.1
Northridge 1994	LOS-270	10.9	10.8	10.9	2.5	5.1	3.8	2.1	4.7	3.4
Northridge 1994	STN-020	3.9	3.1	3.5	0.9	0.4	0.7	0.9	0.7	0.8
Parkfield 1966	C02-065	14.4	13.3	13.8	7.9	0.6	4.2	8.5	0.8	4.6
Westmorland 1981	WSM-180	9.1	8.5	8.8	0.7	3	1.8	1.1	3.1	2.1
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	25.8	20.7	23.2	6.7	2.3	4.5	8.2	3.8	6
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	13.8	13.4	13.6	7.5	4.2	5.8	7.9	5.6	6.8
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	14.4	16	15.2	5.4	8.6	7	5.6	8.3	7
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	17.7	17.6	17.7	5.7	2.1	3.9	4.8	2.6	3.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	15	18.9	17	9.5	5.5	7.5	8.3	5.3	6.8
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	17.4	19.4	18.4	6.9	1.2	4.1	5.9	2.2	4
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	10.9	9.7	10.3	8.5	1.8	5.1	7.4	2.3	4.9
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	16.5	14.4	15.4	11.4	6.6	9	12	6.8	9.4
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	9	7.5	8.3	4.4	1	2.7	4.3	1.4	2.9
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	25.6	17.3	21.5	11.2	11.7	11.4	10.3	9.9	10.1
	Mean value	14.5	13.8	14.1	6.9	5.4	6.1	6.5	5.4	6
	Median value	14.1	13.4	13.7	6.8	3.2	4.7	6	3.5	4.8
	Standard deviation	7.8	7.3	7.4	5.4	6.9	5.9	4.8	6	5.1

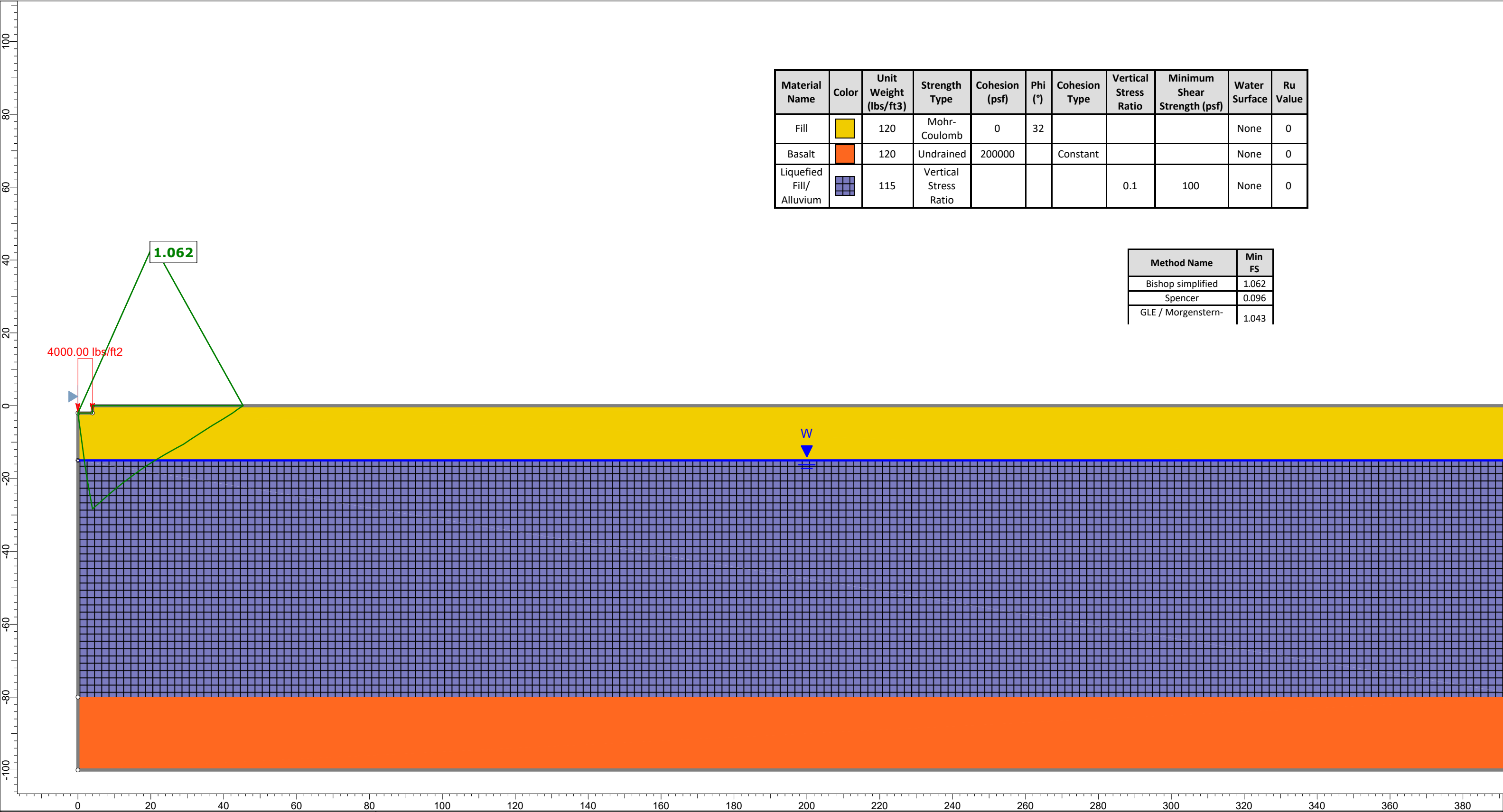
Newmark Calculation Summary

Yield Acceleration = 0.12g

Earthquake	Record	Rigid block	Rigid block	Rigid block	Decoupled	Decoupled	Decoupled	Coupled	Coupled	Coupled
		(in.)Normal	(in.)Inverse	(in.)Average	(in.)Normal	(in.)Inverse	(in.)Average	(in.)Normal	(in.)Inverse	(in.)Average
Imperial Valley 1979	E04-140	5	1.8	3.4	1.2	0	0.6	1.9	0	1
Imperial Valley 1979	E05-140	1.4	4.3	2.9	0.2	0.7	0.5	0.4	1	0.7
Imperial Valley 1979	E07-230	19.8	10.7	15.2	3.6	10	6.8	6	12	9
N. Palm Springs 1986	WWT-180	4.2	3.8	4	0	0	0	0	0.1	0.1
Northridge 1994	LOS-270	6.5	5.3	5.9	0.2	0.5	0.3	0.4	0.8	0.6
Northridge 1994	STN-020	2.1	1.3	1.7	0	0	0	0	0.1	0.1
Parkfield 1966	C02-065	10.4	6.6	8.5	2.8	0	1.4	4.3	0	2.1
Westmorland 1981	WSM-180	4.8	4.3	4.6	0	0.3	0.2	0.1	0.5	0.3
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	11.2	8	9.6	0.5	0	0.2	1	0	0.5
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	5.4	5.1	5.3	1.8	0	0.9	2.2	0	1.1
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	5.9	6.6	6.3	0.3	0.5	0.4	0.6	1.2	0.9
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	7.3	7.8	7.5	0.6	0.3	0.4	0.9	0.6	0.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	7.1	10	8.6	2.8	0.5	1.7	2.7	1.1	1.9
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	8.1	8	8.1	1.6	0	0.8	1.9	0.1	1
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	4.5	4	4.2	1.9	0	0.9	2.2	0	1.1
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	6.4	5.2	5.8	1.2	1.1	1.1	1.9	1.6	1.8
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	3.5	3.4	3.4	0.5	0	0.2	1	0	0.5
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	10.4	8.5	9.5	1.8	2	1.9	2.5	2.1	2.3
	Mean value	6.9	5.8	6.4	1.2	0.9	1	1.7	1.2	1.4
	Median value	6.1	5.3	5.9	0.9	0.2	0.5	1.4	0.3	0.9
	Standard deviation	4.1	2.6	3.2	1.1	2.3	1.5	1.5	2.7	2

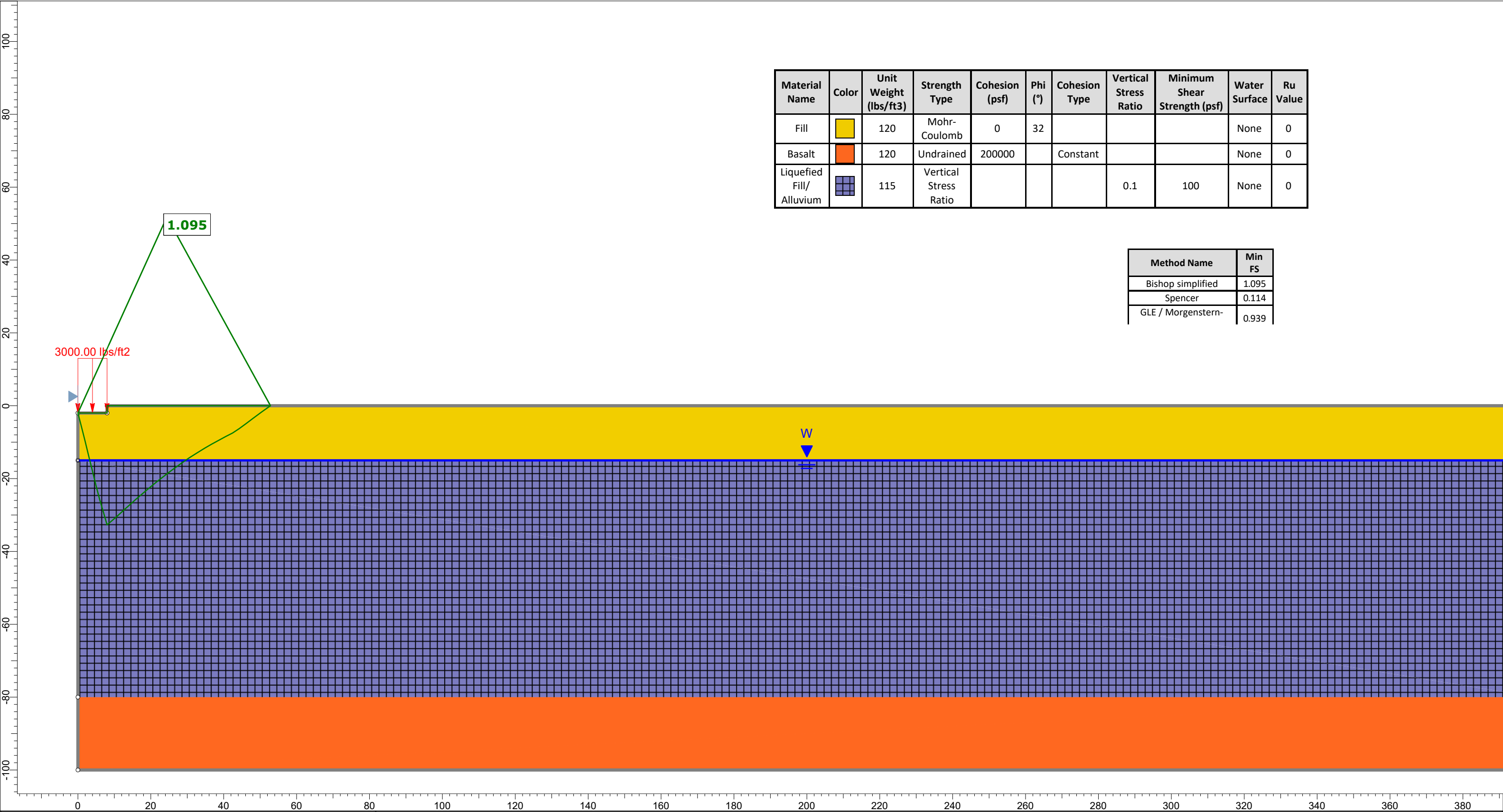
A-3-7

Seismic Bearing Capacity Calculation



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	1.062
Spencer	0.096
GLE / Morgenstern-	1.043



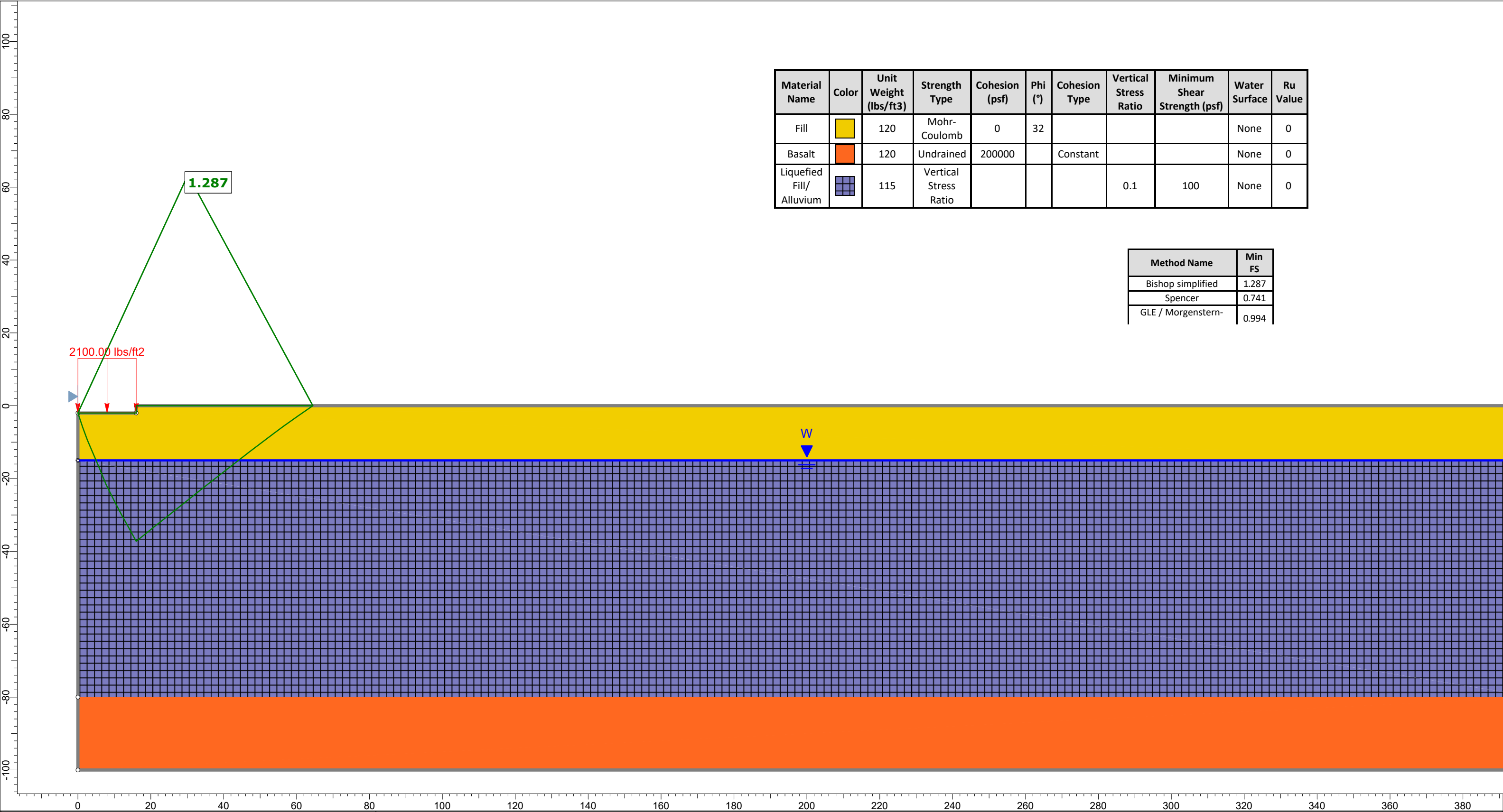
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio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

Method Name	Min FS
Bishop simplified	1.095
Spencer	0.114
GLE / Morgenstern-	0.939



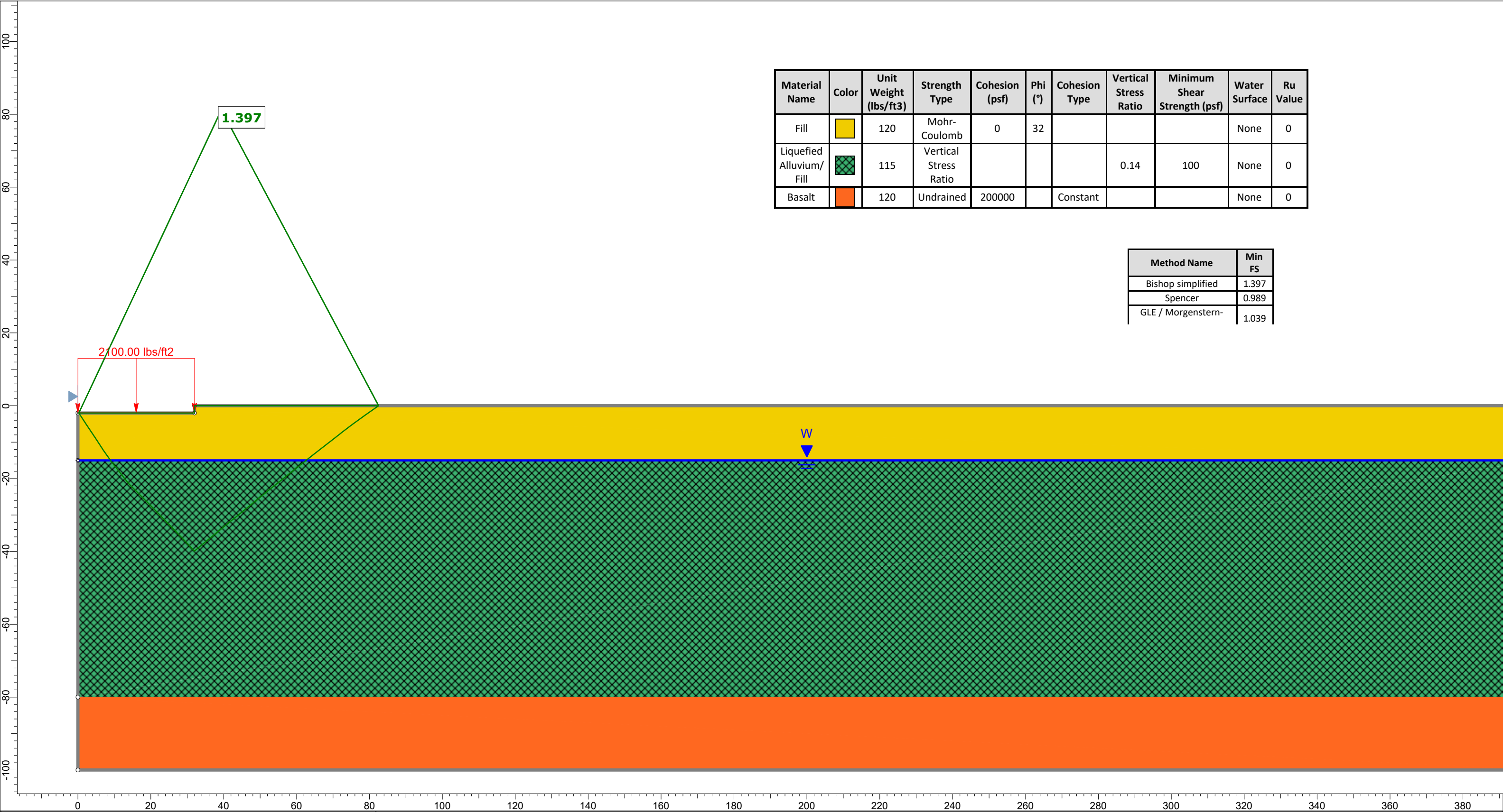
SLIDEINTERPRET 9.028

Project		Slide2 - An Interactive Slope Stability Program	
Group		8ft wide	Scenario
Drawn By			Checked By
Date		3/25/2024, 10:09:55 AM	File Name
		KM Linnton Bearing Cap.slmd	



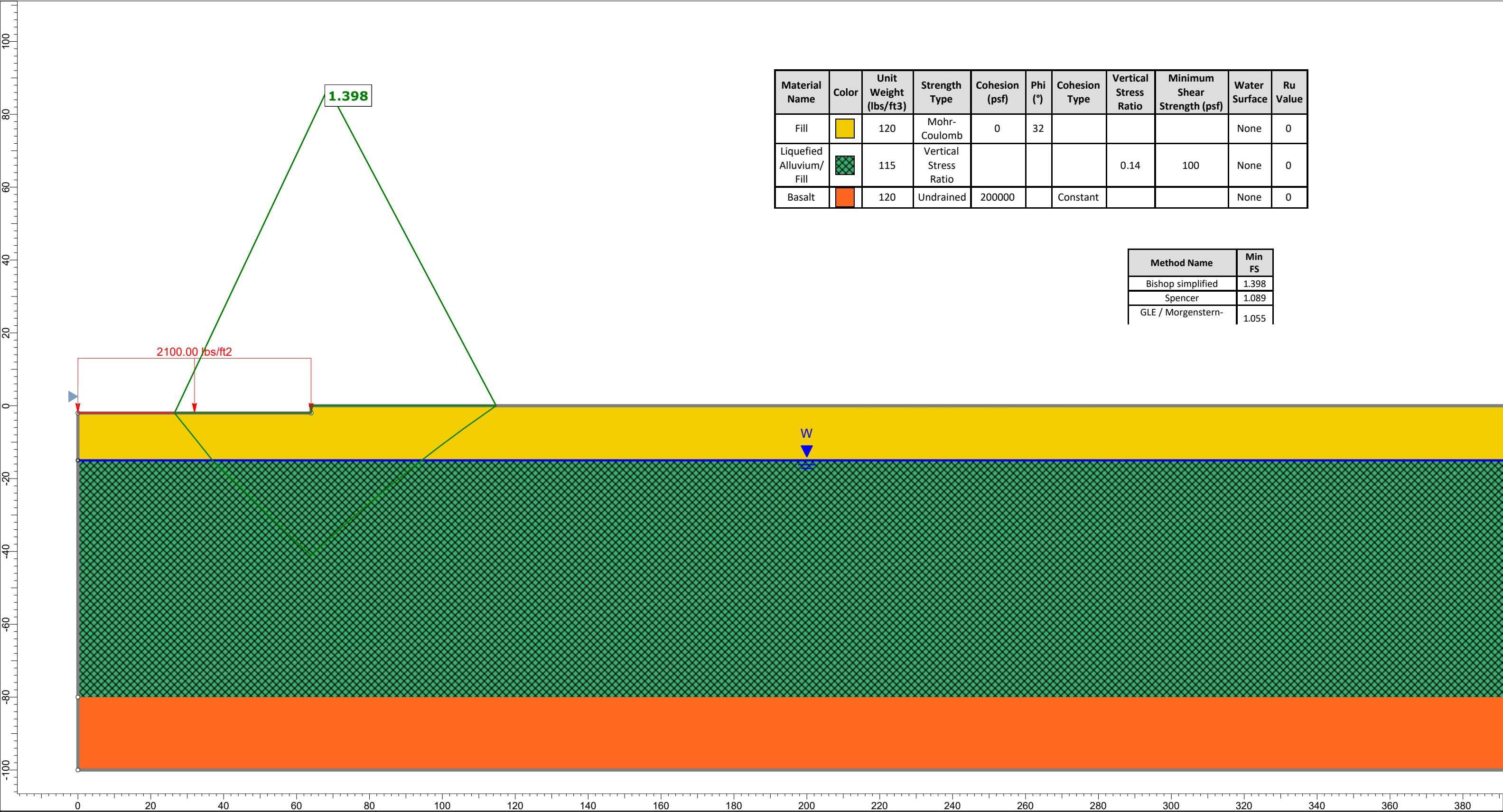
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Basalt		120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium		115	Vertical Stress Ratio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

Method Name	Min FS
Bishop simplified	1.287
Spencer	0.741
GLE / Morgenstern-	0.994



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
Liquefied Alluvium/ Fill		115	Vertical Stress Ratio				0.14	100	None	0
Basalt		120	Undrained	200000		Constant			None	0

Method Name	Min FS
Bishop simplified	1.397
Spencer	0.989
GLE / Morgenstern-	1.039



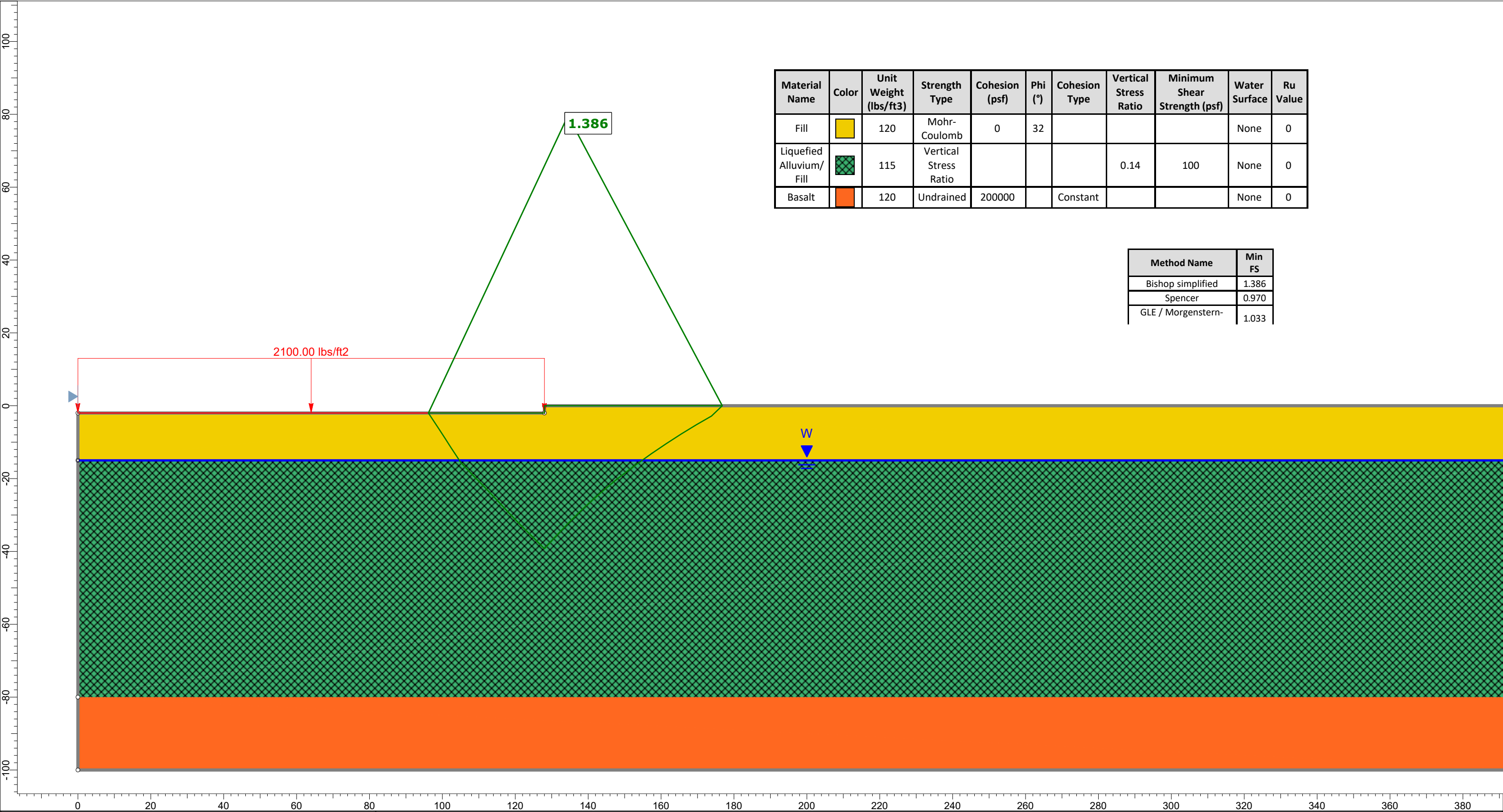
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill		120	Mohr-Coulomb	0	32				None	0
Liquefied Alluvium/ Fill		115	Vertical Stress Ratio				0.14	100	None	0
Basalt		120	Undrained	200000		Constant			None	0

Method Name	Min FS
Bishop simplified	1.398
Spencer	1.089
GLE / Morgenstern-	1.055



SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program	
Group	64ft wide	ScenarioMaster Scenario
Drawn By		Checked By
Date	3/25/2024, 10:09:55 AM	File NameKM 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
Liquefied Alluvium/ Fill		115	Vertical Stress Ratio				0.14	100	None	0
Basalt		120	Undrained	200000		Constant			None	0

Method Name	Min FS
Bishop simplified	1.386
Spencer	0.970
GLE / Morgenstern-	1.033



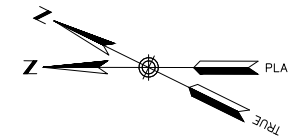
Project	Slide2 - An Interactive Slope Stability Program		
Group	128ft wide	Scenario	Master Scenario
Drawn By		Checked By	
Date	3/25/2024, 10:09:55 AM	File Name	KM Linnton Bearing Cap.slmd

6.2 Appendix B: Site Plans

B-1 Area Key Plan

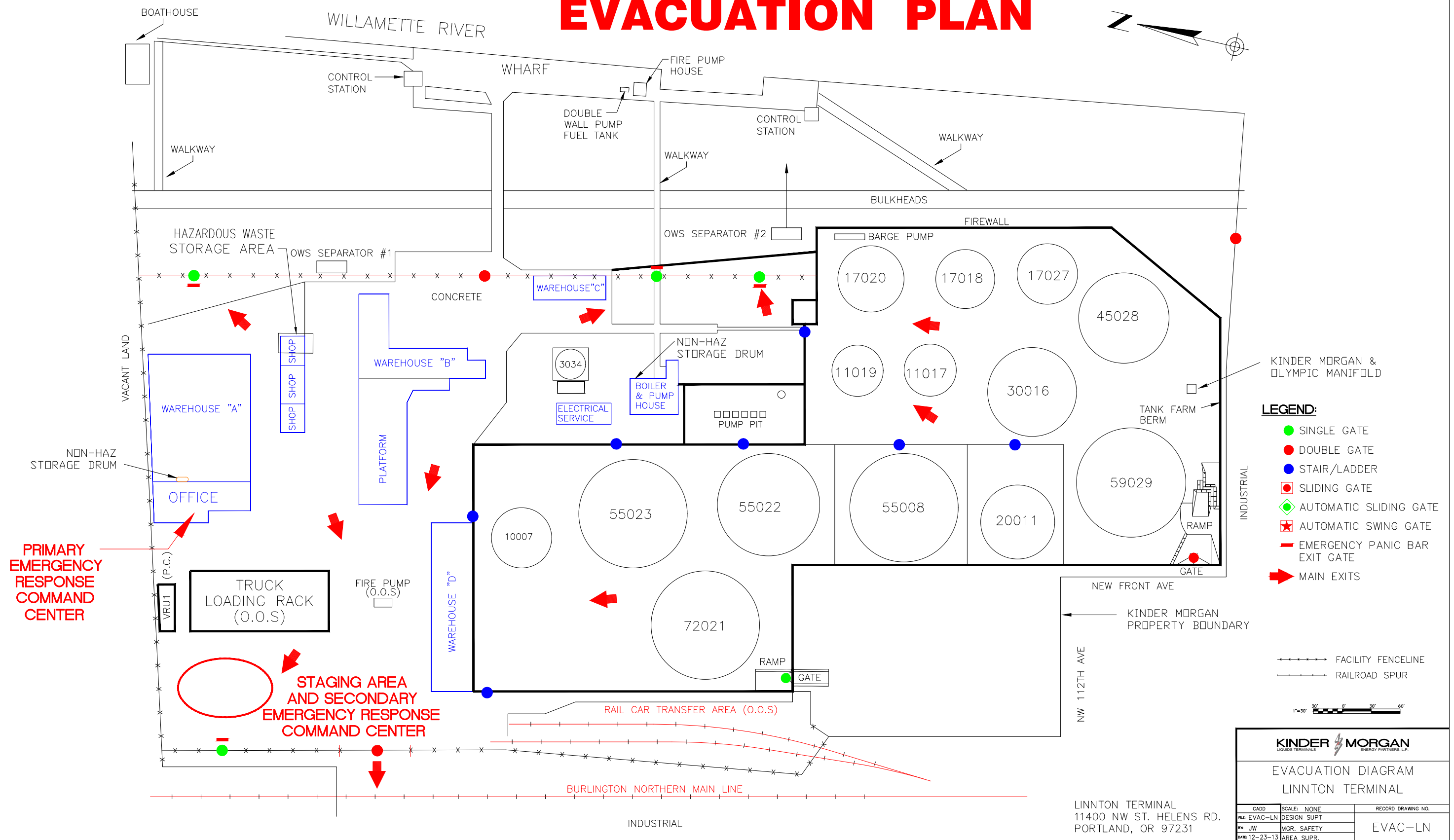
B-2 Fire Protection Plan

B-3 Evacuation Plan



1"=50' 50' 0' 50' 10'

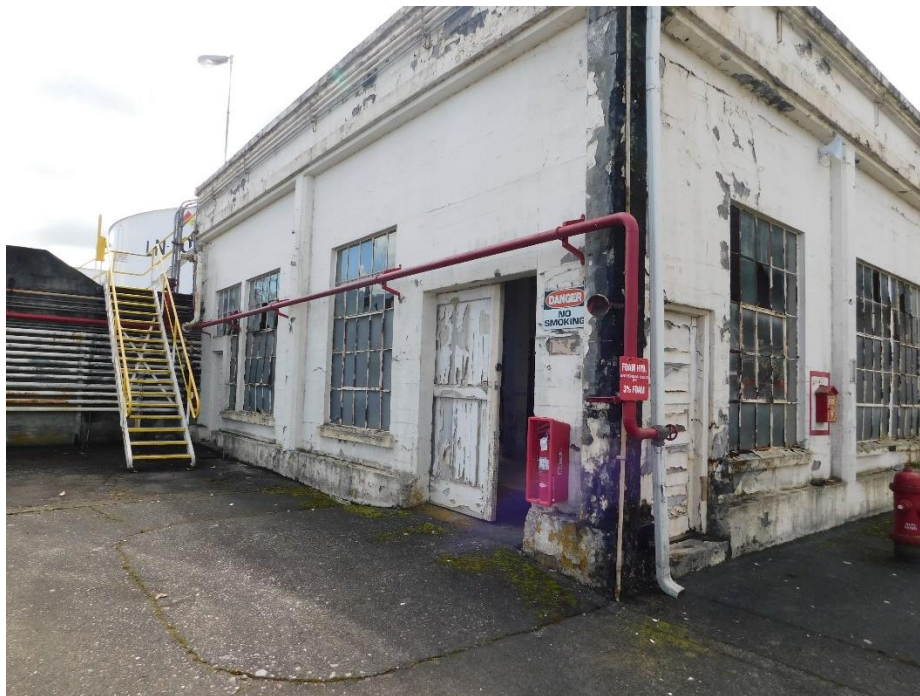
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6.3 Appendix C: Photographs



Picture 1. View of out-of-service truck loading rack and pipe bridge at Area 01.



Picture 2. Foam fire pipe supported at Warehouse D.



Picture 3. Typical out-of-service ancillary equipment at Area 01.



Picture 4. New roof structure at Warehouse A.



Picture 5. Typical warehouse building at Area 01.



Picture 6. Tank farm and typical pipe supports at Area 02.



Picture 7. View of slender pipe support at Area 02.



Picture 8. Typical containment wall structure.



Picture 9. Out-of-service rail car transfer area.



Picture 10. Unanchored foam fire tank at Area 02.



Picture 11. Unanchored electrical transformer at Area 02.



Picture 12. Unanchored water tanks at Area 02.



Picture 13. Typical view of canopy structure at Area 02.



Picture 14. Typical view of tank farm and pipe supports at Area 03.