Golder Associates Ltd.

2640 Douglas Street
Victoria, British Columbia, Canada V8T 4M1
Telephone (250) 881-7372
Fax (250) 881-7470

FACTUAL REPORT ON

GEOTECHNICAL INVESTIGATION
FRASER RIVER ESCARPMENT
MAPLE RIDGE, BRITISH COLUMBIA

Submitted to:

District of Maple Ridge
Engineering Department
11995 Haney Place
Maple Ridge, BC
V2X 6A9

DISTRIBUTION:

3 Copies - District of Maple Ridge
3 Copies - Golder Associates Ltd.

February 12, 2008 07-1414-0096

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The District of Maple Ridge (the District) retained Golder Associates Ltd. (Golder) to carry out a geotechnical investigation within the Fraser River Escarpment area (refer to the Key Plan on Figure 1). The purpose of the investigation was to obtain subsurface data that would augment the limited available information on the variations in soil stratigraphy and groundwater conditions in this area. This factual report documents the methodology and results of the investigation, and provides a summary of the subsurface conditions encountered in the area based on the results of the recent investigation as well as data acquired during previous investigations.

This report shall be read in conjunction with **"Important Information and Limitations of this Report"** which is appended following the text. The reader's attention is specifically drawn to this information for the proper use and interpretation of this report, with particular reference to limitations regarding the reliability of older data.

1.1 Description of Project Area

1.1.1 Topography

The Fraser River Escarpment is located within the District of Maple Ridge and is comprised of steep bluffs which form the north bank of the Fraser River over a length of about 1.7 km from just east of Carshill Street to just west of Fraserview Street (refer to the Site Plan on Figure 2). These bluffs are bounded to the east and west by major landslide features known as the Haney Slide (occurred in 1880) and the earlier Port Hammond Slide, respectively. At the time the Haney Slide occurred, the slide debris extended well across the channel of the Fraser River and has since been eroded to its current configuration. The topography in the project area is shown on Figure 2 by means of topographic contours and a digitally shaded relief image that appears in the background.

The overall height of the bluffs between the Haney and Port Hammond slides decreases from a maximum of about 55 m (including a submerged depth of about 20 m at low river level) at the east end of the bluffs, to about 40 m (including a submerged depth of about 16 m at low river level) near the west end of the bluffs just east of the Port Hammond slide. This is believed to be one of the deepest sections of river downstream of Hope. The bluffs slope down into the river at an overall slope angle that is generally in the range of 22 to 26 degrees. The bluffs continue to the west of the Port Hammond Slide, decreasing in height, and generally less steep, towards the west.

The steeply sloping backscarp of the Haney Slide extends from the escarpment (south of the intersection of Carshill Street with River Road) to the Haney Bypass, and the northern limit is located along the south edge of Cliff Avenue, approximately 250 m north of the escarpment crest. The backscarp of the Port Hammond Slide has an egg-shaped outline which extends almost to the southern end of Steeves Street, up to approximately 300 m north of the escarpment, and is about 470 m in length in the east-west direction.

In addition to the major slide areas, the crest of the escarpment is broken by two smaller slide areas (the Fir Street Slide and the Minor Port Hammond Slide) and by several ravines and gullies that daylight at the slope face, as can be seen on Figure 2. The backscarp of the Fir Street Slide, which is located immediately east of the south end of Fir Street, extends up to about 60 to 70 m back from the general escarpment crest alignment and approximately 140 to 150 m along the length of the escarpment. The Minor Port Hammond Slide, which is located just west of the major Port Hammond Slide, has a similarly sized failure area that extends about 70 m back from the original escarpment crest and approximately 200 m along the length of the escarpment.

The topography along the escarpment slopes has been sculpted by numerous localized surficial slide events.

1.1.2 Development

Since the 1880 Haney Slide, the Fraser River Escarpment area has been developed with a low-density residential land use. Housing developments have also been constructed on the Haney Slide mass and on the eastern half of the Port Hammond Slide mass. The western half of the major Port Hammond Slide and the escarpment area further to the west is occupied by the Maple Ridge Golf Course. The Canadian Pacific Railway (CP Rail) has two lines along a bench about 15 m wide, which is located midway up the overall slope of the escarpment, at approximately 7 to 8 metres geodetic elevation.

River Road, which is classified as a primary road within the District of Maple Ridge road network, is located as close as 50 m from the crest of the bluffs near Carshill Street, just west of the Haney Slide, with the setback increasing in a westerly direction to about 280 m just east of the major Port Hammond Slide (west of Fraserview Street). East of Carshill Street, River Road drops down along the backscarp of the Haney Slide and crosses the landslide failure mass in a southeasterly direction.

Secondary roads located between River Road and the escarpment include (from east to west) Fir Street, Anderson Place, Wood Street, Riverwynd, and Fraserview Street, all of which are located along the western half of the Fraser River Escarpment area.

1.2 Previous Studies and Investigations

In 2003, Golder carried out a preliminary assessment of the vulnerability of properties and infrastructure within the vicinity of the Fraser River Escarpment to damage resulting from potential failures of the escarpment slopes which could occur during or following a major seismic event. The scope of this desk study included compilation and review of available information on soil and groundwater conditions, as well as river survey data obtained from the BC Ministry of Environment (MoE). Analyses of static and seismic slope stability were carried out for three cross-sections along the escarpment using the available information. No additional field investigations had been carried out specifically for that study. The results of the study are contained within the report to the District entitled "Geotechnical Seismic Vulnerability Assessment of Fraser River Escarpment, Maple Ridge, BC", dated March 23, 2004 (Golder 2004).

The stratigraphic information that was available at the time of the 2003 study was based on a limited number of deep boreholes that were put down in 1978 along a 2.13 km length of the escarpment west of the Haney Slide, as part of a slope stability study carried out by Golder for the Water Investigations Branch of the MoE (Golder 1979). During that study, a total of five mud rotary boreholes (BH101, BH103 to BH106) were put down at locations behind the crest of the escarpment (shown on Figure 2) to depths that range from 45 to 90 metres (Record of Borehole sheets are provided in Appendix I of this report). The drilling methods that were used involved sampling a 0.45 m to 0.75 m thickness of soil at typical intervals of 1.5 m to 3.0 m of depth, but also at intervals of 5 m or more at greater depths. This permits inspection of only 15% to 50% of the soil column at best, so characterization of interlayered soil deposits, such as exist at the site, is not very accurate. Standpipe piezometers were also installed in all five of the 1978 boreholes, but their performance was questionable (Golder 1983, Appendix B). The results of that investigation, and the findings of the stability assessment carried out at that time, are documented in the Golder report to the MoE dated August 1979, which is included in Appendix I of the 2004 Golder report to the District.

In 1982, tri-level nested standpipe piezometers were installed by Golder at 10 locations behind the slope crest, and twin-level nested standpipe piezometers were installed at 5 locations along the C.P. Railway bench (locations indicated on Figure 2). Limited stratigraphic information was acquired during drilling for the piezometer installations in 1982. The standpipe piezometer filter zones were typically sealed within, or intersected, sandy layers. Descriptions of the piezometer installations, and falling head tests carried out in selected piezometers to test response to piezometric pressure changes, are provided in Appendix B of the Golder report to the MoE dated July 1983, which is also included in Appendix II of the 2004 Golder report to the District.

Regular monitoring of the groundwater levels within the 1982 piezometers was carried out by District staff following installation in December 1982 until April 1983, and then on a monthly to semi-monthly basis from April 1983 to April 1984, followed by periodic measurements until February 1986. The results of the monitoring, along with a re-assessment of the static slope stability based on the measured piezometric conditions, was reported in the Golder report to the MoE, dated March 1986, which is included in Appendix III of the 2004 Golder report to the District. A summary of that monitoring data is also provided in Appendix II of this report.

Additional piezometer monitoring data from January 1992 to May 1999 and from January to March, 2003 was provided by the District of Maple Ridge. This includes data from six of the ten 1982 piezometer locations behind the crest of the bluffs, as well as two of the five 1978 piezometers. No data after 1985 was available from the piezometers along the CP Rail bench. The results of the monitoring between 1983 and 2003 at six of the piezometers locations from which on-going data was available, was provided in Appendix IV of the 2004 Golder report to the District.

Additional sources of available subsurface information in the Fraser River Escarpment Area are listed in the text of the 2004 Golder report to the District. Of particular relevance to this report, a CPT sounding (herein denoted as CPT-UBC5) was put down immediately north of the escarpment crest and immediately west of the backscarp of the Haney Slide (Davies, 1985) as part of an investigation of the slide area in 1984. A copy of the CPT profiles for CPT-UBC5 is provided in Appendix III of this report.

1.3 Purpose of Present Study

Prior to the 2007 investigation, the number of available test holes within the study area and the subsurface information from these test holes is very limited and is not considered to be adequate to assess variations in hazard level across the study area, nor to assess the extents or likelihood of a retrogressive landslide developing from an initial failure of the escarpment slope. It is also not adequate to carry out assessments for specific features within the study area. Similarly, recommendations on drainage improvements and development controls provided in the Golder report on “Fraser River Bank Stability, Maple Ridge, British Columbia”, submitted to the BC Ministry of Environment and dated March 1986, were based on the limited subsurface information available at that time.

The purpose of the 2007 investigation was to improve the available information on the spatial variations in both stratigraphic and groundwater conditions behind the crest of the escarpment. This expanded database of subsurface information will allow improved characterization of the relative hazard associated with potential deep-seated slope failures and retrogression throughout the escarpment area, will allow a better-informed assessment of the potential benefits for stormwater management measures, and will provide additional data for future slope stability analyses, if/when required.

In the 2004 Golder report, it was postulated that the potential for an initial failure of the escarpment slope to retrogress back a significant distance may be related to the presence or not of saturated layers of granular soils. Therefore, a primary objective of the 2007 investigation was to identify spatial variations in the thickness and elevation of granular layers, as well as the piezometric conditions within these layers.

2.0 SURFICIAL GEOLOGY

The surficial geology in the Maple Ridge area is described on the surficial geology map by the Geological Survey of Canada (Armstrong & Hicock, 1976). Along the north bank of the Fraser River through the study area, deposits of glaciomarine silty clay to fine sand of the *Fort Langley Formation* are indicated to be exposed at ground surface. North of the river, the sediments of the *Fort Langley Formation* are shown to be overlain by deltaic sands and gravels of the *Sumas Drift* unit. The *Fort Langley Formation* is underlain by older glacial deposits of *Vashon Drift*. The geologic origins of these units are described by Armstrong (1981) and summarized below.

Vashon Drift, which is typically comprised of glacial till and glaciofluvial and ice-contact deposits, was deposited during the last advance and retreat of continental ice at the end of the Fraser Glaciation, during the Vashon Stade between approximately 13,000 and 18,000 years ago. The maximum advance of the Fraser ice during this stade, which covered the Fraser Lowland and extended to the Strait of Georgia, is estimated to have occurred about 15,000 years ago. The retreat of the Fraser ice back toward the mountains coincided with inundation of the exposed Fraser Lowland region by rising sea levels. By the end of the Vashon Stade around 13,000 years ago, the sea level is estimated to have been about 200 m above present sea level.

The sediments of the *Fort Langley Formation* were deposited into the sea in front of the remaining Fraser ice during the deglaciation period between about 13,000 and 11,500 years ago. The *Sumas Drift* was deposited by a valley (piedmont) glacier that advanced into the eastern Fraser Lowland around 11,500 years ago and finally retreated again about 11,000 years ago, by which time isostatic rebound had allowed marine sediments to emerge from the sea to an elevation above sea level that is close to that of present time. The *Sumas Drift* sediments in the Haney and Port Hammond areas of Maple Ridge were deposited on top of the *Fort Langley Formation* within a delta that was formed by melt water in front of the piedmont glacier.

3.0 INVESTIGATION METHODOLOGY

A total of 33 electric piezocone penetration test (CPT) soundings were carried out between June 18 to June 29, 2007, and between August 20 to August 30, 2007. The approximate locations of the CPT soundings are shown on Figure 2 (the locations were not accurately surveyed). The CPT soundings were located at distances to the north of the escarpment crest which varied from about 35 m to about 390 m, from about Fraserview Street in the west to Carshill Street in the east, as well as two soundings to the north of the Port Hammond Slide area and two soundings to the north of the Haney Slide area. The maximum depth of penetration of the soundings ranged from 23.5 m to 68.2 m below ground surface (average depth of 47 m).

Most of the soundings were carried out to practical refusal to further penetration, typically due to accumulation of frictional resistance along the cone rods or to a combination of frictional resistance and high tip resistance. The shallowest sounding, CPT07-14, was carried out without installing a soil anchor (thereby minimizing disturbance on site) and had to be terminated at a depth of 23.45 m when the weight of the drill rig alone provided inadequate reaction force to push the penetrometer further.

The approximate locations of the CPT soundings in plan view were established in the field by Golder's field inspector based on proximity to the streets and properties identified on the legal base plan provided by the District. The elevation of the ground surface at the CPT locations was estimated based on their approximate locations on the ground surface contour plan provided by the District. A summary of the approximate UTM coordinates, the estimated ground surface elevations, the maximum penetration depths and the approximate elevation of the bottom of the soundings, for each CPT location, are provided in Table 1.

Descriptions of the CPT sounding methodology, and descriptions of CPT dissipation test and shear wave velocity measurement methods, are provided in the following sub-sections.

3.1 CPT Soundings

During pushing at a constant rate of 0.02 m/s, the CPT probe measures the soil resistance acting on the cone tip (q_t), the pore water pressure (u) acting on the filter element located immediately above the shoulder of the cone, and the soil resistance acting on the friction sleeve (f_s) located immediately above the filter element. The combination of q_t and friction ratio ($R_f = f_s/q_t$) is commonly used to differentiate between different soil behaviour types. Granular soils (sand to silty sand and sand/gravel mixtures) tend to have high q_t and low R_f and low u, while normally consolidated to lightly overconsolidated fine-grained soils (silt/clay mixtures) tend to have low q_t and high u.

The response of sand/silt mixtures tend to be intermediate between granular and fine-grained soils. Thus, the CPT allows rapid profiling of soil behaviour types at very fine resolution (measurements were recorded at 0.05 m intervals of depth).

The CPT soundings were carried out by ConeTec Investigations Ltd. of Vancouver, BC. (ConeTec), under the full-time inspection of a member of Golder's geotechnical engineering staff. All but one of the soundings were carried out using a cone penetrometer with a 15 cm^2 tip area and a tip area ratio of 0.85, load cell capacities of 150 MPa and 1.5 MPa for the tip and friction sleeve, respectively, and a 3.45 MPa pore pressure transducer capacity. CPT07-03 was carried out using a cone penetrometer with a 10 cm^2 tip area and load cell capacities of 100 MPa and 1.0 MPa for the tip and friction sleeve, respectively (tip area ratio and pore pressure transducer capacity same as for the 150 MPa cone). Saturation and assembly of the cone penetrometers were carried out in the field by the ConeTec technicians.

3.2 CPT Dissipation Tests

When penetration of the CPT probe is halted, the excess pore water pressures generated within the soil by cone penetration will dissipate. A pore pressure dissipation test involves measuring the change in water pressure with time over an extended period of time when the probe is stationary at a particular depth. If the dissipation test is carried out for an adequate duration, all of the excess pore water pressures will be completely dissipated and the equilibrium water pressure (u_o) can be measured. The length of time required to achieve u_o depends on the permeability of the soil. In sands with relatively low fines contents, which typically have a relatively high permeability, u_o can be measured during breaks on the order of 10 to 20 minutes in duration. At all CPT locations, measurements of u_o at different depths were attempted within sand strata.

3.3 Shear Wave Velocity Measurements (Seismic CPT)

At four CPT locations (SCPT07-02, 08, 09, 12), shear wave velocity measurements were made at 1 m increments in penetration depth. Once cone pushing was halted at each test depth, shear waves were generated at the ground surface by striking each end of a steel grade beam using a sledge hammer with a contact trigger. The time required for the generated shear wave to travel from the ground surface through the soil to the geophones located within the cone probe above the friction sleeve was measured at each test depth. The difference in travel times between successive test depths allows the average shear wave velocity within the soil between the successive test depths to be calculated.

The shear wave velocity is used to characterize the seismic behaviour of the soil, and to calculate the small-strain shear modulus of the soil.

4.0 INFERRED SUBSURFACE CONDITIONS

Profiles of tip resistance (q_t), sleeve friction (f_s), friction ratio (R_f) and dynamic pore water pressure (u) versus depth from each of the CPT soundings are provided in Appendix IV. The final column on each sheet includes an interpretation of the soil behaviour types that are based on the normalized (overburden stress-corrected) Soil Behaviour Type (SBTn) classification system published by Robertson (1990). The SBTn classification chart is included at the front of Appendix IV. Estimates of total overburden pressure (σ_{vo}) with depth were made by ConeTec using estimated soil unit weights, while estimates of effective overburden pressure ($\sigma'_{vo} = \sigma_{vo} - u_o$) were based on the σ_{vo} profiles and estimated equilibrium groundwater pressure (u_o) distributions with depth provided by Golder.

The shear wave velocity measurements from SCPT07-02, 08, 09, 12 are compiled within the tables and graphical profiles with depth included in Appendix V.

The changes in the groundwater pressures measured at 5 second intervals during each CPT pore pressure dissipation test are plotted against the logarithm of time on the figures in Appendix VI. A summary of the results of the dissipation tests is provided in Table VI-1 at the front of the appendix.

Cross-sections were generated at six locations along the escarpment (from east to west: Sections A-A' through F-F'), which are provided as Figures 3a through 3f. A longitudinal stratigraphic profile roughly parallel to the escarpment crest, which is located about 40 to 70 metres north of the crest, is provided on Figure 4a (western segment) and Figure 4b (eastern segment). The cross-sections are drawn at a natural scale (no vertical exaggeration) in order to maintain proportionality of the escarpment slopes and the groundwater pressure regime, while the longitudinal profile is drawn with a 5 times vertical exaggeration to make fine stratigraphic variations easier to identify. On these drawings, stratigraphic information from CPT soundings and from the 1979 boreholes is plotted against geodetic elevation. At each CPT location, the different Soil Behaviour Types (as indicated by the SBTn integer values) over different elevation ranges are indicated by the multi-coloured shaded areas plotted adjacent to the CPT hole location. A profile showing the variation in cone tip resistance (q_t, which is indicative of soil strength and stiffness) with elevation is also plotted adjacent to each CPT hole location. Due to the highly variable nature of the depth and thickness of the granular layers, no attempt has been made to infer conditions between test holes on the cross-sections and profile for this regional study. It would be more appropriate to attempt such stratigraphic interpretation using more closely spaced test holes during studies of conditions in localized areas.

The interpreted groundwater pressure distributions with depth at the CPT locations and in the standpipe piezometers installed in 1982 have also been plotted on the cross-sections, along with the interpreted groundwater table elevations. Only the interpreted groundwater table elevations at the CPT locations have been included on the stratigraphic profile.

The inferred stratigraphic variations and the groundwater conditions at test hole locations within the study area are described in the following sub-sections.

4.1 Soil Stratigraphy

Based on the previous information, the stratigraphy in the bluffs was characterized as comprising mainly firm to stiff fine-grained soil (typically silty clay but including lower plasticity clayey silt and higher plasticity clay) interlayered in places with seams of fine to medium sand to silty fine sand with highly variable thickness and strength. The thickness of the interbedded sandy layers varies from lenses that are 1 to 5 mm thick, to layers that are several metres in thickness. It was noted that the degree of interlayering varies with depth and from east to west along the bluffs, and the greatest amount of sand appears to occur within the upper 17 to 19 m, particularly at the east end of the bluffs near the Haney Slide and at the west end of the bluffs near the Port Hammond slide.

The CPT soundings provide subsurface information over a much greater extent to the north of the escarpment crest, and provide a much higher density of test holes than was previously available. Samples collected during the 1979 mud-rotary drilling investigation allowed visual identification of thin partings and lenses of sand and silty sand of a few millimetres to a few centimetres in thickness within predominantly fine-grained soil layers, whereas the CPT probe cannot detect such fine layering. However, the CPT is far superior at identifying interlayers that are on the order of tens of centimetres in thickness which can be easily missed during conventional drilling operations involving discrete sampling at typical intervals of 1.5 m to 3.0 m.

At each CPT location, the depth range corresponding to each granular soil layer was recorded for any layers with interpreted soil behaviour types corresponding to sand, silty sand, or gravelly sand with a “continuous” thickness of at least 0.15 m (based on 0.05 m measurement intervals). The frequency and cumulative thickness of all of the granular layers at the 34 CPT locations (33 CPT’s by Golder and one CPT by UBC) north of the escarpment crest, are compiled for different ranges of layer thickness in the histogram on Figure 5. This histogram shows that relatively thin granular layers are much more frequent than the thicker layers (layers that are less than 0.5 m in thickness make up about 40% of the total number of layers identified, and layers that are less than 1.0 m in thickness make up 2/3 of the layers identified). However, the greatest proportion (3/4) of the cumulative thickness of granular soils is due to layers with thicknesses of 1.0 m or greater.

The thickness of each granular layer that is at least 1.0 m in thickness or greater is plotted against the average depth of the layer on Figure 6, showing that most of the significant granular layers are located above a depth of about 19 m below the ground surface behind the escarpment (roughly 80% of the layers that are at least 1.0 m in thickness, and 10 out of 14 of the layers that are at least 6 m in thickness). This is consistent with the observations made based on the borehole information in the 1979 study. The thickest granular layers (at least 6 m in thickness) are identified according to the CPT location. Furthermore, the data on Figure 6 is grouped by the geographic locations of the CPT's along the length of the escarpment, as follows:

- West – 12 CPT locations west of Fir Street, including CPT07-07 at the south end of Fir Street;
- Central – 11 CPT locations from Pine Street in the west to about 120 m east of 216 Street;
- East – 11 CPT locations to the east of a line about 120 m east of 216 Street (within about 450 m from the backscarp of the Haney Slide).

It is apparent from Figure 6 that nearly all of the thickest granular layers (at least 6 m in thickness) are located in the eastern area of the escarpment within about 450 m from the backscarp of the Haney Slide, along with most of the granular layers between 1 m and 3 m in thickness which are located below 19 m depth. In the western and central areas of the escarpment, the vast majority of the granular layers that are at least 1 m in thickness are located above a depth of about 18 m. The only very thick granular layer in this area was encountered between about 20 m and 30 m depth at CPT07-11, which is the northern-most CPT located at the north end of Holly Street, just west of 216 Street.

The percentage of the total thickness of soil above 0 geodetic elevation (roughly the elevation of the river water level) that is comprised of granular soil layers greater than about 0.15 m in thickness is indicated for each CPT location on Figure 7. This figure indicates that over the majority of the escarpment area, the stratigraphy is generally dominated by fine-grained soils and/or zones of fine-grained soils with thin sandy interbeds, with seams of granular soils typically making up less than one third of the total soil thickness above 0 geodetic elevation (with most of this located above a depth of about 18 to 19 metres). The areas where granular soils appear to make up at least one half of the stratigraphy above river level are as follows:

- At the east end of the escarpment, east of Carr Street, where granular soils comprise between about 50% and 80% of the total thickness above 0 m elevation (and major granular layers are encountered all the way down to river level).

- From 117 Avenue to the north, were granular soils comprise about 60% to 65% of the total thickness above 0 m elevation at 3 out of 4 CPT locations from Holly Street to 218 Street.

Consistent with the geologic unit descriptions in Section 2.0, the predominantly fine-grained soil sequences are inferred to be glaciomarine deposits of the *Fort Langley Formation*, while the predominantly granular soil sequences are inferred to be younger deltaic deposits of *Sumas Drift*. Consequently, the thicker layers of granular soils are inferred to belong to the *Sumas Drift* deposit, and the areas of the escarpment with higher percentages of granular thickness above river level are inferred to correspond to the areas where there are thicker *Sumas Drift* deposits overlying the *Fort Langley Formation*. Due to the interlayered nature of both deposits, it can be difficult to clearly identify the boundary between these two geologic units.

More detailed descriptions of the characteristics of the fine-grained and granular sequences encountered at the earlier sampled test hole locations and interpreted from 2007 CPT measurements, are provided below.

4.1.1 Fine-Grained Soil Properties

The properties of the fine-grained soils encountered within the boreholes from previous investigations in the area were described in the 2004 Golder report to the District and in the 1979 Golder report to the MoE. Typical ranges and mean values for the various index properties (moisture content, plastic and liquid limits, plasticity and liquidity indices) are provided in the 2004 Golder report, along with a summary of available information on drained strength parameters.

The available laboratory test data are from samples from boreholes located just behind the crest of the escarpment and along the CP Rail bench, and from block samples obtained by the University of British Columbia from the area of the old brick factory near the intersection of 225th Street and River Road (east of the Haney Slide). The fine-grained soils in these areas are inferred to belong to the *Fort Langley Formation*, and are known locally as Haney Clay.

Liquid limits ranging from 31 to 92 percent and plasticity indices ranging from 12 to 59 percent were measured in Atterberg limit tests carried out during the 1979 study (Golder 1979). This indicates that the fine-grained soils have medium to high plasticity and would be classified as clayey silt to silty clay to clay (in order of increasing plasticity). The typical range of Atterberg limit results indicates that the Haney Clay would most commonly be classified as a silty clay. Measured moisture contents were typically less than the liquid limit, but a few samples (less than 10%) were at or higher than the liquid limit (liquidity index greater than or equal to 1.0). Fine-grained soils with liquidity indices greater than 1.0 typically have a high sensitivity (*i.e.*, a tendency to severe strength loss at high shear strains).

At CPT locations behind the escarpment crest, undrained shear strengths interpreted from the CPT data are generally in the range of 25 to 75 kPa above a depth of about 25 to 30 metres below ground surface, indicating a firm to stiff consistency. Below this depth, interpreted undrained shear strengths are generally greater than 50 kPa with a typical trend of increasing strength with depth (consistency would be described as stiff becoming very stiff).

The ratio of undrained shear strength (s_u) to effective overburden pressure (σ'_{vo}) increases with increasing degree of overconsolidation and is a useful means of estimating the degree of overconsolidation in lieu of consolidation test data. The s_u/σ'_{vo} ratios within the fine-grained soil layers interpreted from the CPT data suggest that this soil is close to normally consolidated below a depth of about 10 to 15 m below the ground surface behind the escarpment crest, and lightly overconsolidated above this depth.

The ratio of excess pore pressure (Δu) measured behind the shoulder of the cone to net cone bearing pressure (q_t - σ_{vo}, where q_t is the measured tip resistance and σ_{vo} is the total overburden pressure), referred to as the B_q ratio, is an indicator of the degree of overconsolidation and the sensitivity of fine-grained soils. Within the thicker fine-grained sequences below a depth of about 10 to 15 m below the ground surface, B_q ratios were typically between 0.7 and 0.9, suggesting a soil that is close to normally consolidated, with some zones generating ratios in the 0.9 to 1.2 range, suggesting a highly sensitive fine-grained soil.

4.1.2 Granular Soil Properties

The granular layers encountered within the 1979 boreholes were typically described as being comprised of silty fine sand or fine to medium sand (Golder 1979), while occasional layers of medium to coarse sand and gravel were noted within the upper 8.5 m of BH101 located near the Haney Slide. A total of eight grain size distributions of selected samples obtained from granular layers encountered during drilling for the standpipe piezometer installations in 1982 (111, 112, 113, 114, 115) were presented in Appendix B of the 1983 Golder report to MoE. The grain size distributions were consistent, showing a uniformly graded fine sand with greater than 97% of particles finer than 0.425 mm, with fines (particles finer than 0.075 mm) contents ranging from 10% to 27%.

Davies (1985) reported that dense gravelly layers were encountered at depths of between 3 and 4 metres during attempts to carry out CPT soundings along Cliff Avenue north of the Haney Slide. This is consistent with our experience during CPT pushing at CPT07-17, located at the east end of Cliff Place, where a drill-out was required between 4.7 and 7.6 metres depth due to the presence of dense gravelly soil. Localized layers where the soil behaviour type could be classified as that of gravelly sand were encountered at various CPT locations, most notably between 2 and 10 metres depth at CPT07-14, 15, 17, 18, 19 and 22, which are located at the eastern end of the escarpment, and between 2 and 8 metres depth at CPT07-05, 07, 27 and 28, which are located in the area east of Laity Street and west of Darby Street.

Based on Standard Penetration Test (SPT) data from the 1979 boreholes, the relative density of the sand to silty sand layers was previously described (Golder, 1979) as being generally loose to compact, with locally denser zones. The relative density of the granular layers encountered during the 2007 investigation was interpreted from the measured CPT tip resistances and estimated effective overburden pressures. For granular layers that are at least 1.0 m in thickness (the tip resistance in thinner layers may be influenced by more compressible fine-grained soils above and below the granular layer), the relative density was interpreted to be generally compact but with some dense zones.

Locally, high penetration resistances were recorded which could suggest a very dense sand, but these zones also tended to exhibit a gravelly sand soil behaviour type, in which the higher penetration resistances can be attributed to a greater soil stiffness (due to the gravel content) rather than to a very dense relative density. Similarly, lower penetration resistances were recorded within localized zones with a silty sand soil behaviour type, in which the lower penetration resistances can be attributed to a lower soil stiffness (due to the higher silt content) rather than to a loose relative density.

Nearly all of the dense zones were located within relatively shallow granular layers and/or within the thicker granular sequences. These dense sands and gravel/sand mixtures are inferred to be deposits of *Sumas Drift*.

4.2 Groundwater Conditions

The distribution of equilibrium groundwater pressures (u_o) with elevation (at which the pressure was measured) at each CPT location are plotted on the figures in Appendix VII. The groundwater pressures that are plotted on these figures include:

- Equilibrium groundwater pressures interpreted from the CPT dissipation tests;

- Selected dynamic pore pressure readings (u) during CPT penetration through granular layers (which may or may not correspond to actual u_o depending on the permeability of the soil); and,

- Standpipe piezometers readings for the piezometers installed during the 1982/83 study which are located in the vicinity of CPT locations (the median pressure for the monitoring period indicated, along with error bars indicating maximum and minimum readings, is plotted against the sounded bottom elevation of the standpipes).

Standpipe piezometers nests 111, 114, 116, 117 and 119 are located reasonably close to CPT07-10, CPT07-23, SCPT07-12, SCPT07-08 and CPT07-05, respectively. The range of groundwater pressure heads measured in these standpipes during the 1983 to 1986 monitoring period were compared to the vertical distribution of u_o interpreted from the CPT dissipation data, and were found to be in general agreement. The similarity in the distribution of pressure with depth between the standpipes and the CPT dissipation tests suggests that i) the water levels measured in the standpipes during the earlier studies has provided a realistic representation of the variation in groundwater pressure with depth, and ii) the water pressures measured by the CPT during the summer of 2007 are representative of the “average” groundwater conditions in the area

The elevation of the water table (the level below which the soil is saturated and the pore water pressure in the soil is greater than zero) was estimated from the interpreted groundwater pressure distributions from the CPT dissipation tests and/or from the median of the water levels measured in the standpipes between 1983 and 1986. The interpreted water table elevations at each CPT and piezometer location are plotted on the attached Figure 8a. The corresponding water table depths below ground surface are plotted on the attached Figure 8b.

In general, the groundwater table is quite shallow (typically in the range of 2 to 4 m deep) at distances in excess of about 100 m behind the crest of the escarpment, except in the vicinity of the backscarps of the Port Hammond Slide and the Haney Slide where greater water table depths were encountered. Within distances less than about 100 m behind the crest of the escarpment, the depth of the water table increases with decreasing distance from the crest of the escarpment, which is to be expected due to the influence of the escarpment slopes. The water table at the piezometers located on the CP Rail bench was up to 3 m deep, on average, during the 1983 to 1986 monitoring period. Localized seepage is known to occur on the slope above the tracks, and drainage measures have previously been installed to help improve stability.

No new information on the response of groundwater elevations to precipitation events is available. Previous monitoring data from the standpipe piezometers (summarized in Table II-1 in Appendix II) suggest that the fluctuation of groundwater levels appears to generally decrease with depth. During the 1983 to 1986 monitoring period, "typical" groundwater level fluctuations (characterized by one standard deviation) in the range of +/- 0.2 to 1.1 metres were recorded in piezometers with tips on the order of 8 to 12 m deep, while "typical" fluctuations in water levels within the deeper piezometers with tips around 45 m deep were in the range of 0.1 m to 0.3 m. This trend is believed to indicate that the effects of stormwater infiltration are limited to the granular soils at relatively shallow depths, probably due to the effective confinement of the deeper granular layers by overlying fine-grained layers.

The standpipe piezometers are expected to respond primarily to changes in groundwater pressure within the more permeable soil layers. Therefore, the fluctuations in the water levels within the standpipes may or may not reflect fluctuations in pore water pressure within the fine-grained soils between the granular layers. Due to their very low permeability, the pore water pressures within the fine-grained soils are not expected to be very responsive to individual precipitation events, but may respond seasonally to prolonged periods of wet or dry weather, particularly at relatively shallow depths. Pneumatic or electric piezometers installed within the fine-grained soil layers would be required to assess the pore pressure response within these soils.

5.0 CLOSURE

We trust that the information contained within this factual report is adequate for your current requirements. If you have any questions regarding the contents of this report, or if you require any further input, please do not hesitate to contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED BY

Chris Weech, M.A.Sc., P.Eng.
Senior Geotechnical Engineer

ORIGINAL SIGNED BY

Trevor P. Fitzell, P.Eng.
Principal

CNW/TPF/knb
Attachments: Table, Figures, Appendices
N:\FINAL\2007\1414\07-1414-0096 MAPLE RIDGE GEOTECH FRASER RIVER\FINAL REPORT\RPT 02-12-08 FRE INVESTIGATION FINAL.DOC

6.0 REFERENCES

Armstrong, J.E. (1981). "Post-Vashon Wisconsin Glaciation, Fraser Lowland, British Columbia", Geological Survey Bulletin 322, Geological Survey of Canada, 1981.

Davies, M.P. (1985). "Application of the Piezometer Cone Penetration Test to Slope Stability Evaluation; Focus: Haney Slide". B.A.Sc. Thesis, University of British Columbia, April 1985.

Golder Associates Ltd. (1979). "Stability Study, Fraser River North River Bank, Haney to Port Hammond, British Columbia". Report to British Columbia Ministry of Environment, Water Investigations Branch, August 1979.

Golder Associates Ltd. (1983). "Groundwater Monitoring and Stabilization Study, Fraser River North River Bank, Maple Ridge, British Columbia". Report to British Columbia Ministry of Environment, Water Investigations Branch, July 1983.

Golder Associates Ltd. (1986). "Fraser River Bank Stability, Maple Ridge, British Columbia". Report to British Columbia Ministry of Environment, March 1986.

Golder Associates Ltd. (2004). "Geotechnical Seismic Vulnerability Assessment of Fraser River Escarpment, Maple Ridge, British Columbia". Report to District of Maple Ridge, March 23, 2004.

Lunne, T., Robertson, P.K. and Powell, J.J.M. (1997). "Cone Penetration Testing in Geotechnical Practice", E&FN Spon, 3rd printing, 312 p.

Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 – 158.

LIMITATIONS AND USE OF THIS REPORT

Standard of Care

Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing in British Columbia, subject to the time limits and physical constraints applicable to this report. No other warranty, express or implied is made.

Basis and Use of the Report

This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. Golder will consent to any reasonable request by the Client to approve the use of this report by other parties as Approved Users. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, and only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use by any party of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs, techniques and equipment choice, scheduling and sequence of operations would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work.

Soil, Rock and Groundwater Conditions

Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgement, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect certain conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between sampling points may differ from those that actually exist.

Groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their measurement. Groundwater conditions may vary between reported locations and can be affected by annual, seasonal and special meteorological conditions or tidal fluctuations. Groundwater conditions may also be altered by construction activity on or in the vicinity of the project site.

Sample Disposal

All contaminated samples and materials shall remain the property and responsibility of the Client for proper disposal. Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense.

Follow-Up and Construction Services

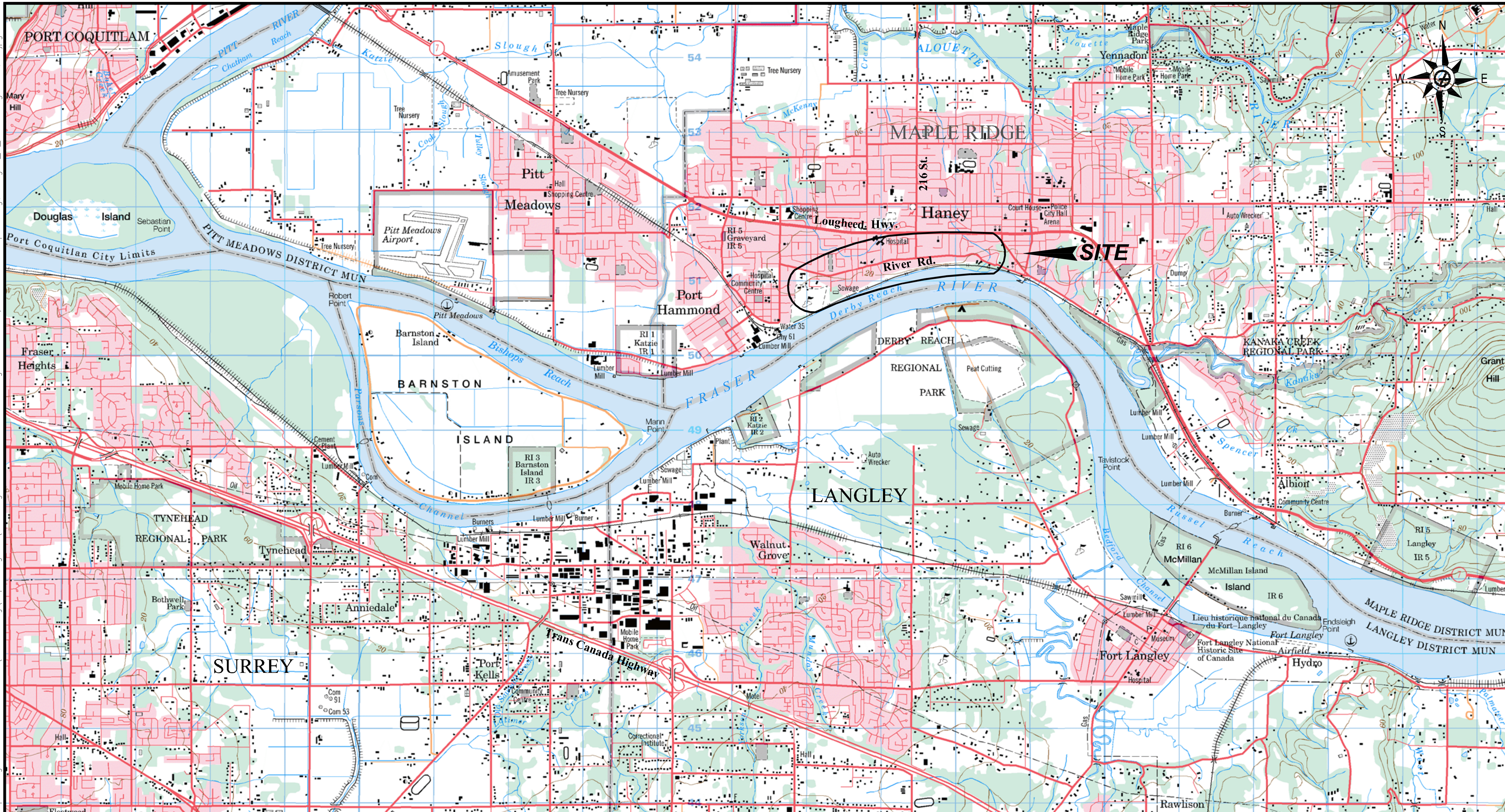
All details of the design and proposed construction may not be known at the time of submission of Golder’s report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder’s report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder’s report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder’s report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

Table 1
Summary of CPT Locations (2007 Investigation)
Fraser River Escarpement, Maple Ridge, BC

CPT Sounding	Approximate UTM Coordinates Northing	Approximate UTM Coordinates Easting	Approx. Elevation of Ground Surface (m geodetic)	Drillout Depth (m)	Maximum Depth (m)	Bottom Elevation (m)
CPT07-01	5452947	526670	23.6	0.75	60.00	-36.40
SCPT07-02	5452874	526869	25.0	0.75	60.30	-35.30
CPT07-03	5453133	526913	25.7	1.00	37.70	-12.00
CPT07-04	5452999	527161	24.8	1.00	60.20	-35.40
CPT07-05	5453146	527159	25.5	1.00	58.45	-32.95
CPT07-06	5453252	527100	26.3	1.00	60.55	-34.25
CPT07-07	5453037	527316	27.0	0.75	49.65	-22.65
SCPT07-08	5453130	527567	32.0	0.30	52.30	-20.30
SCPT07-09	5453396	527431	31.9	0.75	61.75	-29.85
CPT07-10	5453193	527703	33.4	1.22	45.70	-12.30
CPT07-11	5453510	527674	32.5	1.00	68.20	-35.70
SCPT07-12	5453239	527954	34.0	0.30	43.85	-9.85
CPT07-13	5453417	527869	33.0	0.75	37.35	-4.35
CPT07-14	5453272	528153	33.5	0.00	23.45	10.05
CPT07-15	5453488	528117	35.3	1.00	32.05	3.25
CPT07-16	5453470	528373	36.0	0.75	41.70	-5.70
CPT07-17	5453429	528561	33.0	0.75	52.75	-19.75
CPT07-18	5453471	528750	35.7	1.20	27.30	8.40
CPT07-19	5453364	528370	36.0	1.00	47.95	-11.95
CPT07-20	5453296	528284	35.0	0.50	40.05	-5.05
CPT07-21	5453391	528218	35.3	0.90	40.45	-5.15
CPT07-22	5453398	528031	33.0	1.00	39.20	-6.20
CPT07-23	5453266	527799	33.5	0.80	33.90	-0.40
CPT07-24	5453338	527668	33.5	0.90	44.65	-11.15
CPT07-25	5453422	527599	33.2	1.00	43.30	-10.10
CPT07-26	5453281	527521	32.5	0.90	36.25	-3.75
CPT07-27	5453093	527397	29.6	0.00	55.00	-25.40
CPT07-28	5453232	527317	28.8	0.80	45.00	-16.20
CPT07-29	5453064	527050	26.2	0.90	49.95	-23.75
CPT07-30	5452950	526971	25.1	1.00	54.95	-29.85
CPT07-31	5453026	526925	25.5	0.90	39.80	-14.30
CPT07-32	5452967	526805	25.2	1.00	49.95	-24.75
CPT07-33	5452972	526455	21.7	0.90	49.95	-28.25

NOTE:
SCPT indicates Seismic Cone Penetration Test (CPT sounding with shear wave velocity measurements)



0 2000
SCALE (m)

REFERENCE:
1. NTS map "92G02".

PROJECT	DISTRICT OF MAPLE RIDGE FRASER RIVER ESCARPMENT MAPLE RIDGE, B.C.
TITLE	**KEY PLAN**

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	K0714140096-01
DESIGN	CW	08 NOV 07	SCALE AS SHOWN	REV. 0
CADD	JS	09 NOV 07	**FIGURE 1**	
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		

LEGEND:

- CPT07-xx — Cone Penetration Test by Golder (2007)
- BHxxx — Boring by Golder (1978)
- xxx — Standpipe Piezometer Installations by Golder (1982)
- CPT-UBC5 — Cone Penetration Test by University of British Columbia (1984)
- M-E28 — River Survey Lines by BC Ministry of Environment (1978-1997)

NOTES

- All Test Hole Locations are Approximate.
- All Elevations in Meters, referenced to Geodetic Datum
- Elevation Contours above 0m based on District of Maple Ridge Plans (2000); contours at 1 metre intervals.
- Contours below 2m Generated from River Survey Data along MOE Survey Lines; contours at 2 metre intervals.
- Neither the Corporation of the District of Maple Ridge nor Golder Associates Ltd. make any guarantee regarding the accuracy or present status of the information shown on this figure.
- Mile Marker references based on Geographic coordinates from CPR.
- Rail Line digitized from Orthophoto.

REFERENCE

Map Projection: UTM NAD83 Zone 10
Sources: District of Maple Ridge, Ministry of Environment Lands & Parks

PROJECT

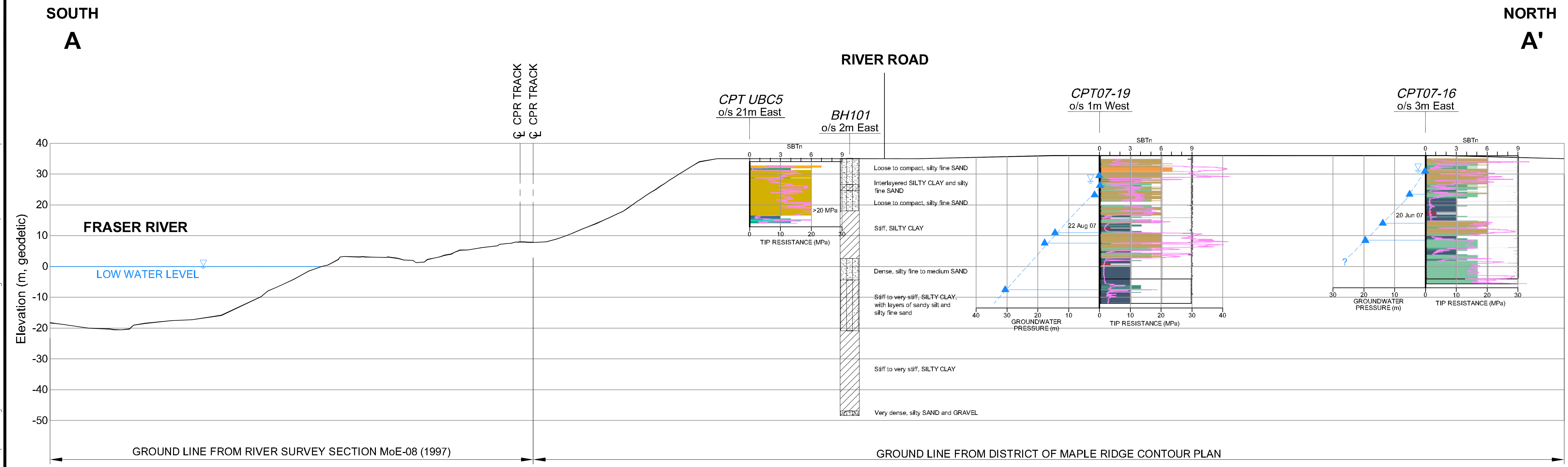
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE

SITE PLAN

Golder Associates
Victoria, BC

PROJECT	No. 07-1414-0096		FILE No.	P0714140096-01
DESIGN			SCALE AS SHOWN	REV. 0
CADD	JEF	NOV 07	**FIGURE 2**	
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		



0 50
VERTICAL SCALE (m)

0 50
HORIZONTAL SCALE (m)

LEGEND:

CPT Tip Resistance (q_t, MPa)

Bottom of Standpipe Piezometer

Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)

Equilibrium Water Pressure Measured by CPT Dissipation Test

Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

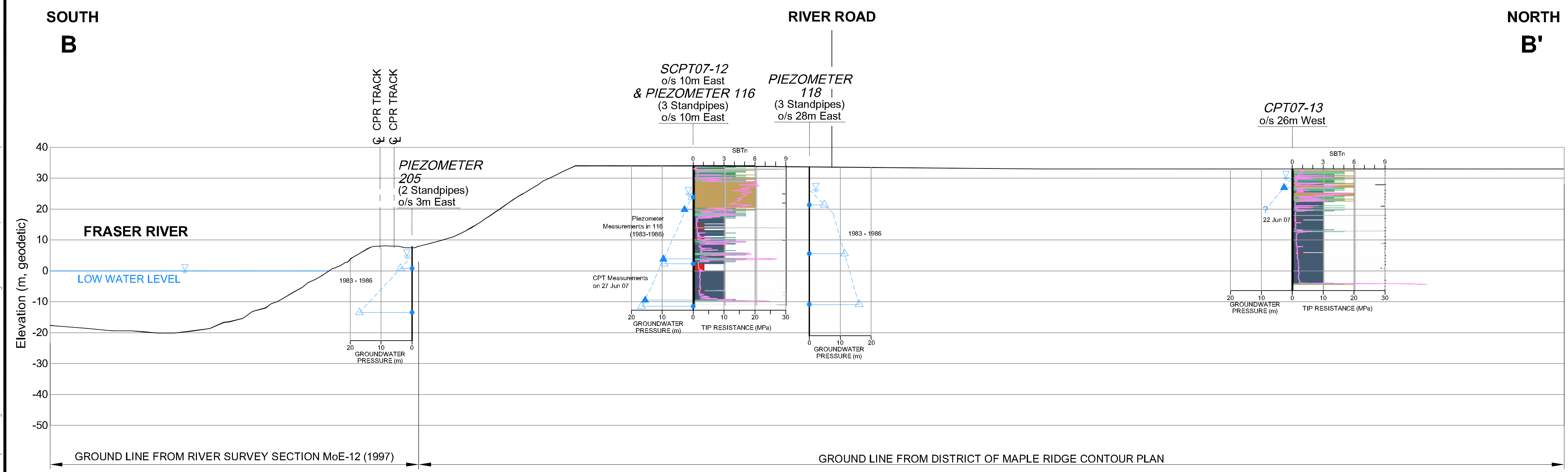
PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
CROSS SECTION A-A'

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No. S0714140096-A
DESIGN			SCALE AS SHOWN REV. 0
CADD	AMT/JS	06 NOV 07	**FIGURE 3a**
CHECK	CNW	12 FEB 08	
REVIEW	TPF	12 FEB 08	

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: S0714140096-A2.dwg Feb 12, 2008 - 3:14pm



LEGEND:

CPT Tip Resistance (q_t, MPa)

Bottom of Standpipe Piezometer

Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)

Equilibrium Water Pressure Measured by CPT Dissipation Test

Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

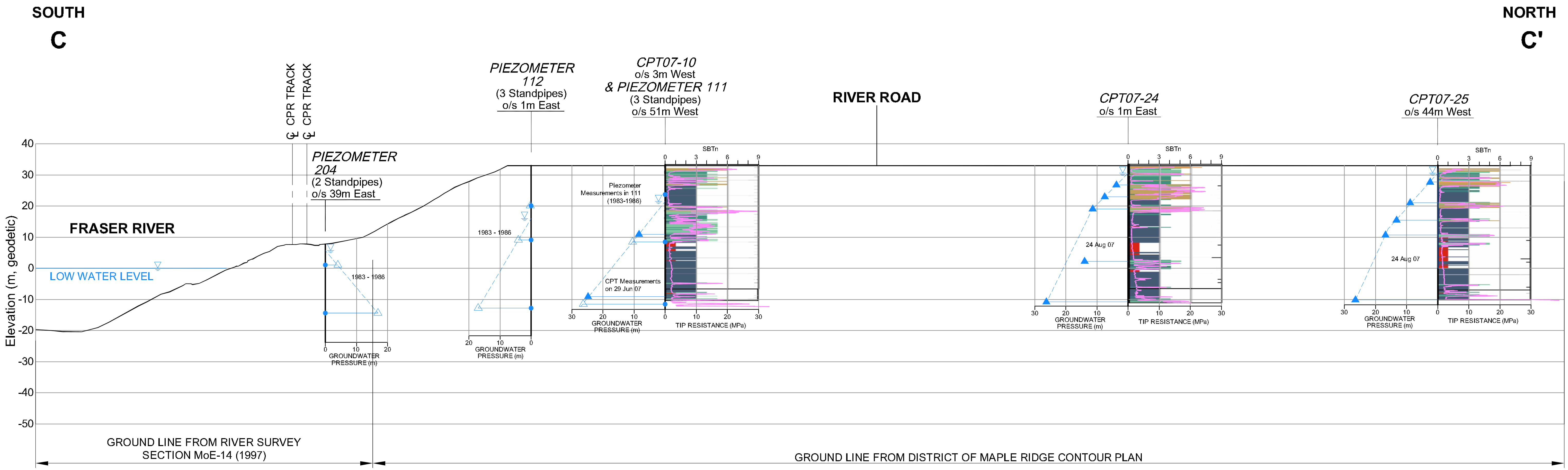
SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
CROSS SECTION B-B'

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	S0714140096-B
DESIGN			SCALE AS SHOWN	REV. 0
CADD	AMT/JS	06 NOV 07		
CHECK	CNW	12 FEB 08	**FIGURE 3b**	
REVIEW	TPF	12 FEB 08		



LEGEND:

CPT Tip Resistance (q_t, MPa)

Bottom of Standpipe Piezometer

Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)

Equilibrium Water Pressure Measured by CPT Dissipation Test

Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

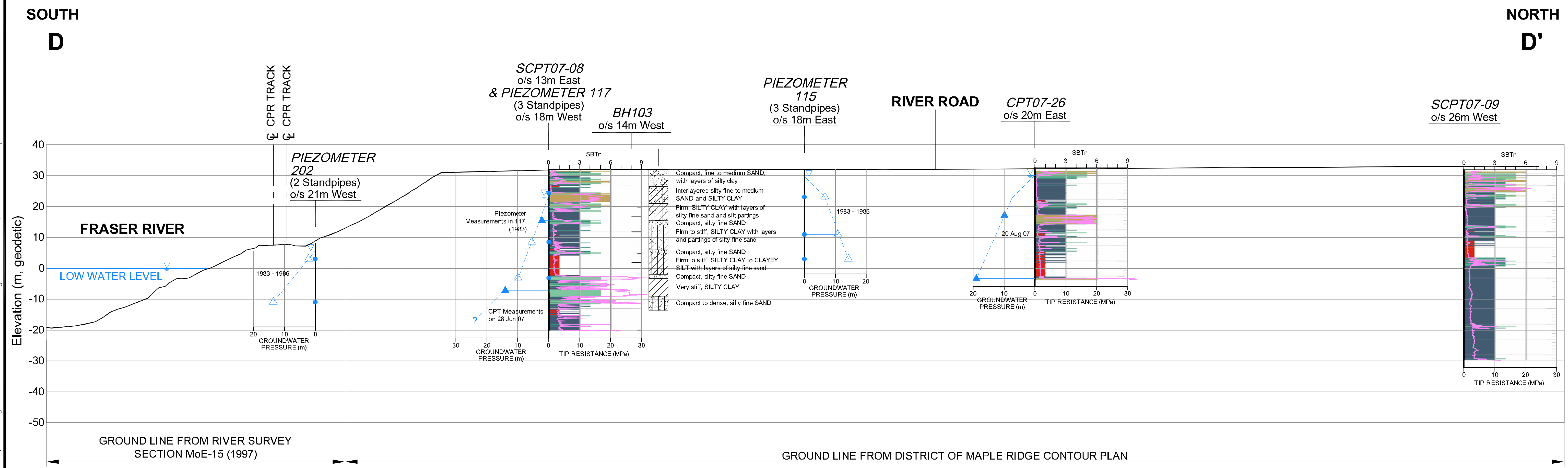
TITLE
CROSS SECTION C-C'

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096		FILE No.	S0714140096-C	
DESIGN			SCALE AS SHOWN	REV. 0
CADD	AMT/JS	06 NOV 07		
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		

FIGURE 3c

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: S0714140096-C2.dwg Feb 12, 2008 - 3:17pm



LEGEND:

- CPT Tip Resistance (q_t, MPa)
- Bottom of Standpipe Piezometer
- Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)
- Equilibrium Water Pressure Measured by CPT Dissipation Test
- Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

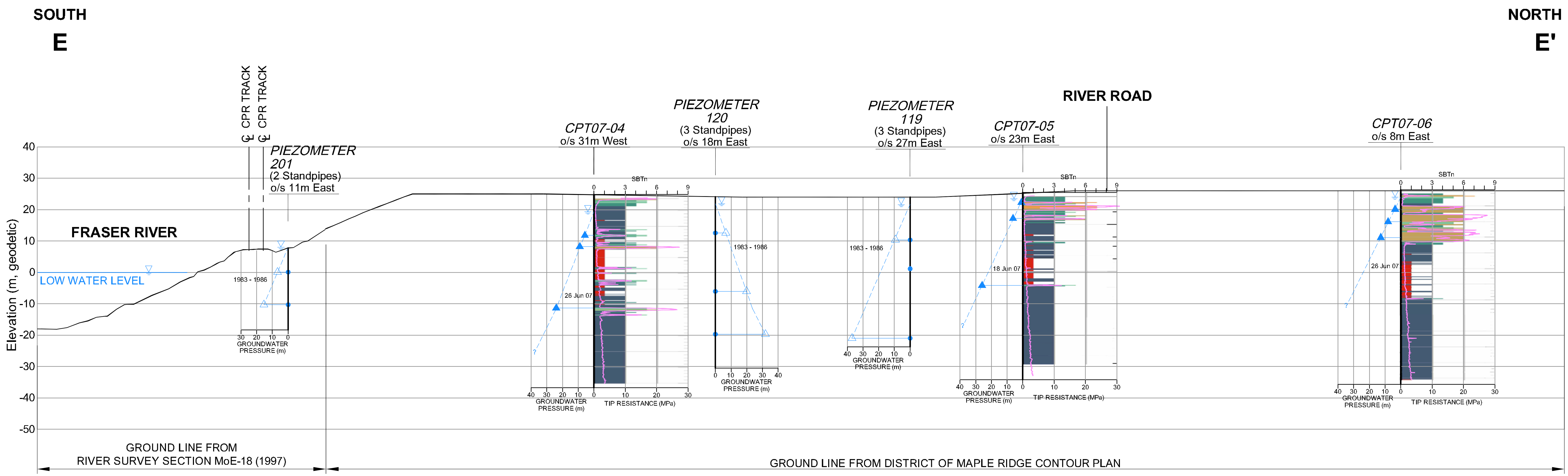
PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
CROSS SECTION D-D'

Golder Associates, Victoria, BC

PROJECT No. 07-1414-0096		FILE No. S0714140096-D		
DESIGN		SCALE AS SHOWN	REV. 0	
CADD	AMT/JS	06 NOV 07	FIGURE 3d	
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: S0714140096-D2.dwg Feb 12, 2008 - 3:19pm



0 50
VERTICAL SCALE (m)

0 50
HORIZONTAL DISTANCE SCALE (m)

LEGEND:

CPT Tip Resistance (q_t, MPa)

Bottom of Standpipe Piezometer

Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)

Equilibrium Water Pressure Measured by CPT Dissipation Test

Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151-158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

NOTE:
Groundwater Pressure Scale at 50% of Horizontal Distance Scale.

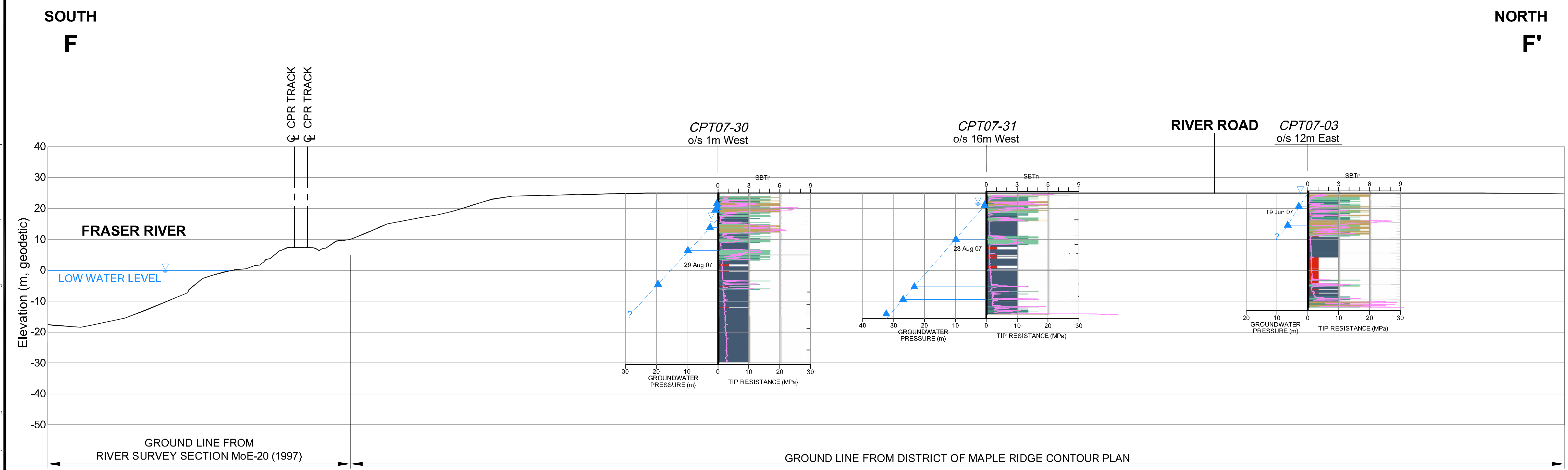
PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
CROSS SECTION E-E'

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096		FILE No.	S0714140096-E
DESIGN		SCALE AS SHOWN	REV. 0
CADD	AMT/JS	06 NOV 07	
CHECK	CNW	12 FEB 08	
REVIEW	TPF	12 FEB 08	

FIGURE 3e



0 50
VERTICAL SCALE (m)

0 50
HORIZONTAL SCALE (m)

LEGEND:

- CPT Tip Resistance (q_t, MPa)
- Bottom of Standpipe Piezometer
- Equilibrium Water Pressure Measured in Standpipe Piezometer (Median of Measurements over Time Period Indicated)
- Equilibrium Water Pressure Measured by CPT Dissipation Test
- Interpreted Water Table Elevation and Groundwater Pressure Distribution

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

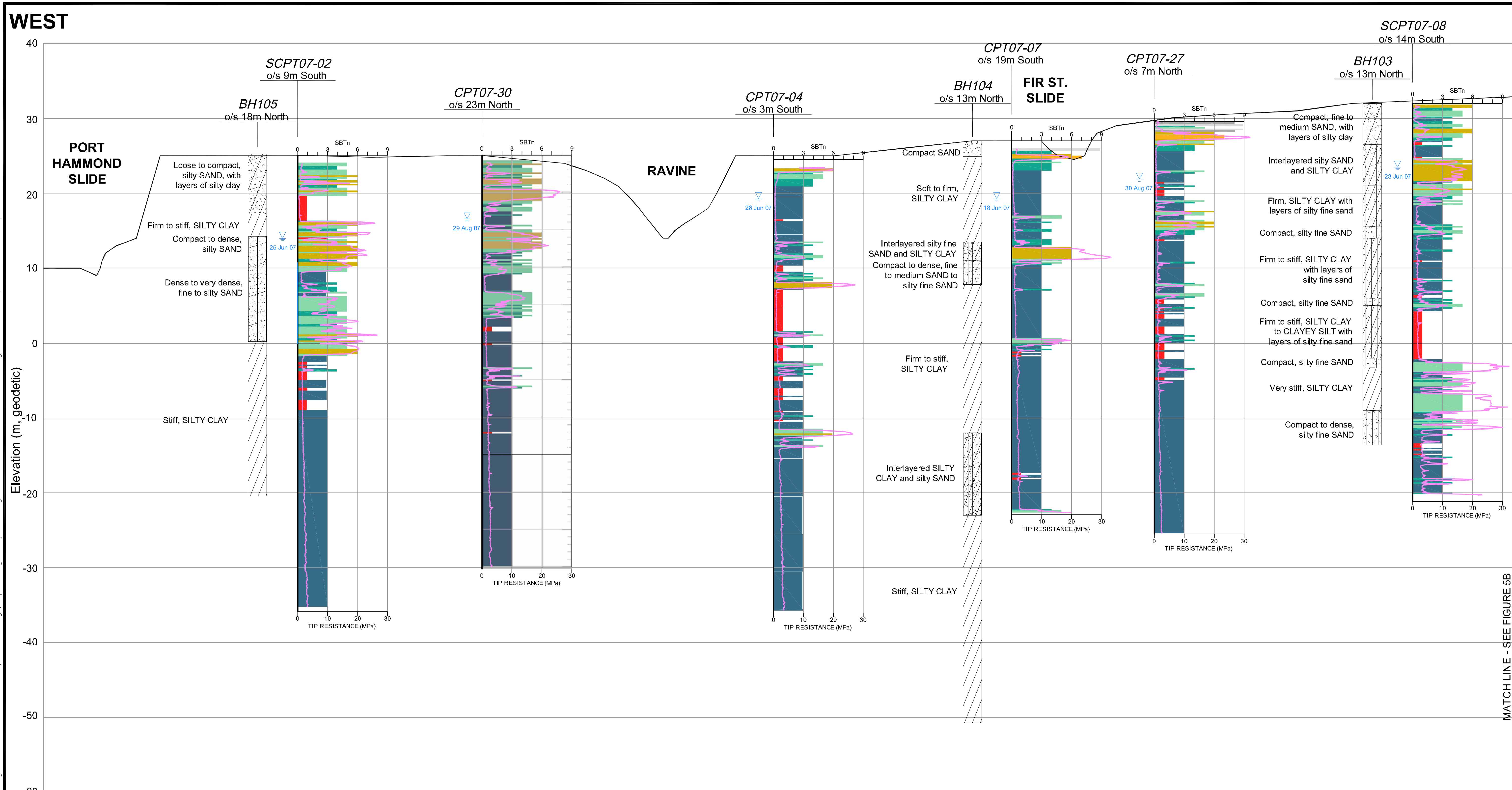
PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
CROSS SECTION F-F'

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	S0714140096-F
DESIGN			SCALE AS SHOWN	REV. 0
CADD	AMT/JS	06 NOV 07	**FIGURE 3f**	
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: S0714140096-F2.dwg Feb 12, 2008 – 3:39pm



LEGEND:

CPT Tip Resistance (q_t, MPa)

Interpreted Water Table Elevation

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

0 — 125 HORIZONTAL SCALE (m)

0 — 25 VERTICAL SCALE (m)

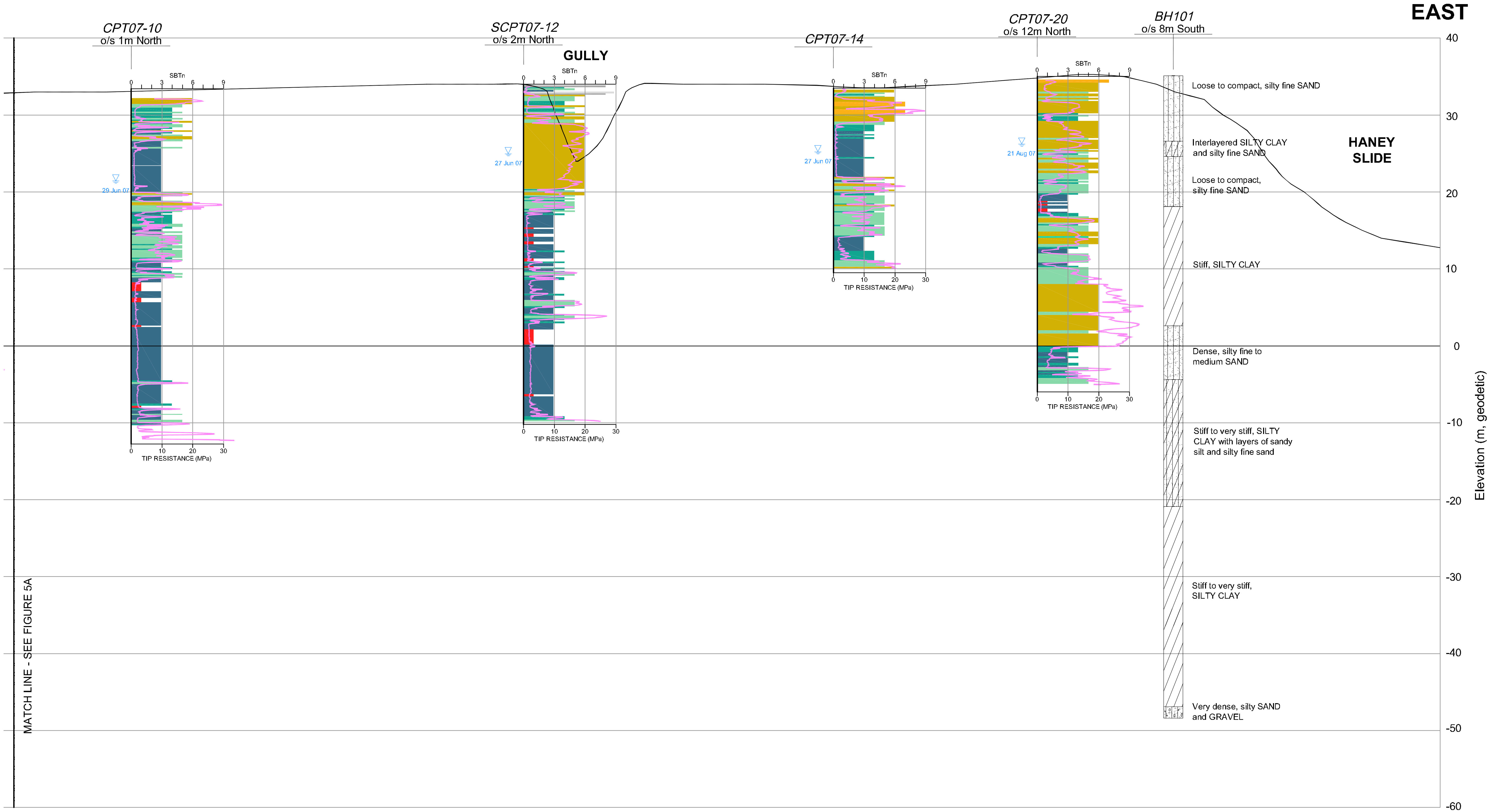
PROJECT: DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE: **STRATIGRAPHIC PROFILE ALONG ESCARPMENT (WEST)**

Golder Associates, Victoria, BC

PROJECT No. 07-1414-0096		FILE No. S0714140096-Profile.dwg
DESIGN		SCALE AS SHOWN REV. 0
CADD	KDJ	OCT 07
CHECK	CNW	12 FEB 08
REVIEW	TPF	12 FEB 08

FIGURE 4a



LEGEND:

CPT Tip Resistance (q_t, MPa)

Interpreted Water Table Elevation

KEY:

SBTn Soil Behavior Type based on Tip Resistance and Friction Ratio normalized for overburden stress (See Classification Chart in Appendix IV)
[Ref.: Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 - 158.]

SBTn No.	Soil Behavior Type
1	Sensitive fine-grained
2	Organic soils
3	Clays (silty clay to clay)
4	Silt Mixtures (clayey silt to silty clay)
5	Sand Mixtures (silty sand to sandy silt)
6	Sands (clean sand to silty sand)
7	Gravelly sand to dense sand
8	Very stiff cemented sand to clayey sand
9	Very stiff, over-consolidated fine-grained soil

0 125
HORIZONTAL SCALE (m)

0 25
VERTICAL SCALE (m)

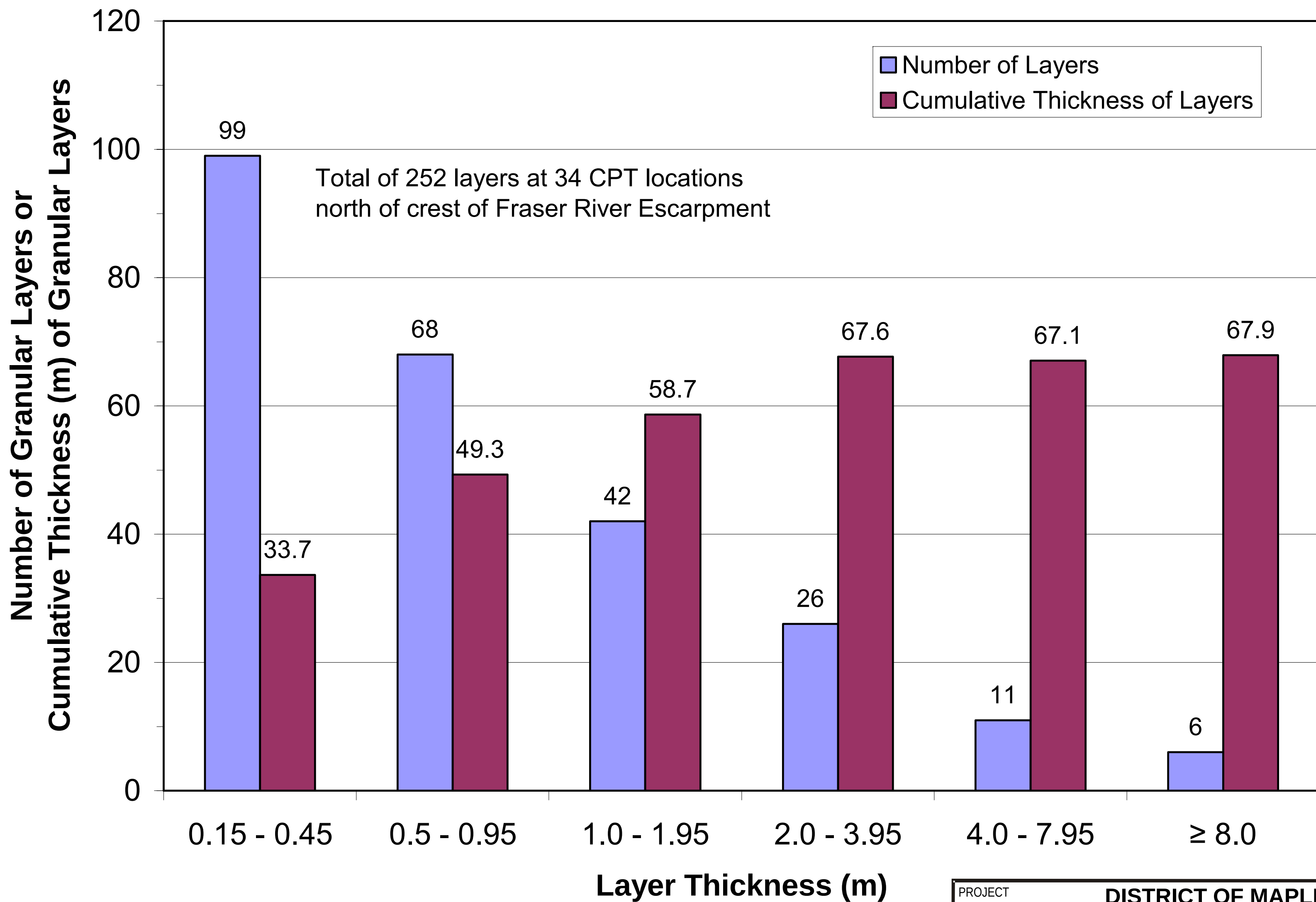
PROJECT
DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE
STRATIGRAPHIC PROFILE ALONG ESCARPMENT (EAST)

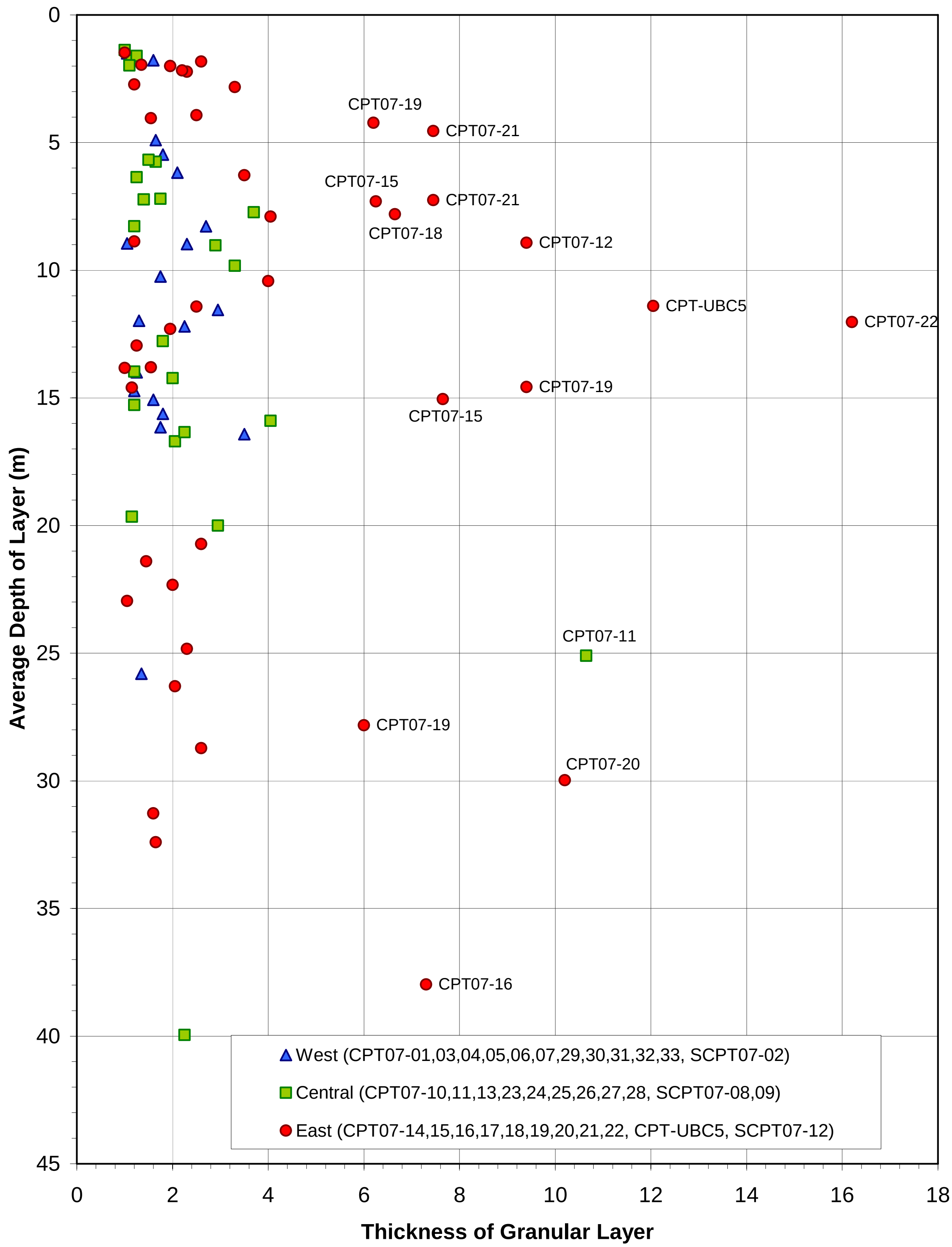
Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096		FILE No. S0714140096-Profile.dwg
DESIGN		SCALE AS SHOWN REV. 0
CADD	KDJ	OCT 07
CHECK	CNW	12 FEB 08
REVIEW	TPF	12 FEB 08

FIGURE 4b



PROJECT	DISTRICT OF MAPLE RIDGE FRASER RIVER ESCARPMENT MAPLE RIDGE, B.C.		
TITLE	HISTOGRAM OF FREQUENCY AND CUMULATIVE THICKNESS OF GRANULAR LAYERS		
Golder Associates	PROJECT No. 07-1414-0096		FILE No.
	DESIGN		SCALE AS SHOWN REV.
	DRAWN	VN NOV07	FIGURE 5
	CHECK	CW FEB08	
	REVIEW	TF FEB08	



NOTE:
Only layers with thickness greater than or equal to 1.0 m are shown.

PROJECT	DISTRICT OF MAPLE RIDGE FRASER RIVER ESCARPMENT MAPLE RIDGE, B.C.		
TITLE	GRANULAR LAYER THICKNESS VS. DEPTH		
Golder Associates	PROJECT No. 07-1414-0096		FILE No.
	DESIGN		SCALE AS SHOWN / REV.
	DRAWN	VN	NOV 07	FIGURE 6
	CHECK	CW	FEB08	
	REVIEW	TF	FEB08	

REVISION DATE: 30NOV07 BY: BC FILE: N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Data\MapleRidge – Sand Thickness.ppt

LEGEND:

CPT07-xx — Cone Penetration Test by Golder (2007)

CPT-UBC5 — Cone Penetration Test by University of British Columbia (1984)

xx % — Total Thickness of Granular Layers above +0 m Elevation as Percentage of Total Sounded Thickness above +0 m Elevation

— 30 — Granular Thickness Contour (shown in 10% intervals)

NOTES:

- All test hole locations are approximate.
- All elevations in meters, referenced to Geodetic Datum
- Neither the Corporation of the District of Maple Ridge nor Golder Associates Ltd. make any guarantee regarding the accuracy or present status of the information shown on this figure.

REFERENCE:

Map Projection: UTM NAD83 Zone 10
Sources: District of Maple Ridge

PROJECT

DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE

RELATIVE THICKNESS OF GRANULAR LAYERS ABOVE 0 m ELEVATION ACROSS STUDY AREA

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	P0714140096-04	
DESIGN	CW	OCT 07	SCALE	AS SHOWN	REV. 0
CADD	JEF	NOV 07	**FIGURE 7**		
CHECK	CNW	12 FEB 08			
REVIEW	TPF	12 FEB 08			

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: P0714140096-04.dwg Feb 12, 2008 – 3:10pm

LEGEND:

CPT07-xx x.x m date	Cone Penetration Test by Golder (2007) with interpreted water table elevation on date indicated
xxx x.x m 1983-1986	Standpipe Piezometer Installations by Golder (1982) with interpreted water table elevation based on median of readings from 1983 to 1986

NOTES:

- All test hole locations are approximate.
- All elevations in meters, referenced to Geodetic Datum
- Neither the Corporation of the District of Maple Ridge nor Golder Associates Ltd. make any guarantee regarding the accuracy or present status of the information shown on this figure.

REFERENCE:

Map Projection: UTM NAD83 Zone 10
Sources: District of Maple Ridge

PROJECT

DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE

WATER TABLE ELEVATIONS ACROSS STUDY AREA

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	P0714140096-03
DESIGN	CW	OCT 07	SCALE AS SHOWN	REV. 0
CADD	AMT	OCT 07		
CHECK	CNW	12 FEB 08	**FIGURE 8a**	
REVIEW	TPF	12 FEB 08		

N:\Active\2007\1414\07-1414-0096 Maple Ridge Geotech Fraser River\Vic Drafting\Report Figures\ Drawing file: P0714140096-02.dwg Feb 12, 2008 – 3:06pm

LEGEND:

CPT07-xx x.x m date	Cone Penetration Test by Golder (2007) with interpreted water table depth on date indicated
xxx x.x m 1983-1986	Standpipe Piezometer Installations by Golder (1982) with interpreted water table depth based on median of readings from 1983 to 1986

NOTES:

- All test hole locations are approximate.
- Neither the Corporation of the District of Maple Ridge nor Golder Associates Ltd. make any guarantee regarding the accuracy or present status of the information shown on this figure.

REFERENCE:

Map Projection: UTM NAD83 Zone 10
Sources: District of Maple Ridge

PROJECT

DISTRICT OF MAPLE RIDGE
FRASER RIVER ESCARPMENT
MAPLE RIDGE, B.C.

TITLE

WATER TABLE DEPTHS ACROSS STUDY AREA

Golder Associates
Victoria, BC

PROJECT No. 07-1414-0096			FILE No.	P0714140096-02
DESIGN	CW	OCT 07	SCALE AS SHOWN	REV. 0
CADD	AMT	OCT 07	**FIGURE 8b**	
CHECK	CNW	12 FEB 08		
REVIEW	TPF	12 FEB 08		

APPENDIX I

RECORD OF BOREHOLE SHEETS – 1979 INVESTIGATION BY GOLDER ASSOCIATES LTD.

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS	auger sample
CS	chunk sample
DO	drive open
DS	Denison type sample
FS	foil sample
RC	rock core
ST	slotted tube
TO	thin-walled, open
TP	thin-walled, piston
WS	wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	*N, blows/ft.*
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	c_u*, lb./sq. ft.*
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

IV. SOIL TESTS

C	consolidation test
H	hydrometer analysis
M	sieve analysis
MH	combined analysis, sieve and hydrometer[1]
Q	undrained triaxial[2]
R	consolidated undrained triaxial[2]
S	drained triaxial
U	unconfined compression
V	field vane test

NOTES:

[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

Project No. 7821179

RECORD OF BOREHOLE 101

SHEET 1 OF 3

LOCATION (see Figure 2)

BOREHOLE TYPE Rotary

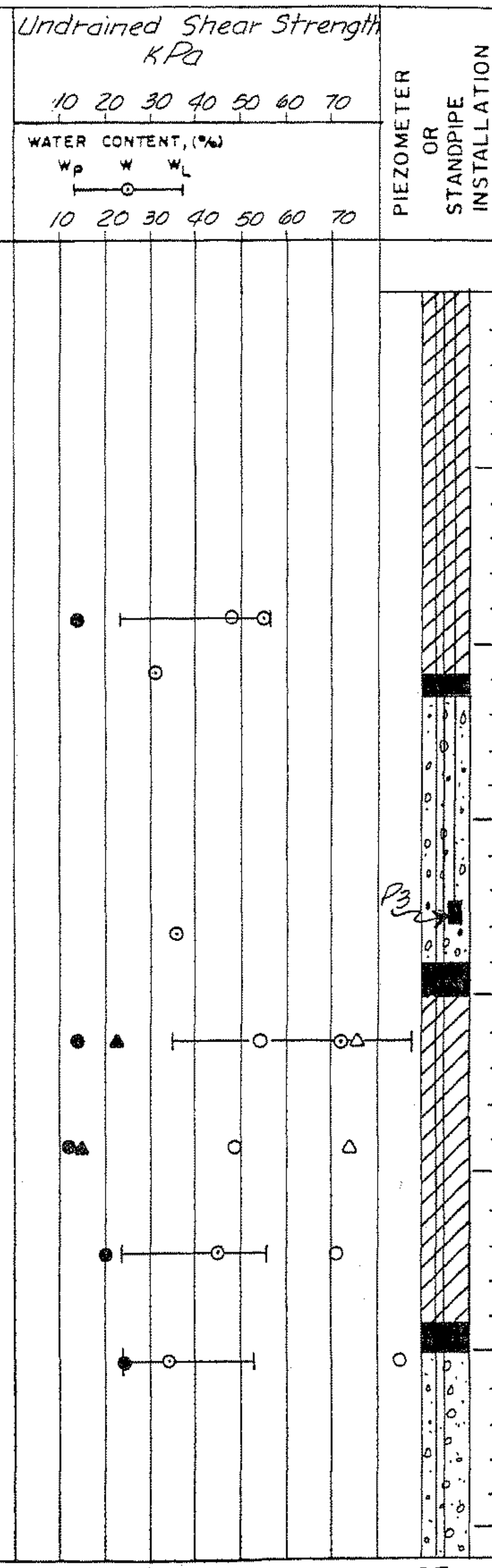
SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

BORING DATE NOV. 27-29, 1978

BOREHOLE DIAMETER 114 mm

DATUM Ground Surface

DEPTH (m.)	ELEV. (m.)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING
0.00	35.1	GROUND SURFACE					
		Loose to compact grey-brown silty fine SAND, occ. layers of firm grey clayey silt and medium to coarse sand and gravel.		1	D.O.	21	
				2	"	33	
				3	"	15	
				4	"	23	
8.50	26.6			5	"	21	
10.50	24.6	Interlayered firm grey silty CLAY & loose to compact silty fine SAND		6	TP	Ph	
		Loose to compact grey silty fine SAND, occ. layers of firm grey silty clay, occ. gravel		7	D.O.	14	
				8	"	12	
				9	"	17	
17.00	18.1			10	"	11	
		Stiff blue-grey sensitive silty CLAY, occ. bands of dark grey clay. Below 29.0m. - occ. zones & partings of silt & silty fine sand.		11	D.O.	7	
				12	TP	Ph	
				13	"	Ph	
				14	TP	Ph	
32.50	2.6			15	"	Ph	
		Dense grey fine to medium silty SAND					
		Cont'd					



Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

VERTICAL SCALE 1:200

DRAWN SF

CHECKED

RECORD OF BOREHOLE 101

SHEET 2 OF 3

Project No. 7821179

LOCATION (see Figure 2)

BORING DATE Nov. 27-29, 1978

BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

DATUM Ground Surface

DEPTH (metres)	ELEV. (m.)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, kPa (10 20 30 40 50 60 70) / WATER CONTENT, (%) W_p W W_L (10 20 30 40 50 60 70)	PIEZOMETER OR STANDPIPE INSTALLATION
		Dense grey fine to medium silty SAND		16	D.O.	56			
39.5	-4.4								P2
40		Stiff to very stiff blue-grey sensitive silty clay, with frequent layers (up to 500 mm) of sandy silt and silty fine sand.		17	TP	Ph			
45				18	TP	Ph			
50									
55									
56.0	-20.9	Stiff to very stiff grey sensitive silty CLAY, occ. sand layers							
60									
65									
70		Cont'd							

VERTICAL SCALE 1:200

DRAWN SF

CHECKED RJ

Golder Associates

Project No. 7821179

RECORD OF BOREHOLE 101

LOCATION (see Figure 2)

BORING DATE Nov. 27-29, 1978

BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

DATUM Ground Surface

DEPTH (metres)	ELEV. (m.)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, kPa (10 20 30 40 50 60 70) / WATER CONTENT, (%) W_p W W_L (10 20 30 40 50 60 70)	PIEZOMETER OR STANDPIPE INSTALLATION
		Stiff to very stiff grey sensitive silty CLAY, occ. sand layers.							
82.0	-46.9	Very dense grey silty SAND & GRAVEL							P1
83.5	-48.4	End of Borehole							

Depth scale: 75, 80, 85, 90, 95

LEGEND

	Undisturbed	Remoulded
Field Vane	△	▲
Lab Vane	○	●

Piezometer Installation

- General Backfill
- Bentonite Seal
- 'Pea' Gravel
- Piezometer

VERTICAL SCALE 1 : 200

DRAWN SF

CHECKED AJ

Golder Associates

Project No. 782/179

RECORD OF BOREHOLE 103

SHEET 1 OF 2

LOCATION (see Figure 2) BORING DATE December 1, 1978

BOREHOLE TYPE Rotary BOREHOLE DIAMETER 114 mm

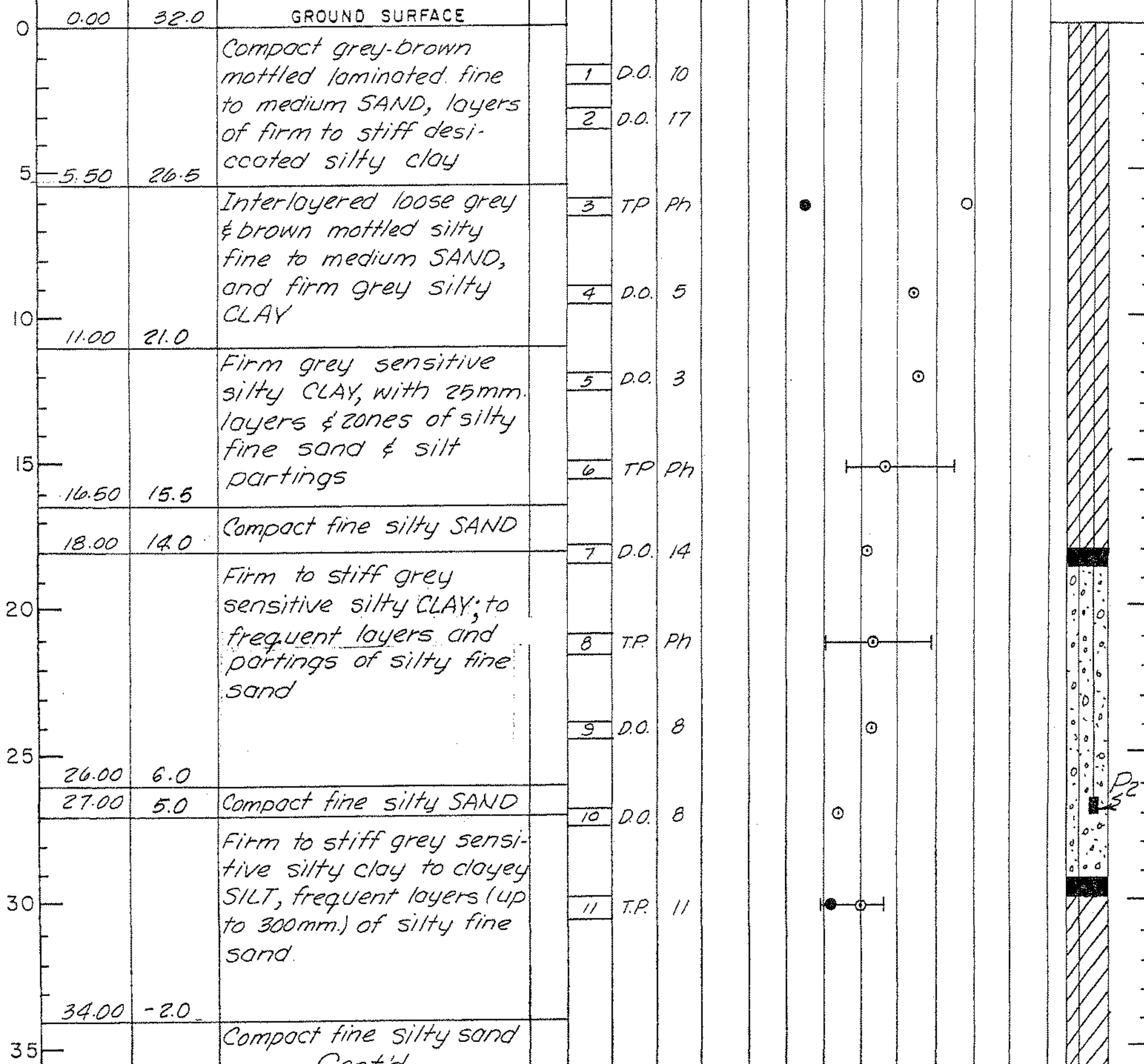
SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING
0.00	32.0	GROUND SURFACE					
		Compact grey-brown mottled laminated fine to medium SAND, layers of firm to stiff desiccated silty clay		1	D.O.	10	
				2	D.O.	17	
5.50	26.5	Interlayered loose grey & brown mottled silty fine to medium SAND, and firm grey silty CLAY		3	TP	Ph	
				4	D.O.	5	
11.00	21.0	Firm grey sensitive silty CLAY, with 25mm. layers & zones of silty fine sand & silt partings		5	D.O.	3	
				6	TP	Ph	
16.50	15.5	Compact fine silty SAND					
18.00	14.0	Firm to stiff grey sensitive silty CLAY; to frequent layers and partings of silty fine sand		7	D.O.	14	
				8	T.P.	Ph	
				9	D.O.	8	
26.00	6.0	Compact fine silty SAND					
27.00	5.0	Firm to stiff grey sensitive silty clay to clayey SILT, frequent layers (up to 300mm.) of silty fine sand.		10	D.O.	8	
				11	T.P.	11	
34.00	-2.0	Compact fine silty sand					
		Cont'd					

Undrained Shear Strength, kPa: 10 20 30 40 50 60 70

WATER CONTENT, (%) W_P W W_L: 10 20 30 40 50 60 70

PIEZOMETER OR STANDPIPE INSTALLATION



VERTICAL SCALE 1:200

DRAWN SF

CHECKED [illegible]

RECORD OF BOREHOLE 103

SHEET 2 OF 2

Project No. 782/179

LOCATION (see Figure 2)
BORING DATE Dec. 1, 1978
BOREHOLE TYPE Rotary
BOREHOLE DIAMETER 114 mm
SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M
DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, kPa (10 20 30 40 50 60 70) / WATER CONTENT, (%) W_p W W_L (10 20 30 40 50 60 70)	PIEZOMETER OR STANDPIPE INSTALLATION
		Very stiff grey sensitive silty CLAY, occ. zones of silt and silty fine sand.		12	T.P.	Ph			
40									
41.00	-9.0	Compact to dense silty fine SAND		13	T.P.	Ph			
45									
45.60	-13.6	End of Borehole		14	T.P.				P1
50									
55									

LEGEND

	Undisturbed	Remoulded
Field Vane	△	▲
Lab Vane	○	●

Piezometer Installation

- ▨ General Backfill
- ■ Bentonite Seal
- ░ 'Pea' Gravel
- Piezometer

VERTICAL SCALE 1 : 200

DRAWN SF
CHECKED [illegible]

Golder Associates

Project No. 7821179

RECORD OF BOREHOLE 104

SHEET 1 OF 3

LOCATION (see Figure 2)

BORING DATE Nov. 15-21, 1978

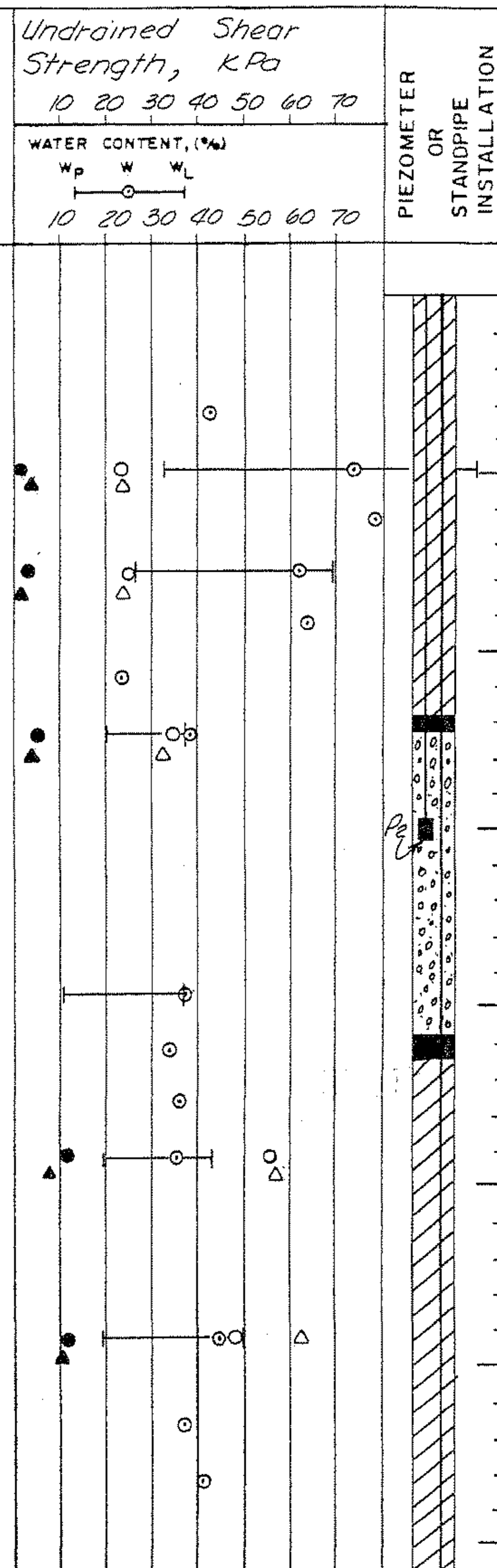
BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING
0.00	27.0	GROUND SURFACE					
0.55	26.5	Sand & Gravel (FILL)					
2.10	24.9	Compact grey & brown mottled laminated fine to medium SAND.		1	D.O.	17	
4.00	23.0	Firm grey & brown silty CLAY, fine sand partings		2	"	3	
		Soft to firm blue-grey sensitive silty CLAY		3	T.P.	Ph	
				4	D.O.	Pm	
				5	T.P.	Ph	
				6	D.O.	Pm	
				7	D.O.	Pm	
13.50	13.5			8	T.P.	Ph	
16.00	11.0	Interlayered compact grey fine silty SAND and firm blue-grey silty clay		9	D.O.	8	
				10	D.O.	16	
19.20	7.8	Compact to dense layered fine silty SAND and fine to medium SAND		11	T.P.	Ph	
				12	D.O.	38	
				13	D.O.	46	
		Firm to stiff blue-grey sensitive silty clay, occ. thin layers of silty fine sand.		14	T.P.	Ph	
				15	D.O.	2	
				16	D.O.	Wr	
				17	T.P.	Ph	
				18	D.O.	Wr	
				19	D.O.	Wr	
				20	T.P.	Ph	
				21	D.O.	Wr	
34.00	-7.0			22	D.O.	Wr	
		Cont'd					



VERTICAL SCALE 1:200

DRAWN SF

CHECKED [illegible]

Golder Associates

Project No. 7821179

RECORD OF BOREHOLE 104

SHEET 2 OF 3

LOCATION (see Figure 2)
BORING DATE Nov. 15-21, 1978
BOREHOLE TYPE Rotary
BOREHOLE DIAMETER 114 mm
SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M
DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, KPa 10 20 30 40 50 60 70 / WATER CONTENT, (%) W_p W W_L 10 20 30 40 50 60 70	PIEZOMETER OR STANDPIPE INSTALLATION
34.00	-7.0								
		Firm to stiff blue-grey sensitive silty CLAY		23	T.P.	Ph			
				24	D.O.	Wr			
39.00	-12.0			25	D.O.	Wr			
		Interlayered stiff blue-grey silty CLAY and compact to dense grey fine to medium silty sand.		26	T.P.	Ph			P1
				27	D.O.	17			
				28	D.O.	46			
				29	D.O.	45			
				30	D.O.	17			
				31	T.P.	Ph			
50.00	-23.0			32	D.O.	19			
		Stiff blue-grey sensitive silty CLAY; occ. thin layers of silty fine sand		33	D.O.	Wr			
				34	T.O.	Ph			
				35	D.O.	Wr			
				36	T.O.	Ph		95	
				37	T.O.	Ph			
				38	T.O.	Ph			
		Cont'd							

Depth scale: 40, 45, 50, 55, 60, 65, 70

VERTICAL SCALE 1:200

DRAWN SF

CHECKED [illegible]

Golder Associates

Project No. 7821179

RECORD OF BOREHOLE 104

SHEET 3 OF 3

LOCATION (see Figure 2)

BORING DATE Nov. 15-21, 1978

BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, kPa 10 20 30 40 50 60 70 / WATER CONTENT, (%) W_p W W_L 10 20 30 40 50 60 70	PIEZOMETER OR STANDPIPE INSTALLATION
		Stiff blue-grey sensitive silty clay							General Backfill
75									
77.75	-50.75	End of Borehole							
80									
85									

LEGEND

	Undisturbed	Remoulded
Field Vane	△	▲
Lab Vane	○	●

Piezometer Installation

- General Backfill
- Bentonite Seal
- 'Pea' Gravel
- Piezometer

VERTICAL SCALE 1:200

DRAWN SF

CHECKED [illegible]

Golder Associates

RECORD OF BOREHOLE 105

SHEET 1 OF 2

Project No. 782-1179

LOCATION (see Figure 2)

BORING DATE Dec. 2-4, 1978

BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, KPa (10 20 30 40 50 60 70) / WATER CONTENT, (%) W_P W W_L (10 20 30 40 50 60 70)	PIEZOMETER OR STANDPIPE INSTALLATION
0.00	25.2	GROUND SURFACE							
		Loose to compact grey-brown mottled fine to medium silty SAND, layers of firm brown desiccated silty clay		1	D.O.	13			
				2	D.O.	9			
8.00	17.2	Firm to stiff blue-grey sensitive silty clay		3	T.P.	Ph			
11.00	14.2	Compact to dense grey & brown silty medium SAND		4	D.O.	17			
13.00	12.2	Dense to very dense grey fine to medium silty SAND		5	D.O.	33			
				6	D.O.	87			
				7	D.O.	62			
				8	D.O.	52			P1
25.00	0.2	Stiff grey sensitive silty CLAY, occ. partings of silty fine sand		9	T.P.	Ph			
				10	T.P.	Ph			
		Cont'd							

VERTICAL SCALE 1:200

DRAWN SF

CHECKED [illegible]

Golder Associates

Project No. 7821179

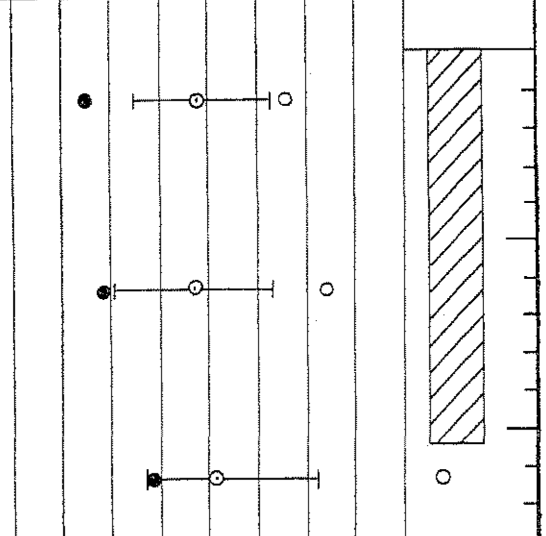
RECORD OF BOREHOLE 105

SHEET 2 OF 2

LOCATION (see Figure 2)
BOREHOLE TYPE Rotary
SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

BORING DATE Dec. 2-4, 1978
BOREHOLE DIAMETER 114 mm
DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING	Undrained Shear Strength, kPa (10 20 30 40 50 60 70) / WATER CONTENT, (%) W_p W W_L (10 20 30 40 50 60 70)	PIEZOMETER OR STANDPIPE INSTALLATION
		Stiff grey sensitive silty CLAY, occ. thin layers and zones of silty fine sand		11	T.P.	Ph			
40				12	T.P.	Ph			
45 — 45.60	-20.4	End of Borehole		13	T.P.	Ph			
50									



LEGEND

	Undisturbed	Remoulded
Field Vane	△	▲
Lab Vane	○	●

Piezometer Installation
- General Backfill
- Bentonite Seal
- 'Pea' Gravel
- Piezometer

VERTICAL SCALE 1:200

DRAWN SF
CHECKED [initials]

Project No. 7821179

RECORD OF BOREHOLE 106

SHEET 1 OF 2

LOCATION (see Figure 2)

BORING DATE Nov. 22-24, 1978

BOREHOLE TYPE Rotary

BOREHOLE DIAMETER 114 mm

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

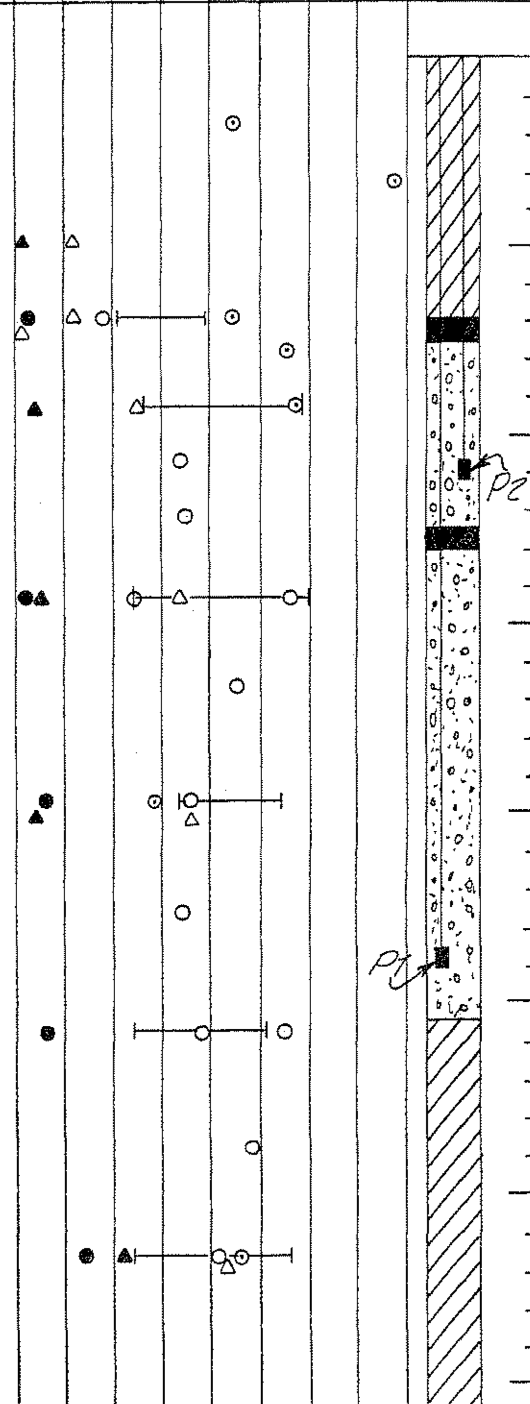
DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING
0.00	19.8	GROUND SURFACE				
1.00	18.8	Topsoil & firm brown silt				
2.50	17.3	Firm to stiff brown-grey clayey SILT and compact grey brown fine to medium SAND	1	D.O.	21	
			2	D.O.	Wr	
8.00	11.8	Soft blue-grey sensitive silty CLAY	3	T.O.	Ph	
			4	T.P.	Ph	
			5	T.P.		
			6	D.O.	Wr	
18.00	1.8	Soft to firm blue-grey sensitive silty CLAY occ. layers (up to 100 mm.) of silty fine sand	7	T.P.	Ph	
			8	D.O.	3	
			9	D.O.	Wr	
			10	T.P.	Ph	
			11	D.O.	Wr	
		Firm blue-grey sensitive silty CLAY; occ. thin layers of silty fine sand.	12	T.P.	Ph	
			13	D.O.	Wr	
			14	T.P.	Ph	
			15	D.O.	Wr	
			16	T.P.	Ph	
		Cont'd				

Undrained Shear Strength, kPa: 10 20 30 40 50 60 70

WATER CONTENT, (%): W_p W W_L: 10 20 30 40 50 60 70

PIEZOMETER OR STANDPIPE INSTALLATION



VERTICAL SCALE 1:200

DRAWN SF

CHECKED

Golder Associates

RECORD OF BOREHOLE 106

SHEET 2 OF 2

Project No. 7821179

LOCATION (see Figure 2)

BOREHOLE TYPE Rotary

SAMPLER HAMMER WEIGHT 0.6 KN DROP 0.76 M

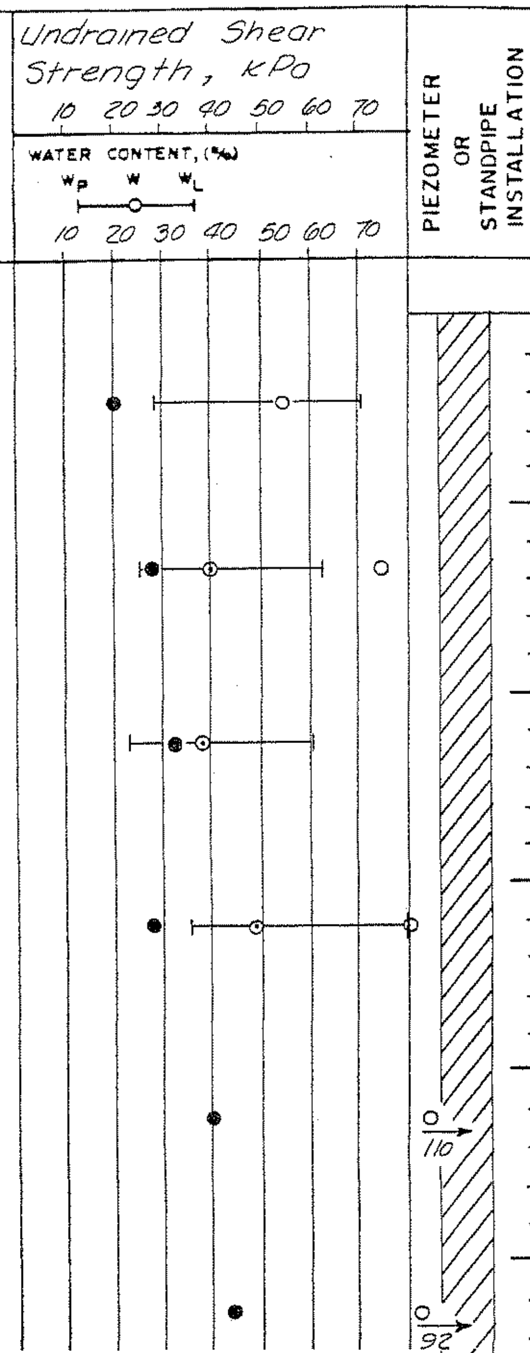
BORING DATE Nov. 22-24, 1978

BOREHOLE DIAMETER 114 mm

DATUM Ground Surface

DEPTH (metres)	ELEV. (m)	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / 0.3 M	LAB. TESTING
		Stiff blue-grey sensitive silty CLAY, occ. thin layers of silty fine sand		17	T.P.	Ph	
				18	T.P.	Ph	
				19	T.P.	Ph	
				20	T.P.	Ph	
54.00	-34.2	Stiff to very stiff blue-grey silty CLAY, occ. layers of silty fine sand		21	T.P.	Ph	
				22	T.P.	Ph	
65.00	-45.2	Interlayered very stiff blue-grey silty CLAY and dense silty fine sand					
75.00	-55.2	End of Borehole					

Depth scale: 40, 45, 50, 55, 60, 65, 75



PIEZOMETER OR STANDPIPE INSTALLATION

LEGEND

	Undisturbed	Remoulded
Field Vane	△	▲
Lab Vane	○	●

Piezometer Installation

- General Backfill
- Bentonite Seal
- 'Pea' Gravel
- Piezometer

VERTICAL SCALE 1:200

DRAWN SF

CHECKED RV

Golder Associates

APPENDIX II

SUMMARY OF STANDPIPE PIEZOMETER MONITORING DATA – 1983 TO 1986

Table II-1
Summary of Piezometer Monitoring Results[1]
(Dec. 1982 - Feb. 1986)

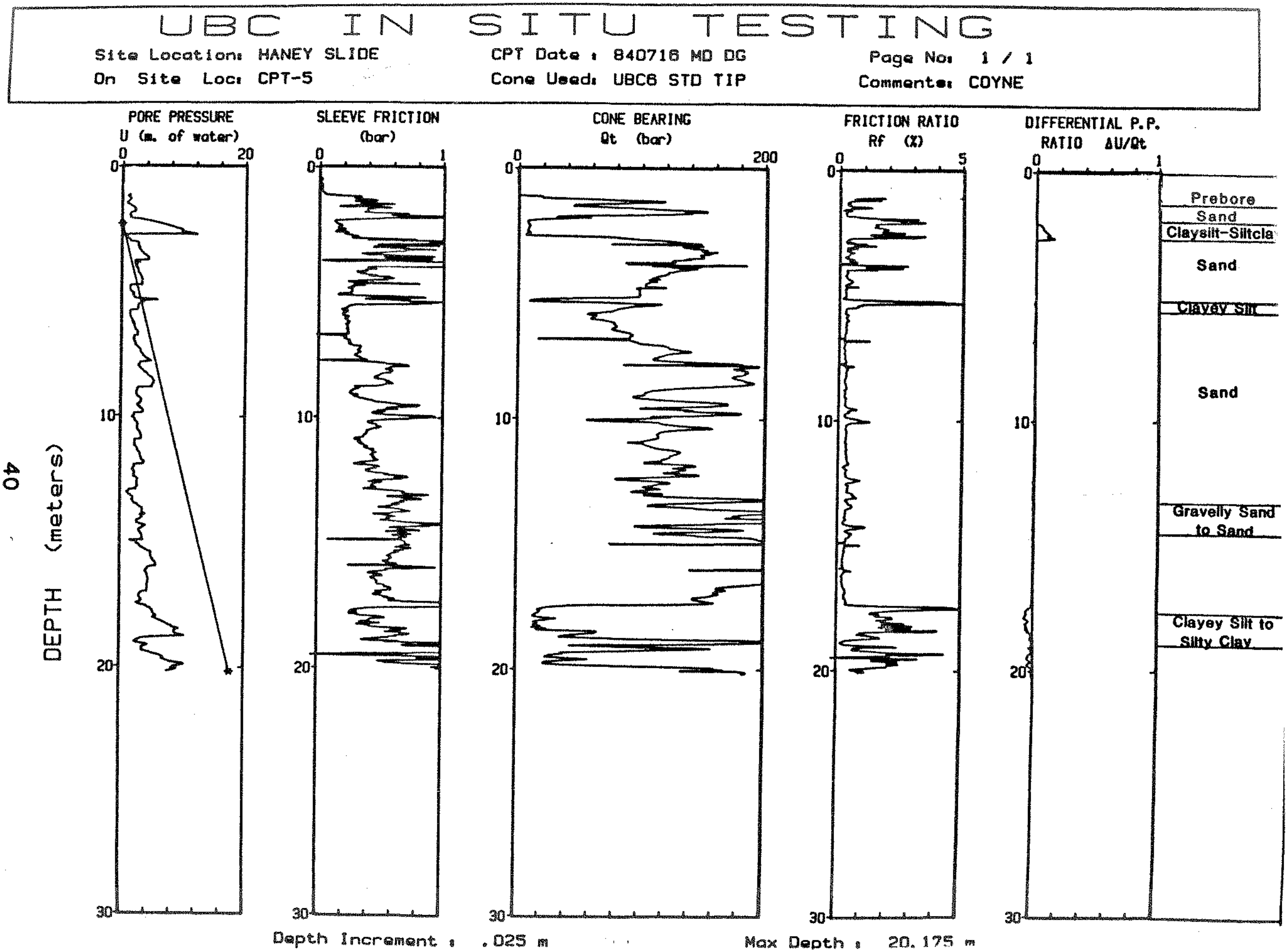
Golder Piezometer No.	Approximate Ground Elevation[2] (m)	Tip Depth (m)	Approximate Tip Elevation[3] (m)	Median Groundwater Elevation[4] (m)	Pressure Head (m)		Maximum Rise above Median Level (m)	Interpreted Water Table Elevation (m)
					Median	Standard Deviation		
111-1	33.0[5]	9.3	23.7	Piezometer flooded - No reliable data available				21.8
111-2		24.5	8.5	19.00	10.50	0.32	1.00	
111-3		44.5	-11.5	14.82	26.32	0.12	0.38	
112-1	33.5	13.4	20.1	20.37	0.27	0.32	0.69	16.0
112-2		24.4	9.1	13.20	4.10	0.13	0.22	
112-3		46.3	-12.8	4.22	17.02	0.16	0.24	
113-1,2,3				Data highly variable - Not Reliable				
114-1	33.5[6]	9.1	24.4	31.00	6.60	1.12	2.00	?
114-2		25.7	7.8	19.10	11.30	0.27	0.38	
114-3		34.2	-0.7	4.00	4.70	0.06	0.18	
115-1	32.6	9.5	23.1	29.71	6.61	0.80	0.81	29.7
115-2		21.6	11.0	21.83	10.83	0.21	0.25	
115-3		29.6	3.0	17.2 ('83 only)	14.23	0.03	0.02	
116-1	34.0[7]	10.1	23.9	24.29	0.39	0.19	0.53	24.8
116-2		31.7	2.3	11.75	9.45	0.18	0.23	
116-3		45.4	-11.4	5.30	16.70	0.27	0.74	
117-1	32.0	7.6	24.4	27.4('83 only)	3.00	0.52	0.68	23.4
117-2		23.5	8.5	14.1('83 only)	5.60	0.34	0.49	
117-3		35.1	-3.1	6.9('83 only)	10.00	0.35	0.56	
118-1	33.6[8]	12.2	21.4	26.27	4.87	0.60	0.86	26.3
118-2		28.0	5.6	16.98	11.38	0.45	0.77	
118-3		44.5	-10.9	5.18	16.08	0.21	0.49	
119-1	24.7[9]	14.3	10.4	19.72	9.32	0.23	1.02	21.7
119-2		23.5	1.2	19.87	18.67	0.39	1.53	
119-3		45.7	-21.0	15.91	36.91	0.22	0.79	
120-1	25.1[10]	12.5	12.6	19.20	6.60	0.40	0.29	21.9
120-2		31.1	-6.0	13.77	19.77	0.09	0.18	
120-3		44.8	-19.7	12.17	31.87	0.11	0.24	
201-1	8.0	7.9	0.1	6.81	6.71	0.25	0.12	8.0
201-2		18.3	-10.3	5.03	15.33	0.17	0.59	
202-1	8.0	5.0	3.0	5.09	2.09	0.19	0.46	5.5
202-2		18.9	-10.9	2.66	13.56	0.62	2.28	
204-1	7.5	6.4	1.1	5.02	3.92	0.24	0.65	5.8
204-2		21.9	-14.4	2.45	16.85	0.55	0.84	
205-1	8.0	7.2	0.8	4.40	3.60	0.55	1.24	4.7
205-2		21.5	-13.5	3.37	16.87	0.18	0.34	

Notes:

1) Piezometer monitoring data plotted in Appendix B of Golder Associates Ltd. report to BC Ministry of Environment, "Fraser River Bank Stability, Maple Ridge, British Columbia", dated March 1986.
2) Ground elevations estimated from contour plan (1m contour intervals) from District of Maple Ridge, shown on Fig. 2
3) Piezometer tip elevations estimated from approximate ground elevations (see Note 2) and recorded tip depths. Elevations may vary from previously reported elevations (see notes below).
4) Groundwater elevations estimated from approximate ground elevations (see Note 2) and recorded groundwater depths. Elevations may vary from previously reported elevations (see notes below).
5) Ground elevation at 111 originally estimated to be 33.5 m; reduced to 33.0 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 0.5 m.
6) Ground elevation at 114 originally estimated to be 34.5 m; reduced to 33.5 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 1.0 m.
7) Ground elevation at 116 originally estimated to be 34.7 m; reduced to 34.0 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 0.7 m.
8) Ground elevation at 118 originally estimated to be 34.4 m; reduced to 33.6 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 0.8 m.
9) Ground elevation at 119 originally estimated to be 26.0 m; reduced to 24.7 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 1.3 m.
10) Ground elevation at 120 originally estimated to be 26.0 m; reduced to 25.1 m EL. based on more recent contour plan. Previously reported tip elevations and groundwater elevations reduced by 0.9 m.

APPENDIX III

CONE PENETRATION TEST DATA – 1984 INVESTIGATION BY UNIVERSITY OF BRITISH COLUMBIA



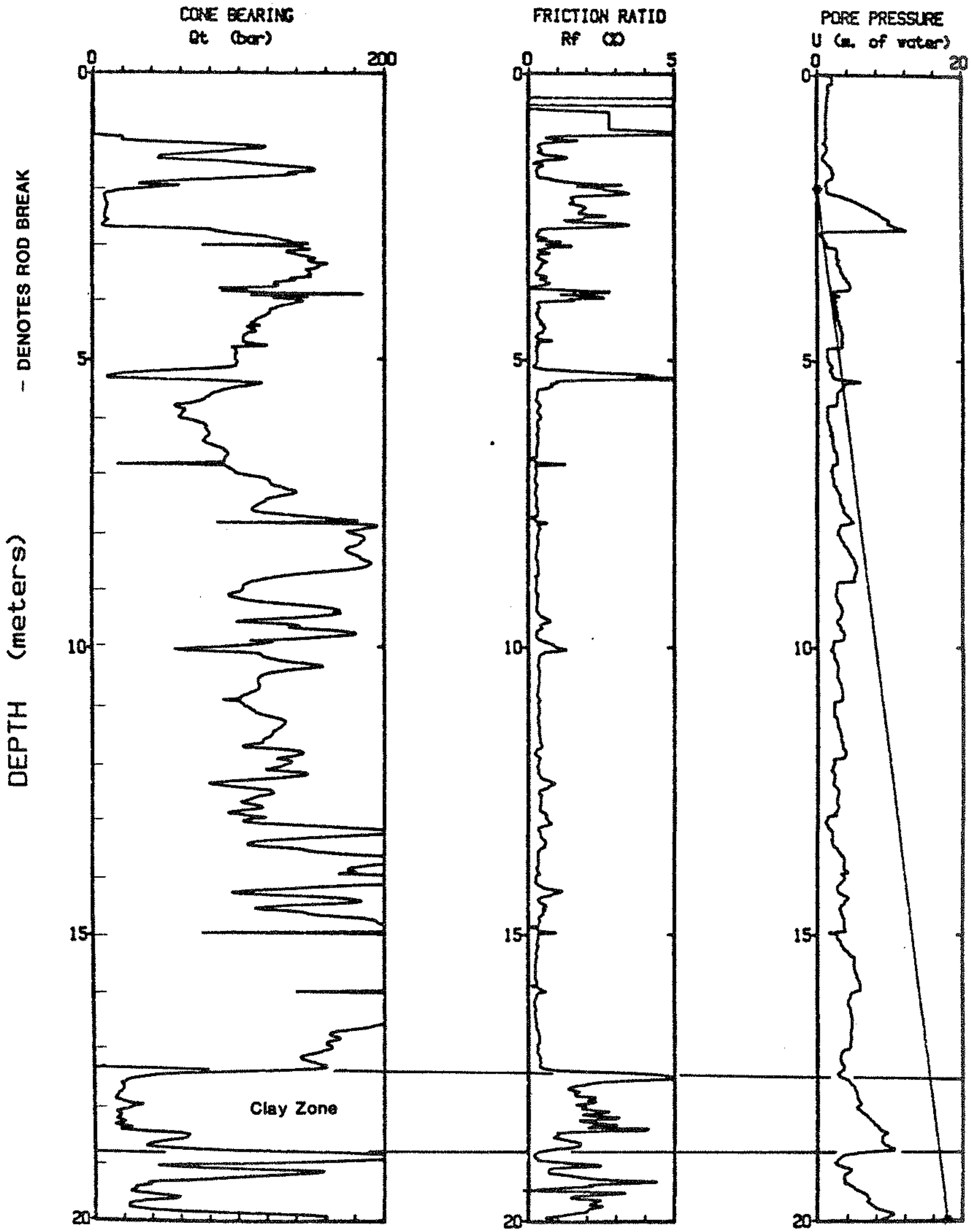
UBC IN SITU TESTING
Site Location: HANEY SLIDE
On Site Loc: CPT-5
CPT Date : 840716 MD DG
Cone Used: UBC6 STD TIP
Page No: 1 / 1
Comments: COYNE
PORE PRESSURE
U (m. of water)
SLEEVE FRICTION
(bar)
CONE BEARING
Qt (bar)
FRICTION RATIO
Rf (%)
DIFFERENTIAL P.P.
RATIO ΔU/Qt
DEPTH (meters)
Prebore
Sand
Claysilt-Siltcla
Sand
Clayey Silt
Sand
Gravelly Sand
to Sand
Clayey Silt to
Silty Clay
Depth Increment : .025 m
Max Depth : 20.175 m

Fig 3.14

UBC IN SITU TESTING

Site Location: HANEY SLIDE CPT Date : 840716 MD DG Page No: 1 / 2

On Site Loc: CPT-5 Cone Used: UBC6 STD TIP Comments: COYNE



Depth Increment : .025 m Max Depth : 20.175 m

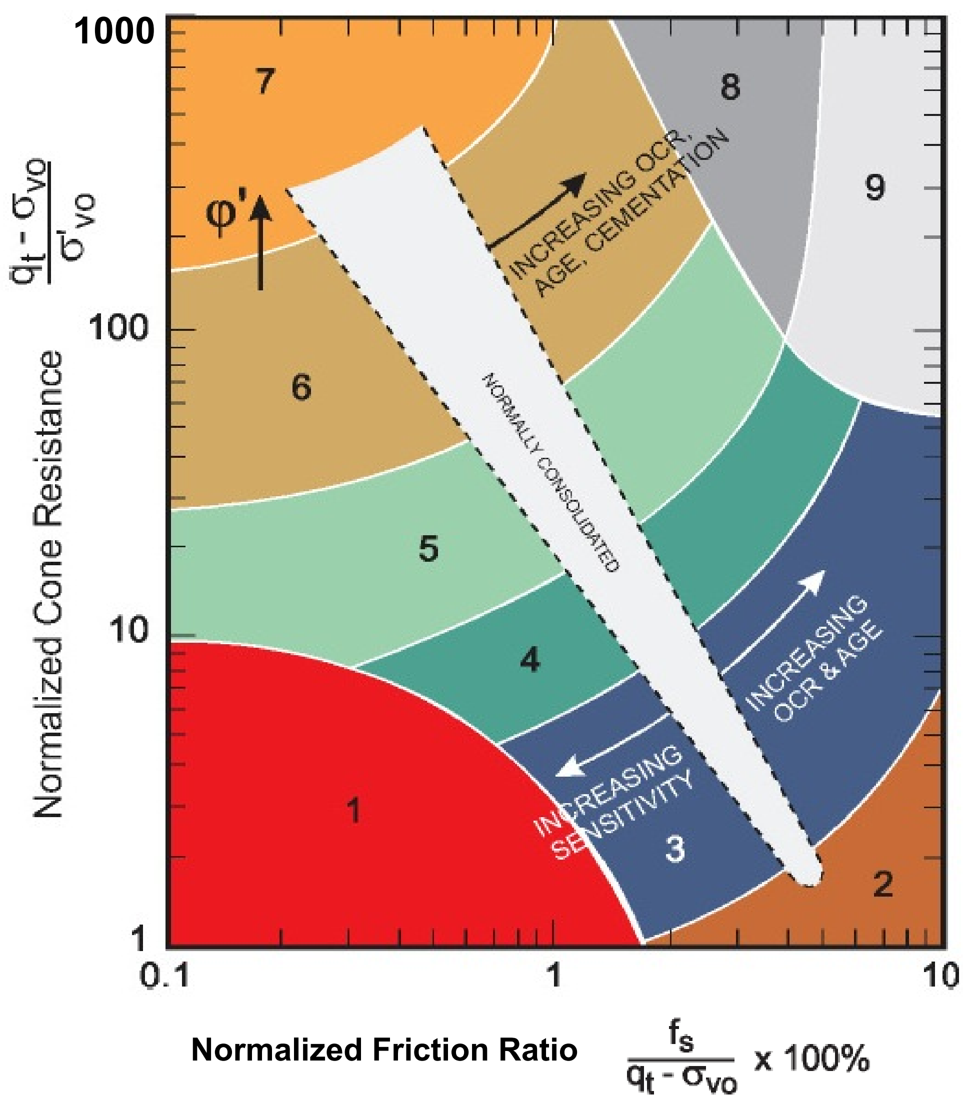
Fig. 3.15

APPENDIX IV

CONE PENETRATION TEST SOUNDING PROFILES – 2007 INVESTIGATION BY GOLDER ASSOCIATES LTD.

CPT Soil Behaviour Type Classification

CPT Classification Chart – Normalized



Zone		Soil Behavior Type
1		Sensitive fine-grained
2		Organic soils
3		Clays (silty clay to clay)
4		Silt Mixtures (clayey silt to silty clay)
5		Sand Mixtures (silty sand to sandy silt)
6		Sands (clean sand to silty sand)
7		Gravelly sand to dense sand
8		Very stiff cemented sand to clayey sand
9		Very stiff, over-consolidated fine-grained soil

q_t = cone tip resistance

f_s = sleeve friction

σ_{vo} = total overburden pressure

σ'_{vo} = effective overburden pressure
$= \sigma_{vo} - u_o$

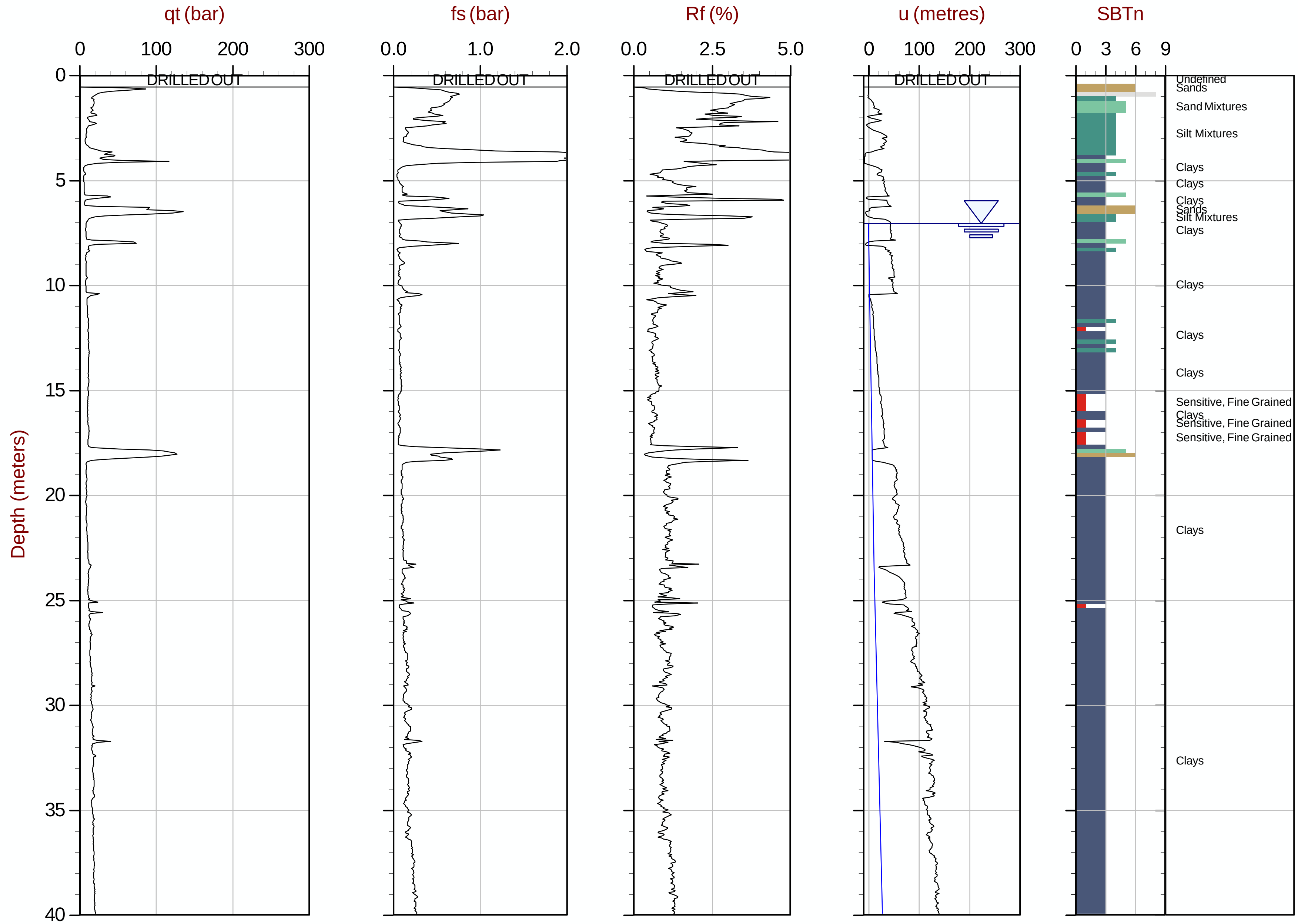
u_o = equilibrium pore water pressure

Robertson, P.K. (1990). "Soil Classification Using the Cone Penetration Test". Canadian Geotechnical Journal, Vol. 27, No. 1, pp. 151 – 158.

Golder

Job No: 07-208
Date: 06:25:07 15:09
Site: CPT07-01

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.000 m / 196.85 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP01.COR
Unit Wt: SBT Chart Soil Zones

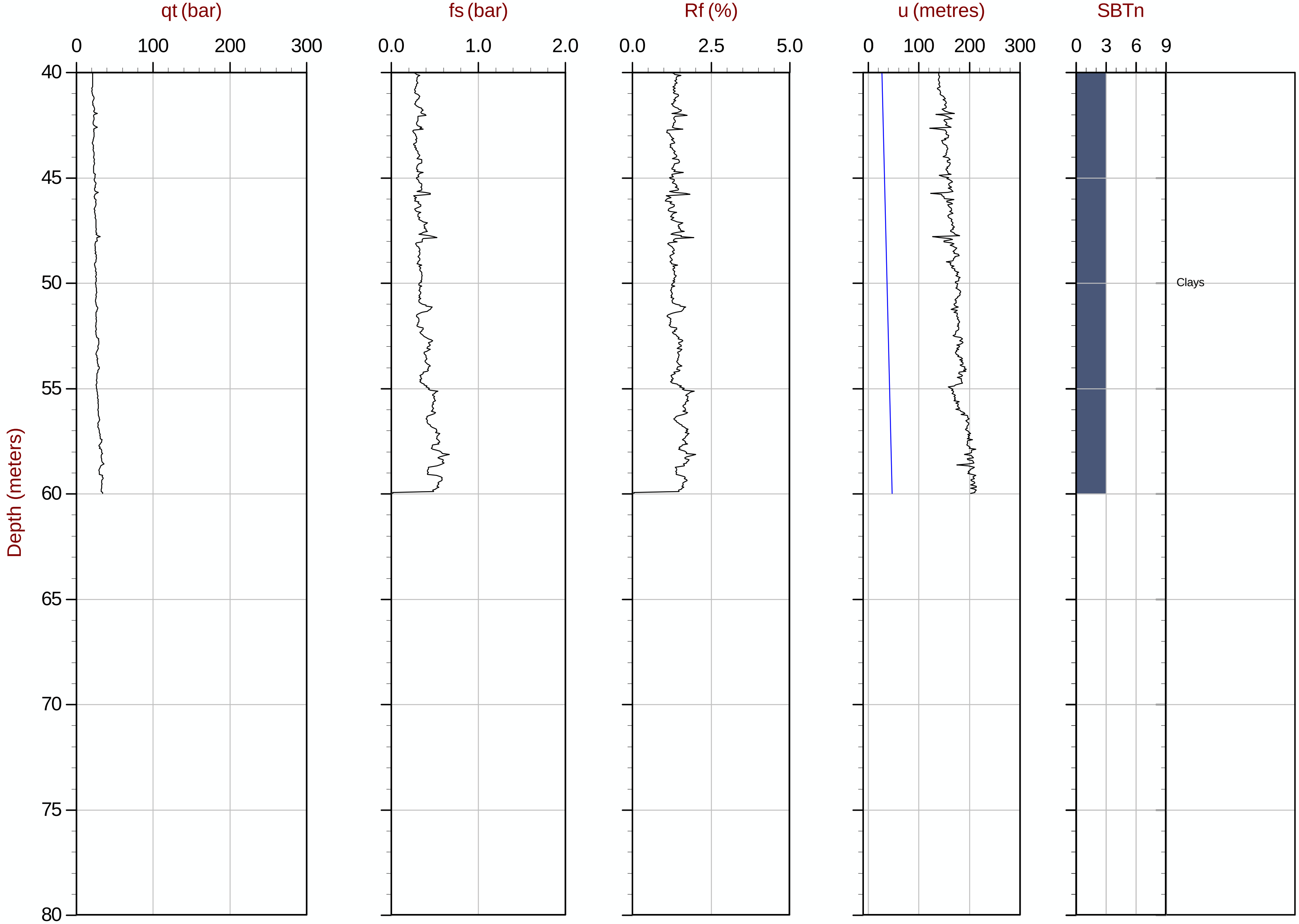
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

ConeTec

Golder

Job No: 07-208
Date: 06:25:07 15:09
Site: CPT07-01

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.000 m / 196.85 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP01.COR
Unit Wt: SBT Chart Soil Zones

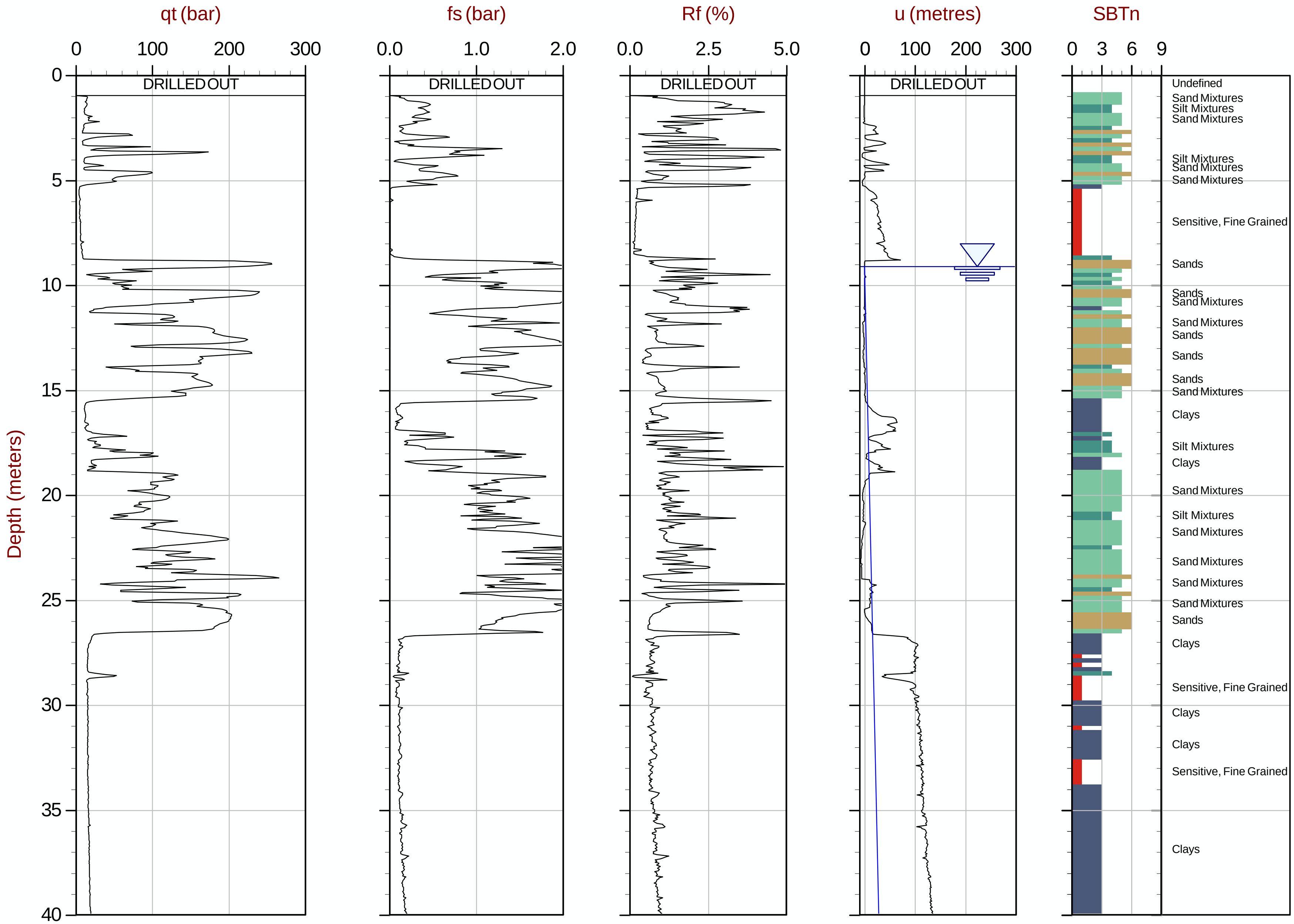
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

ConeTec

Golder

Job No: 07-208
Date: 06:25:07 09:07
Site: SCPT07-02

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.300 m / 197.83 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP02.COR
Unit Wt: SBT Chart Soil Zones

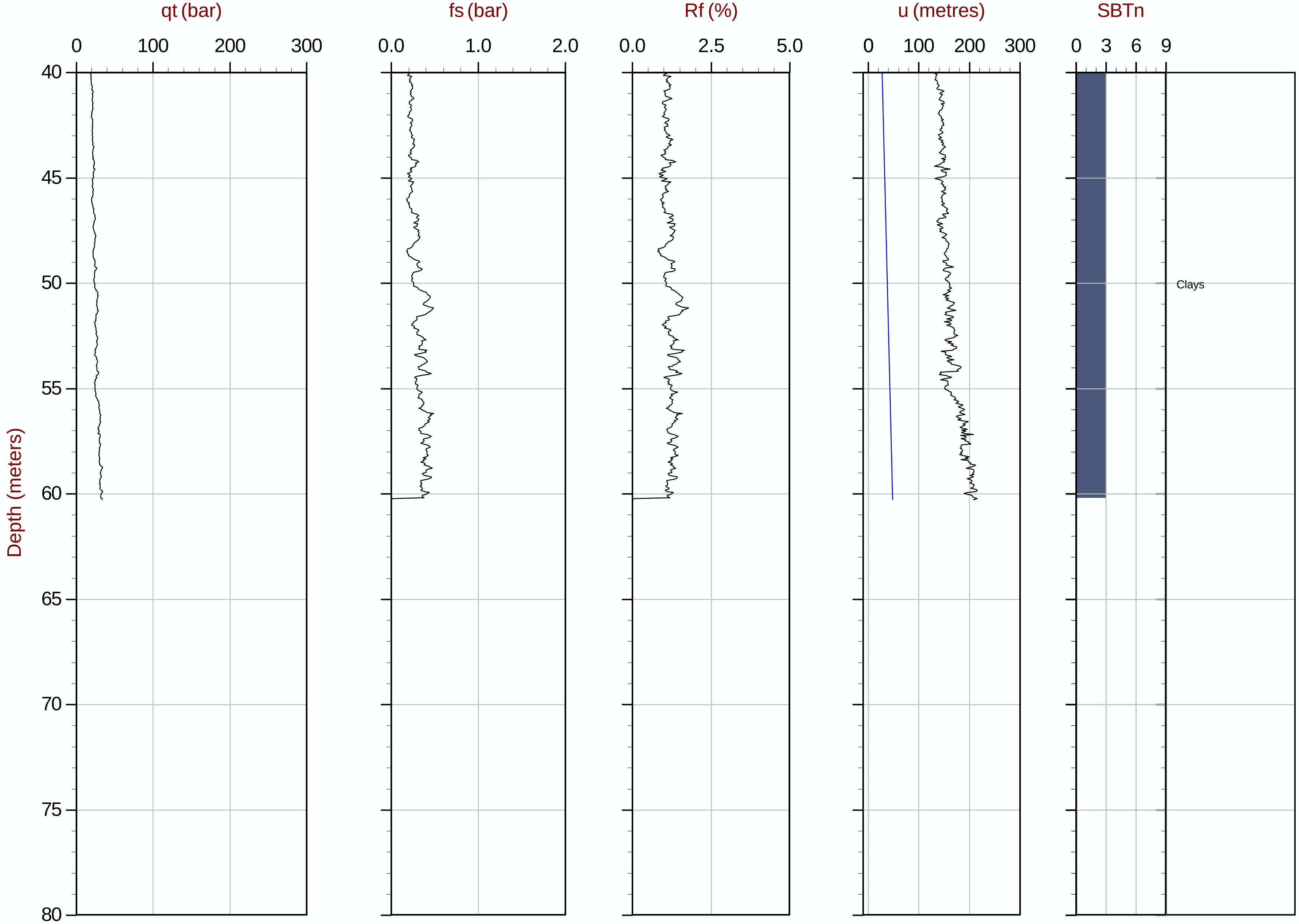
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:25:07 09:07
Site: SCPT07-02

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.300 m / 197.83 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP02.COR
Unit Wt: SBT Chart Soil Zones

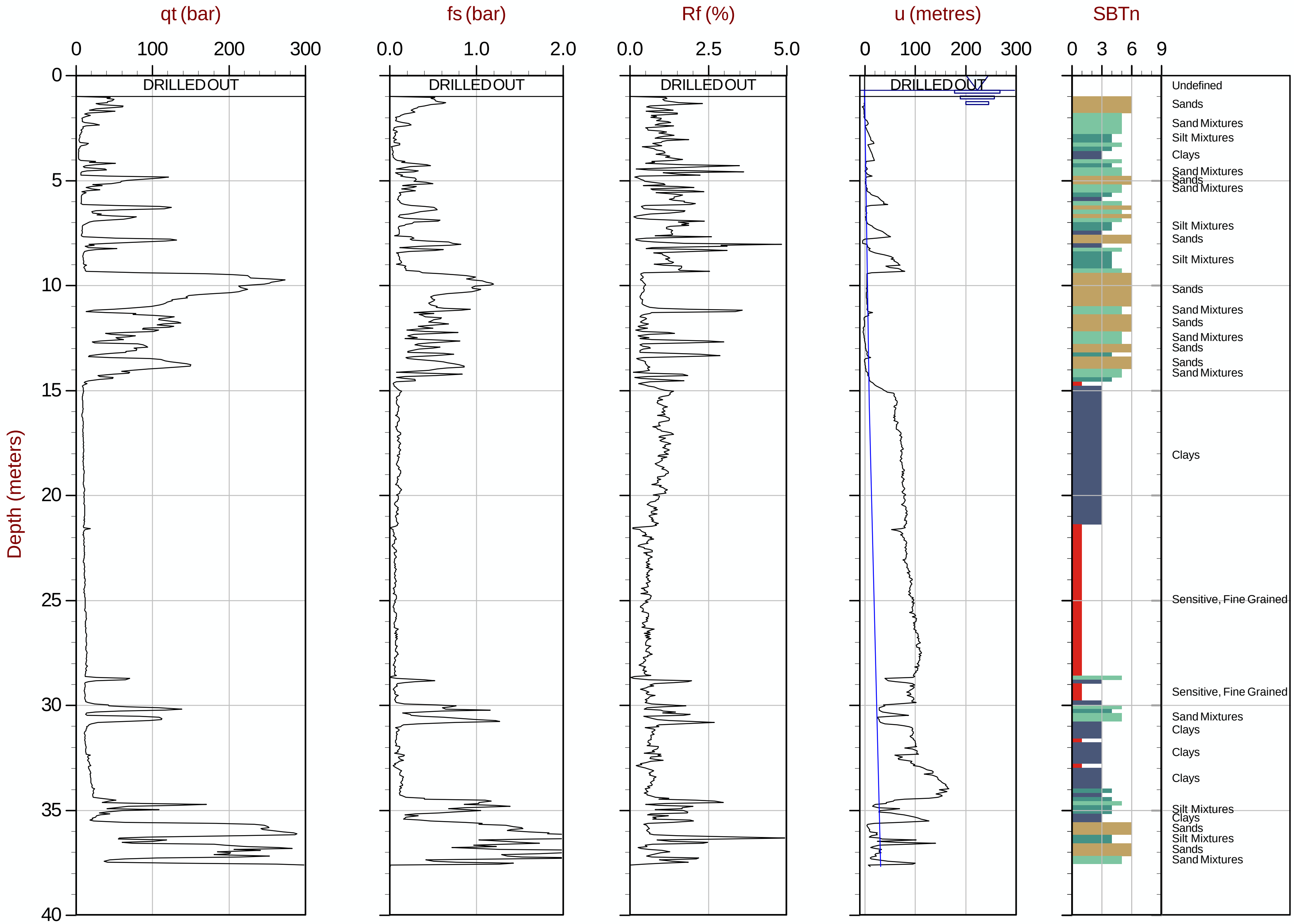
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

ConeTec

Golder

Job No: 07-208
Date: 06:19:07 08:55
Site: CPT07-03

Sounding: Fraser R Escarp.
Cone: 10 TON 219



Max Depth: 37.700 m / 123.69 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP03.COR
Unit Wt: SBT Chart Soil Zones

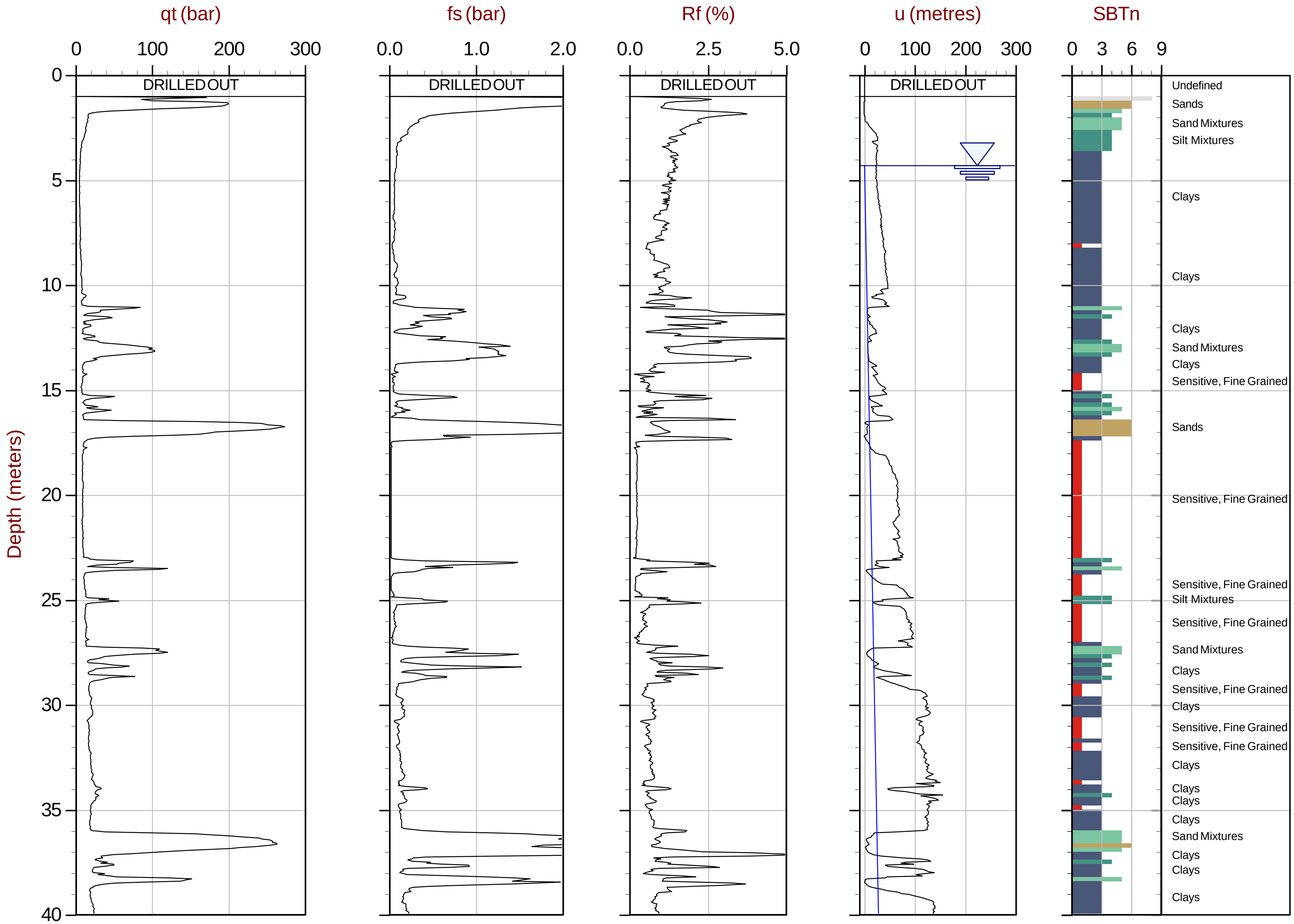
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

Golder

Job No: 07-208
Date: 06:26:07 09:35
Site: CPT07-04

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.200 m / 197.50 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP04.COR
Unit Wt: SBT Chart Soil Zones

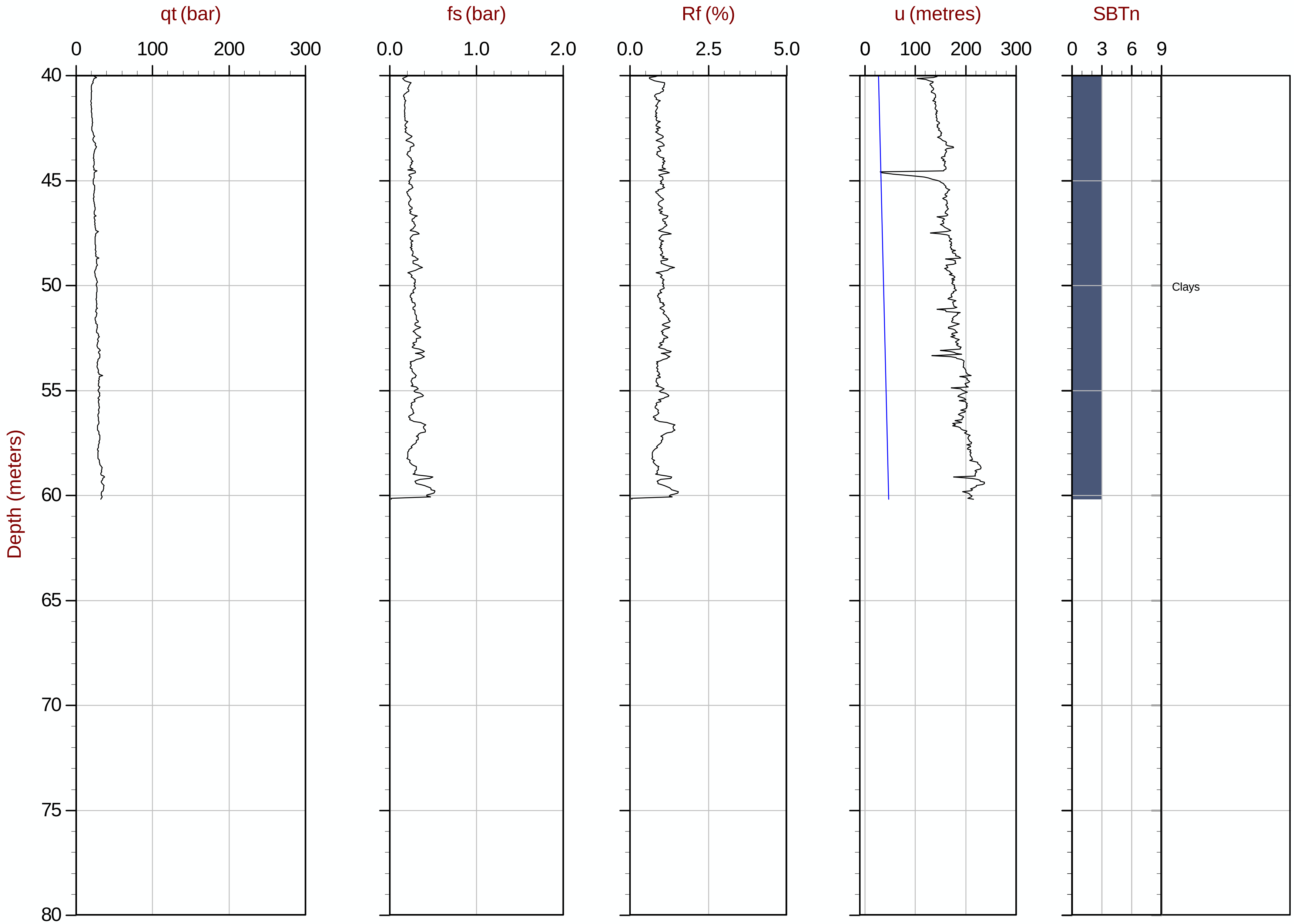
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:26:07 09:35
Site: CPT07-04

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.200 m / 197.50 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP04.COR
Unit Wt: SBT Chart Soil Zones

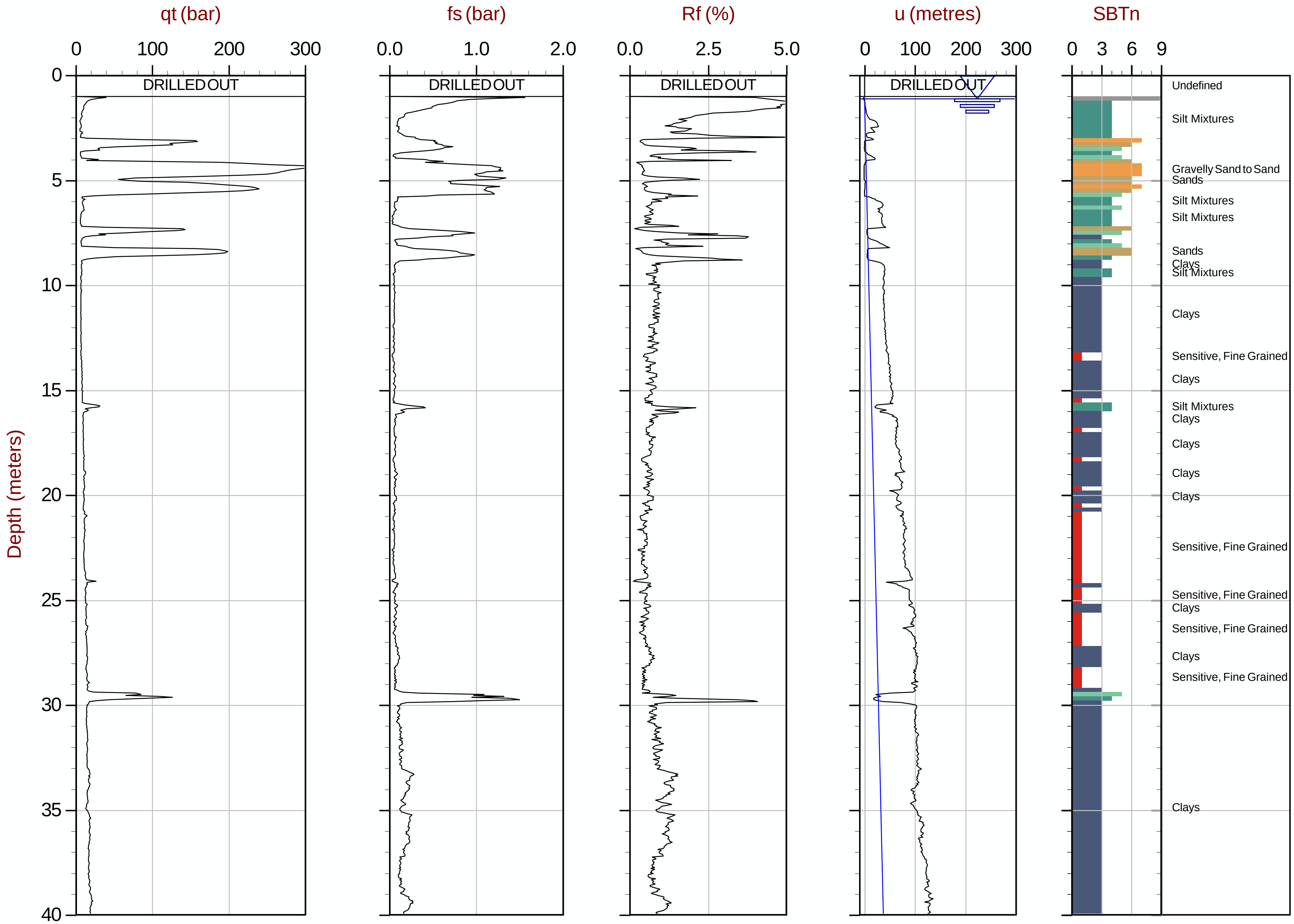
SBT: Lunne, Robertson and Powell, 1997

ConeTec

Golder

Job No: 07-208
Date: 06:18:07 13:53
Site: CPT07-05

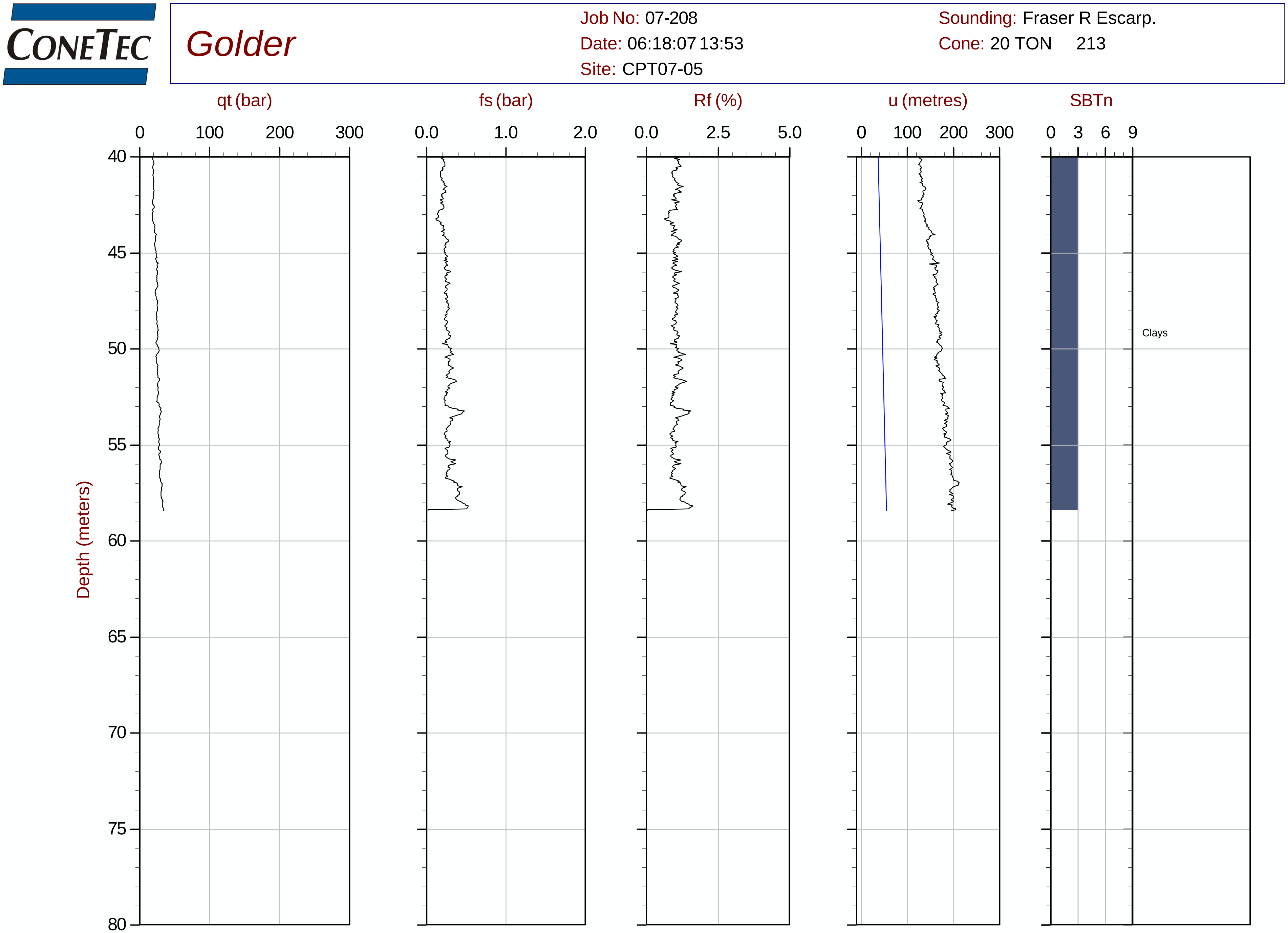
Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 58.450 m / 191.76 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP05.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2



Max Depth: 58.450 m / 191.76 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP05.COR
Unit Wt: SBT Chart Soil Zones

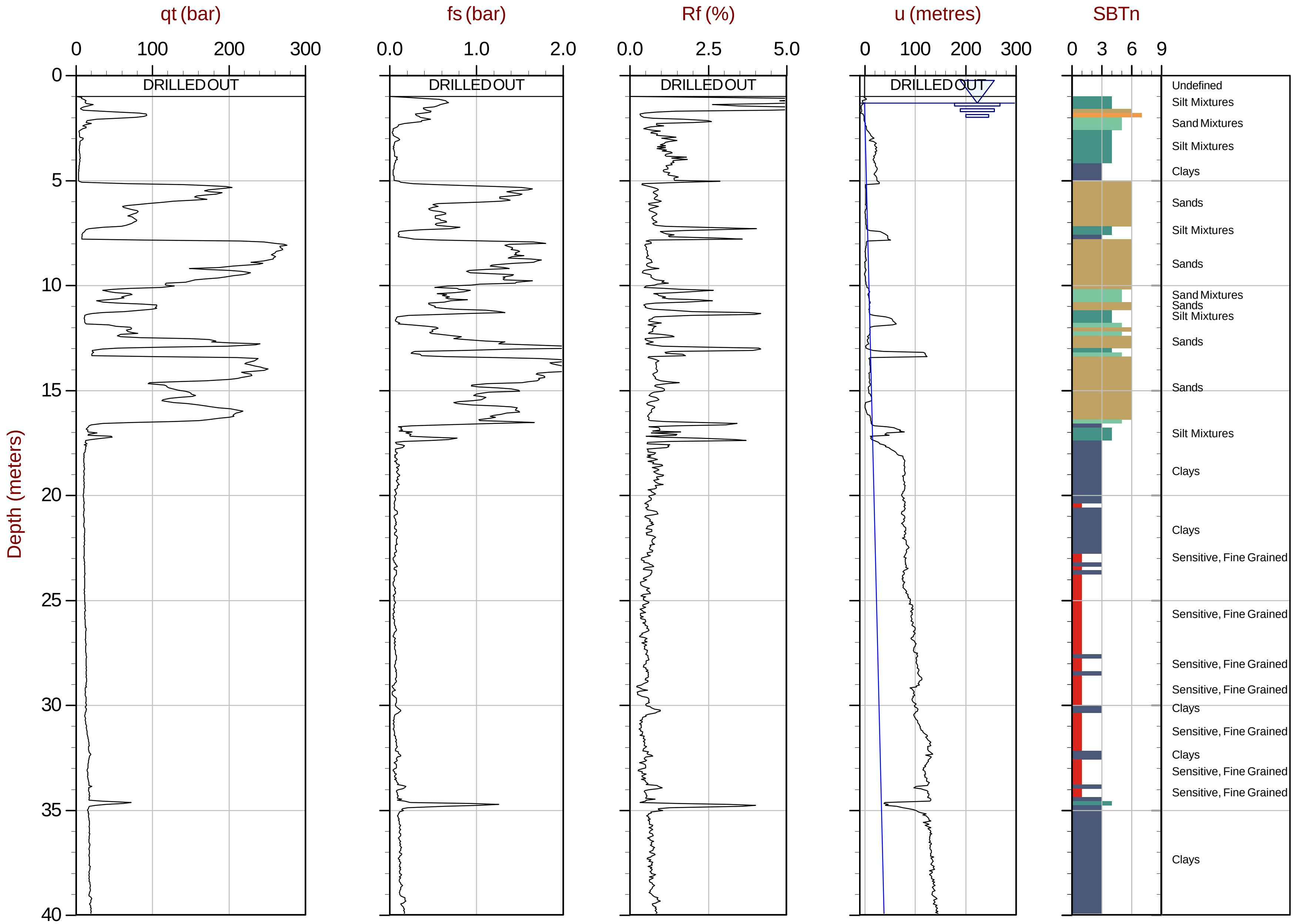
SBT: Lunne, Robertson and Powell, 1997

ConeTec

Golder

Job No: 07-208
Date: 06:26:07 13:29
Site: CPT07-06

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.550 m / 198.65 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP06.COR
Unit Wt: SBT Chart Soil Zones

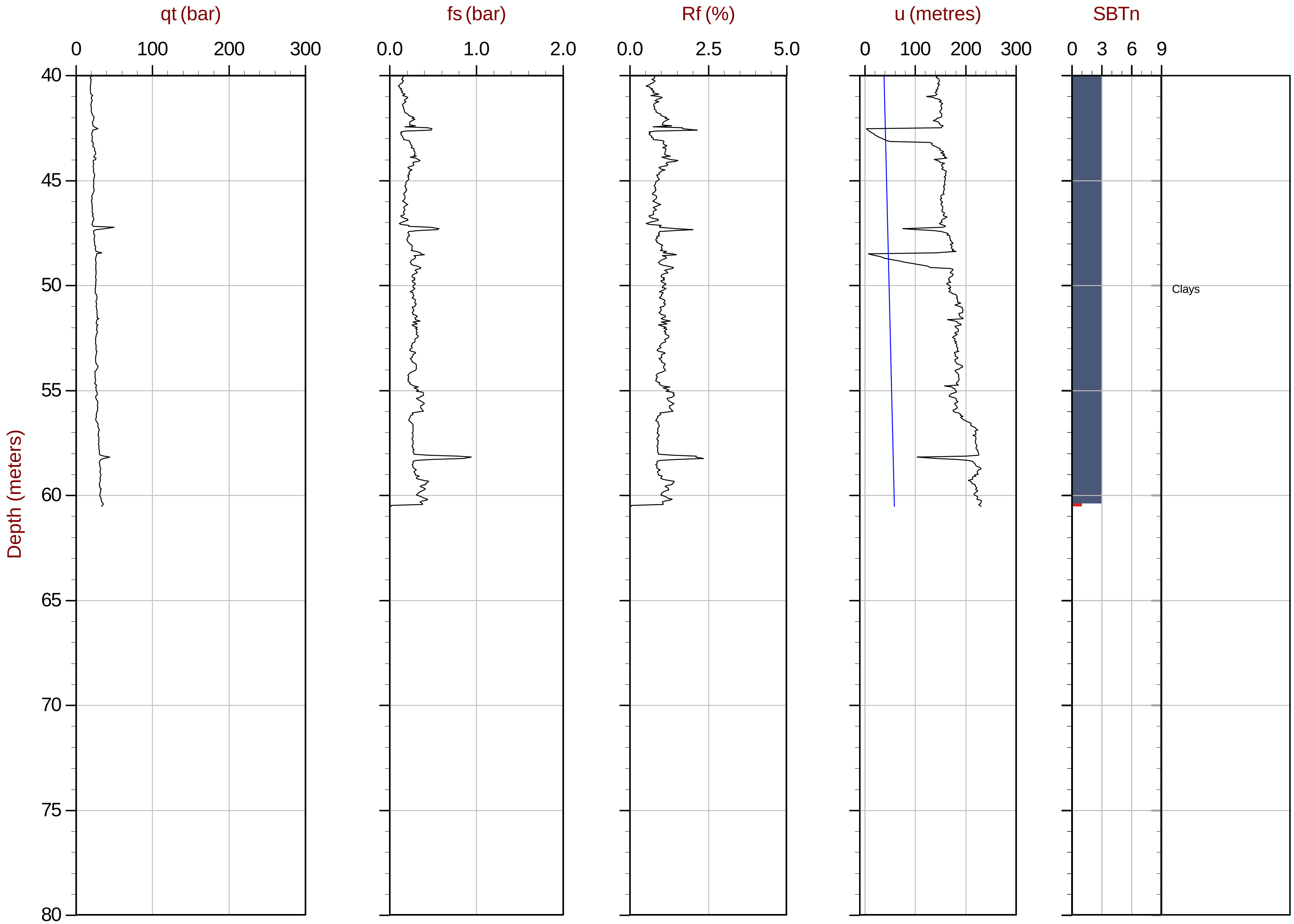
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:26:07 13:29
Site: CPT07-06

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.550 m / 198.65 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP06.COR
Unit Wt: SBT Chart Soil Zones

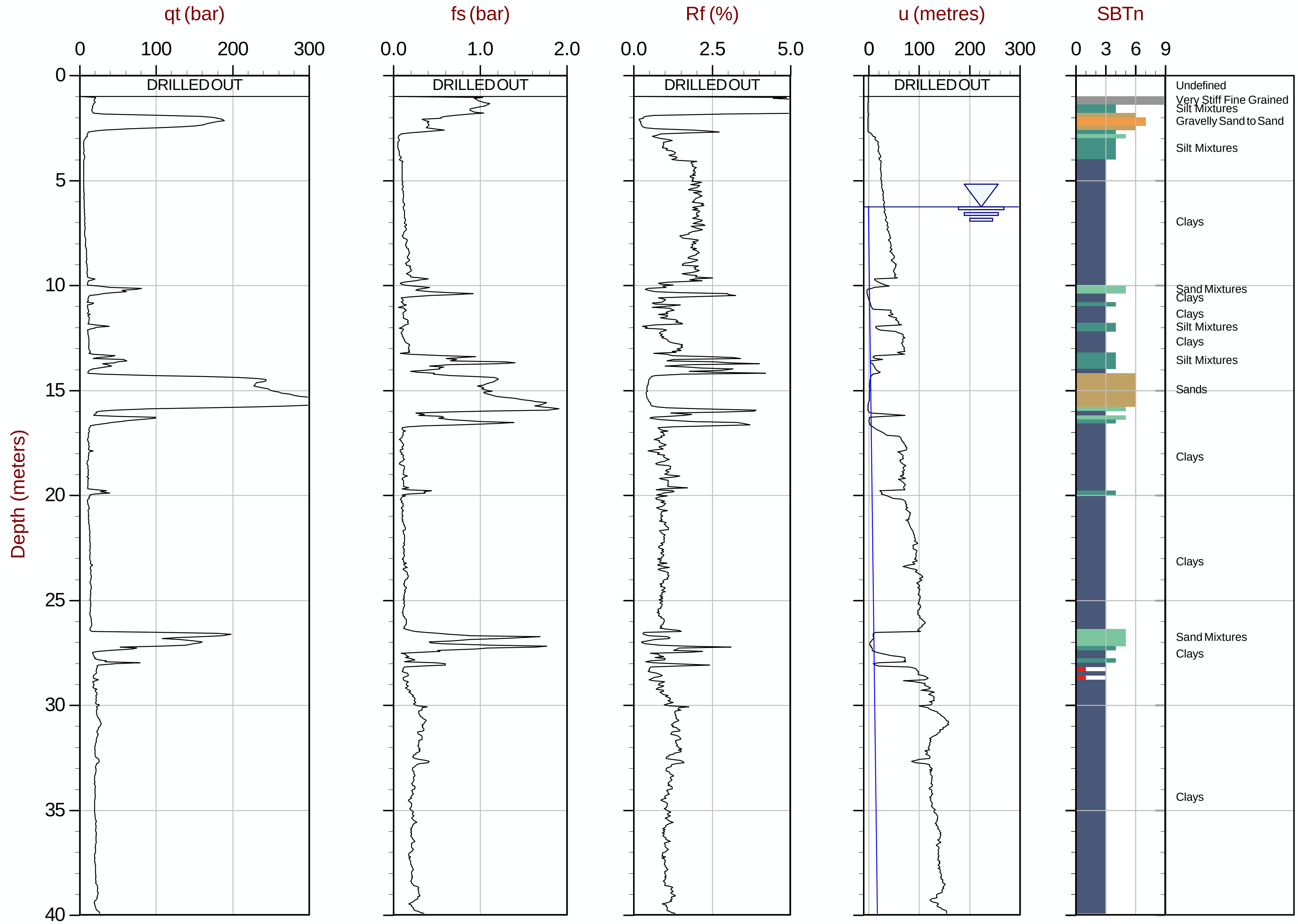
SBT: Lunne, Robertson and Powell, 1997

CONETEC

Golder

Job No: 07-208
Date: 06:18:07 09:02
Site: CPT07-07

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 49.650 m / 162.89 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP07.COR
Unit Wt: SBT Chart Soil Zones

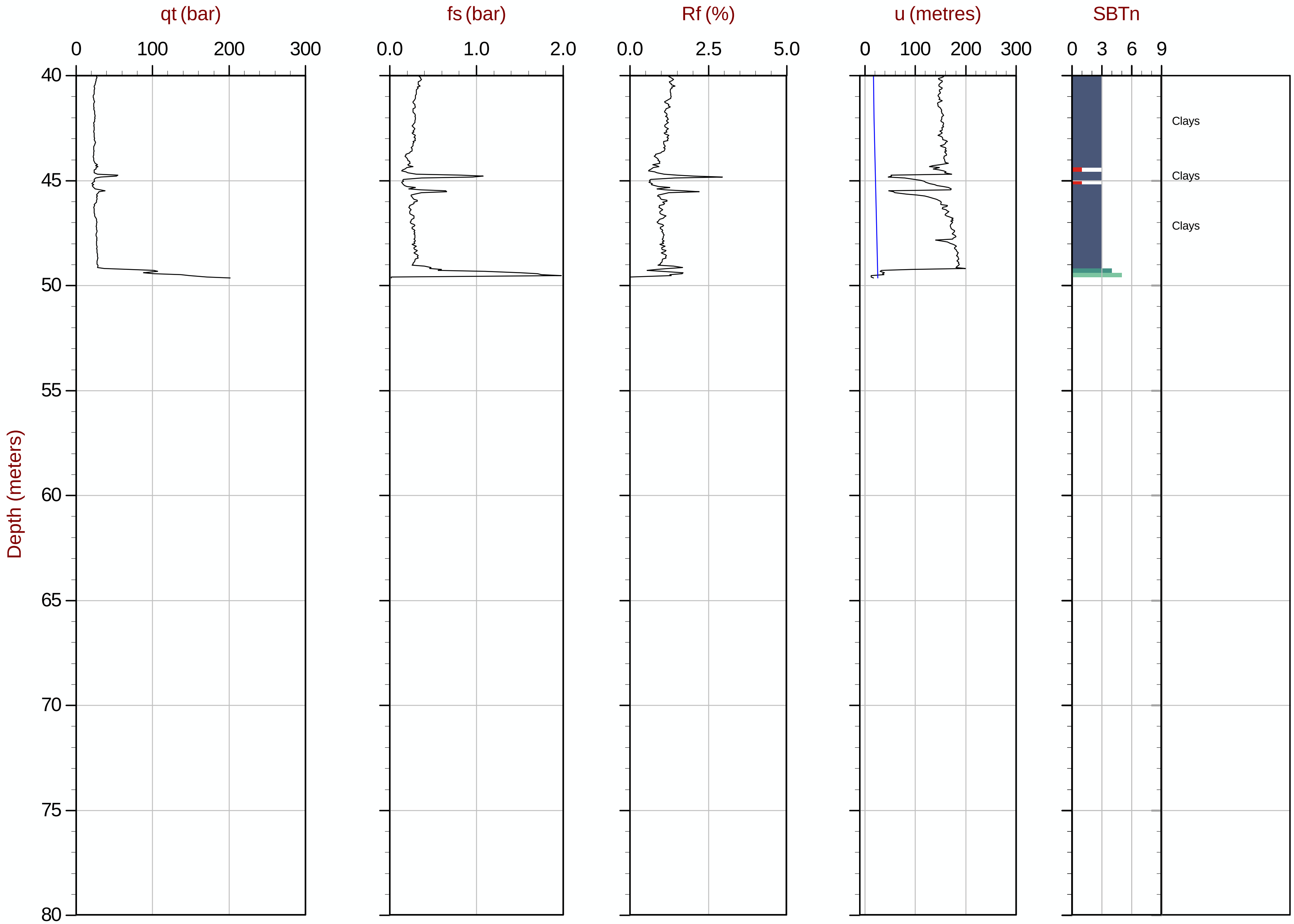
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:18:07 09:02
Site: CPT07-07

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 49.650 m / 162.89 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP07.COR
Unit Wt: SBT Chart Soil Zones

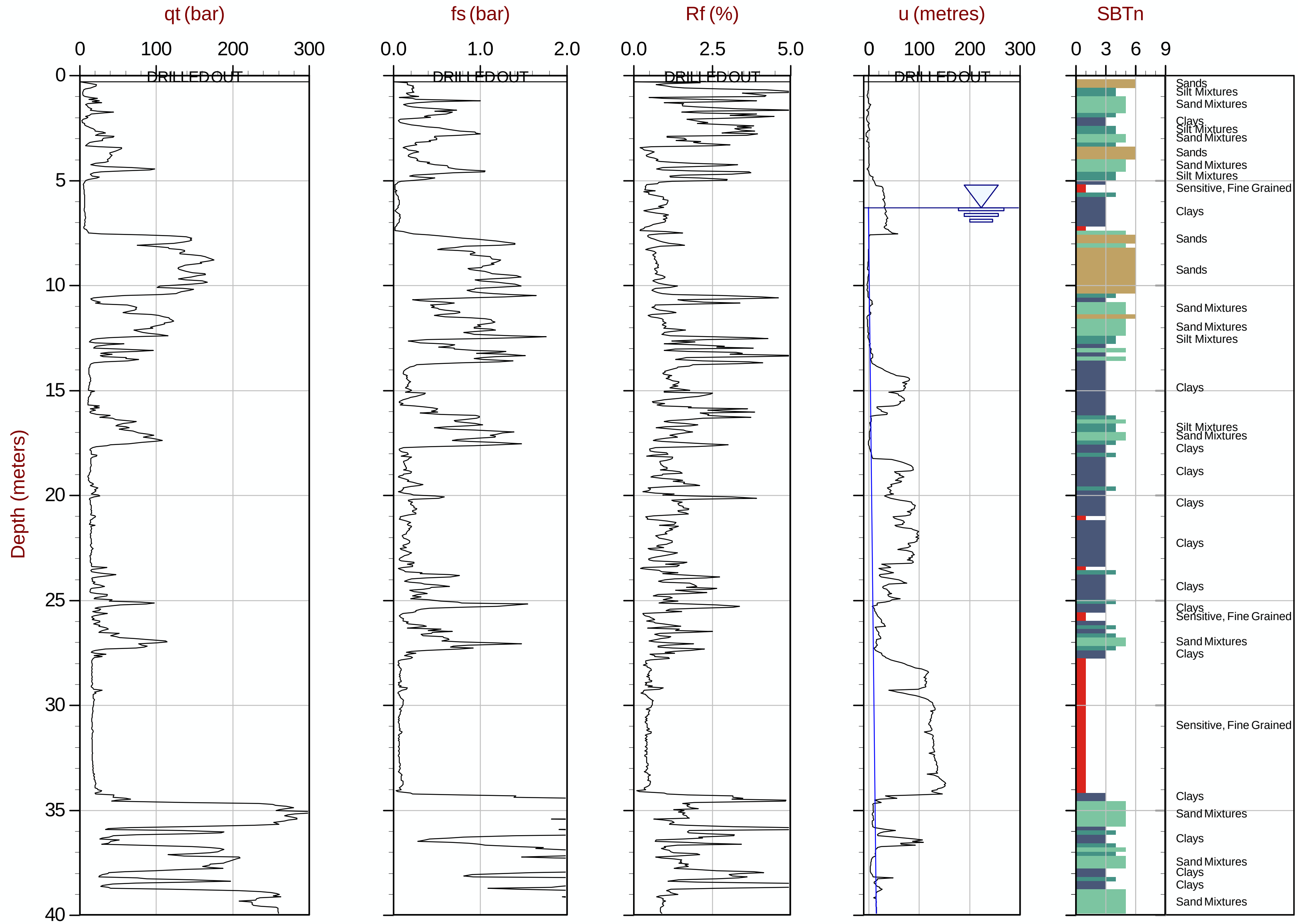
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:28:07 09:30
Site: SCPT07-08

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 52.300 m / 171.59 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP08.COR
Unit Wt: SBT Chart Soil Zones

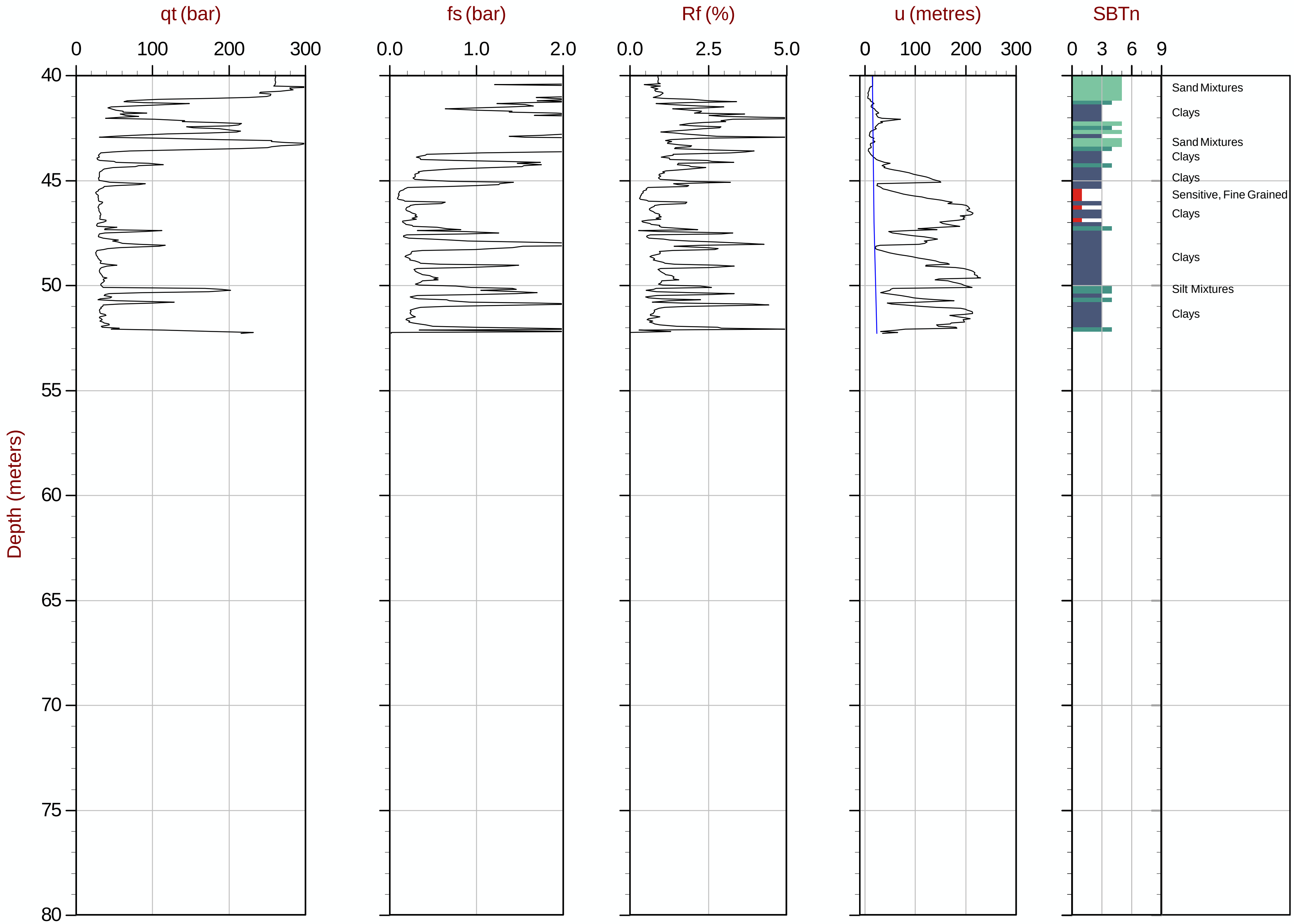
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:28:07 09:30
Site: SCPT07-08

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 52.300 m / 171.59 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP08.COR
Unit Wt: SBT Chart Soil Zones

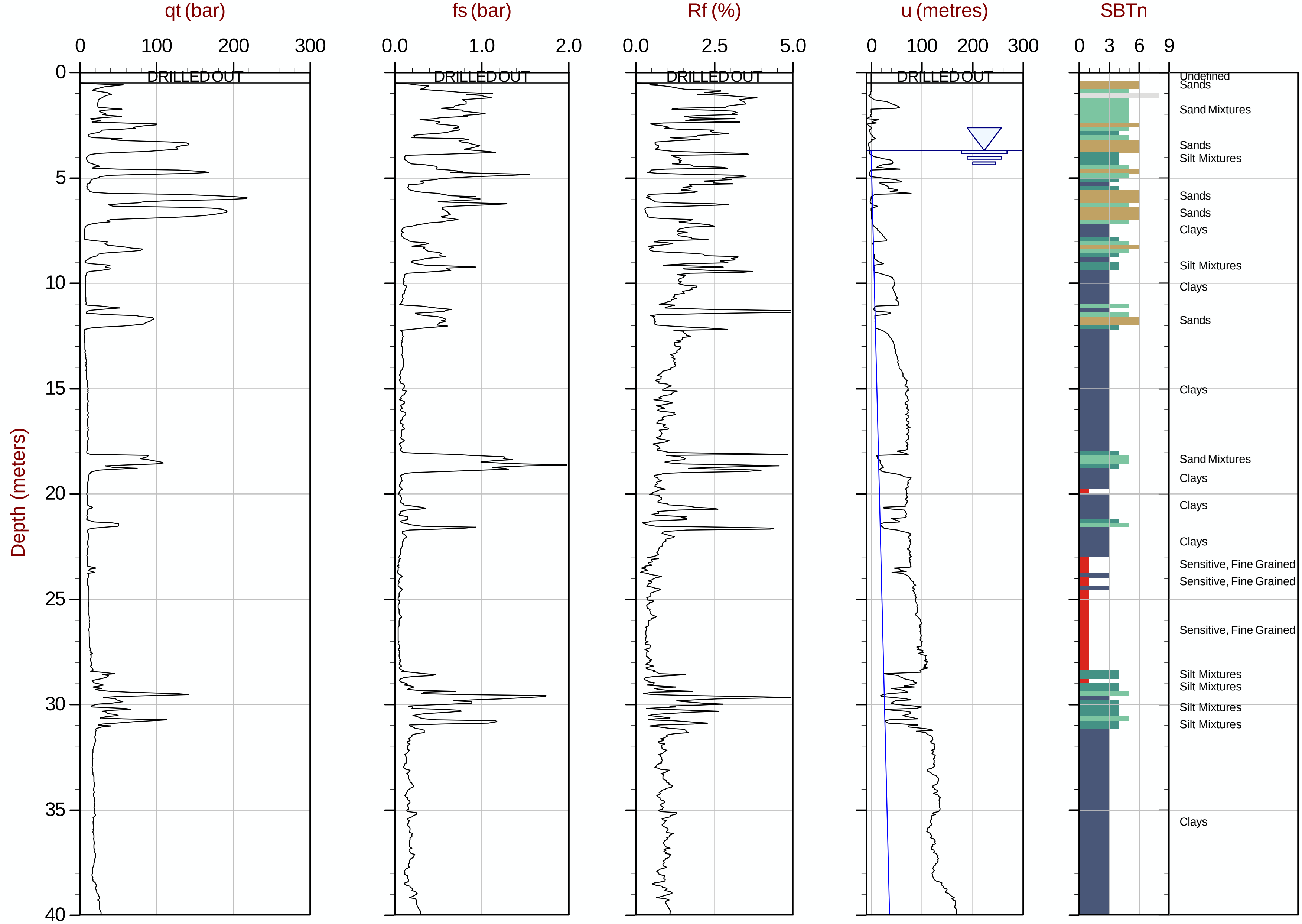
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:21:07 09:28
Site: SCPT07-09

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 61.700 m / 202.43 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

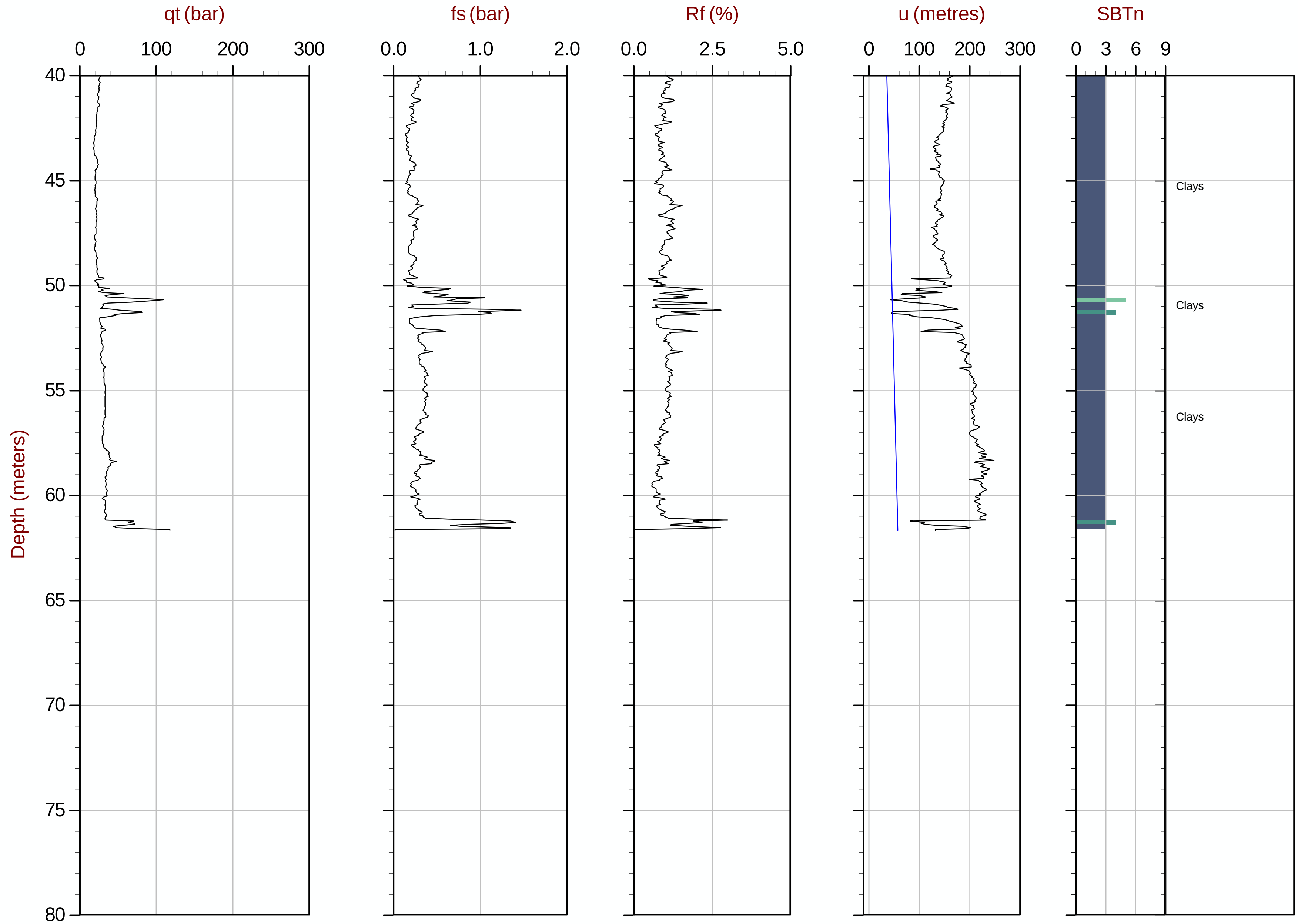
File: 208CP09.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:21:07 09:28
Site: SCPT07-09
Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 61.700 m / 202.43 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP09.COR
Unit Wt: SBT Chart Soil Zones

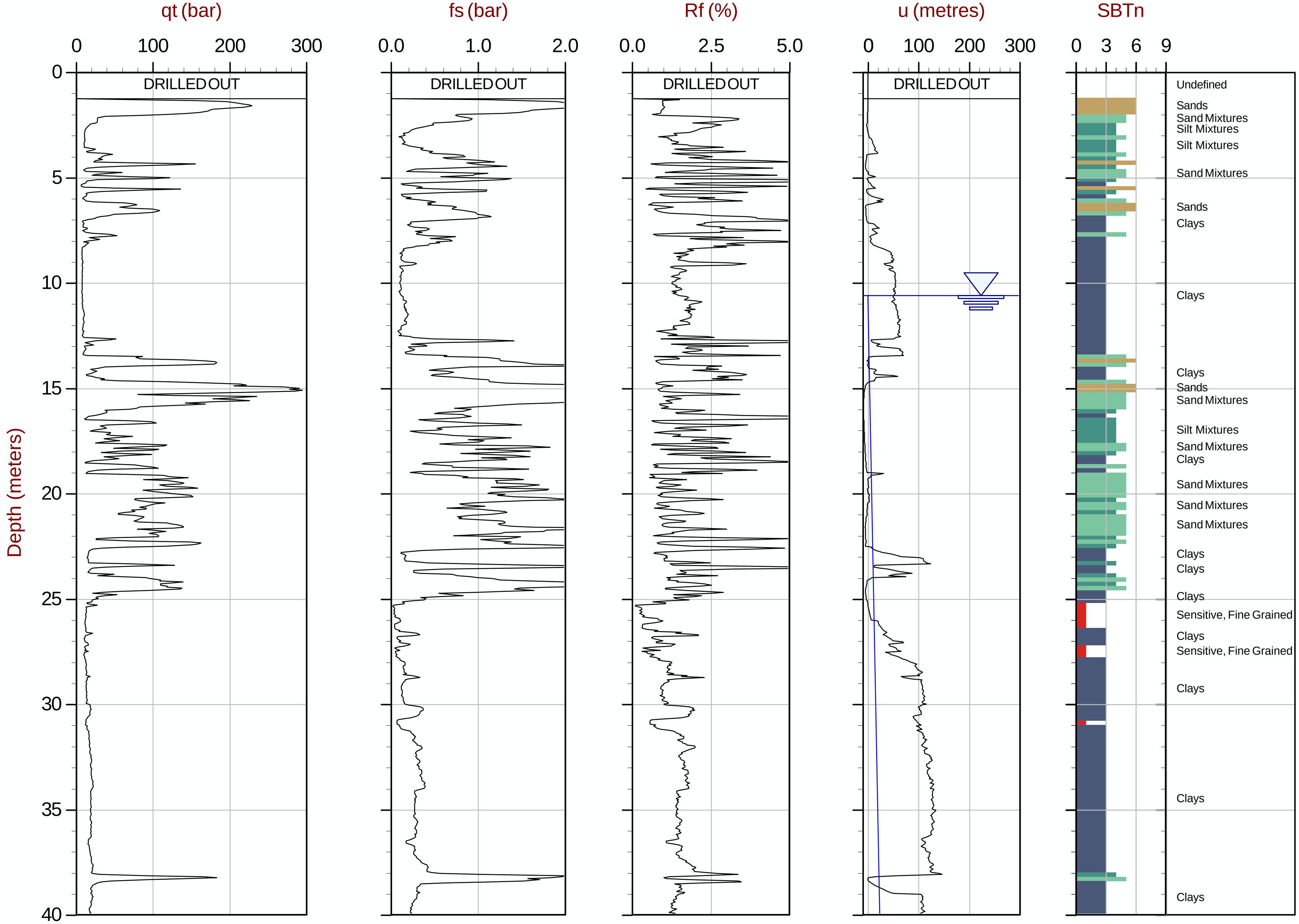
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:29:07 09:51
Site: CPT07-10

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 45.700 m / 149.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

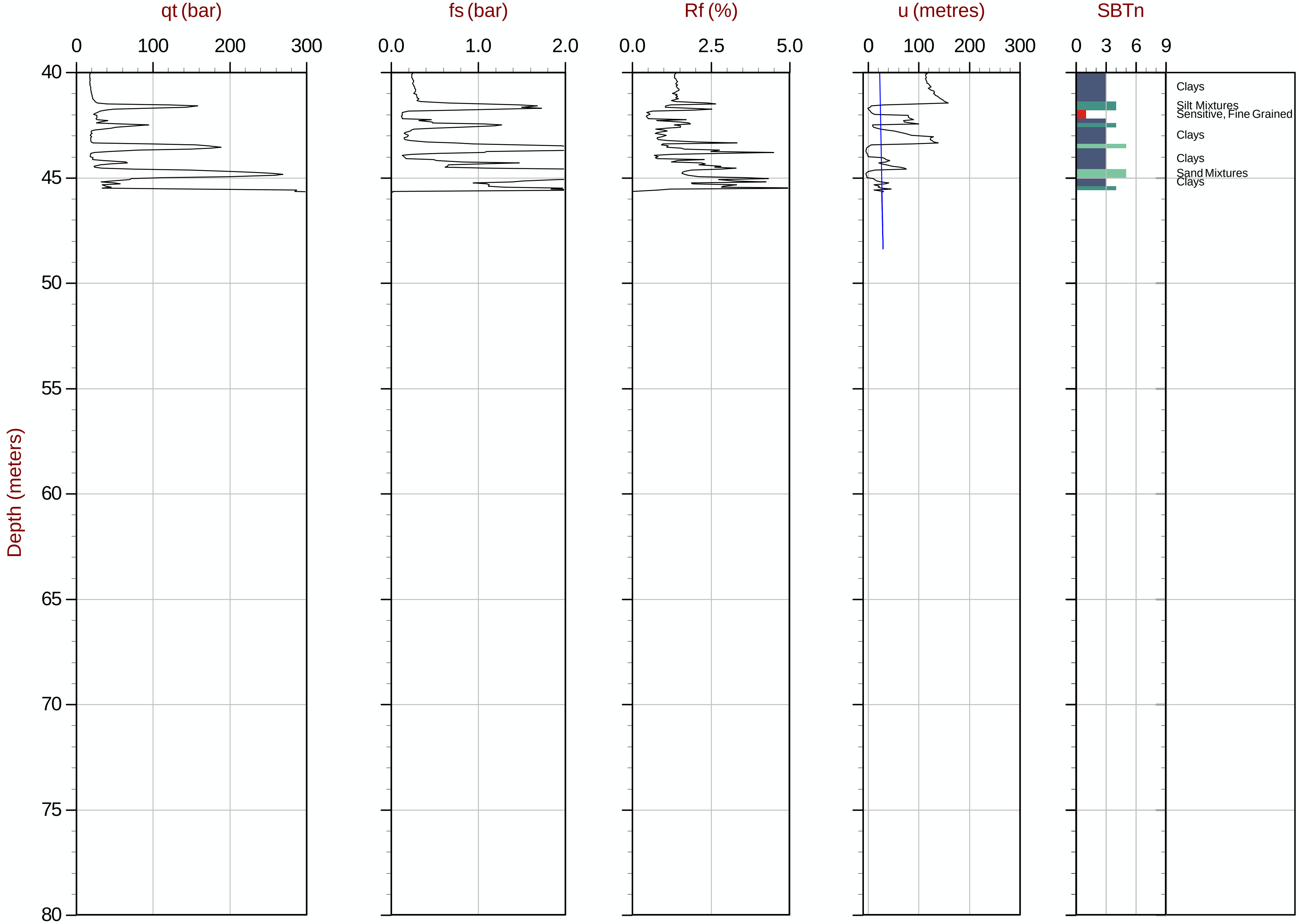
File: 208CP10.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

Golder

Job No: 07-208
Date: 06:29:07 09:51
Site: CPT07-10

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 45.700 m / 149.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP10.COR
Unit Wt: SBT Chart Soil Zones

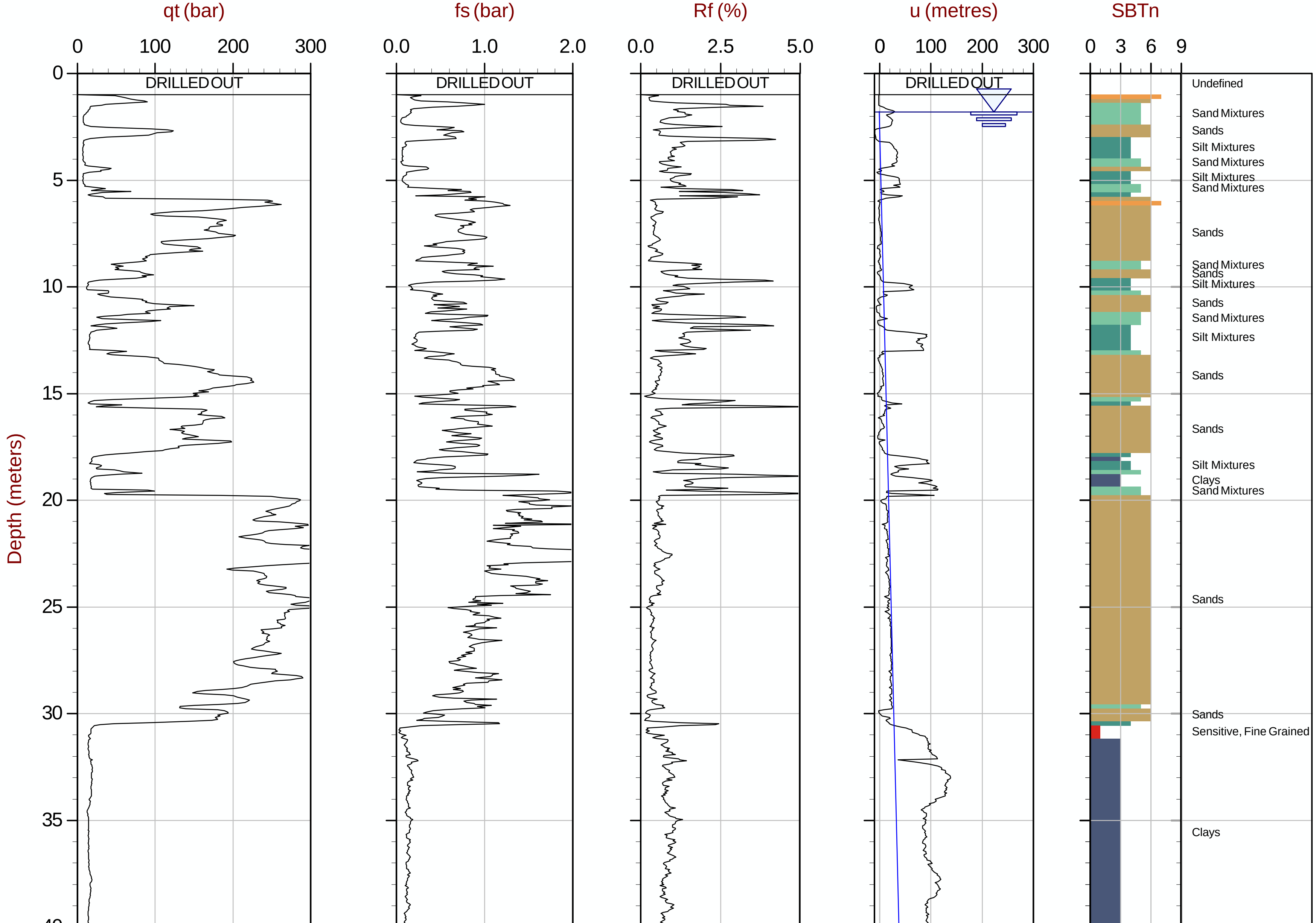
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:21:07 15:22
Site: CPT07-11

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 68.200 m / 223.75 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP11.COR
Unit Wt: SBT Chart Soil Zones

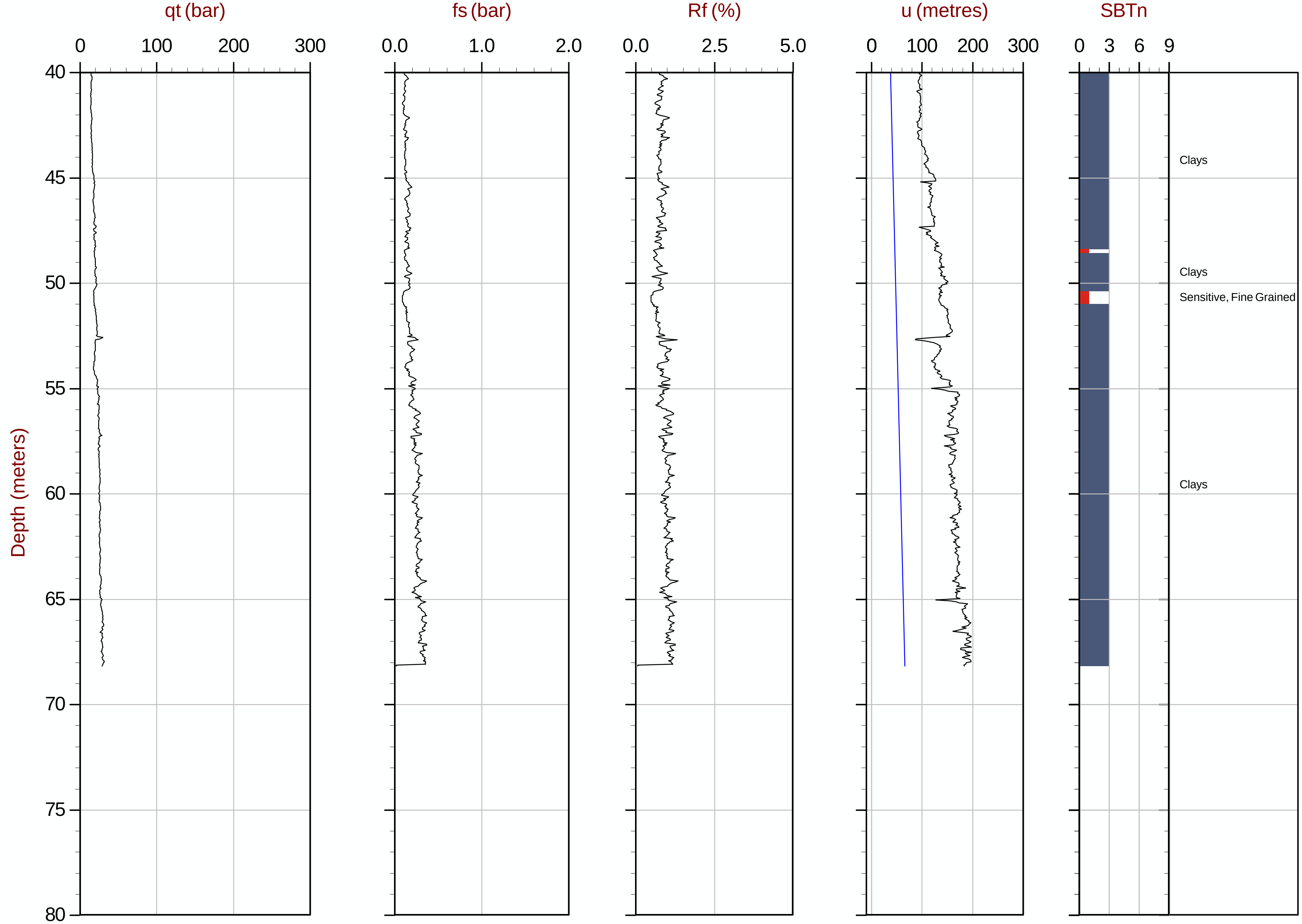
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:21:07 15:22
Site: CPT07-11

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 68.200 m / 223.75 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP11.COR
Unit Wt: SBT Chart Soil Zones

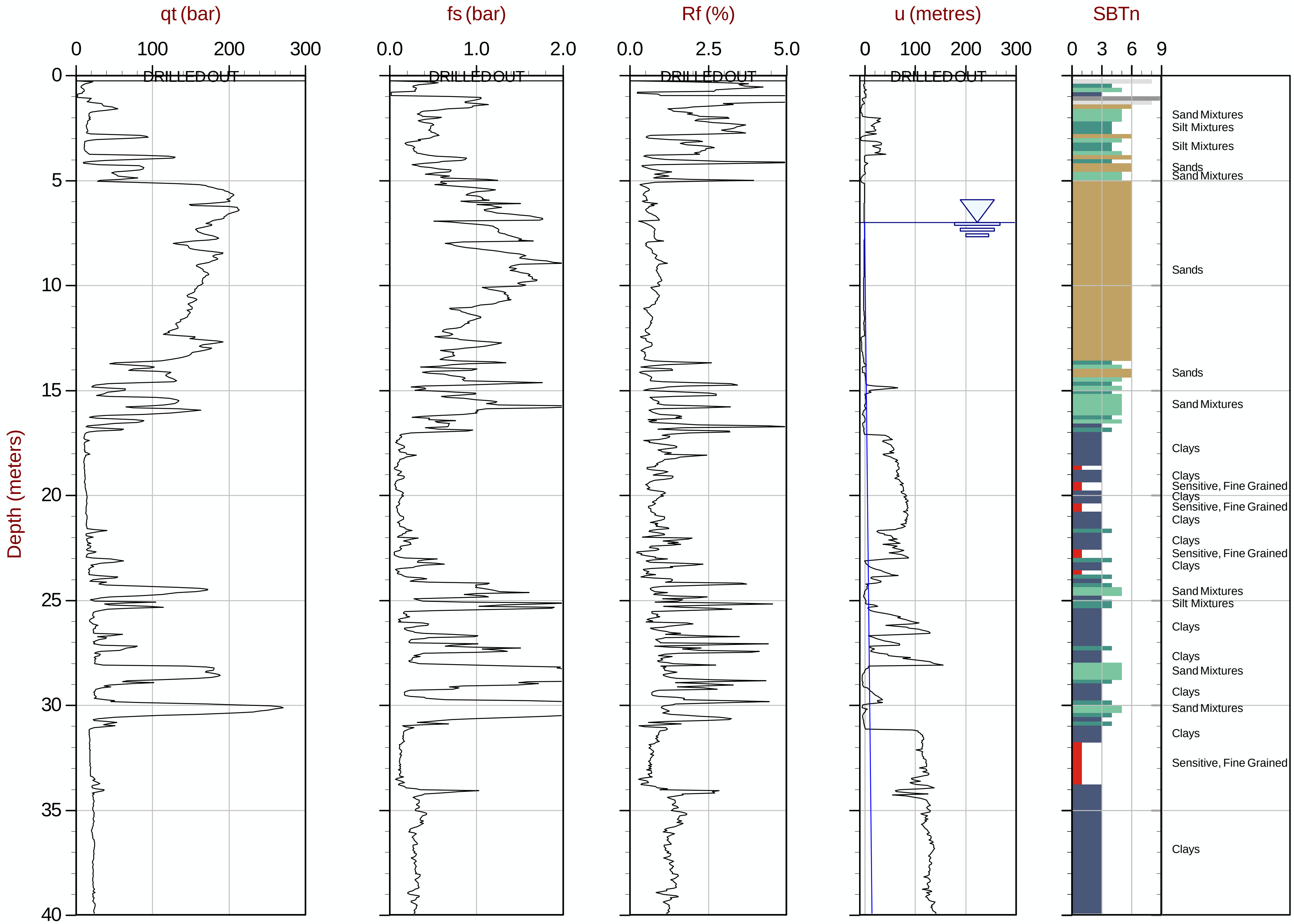
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:27:07 12:17
Site: SCPT07-12

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 43.850 m / 143.86 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

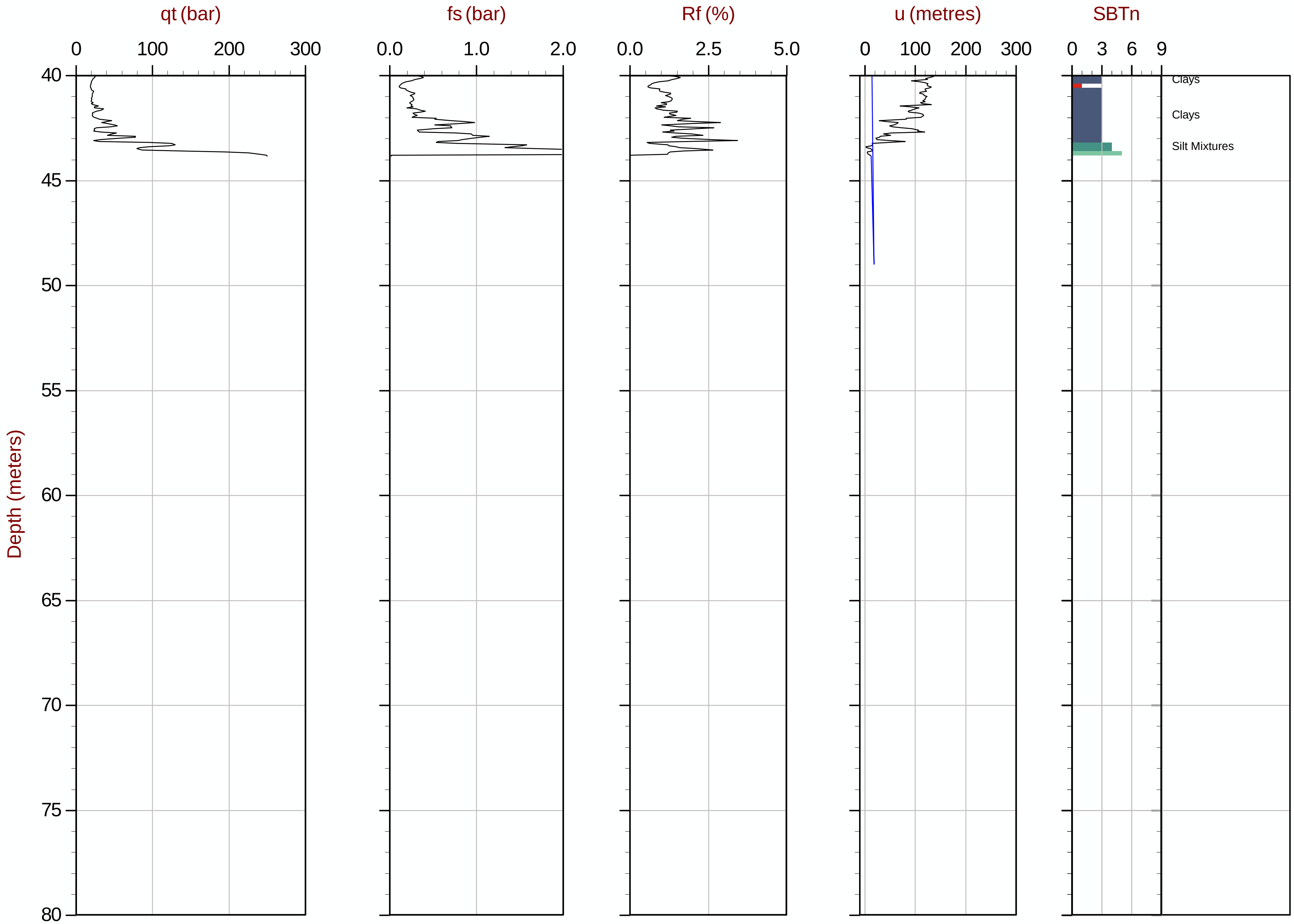
File: 208CP12.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

Golder

Job No: 07-208
Date: 06:27:07 12:17
Site: SCPT07-12

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 43.850 m / 143.86 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP12.COR
Unit Wt: SBT Chart Soil Zones

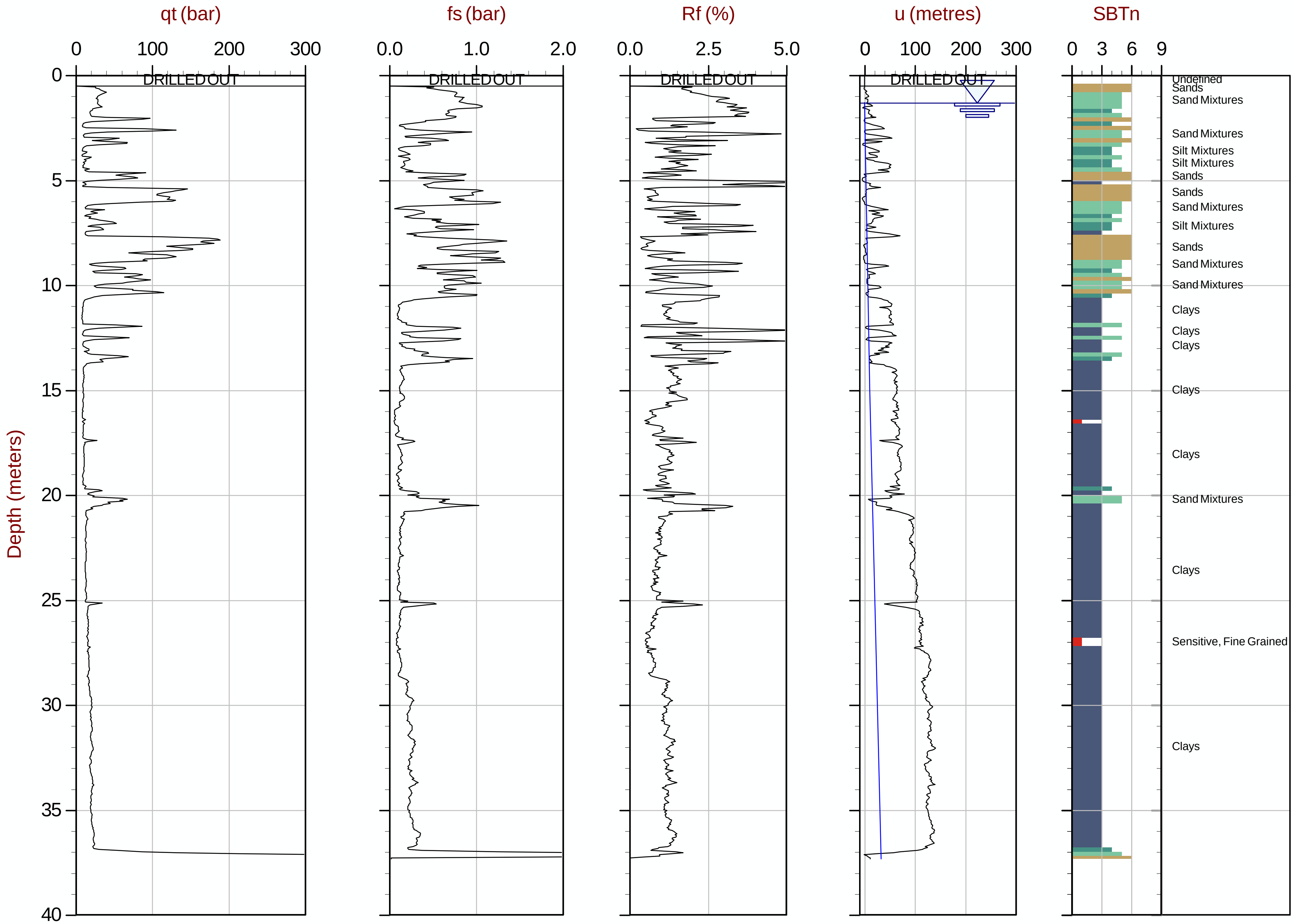
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 06:22:07 12:58
Site: CPT07-13

Sounding: Fraser R Escarp.
Cone: 20 TON 213



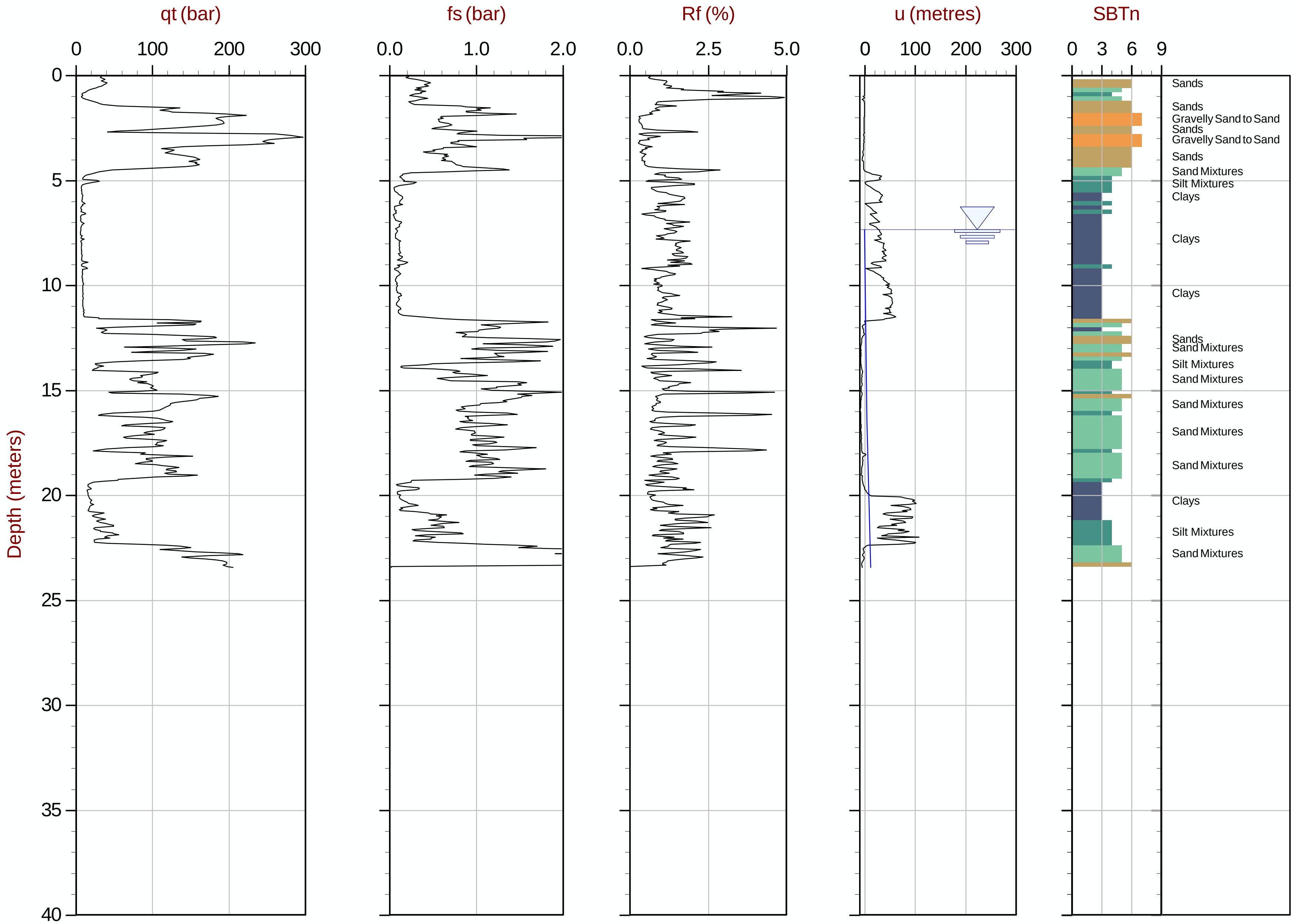
Max Depth: 37.350 m / 122.54 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP13.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

Job No: 07-208
Date: 06:27:07 08:44
Site: CPT07-14

Sounding: Fraser R Escarp.
Cone: 20 TON 213

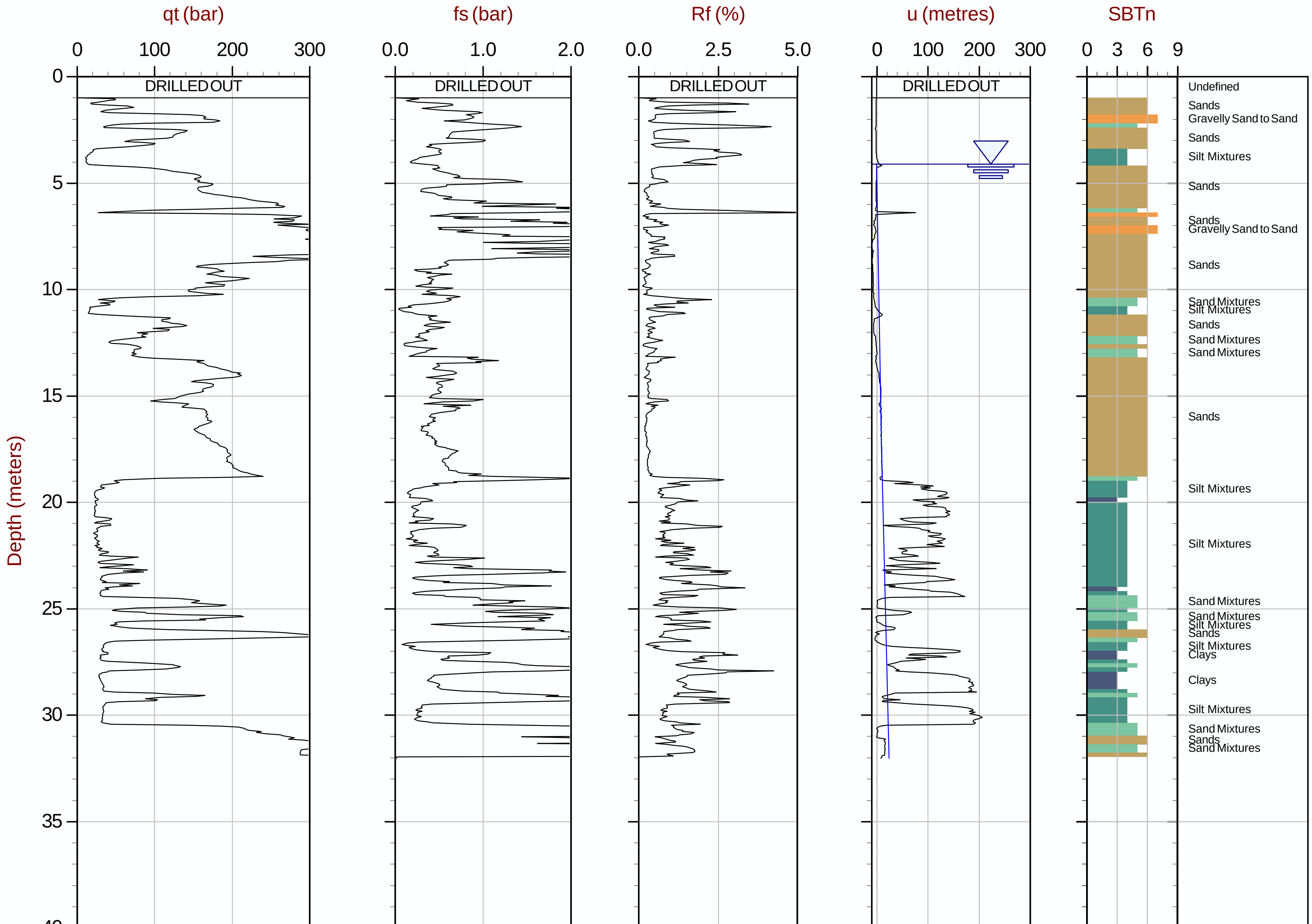


Max Depth: 23.450 m / 76.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP14.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

Golder	Job No: 07-208 Date: 06:22:07 08:52 Site: CPT07-15	Sounding: Fraser R Escarp. Cone: 20 TON 213



Max Depth: 32.050 m / 105.15 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP15.COR
Unit Wt: SBT Chart Soil Zones

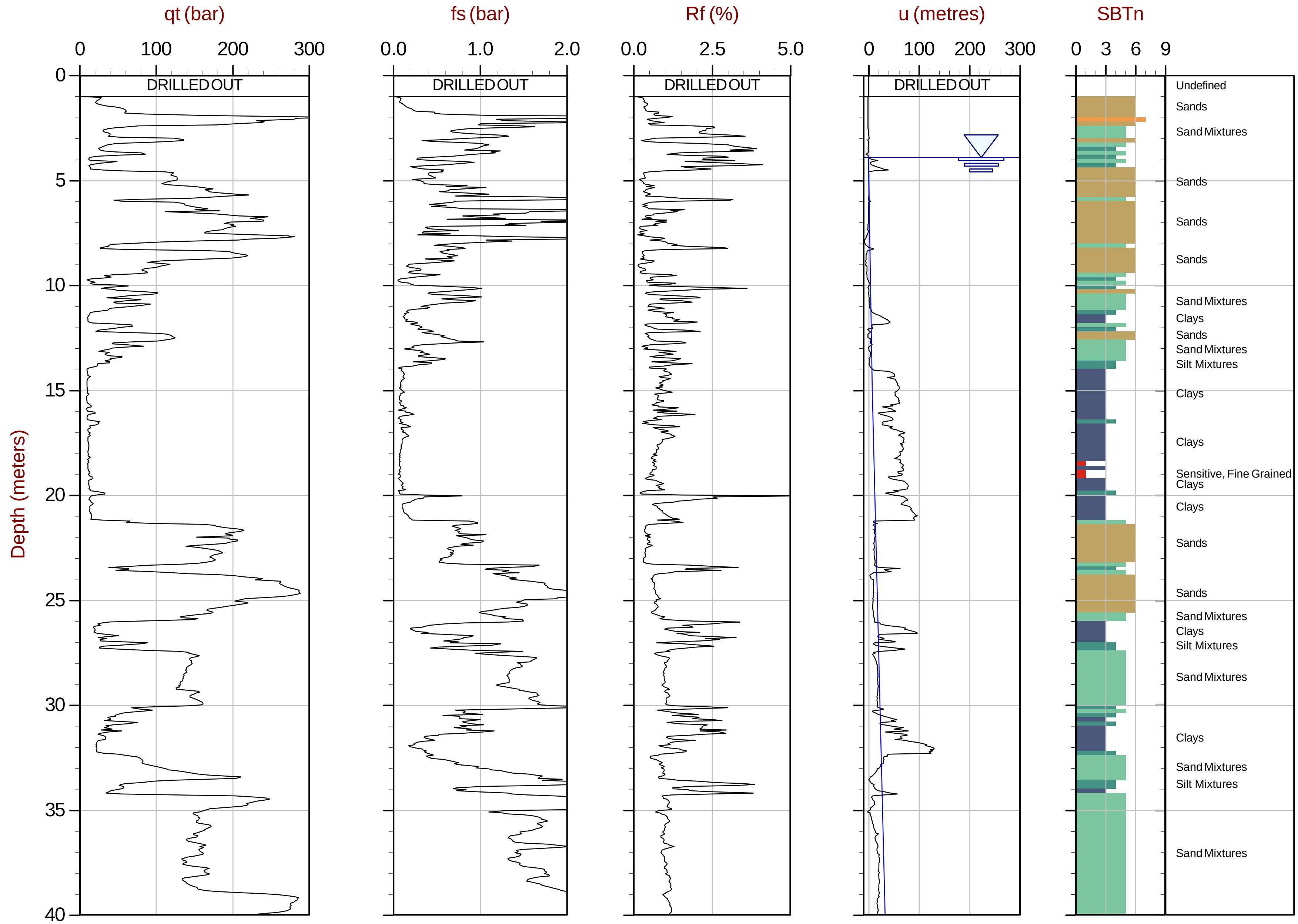
SBT: Lunne, Robertson and Powell, 1997

ConeTec

Golder

Job No: 07-208
Date: 06:20:07 10:57
Site: CPT07-16

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 41.700 m / 136.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

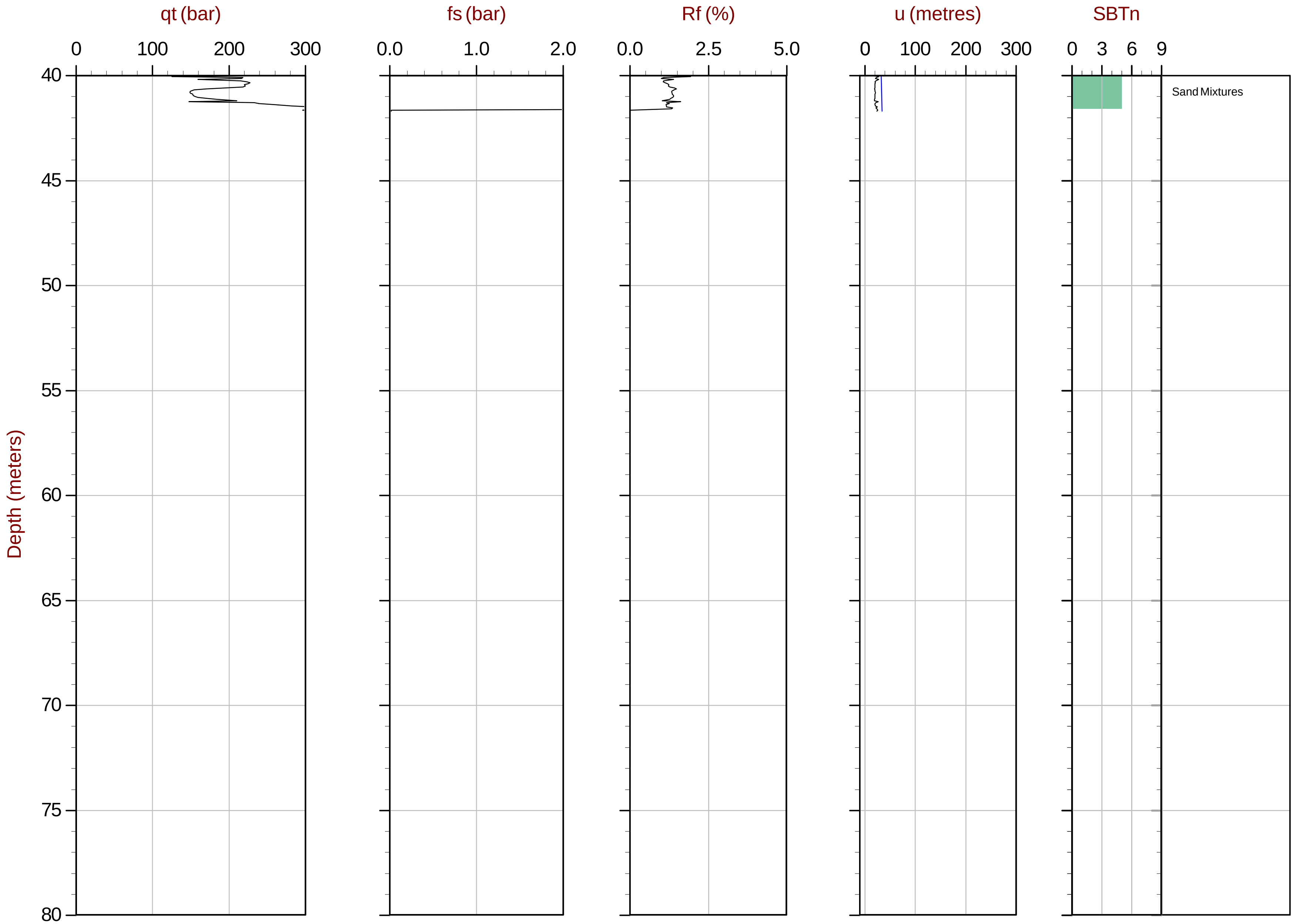
File: 208CP16.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

Golder

Job No: 07-208
Date: 06:20:07 10:57
Site: CPT07-16

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 41.700 m / 136.81 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

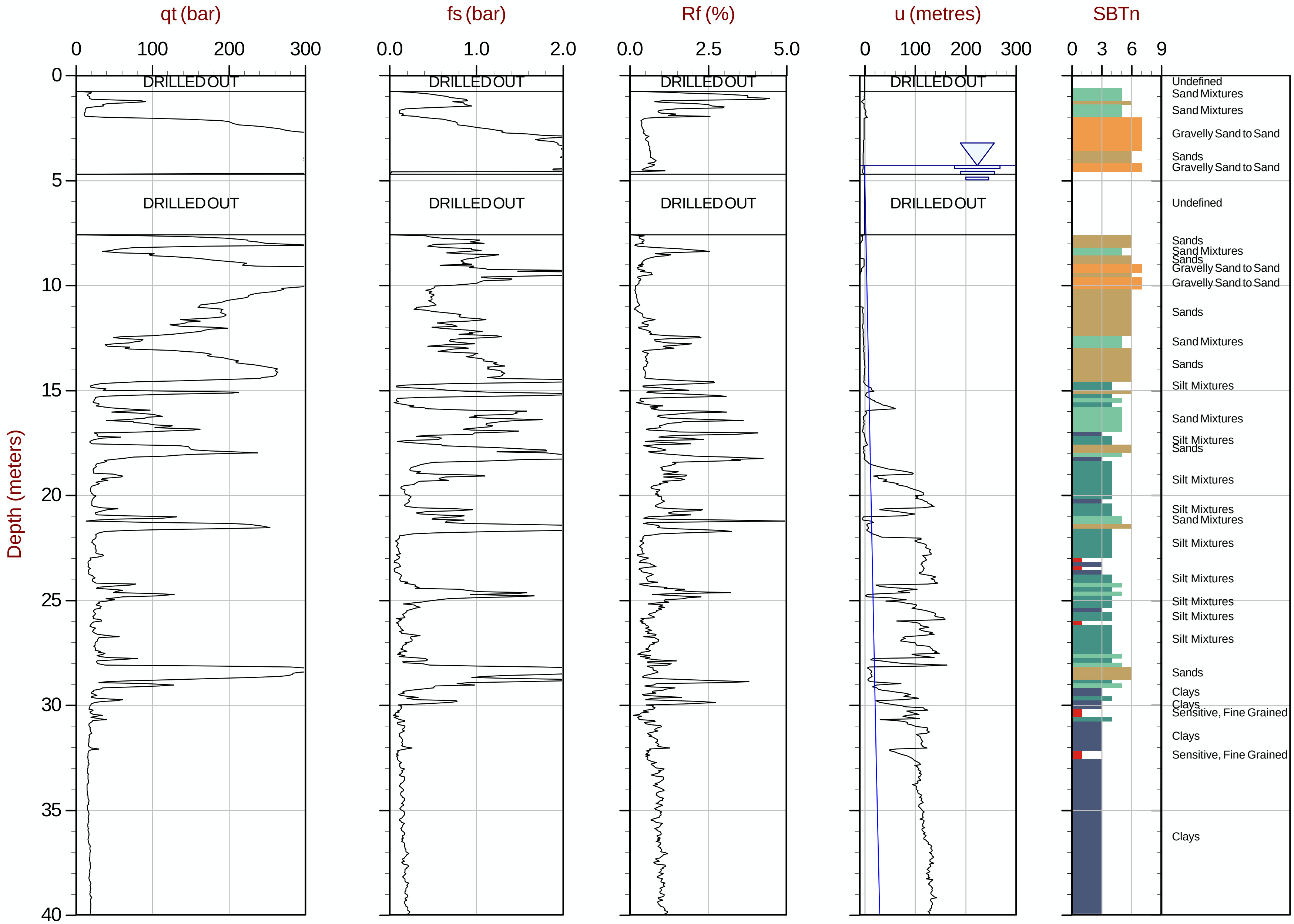
File: 208CP16.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

ConeTec | Golder

Job No: 07-208
Date: 06:19:07 14:04
Site: CPT07-17

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 52.750 m / 173.06 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP17.COR
Unit Wt: SBT Chart Soil Zones

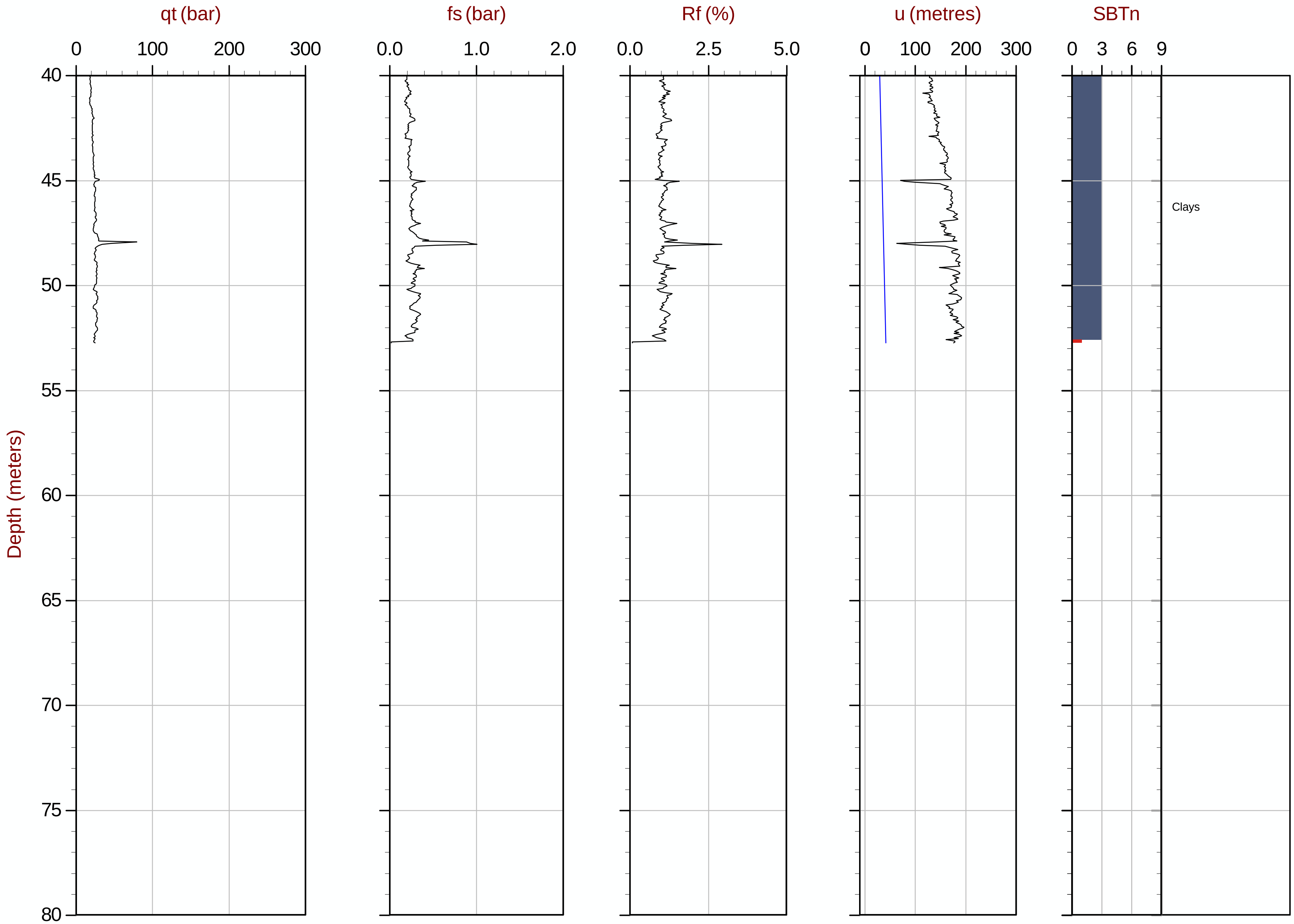
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

ConeTec

Golder

Job No: 07-208
Date: 06:19:07 14:04
Site: CPT07-17

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 52.750 m / 173.06 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP17.COR
Unit Wt: SBT Chart Soil Zones

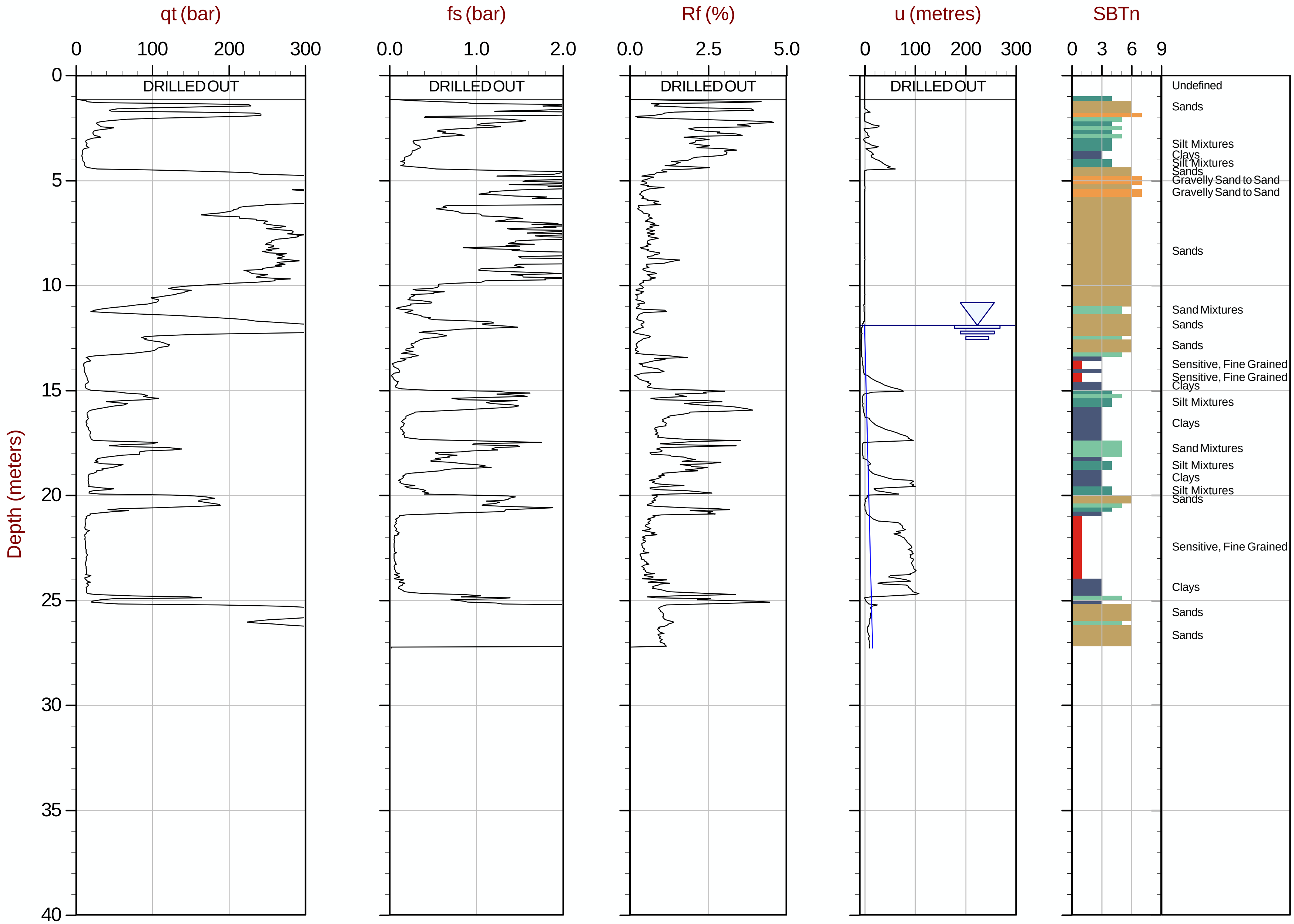
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:22:07 08:34
Site: CPT07-18

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 27.300 m / 89.57 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP18.COR
Unit Wt: SBT Chart Soil Zones

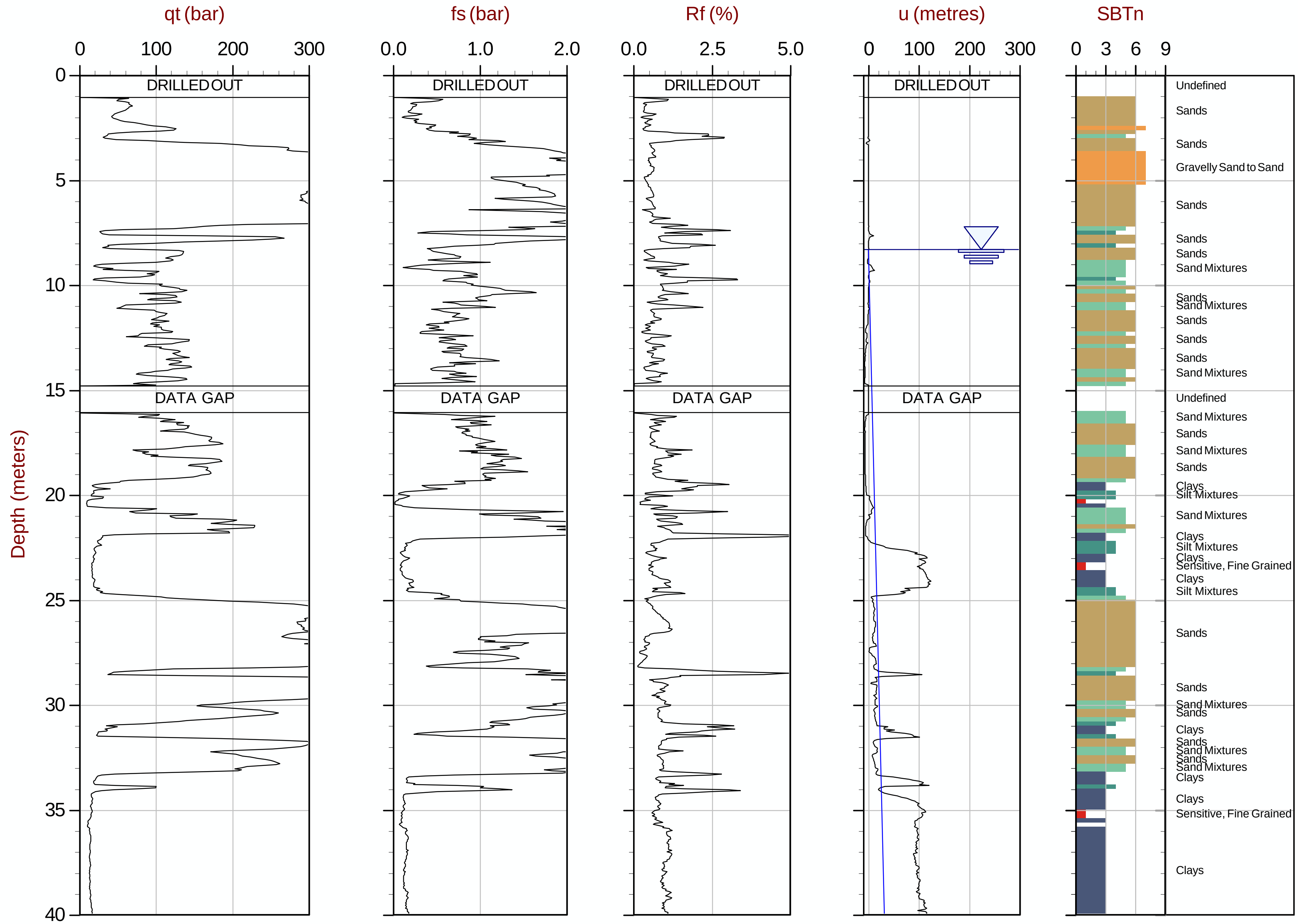
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

Golder

Job No: 07-208
Date: 08:22:07 13:14
Site: CPT07-19

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 47.950 m / 157.31 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP19.COR
Unit Wt: SBT Chart Soil Zones

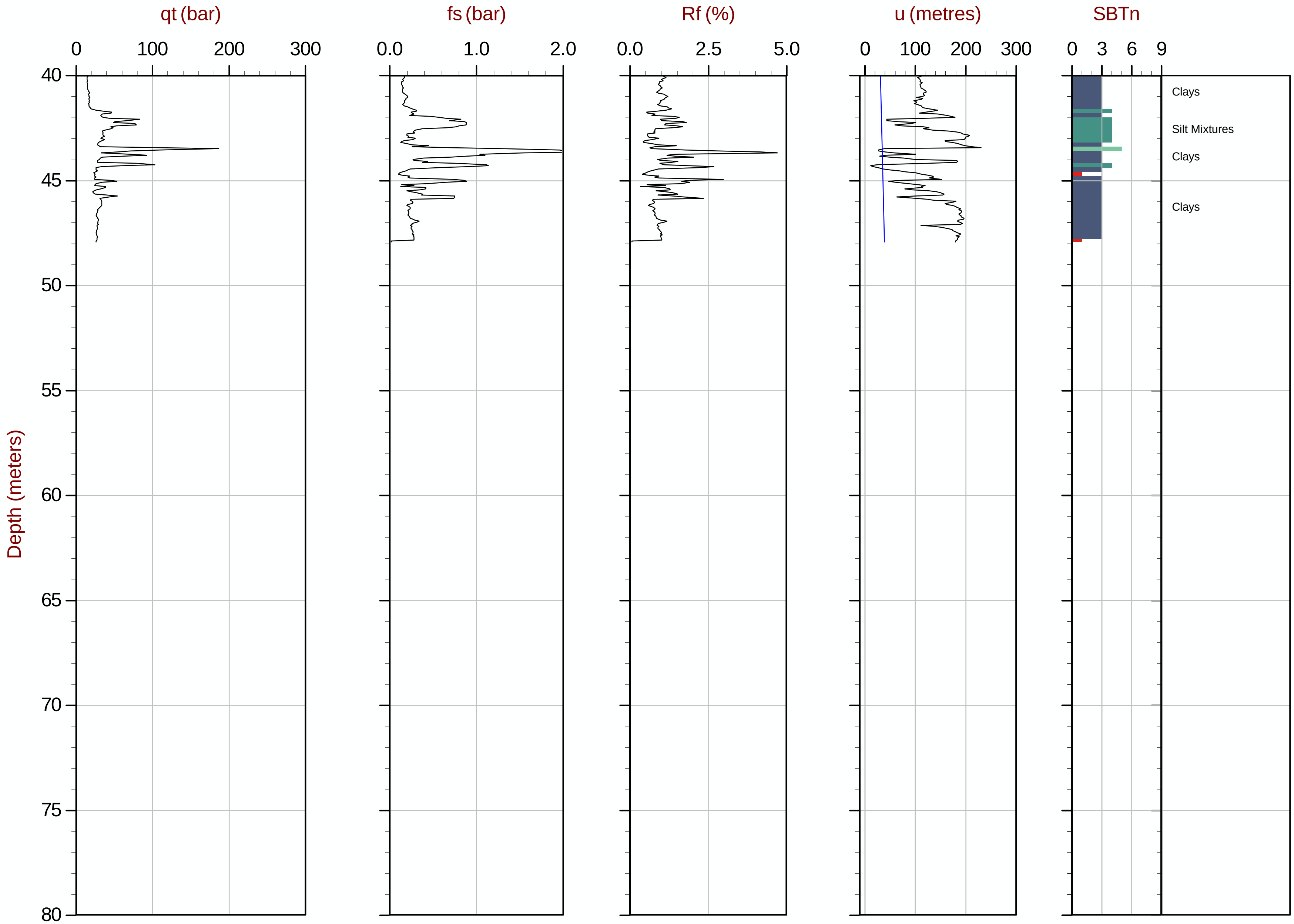
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

ConeTec

Golder

Job No: 07-208
Date: 08:22:07 13:14
Site: CPT07-19

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 47.950 m / 157.31 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP19.COR
Unit Wt: SBT Chart Soil Zones

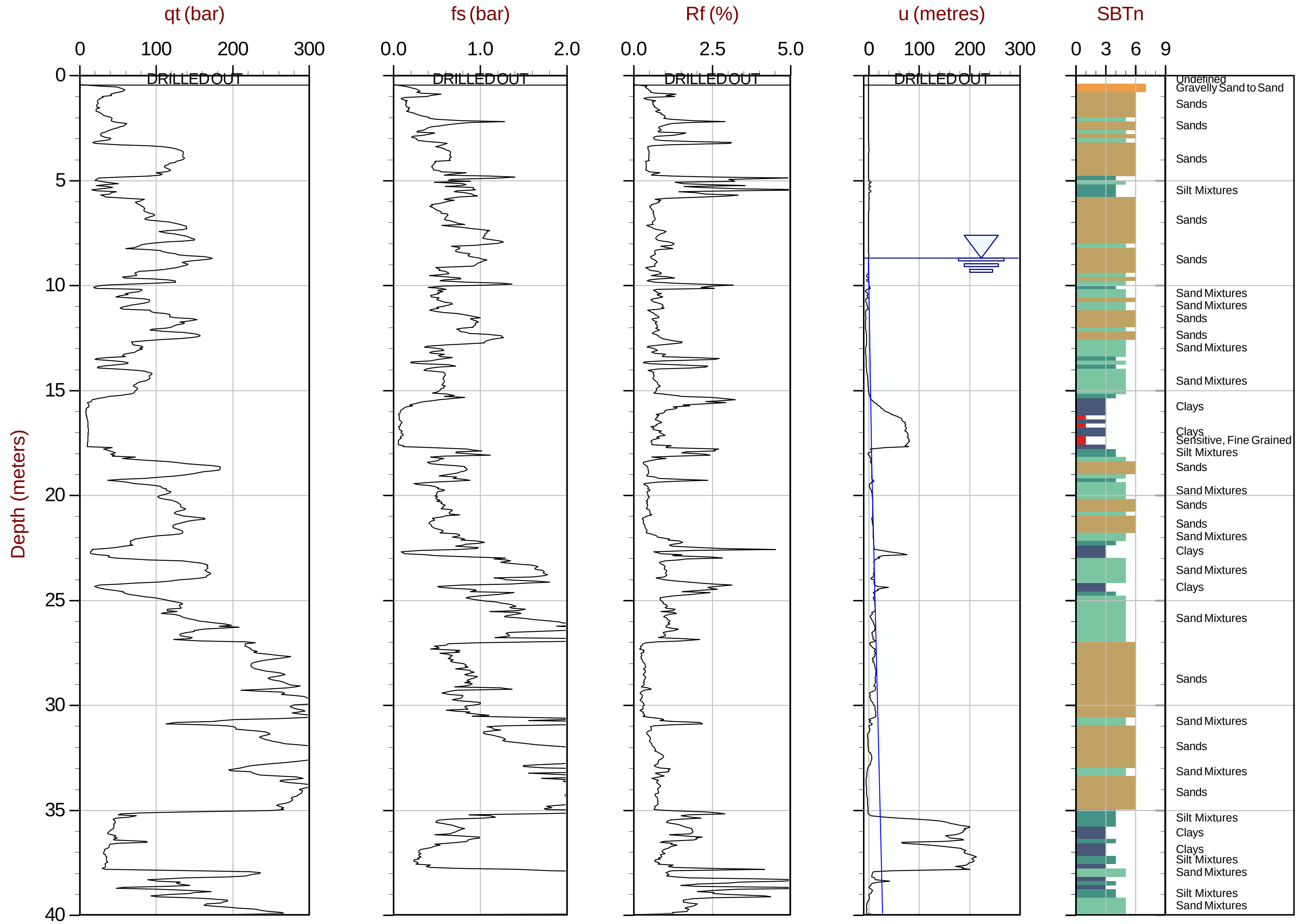
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:21:07 14:02
Site: CPT07-20

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 40.050 m / 131.40 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP20.COR
Unit Wt: SBT Chart Soil Zones

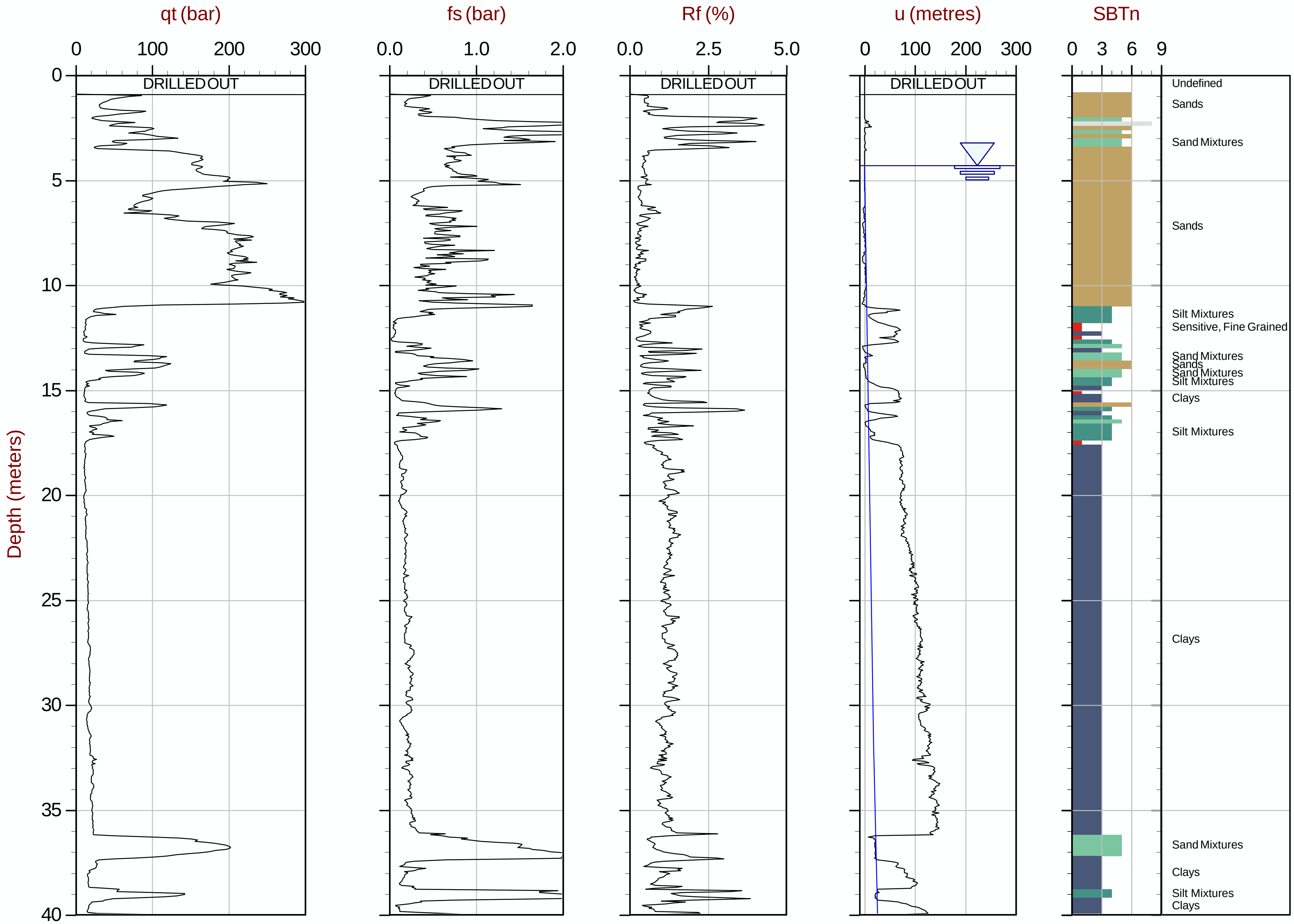
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:23:07 08:41
Site: CPT07-21

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 40.450 m / 132.71 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP21.COR
Unit Wt: SBT Chart Soil Zones

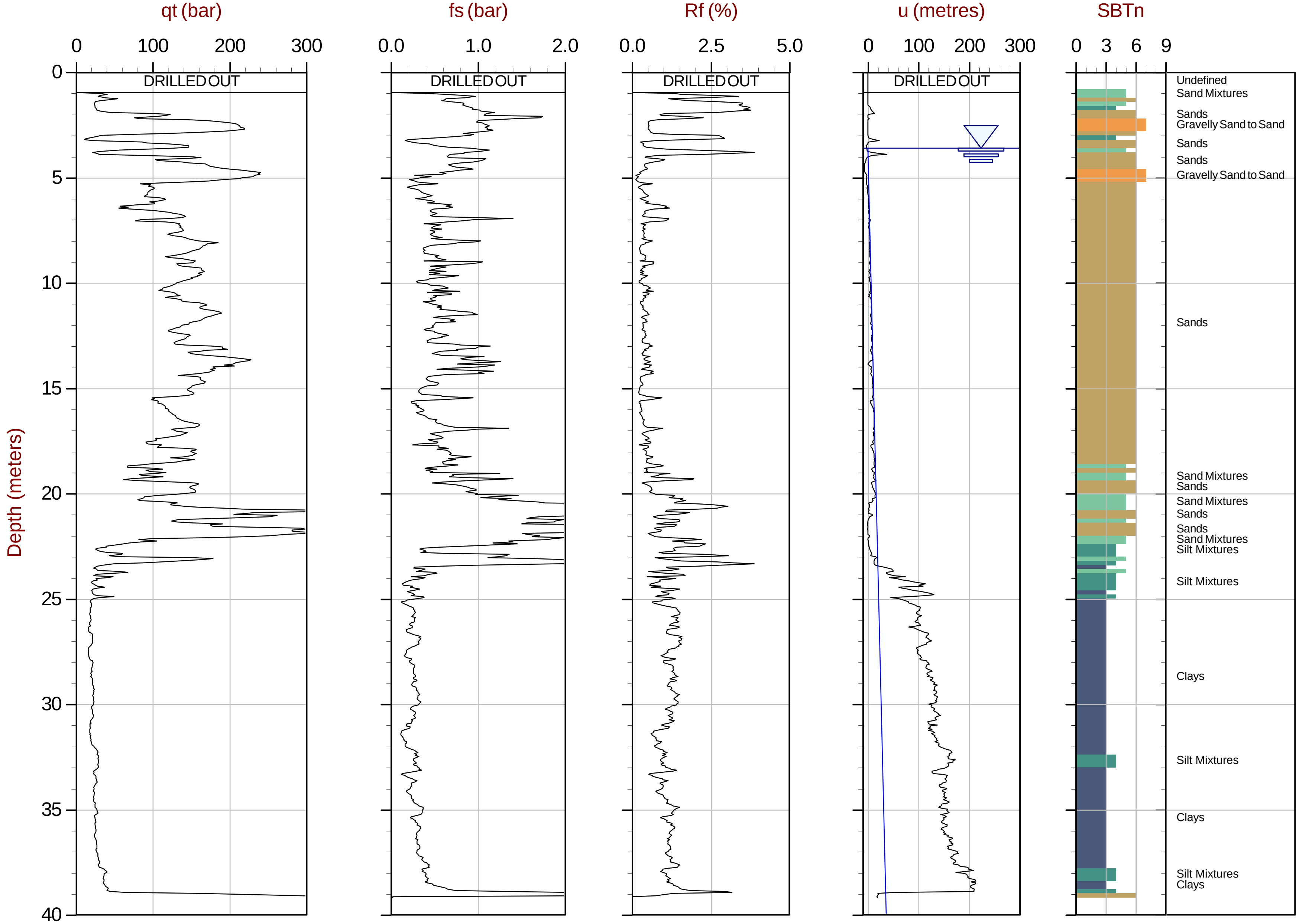
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:23:07 13:12
Site: CPT07-22

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 39.200 m / 128.61 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP22.COR
Unit Wt: SBT Chart Soil Zones

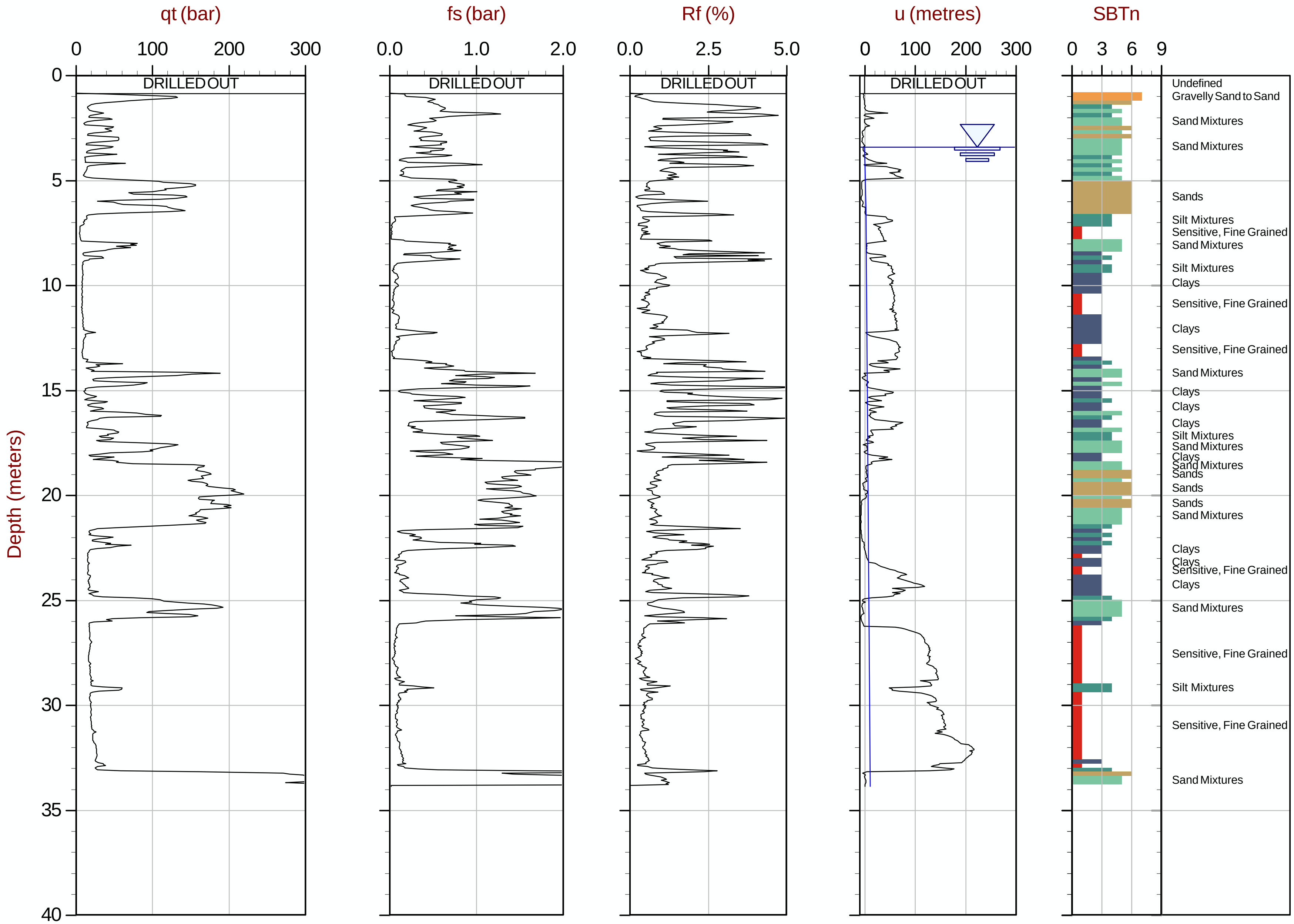
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

Golder

Job No: 07-208
Date: 08:21:07 08:40
Site: CPT07-23

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 33.900 m / 111.22 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP23.COR
Unit Wt: SBT Chart Soil Zones

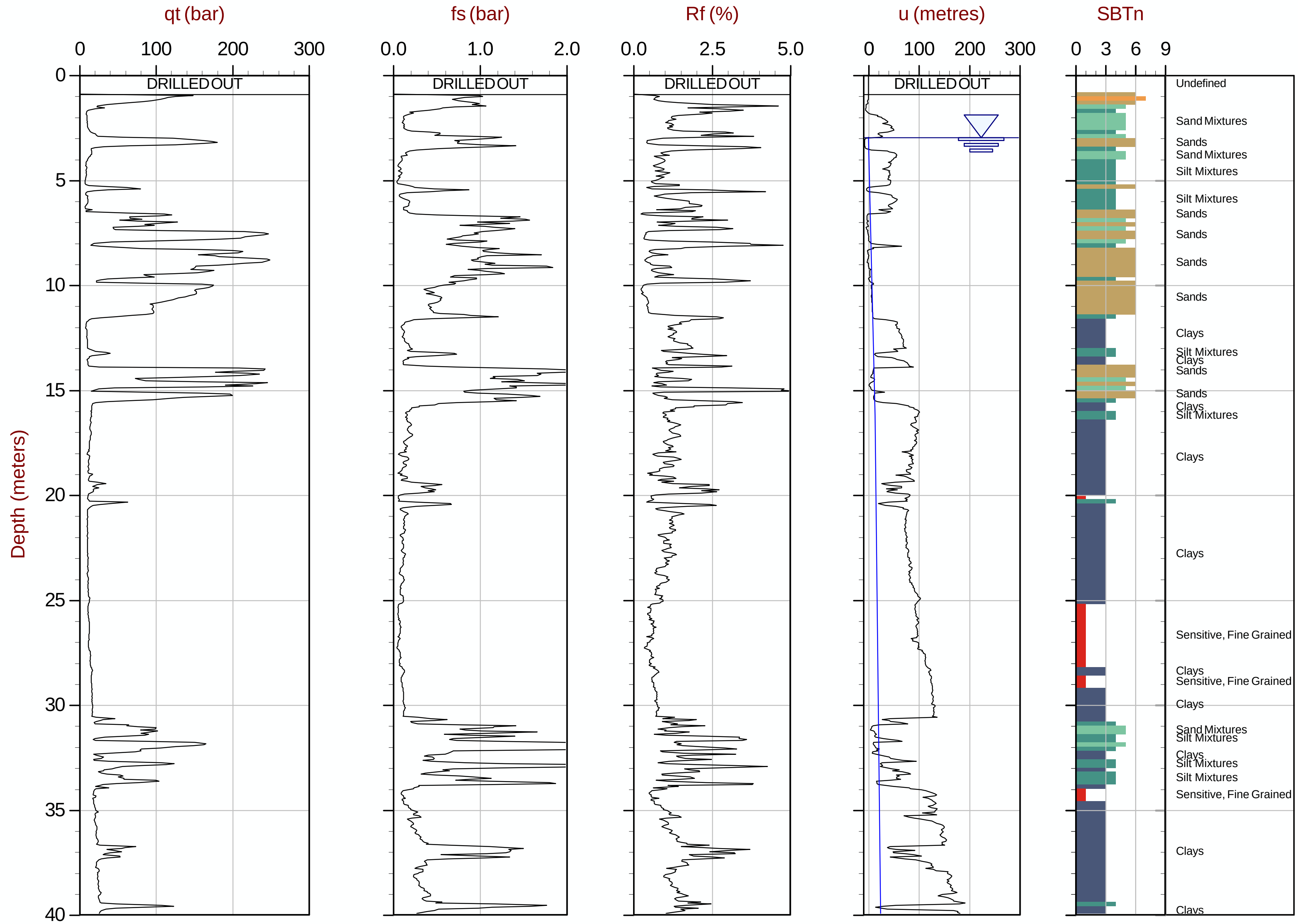
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

Golder

Job No: 07-208
Date: 08:24:07 09:21
Site: CPT07-24

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 44.650 m / 146.49 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP24.COR
Unit Wt: SBT Chart Soil Zones

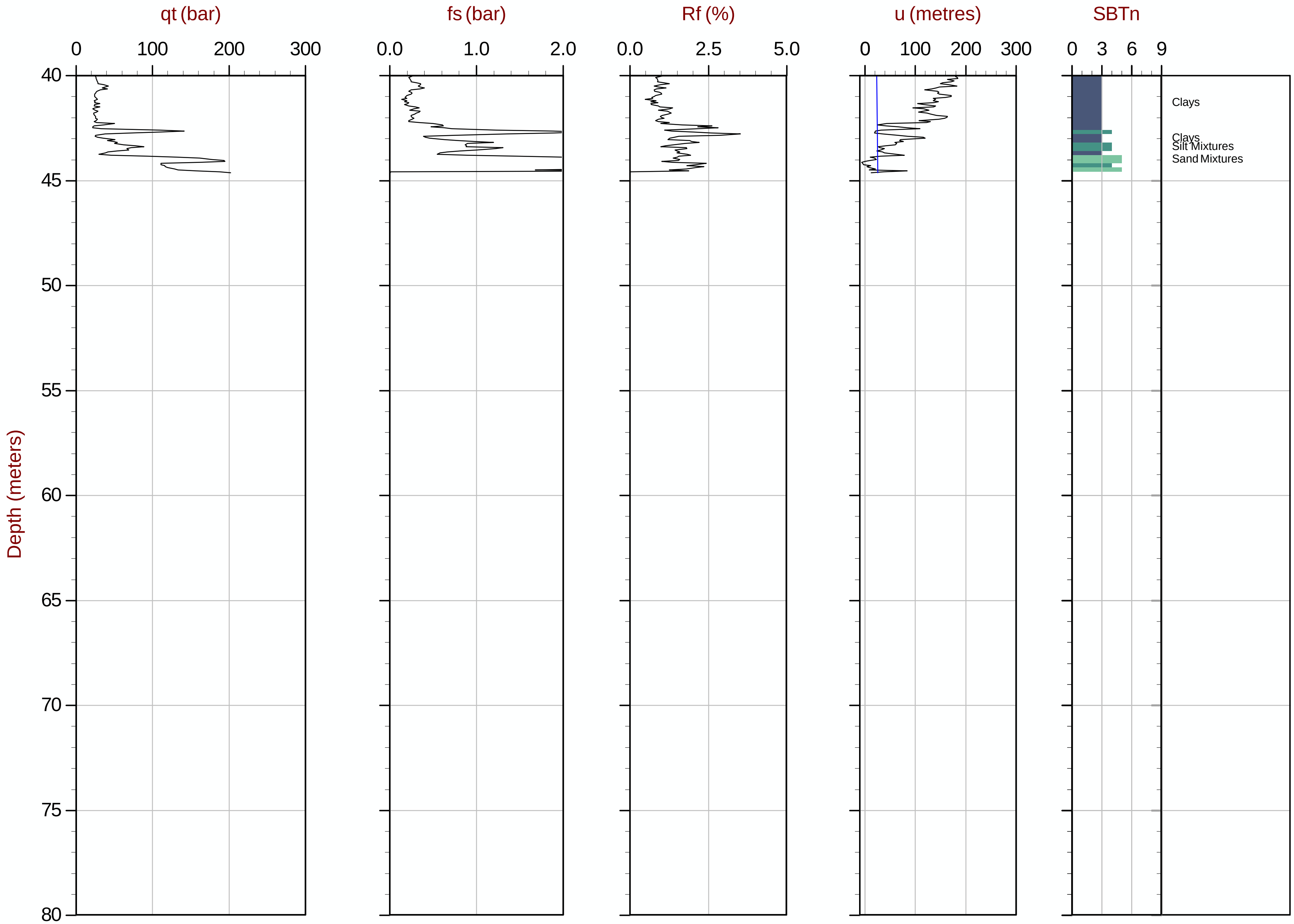
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:24:07 09:21
Site: CPT07-24

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 44.650 m / 146.49 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP24.COR
Unit Wt: SBT Chart Soil Zones

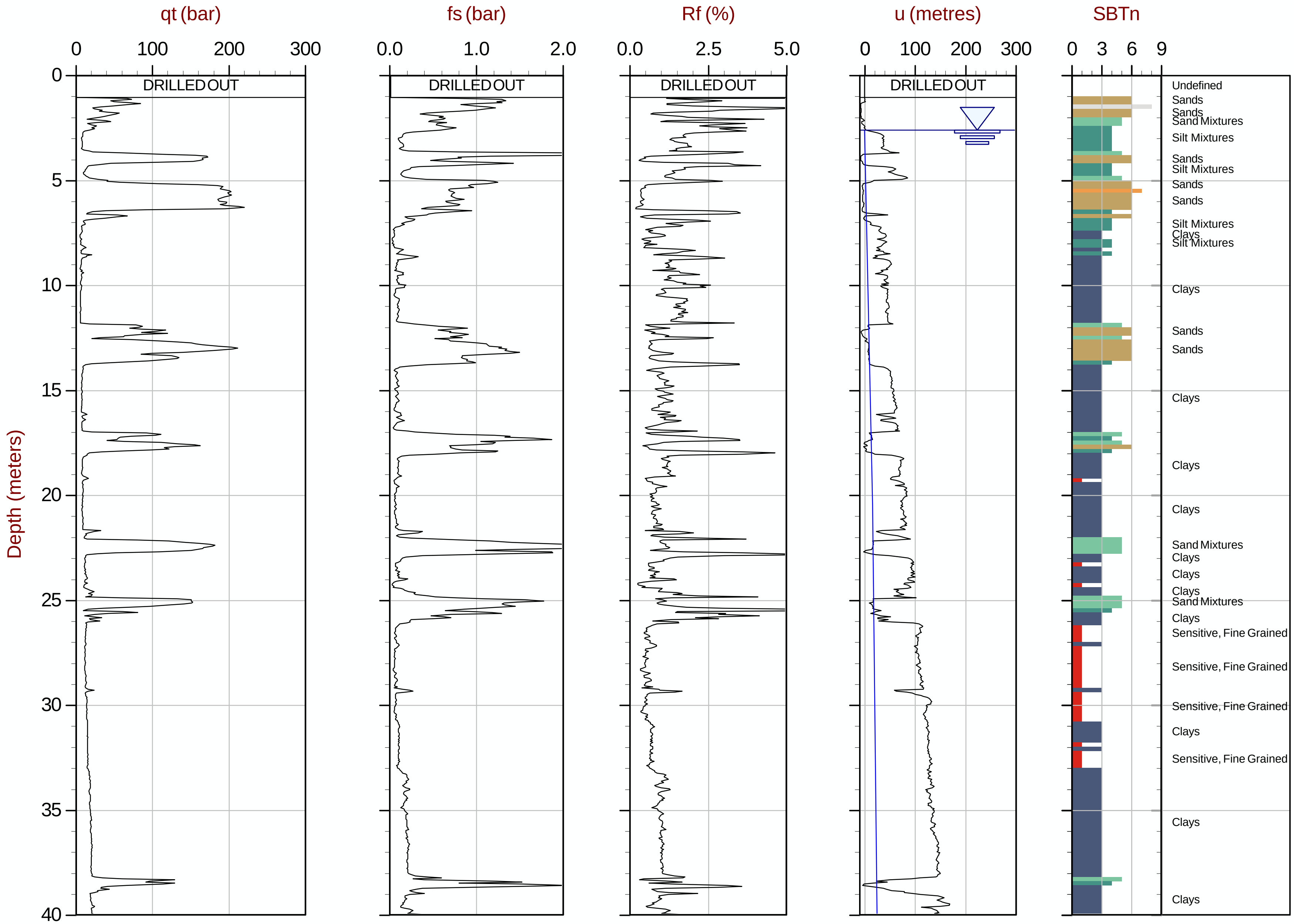
SBT: Lunne, Robertson and Powell, 1997

ConeTec

Golder

Job No: 07-208
Date: 08:24:07 14:15
Site: CPT07-25

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 43.300 m / 142.06 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP25.COR
Unit Wt: SBT Chart Soil Zones

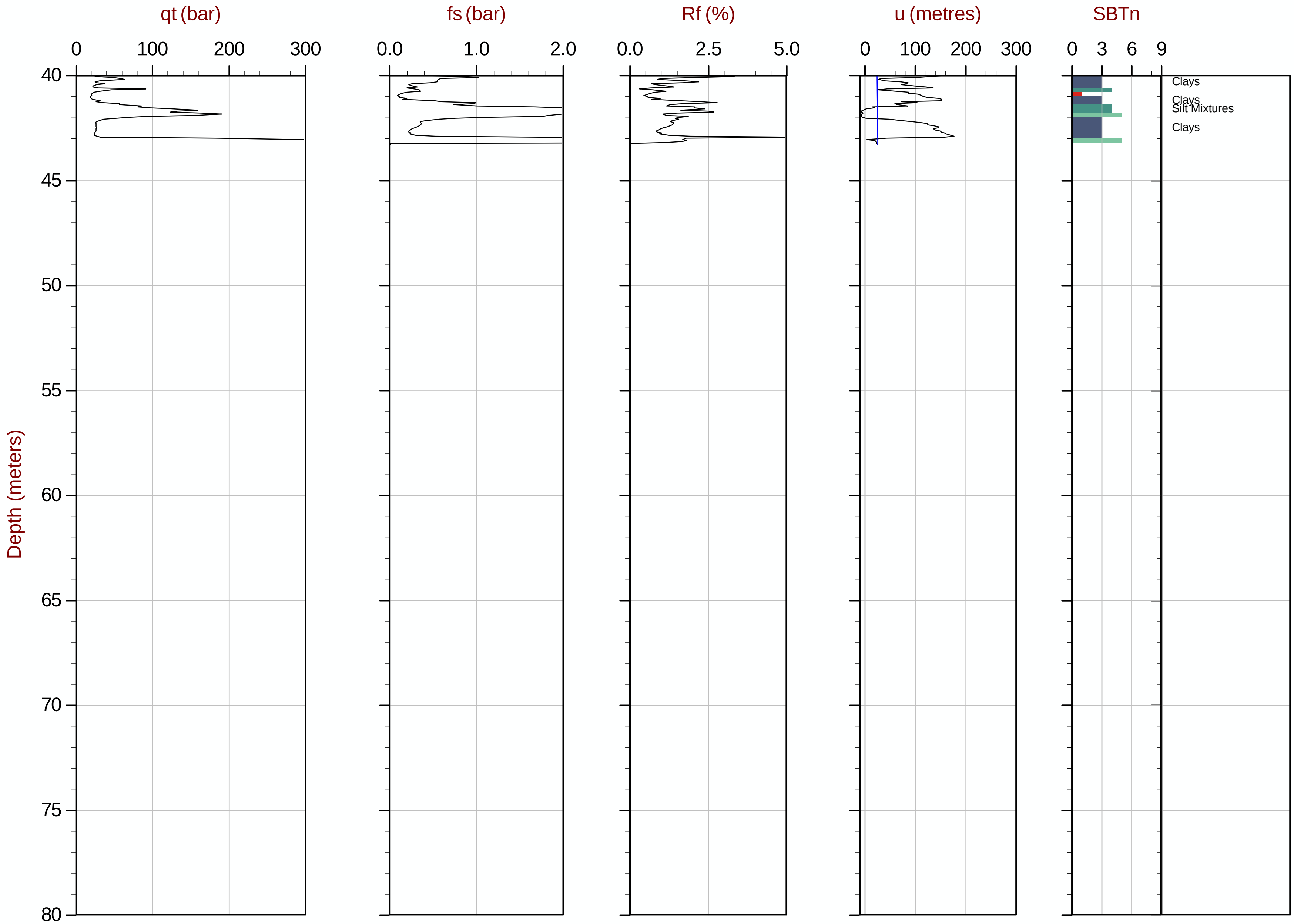
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:24:07 14:15
Site: CPT07-25

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 43.300 m / 142.06 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP25.COR
Unit Wt: SBT Chart Soil Zones

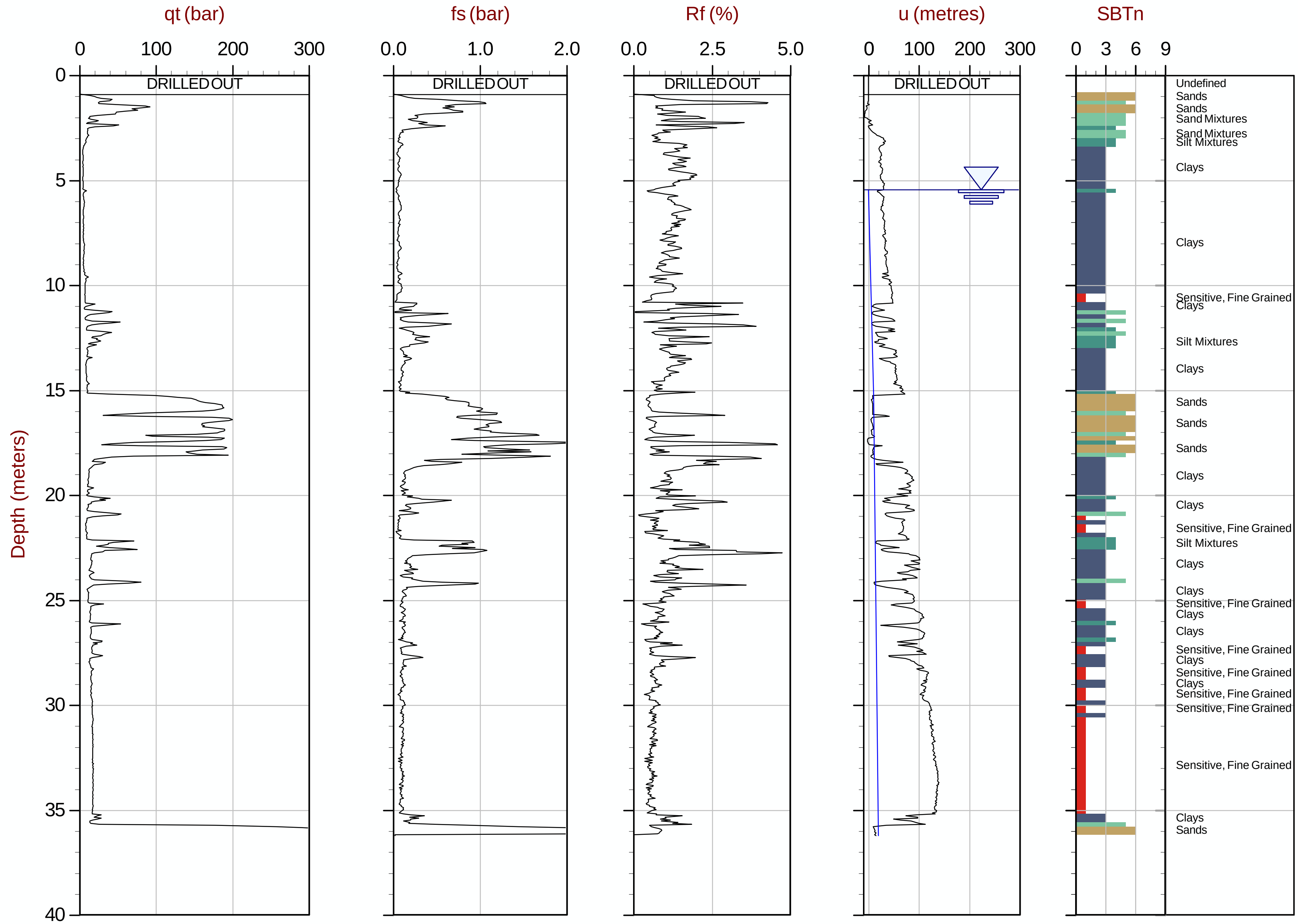
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:20:07 12:34
Site: CPT07-26

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 36.250 m / 118.93 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP26.COR
Unit Wt: SBT Chart Soil Zones

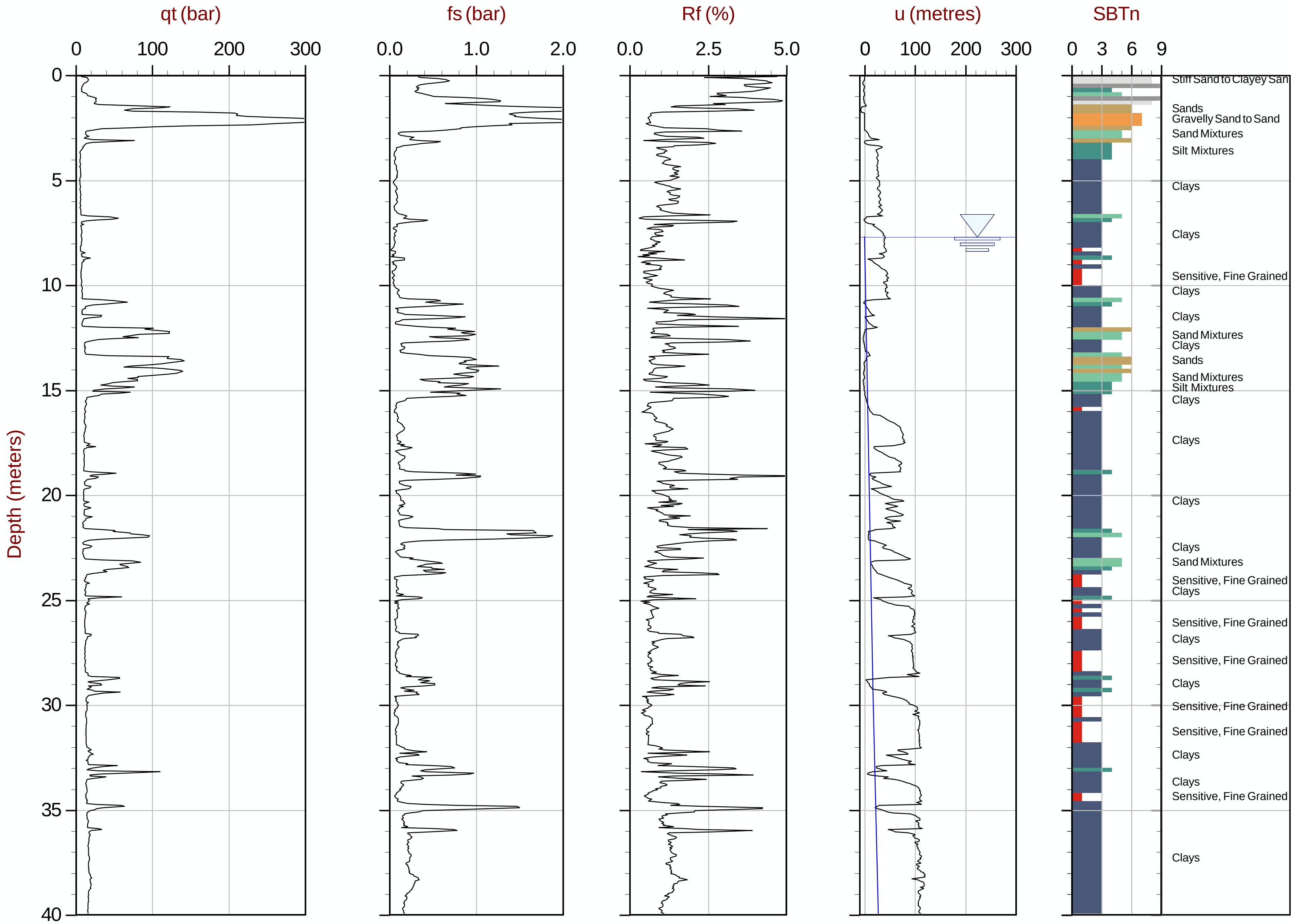
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

ConeTec

Golder

Job No: 07-208
Date: 08:30:07 13:17
Site: CPT07-27

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 54.999 m / 180.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP27.COR
Unit Wt: SBT Chart Soil Zones

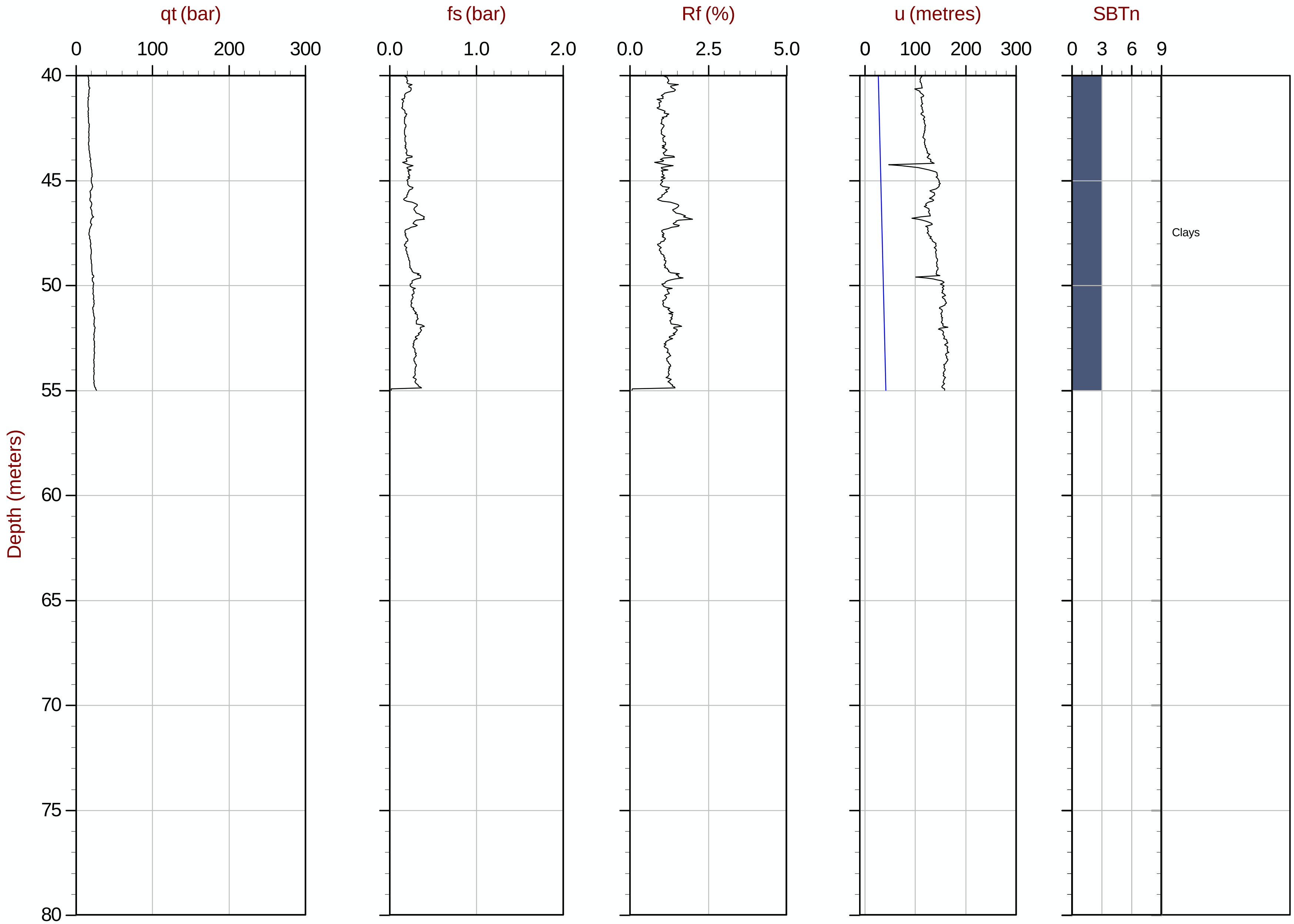
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:30:07 13:17
Site: CPT07-27

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 54.999 m / 180.44 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP27.COR
Unit Wt: SBT Chart Soil Zones

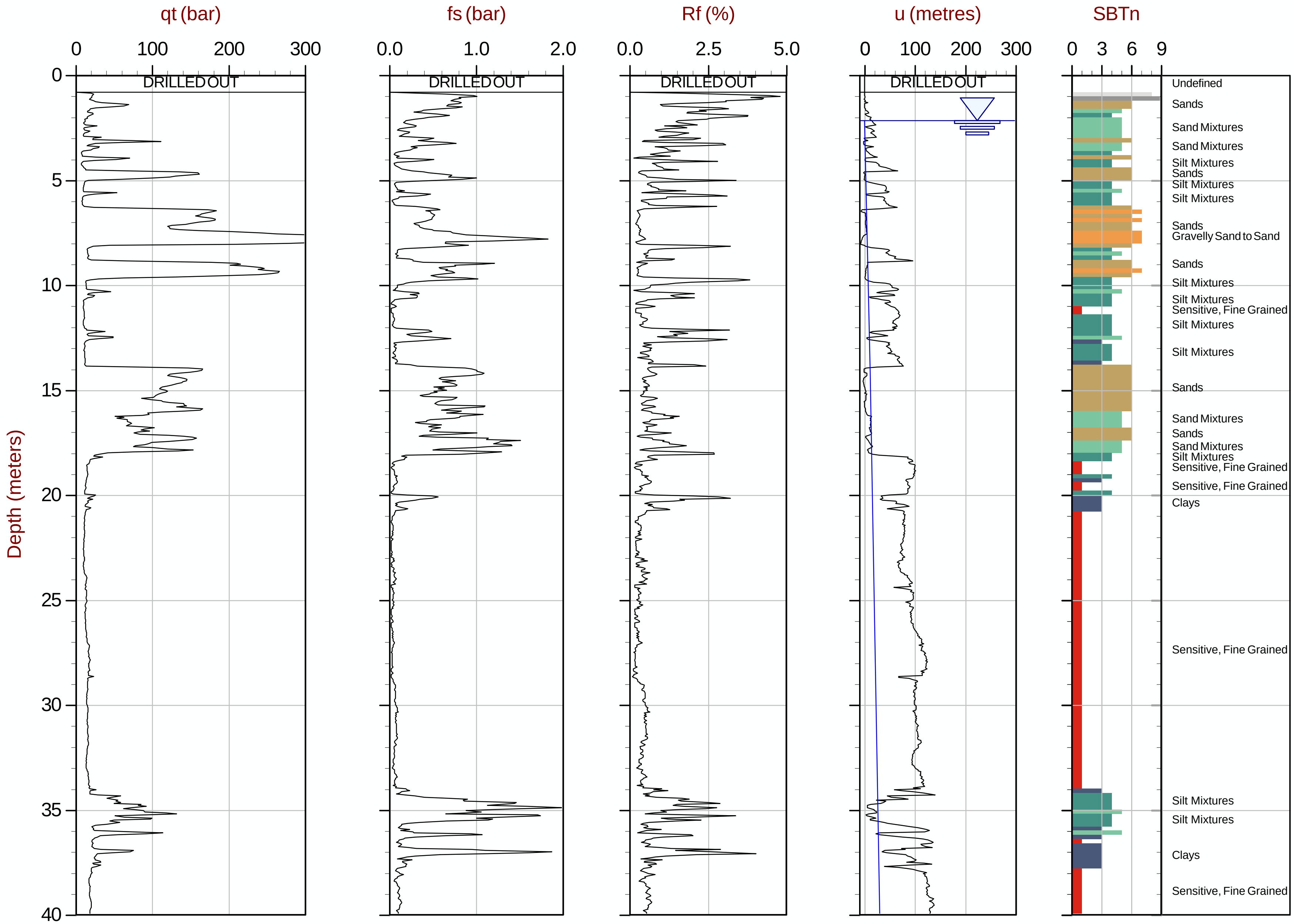
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

ConeTec

Golder

Job No: 07-208
Date: 08:20:07 08:21
Site: CPT07-28

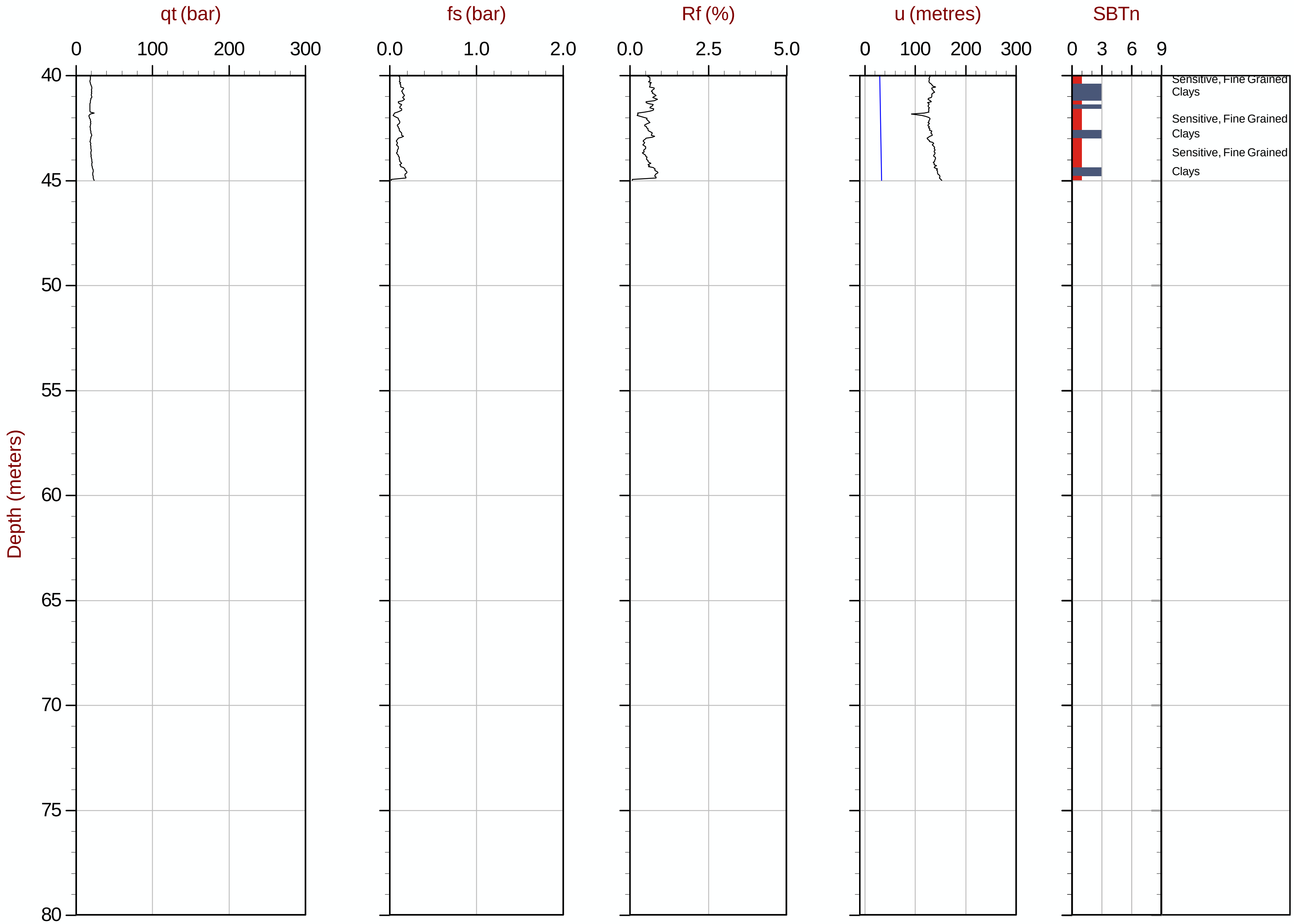
Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 45.000 m / 147.64 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP28.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2



Max Depth: 45.000 m / 147.64 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP28.COR
Unit Wt: SBT Chart Soil Zones

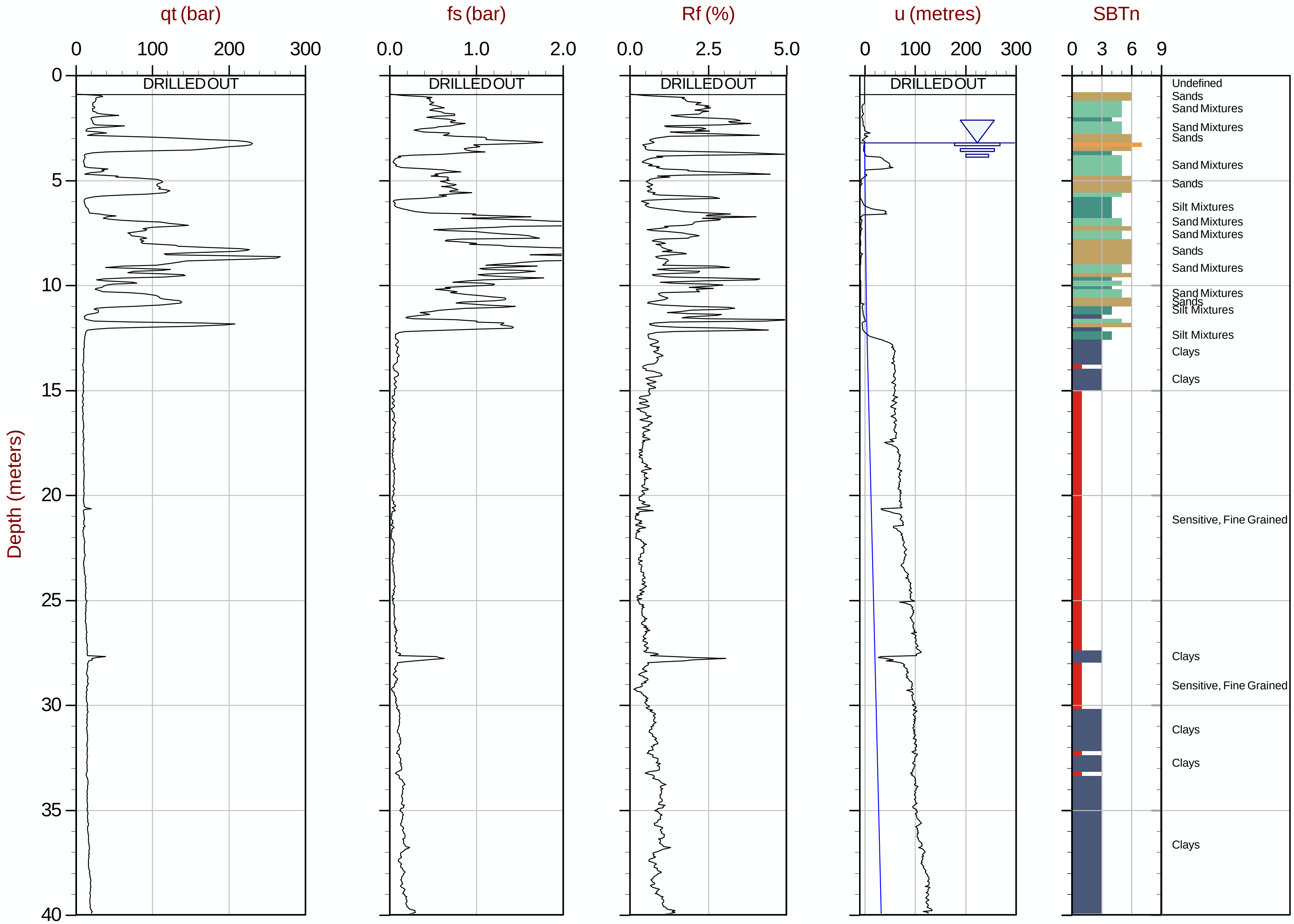
SBT: Lunne, Robertson and Powell, 1997

ConeTec

Golder

Job No: 07-208
Date: 08:29:07 08:46
Site: CPT07-29

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP29.COR
Unit Wt: SBT Chart Soil Zones

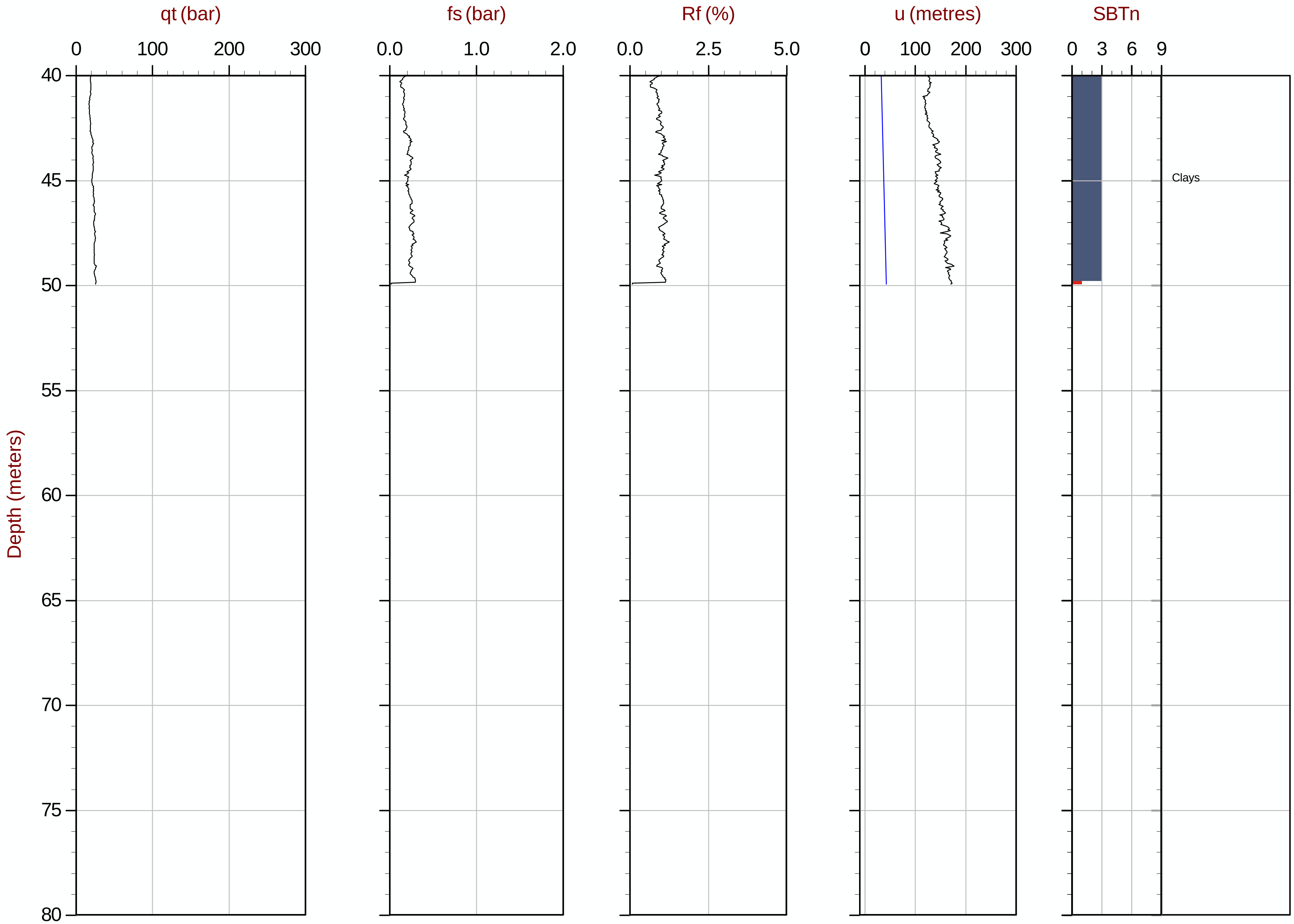
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:29:07 08:46
Site: CPT07-29

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP29.COR
Unit Wt: SBT Chart Soil Zones

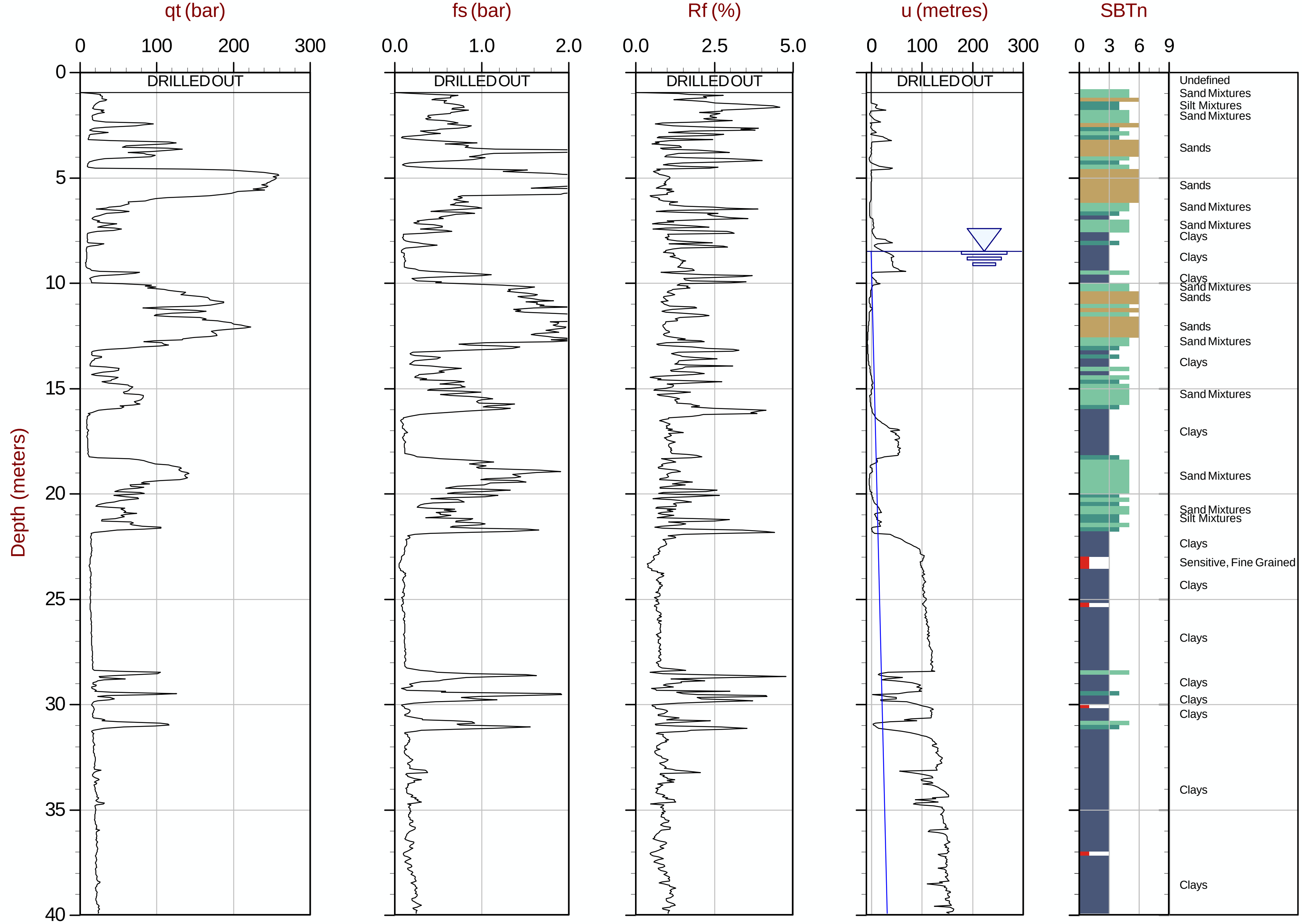
SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

ConeTec

Golder

Job No: 07-208
Date: 08:29:07 12:06
Site: CPT07-30

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 54.949 m / 180.28 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP30.COR
Unit Wt: SBT Chart Soil Zones

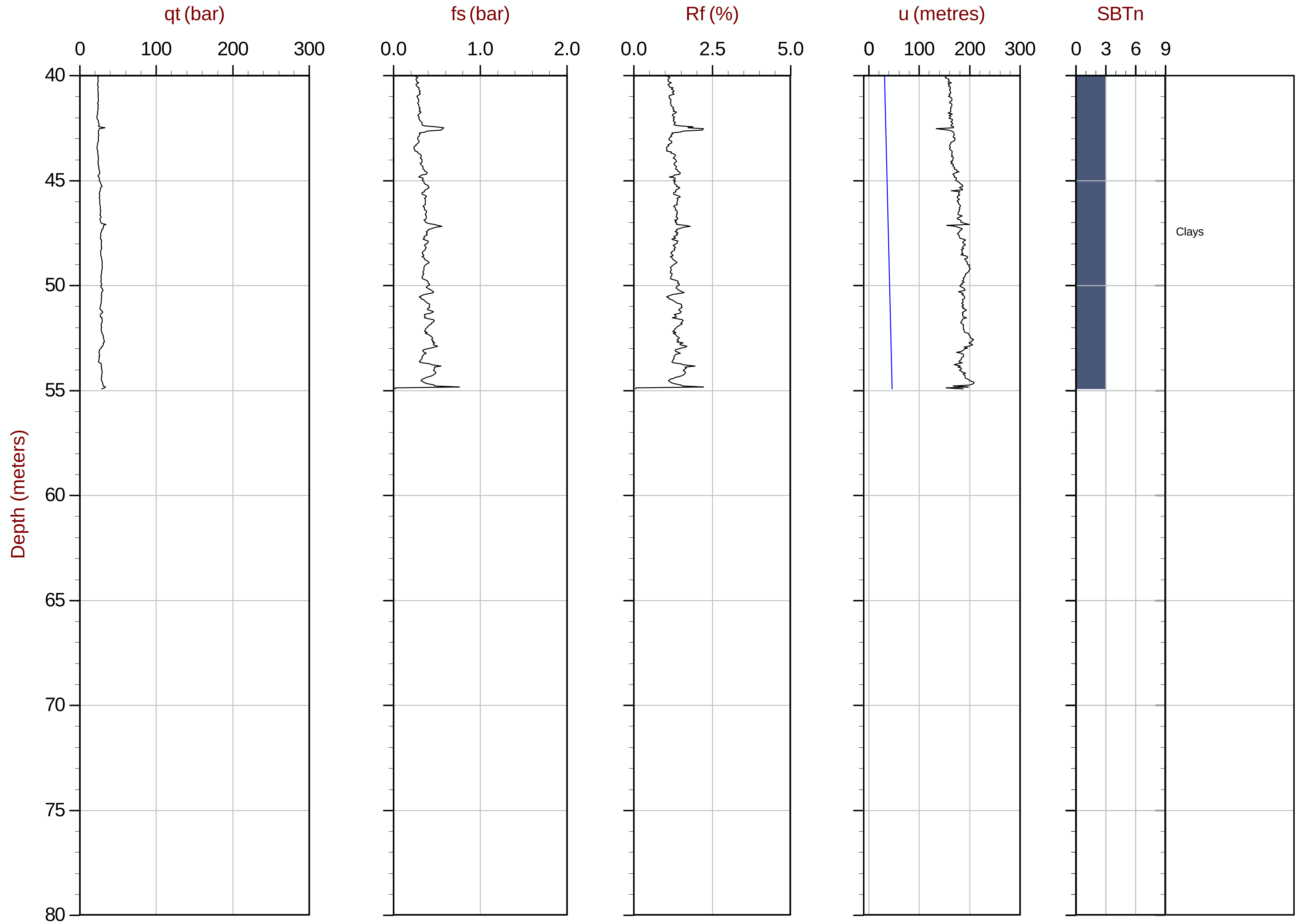
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

ConeTec

Golder

Job No: 07-208
Date: 08:29:07 12:06
Site: CPT07-30

Sounding: FRASER R ESCARP
Cone: 20 TON 198



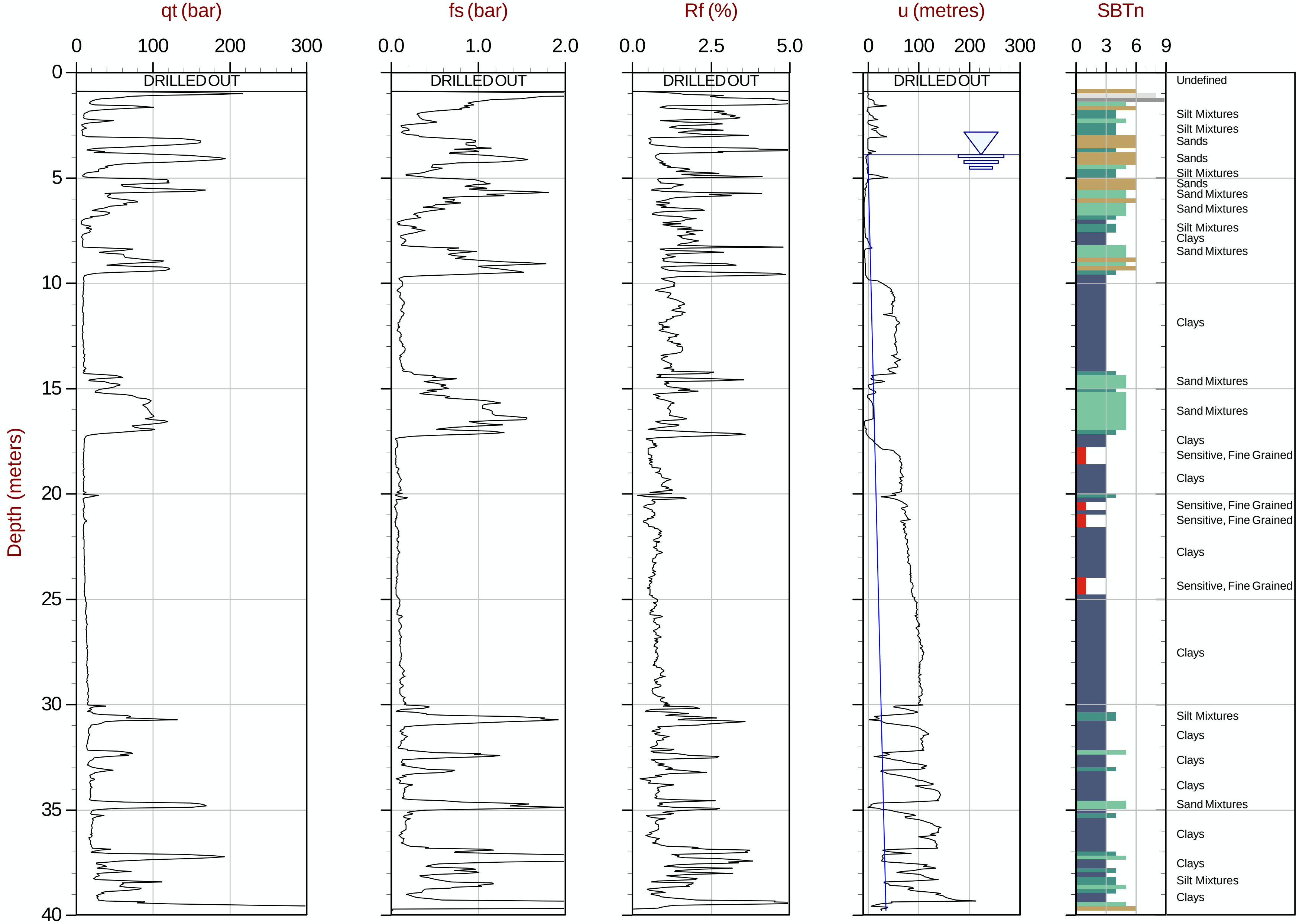
Max Depth: 54.949 m / 180.28 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP30.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 2 of 2

Job No: 07-208
Date: 08:28:07 08:25
Site: CPT07-31

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 39.800 m / 130.58 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP31.COR
Unit Wt: SBT Chart Soil Zones

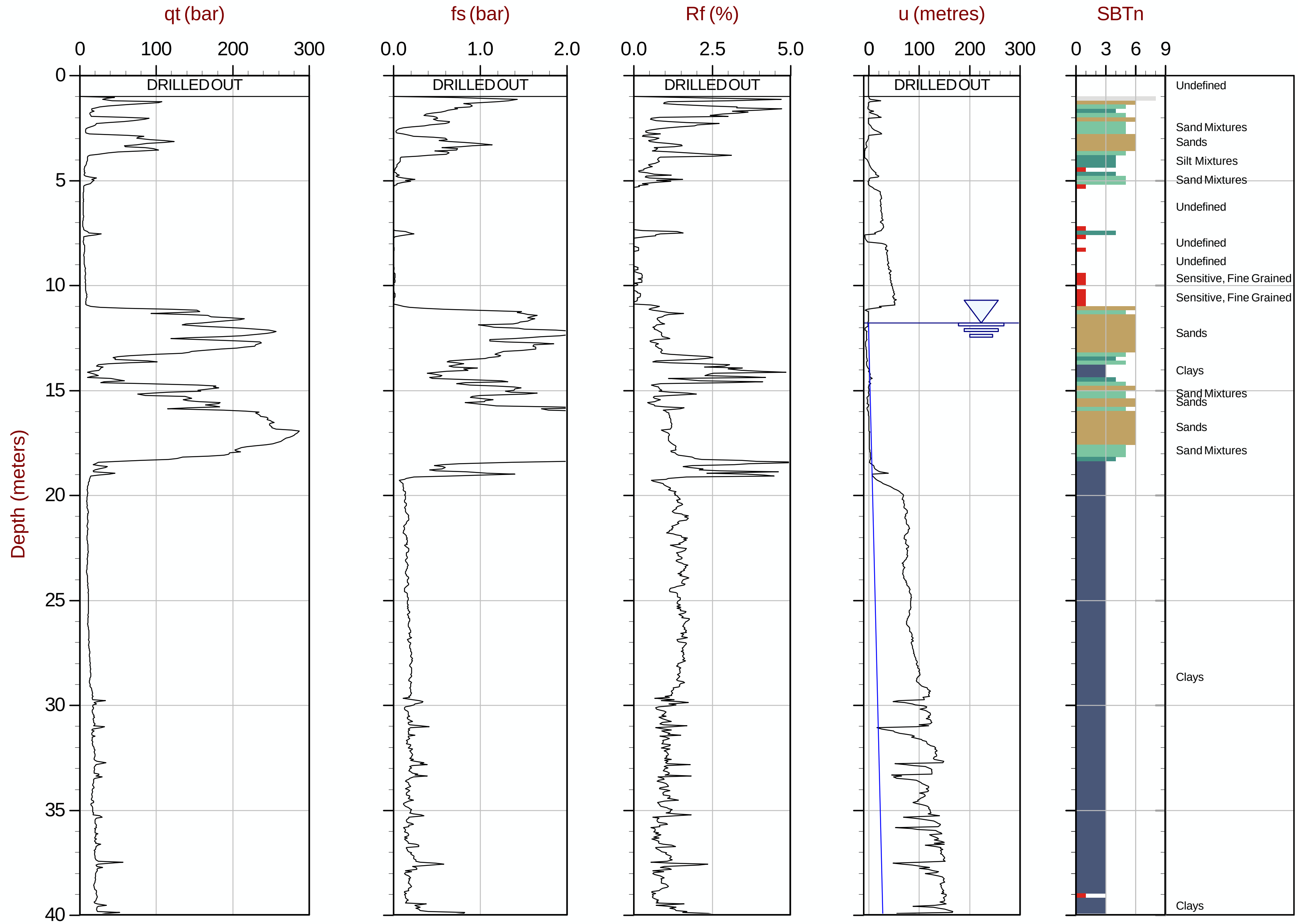
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 1

CONETEC

Golder

Job No: 07-208
Date: 08:28:07 11:49
Site: CPT07-32

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

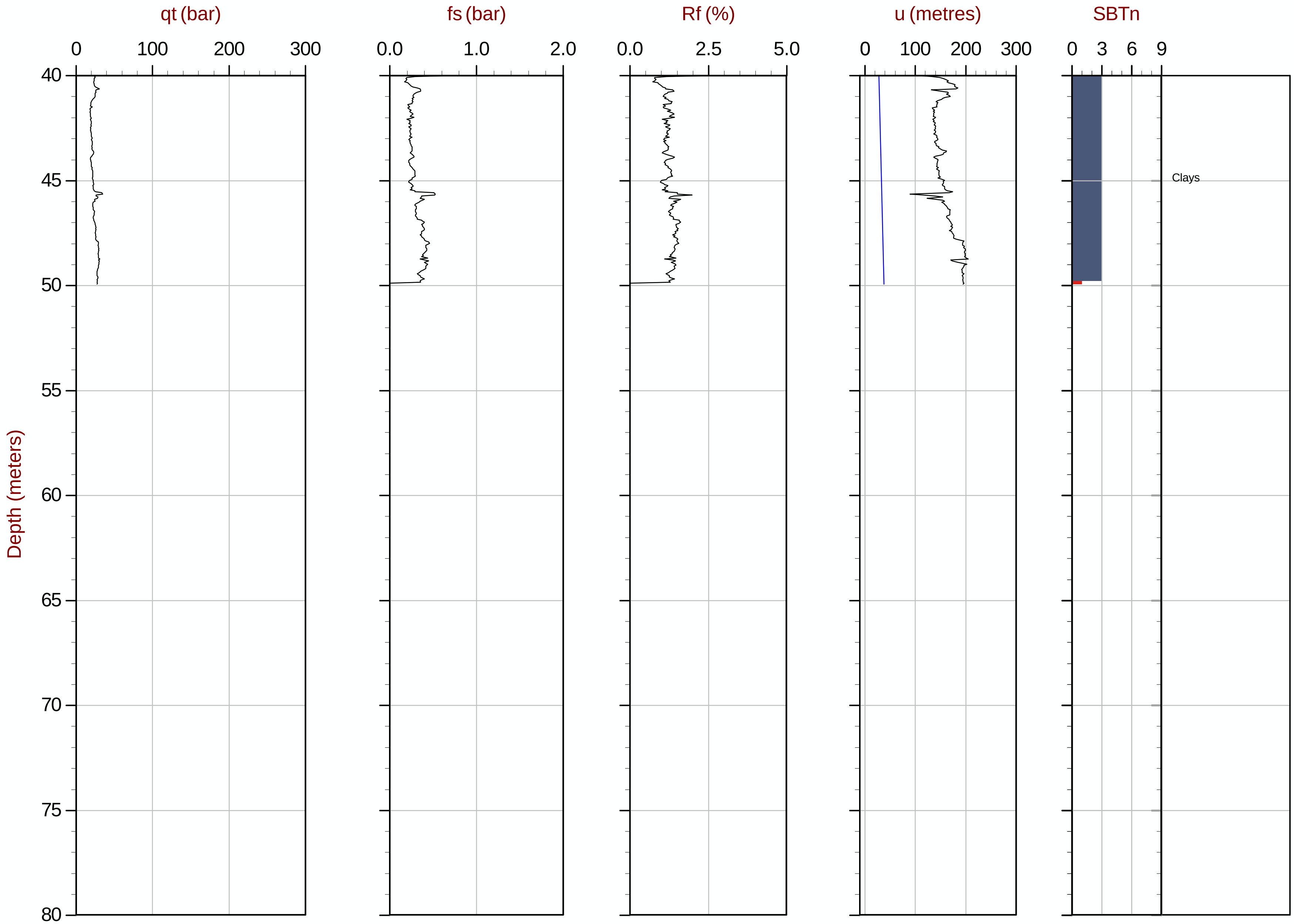
File: 208CP32.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

Golder

Job No: 07-208
Date: 08:28:07 11:49
Site: CPT07-32

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP32.COR
Unit Wt: SBT Chart Soil Zones

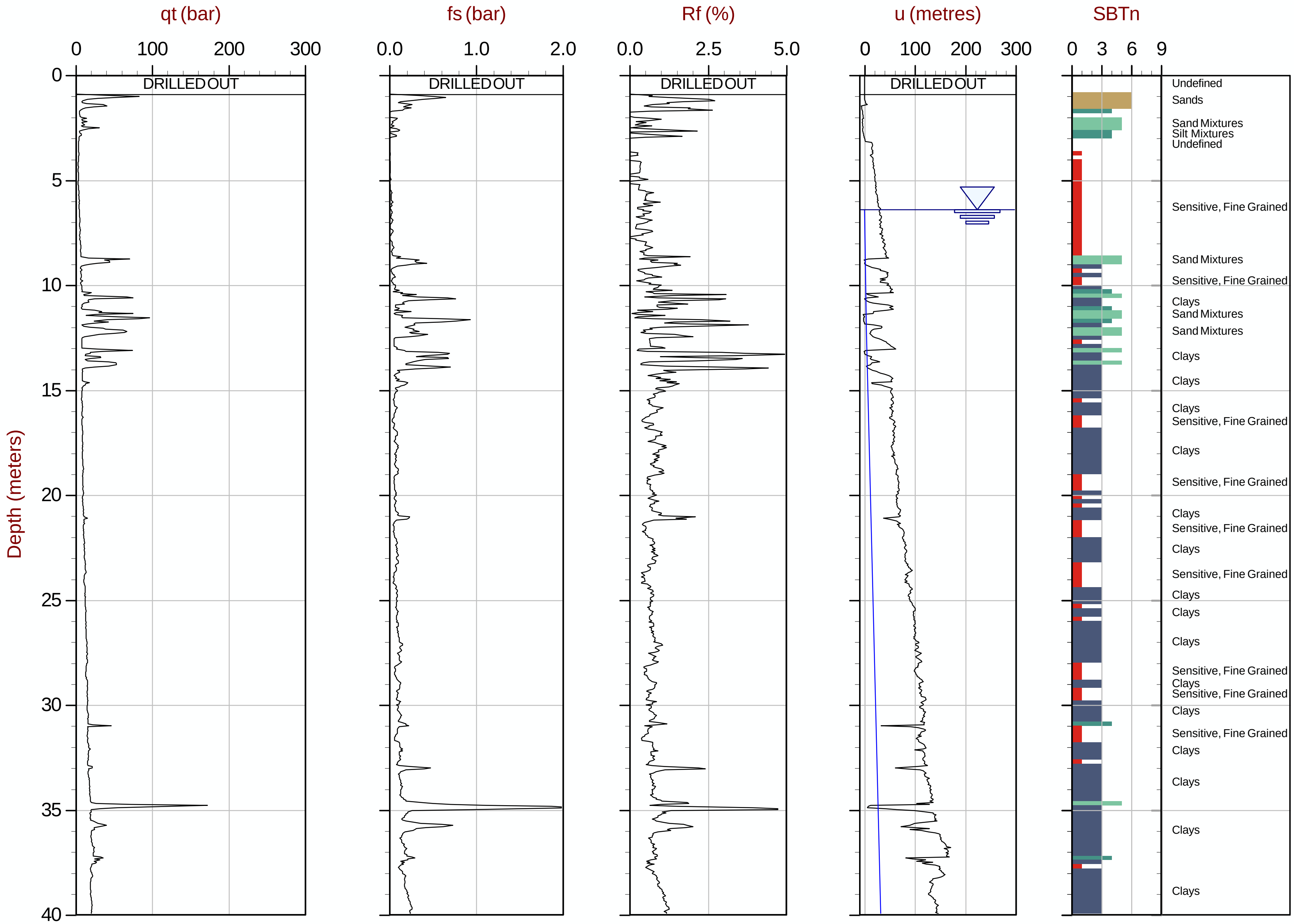
SBT: Lunne, Robertson and Powell, 1997

CONETEC

Golder

Job No: 07-208
Date: 08:30:07 08:57
Site: CPT07-33

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP33.COR
Unit Wt: SBT Chart Soil Zones

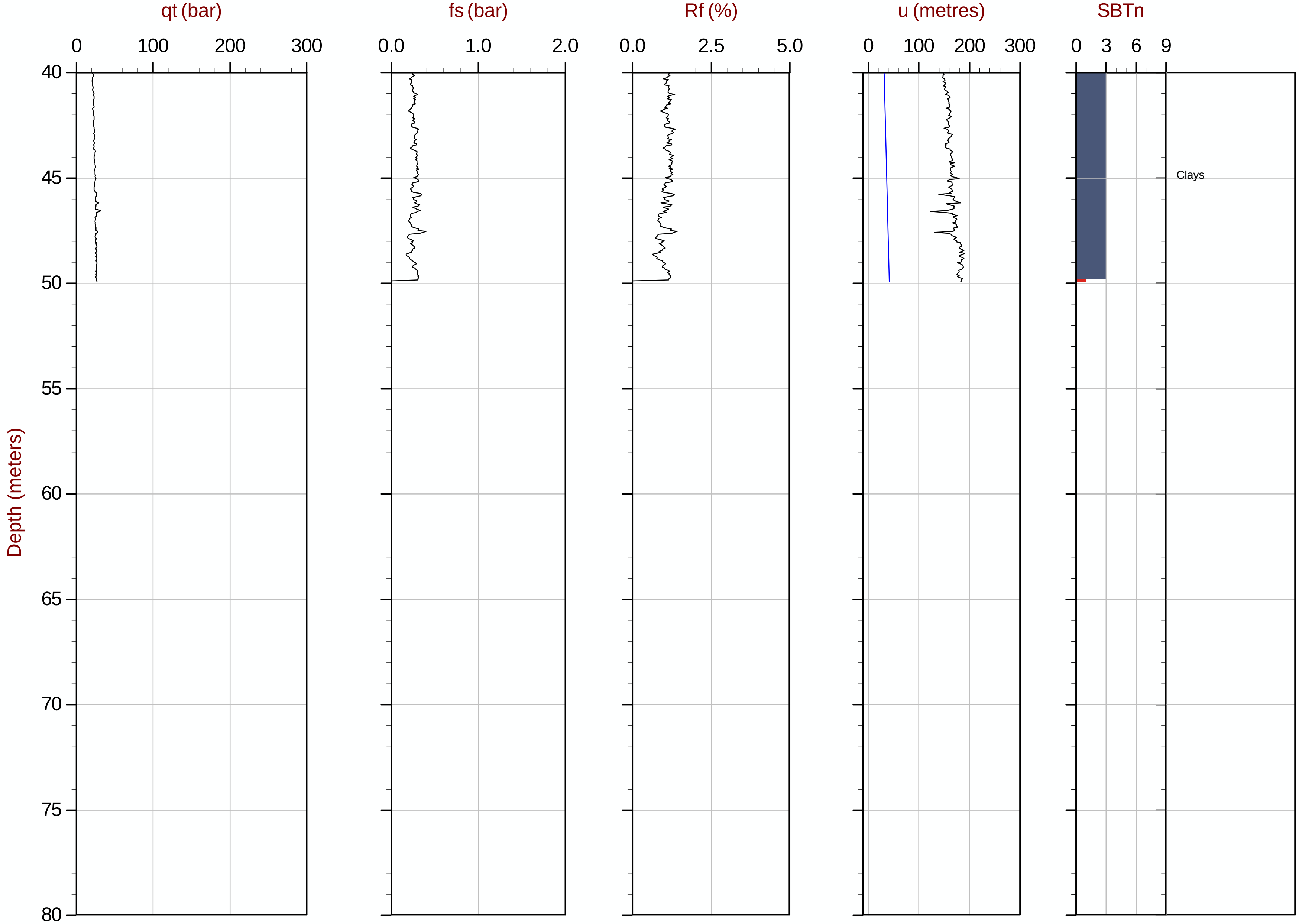
SBT: Lunne, Robertson and Powell, 1997
Page No: 1 of 2

CONETEC

Golder

Job No: 07-208
Date: 08:30:07 08:57
Site: CPT07-33

Sounding: FRASER R ESCARP
Cone: 20 TON 198



Max Depth: 49.950 m / 163.88 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP33.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997

APPENDIX V

SEISMIC CPT DATA - 2007 INVESTIGATION BY GOLDER ASSOCIATES LTD.

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-02
Date: June 25, 2007

Seismic Source: Beam
Source Offset (m): 1.00
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
2.25	2.05	2.28				
3.25	3.05	3.21	0.93	6.21	150	2.55
4.25	4.05	4.17	0.96	5.62	171	3.55
5.25	5.05	5.15	0.98	6.38	153	4.55
6.25	6.05	6.13	0.98	6.71	147	5.55
7.25	7.05	7.12	0.99	6.97	142	6.55
8.25	8.05	8.11	0.99	6.71	148	7.55
9.25	9.05	9.11	0.99	5.47	182	8.55
10.25	10.05	10.10	0.99	4.05	246	9.55
11.25	11.05	11.10	1.00	4.01	249	10.55
13.25	13.05	13.09	1.99	8.29	241	12.05
14.25	14.05	14.09	1.00	3.90	256	13.55
15.25	15.05	15.08	1.00	4.12	242	14.55
16.25	16.05	16.08	1.00	4.15	240	15.55
17.25	17.05	17.08	1.00	5.20	192	16.55
18.25	18.05	18.08	1.00	4.53	220	17.55
19.25	19.05	19.08	1.00	4.87	205	18.55
20.25	20.05	20.07	1.00	4.36	229	19.55
21.25	21.05	21.07	1.00	4.03	248	20.55
22.25	22.05	22.07	1.00	3.97	252	21.55
23.25	23.05	23.07	1.00	3.91	255	22.55
24.25	24.05	24.07	1.00	3.92	255	23.55
25.25	25.05	25.07	1.00	4.14	242	24.55
26.25	26.05	26.07	1.00	4.45	225	25.55
27.25	27.05	27.07	1.00	4.79	209	26.55
28.25	28.05	28.07	1.00	4.86	205	27.55
29.25	29.05	29.07	1.00	4.53	221	28.55
30.25	30.05	30.07	1.00	5.37	186	29.55
31.25	31.05	31.07	1.00	5.89	170	30.55
33.25	33.05	33.07	2.00	10.41	192	32.05
34.25	34.05	34.06	1.00	4.87	205	33.55
35.25	35.05	35.06	1.00	4.87	205	34.55
36.25	36.05	36.06	1.00	4.87	205	35.55
37.25	37.05	37.06	1.00	4.70	213	36.55
38.25	38.05	38.06	1.00	4.53	221	37.55

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-02
Date: June 25, 2007

Seismic Source: Beam
Source Offset (m): 1.00
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

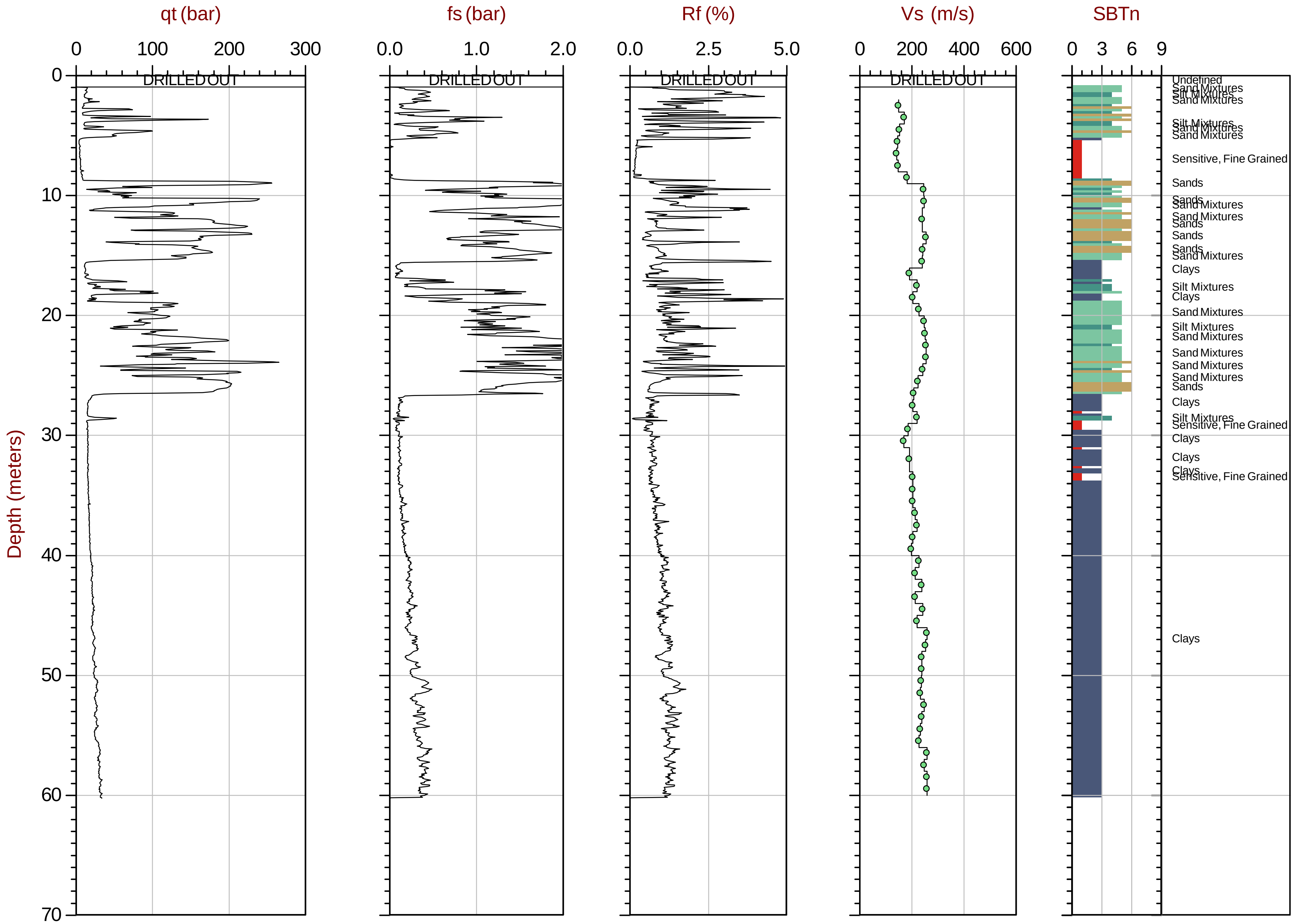
Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
39.25	39.05	39.06	1.00	4.87	205	38.55
40.25	40.05	40.06	1.00	5.03	199	39.55
41.25	41.05	41.06	1.00	4.36	229	40.55
42.25	42.05	42.06	1.00	4.70	213	41.55
43.25	43.05	43.06	1.00	4.19	239	42.55
44.25	44.05	44.06	1.00	4.70	213	43.55
45.25	45.05	45.06	1.00	4.13	242	44.55
46.25	46.05	46.06	1.00	4.53	221	45.55
47.25	47.05	47.06	1.00	3.86	259	46.55
48.25	48.05	48.06	1.00	3.94	254	47.55
49.25	49.05	49.06	1.00	4.19	239	48.55
50.25	50.05	50.06	1.00	4.19	239	49.55
51.25	51.05	51.06	1.00	4.20	238	50.55
52.25	52.05	52.06	1.00	4.30	233	51.55
53.25	53.05	53.06	1.00	4.03	248	52.55
54.25	54.05	54.06	1.00	4.19	239	53.55
55.25	55.05	55.06	1.00	4.30	233	54.55
56.25	56.05	56.06	1.00	4.36	229	55.55
57.25	57.05	57.06	1.00	3.86	259	56.55
58.25	58.05	58.06	1.00	4.03	248	57.55
59.25	59.05	59.06	1.00	3.86	259	58.55
60.25	60.05	60.06	1.00	3.86	259	59.55

CONETEC

Golder

Job No: 07-208
Date: 06:25:07 09:07
Site: SCPT07-02

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 60.300 m / 197.83 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP02.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Not Available
Page No: 1 of 1

CONETEC

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-08
Date: June 28, 2007

Seismic Source: Beam
Source Offset (m): 1.00
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
1.25	1.05	1.45				
2.25	2.05	2.28	0.83	9.86	84	1.55
3.25	3.05	3.21	0.93	5.93	157	2.55
4.25	4.05	4.17	0.96	4.98	193	3.55
5.25	5.05	5.15	0.98	7.06	138	4.55
6.25	6.05	6.13	0.98	9.52	103	5.55
7.25	7.05	7.12	0.99	7.37	134	6.55
8.25	8.05	8.11	0.99	5.54	179	7.55
9.25	9.05	9.11	0.99	4.23	235	8.55
10.25	10.05	10.10	0.99	4.38	227	9.55
11.25	11.05	11.10	1.00	4.16	239	10.55
12.25	12.05	12.09	1.00	4.50	221	11.55
13.25	13.05	13.09	1.00	4.73	211	12.55
14.25	14.05	14.09	1.00	5.51	181	13.55
15.25	15.05	15.08	1.00	5.19	192	14.55
16.25	16.05	16.08	1.00	4.89	204	15.55
17.25	17.05	17.08	1.00	4.45	224	16.55
18.25	18.05	18.08	1.00	4.81	208	17.55
19.25	19.05	19.08	1.00	4.15	240	18.55
20.25	20.05	20.07	1.00	4.65	215	19.55
21.25	21.05	21.07	1.00	4.76	210	20.55
22.25	22.05	22.07	1.00	4.85	206	21.55
23.25	23.05	23.07	1.00	4.55	220	22.55
24.25	24.05	24.07	1.00	4.50	222	23.55
25.25	25.05	25.07	1.00	4.01	249	24.55
26.25	26.05	26.07	1.00	4.26	235	25.55
27.25	27.05	27.07	1.00	3.88	257	26.55
28.25	28.05	28.07	1.00	4.01	249	27.55
29.25	29.05	29.07	1.00	4.03	248	28.55
30.25	30.05	30.07	1.00	3.49	286	29.55
31.25	31.05	31.07	1.00	3.74	267	30.55
32.25	32.05	32.07	1.00	3.72	269	31.55
33.25	33.05	33.07	1.00	3.77	265	32.55
34.25	34.05	34.06	1.00	3.65	274	33.55
35.25	35.05	35.06	1.00	5.04	198	34.55

Client:	Golder Associates Ltd.
Project:	Fraser River Escarpment, Maple Ridge, BC.
Sounding:	SCPT07-08
Date:	June 28, 2007

Seismic Source:	Beam
Source Offset (m):	1.00
Source Depth (m):	0.00
Geophone Offset (m):	0.20

SEISMIC

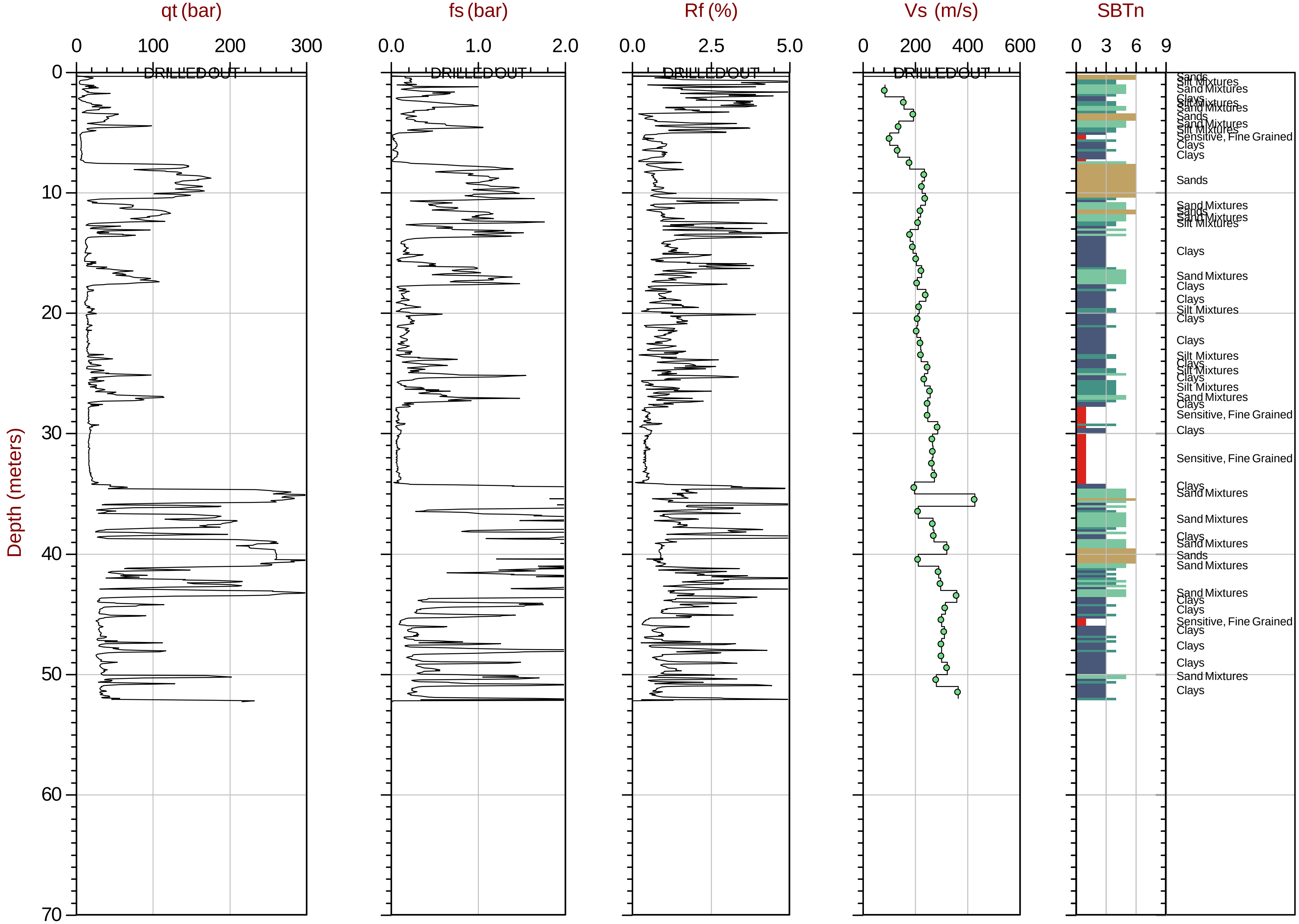
Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
36.25	36.05	36.06	1.00	2.34	428	35.55
37.25	37.05	37.06	1.00	4.75	211	36.55
38.25	38.05	38.06	1.00	3.73	268	37.55
39.25	39.05	39.06	1.00	3.69	271	38.55
40.25	40.05	40.06	1.00	3.13	320	39.55
41.25	41.05	41.06	1.00	4.74	211	40.55
42.25	42.05	42.06	1.00	3.44	290	41.55
43.25	43.05	43.06	1.00	3.36	298	42.55
44.25	44.05	44.06	1.00	2.79	359	43.55
45.25	45.05	45.06	1.00	3.17	316	44.55
46.25	46.05	46.06	1.00	3.32	301	45.55
47.25	47.05	47.06	1.00	3.21	311	46.55
48.25	48.05	48.06	1.00	3.33	300	47.55
49.25	49.05	49.06	1.00	3.33	300	48.55
50.25	50.05	50.06	1.00	3.11	322	49.55
51.25	51.05	51.06	1.00	3.57	280	50.55
52.25	52.05	52.06	1.00	2.75	364	51.55

ConeTec

Golder

Job No: 07-208
Date: 06:28:07 09:30
Site: SCPT07-08

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 52.300 m / 171.59 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP08.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Not Available
Page No: 1 of 1

ConeTec

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-09
Date: June 21, 2007

Seismic Source: Beam
Source Offset (m): 0.90
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
1.20	1.00	1.35				
2.20	2.00	2.19	0.85	4.53	187	1.50
3.20	3.00	3.13	0.94	6.12	154	2.50
4.20	4.00	4.10	0.97	5.81	166	3.50
5.20	5.00	5.08	0.98	5.97	164	4.50
6.20	6.00	6.07	0.99	5.61	176	5.50
7.20	7.00	7.06	0.99	5.11	194	6.50
8.20	8.00	8.05	0.99	5.83	170	7.50
9.20	9.00	9.04	0.99	5.21	191	8.50
10.20	10.00	10.04	1.00	5.19	192	9.50
11.20	11.00	11.04	1.00	5.29	188	10.50
12.20	12.00	12.03	1.00	5.18	192	11.50
13.20	13.00	13.03	1.00	6.40	156	12.50
14.20	14.00	14.03	1.00	5.57	179	13.50
15.20	15.00	15.03	1.00	5.29	189	14.50
16.20	16.00	16.03	1.00	5.91	169	15.50
17.20	17.00	17.02	1.00	5.89	169	16.50
18.20	18.00	18.02	1.00	5.76	173	17.50
19.20	19.00	19.02	1.00	5.39	185	18.50
20.20	20.00	20.02	1.00	5.47	183	19.50
21.20	21.00	21.02	1.00	5.62	178	20.50
22.20	22.00	22.02	1.00	5.74	174	21.50
23.20	23.00	23.02	1.00	6.23	160	22.50
24.20	24.00	24.02	1.00	5.81	172	23.50
25.20	25.00	25.02	1.00	5.21	192	24.50
26.20	26.00	26.02	1.00	4.53	221	25.50
27.20	27.00	27.01	1.00	4.30	232	26.50
28.20	28.00	28.01	1.00	3.85	260	27.50
29.20	29.00	29.01	1.00	3.85	260	28.50
30.20	30.00	30.01	1.00	3.62	276	29.50
31.20	31.00	31.01	1.00	3.70	270	30.50
32.20	32.00	32.01	1.00	3.92	255	31.50
33.20	33.00	33.01	1.00	3.51	285	32.50
34.20	34.00	34.01	1.00	3.63	275	33.50
35.20	35.00	35.01	1.00	4.17	240	34.50

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-09
Date: June 21, 2007

Seismic Source: Beam
Source Offset (m): 0.90
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

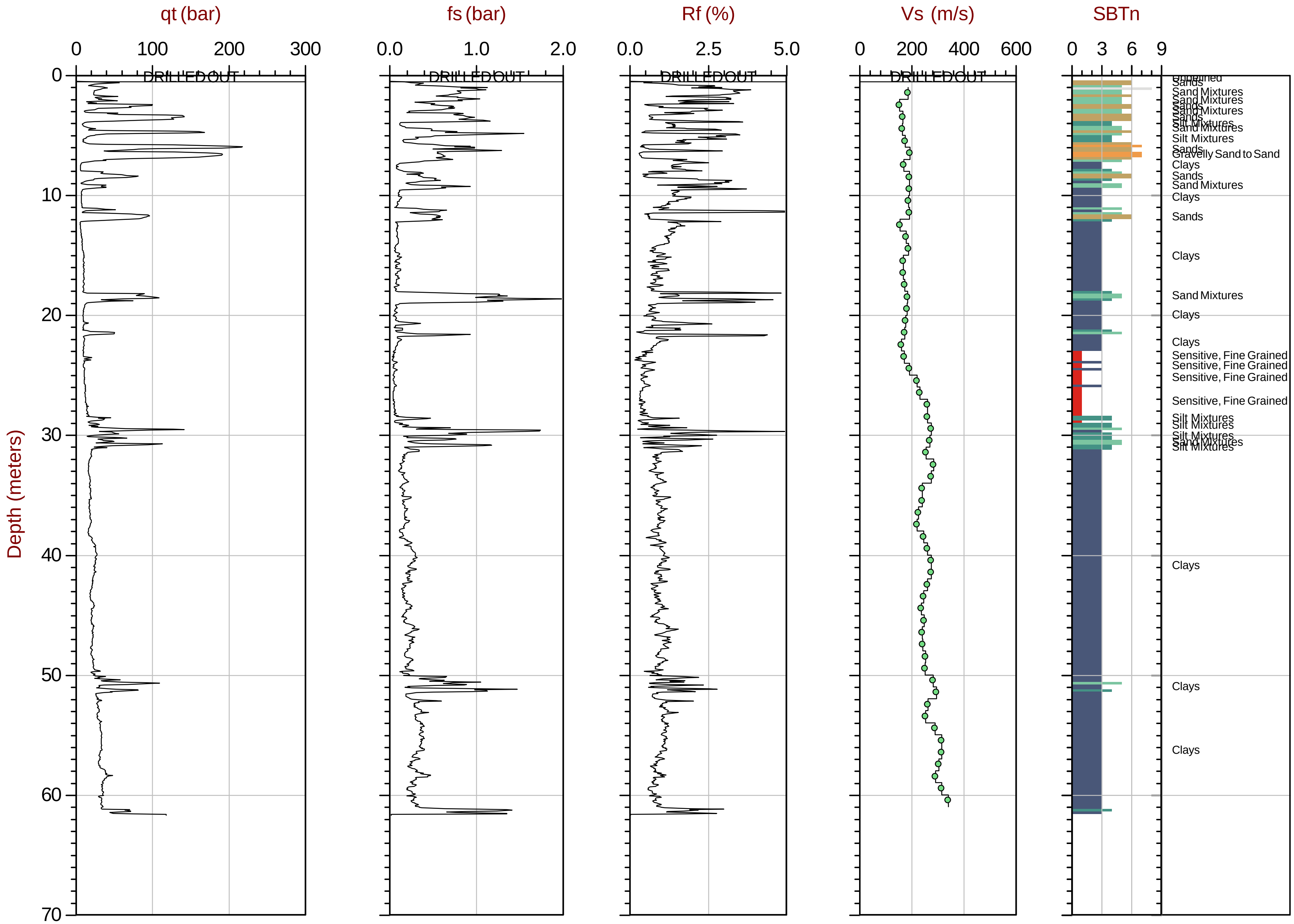
Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
36.20	36.00	36.01	1.00	4.17	240	35.50
37.20	37.00	37.01	1.00	4.43	226	36.50
38.20	38.00	38.01	1.00	4.55	220	37.50
39.20	39.00	39.01	1.00	4.06	247	38.50
40.20	40.00	40.01	1.00	3.85	260	39.50
41.20	41.00	41.01	1.00	3.62	276	40.50
42.20	42.00	42.01	1.00	3.62	276	41.50
43.20	43.00	43.01	1.00	3.85	260	42.50
44.20	44.00	44.01	1.00	4.06	246	43.50
45.20	45.00	45.01	1.00	4.20	238	44.50
46.20	46.00	46.01	1.00	4.02	249	45.50
47.20	47.00	47.01	1.00	4.17	240	46.50
48.20	48.00	48.01	1.00	4.13	242	47.50
49.20	49.00	49.01	1.00	3.95	253	48.50
50.20	50.00	50.01	1.00	3.98	252	49.50
51.20	51.00	51.01	1.00	3.53	283	50.50
52.20	52.00	52.01	1.00	3.39	295	51.50
53.20	53.00	53.01	1.00	3.82	262	52.50
54.20	54.00	54.01	1.00	3.96	253	53.50
55.20	55.00	55.01	1.00	3.45	290	54.50
56.20	56.00	56.01	1.00	3.17	315	55.50
57.20	57.00	57.01	1.00	3.16	316	56.50
58.20	58.00	58.01	1.00	3.28	305	57.50
59.20	59.00	59.01	1.00	3.42	292	58.50
60.20	60.00	60.01	1.00	3.17	315	59.50
61.20	61.00	61.01	1.00	2.94	340	60.50

CONETEC

Golder

Job No: 07-208
Date: 06:21:07 09:28
Site: SCPT07-09

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 61.700 m / 202.43 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP09.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Not Available
Page No: 1 of 1

Client:	Golder Associates Ltd.
Project:	Fraser River Escarpment, Maple Ridge, BC.
Sounding:	SCPT07-12
Date:	June 27, 2007

Seismic Source:	Beam
Source Offset (m):	0.95
Source Depth (m):	0.00
Geophone Offset (m):	0.20

SEISMIC

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
1.15	0.95	1.34				
2.15	1.95	2.17	0.83	3.30	250	1.45
3.15	2.95	3.10	0.93	6.05	154	2.45
4.15	3.95	4.06	0.96	6.13	157	3.45
5.15	4.95	5.04	0.98	4.82	203	4.45
6.15	5.95	6.03	0.99	5.08	194	5.45
7.15	6.95	7.01	0.99	3.67	270	6.45
8.15	7.95	8.01	0.99	3.63	273	7.45
9.15	8.95	9.00	0.99	3.67	271	8.45
10.15	9.95	10.00	0.99	3.10	321	9.45
11.15	10.95	10.99	1.00	3.32	300	10.45
12.15	11.95	11.99	1.00	3.28	304	11.45
13.15	12.95	12.98	1.00	4.08	245	12.45
14.15	13.95	13.98	1.00	4.00	249	13.45
15.15	14.95	14.98	1.00	3.87	258	14.45
16.15	15.95	15.98	1.00	3.76	265	15.45
17.15	16.95	16.98	1.00	4.24	236	16.45
18.15	17.95	17.98	1.00	5.32	188	17.45
19.15	18.95	18.97	1.00	5.50	182	18.45
20.15	19.95	19.97	1.00	4.66	214	19.45
21.15	20.95	20.97	1.00	4.77	210	20.45
22.15	21.95	21.97	1.00	4.89	205	21.45
23.15	22.95	22.97	1.00	3.62	276	22.45
24.15	23.95	23.97	1.00	3.79	264	23.45
25.15	24.95	24.97	1.00	2.85	350	24.45
26.15	25.95	25.97	1.00	4.11	243	25.45
27.15	26.95	26.97	1.00	3.92	255	26.45
28.15	27.95	27.97	1.00	3.45	290	27.45
29.15	28.95	28.97	1.00	3.58	279	28.45
30.15	29.95	29.97	1.00	2.97	336	29.45
31.15	30.95	30.96	1.00	4.23	236	30.45
32.15	31.95	31.96	1.00	3.73	268	31.45
33.15	32.95	32.96	1.00	3.71	269	32.45
34.15	33.95	33.96	1.00	3.90	256	33.45
35.15	34.95	34.96	1.00	3.95	253	34.45

Client: Golder Associates Ltd.
Project: Fraser River Escarpment, Maple Ridge, BC.
Sounding: SCPT07-12
Date: June 27, 2007

Seismic Source: Beam
Source Offset (m): 0.95
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SEISMIC

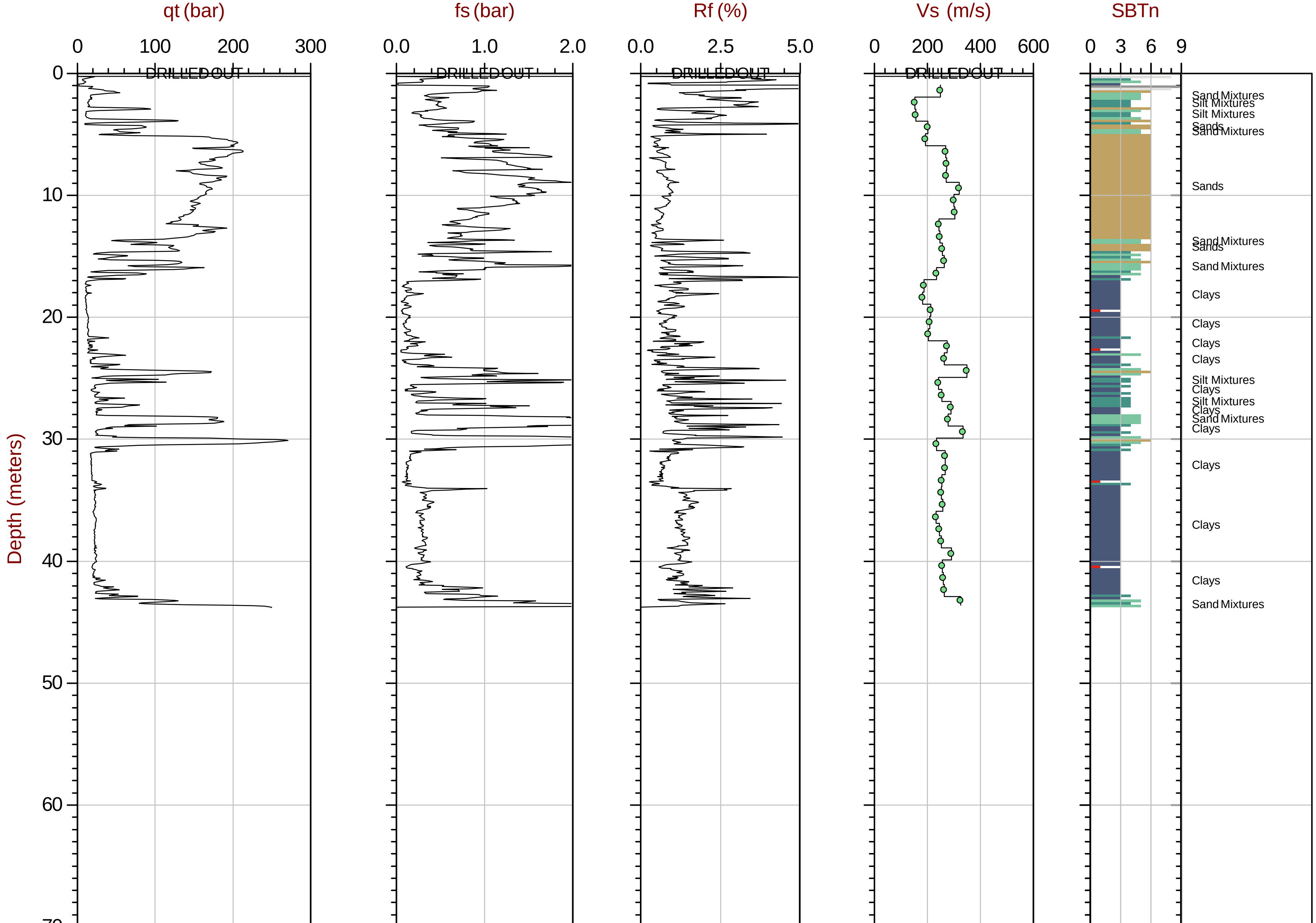
Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Depth Interval (m)	Time Interval (ms)	Vs (m/s)	Mid Layer (m)
36.15	35.95	35.96	1.00	3.86	259	35.45
37.15	36.95	36.96	1.00	4.27	234	36.45
38.15	37.95	37.96	1.00	4.07	246	37.45
39.15	38.95	38.96	1.00	3.94	254	38.45
40.15	39.95	39.96	1.00	3.43	291	39.45
41.15	40.95	40.96	1.00	3.88	257	40.45
42.15	41.95	41.96	1.00	3.83	261	41.45
43.15	42.95	42.96	1.00	3.78	264	42.45
43.85	43.65	43.66	0.70	2.15	326	43.30

CONETEC

Golder

Job No: 07-208
Date: 06:27:07 12:17
Site: SCPT07-12

Sounding: Fraser R Escarp.
Cone: 20 TON 213



Max Depth: 43.850 m / 143.86 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 208CP12.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Not Available
Page No: 1 of 1

APPENDIX VI

CPT DISSIPATION TEST DATA - 2007 INVESTIGATION BY GOLDER ASSOCIATES LTD.

Table VI-1
Summary of CPT Dissipation Tests
Fraser River Escarpment Maple Ridge, BC

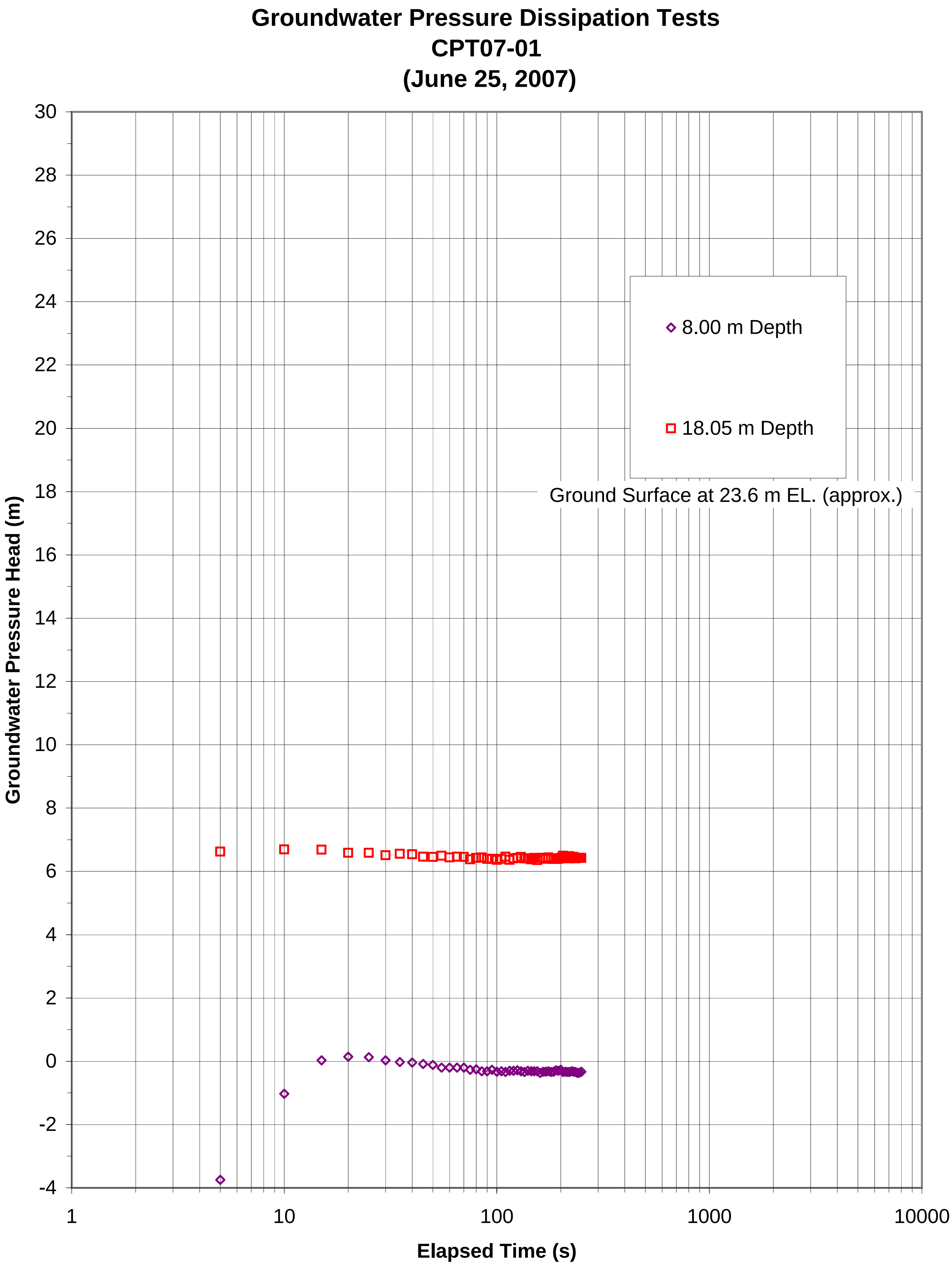
CPT Sounding	Date of Tests	Approx. Elevation of Ground Surface (m geodetic)	Test Depth (m)	Approx. Test Elevation (m geodetic)	Test Duration (s)	Equilibrium Pressure Head (m)
CPT07-01	25-Jun-07	23.6	8.00	15.60	250	-0.32
			18.05	5.55	250	6.42
SCPT07-02	25-Jun-07	25.0	9.00	16.00	600	-0.61
			19.00	6.00	250	8.13
			24.00	1.00	800	12.95
CPT07-03	19-Jun-07	25.7	5.00	20.70	305	2.92
			8.00	17.70	500	4.46
			11.10	14.60	300	6.50
			30.35	-4.65	1240	n/a (< 26.9 m)
			34.60	-8.90	1000	n/a (< 30.8 m)
			36.85	-11.15	630	31.33
			37.70	-12.00	1150	32.23
CPT07-04	26-Jun-07	24.8	13.00	11.80	400	5.68
			16.60	8.20	800	8.99
			36.15	-11.35	250	24.01
CPT07-05	18-Jun-07	25.5	3.20	22.30	300	0.95
			4.20	21.30	350	0.82
			7.30	18.20	250	n/a (< 1.3 m)
			8.30	17.20	300	6.23
			29.65	-4.15	600	25.98
CPT07-06	26-Jun-07	26.3	6.15	20.15	655	3.59
			10.10	16.20	1800	8.06
			15.15	11.15	600	12.74
			34.75	-8.45	1020	n/a (< 32.4 m)
CPT07-07	18-Jun-07	27.0	10.15	16.85	650	n/a (< 2.4 m)
			13.65	13.35	300	2.90
			14.50	12.50	300	3.80
			26.85	0.15	300	9.97
			49.40	-22.40	600	33.06
SCPT07-08	28-Jun-07	32.0	7.75	24.25	450	1.42
			16.50	15.50	900	2.17
			25.25	6.75	1500	n/a (< 7.8 m)
			34.50	-2.50	1250	n/a (< 11.6 m)
			39.15	-7.15	695	14.07
SCPT07-09	21-Jun-07	31.9	50.65	-18.75	700	n/a (< 52.2 m)
			61.70	-29.80	2250	n/a (< 62.5 m)
CPT07-10	29-Jun-07	33.4	13.55	19.85	1250	n/a (< 0.6 m)
			22.50	10.90	1000	8.41
			42.50	-9.10	600	24.79
CPT07-11	21-Jun-07	32.5	6.00	26.50	250	3.95
			14.50	18.00	250	12.00
			25.10	7.40	1250	23.21
SCPT07-12	27-Jun-07	34.0	7.00	27.00	1100	n/a (> -0.4 m)
			14.15	19.85	800	2.78
			24.50	9.50	400	n/a (< 4.7 m)
			30.15	3.85	600	9.62
			43.45	-9.45	300	15.49
CPT07-13	22-Jun-07	33.0	6.00	27.00	300	2.66
			37.20	-4.20	600	n/a (> 10.4 m)
CPT07-14	27-Jun-07	33.5	11.75	21.75	850	1.84
			18.00	15.50	1215	5.14
			23.45	10.05	780	11.34

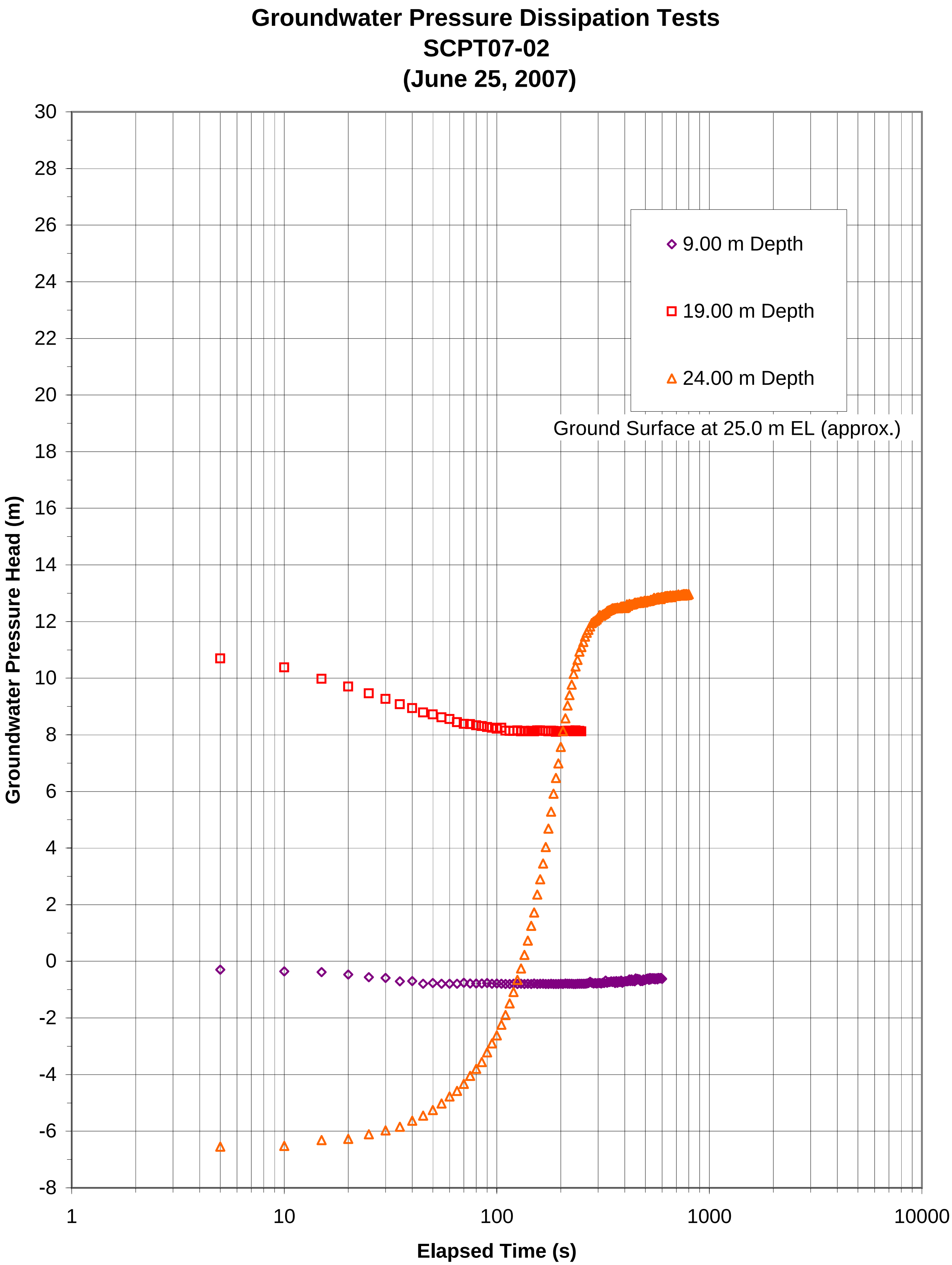
Table VI-1
Summary of CPT Dissipation Tests
Fraser River Escarpment Maple Ridge, BC

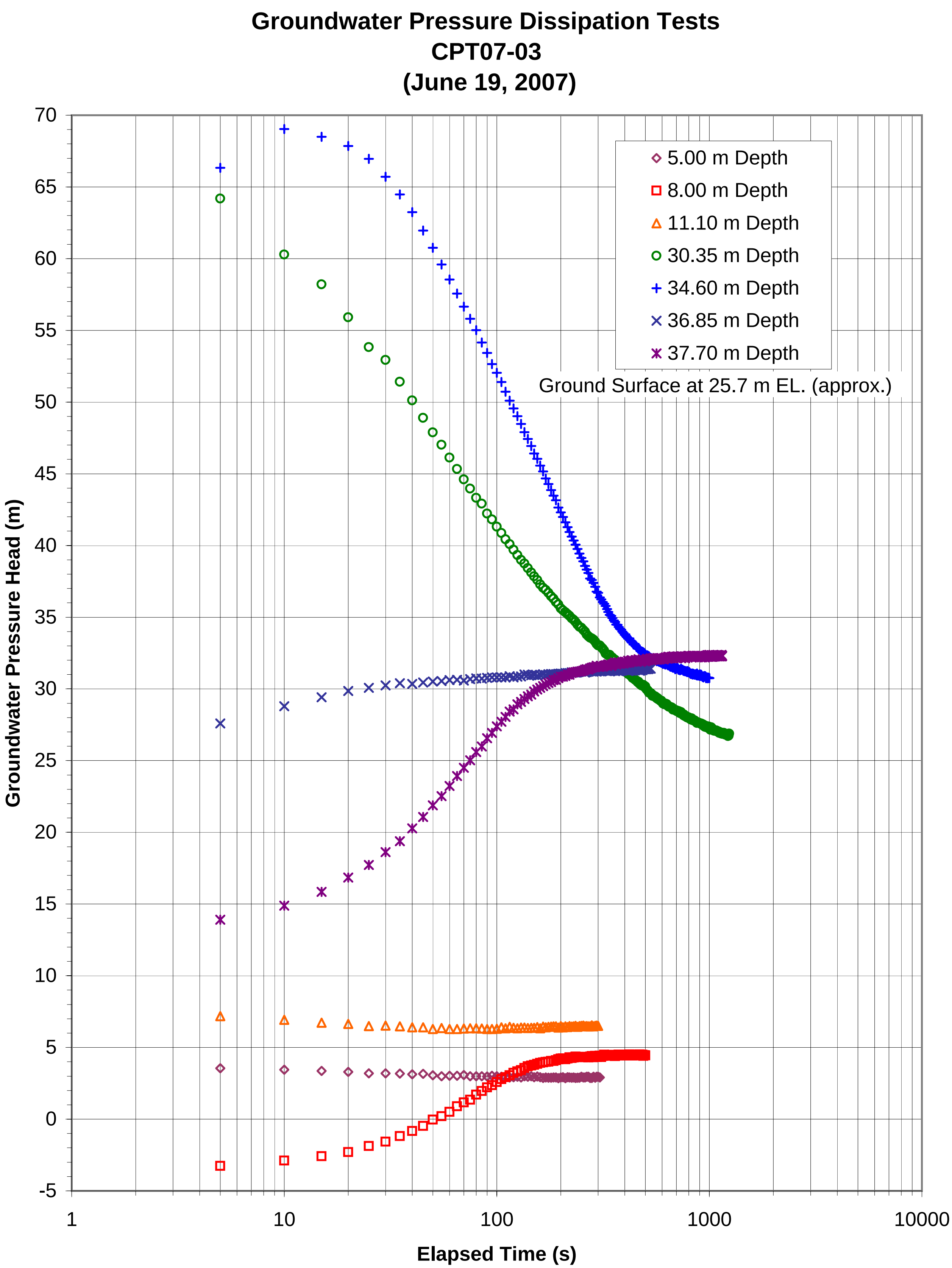
CPT Sounding	Date of Tests	Approx. Elevation of Ground Surface (m geodetic)	Test Depth (m)	Approx. Test Elevation (m geodetic)	Test Duration (s)	Equilibrium Pressure Head (m)
CPT07-15	22-Jun-07	35.3	8.15	27.15	1000	n/a (> 2.4 m)
			14.15	21.15	900	8.41
			25.00	10.30	700	17.07
			32.05	3.25	1300	n/a (> 17.0 m)
CPT07-16	20-Jun-07	36.0	4.65	31.35	255	-0.10
			5.00	31.00	500	0.15
			12.50	23.50	850	5.17
			21.95	14.05	250	13.85
			27.50	8.50	200	19.49
			40.00	-4.00	900	n/a (> 27.2 m)
CPT07-17	19-Jun-07	33.0	11.00	22.00	2300	n/a (> 1.7 m)
			21.20	11.80	600	13.10
			29.05	3.95	250	19.58
CPT07-18	22-Aug-07	35.7	6.25	29.45	1200	0.11
			10.50	25.20	800	0.03
			15.25	20.45	1400	3.00
			20.25	15.45	1100	8.04
			27.30	8.40	200	15.60
CPT07-19	22-Aug-07	36.0	6.50	29.50	605	0.09
			9.65	26.35	560	-0.15
			12.75	23.25	1900	n/a (> 1.6 m)
			25.05	10.95	600	14.38
			28.35	7.65	900	17.81
			43.55	-7.55	800	30.55
CPT07-20	21-Aug-07	35.0	9.60	25.40	600	0.59
			18.50	16.50	600	6.64
			24.00	11.00	600	12.10
			38.20	-3.20	600	15.11
CPT07-21	23-Aug-07	35.3	5.00	30.30	770	0.53
			9.00	26.30	1200	4.11
			13.50	21.80	700	5.72
			36.50	-1.20	900	22.07
			40.50	-5.20	600	26.01
CPT07-22	23-Aug-07	33.0	5.00	28.00	600	1.56
			8.00	25.00	600	4.54
			12.25	20.75	600	8.74
			16.25	16.75	700	12.69
			20.00	13.00	700	16.38
			39.25	-6.25	600	25.87
CPT07-23	21-Aug-07	33.5	5.00	28.50	905	1.62
			6.25	27.25	900	2.83
			14.20	19.30	1200	3.07
			17.60	15.90	800	5.60
			19.75	13.75	600	7.78
			25.05	8.45	930	8.21
			33.25	0.25	1300	2.92
CPT07-24	24-Aug-07	33.5	6.75	26.75	600	3.79
			10.50	23.00	800	7.51
			14.45	19.05	600	11.40
			31.25	2.25	600	13.97
			44.30	-10.80	800	26.27
CPT07-25	24-Aug-07	33.2	5.50	27.70	600	2.44
			12.10	21.10	600	8.85
			17.75	15.45	600	13.23
			22.50	10.70	600	16.81
			38.60	-5.40	605	n/a (< 22.9 m)
			43.35	-10.15	300	26.47

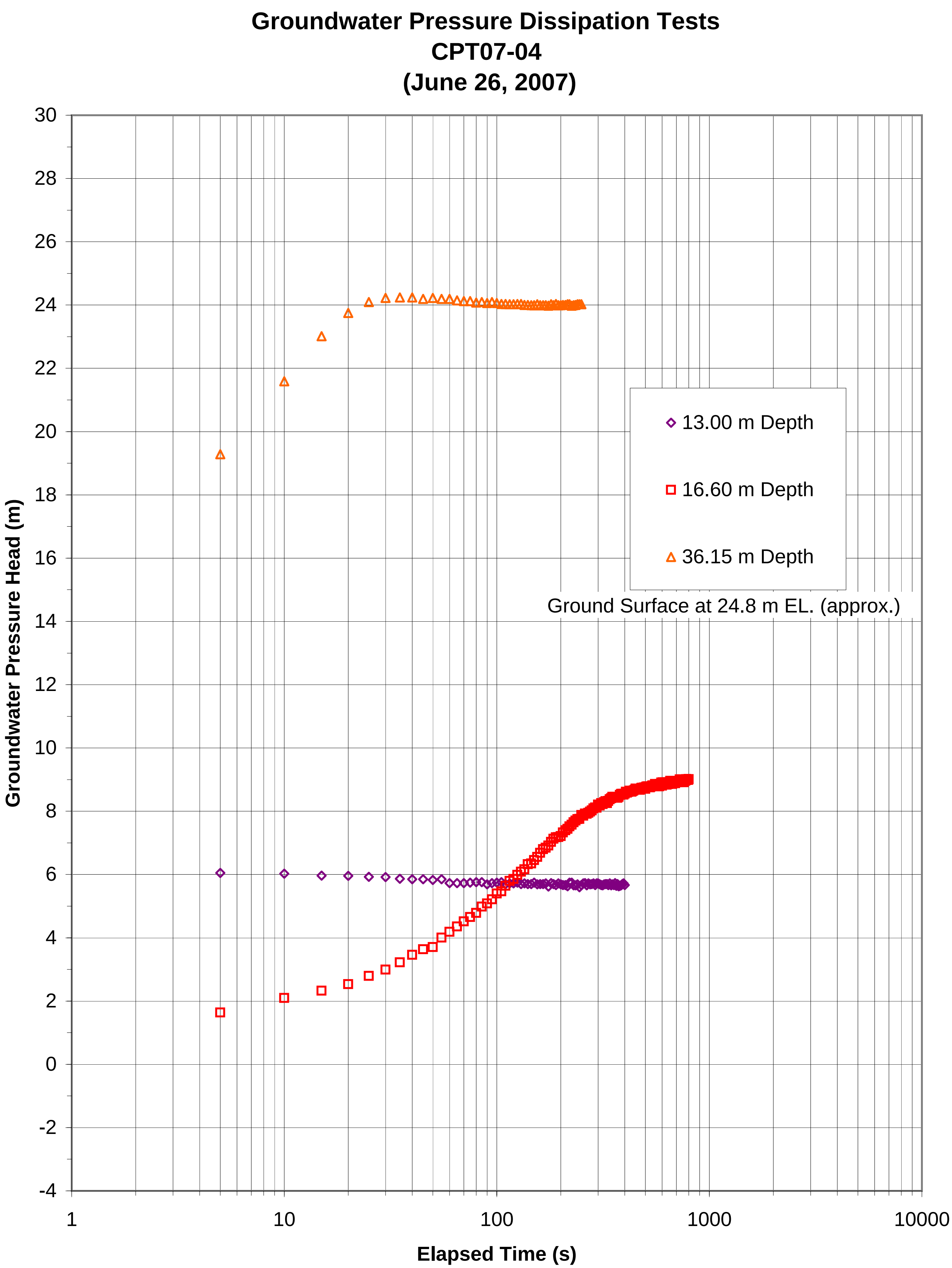
Table VI-1
Summary of CPT Dissipation Tests
Fraser River Escarpment Maple Ridge, BC

CPT Sounding	Date of Tests	Approx. Elevation of Ground Surface (m geodetic)	Test Depth (m)	Approx. Test Elevation (m geodetic)	Test Duration (s)	Equilibrium Pressure Head (m)
CPT07-26	20-Aug-07	32.5	11.00	21.50	2500	n/a (< 8.7 m)
			15.30	17.20	900	9.85
			35.80	-3.30	910	18.95
CPT07-27	30-Aug-07	29.6	6.90	22.70	900	1.36
			10.85	18.75	600	2.36
			12.10	17.50	600	3.45
			13.50	16.10	950	4.38
			21.70	7.90	1300	n/a (< 8.8 m)
			28.75	0.85	800	n/a (< 15.1 m)
CPT07-28	20-Aug-07	28.8	3.15	25.65	600	0.85
			4.65	24.15	600	2.50
			6.50	22.30	400	4.09
			7.55	21.25	890	5.06
			8.05	20.75	600	5.63
			14.30	14.50	605	11.48
			34.70	-5.90	905	26.02
CPT07-29	29-Aug-07	26.2	3.40	22.80	405	n/a (< 1.1 m)
			5.15	21.05	600	0.98
			7.30	18.90	850	n/a (< 0.5 m)
			8.50	17.70	600	1.51
			10.90	15.30	700	3.84
CPT07-30	29-Aug-07	25.1	3.50	21.60	585	0.34
			4.80	20.30	890	0.30
			9.60	15.50	800	0.86
			11.20	13.90	1100	2.54
			18.65	6.45	650	9.73
			29.60	-4.50	600	19.39
CPT07-31	28-Aug-07	25.5	4.40	21.10	600	0.55
			15.50	10.00	600	9.85
			30.80	-5.30	600	23.30
			34.95	-9.45	600	26.95
			39.55	-14.05	1010	32.39
CPT07-32	28-Aug-07	25.2	12.20	13.00	1400	0.39
			15.70	9.50	600	3.86
CPT07-33	30-Aug-07	21.7	8.80	12.90	600	1.66
			10.65	11.05	600	2.95
			11.40	10.30	600	3.65
			13.85	7.85	750	5.79
			34.85	-13.15	600	26.35

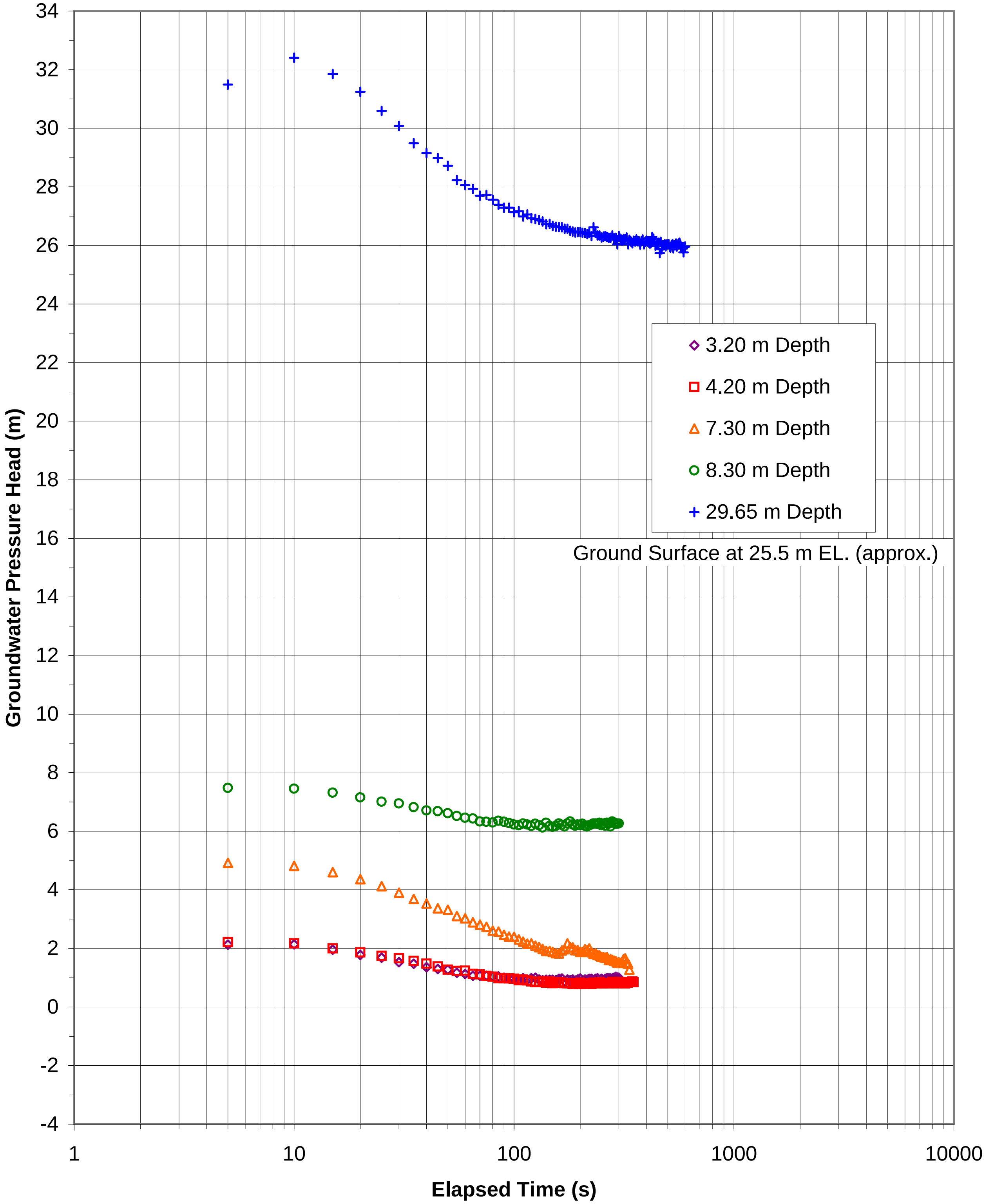

Groundwater Pressure Dissipation Tests
CPT07-01
(June 25, 2007)
8.00 m Depth
18.05 m Depth
Ground Surface at 23.6 m EL. (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000

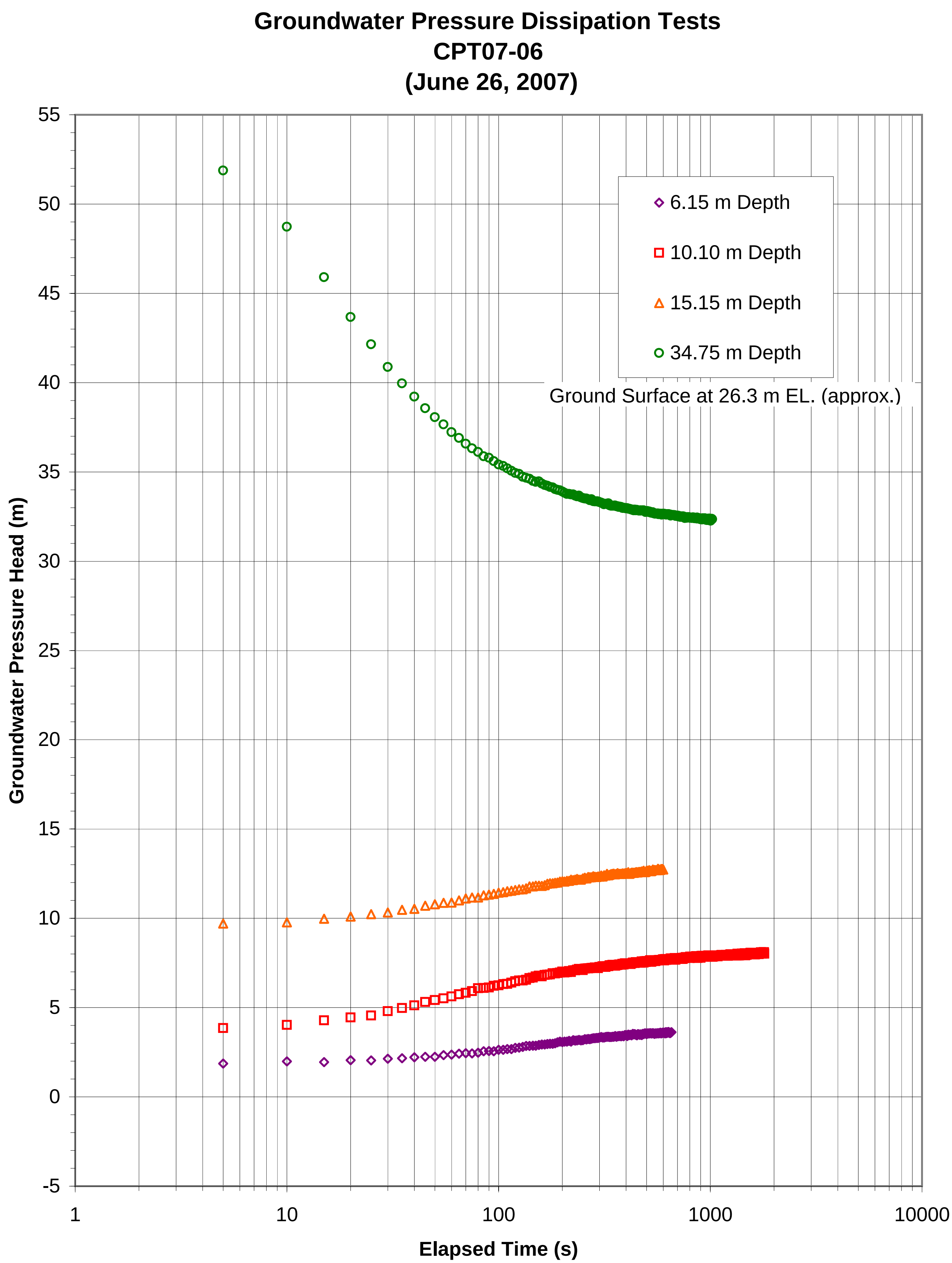

Groundwater Pressure Dissipation Tests
SCPT07-02
(June 25, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
1
10
100
1000
10000
9.00 m Depth
19.00 m Depth
24.00 m Depth
Ground Surface at 25.0 m EL (approx.)


Groundwater Pressure Dissipation Tests
CPT07-03
(June 19, 2007)
5.00 m Depth
8.00 m Depth
11.10 m Depth
30.35 m Depth
34.60 m Depth
36.85 m Depth
37.70 m Depth
Ground Surface at 25.7 m EL. (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
1
10
100
1000
10000


Groundwater Pressure Dissipation Tests
CPT07-04
(June 26, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
13.00 m Depth
16.60 m Depth
36.15 m Depth
Ground Surface at 24.8 m EL. (approx.)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000

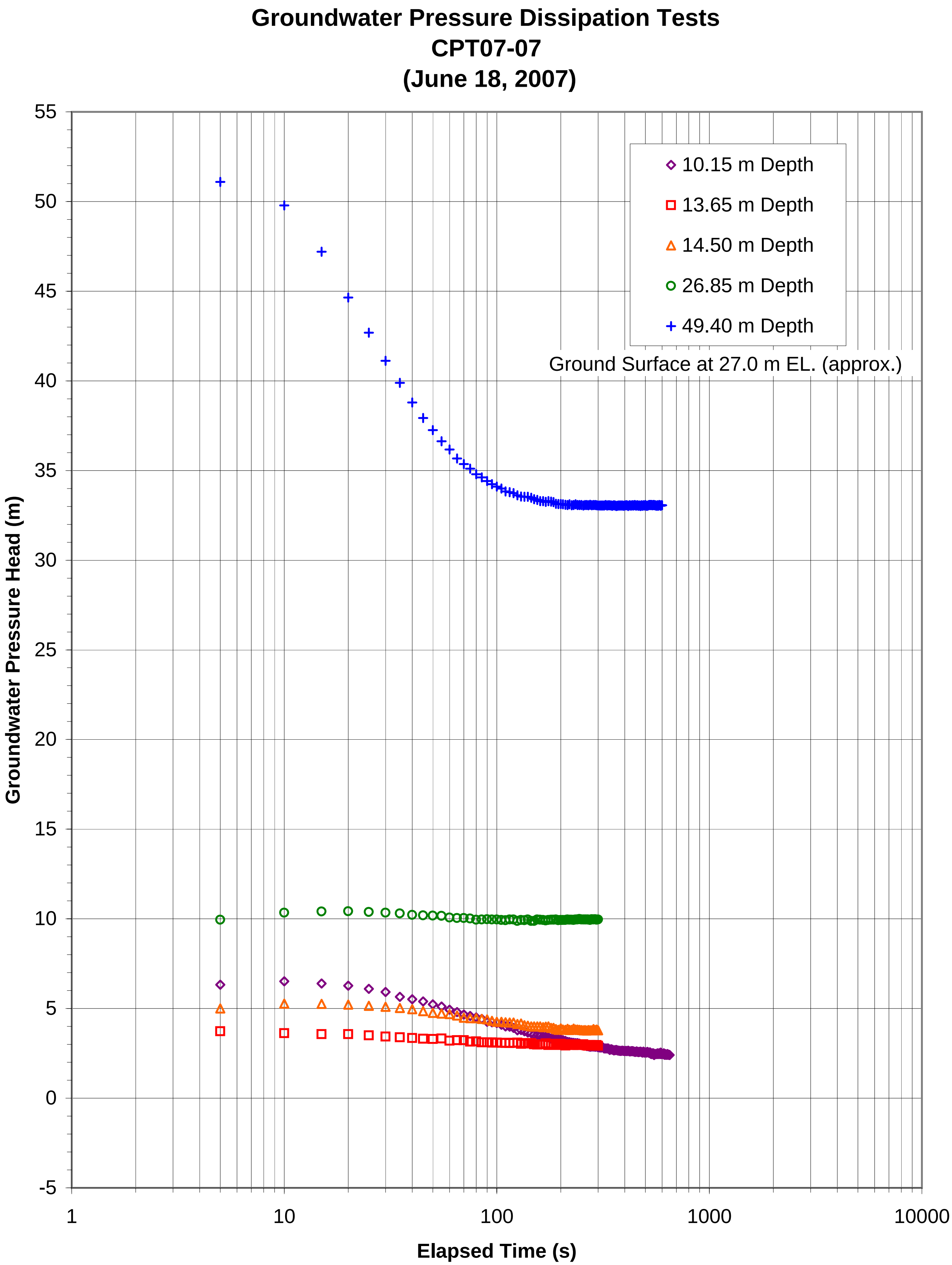
Groundwater Pressure Dissipation Tests
CPT07-05
(June 18, 2007)



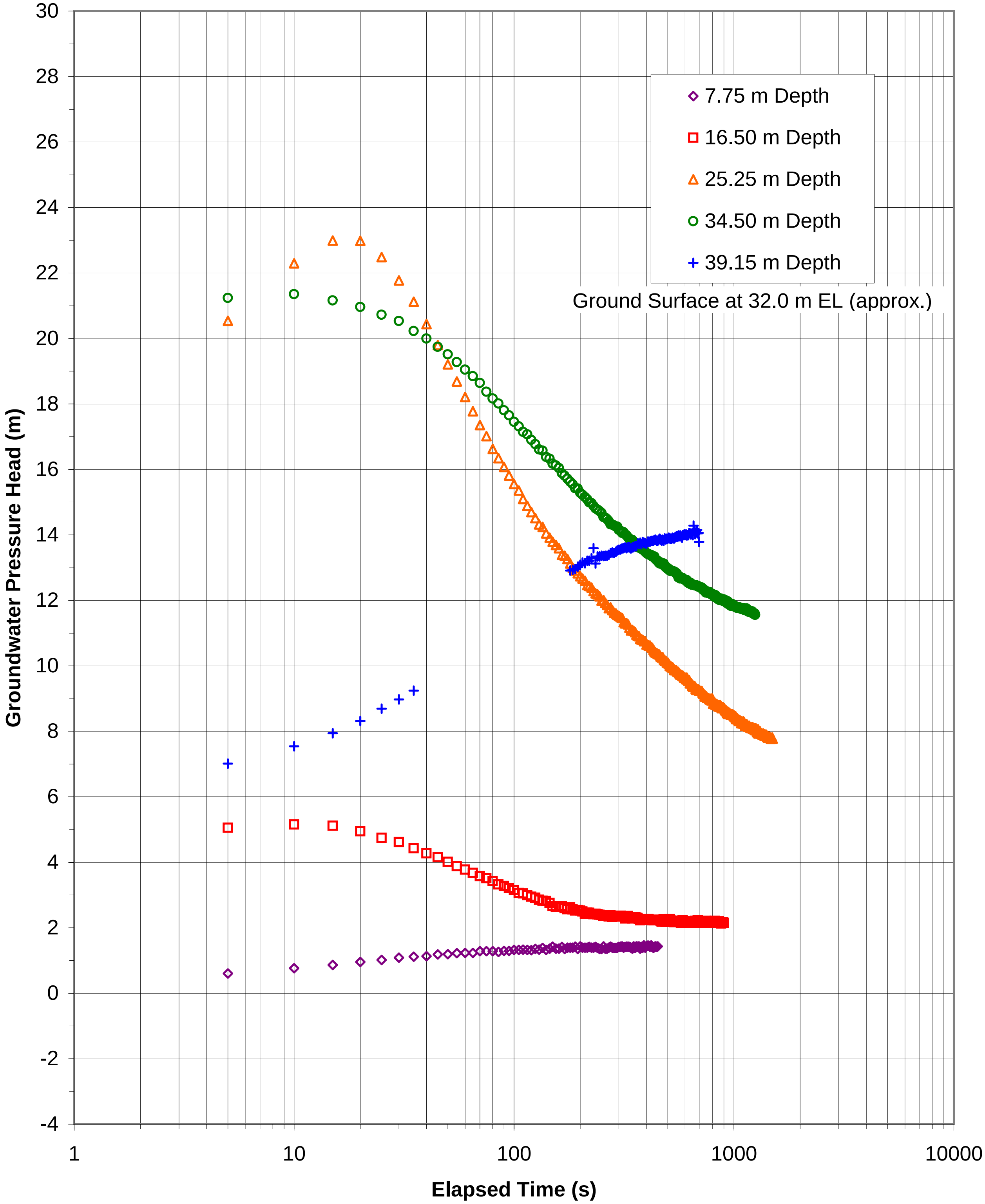

Groundwater Pressure Dissipation Tests
CPT07-06
(June 26, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
6.15 m Depth
10.10 m Depth
15.15 m Depth
34.75 m Depth
Ground Surface at 26.3 m EL. (approx.)
55
50
45
40
35
30
25
20
15
10
5
0
-5
1
10
100
1000
10000

Fraser River Escarpment
Maple Ridge, BC

07-1414-0096



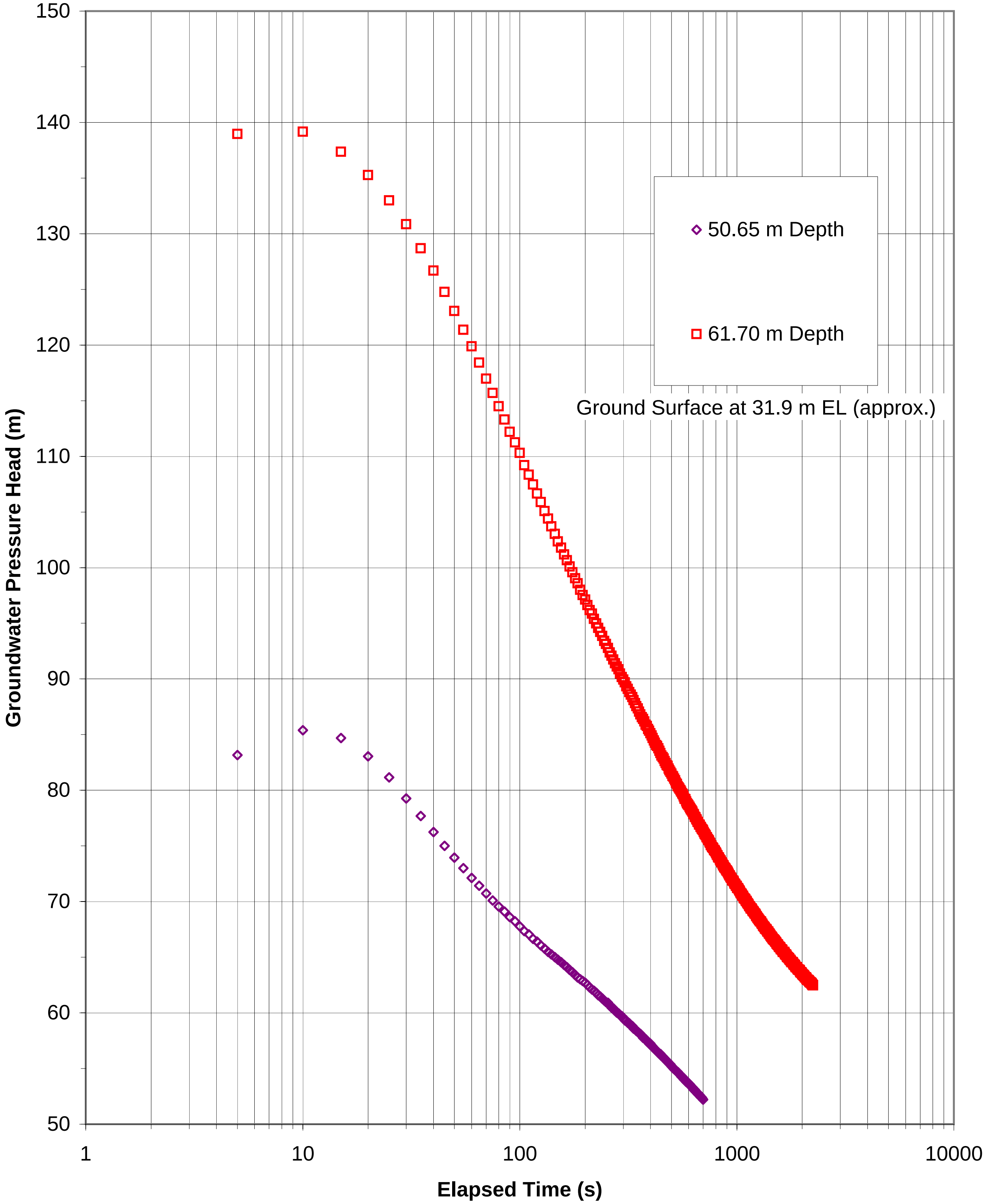
Groundwater Pressure Dissipation Tests
SCPT07-08
(June 28, 2007)



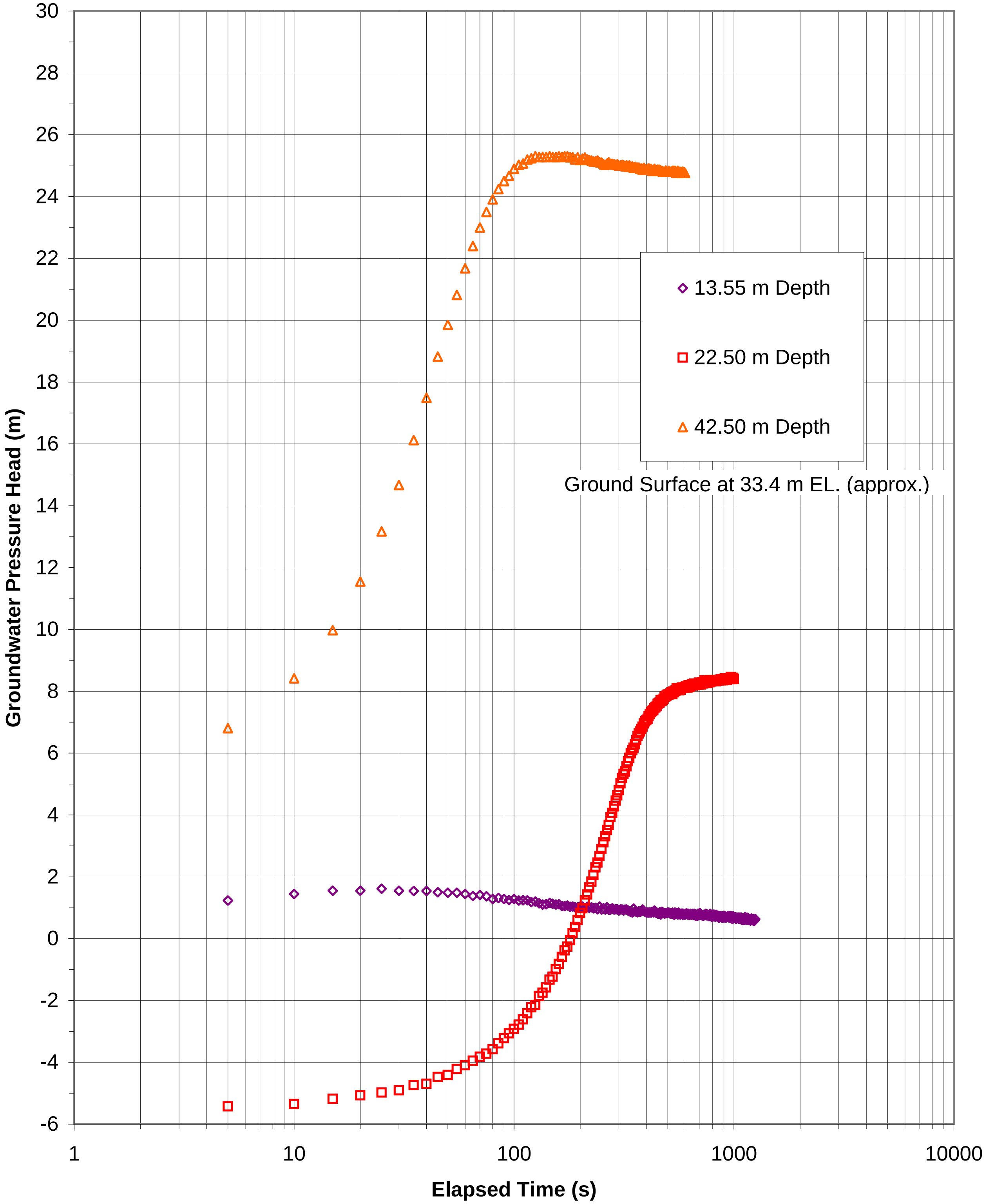
Fraser River Escarpment
Maple Ridge, BC

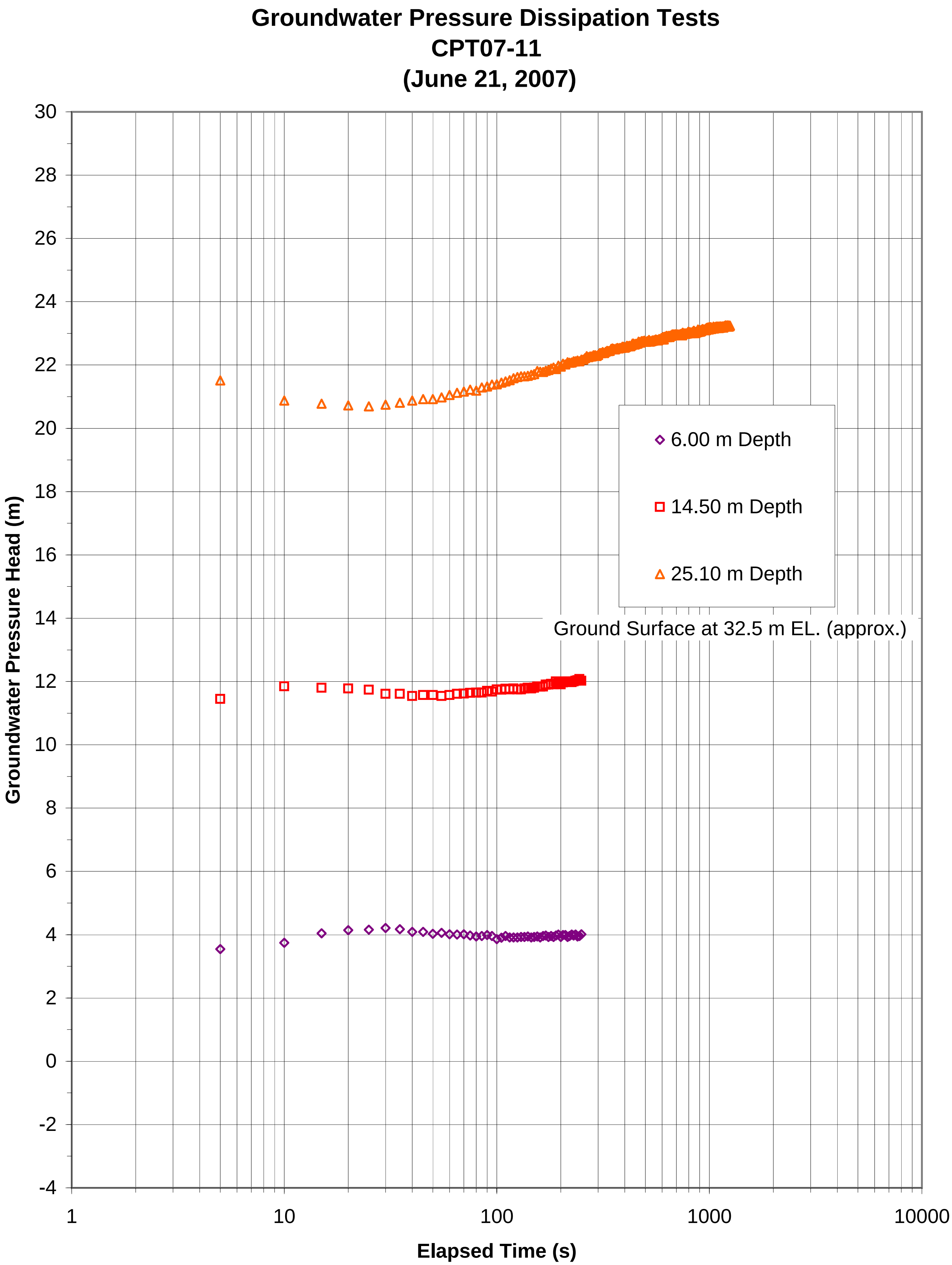
07-1414-0096

Groundwater Pressure Dissipation Tests
SCPT07-09
(June 21, 2007)



Groundwater Pressure Dissipation Tests
CPT07-10
(June 29, 2007)

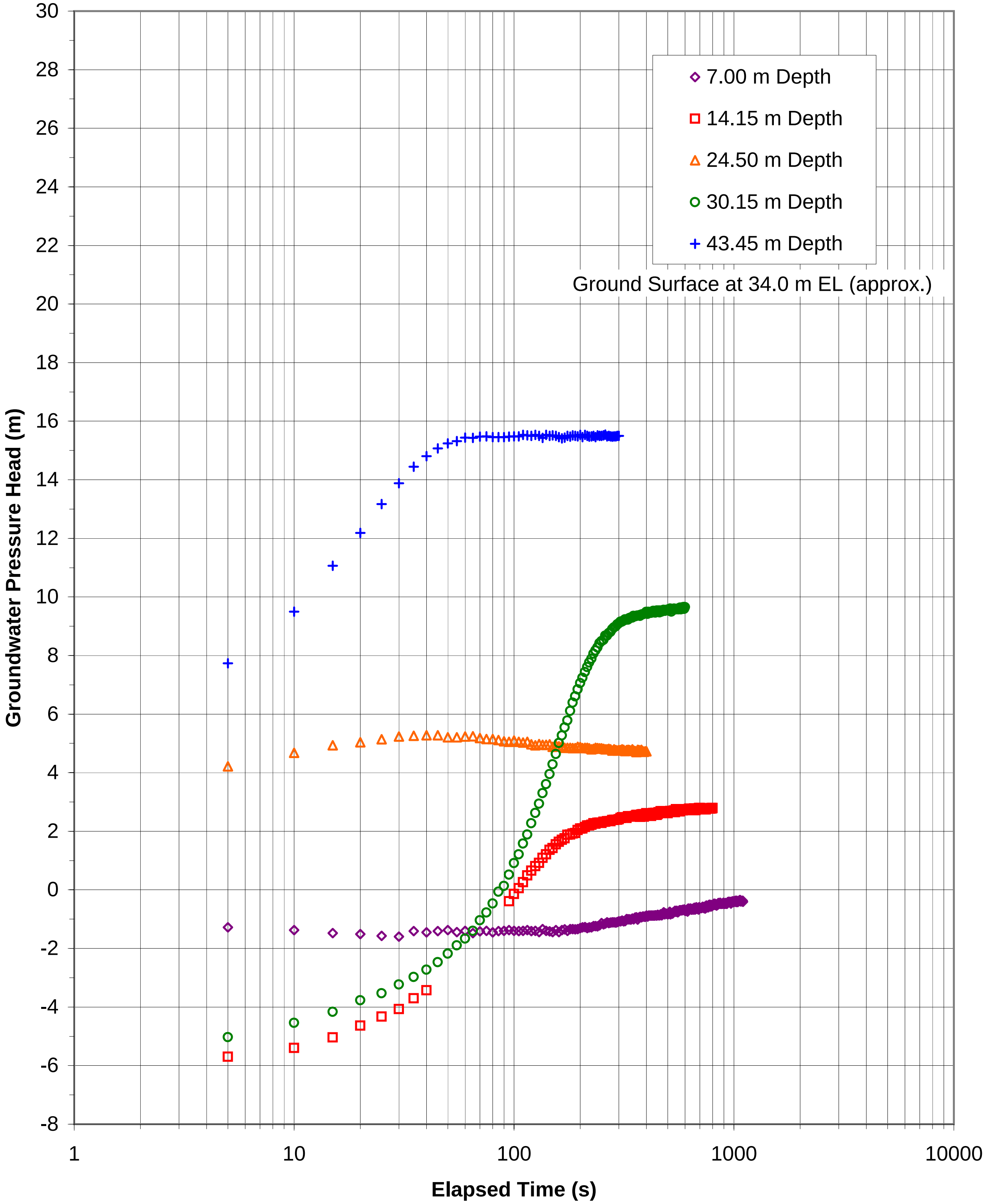



Groundwater Pressure Dissipation Tests
CPT07-11
(June 21, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000
6.00 m Depth
14.50 m Depth
25.10 m Depth
Ground Surface at 32.5 m EL. (approx.)

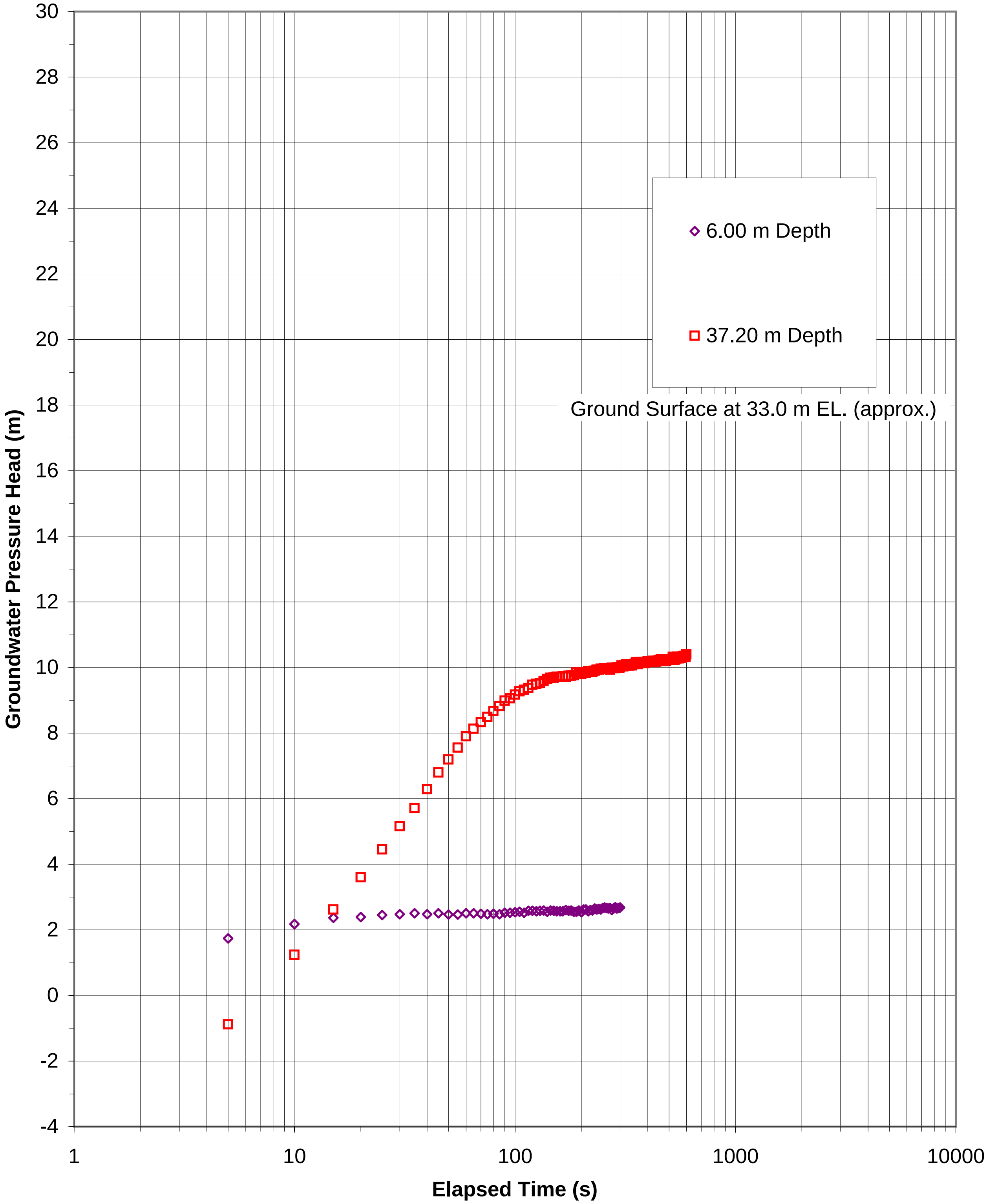
Fraser River Escarpment
Maple Ridge, BC

07-1414-0096

Groundwater Pressure Dissipation Tests
SCPT07-12
(June 27, 2007)

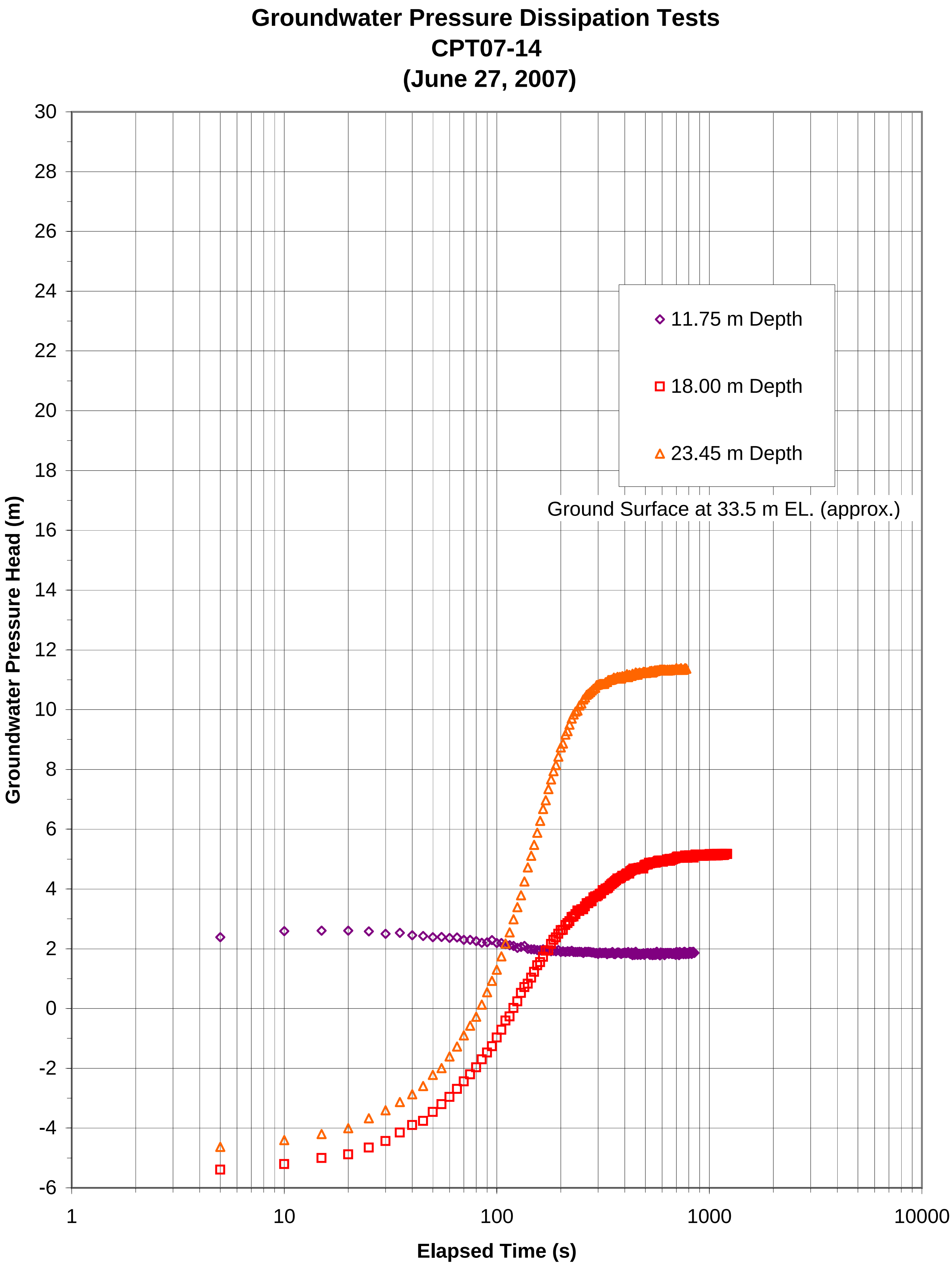


Groundwater Pressure Dissipation Tests
CPT07-13
(June 22, 2007)



Fraser River Escarpment
Maple Ridge, BC

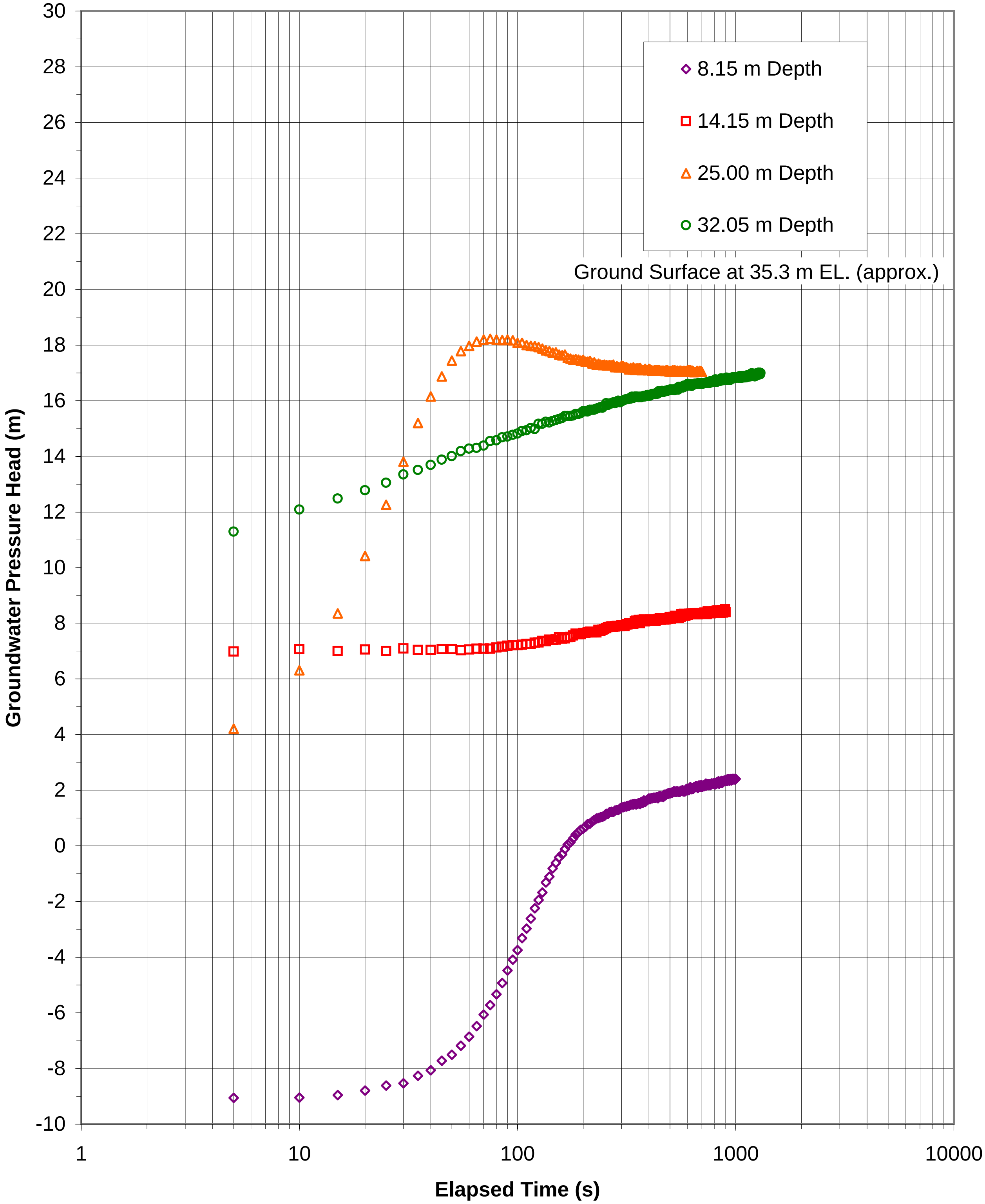
07-1414-0096

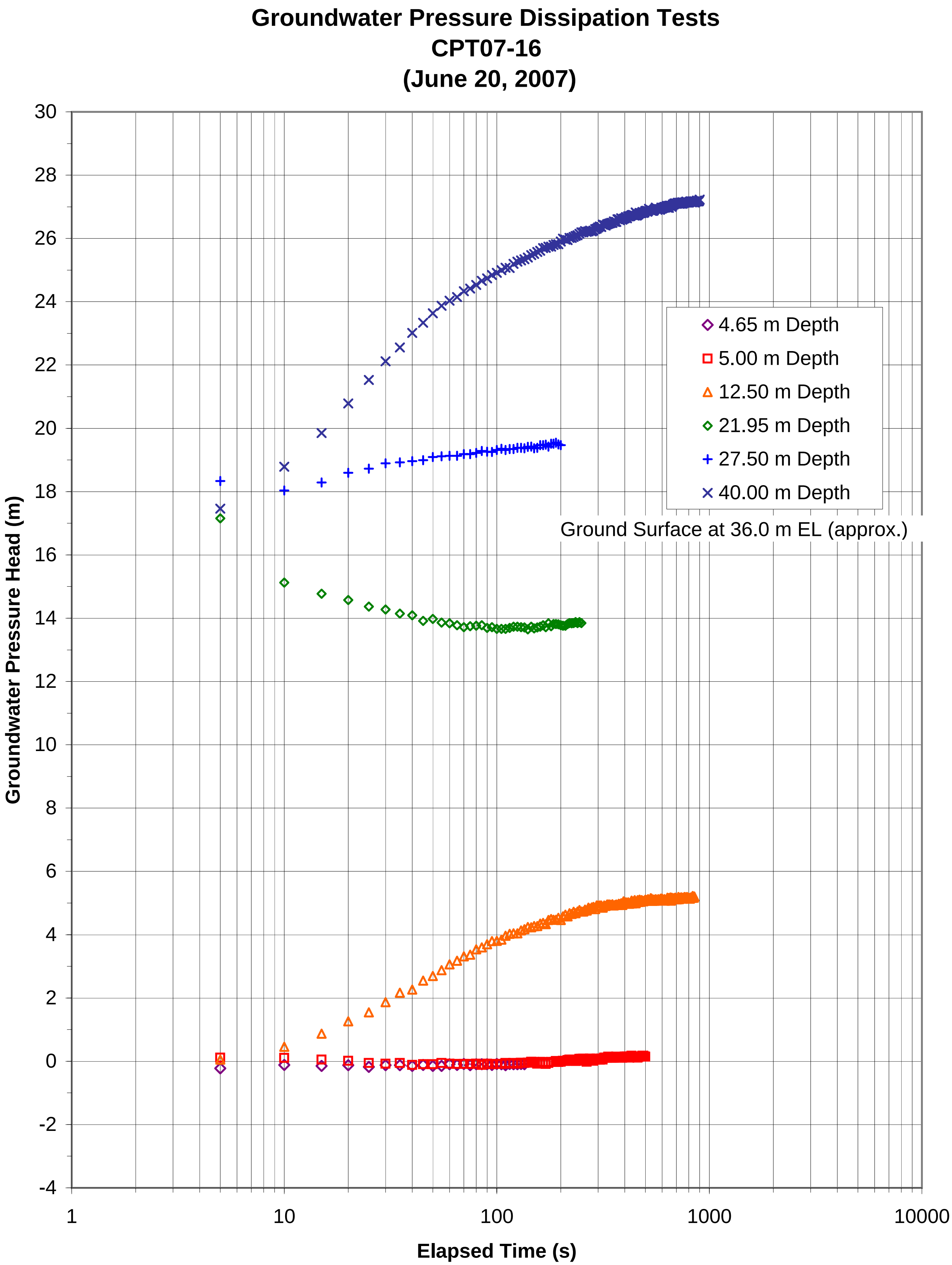


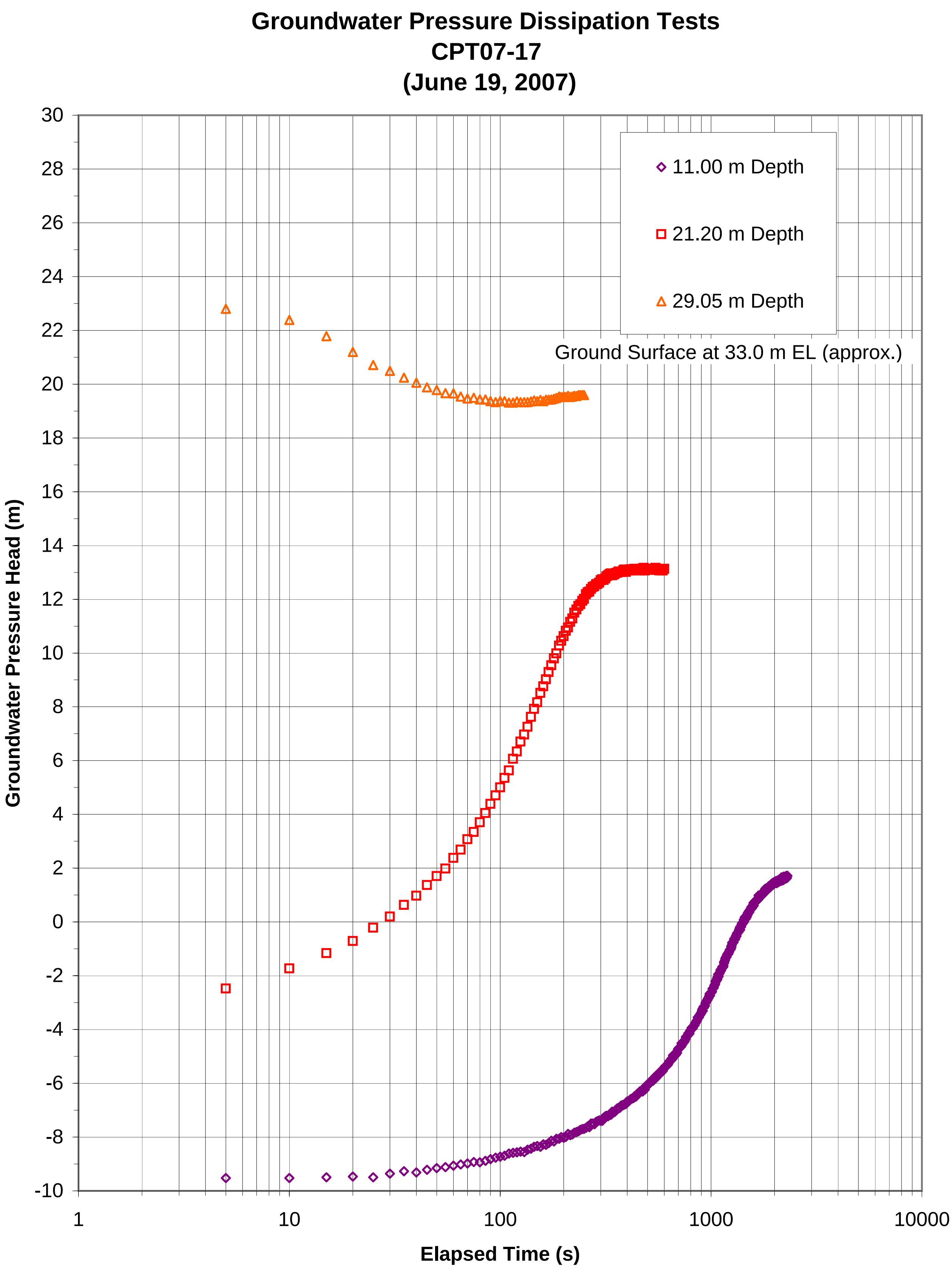
Fraser River Escarpment
Maple Ridge, BC

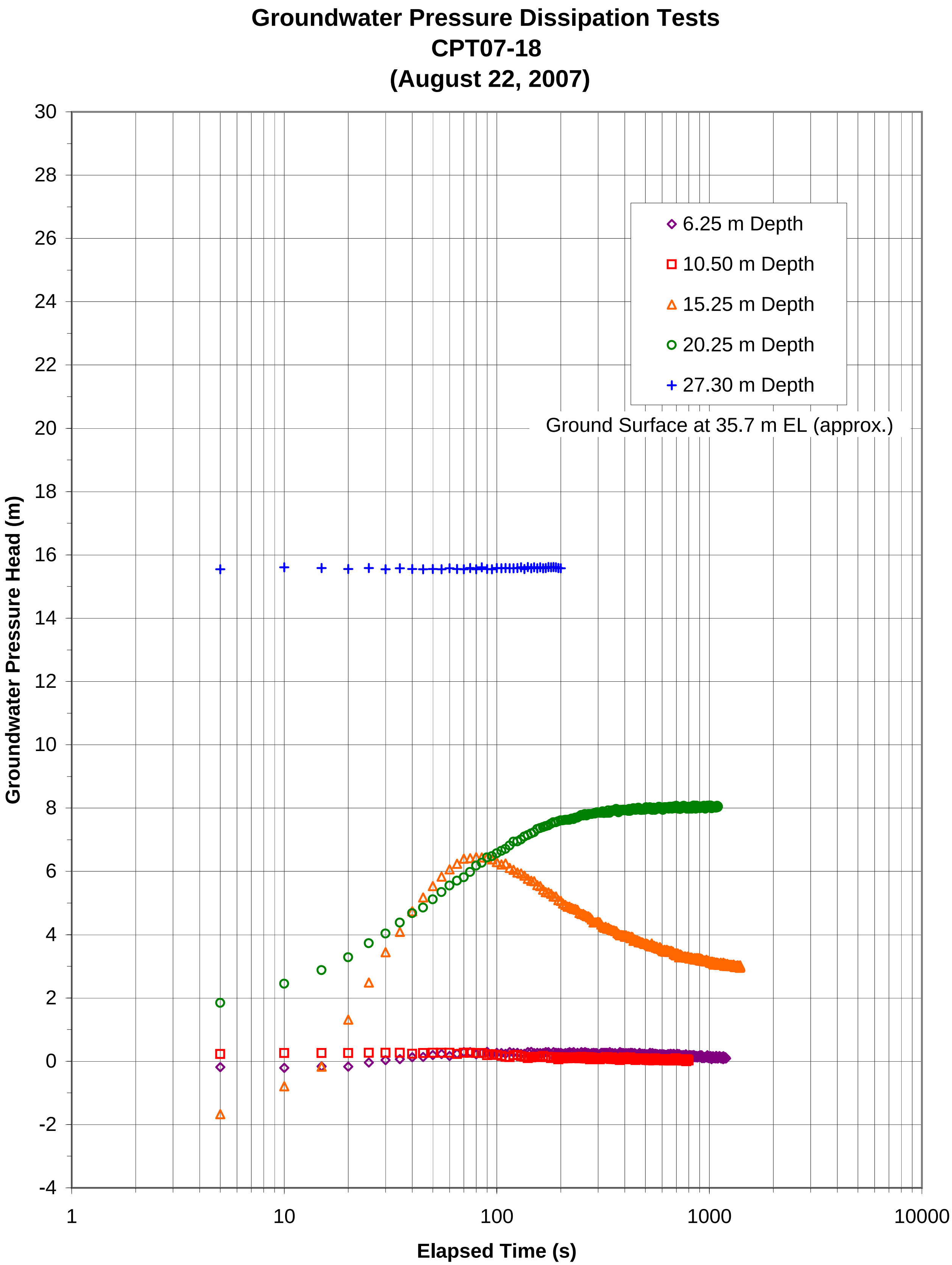
07-1414-0096

Groundwater Pressure Dissipation Tests
CPT07-15
(June 22, 2007)



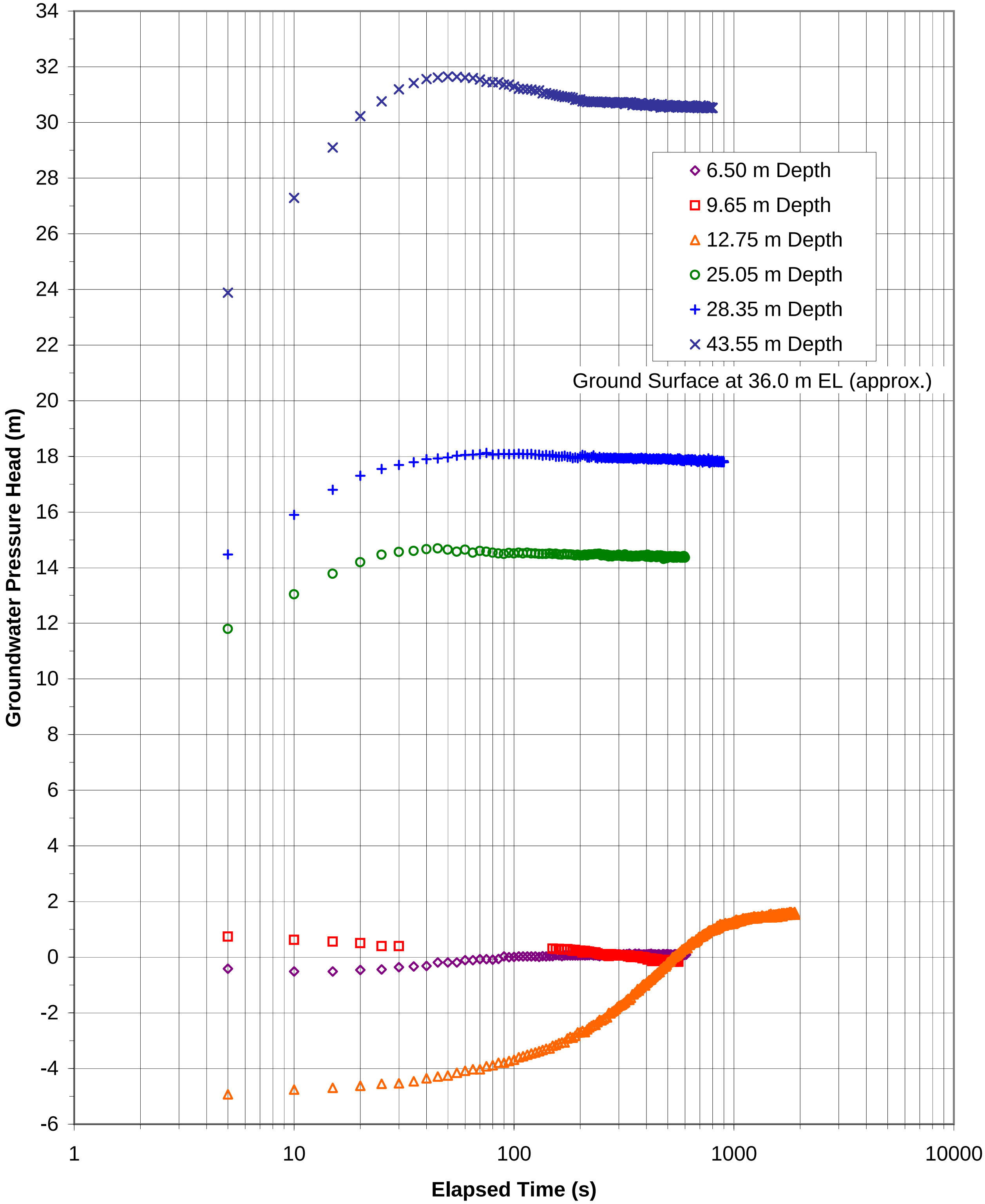

Groundwater Pressure Dissipation Tests
CPT07-16
(June 20, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
4.65 m Depth
5.00 m Depth
12.50 m Depth
21.95 m Depth
27.50 m Depth
40.00 m Depth
Ground Surface at 36.0 m EL (approx.)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000


Groundwater Pressure Dissipation Tests
CPT07-17
(June 19, 2007)
11.00 m Depth
21.20 m Depth
29.05 m Depth
Ground Surface at 33.0 m EL (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
1
10
100
1000
10000


Groundwater Pressure Dissipation Tests
CPT07-18
(August 22, 2007)
6.25 m Depth
10.50 m Depth
15.25 m Depth
20.25 m Depth
27.30 m Depth
Ground Surface at 35.7 m EL (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000

Fraser River Escarpment
Maple Ridge, BC

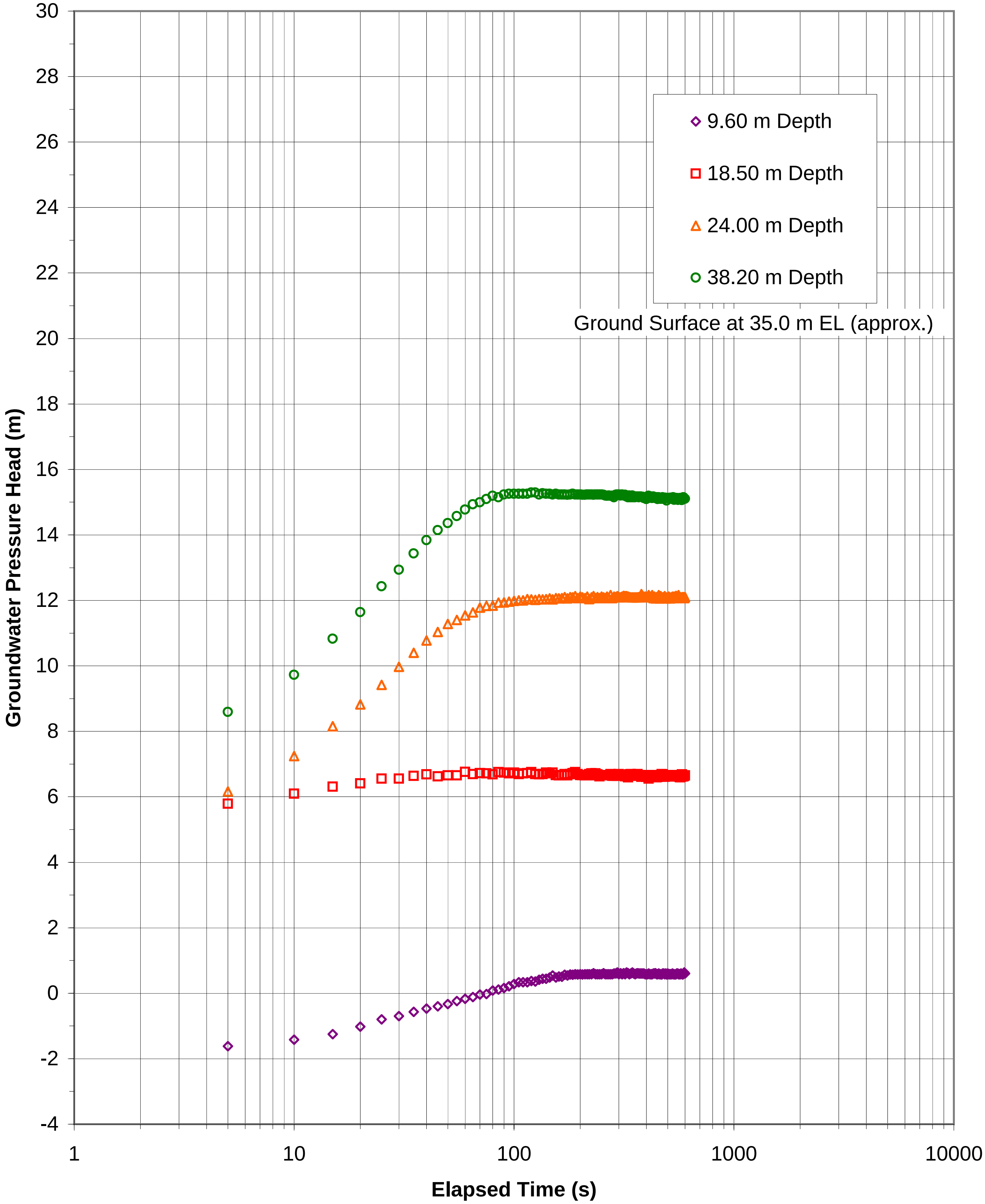
Groundwater Pressure Dissipation Tests
CPT07-19
(August 22, 2007)



Fraser River Escarpment
Maple Ridge, BC

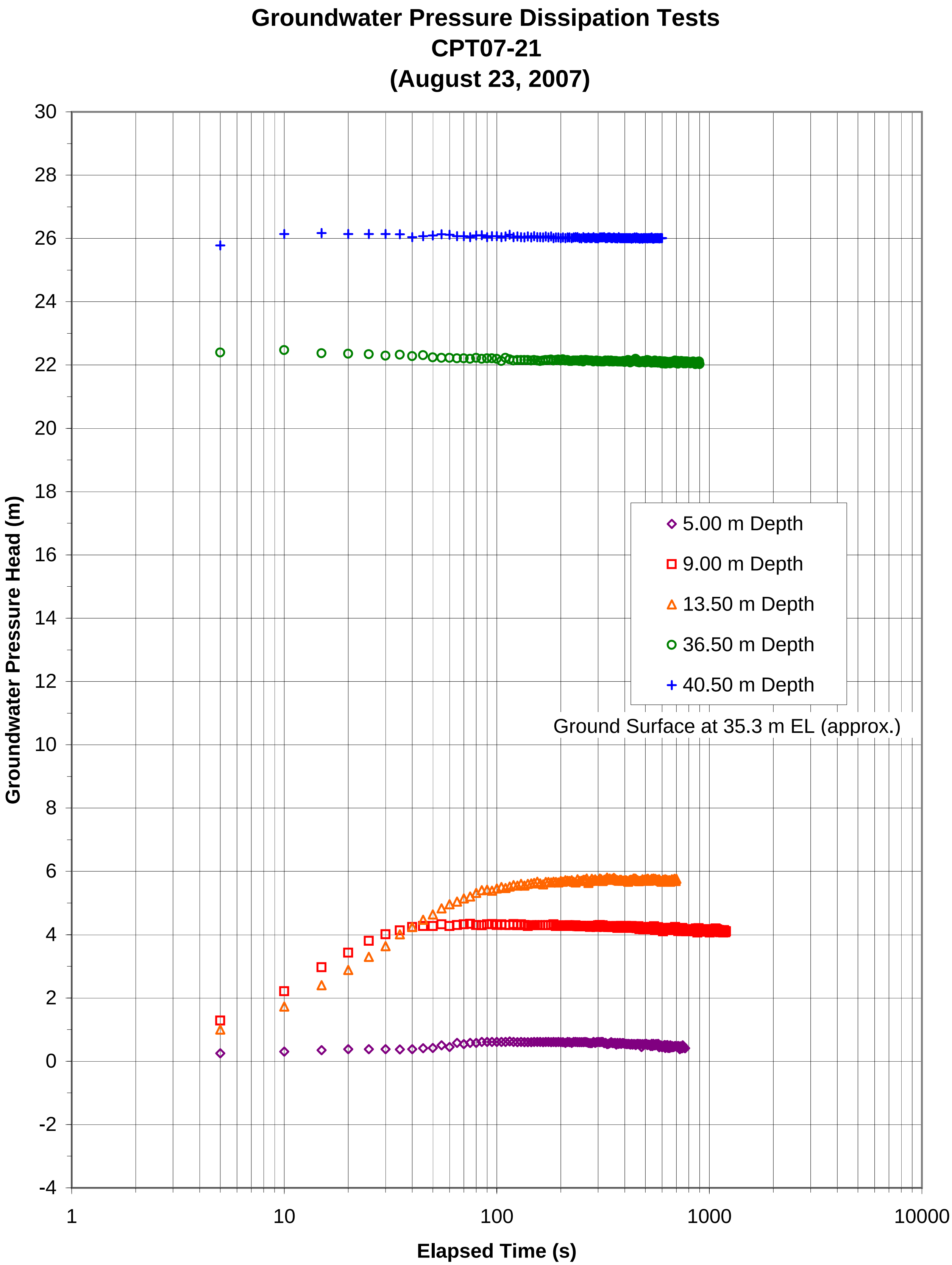
07-1414-0096

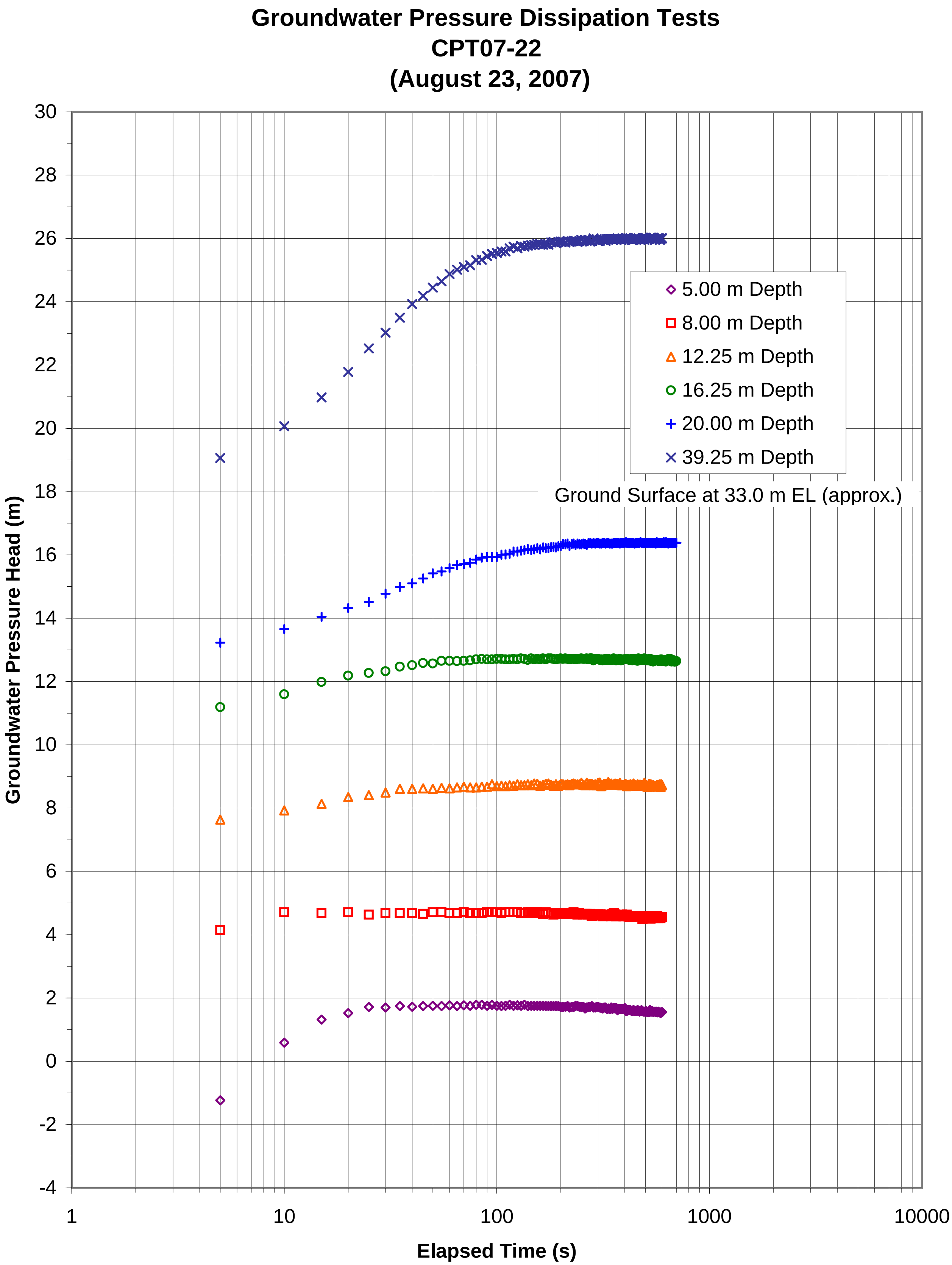
Groundwater Pressure Dissipation Tests
CPT07-20
(August 21, 2007)



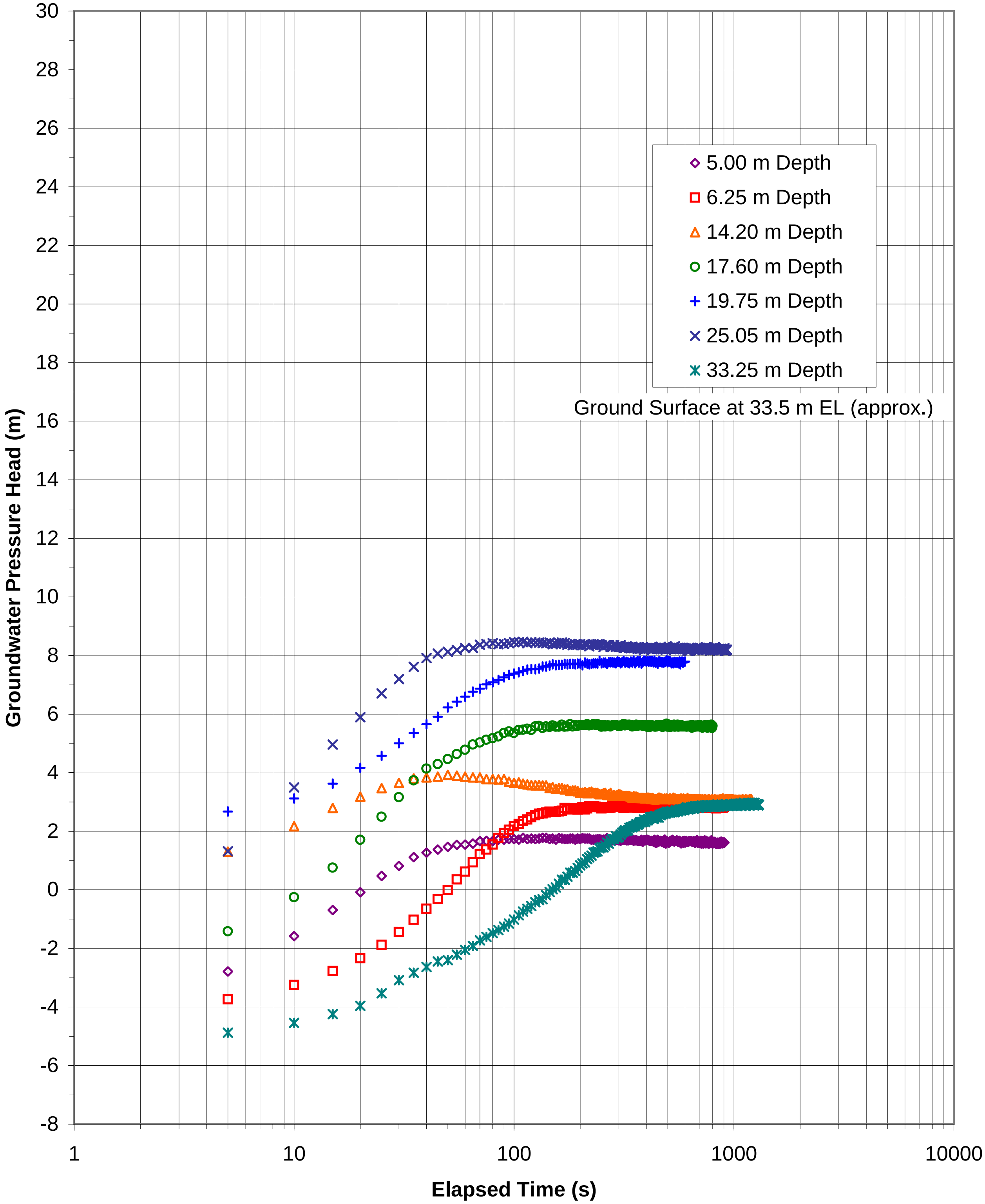
Fraser River Escarpment
Maple Ridge, BC

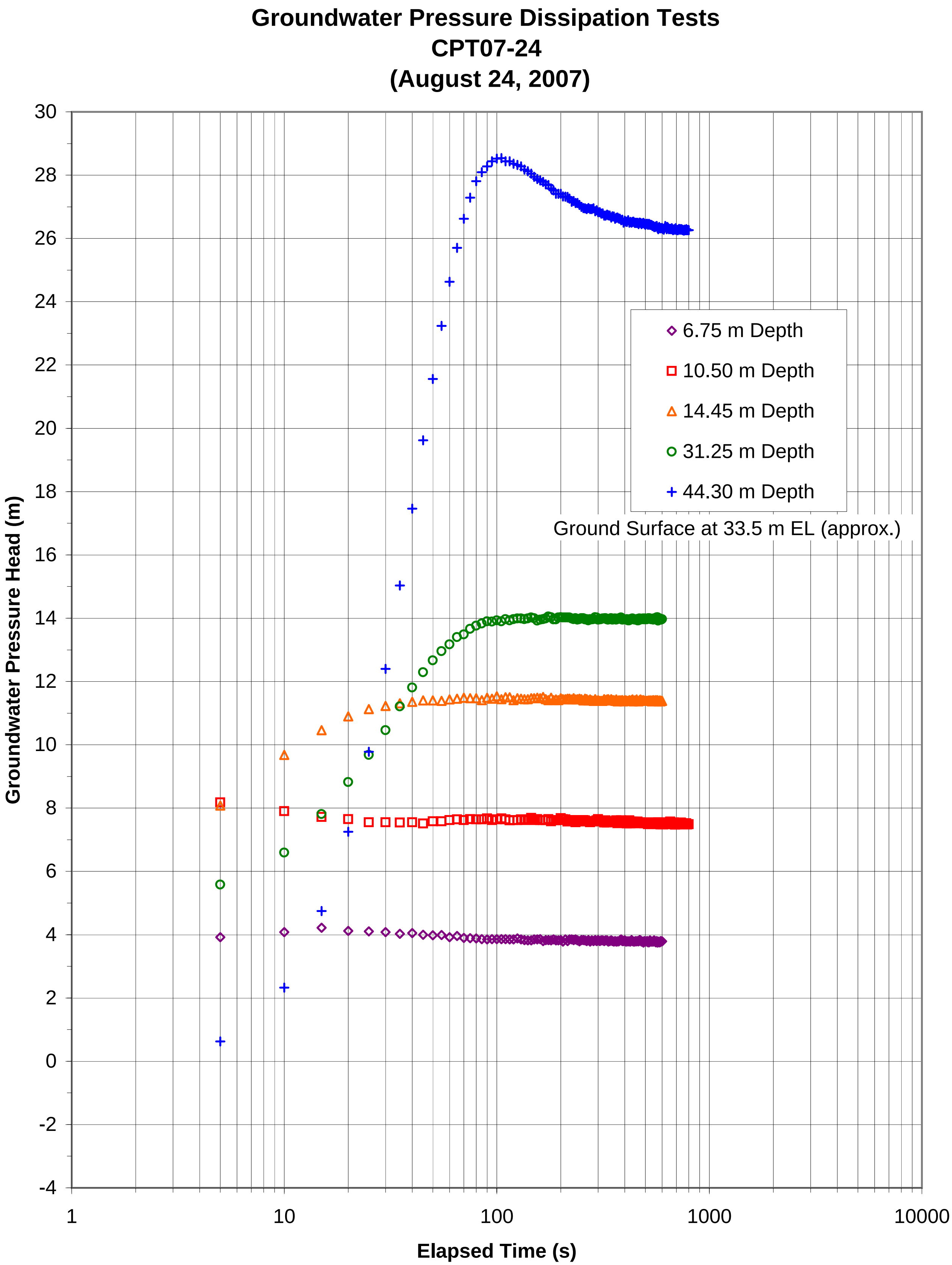
07-1414-0096

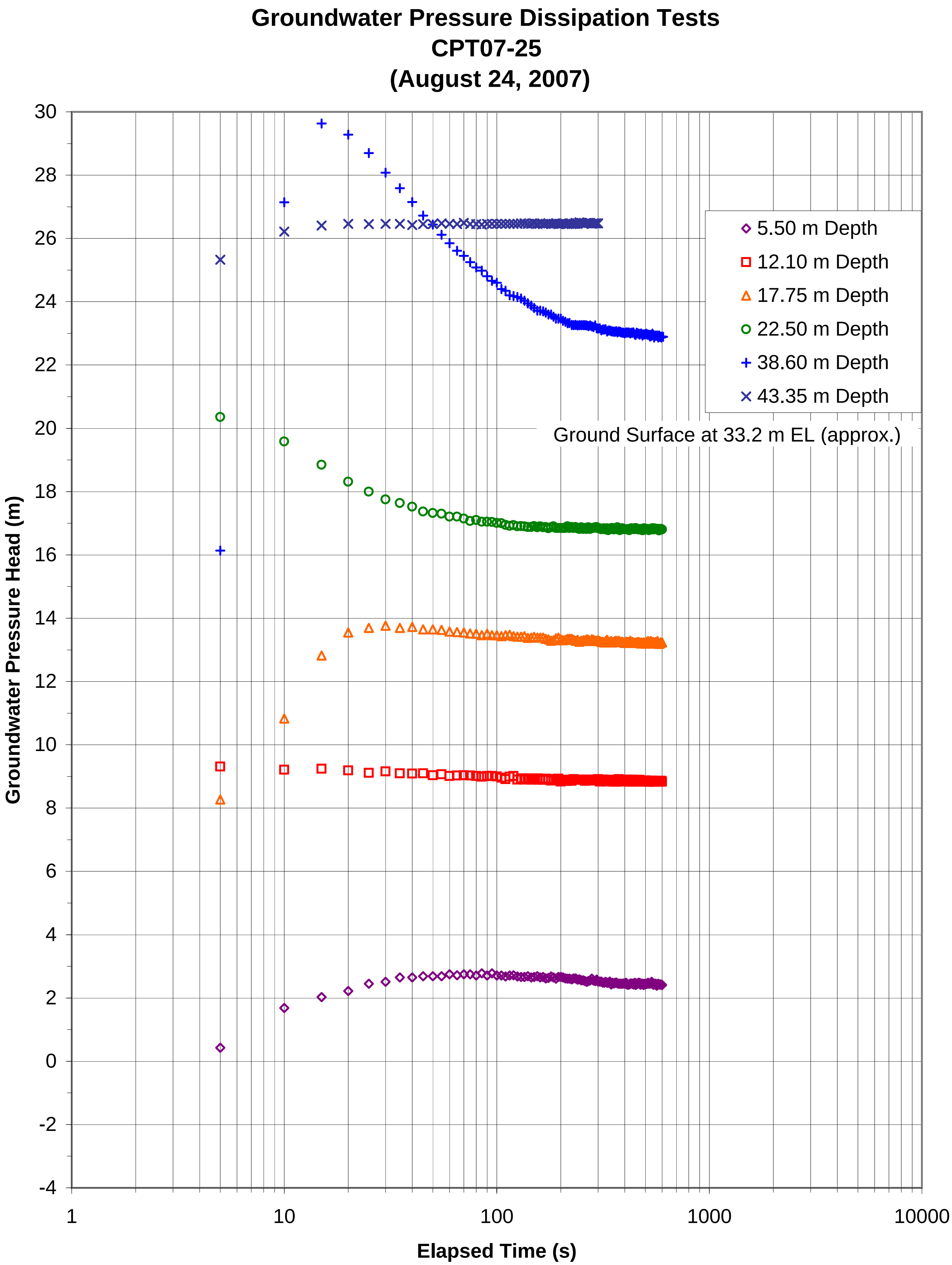



Groundwater Pressure Dissipation Tests
CPT07-22
(August 23, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000
5.00 m Depth
8.00 m Depth
12.25 m Depth
16.25 m Depth
20.00 m Depth
39.25 m Depth
Ground Surface at 33.0 m EL (approx.)

Groundwater Pressure Dissipation Tests
CPT07-23
(August 21, 2007)

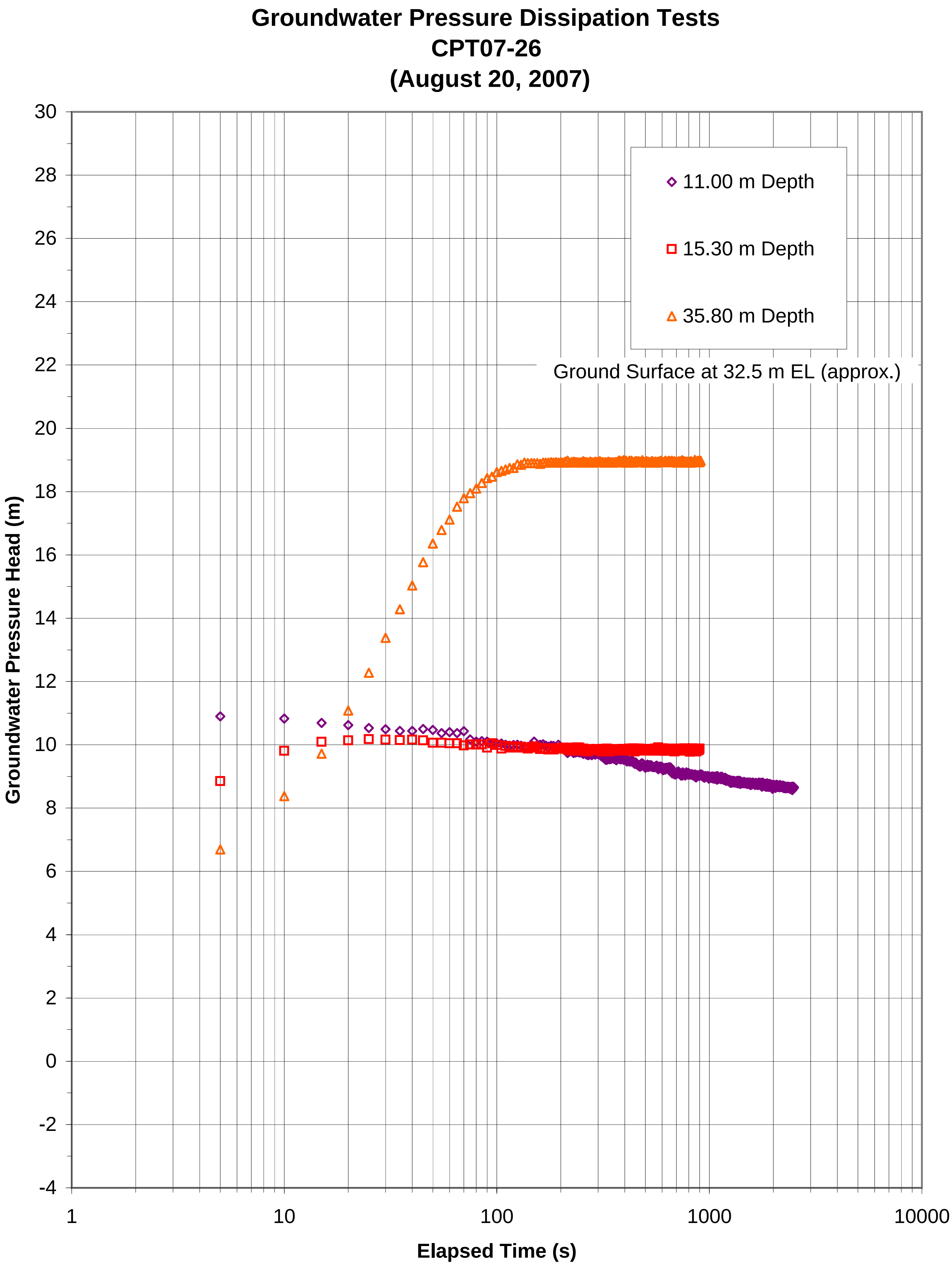


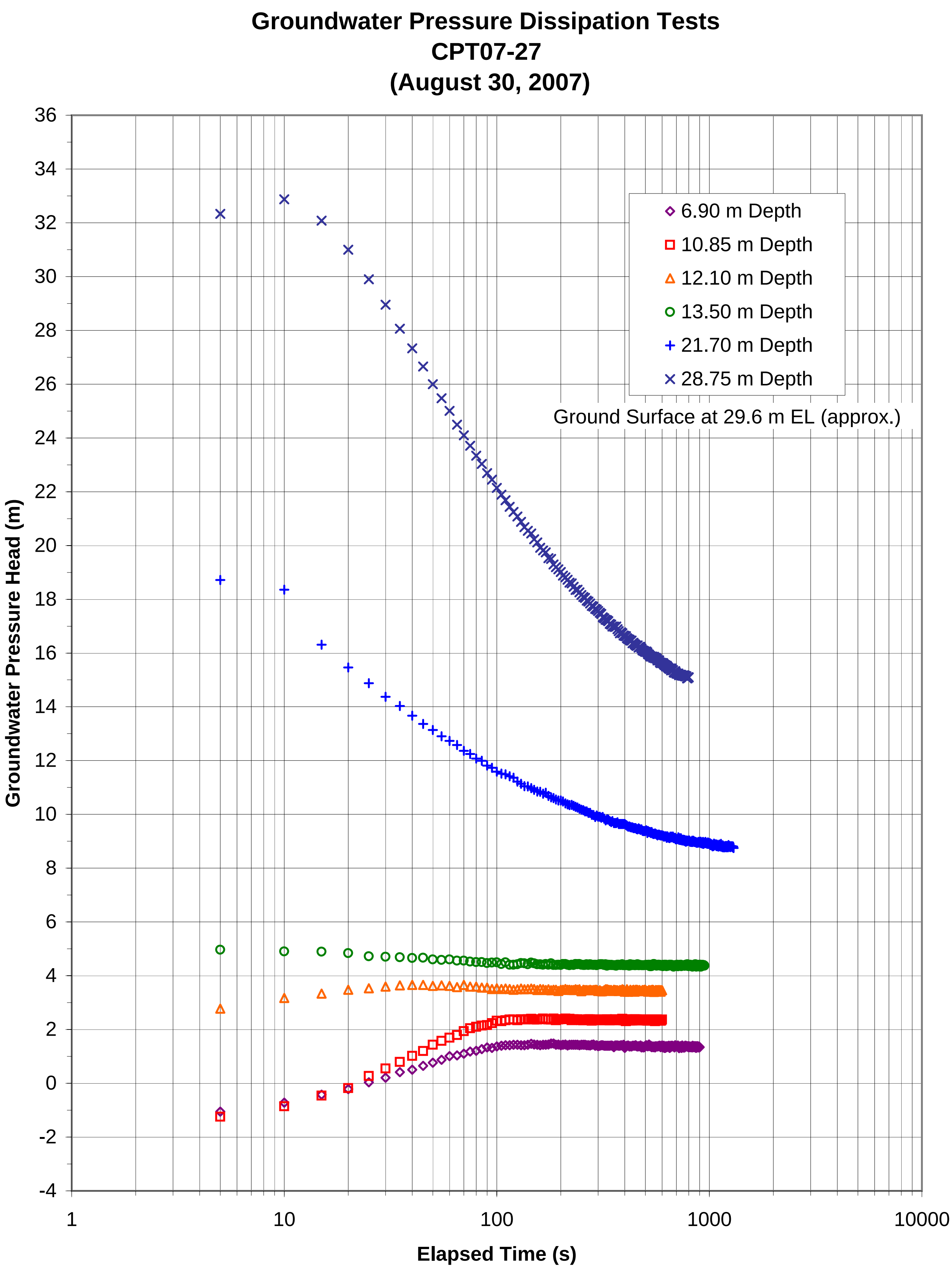

Groundwater Pressure Dissipation Tests
CPT07-24
(August 24, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000
6.75 m Depth
10.50 m Depth
14.45 m Depth
31.25 m Depth
44.30 m Depth
Ground Surface at 33.5 m EL (approx.)

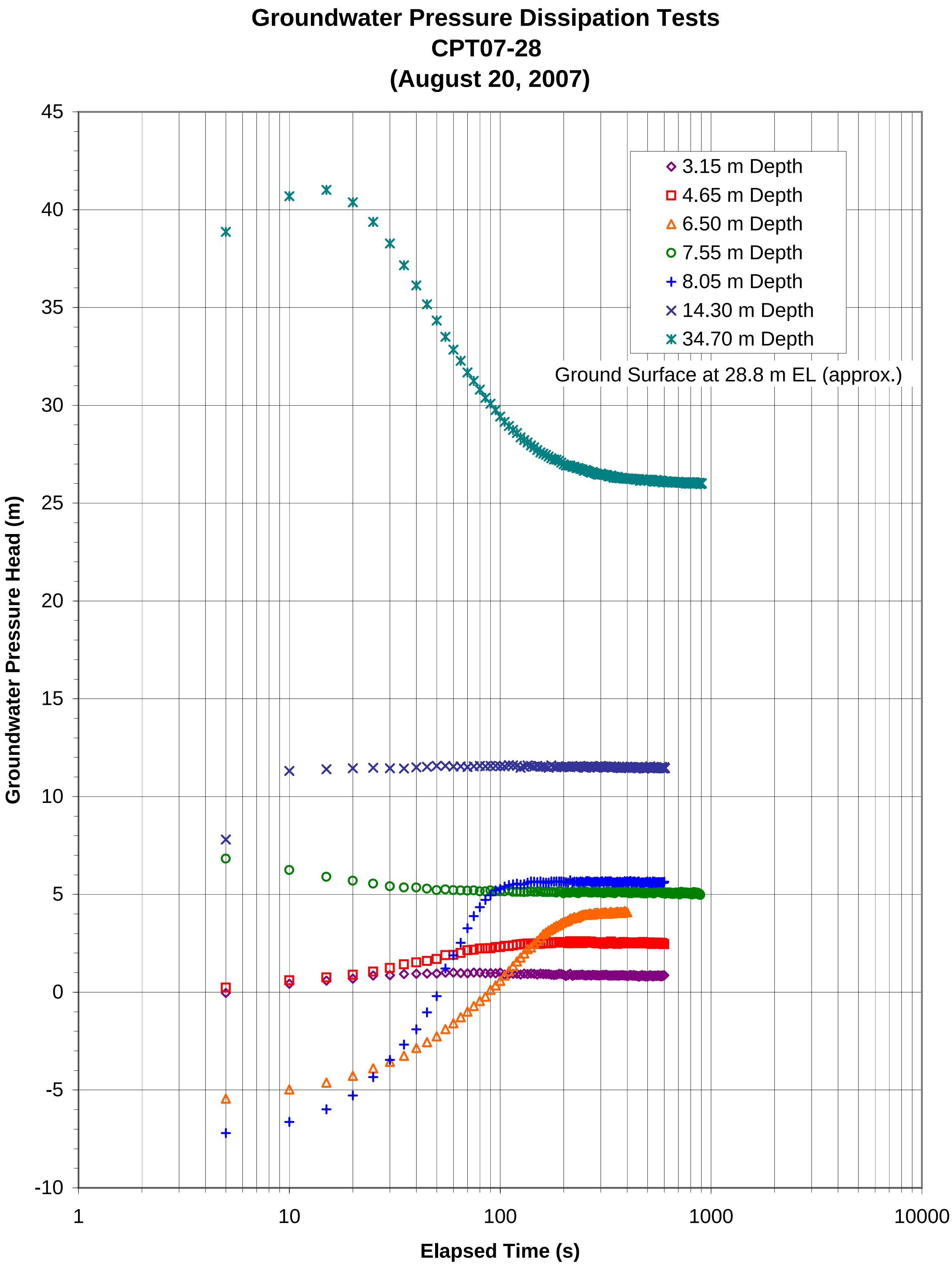

Groundwater Pressure Dissipation Tests
CPT07-25
(August 24, 2007)
Groundwater Pressure Head (m)
Elapsed Time (s)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000
5.50 m Depth
12.10 m Depth
17.75 m Depth
22.50 m Depth
38.60 m Depth
43.35 m Depth
Ground Surface at 33.2 m EL (approx.)

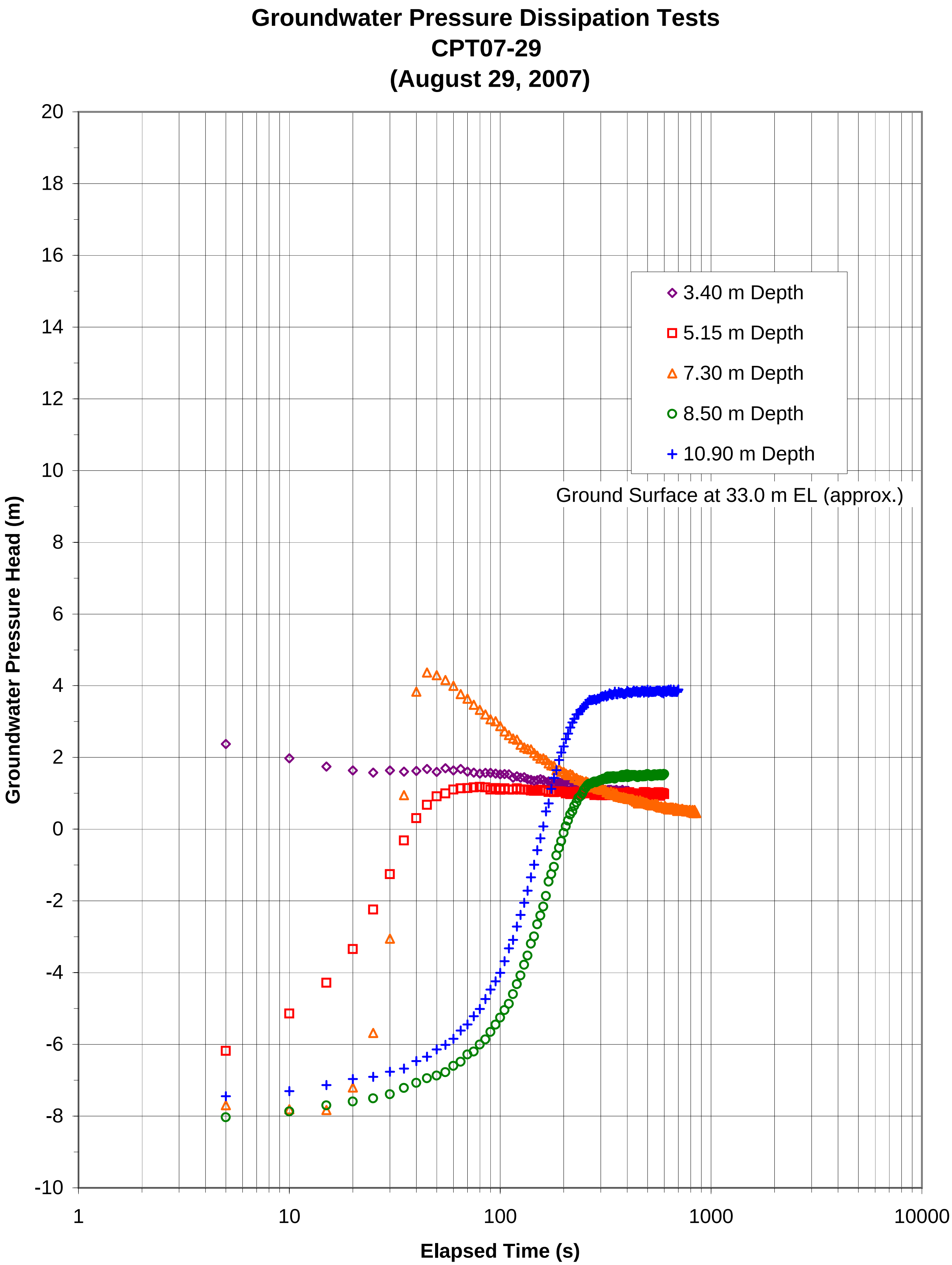
Fraser River Escarpment
Maple Ridge, BC

07-1414-0096

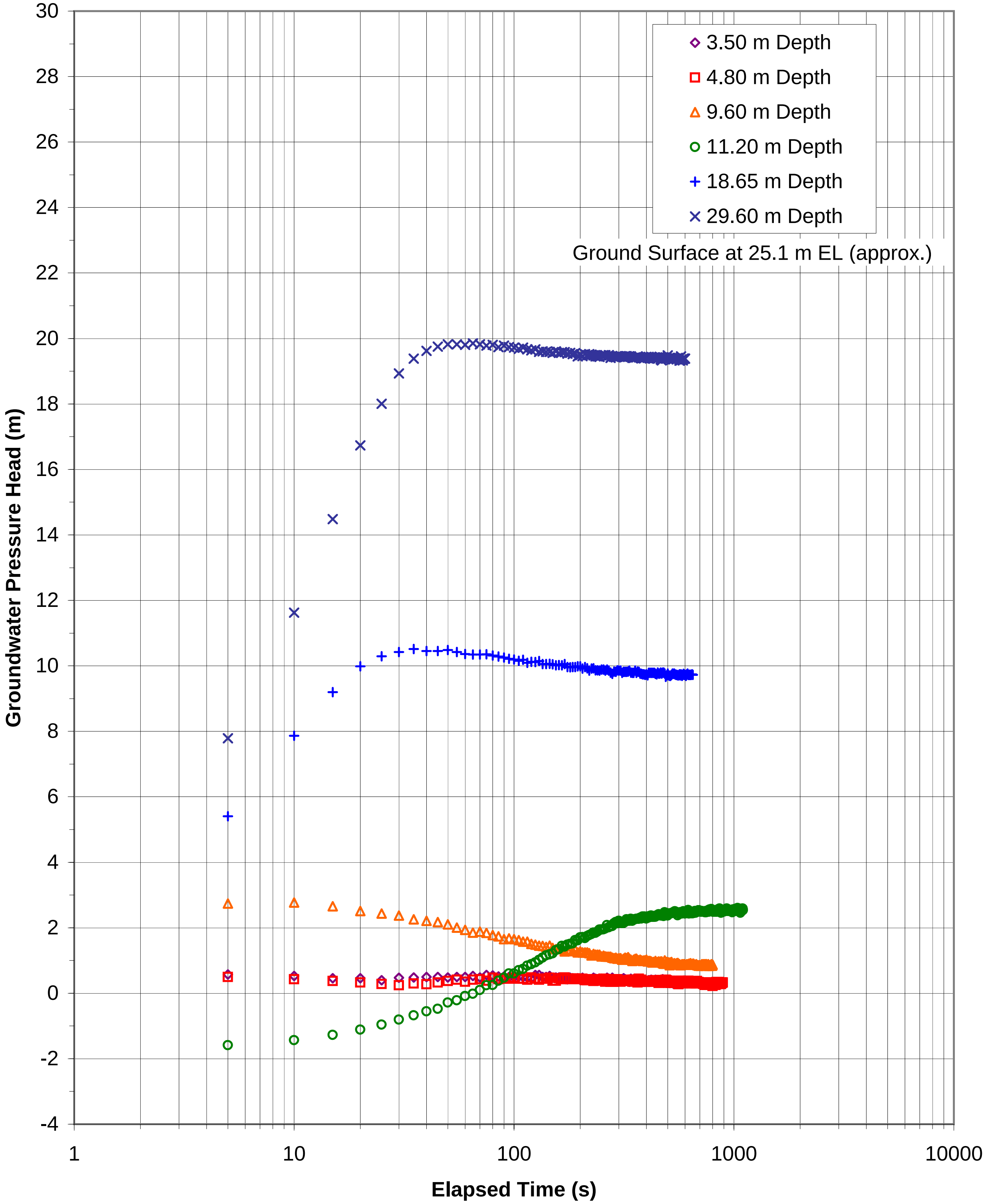



Groundwater Pressure Dissipation Tests
CPT07-27
(August 30, 2007)
6.90 m Depth
10.85 m Depth
12.10 m Depth
13.50 m Depth
21.70 m Depth
28.75 m Depth
Ground Surface at 29.6 m EL (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
1
10
100
1000
10000

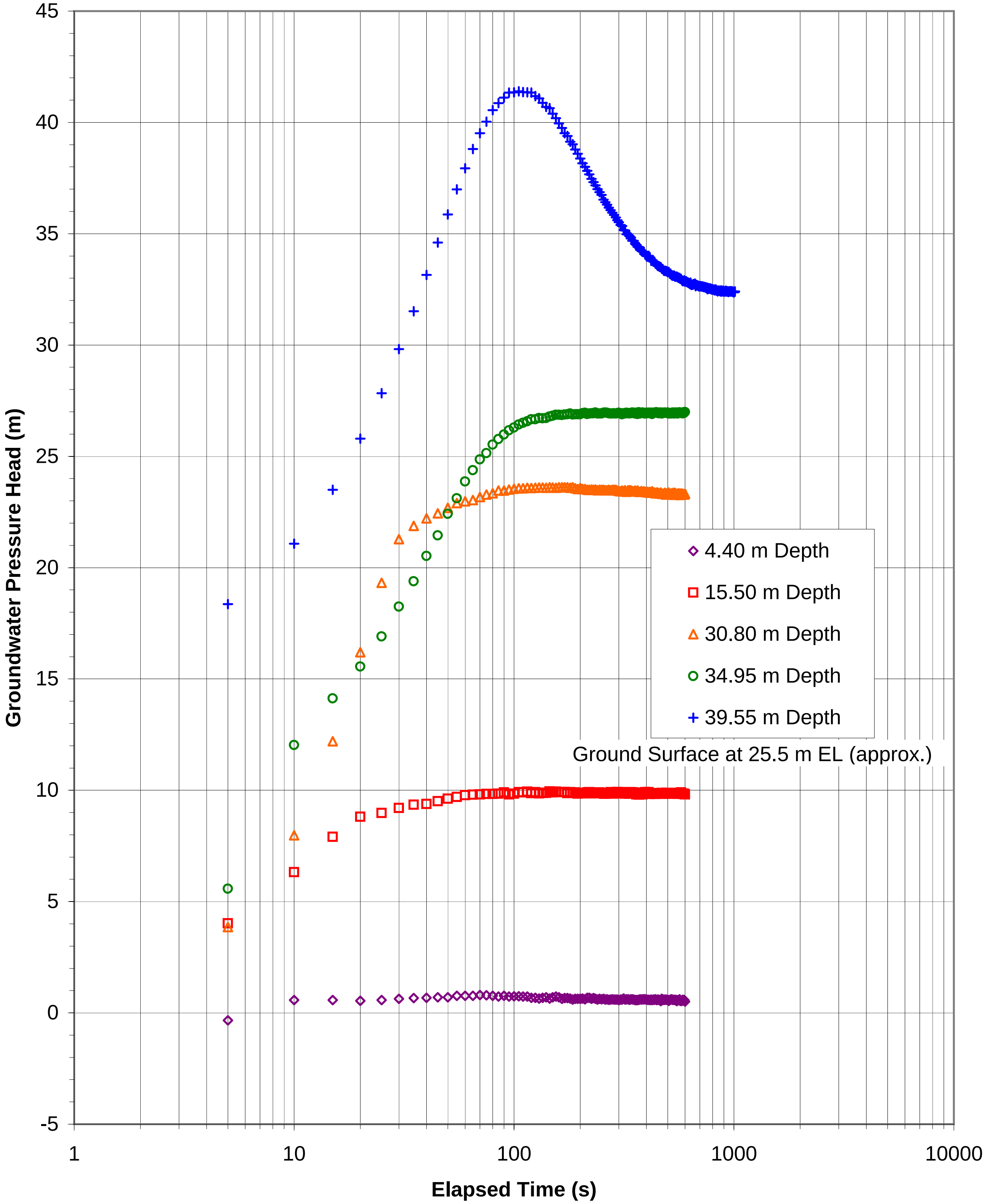

Groundwater Pressure Dissipation Tests
CPT07-28
(August 20, 2007)
3.15 m Depth
4.65 m Depth
6.50 m Depth
7.55 m Depth
8.05 m Depth
14.30 m Depth
34.70 m Depth
Ground Surface at 28.8 m EL (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
45
40
35
30
25
20
15
10
5
0
-5
-10
1
10
100
1000
10000


Groundwater Pressure Dissipation Tests
CPT07-29
(August 29, 2007)
3.40 m Depth
5.15 m Depth
7.30 m Depth
8.50 m Depth
10.90 m Depth
Ground Surface at 33.0 m EL (approx.)
Groundwater Pressure Head (m)
Elapsed Time (s)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
1
10
100
1000
10000

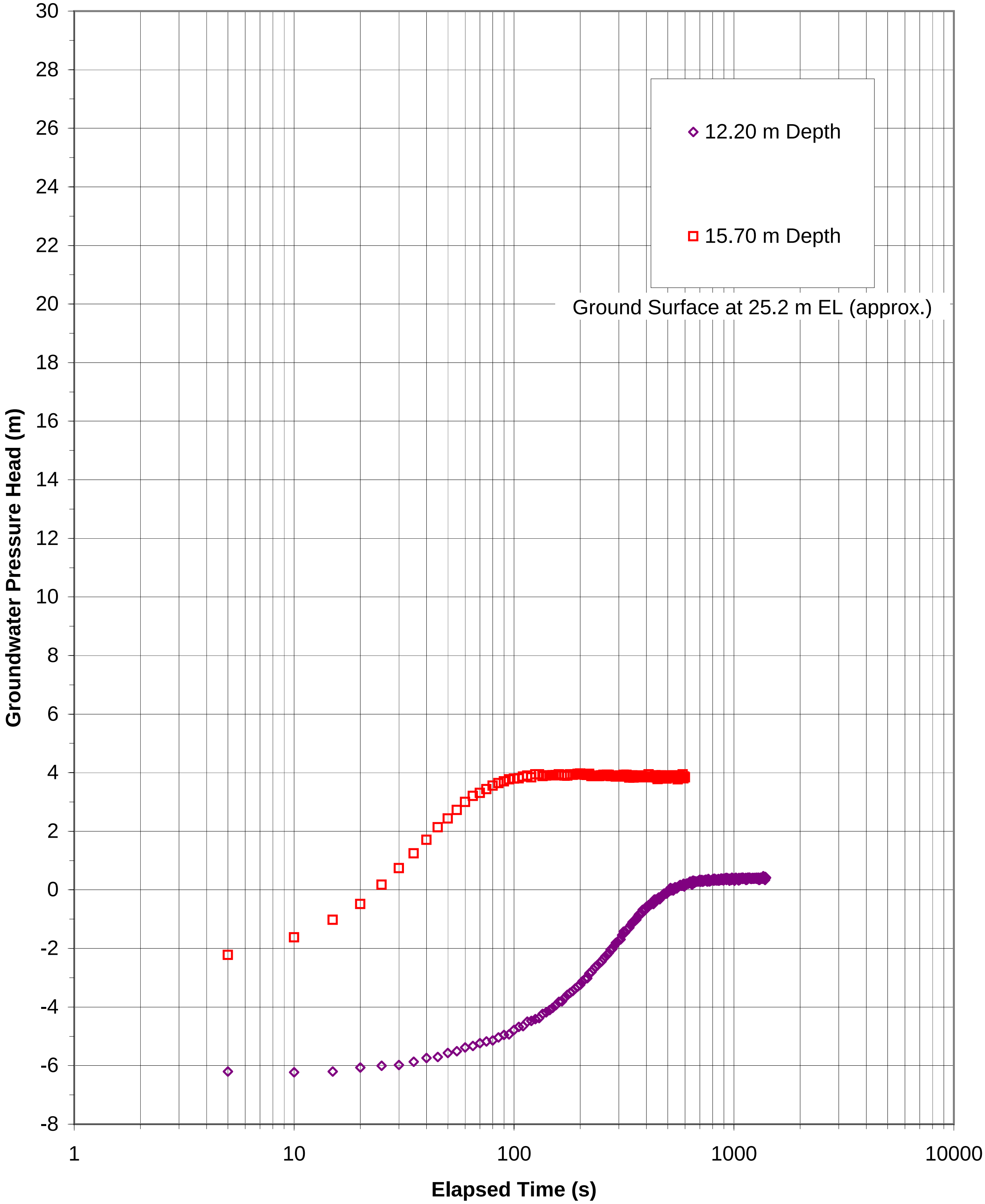
Groundwater Pressure Dissipation Tests
CPT07-30
(August 29, 2007)



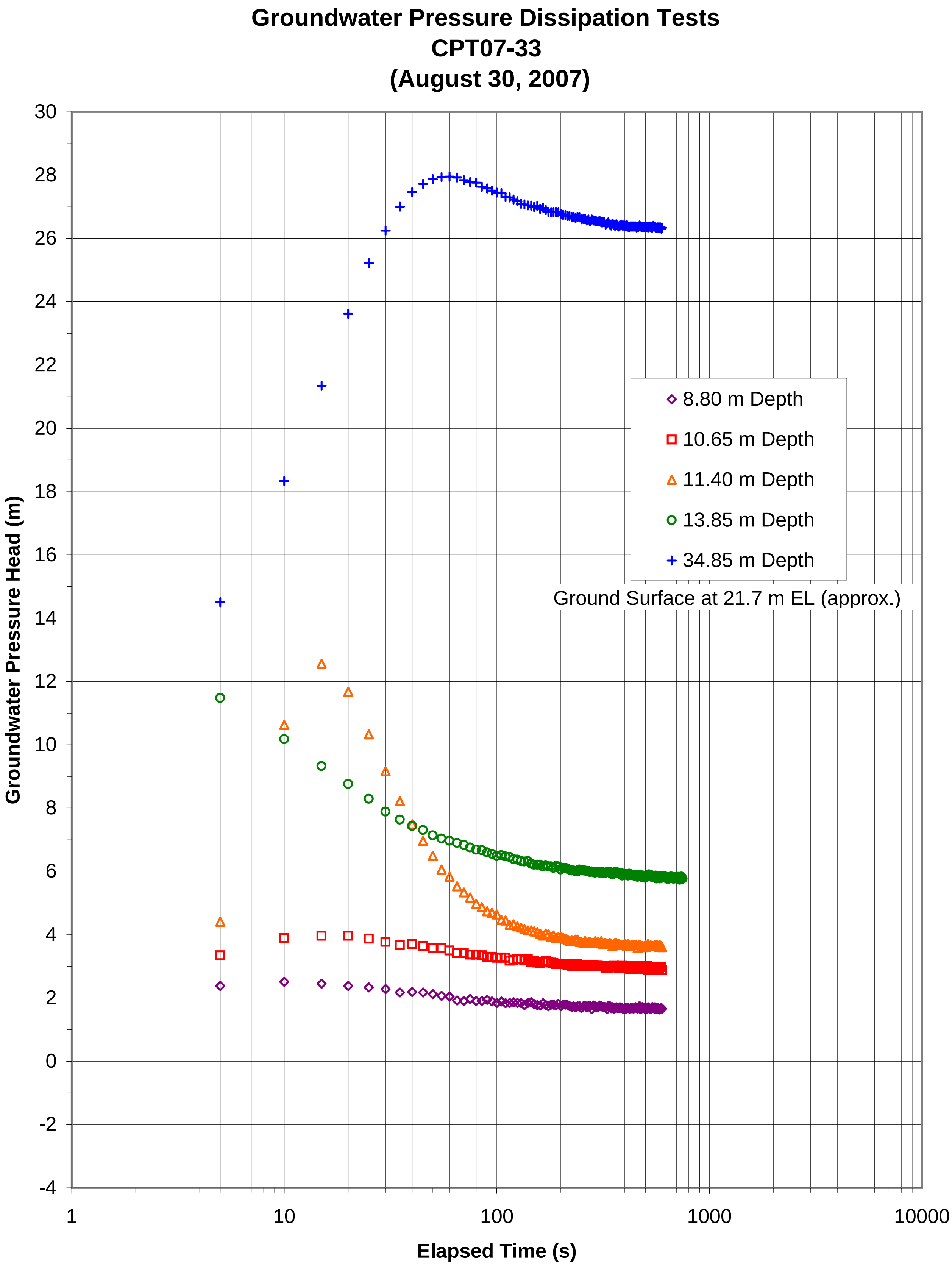
Groundwater Pressure Dissipation Tests
CPT07-31
(August 28, 2007)



Groundwater Pressure Dissipation Tests
CPT07-32
(August 28, 2007)



Fraser River Escarpment
Maple Ridge, BC

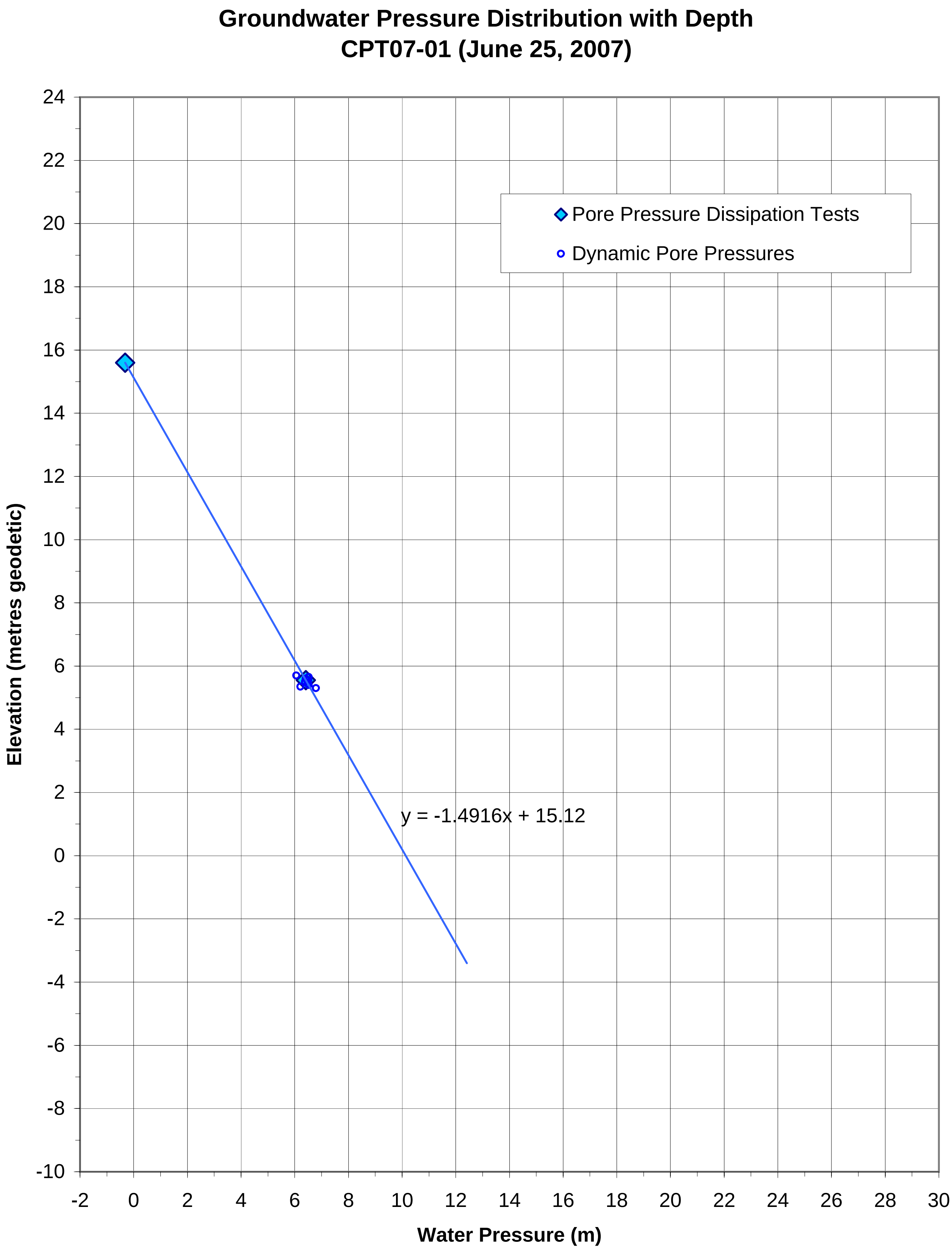


APPENDIX VII

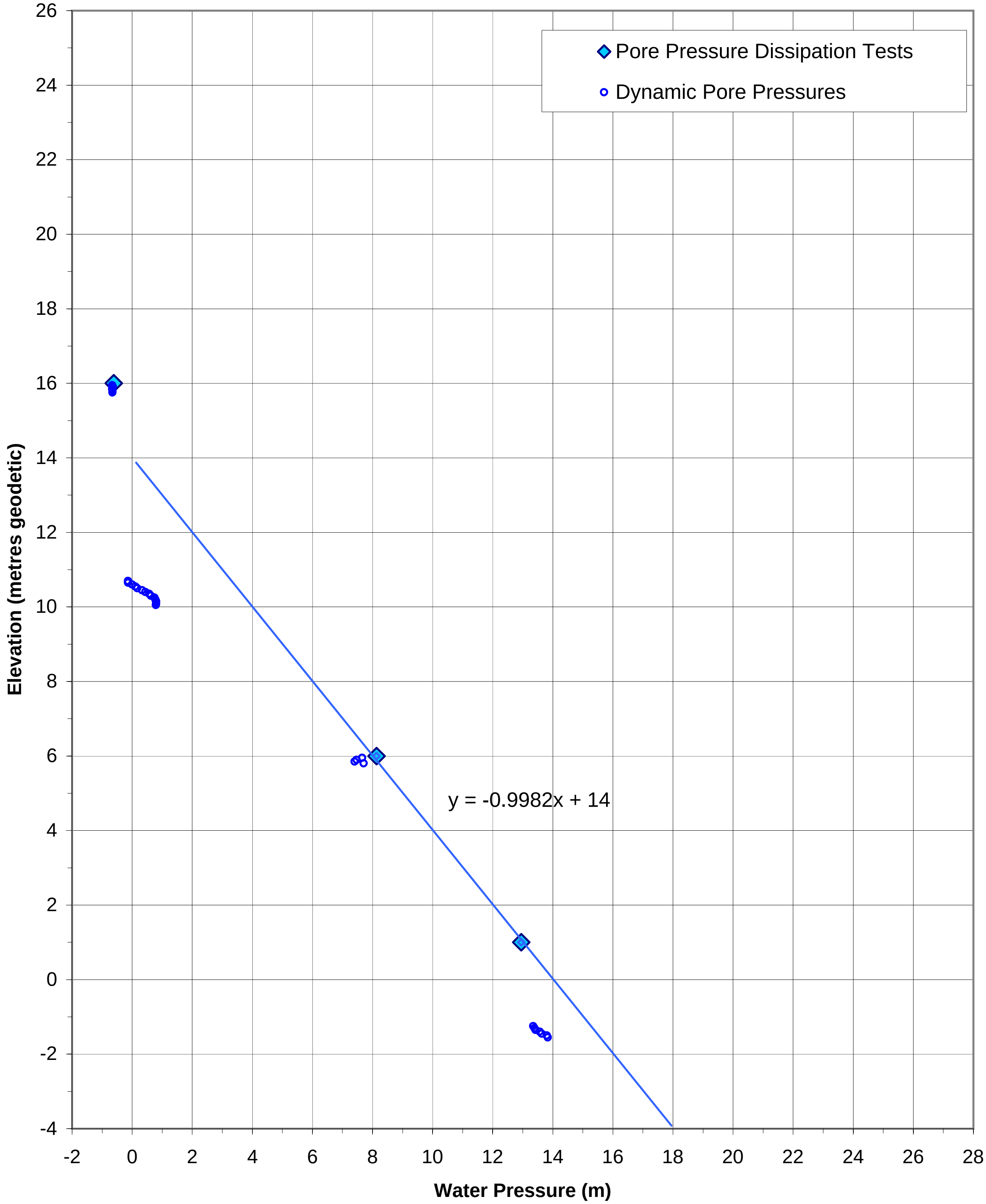
GROUNDWATER PRESSURE HEAD VS. ELEVATION AT CPT LOCATIONS

Fraser River Escarpment
Maple Ridge, BC

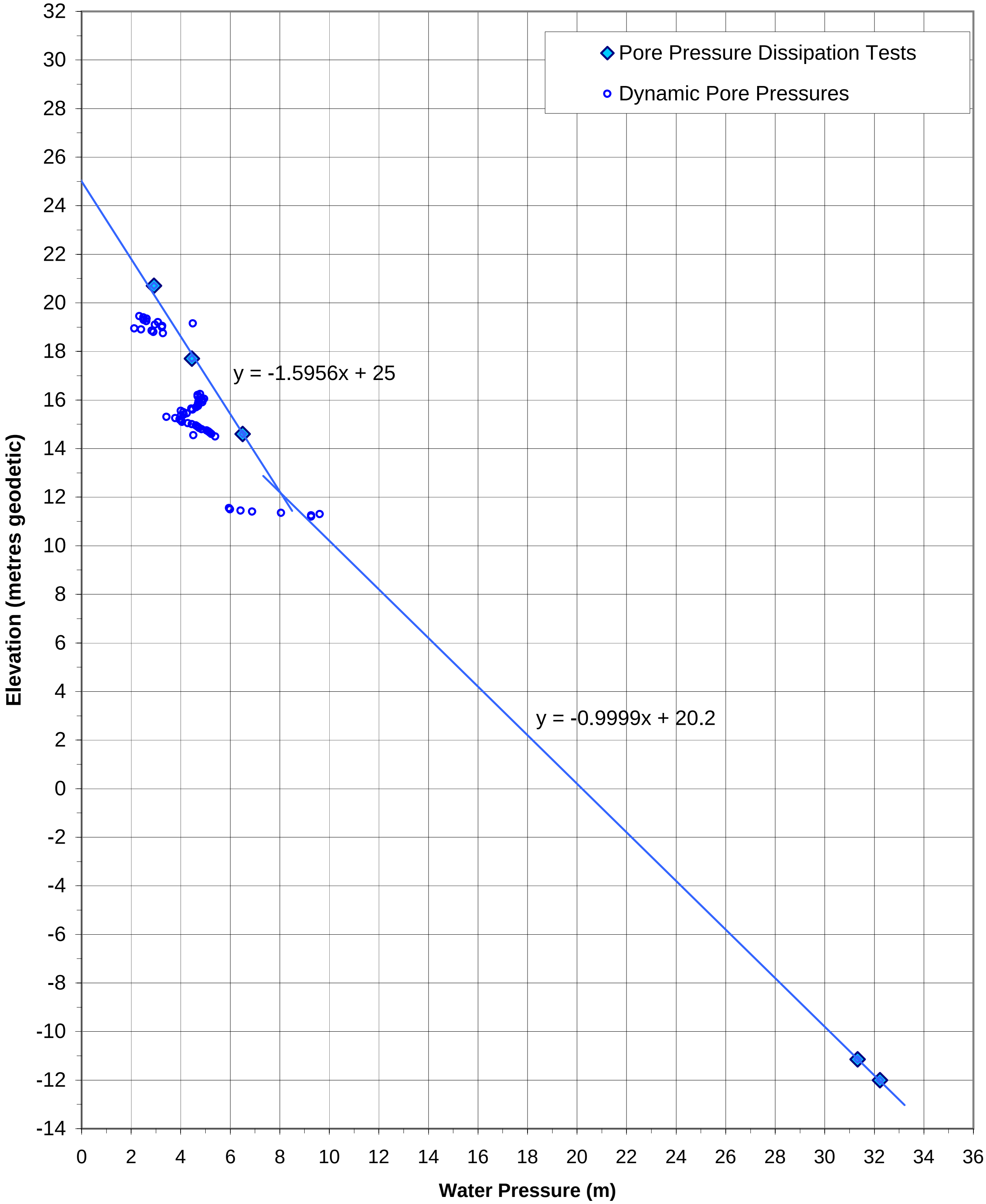
07-1414-0096



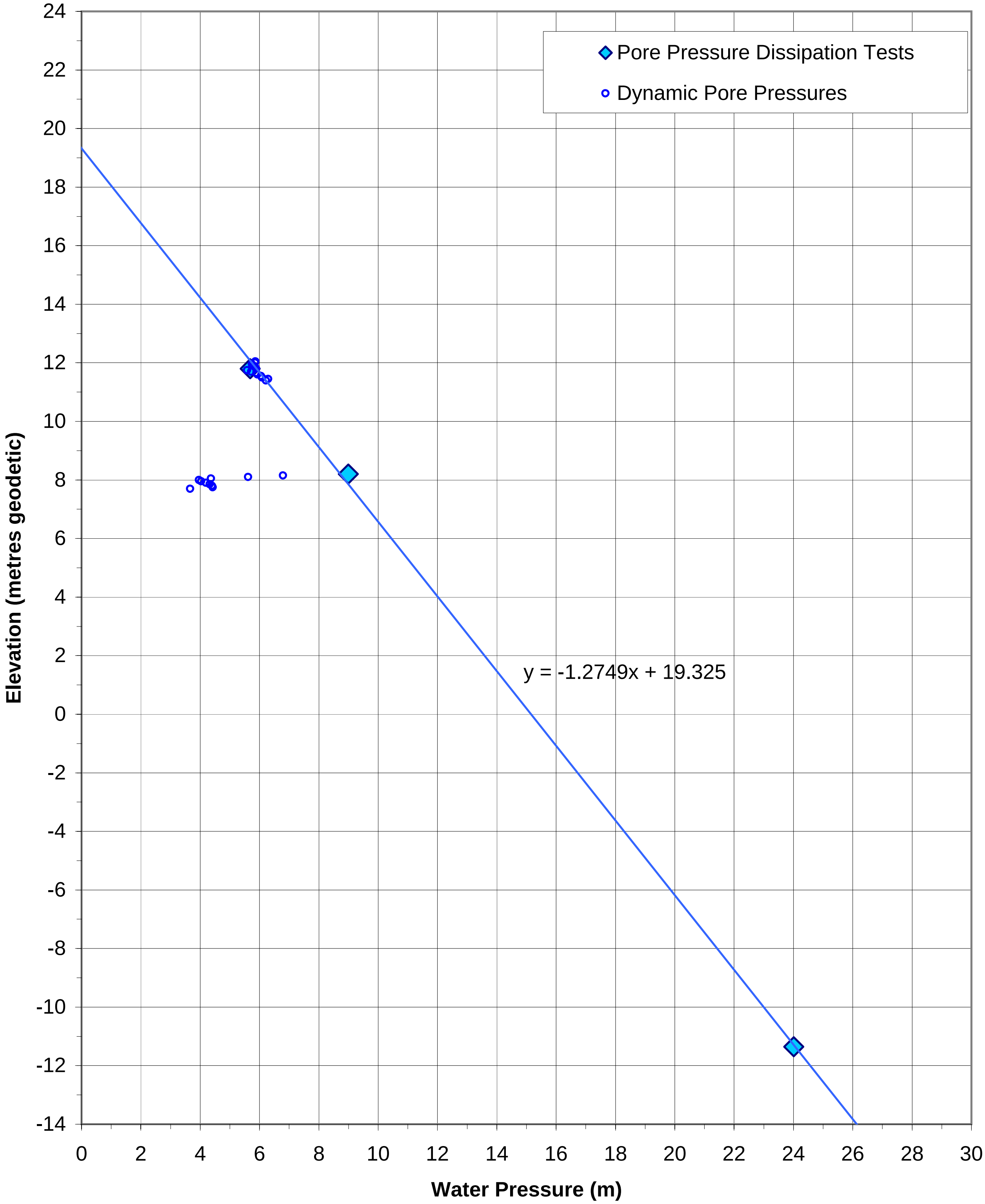
Groundwater Pressure Distribution with Depth
SCPT07-02 (June 25, 2007)



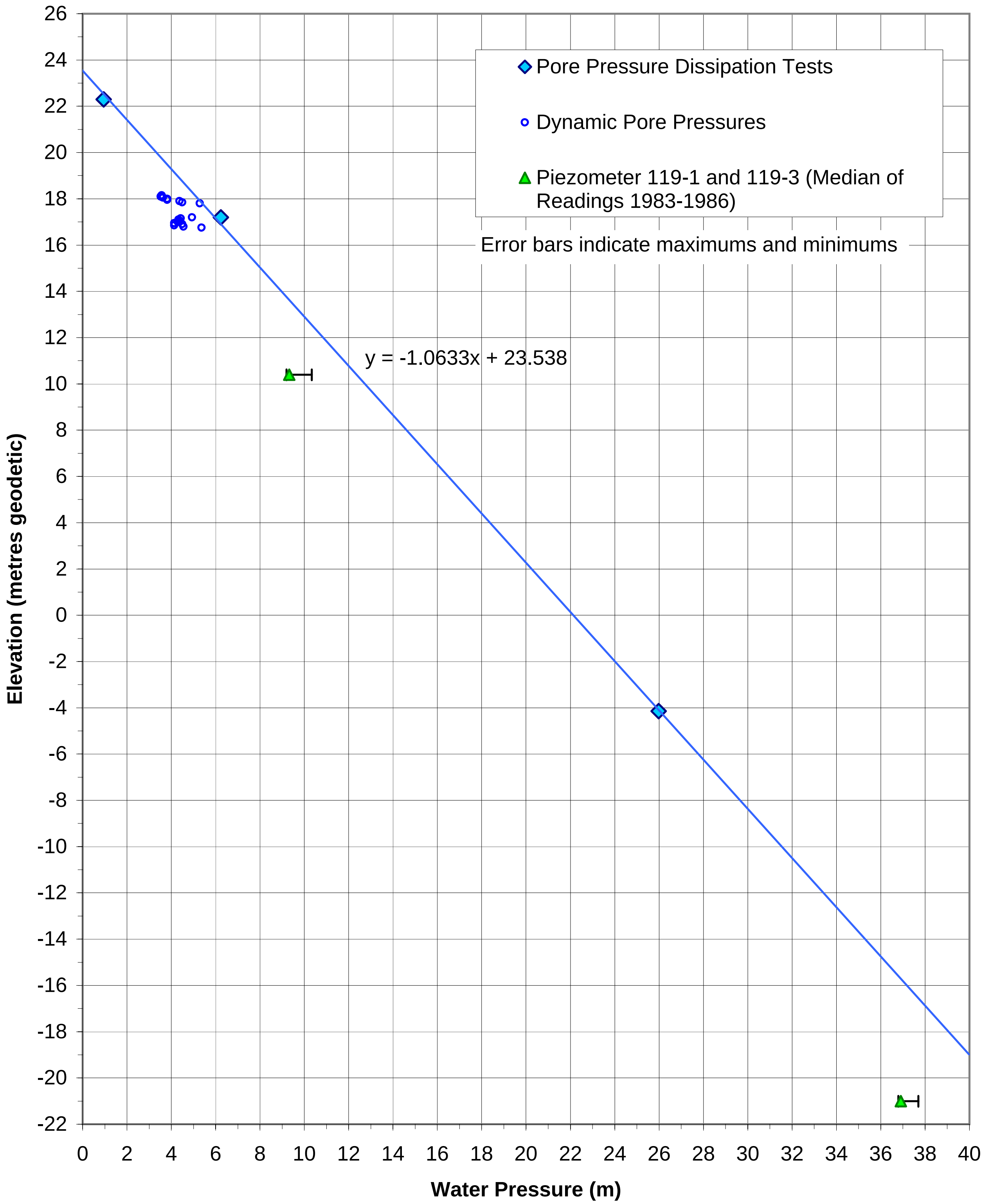
Groundwater Pressure Distribution with Depth
CPT07-03 (June 19, 2007)



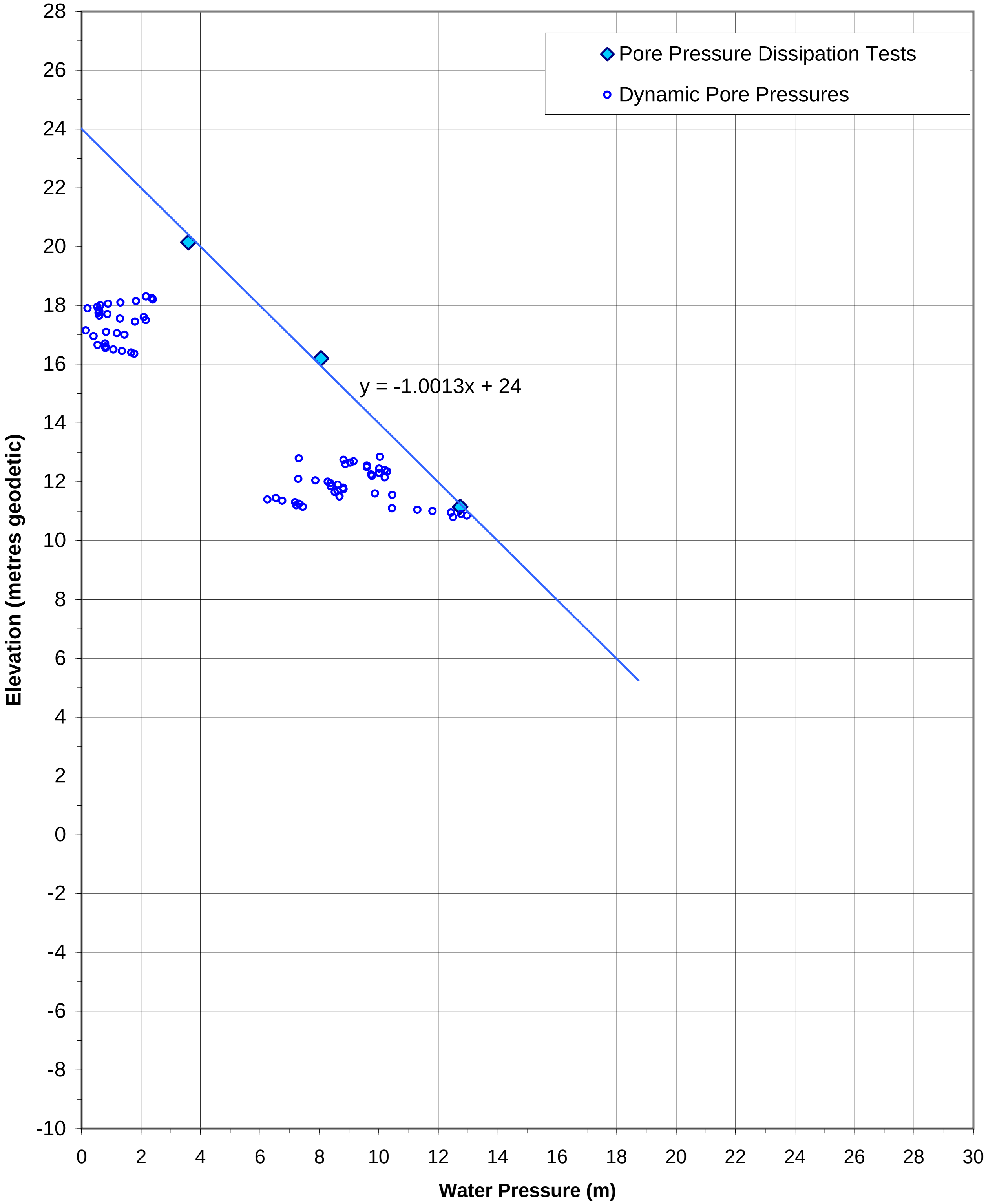
Groundwater Pressure Distribution with Depth
CPT07-04 (June 26, 2007)

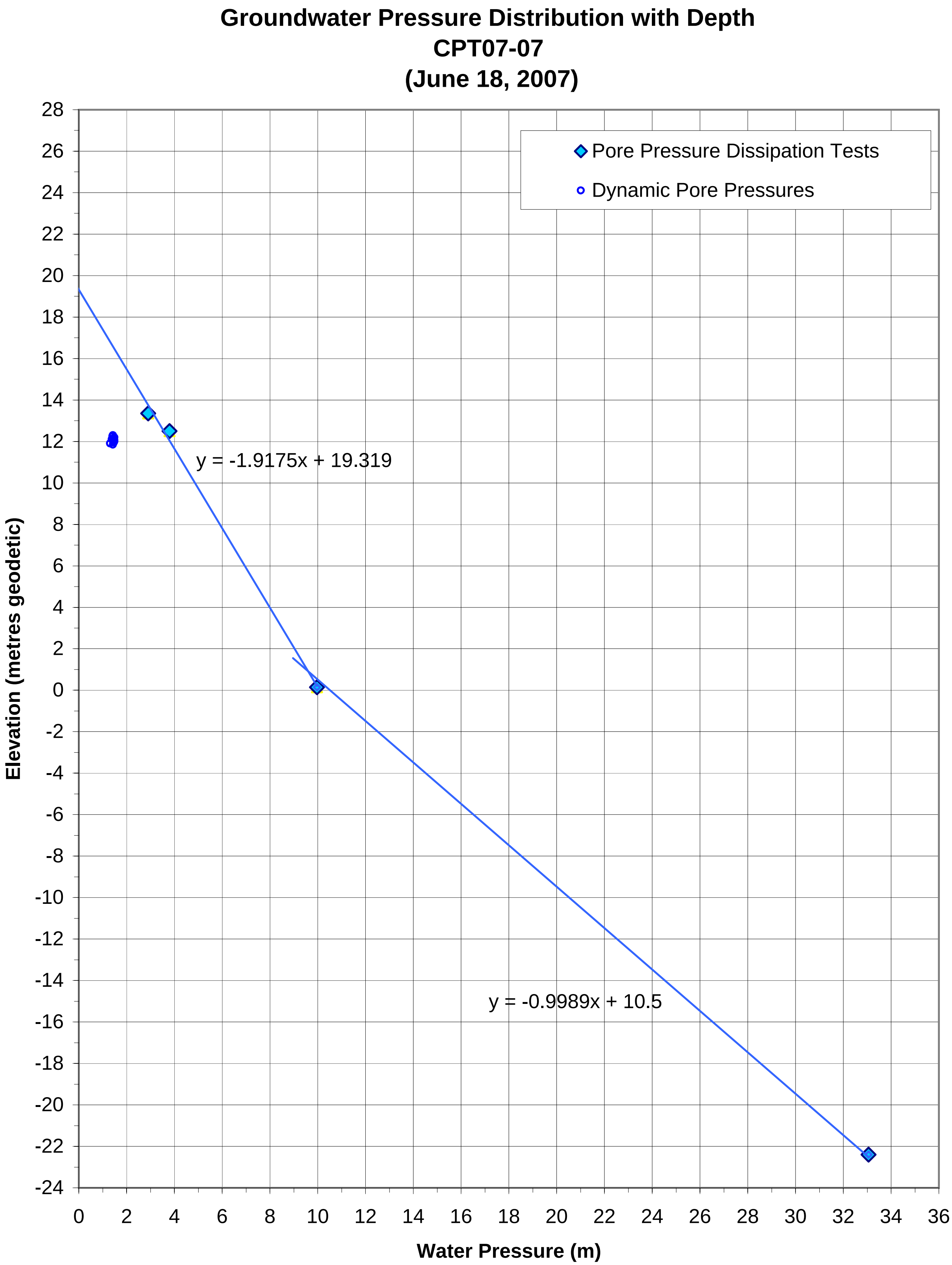


Groundwater Pressure Distribution with Depth
CPT07-05 (June 18, 2007)

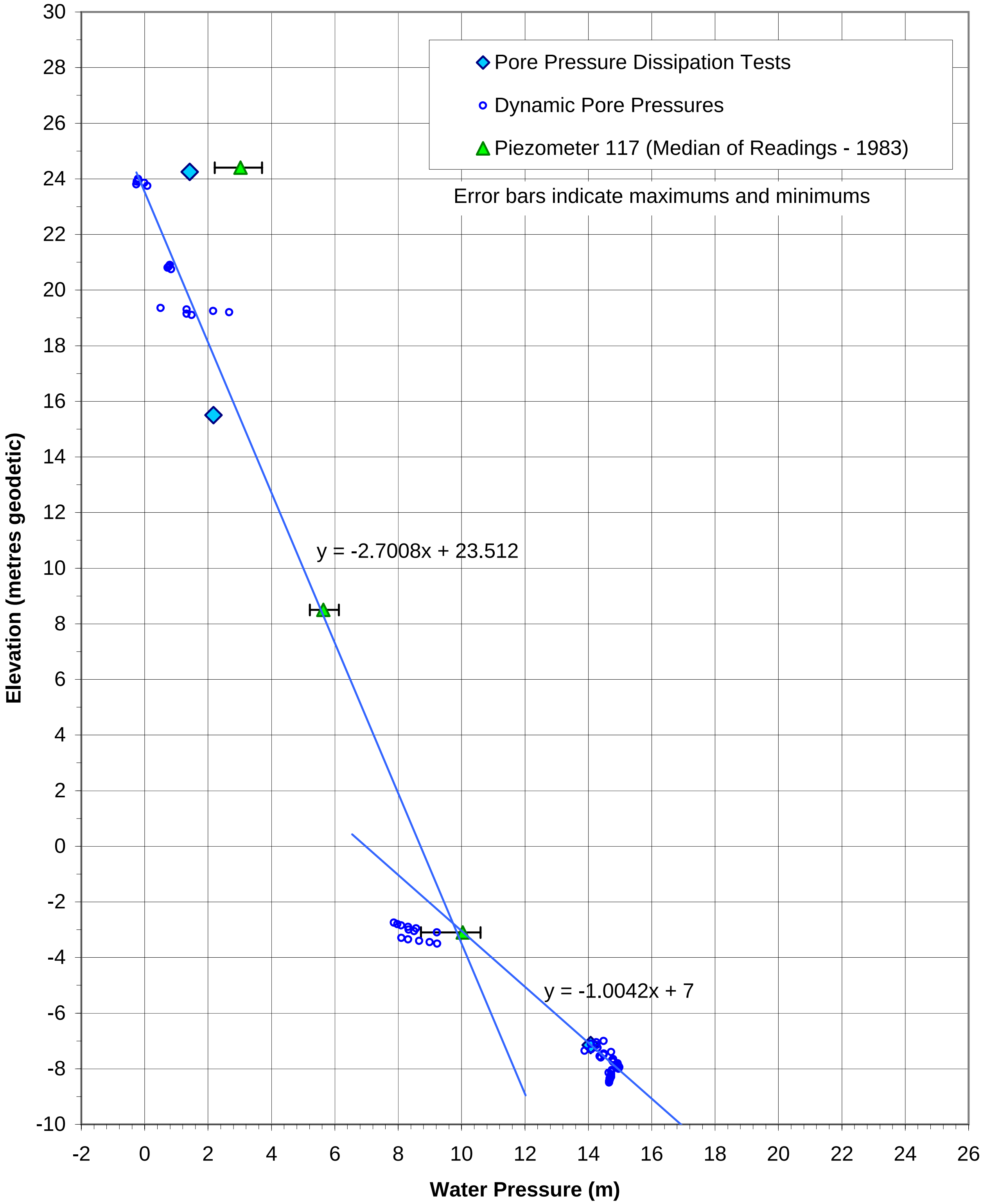


Groundwater Pressure Distribution with Depth
CPT07-06 (June 26, 2007)

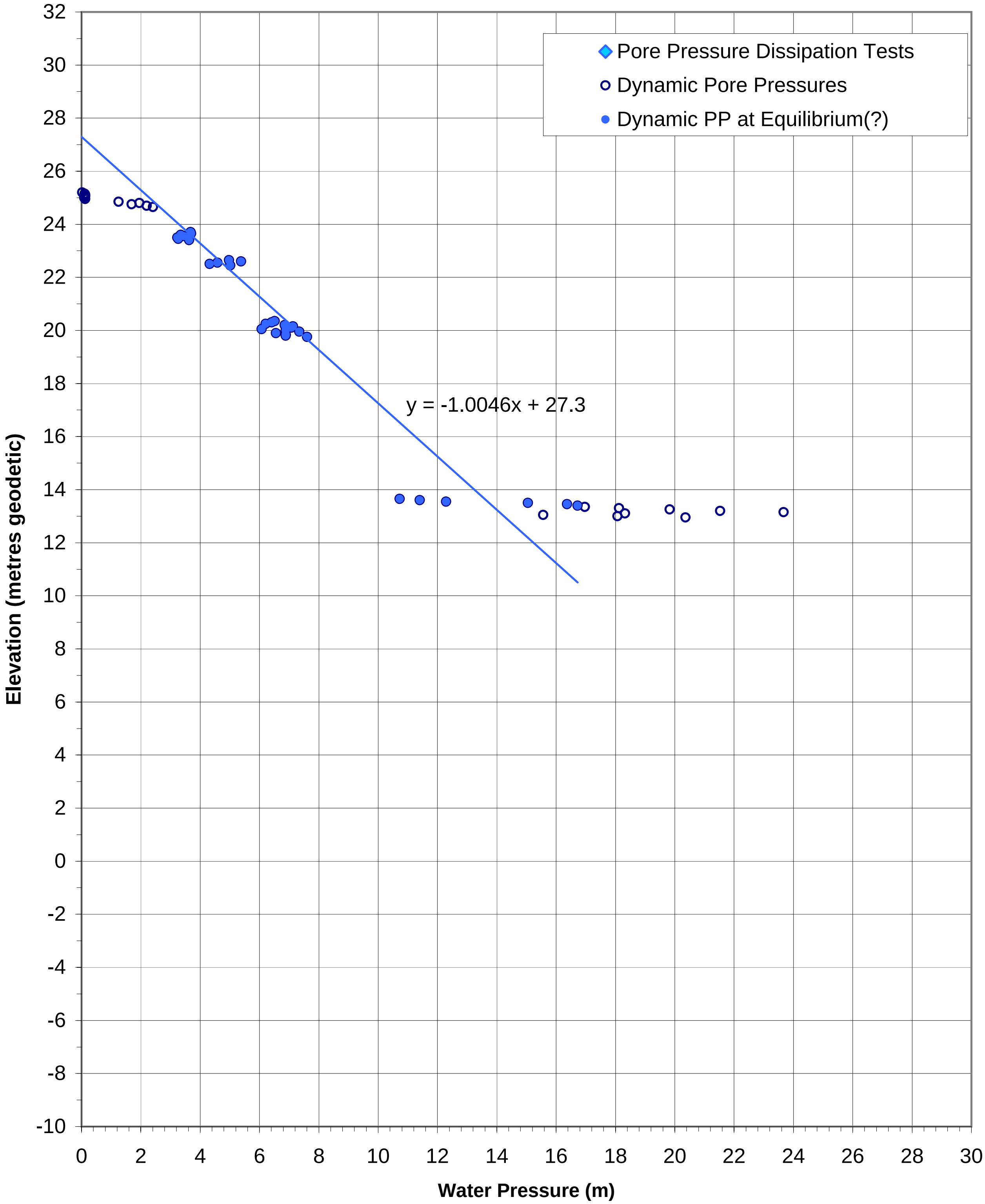



Groundwater Pressure Distribution with Depth
CPT07-07
(June 18, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.9175x + 19.319
y = -0.9989x + 10.5
Elevation (metres geodetic)
Water Pressure (m)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36

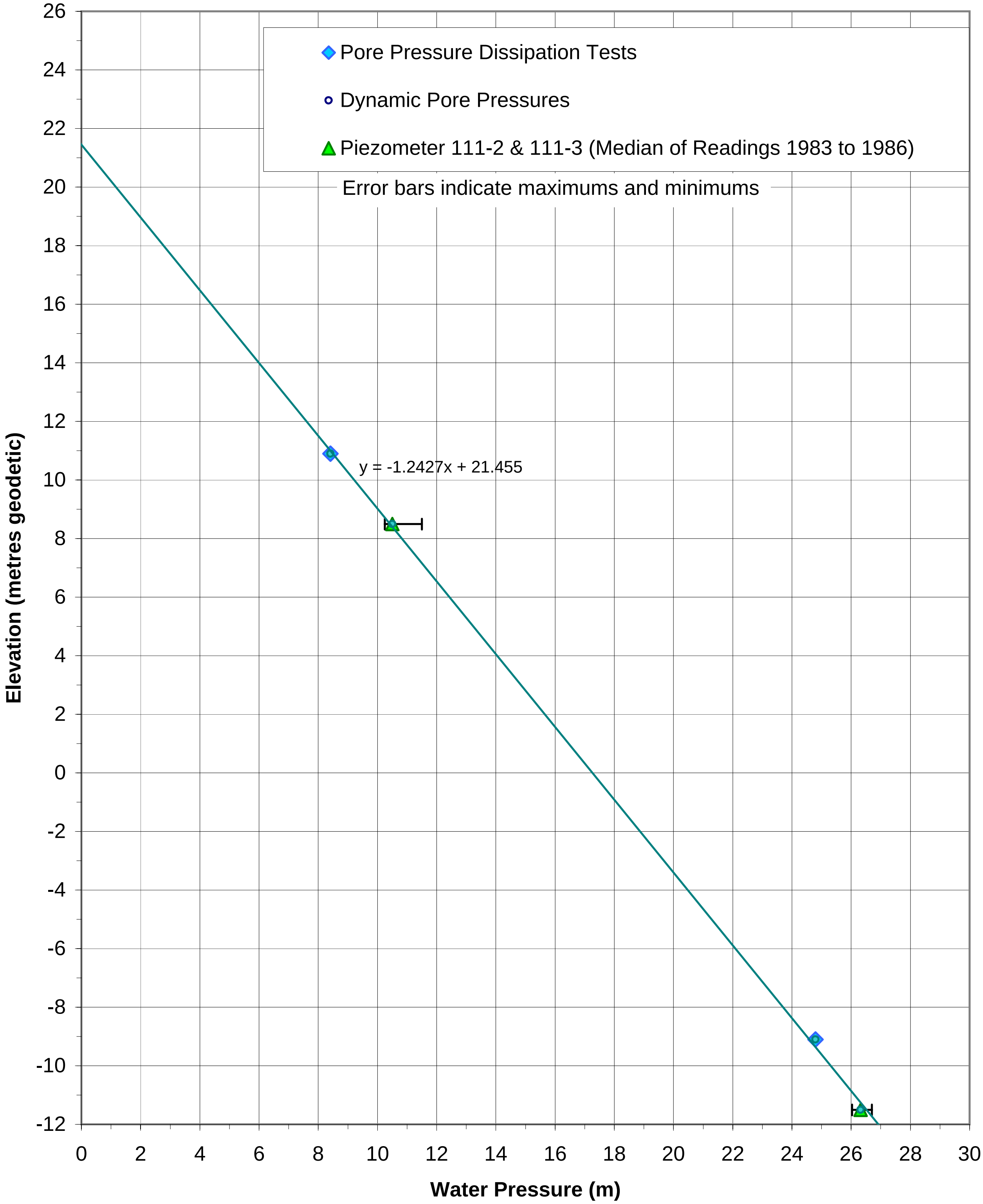
Groundwater Pressure Distribution with Depth
SCPT07-08
(June 28, 2007)



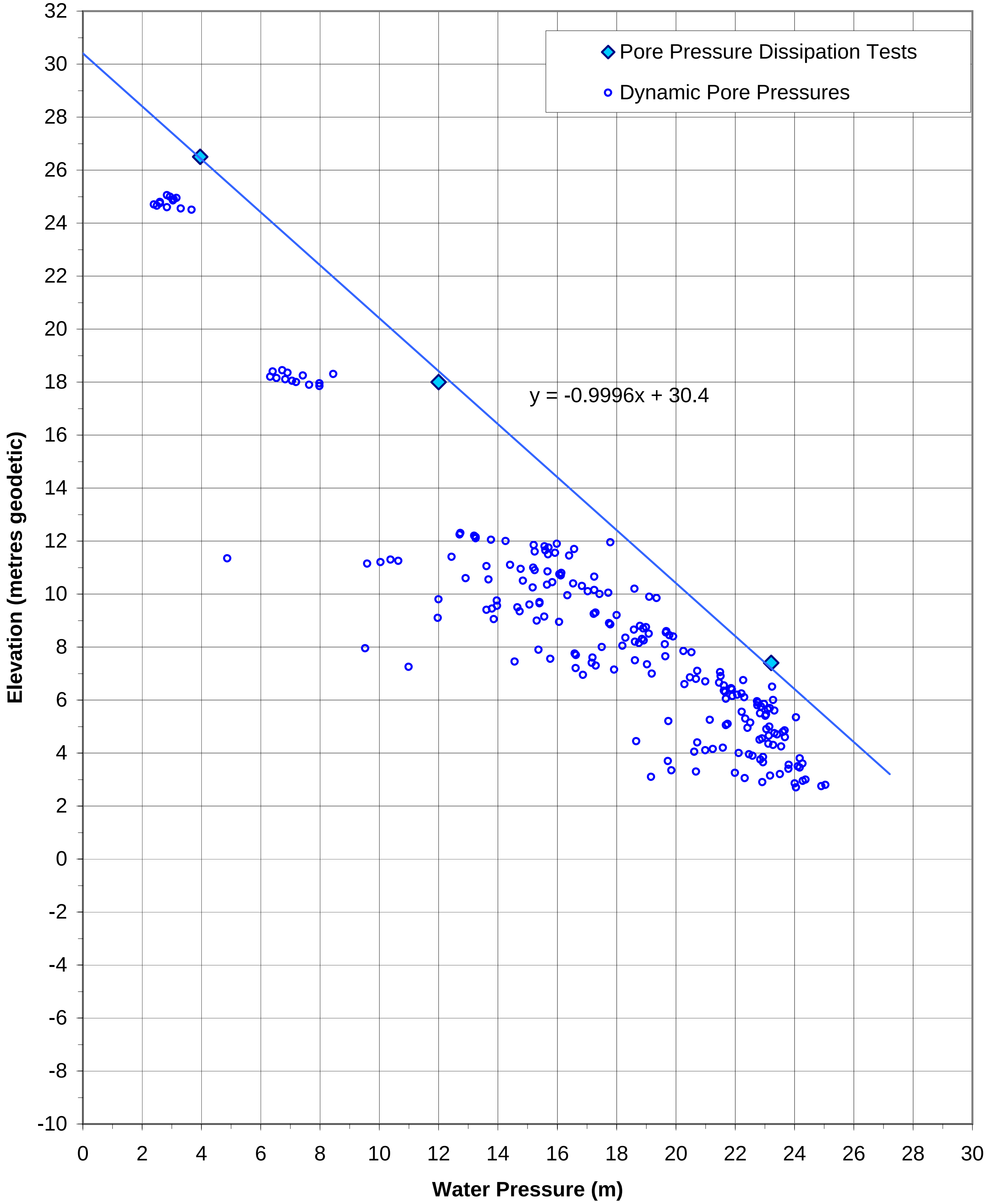
Groundwater Pressure Distribution with Depth
SCPT07-09
(June 21, 2007)



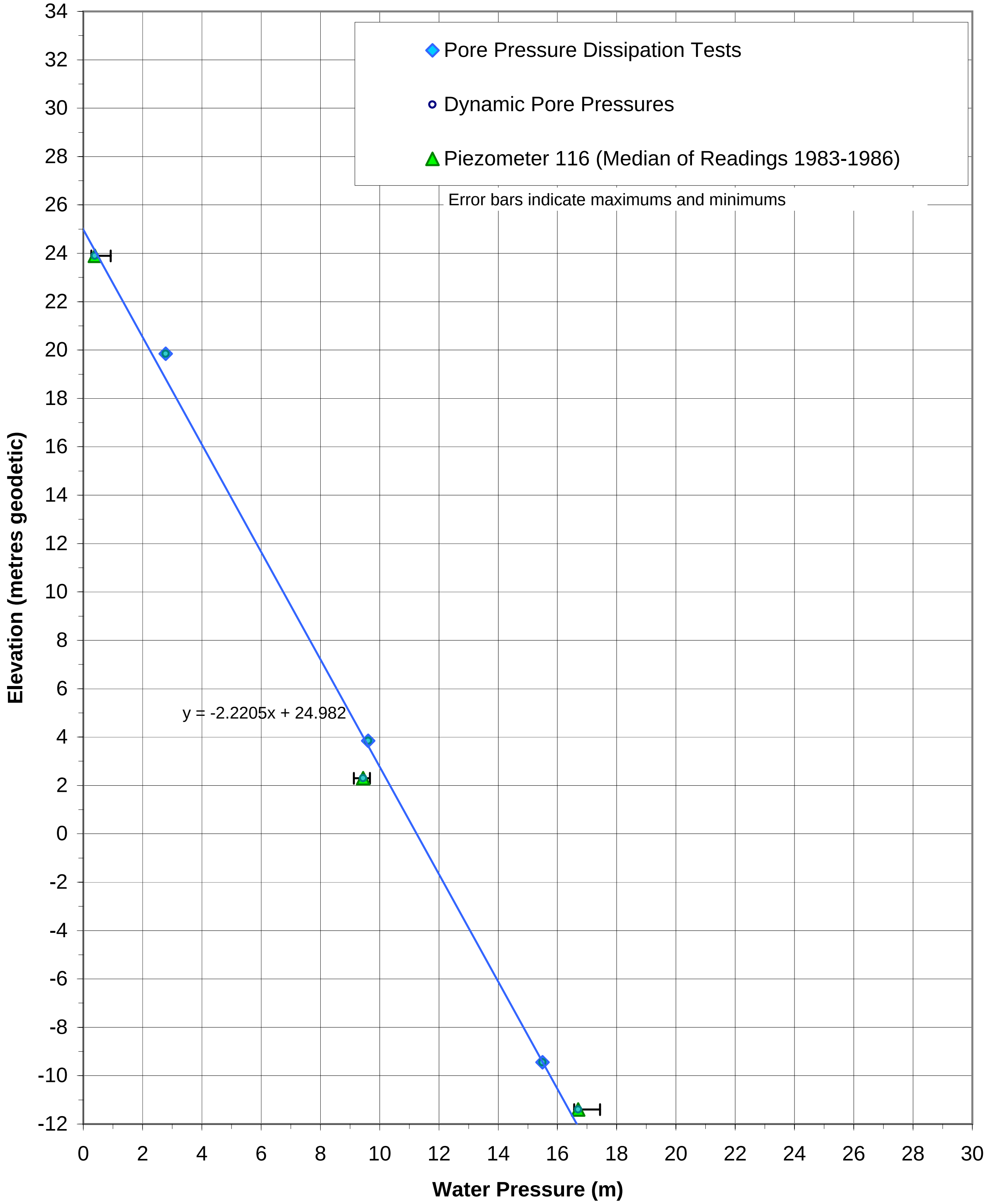
Groundwater Pressure Distribution with Depth
CPT07-10
(June 29, 2007)



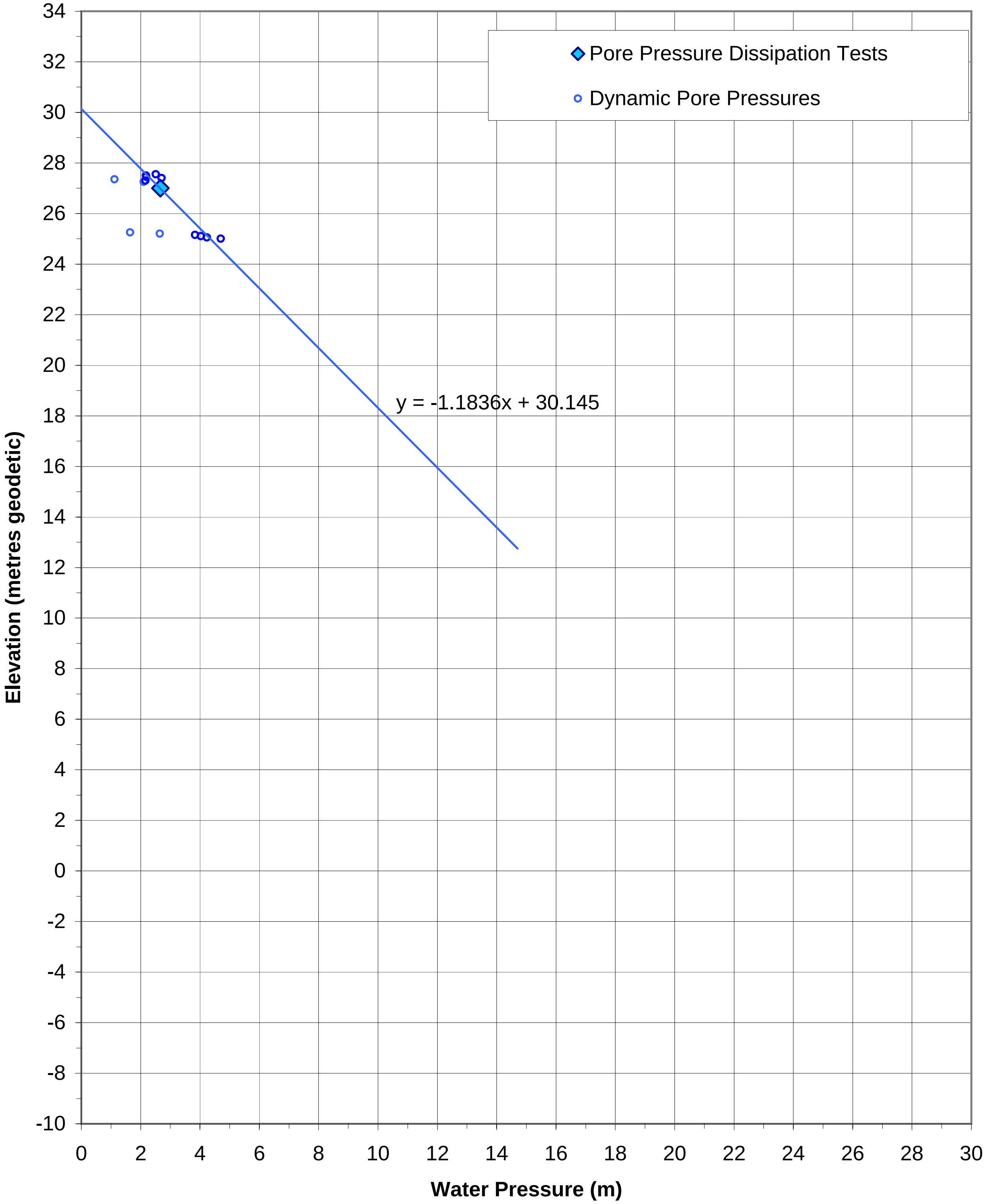
Groundwater Pressure Distribution with Depth
CPT07-11 (June 21, 2007)



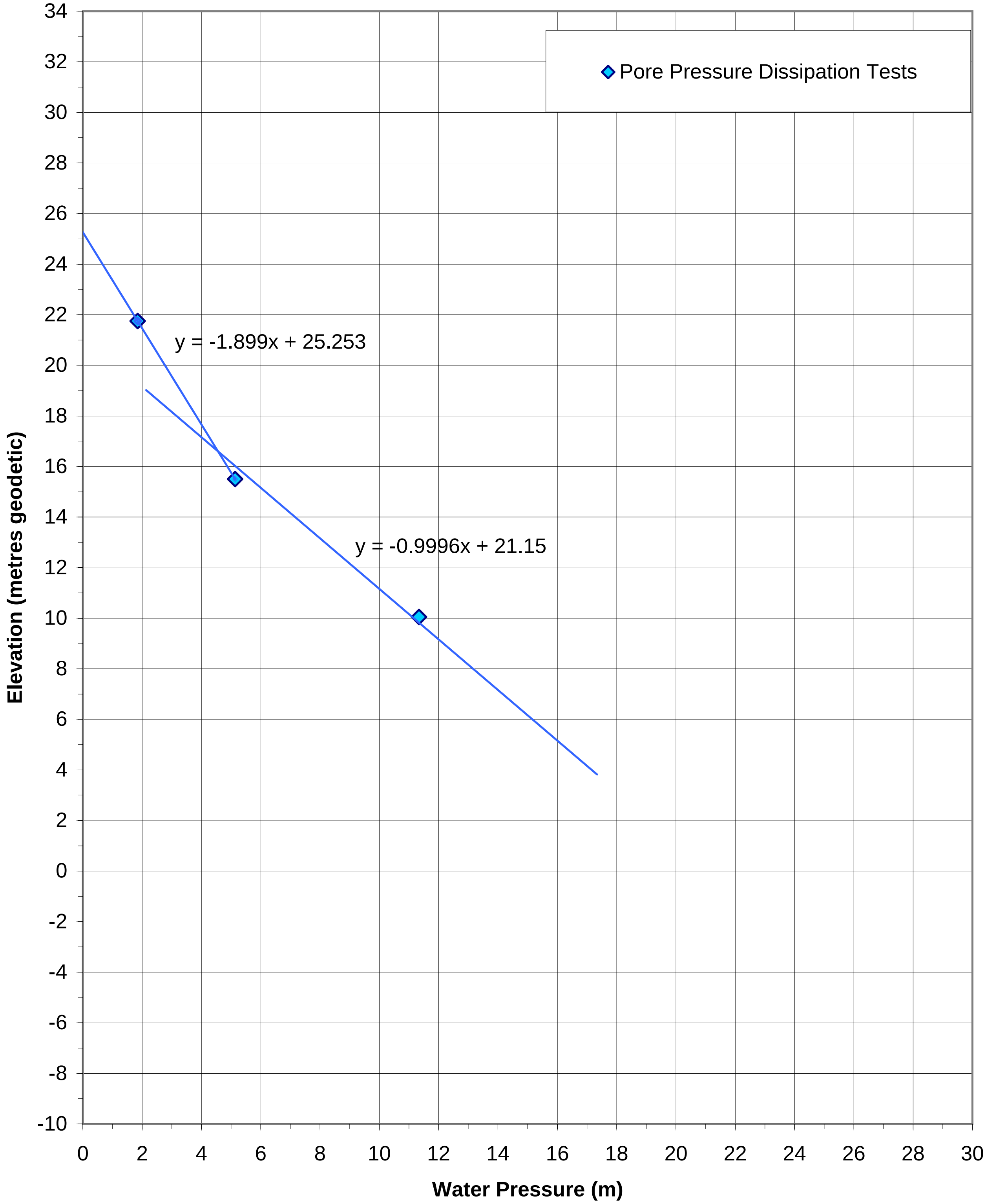
Groundwater Pressure Distribution with Depth
SCPT07-12
(June 27, 2007)



Groundwater Pressure Distribution with Depth
CPT07-13
(June 22, 2007)

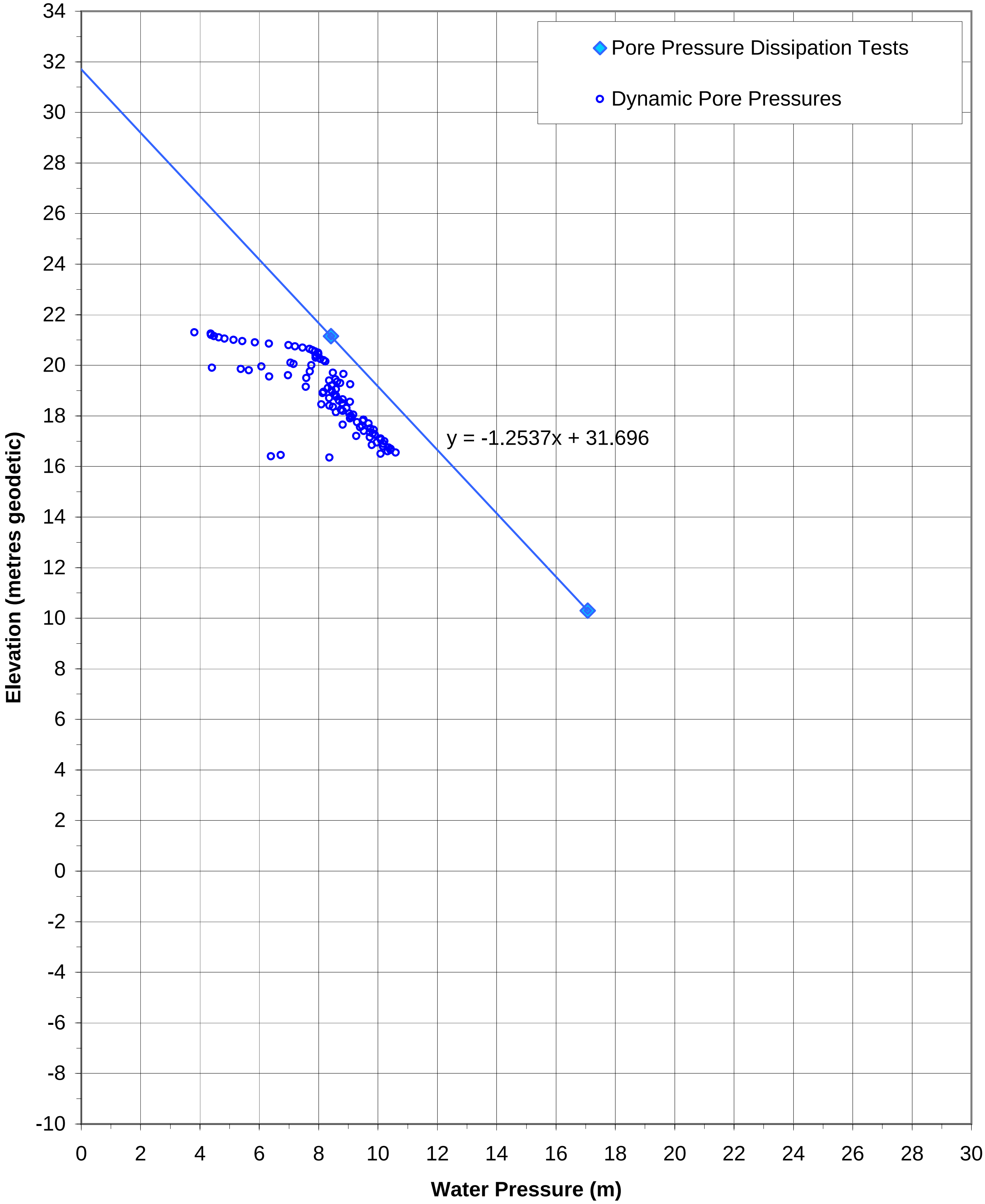


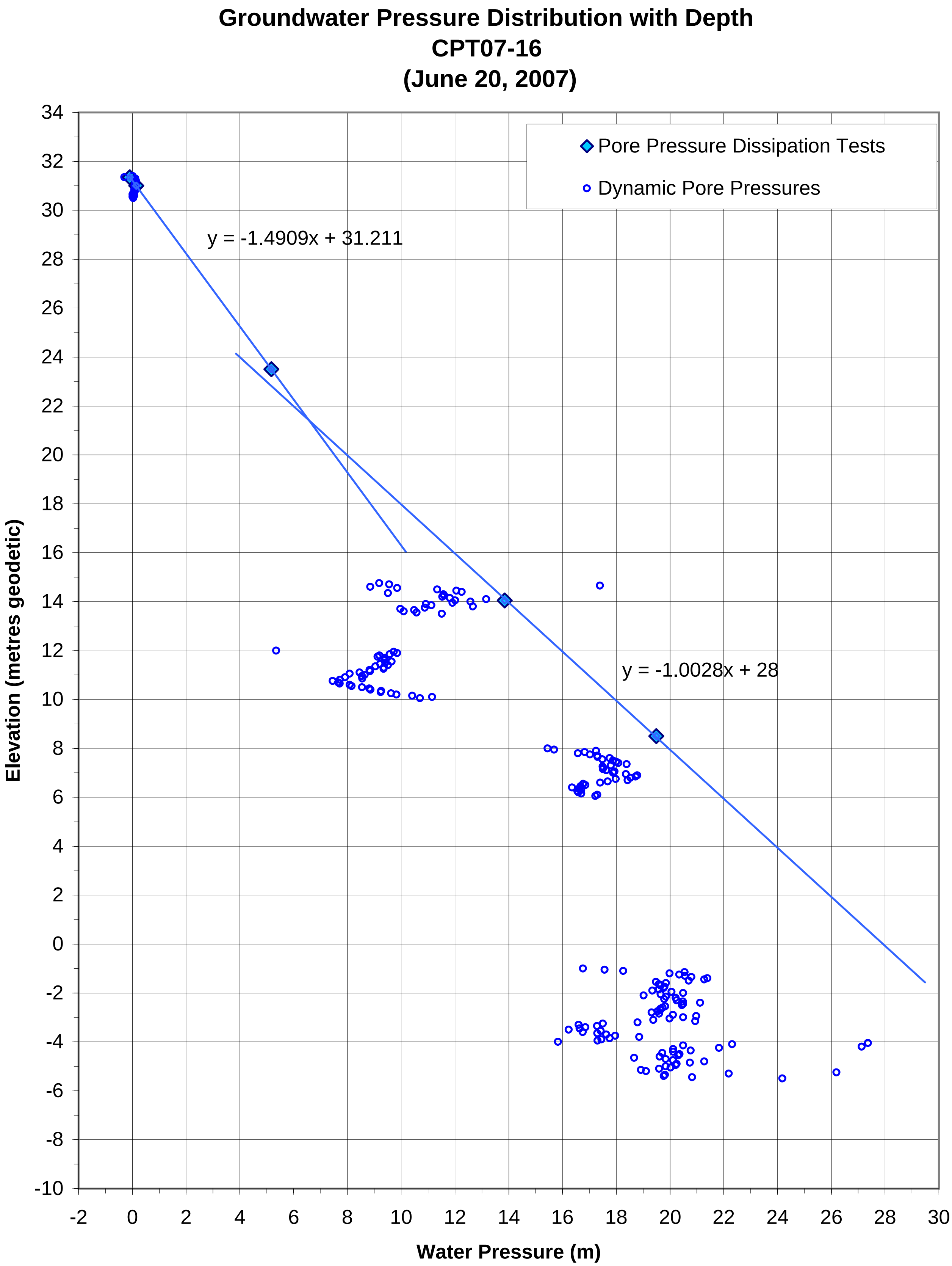
Groundwater Pressure Distribution with Depth
CPT07-14
(June 27, 2007)



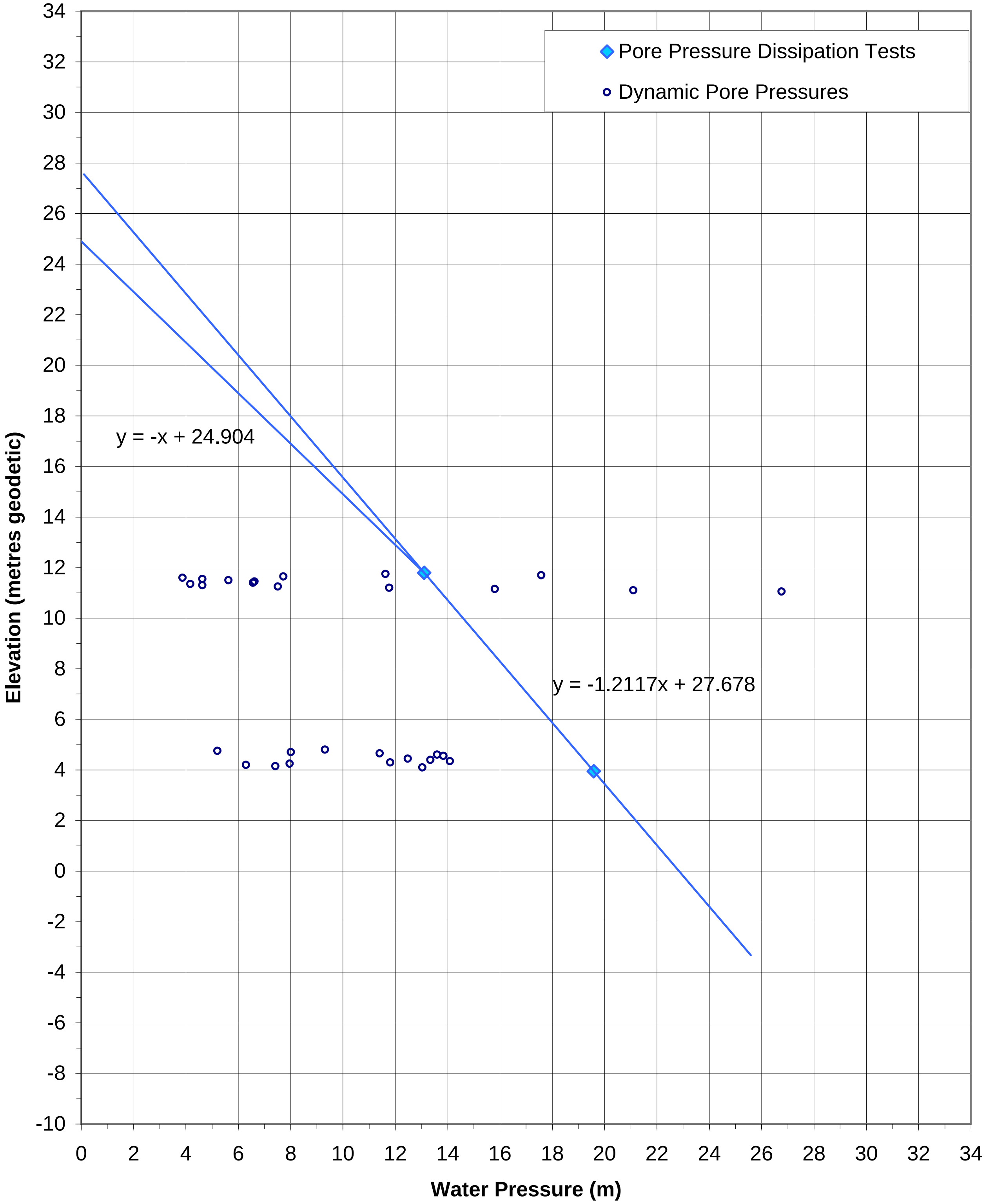
Fraser River Escarpment
Maple Ridge, BC

Groundwater Pressure Distribution with Depth
CPT07-15
(June 22, 2007)

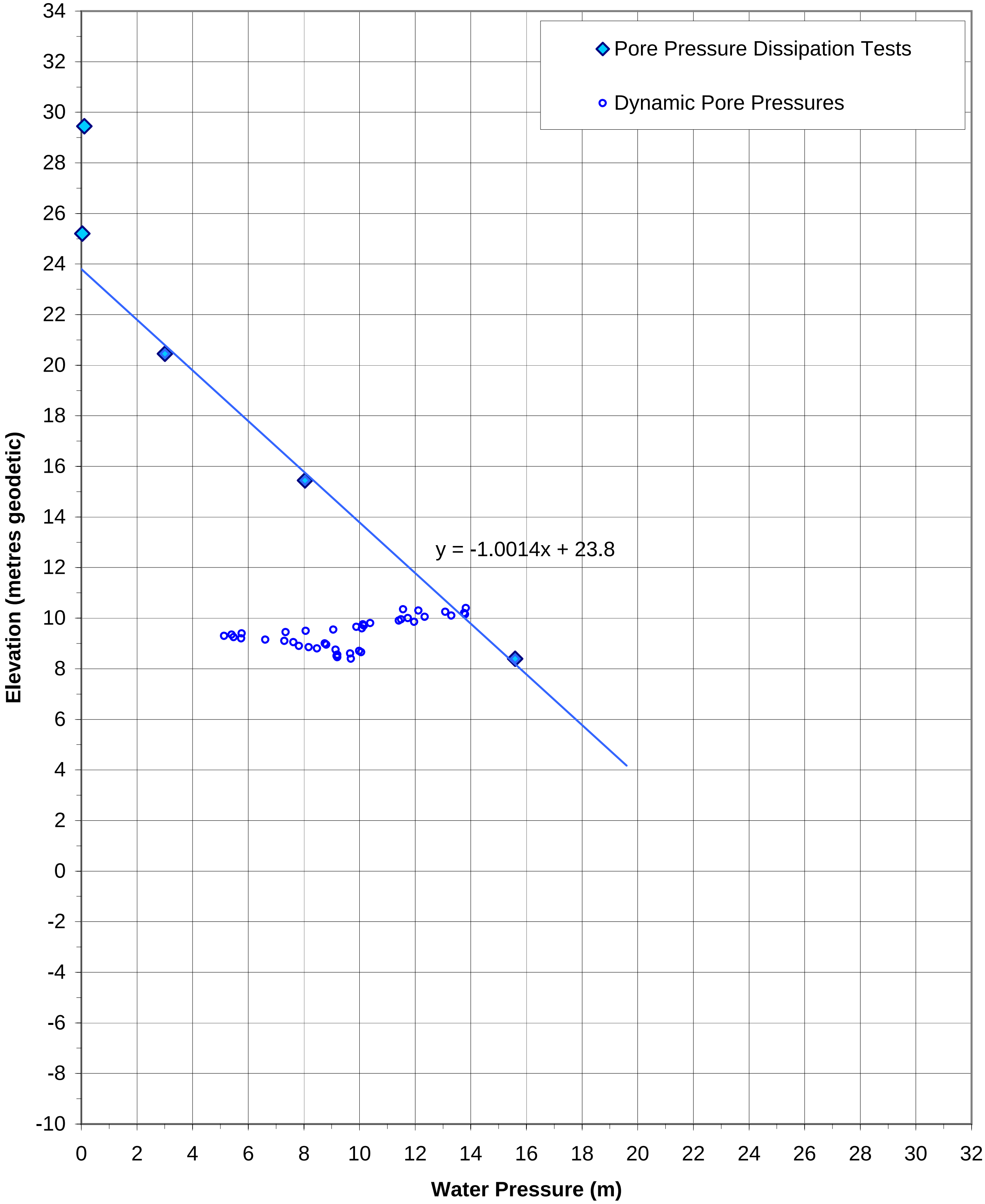



Groundwater Pressure Distribution with Depth
CPT07-16
(June 20, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.4909x + 31.211
y = -1.0028x + 28
Elevation (metres geodetic)
Water Pressure (m)
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

Groundwater Pressure Distribution with Depth
CPT07-17
(June 19, 2007)

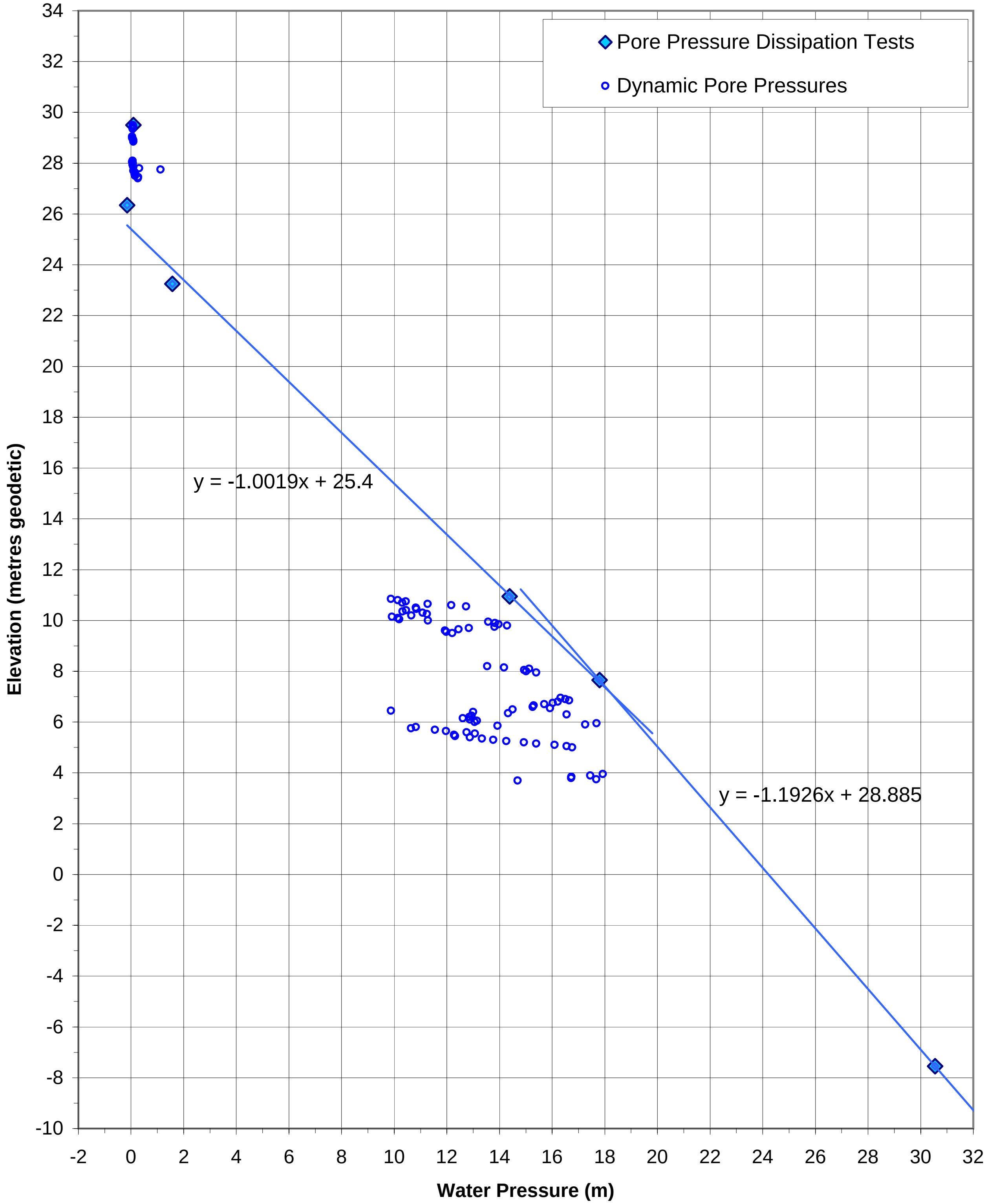


Groundwater Pressure Distribution with Depth
CPT07-18
(August 22, 2007)

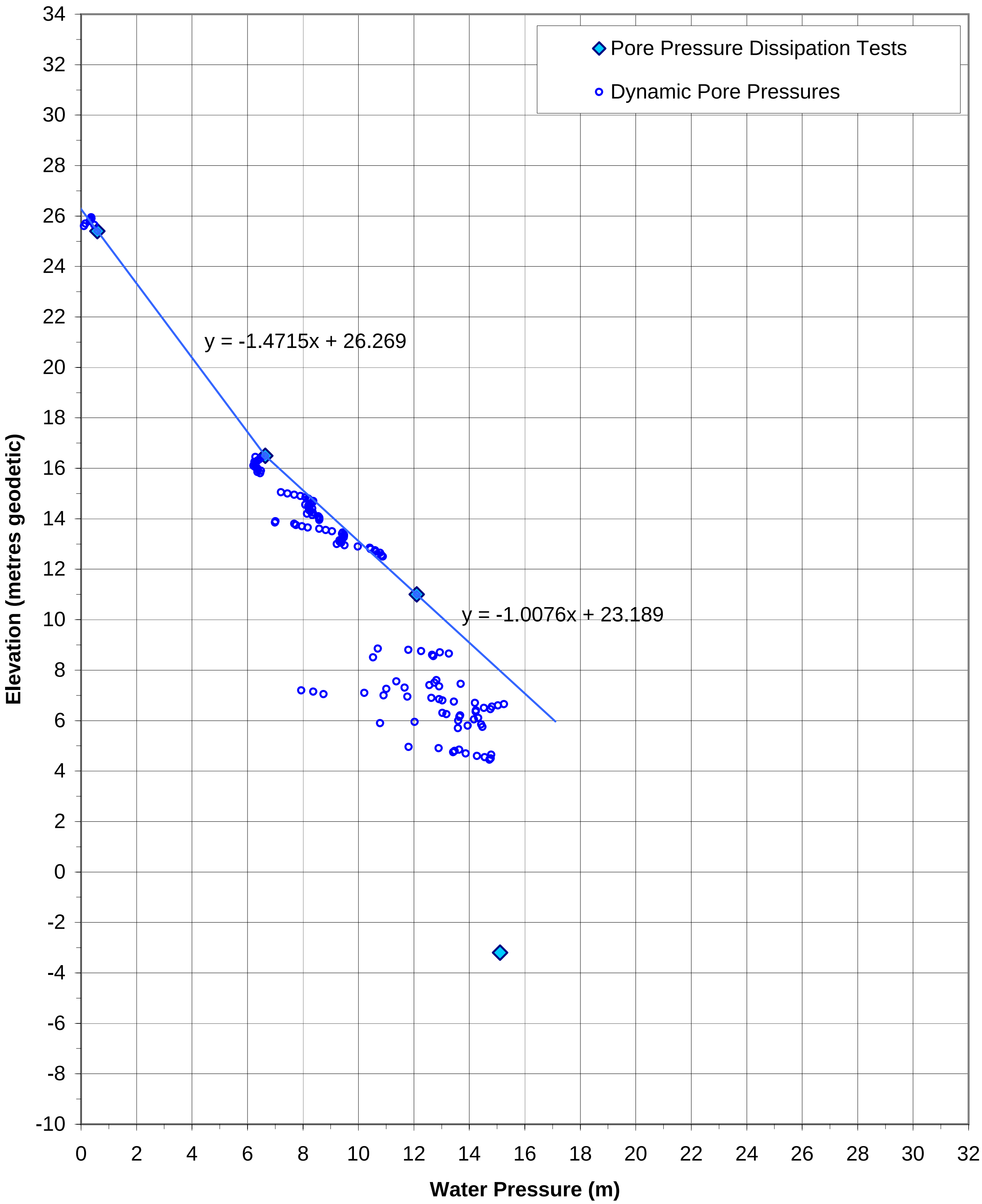


Fraser River Escarpment
Maple Ridge, BC

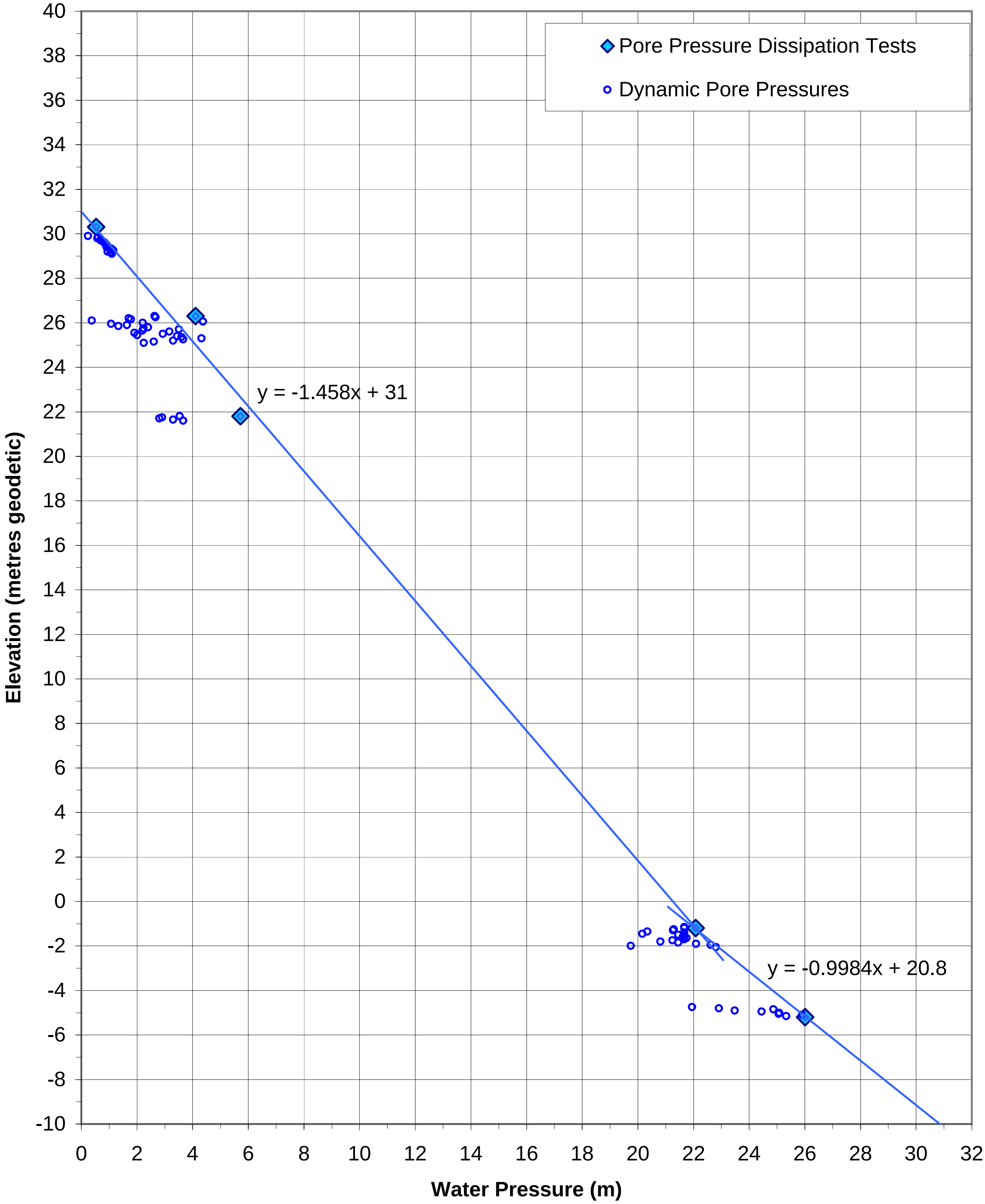
Groundwater Pressure Distribution with Depth
CPT07-19
(August 22, 2007)

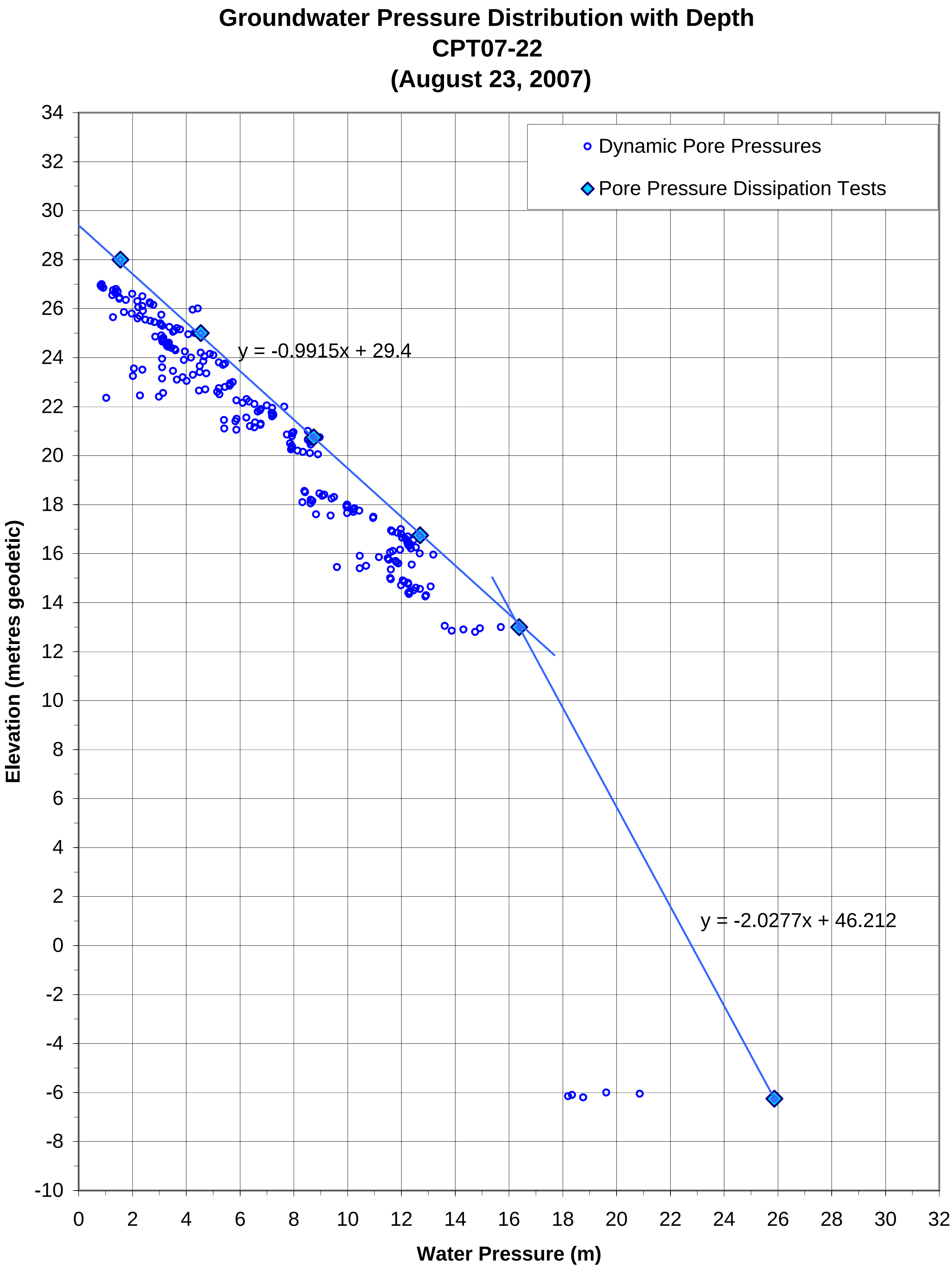


Groundwater Pressure Distribution with Depth
CPT07-20
(August 21, 2007)

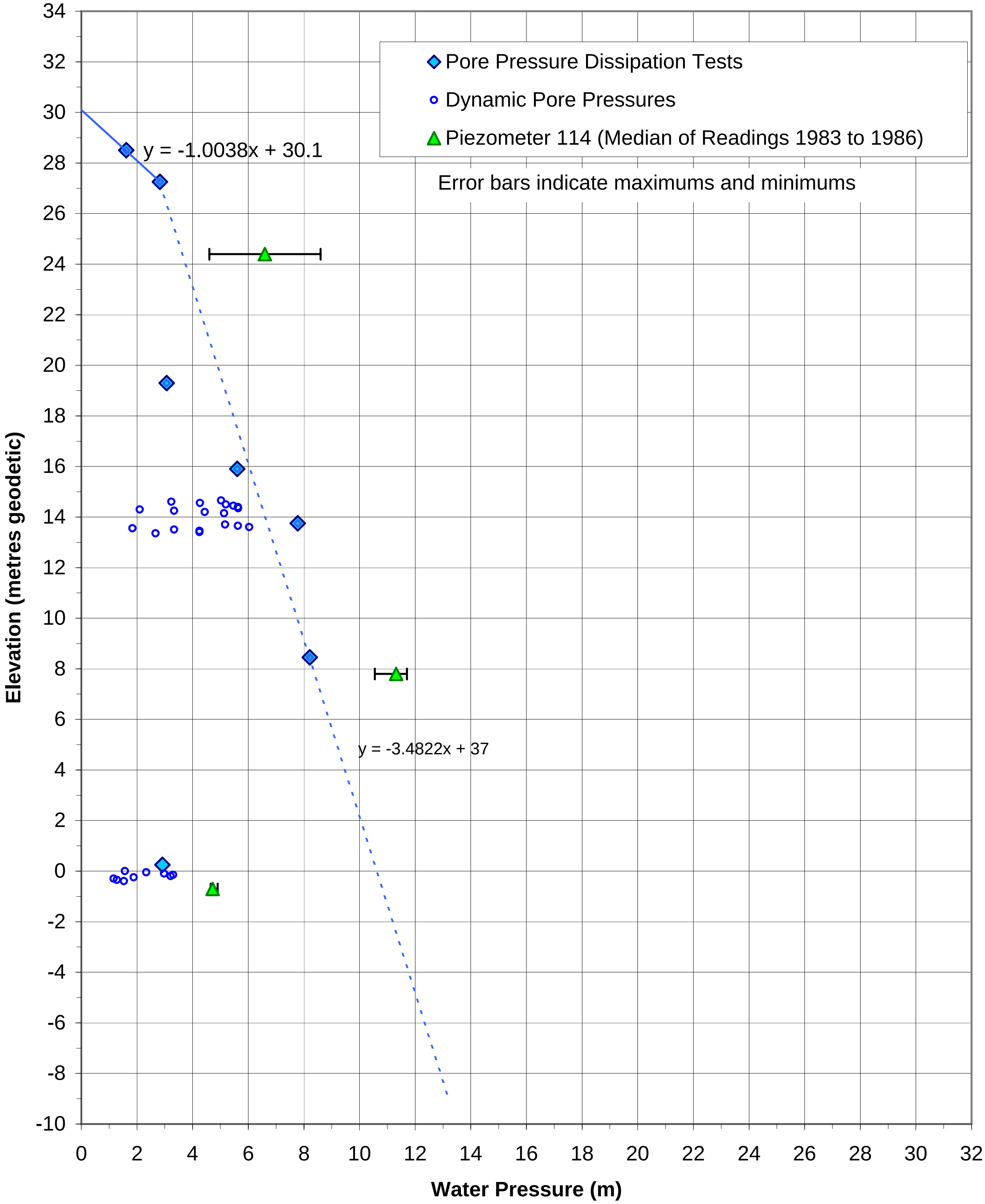


Groundwater Pressure Distribution with Depth
CPT07-21
(August 23, 2007)




Groundwater Pressure Distribution with Depth
CPT07-22
(August 23, 2007)
Dynamic Pore Pressures
Pore Pressure Dissipation Tests
y = -0.9915x + 29.4
y = -2.0277x + 46.212
Elevation (metres geodetic)
Water Pressure (m)
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

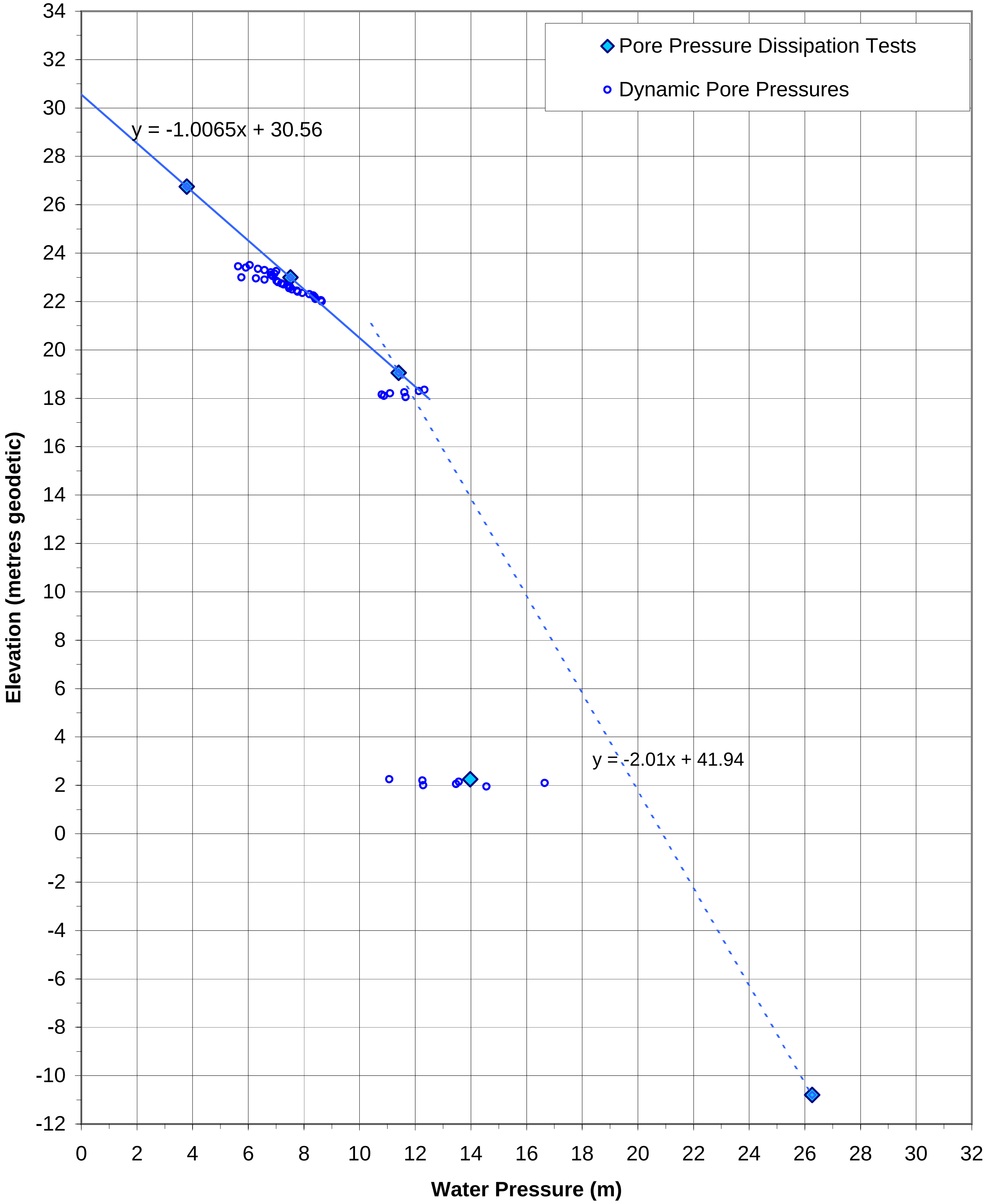
Groundwater Pressure Distribution with Depth
CPT07-23
(August 21, 2007)

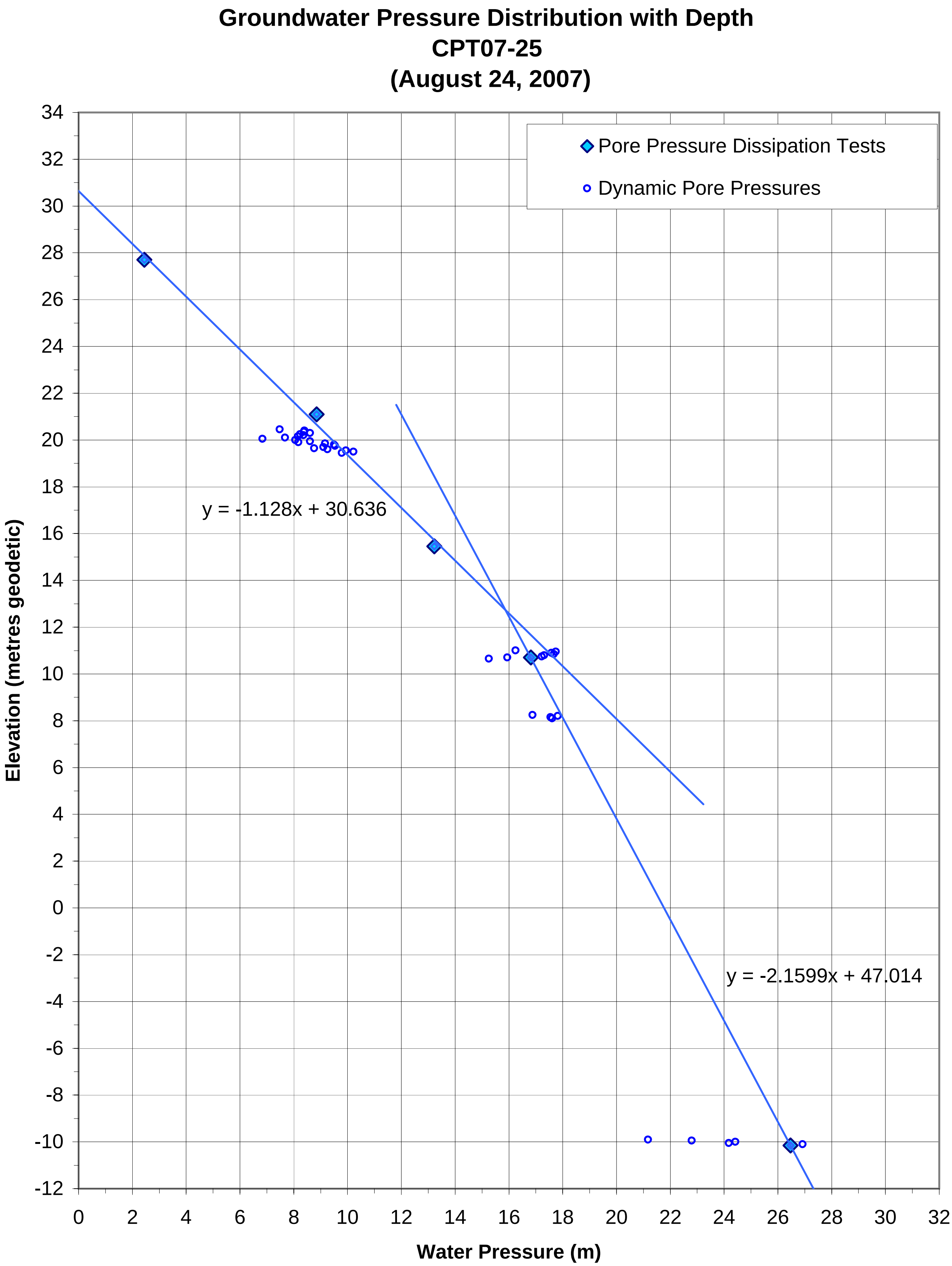


Fraser River Escarpment
Maple Ridge, BC

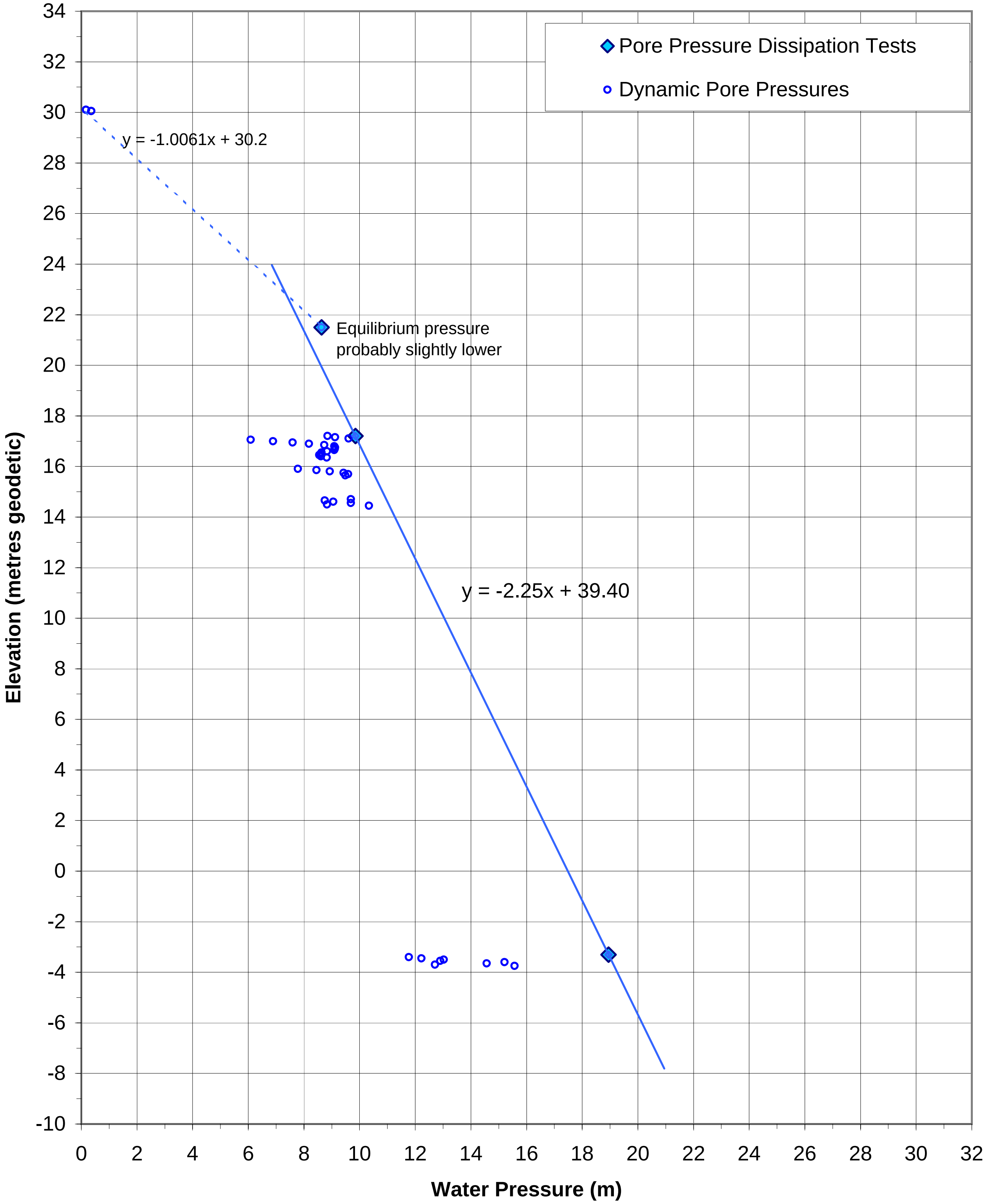
07-1414-0096

Groundwater Pressure Distribution with Depth
CPT07-24
(August 24, 2007)

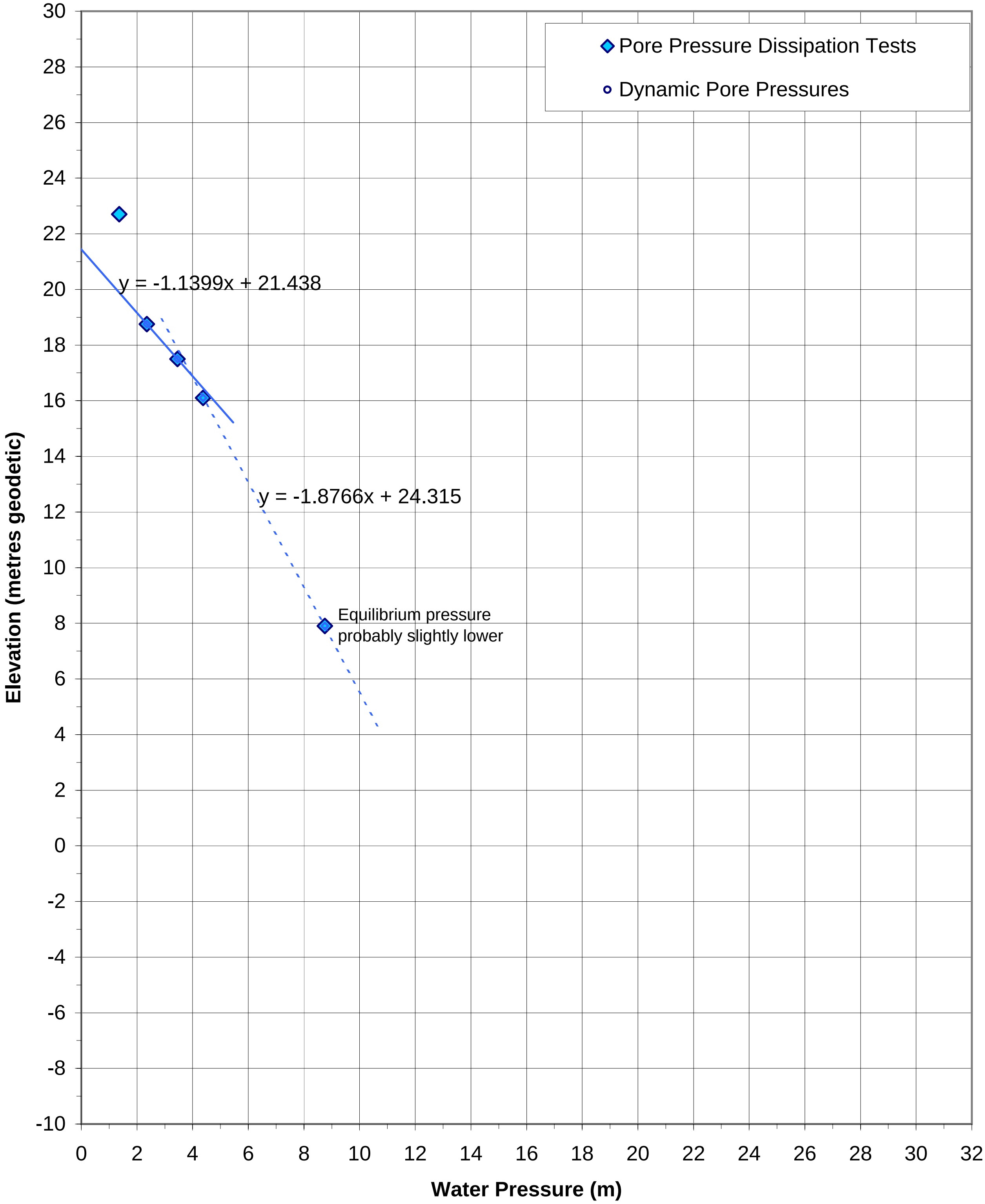


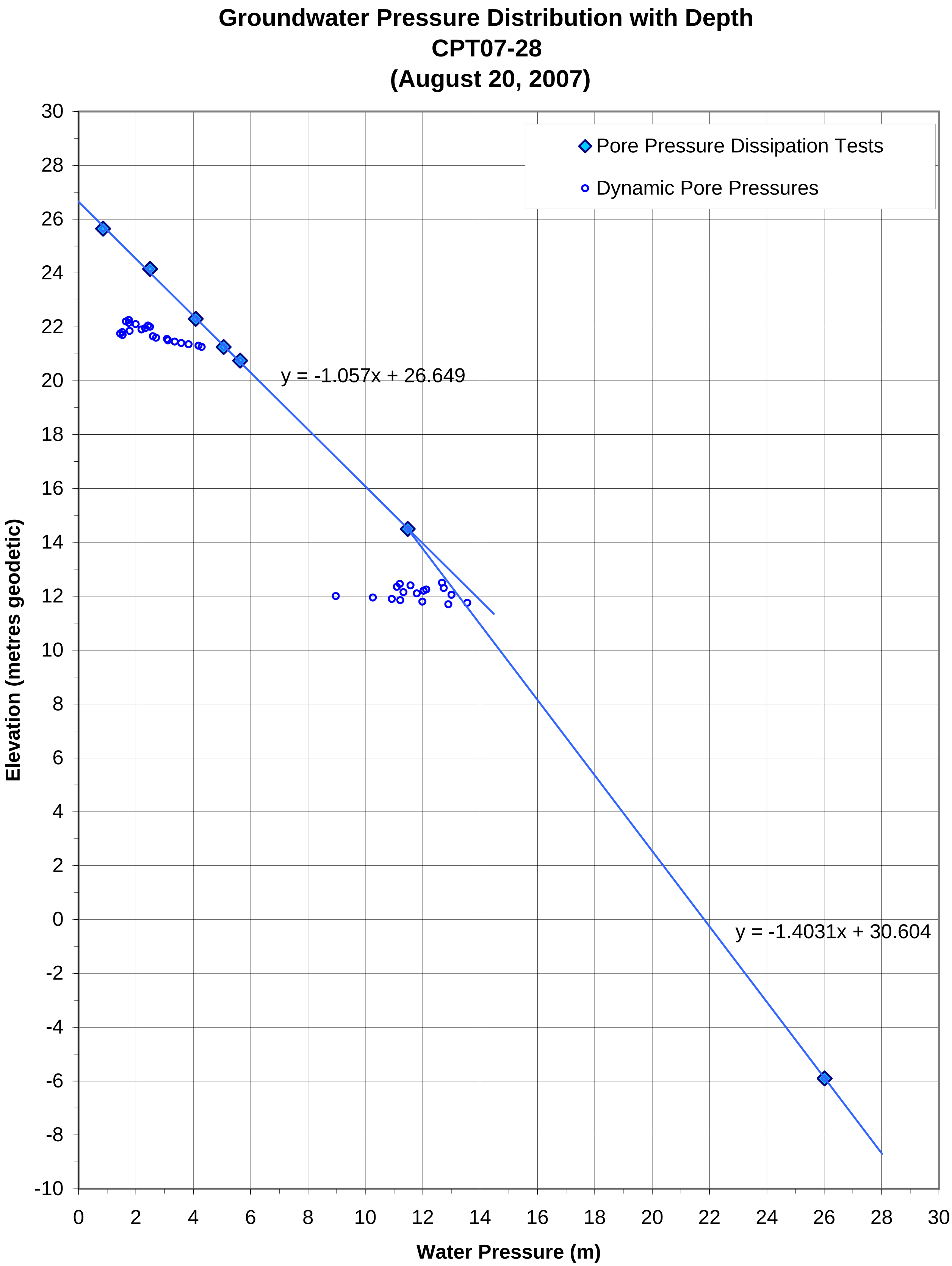

Groundwater Pressure Distribution with Depth
CPT07-25
(August 24, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.128x + 30.636
y = -2.1599x + 47.014
Elevation (metres geodetic)
Water Pressure (m)
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

Groundwater Pressure Distribution with Depth CPT07-26 (August 20, 2007)



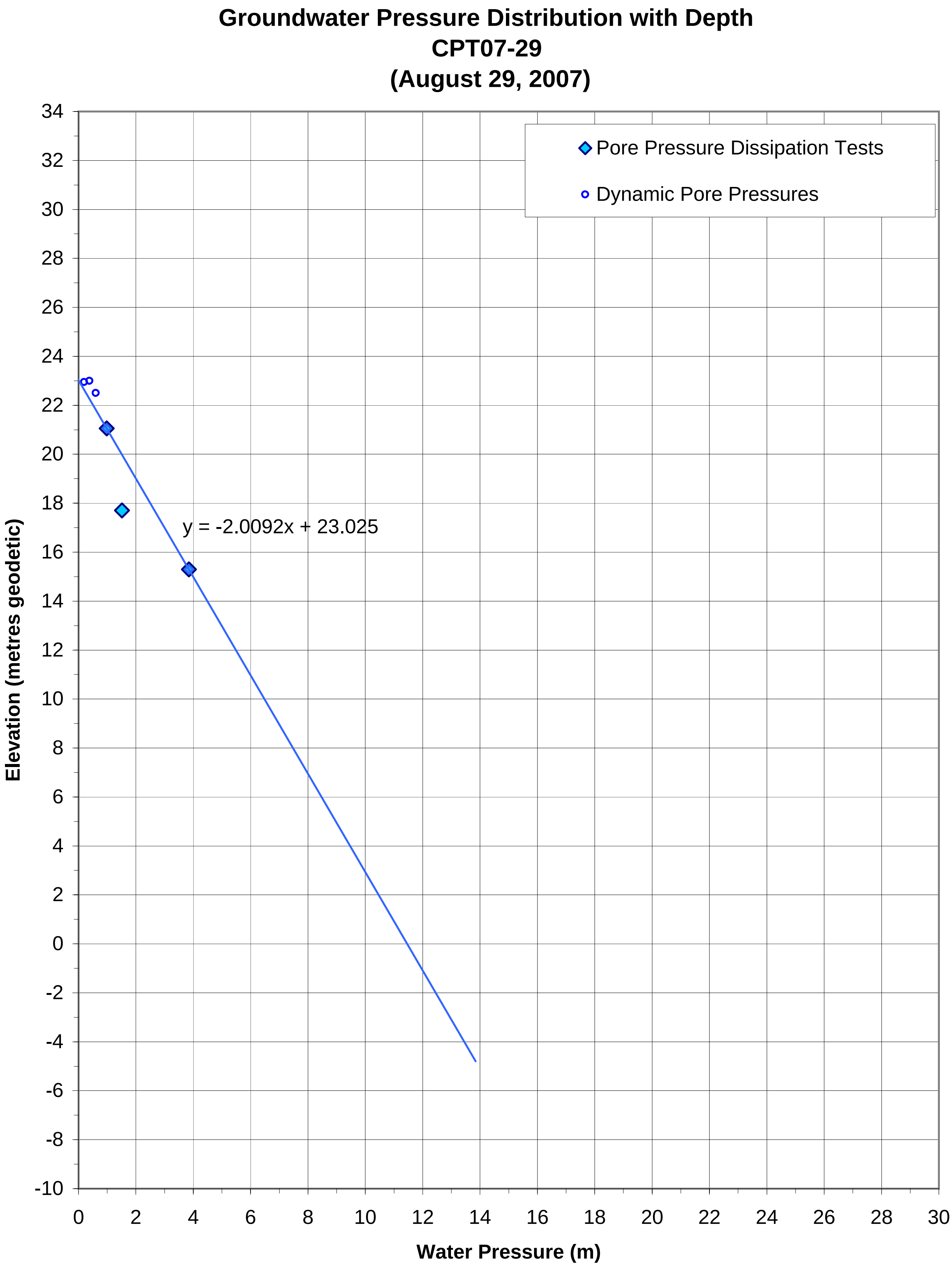
Groundwater Pressure Distribution with Depth
CPT07-27
(August 30, 2007)

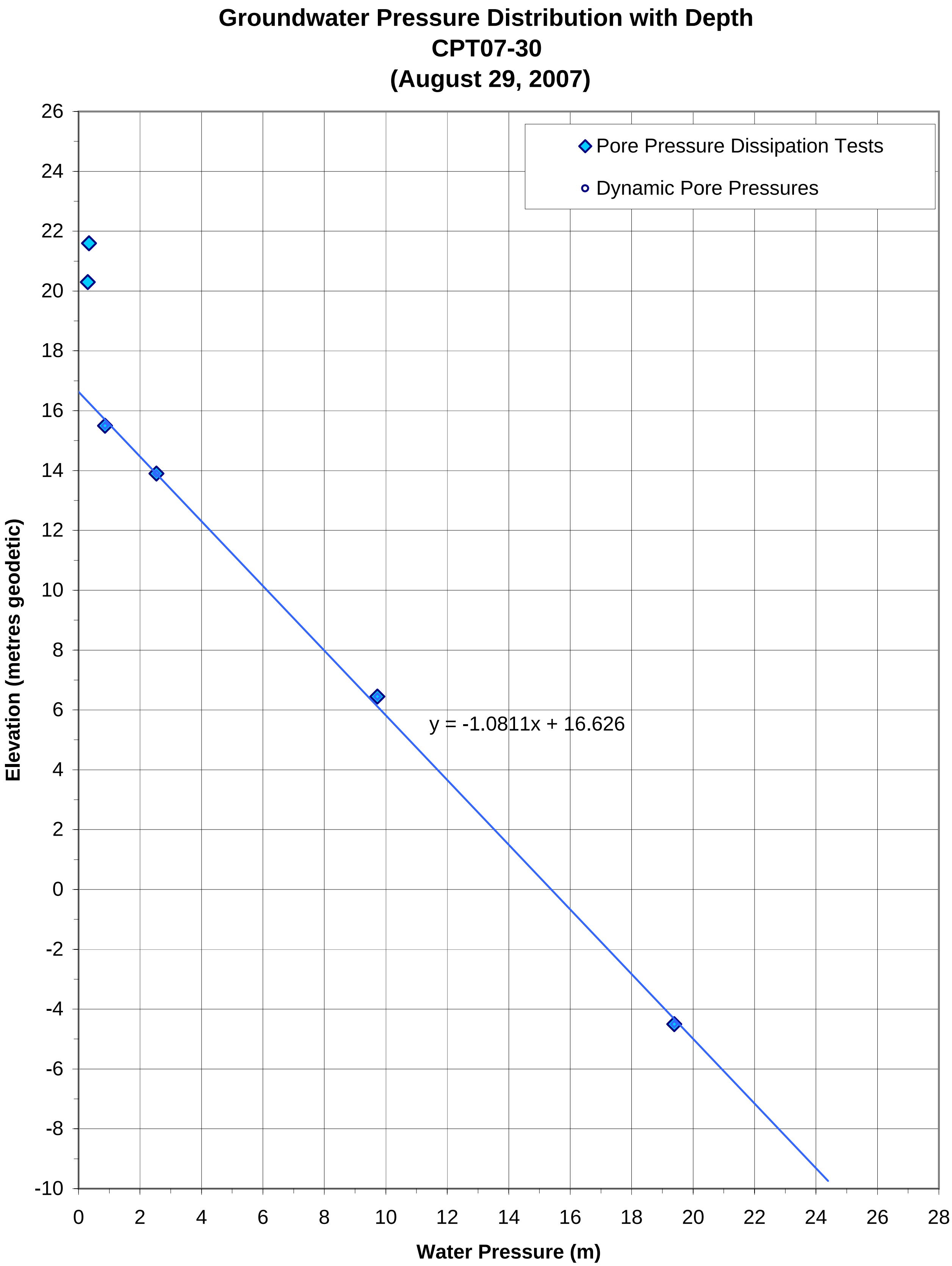


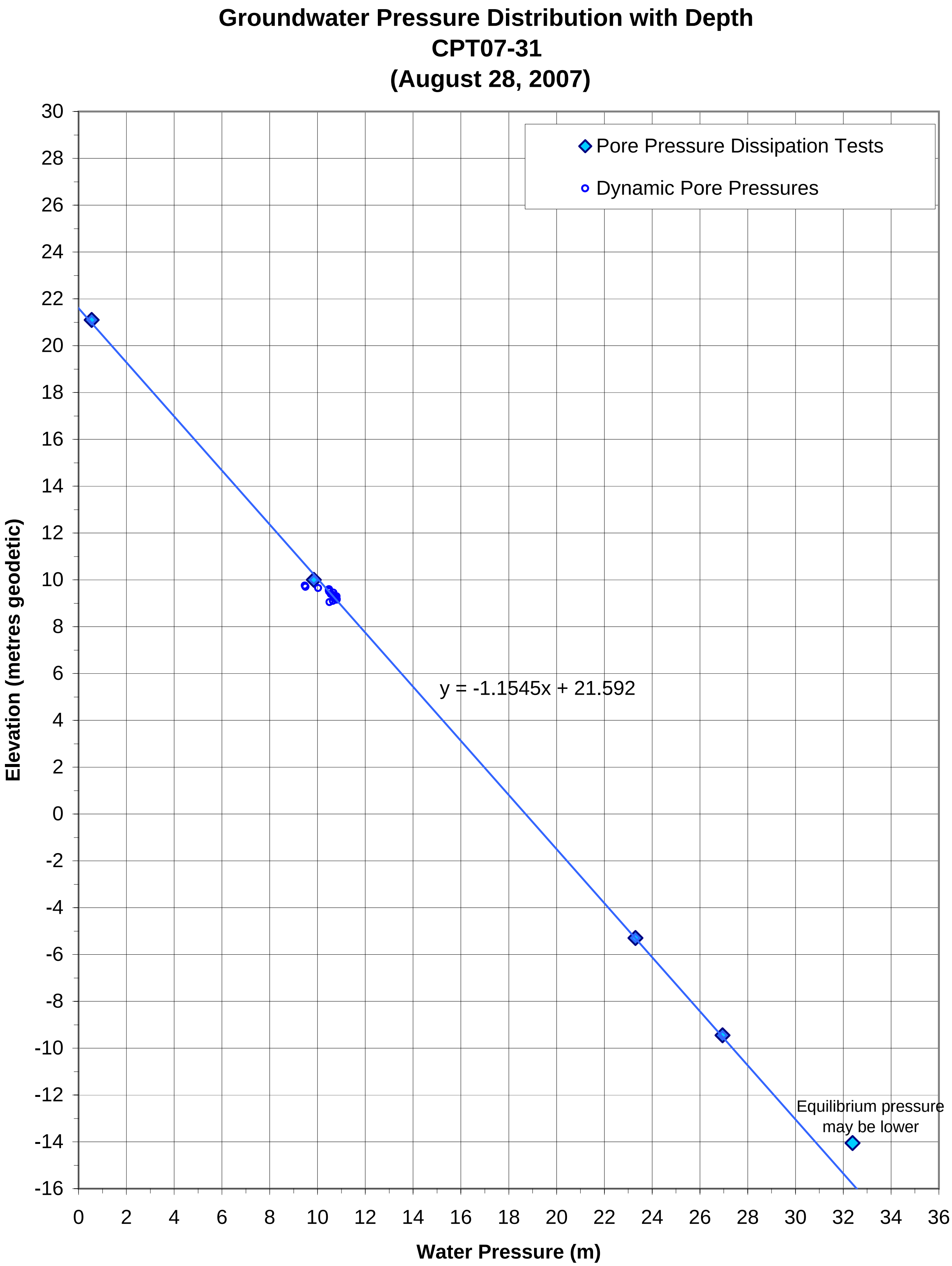

Groundwater Pressure Distribution with Depth
CPT07-28
(August 20, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.057x + 26.649
y = -1.4031x + 30.604
Elevation (metres geodetic)
Water Pressure (m)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

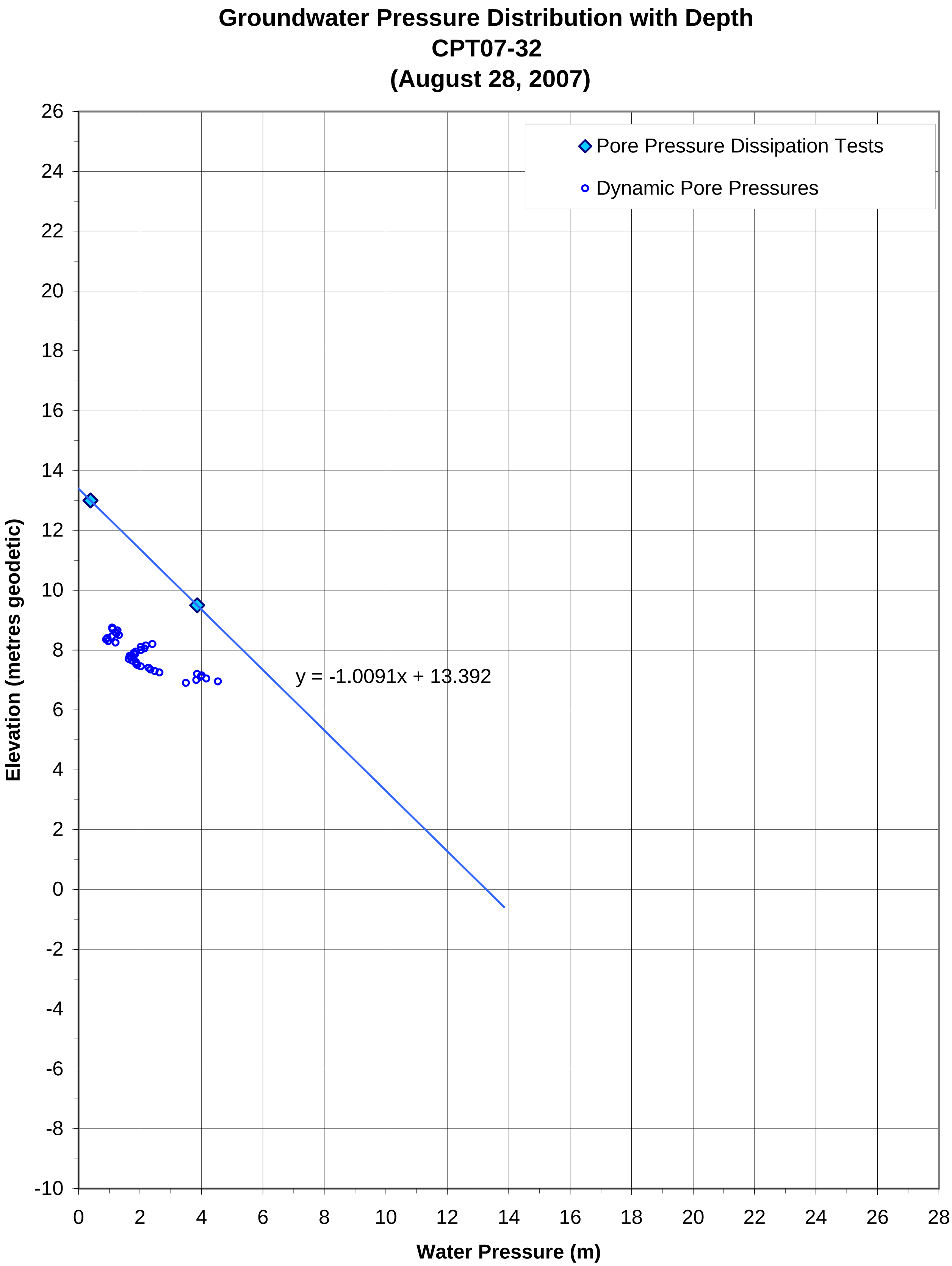
Fraser River Escarpment
Maple Ridge, BC

07-1414-0096




Groundwater Pressure Distribution with Depth
CPT07-30
(August 29, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.0811x + 16.626
Elevation (metres geodetic)
Water Pressure (m)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28


Groundwater Pressure Distribution with Depth
CPT07-31
(August 28, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.1545x + 21.592
Equilibrium pressure may be lower
Elevation (metres geodetic)
Water Pressure (m)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36


Groundwater Pressure Distribution with Depth
CPT07-32
(August 28, 2007)
Pore Pressure Dissipation Tests
Dynamic Pore Pressures
y = -1.0091x + 13.392
Elevation (metres geodetic)
Water Pressure (m)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28

Fraser River Escarpment
Maple Ridge, BC

07-1414-0096