



## REPORT

# Foundation Investigation Strandherd Drive and CNR Overpass Bridges Site No. 3-549, Highway 416 Ottawa, Ontario

*W.P. 4133-01-01 & 4134-01-01*

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Geocres Number: 31G5-299

March 2019

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**PART A**

Foundation Investigation Report  
Strandherd Drive and CNR Overpass Bridges  
Site No. 3-549, Highway 416  
Ottawa, Ontario  
W.P. 4133-01-01 & 4134-01-01

## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP Canada Group Limited (WSP) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering input required for the seismic evaluation of several existing structures included as part of the Mega 6 Rehabilitation of 21 Structures project. This report presents the results of the detailed foundation investigation conducted for the seismic evaluation of the Highway 416 overpass bridges at McKenna Casey Drive (formerly known, and referenced herein, as Strandherd Drive) and the Canadian National Rail (CNR) tracks (Site 3-549) in Ottawa, Ontario.

At the preliminary design stage of the project, a geotechnical desktop study based on the available GEOCREs information and original structural design drawings was carried out. The existing subsurface information was provided in the following three reports contained in the GEOCREs Report No. 31G5-162:

- Report prepared by MTO Engineering Materials Office, Foundation Design Section “*Foundation Investigation Report for Hwy 416, Strandherd Drive/CNR Overpass, Structures #21A and #21B, W.P. 128-87-05/06, Site 3-549, District 9, Ottawa*”, 1989 (GEOCREs No. 31G5-162);
- Report prepared by MTO Engineering Materials Office, Foundation Design Section “*Foundation Investigation Report for Hwy 416 Fill Area between Strandherd Drive Overpass (Structure #21) and Jock River Overpass (Structure #22), W.P. 128-87-00, District 9, Ottawa*”, 1989 (GEOCREs No. 31G5-162); and,
- Report prepared by MTO Engineering Materials Office, Foundation Design Section “*Foundation Investigation Report for Hwy 416/Strandherd Rive and C.N.R., W.P. 128-87-05/06, District 9, Ottawa*”, 1989 (GEOCREs No. 31G5-162).

The purpose of the current foundation investigation was to assess the subsurface conditions and provide additional subsurface information required for the detailed seismic assessment of the structures. A total of four boreholes and eight Seismic Cone Penetration Tests (SCPTs) were put down at the site as part of the current study. The field work and foundation design work were carried out in accordance with Golder’s change proposal to WSP, dated November 10, 2017.

## 2.0 SITE DESCRIPTION AND GEOLOGY

### 2.1 General

The twin bridges, which carry a total of four lanes of traffic over the former Strandherd Drive and CNR tracks, are located on Highway 416 about 2.0 km south of Fallowfield Road in Ottawa, Ontario.

Each bridge consists of a fifteen-span, pre-cast concrete deck supported predominantly on HP 310x110 piles driven to bedrock. The northernmost piers and north abutments are supported on spread footings. The structures are relatively straight, aligned approximately north-south, about 384 m long at their centrelines and about 14 m wide.

The 1991 structural design drawings indicate that the natural ground surface prior to construction of the bridge was at about Elevation 91 m at the south abutments to about Elevation 93 m at Pier N13/S13, and increased to the north to about Elevation 99 m at the north abutments. The results of the current field investigation indicate that natural ground surface below the bridge is currently between about Elevation 92 and 93 m. In the area of the bridge, the embankments range from about 7 m in height (at the south abutment) to 4 m in height (at the north abutment) above the ground surface. The bridge pavement surface ranges from about Elevation 96.5 m, at the south abutments, to Elevation 103.5 m, at the north abutments.

Based on the 1991 structural design drawings and observations during the current field investigation, the embankment side slopes are oriented at about 2 horizontal to 1 vertical (i.e., 2H:1V). Based on visual observation at the time of planning and carrying out the site investigation, the existing embankment side slopes appear to be performing satisfactorily.

## 2.2 Regional Geological Conditions

The site is located within the physiographic region known as the Ottawa Valley Clay Flats adjacent to the Ottawa River, as delineated in *The Physiography of Southern Ontario*<sup>1</sup>.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silty clay and silt that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thinner, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.<sup>1</sup>

## 3.0 INVESTIGATION PROCEDURES

### 3.1 Current Investigation (2018)

The current subsurface investigation for the overpass bridges was carried out between April 30 and May 16, 2018 at which time four boreholes (numbered 18-01, 18-02, 18-05 and 18-08) and eight Seismic Cone Penetration Test holes (numbered SCPT-18-03 to SCPT-18-10, inclusive) were advanced at the locations shown on Drawings 1 and 2 and outlined below.

- Boreholes 18-01 and 18-02 were located near the north and south abutments of the bridges, respectively. Borehole 18-01 was put down within the passing lane of the of the southbound structure. Borehole 18-02 was put down within the median of the south abutment, adjacent to the passing lane of the southbound structure. The boreholes were advanced using 200 mm inside diameter continuous-flight hollow-stem augers and/or wash boring using NW casing with a truck-mounted drill rig, supplied and operated by CCC Geotechnical & Environmental Drilling Ltd. (CCC) of Ottawa, Ontario. The boreholes were advanced through the overburden to depths of about 20.8 and 14.8 m below the existing ground surface (Elevations 82.7 to 80.9 m). At the bedrock surface, the boreholes were then cored about 5.5 m into the bedrock using HQ-size coring equipment.
- Boreholes 18-05 and 18-08 were advanced from ground surface below the existing bridges at selected pier locations. Borehole 18-05 was put down adjacent to pier N11/S11 and Borehole 18-08 was advanced between Piers N7/S7 and Piers N8/S8. The boreholes were put down with a track-mounted drill rig, also supplied and operated by CCC. The boreholes were advanced to depths of about 10.5 and 12.2 m (Elevations 82.5 to 80.20 m) below the existing ground surface in the overburden, to effective refusal.
- Eight seismic cone penetration tests (denoted as SCPT18-03 to SCPT18-10) were carried out adjacent to selected piers along the bridges. The portable SCPT equipment was supplied and operated by ConeTec Investigations Ltd. (ConeTec) of Richmond Hill, Ontario, and included a 15 cm<sup>2</sup> tip base area probe with an equal end area friction sleeve and tip and sleeve capacities of 1,500 bar and 15 bar, respectively. SCPT18-03 to SCPT18-06 were pre-drilled and cased to about 1.5 metres below ground surface to allow for penetration of the upper granular fill present at the site. The pre-drilling (where required) and advancement of the SCPT probe was carried out by CCC. The SCPTs were advanced to probe refusal at depths ranging from 4.77 to 11.37 m below the existing ground surface (Elevations 91.9 to 93.5 m).

<sup>1</sup> Chapman, L.J. and D.F. Putnam. *The Physiography of Southern Ontario*. Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715, Scale 1:600,000.

Soil samples in the boreholes were obtained at vertical intervals of about 0.6 to 1.5 m, using a 50 mm outer diameter split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures. Water was maintained in the hollow-stem augers during drilling and testing to minimize the potential for sample disturbance.

The ground water levels at SCPT locations were inferred based on pore water pressure measurements and dissipation tests taken during advancement. The summary and plots of the pore pressure dissipation tests are included in Conetec report provided in Appendix C.

At Boreholes 18-01 and 18-02, a 64 mm inside diameter rigid PVC casing was grouted for the full advancement depth (i.e., through the overburden and into the bedrock) to allow for Vertical Seismic Profile (VSP) testing to support the selection of a seismic Site Class for the site and site-specific ground-response analyses. VSP testing was carried out on June 25, 2018 to measure the shear wave velocity of the soil and bedrock at regular intervals of depth. Further discussion on the VSP testing methodology and results is provided in Appendix G.

Shear wave velocity testing was also carried out as part of the seismic cone penetration testing. A built-in geophone within the cone penetration probe recorded seismic wave traces from a surface source as the SCPTs were advanced. Measurements were recorded at roughly one-meter intervals. A more detailed description of the test methodology is provided in Conetec report in Appendix C.

The boreholes were backfilled with bentonite pellets, mixed with native soils in the overburden and bentonite pellets in the bedrock, except as indicated previously for the VSP casings. The site conditions were substantially restored following completion of work.

| Test Hole Number | Test Hole Location      | Northing <sup>1</sup><br>(m) | Easting <sup>1</sup><br>(m) | Ground Surface<br>Elevation <sup>2</sup><br>(m) |
|------------------|-------------------------|------------------------------|-----------------------------|-------------------------------------------------|
| BH18-01          | North Abutment          | 5013055.7                    | 360897.3                    | 103.5                                           |
| BH18-02          | South Abutment          | 5012694.5                    | 361054.6                    | 95.7                                            |
| BH/SCPT18-03     | Adjacent to Pier N13    | 5013014.7                    | 360932.7                    | 93.5                                            |
| BH/SCPT18-04     | Between Piers N12/S12   | 5012990.4                    | 360937.4                    | 93.4                                            |
| BH/SCPT18-05     | Between Piers N11/S11   | 5012966.7                    | 360946.9                    | 93.1                                            |
| BH/SCPT18-06     | Adjacent to Pier S10    | 5012941.5                    | 360949.5                    | 92.9                                            |
| BH/SCPT18-07     | Adjacent to Pier S9     | 5012909.3                    | 360963.5                    | 92.3                                            |
| BH/SCPT18-08     | Between Piers N7 and S8 | 5012883.4                    | 360982.3                    | 92.4                                            |
| BH/SCPT18-09     | Adjacent to Pier N6     | 5012852.4                    | 361000.9                    | 92.4                                            |
| BH/SCPT18-10     | Adjacent to Pier S3     | 5012774.1                    | 361022.1                    | 91.9                                            |

<sup>1</sup> Northing and Easting coordinates shown are relative to the MTM NAD83 (Zone 9) coordinate system.

<sup>2</sup> Ground surface elevations shown are relative to Geodetic Datum.

The field work was supervised by members of Golder's technical and engineering staff, who located the boreholes, supervised the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled, and transported to Golder's laboratory in Ottawa for further examination. Index and classification tests consisting of grain size distribution, Atterberg limits, organic content and water content testing were carried out on selected soil samples and unconfined compressive strength tests were carried out on selected rock core samples at the Golder Ottawa laboratory. All laboratory tests were carried out to MTO and/or ASTM standards as appropriate.

Following completion of the field work, the borehole and SCPT locations were surveyed by Golder personnel using a Trimble R8 GPS unit. The boreholes and locations, including MTM NAD83 northing and easting coordinates and ground surface elevations referenced to Geodetic datum, are summarized in the table above and are shown on Drawings 1 and 2.

### 3.2 Previous Investigations (1989 and 1991)

The original foundation investigations for the design of the existing bridges were carried out in 1989 and 1991. At that time, 31 boreholes were put down along the then-proposed bridge alignments. The investigation procedures and results were contained in the reports included as part of the GEOCRE Report No. 31G5-162 (see Section 1.0).

The boreholes were put down with a hollow-stem auger through the overburden to effective refusal. The boreholes within the southern portion of the then-proposed alignments and selected boreholes in the northern portion of the alignment (Boreholes 21A-8 through 21A-11, 21B-8 through 21B-11, 89-7, 89-7A, 89-87, 89-8A, 89-9, 89-9A, 89-10, and 16) were terminated upon auger refusal. The remaining boreholes, which were mostly put down within the northern portion of the site (Boreholes 21A-1 through 21A-7, and 21B-1 through 21B-7, 15, 31, and 32), were cored up to about 3.5 m into the underlying bedrock following auger refusal.

The approximate location and ground surface elevation at each borehole at the time of the 1989 and 1991 investigations were provided on the borehole records, included on the Record of Borehole sheets in Appendix E. The ground surface elevations were surveyed relative to Geodetic datum. The borehole locations in plan were surveyed relative to an unknown datum and were adjusted to be consistent with the MTM NAD83 (Zone 9) coordinate system based on prominent site features provided on the site plans included in the source GEOCRE reports. The approximate borehole locations and ground surface elevations at the borehole locations are shown on Drawings 1 and 2, and are summarized in the table below.

| Test Hole Number | Test Hole Location                           | Northing <sup>1</sup><br>(m) | Easting <sup>1</sup><br>(m) | Ground Surface Elevation <sup>2</sup><br>(m) |
|------------------|----------------------------------------------|------------------------------|-----------------------------|----------------------------------------------|
| BH21A-1          | NBL, near Pier N8                            | 5012906.7                    | 360993.0                    | 91.4                                         |
| BH21A-2          | NBL, between Piers N8 and N9                 | 5012921.3                    | 360986.9                    | 91.4                                         |
| BH21A-3          | NBL, between Piers N8 and N9                 | 5012921.9                    | 360977.3                    | 91.5                                         |
| BH21A-4          | NBL, between Piers N10 and N11               | 5012960.4                    | 360970.8                    | 91.8                                         |
| BH21A-5          | NBL, between Piers N11 and N12               | 5012982.4                    | 360961.6                    | 92.0                                         |
| BH21A-6          | NBL, near Pier N12                           | 5012999.1                    | 360954.5                    | 92.3                                         |
| BH21A-7          | NBL, between Piers N12 and N13               | 5013013.8                    | 360948.5                    | 92.5                                         |
| BH21A-8          | NBL, near Pier N6                            | 5012857.6                    | 361008.8                    | 91.3                                         |
| BH21A-9          | NBL, near Pier N7                            | 5012885.2                    | 360997.4                    | 91.3                                         |
| BH21A-10         | NBL, between Piers N13 and N14               | 5013029.3                    | 360937.4                    | 94.4                                         |
| BH21A-11         | NBL, between Pier N14 and the North Abutment | 5013053.6                    | 360917.6                    | 96.7                                         |
| BH21B-1          | SBL, near Pier S8                            | 5012880.6                    | 360962.7                    | 91.3                                         |
| BH21B-2          | SBL, between Piers S8 and S9                 | 5012895.3                    | 360956.6                    | 91.4                                         |
| BH21B-4          | SBL, near Pier S10                           | 5012934.2                    | 360940.4                    | 91.8                                         |
| BH21B-5          | SBL, near Pier S11                           | 5012956.3                    | 360931.2                    | 92.1                                         |
| BH21B-6          | SBL, between Piers S11 and S12               | 5012973.1                    | 360924.2                    | 92.3                                         |

| Test Hole Number | Test Hole Location                           | Northing <sup>1</sup><br>(m) | Easting <sup>1</sup><br>(m) | Ground Surface Elevation <sup>2</sup><br>(m) |
|------------------|----------------------------------------------|------------------------------|-----------------------------|----------------------------------------------|
| BH21B-7          | SBL, between Piers S12 and S13               | 5012987.7                    | 360918.1                    | 92.5                                         |
| BH21B-8          | SBL, near Pier S6                            | 5012837.4                    | 360985.3                    | 91.3                                         |
| BH21B-9          | SBL, near Pier S7                            | 5012865.1                    | 360973.7                    | 91.3                                         |
| BH21B-10         | SBL, between Piers S13 and S14               | 5013013.6                    | 360911.6                    | 95.1                                         |
| BH21B-11         | SBL, between Pier S14 and the North Abutment | 5013030.6                    | 360899.6                    | 96.4                                         |
| BH89-7           | SBL, near South Abutment                     | 5012686.7                    | 361047.9                    | 91.3                                         |
| BH89-7A          | SBL, south of South Abutment                 | 5012640.1                    | 361067.1                    | 91.3                                         |
| BH89-8           | NBL, near Pier N1                            | 5012744.1                    | 361056.0                    | 91.3                                         |
| BH89-8A          | NBL, near South Abutment                     | 5012716.6                    | 361067.1                    | 91.3                                         |
| BH89-9           | SBL, between Piers S3 and S4                 | 5012779.0                    | 361009.5                    | 91.2                                         |
| BH89-9A          | SBL, between South Abutment and Pier S1      | 5012705.6                    | 361040.1                    | 91.2                                         |
| BH89-10          | NBL, near Pier N5                            | 5012836.5                    | 361017.6                    | 91.3                                         |
| 15               | NBL, near Pier N14                           | 5013047.0                    | 360930.0                    | 97.0                                         |
| 16               | NBL, near North Abutment                     | 5013070.7                    | 360920.2                    | 100.0                                        |
| 31               | SBL, near Pier S14                           | 5013029.1                    | 360905.5                    | 95.0                                         |
| 32               | SBL, near South Abutment                     | 5013052.9                    | 360895.7                    | 98.8                                         |

<sup>1</sup> Northing and Easting coordinates shown are approximate and given relative to the MTM NAD83 (Zone 9) coordinate system.

<sup>2</sup> Ground surface elevations shown are relative to Geodetic Datum.

## 4.0 SITE STRATIGRAPHY

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of related in situ and laboratory testing of the current geotechnical investigation are given on the Record of Borehole and Drillhole sheets contained in Appendix A. The results of geotechnical laboratory testing are also included in Appendix B. The results of the seismic cone penetration testing are provided in Appendix C, which includes the result of shear wave velocity tests and pore pressure dissipation tests. Photographs of the bedrock core from the current investigation are presented in Appendix D. The subsurface soil and groundwater conditions encountered in the boreholes put down as part of the original 1989 and 1991 investigations, and the results of related in situ and laboratory testing, are given on the Record of Borehole and Drillhole sheets contained in Appendix E and the geotechnical laboratory test result sheets contained in Appendix F.

The results of VSP testing conducted as part of the current investigation in Boreholes 18-01 and 18-02 are provided in Appendix G of this report.

The interpreted stratigraphic conditions along the centrelines of the existing bridges are shown on Drawings 1 and 2. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic section included on Drawings 1 and 2 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the site generally consist of a deposit of silty clay up to 11 m thick over glacial till overlying dolostone and sandstone bedrock.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

## 4.1 Pavement Structure and Embankment Fill

The southbound Highway 416 pavement structure was penetrated at borehole 18-01. The pavement structure consists of 100 mm of asphaltic concrete overlying about 300 mm of Portland cement concrete. The pavement is underlain by about 5.0 m of embankment fill (Elevations 103.1 to 98.1). The embankment fill generally consists of a gravelly sand to sandy gravel with the Standard Penetration Test (SPT) “N” values ranging from 9 to 22 blows per 0.3 m of penetration indicating a loose to compact state of packing.

Borehole 18-02 was put down in the highway median between the south abutments. At the location of BH18-02 the embankment fill is about 4.4 m thick, extending down to about Elevation 91.3 m, and consists of a sand with trace to some silt, some gravel to gravelly. The SPT “N” values range from 16 to 31 blows per 0.3 m of penetration indicating a compact to dense state of packing. The fill is underlain by a layer of topsoil about 300 mm thick.

Boreholes 18-05 and 18-08 were put down below the existing bridges near the piers. Topsoil about 20 mm thick was encountered at both locations, and consisted of silt, clay, and sand containing organics, and trace amounts of gravel. The topsoil is underlain by about 0.9 m of granular fill consisting of gravelly silty sand. The SPT “N” values in the granular fill at both locations range from 8 to 24 blows per 0.3 m of penetration indicating a loose to compact state of packing. The granular fill is underlain by another thin topsoil layer that ranged from 100 to 300 mm thick.

Three grain size distribution tests were carried out on samples of the embankment and grade fill. The results of these tests are provided on Figure B1 in Appendix B. The measured water content of selected samples of the granular fill ranged from approximately 7 to 33 percent.

## 4.2 Silty Clay to Clay

A deposit of silty clay to clay containing silty sand seams was encountered beneath the existing grade fill under the bridges and the embankment fill at the south abutments. The silty clay to clay was also encountered at ground surface at the time of the 1989 and 1991 investigations, at the locations of the boreholes put down near the then-proposed pier locations. In general, the upper portion of the deposit has been weathered to a grey brown crust. The weathered crust extends to depths below the current ground surface ranging from about 3.0 m near the piers to about 6.0 metres at the south abutment (Elevations ranging from about 89 to 90 m).

South of the CNR line, the silty clay to clay deposit generally extends to depths ranging from about 7.7 to 9.5 m below the existing ground surface (Elevations ranging from about 83.3 to 87.0 m). The silty clay to clay north of the CNR line extends to depths ranging from about 7.1 to 3.7 m (Elevations ranging from about 86.5 to 94.3 m), generally getting thinner to the north.

The SPT “N” values in the weathered crust measured during the current investigation ranged from 1 to 8 blows per 0.3 m of penetration. The results of in situ vane testing carried out in the unweathered portion of the deposit measured undrained shear strength values ranging from about 12 to 70 kPa. In the upper 4 to 8 m of the unweathered portion (above about Elevation 86 m), the shear strength values generally ranged from about 15 to 30 kPa indicating a soft consistency.



The measured tip resistances within the deposit at the SCPT locations were generally in the range of 400 to 1,300 kPa, with localized “spikes” in the tip resistance of up to about 2,500 kPa which likely reflect interlayered silt and fine sand layers.

Three grain size distribution tests were carried out on samples of the silty clay deposit from the current investigation. The results of these tests are provided on Figure B2 in Appendix B. Several grain size distribution tests were carried out on samples of the silty clay to clay as part of the 1989 and 1991 investigations. Gradation envelopes representing the results of these tests are provided in Appendix F.

Atterberg limit tests carried out on samples of the silty clay to clay deposit obtained from the previous and current investigations gave plasticity index values ranging from about 20 to 52 percent and liquid limit values ranging from about 35 to 75 percent, indicating a medium to high plasticity soil. The measured water content ranged from approximately 30 to 50 percent in the weathered crust, and about 50 to 90 in the unweathered portion of the deposit.

Oedometer consolidation testing was carried out on four Shelby tube samples from the grey silty clay deposit at Boreholes 21A-1, 21B-6, and 21B-2 following the 1989 investigation. The results of this testing are summarized in the table below.

| Borehole/<br>Sample Number | Sample<br>Depth/Elevation<br>(m) | $\sigma_p'$<br>(kPa) | $\sigma_o'$<br>(kPa) | $C_c$ | $C_r$ | $e_o$ | OCR |
|----------------------------|----------------------------------|----------------------|----------------------|-------|-------|-------|-----|
| 21A-1 / 7                  | 5.5 / 85.9                       | 105                  | 35                   | 1.65  | -     | 1.91  | 3.0 |
| 21A-6 / 4                  | 3.3 / 89.0                       | 68                   | 18                   | 1.62  | -     | 2.32  | 3.8 |
| 21B-2 / 5                  | 4.1 / 87.3                       | 62                   | 20                   | 2.54  | -     | 2.51  | 3.1 |
| 21B-6 / 2                  | 2.6 / 89.7                       | 68                   | 15                   | 2.12  | -     | 2.31  | 4.5 |
| 89-1 / 6                   | 8.0 / 83.2                       | 102                  | 58                   | 1.09  | -     | 0.70  | 1.8 |
| 89-2 / 7                   | 9.4 / 81.9                       | 102                  | 71                   | 1.74  | -     | 1.89  | 1.4 |
| 89-8 / 3                   | 3.3 / 88.0                       | 95                   | 30                   | 1.75  | -     | 2.19  | 3.2 |
| 89-8 / 6                   | 7.9 / 83.4                       | 105                  | 58                   | 0.86  | -     | 1.49  | 1.8 |
| 89-10 / 3                  | 3.2 / 88.1                       | 85                   | 25                   | 0.91  | -     | 1.71  | 3.4 |

$\sigma_o'$  - Initial effective stress

$C_c$  - Compression index

$e_o$  - Initial void ratio

$\sigma_p'$  - Apparent preconsolidation pressure

$C_r$  - Recompression index

OCR - Overconsolidation Ratio

### 4.3 Glacial Till

Glacial till was encountered beneath the silty clay to clay and the grade and embankment fill at the northern extent of the site. In general, the deposit consists of a heterogeneous mixture of silty clay to clayey silt to silt, sand and gravel to a more granular mixture of silt, sand, and gravel. The glacial till deposit also contains cobbles and boulders.

South of the CNR line, the glacial till was generally encountered at depths ranging from about 7.9 to 9.5 m below the current existing ground surface. The glacial till extends down to elevations ranging from about 79 to 80 m and, where fully penetrated, the glacial till has a thickness ranging from about 3.3 to 5.0 m.

North of the CNR line, the glacial till was encountered below the silty clay, except at Boreholes 15, 16, 32, and 21A-11 where it was encountered at the ground surface, and at 18-01 where it was encountered below the embankment fill. The glacial till was encountered at depths up to 2.1 to 6.2 m below the existing ground surface, generally getting shallower to the north. Where fully penetrated, the glacial till extends down to elevations ranging from about 78 to 83 m.



Discontinuous layers of sandy silt to sand with gravel were encountered within the glacial till deposit, generally north of the CNR line. The layers were generally encountered at depths greater than about 5 m and have thicknesses that ranges from about 1.0 to 5.0 m.

SPT “N” values in the glacial till ranged from 2 to greater than 100 blows per 0.3 m of penetration, but generally greater than 10 blows, indicating a compact to very dense state of packing. Diamond drilling techniques were required to penetrate portions of the deposit.

Atterberg limit tests carried out on samples of the cohesive portions of the deposit recovered during the 1989 investigation gave plasticity index values of about 2 to 23 percent and liquid limit values of about 15 to 37 percent, indicating a low plasticity soil. A summary of the Atterberg limits are provided in Appendix F. The measured water content of the deposit ranged from approximately 6 to 54 percent.

The results of grain size distribution testing carried out on seven samples of the glacial till deposit collected during the current investigation are provided on Figure B3 in Appendix B. Gradation envelopes representing the results of the grain size tests carried out on samples of the glacial till deposit recovered during the 1989 and 1991 investigations are provided in Appendix F.

#### 4.4 Refusal and Bedrock

At all locations where borehole drilling penetrated the glacial till, bedrock was encountered at elevations ranging from about 78 to 83 m. The bedrock was cored for lengths of 5.2 and 5.4 m at the abutments during the current investigation, and lengths ranging from about 1.3 to 3.5 m during the 1989 and 1991 investigations. Photographs of the bedrock recovered from the current investigation are provided in Appendix D.

The bedrock recovered from the 1989 and 1991 investigations was described as silty dolostone and dolomitic shale. During the current investigation, dolostone was encountered in borehole 18-02 at the south abutments, and about 3.4 m of sandstone was encountered overlying dolostone, interbedded with shale in borehole 18-01 at the north abutments.

The Rock Quality Designation (RQD) values measured on the bedrock samples collected as part of the current investigation ranged from about 57 to 100 percent, but were generally above 80 percent, indicating a good to excellent quality rock. The RQD values measured during the 1989 and 1991 investigations ranged from about 0 to 97 percent, but were generally greater than 40 percent, indicating a poor to excellent quality rock.

Laboratory unconfined compressive strength testing was carried out on selected specimens of the bedrock core recovered as part of the current investigation. The results of the testing are summarized in Appendix B and indicate values of 127 MPa (in the sandstone) and 187 MPa (in the dolostone).

#### 4.5 Groundwater Conditions

During the current investigation, ground water levels were inferred from the results of dissipation tests carried out in the granular layers during the SCPT advancement. The inferred ground water levels at the SCPT locations are presented in the table below:

| Borehole  | Ground Surface Elevation (m) | Water Level Depth <sup>1</sup> (m) | Water Level Elevation <sup>1</sup> (m) | Date         |
|-----------|------------------------------|------------------------------------|----------------------------------------|--------------|
| SCPT18-03 | 93.5                         | 1.6                                | 91.9                                   | May 16, 2018 |
| SCPT18-04 | 93.4                         | 1.6                                | 91.8                                   | May 16, 2018 |
| SCPT18-05 | 93.1                         | 1.6                                | 91.5                                   | May 16, 2018 |

| Borehole  | Ground Surface Elevation (m) | Water Level Depth <sup>1</sup> (m) | Water Level Elevation <sup>1</sup> (m) | Date         |
|-----------|------------------------------|------------------------------------|----------------------------------------|--------------|
| SCPT18-06 | 92.9                         | 1.7                                | 91.2                                   | May 15, 2018 |
| SCPT18-07 | 92.3                         | 1.8                                | 90.5                                   | May 14, 2018 |
| SCPT18-08 | 92.4                         | 1.9                                | 90.5                                   | May 15, 2018 |
| SCPT18-09 | 92.4                         | 1.9                                | 90.5                                   | May 15, 2018 |
| SCPT18-10 | 91.9                         | 1.8                                | 90.1                                   | May 15, 2018 |

<sup>1</sup> Ground water level inferred from SCPT data

Ground water levels were recorded in the open boreholes during the 1989 and 1991 investigations and were encountered generally at or up to 1.0 m below the existing ground surface (about Elevation 91 to 92 m) with the exception of the area around the north abutment where the groundwater was encountered at about 4.6 to 6.0 m depth (Elevations 92 to 94 m) at the time of drilling.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Matt Kennedy, P.Eng., and reviewed by Mr. Michael Snow, P.Eng., a geotechnical engineer and Principal with Golder. Mr. Fin Heffernan, P.Eng., Golder's Designated MTO Foundations Contact for this project, conducted an independent quality review of the report.

### Golder Associates Ltd.



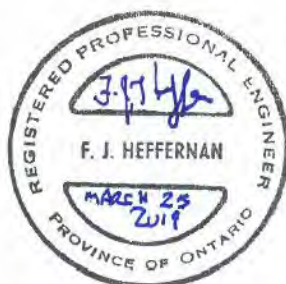
Matt Kennedy, P.Eng.  
Senior Geotechnical Engineer




Michael Snow, P.Eng.  
Principal, Senior Geotechnical Engineer



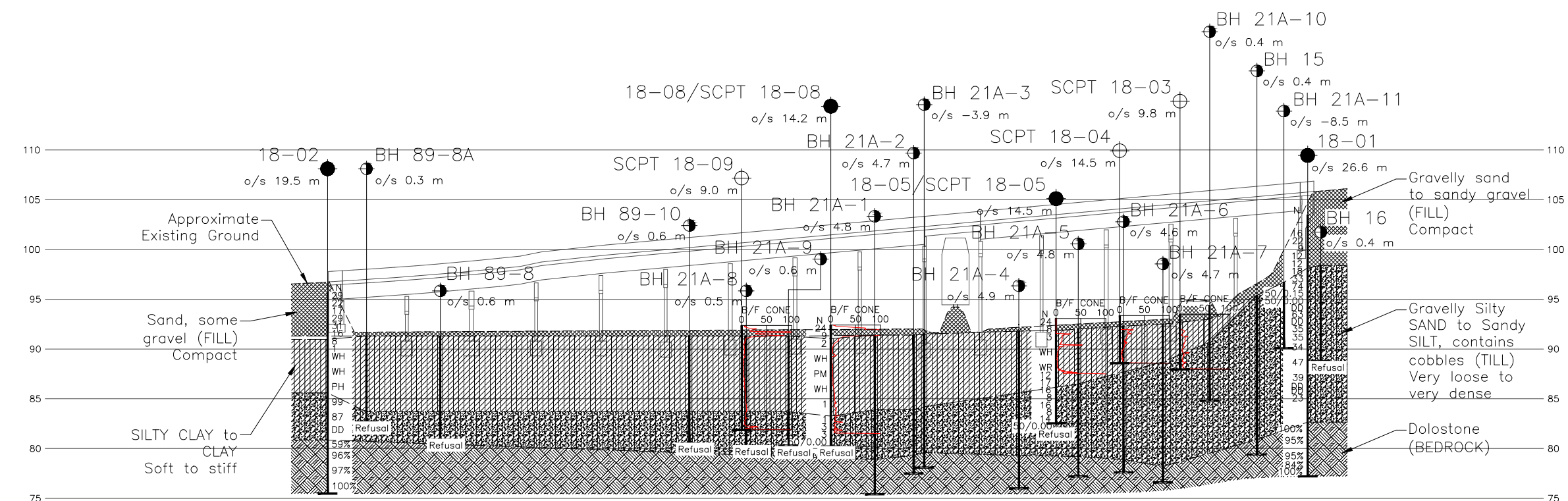
Fintan Heffernan, P.Eng.  
Designated MTO Foundations Contact



MJK/MSS/FJH/mvrd

[https://golderassociates.sharepoint.com/sites/21451g/08\\_reports/phase 1231 - strandherd cnr bridges/1417217-1231 rpt-001 final fir strandherd cnr site 3-549 march 2019.docx](https://golderassociates.sharepoint.com/sites/21451g/08_reports/phase%201231-strandherd%20cnr%20bridges/1417217-1231-rpt-001-final-fir-strandherd%20cnr%20site-3-549-march-2019.docx)

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The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

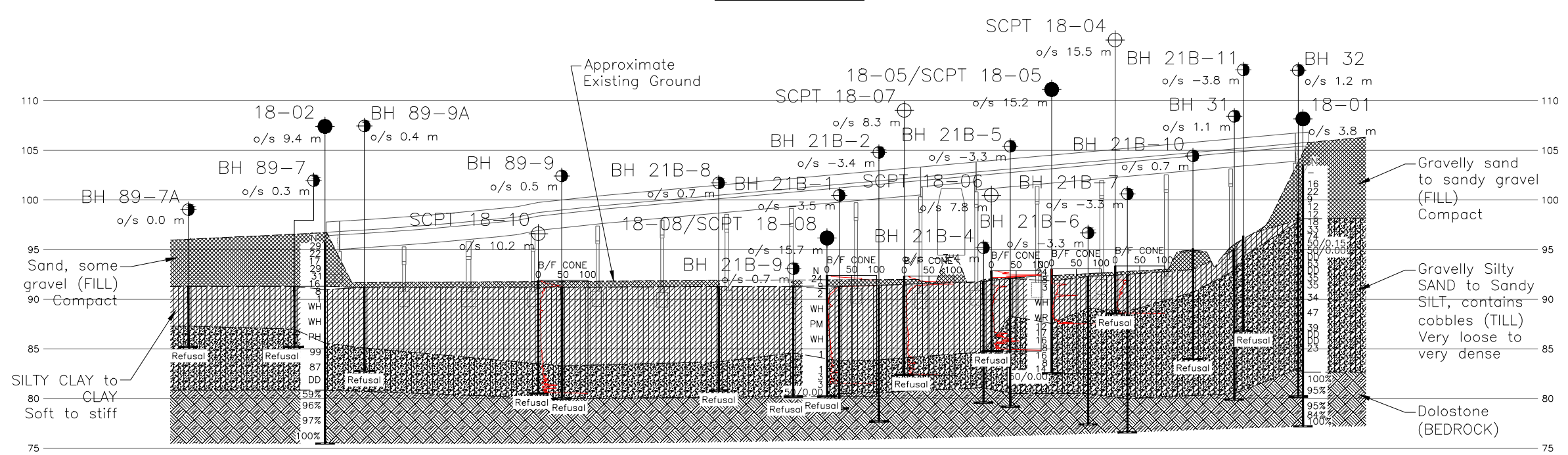
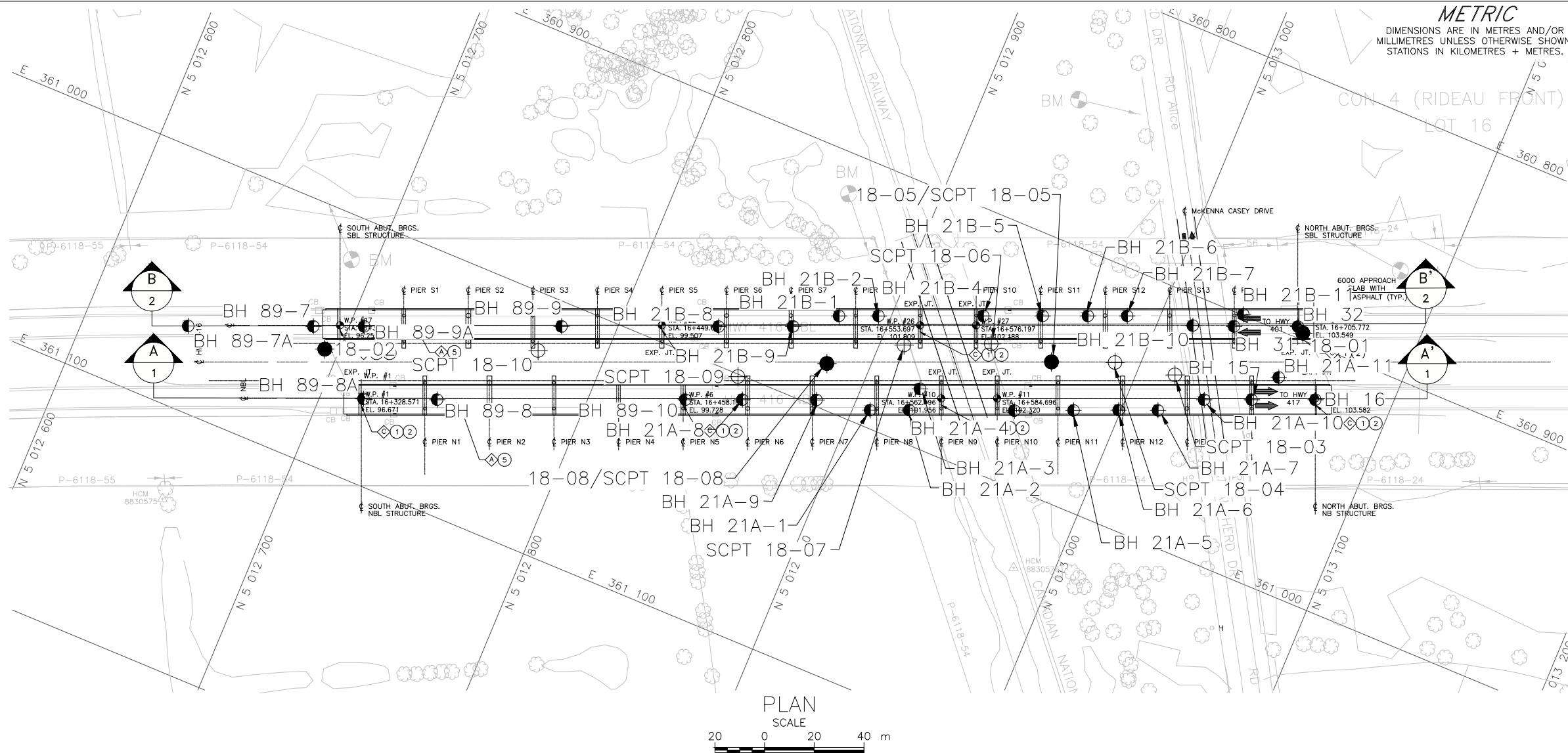
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|-------------|--|---------------------|--|-----------------|--|
| HWY. 416    |  | PROJECT NO. 1417217 |  | DIST. EASTERN   |  |
| SUBM'D. MJK |  | CHKD. MJK           |  | DATE: 10/3/2018 |  |
| DRAWN: JM   |  | CHKD. FJH           |  | APPD. FJH       |  |
|             |  |                     |  | DWG. 1          |  |



SHEET





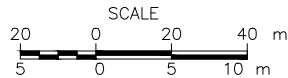


#### NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

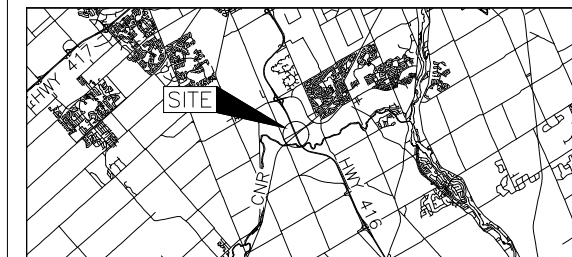
#### PROFILE B-B' ALONG HWY 416 SBL



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. 4133-01-01 & 4134-01-01  
WP No. 4133-01-01 & 4134-01-01

HIGHWAY 416 OVERPASS  
BRIDGES AT STRANDHERD DRIVE  
AND CNR  
BOREHOLE LOCATIONS AND SOIL STRATA



#### LEGEND

- Borehole - Current Investigation
- ⊕ Dynamic Cone Penetration Test - Current Investigation
- Borehole - Previous Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Total Core Recovery (REC)

#### BOREHOLE CO-ORDINATES (MTM ZONE 9)

| No.              | ELEVATION | NORTHING  | EASTING  |
|------------------|-----------|-----------|----------|
| 18-01            | 103.5     | 5013055.7 | 360897.3 |
| 18-02            | 95.7      | 5012694.5 | 361054.6 |
| 18-05/SCPT 18-05 | 93.1      | 5012966.7 | 360946.9 |
| 18-08/SCPT 18-08 | 92.4      | 5012883.4 | 360982.3 |
| SCPT 18-03       | 93.5      | 5013014.7 | 360932.7 |
| SCPT 18-04       | 93.4      | 5012990.4 | 360937.4 |
| SCPT 18-06       | 92.9      | 5012941.5 | 360949.5 |
| SCPT 18-07       | 92.3      | 5012909.3 | 360963.5 |
| SCPT 18-09       | 92.4      | 5012852.4 | 361000.9 |
| SCPT 18-10       | 91.9      | 5012774.1 | 361022.1 |
| BH 15            | 97.0      | 5013047.0 | 360930.0 |
| BH 16            | 100.0     | 5013070.7 | 360920.2 |
| BH 21A-1         | 91.4      | 5012906.7 | 360993.0 |
| BH 21A-2         | 91.4      | 5012921.3 | 360986.9 |
| BH 21A-3         | 91.5      | 5012921.9 | 360977.3 |
| BH 21A-4         | 91.8      | 5012960.4 | 360970.8 |
| BH 21A-5         | 92.0      | 5012982.4 | 360961.6 |
| BH 21A-6         | 92.3      | 5012999.1 | 360954.5 |
| BH 21A-7         | 92.5      | 5013013.8 | 360948.5 |
| BH 21A-8         | 91.0      | 5012857.6 | 361008.8 |
| BH 21A-9         | 91.3      | 5012885.2 | 360997.4 |
| BH 21A-10        | 94.4      | 5013029.3 | 360937.4 |
| BH 21A-11        | 96.7      | 5013052.6 | 360917.6 |
| BH 21B-1         | 91.3      | 5012880.6 | 360962.7 |
| BH 21B-2         | 91.4      | 5012895.3 | 360956.6 |
| BH 21B-4         | 91.8      | 5012934.2 | 360940.4 |
| BH 21B-5         | 92.1      | 5012956.3 | 360931.2 |
| BH 21B-6         | 92.3      | 5012973.1 | 360924.2 |
| BH 21B-7         | 92.5      | 5012987.7 | 360918.1 |
| BH 21B-8         | 91.3      | 5012837.4 | 360985.3 |
| BH 21B-9         | 91.3      | 5012865.1 | 360973.7 |
| BH 21B-10        | 95.1      | 5013013.6 | 360911.6 |
| BH 21B-11        | 96.4      | 5013030.6 | 360899.6 |
| BH 31            | 95.0      | 5013029.1 | 360905.5 |
| BH 32            | 98.8      | 5013052.9 | 360895.7 |
| BH 89-7          | 91.3      | 5012686.7 | 361047.9 |
| BH 89-7A         | 91.3      | 5012640.1 | 361067.1 |
| BH 89-8          | 91.3      | 5012744.1 | 361056.0 |
| BH 89-8A         | 91.3      | 5012716.6 | 361067.1 |
| BH 89-9          | 91.2      | 5012779.0 | 361009.5 |
| BH 89-9A         | 91.2      | 5012705.6 | 361040.1 |
| BH 89-10         | 91.3      | 5012836.5 | 361017.6 |

#### REFERENCE

Base plans provided in digital format by WSP, drawing file no. 3415003-180-001\_STRANDHERD\_GA.dwg, received JULY 26, 2018.

| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
|     |      |    |          |

|                      |           |                     |               |
|----------------------|-----------|---------------------|---------------|
| Geocres No. 3165-299 | HWY. 416  | PROJECT NO. 1417217 | DIST. EASTERN |
| SUBM'D. MJK          | CHKD. MJK | DATE: 10/3/2018     | SITE: 3-549   |
| DRAWN: JM            | CHKD. FJH | APPD. FJH           | DWG. 2        |



**APPENDIX A**

**Borehole and Drillhole Records  
(Golder, 2018)**



## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

### I. GENERAL

|             |                                       |
|-------------|---------------------------------------|
| $\pi$       | 3.1416                                |
| $\ln x$ ,   | natural logarithm of x                |
| $\log_{10}$ | x or log x, logarithm of x to base 10 |
| g           | acceleration due to gravity           |
| t           | time                                  |
| FoS         | factor of safety                      |

### II. STRESS AND STRAIN

|                                |                                                                            |
|--------------------------------|----------------------------------------------------------------------------|
| $\gamma$                       | shear strain                                                               |
| $\Delta$                       | change in, e.g. in stress: $\Delta \sigma$                                 |
| $\varepsilon$                  | linear strain                                                              |
| $\varepsilon_v$                | volumetric strain                                                          |
| $\eta$                         | coefficient of viscosity                                                   |
| $\nu$                          | Poisson's ratio                                                            |
| $\sigma$                       | total stress                                                               |
| $\sigma'$                      | effective stress ( $\sigma' = \sigma - u$ )                                |
| $\sigma'_{vo}$                 | initial effective overburden stress                                        |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor)                              |
| $\sigma_{oct}$                 | mean stress or octahedral stress<br>$= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$                         | shear stress                                                               |
| u                              | porewater pressure                                                         |
| E                              | modulus of deformation                                                     |
| G                              | shear modulus of deformation                                               |
| K                              | bulk modulus of compressibility                                            |

### III. SOIL PROPERTIES

|                    |                                                                                                      |
|--------------------|------------------------------------------------------------------------------------------------------|
| <b>(a)</b>         | <b>Index Properties</b>                                                                              |
| $\rho(\gamma)$     | bulk density (bulk unit weight)*                                                                     |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight)                                                                        |
| $\rho_w(\gamma_w)$ | density (unit weight) of water                                                                       |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles                                                             |
| $\gamma'$          | unit weight of submerged soil<br>( $\gamma' = \gamma - \gamma_w$ )                                   |
| $D_R$              | relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ ) |
| e                  | void ratio                                                                                           |
| n                  | porosity                                                                                             |
| S                  | degree of saturation                                                                                 |

### (a) Index Properties (continued)

|             |                                                                                      |
|-------------|--------------------------------------------------------------------------------------|
| w           | water content                                                                        |
| $w_l$ or LL | liquid limit                                                                         |
| $w_p$ or PL | plastic limit                                                                        |
| $I_p$ or PI | plasticity index = $(w_l - w_p)$                                                     |
| $w_s$       | shrinkage limit                                                                      |
| $I_L$       | liquidity index = $(w - w_p) / I_p$                                                  |
| $I_c$       | consistency index = $(w_l - w) / I_p$                                                |
| $e_{max}$   | void ratio in loosest state                                                          |
| $e_{min}$   | void ratio in densest state                                                          |
| $I_D$       | density index = $(e_{max} - e) / (e_{max} - e_{min})$<br>(formerly relative density) |

### (b) Hydraulic Properties

|   |                                                         |
|---|---------------------------------------------------------|
| h | hydraulic head or potential                             |
| q | rate of flow                                            |
| v | velocity of flow                                        |
| i | hydraulic gradient                                      |
| k | hydraulic conductivity<br>(coefficient of permeability) |
| j | seepage force per unit volume                           |

### (c) Consolidation (one-dimensional)

|             |                                                       |
|-------------|-------------------------------------------------------|
| $C_c$       | compression index<br>(normally consolidated range)    |
| $C_r$       | recompression index<br>(over-consolidated range)      |
| $C_s$       | swelling index                                        |
| $C_\alpha$  | secondary compression index                           |
| $m_v$       | coefficient of volume change                          |
| $C_v$       | coefficient of consolidation (vertical direction)     |
| $C_h$       | coefficient of consolidation (horizontal direction)   |
| $T_v$       | time factor (vertical direction)                      |
| U           | degree of consolidation                               |
| $\sigma'_p$ | pre-consolidation stress                              |
| OCR         | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

|                  |                                                          |
|------------------|----------------------------------------------------------|
| $\tau_p, \tau_r$ | peak and residual shear strength                         |
| $\phi'$          | effective angle of internal friction                     |
| $\delta$         | angle of interface friction                              |
| $\mu$            | coefficient of friction = $\tan \delta$                  |
| $c'$             | effective cohesion                                       |
| $c_u, s_u$       | undrained shear strength ( $\phi = 0$ analysis)          |
| p                | mean total stress $(\sigma_1 + \sigma_3)/2$              |
| $p'$             | mean effective stress $(\sigma'_1 + \sigma'_3)/2$        |
| q                | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$            | compressive strength $(\sigma_1 - \sigma_3)$             |
| $S_t$            | sensitivity                                              |

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

|    |                     |
|----|---------------------|
| AS | Auger sample        |
| BS | Block sample        |
| CS | Chunk sample        |
| DS | Denison type sample |
| FS | Foil sample         |
| RC | Rock core           |
| SC | Soil core           |
| SS | Split-spoon         |
| ST | Slotted tube        |
| TO | Thin-walled, open   |
| TP | Thin-walled, piston |
| WS | Wash sample         |

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

| Condition  | N<br>Blows/300 mm or 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

|            | $c_u, s_u$<br>kPa | psf            |
|------------|-------------------|----------------|
| Very soft  | 0 to 12           | 0 to 250       |
| Soft       | 12 to 25          | 250 to 500     |
| Firm       | 25 to 50          | 500 to 1,000   |
| Stiff      | 50 to 100         | 1,000 to 2,000 |
| Very stiff | 100 to 200        | 2,000 to 4,000 |
| Hard       | over 200          | over 4,000     |

### IV. SOIL TESTS

|                 |                                                                                                     |
|-----------------|-----------------------------------------------------------------------------------------------------|
| w               | water content                                                                                       |
| $w_p$           | plastic limit                                                                                       |
| $w_l$           | liquid limit                                                                                        |
| C               | consolidation (oedometer) test                                                                      |
| CHEM            | chemical analysis (refer to text)                                                                   |
| CID             | consolidated isotropically drained triaxial test <sup>1</sup>                                       |
| CIU             | consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup> |
| $D_R$           | relative density (specific gravity, $G_s$ )                                                         |
| DS              | direct shear test                                                                                   |
| M               | sieve analysis for particle size                                                                    |
| MH              | combined sieve and hydrometer (H) analysis                                                          |
| MPC             | Modified Proctor compaction test                                                                    |
| SPC             | Standard Proctor compaction test                                                                    |
| OC              | organic content test                                                                                |
| SO <sub>4</sub> | concentration of water-soluble sulphates                                                            |
| UC              | unconfined compression test                                                                         |
| UU              | unconsolidated undrained triaxial test                                                              |
| V               | field vane (LV-laboratory vane test)                                                                |
| $\gamma$        | unit weight                                                                                         |

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

| Per cent by Weight | Modifier                                             | Example                                                         |
|--------------------|------------------------------------------------------|-----------------------------------------------------------------|
| 0 to 5             | Trace                                                | Trace sand                                                      |
| 5 to 12            | Trace to Some (or Little)                            | Trace to some sand                                              |
| 12 to 20           | Some                                                 | Some sand                                                       |
| 20 to 30           | (ey) or (y)                                          | Sandy                                                           |
| over 30            | And (non-cohesive (cohesionless)) or With (cohesive) | Sand and Gravel<br>Silty Clay with sand / Clayey Silt with sand |



## LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

### WEATHERINGS STATE

**Fresh:** no visible sign of weathering

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

### BEDDING THICKNESS

| Description         | Bedding Plane Spacing |
|---------------------|-----------------------|
| Very thickly bedded | Greater than 2 m      |
| Thickly bedded      | 0.6 m to 2 m          |
| Medium bedded       | 0.2 m to 0.6 m        |
| Thinly bedded       | 60 mm to 0.2 m        |
| Very thinly bedded  | 20 mm to 60 mm        |
| Laminated           | 6 mm to 20 mm         |
| Thinly laminated    | Less than 6 mm        |

### JOINT OR FOLIATION SPACING

| Description      | Spacing          |
|------------------|------------------|
| Very wide        | Greater than 3 m |
| Wide             | 1 m to 3 m       |
| Moderately close | 0.3 m to 1 m     |
| Close            | 50 mm to 300 mm  |
| Very close       | Less than 50 mm  |

### GRAIN SIZE

| Term                | Size*                   |
|---------------------|-------------------------|
| Very Coarse Grained | Greater than 60 mm      |
| Coarse Grained      | 2 mm to 60 mm           |
| Medium Grained      | 60 microns to 2 mm      |
| Fine Grained        | 2 microns to 60 microns |
| Very Fine Grained   | Less than 2 microns     |

Note: \* Grains greater than 60 microns diameter are visible to the naked eye.

### CORE CONDITION

#### Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

#### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

#### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

### DISCONTINUITY DATA

#### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

#### Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

#### Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

#### Abbreviations

|                     |                   |
|---------------------|-------------------|
| JN Joint            | PL Planar         |
| FLT Fault           | CU Curved         |
| SH Shear            | UN Undulating     |
| VN Vein             | IR Irregular      |
| FR Fracture         | K Slickensided    |
| SY Stylolite        | PO Polished       |
| BD Bedding          | SM Smooth         |
| FO Foliation        | SR Slightly Rough |
| CO Contact          | RO Rough          |
| AXJ Axial Joint     | VR Very Rough     |
| KV Karstic Void     |                   |
| MB Mechanical Break |                   |





|                                       |  |                                                                                                       |  |                         |  |               |  |
|---------------------------------------|--|-------------------------------------------------------------------------------------------------------|--|-------------------------|--|---------------|--|
| <b>PROJECT</b> 1417217-1231           |  | <b>RECORD OF BOREHOLE No 18-01</b>                                                                    |  | SHEET 1 OF 4            |  | <b>METRIC</b> |  |
| <b>G.W.P.</b> 4133-01-01 & 4134-01-01 |  | <b>LOCATION</b> N 5013055.7; E 360897.3 NAD MTM ZONE 9 (LAT. 45.255220; LONG. -75.785300)             |  | <b>ORIGINATED BY</b> RI |  |               |  |
| <b>DIST</b> Eastern HWY 416           |  | <b>BOREHOLE TYPE</b> Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring, NW Casing/Rotary Drill, HOD |  | <b>COMPILED BY</b> ZS   |  |               |  |
| <b>DATUM</b> CGVD28                   |  | <b>DATE</b> April 30, 2018                                                                            |  | <b>CHECKED BY</b> WAM   |  |               |  |

| SOIL PROFILE  |                                                                                                                                        |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                                         |  |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT                   |  |  | UNIT<br>WEIGHT<br><br><b>γ</b><br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|-------------------------------------------------------------------------------------|--|--|--|--|---------------------------------------------------------------------------|--|--|---------------------------------------------------------|---------------------------------------------------|----|----|----|
| ELEV<br>DEPTH | DESCRIPTION                                                                                                                            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa<br>○ UNCONFINED   + FIELD VANE<br>● QUICK TRIAXIAL   × REMOULDED |  |  |  |  | W <sub>P</sub> W                      W <sub>L</sub><br>WATER CONTENT (%) |  |  |                                                         | GR                                                | SA | SI | CL |
| 103.5         | GROUND SURFACE                                                                                                                         |            |         |      |            |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 0.0           | ASPHALTIC CONCRETE                                                                                                                     |            |         |      |            |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 0.1           | PORTLAND CEMENT CONCRETE                                                                                                               |            |         |      |            |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 103.1         |                                                                                                                                        |            |         |      |            |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 0.4           | (SP/GP) Gravelly sand to sandy gravel, angular (FILL)<br>Compact to loose<br>Grey to dark grey<br>Moist to wet                         |            | 1       | GRAB | -          |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 2       | SS   | 16         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 3       | SS   | 22         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 4       | SS   | 9          |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 5       | SS   | 12         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 6       | SS   | 12         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 98.2          |                                                                                                                                        |            |         |      |            |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
| 5.3           | (SM/ML) Gravelly Silty SAND to Sandy SILT, trace to some clay, contains cobbles (TILL)<br>Compact to very dense<br>Grey brown<br>Moist |            | 7       | SS   | 18         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 8       | SS   | 33         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 9       | SS   | 74         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 10      | SS   | 50/0.15    |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 11      | SS   | 50/0.06    |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 12      | RC   | DD         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |
|               |                                                                                                                                        |            | 13      | SS   | 63         |                            |                 |                                                                                     |  |  |  |  |                                                                           |  |  |                                                         |                                                   |    |    |    |

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

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| PROJECT 1417217-1231           |                                                                                                       |                                                                                     | RECORD OF BOREHOLE No 18-01                                                                    |      |                         | SHEET 2 OF 4     |                                                                              |                    | METRIC |  |  |                                 |                               |                                |                                       |                                                      |
|--------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------|-------------------------|------------------|------------------------------------------------------------------------------|--------------------|--------|--|--|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|------------------------------------------------------|
| G.W.P. 4133-01-01 & 4134-01-01 |                                                                                                       |                                                                                     | LOCATION N 5013055.7; E 360897.3 NAD MTM ZONE 9 (LAT. 45.255220; LONG. -75.785300)             |      |                         | ORIGINATED BY RI |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
| DIST Eastern HWY 416           |                                                                                                       |                                                                                     | BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring, NW Casing/Rotary Drill, HOB |      |                         | COMPILED BY ZS   |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
| DATUM CGVD28                   |                                                                                                       |                                                                                     | DATE April 30, 2018                                                                            |      |                         | CHECKED BY WAM   |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
| SOIL PROFILE                   |                                                                                                       | SAMPLES                                                                             |                                                                                                |      | GROUND WATER CONDITIONS | ELEVATION SCALE  | DYNAMIC CONE PENETRATION RESISTANCE PLOT                                     |                    |        |  |  | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
| ELEV<br>DEPTH                  | DESCRIPTION                                                                                           | STRAT PLOT                                                                          | NUMBER                                                                                         | TYPE |                         |                  | "N" VALUES                                                                   | SHEAR STRENGTH kPa |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                | --- CONTINUED FROM PREVIOUS PAGE ---                                                                  |                                                                                     |                                                                                                |      |                         |                  | 20 40 60 80 100<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |                    |        |  |  | 25 50 75                        |                               |                                |                                       |                                                      |
| 93.3<br>10.2                   | (SP/ML) SAND and SILT, trace to some gravel and clay, contains cobbles (TILL)<br>Dense<br>Grey<br>Wet |   | 14                                                                                             | RC   | DD                      |                  | 93                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 15                                                                                             | SS   | 35                      |                  |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 16                                                                                             | SS   | 35                      |                  | 92                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     |                                                                                                |      |                         |                  |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 17                                                                                             | SS   | 34                      |                  | 91                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     |                                                                                                |      |                         |                  | 90                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 18                                                                                             | SS   | 47                      |                  | 89                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     |                                                                                                |      |                         |                  |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
| 88.0<br>15.6                   | (SM) Gravelly Silty SAND, contains cobbles and boulders (TILL)<br>Dense to compact<br>Grey<br>Wet     |  | 19                                                                                             | SS   | 39                      |                  | 88                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 20                                                                                             | RC   | DD                      |                  | 87                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 21                                                                                             | RC   | DD                      |                  | 86                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     | 22                                                                                             | SS   | 23                      |                  | 85                                                                           |                    |        |  |  |                                 |                               |                                |                                       |                                                      |
|                                |                                                                                                       |                                                                                     |                                                                                                |      |                         | 84               |                                                                              |                    |        |  |  |                                 |                               |                                |                                       |                                                      |

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

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| PROJECT 1417217-1231           |                                                                                                   |            |        | RECORD OF BOREHOLE No 18-01                                                                    |                         |                 |                                          | SHEET 3 OF 4       |            |    |     | METRIC                                              |                   |                |                                        |                                       |
|--------------------------------|---------------------------------------------------------------------------------------------------|------------|--------|------------------------------------------------------------------------------------------------|-------------------------|-----------------|------------------------------------------|--------------------|------------|----|-----|-----------------------------------------------------|-------------------|----------------|----------------------------------------|---------------------------------------|
| G.W.P. 4133-01-01 & 4134-01-01 |                                                                                                   |            |        | LOCATION N 5013055.7; E 360897.3 NAD MTM ZONE 9 (LAT. 45.255220; LONG. -75.785300)             |                         |                 |                                          | ORIGINATED BY RI   |            |    |     |                                                     |                   |                |                                        |                                       |
| DIST Eastern HWY 416           |                                                                                                   |            |        | BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring, NW Casing/Rotary Drill, HOD |                         |                 |                                          | COMPILED BY ZS     |            |    |     |                                                     |                   |                |                                        |                                       |
| DATUM CGVD28                   |                                                                                                   |            |        | DATE April 30, 2018                                                                            |                         |                 |                                          | CHECKED BY WAM     |            |    |     |                                                     |                   |                |                                        |                                       |
| SOIL PROFILE                   |                                                                                                   | SAMPLES    |        |                                                                                                | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                    |            |    |     | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |                   |                | UNIT WEIGHT $\gamma$ kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH                     | DESCRIPTION                                                                                       | STRAT PLOT | NUMBER | TYPE                                                                                           |                         |                 | "N" VALUES                               | SHEAR STRENGTH kPa |            |    |     |                                                     | WATER CONTENT (%) |                |                                        |                                       |
|                                | --- CONTINUED FROM PREVIOUS PAGE ---                                                              |            |        |                                                                                                |                         |                 | 20                                       | 40                 | 60         | 80 | 100 | W <sub>p</sub>                                      | W                 | W <sub>L</sub> |                                        |                                       |
|                                |                                                                                                   |            |        |                                                                                                |                         |                 | ○ UNCONFINED                             | +                  | FIELD VANE |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            |        |                                                                                                |                         |                 | ● QUICK TRIAXIAL                         | x                  | REMOULDED  |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            |        |                                                                                                |                         |                 | 20                                       | 40                 | 60         | 80 | 100 | 25                                                  | 50                | 75             |                                        |                                       |
| 82.7                           | (SM) Gravelly Silty SAND, contains cobbles and boulders (TILL)<br>Dense to compact<br>Grey<br>Wet |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
| 20.8                           | Possible Bedrock                                                                                  |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
| 82.4                           |                                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
| 21.1                           | Sandstone (BEDROCK)                                                                               |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
|                                | Bedrock cored from depths 21.1 m to 26.3 m                                                        |            | 1      | RC                                                                                             | REC 100%                |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        | RQD = 100%                            |
|                                | For bedrock coring detail refer to Record of Drillhole 18-01                                      |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            | 2      | RC                                                                                             | REC 100%                |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        | RQD = 95%                             |
|                                |                                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            | 3      | RC                                                                                             | REC 100%                |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        | RQD = 95%                             |
| 79.0                           |                                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
| 24.6                           | Dolostone (BEDROCK)                                                                               |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            | 4      | RC                                                                                             | REC 96%                 |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        | RQD = 84%                             |
|                                |                                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
|                                |                                                                                                   |            | 5      | RC                                                                                             | REC 100%                |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        | RQD = 100%                            |
| 77.2                           |                                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |
| 26.3                           | END OF BOREHOLE                                                                                   |            |        |                                                                                                |                         |                 |                                          |                    |            |    |     |                                                     |                   |                |                                        |                                       |

GTA-MTO 001 N:\ACTIVE\SPATIAL\IMMM\GROUP\MEGA6\_VARIOUS\STRUCTURES02\_DATAGINT\1417217.GPJ GAL-GTA.GDT 28/3/19

PROJECT: 1417217-1231

**RECORD OF DRILLHOLE: 18-01**

SHEET 4 OF 4

LOCATION: N 5013055.7 ;E 360897.3

DRILLING DATE: April 30, 2018

DATUM: CGVD28

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: CCC Drilling

| DEPTH SCALE<br>METRES | DRILLING RECORD | DESCRIPTION     | SYMBOLIC LOG | ELEV.<br>DEPTH<br>(m) | RUN No. | NOTE:<br>For abbreviations, symbols and descriptions refer to<br>LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY |                 |             |                        |                           |                                 |    |                                        |                  |                          |                  |                  |    |    | FEATURES |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |
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|                       |                 |                 |              |                       |         | RECOVERY                                                                                                                    |                 | R.Q.D.<br>% | FRACT.<br>INDEX<br>PER | DIP w.r.t<br>CORE<br>AXIS | DISCONTINUITY DATA              |    | HYDRAULIC<br>CONDUCTIVITY<br>K, cm/sec |                  | WEATH-<br>ERING<br>INDEX |                  |                  |    |    |          |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |
|                       |                 |                 |              |                       |         | TOTAL<br>CORE %                                                                                                             | SOLID<br>CORE % |             |                        |                           | TYPE AND SURFACE<br>DESCRIPTION | Jr | Ja                                     | 10 <sup>-9</sup> | 10 <sup>-8</sup>         | 10 <sup>-7</sup> | 10 <sup>-6</sup> | W1 | W2 |          | W3 | W4 | W5 | W6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |
|                       |                 |                 |              |                       |         |                                                                                                                             |                 |             |                        |                           |                                 |    |                                        |                  |                          |                  |                  |    |    |          |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |
|                       |                 |                 |              |                       |         |                                                                                                                             |                 |             |                        |                           |                                 |    |                                        |                  |                          |                  |                  |    |    |          |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |
|                       |                 | BEDROCK SURFACE |              | 82.36                 |         |                                                                                                                             |                 |             |                        |                           |                                 |    |                                        |                  |                          |                  |                  |    |    |          |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | </ |

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: RI

CHECKED: MJK

GTA-RCK 031 N:\ACTIVE\SPATIAL\_IMMM\GROUP\MEGA6\_VARIOUS\STRUCTURES\02\_DATA\GINT\1417217.GPJ GAL-MISS.GDT 28/3/19

| PROJECT      |       | 1417217-1231                                                                                                             |            | RECORD OF BOREHOLE No 18-02 |      | SHEET 1 OF 4                                                                      |  | METRIC          |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|--------------|-------|--------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------|------|-----------------------------------------------------------------------------------|--|-----------------|------------------------------------------|--------------|------------------|-----------------------------------------------------|-----------------|-------------------|-------------|----------------|---|---------------------------------------|----|----|----|----------|
| G.W.P.       |       | 4133-01-01 & 4134-01-01                                                                                                  |            | LOCATION                    |      | N 5012694.5; E 361054.6 NAD MTM ZONE 9 (LAT. 45.251960; LONG. -75.783300)         |  | ORIGINATED BY   |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| DIST         |       | Eastern HWY 416                                                                                                          |            | BOREHOLE TYPE               |      | Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring, NW Casing/Rotary Drill, HCCM |  | COMPILED BY     |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| DATUM        |       | CGVD28                                                                                                                   |            | DATE                        |      | May 14, 2018                                                                      |  | CHECKED BY      |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            |                             |      |                                                                                   |  | WAM             |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| SOIL PROFILE |       |                                                                                                                          | SAMPLES    |                             |      | GROUND WATER CONDITIONS                                                           |  |                 | DYNAMIC CONE PENETRATION RESISTANCE PLOT |              |                  | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |                 |                   | UNIT WEIGHT |                |   | REMARKS & GRAIN SIZE DISTRIBUTION (%) |    |    |    |          |
| ELEV         | DEPTH | DESCRIPTION                                                                                                              | STRAT PLOT | NUMBER                      | TYPE | "N" VALUES                                                                        |  | ELEVATION SCALE | SHEAR STRENGTH kPa                       |              |                  |                                                     |                 | WATER CONTENT (%) |             |                | γ | GR                                    | SA | SI | CL |          |
|              |       |                                                                                                                          |            |                             |      |                                                                                   |  | 20 40 60 80 100 | ○ UNCONFINED                             | + FIELD VANE | ● QUICK TRIAXIAL | × REMOULDED                                         | 20 40 60 80 100 | W <sub>p</sub>    | W           | W <sub>L</sub> |   |                                       |    |    |    | 25 50 75 |
| 95.7         | 0.0   | GROUND SURFACE<br>(SP) Sand, trace to some silt,<br>some gravel to gravelly (FILL)<br>Compact to dense<br>Brown<br>Moist |            | 1                           | SS   | 29                                                                                |  | 95              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 2                           | SS   | 22                                                                                |  | 94              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 3                           | SS   | 17                                                                                |  | 93              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 4                           | SS   | 29                                                                                |  | 92              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 5                           | SS   | 31                                                                                |  | 91              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 6                           | SS   | 16                                                                                |  | 90              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| 91.3         | 4.4   | (CL/ML) Silty clay to clayey silt<br>(TOPSOIL)<br>Brown<br>Moist                                                         |            | 7                           | SS   | 8                                                                                 |  | 89              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| 91.0         | 4.7   | (CL/CH) SILTY CLAY to CLAY<br>(WEATHERED CRUST)<br>Stiff<br>Grey-brown<br>Moist                                          |            | 8                           | SS   | 1                                                                                 |  | 88              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 9                           | SS   | WH                                                                                |  | 87              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
| 89.8         | 5.9   | (CL/CH) SILTY CLAY to CLAY<br>Firm to stiff<br>Grey<br>Moist to wet                                                      |            | 10                          | SS   | WH                                                                                |  | 86              |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |
|              |       |                                                                                                                          |            | 11                          | TP   | PH                                                                                |  |                 |                                          |              |                  |                                                     |                 |                   |             |                |   |                                       |    |    |    |          |

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE


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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

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|                                           |  |                                                                                                         |  |  |  |                         |  |               |  |
|-------------------------------------------|--|---------------------------------------------------------------------------------------------------------|--|--|--|-------------------------|--|---------------|--|
| PROJECT <u>1417217-1231</u>               |  | <b>RECORD OF BOREHOLE No 18-02</b>                                                                      |  |  |  | SHEET 3 OF 4            |  | <b>METRIC</b> |  |
| G.W.P. <u>4133-01-01 &amp; 4134-01-01</u> |  | LOCATION <u>N 5012694.5; E 361054.6 NAD MTM ZONE 9 (LAT. 45.251960; LONG. -75.783300)</u>               |  |  |  | ORIGINATED BY <u>DG</u> |  |               |  |
| DIST <u>Eastern</u> HWY <u>416</u>        |  | BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring, NW Casing/Rotary Drill, HODME</u> |  |  |  | COMPILED BY <u>ZS</u>   |  |               |  |
| DATUM <u>CGVD28</u>                       |  | DATE <u>May 14, 2018</u>                                                                                |  |  |  | CHECKED BY <u>WAM</u>   |  |               |  |

| SOIL PROFILE  |                 | SAMPLES                                                                           |        |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE                                                                                 | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                    |  |  |                                                 | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE CONTENT LIMIT |                   |  | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |
|---------------|-----------------|-----------------------------------------------------------------------------------|--------|------|----------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------|--|--|-------------------------------------------------|--------------------------------------------------------|-------------------|--|-------------------------------------------------|----------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION     | STRAT PLOT                                                                        | NUMBER | TYPE |                            |                                                                                                 | "N" VALUES                                  | SHEAR STRENGTH kPa |  |  |                                                 |                                                        | WATER CONTENT (%) |  |                                                 |                                                                      |
|               |                 |                                                                                   |        |      |                            | 20 40 60 80 100<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>20 40 60 80 100 |                                             |                    |  |  | W <sub>p</sub> — W — W <sub>L</sub><br>25 50 75 |                                                        |                   |  |                                                 |                                                                      |
| 75.5<br>20.2  | END OF BOREHOLE |  | 4      | RC   |                            |                                                                                                 |                                             |                    |  |  |                                                 |                                                        |                   |  |                                                 |                                                                      |
|               |                 |                                                                                   |        |      |                            |                                                                                                 |                                             |                    |  |  |                                                 |                                                        |                   |  |                                                 |                                                                      |

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SHEET 4 OF 4

DATUM: CGVD28

DRILLING CONTRACTOR: CCC Drilling

CHECKED: WAM



| PROJECT       |                                                                                                                                           | 1417217-1231            |         | RECORD OF BOREHOLE No 18-05 |            |                                                                           |                 | SHEET 1 OF 2                             |                                 | METRIC                        |                           |                                       |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------|-----------------------------|------------|---------------------------------------------------------------------------|-----------------|------------------------------------------|---------------------------------|-------------------------------|---------------------------|---------------------------------------|
| G.W.P.        |                                                                                                                                           | 4133-01-01 & 4134-01-01 |         | LOCATION                    |            | N 5012966.7; E 360946.9 NAD MTM ZONE 9 (LAT. 45.254420; LONG. -75.784700) |                 | ORIGINATED BY                            |                                 | RI                            |                           |                                       |
| DIST          |                                                                                                                                           | Eastern HWY 416         |         | BOREHOLE TYPE               |            | Rotary Drill/Wash Boring, NQ Casing                                       |                 | COMPILED BY                              |                                 | ZS                            |                           |                                       |
| DATUM         |                                                                                                                                           | CGVD28                  |         | DATE                        |            | May 16, 2018                                                              |                 | CHECKED BY                               |                                 | WAM                           |                           |                                       |
| SOIL PROFILE  |                                                                                                                                           |                         | SAMPLES |                             |            | GROUND WATER CONDITIONS                                                   | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                                 |                               | UNIT WEIGHT<br>γ<br>kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV<br>DEPTH | DESCRIPTION                                                                                                                               | STRAT PLOT              | NUMBER  | TYPE                        | "N" VALUES |                                                                           |                 | 20 40 60 80 100                          | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w |                           |                                       |
| 93.1          | GROUND SURFACE                                                                                                                            |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 0.0           | (SM) Gravelly silty sand (TOPSOIL)                                                                                                        |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 0.2           | Brown Moist                                                                                                                               |                         | 1       | SS                          | 24         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 92.3          | (SM) Gravelly silty sand, contains cobbles and boulders (FILL)                                                                            |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 0.8           | Compact Brown Moist                                                                                                                       |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 92.0          | (SP) Sand, trace silt and gravel (FILL)                                                                                                   |                         | 2       | SS                          | 8          |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 1.2           | Loose Brown Wet                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               | (CL) Silty clay, trace sand (TOPSOIL)                                                                                                     |                         | 3       | SS                          | 3          |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               | Black Moist                                                                                                                               |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               | (CI/CH) SILTY CLAY to CLAY, trace sand, highly fissured, contains silty sand seams (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 90.1          | (CI/CH) SILTY CLAY to CLAY, contains silty sand seams Very soft to stiff Grey                                                             |                         | 4       | SS                          | WH         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 3.1           |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         | 5       | SS                          | WR         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 87.6          | (SP/GP) SAND and GRAVEL, some silt, contains cobbles (TILL) Compact to loose Grey Wet                                                     |                         | 6       | SS                          | 12         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 5.5           |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         | 7       | SS                          | 17         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         | 8       | SS                          | 16         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         | 9       | SS                          | 8          |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 84.9          | (SM) Gravelly Silty SAND, trace to some clay, contains cobbles (TILL) Compact to loose Grey Wet                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
| 8.2           |                                                                                                                                           |                         | 10      | SS                          | 16         |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         | 11      | SS                          | 8          |                                                                           |                 |                                          |                                 |                               |                           |                                       |
|               |                                                                                                                                           |                         |         |                             |            |                                                                           |                 |                                          |                                 |                               |                           |                                       |

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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| PROJECT 1417217-1231           |                                      |            |         | RECORD OF BOREHOLE No 18-05                                                        |            |                         |                 | SHEET 2 OF 2                             |    |    |    | METRIC |                                                     |  |  |                      |                                       |
|--------------------------------|--------------------------------------|------------|---------|------------------------------------------------------------------------------------|------------|-------------------------|-----------------|------------------------------------------|----|----|----|--------|-----------------------------------------------------|--|--|----------------------|---------------------------------------|
| G.W.P. 4133-01-01 & 4134-01-01 |                                      |            |         | LOCATION N 5012966.7; E 360946.9 NAD MTM ZONE 9 (LAT. 45.254420; LONG. -75.784700) |            |                         |                 | ORIGINATED BY RI                         |    |    |    |        |                                                     |  |  |                      |                                       |
| DIST Eastern HWY 416           |                                      |            |         | BOREHOLE TYPE Rotary Drill/Wash Boring, NQ Casing                                  |            |                         |                 | COMPILED BY ZS                           |    |    |    |        |                                                     |  |  |                      |                                       |
| DATUM CGVD28                   |                                      |            |         | DATE May 16, 2018                                                                  |            |                         |                 | CHECKED BY WAM                           |    |    |    |        |                                                     |  |  |                      |                                       |
| SOIL PROFILE                   |                                      |            | SAMPLES |                                                                                    |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |    |        | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  |  | UNIT WEIGHT $\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH                     | DESCRIPTION                          | STRAT PLOT | NUMBER  | TYPE                                                                               | "N" VALUES |                         |                 | SHEAR STRENGTH kPa                       |    |    |    |        | WATER CONTENT (%)                                   |  |  |                      |                                       |
|                                | --- CONTINUED FROM PREVIOUS PAGE --- |            |         |                                                                                    |            |                         |                 | 20                                       | 40 | 60 | 80 | 100    |                                                     |  |  |                      |                                       |
| 82.6                           |                                      |            | 12      | SS                                                                                 | 14         |                         | 83              |                                          |    |    |    |        |                                                     |  |  |                      |                                       |
| 10.5                           | END OF BOREHOLE                      |            | 13      | SS                                                                                 | 50/0.06    |                         |                 |                                          |    |    |    |        |                                                     |  |  |                      |                                       |

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

| PROJECT                        |                                      | RECORD OF BOREHOLE No 18-08                                                        |        |      |                         | SHEET 2 OF 2     |                                          | METRIC             |    |    |     |                                 |                               |                                |                  |                                       |                   |
|--------------------------------|--------------------------------------|------------------------------------------------------------------------------------|--------|------|-------------------------|------------------|------------------------------------------|--------------------|----|----|-----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|-------------------|
| 1417217-1231                   |                                      |                                                                                    |        |      |                         |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| G.W.P. 4133-01-01 & 4134-01-01 |                                      | LOCATION N 5012883.4; E 360982.3 NAD MTM ZONE 9 (LAT. 45.253670; LONG. -75.784200) |        |      |                         | ORIGINATED BY RI |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| DIST Eastern HWY 416           |                                      | BOREHOLE TYPE Rotary Drill/Wash Boring, NQ Casing                                  |        |      |                         | COMPILED BY ZS   |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| DATUM CGVD28                   |                                      | DATE May 16, 2018                                                                  |        |      |                         | CHECKED BY WAM   |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| SOIL PROFILE                   |                                      | SAMPLES                                                                            |        |      | GROUND WATER CONDITIONS | ELEVATION SCALE  | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                    |    |    |     | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |                   |
| ELEV DEPTH                     | DESCRIPTION                          | STRAT PLOT                                                                         | NUMBER | TYPE |                         |                  | "N" VALUES                               | SHEAR STRENGTH kPa |    |    |     |                                 |                               |                                |                  |                                       | WATER CONTENT (%) |
|                                | --- CONTINUED FROM PREVIOUS PAGE --- |                                                                                    |        |      |                         |                  | 20                                       | 40                 | 60 | 80 | 100 |                                 |                               |                                |                  |                                       |                   |
|                                |                                      |                                                                                    | 9      | SS   | 3                       |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
|                                |                                      |                                                                                    | 10     | SS   | 3                       |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
|                                |                                      |                                                                                    |        |      |                         |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| 80.2                           |                                      |                                                                                    |        |      |                         |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |
| 12.2                           | END OF BOREHOLE                      |                                                                                    | 11     | SS   | 50/0.00                 |                  |                                          |                    |    |    |     |                                 |                               |                                |                  |                                       |                   |

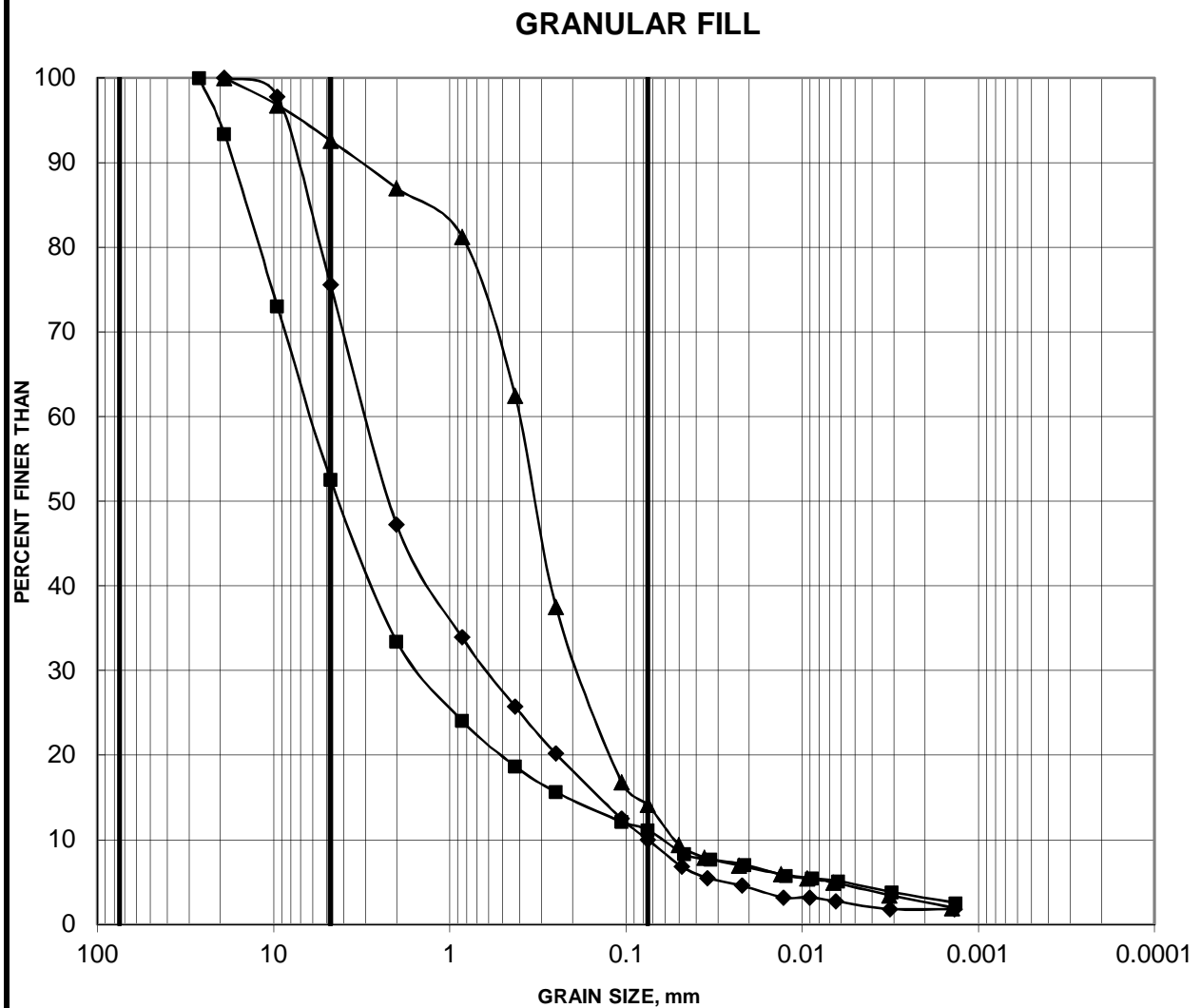
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**APPENDIX B**

**Laboratory Test Results  
(Golder, 2018)**

# GRAIN SIZE DISTRIBUTION

FIGURE B1

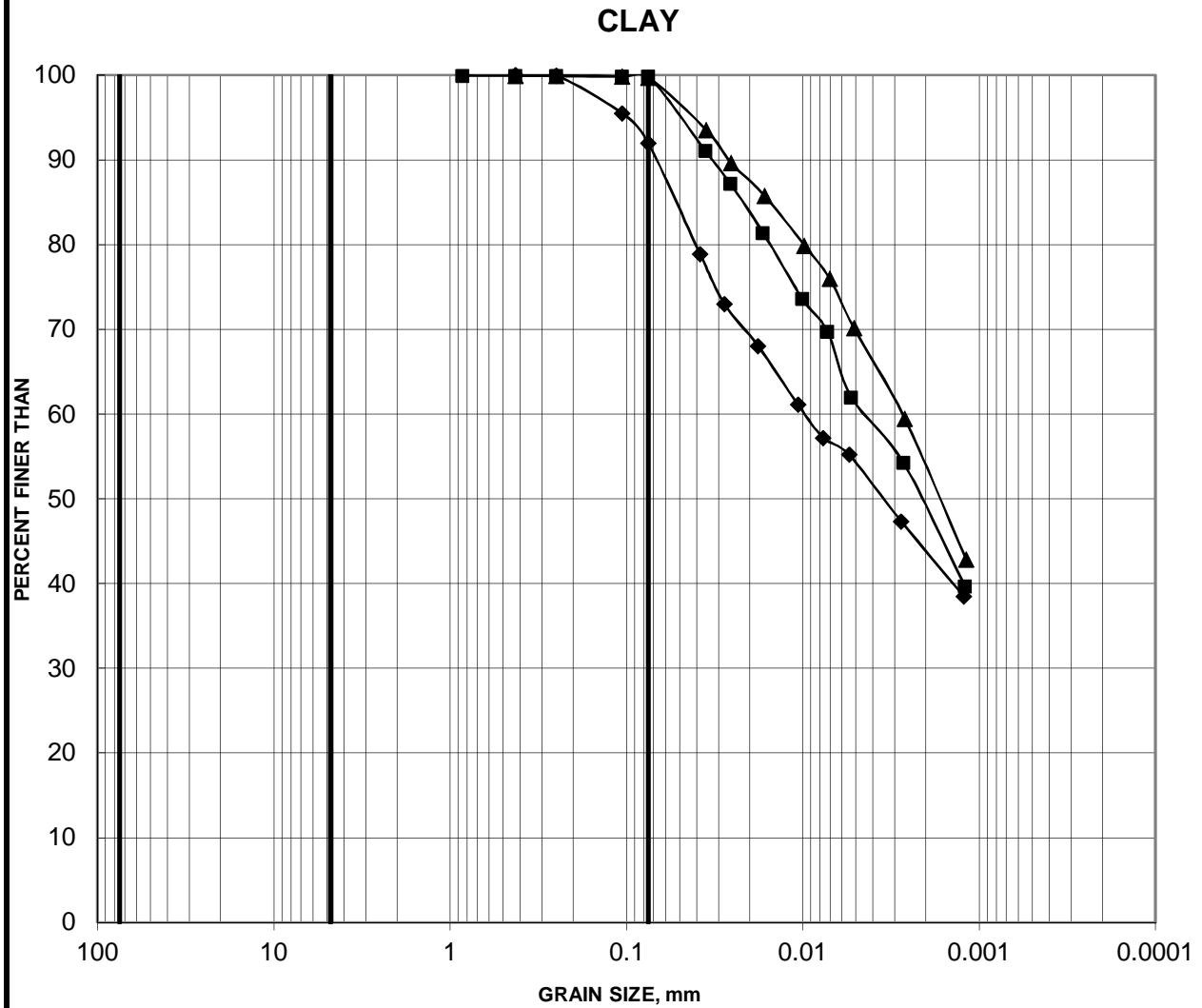


|                |             |      |           |        |      |               |
|----------------|-------------|------|-----------|--------|------|---------------|
| Cobble<br>Size | coarse      | fine | coarse    | medium | fine | SILT AND CLAY |
|                | GRAVEL SIZE |      | SAND SIZE |        |      |               |

| Borehole | Sample | Depth (m) |
|----------|--------|-----------|
| 18-01    | 3      | 2.29-2.90 |
| 18-02    | 4      | 2.29-2.90 |
| 18-08    | 2A     | 0.76-1.07 |

# GRAIN SIZE DISTRIBUTION

FIGURE B2

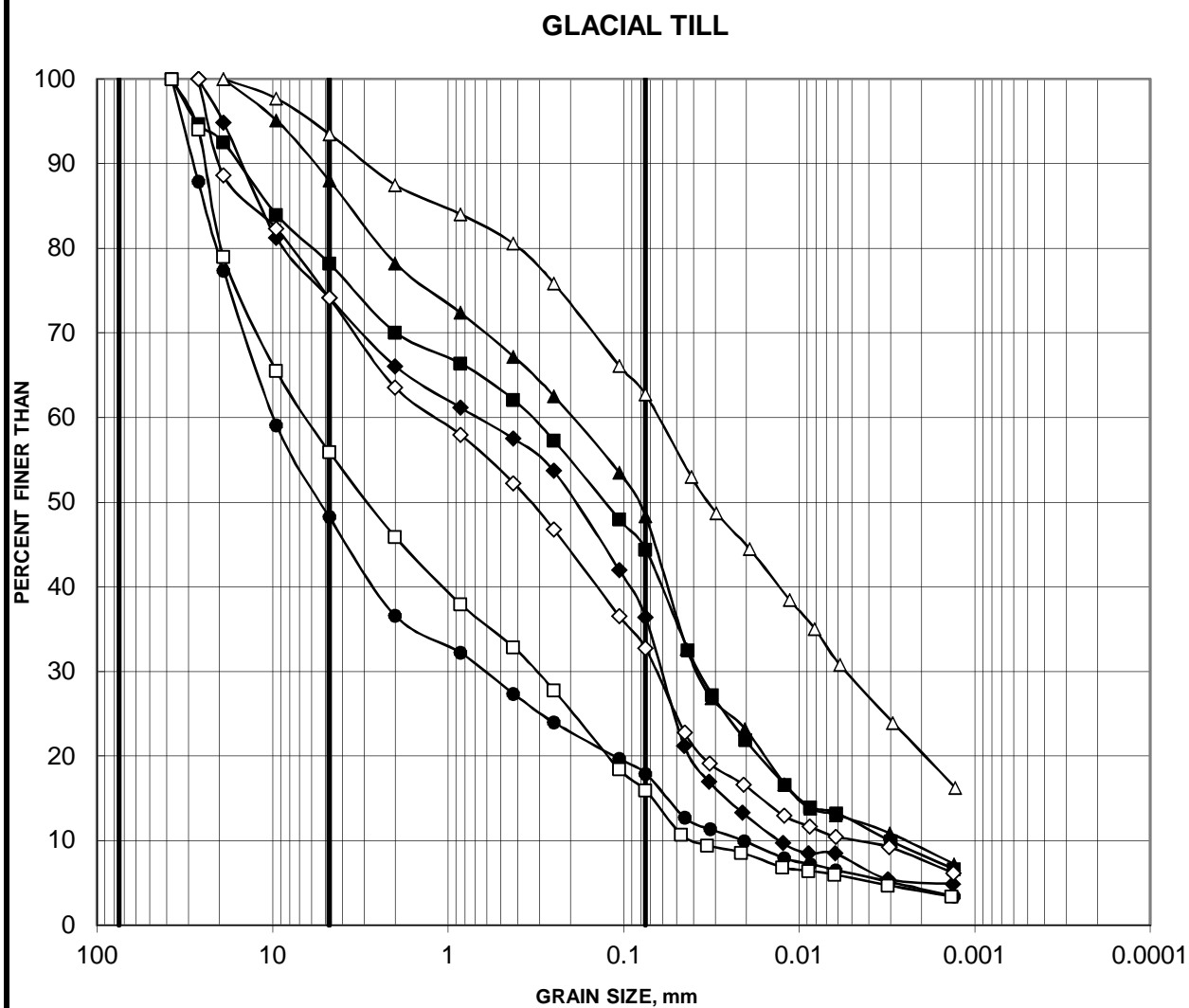


|                |             |      |           |        |      |               |
|----------------|-------------|------|-----------|--------|------|---------------|
| Cobble<br>Size | coarse      | fine | coarse    | medium | fine | SILT AND CLAY |
|                | GRAVEL SIZE |      | SAND SIZE |        |      |               |

| Borehole  | Sample | Depth (m) |
|-----------|--------|-----------|
| —■— 18-02 | 10     | 7.62-8.23 |
| —◆— 18-05 | 3      | 1.52-2.13 |
| —▲— 18-08 | 5      | 4.57-5.18 |

# GRAIN SIZE DISTRIBUTION

FIGURE B3



|        |             |      |           |        |      |               |
|--------|-------------|------|-----------|--------|------|---------------|
| Cobble | coarse      | fine | coarse    | medium | fine | SILT AND CLAY |
| Size   | GRAVEL SIZE |      | SAND SIZE |        |      |               |

| Borehole | Sample   | Depth (m)   |
|----------|----------|-------------|
| —■—      | 18-01 8  | 6.10-6.71   |
| —◆—      | 18-01 13 | 9.54-10.15  |
| —▲—      | 18-01 17 | 12.95-13.56 |
| —●—      | 18-02 13 | 12.19-12.80 |
| —□—      | 18-05 7  | 6.10-6.71   |
| —◇—      | 18-05 11 | 9.14-9.75   |
| —△—      | 18-08 9  | 9.91-10.52  |



**Golder Associates Ltd.**  
1931 Robertson Road  
Ottawa, Ontario  
K2H 5B7





## UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE

**Project:** MMM 4014 E 0015 Mega 6 Eastern Region  
- Strandherd Bridge

**Project No.:** 1417217/1231

**Date:** June 21, 2018


**Location(s):** See below

| Bore Hole No. | Depth (m)   | Date Tested | Core Size | Diameter (mm) | Density (kg/m <sup>3</sup> ) | Compressive Strength (MPa) | Failure Mode                                                                          |
|---------------|-------------|-------------|-----------|---------------|------------------------------|----------------------------|---------------------------------------------------------------------------------------|
| 18-01         | 21.35-21.49 | Jun 20/18   | HQ        | 60.7          | 2538                         | 127.1                      |   |
| 18-02         | 15.31-15.45 | Jun 20/18   | HQ        | 60.6          | 2736                         | 186.8                      |  |

REMARKS : - Cores tested in vertical direction.  
- Cores tested in air-dry condition.  
- Specimen ends prepared with high-strength plaster, but un-restrained.  
- L/D ratio's between 2.0:1 and 2.5:1  
- Time to failure > 2 and < 15 minutes.

TESTING WAS CARRIED OUT IN GENERAL ACCORDANCE WITH ASTM D7012 - Method C

SIGNED:

  
C.N. Mangione P.Eng.

**APPENDIX C**

**Cone Penetration Testing Report  
(ConeTec Investigations Ltd., 2018)**

# PRESENTATION OF SITE INVESTIGATION RESULTS

## Hwy 416 and McKenna Casey Dr

*Prepared for:*

Golder Associates

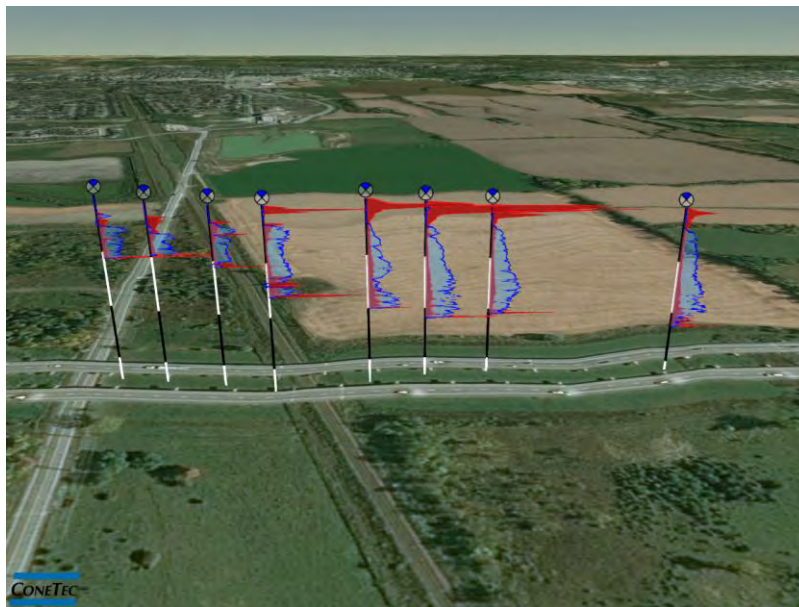
ConeTec Job No: 18-05030

Project Start Date: 14-May-2018

Project End Date: 16-May-2018

Report Date: 29-May-2018

Revision Date: 15-Jun-2018



*Prepared by:*

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[www.conetec.com](http://www.conetec.com)

[www.conetecdataservices.com](http://www.conetecdataservices.com)



## Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Golder Associates near Hwy 416 and McKenna Casey Dr, Ontario. The program consisted eight seismic cone penetration tests (SCPT).

## Project Information

| Project                |                              |
|------------------------|------------------------------|
| Client                 | Golder Associates            |
| Project                | Hwy 416 and McKenna Casey Dr |
| ConeTec project number | 18-05030                     |

An aerial overview from Google Earth including the CPT locations is presented below.



| Rig Description    | Deployment System | Test Type |
|--------------------|-------------------|-----------|
| Portable Track Rig | Portable          | SCPT      |

| Coordinates |                    |             |
|-------------|--------------------|-------------|
| Test Type   | Collection Method  | EPSG Number |
| SCPT        | Consumer grade GPS | 32618       |

| Cone Penetration Test (CPT) |                                                                                                                                                                                                         |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Depth reference             | Depths are referenced to the existing ground surface at the time of each test.                                                                                                                          |
| Tip and sleeve data offset  | 0.1 meter<br>This has been accounted for in the CPT data files.                                                                                                                                         |
| Additional plots            | Expanded range plots, advanced CPT plots with $I_c$ , $S_u$ and N160 (IC RW1998), Soil Behavior Type (SBT) scatter plots as well as seismic $V_s$ plots have been included in the data release package. |
| Additional Comment          | The dynamic pore pressure response at SCPT18-07 was subdued due to saturation loss.                                                                                                                     |

| Cone Penetrometers Used for this Project |             |                                         |                                |                    |                       |                              |
|------------------------------------------|-------------|-----------------------------------------|--------------------------------|--------------------|-----------------------|------------------------------|
| Cone Description                         | Cone Number | Cross Sectional Area (cm <sup>2</sup> ) | Sleeve Area (cm <sup>2</sup> ) | Tip Capacity (bar) | Sleeve Capacity (bar) | Pore Pressure Capacity (psi) |
| 330:T1500F15U500                         | 330         | 15                                      | 225                            | 1500               | 15                    | 500                          |
| Cone 330 was used for all CPT soundings. |             |                                         |                                |                    |                       |                              |

| Calculated Geotechnical Parameter Tables |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Additional information                   | <p>The Normalized Soil Behaviour Type Chart based on <math>Q_{tn}</math> (SBT <math>Q_{tn}</math>) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPT parameters have been generated and are provided in Excel format files in the release folder. The CPT parameter calculations are based on values of corrected tip resistance (<math>q_t</math>) sleeve friction (<math>f_s</math>) and pore pressure (<math>u_2</math>). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behaviour type zones and the assumed equilibrium pore pressure profile.</p> <p>Soils were classified as either drained or undrained based on the <math>Q_{tn}</math> Normalized Soil Behaviour Type Chart (Robertson, 2009). Both drained and undrained parameters were calculated for soils that classified as Sand Mixtures (zone 5).</p> |

## Limitations

This report has been prepared for the exclusive use of Golder Associates (Client) for the project titled "Hwy 416 and McKenna Casey Dr". The report's contents may not be relied upon by any other party without the express written permission of ConeTec Investigations Ltd. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

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





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

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

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

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

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

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



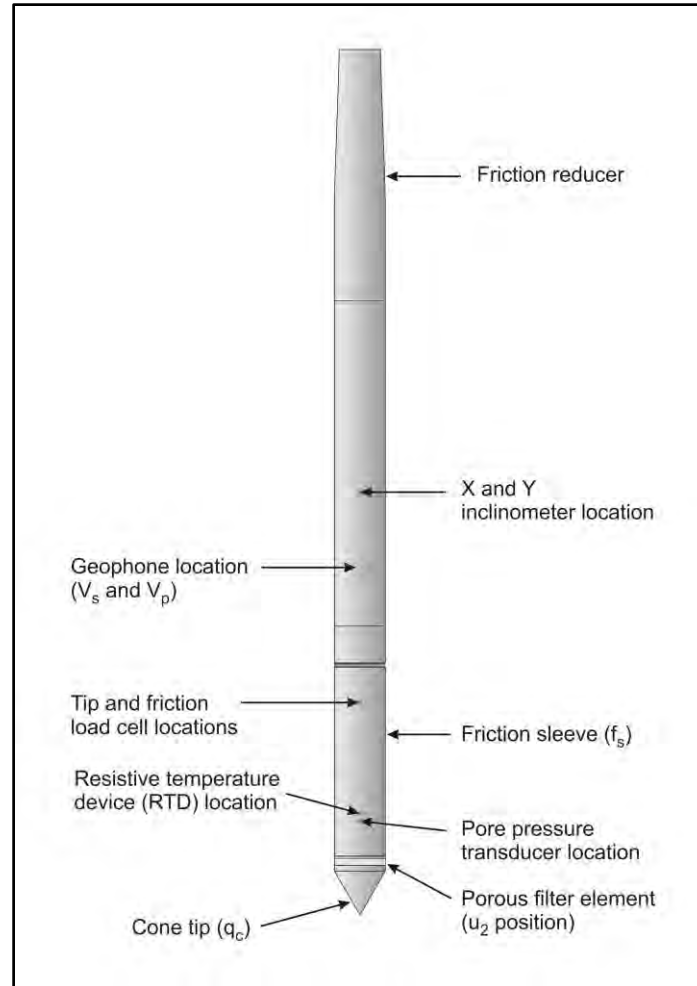


Figure CPTu. Piezocone Penetrometer (15 cm<sup>2</sup>)

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

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

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



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

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

Additional information pertaining to ConeTec's cone penetration testing procedures:

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

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

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

$$q_t = q_c + (1-a) \cdot u_2$$

where:  $q_t$  is the corrected tip resistance

$q_c$  is the recorded tip resistance

$u_2$  is the recorded dynamic pore pressure behind the tip ( $u_2$  position)

$a$  is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

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

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

The friction ratio ( $R_f$ ) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high



friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

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

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

Shear wave velocity testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave ( $V_p$ ) velocity is also determined.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances an auger source or an imbedded impulsive source maybe used for both shear waves and compression waves. The hammer and beam act as a contact trigger that triggers the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an up-hole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

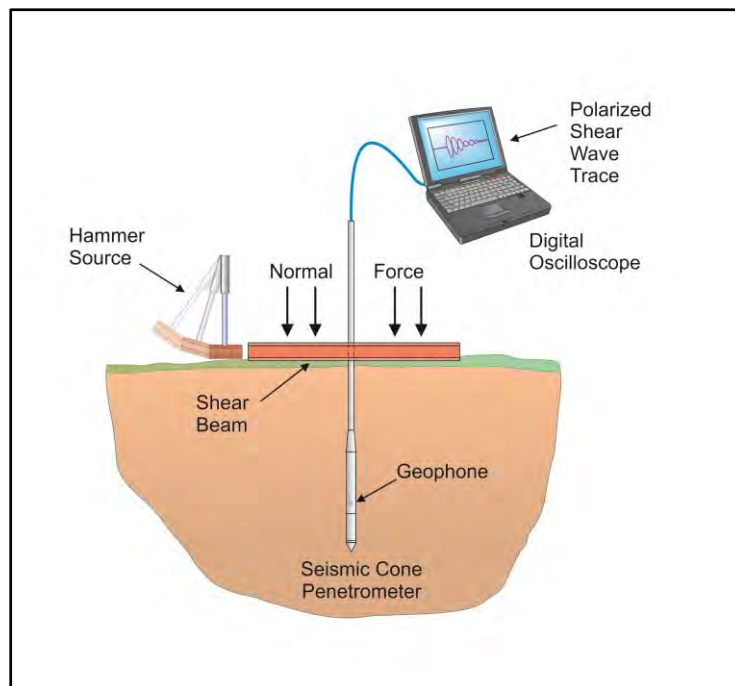


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Multiple wave traces are recorded for quality control purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et.al. (1986).

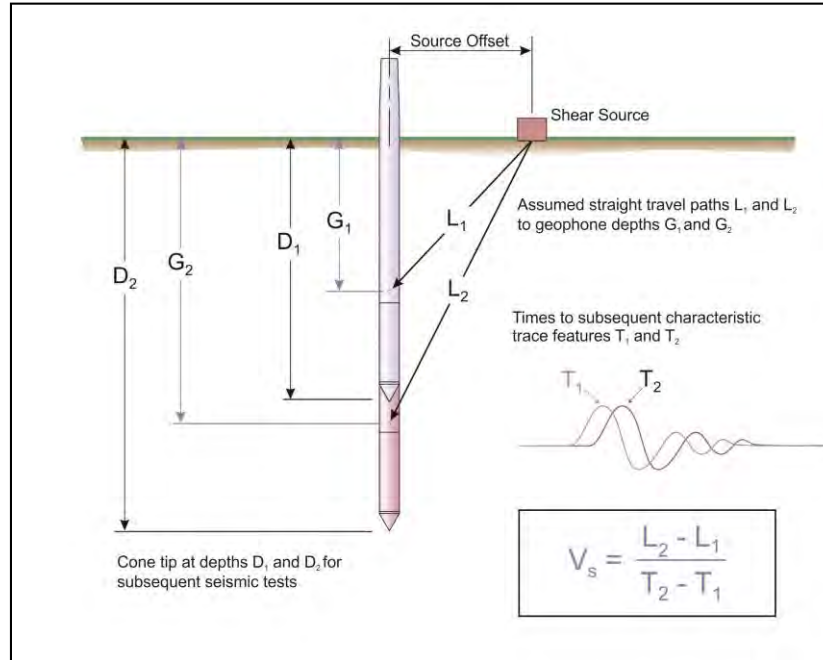


Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of 30 meters ( $V_{s30}$ ) has been calculated and provided for all applicable soundings using an equation presented in Crow et al., 2012.

$$V_{s30} = \frac{\text{total thickness of all layers (30m)}}{\sum(\text{layer traveltimes})}$$

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

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

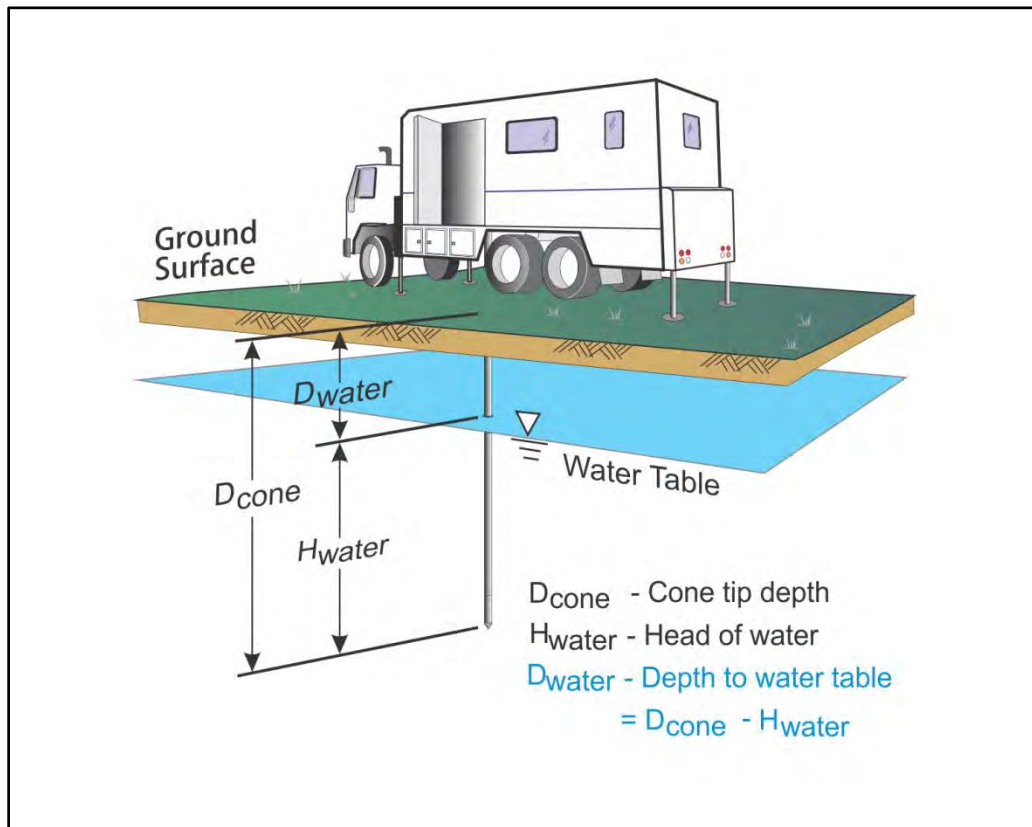


Figure PPD-1. Pore pressure dissipation test setup

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

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

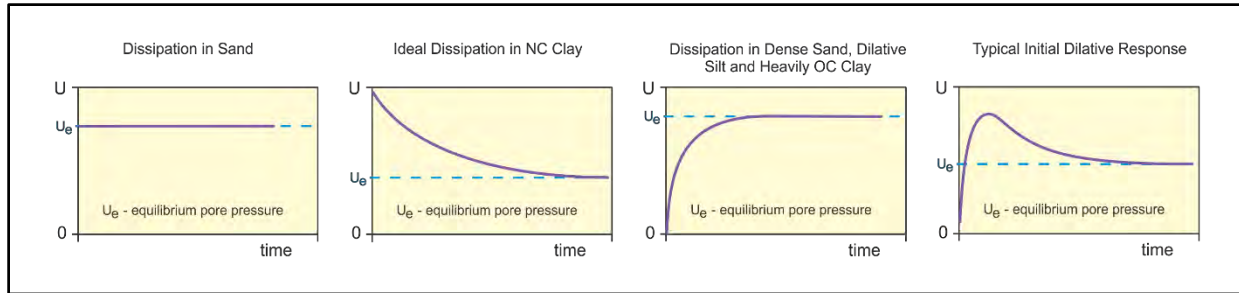


Figure PPD-2. Pore pressure dissipation curve examples

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

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

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

Where:

- $T^*$  is the dimensionless time factor (Table Time Factor)
- $a$  is the radius of the cone
- $I_r$  is the rigidity index
- $t$  is the time at the degree of consolidation

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

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

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

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

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

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

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

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

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

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots
- Soil Behavior Type (SBT) Scatter Plots
- Seismic Cone Penetration Test Tabular Results
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Wave Traces
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

## Cone Penetration Test Summary and Standard Cone Penetration Test Plots





Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Start Date: 14-May-2018  
End Date: 16-May-2018

### ***CONE PENETRATION TEST SUMMARY***

| Sounding ID | File Name     | Date        | Cone             | Assumed Phreatic Surface <sup>1</sup> (m) | Final Depth (m) | Northing <sup>2</sup> (m) | Easting (m) | Refer to Notation Number |
|-------------|---------------|-------------|------------------|-------------------------------------------|-----------------|---------------------------|-------------|--------------------------|
| SCPT18-03   | 18-05030_SP03 | 16-May-2018 | 330:T1500F15U500 | 1.6                                       | 5.550           | 5011559                   | 438416      |                          |
| SCPT18-04   | 18-05030_SP04 | 16-May-2018 | 330:T1500F15U500 | 1.6                                       | 4.775           | 5011539                   | 438422      |                          |
| SCPT18-05   | 18-05030_SP05 | 16-May-2018 | 330:T1500F15U500 | 1.6                                       | 5.550           | 5011513                   | 438429      |                          |
| SCPT18-06   | 18-05030_SP06 | 15-May-2018 | 330:T1500F15U500 | 1.7                                       | 8.100           | 5011489                   | 438432      |                          |
| SCPT18-07   | 18-05030_SP07 | 14-May-2018 | 330:T1500F15U500 | 1.8                                       | 9.975           | 5011450                   | 438451      |                          |
| SCPT18-08   | 18-05030_SP08 | 15-May-2018 | 330:T1500F15U500 | 1.9                                       | 10.925          | 5011428                   | 438467      |                          |
| SCPT18-09   | 18-05030_SP09 | 15-May-2018 | 330:T1500F15U500 | 1.9                                       | 10.500          | 5011401                   | 438482      |                          |
| SCPT18-10   | 18-05030_SP10 | 15-May-2018 | 330:T1500F15U500 | 1.8                                       | 11.375          | 5011318                   | 438505      |                          |

1. The assumed phreatic surface was based on dynamic pore pressure response. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were acquired using consumer grade GPS equipment in datum WGS1984/UTM Zone 18 North.



Golder

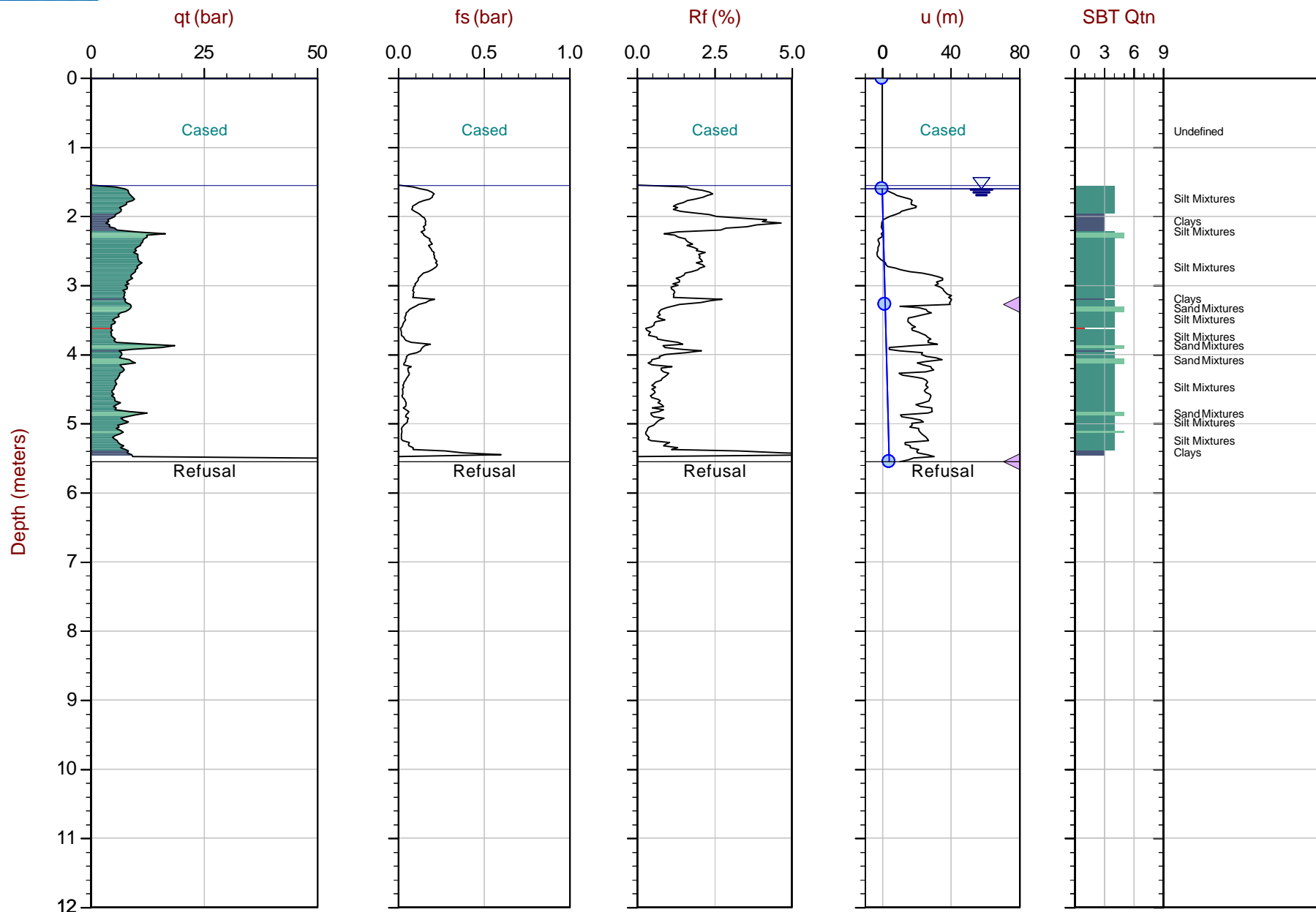
Job No: 18-05030

Date: 2018-05-16 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500



Max Depth: 5.550 m / 18.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP03.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011559m E: 438416m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



Golder

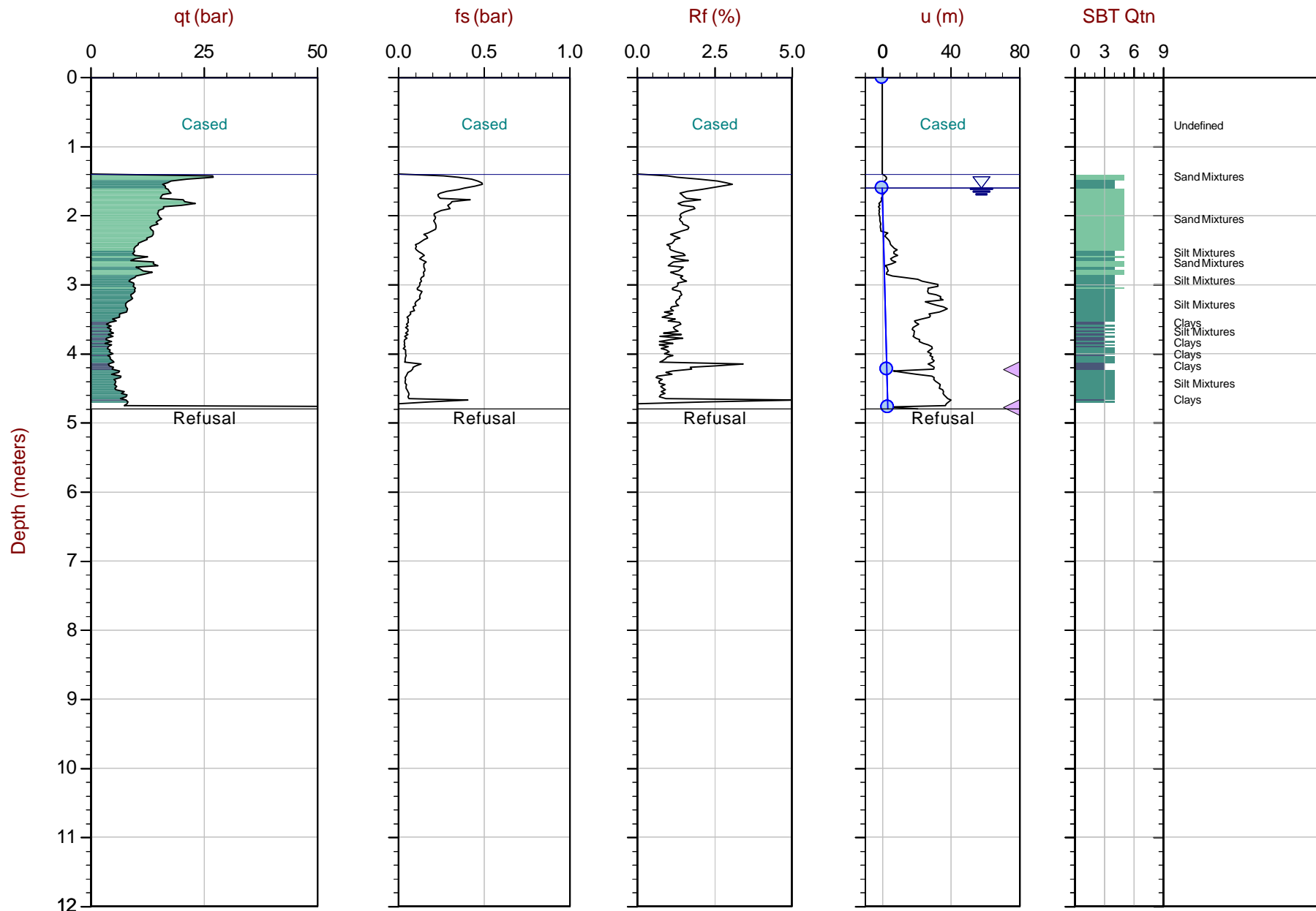
Job No: 18-05030

Date: 2018-05-16 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500



Max Depth: 4.800 m / 15.75 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP04.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011539m E: 438422m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



Golder

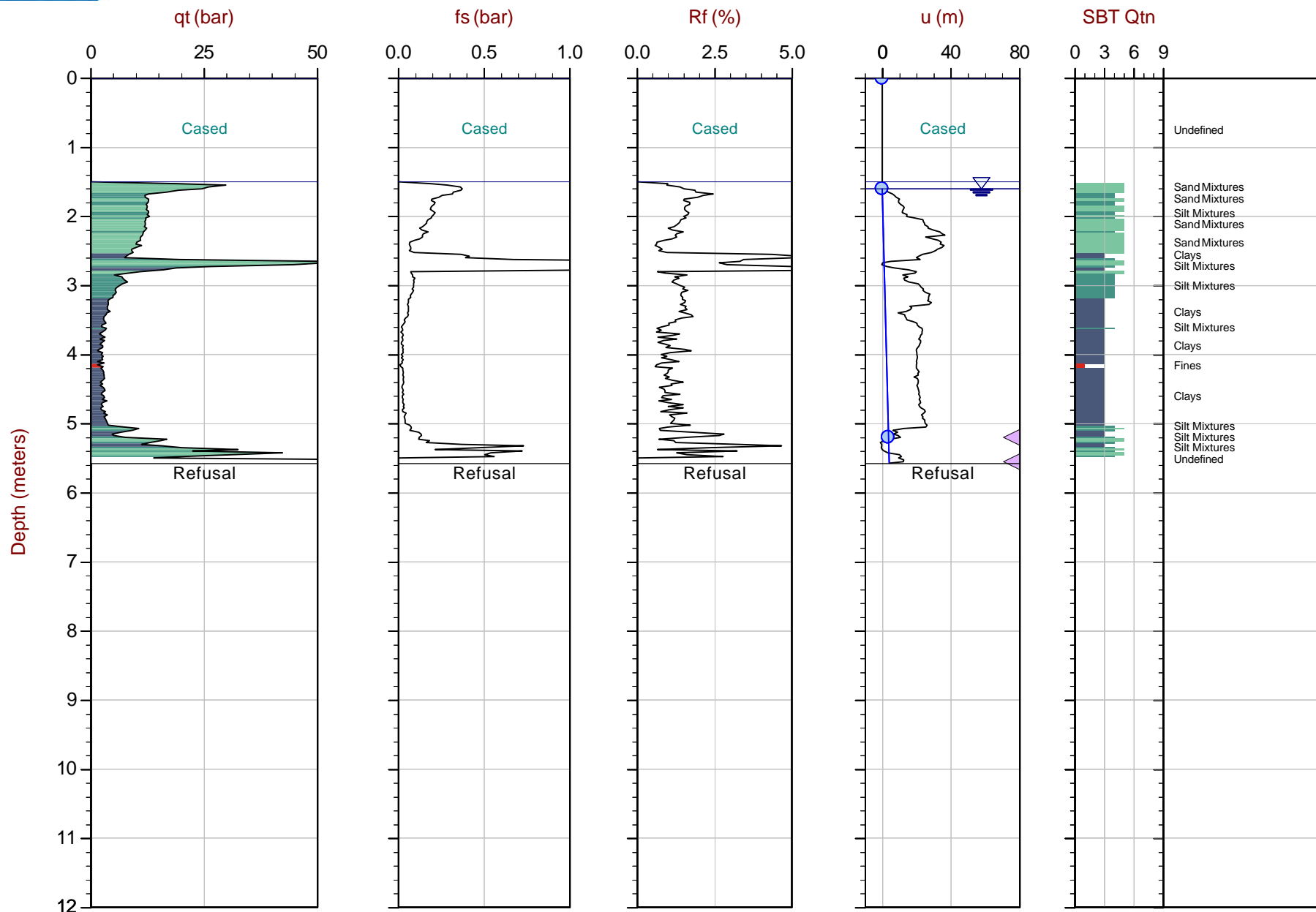
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Date: 2018-05-16 08:22

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500



Max Depth: 5.575 m / 18.29 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP05.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011513m E: 438429m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



Golder

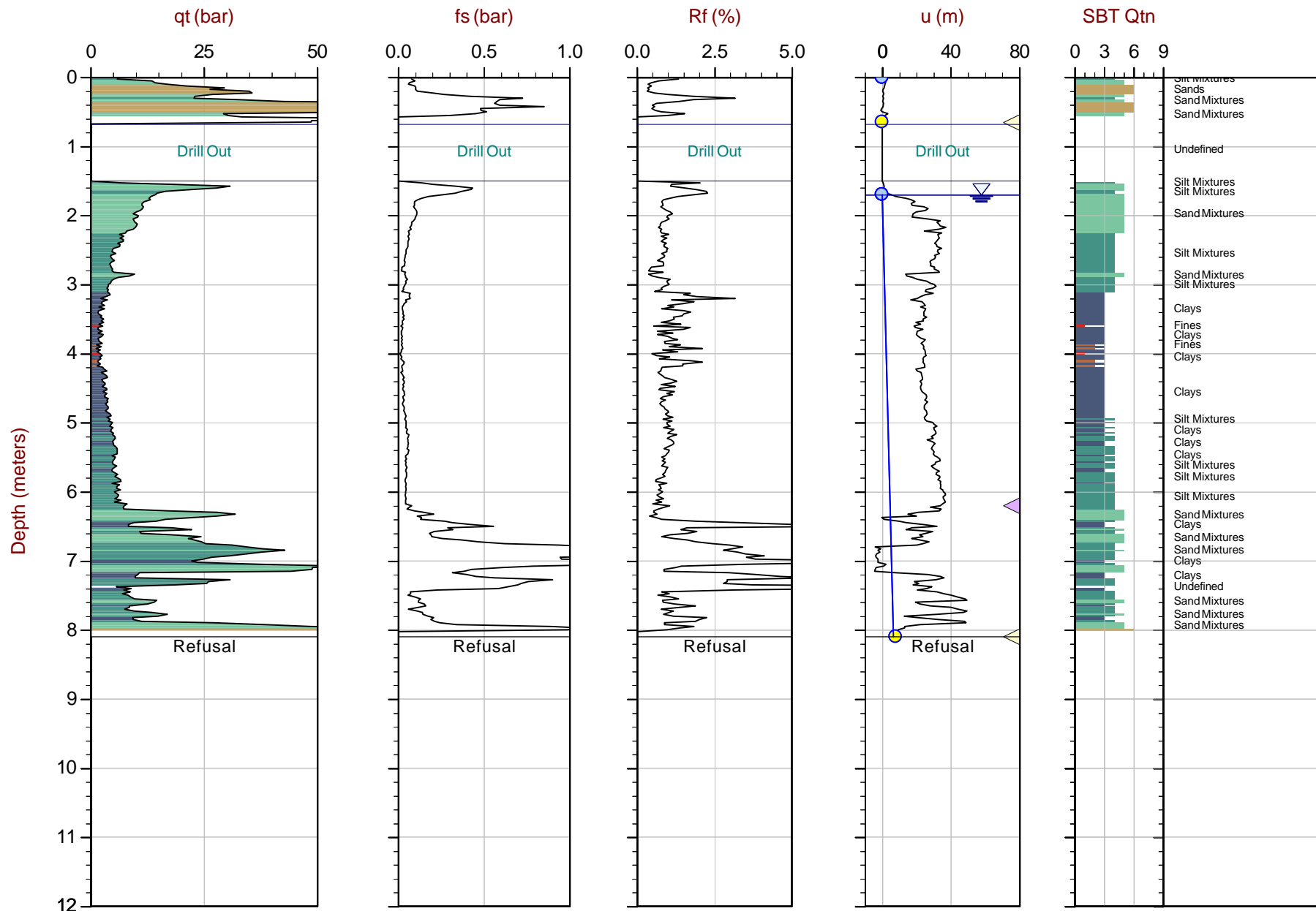
Job No: 18-05030

Date: 2018-05-15 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500



Max Depth: 8.100 m / 26.57 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP06.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N:5011489m E:438432m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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





Golder

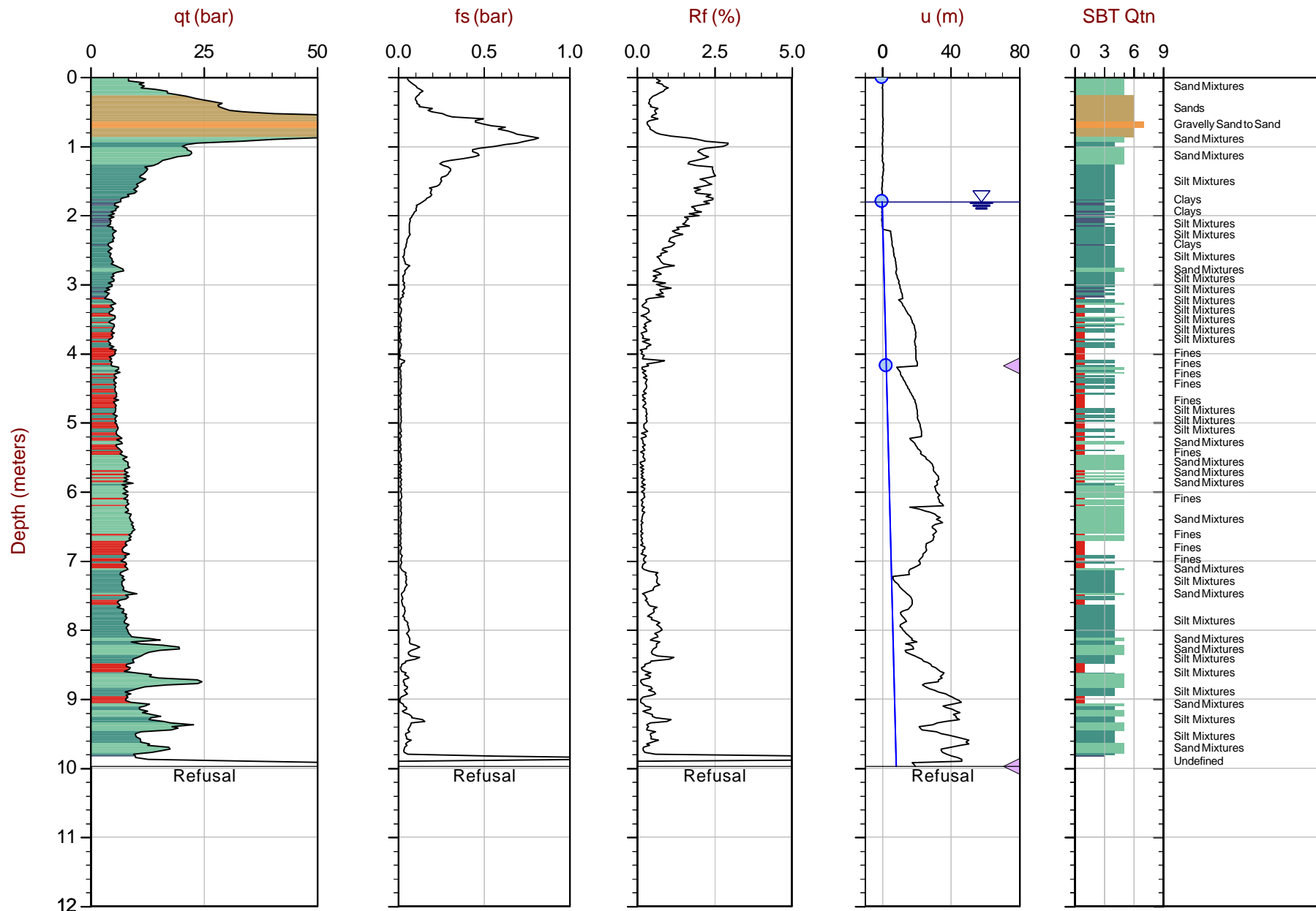
Job No: 18-05030

Date: 2018-05-14 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500



Max Depth: 9.975 m / 32.73 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP07.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011450mE: 438451m

Sheet No: 1 of 1

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

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



Golder

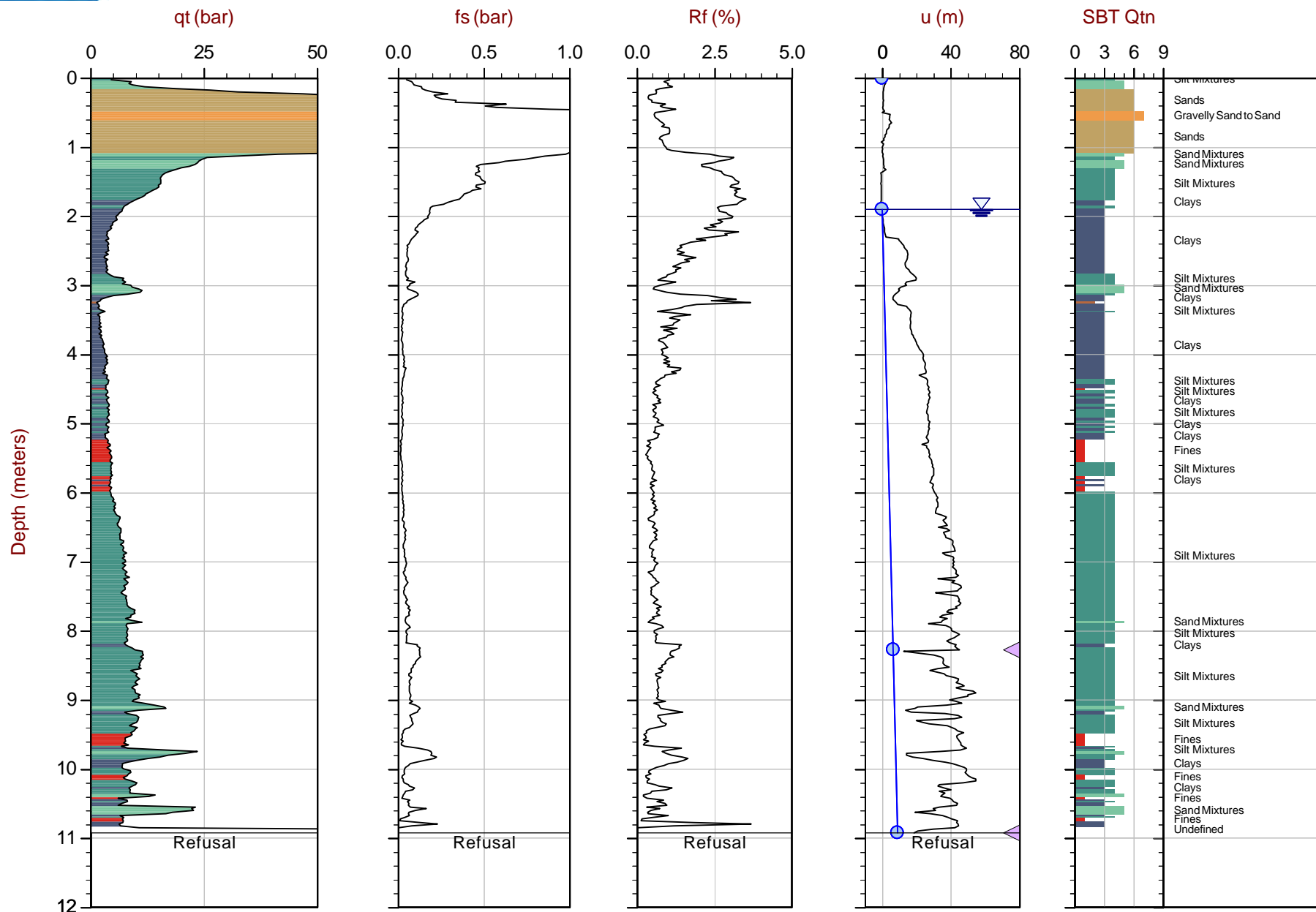
Job No: 18-05030

Date: 2018-05-15 10:18

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-08

Cone: 330:T1500F15U500



Max Depth: 10.925 m / 35.84 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP08.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N:5011428mE:438467m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



Golder

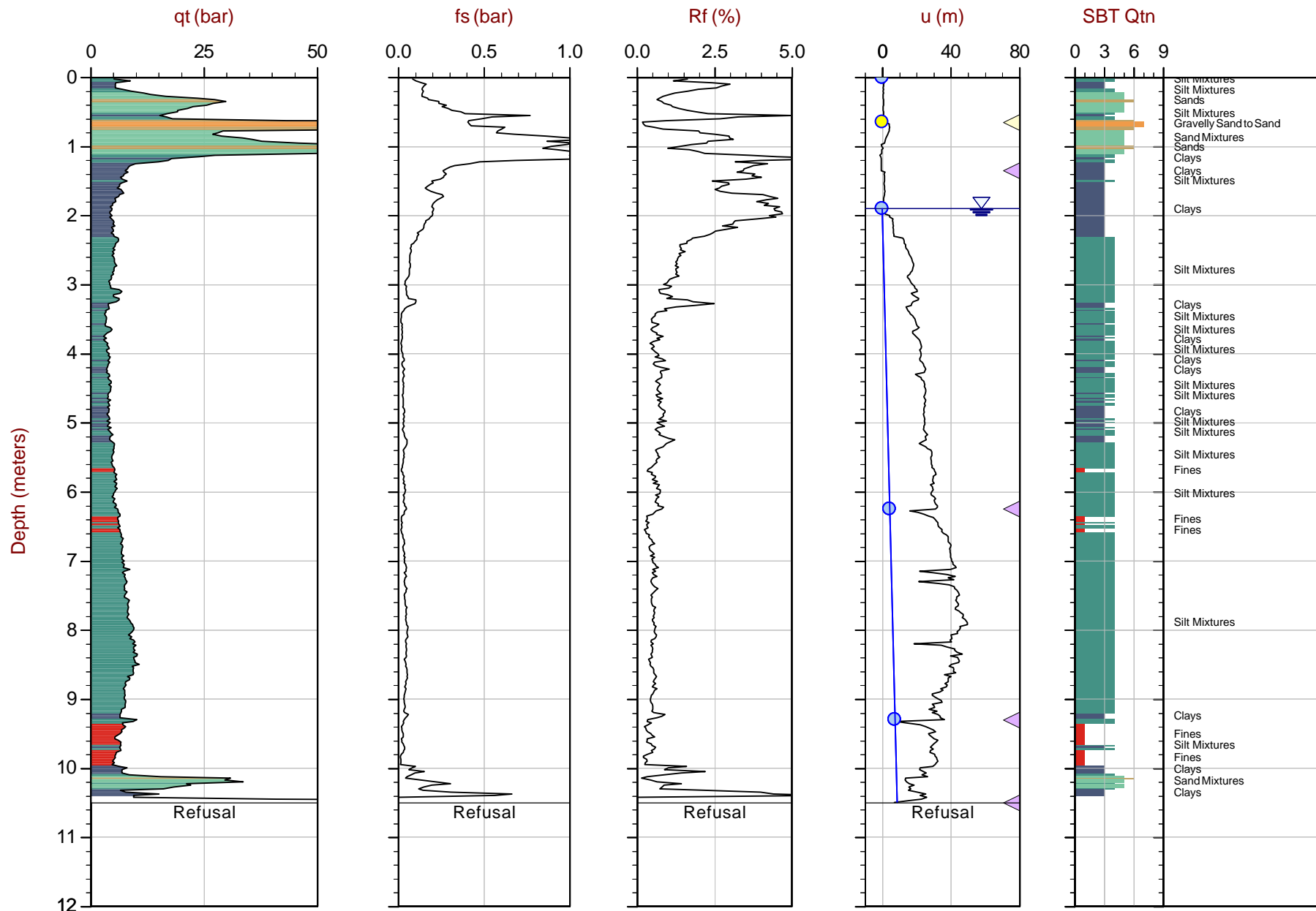
Job No: 18-05030

Date: 2018-05-15 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500



Max Depth: 10.500 m / 34.45 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP09.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N:5011401mE:438482m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

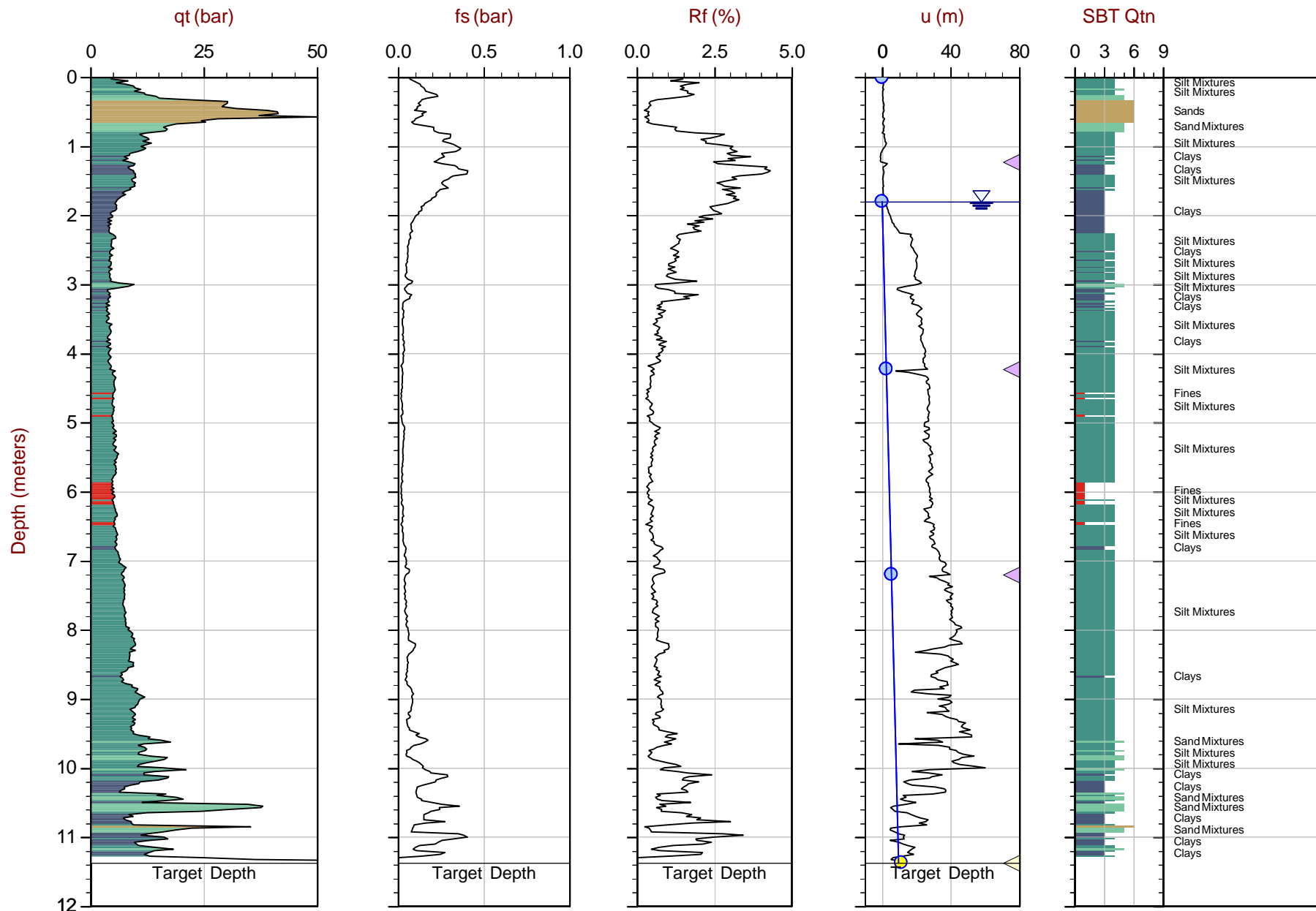
Job No: 18-05030

Date: 2018-05-15 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500



Max Depth: 11.375 m / 37.32 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP10.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N:5011318mE:438505m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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

## Advanced Cone Penetration Test Plots



Golder

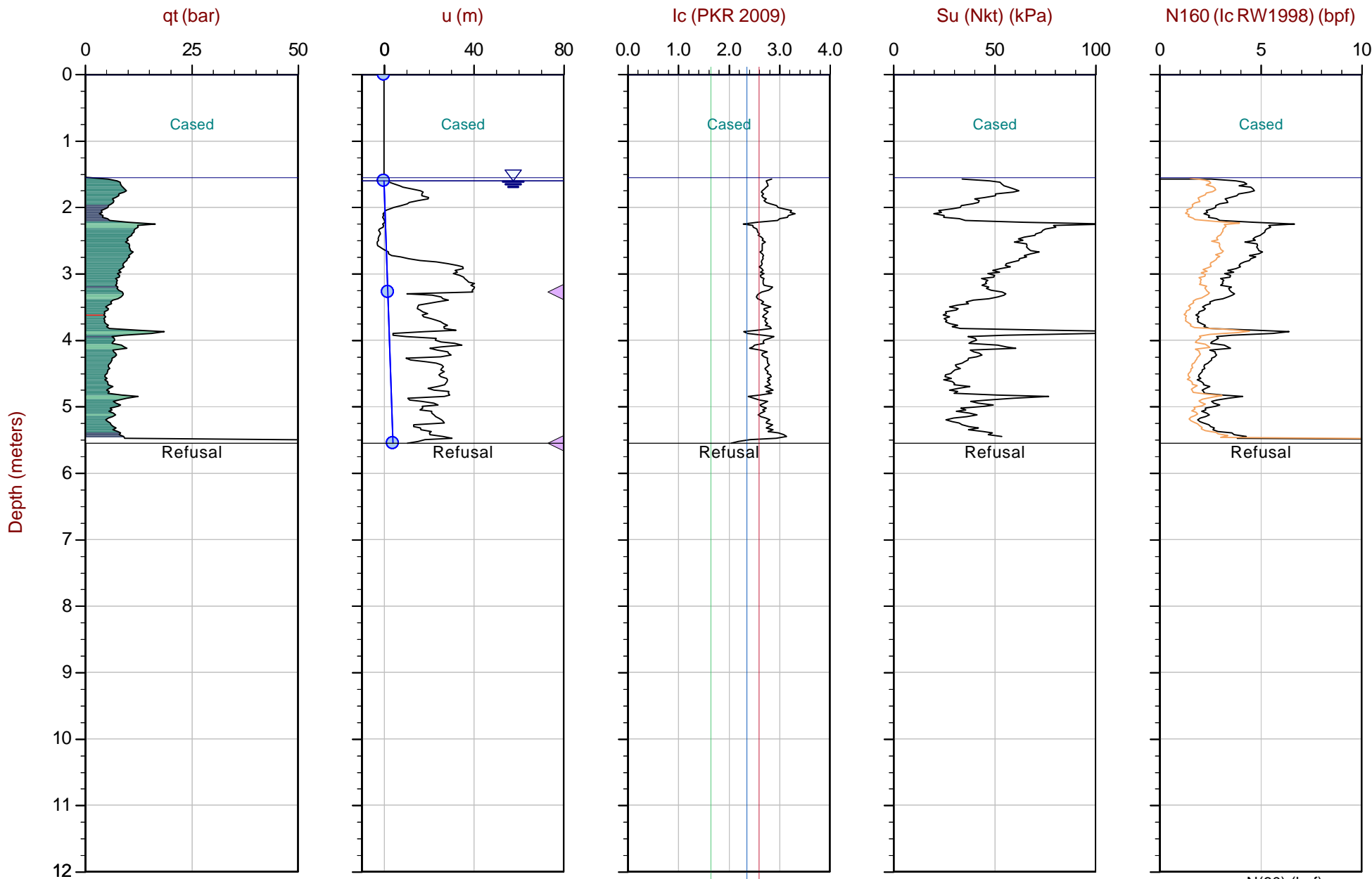
Job No: 18-05030

Date: 2018-05-16 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500



Max Depth: 5.550 m / 18.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP03.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011559m E: 438416m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

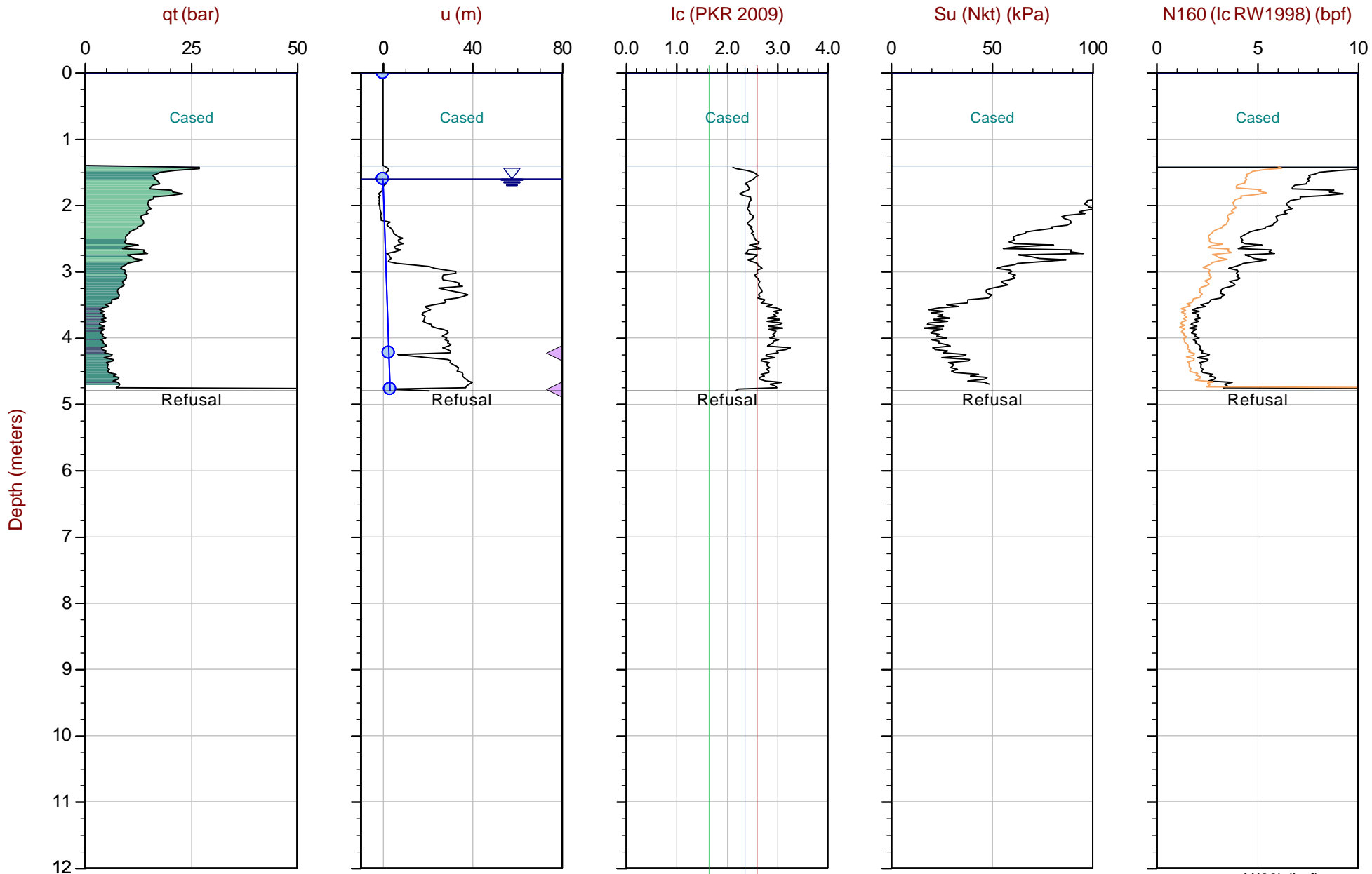
Job No: 18-05030

Date: 2018-05-16 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500



Max Depth: 4.800 m / 15.75 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP04.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM 18N N: 5011539m E: 438422m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

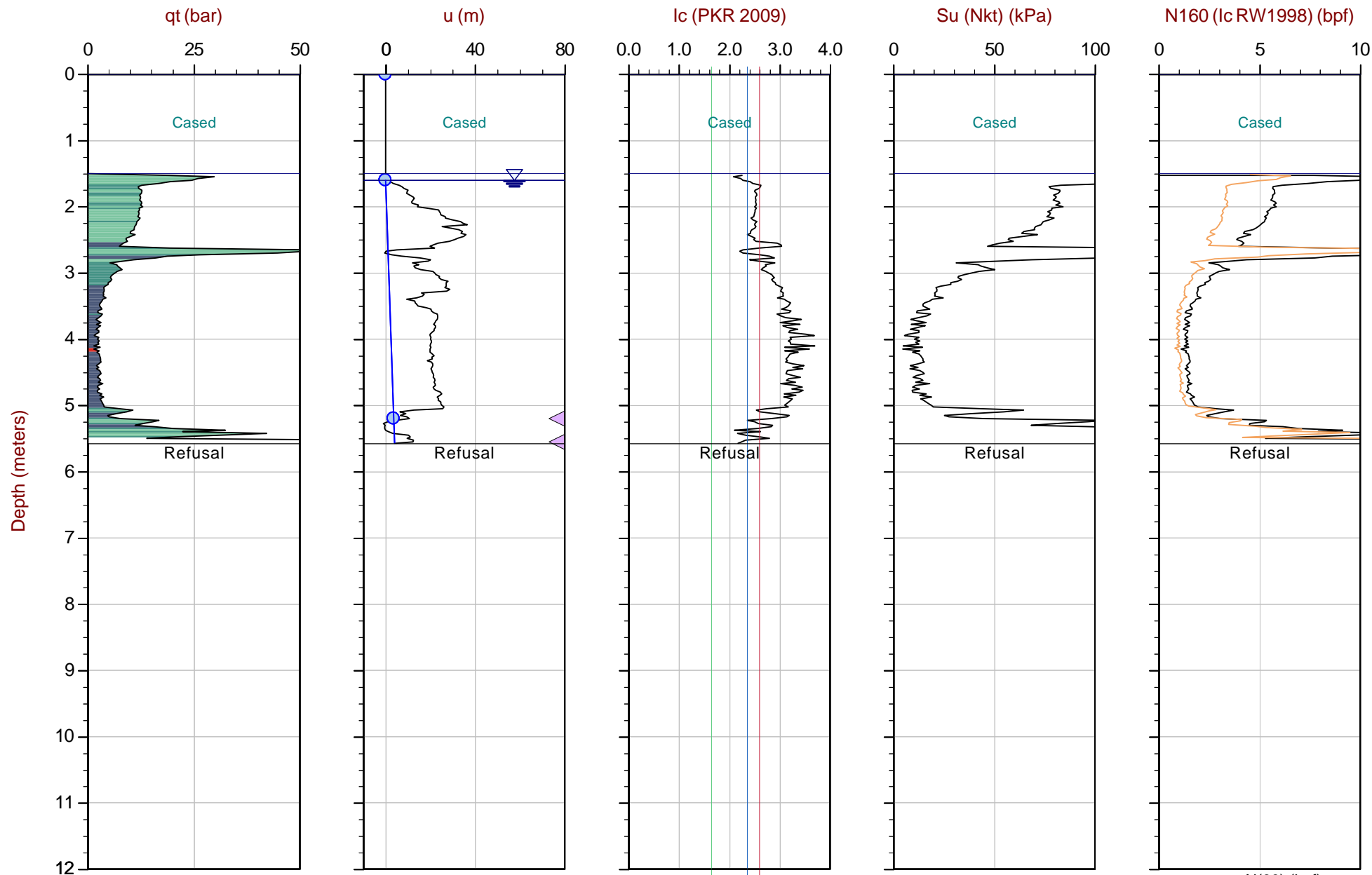
Job No: 18-05030

Date: 2018-05-16 08:22

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500



Max Depth: 5.575 m / 18.29 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP05.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011513m E: 438429m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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





Golder

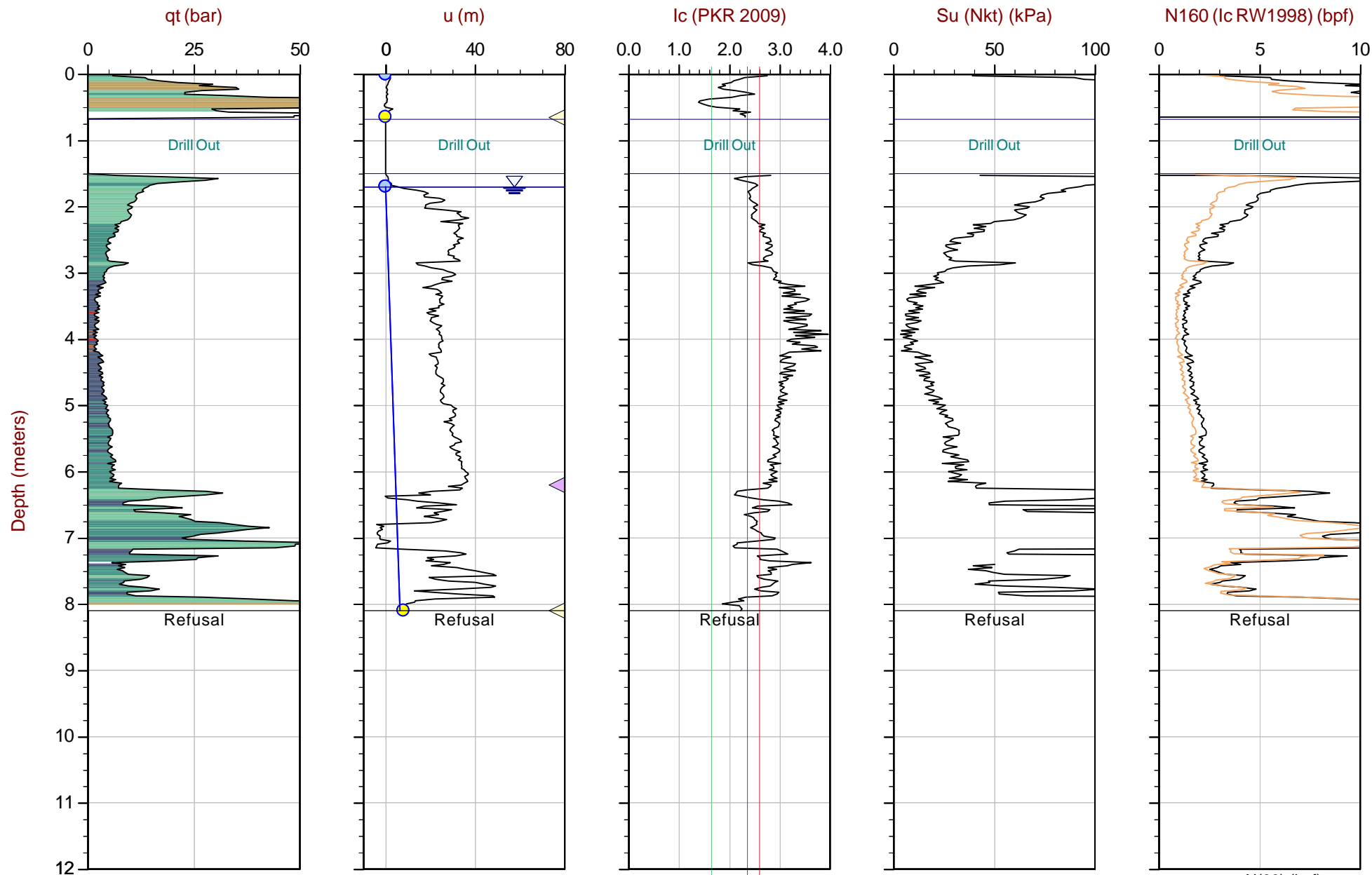
Job No: 18-05030

Date: 2018-05-15 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500



Max Depth: 8.100 m / 26.57 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP06.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011489m E: 438432m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

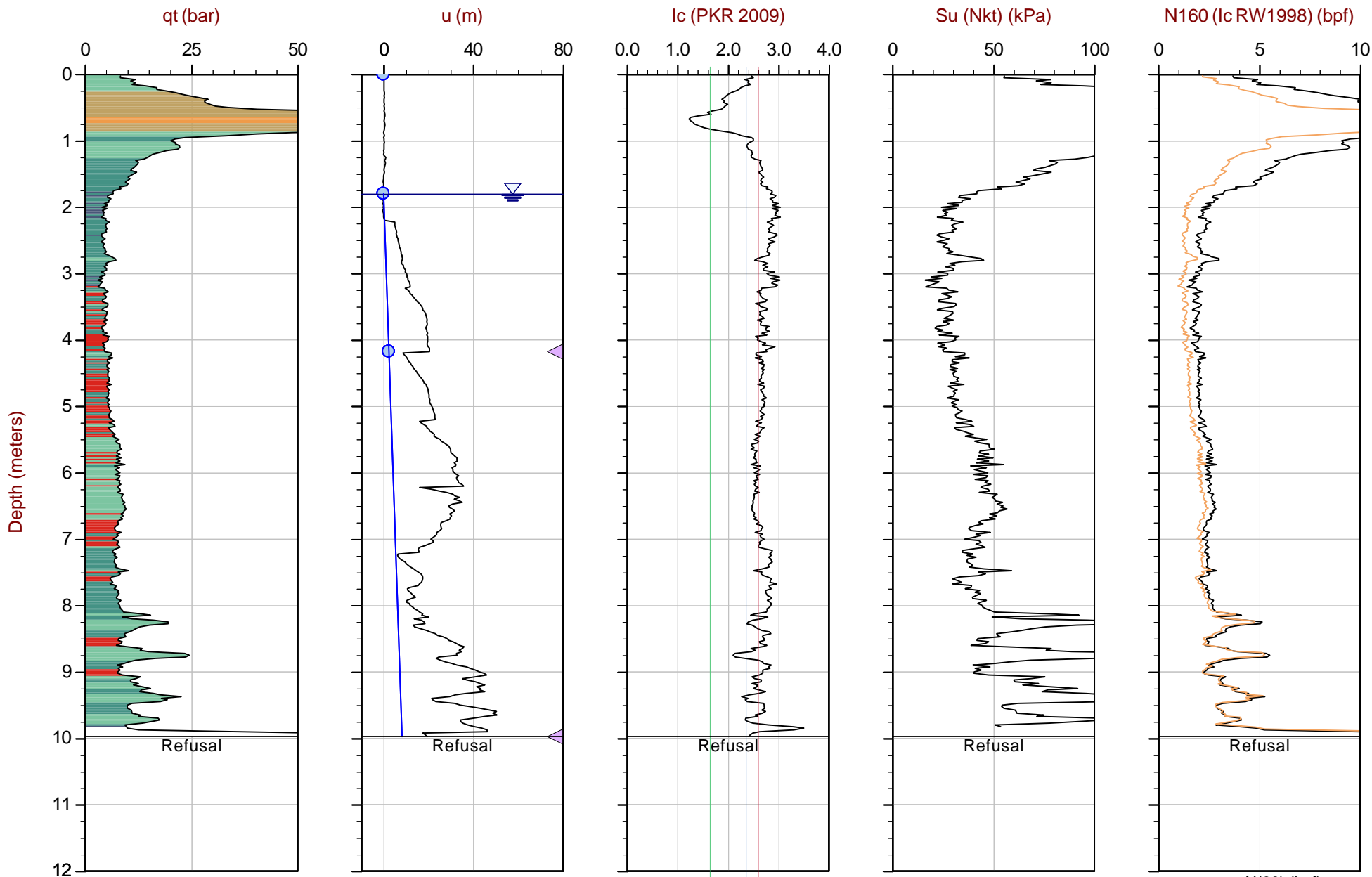
Job No: 18-05030

Date: 2018-05-14 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500



Max Depth: 9.975 m / 32.73 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP07.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011450m E: 438451m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

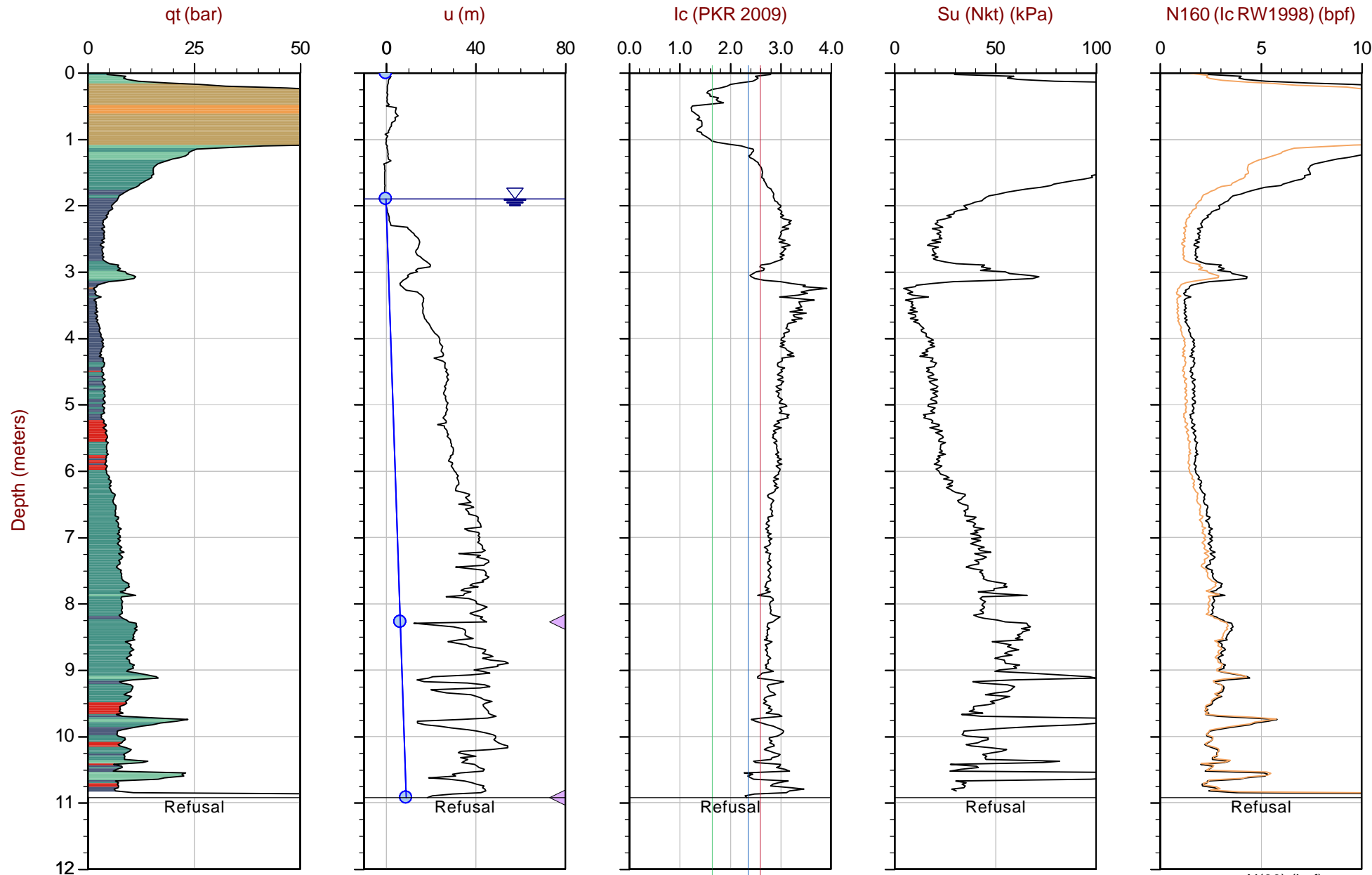
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Date: 2018-05-15 10:18

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-08

Cone: 330:T1500F15U500



Max Depth: 10.925 m / 35.84 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP08.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011428mE: 438467m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

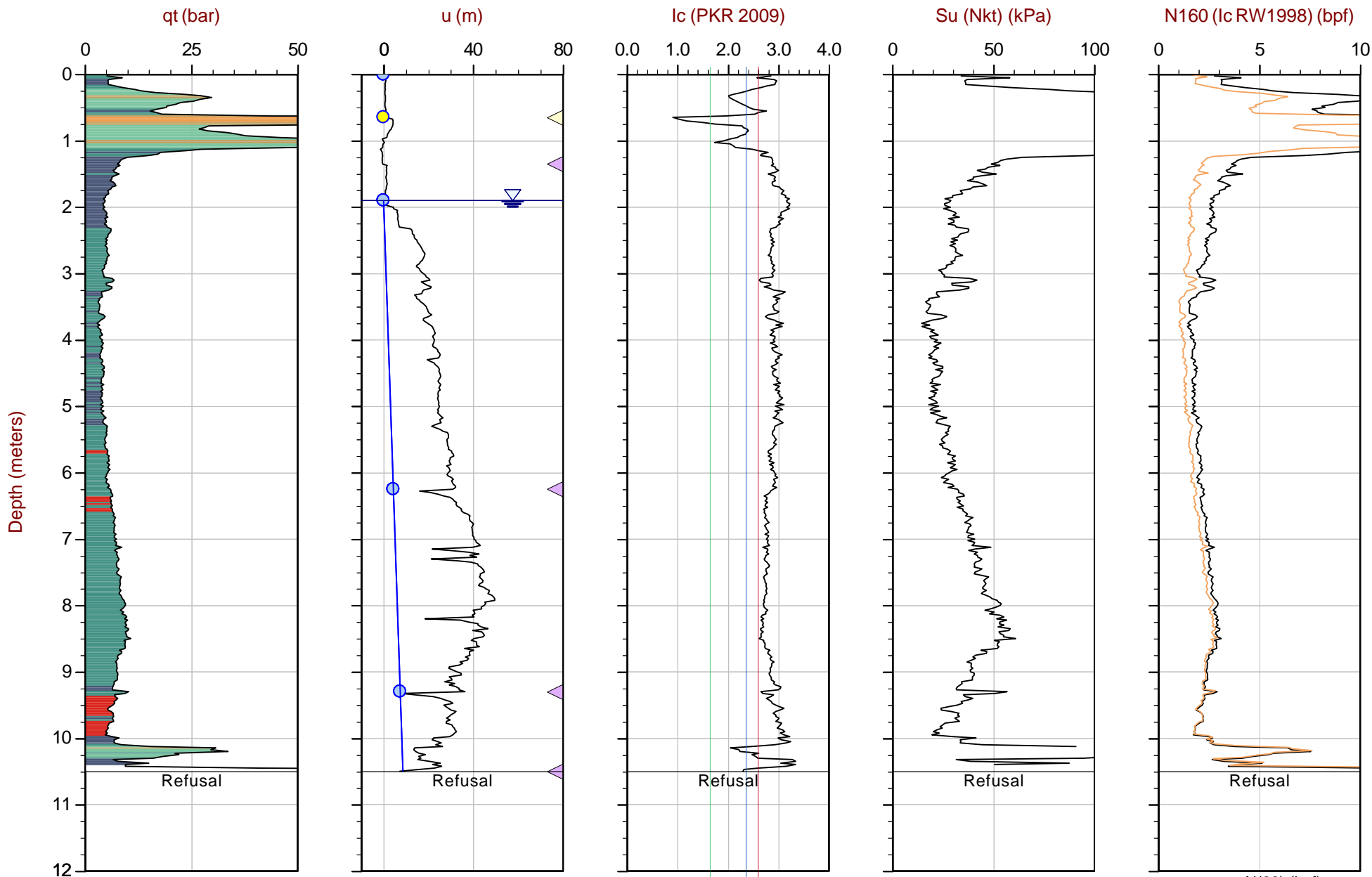
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Date: 2018-05-15 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500



Max Depth: 10.500 m / 34.45 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP09.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011401mE: 438482m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

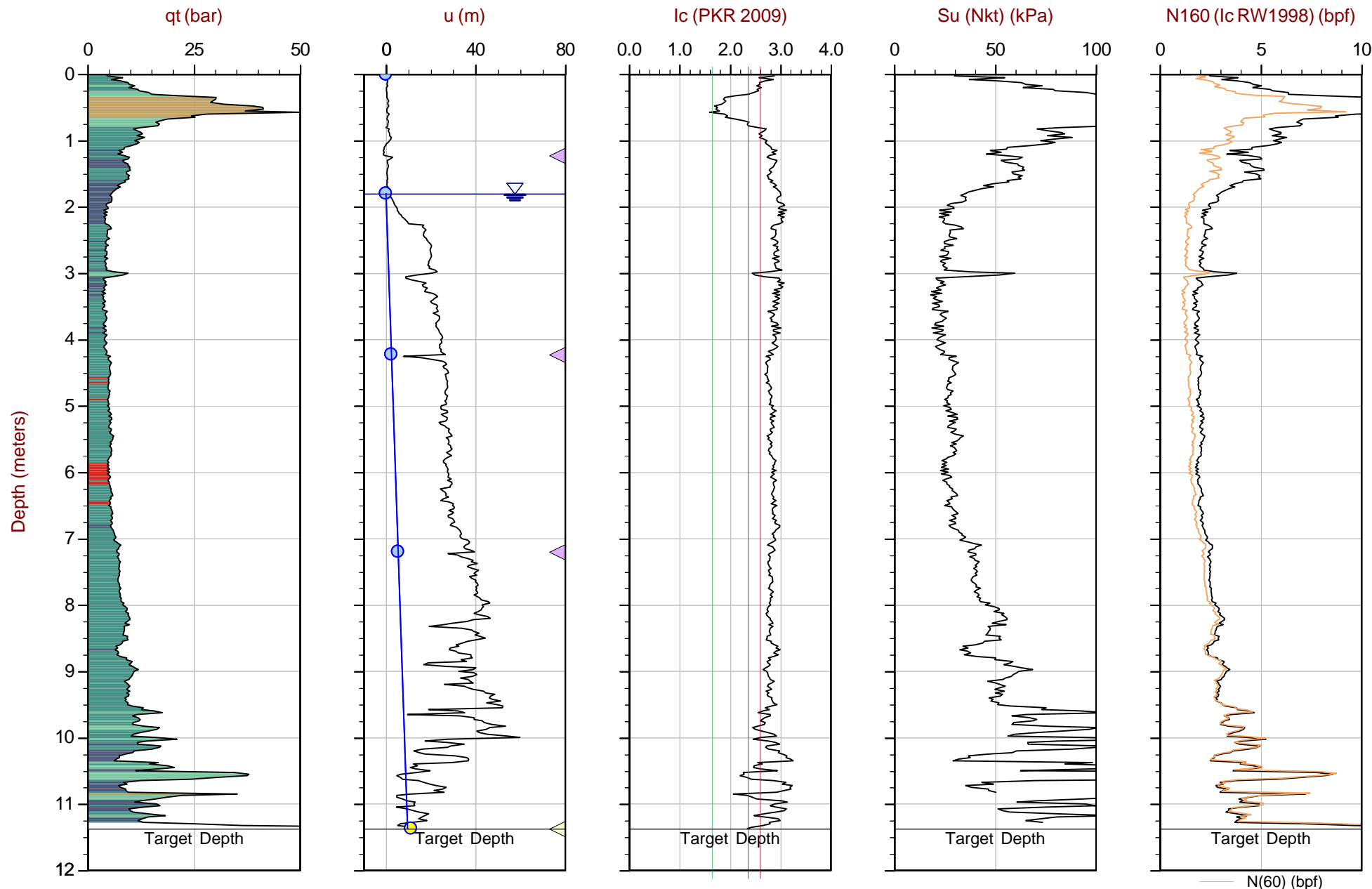
Job No: 18-05030

Date: 2018-05-15 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500



Max Depth: 11.375 m / 37.32 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 18-05030\_SP10.COR

Unit Wt: SBTQtn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011318mE: 438505m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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

## Soil Behaviour Type (SBT) Scatter Plots



*Golder*

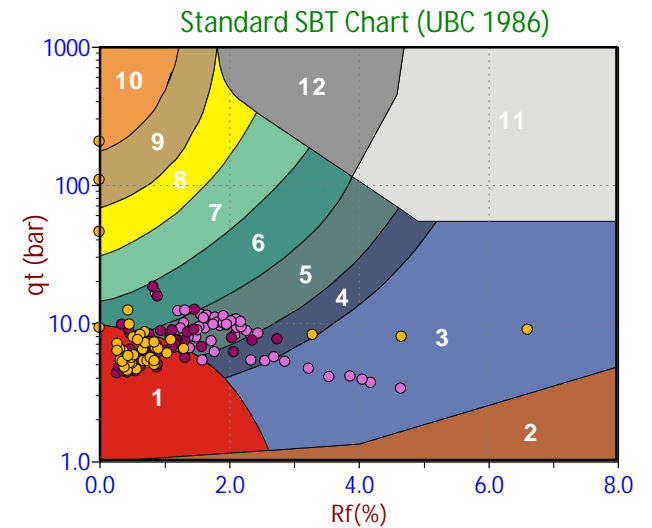
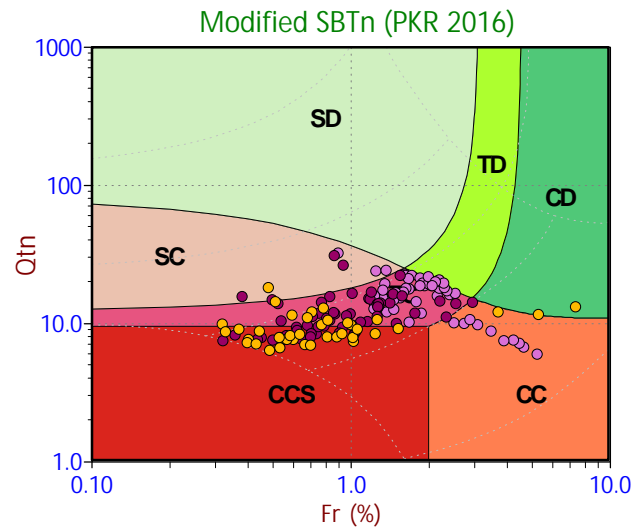
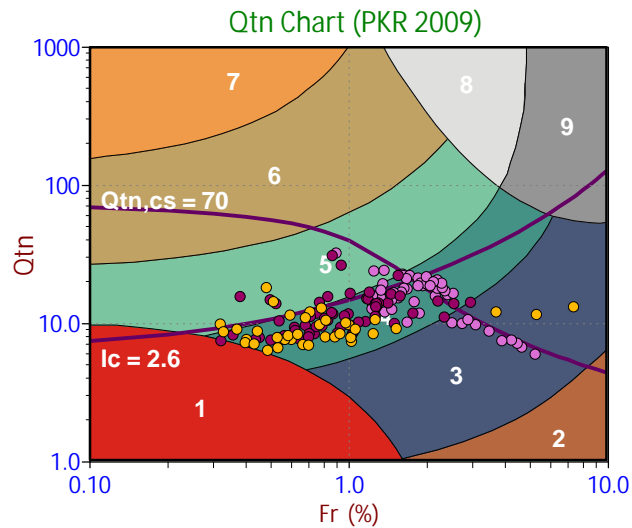
Job No: 18-05030

Date: 2018-05-16 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500



#### Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

#### Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

#### Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

#### Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

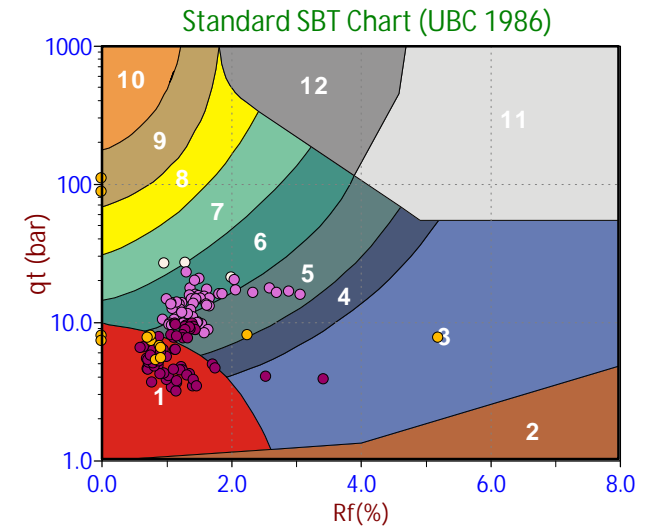
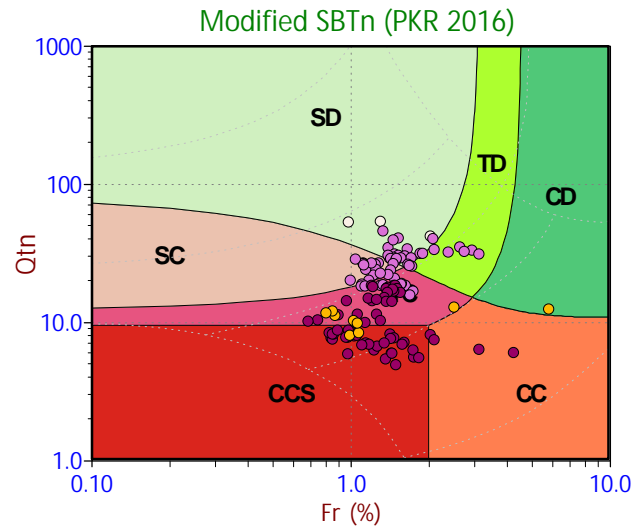
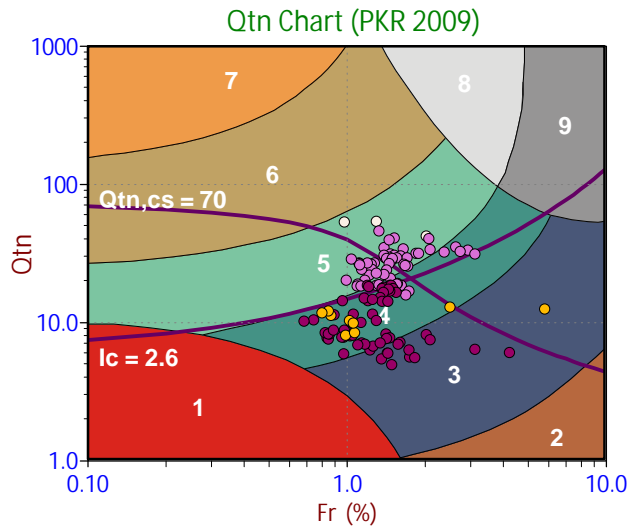
Job No: 18-05030

Date: 2018-05-16 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500



#### Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

#### Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

#### Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

#### Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand





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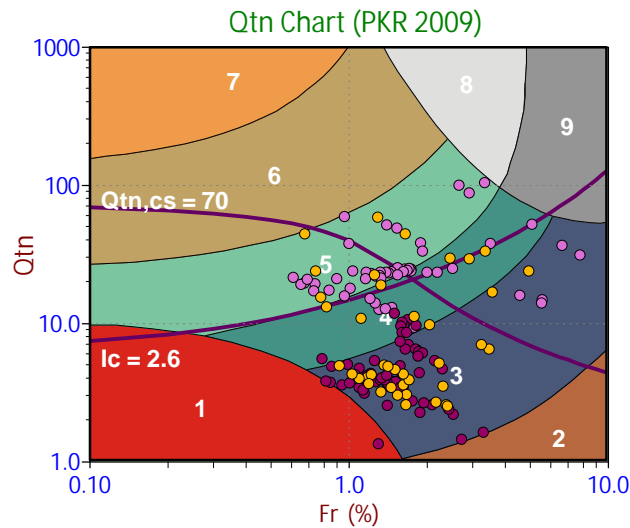
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Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500

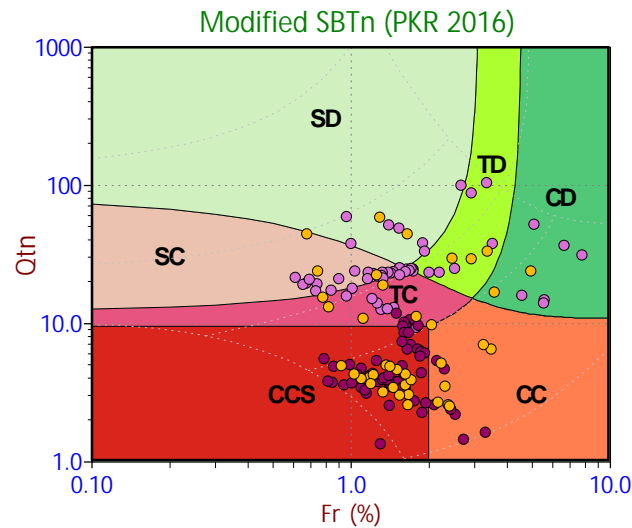


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

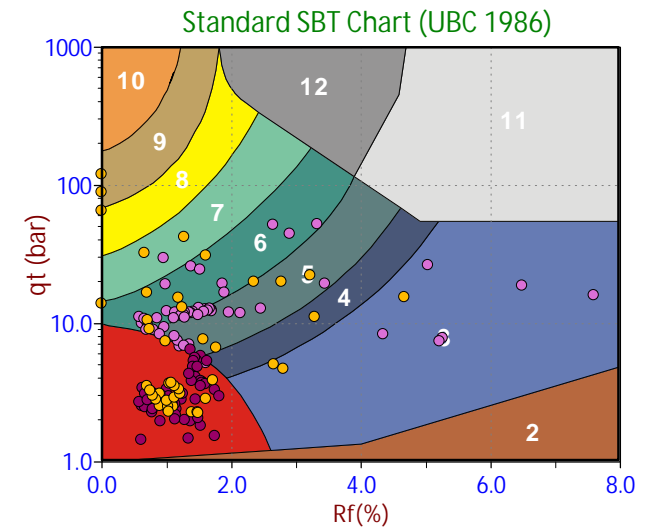
Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

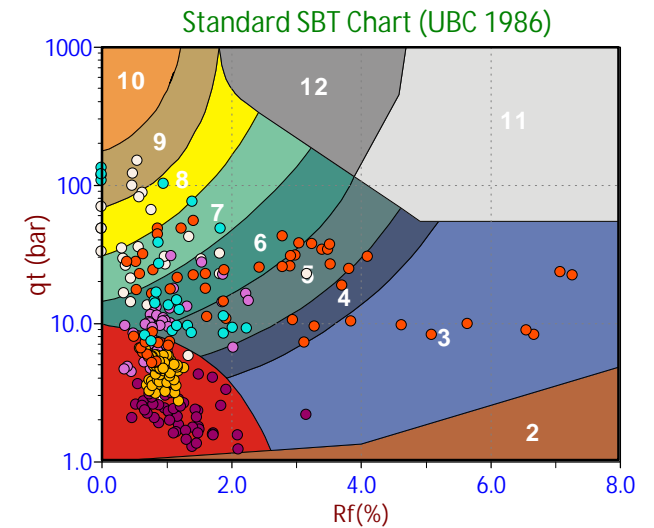
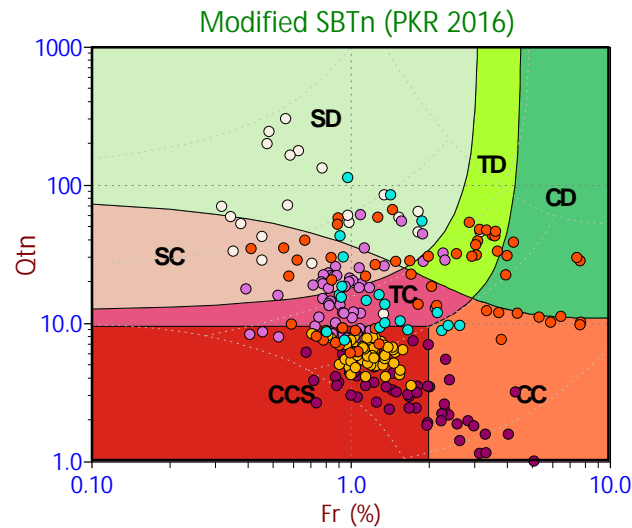
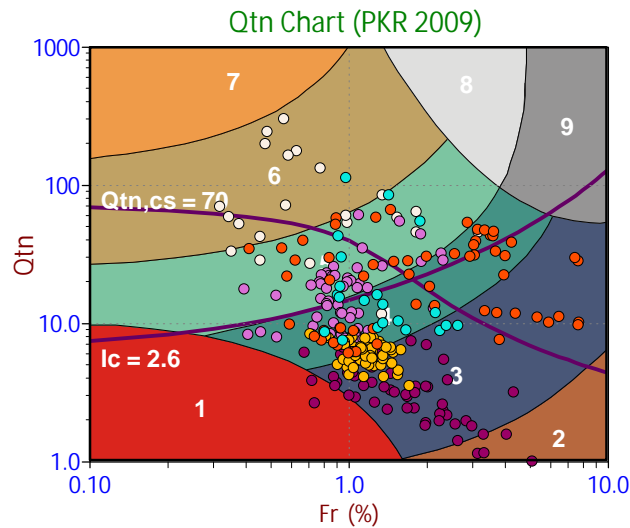
Job No: 18-05030

Date: 2018-05-15 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500



#### Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

#### Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

#### Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

#### Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

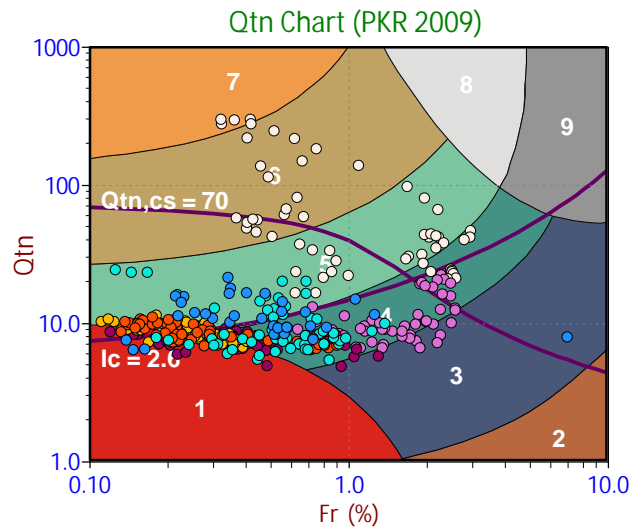
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Date: 2018-05-14 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500

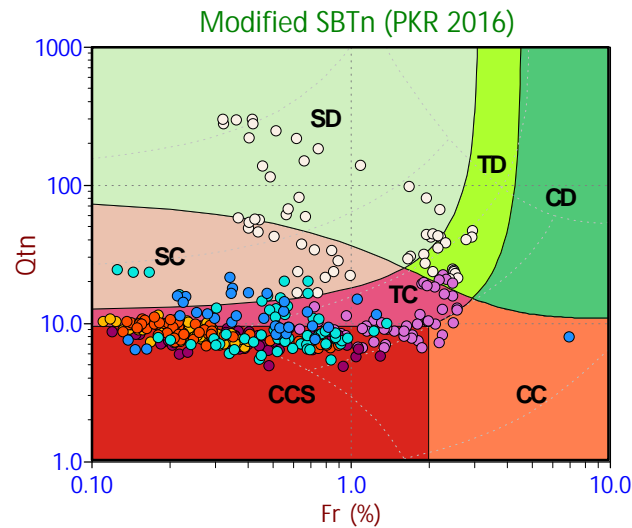


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

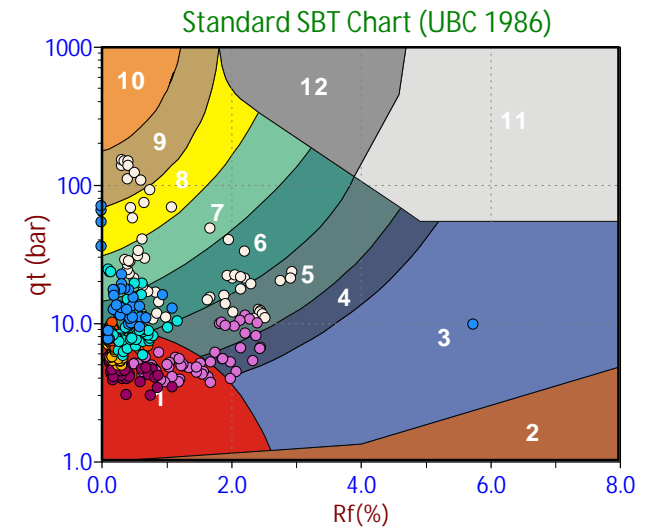
Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

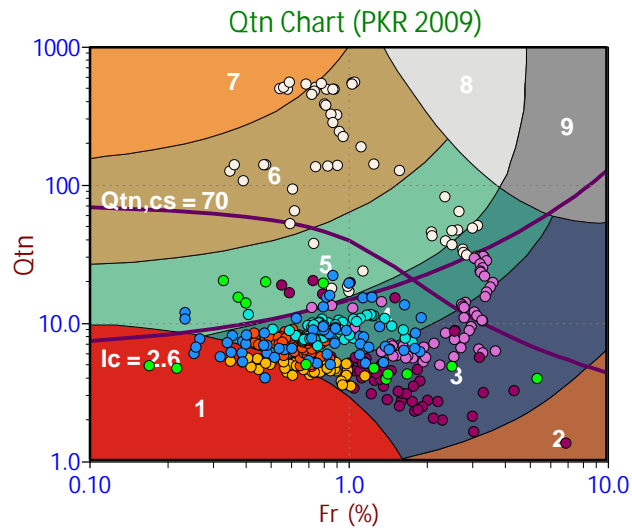
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Sounding: SCPT18-08

Cone: 330:T1500F15U500

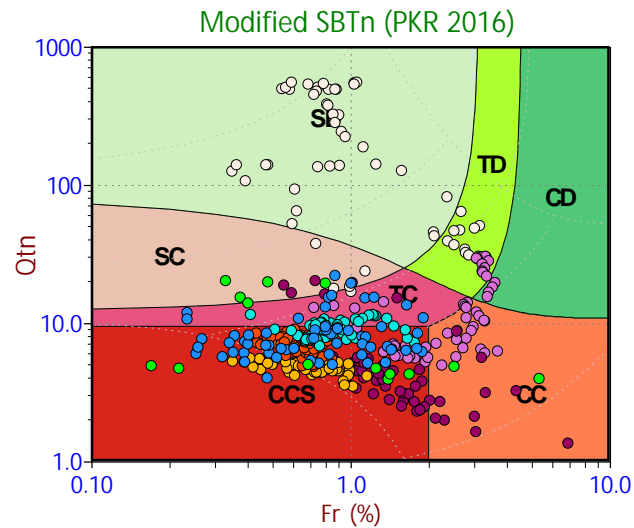


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

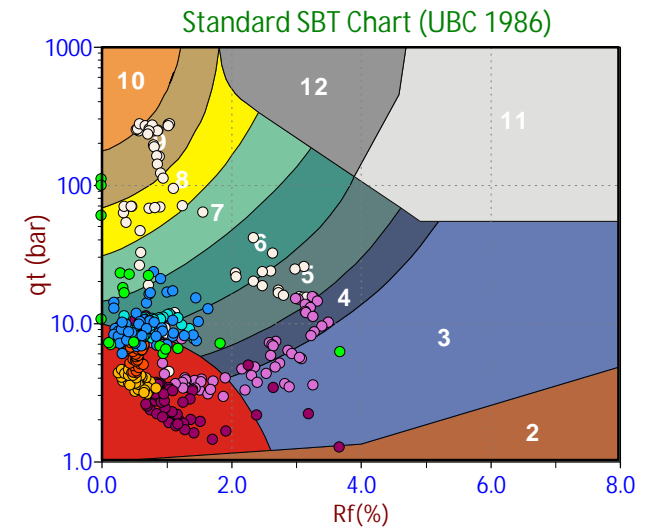
Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
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- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

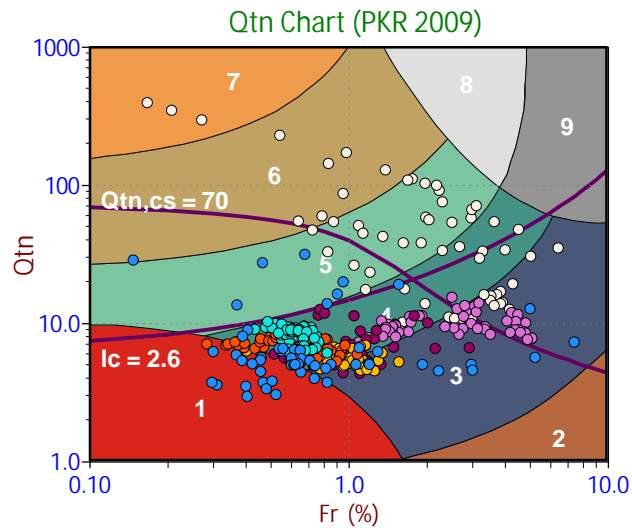
Job No: 18-05030

Date: 2018-05-15 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500

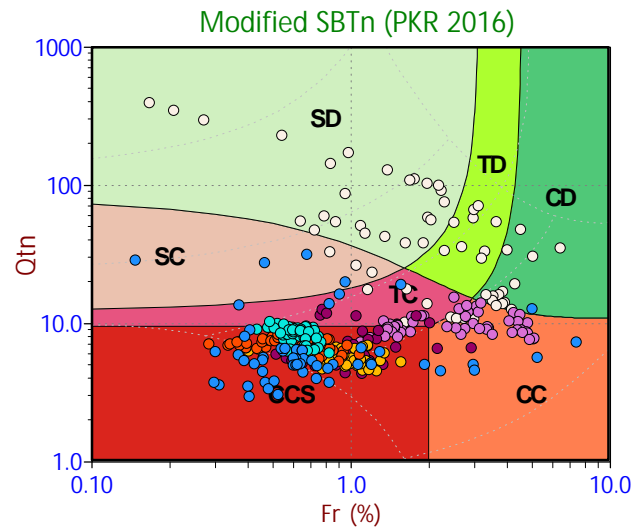


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

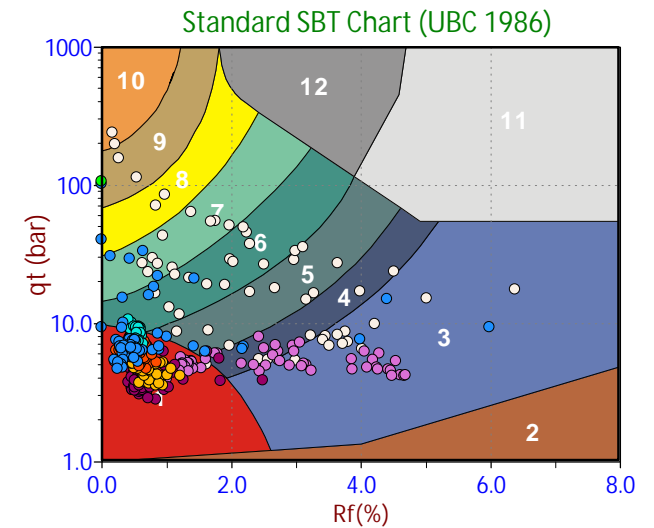
Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
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Legend

- CCS (Cont. sensitive clay like)
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- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
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- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand



*Golder*

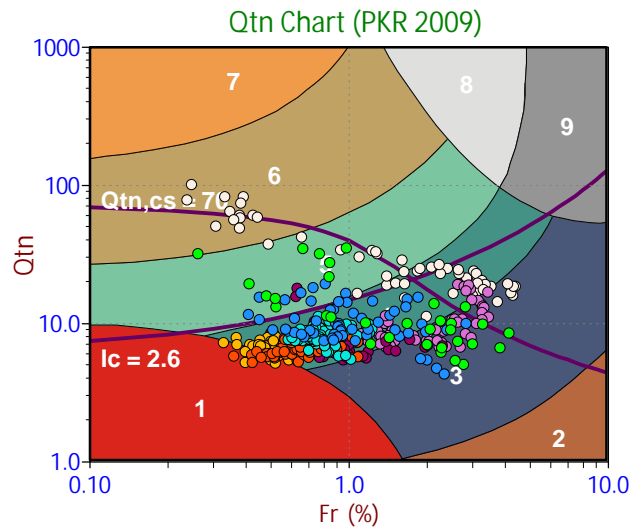
Job No: 18-05030

Date: 2018-05-15 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500

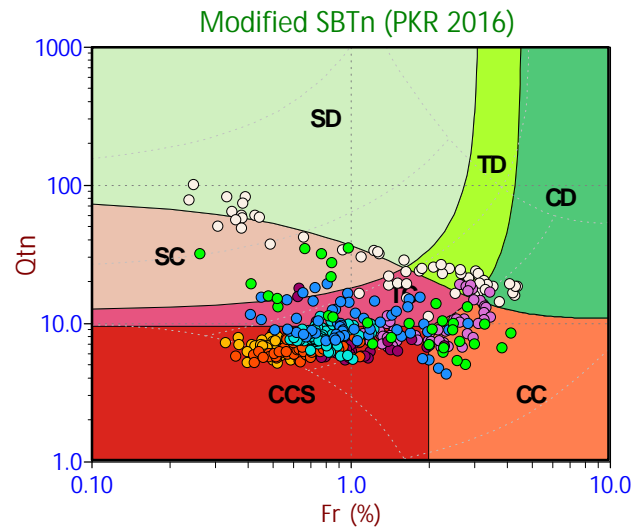


Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

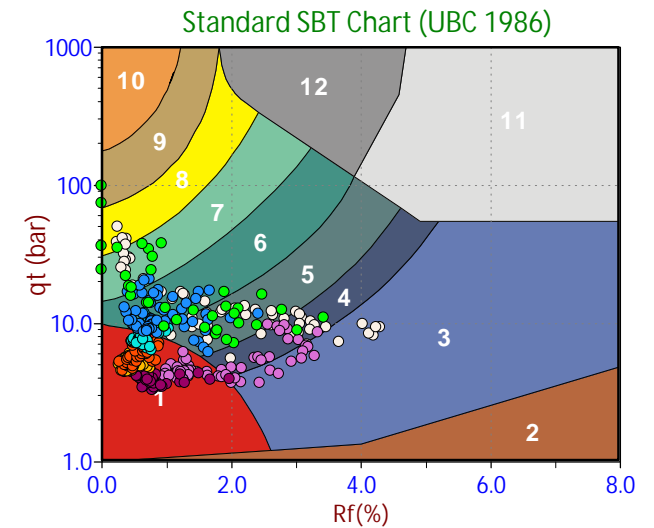
Legend

- Fines
- Fines
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained



Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

## Seismic Cone Penetration Test Tabular Results



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-03  
Date: 16-May-2018

Seismic Source: Beam  
Source Offset (m): 1.15  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>***

| Tip<br>Depth<br>(m) | Geophone<br>Depth<br>(m) | Ray<br>Path<br>(m) | Ray Path<br>Difference<br>(m) | Travel Time<br>Interval<br>(ms) | Interval<br>Velocity<br>(m/s) |
|---------------------|--------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------|
| 2.27                | 2.07                     | 2.37               |                               |                                 |                               |
| 3.28                | 3.08                     | 3.29               | 0.92                          | 5.65                            | 163                           |
| 4.25                | 4.05                     | 4.21               | 0.92                          | 8.08                            | 114                           |
| 5.25                | 5.05                     | 5.18               | 0.97                          | 8.22                            | 118                           |





Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-04  
Date: 16-May-2018

Seismic Source: Beam  
Source Offset (m): 1.20  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>***

| Tip<br>Depth<br>(m) | Geophone<br>Depth<br>(m) | Ray<br>Path<br>(m) | Ray Path<br>Difference<br>(m) | Travel Time<br>Interval<br>(ms) | Interval<br>Velocity<br>(m/s) |
|---------------------|--------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------|
| 2.23                | 2.03                     | 2.36               |                               |                                 |                               |
| 3.23                | 3.03                     | 3.26               | 0.90                          | 5.46                            | 165                           |
| 4.22                | 4.02                     | 4.20               | 0.94                          | 6.46                            | 145                           |
| 4.80                | 4.60                     | 4.75               | 0.56                          | 5.62                            | 99                            |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-05  
Date: 16-May-2018

Seismic Source: Beam  
Source Offset (m): 1.15  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>***

| Tip<br>Depth<br>(m) | Geophone<br>Depth<br>(m) | Ray<br>Path<br>(m) | Ray Path<br>Difference<br>(m) | Travel Time<br>Interval<br>(ms) | Interval<br>Velocity<br>(m/s) |
|---------------------|--------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------|
| 2.28                | 2.08                     | 2.35               |                               |                                 |                               |
| 3.27                | 3.07                     | 3.26               | 0.91                          | 5.82                            | 156                           |
| 4.28                | 4.08                     | 4.23               | 0.96                          | 9.52                            | 101                           |
| 5.20                | 5.00                     | 5.12               | 0.89                          | 11.14                           | 80                            |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-06  
Date: 15-May-2018

Seismic Source: Beam  
Source Offset (m): 1.15  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>***

| Tip<br>Depth<br>(m) | Geophone<br>Depth<br>(m) | Ray<br>Path<br>(m) | Ray Path<br>Difference<br>(m) | Travel Time<br>Interval<br>(ms) | Interval<br>Velocity<br>(m/s) |
|---------------------|--------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------|
| 2.20                | 2.00                     | 2.31               |                               |                                 |                               |
| 3.20                | 3.00                     | 3.21               | 0.91                          | 7.13                            | 127                           |
| 4.20                | 4.00                     | 4.16               | 0.95                          | 9.21                            | 103                           |
| 5.22                | 5.02                     | 5.15               | 0.99                          | 11.47                           | 86                            |
| 6.20                | 6.00                     | 6.11               | 0.96                          | 7.87                            | 122                           |
| 7.20                | 7.00                     | 7.09               | 0.98                          | 4.32                            | 228                           |
| 8.10                | 7.90                     | 7.98               | 0.89                          | 2.85                            | 312                           |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-07  
Date: 14-May-2018

Seismic Source: Beam  
Source Offset (m): 1.20  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### **SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - Vs**

| Tip Depth (m) | Geophone Depth (m) | Ray Path (m) | Ray Path Difference (m) | Travel Time Interval (ms) | Interval Velocity (m/s) |
|---------------|--------------------|--------------|-------------------------|---------------------------|-------------------------|
| 1.23          | 1.03               | 1.58         |                         |                           |                         |
| 2.20          | 2.00               | 2.33         | 0.75                    | 6.61                      | 114                     |
| 3.20          | 3.00               | 3.23         | 0.90                    | 7.03                      | 128                     |
| 4.17          | 3.97               | 4.15         | 0.92                    | 10.39                     | 88                      |
| 5.20          | 5.00               | 5.14         | 0.99                    | 12.56                     | 79                      |
| 6.20          | 6.00               | 6.12         | 0.98                    | 10.91                     | 90                      |
| 7.20          | 7.00               | 7.10         | 0.98                    | 7.23                      | 136                     |
| 8.18          | 7.98               | 8.07         | 0.97                    | 5.79                      | 167                     |
| 9.20          | 9.00               | 9.08         | 1.01                    | 4.67                      | 216                     |
| 9.97          | 9.77               | 9.84         | 0.76                    | 1.93                      | 397                     |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-08  
Date: 15-May-2018

Seismic Source: Beam  
Source Offset (m): 1.10  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - Vs***

| Tip Depth (m) | Geophone Depth (m) | Ray Path (m) | Ray Path Difference (m) | Travel Time Interval (ms) | Interval Velocity (m/s) |
|---------------|--------------------|--------------|-------------------------|---------------------------|-------------------------|
| 1.30          | 1.10               | 1.56         |                         |                           |                         |
| 2.30          | 2.10               | 2.37         | 0.82                    | 7.44                      | 110                     |
| 3.30          | 3.10               | 3.29         | 0.92                    | 7.80                      | 118                     |
| 4.28          | 4.08               | 4.23         | 0.94                    | 9.64                      | 97                      |
| 5.28          | 5.08               | 5.20         | 0.97                    | 10.80                     | 90                      |
| 6.28          | 6.08               | 6.18         | 0.98                    | 10.79                     | 91                      |
| 7.28          | 7.08               | 7.16         | 0.99                    | 9.43                      | 105                     |
| 8.28          | 8.08               | 8.15         | 0.99                    | 6.56                      | 151                     |
| 9.28          | 9.08               | 9.15         | 0.99                    | 5.75                      | 173                     |
| 10.30         | 10.10              | 10.16        | 1.01                    | 4.55                      | 223                     |
| 10.93         | 10.73              | 10.79        | 0.63                    | 2.07                      | 302                     |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-09  
Date: 15-May-2018

Seismic Source: Beam  
Source Offset (m): 1.20  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### ***SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - Vs***

| Tip<br>Depth<br>(m) | Geophone<br>Depth<br>(m) | Ray<br>Path<br>(m) | Ray Path<br>Difference<br>(m) | Travel Time<br>Interval<br>(ms) | Interval<br>Velocity<br>(m/s) |
|---------------------|--------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------|
| 1.35                | 1.15                     | 1.66               |                               |                                 |                               |
| 2.30                | 2.10                     | 2.42               | 0.76                          | 5.94                            | 127                           |
| 3.30                | 3.10                     | 3.32               | 0.91                          | 8.90                            | 102                           |
| 4.30                | 4.10                     | 4.27               | 0.95                          | 7.70                            | 123                           |
| 5.30                | 5.10                     | 5.24               | 0.97                          | 9.13                            | 106                           |
| 6.30                | 6.10                     | 6.22               | 0.98                          | 9.22                            | 106                           |
| 7.30                | 7.10                     | 7.20               | 0.98                          | 8.85                            | 111                           |
| 8.28                | 8.08                     | 8.17               | 0.97                          | 7.12                            | 136                           |
| 9.30                | 9.10                     | 9.18               | 1.01                          | 6.72                            | 150                           |
| 10.32               | 10.12                    | 10.19              | 1.01                          | 5.84                            | 173                           |



Job No: 18-05030  
Client: Golder Associates  
Project: Hwy 416 and McKenna Casey Dr  
Sounding ID: SCPT18-10  
Date: 15-May-2018

Seismic Source: Beam  
Source Offset (m): 1.10  
Source Depth (m): 0.00  
Geophone Offset (m): 0.20

### **SCPT<sub>u</sub> SHEAR WAVE VELOCITY TEST RESULTS - V<sub>s</sub>**

| Tip Depth (m) | Geophone Depth (m) | Ray Path (m) | Ray Path Difference (m) | Travel Time Interval (ms) | Interval Velocity (m/s) |
|---------------|--------------------|--------------|-------------------------|---------------------------|-------------------------|
| 1.23          | 1.03               | 1.51         |                         |                           |                         |
| 2.23          | 2.03               | 2.31         | 0.80                    | 5.75                      | 139                     |
| 3.23          | 3.03               | 3.22         | 0.91                    | 7.04                      | 130                     |
| 4.23          | 4.03               | 4.18         | 0.95                    | 8.21                      | 116                     |
| 5.23          | 5.03               | 5.15         | 0.97                    | 8.31                      | 117                     |
| 6.22          | 6.02               | 6.12         | 0.97                    | 10.78                     | 90                      |
| 7.20          | 7.00               | 7.09         | 0.97                    | 9.50                      | 102                     |
| 8.25          | 8.05               | 8.12         | 1.04                    | 6.40                      | 162                     |
| 9.18          | 8.98               | 9.05         | 0.92                    | 5.26                      | 175                     |
| 10.22         | 10.02              | 10.08        | 1.03                    | 4.77                      | 216                     |
| 11.20         | 11.00              | 11.05        | 0.97                    | 3.11                      | 314                     |

## Seismic Cone Penetration Test Plots





Golder

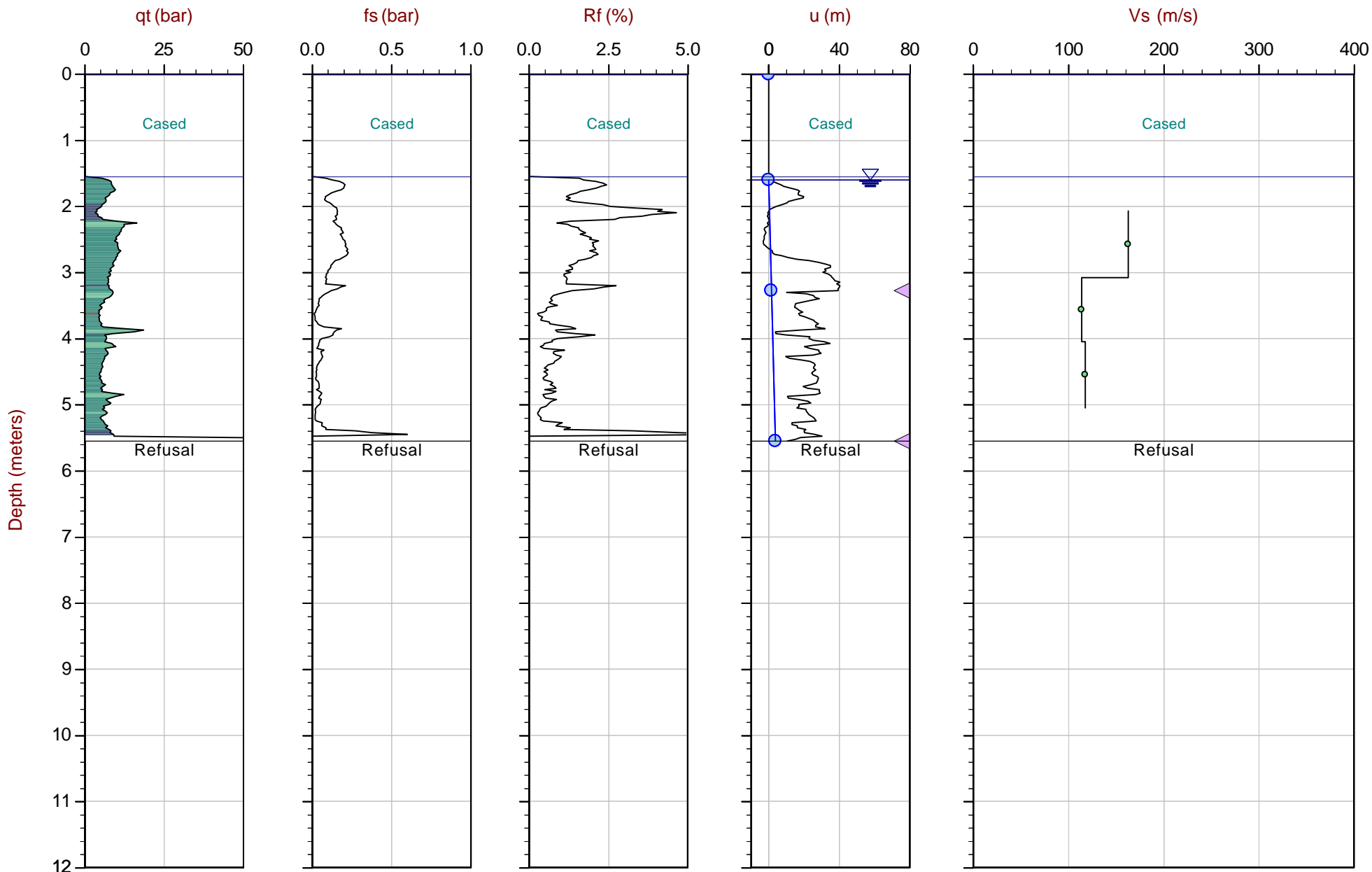
Job No: 18-05030

Date: 2018-05-16 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500



Max Depth: 5.550 m / 18.21 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP03.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011559mE: 438416m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

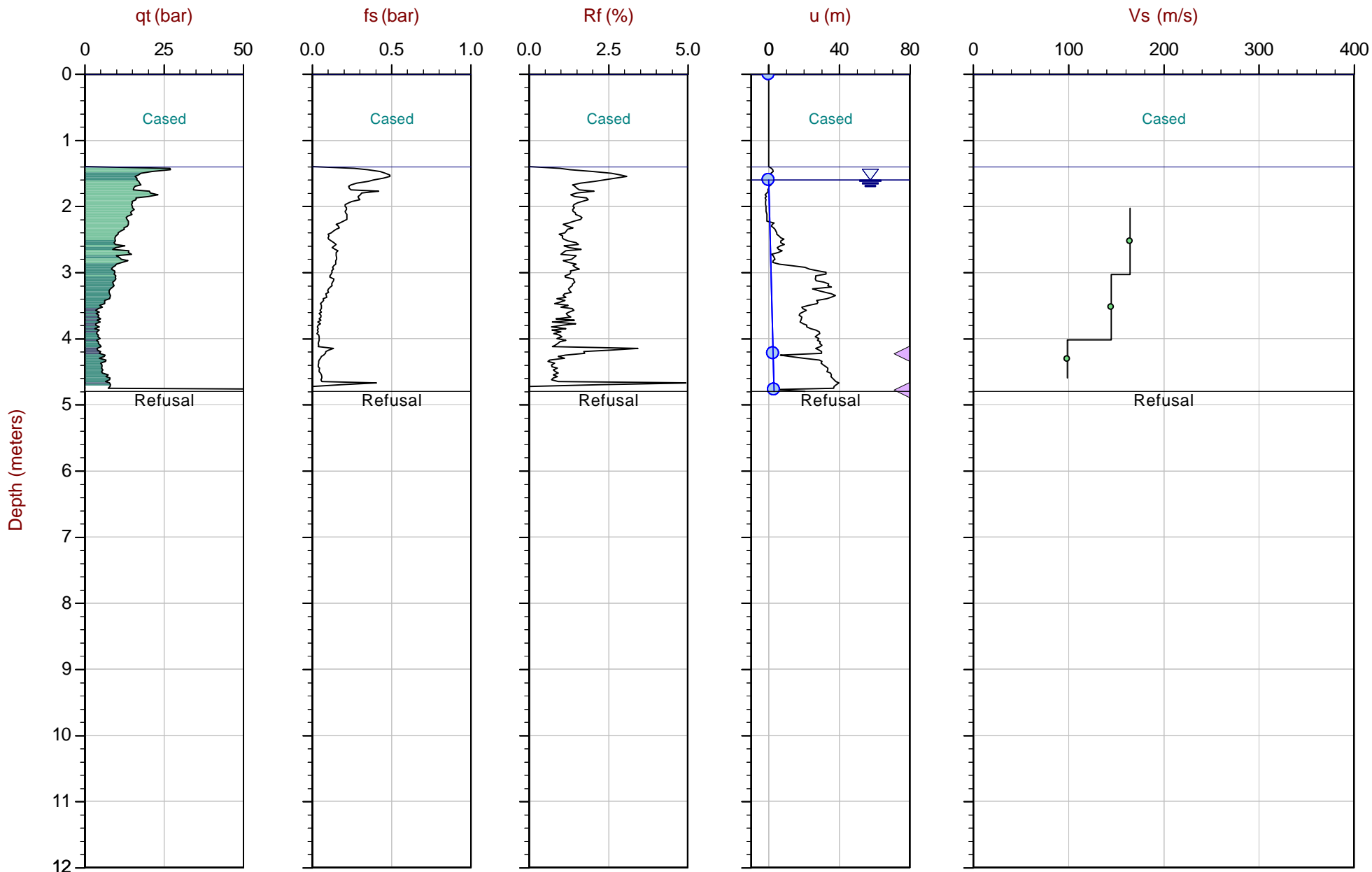
Job No: 18-05030

Date: 2018-05-16 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500



Max Depth: 4.800 m / 15.75 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP04.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011539m E: 438422m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



Golder

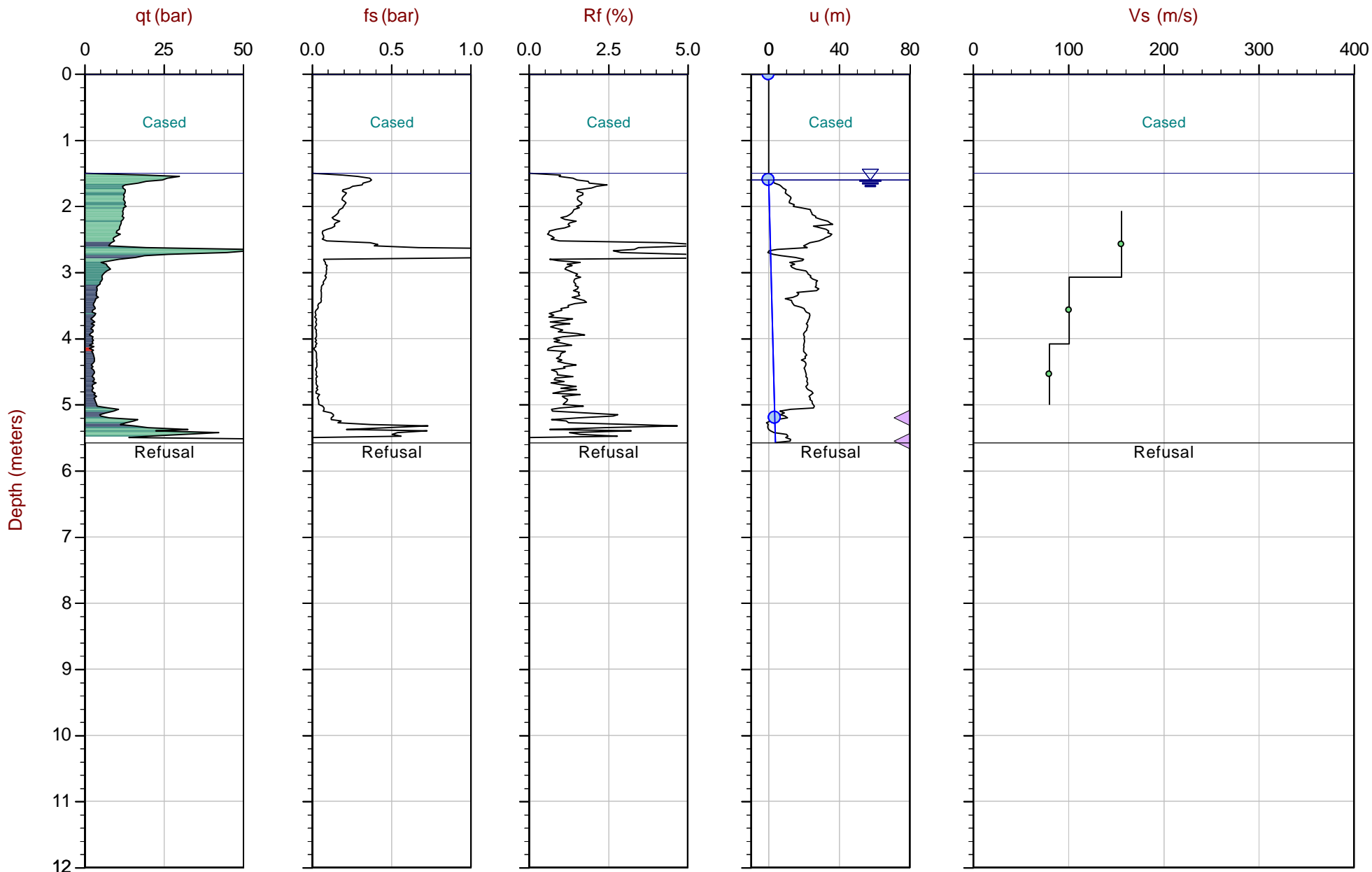
Job No: 18-05030

Date: 2018-05-16 08:22

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500



Max Depth: 5.575 m / 18.29 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP05.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011513mE: 438429m

Sheet No: 1 of 1

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

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



Golder

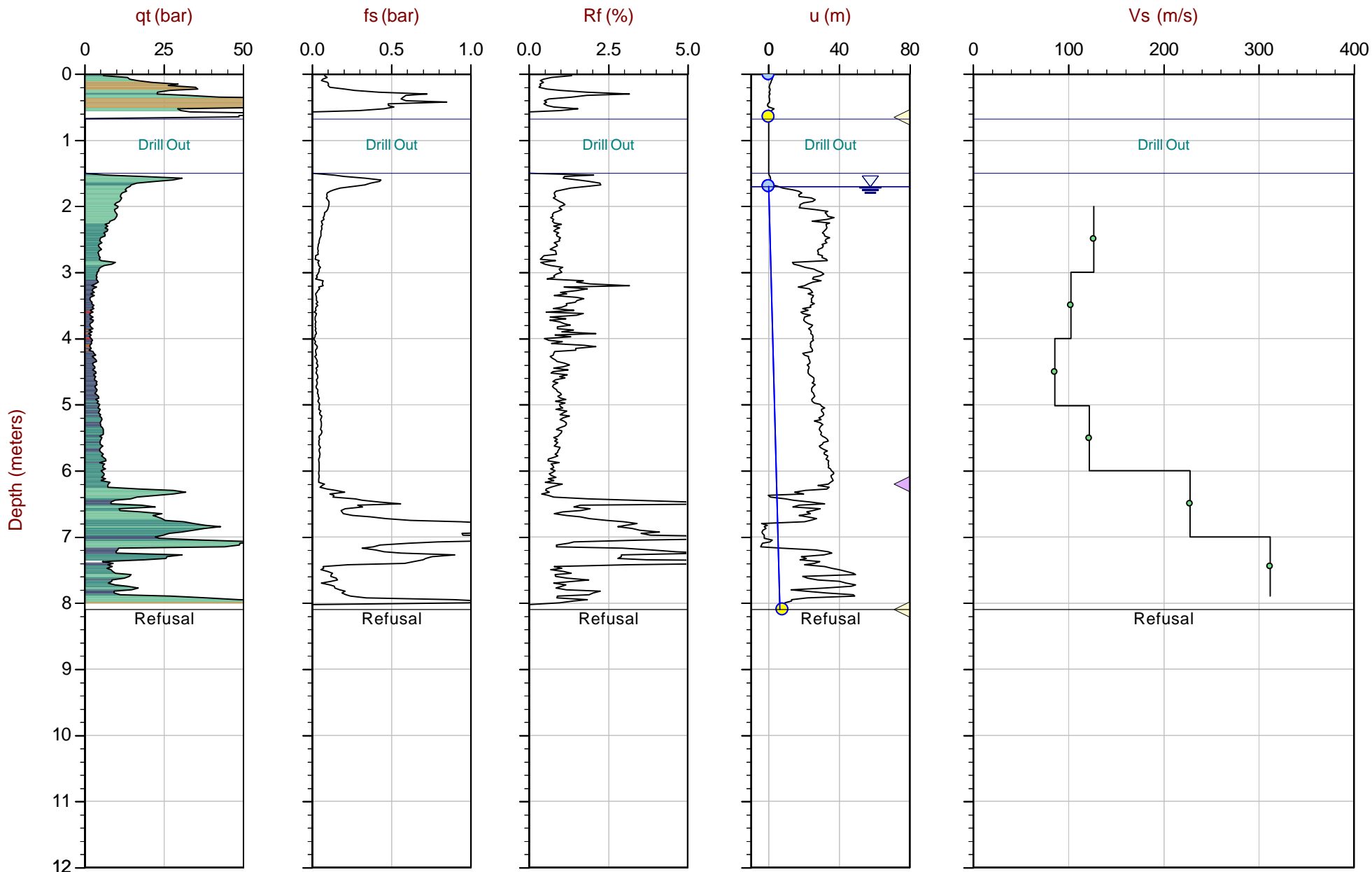
Job No: 18-05030

Date: 2018-05-15 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500



Max Depth: 8.100 m / 26.57 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP06.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N N: 5011489m E: 438432m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



Golder

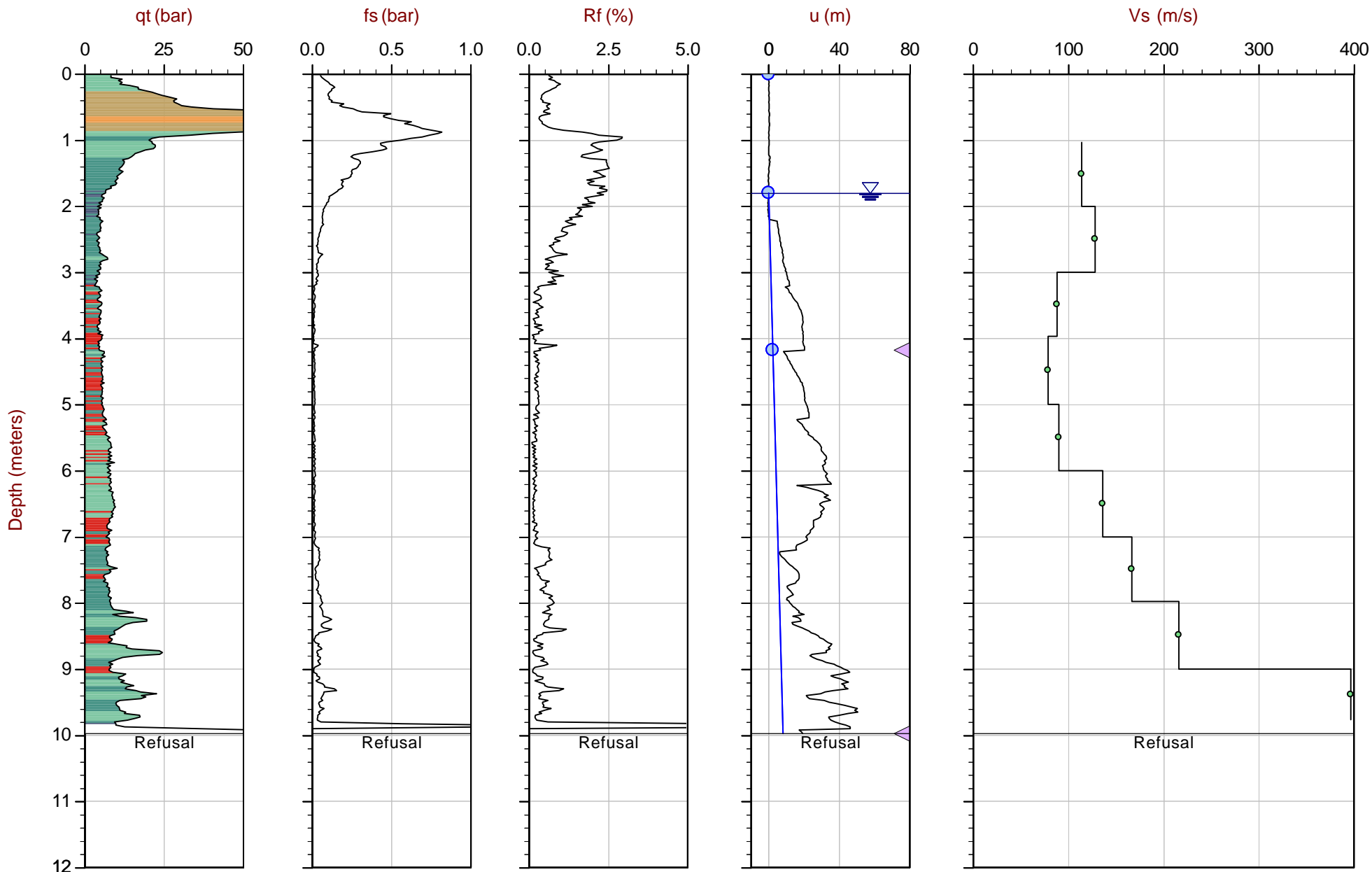
Job No: 18-05030

Date: 2018-05-14 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500



Max Depth: 9.975 m / 32.73 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: EveryPoint

File: 18-05030\_SP07.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011450mE: 438451m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

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



*Golder*

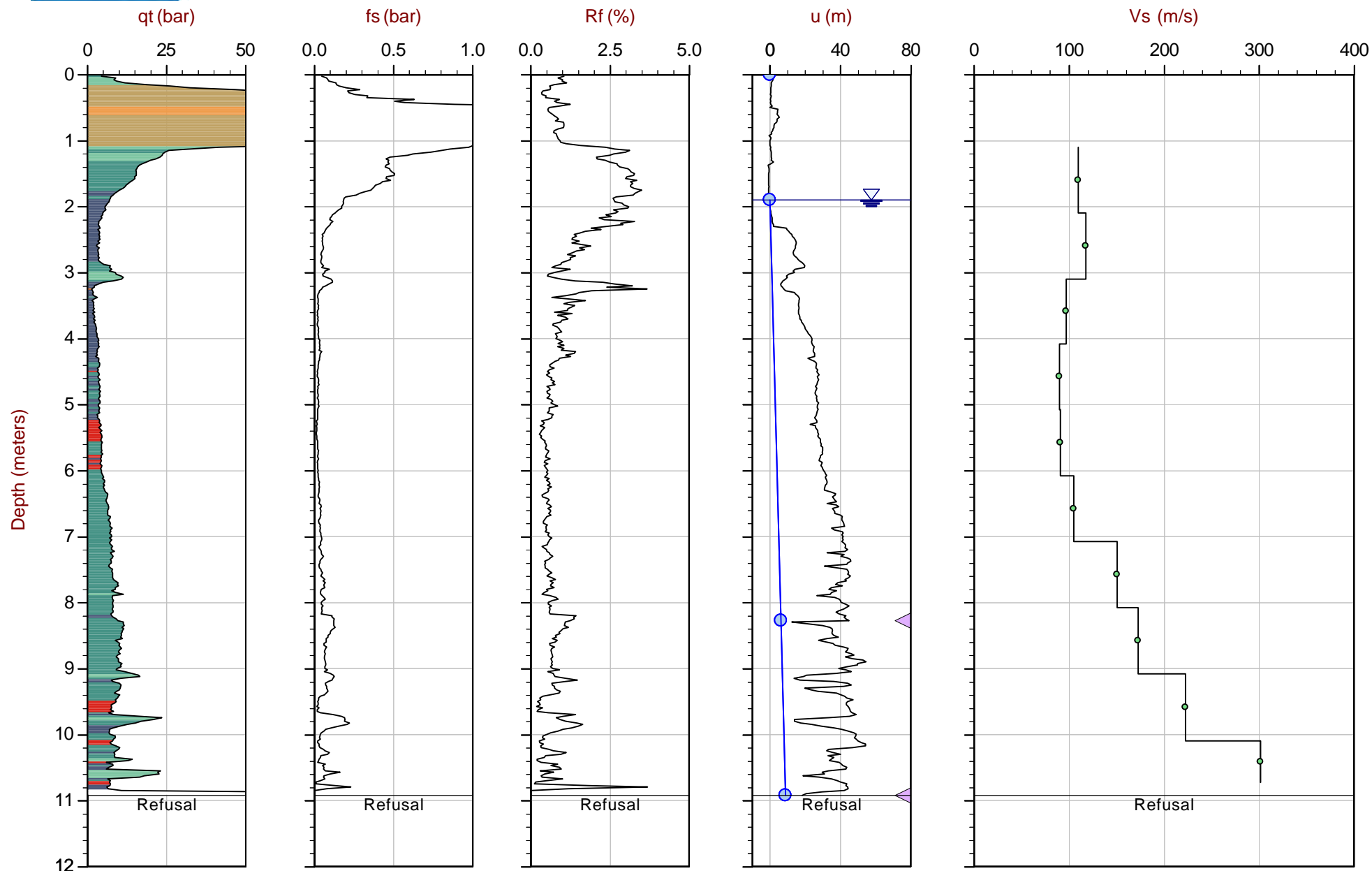
Job No: 18-05030

Date: 2018-05-15 10:18

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-08

Cone: 330:T1500F15U500



Max Depth: 10.925 m / 35.84 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP08.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011428mE: 438467m

Sheet No: 1 of 1

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

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



Golder

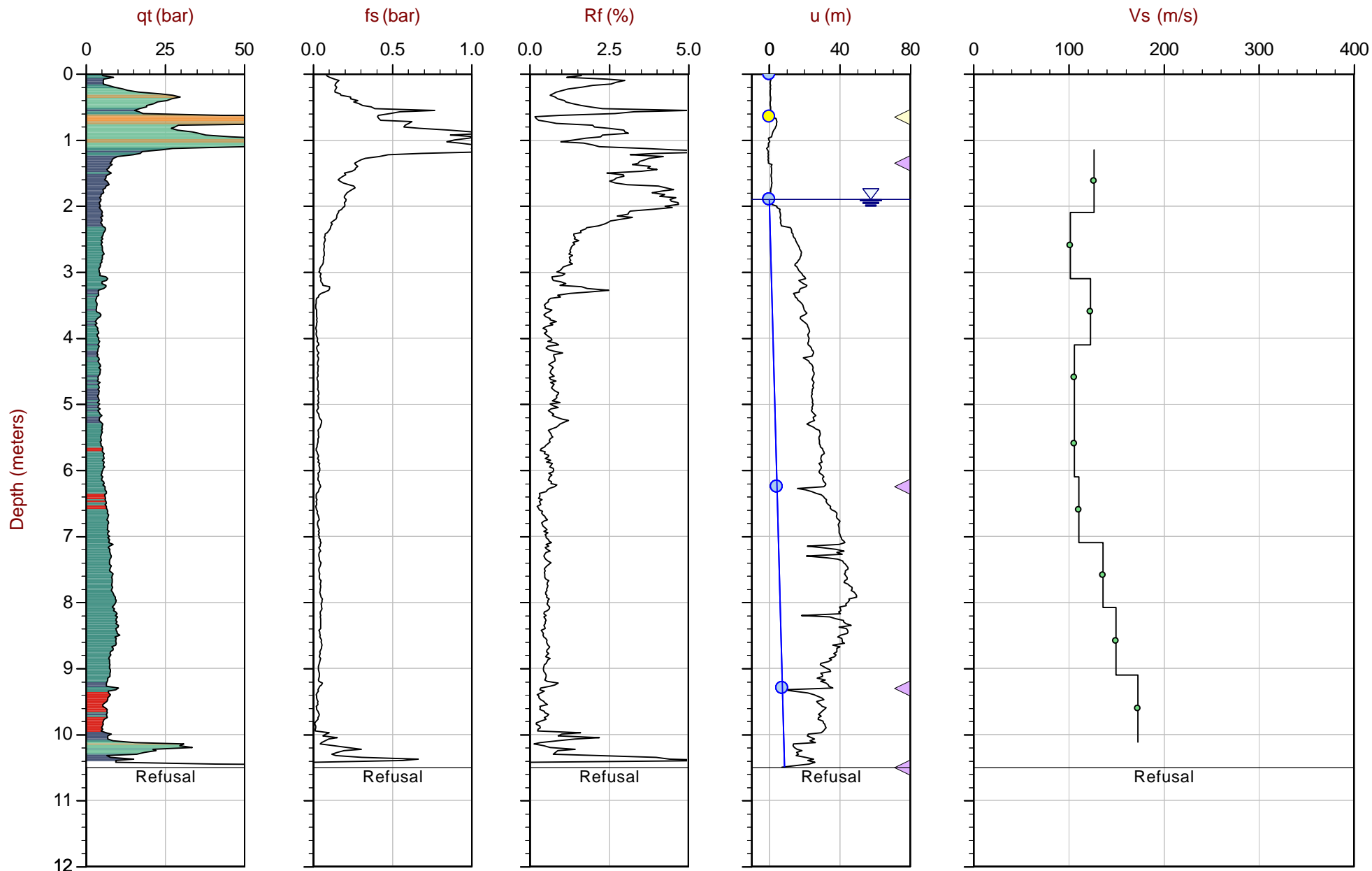
Job No: 18-05030

Date: 2018-05-15 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500



Max Depth: 10.500 m / 34.45 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP09.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N:5011401mE:438482m

Sheet No: 1 of 1

● Equilibrium Pore Pressure (Ueq)    ● Assumed Ueq    ▲ Dissipation, Ueq achieved    ▼ Dissipation, Ueq not achieved    — Hydrostatic Line

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



*Golder*

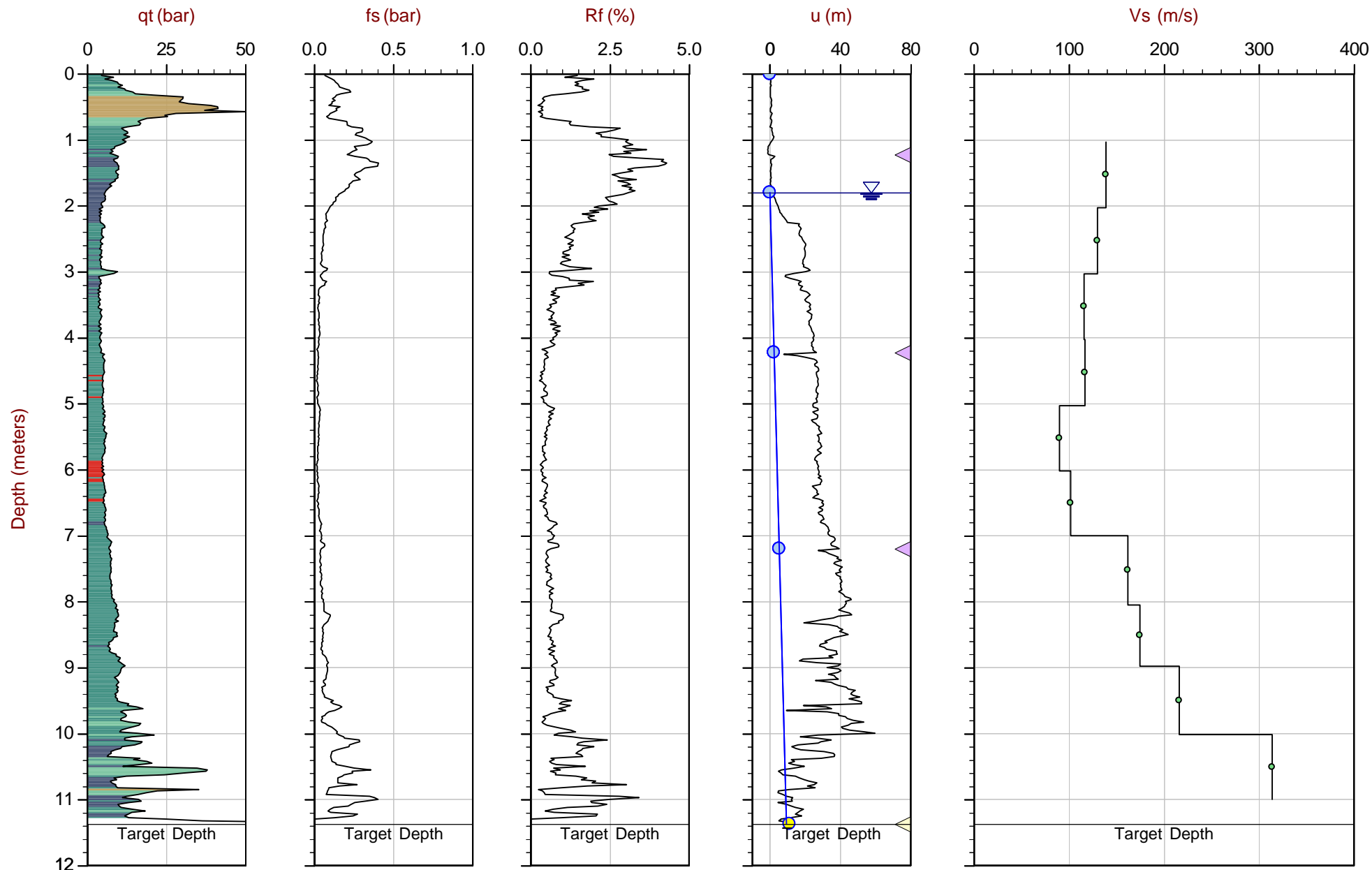
Job No: 18-05030

Date: 2018-05-15 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500



Max Depth: 11.375 m / 37.32 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 18-05030\_SP10.COR

Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010

Coords: UTM18N: 5011318m E: 438505m

Sheet No: 1 of 1

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

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



## Seismic Cone Penetration Wave Traces





Job No: 18-05030

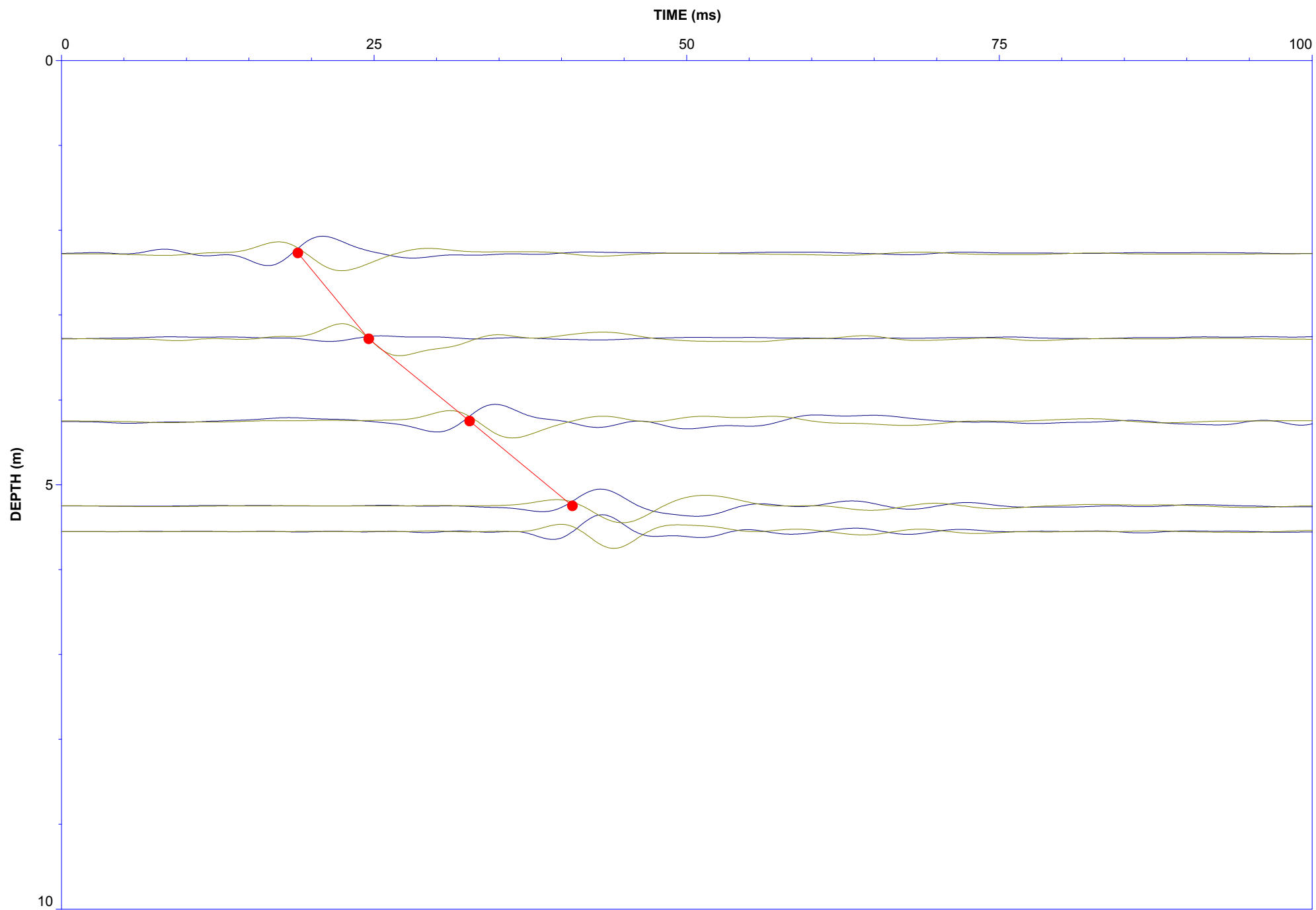
Client: Golder

Project Title: Hwy 416 & Mckenna Casey Dr

Filter: 0-200 Hz BP

Sounding ID: SCPT18-03

Date: 16-May-2018





Job No: 18-05030

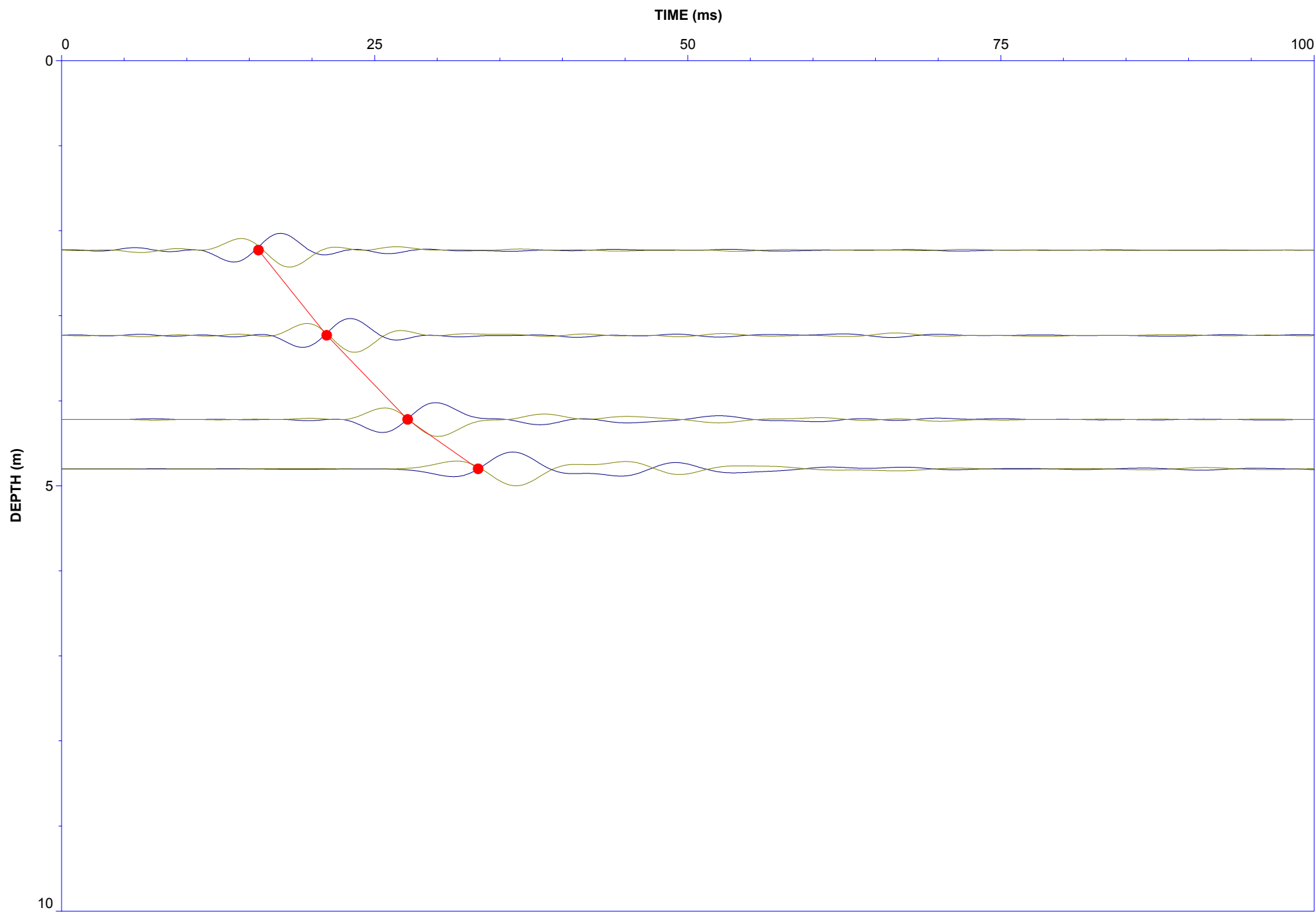
Client: Golder

Project Title: Hwy 416 & Mckenna Casey Dr

Filter: 0-200 Hz BP

Sounding ID: SCPT18-04

Date: 16-May-2018





Job No: 18-05030

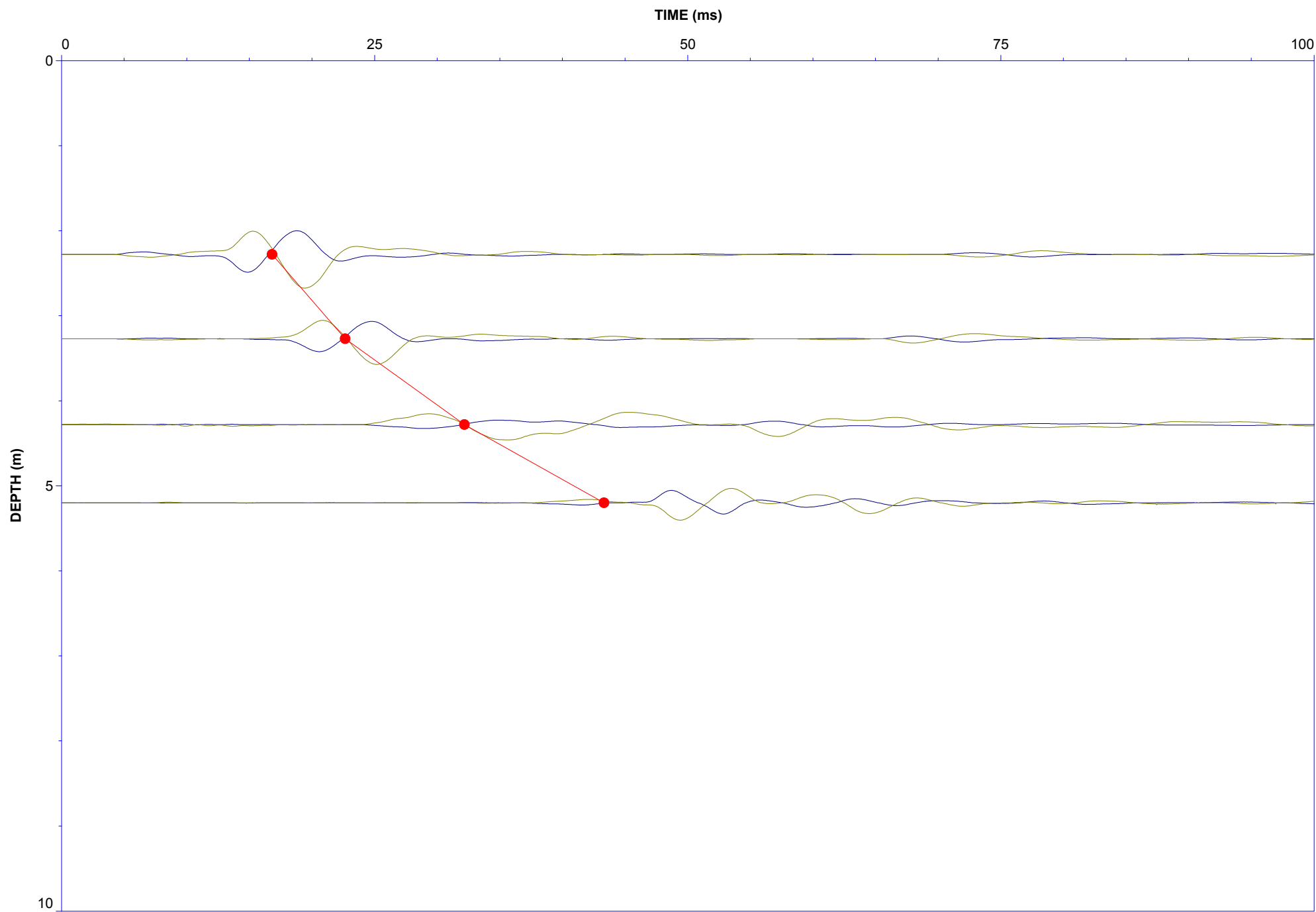
Client: Golder

Project Title: Hwy 416 & Mckenna Casey Dr

Filter: 0-200 Hz BP

Sounding ID: SCPT18-05

Date: 16-May-2018





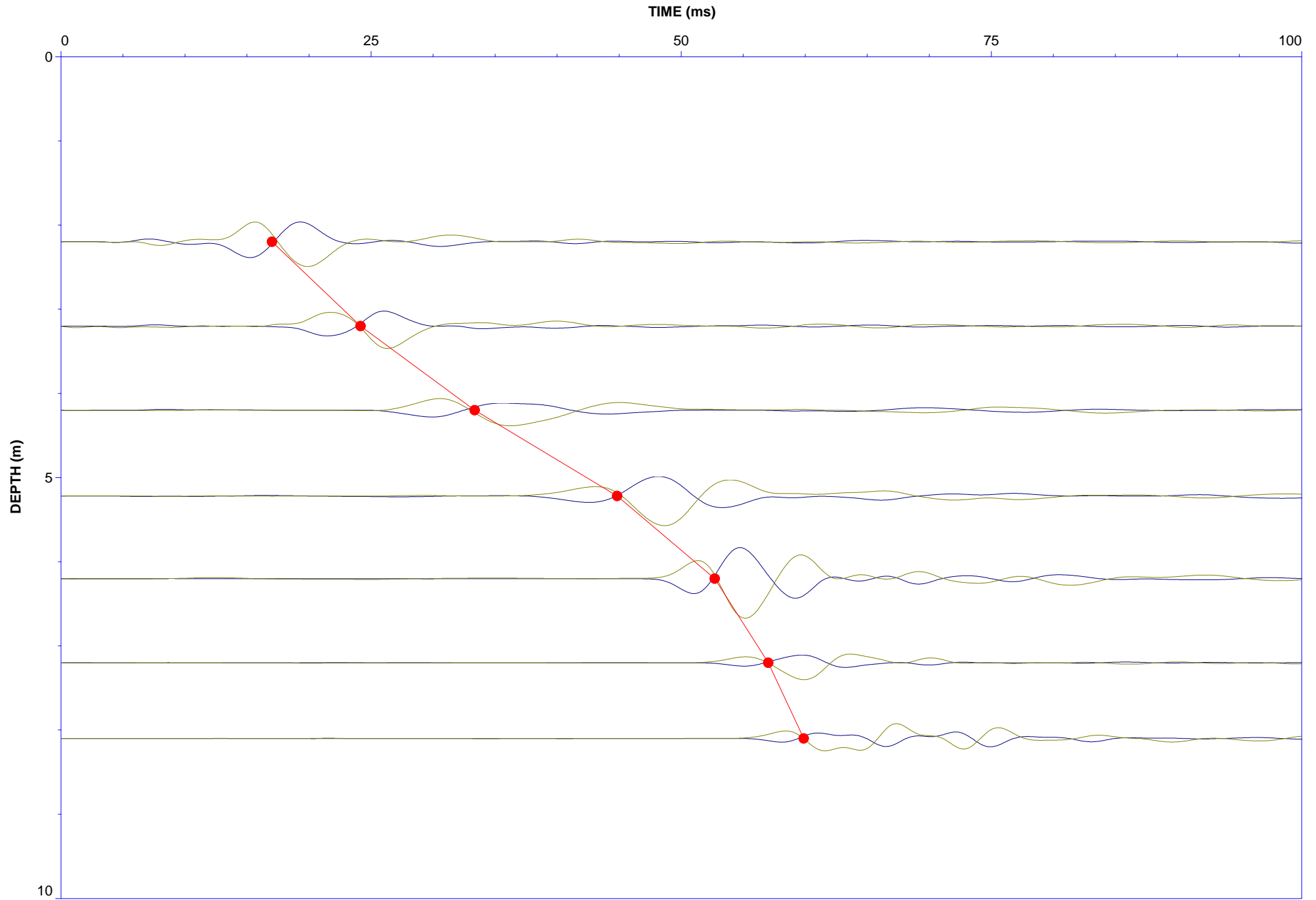
Job No: 18-05030

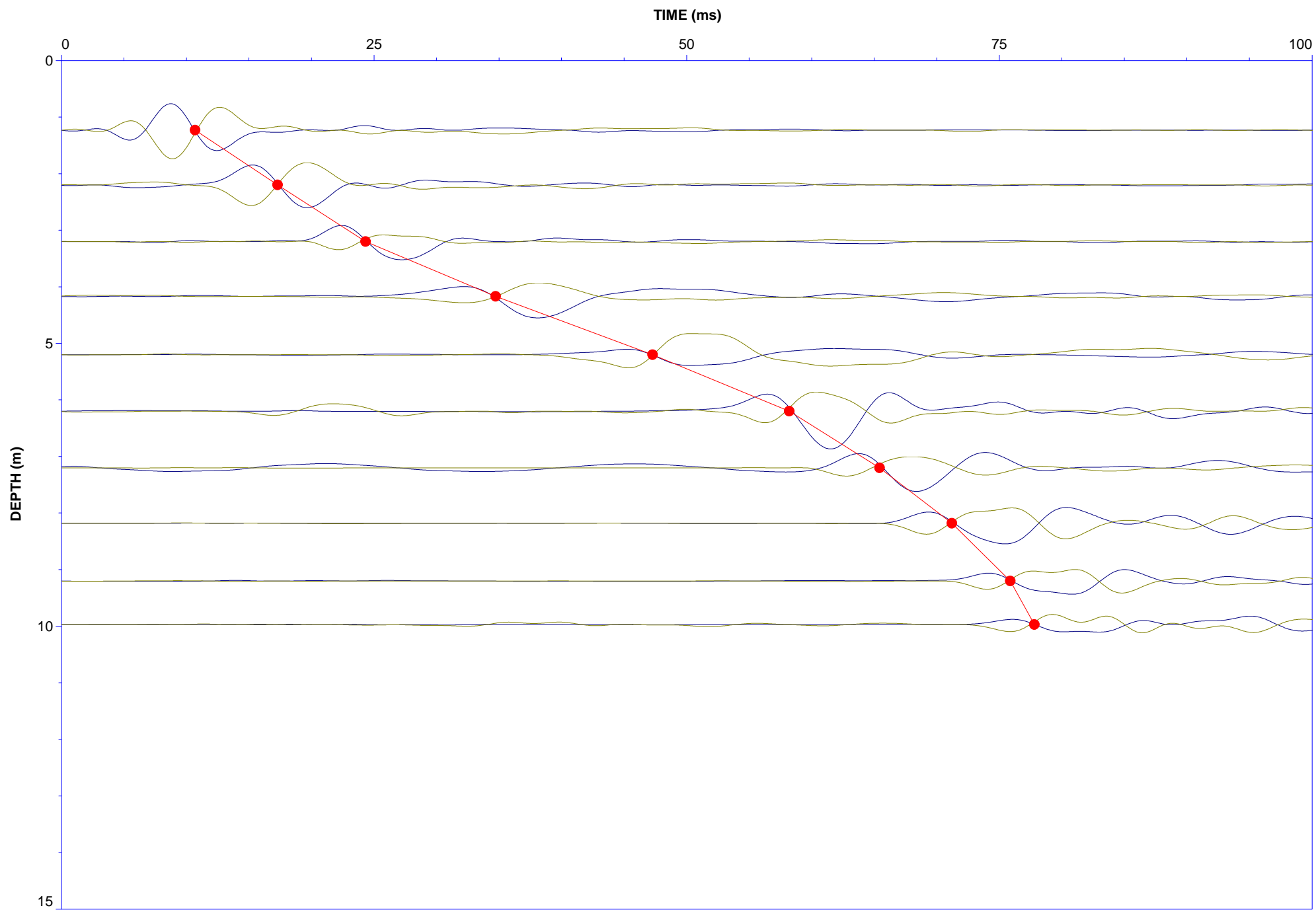
Client: Golder

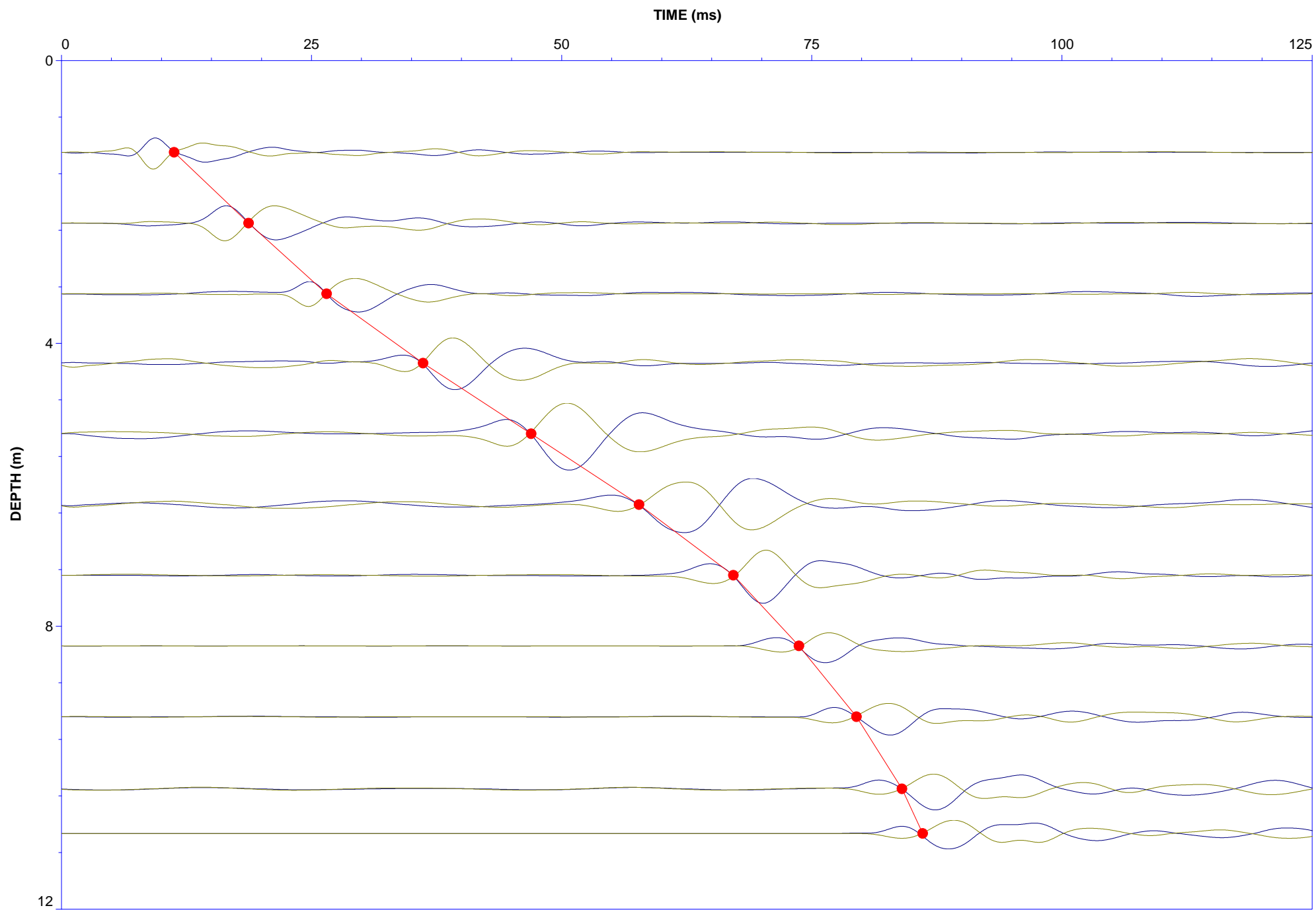
Project Title: Hwy 416 and McKenna Casey Dr

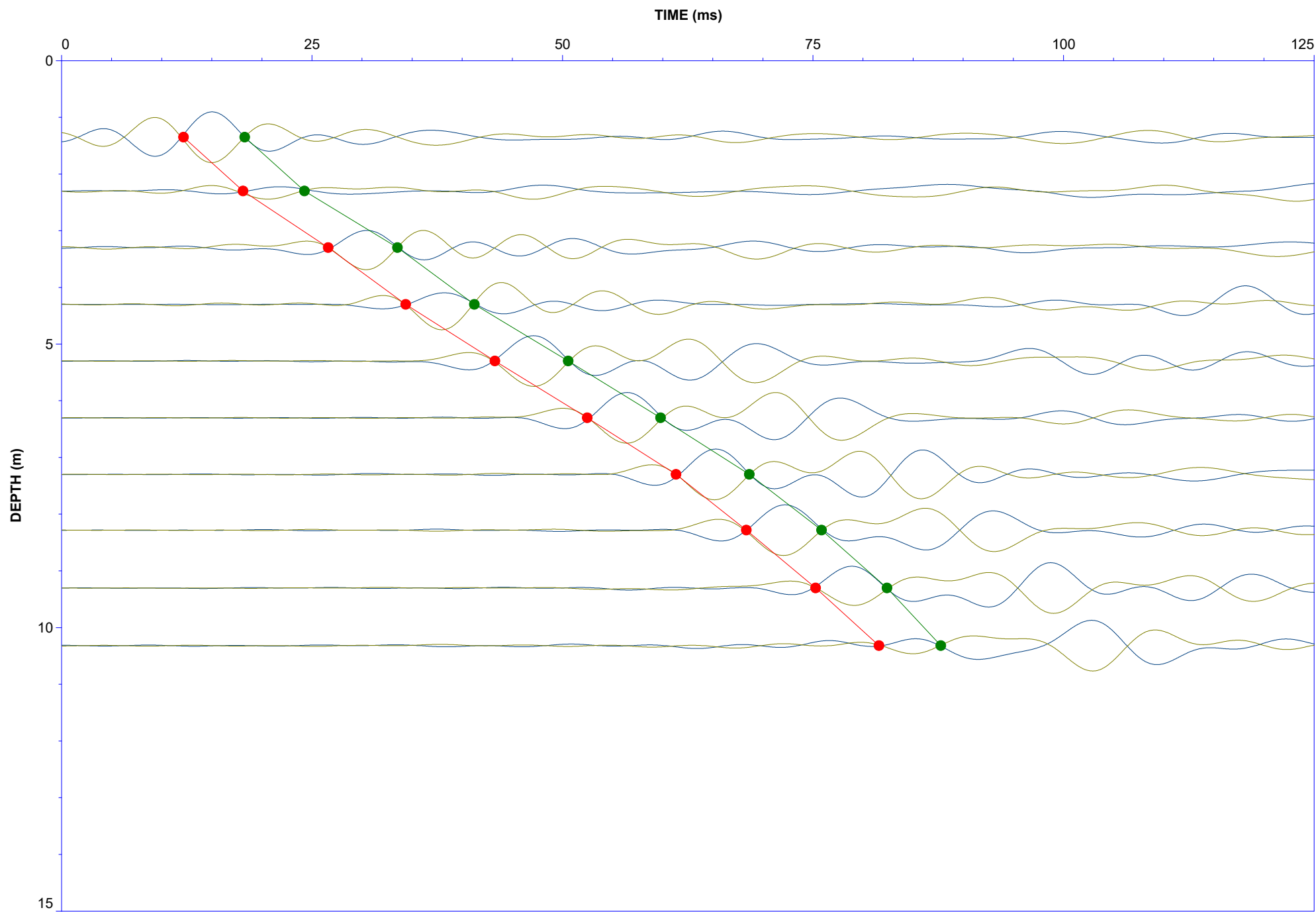
Hole: SCPT18-06

Date: 15-May-2018

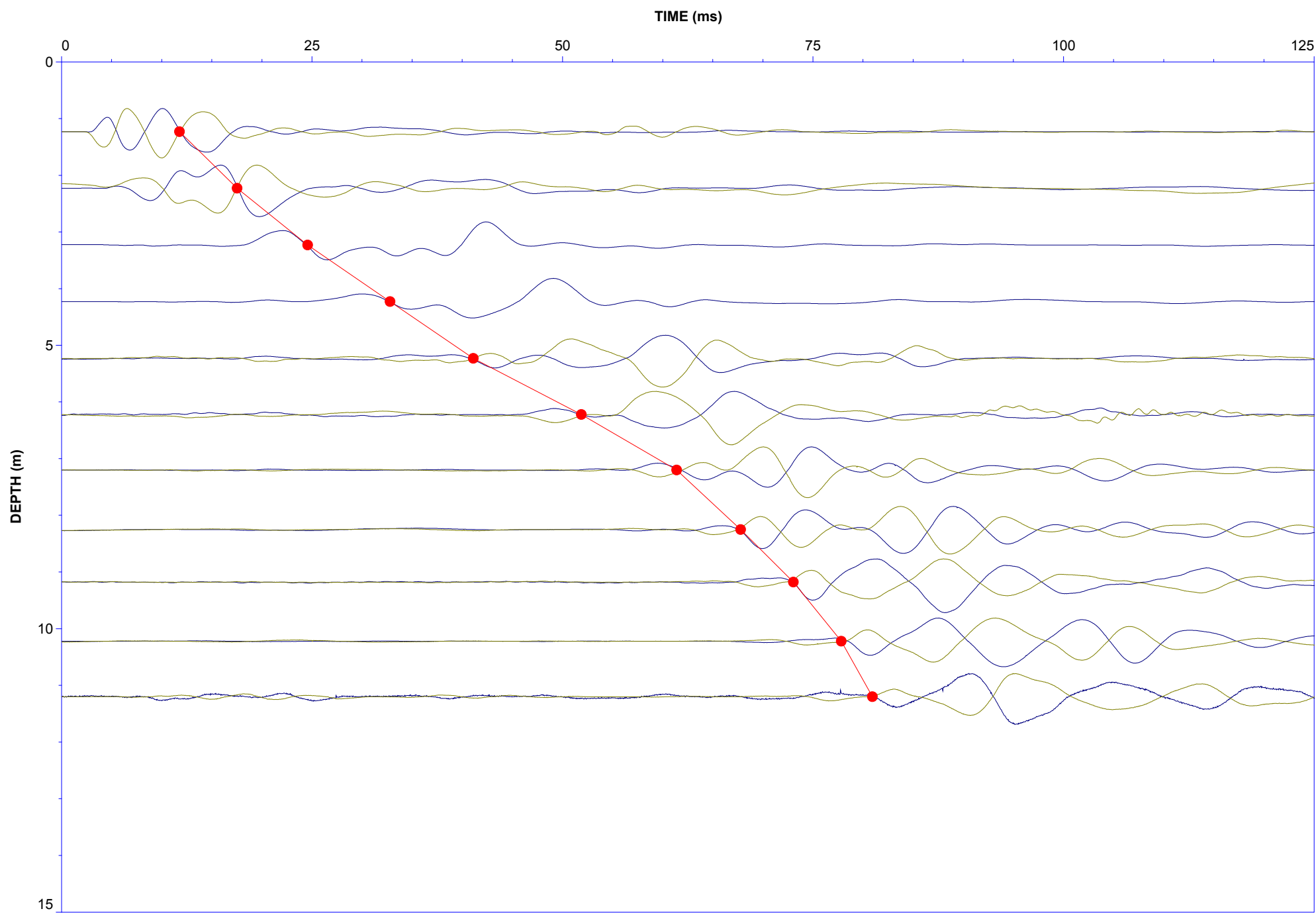












## Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots



Job No: 18-05030  
 Client: Golder Associates  
 Project: Hwy 416 and McKenna Casey Dr  
 Start Date: 14-May-2018  
 End Date: 16-May-2018

### CPT<sub>u</sub> PORE PRESSURE DISSIPATION SUMMARY

| Sounding ID | File Name     | Cone Area<br>(cm <sup>2</sup> ) | Duration<br>(s) | Test<br>Depth<br>(m) | Estimated<br>Equilibrium Pore<br>Pressure U <sub>eq</sub><br>(m) | Calculated<br>Phreatic<br>Surface<br>(m) | Estimated<br>Phreatic Surface<br>(m) | t <sub>50</sub> <sup>a</sup><br>(s) | Assumed<br>Rigidity<br>Index (I <sub>r</sub> ) | c <sub>h</sub> <sup>b</sup><br>(cm <sup>2</sup> /min) |
|-------------|---------------|---------------------------------|-----------------|----------------------|------------------------------------------------------------------|------------------------------------------|--------------------------------------|-------------------------------------|------------------------------------------------|-------------------------------------------------------|
| SCPT18-03   | 18-05030_SP03 | 15                              | 900             | 3.275                | Not achieved                                                     |                                          | 1.6                                  | 182                                 | 100                                            | 3.9                                                   |
| SCPT18-03   | 18-05030_SP03 | 15                              | 1200            | 5.550                | Not achieved                                                     |                                          | 1.6                                  | 298                                 | 100                                            | 2.4                                                   |
| SCPT18-04   | 18-05030_SP04 | 15                              | 900             | 4.225                | Not achieved                                                     |                                          | 1.6                                  | 301                                 | 100                                            | 2.3                                                   |
| SCPT18-04   | 18-05030_SP04 | 15                              | 900             | 4.775                | Not achieved                                                     |                                          | 1.6                                  | 524                                 | 100                                            | 1.3                                                   |
| SCPT18-05   | 18-05030_SP05 | 15                              | 900             | 5.200                | Not achieved                                                     |                                          | 1.6                                  | 535                                 | 100                                            | 1.3                                                   |
| SCPT18-05   | 18-05030_SP05 | 15                              | 400             | 5.550                | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-06   | 18-05030_SP06 | 15                              | 120             | 0.650                | 0.0                                                              |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-06   | 18-05030_SP06 | 15                              | 1550            | 6.200                | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-06   | 18-05030_SP06 | 15                              | 200             | 8.100                | 7.9                                                              |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-07   | 18-05030_SP07 | 15                              | 900             | 4.175                | Not achieved                                                     |                                          | 1.8                                  | 578                                 | 100                                            | 1.2                                                   |
| SCPT18-07   | 18-05030_SP07 | 15                              | 400             | 9.975                | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-08   | 18-05030_SP08 | 15                              | 900             | 8.275                | Not achieved                                                     |                                          | 1.9                                  | 114                                 | 100                                            | 6.2                                                   |
| SCPT18-08   | 18-05030_SP08 | 15                              | 600             | 10.925               | Not achieved                                                     |                                          | 1.9                                  | 45                                  | 100                                            | 15.7                                                  |
| SCPT18-09   | 18-05030_SP09 | 15                              | 245             | 0.650                | 0.0                                                              |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-09   | 18-05030_SP09 | 15                              | 110             | 1.350                | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-09   | 18-05030_SP09 | 15                              | 900             | 6.250                | Not achieved                                                     |                                          | 1.9                                  | 373                                 | 100                                            | 1.9                                                   |
| SCPT18-09   | 18-05030_SP09 | 15                              | 95              | 9.300                | Not achieved                                                     |                                          | 1.9                                  | 54                                  | 100                                            | 12.9                                                  |
| SCPT18-09   | 18-05030_SP09 | 15                              | 350             | 10.500               | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-10   | 18-05030_SP10 | 15                              | 115             | 1.225                | Not achieved                                                     |                                          |                                      |                                     |                                                |                                                       |
| SCPT18-10   | 18-05030_SP10 | 15                              | 900             | 4.225                | Not achieved                                                     |                                          | 1.8                                  | 452                                 | 100                                            | 1.6                                                   |
| SCPT18-10   | 18-05030_SP10 | 15                              | 900             | 7.200                | Not achieved                                                     |                                          | 1.8                                  | 789                                 | 100                                            | 0.9                                                   |
| SCPT18-10   | 18-05030_SP10 | 15                              | 200             | 11.375               | 11.2                                                             |                                          |                                      |                                     |                                                |                                                       |

a. Time is relative to where umax occurred

b. Houlsby and Teh, 1991



*Golder*

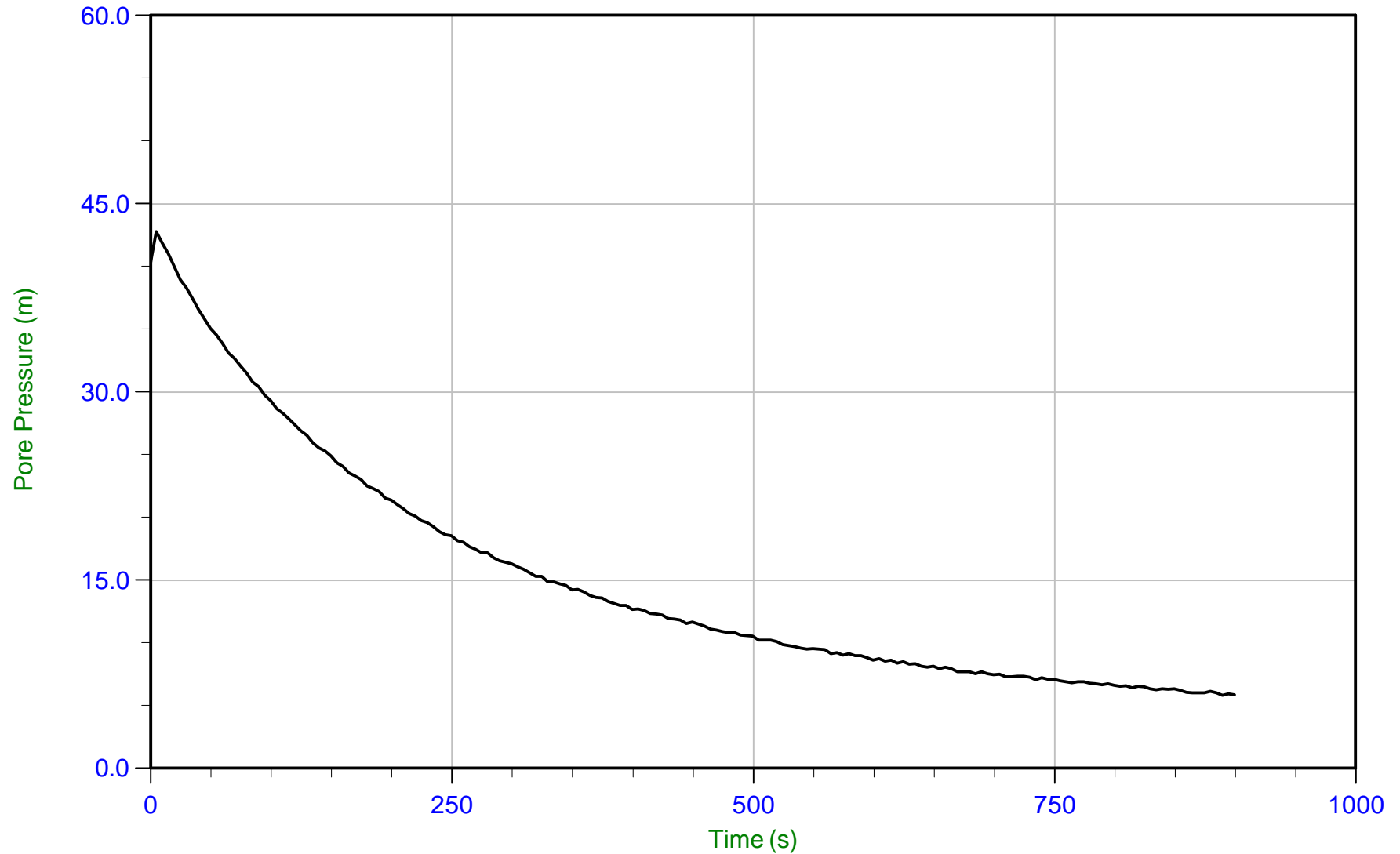
Job No: 18-05030

Date: 05/16/2018 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP03.PPF  
Depth: 3.275 m / 10.745 ft  
Duration: 900.0 s

U Min: 5.8 m  
U Max: 42.8 m

WT: 1.600 m / 5.249 ft  
Ueq: 1.7 m  
U(50): 22.22 m

T(50): 181.8 s  
Ir: 100  
Ch: 3.9 cm<sup>2</sup>/min



*Golder*

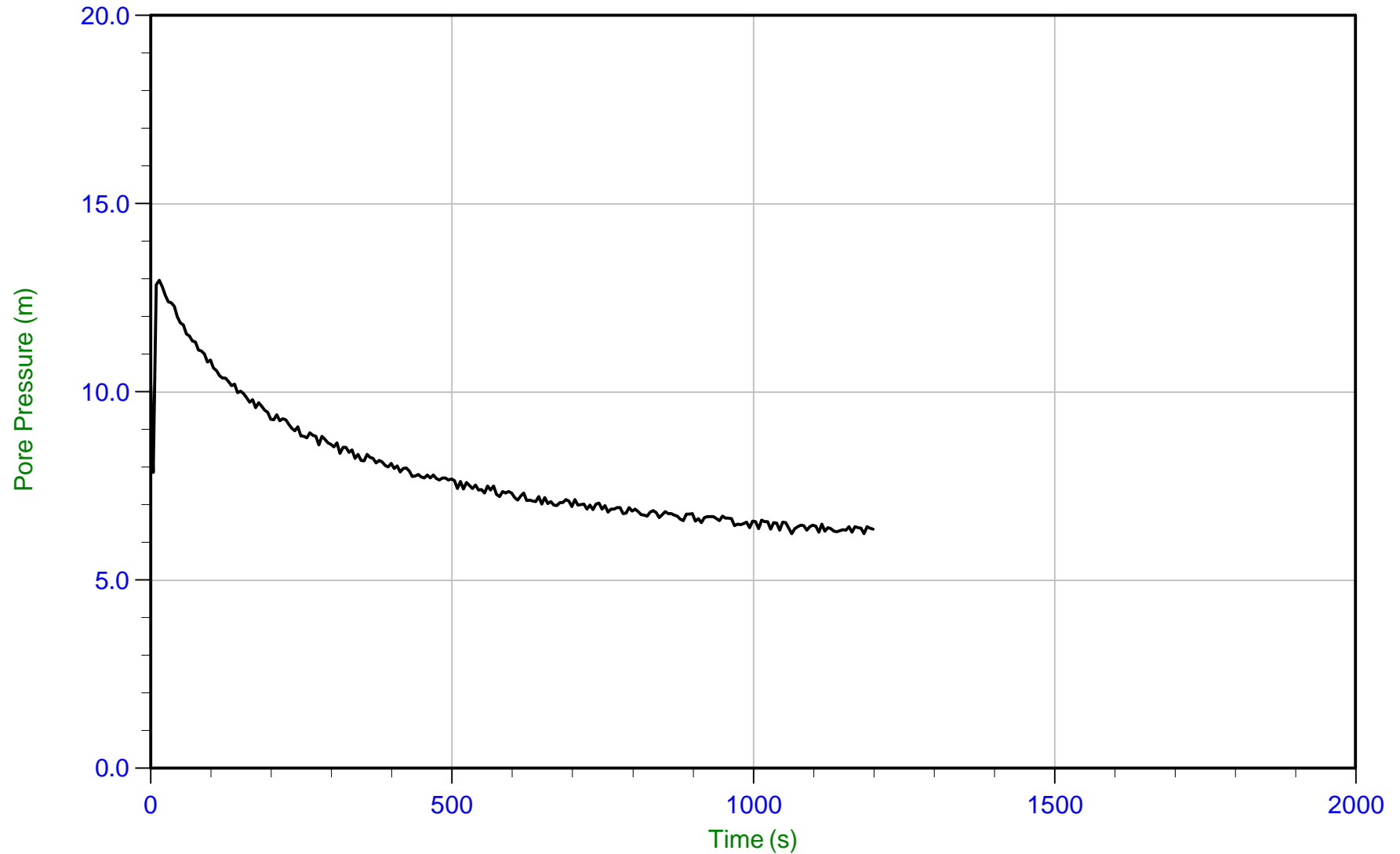
Job No: 18-05030

Date: 05/16/2018 11:08

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-03

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP03.PPF  
Depth: 5.550 m / 18.208 ft  
Duration: 1200.0 s

U Min: 6.2 m  
U Max: 13.0 m

WT: 1.600 m / 5.249 ft  
Ueq: 4.0 m  
U(50): 8.46 m

T(50): 298.4 s  
Ir: 100  
Ch: 2.4 cm<sup>2</sup>/min



*Golder*

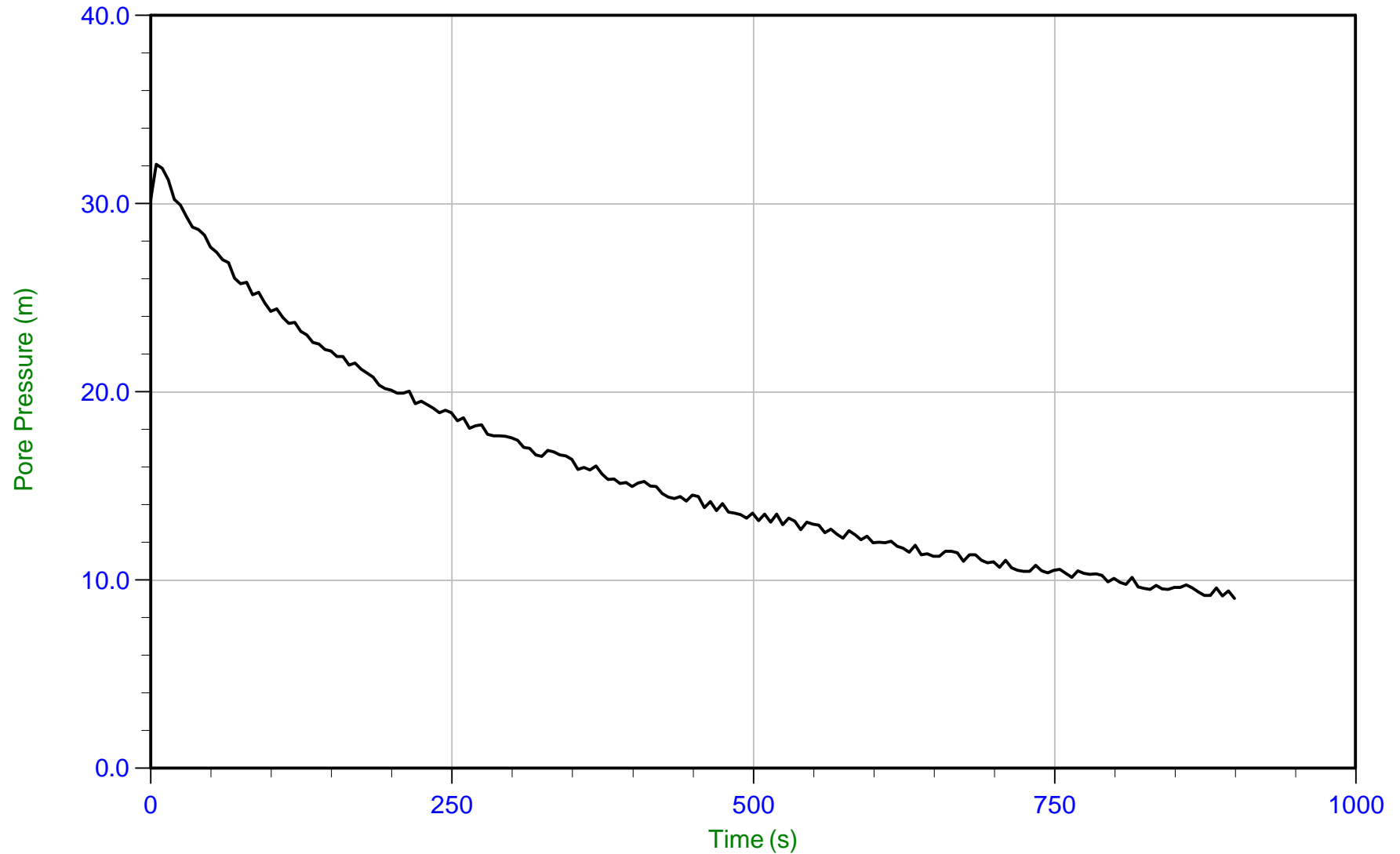
Job No: 18-05030

Date: 05/16/2018 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP04.PPF  
Depth: 4.225 m / 13.861 ft  
Duration: 900.0 s

U Min: 9.0 m  
U Max: 32.1 m

WT: 1.600 m / 5.249 ft  
Ueq: 2.6 m  
U(50): 17.36 m

T(50): 300.9 s  
Ir: 100  
Ch: 2.3 cm<sup>2</sup>/min



*Golder*

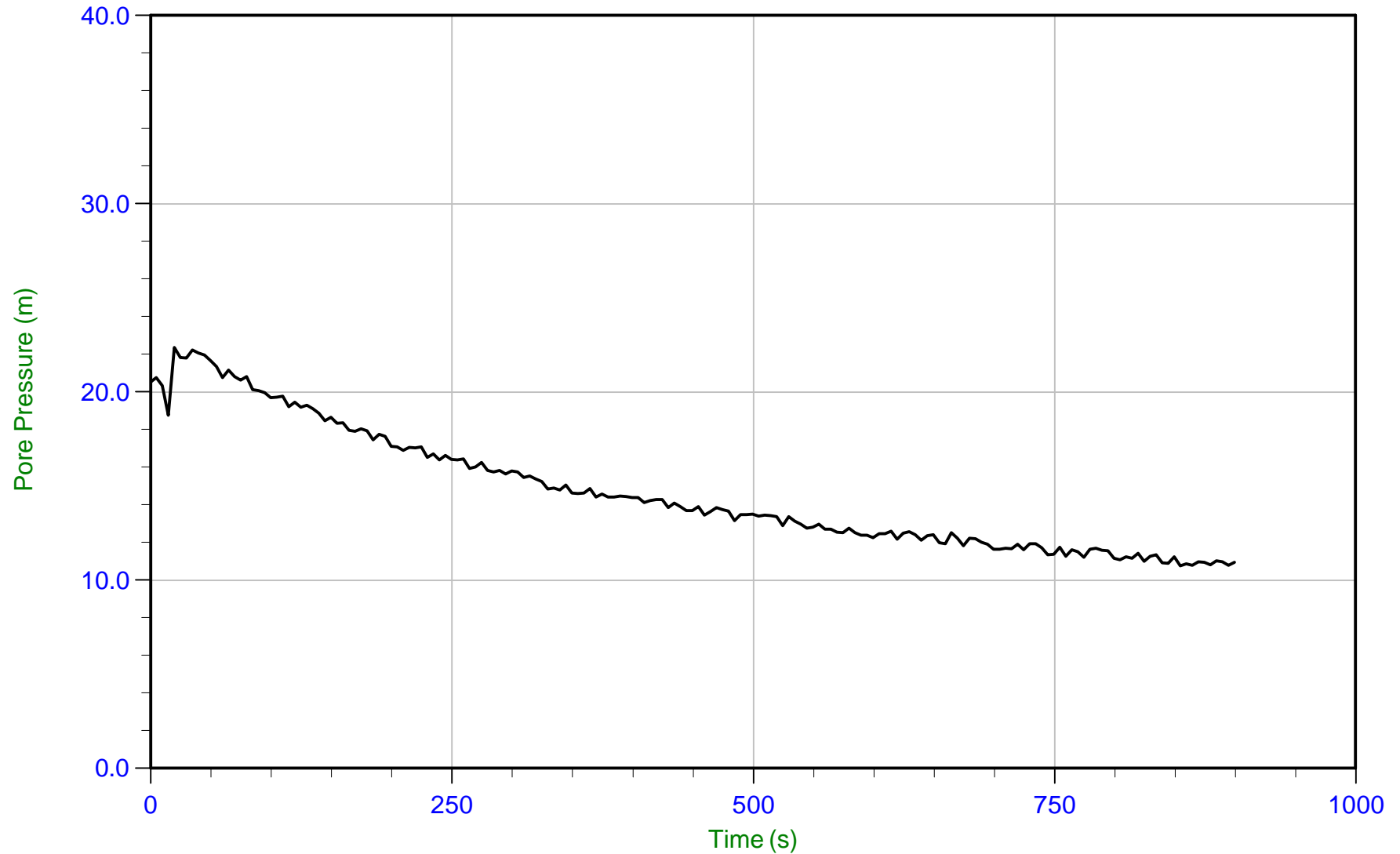
Job No: 18-05030

Date: 05/16/2018 09:32

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-04

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP04.PPF  
Depth: 4.775 m / 15.666 ft  
Duration: 900.0 s

U Min: 10.8 m  
U Max: 22.4 m

WT: 1.600 m / 5.249 ft  
Ueq: 3.2 m  
U(50): 12.77 m

T(50): 524.5 s  
Ir: 100  
Ch: 1.3 cm<sup>2</sup>/min



*Golder*

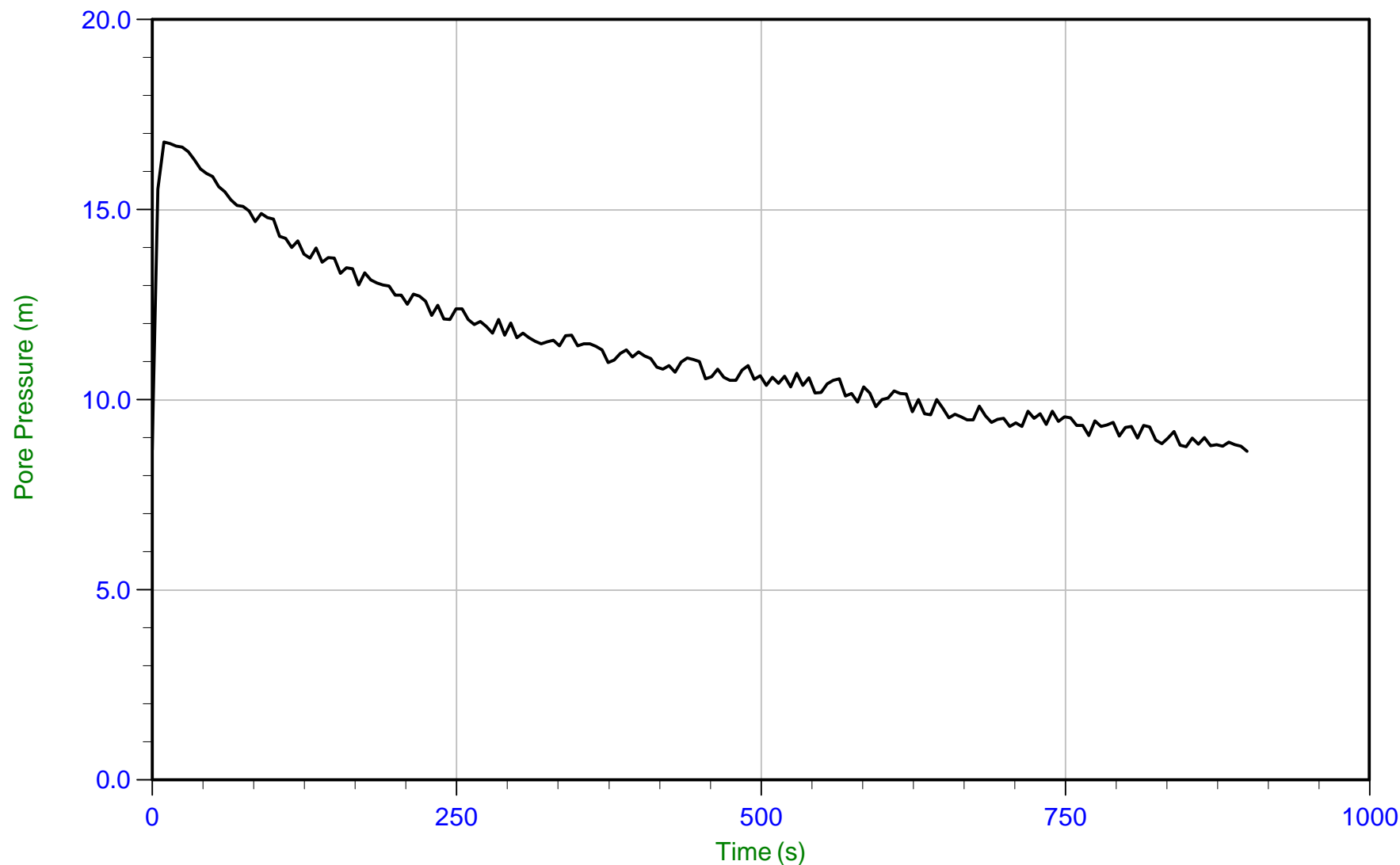
Job No: 18-05030

Date: 05/16/2018 08:22

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary:

Filename: 18-05030\_SP05.PPF  
Depth: 5.200 m / 17.060 ft  
Duration: 900.0 s

U Min: 8.6 m  
U Max: 16.8 m

WT: 1.600 m / 5.249 ft  
Ueq: 3.6 m  
U(50): 10.19 m

T(50): 534.9 s  
Ir: 100  
Ch: 1.3 cm<sup>2</sup>/min





*Golder*

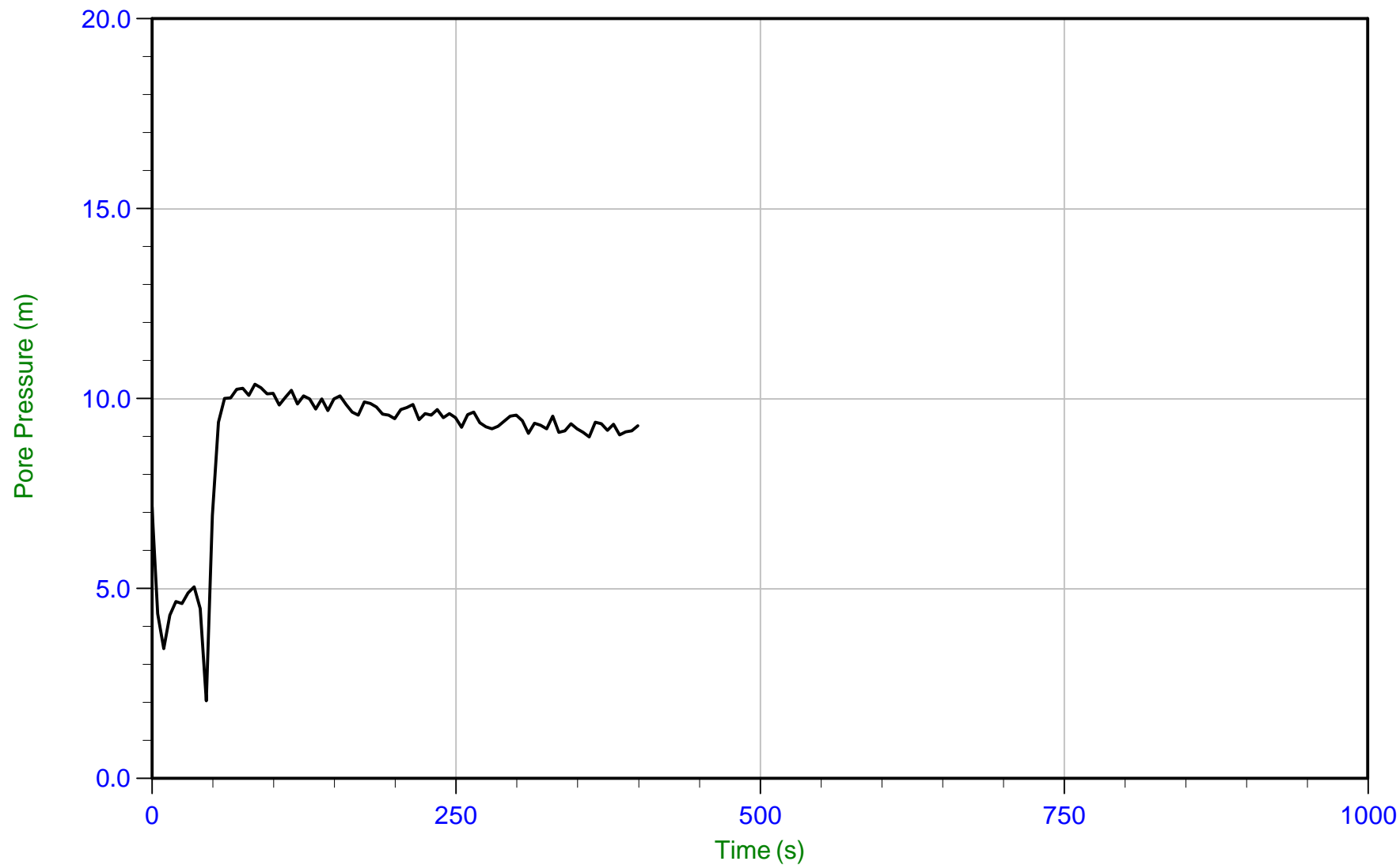
Job No: 18-05030

Date: 05/16/2018 08:22

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-05

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP05.PPF  
Depth: 5.550 m / 18.208 ft  
Duration: 400.0 s

U Min: 2.0 m  
U Max: 10.4 m



*Golder*

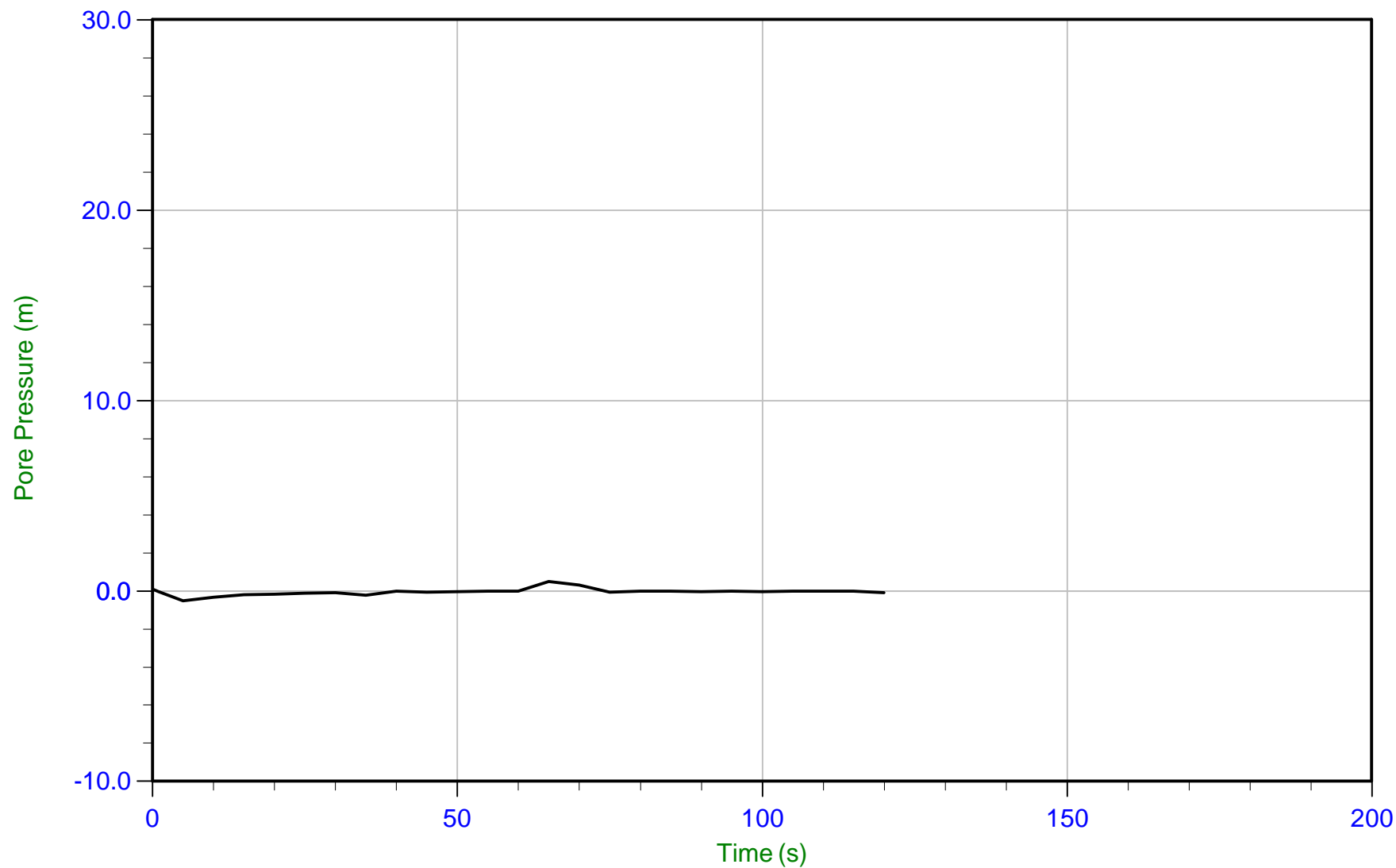
Job No: 18-05030

Date: 05/15/2018 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary:

Filename: 18-05030\_SP06.PPF

Depth: 0.650 m / 2.133 ft

Duration: 120.0 s

U Min: -0.5 m

U Max: 0.5 m

WT: 0.650 m / 2.133 ft

Ueq: 0.0 m



*Golder*

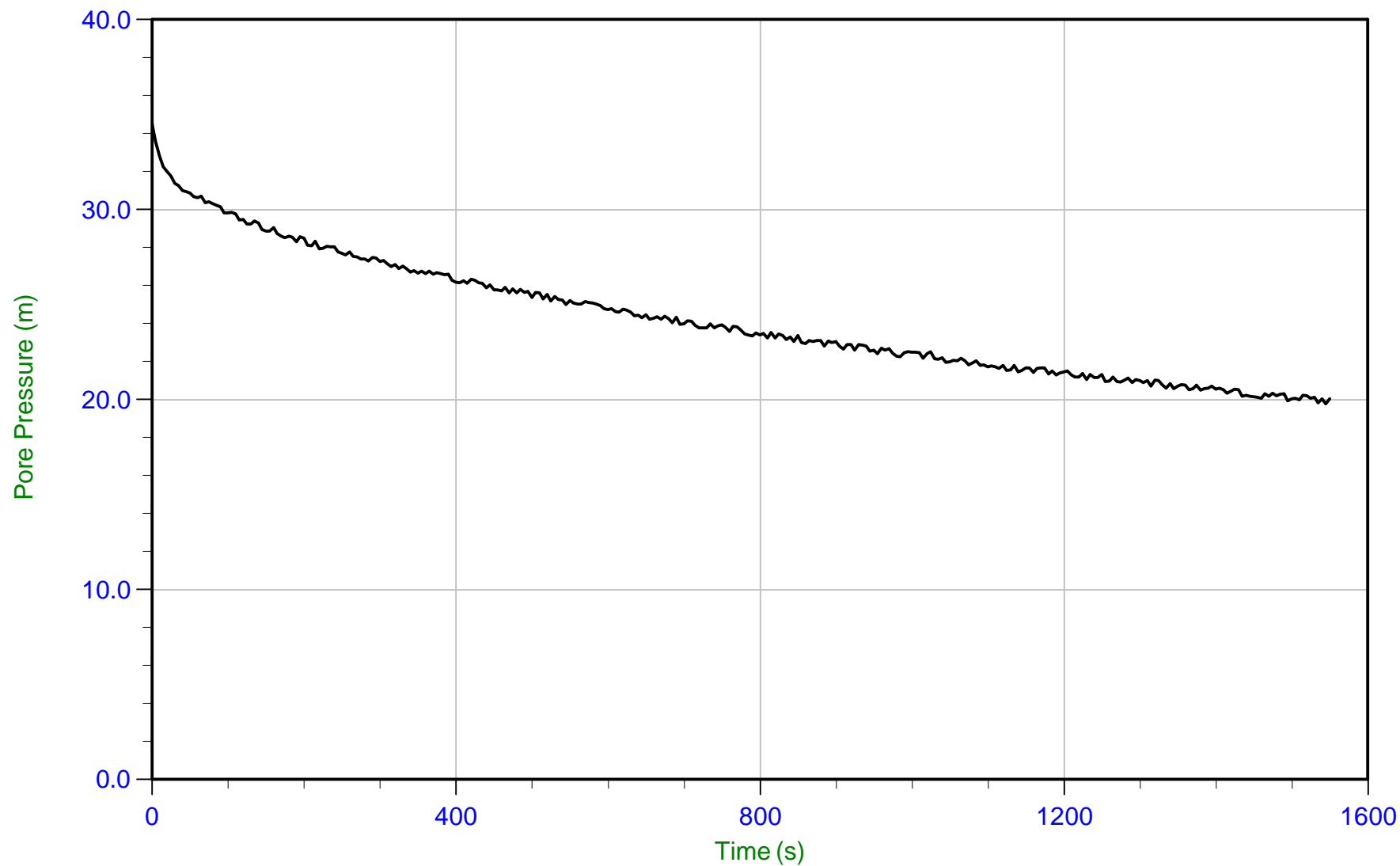
Job No: 18-05030

Date: 05/15/2018 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP06.PPF  
Depth: 6.200 m / 20.341 ft  
Duration: 1550.0 s

U Min: 19.8 m  
U Max: 34.6 m



*Golder*

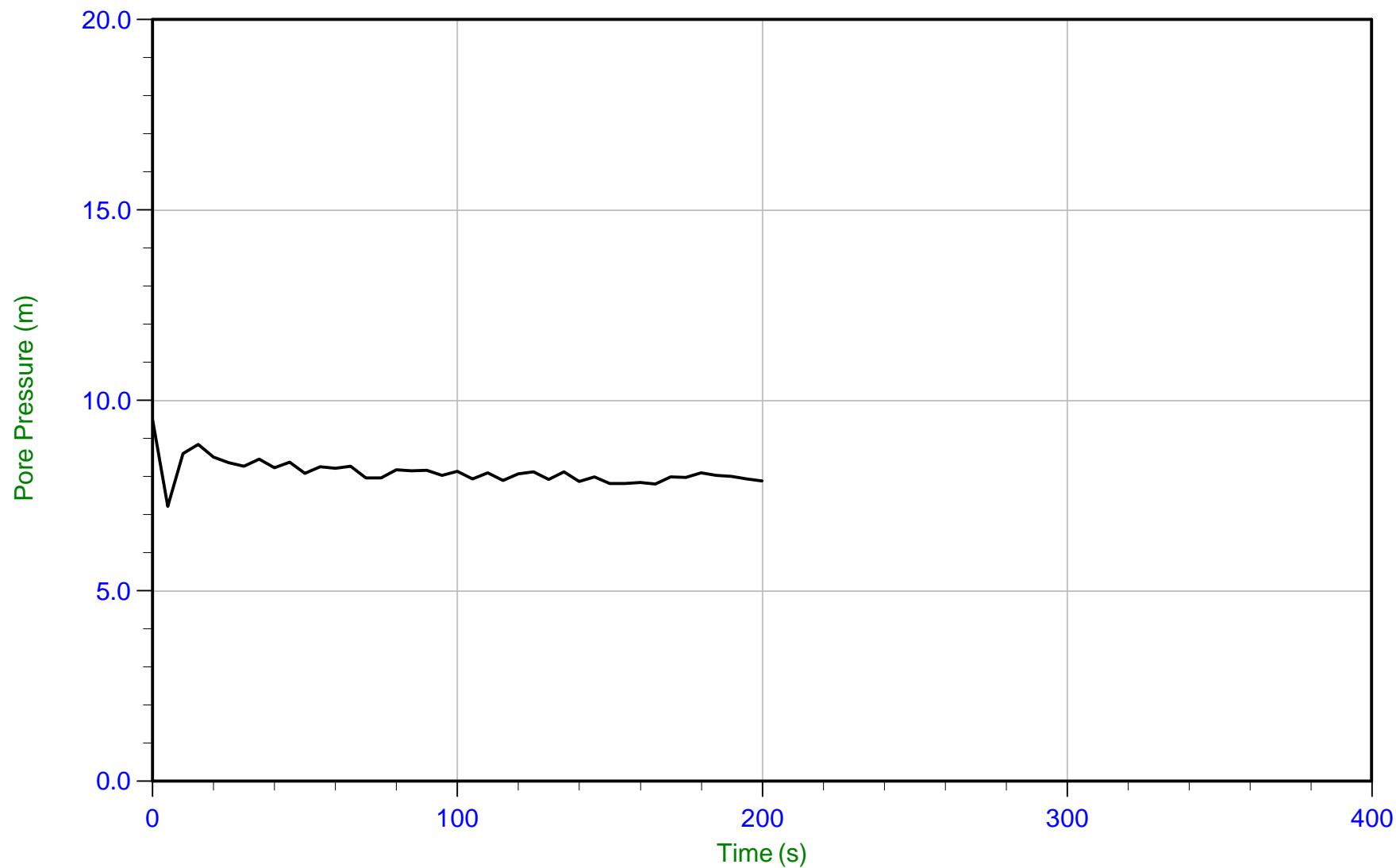
Job No: 18-05030

Date: 05/15/2018 14:58

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-06

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP06.PPF U Min: 7.2 m WT: 0.219 m / 0.718 ft  
Depth: 8.100 m / 26.574 ft U Max: 9.5 m Ueq: 7.9 m  
Duration: 200.0 s



*Golder*

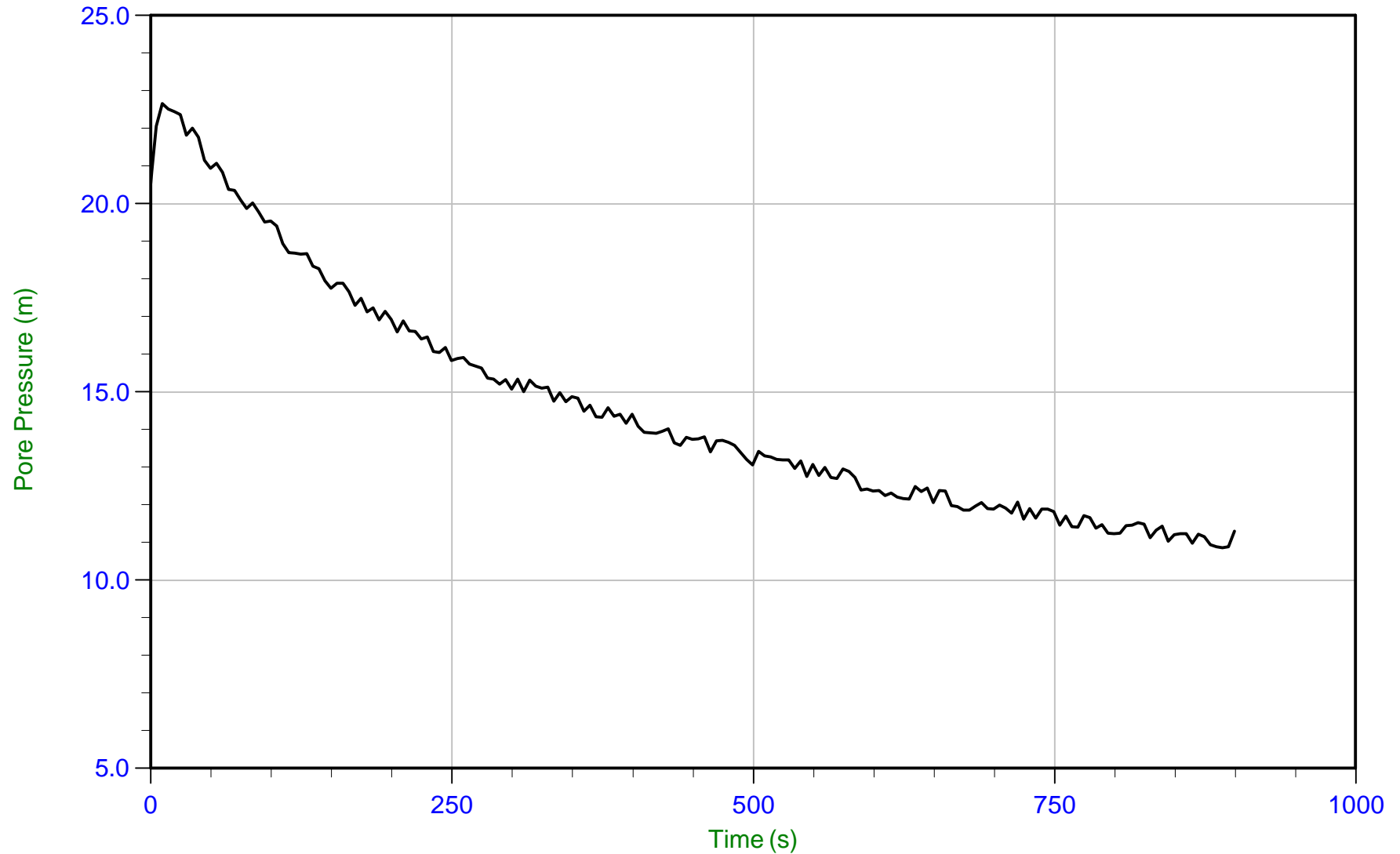
Job No: 18-05030

Date: 05/14/2018 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP07.PPF  
Depth: 4.175 m / 13.697 ft  
Duration: 900.0 s

U Min: 10.9 m  
U Max: 22.7 m

WT: 1.800 m / 5.905 ft  
Ueq: 2.4 m  
U(50): 12.52 m

T(50): 578.1 s  
Ir: 100  
Ch: 1.2 cm<sup>2</sup>/min



*Golder*

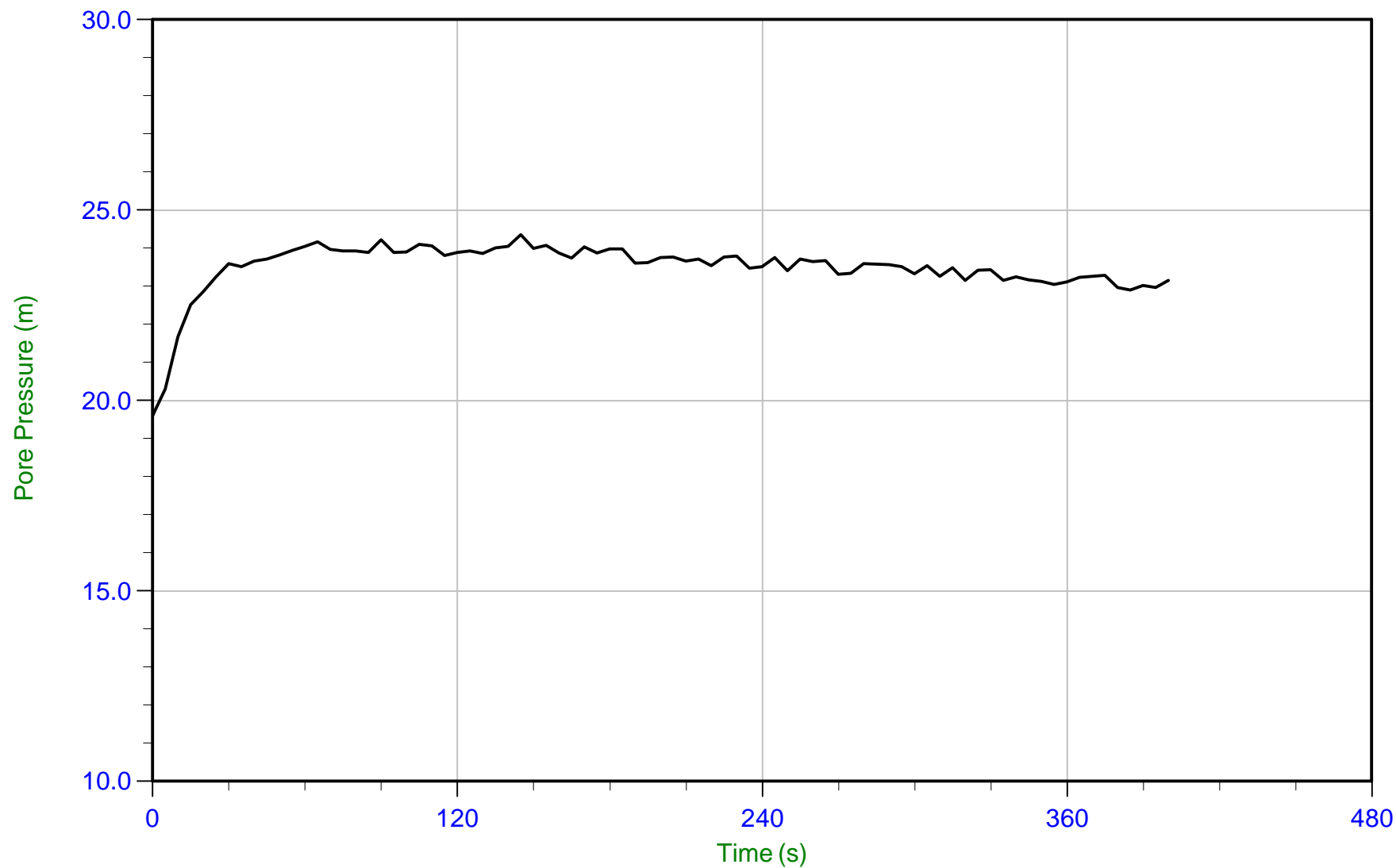
Job No: 18-05030

Date: 05/14/2018 14:54

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-07

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP07.PPF  
Depth: 9.975 m / 32.726 ft  
Duration: 400.0 s

U Min: 19.6 m  
U Max: 24.4 m



*Golder*

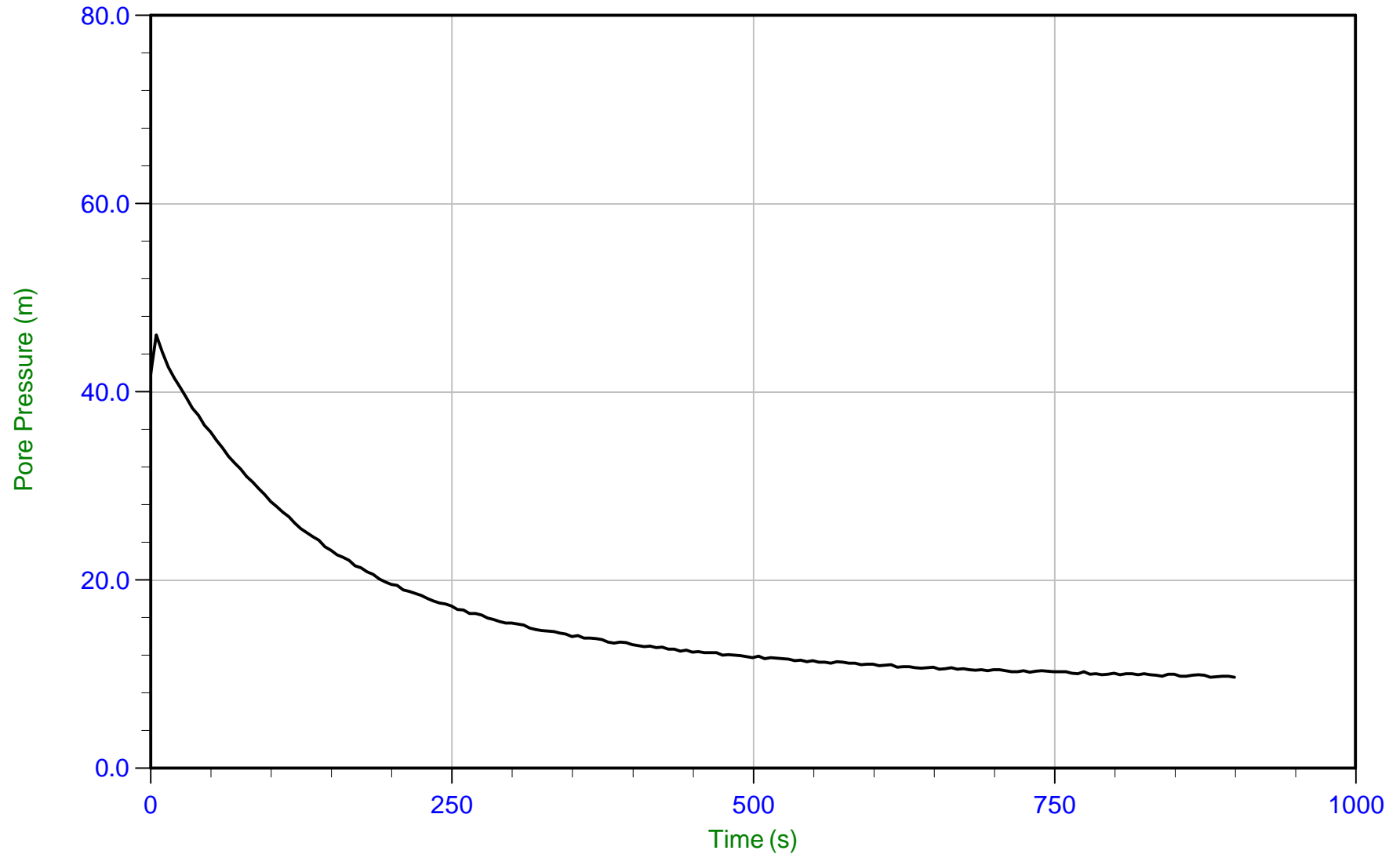
Job No: 18-05030

Date: 05/15/2018 10:18

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-08

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP08.PPF  
Depth: 8.275 m / 27.149 ft  
Duration: 900.0 s

U Min: 9.7 m  
U Max: 46.1 m

WT: 1.900 m / 6.234 ft  
Ueq: 6.4 m  
U(50): 26.23 m

T(50): 113.8 s  
Ir: 100  
Ch: 6.2 cm<sup>2</sup>/min



*Golder*

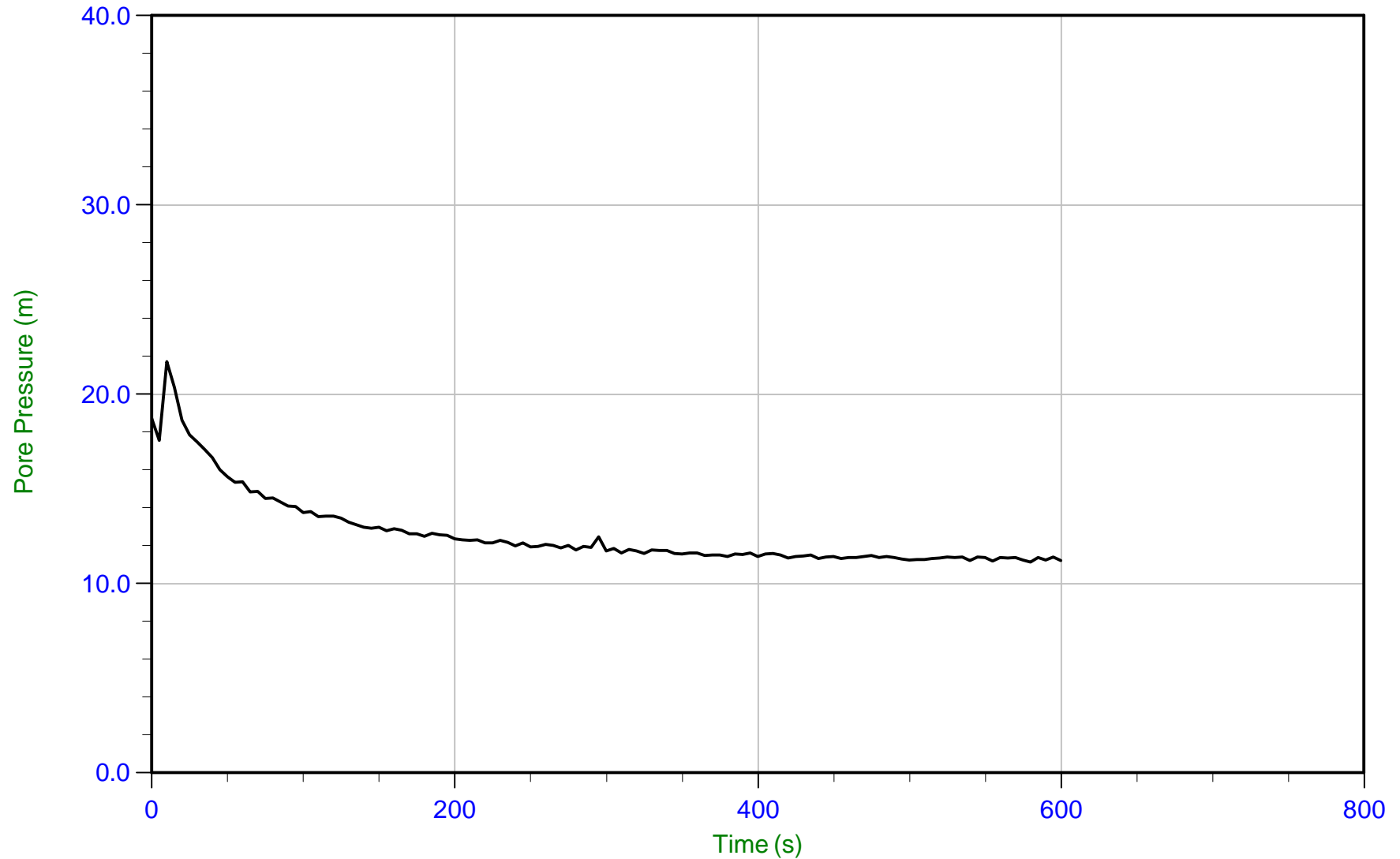
Job No: 18-05030

Date: 05/15/2018 10:18

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-08

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP08.PPF  
Depth: 10.925 m / 35.843 ft  
Duration: 600.0 s

U Min: 11.1 m  
U Max: 21.7 m

WT: 1.900 m / 6.234 ft  
Ueq: 9.0 m  
U(50): 15.37 m

T(50): 44.6 s  
Ir: 100  
Ch: 15.7 cm<sup>2</sup>/min





*Golder*

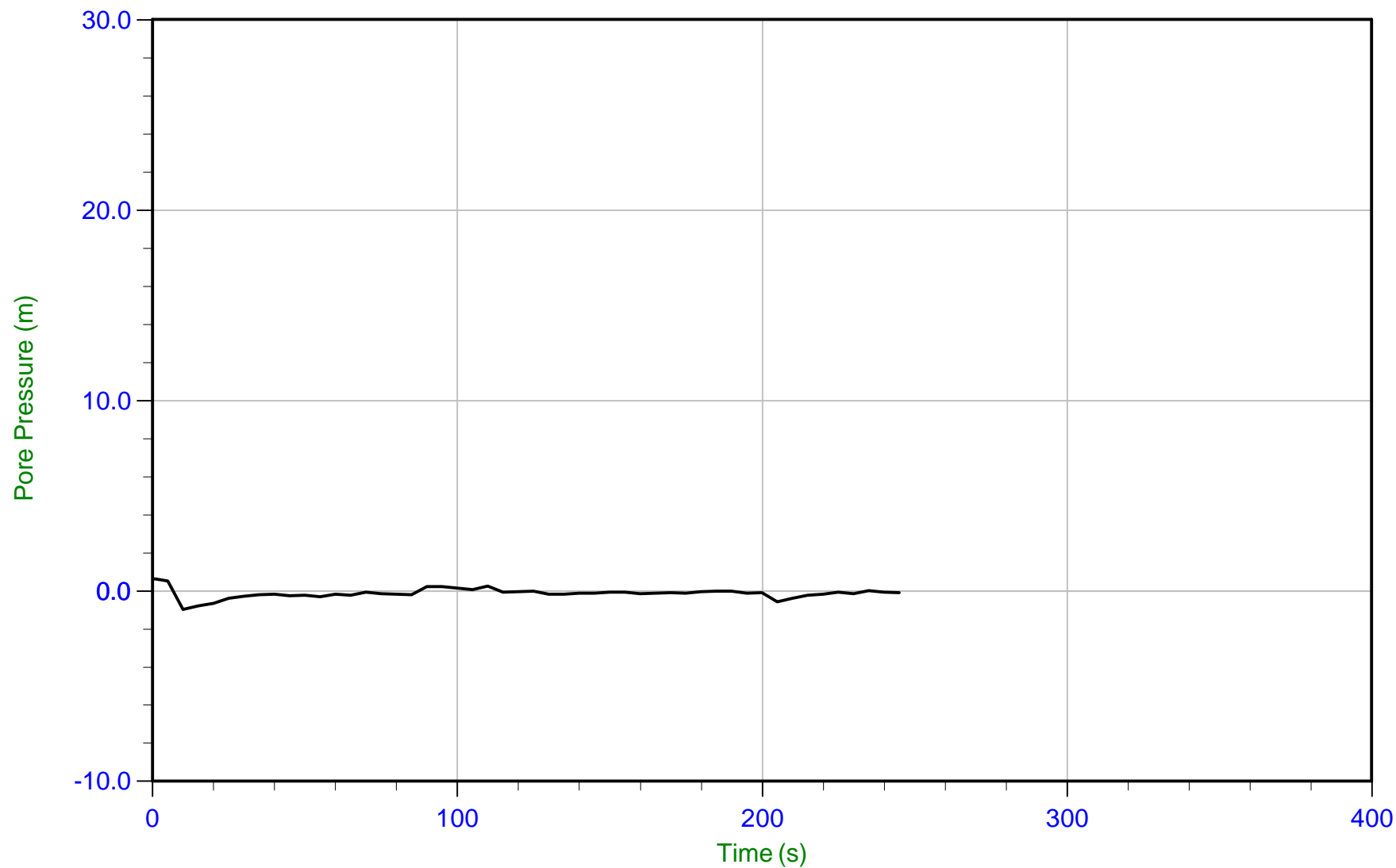
Job No: 18-05030

Date: 05/15/2018 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



|                |                             |               |                        |
|----------------|-----------------------------|---------------|------------------------|
| Trace Summary: | Filename: 18-05030_SP09.PPF | U Min: -1.0 m | WT: 0.650 m / 2.133 ft |
|                | Depth: 0.650 m / 2.133 ft   | U Max: 0.6 m  | Ueq: 0.0 m             |
|                | Duration: 245.0 s           |               |                        |



*Golder*

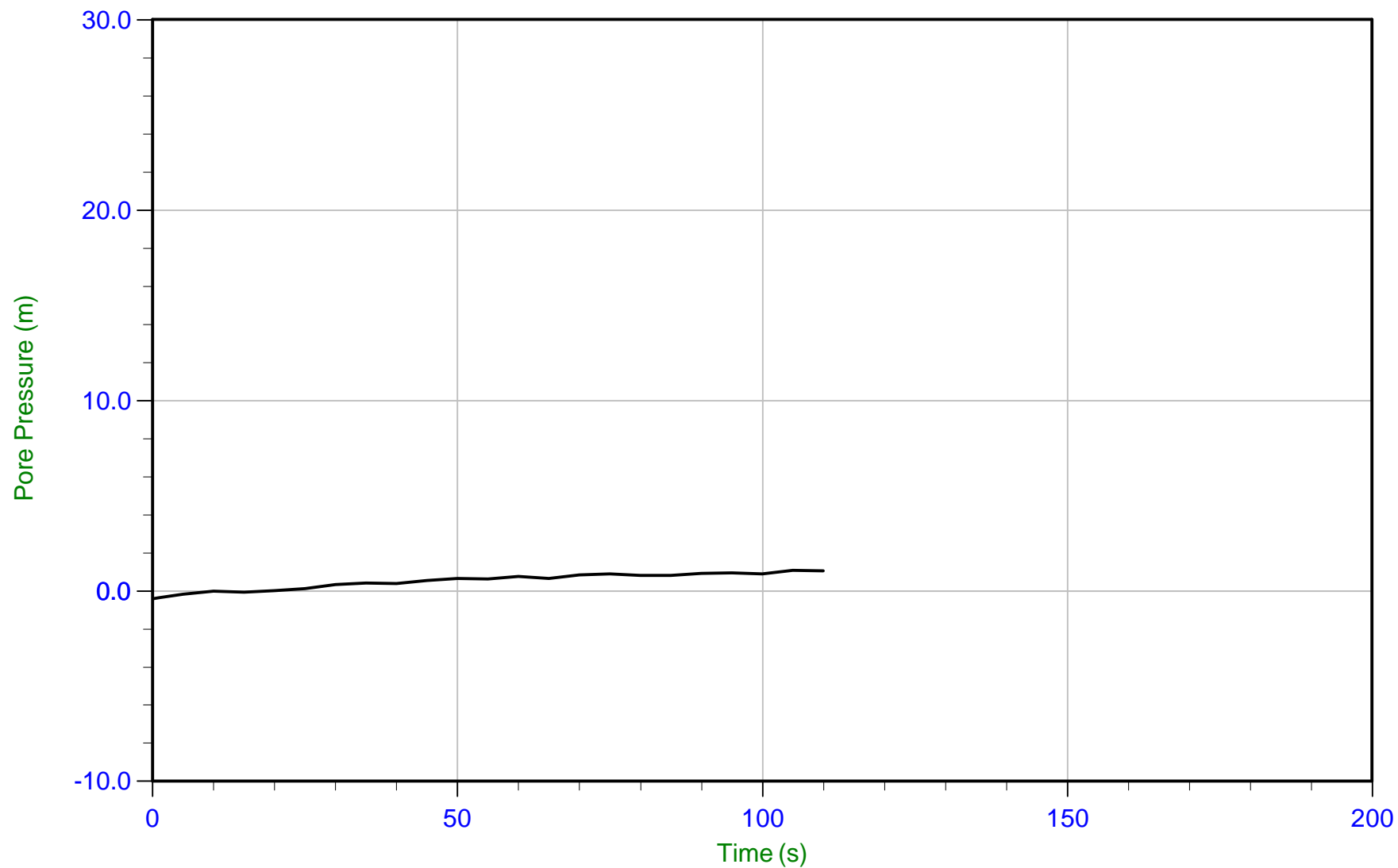
Job No: 18-05030

Date: 05/15/2018 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary:

Filename: 18-05030\_SP09.PPF

Depth: 1.350 m / 4.429 ft

Duration: 110.0 s

U Min: -0.4 m

U Max: 1.1 m



*Golder*

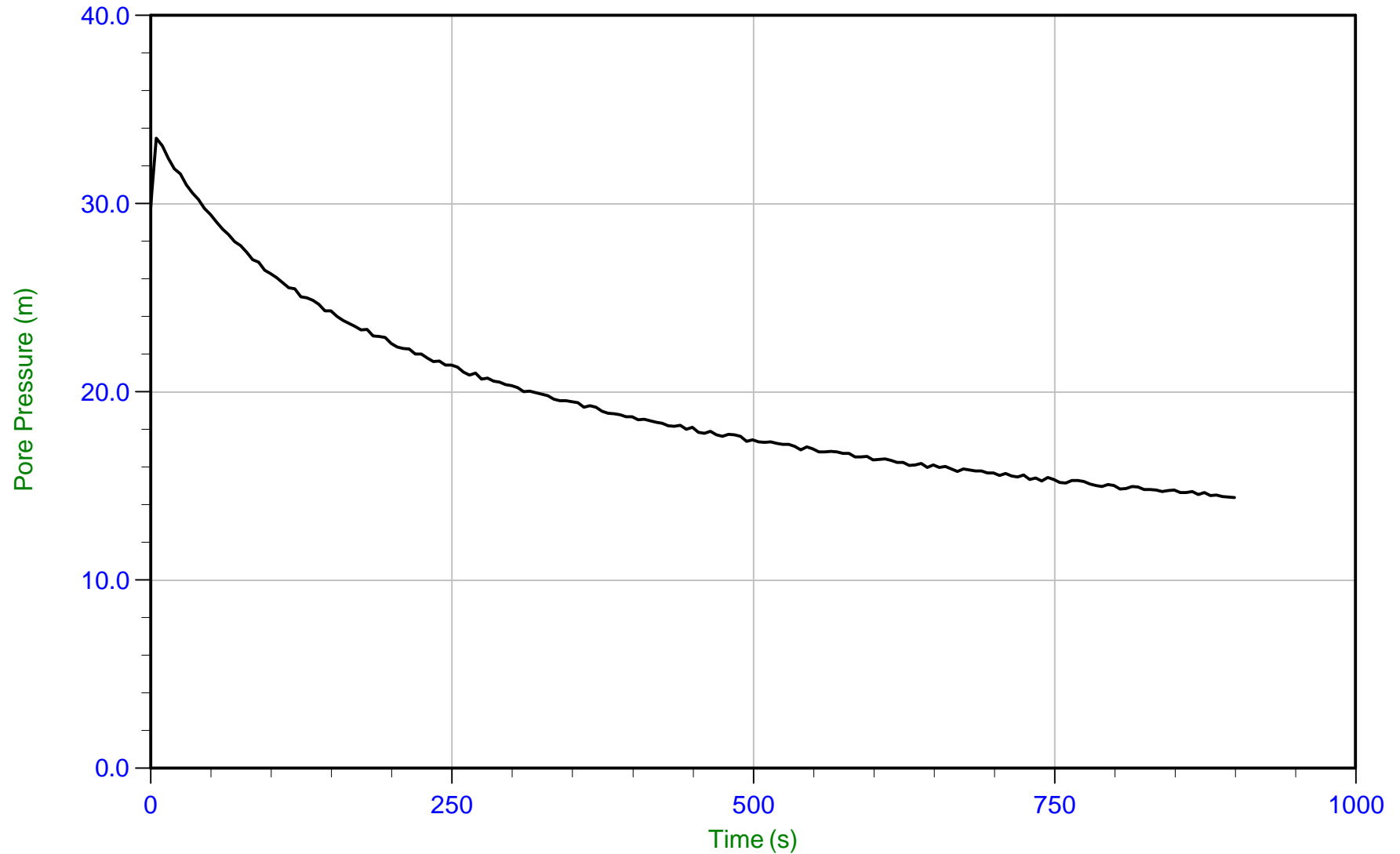
Job No: 18-05030

Date: 05/15/2018 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP09.PPF  
Depth: 6.250 m / 20.505 ft  
Duration: 900.0 s

U Min: 14.4 m  
U Max: 33.5 m

WT: 1.900 m / 6.234 ft  
Ueq: 4.3 m  
U(50): 18.92 m

T(50): 372.6 s  
Ir: 100  
Ch: 1.9 cm<sup>2</sup>/min



*Golder*

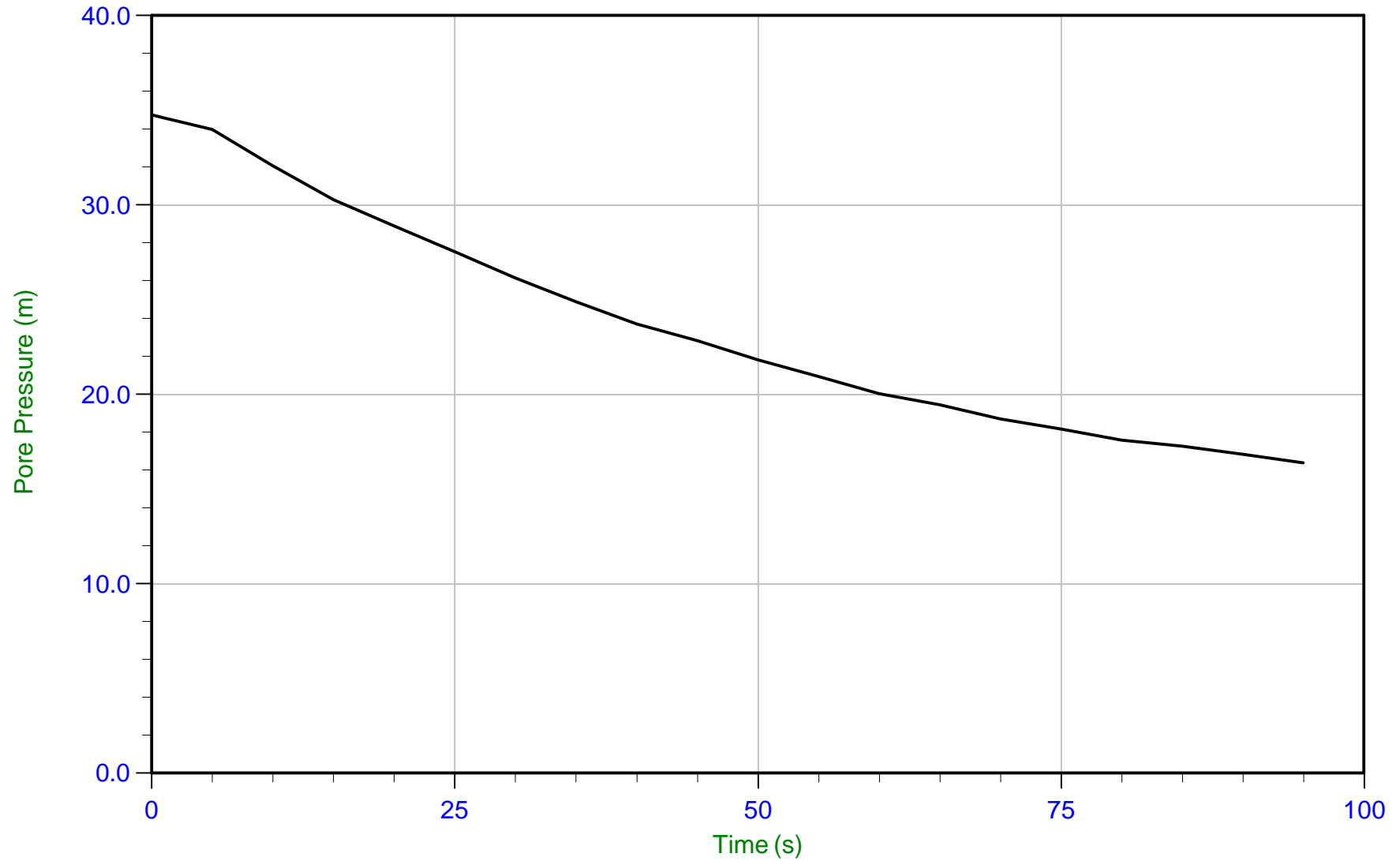
Job No: 18-05030

Date: 05/15/2018 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP09.PPF  
Depth: 9.300 m / 30.511 ft  
Duration: 95.0 s

U Min: 16.4 m  
U Max: 34.8 m

WT: 1.900 m / 6.234 ft  
Ueq: 7.4 m  
U(50): 21.08 m

T(50): 54.2 s  
Ir: 100  
Ch: 12.9 cm<sup>2</sup>/min



*Golder*

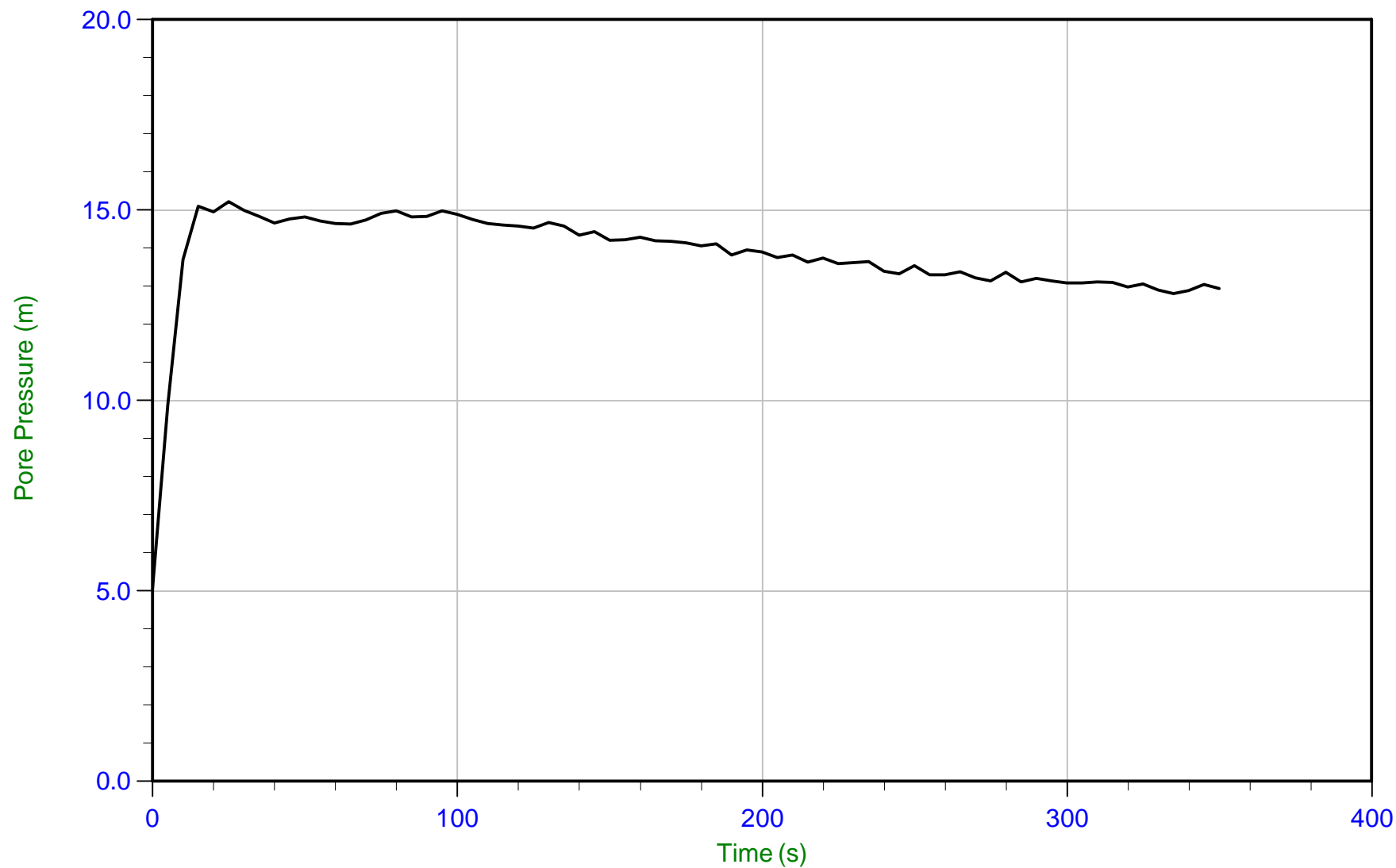
Job No: 18-05030

Date: 05/15/2018 08:36

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-09

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP09.PPF  
Depth: 10.500 m / 34.448 ft  
Duration: 350.0 s

U Min: 5.1 m  
U Max: 15.2 m



*Golder*

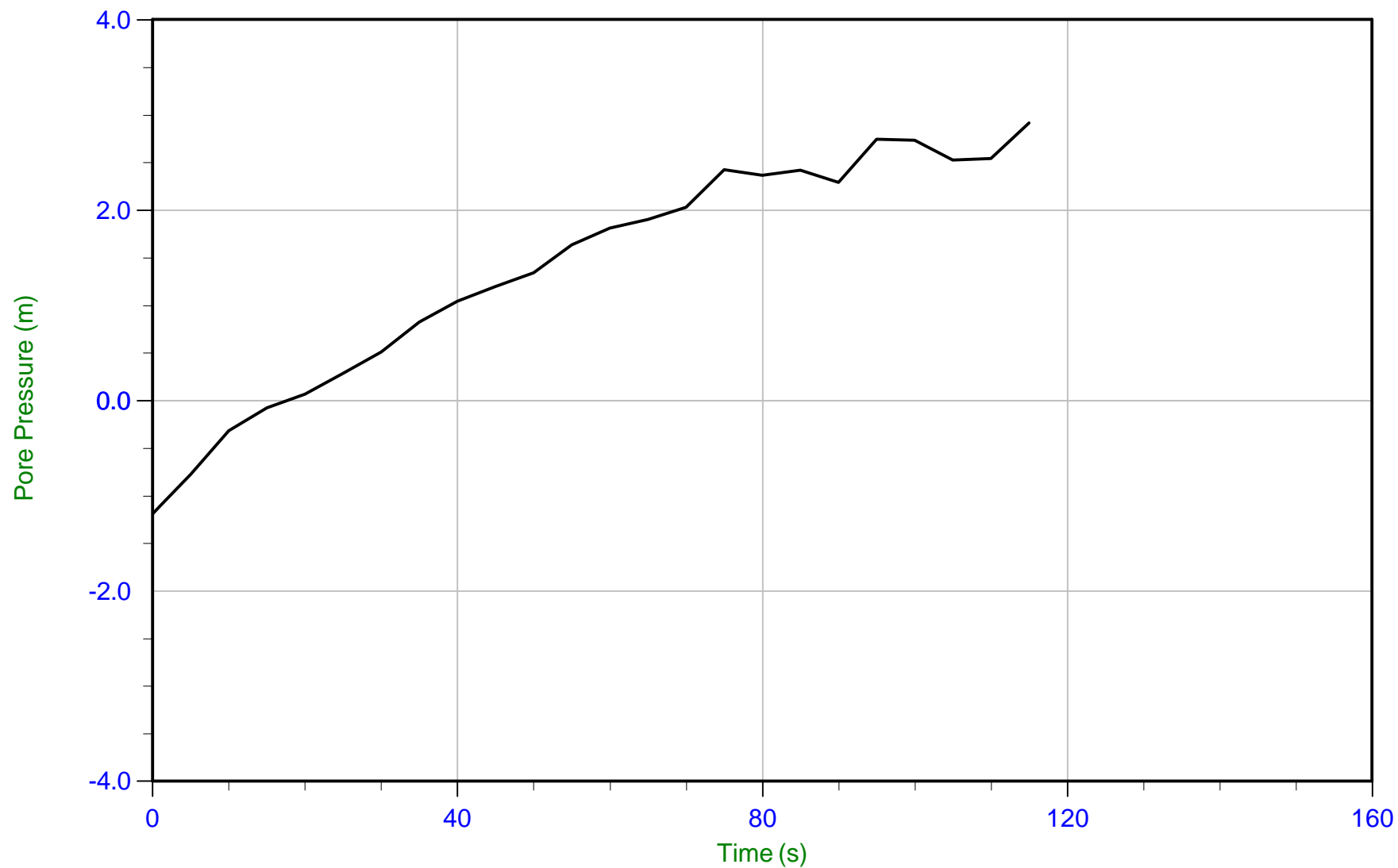
Job No: 18-05030

Date: 05/15/2018 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP10.PPF  
Depth: 1.225 m / 4.019 ft  
Duration: 115.0 s

U Min: -1.2 m  
U Max: 2.9 m



*Golder*

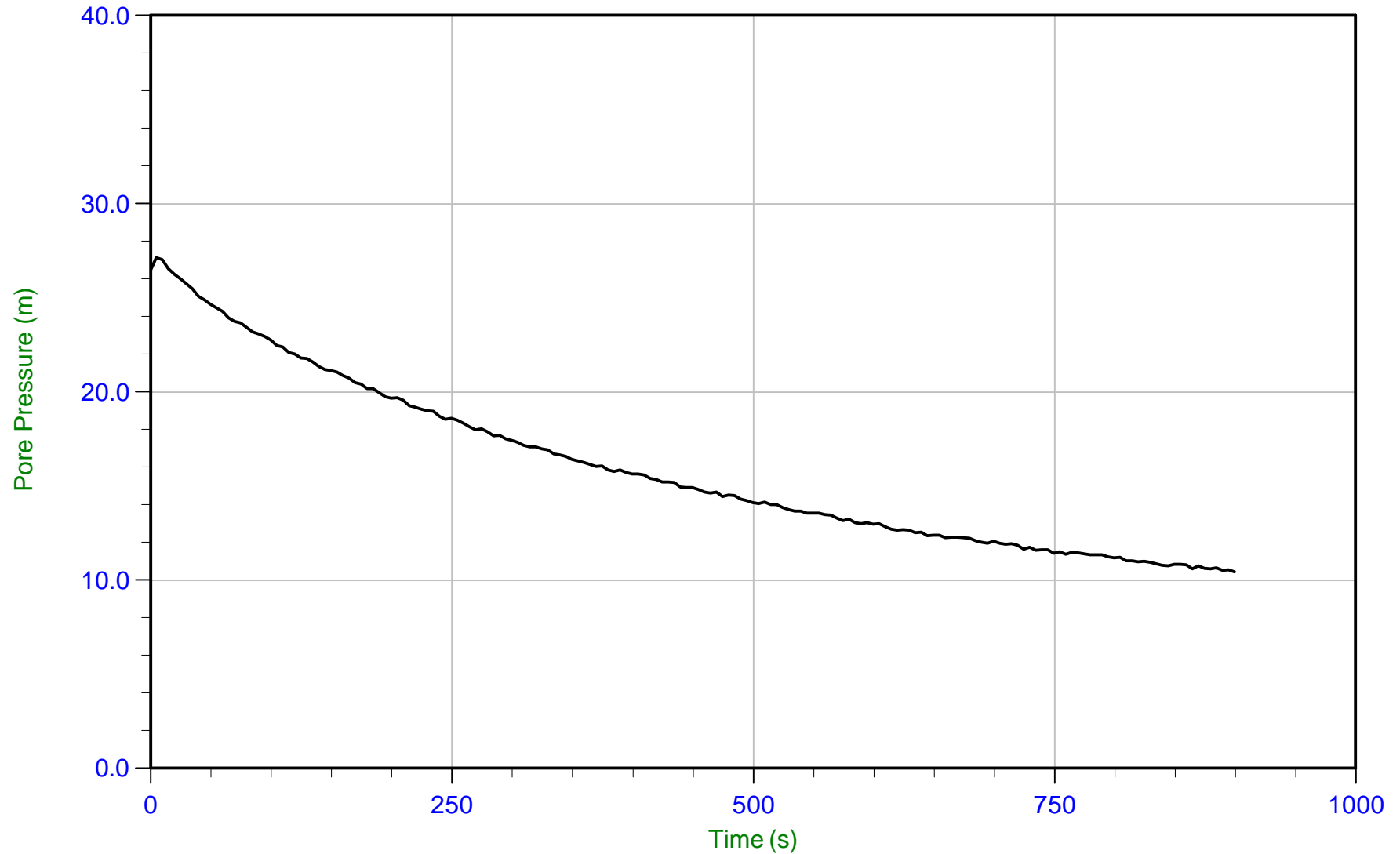
Job No: 18-05030

Date: 05/15/2018 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP10.PPF  
Depth: 4.225 m / 13.861 ft  
Duration: 900.0 s

U Min: 10.4 m  
U Max: 27.1 m

WT: 1.800 m / 5.905 ft  
Ueq: 2.4 m  
U(50): 14.77 m

T(50): 451.9 s  
Ir: 100  
Ch: 1.6 cm<sup>2</sup>/min



*Golder*

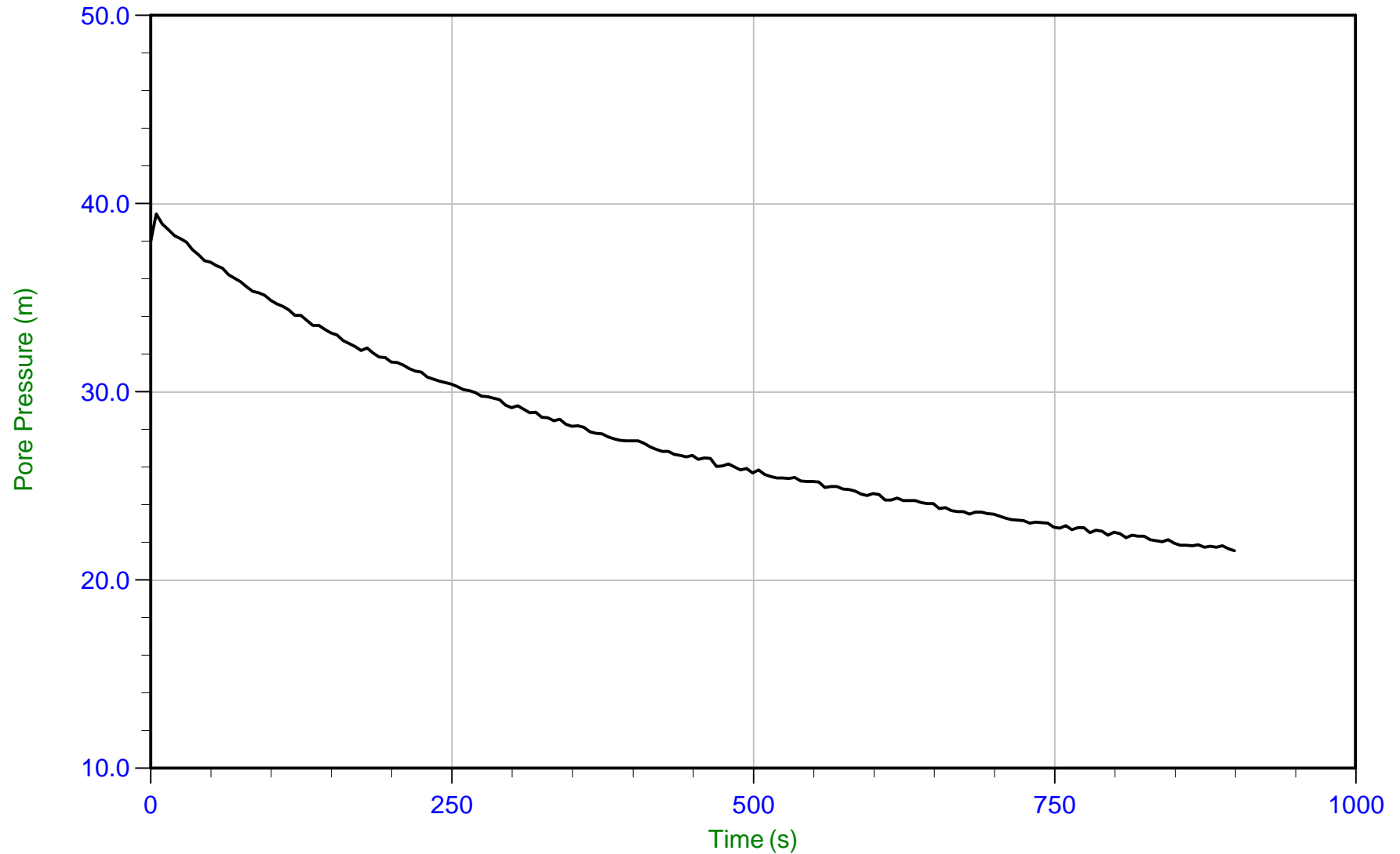
Job No: 18-05030

Date: 05/15/2018 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>



Trace Summary: Filename: 18-05030\_SP10.PPF  
Depth: 7.200 m / 23.622 ft  
Duration: 900.0 s

U Min: 21.6 m  
U Max: 39.5 m

WT: 1.800 m / 5.905 ft  
Ueq: 5.4 m  
U(50): 22.43 m

T(50): 788.9 s  
Ir: 100  
Ch: 0.9 cm<sup>2</sup>/min





*Golder*

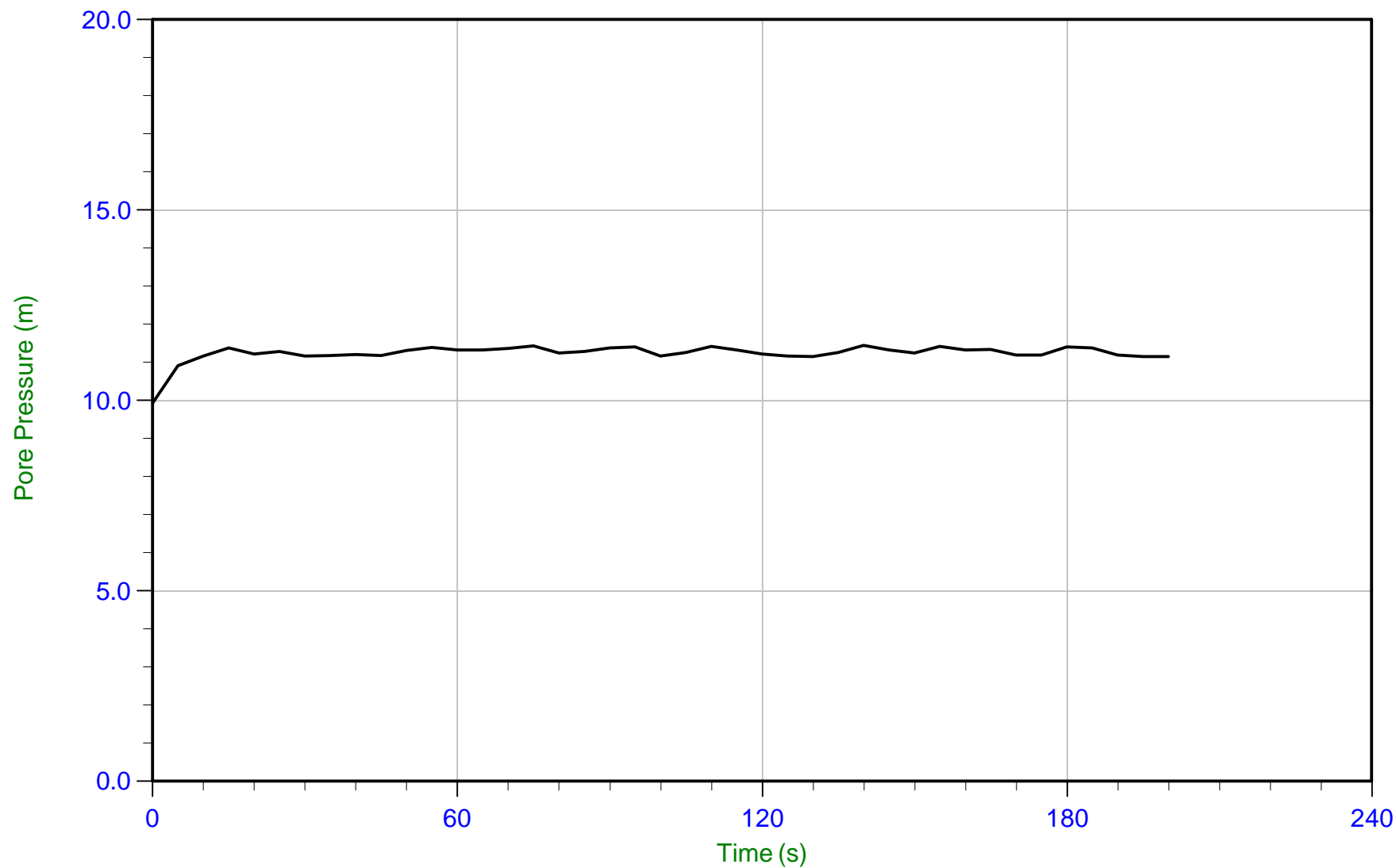
Job No: 18-05030

Date: 05/15/2018 12:01

Site: Hwy 416 and McKenna Casey Dr

Sounding: SCPT18-10

Cone: 330:T1500F15U500 Area=15 cm<sup>2</sup>

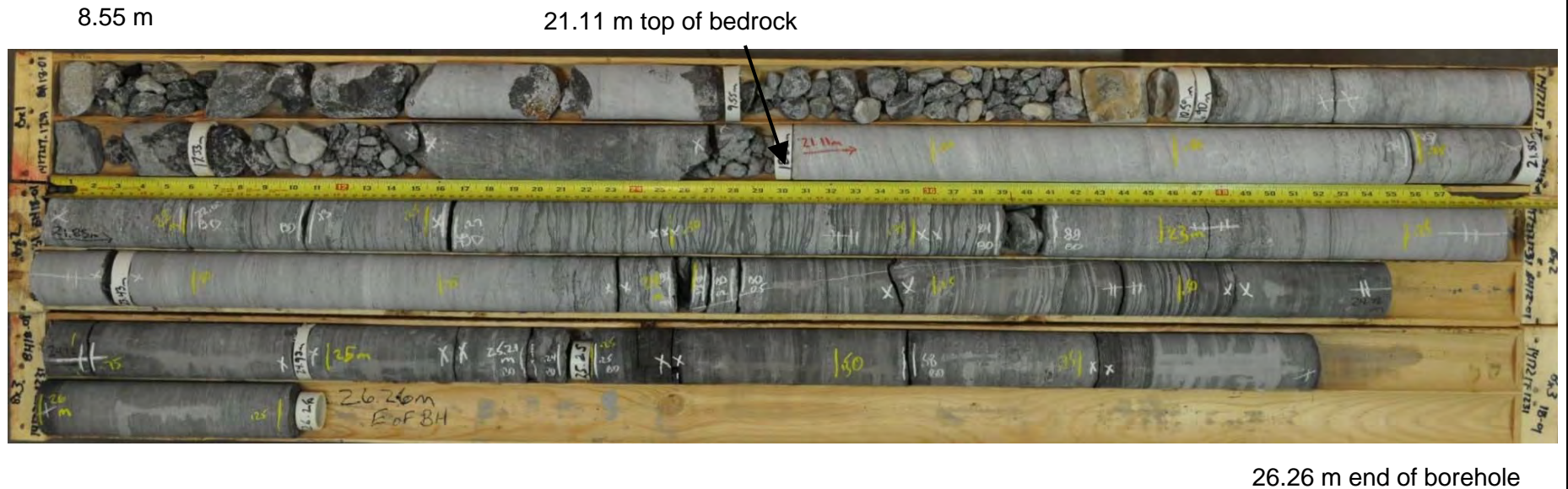


|                |                             |               |                        |
|----------------|-----------------------------|---------------|------------------------|
| Trace Summary: | Filename: 18-05030_SP10.PPF | U Min: 9.9 m  | WT: 0.194 m / 0.636 ft |
|                | Depth: 11.375 m / 37.319 ft | U Max: 11.5 m | Ueq: 11.2 m            |
|                | Duration: 200.0 s           |               |                        |

**APPENDIX D**

**Bedrock Core Photographs  
(Golder, 2018)**

**BH 18-01 (Dry)**  
**Cored Length of 8.55 to 26.26 metres**  
**Core Box 1 to 3 of 3**



Note: Materials in coreboxes from 8.55 to 21.11 metres is gravel and cobbles recovered from overburden.



**Geotechnical Investigation**  
**Hwy 416 Overpass Bridges at Strandherd Drive and CNR**  
**Ottawa, Ontario**

|             |            |
|-------------|------------|
| Project No. | 1417217    |
| Drawn:      | MVRD       |
| Date:       | 2018/06/06 |
| Checked:    | MJK        |
| Review:     | MSS        |

**Figure D1**

**BH 18-01 (Wet)**  
**Cored Length of 8.55 to 26.26 metres**  
**Core Box 1 to 3 of 3**

8.55 m

21.11 m top of bedrock



26.26 m end of borehole

Note: Materials in coreboxes from 8.55 to 21.11 metres is gravel and cobble recovered from overburden.



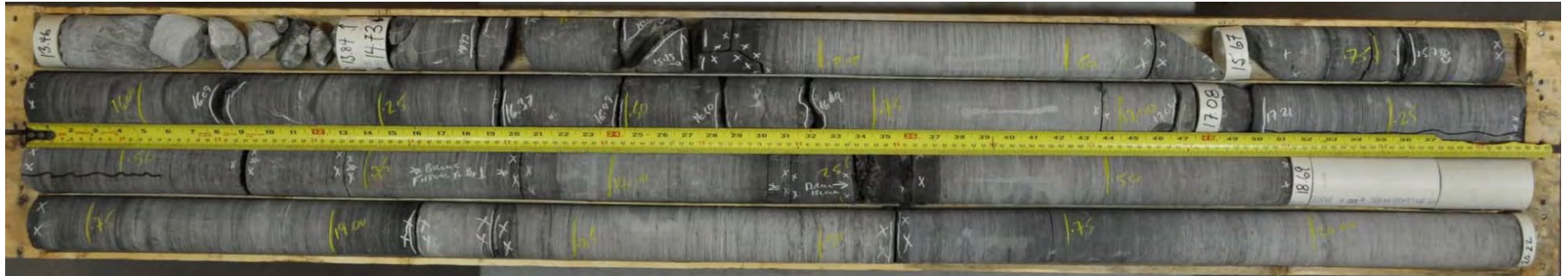
**Geotechnical Investigation**  
**Hwy 416 Overpass Bridges at Strandherd Drive and CNR**  
**Ottawa, Ontario**

|             |            |
|-------------|------------|
| Project No. | 1417217    |
| Drawn:      | MVRD       |
| Date:       | 2018/06/06 |
| Checked:    | MJK        |
| Review:     | MSS        |

**Figure D2**

**BH 18-02 (Dry)**  
**Cored Length of 14.73 to 20.22 metres**  
**Core Box 1 and 2 of 2**

14.73 m top of bedrock



20.22 m end of borehole

Note: Materials in coreboxes from 13.46 to 14.73 metres is gravel and cobbles recovered from overburden.



**Geotechnical Investigation**  
**Hwy 416 Overpass Bridges at Strandherd Drive and CNR**  
**Ottawa, Ontario**

|             |            |
|-------------|------------|
| Project No. | 1417217    |
| Drawn:      | MVRD       |
| Date:       | 2018/06/06 |
| Checked:    | MJK        |
| Review:     | MSS        |

**Figure D3**



**BH 18-02 (Wet)**  
**Cored Length of 14.73 to 20.22 metres**  
**Core Box 1 and 2 of 2**

14.73 m top of bedrock



20.22 m end of borehole

Note: Materials in coreboxes from 13.46 to 14.73 metres is gravel and cobbles recovered from overburden.



**Geotechnical Investigation**  
**Hwy 416 Overpass Bridges at Strandherd Drive and CNR**  
**Ottawa, Ontario**

|             |            |
|-------------|------------|
| Project No. | 1417217    |
| Drawn:      | MVRD       |
| Date:       | 2018/06/06 |
| Checked:    | MJK        |
| Review:     | MSS        |

**Figure D4**

**APPENDIX E**

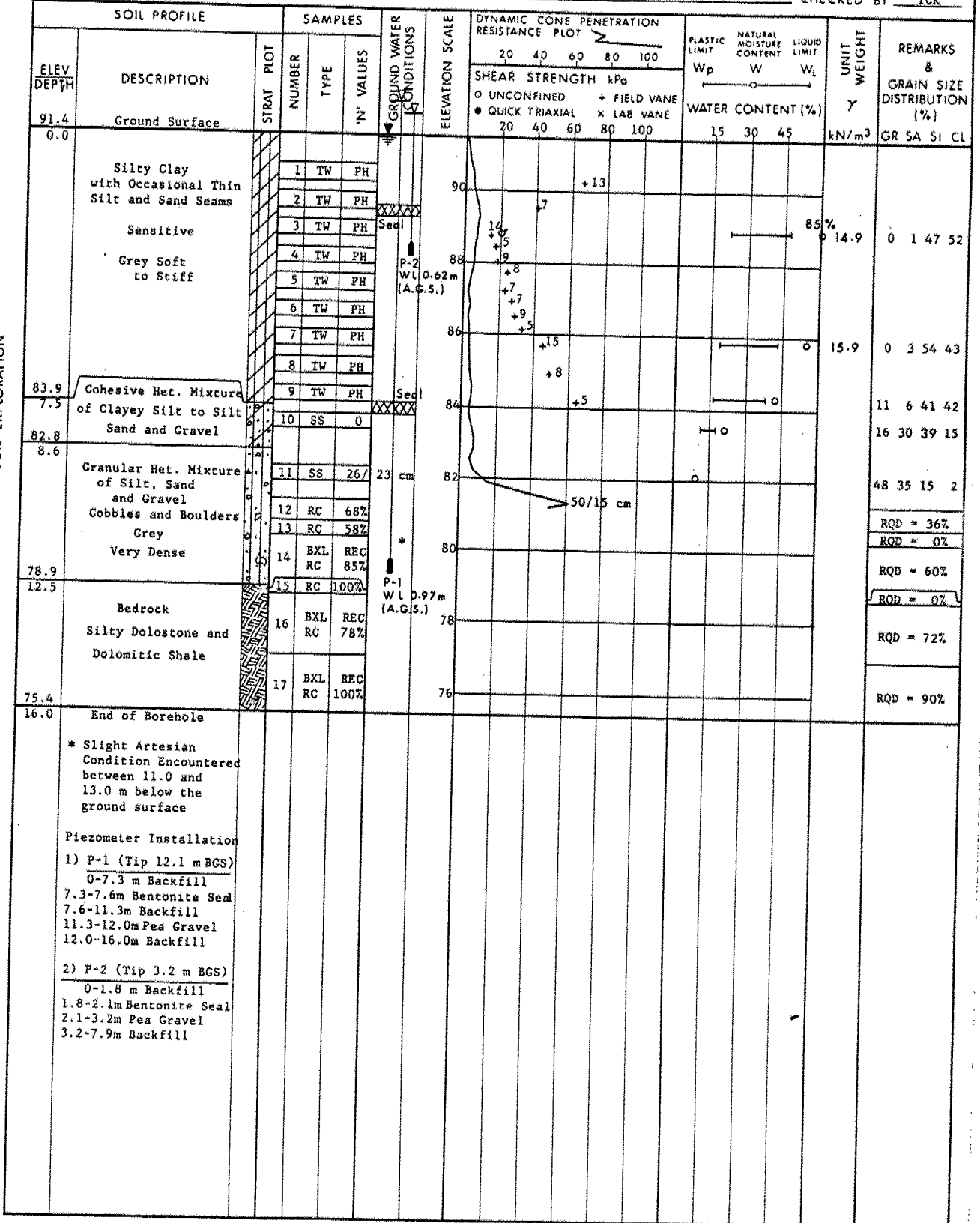
**Borehole and Drillhole Logs  
(1989 and 1991 Investigations)**

# RECORD OF BOREHOLE No 21A-1

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 683.1; E 360 968.9  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test  
 DATUM Geodetic DATE 89 05 08 - 09  
 ORIGINATED BY TK  
 COMPILED BY AL  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION



+3, x5: Numbers refer to  
Sensitivity  
20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 21A-2

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 697.7; E 360 962.8 ORIGINATED BY TCK  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test COMPILED BY AL  
 DATUM Geodetic DATE 89 05 09 - 10 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                         |            | SAMPLES |           |             | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE<br>20 40 60 80 100 | PLASTIC LIMIT<br>Wp | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID LIMIT<br>WL | WATER CONTENT (%)<br>Wp W WL | UNIT WEIGHT<br>γ<br>KN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------------------------------|------------|---------|-----------|-------------|----------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------|--------------------|------------------------------|---------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                             | STRAT PLOT | NUMBER  | TYPE      | 'N' VALUES  |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 91.4          | Ground Surface                                                                                          |            |         |           |             |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 0.0           | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Stiff |            | 1       | TW        | PH          |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       | 0 4 56 40                                                        |
|               |                                                                                                         |            | 2       | TW        | PH          |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 3       | TW        | PH          |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 4       | TW        | PH          |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 5       | TW        | PH          |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 83.9          | Cohesive Het. Mixture<br>of Clayey Silt to Silt                                                         |            | 6       | SS        | 0           |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       | 0 0 55 45                                                        |
| 7.5           | Sand and Gravel                                                                                         |            |         |           |             |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 82.8          | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Grey<br>Very Dense      |            | 7       | SS        | 110         |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       | 2 2 66 30                                                        |
| 8.6           |                                                                                                         |            | 8       | RC        | -           |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 9       | RC        | 100%        |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 10      | RC        | 88%         |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               |                                                                                                         |            | 11      | RC        | 92%         |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 79.3          | Bedrock                                                                                                 |            | 12      | RC        | 100%        |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 12.1          | Silty Dolostone and<br>Dolomitic Shale                                                                  |            | 13      | BXL<br>RC | 100%<br>REC |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 77.5          |                                                                                                         |            |         |           |             |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
| 13.9          | End of Borehole                                                                                         |            |         |           |             |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |
|               | * Slight Artesian<br>Condition Encountered<br>Below 9.8 m G.S.                                          |            |         |           |             |                            |                 |                                                                                                                                                                     |                     |                                     |                    |                              |                                       |                                                                  |

+3, x5: Numbers refer to 20  
Sensitivity 15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21A-3

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 698.3; E 360 953.2  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test  
 DATUM Geodetic DATE 89 05 10  
 ORIGINATED BY TCK  
 COMPILED BY AL  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE |                                                                                                             | SAMPLES     |        | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-------------------------------------------------------------------------------------------------------------|-------------|--------|-------------------------|-----------------|------------------------------------------|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION                                                                                                 | STRAT. PLOT | NUMBER |                         |                 |                                          |                                 |                               |                                |                  |                                       |
| 91.5         | Ground Surface                                                                                              |             |        |                         |                 |                                          |                                 |                               |                                |                  |                                       |
| 0.0          | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Stiff     |             | 1      | TW                      | PH              |                                          |                                 |                               |                                |                  |                                       |
|              |                                                                                                             |             | 2      | TW                      | PH              |                                          |                                 |                               |                                |                  |                                       |
|              |                                                                                                             |             | 3      | TW                      | PH              |                                          |                                 |                               |                                |                  |                                       |
|              |                                                                                                             |             | 4      | TW                      | PH              |                                          |                                 |                               |                                |                  |                                       |
| 84.2         | Cohesive Het. Mixture                                                                                       |             |        |                         |                 |                                          |                                 |                               |                                |                  | 3 5 56 36                             |
| 7.3          | Clayey Silt to Silt                                                                                         |             |        |                         |                 |                                          |                                 |                               |                                |                  |                                       |
| 82.9         | Sand and Gravel                                                                                             |             | 5      | SS                      | 2/38 cm         |                                          |                                 |                               |                                |                  | 2 29 48 21                            |
| 8.6          | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Grey<br>Dense to Very Dense |             | 6      | SS                      | 35              |                                          |                                 |                               |                                |                  | 45 38 13 4                            |
|              |                                                                                                             |             | 7      | SS                      | Bouncing *      |                                          |                                 |                               |                                |                  |                                       |
| 79.6         |                                                                                                             |             | 8      | RC                      | REC 100%        |                                          |                                 |                               |                                |                  |                                       |
| 11.9         | Bedrock                                                                                                     |             | 9      | RC                      | -               |                                          |                                 |                               |                                |                  | RQD = 77%                             |
| 78.1         | Silty Dolostone and<br>Dolomitic Shale                                                                      |             | 10     | BXL RC                  | REC 100%        |                                          |                                 |                               |                                |                  | RQD = 76%                             |
| 13.4         | End of Borehole                                                                                             |             |        |                         |                 |                                          |                                 |                               |                                |                  |                                       |
|              | * Slight Artesian Condition Encountered Below 10.7 m G.S.                                                   |             |        |                         |                 |                                          |                                 |                               |                                |                  |                                       |

+3, x5: Numbers refer to 20  
 15 5 (%) STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 21A-4

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 736.8; E 360 946.7  
DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BXL Rock Coring & Cone Test  
DATUM Geodetic DATE 89 05 04  
ORIGINATED BY TS  
COMPILED BY TCK  
CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                         |            | SAMPLES |           |             | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE LIMIT<br>CONTENT |                   |          | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------------------------------|------------|---------|-----------|-------------|----------------------------|--------------------|---------------------------------------------|-----------------|-----------------------------------------------------------|-------------------|----------|---------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                             | STRAT PLOT | NUMBER  | TYPE      | 'N' VALUES  |                            |                    | 20 40 60 80 100                             | 20 40 60 80 100 | W <sub>p</sub> W W <sub>L</sub>                           | WATER CONTENT (%) | 15 30 45 |                     |                                                                  |
| 91.8<br>0.0   | Ground Surface                                                                                          |            |         |           |             |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Stiff |            | 1       | SS        | 4           |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 2       | TW        | PH          |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 3       | TW        | PH          |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 4       | TW        | PH          |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
| 85.6<br>6.2   | Cohesive Het. Mixture<br>of Clayey Silt to Silt<br>Sand and Gravel                                      |            | 5       | TW        | PH          |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 6       | SS        | 12          |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
| 82.4<br>9.4   | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Very Dense              |            | 7       | SS        | 8           |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 8       | RC        | 58%         |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 9       | RC        | REC<br>32%  |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 10      | RC        | REC<br>27%  |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
| 79.3<br>12.5  | Bedrock<br>Silty Dolostone and<br>Dolomitic Shale                                                       |            | 11      | RC        | 65%         |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 12      | BXL<br>RC | REC<br>100% |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
|               |                                                                                                         |            | 13      | BXL<br>RC | REC<br>100% |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |
| 76.0<br>15.8  | End of Borehole                                                                                         |            |         |           |             |                            |                    |                                             |                 |                                                           |                   |          |                     |                                                                  |

+3, x5: Numbers refer to  
Sensitivity  
20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21A-5

METRIC

W P 128-87-05/06

LOCATION Co-ords. N 5 012 758.8; E 360 937.5

ORIGINATED BY TCK

DIST 9 HWY 416

BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test

COMPILED BY AL

DATUM Geodetic

DATE 89 05 05 - 06

CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE |                                                     |            | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |    |
|--------------|-----------------------------------------------------|------------|---------|------|------------|-------------------------|-----------------|------------------------------------------|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|----|
| ELEV DEPTH   | DESCRIPTION                                         | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                         |                 | 20                                       | 40 |                                 |                               |                                |                  |                                       | 60 |
| 92.0         | Ground Surface                                      |            |         |      |            |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 0.0          | Silty Clay With Occasional Thin Silt and Sand Seams |            | 1       | SS   | 3          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|              | Sensitive                                           |            | 2       | TW   | PH         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|              | Grey Soft to Stiff                                  |            | 3       | TW   | PH         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 86.5         |                                                     |            | 4       | TW   | PH         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 5.5          | Granular Het. Mixture of Silt, Sand and Gravel      |            | 5       | SS   | 5          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|              | Cobbles and Boulders                                |            | 6       | SS   | 10         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 81.9         |                                                     |            | 7       | SS   | 4          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 10.1         | Sandy Silt Trace of Gravel Very Loose               |            | 8       | SS   | 1          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 79.9         |                                                     |            | 9       | SS   | 34         | 8 cm                    |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 12.1         | Loose to Very Dense                                 |            | 10      | RC   | 100%       | REC                     |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 79.2         |                                                     |            | 12      | RC   | 86%        | REC                     |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 12.8         | Bedrock                                             |            | 13      | RC   | 100%       | REC                     |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|              | Silty Dolostone and Dolomitic Shale                 |            | 14      | BXL  | REC        |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 77.2         |                                                     |            |         | RC   | 93%        |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 14.8         | End of Borehole                                     |            |         |      |            |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |

+3, x5: Numbers refer to Sensitivity  
20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21A-6

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 775.5; E 360 930.4 ORIGINATED BY TCK  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test COMPILED BY AL  
 DATUM Geodetic DATE 89 05 05 - 06 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                           |            | SAMPLES |           |             | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|-----------------------------------------------------------|------------|---------|-----------|-------------|----------------------------|-----------------|---------------------------------------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                               | STRAT PLOT | NUMBER  | TYPE      | 'N' VALUES  |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 |                                    |                                     |                                   |                     |                                                   |
| 92.3<br>0.0   | Ground Surface                                            |            |         |           |             |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               | Silty Clay With<br>Occasional Thin Silt<br>and Sand Seams |            | 1       | TW        | PH          |                            | 92              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                           |            | 2       | TW        | PH          |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               | Sensitive                                                 |            | 3       | TW        | PH          |                            | 90              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               | Grey Soft<br>to Stiff                                     |            | 4       | TW        | PH          |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 87.7          |                                                           |            | 5       | TW        | PH          |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 4.6           | Cohesive Het. Mixture<br>Clayey Silt to Silt              |            | 6       | TW        | PH          |                            | 88              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 86.5          | Sand and Gravel                                           |            | 7       | TW        | PH          |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 5.8           |                                                           |            | 8       | SS        | 5           |                            | 86              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel      |            | 9       | SS        | 8           |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
|               | Cobbles and Boulders                                      |            | 10      | SS        | 7           |                            | 84              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 82.2          |                                                           |            | 11      | SS        | 4           |                            | 82              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 10.1          | Sandy Silt<br>Trace of Gravel                             |            | 12      | SS        | -           |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 80.6          | Loose                                                     |            | 13      | BXL<br>RC | REC<br>14%  |                            | 80              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 11.7          | Loose to Very Dense                                       |            | 14      | BXL<br>RC | REC<br>100% |                            | 78              |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 78.9          |                                                           |            |         |           |             |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 13.4          | Bedrock<br>Silty Dolostone<br>and Dolomitic Shale         |            |         |           |             |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 77.6          |                                                           |            |         |           |             |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |
| 14.7          | End of Borehole                                           |            |         |           |             |                            |                 |                                             |                 |                                    |                                     |                                   |                     |                                                   |

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 21A-7

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 790.2; E 360 924.4  
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test  
DATUM Geodetic DATE 89 05 04 - 05  
ORIGINATED BY TCK  
COMPILED BY AL  
CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                       |            | SAMPLES |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE LIMIT<br>W <sub>p</sub> W W <sub>L</sub> |          |  | UNIT<br>WEIGHT<br>γ<br>KN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------------|------------|---------|------|----------------------------|-----------------|---------------------------------------------|-----------------|-----------------------------------------------------------------------------------|----------|--|------------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                           | STRAT PLOT | NUMBER  | TYPE |                            |                 | VALUES                                      | 20 40 60 80 100 | 20 40 60 80 100                                                                   | 15 30 45 |  |                                          |                                                                  |
| 92.5          | Ground Surface                                                                        |            |         |      |                            |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 0.0           | Silty Clay with Occasional Thin Silt and Sand Seams Sensitive Grey Soft to Very Stiff |            | 1       | TW   | PH                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 2       | TW   | PH                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 3       | TW   | PH                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 88.7          |                                                                                       |            | 4       | TW   | PH                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 3.8           | Cohesive Het. Mixture of Clayey Silt to Silt Sand and Gravel                          |            | 5       | TW   | refusal                    |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 87.3          |                                                                                       |            | 6       | SS   | 0                          |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 5.2           | Sand with Gravel Some Silt Grey Loose to Compact                                      |            | 7       | SS   | 1                          |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 8       | SS   | 7                          |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 9       | SS   | 5                          |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 10      | SS   | 13                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 11      | SS   | 13                         |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 82.4          |                                                                                       |            | 12      | SS   | 52                         | 13 cm           |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 10.1          | Granular Het. Mixture of Silt, Sand and Gravel Cobbles and Boulders Very Dense        |            | 13      | BXL  | REC                        |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 14      | RC   | 38%                        |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
|               |                                                                                       |            | 15      | RC   | 58%                        | REC             |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 78.2          |                                                                                       |            | 16      | BXL  | REC                        |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 14.3          | Bedrock Silty Dolostone and Dolomitic Shale                                           |            |         | RC   | 59%                        |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 76.6          |                                                                                       |            |         | RC   | 100%                       |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |
| 15.9          | End of Borehole                                                                       |            |         |      |                            |                 |                                             |                 |                                                                                   |          |  |                                          |                                                                  |

+3, x5; Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 21A-8

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 634.0; E 360 984.7  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger and Cone Test ORIGINATED BY TS  
 DATUM Geodetic DATE 89 05 09 COMPILED BY TCK  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE   |                                                                                                        |             | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|----------------|--------------------------------------------------------------------------------------------------------|-------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|---------------------------------|-------------------------------------|--------------------------------|------------------|---------------------------------------------------|
| ELEV.<br>DEPTH | DESCRIPTION                                                                                            | STRAT. PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
| 91.3<br>0.0    | Ground Surface                                                                                         |             |         |      |            |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
|                | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br>Grey Soft<br>to Stiff    |             | 1       | SS   | 5          |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
|                |                                                                                                        |             | 2       | TW   | PH         |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
|                |                                                                                                        |             | 3       | TW   | PH         |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
|                |                                                                                                        |             | 4       | TW   | PH         |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
|                |                                                                                                        |             | 5       | TW   | PH         |                            |                 |                                             |                                 |                                     |                                |                  |                                                   |
| 83.7<br>7.6    | Cohesive Het. Mixture<br>of Clayey Silt to Silt<br>Sand and Gravel                                     |             | 6       | SS   | 1          |                            |                 |                                             |                                 |                                     |                                | 18.9             | 0 21 55 24                                        |
| 82.5<br>8.8    | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Very Loose to V. Dense |             | 7       | SS   | 2          |                            |                 |                                             |                                 |                                     |                                |                  | 1 11 43 45                                        |
| 80.2<br>11.1   | End of Borehole                                                                                        |             | 8       | SS   | 100/25     |                            |                 |                                             |                                 |                                     |                                |                  | 1 14 55 30                                        |
|                | * Slight Artesian<br>Condition Encountered<br>below 10.7 m G.S.                                        |             |         |      |            |                            |                 |                                             |                                 |                                     |                                |                  | 22 57 18 3                                        |

+3, x5; Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 21A-9

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 661.6; E 360 973.3 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK  
 DATUM Geodetic DATE 89 05 08 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                         |            | SAMPLES |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE CONTENT LIMIT |                |   | UNIT<br>WEIGHT<br>Y<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------------------------------|------------|---------|------|----------------------------|-----------------|---------------------------------------------|-----------------|--------------------------------------------------------|----------------|---|------------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                             | STRAT PLOT | NUMBER  | TYPE |                            |                 | VALUES                                      | 20 40 60 80 100 | 20 40 60 80 100                                        | W <sub>p</sub> | W |                                          |                                                                  |
| 91.3          | Ground Surface                                                                                          |            |         |      |                            |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
| 0.0           | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Gray Soft<br>to Stiff |            | 1       | SS   | 4                          |                 |                                             |                 |                                                        |                |   | 19.2                                     | 4 14 58 24                                                       |
|               |                                                                                                         |            | 2       | TW   | PH                         |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
|               |                                                                                                         |            | 3       | TW   | PH                         |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
|               |                                                                                                         |            | 4       | TW   | PH                         |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
| 83.7          | Cohesive Het. Mixture<br>of Clayey Silt to Silt                                                         |            | 5       | SS   | 4                          |                 |                                             |                 |                                                        |                |   |                                          | 0 1 40 59                                                        |
| 7.6           | Sand and Gravel                                                                                         |            |         |      |                            |                 |                                             |                 |                                                        |                |   |                                          | 32 37 24 7                                                       |
| 82.5          | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel                                                    |            | 6       | SS   | 16                         |                 |                                             |                 |                                                        |                |   |                                          | 22 46 26 6                                                       |
| 8.8           | Cobbles and Boulders<br>Compact to Very Dense                                                           |            | 7       | SS   | 100/18 cm                  |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
| 80.3          | End of Borehole                                                                                         |            |         |      |                            |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |
| 11.0          |                                                                                                         |            |         |      |                            |                 |                                             |                 |                                                        |                |   |                                          |                                                                  |

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 21A-10

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 805.7; E 360 913.3  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger ORIGINATED BY TS  
 DATUM Geodetic DATE 89 05 06 COMPILED BY TCK  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                        |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|----------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                            | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20                                          | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     |                                                   |
| 94.4          | Ground Surface                         |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 0.0           | Sand and Gravel                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 93.0          | Brown (Fill)                           |            | 1       | SS   | 11         |                            | 94              |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 1.4           | Silty Clay Brown<br>With Grey          |            | 2       | SS   | 10         |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | Occasional Thin<br>Silt and Sand Seams |            | 3       | SS   | 7          |                            | 92              |                                             |    |    |    |     |                                    |                                     |                                   |                     | 0 10 52 38                                        |
| 90.7          |                                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 3.7           | Cohesive Het. Mixture                  |            | 4       | SS   | 20         |                            | 90              |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | Clayey Silt to Silt                    |            | 5       | SS   | 6          |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | 7 14 35 44                                        |
| 88.8          | Sand and Gravel                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 5.6           | Sand with Gravel                       |            | 6       | SS   | 70         |                            | 88              |                                             |    |    |    |     |                                    |                                     |                                   |                     | 41 47 8 4                                         |
| 87.3          | Some Silt, Grey                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 7.1           | Very Dense                             |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | Granular Het. Mixture                  |            | 7       | SS   | 18         |                            | 86              |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | of Silt, Sand                          |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | and Gravel                             |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 84.8          | Grey, Compact                          |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               |                                        |            | 8       | SS   | 11         |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 9.6           | End of Borehole                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | 6 32 52 10                                        |

+3, x5: Numbers refer to 20  
Sensitivity 15 ± 5 (%) STRAIN AT FAILURE  
10

## RECORD OF BOREHOLE No 21A-11

METRIC

W P 128-87-05/06

LOCATION Co-ords. N 5 012 830.0; E 360 893.5

ORIGINATED BY TS

DIST 9 HWY 416

BOREHOLE TYPE HS Auger

COMPILED BY TCK

DATUM Geodetic

DATE 89 05 06

CHECKED BY        TCK

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

15-20 5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 21B-1

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 657.0; E 360 938.6  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, EXL Rock Coring & Cone Test ORIGINATED BY TCK  
 DATUM Geodetic DATE 89 05 09 COMPILED BY AL  
 CHECKED BY TCK

| SOIL PROFILE  |                                                                                                     |            | SAMPLES |           | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE<br>20 40 60 80 100 | PLASTIC LIMIT<br>Wp<br>NATURAL MOISTURE<br>CONTENT<br>W<br>LIQUID LIMIT<br>Wl<br>WATER CONTENT (%)<br>15 30 45 | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|-----------------------------------------------------------------------------------------------------|------------|---------|-----------|----------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                         | STRAT PLOT | NUMBER  | TYPE      |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 91.3          | Ground Surface                                                                                      |            |         |           |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 0.0           |                                                                                                     |            | 1       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
|               | Silty Clay                                                                                          |            | 2       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
|               | With Occasional Thin<br>Silt and Sand Seams                                                         |            | 3       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
|               | Sensitive                                                                                           |            | 4       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
|               | Grey Soft<br>to Firm                                                                                |            | 5       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 83.8          |                                                                                                     |            | 6       | TW        | PH                         |                 |                                                                                                                                                                     |                                                                                                                | 15.3                                  | 0 0 52 48                                                        |
| 7.5           | Cohesive Het. Mixture<br>of Clayey Silt to Silt<br>Sand and Gravel                                  |            | 7       | SS        | 6                          |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 82.7          |                                                                                                     |            | 8       | SS        | Refusal                    |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 8.6           | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Loose to Very Dense |            | 9       | EXL<br>RC | REC<br>100%                |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 80.5          |                                                                                                     |            |         |           |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 10.8          | Bedrock                                                                                             |            |         |           |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 79.0          | Silty Dolostone<br>and Dolomitic Shale                                                              |            |         |           |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       |                                                                  |
| 12.3          | End of Borehole                                                                                     |            |         |           |                            |                 |                                                                                                                                                                     |                                                                                                                |                                       | RQD = 87%                                                        |

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 21B-2

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 671.7; E 360 932.5 ORIGINATED BY TCK  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring & Cone Test COMPILED BY AL  
 DATUM Geodetic DATE 89 05 08 - 09 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                     |            | SAMPLES |           |             | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE<br>20 40 60 80 100 | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE<br>CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|-----------------------------------------------------------------------------------------------------|------------|---------|-----------|-------------|----------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------|--------------------------------|---------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                         | STRAT PLOT | NUMBER  | TYPE      | 'N' VALUES  |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
| 91.4<br>0.0   | Ground Surface                                                                                      |            |         |           |             |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br>Sensitive<br>Grey Soft<br>to Stiff     |            | 1       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 2       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 3       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 5       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 6       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 7       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 8       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 9       | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
| 83.9<br>7.5   | Granular Mat. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Loose to Very Dense |            | 10      | TW        | PH          |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 11      | SS        | 4           |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
| 80.6<br>10.8  | Bedrock<br>Silty Dolostone and<br>Dolomitic Shale                                                   |            | 12      | SS        | Refusal *   |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               |                                                                                                     |            | 13      | BXL<br>RC | REC<br>100% |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
| 77.7          |                                                                                                     |            | 14      | BXL<br>RC | REC<br>98%  |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
| 13.7          | End of Borehole                                                                                     |            |         |           |             |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |
|               | * Slight Artesian<br>Condition Encountered<br>Below 10.7 m B.G.                                     |            |         |           |             |                            |                 |                                                                                                                                                                     |                                 |                                  |                                |                                       |                                                                  |

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (5%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21B-4

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 710.6; E 360 916.3  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger, Washboring, BXL Rock Coring & Cone Test  
 DATUM Geodetic DATE 89 05 03 - 04  
 ORIGINATED BY TS  
 COMPILED BY TCK  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE |                                                                                                        | SAMPLES |           | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|--------------------------------------------------------------------------------------------------------|---------|-----------|-------------------------|-----------------|------------------------------------------|-----------------|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION                                                                                            | NUMBER  | TYPE      |                         |                 | VALUES                                   | 20 40 60 80 100 |                                 |                               |                                |                  |                                       |
| 91.8         | Ground Surface                                                                                         |         |           |                         |                 |                                          |                 |                                 |                               |                                |                  |                                       |
| 0.0          | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Firm | 1       | SS        | 4                       |                 |                                          |                 |                                 |                               |                                | 15.2             | 0 1 42 57                             |
|              |                                                                                                        | 2       | TW        | PH                      |                 |                                          |                 |                                 |                               |                                |                  |                                       |
|              |                                                                                                        | 3       | TW        | PM                      |                 |                                          |                 |                                 |                               |                                |                  |                                       |
|              |                                                                                                        | 4       | SS        | 2                       |                 |                                          |                 |                                 |                               |                                |                  |                                       |
| 84.7         |                                                                                                        | 5       | TW        | PH                      |                 |                                          |                 |                                 |                               |                                |                  | 1 11 33 55                            |
| 7.1          | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br><br>Loose              | 6       | SS        | 1                       |                 |                                          |                 |                                 |                               |                                |                  | 25 29 36 10                           |
|              |                                                                                                        | 7       | SS        | 5                       |                 |                                          |                 |                                 |                               |                                |                  |                                       |
| 81.1         |                                                                                                        | 8       | SS        | Bouncing                |                 |                                          |                 |                                 |                               |                                |                  |                                       |
| 10.7         | Bedrock<br>Silty Dolostone<br>and Dolomitic Shale                                                      | 9       | BXL<br>RC | REC<br>98%              |                 |                                          |                 |                                 |                               |                                |                  | RQD = 55%                             |
| 79.6         |                                                                                                        |         |           |                         |                 |                                          |                 |                                 |                               |                                |                  |                                       |
| 12.2         | End of Borehole                                                                                        |         |           |                         |                 |                                          |                 |                                 |                               |                                |                  |                                       |

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 21B-5

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 732.7; E 360 907.1  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, BXL Rock Coring & Cone Test  
 DATUM Geodetic DATE 89 05 04  
 ORIGINATED BY TS  
 COMPILED BY TCK  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                        |            | SAMPLES |           |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--------------------------------------------------------------------------------------------------------|------------|---------|-----------|------------|----------------------------|-----------------|---------------------------------------------|-----------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                            | STRAT PLOT | NUMBER  | TYPE      | 'N' VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | 20 40 60 80 100 |                                    |                                     |                                   |                     |                                                   |
| 92.1          | Ground Surface                                                                                         |            |         |           |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 0.0           | Silty Clay With<br>Occasional Thin Silt<br>and Sand Seams<br>Sensitive<br>Grey Soft<br>to Stiff        |            | 1       | SS        | 5          |                            | 92              |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 88.3          |                                                                                                        |            | 2       | TW        | PH         |                            | 90              |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 3.8           | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Loose to<br>Very Dense |            | 3       | TW        | PH         |                            | 88              |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                        |            | 4       | SS        | 7          |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                        |            | 5       | SS        | 12         |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                        |            | 6       | SS        | 13         |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                        |            | 7       | SS        | 20         |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                        |            | 8       | RC        | 58%        |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 81.7          |                                                                                                        |            | 9       | SS        | 1          |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 10.4          | Sandy Silt<br>Trace Gravel                                                                             |            |         |           |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 80.5          |                                                                                                        |            |         |           |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 11.6          | Bedrock<br>Silty Dolostone<br>and Dolomitic Shale                                                      |            | 10      | BXL<br>RC | REC<br>90% |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 79.2          |                                                                                                        |            |         |           |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |
| 12.9          | End of Borehole                                                                                        |            |         |           |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                     |                                                   |

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21B-6

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 749.5; E 360 900.1 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, Washboring, BXL Rock Coring COMPILED BY TCK  
 DATUM Geodetic DATE 89 05 03 - 06 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE |                                                                                           | SAMPLES    |        |        | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 | PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT |   |                | UNIT WEIGHT<br>γ<br>KN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-------------------------------------------------------------------------------------------|------------|--------|--------|-------------------------|-----------------|------------------------------------------|-----------------|-----------------------------------------------------|---|----------------|---------------------------------------|---------------------------------------|
| ELEV DEPTH   | DESCRIPTION                                                                               | STRAT PLOT | NUMBER | TYPE   |                         |                 | 20 40 60 80 100                          | 20 40 60 80 100 | W <sub>p</sub>                                      | W | W <sub>L</sub> |                                       |                                       |
| 92.3         | Ground Surface                                                                            |            |        |        |                         |                 |                                          |                 |                                                     |   |                |                                       |                                       |
| 0.0          | Silty Clay With Occasional Thin Silt and Sand Seams Sensitive Grey Soft to Stiff          |            | 1      | SS     | 6                       |                 |                                          |                 |                                                     |   |                |                                       | 0 15 57 28                            |
| 89.1         |                                                                                           |            | 2      | TW     | PM                      |                 |                                          |                 |                                                     |   |                | 15.2                                  | 0 2 49 49                             |
| 3.2          | Granular Het. Mixture of Silt, Sand and Gravel Cobbles and Boulders Compact to Very Dense |            | 3      | SS     | 11                      |                 |                                          |                 |                                                     |   |                |                                       |                                       |
|              |                                                                                           |            | 4      | SS     | 30                      |                 |                                          |                 |                                                     |   |                |                                       |                                       |
|              |                                                                                           |            | 5      | RC     | REC 40%                 |                 |                                          |                 |                                                     |   |                |                                       |                                       |
|              |                                                                                           |            | 6      | SS     | 48                      |                 |                                          |                 |                                                     |   |                |                                       | RQD = 0%                              |
|              |                                                                                           |            | 7      | SS     | 69                      |                 |                                          |                 |                                                     |   |                |                                       |                                       |
|              |                                                                                           |            | 8      | RC     | 31%                     |                 |                                          |                 |                                                     |   |                |                                       | RQD = 0%                              |
| 82.2         |                                                                                           |            | 9      | SS     | 14                      |                 |                                          |                 |                                                     |   |                |                                       | 23 35 33 9                            |
| 10.1         | Sandy Silt Trace Gravel Loose                                                             |            | 10     | SS     | 6                       |                 |                                          |                 |                                                     |   |                |                                       | 6 37 47 10                            |
| 80.5         |                                                                                           |            |        |        |                         |                 |                                          |                 |                                                     |   |                |                                       |                                       |
| 11.8         | Bedrock Silty Dolostone and Dolomitic Shale                                               |            | 11     | RC     | 81%                     |                 |                                          |                 |                                                     |   |                |                                       | RQD = 0%                              |
|              |                                                                                           |            | 12     | BXL RC | REC 100%                |                 |                                          |                 |                                                     |   |                |                                       | RQD = 69%                             |
|              |                                                                                           |            | 13     | BXL RC | REC 31%                 |                 |                                          |                 |                                                     |   |                |                                       | RQD = 0%                              |
| 77.4         |                                                                                           |            |        |        |                         |                 |                                          |                 |                                                     |   |                |                                       |                                       |
| 14.9         | End of Borehole                                                                           |            |        |        |                         |                 |                                          |                 |                                                     |   |                |                                       |                                       |

+3, x5: Numbers refer to Sensitivity  
 20  
 15 5 (%) STRAIN AT FAILURE  
 10

# RECORD OF BOREHOLE No 21B-7

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 764.1; E 360 894.0 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, Washboring, BXL Rock Coring & Cone Test COMPILED BY TCK  
 DATUM Geodetic DATE 89 05 02 - 03 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                          |               | SAMPLES |           | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100<br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|----------------------------------------------------------------------------------------------------------|---------------|---------|-----------|----------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|-----------------------------------|---------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                              | STRAT<br>PLOT | NUMBER  | TYPE      |                            |                    |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 92.5          | Ground Surface                                                                                           |               |         |           |                            |                    |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 0.0           | Silty Clay With<br>Occasional Thin Silt<br>and Sand Seams<br>Sensitive<br>Grey Stiff                     |               | 1       | SS        |                            | 3                  |                                                                                                                                                  |                                 |                                     |                                   |                     | 0 1 59 40                                                        |
| 88.8          |                                                                                                          |               | 2       | TW        |                            | PH                 |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 3.7           | Granular Het. Mixture<br>of Silt, Sand<br>and Gravel<br>Cobbles and Boulders<br>Compact to<br>Very Dense |               | 3       | SS        |                            | 16                 |                                                                                                                                                  |                                 |                                     |                                   |                     | 37 38 18 7                                                       |
| 83.9          |                                                                                                          |               | 4       | SS        |                            | 17                 |                                                                                                                                                  |                                 |                                     |                                   |                     | RQD = 0%                                                         |
| 8.6           |                                                                                                          |               | 5       | SS        |                            | 16                 |                                                                                                                                                  |                                 |                                     |                                   |                     | RQD = 75%                                                        |
| 8.6           |                                                                                                          |               | 6       | RC        |                            | REC<br>67%         |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 8.6           |                                                                                                          |               | 7       | SS        |                            | 10                 |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 8.6           |                                                                                                          |               | 8       | RC        |                            | REC<br>96%         |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 8.6           |                                                                                                          |               | 9       | SS        |                            | 50                 |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 8.6           | Cohesive Het. Mixture<br>of Silty Clay,<br>Sand and Gravel                                               |               | 10      | SS        |                            | 4                  |                                                                                                                                                  |                                 |                                     |                                   |                     | 12 32 41 15                                                      |
| 8.6           |                                                                                                          |               | 11      | SS        |                            | 1                  |                                                                                                                                                  |                                 |                                     |                                   |                     | 1 9 80 10                                                        |
| 8.6           | Sandy Silt<br>Trace of Clay<br>and Gravel                                                                |               | 12      | SS        |                            | 25                 |                                                                                                                                                  |                                 |                                     |                                   |                     | RQD = 0%                                                         |
| 8.6           |                                                                                                          |               | 13      | RC        |                            | 62%                |                                                                                                                                                  |                                 |                                     |                                   |                     | RQD = 79%                                                        |
| 8.6           | Bedrock<br>Silty Dolostone and<br>Dolomitic Shale                                                        |               | 14      | BXL<br>RC |                            | REC<br>100%        |                                                                                                                                                  |                                 |                                     |                                   |                     | RQD = 86%                                                        |
| 8.6           |                                                                                                          |               | 15      | BXL<br>RC |                            | REC<br>100%        |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |
| 8.6           | End of Borehole                                                                                          |               |         |           |                            |                    |                                                                                                                                                  |                                 |                                     |                                   |                     |                                                                  |

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 21B-8

METRIC

W P 128-87-05/06

LOCATION Co-ords. N 5 012 613.8; E 360 961.2

ORIGINATED BY JS

DIST 9 HWY 416

BOREHOLE TYPE H.S. Auger & Cone Test

COMPILED BY TCK

DATUM Geodetic

DATE 89 05 08

CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                        |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100 | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE<br>20 40 60 80 100 | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE<br>CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | WATER CONTENT (%)<br>15 30 45 | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--------------------------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------|--------------------------------|-------------------------------|---------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                            | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 |                                                                |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
| 91.3          | Ground Surface                                                                                         |            |         |      |            |                            |                 |                                                                |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
| 0.0           | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Firm |            | 1       | SS   | 3          |                            | 90              | 8                                                              |                                                                                                   |                                 |                                  |                                |                               | 17.7                                  | 0 2 43 55                                                        |
|               |                                                                                                        |            | 2       | TW   | PH         |                            | 88              | +7<br>+3                                                       |                                                                                                   |                                 |                                  |                                |                               |                                       | 0 10 56 34                                                       |
|               |                                                                                                        |            | 3       | TW   | PH         |                            | 86              | +7<br>+8                                                       |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
|               |                                                                                                        |            | 4       | TW   | PH         |                            | 84              | +7<br>+5                                                       |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
|               |                                                                                                        |            | 5       | TW   | PH         |                            | 82              | +7<br>+4<br>+5<br>+4                                           |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
| 83.7<br>7.6   | Cohesive Het. Mixture<br>of Silty Clay,<br>Sand and Gravel<br><br>Soft                                 |            | 6       | TW   | PH         |                            |                 |                                                                |                                                                                                   |                                 |                                  |                                |                               | 0 15 46 39                            |                                                                  |
|               |                                                                                                        |            | 7       | SS   | 3          |                            |                 |                                                                |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |
| 80.8<br>10.5  | End of Borehole<br>At Refusal<br>(Probable Boulders)                                                   |            |         |      |            |                            |                 |                                                                |                                                                                                   |                                 |                                  |                                |                               |                                       |                                                                  |

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21B-9

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 641.5; E 360 949.6  
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test ORIGINATED BY TS  
 DATUM Geodetic DATE 89 05 08 COMPILED BY TCK  
 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                                         |            | SAMPLES |      | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 | NATURAL MOISTURE CONTENT |                |   | UNIT WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------------------------------|------------|---------|------|-------------------------|-----------------|------------------------------------------|-----------------|--------------------------|----------------|---|----------------------------------------------|------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                             | STRAT PLOT | NUMBER  | TYPE |                         |                 | VALUES                                   | 20 40 60 80 100 | 20 40 60 80 100          | W <sub>p</sub> | W |                                              |                                                      |
| 91.3<br>0.0   | Ground Surface                                                                                          |            |         |      |                         |                 |                                          |                 |                          |                |   |                                              |                                                      |
| 84.6<br>6.7   | Silty Clay<br>With Occasional Thin<br>Silt and Sand Seams<br><br>Sensitive<br><br>Grey Soft<br>to Stiff |            | 1       | SS   | 6                       |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               |                                                                                                         |            | 2       | TW   | PH                      |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               |                                                                                                         |            | 3       | TW   | PH                      |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               |                                                                                                         |            | 4       | TW   | PH                      |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               |                                                                                                         |            | 5       | TW   | PH                      |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               | Cohesive Het. Mixture<br>of Silty Clay<br>Sand and Gravel<br><br>Soft to<br>Stiff                       |            | 6       | SS   | 4                       |                 |                                          |                 |                          |                |   |                                              |                                                      |
|               |                                                                                                         |            | 7       | SS   | 9                       |                 |                                          |                 |                          |                |   |                                              |                                                      |
| 80.2<br>11.1  | End of Borehole<br><br>* Sampler Bouncing                                                               |            | 8       | SS   | 8                       | 25 cm           |                                          |                 |                          |                |   |                                              |                                                      |

+3, x5: Numbers refer to  
Sensitivity  
20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 21B-10

METRIC

W P 128-87-05/06 LOCATION Co-ords. N 5 012 790.0; E 360 887.5 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY TCK  
 DATUM Geodetic DATE 89 05 05 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                          |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br>20 40 60 80 100 | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|------------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|----------------------------------------------------------------|---------------------------------|-------------------------------------|-----------------------------------|---------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                              | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 95.1          | Ground Surface                                                                           |            |         |      |            |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 0.0           | Sand and Gravel<br>(Fill)                                                                |            | 1       | SS   | 40         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 93.0          |                                                                                          |            | 2       | SS   | 13         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 2.1           | Silty Clay with<br>Occasional<br>thin Silt and<br>Sand Seams<br>Stiff to Very Stiff      |            | 3       | SS   | 14         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 90.7          |                                                                                          |            | 4       | SS   | 18         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 4.4           | Cohesive Het. Mixture<br>of Silty Clay, Sand<br>and Gravel                               |            | 5       | SS   | 10         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 89.9          |                                                                                          |            | 6       | SS   | 2          |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 5.2           |                                                                                          |            | 7       | SS   | 13         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
|               | Granular Het. Mixture<br>of Silt, Sand and<br>Gravel, Cobbles and<br>Boulders<br>Compact |            | 8       | SS   | 24         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
|               |                                                                                          |            | 9       | SS   | 27         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 85.0          |                                                                                          |            | 10      | SS   | 30         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 10.1          | Sandy Silt, Dense                                                                        |            |         |      |            |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 84.0          |                                                                                          |            |         |      |            |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |
| 11.1          | End of Borehole                                                                          |            | 11      | SS   | 30         |                            |                 |                                                                |                                 |                                     |                                   |                     |                                                                  |

# RECORD OF BOREHOLE No 21B-11

METRIC

W P 128-87-05/06

LOCATION Co-ords. N 5 012 807.0; E 360 875.5

ORIGINATED BY TS

DIST 9 HWY 416

BOREHOLE TYPE H.S. Auger

COMPILED BY TCK

DATUM Geodetic

DATE 89 05 05

CHECKED BY TCK

| SOIL PROFILE  |                                                               |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT              |                    | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>Y | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |                   |
|---------------|---------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|----------------------------------------------------------|--------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|------------------------------------------------------------------|-------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                   | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20 40 60 80 100                                          | SHEAR STRENGTH kPa |                                    |                                     |                                   |                     |                                                                  | WATER CONTENT (%) |
|               |                                                               |            |         |      |            |                            |                 | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 96.4          | Ground Surface                                                |            |         |      |            |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 0.0           | Silty Clay with Sand and Gravel                               |            | 1       | SS   | 7          |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 94.3          | Firm to Stiff Brown Grey                                      |            | 2       | SS   | 20         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 2.1           | Heterogeneous mixture of Silt, Sand and Gravel (Glacial Till) |            | 3       | SS   | 60         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
|               | Compact to Very Dense                                         |            | 4       | SS   | 60         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
|               |                                                               |            | 5       | SS   | 58         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
|               | SANDY SILT                                                    |            | 6       | SS   | 45         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 86.8          |                                                               |            | 7       | SS   | 20         |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |
| 9.6           | End of Borehole                                               |            |         |      |            |                            |                 |                                                          |                    |                                    |                                     |                                   |                     |                                                                  |                   |

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

**ROCK CORE DESCRIPTION**  
**WP 128-87-05/06**

1../3

| CORE RECOVERY  |              |             |             |              | CORE DESCRIPTION |                                                                                                                                                                   |
|----------------|--------------|-------------|-------------|--------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH - RC<br># # | DEPTH<br>(m) | CR*<br>(%)  | RQD*<br>(%) | DEPTH<br>(m) | DESCRIPTION      |                                                                                                                                                                   |
| 21<br>A1       | 12           | 10.06-10.69 | 68          | 36           | 10.06-12.50      | OVERBURDEN - rock fragments up to 53 cm.                                                                                                                          |
|                | 13           | 10.69-11.00 | 58          | 0            | 12.50-15.98      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close spaced fractures.                         |
|                | 14           | 10.00-12.57 | 85          | 60           |                  |                                                                                                                                                                   |
|                | 15           | 12.57-12.62 | 100         | 0            |                  |                                                                                                                                                                   |
|                | 16           | 12.62-14.38 | 78          | 72           |                  |                                                                                                                                                                   |
|                | 17           | 14.38-15.98 | 100         | 90           |                  |                                                                                                                                                                   |
| 21<br>A2       | 8            | 9.50- 9.65  | 100         | 0            | 9.50-12.09       | OVERBURDEN - rock fragments up to 65 cm.                                                                                                                          |
|                | 9            | 9.65-10.41  | 100         | 75           | 12.09-13.92      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close to very close spaced fractures.           |
|                | 10           | 10.41-11.02 | 88          | 69           |                  |                                                                                                                                                                   |
|                | 11           | 11.02-11.99 | 92          | 67           |                  |                                                                                                                                                                   |
|                | 12           | 11.99-12.40 | 100         | 38           |                  |                                                                                                                                                                   |
|                | 13           | 12.40-13.92 | 100         | 76           |                  |                                                                                                                                                                   |
| 21<br>A3       | 8            | 10.69-11.68 | 100         | 77           | 10.69-11.99      | OVERBURDEN - rock fragments up to 51 cm.                                                                                                                          |
|                | 9            | 11.68-11.76 | 100         | 0            | 11.99-13.36      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close spaced fractures.                         |
|                | 10           | 11.76-13.36 | 100         | 76           |                  |                                                                                                                                                                   |
| 21<br>A4       | 8            | 9.45-10.06  | 58          | 23           | 9.45-12.50       | OVERBURDEN - rock fragments up to 15 cm.                                                                                                                          |
|                | 9            | 10.06-11.20 | 32          | 20           | 12.50-15.82      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; very close to moderately wide spaced fractures. |
|                | 10           | 11.20-11.99 | 27          | 0            |                  |                                                                                                                                                                   |
|                | 11           | 11.99-12.67 | 65          | 0            |                  |                                                                                                                                                                   |
|                | 12           | 12.67-14.22 | 100         | 72           |                  |                                                                                                                                                                   |
|                | 13           | 14.22-15.82 | 100         | 70           |                  |                                                                                                                                                                   |

\*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

\*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

**ROCK CORE DESCRIPTION**  
**WP 128-87-05/06**

2../3

| CORE RECOVERY     |    |              |            |             | CORE DESCRIPTION |                                                                                                                                                                                                           |
|-------------------|----|--------------|------------|-------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH - RC<br>#    # |    | DEPTH<br>(m) | CR*<br>(%) | RQD*<br>(%) | DEPTH<br>(m)     | DESCRIPTION                                                                                                                                                                                               |
| 21<br>A5          | 10 | 12.65-12.80  | 100        | 0           | 12.65-12.80      | OVERBURDEN - rock fragments up to 8 cm.                                                                                                                                                                   |
|                   | 11 | 12.80-12.98  | 100        | 0           |                  |                                                                                                                                                                                                           |
|                   | 12 | 12.98-13.54  | 86         | 23          | 12.80-14.78      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered to slightly weathered, some fractures clay coated; very close to close spaced fractures. |
|                   | 13 | 13.54-13.72  | 100        | 71          |                  |                                                                                                                                                                                                           |
|                   | 14 | 13.72-14.78  | 93         | 24          |                  |                                                                                                                                                                                                           |
| 21<br>A6          | 13 | 12.27-13.36  | 14         | 0           | 12.27-13.36      | OVERBURDEN - rock fragments up to 3 cm, weathered, rounded.                                                                                                                                               |
|                   | 14 | 13.36-14.71  | 100        | 92          | 13.36-14.71      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; very close to moderately wide spaced fractures.                                         |
| 21<br>A7          | 13 | 11.58-13.23  | 38         | 0           | 11.58-14.20      | OVERBURDEN - rock fragments up to 9 cm.                                                                                                                                                                   |
|                   | 14 | 13.23-13.54  | 58         | 0           |                  |                                                                                                                                                                                                           |
|                   | 15 | 13.54-14.53  | 59         | 0           | 14.20-15.93      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close to moderately wide spaced fractures.                                              |
|                   | 16 | 14.33-15.93  | 100        | 65          |                  |                                                                                                                                                                                                           |
| 21<br>B1          | 9  | 10.80-12.32  | 100        | 87          | 10.80-12.32      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close to moderately wide spaced fractures.                                              |
| 21<br>B2          | 13 | 10.80-12.19  | 100        | 77          | 10.80-13.69      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close to moderately spaced fractures.                                                   |
|                   | 14 | 12.19-13.69  | 98         | 84          |                  |                                                                                                                                                                                                           |

\*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

\*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

**ROCK CORE DESCRIPTION**  
**WP 128-87-05/06**

3../3

| CORE RECOVERY |      |             |         |          | CORE DESCRIPTION |                                                                                                                                                         |
|---------------|------|-------------|---------|----------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH #          | RC # | DEPTH (m)   | CR* (%) | RQD* (%) | DEPTH (m)        | DESCRIPTION                                                                                                                                             |
| 21 B4         | 9    | 10.67-12.19 | 98      | 55       | 10.67-12.19      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; very close to close spaced fractures. |
| 21 B5         | 8    | 9.45-10.06  | 58      | 42       | 9.45-11.63       | OVERBURDEN - rock fragments up to 25 cm.                                                                                                                |
|               | 10   | 11.38-12.90 | 90      | 42       | 11.63-12.90      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; very close to close spaced fractures. |
| 21 B6         | 8    | 8.53- 9.14  | 31      | 0        | 8.53-11.84       | OVERBURDEN - rock fragments up to 8 cm.                                                                                                                 |
|               | -    | not cored   | -       | -        |                  |                                                                                                                                                         |
|               | 11   | 11.86-12.32 | 81      | 0        | 11.84-14.94      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; very close to close spaced fractures. |
|               | 12   | 12.32-13.69 | 100     | 69       |                  |                                                                                                                                                         |
|               | 13   | 13.69-14.94 | 31      | 0        |                  |                                                                                                                                                         |
| 21 B7         | 6    | 5.03- 5.94  | 67      | 0        | 5.03-12.50       | OVERBURDEN - rock fragments up to 34 cm.                                                                                                                |
|               | -    | not cored   | -       | -        |                  |                                                                                                                                                         |
|               | 8    | 6.71- 7.62  | 96      | 75       | 12.50-15.88      | SILTY DOLOSTONE and DOLOMITIC SHALE, medium to light grey; fine grained; weak to medium strong rock; unweathered; close spaced fractures.               |
|               | -    | not cored   | -       | -        |                  |                                                                                                                                                         |
|               | 13   | 12.50-12.83 | 62      | 0        |                  |                                                                                                                                                         |
|               | 14   | 12.83-14.35 | 100     | 79       |                  |                                                                                                                                                         |
|               | 15   | 14.35-15.80 | 100     | 86       |                  |                                                                                                                                                         |

\*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

\*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

# RECORD OF BOREHOLE No 89-6

METRIC

W P 128-87-00 LOCATION Co-ords: N 5 012 428.3; E 361 070.2 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE H S Auger & Cone Test COMPILED BY TS  
 DATUM Geodetic DATE 89 05 10 CHECKED BY           

| SOIL PROFILE  |                      |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|----------------------|------------|---------|------|------------|----------------------------|--------------------|---------------------------------------------|----|----|----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION          | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                    | 20                                          | 40 | 60 | 80 | 100                                |                                     |                                   |                     |                                                   |
| 91.3<br>0.0   | Ground Surface       |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | Silty Clay           |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | With occ. Sand Seams |            | 1       | SS   | 2          |                            | 90                 |                                             |    |    |    |                                    |                                     |                                   |                     | 0 2 50 48                                         |
|               | Trace Organics       |            | 2       | TW   | PH         |                            | 88                 |                                             |    |    |    |                                    |                                     |                                   | 18.5                | 0 10 65 25                                        |
|               | Grey, Soft           |            |         |      |            |                            | 86                 |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | to Firm              |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
| 84.3          | Het. Mixture of      |            | 3       | TW   | PH         |                            | 84                 |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
| 83.8          | Silt Sand & Gravel   |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | (Glacial Till)       |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
| 7.5           | Auger Refusal        |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | (Probable Boulder)   |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |
|               | End of Borehole      |            |         |      |            |                            |                    |                                             |    |    |    |                                    |                                     |                                   |                     |                                                   |

OFFICE REPORT ON SOIL EXPLORATION





# RECORD OF BOREHOLE No\*89-7

METRIC

W P 128-87-00

LOCATION Co-ords: N 5 012 463.1; E 361 023.8

ORIGINATED BY TS

DIST 9 HWY 416

BOREHOLE TYPE H S Auger & Cone Test

COMPILED BY TS

DATUM Geodetic

DATE 89 05 10

CHECKED BY

## SOIL PROFILE

## SAMPLES

## GROUND WATER CONDITIONS

## ELEVATION SCALE

## DYNAMIC CONE PENETRATION RESISTANCE PLOT

20 40 60 80 100

## SHEAR STRENGTH kPa

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL x LAB VANE

20 40 60 80 100

PLASTIC LIMIT  
W<sub>p</sub>

NATURAL MOISTURE CONTENT  
W

LIQUID LIMIT  
W<sub>L</sub>

WATER CONTENT (%)

20 40 60

UNIT WEIGHT  
γ

REMARKS &  
GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

ELEV DEPTH

## DESCRIPTION

## STRAT PLOT

NUMBER

TYPE

'N' VALUES

91.3

Ground Surface

0.0

Silty Clay

With occ. Sand

Seams, Trace Organics

Grey, Firm to

Stiff

87.0

4.3

Het. Mixture of Silt

Sand and Gravel

(Glacial Till)

Very Dense

85.2

6.1

Auger Refusal

(Probable Boulder)

End of Borehole

1

SS

8

2

SS

4

3

TW

PH

4

SS

60

15cm

90

88

86

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 89-7A

METRIC

W P 128-87-00

LOCATION Co-ords: N 5 012 416.5; E 361 043.0

ORIGINATED BY TS

DIST 9 HWY 416

BOREHOLE TYPE H S Auger & Cone Test

COMPILED BY TS

DATUM Geodetic

DATE 89 05 10

CHECKED BY

## SOIL PROFILE

## SAMPLES

## GROUND WATER CONDITIONS

## ELEVATION SCALE

## DYNAMIC CONE PENETRATION RESISTANCE PLOT

20 40 60 80 100  
SHEAR STRENGTH  $kPa$   
○ UNCONFINED + FIELD VANE  
● QUICK TRIAXIAL \* LAB VANE

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT  
Wp W WL  
WATER CONTENT (%)

UNIT WEIGHT  
Y

REMARKS & GRAIN SIZE DISTRIBUTION (%)  
GR SA SI CL

ELEV DEPTH

DESCRIPTION

STRAT PLOT

NUMBER

TYPE

'N' VALUES

91.3  
0.0

Ground Surface

Silty Clay  
Grey, Firm  
to Stiff

1 SS 2

Seal

90

Piezometer

Seal

88

87.3  
4.0

Het. Mixture of  
Silt, Sand, &  
Gravel

2 SS 2

85.2  
6.1

(Glacial Till)

3 SS \*

\* Sampler Bouncing  
(Probable Boulder)  
End of Borehole

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 89-8

METRIC

W P 128-87-00 LOCATION Co-ords: N 5 012 520.5; E 361 031.9 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY TS  
 DATUM Geodetic DATE 89 05 10 CHECKED BY

| SOIL PROFILE  |                                                                                    |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ,<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|-----------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------|-------------------------------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                        | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | 20 40 60 80 100 |                                    |                                     |                                   |                                           |                                                   |
| 91.3          | Ground Surface                                                                     |            |         |      |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 0.0           | Silty Clay<br>With occ.<br>Sand Seams, Trace<br>Organics<br>Grey, Firm to<br>Stiff |            | 1       | SS   | 5          |                            | 90              | 6                                           |                 |                 |                                    |                                     |                                   | 15.6                                      | 0 1 51 48                                         |
|               |                                                                                    |            | 2       | SS   | 3          |                            | 88              | 10                                          |                 |                 |                                    |                                     |                                   |                                           |                                                   |
|               |                                                                                    |            | 3       | TW   | PH         |                            | 86              | 5                                           |                 |                 |                                    |                                     |                                   | 17.4                                      | 0 10 49 41                                        |
|               |                                                                                    |            | 4       | TW   | PH         |                            | 84              | 5                                           |                 |                 |                                    |                                     |                                   |                                           |                                                   |
|               |                                                                                    |            | 5       | TW   | PH         |                            | 82              | 5                                           |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 83.7          | Het. Mixture of<br>Silty Clay, Sand and<br>Gravel (Glacial Till)                   |            | 6       | TW   | PH         |                            |                 | 10                                          |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 7.6           | Grey, Firm                                                                         |            |         |      |            |                            |                 | 5                                           |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 82.2          | Het. Mixture of Silt,<br>Sand and Gravel<br>(Glacial Till) Compact                 |            | 7       | SS   | 10         |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 9.1           | Auger Refusal<br>(Probable Boulder)<br>End of Borehole                             |            |         |      |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 80.9          |                                                                                    |            |         |      |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                                           |                                                   |
| 10.4          |                                                                                    |            |         |      |            |                            |                 |                                             |                 |                 |                                    |                                     |                                   |                                           |                                                   |

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 89-8A

METRIC

W P 128-87-00

LOCATION Co-ords: N 5 012 493.0; E 361 043.0

DIST 9 HWY 416

BOREHOLE TYPE H S Auger

ORIGINATED BY TS

DATUM Geodetic

DATE 89 05 10

COMPILED BY TS

CHECKED BY

## SOIL PROFILE

## SAMPLES

GROUND WATER CONDITIONS

ELEVATION SCALE

DYNAMIC CONE PENETRATION RESISTANCE PLOT

20 40 60 80 100  
SHEAR STRENGTH kPa  
○ UNCONFINED + FIELD VANE  
● QUICK TRIAXIAL x LAB VANE  
20 40 60 80 100

PLASTIC LIMIT Wp NATURAL MOISTURE CONTENT W LIQUID LIMIT Wl  
WATER CONTENT (%)  
20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)  
GR SA SI CL

ELEV DEPTH

DESCRIPTION

STRAT PLOT

NUMBER

TYPE

'N' VALUES

91.3

0.0

Ground Surface

Silty Clay

With occ. Sand Seams

Trace Organics

Grey, Firm

to Stiff

1

AS

--

2

SS

2

3

SS

1

4

TW

PH

5

SS

1

83.7

7.6

Het. Mixture of Silty Clay, Sand and Gravel (Glacial Till)

82.7

8.6

Grey, Soft to Firm

Auger Refusal (Probable Boulder) End of Borehole

6

SS

1

90

88

86

84

15.7

0 9 53 38

0 3 57 40

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 89-9

METRIC

W P 128-87-00 LOCATION Co-ords: N 5 012 555.4; E 360 985.4  
 DIST 9 HWY 416 BOREHOLE TYPE H S Auger & Cone Test ORIGINATED BY TS  
 DATUM Geodetic DATE 89 05 09-10 COMPILED BY TS  
 CHECKED BY

## SOIL PROFILE

## SAMPLES

GROUND WATER  
CONDITIONS

ELEVATION SCALE

DYNAMIC CONE PENETRATION  
RESISTANCE PLOT

20 40 60 80 100

SHEAR STRENGTH kPa

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL x LAB VANE

20 40 60 80 100

PLASTIC LIMIT  
W<sub>p</sub>

NATURAL MOISTURE  
CONTENT W

LIQUID LIMIT  
W<sub>L</sub>

WATER CONTENT (%)

20 40 60

UNIT  
WEIGHT

Y

kN/m<sup>3</sup>

GR SA SI CL

REMARKS  
&  
GRAIN SIZE  
DISTRIBUTION  
(%)

| ELEV<br>DEPTH | DESCRIPTION                                                     | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE<br>CONTENT W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>Y | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|-----------------------------------------------------------------|------------|--------|------|------------|-----------------|---------------------------------------------|---------------------------------|-------------------------------|--------------------------------|---------------------|---------------------------------------------------|
| 91.2<br>0.0   | Ground Surface                                                  |            |        |      |            |                 |                                             |                                 |                               |                                |                     |                                                   |
|               | Silty Clay                                                      |            | 1      | SS   | 2          |                 |                                             |                                 |                               |                                |                     | 0 3 54 43                                         |
|               | With occ. Sand                                                  |            | 2      | TW   | PH         |                 |                                             |                                 |                               |                                | 17.2                |                                                   |
|               | Seams, Trace                                                    |            | 3      | TW   | PH         |                 |                                             |                                 |                               |                                |                     |                                                   |
|               | Organics                                                        |            | 4      | TW   | PH         |                 |                                             |                                 |                               |                                | 17.7                | 0 9 54 37                                         |
|               | Grey, Soft to                                                   |            | 5      | TW   | PH         |                 |                                             |                                 |                               |                                |                     |                                                   |
|               | Stiff                                                           |            | 6      | SS   | 2          |                 |                                             |                                 |                               |                                |                     | 0 7 37 56                                         |
| 83.3<br>7.9   | Met. Mixture of<br>Silty, Clay, Sand &<br>Gravel (Glacial Till) |            | 7      | SS   | 10         |                 |                                             |                                 |                               |                                |                     |                                                   |
| 82.1<br>9.1   | Grey, Firm                                                      |            | 8      | SS   | 24         |                 |                                             |                                 |                               |                                |                     |                                                   |
|               | Met. Mixture of<br>Silt, Sand &<br>Gravel (Glacial Till)        |            |        |      |            |                 |                                             |                                 |                               |                                |                     |                                                   |
| 80.0<br>11.2  | Compact                                                         |            |        |      |            |                 |                                             |                                 |                               |                                |                     |                                                   |
|               | Auger Refusal<br>(Probable Boulder)                             |            |        |      |            |                 |                                             |                                 |                               |                                | 15 73 10 2          |                                                   |
|               | End of Borehole                                                 |            |        |      |            |                 |                                             |                                 |                               |                                |                     |                                                   |

73/5cm  
Bouncing

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 89-9A

METRIC

W P 128-87-00

LOCATION Co-ords: N 5 012 482.0; E 361 016.0

ORIGINATED BY TS

DIST 9 HWY 416

BOREHOLE TYPE H S Auger & Cone Test

COMPILED BY TS

DATUM Geodetic

DATE 89 05 10

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE  |                                                                                 |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |          | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>Y | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|----------|---------------------------------|-------------------------------------|-----------------------------------|---------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                     | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | SHEAR STRENGTH kPa                          |          |                                 |                                     |                                   |                     |                                                                  |
|               |                                                                                 |            |         |      |            |                            |                 | 20 40 60 80 100                             | 20 40 60 |                                 |                                     |                                   |                     |                                                                  |
| 91.2          | Ground Surface                                                                  |            |         |      |            |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
| 0.0           |                                                                                 |            |         |      |            |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
|               | Silty Clay<br>With occ. Sand<br>Seams, Trace Organics<br>Grey, Firm to<br>Stiff |            | 1       | SS   | 2          |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
|               |                                                                                 |            | 2       | SS   | 1          |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
| 85.1          |                                                                                 |            | 3       | SS   | 8          |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
| 6.1           | Het. Mixture of Silt,<br>Sand and Gravel<br>(Glacial Till)                      |            | 4       | SS   | 30         |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
| 82.8          | Loose to Dense                                                                  |            |         |      |            |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |
| 8.4           | Auger Refusal<br>(Probable Boulder)<br>End of Borehole                          |            |         |      |            |                            |                 |                                             |          |                                 |                                     |                                   |                     |                                                                  |

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 89-10

METRIC

W P 128-87-00

LOCATION Co-ords: N 5 012 612.9; E 360 993.5

DIST 9 HWY 416

BOREHOLE TYPE R S Auger

ORIGINATED BY TS

DATUM Geodetic

DATE 89 05 09

COMPILED BY TS

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE |                                                                       |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-----------------------------------------------------------------------|-------------|---------|------|------------|-------------------------|-----------------|------------------------------------------|----|----|----|-----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION                                                           | STRAT. PLOT | NUMBER  | TYPE | 'N' VALUES |                         |                 | 20                                       | 40 | 60 | 80 | 100 |                                 |                               |                                |                  |                                       |
| 91.3         | Ground Surface                                                        |             |         |      |            |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 0.0          |                                                                       |             |         |      |            |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
|              | Silty Clay                                                            |             | 1       | SS   | 3          |                         | 90              |                                          |    |    |    |     |                                 |                               |                                | 18.4             | 0 4 64 32                             |
|              | With occ. Sand                                                        |             | 2       | TW   | PH         |                         |                 |                                          |    |    |    |     |                                 |                               |                                | 17.4             |                                       |
|              | Seams, Trace Organics                                                 |             | 3       | TW   | PH         |                         | 88              |                                          |    |    |    |     |                                 |                               |                                | 17.1             | 0 8 62 30                             |
|              | Grey, Soft to Stiff                                                   |             | 4       | TW   | PH         |                         | 86              |                                          |    |    |    |     |                                 |                               |                                | 15.3             | 0 1 52 47                             |
|              |                                                                       |             | 5       | TW   | PH         |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 83.7         | Het. Mixture of Silty Clay, Sand and Gravel (Glacial Till) Grey Firm  |             | 6       | SS   | 3          |                         | 84              |                                          |    |    |    |     |                                 |                               |                                |                  | 1 6 47 46                             |
| 7.6          |                                                                       |             |         |      |            |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 82.8         |                                                                       |             |         |      |            |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 8.5          | Het. Mixture of Silt, Sand and Gravel (Glacial Till) Compact to Dense |             | 7       | SS   | 18         |                         | 82              |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 80.5         |                                                                       |             |         |      |            |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  |                                       |
| 10.8         | End of Borehole                                                       |             | 8       | SS   | 30/3cm     |                         |                 |                                          |    |    |    |     |                                 |                               |                                |                  | 27 42 25 6                            |

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 15

1 OF 1

METRIC

W.P. 128-87-05/06 LOCATION Coords: N 5 012 823.4, E 360 905.9 ORIGINATED BY M.M.  
DIST 5 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring COMPILED BY M.M.  
DATUM Geodetic DATE 91 02 07 CHECKED BY B.I.

| SOIL PROFILE  |                                                                                                       |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>7<br>KN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|-------------------------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|------------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                           | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20                                          | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                                          |                                                                  |
| 95.4          | Ground Surface                                                                                        |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
| 0.0           | Heterogeneous mixture of<br>of Clay, Silt, Sand and<br>Gravel<br>(Glacial Till)<br>Firm To Very Stiff |            | 1       | SS   | 10         |                            | 95              |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
|               |                                                                                                       |            | 2       | SS   | 7          |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          | 4 11 55 30                                                       |
| 92.5          |                                                                                                       |            | 3       | SS   | 22         |                            | 93              |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
| 2.9           |                                                                                                       |            | 4       | SS   | 29         |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
|               |                                                                                                       |            | 5       | SS   | 42         |                            | 91              |                                             |    |    |    |     |                                    |                                     |                                   |                                          | 35 51 7 7                                                        |
|               |                                                                                                       |            | 6       | SS   | 39         |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
|               |                                                                                                       |            | 7       | RC   | REC        | 100%                       | 89              |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 96%                                                          |
|               |                                                                                                       |            |         |      |            |                            | 87              |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
|               |                                                                                                       |            | 8       | SS   | 24         |                            | 85              |                                             |    |    |    |     |                                    |                                     |                                   |                                          | 9 36 46 9                                                        |
|               |                                                                                                       |            | 9       | RC   | REC        | 84%                        |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 0%                                                           |
|               |                                                                                                       |            | 10      | RC   | REC        | 73%                        | 83              |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 51%                                                          |
|               |                                                                                                       |            | 11      | RC   | REC        | 38%                        |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 17%                                                          |
| 80.9          |                                                                                                       |            | 12      | RC   | REC        | 100%                       | 81              |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 0%                                                           |
| 14.5          | Bedrock                                                                                               |            | 13      | RC   | REC        | 98%                        |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          | RQD 97%                                                          |
| 79.4          | Sandy Dolostone                                                                                       |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |
| 16.0          | End of Borehole                                                                                       |            |         |      |            |                            |                 |                                             |    |    |    |     |                                    |                                     |                                   |                                          |                                                                  |



# RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 128-87-05/05 LOCATION Coords: N 5 012 847.1, E 360 896.1 ORIGINATED BY M.M.  
DIST 6 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring COMPILED BY M.M.  
DATUM Geodetic DATE 91 02 07 CHECKED BY B.J.

| SOIL PROFILE  |                                                                     |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT<br>NATURAL<br>MOISTURE<br>CONTENT |   |                | UNIT<br>WEIGHT<br>7<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---------------------------------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|----|----|----|-----|-------------------------------------------------|---|----------------|------------------------------------------|------------------------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                         | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20                                          | 40 | 60 | 80 | 100 | W <sub>p</sub>                                  | W | W <sub>L</sub> |                                          |                                                                  |
| 98.4          | Ground Surface                                                      |            |         |      |            |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
| 0.0           |                                                                     |            | 1       | SS   | 0          |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               |                                                                     |            | 2       | SS   | 100        | /15cm                      |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               | Cloyey Silt with Sand and<br>Gravel, Hard                           |            | 3       | SS   | 100        | /25cm                      |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               |                                                                     |            | 4       | SS   | 126        |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               |                                                                     |            | 5       | SS   | 120        |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               | Heterogeneous mixture of<br>Silt, Sand and Gravel<br>(Glacial Till) |            | 6       | SS   | 110        |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               | Trace Clay, Very Dense                                              |            | 7       | SS   | 85         |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
|               |                                                                     |            | 8       | SS   | 85         |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
| 88.8          |                                                                     |            | 9       | SS   | 100        | /15cm                      |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |
| 9.6           | End of Borehole                                                     |            |         |      |            |                            |                 |                                             |    |    |    |     |                                                 |   |                |                                          |                                                                  |

# RECORD OF BOREHOLE No 31

1 OF 1

METRIC

W.P. 128-87-05/06

LOCATION Coords: N 5 012 805.5, E 360 881.4

ORIGINATED BY M.M.

DIST 6 HWY 416

BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring

COMPILED BY M.M.

DATUM Geodetic

DATE 91 02 07

CHECKED BY B.I.

| SOIL PROFILE  |                                                |            | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |    |
|---------------|------------------------------------------------|------------|---------|------|------------|-------------------------|-----------------|------------------------------------------|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|----|
| ELEV<br>DEPTH | DESCRIPTION                                    | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                         |                 | 20                                       | 40 |                                 |                               |                                |                  |                                       | 60 |
| 95.0          | Ground Surface                                 |            |         |      |            |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 0.0           | Clayey Silt with Sand and Gravel               |            | 1       | SS   | 7          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 92.8          | Trace Organics, Firm                           |            | 2       | SS   | 6          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 2.1           | Heterogeneous mixture of Silt, Sand and Gravel |            | 3       | SS   | 35         |                         |                 |                                          |    |                                 |                               |                                |                  | 40 43 13 4                            |    |
|               | Trace Clay                                     |            | 4       | SS   | 33         |                         |                 |                                          |    |                                 |                               |                                |                  | 52 38 7 3                             |    |
|               | Dense to very Dense                            |            | 5       | SS   | 44         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|               | (Glacial Till)                                 |            | 6       | SS   | 28         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|               | Sandy Silt                                     |            | 7       | SS   | 46         |                         |                 |                                          |    |                                 |                               |                                |                  | 3 13 74 10                            |    |
|               | Some boulders                                  |            | 8       | SS   | 8          |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|               |                                                |            | 9       | RC   | REC 37%    |                         |                 |                                          |    |                                 |                               |                                |                  | RQD 23%                               |    |
|               |                                                |            | 10      | SS   | 31         |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
|               |                                                |            | 11      | RC   | REC 31%    |                         |                 |                                          |    |                                 |                               |                                |                  | RQD 0%                                |    |
|               |                                                |            | 12      | RC   | REC 38%    |                         |                 |                                          |    |                                 |                               |                                |                  | RQD 0%                                |    |
| 80.5          |                                                |            |         |      |            |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |
| 79.8          | Bedrock Dolomitic Sandstone                    |            | 13      | RC   | REC        | 83%                     |                 |                                          |    |                                 |                               |                                |                  | RQD 26%                               |    |
| 15.1          | End of Borehole                                |            |         |      |            |                         |                 |                                          |    |                                 |                               |                                |                  |                                       |    |

RECORD OF BOREHOLE No 32

1 OF 1

METRIC

W.P. 128-87-05/06

LOCATION Coords: N 5 012 829.3, E 360 871.6

ORIGINATED BY M.M.

DIST 9 HWY 416

BOREHOLE TYPE Hollow Stem Auger, BXL Rock Coring

COMPILED BY M.M.

DATUM Geodetic

DATE 90 02 03

CHECKED BY B.L.

| SOIL PROFILE  |                                                                                                                |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|----------------------------------------------------------------------------------------------------------------|------------|---------|------|------------|----------------------------|--------------------|---------------------------------------------|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---------------------------------------------------|
| ELEV<br>DEPTH | DESCRIPTION                                                                                                    | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                    | 20                                          | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     |                                                   |
| 98.8          | Ground Surface                                                                                                 |            |         |      |            |                            |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 0.0           | Heterogeneous mixture of<br>Silt, Sand and Gravel<br>Trace Clay<br><br>Compact to Very Dense<br>(Glacial Till) |            | 1       | SS   | 23         |                            | 98                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | 61 22 12 5                                        |
|               |                                                                                                                |            | 2       | SS   | 22         | /8cm                       |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                                |            | 3       | SS   | 46         |                            | 96                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 37%                                           |
|               | Boulders                                                                                                       |            | 4       | RC   | REC        | 53%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               | Quartz<br>Sandstone                                                                                            |            | 5       | RC   | REC        | 15%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               |                                                                                                                |            | 6       | RC   | REC        | 45%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               |                                                                                                                |            | 7       | SS   | 18         | /15cm                      |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               |                                                                                                                |            | 8       | RC   | REC        | 36%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               | Some Silt                                                                                                      |            | 9       | SS   | 46         |                            | 92                 |                                             |    |    |    |     |                                    |                                     |                                   | 23.1                | 13 23 51 13                                       |
|               |                                                                                                                |            | 10      | SS   | 92         |                            |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                                |            | 11      | SS   | 126        |                            | 90                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | 56 33 9 2                                         |
|               |                                                                                                                |            | 12      | SS   | 32         |                            | 88                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                                |            | 13      | RC   | REC        | 38%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               |                                                                                                                |            | 14      | SS   | 52         |                            | 86                 |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
|               |                                                                                                                |            | 15      | SS   | 29         |                            | 84                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | 69 22 8 1                                         |
| 82.9          |                                                                                                                |            | 16      | SS   | 100        | /8cm                       |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 15.8          | Bedrock                                                                                                        |            | 17      | RC   | REC        | 78%                        | 82                 |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 0%                                            |
|               | Sandy Dolostone                                                                                                |            | 18      | RC   | REC        | 96%                        |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     | RQD 40%                                           |
| 80.2          |                                                                                                                |            |         |      |            |                            |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |
| 18.5          | End of Borehole                                                                                                |            |         |      |            |                            |                    |                                             |    |    |    |     |                                    |                                     |                                   |                     |                                                   |

# **ROCK CORE DESCRIPTION** **WP 128-87-05/06**

Page 1 of 2

| CORE RECOVERY |     |             |       |        | CORE DESCRIPTION |                                                                                                                                                                                                                                       |
|---------------|-----|-------------|-------|--------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH#           | RC# | DEPTH (m)   | % CR* | % RQD* | DEPTH (m)        | DESCRIPTION                                                                                                                                                                                                                           |
| 15            | 7   | 5.94-6.55   | 100   | 96     | 5.94-14.43       | OVERBURDEN (boulder till).                                                                                                                                                                                                            |
|               | 9   | 10.06-10.54 | 84    | 0      | 14.43-15.70      | DOLOMITIC SANDSTONE, light grey to medium light grey; fine to coarse grained; medium strong; unweathered to slightly weathered; fractures wide spaced, flat, undulating, smooth to rough.                                             |
|               | 10  | 10.54-12.04 | 73    | 51     |                  |                                                                                                                                                                                                                                       |
|               | 11  | 12.19-13.72 | 38    | 17     |                  |                                                                                                                                                                                                                                       |
|               | 12  | 14.02-14.43 | 100   | 0      | 15.70-15.95      | SANDY DOLOSTONE, light grey to medium dark grey; fine crystalline; medium strong; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth.                  |
|               | 13  | 14.43-15.95 | 98    | 97     |                  |                                                                                                                                                                                                                                       |
| 31            | 9   | 8.53-10.06  | 37    | 23     | 8.53-14.48       | OVERBURDEN (boulder till).                                                                                                                                                                                                            |
|               | 11  | 10.52-11.89 | 31    | 0      | 14.48-15.04      | DOLOMITIC SANDSTONE, light grey to medium light grey; medium to coarse grained; medium strong; unweathered to slightly weathered; fractures close to very close spaced, flat to near vertical, planar to undulating, smooth to rough. |
|               | 12  | 12.65-14.17 | 38    | 0      |                  |                                                                                                                                                                                                                                       |
|               | 13  | 14.17-15.09 | 83    | 26     | 15.04-15.09      | DOLOSTONE, medium grey to medium dark grey; fine crystalline; medium strong; unweathered to slightly weathered; fractures close spaced, flat to near vertical, planar to undulating, smooth.                                          |
|               |     |             |       |        |                  |                                                                                                                                                                                                                                       |

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

# **ROCK CORE DESCRIPTION** **WP 128-87-05/06**

Page 2 of 2

| CORE RECOVERY |     |             |       |        | CORE DESCRIPTION |                                                                                                                                                                                                                 |
|---------------|-----|-------------|-------|--------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH#           | RC# | DEPTH (m)   | % CR* | % RQD* | DEPTH (m)        | DESCRIPTION                                                                                                                                                                                                     |
| 32            | 4   | 3.05-3.81   | 53    | 37     | 3.05-15.85       | OVERBURDEN (boulder till).                                                                                                                                                                                      |
|               | 5   | 3.81-4.57   | 15    | 0      | 15.85-18.11      | QUARTZ SANDSTONE, very light grey to light grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures very close to moderately close spaced, flat, planar to undulating, smooth. |
|               | 6   | 4.57-6.10   | 45    | 0      |                  |                                                                                                                                                                                                                 |
|               | 8   | 6.10-7.01   | 36    | 0      |                  |                                                                                                                                                                                                                 |
|               | 13  | 12.19-12.80 | 38    | 0      | 18.11-18.59      | SANDY DOLOSTONE, light grey to medium dark grey; fine crystalline; medium strong; unweathered to slightly weathered; fractures extremely close to close spaced, flat, undulating to planar, smooth.             |
|               | 17  | 15.85-17.37 | 78    | 0      |                  |                                                                                                                                                                                                                 |
|               | 18  | 17.37-18.59 | 96    | 40     |                  |                                                                                                                                                                                                                 |

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

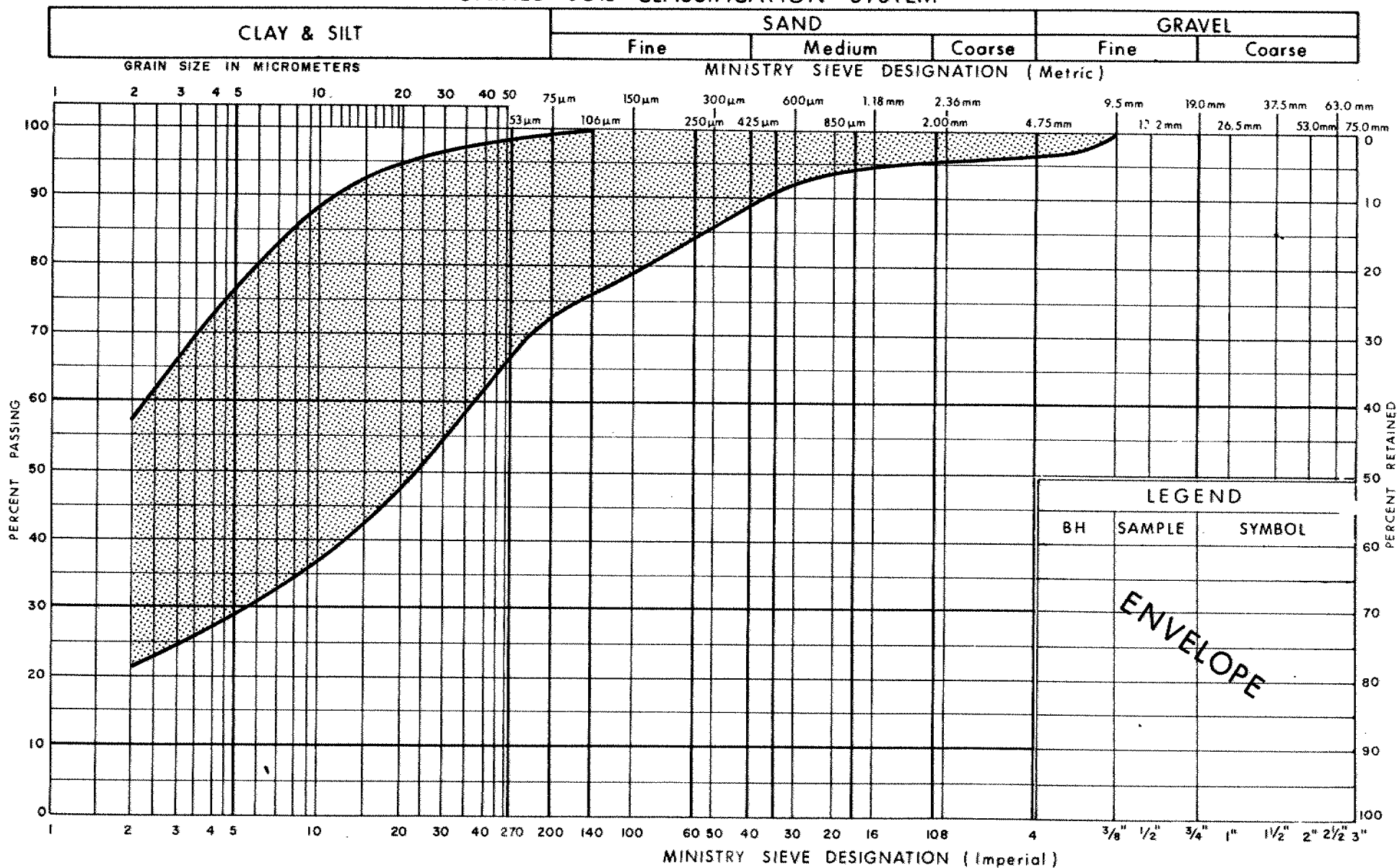
Logged by: DAW, Soils and Aggregates Section

**APPENDIX F**

**Laboratory Test Results  
(1989 and 1991 Investigations)**



## UNIFIED SOIL CLASSIFICATION SYSTEM

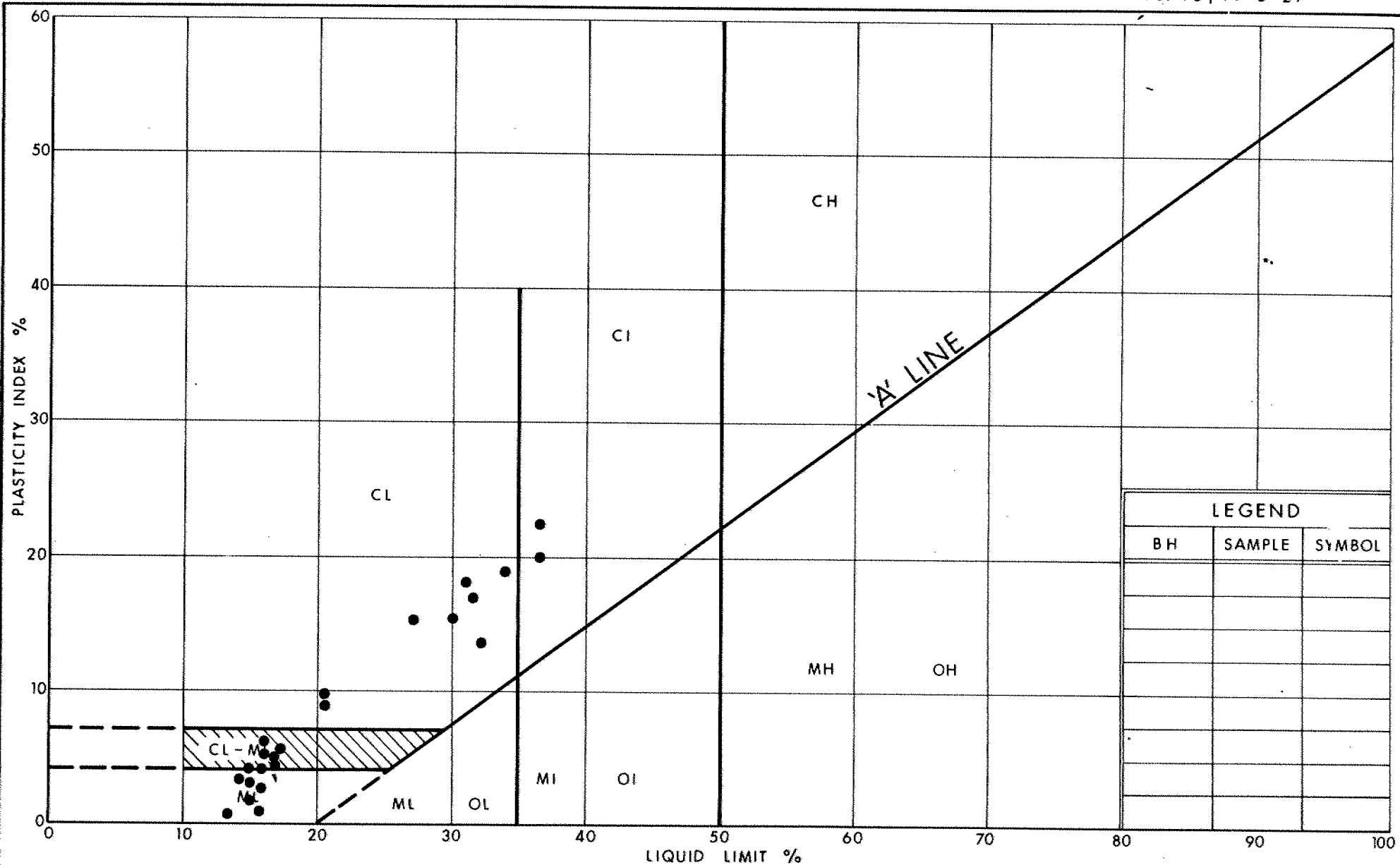

 Ministry of  
Transportation

 GRAIN SIZE DISTRIBUTION  
SILTY CLAY

FIG No 2

W P 128-87-05/06





Ministry of  
Transportation

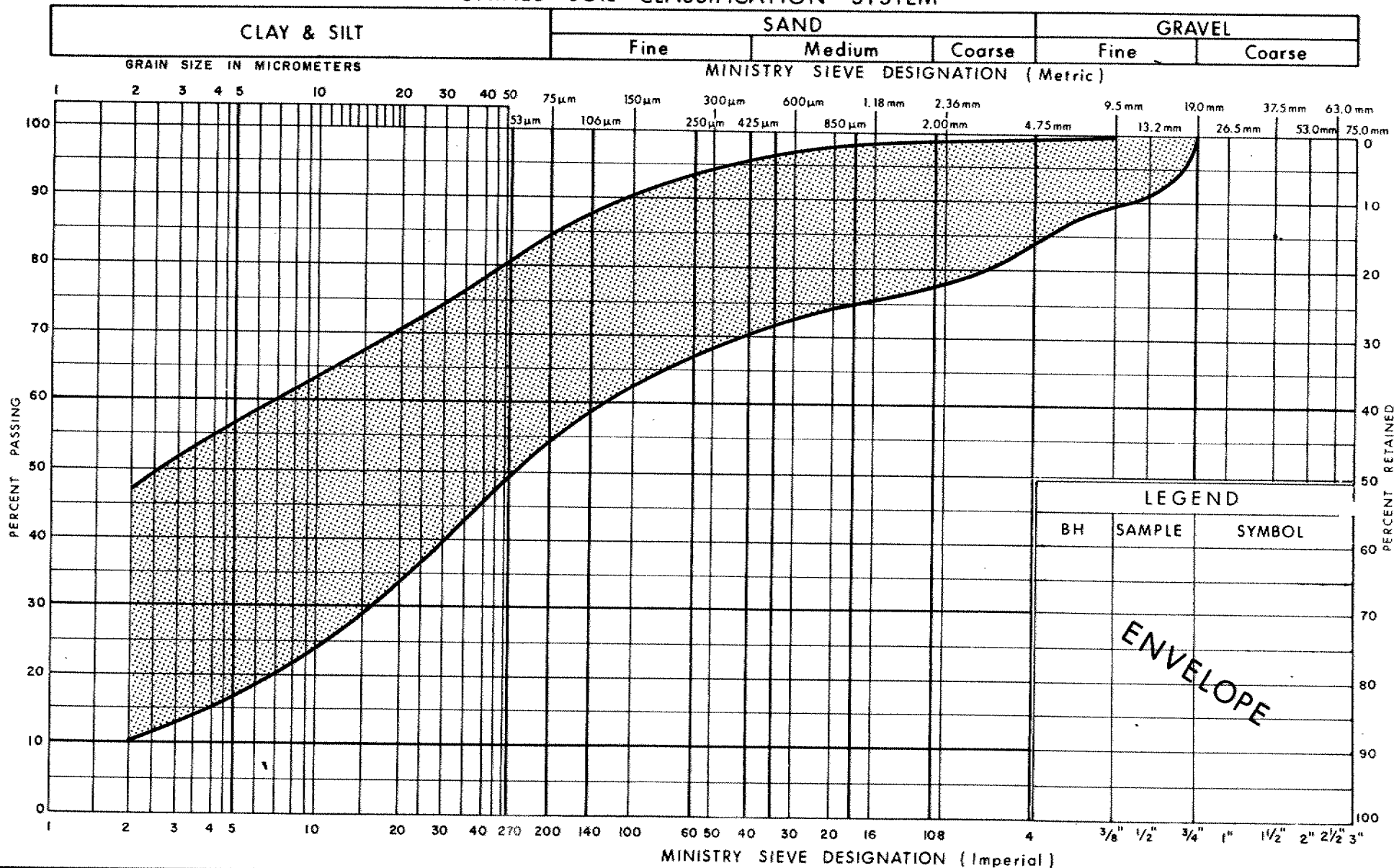
Ontario

# PLASTICITY CHART COHESIVE HET MIXTURE OF CLAYEY SILT TO SILT, SAND & GRAVEL

FIG No 3

W P 128-87-05/06

## UNIFIED SOIL CLASSIFICATION SYSTEM



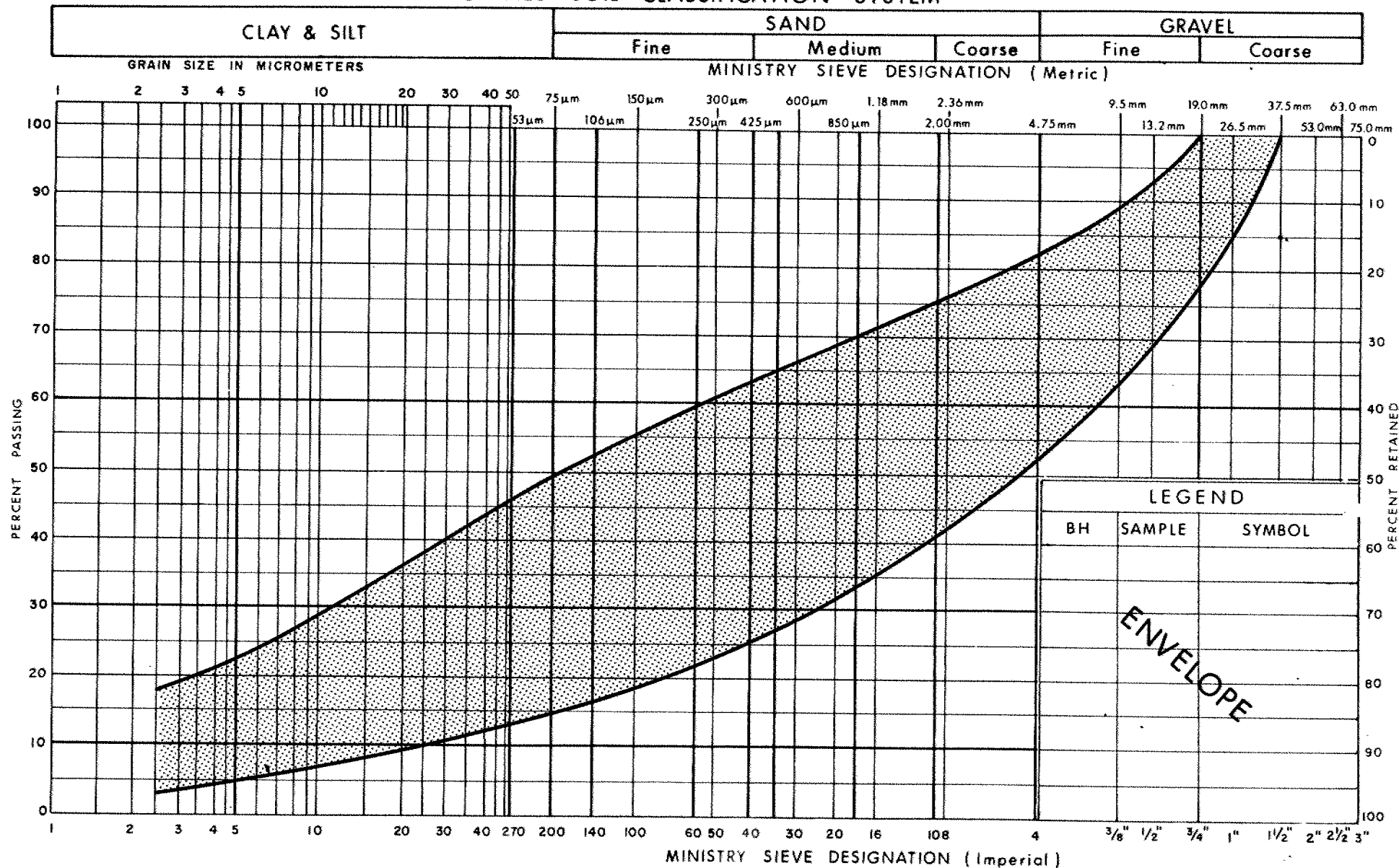
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
COHESIVE HET MIXTURE OF  
CLAYEY SILT TO SILT, SAND & GRAVEL

FIG No 4

W P 128-87-05/06

## UNIFIED SOIL CLASSIFICATION SYSTEM



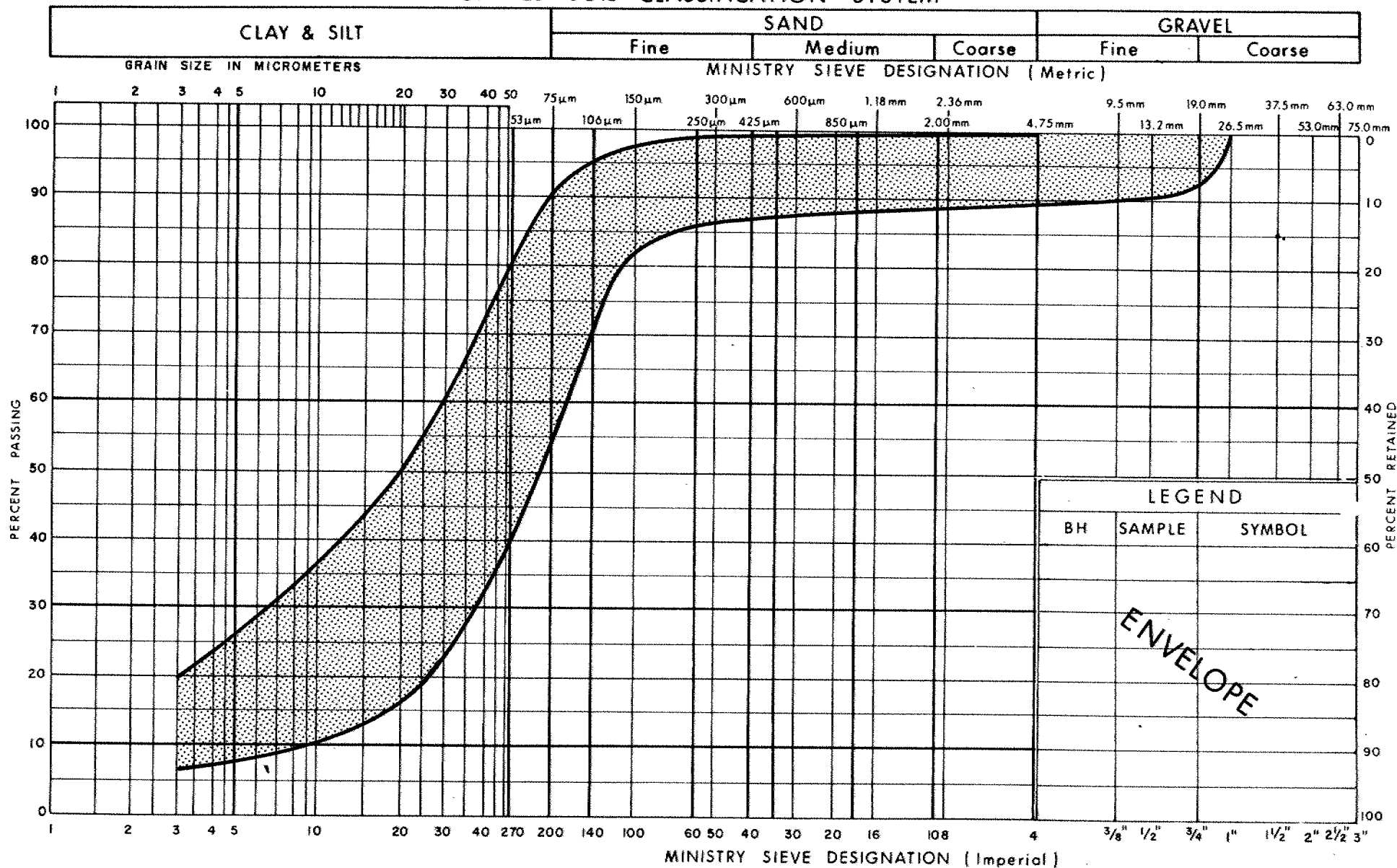
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**GRANULAR HET MIXTURE OF**  
**SILT, SAND & GRAVEL**

FIG No 5

W P 128-87-05/06

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

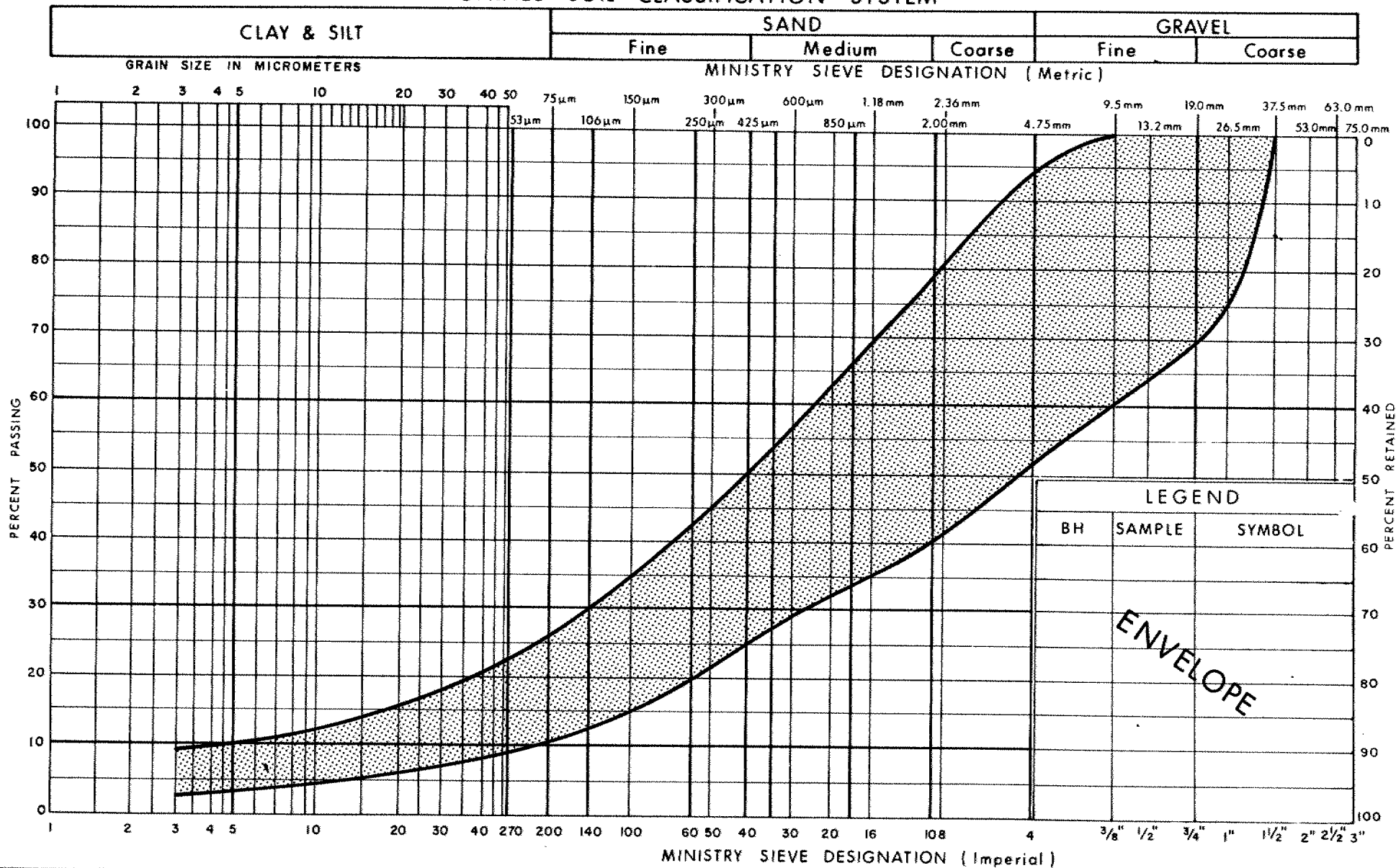
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**SANDY SILT, SOME CLAY TRACE OF GRAVEL**

FIG No 6

W P 128-87-05/06

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SAND WITH GRAVEL, SOME SILT

FIG No 7

W P 128-87-05/06

# VOID RATIO - PRESSURE CURVES

23

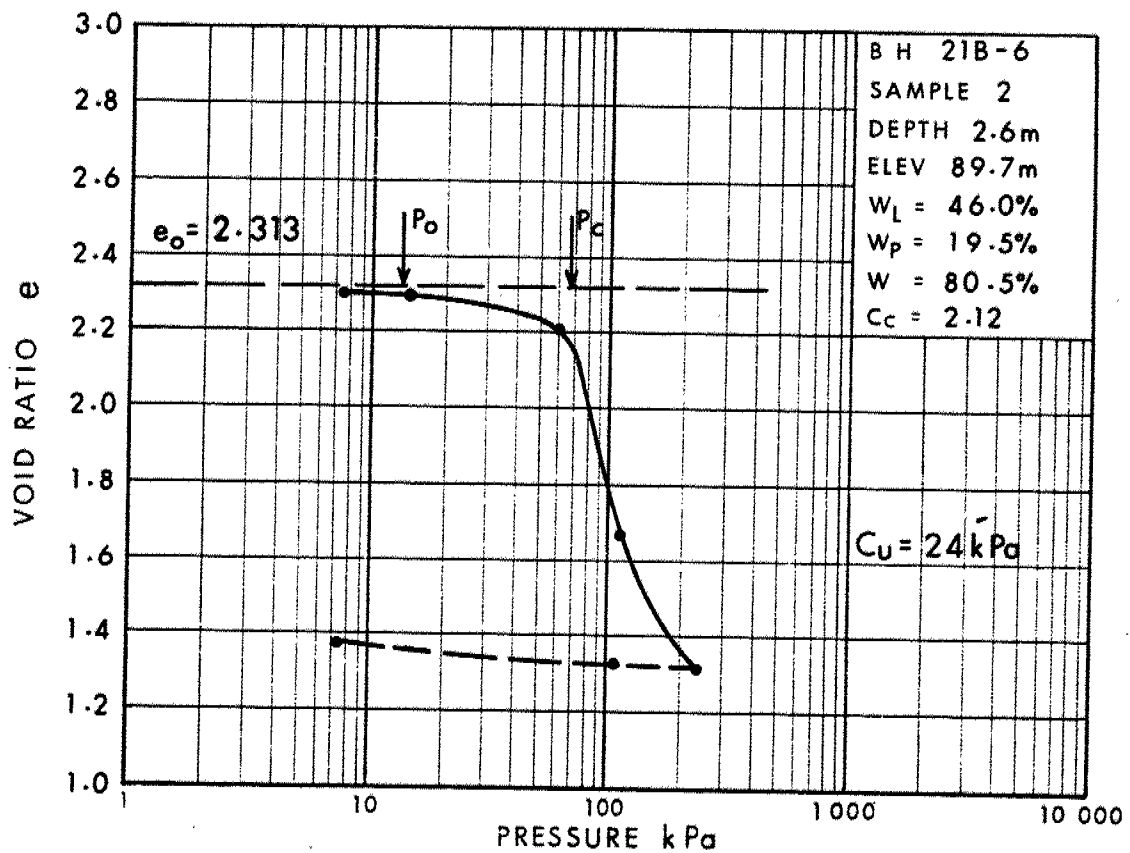
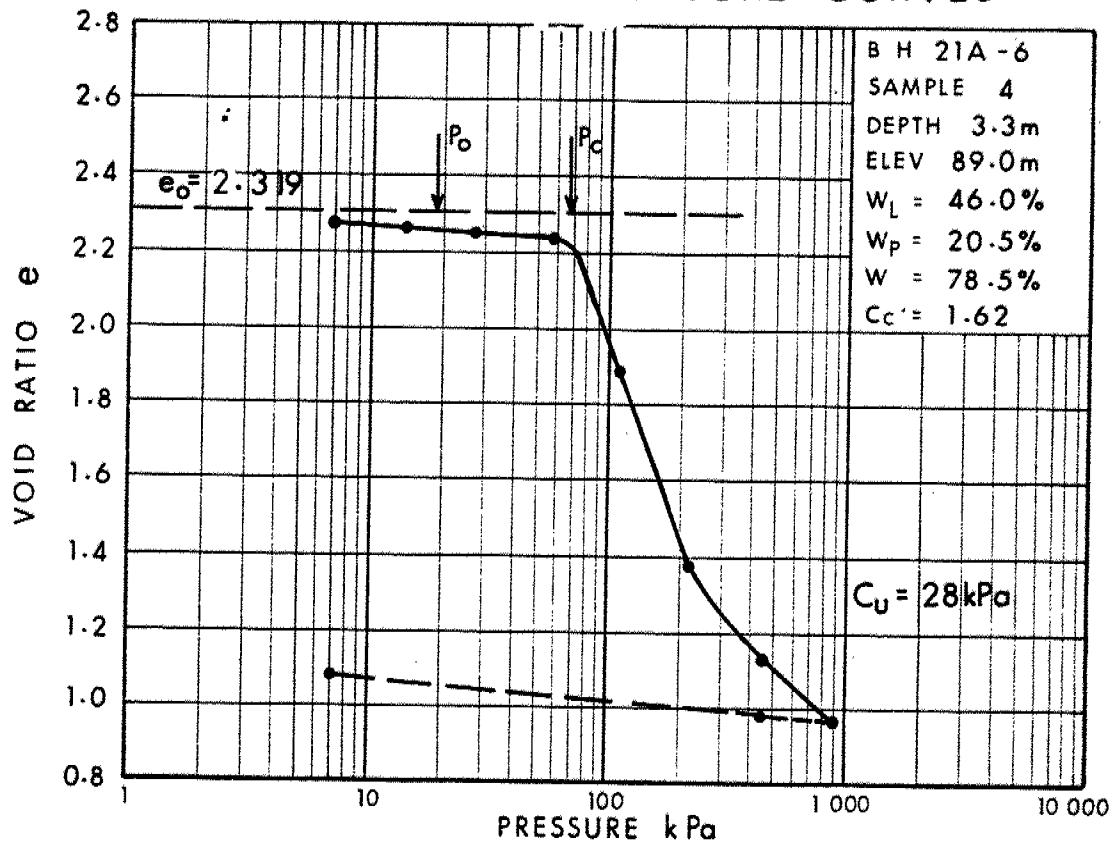


Fig 8

W P 128-87-05/06

## VOID RATIO - PRESSURE CURVES

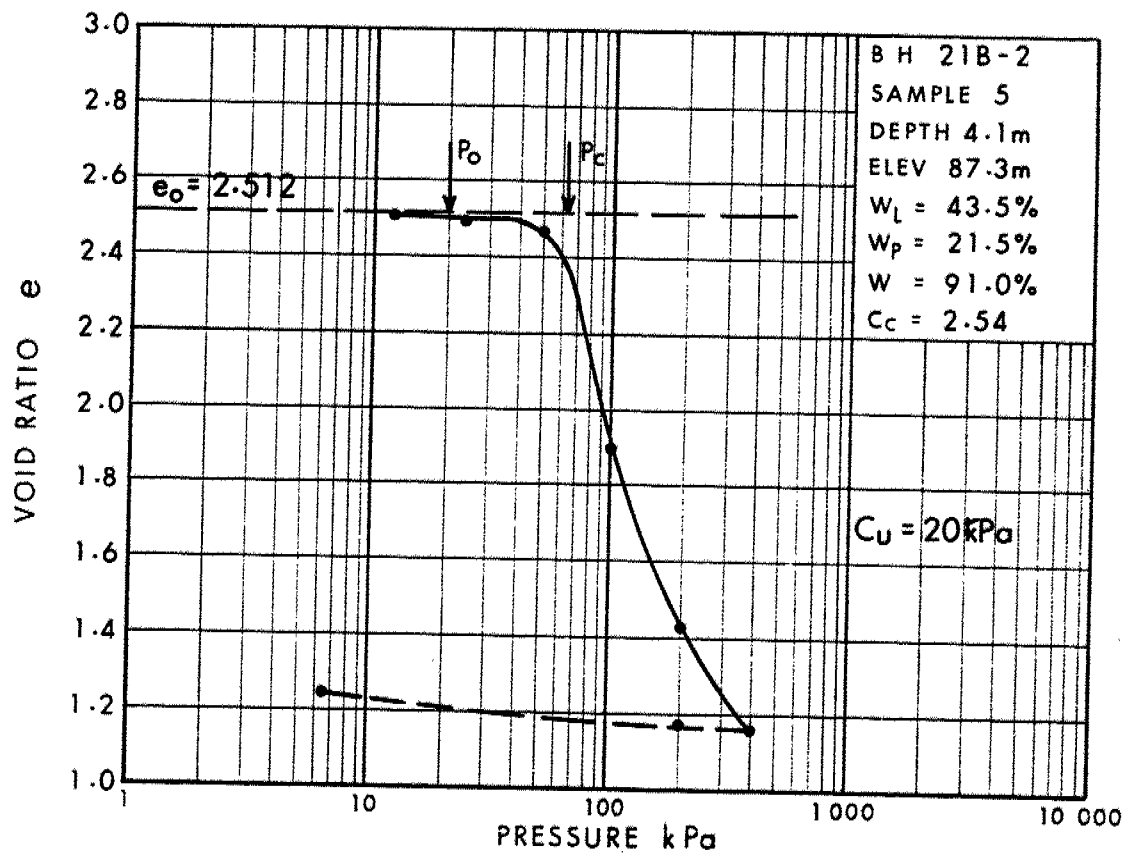
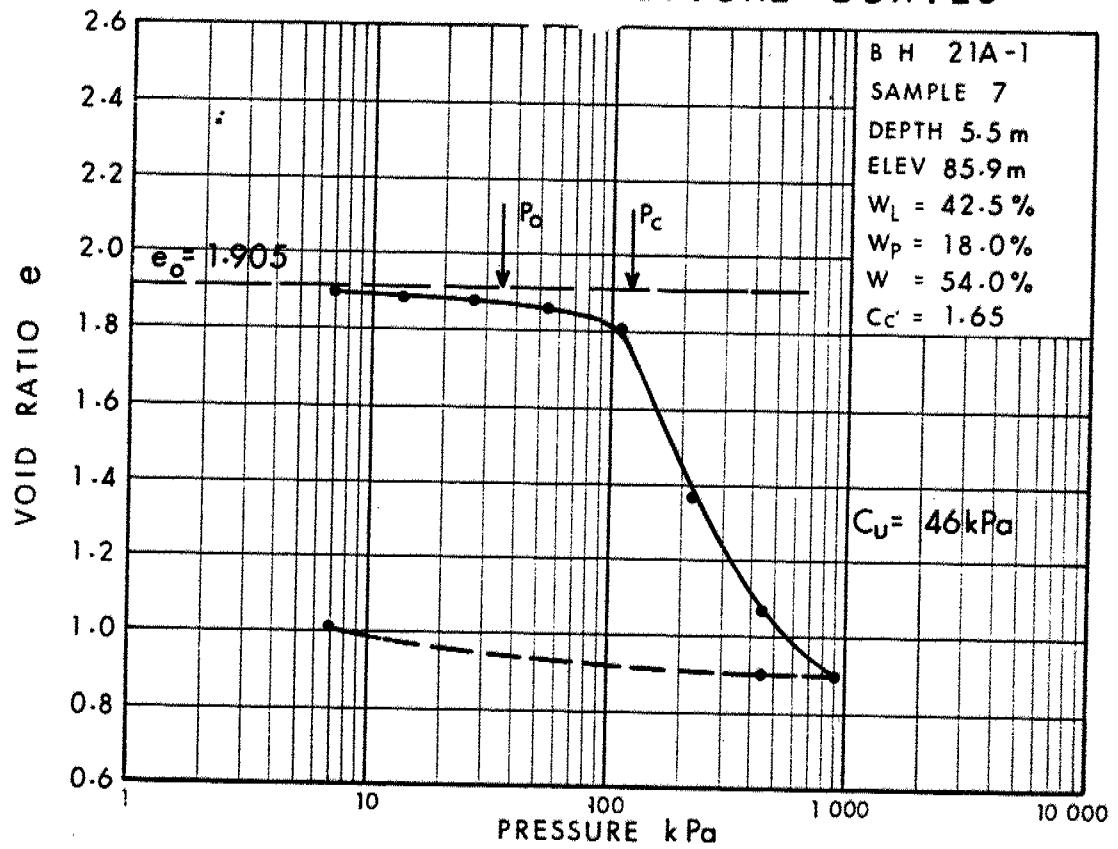
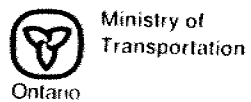


Fig 9

W P 128-87-05/06

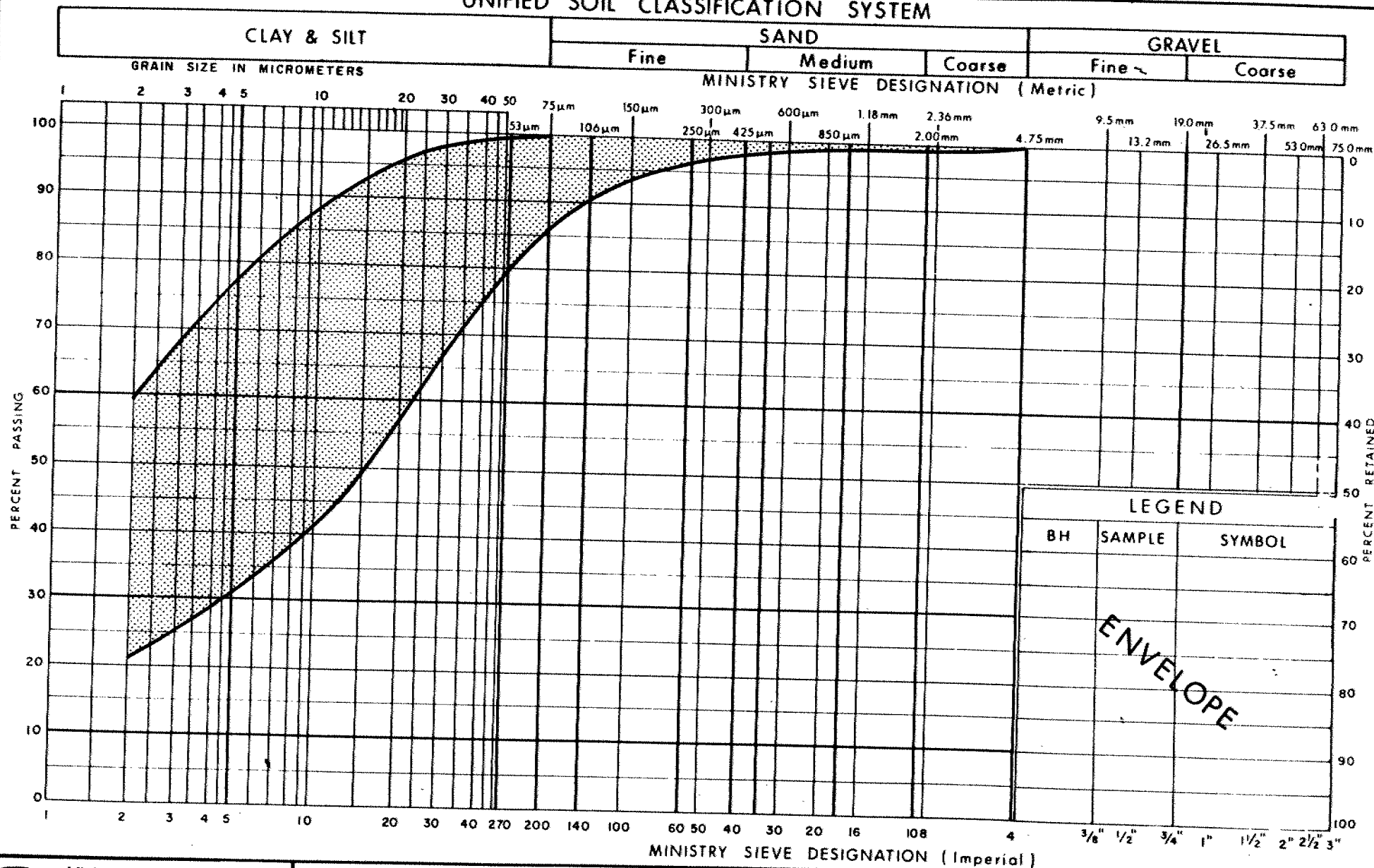


WITH OCC SAND SEAMS, TRACE OF ORGANICS

W P 128-87-00



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SILTY CLAY  
WITH OCC SAND SEAMS, TRACE OF ORGANICS

FIG No 7

WP 128-87-00

# VOID RATIO - PRESSURE CURVES

106

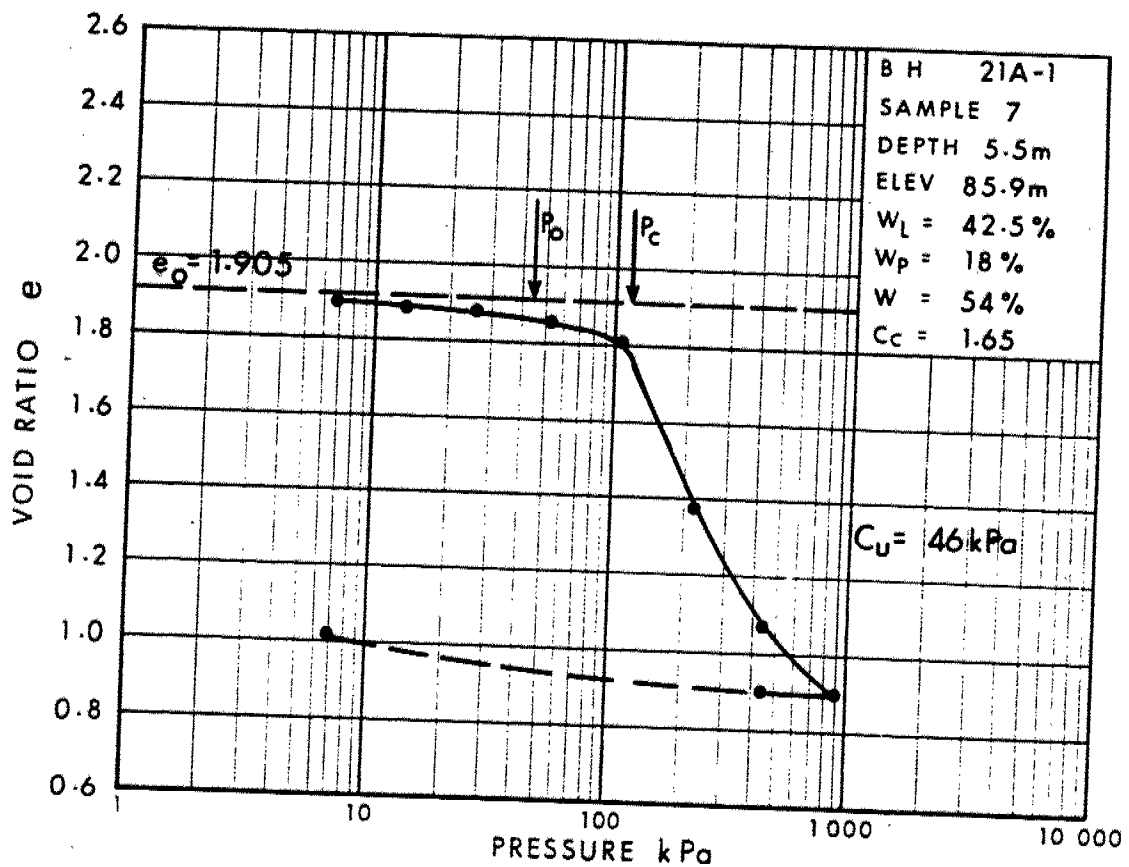
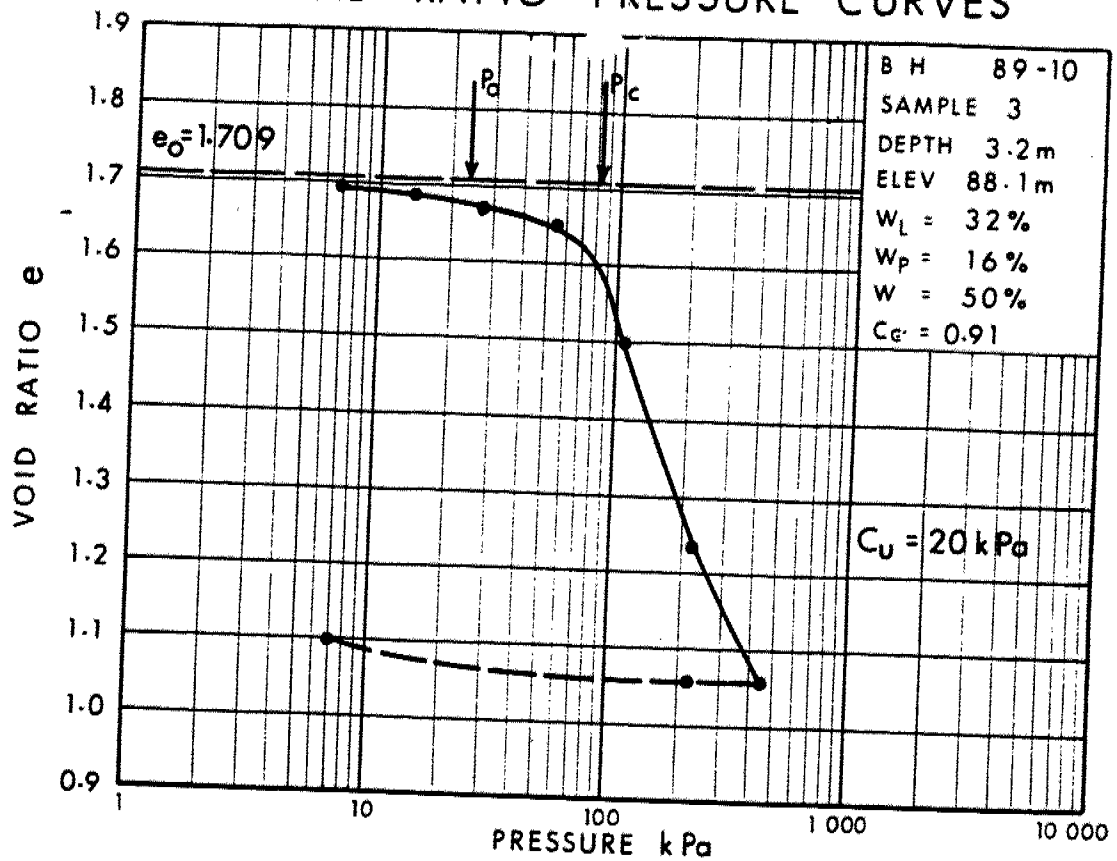


Fig 8 FILL AREA -1

W P 128-87-00

# VOID RATIO - PRESSURE CURVES

107

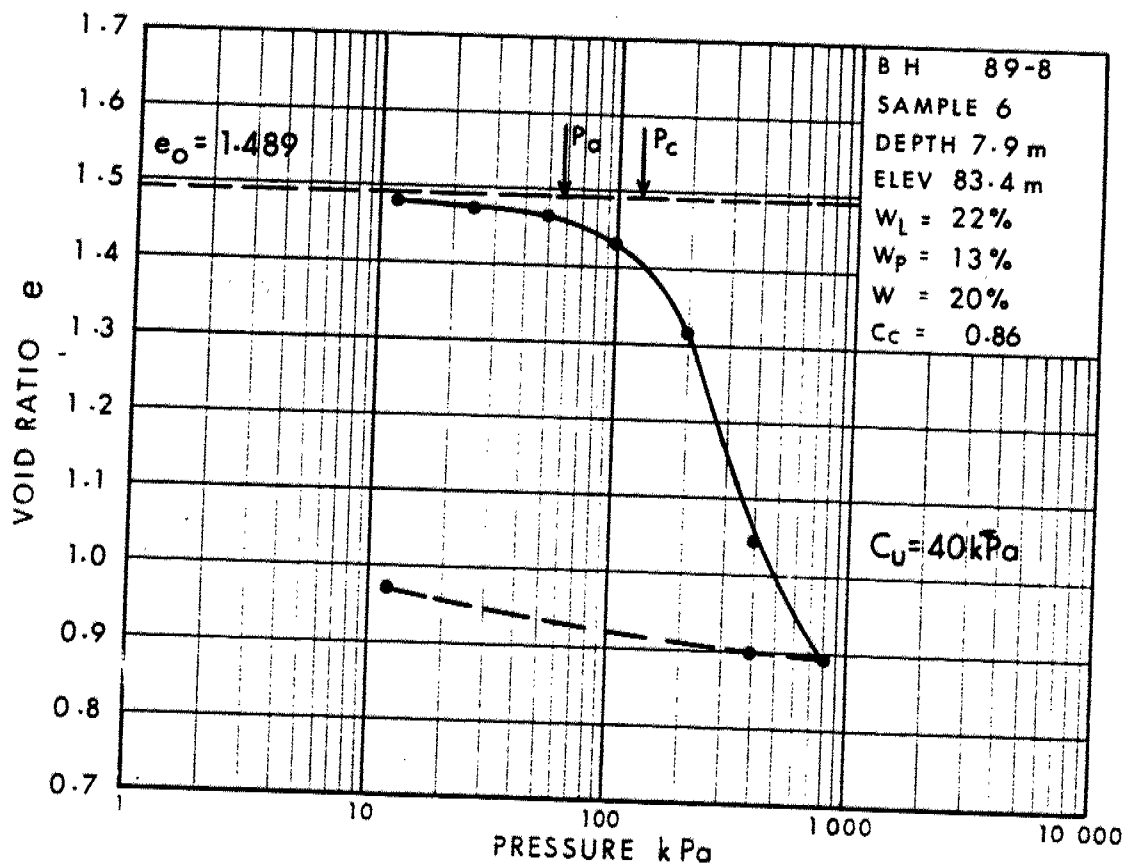
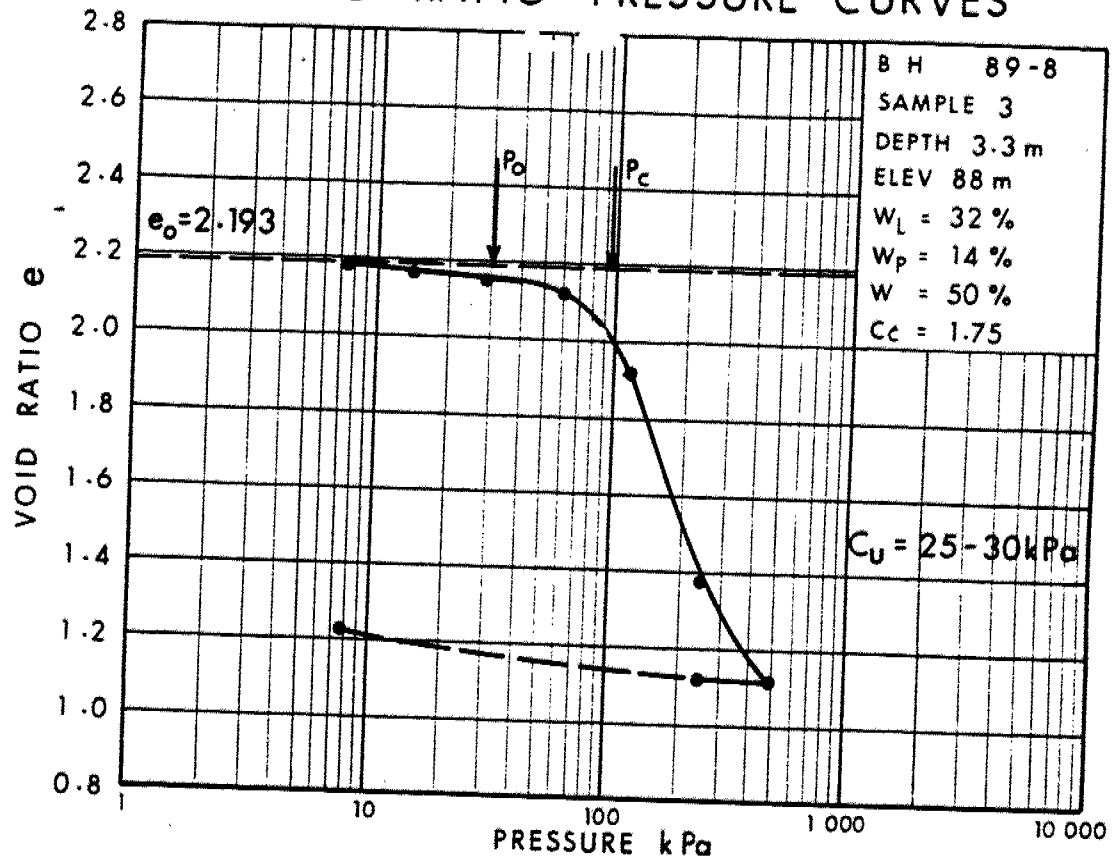


Fig 9- FILL AREA-2

W P 128-87-00

# VOID RATIO - PRESSURE CURVES

108

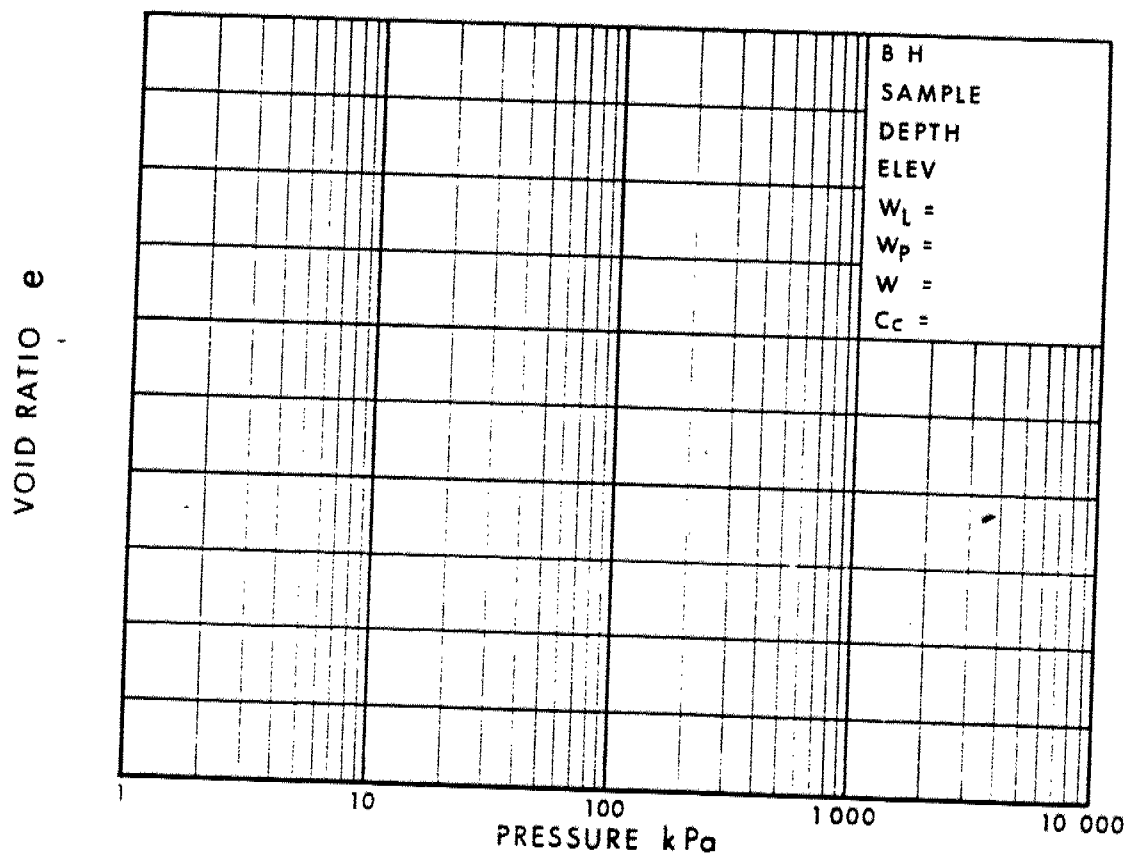
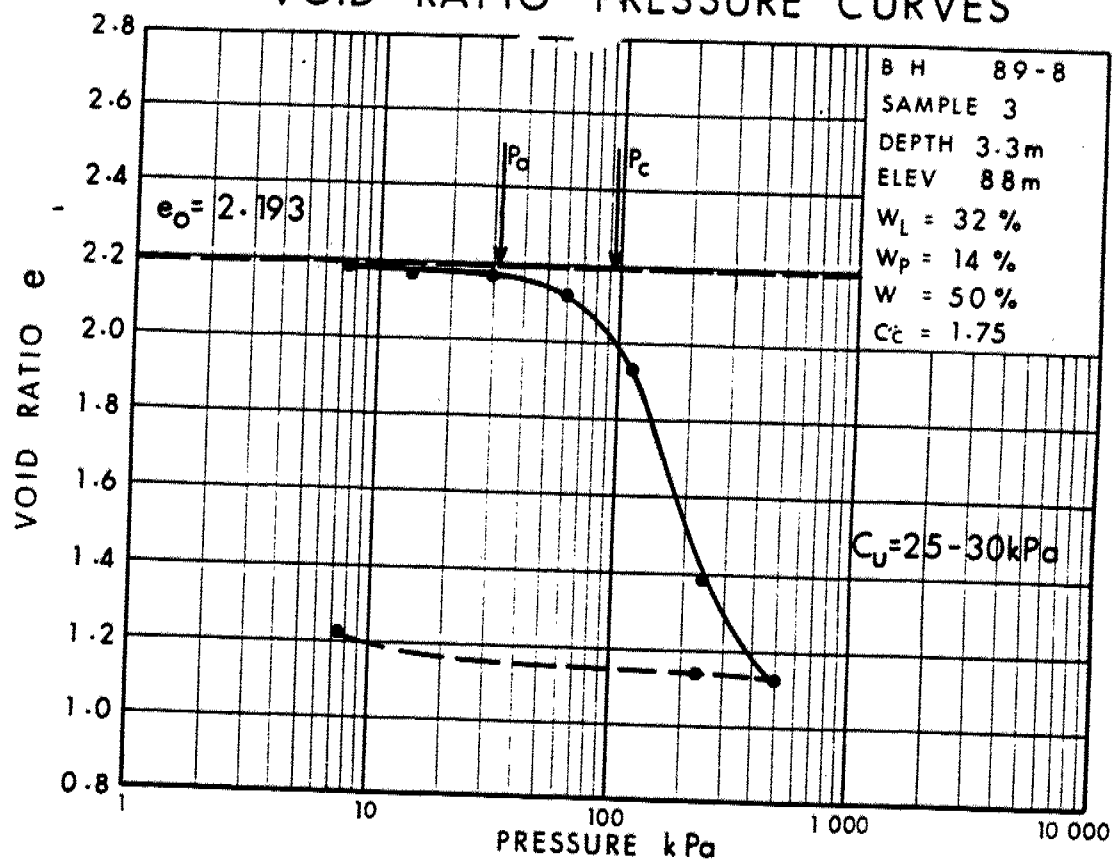


Fig 9a FILL AREA-2A W P 128-87-00

# VOID RATIO - PRESSURE CURVES

109

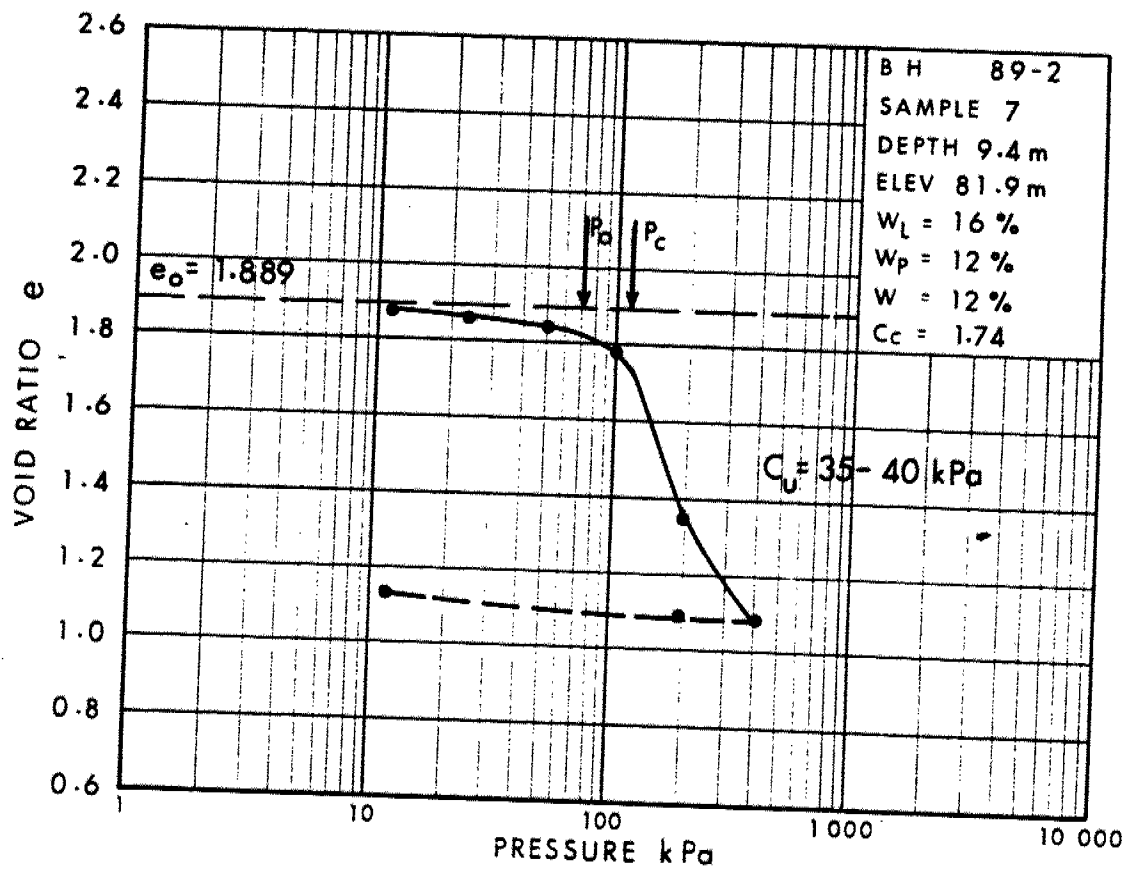
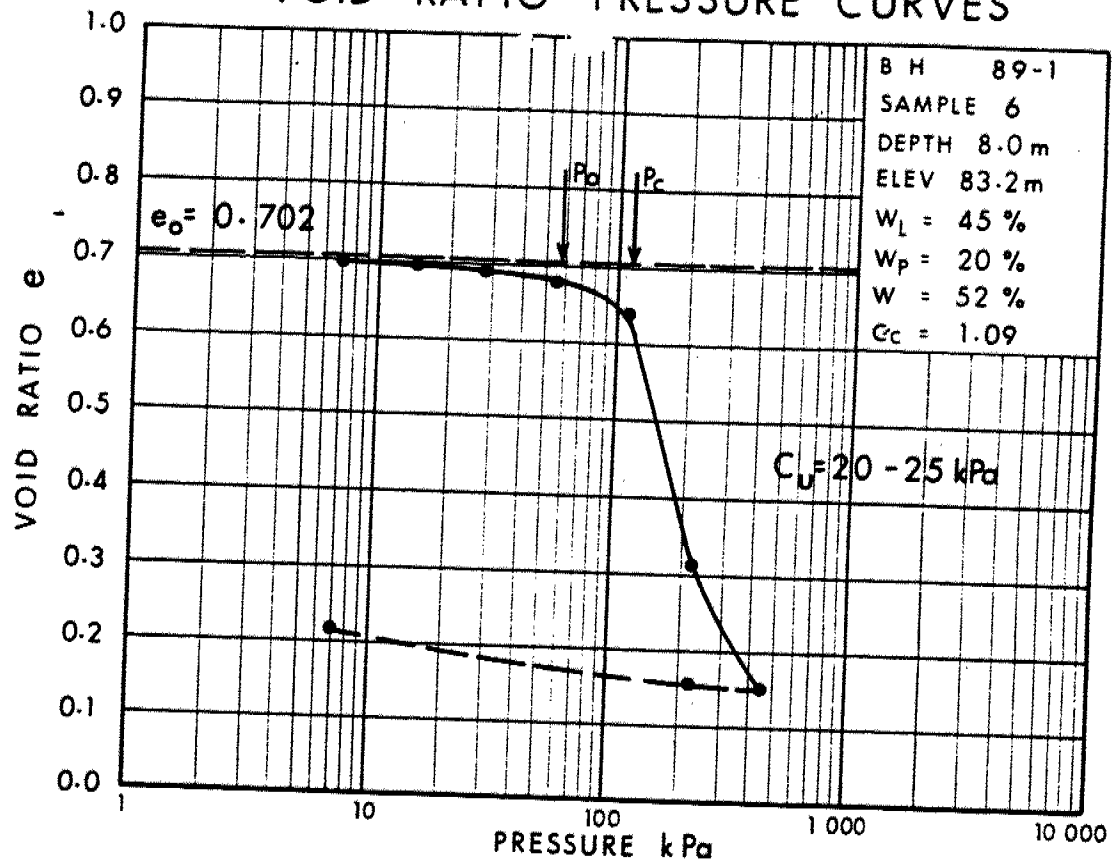
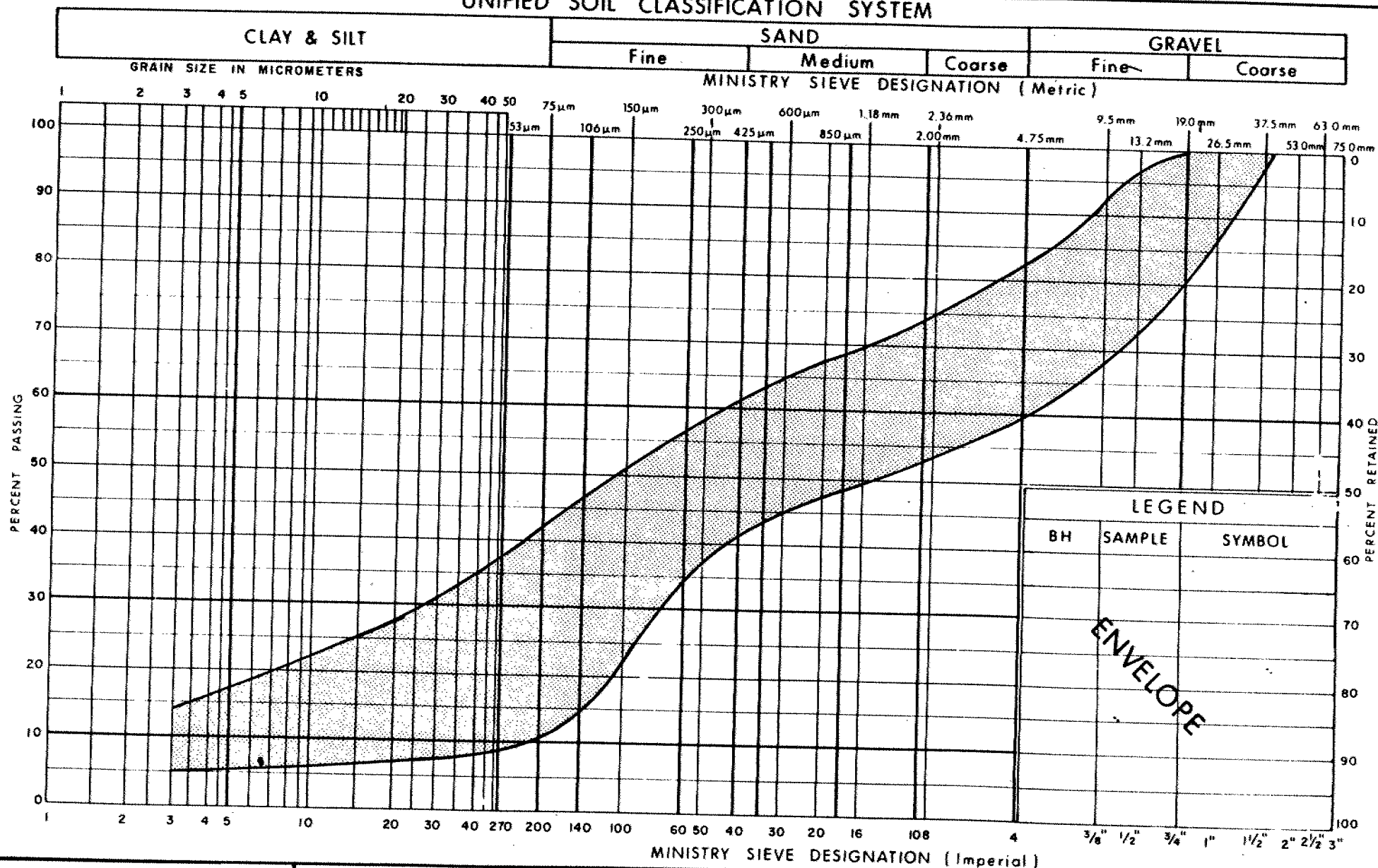


Fig 10 - FILL AREA-3

WP 128-87-00

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

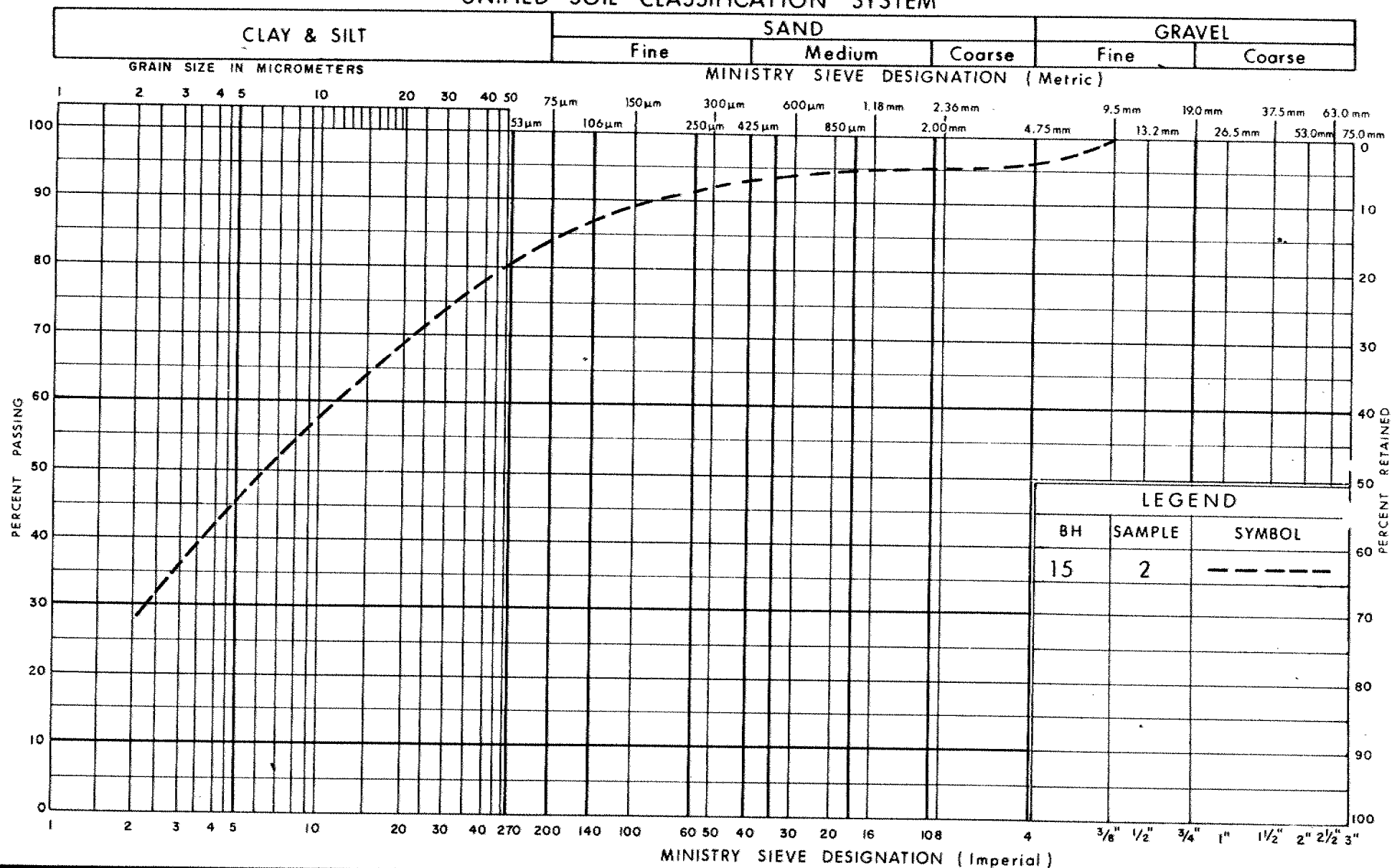
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL

FIG No 11

W P 128-87-00

## UNIFIED SOIL CLASSIFICATION SYSTEM

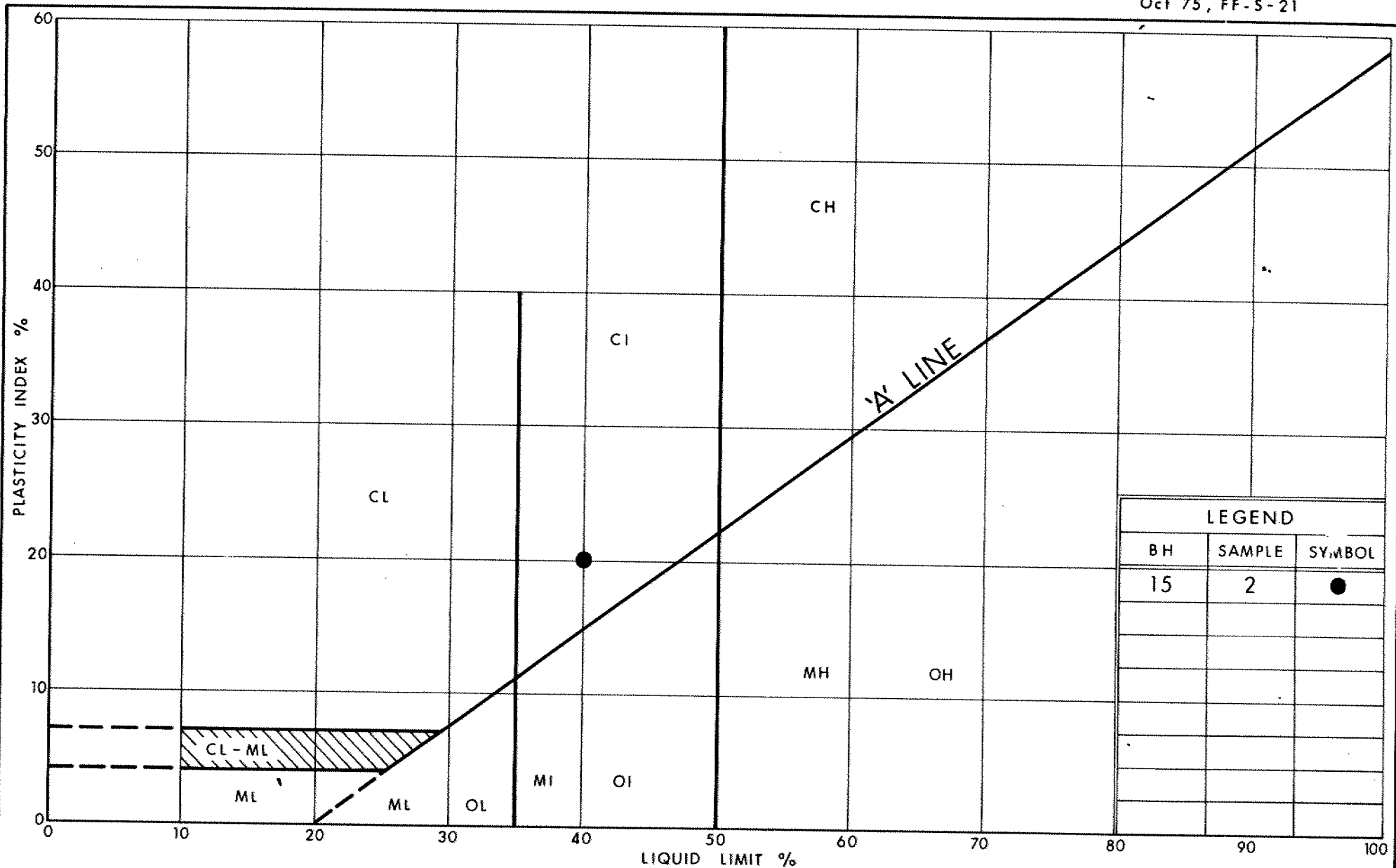

 Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
CLAYEY SILT

TRACE SAND, GRAVEL, INCLUSION OF ORGANICS

FIG No 18

W P 128-87-05/06



Ministry of  
Transportation

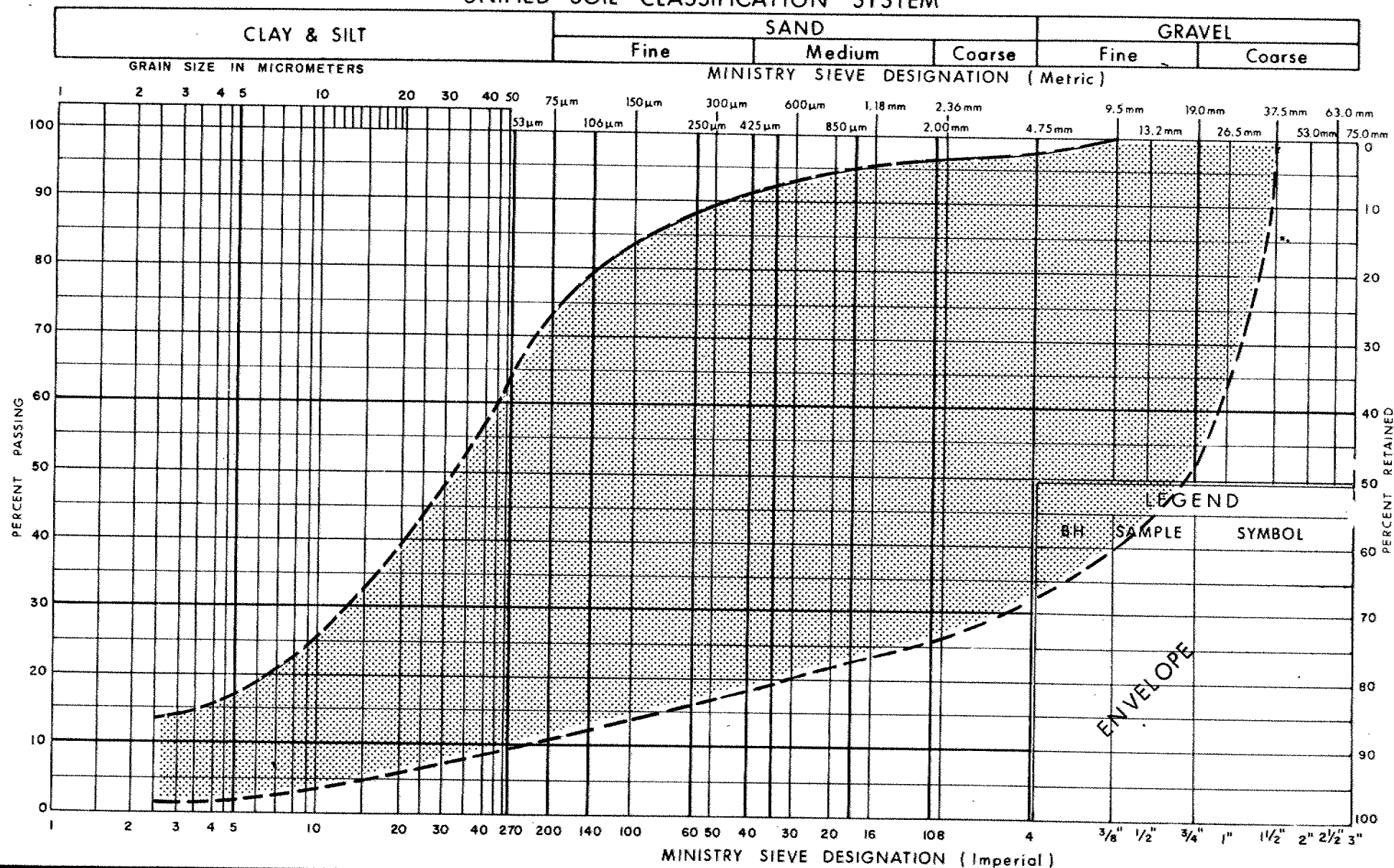
# PLASTICITY CHART CLAYEY SILT TRACE SAND, GRAVEL, INCLUSION OF ORGANICS

FIG No 19

W P 128-87-05/06



## UNIFIED SOIL CLASSIFICATION SYSTEM

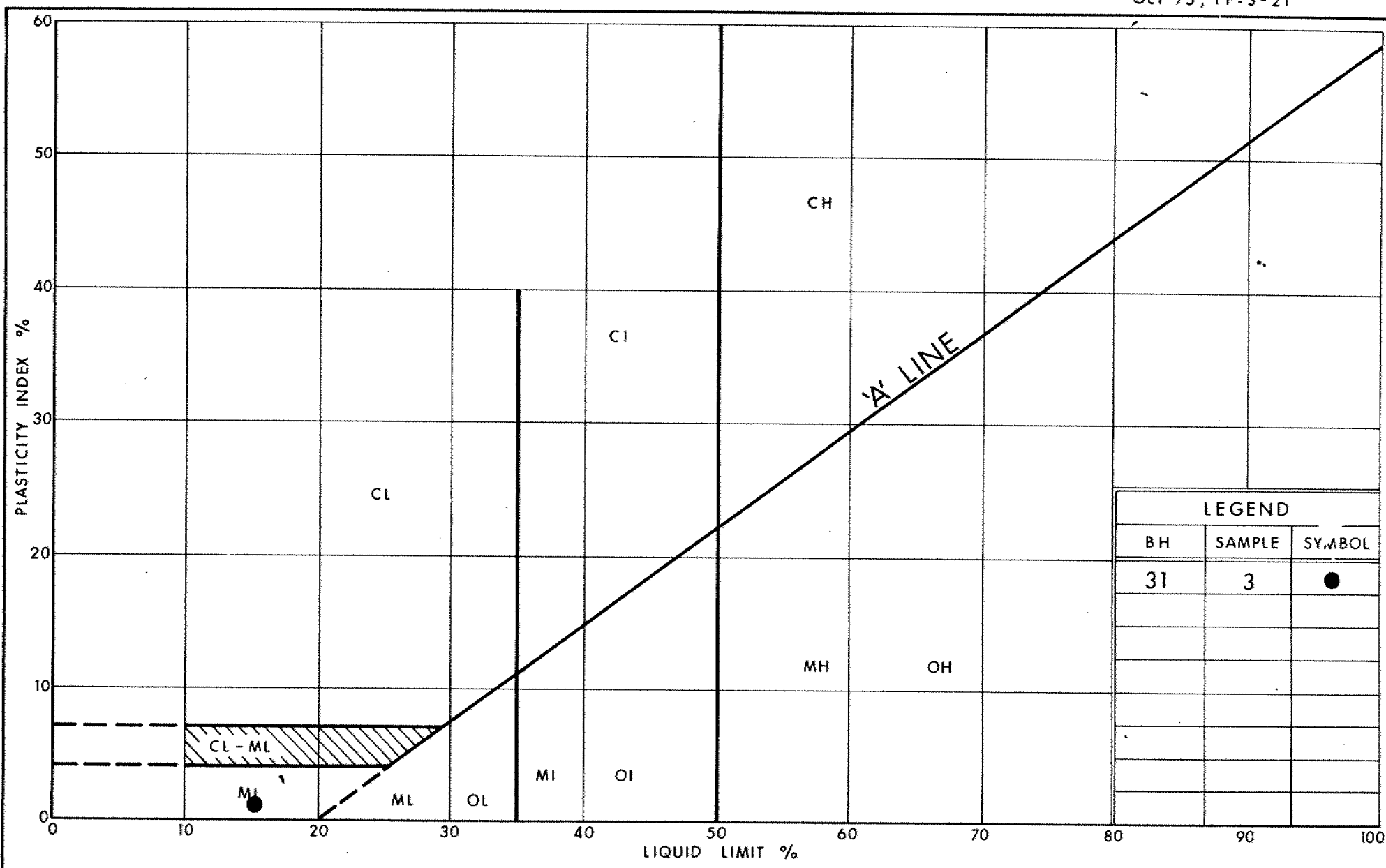


Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
HETEROGENEOUS MIXTURE OF  
**SILT, SAND AND GRAVEL,**  
TRACE CLAY

FIG No 20

W P 128-87-05/06



| LEGEND |        |        |
|--------|--------|--------|
| BH     | SAMPLE | SYMBOL |
| 31     | 3      | ●      |
|        |        |        |
|        |        |        |
|        |        |        |
|        |        |        |
|        |        |        |
|        |        |        |
|        |        |        |
|        |        |        |

**APPENDIX G**

**Vertical Seismic Profile Testing Results  
(Golder, 2018)**

## TECHNICAL MEMORANDUM

**DATE** July 6, 2018

**Project No.** 1417217/1231

**TO** Alex Meacoe, Golder Associates Ltd

**FROM** Stephane Sol, Christopher Phillips

**EMAIL** ssol@golder.com, cphillips@golder.com

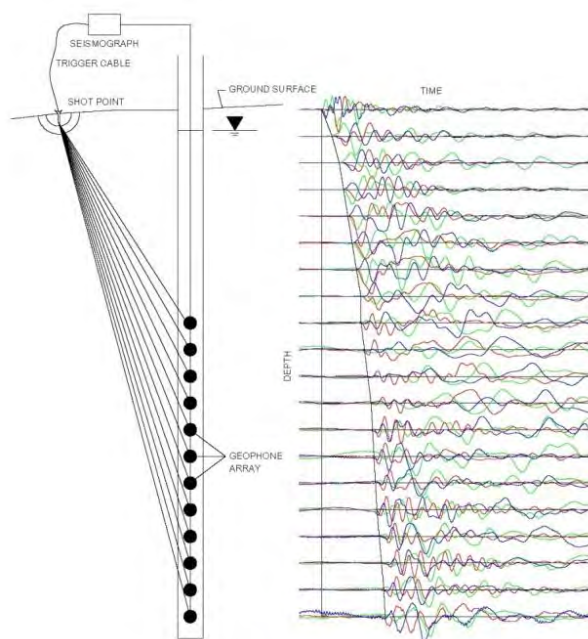
### **VERTICAL SEISMIC PROFILING TEST RESULTS OVERPASS ALONG HIGHWAY 16, OTTAWA, ONTARIO**

This memorandum presents the results of two Vertical Seismic Profiling (VSP) testing carried out at an overpass located along Highway 416 near McKenna Casey Drive in Ottawa, Ontario. VSP testing was carried out on June 25, 2018. Borehole 18-01, located north of the overpass, was drilled to an approximate depth of 26.6 m below the existing ground surface and then cased with a 2.5 inch PVC pipe grouted in place. The borehole consisted of approximately 5.3 m of gravelly sand fill, 15.5 m of gravelly silty sand, 3.2 m of sandstone, and shale/dolomite bedrock to bottom of the borehole. Borehole 18-02, located in south of the overpass, was drilled to an approximate depth of 20.2 m below the existing ground surface and then cased with a 2.5 inch PVC pipe grouted in place. The borehole consisted of approximately 4.4 m of sand fill, 5.7 m of silty clay, 4.7 m of silty sand, and dolomite bedrock.

### **Methodology**

For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in a nearby borehole at a known depth. The active seismic source can be either compression or shear wave. The time required for the energy to travel from the source to the receiver (geophone) provides a measurement of the average compression or shear-wave seismic velocity of the medium between the source and the receiver. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the test borehole.

The high resolution results of a VSP survey are often used for earthquake engineering site classification, as per the 2014 Canadian Highway Bridge Design Code (CHBDC 2014).



**Example 1: Layout and resulting time traces from a VSP survey.**

## Fieldwork

The fieldwork was carried out on June 25, 2018, by personnel from the Golder Mississauga and Ottawa offices.

At BH18-01, the compression and shear-wave seismic sources were used and they were located 2 m, and 2.03 m from the borehole. The seismic source for the compression wave test consisted of a 9.9 kilogram sledge hammer vertically impacted on a metal plate. The seismic source for the shear-wave test consisted of a 1 metre long aluminium plate, hammer into the ground and horizontally struck with a 9.9 kilogram sledge hammer on alternate ends of the beam to induce polarized shear waves. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced mostly at 1-metre intervals below the ground surface to a depth of 20 m and 0.5-metre intervals down to the maximum depth of the casing (25.7 m).

At BH18-02, the compression and shear-wave seismic sources were used and they were located 2 m, and 1.93 m from the borehole. The seismic source for the shear-wave test consisted of a 2.4 metre long, 150 millimetre by 150 millimetre wooden beam, weighted by a vehicle and horizontally struck with a 9.9 kilogram sledge hammer on alternate ends of the beam to induce polarized shear waves. The shear source was coupled to the ground surface by parking a vehicle on top of it. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced mostly at 1-metre intervals below the ground surface to a depth of 14 m and 0.5-metre intervals down to the maximum depth of the casing (19.7 m).

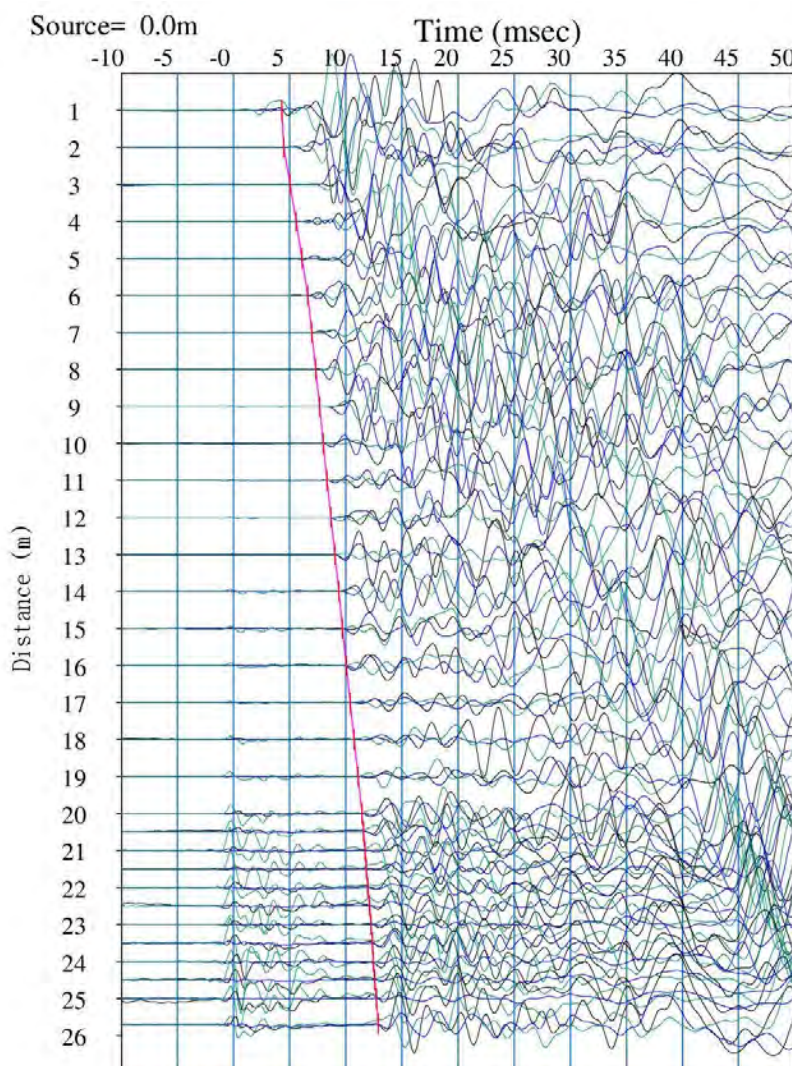
The seismic records collected for each source location were stacked a minimum of five times to minimize the effects of ambient background seismic noise on the collected data. The data was sampled at 0.020833 millisecond intervals and a total time window of 0.341 seconds was collected for each seismic shot.

## Data Processing

Processing of the VSP test results consisted of the following main steps:

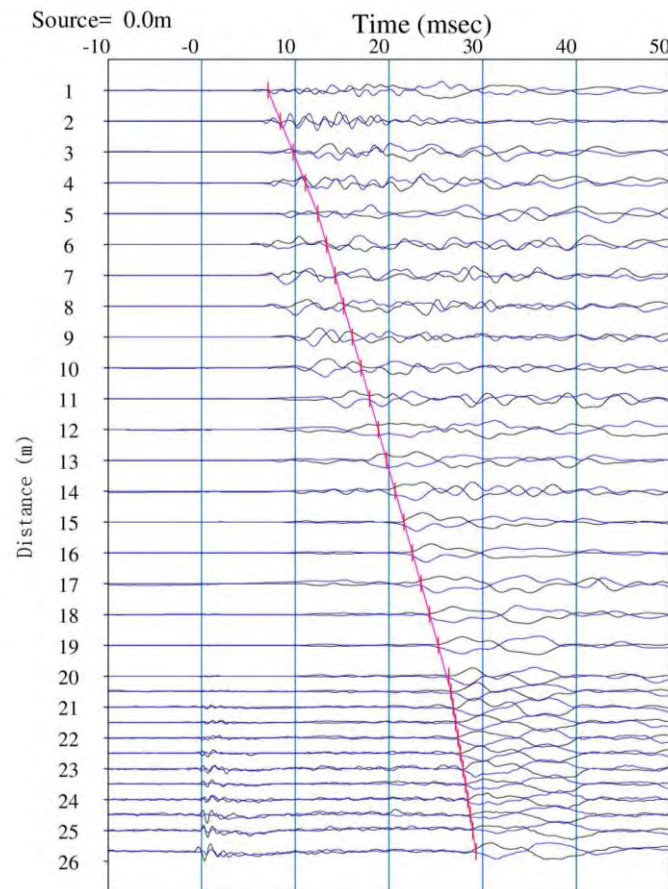
- 1) Combination of seismic records to present seismic traces for all depth intervals on a single plot for each seismic source and for each component;
- 2) Low Pass Filtering of data to remove spurious high frequency noise;
- 3) First break picking of the compression and shear-wave arrivals; and,
- 4) Calculation of the average compression and shear-wave velocity to each tested depth interval.

Processing of the VSP data was completed using the SeisImager/SW software package (Geometrics Inc.). The seismic records at BH18-01 are presented on the following two plots and show the first break picks of the compression wave (Figure 1) and shear wave arrivals (Figure 2) overlaid on the seismic waveform traces recorded at the different geophone depths. The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.



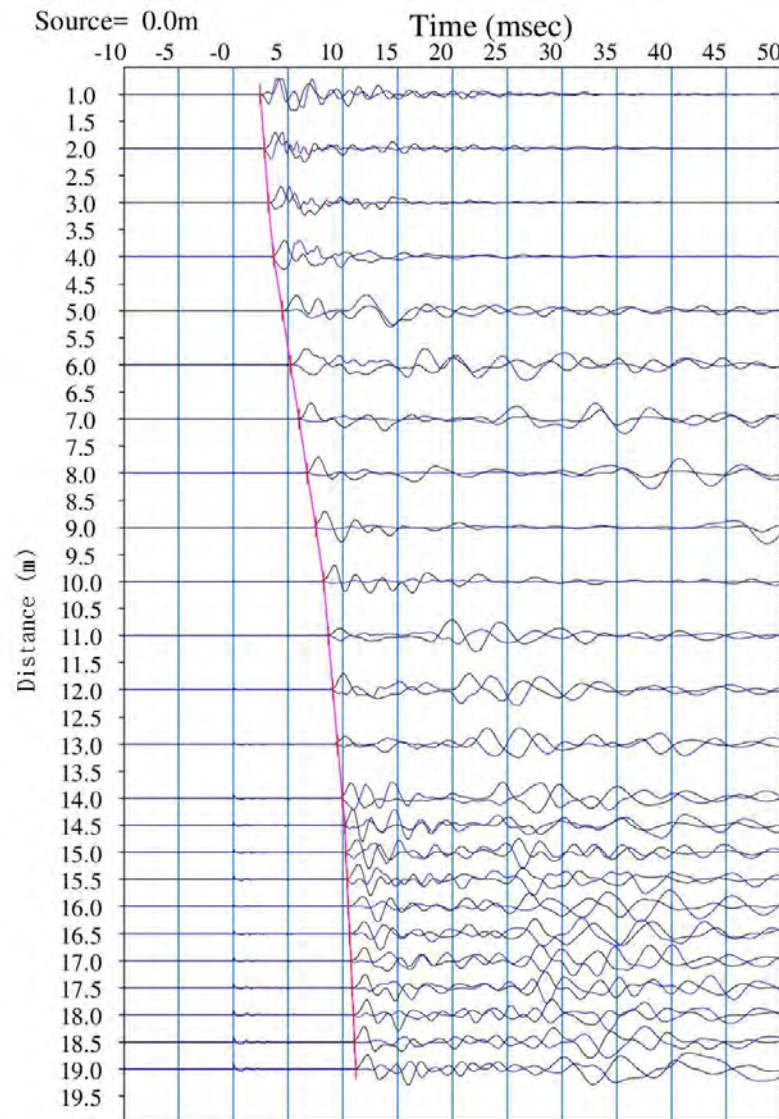
**Figure 1: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole BH18-01.**





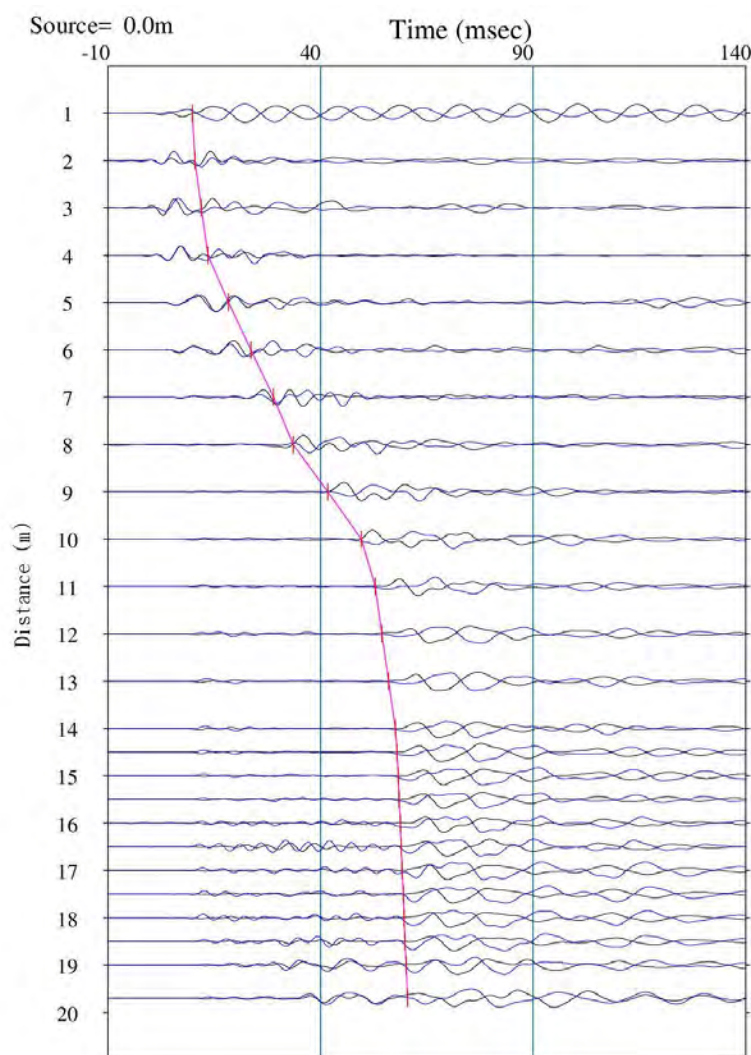
**Figure 2: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 18-01.**

The seismic records at BH18-02 are presented on the following two plots and show the first break picks of the compression wave (Figure 3) and shear wave arrivals (Figure 4) overlaid on the seismic waveform traces recorded at the different geophone depths. The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.



**Figure 3: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 18-02.**





**Figure 4: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 18-02.**

## Results

The VSP results at BH18-01 and BH18-02 are summarized in Tables 1, and Table 2, respectively. The shear wave and compression wave layer velocities were calculated by best fitting a theoretical travel time model to the field data. The depths presented on the table are relative to ground surface.

The estimated dynamic engineering moduli, based on the calculated wave velocities, are also presented in Tables 1 and 2. The engineering moduli were calculated using an estimated bulk density, based on the borehole log. At borehole 18-01, an estimated bulk density of 2000 kg/m<sup>3</sup> was used for fill and gravelly silty sand and an estimated bulk density of 2,300 kg/m<sup>3</sup> was used for the sandstone and shale bedrock. At borehole 18-02, an estimated bulk density of 2000 kg/m<sup>3</sup> was used for fill, 1,550 kg/m<sup>3</sup> for silty clay, 2,000 kg/m<sup>3</sup> for the silty sand and 2,600 kg/m<sup>3</sup> for the dolostone bedrock.

At borehole 18-01, the average shear wave velocity from ground surface to a depth of 30 metres was measured to be 953 metres per second. The average velocity at 18-01 was calculated assuming that the

velocity from 25.7 metres to a depth of 30 metres was constant with an average shear-wave velocity value of 1,900 m/s which is equal to the velocity at the bottom of the borehole.

At borehole 18-02, the average shear wave velocity from ground surface to a depth of 30 metres was measured to be 460 metres per second. The average velocity at 18-02 was calculated assuming that the velocity from 19.7 metres to a depth of 30 metres was constant with an average shear-wave velocity value of 2,000 m/s which is equal to the velocity at the bottom of the borehole.

## Limitations

This technical memorandum, which specifically includes all tables, figures and attachments, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The services performed, as described in this memo, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this memo, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this memo.

The findings and conclusions of this memo are valid only as of the date of this memo. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this memo, and to provide amendments as required.

## Closure

We trust that these results meet your current needs. If you have any questions or require clarification, please contact the undersigned at your convenience.

### **GOLDER ASSOCIATES LTD.**



Stephane Sol, Ph.D., P. geo.  
*Senior Geophysicist*

SS/CRP

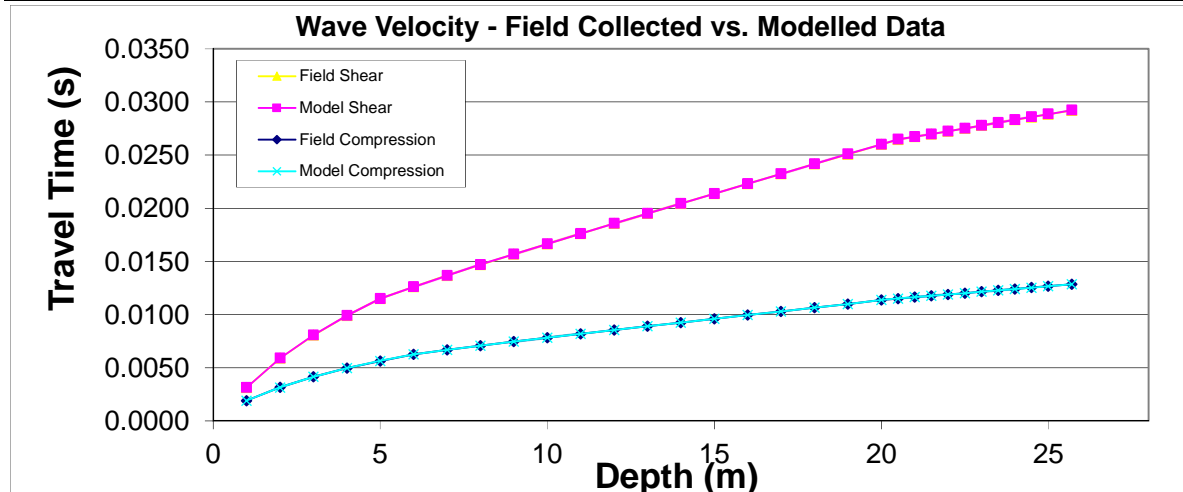


Christopher Phillips, M.Sc., P. Geo.  
*Senior Geophysicist, Principal*

Attachment: Tables 1 & 2

**TABLE 1**  
**SHEAR WAVE VELOCITY PROFILE AT BOREHOLE 18-01**

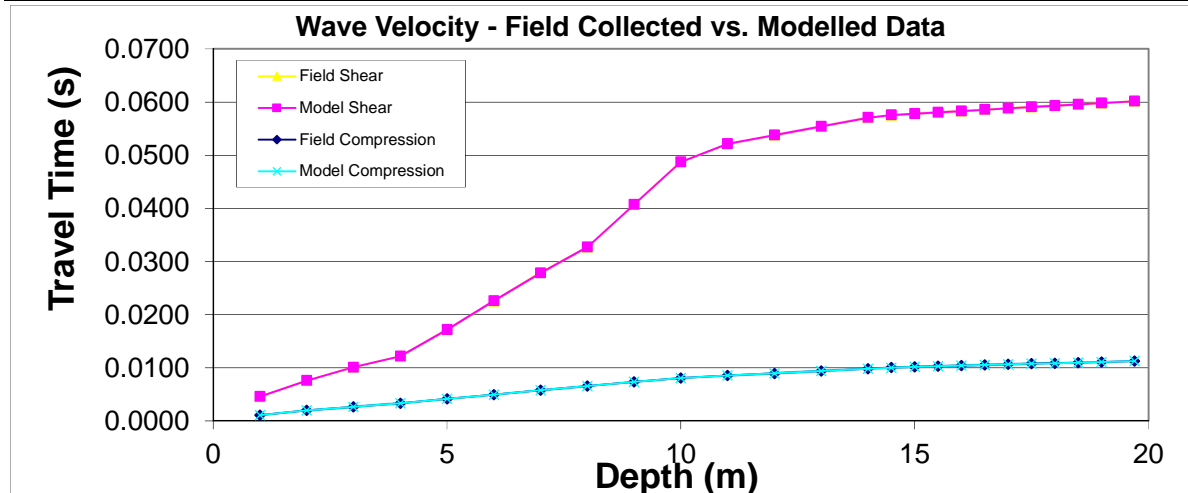
| Layer Depth (m) |        | Velocities (m/s)   |            | Estimated Bulk Density (kg/m <sup>3</sup> ) | Dynamic Engineering Properties |                     |                           |                    |
|-----------------|--------|--------------------|------------|---------------------------------------------|--------------------------------|---------------------|---------------------------|--------------------|
| Top             | Bottom | Compressional Wave | Shear Wave |                                             | Poissons Ratio                 | Shear Modulus (MPa) | Deformation Modulus (MPa) | Bulk Modulus (MPa) |
| 0.0             | 1.0    | 525                | 320        | 2000                                        | 0.20                           | 205                 | 493                       | 278                |
| 1.0             | 2.0    | 810                | 360        | 2000                                        | 0.38                           | 259                 | 714                       | 967                |
| 2.0             | 3.0    | 990                | 460        | 2000                                        | 0.36                           | 423                 | 1153                      | 1396               |
| 3.0             | 4.0    | 1250               | 550        | 2000                                        | 0.38                           | 605                 | 1670                      | 2318               |
| 4.0             | 5.0    | 1450               | 620        | 2000                                        | 0.39                           | 769                 | 2134                      | 3180               |
| 5.0             | 6.0    | 1600               | 900        | 2000                                        | 0.27                           | 1620                | 4110                      | 2960               |
| 6.0             | 7.0    | 2400               | 950        | 2000                                        | 0.41                           | 1805                | 5080                      | 9113               |
| 7.0             | 8.0    | 2530               | 970        | 2000                                        | 0.41                           | 1882                | 5321                      | 10293              |
| 8.0             | 9.0    | 2650               | 1020       | 2000                                        | 0.41                           | 2081                | 5881                      | 11271              |
| 9.0             | 10.0   | 2750               | 1030       | 2000                                        | 0.42                           | 2122                | 6019                      | 12296              |
| 10.0            | 11.0   | 2750               | 1040       | 2000                                        | 0.42                           | 2163                | 6129                      | 12241              |
| 11.0            | 12.0   | 2800               | 1050       | 2000                                        | 0.42                           | 2205                | 6254                      | 12740              |
| 12.0            | 13.0   | 2800               | 1060       | 2000                                        | 0.42                           | 2247                | 6366                      | 12684              |
| 13.0            | 14.0   | 2830               | 1070       | 2000                                        | 0.42                           | 2290                | 6487                      | 12965              |
| 14.0            | 15.0   | 2850               | 1070       | 2000                                        | 0.42                           | 2290                | 6494                      | 13192              |
| 15.0            | 16.0   | 2870               | 1070       | 2000                                        | 0.42                           | 2290                | 6500                      | 13421              |
| 16.0            | 17.0   | 2870               | 1080       | 2000                                        | 0.42                           | 2333                | 6614                      | 13363              |
| 17.0            | 18.0   | 2870               | 1080       | 2000                                        | 0.42                           | 2333                | 6614                      | 13363              |
| 18.0            | 19.0   | 2870               | 1080       | 2000                                        | 0.42                           | 2333                | 6614                      | 13363              |
| 19.0            | 20.0   | 2700               | 1080       | 2000                                        | 0.40                           | 2333                | 6554                      | 11470              |
| 20.0            | 20.5   | 3400               | 1080       | 2000                                        | 0.44                           | 2333                | 6737                      | 20010              |
| 20.5            | 21.0   | 4000               | 2000       | 2300                                        | 0.33                           | 9200                | 24533                     | 24533              |
| 21.0            | 21.5   | 4000               | 2000       | 2300                                        | 0.33                           | 9200                | 24533                     | 24533              |
| 21.5            | 22.0   | 3900               | 2000       | 2300                                        | 0.32                           | 9200                | 24317                     | 22716              |
| 22.0            | 22.5   | 3850               | 1800       | 2300                                        | 0.36                           | 7452                | 20271                     | 24156              |
| 22.5            | 23.0   | 3850               | 1800       | 2300                                        | 0.36                           | 7452                | 20271                     | 24156              |
| 23.0            | 23.5   | 3900               | 1800       | 2300                                        | 0.36                           | 7452                | 20339                     | 25047              |
| 23.5            | 24.0   | 3900               | 1900       | 2300                                        | 0.34                           | 8303                | 22325                     | 23912              |
| 24.0            | 24.5   | 3900               | 1900       | 2300                                        | 0.34                           | 8303                | 22325                     | 23912              |
| 24.5            | 25.0   | 3900               | 1900       | 2300                                        | 0.34                           | 8303                | 22325                     | 23912              |
| 25.0            | 25.7   | 3900               | 1900       | 2300                                        | 0.34                           | 8303                | 22325                     | 23912              |

**Notes**

1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.

**TABLE 2**  
**SHEAR WAVE VELOCITY PROFILE AT BOREHOLE 18-02**

| Layer Depth (m) |        | Velocities (m/s)   |            | Estimated Bulk Density (kg/m <sup>3</sup> ) | Dynamic Engineering Properties |                     |                           |                    |
|-----------------|--------|--------------------|------------|---------------------------------------------|--------------------------------|---------------------|---------------------------|--------------------|
| Top             | Bottom | Compressional Wave | Shear Wave |                                             | Poissons Ratio                 | Shear Modulus (MPa) | Deformation Modulus (MPa) | Bulk Modulus (MPa) |
| 0.0             | 1.0    | 920                | 220        | 2000                                        | 0.47                           | 97                  | 285                       | 1564               |
| 1.0             | 2.0    | 1110               | 330        | 2000                                        | 0.45                           | 218                 | 632                       | 2174               |
| 2.0             | 3.0    | 1520               | 400        | 2000                                        | 0.46                           | 320                 | 936                       | 4194               |
| 3.0             | 4.0    | 1580               | 485        | 2000                                        | 0.45                           | 470                 | 1362                      | 4366               |
| 4.0             | 5.0    | 1190               | 200        | 1550                                        | 0.49                           | 62                  | 184                       | 2112               |
| 5.0             | 6.0    | 1220               | 185        | 1550                                        | 0.49                           | 53                  | 158                       | 2236               |
| 6.0             | 7.0    | 1240               | 190        | 1550                                        | 0.49                           | 56                  | 167                       | 2309               |
| 7.0             | 8.0    | 1250               | 205        | 1550                                        | 0.49                           | 65                  | 194                       | 2335               |
| 8.0             | 9.0    | 1260               | 125        | 1550                                        | 0.50                           | 24                  | 72                        | 2428               |
| 9.0             | 10.0   | 1350               | 125        | 1550                                        | 0.50                           | 24                  | 72                        | 2793               |
| 10.0            | 11.0   | 2300               | 290        | 2000                                        | 0.49                           | 168                 | 502                       | 10356              |
| 11.0            | 12.0   | 2400               | 610        | 2000                                        | 0.47                           | 744                 | 2181                      | 10528              |
| 12.0            | 13.0   | 2250               | 610        | 2000                                        | 0.46                           | 744                 | 2174                      | 9133               |
| 13.0            | 14.0   | 2250               | 610        | 2000                                        | 0.46                           | 744                 | 2174                      | 9133               |
| 14.0            | 14.5   | 2600               | 990        | 2000                                        | 0.42                           | 1960                | 5548                      | 10906              |
| 14.5            | 15.0   | 3600               | 2000       | 2000                                        | 0.28                           | 8000                | 20429                     | 15253              |
| 15.0            | 15.5   | 3800               | 2000       | 2600                                        | 0.31                           | 10400               | 27215                     | 23677              |
| 15.5            | 16.0   | 4300               | 2000       | 2600                                        | 0.36                           | 10400               | 28329                     | 34207              |
| 16.0            | 16.5   | 4300               | 2000       | 2600                                        | 0.36                           | 10400               | 28329                     | 34207              |
| 16.5            | 17.0   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |
| 17.0            | 17.5   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |
| 17.5            | 18.0   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |
| 18.0            | 18.5   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |
| 18.5            | 19.0   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |
| 19.0            | 19.7   | 4400               | 2000       | 2600                                        | 0.37                           | 10400               | 28492                     | 36469              |

**Notes**

1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.



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