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FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH FILLS AND DEEP CUTS
HIGHWAY 400 / BRADFORD BYPASS FREEWAY TO FREEWAY INTERCHANGE, INCLUDING HIGHWAY 400 MAIN ALIGNMENT, 9TH LINE MAIN ALIGNMENT, N-E RAMP, E-N RAMP, S-E RAMP AND E-S RAMP BRADFORD WEST GWILLIMBURY, ONTARIO

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PART A: FOUNDATION INVESTIGATION REPORT

1. INTRODUCTION

Thurber was retained by AECOM on behalf of the Ministry of Transportation Ontario (MTO) to carry out detail foundation investigation services for the western portion of the new Bradford Bypass under Assignment No. 2023-E-0068. The proposed Bradford Bypass will be a four-lane rural divided freeway connecting Highway 400 to Highway 404 and can accommodate future widening of up to eight lanes.

The proposed work for this assignment involves the design of a 6.5 km stretch of Bradford Bypass from Highway 400 to west of Artesian Industrial Parkway. This report only addresses the investigation carried out for the proposed high fill embankments and deep cut associated with the planned Highway 400 / Bradford Bypass freeway to freeway interchange, including Highway 400 main alignment, 9th Line main alignment, N-E Ramp, E-N Ramp, S-E Ramp and E-S Ramp in the Town of Bradford West Gwillimbury, Ontario.

The purpose of this investigation is to explore the subsurface conditions at sites where the high fill embankments and deep cut are proposed based on borehole drilling, in-situ testing, and laboratory testing of selected samples.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement for Use and Interpretation of Report.

2. SITE DESCRIPTION

The site covers an area which extends from the intersection of Highway 400 and 9th Line to about 1.4 km south, in the Town of Bradford West Gwillimbury, Ontario.

Highway 400 is currently a six-lane highway oriented in a north to south direction, with three lanes in each NBL and SBL direction, separated by a concrete median.

The land surrounding the subject section of Highway 400 at the high fills and deep cut sites generally consists of farmland and the vegetative cover generally consists of tall grass, shrubs, and crop residue. The topography to the northwest of Highway 400 and 9th Line is elevated and slopes downwards towards the southeast.

Site photographs collected during site visit in October 2024 are presented in Appendix A. The locations of the proposed high fills and deep cut investigated during the current study are shown in the Key Plan on Drawing 1 (Appendix B), and summarized below:

High Fills

- **Highway 400 N-E Ramp south of 9th Line, Approximate Stations 10+270 to 10+410 (Drawing 2)**
  A high fill embankment, with a maximum approximate height of 5.8 m, is proposed on the southwest side of the 9th Line and Highway 400 crossing, just south of the south abutment of the proposed N-E Ramp structure over 9th Line. The embankment forms part of the design for the new Highway 400 N-E Ramp, which will connect the Highway 400 southbound lane (SBL) to the proposed Bradford Bypass eastbound lane (EBL).

- **Highway 400 N-E Ramp (east of flyover), Approximate Stations 11+000 to 11+280 (Drawing 3)**
  High fill to be located on the east side of Highway 400, designed as part of the new Highway 400 N-E Ramp connecting Highway 400 SBL to the proposed BBP EBL. This high fill will be located on the east side of the proposed N-E flyover east abutment. Embankment height of up to 17 m is planned.

- **Highway 400 E-N Ramp south of 9th Line, Approximate Stations 10+620 to 10+890 (Drawing 4)**
  High fill to be located on the east side of Highway 400 NBL designed as part of the new Highway 400 E-N Ramp connecting the proposed BBP WBL to Highway 400 NBL. This high fill will be located on the south side of the proposed N-E Ramp structure over 9th Line. Embankment height will be up to about 8.2 m.

- **Highway 400 E-N Ramp north of 9th Line, Approximate Stations 10+950 to 11+170 (Drawing 5)**
  High fill to be located on the east side of Highway 400 NBL designed as part of the new Highway 400 E-N Ramp connecting the proposed BBP WBL to Highway 400 NBL. This high fill will be located on the north side of the proposed N-E Ramp structure over 9th Line. Embankment height will be up to 7.6 m.

- **Highway 400 E-S Ramp at BBP (east of flyover), Approximate Stations 11+520 to 11+670 (Drawing 6)**
  High fill to be located on the east side of Highway 400 designed as part of the new Highway 400 E-S Ramp connecting the proposed BBP WBL to Highway 400 SBL. This high fill will be located on the east side of the proposed E-S flyover east abutment. Embankment height of up to 10.5 m is planned.

- **Highway 400 E-S Ramp at BBP (west of flyover), Approximate Stations 11+950 to 12+210 (Drawing 7)**
  High fill to be located on the west side of Highway 400 SBL designed as part of the new Highway 400 E-S Ramp connecting the proposed BBP WBL to Highway 400 SBL. Embankment height of up to 10.5 m is planned.

- **Highway 400 S-E Ramp to Bradford Bypass EBL, Approximate Stations 10+400 to 10+640 (Drawing 8)**
  A high fill embankment, with a maximum height of about 5.1 m, is proposed to be constructed on the east side of the Highway 400 NBL. The embankment forms part of the design for the new Highway 400 S-E ramp, which will connect the Highway 400 NBL to the proposed BBP EBL.

Deep Cut

- **Highway 400 SBL, Approximate Stations 18+350 to 18+570 (Drawing 9)**
  Deep cut to be located on the west side of Highway 400 SBL to accommodate highway widening. The depth of excavation will be up to about 9.1 m.

2.1 Site Geology

Based on published geological information, The Town of West Gwillimbury is located within three major physiographic regions of southern Ontario: the Simcoe Lowlands, the Schomberg Clay Plains, the Peterborough Drumlin Field.

The Simcoe Lowlands form part of the larger Great Lakes–St. Lawrence Lowlands and are characterized by flat to gently undulating terrain. This region predominantly consists of clayey to silty glaciolacustrine deposits overlying till or glaciofluvial materials. The soils tend to have low permeability, and the area is often associated with poor drainage, wetlands, and organic deposits in depressions.

The Schomberg Clay Plains extend across parts of southern Simcoe County, northern York Region, and adjacent areas. These clay plains are characterized by flat to gently undulating topography and are underlain predominantly by glaciolacustrine silts and clays, which were deposited in the post-glacial Lake Algonquin and Lake Iroquois basins. In the West Gwillimbury area, particularly west and southwest of Bradford, the Schomberg Clay Plain dominates the surface geology, forming thick, cohesive deposits with low permeability.

The Peterborough Drumlin Field covers approximately 900 km^2 on a Paleozoic limestone plain and is one of the largest drumlin fields in southern Ontario. This physiographic region is located

between the Oak Ridges Moraine and the area of shallow overburden on the limestones of the Gull River Formation, extending from Hastings County in the east to Simcoe County in the west, and including the drumlins south of the moraine in Northumberland County. The surficial soils in the Peterborough Drumlin Field consist primarily of gravelly sand till or sand and gravel deposits. Deposits of silt, clay or peat may be found in the low-lying areas between drumlins.

The bedrock in this region is predominantly composed of limestone belonging to the Lindsay and Verulam Formations, which are part of the Upper Ordovician sequence. These formations are typically softer, more thinly bedded, and less massive than the older Gull River Formation, which lies stratigraphically below.

3. SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing program completed for the new high fills and deep cut were carried out from September 25 to October 31,2024, on November 28, 2024, and on March 18, 2025. The site investigation consisted of drilling and sampling twenty-four (24) boreholes, designated as Boreholes DC-27 to DC-30, HF-01 to HF-06, HF-09 to HF-18, HF-16(A), and HF-20 to HF-22. The boreholes were positioned at selected locations across the sites to provide information within the areas of the proposed high fills and deep cut.

In addition, four (4) seismic cone penetration tests (sCPTu), designated as HF-01 (sCPTu), HF-07 (sCPTu), HF-08 (sCPTu) and HF-21 (sCPTu), were carried out to supplement the borehole investigation.

Details of the borehole/sCPTu locations, ground surface elevations, and termination depths/elevations are summarized in Table 3.1 below.

Table 3.1: Borehole Completion Details

Borehole / sCPTu	Co-ordinates MTM [1] NAD 83 Zone 10		Ground Surface Elevation (m)	Borehole / sCPTu Termination Depth (m)	Borehole / sCPTu Termination Elevation (m)
	Northing	Easting			
HIGH FILL - Highway 400 N-E Ramp south of 9th Line					
HF-11[2]	4,887,036.65	293,776.58	274.6	9.8	264.8
HF-12	4,886,989.27	293,772.74	273.8	9.8	264.0
HIGH FILL - Highway 400 N-E Ramp (east of flyover)					
HF-13	4,886,467.60	294,165.99	259.0	11.3	247.7
HF-14[2]	4,886,479.80	294,239.55	260.4	9.8	250.6

Borehole / sCPTu	Co-ordinates MTM [1] NAD 83 Zone 10		Ground Surface Elevation (m)	Borehole / sCPTu Termination Depth (m)	Borehole / sCPTu Termination Elevation (m)
	Northing	Easting			
HF-15	4,886,485.32	294,312.33	261.3	9.8	251.5
HF-16	4,886,492.20	294,363.72	261.8	12.8	249.0
HF-16(A)	4,886,492.35	294,363.76	261.9	22.9	239.0
HIGH FILL - Highway 400 E-N Ramp south of 9th Line					
HF-17	4,887,031.81	293,988.61	267.9	14.3	253.6
HF-18 (MW)[3]	4,887,094.98	293,948.84	269.2	14.3	254.9
HIGH FILL - Highway 400 E-N Ramp north of 9th Line					
HF-20[2]	4,887,229.69	293,875.90	275.5	9.8	265.7
HF-21 (sCPTu)	4,887,273.70	293,869.76	273.8	9.9	263.9
HF-21	4,887,244.12	293,871.85	275.7	9.8	265.9
HF-22	4,887,358.56	293,862.40	277.1	9.8	267.3
HIGH FILL - Highway 400 E-S Ramp at Bradford Bypass BBP (east of flyover)					
HF-05	4,886,598.72	294,169.08	260.9	15.8	245.1
HF-06[2]	4,886,542.53	294,097.31	259.2	12.8	246.4
HF-07 (sCPTu)	4,886,486.4	294,050.9	257.8	23.3	234.5
HIGH FILL - Highway 400 E-S Ramp at Bradford Bypass (west of flyover)					
HF-08 (sCPTu)	4,886,233.98	293,945.84	255.0	17.4	237.6
HF-09	4,886,146.24	293,932.55	254.8	9.8	245.0
HF-10	4,886,076.16	293,950.11	253.5	14.3	239.2
HIGH FILL - Ramp S-E (to Bradford Bypass EBL)					
HF-01 (sCPTu)	4,886,429.27	294,262.50	261.0	20.6	258.0

Borehole / sCPTu	Co-ordinates MTM [1] NAD 83 Zone 10		Ground Surface Elevation (m)	Borehole / sCPTu Termination Depth (m)	Borehole / sCPTu Termination Elevation (m)
	Northing	Easting			
HF-01	4,886,426.30	294,263.15	261.0	11.3	249.7
HF-02[2]	4,886,454.31	294,321.14	261.5	9.8	251.7
DEEP CUT- Highway 400 SBL					
DC-27	4,886,644.91	293,898.48	270.8	15.8	255.0
DC-28[2]	4,886,713.95	293,876.95	275.8	15.6	260.2
DC-29	4,886,771.71	293,868.24	276.0	15.8	260.2
DC-30[2]	4,886,831.76	293,852.29	272.0	15.8	256.2

Notes: 1. Survey of as-drilled borehole and sCPTu locations was provided by AECOM.
2. Monitoring well was installed at borehole location.

The locations of the boreholes and sCPTus are shown on the Borehole Location Plan and Soil Strata drawings in Appendix B. The Record of Borehole sheets of the current investigation are provided in Appendix C.

AECOM provided coordinates and ground surface elevations for the as-drilled borehole locations, which meets MTO's requirements for the horizontal and vertical accuracy. The coordinates and elevations of the boreholes are given on the Borehole Location Plan and Soil Strata drawings and Record of Borehole sheets.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. In addition, lane and/or shoulder closures and traffic control were implemented, where required, for drilling the boreholes.

The boreholes were advanced using track-mounted and truck-mounted drill rigs. Hollow stem augers were used to full depth to advance the high fill boreholes. In the deep cut boreholes (DC-27, DC-28, DC-29, and DC-30), the upper 3 m were advanced using hollow stem augers, followed by wash boring with a tricone bit and temporary casing to reach the termination depths. Stabilizing drilling fluid was used in the deep boreholes to reach the desired depths. Soil samples were obtained at selected depth intervals (in accordance with MTO guidelines) using a 50 mm outside diameter split-spoon sampler driven in conjunction with the Standard Penetration Test (SPT) which was performed in accordance with ASTM D1586.

In the cohesive deposits, the undrained shear strength of the material was measured in-situ by means of field vane tests (MTO N-Vane).

The seismic cone penetration tests were carried out using an integrated electronic piezocone penetrometer and data acquisition system. Soil properties and a stratigraphic prolife (based on Soil Behaviour Type (SBT)) can be inferred from the results of piezocone testing. The sCPTu tests included pore pressure dissipation tests and shear wave velocity measurements. The results of the sCPTu testing are provided in Appendix D.

The field investigation was observed on a full-time basis by a member of Thurber's technical staff who marked/staked the boreholes in the field, directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Nine (9) monitoring well (each consists of 50 mm outside diameter Schedule 40 PVC pipes with 3 m long screen) were installed and enclosed in filter sand to permit groundwater level monitoring. Well installation details, and groundwater level readings are shown on the record of boreholes and are summarized in Table 3.2.

Table 3.2: Monitoring Well Installation Details

Borehole	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
DC-28	15.6 / 260.1	9.1 / 266.6	Bentonite holeplug from 15.6 m to 9.1 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 9.1 m to 5.5 m, then backfilled with bentonite holeplug from 5.5 m to ground surface.
DC-30	15.8 / 256.1	10.7 / 261.3	Bentonite holeplug from 15.8 m to 10.7 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 10.7 m to 7.0 m, then backfilled with bentonite holeplug from 7.0 m to ground surface.
HF-02	9.8 / 251.7	6.1 / 255.4	Monitoring well with 3.0 m slotted screen installed within sand filter from 6.4 m to 2.4 m, then backfilled with bentonite holeplug from 2.4 m to ground surface
HF-06	12.8 / 246.4	4.6 / 254.6	Auger cuttings from 12.8 m to 5.8 m and bentonite holeplug from 5.8 to 4.9 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 4.9 m to 2.6 m, backfilled with bentonite holeplug from 2.6 m to 1.5 m then bentonite holeplug and auger cuttings to ground surface.

Borehole	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
HF-11	9.8 / 264.8	4.6 / 270.0	Auger cuttings from 9.8 m to 5.8 m and bentonite holeplug from 5.8 m to 4.7 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 4.6 m to 0.9 m, then backfilled with bentonite holeplug from 0.9 m to ground surface.
HF-14	9.8 / 250.6	6.7 / 253.7	Auger cuttings from 9.8 m to 7.6 m and bentonite holeplug from 7.6 m to 7.0 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 7.0 m to 3.0 m, backfilled with bentonite holeplug from 3.0 m to 2.1 m, then auger cuttings and bentonite holeplug to ground surface.
HF-18(MW)	14.3 / 254.9	3.0 / 266.2	Bentonite holeplug from 14.3 m to 3.7 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 3.7 m to 0.9 m, then backfilled with bentonite holeplug to ground surface.
HF-20	9.8 / 265.7	5.2 / 270.3	Auger cuttings from 9.8 m to 5.8 m and bentonite holeplug from 5.8 m to 5.3 m. Monitoring well with 3.0 m slotted screen installed within sand filter from 5.3 m to 1.8 m, backfilled with bentonite holeplug from 1.8 m to 0.9 m, auger cuttings from 0.9 m to 0.5 m, holeplug from 0.5 m to 0.25 m, then concrete to ground surface.

All boreholes without monitoring well installations were backfilled upon completion of drilling in general accordance with O.Reg. 903.

Monitoring wells are to remain in place to permit groundwater level measurements prior to and during construction operations. The Tender Document includes a Special Provision for the Contractor to decommission the monitoring wells in accordance with O.Reg. 903.

4. LABORATORY TESTING

The recovered soil samples were subjected to visual identification and natural moisture content determination. Approximately 25% of soil samples were subjected to grain size distribution analyses (sieve and/or hydrometer), and Atterberg Limits testing. Geotechnical laboratory testing results of the current investigation are summarized on the Record of Borehole sheets in Appendix C and are presented on the figures in Appendix E.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered subsurface stratigraphy from the investigation are presented on the Record of Borehole sheets in Appendix C, and on the Borehole Locations and Soil Strata drawings in Appendix B. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized and anticipated that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface stratigraphy at the proposed high fill sites consists of a surficial layer of topsoil underlain by native soil until the termination depth of the boreholes. Locally in Borehole HF-10, drilled near the proposed E-S ramp, fill was encountered below the topsoil. The fill comprised brown stiff to soft sandy silt clay, and brown to grey compact silty sand. The total thickness of the fill was approximately 2 m. Layers of native brown to grey, firm to hard clay, silty clay, and clay with sand were encountered at various depths in all boreholes (except Boreholes HF-09, HF-10, HF-18(MW), and HF-20 to HF-22), typically overlying or interbedded within the glacial till layers. The thickness of these cohesive layers ranges from 1.5 m to 6.9 m. Additionally, interbedded layers of brown to grey, compact to very dense silty sand, sandy silt, and sand with silt were encountered within both cohesive and cohesionless glacial tills, with thicknesses ranging from 0.5 m to 2.2 m. At some locations, these granular layers were observed directly beneath the topsoil or fill. Layers of brown to grey, loose to dense cohesionless till (sandy silt and silty sand) and brown to grey, firm to hard cohesive tills (silty clay, sandy silty clay, sandy clay, clayey sand and clay with sand) were encountered in the boreholes across the high fill sites, typically below the sandy silt clay, silty clay and sandy silt layers. Where fully penetrated, the thickness of the sandy silt till and silty sand till ranged from 1.6 m to 13.1 m thick. The thickness of the silty clay till, sandy silty clay till, sandy clay till, clayey sand till and clay with sand till ranged from 0.6 m to 12.6 m. The groundwater was measured in the monitoring wells at depths ranging from 0.4 m to 7.5 m (Elevations 273.1 m to 268.3 m) below the existing ground surface.

At the proposed deep cut, the subsurface stratigraphy consisted of surficial topsoil overlying brown, loose to compact silty sand fill and brown, soft to stiff sandy silty clay fill. The thickness of the fill was 0.5 m. Below the fill, a layer of brown to grey, firm to hard sandy silty clay till was contacted. A 1.1-m thick layer of very dense silty sand was contacted within the cohesive till at 3.0 m depth in Borehole DC-29. A layer of grey, hard clay was encountered below the cohesive till at 10.2 m in Borehole DC-30. A layer of hard silty clay till/non-till was encountered below the sandy silty clay till at boreholes DC-28 and DC-29. The groundwater was measured in the monitoring wells at depths ranging from 0.5 m to 8.5 m below the existing ground surface (Elevations 273.8 to 251.8).

More detailed descriptions of the individual stratum are presented below.

5.1 Topsoil

Topsoil was encountered at the ground surface in all the boreholes drilled at the proposed high fills and deep cut locations. The thickness of the topsoil varied from 50 mm to 260 mm, and locally 25 mm in Borehole HF-21.

The topsoil thickness may vary between and beyond the borehole locations, and the data is not intended for the purpose of estimating quantities.

5.2 Fill

Fill was contacted underlying the topsoil in Boreholes DC-27, DC-28, DC-29, DC-30 drilled at the proposed deep cut location, and in Borehole HF-10. The fill consisted of layers of brown to grey silty sand and/or brown sandy silty clay. The overall thickness of the fill ranged from 0.5 m to 1.8 m. The depth to the base of the fill ranged from 0.7 m to 2.2 m below existing ground surface.

SPT 'N' value recorded in the cohesionless fill ranged from 4 to 23 blows per 0.3 m penetration indicating a loose to compact state. The natural moisture content measured in samples of the cohesionless fill varied from 8 percent to 10 percent. In the cohesive fill, the measured SPT 'N' values ranged from 3 to 13 blows per 0.3 m of penetration indicating a soft to stiff consistency. Moisture contents measured in the sandy silty clay fill varied from 9 percent to 29 percent.

The results of grain size distribution analyses carried out on samples of the cohesive and cohesionless fill are shown on Figures 1 and 2 in Appendix E and summarized in Table 5.1.

Table 5.1 Grain Size Distribution of Fill

Soil Particle	Percentage (%)	
	Fill Cohesionless Soils (Percent)	Fill Cohesive Soils (Percent)
Gravel	24	5
Sand	52	36
Silt	19	49
Clay	5	10

The results of Atterberg Limits tests conducted on a sample of the sandy silty clay fill are presented on the Record of Borehole sheets in Appendix C and illustrated in Figure 3 of Appendix E. The results are summarized in Table 5.2.

Table 5.2 Atterberg Limits of Fill

Parameter	Value
Liquid Limit	25
Plastic Limit	20
Plasticity Index	5

The results of the Atterberg Limits testing indicate that the sandy silty clay fill is slight to low plastic with a group symbol of CL-ML.

5.3 Clay, Silty Clay, Clay with Sand (CL, CI)

Layers of brown to grey clay, silty clay and clay with sand were contacted at various depths and elevations in all the boreholes, except in Boreholes DC-27, DC-29, HF-18(MW), HF-20, HF-21 and HF-22. These cohesive layers were encountered above, and interbedded within the glacial tills. In Boreholes HF-01, HF-02, HF-05, HF-06, HF-09, HF-10, HF-11, HF-12, HF-13, HF-14, HF-15, HF-16 and HF-17 the clay, silty clay and clay with sand layers were contacted at depths ranging from 0.1 m to 4.1 m (Elevations 273.9 m to 250.2 m). . In Boreholes DC-28, DC-30, HF-06 and HF-17, these cohesive layers were contacted at lower depths varying from 10.2 m and 13.3 m (Elevations 262.6 m to 247.5 m). Where fully penetrated, the thickness of the clay, silty clay and clay with sand layers varied from 1.5 m to 6.9 m.

The depth to the base of the clay, silty clay and clay with sand layers ranged from 2.2 m to 10.2 m (Elevations 272.0 m to 243.3 m).

Boreholes DC-28, DC-30, HF-06, HF-09 and HF-17 were terminated within the clay and silty clay layers at depths varying from 9.8 m to 15.8 m (Elevations 260.2 m to 245.0 m).

In general, SPT ‘N’ values measured in the clay, silty clay and clay with sand ranged from 6 to 42 blows per 0.3 m of penetration. Shear strengths from field vane tests carried out in the clay and clay with sand at selected depths (varying from 4.1 m to 10.2 m) in Boreholes HF-01, HF-02, HF-06, HF-10, HF-13 and HF-15 ranged from approximately 35 kPa to 88 kPa. This combined information indicates that the clay and clay with sand has a generally firm to stiff consistency at locations where the ‘N’ values are less than 14 blows. SPT ‘N’ values ranging from 15 to 42 blows per 0.3 m of penetration, indicate a very stiff to hard consistency. Locally in Boreholes DC-28 and DC-30, SPT ‘N’ values of 67 blows per 0.3 m of penetration and greater than 100 blows per less than 0.3 m of penetration, respectively, indicating a hard consistency, were measured near Elevations 261 m and 258.0 m, respectively.

Moisture contents measured in the clay, silty clay and clay with sand ranged approximately from 8 percent to 30 percent.

The results of grain size distribution analyses carried out on selected samples of the clay, silty clay and clay with sand are presented on the Record of Borehole sheets included in Appendix C. Grain size distribution curves of samples tested are presented on Figures 4A to 4C in Appendix E. The results of the grain size distribution analyses are summarized in Table 5.3.

Table 5.3 Grain Size Distribution of Clay, Silty Clay and Clay with Sand

Particle Size	Percentage (%)
Gravel	0 to 1
Sand	0 to 27
Silt	42 to 81
Clay	19 to 54

The results of Atterberg Limits tests conducted on samples of the clay and clay with sand are presented on the Record of Borehole sheets in Appendix C and illustrated in Figures 5A and 5B of Appendix E. The results are summarized in Table 5.4.

Table 5.4 Atterberg Limits of Clay and Clay with Sand

Parameter	Value
Liquid Limit	24 to 42
Plastic Limit	10 to 22
Plasticity Index	8 to 21

The results of the Atterberg Limits testing indicate that the silty clay is generally of low plasticity with a group symbol of CL. Two samples of the clay from Boreholes HF-09 and HF-13 revealed a medium plasticity with a group symbol of CI.

5.4 Silty Sand, Sandy Silt and Sand with Silt

Layers of brown to grey silty sand, sandy silt and sand with silt containing and occasional rootlets and organics were contacted below the topsoil in Boreholes HF-01, HF-02, HF-11, HF-12, HF-14, HF-15, HF-16 and HF-17, below the fill at 2.2 m depth in Borehole HF-10, interbedded within the sandy silty clay till at 3.0 m depth in Borehole DC-29, and below the silty sand till in Borehole HF-18 (MW). The thickness of the silty sand, sandy silt and sand with silt varied from 0.5 m to 1.3 m.

The depth to the base of the silty sand, sandy silt and sand with silt layer ranged from 0.7 m to 4.1 m (Elevations 273.9 m to 250.2 m). Borehole HF-18 (MW) was terminated within the sandy with silt at 14.3 m (Elevation 254.9 m).

SPT 'N' values recorded in the silty sand, sandy silt and sand with silt layers ranged from 12 to 50 blows per 0.3 m of penetration, indicating a compact to very dense state. SPT 'N' values of 3 and 6 blows per 0.3 m of penetration, indicating a very loose to loose state, were measured in Boreholes HF-17 (just below the topsoil), and HF-18(MW) (below the silty sand till, near Elevation 255.3 m).

The natural moisture content measured on samples of the silty sand, sandy silt and sand with silt varied from 8 percent to 22 percent, and locally, 48 percent in one sample collected just below the topsoil in Borehole HF-17.

The results of grain size distribution analyses carried out on a sample of the silty sand are shown on Figure 6 in Appendix E and summarized in Table 5.5.

Table 5.5 Grain Size Distribution of Silty Sand

Particle Size	Percentage (%)
Gravel	0
Sand	53
Silt	35
Clay	12

5.5 Sandy Silt Till and Silty Sand Till (ML), and Clayey Sand Till (CL)

A deposit of brown to grey sandy silt till and silty sand till containing occasional cobbles was encountered in Boreholes HF-05, HF-06, HF-11, HF-12, HF-13, HF-14, HF-15, HF-17, HF-18(MW), HF-20, HF-21 and HF-22 at depths ranging from 0.1 m to 5.6 m, at 10.2 m in Borehole HF-10, at 17.8 m in Borehole HF-16(A), and at the ground surface in Borehole HF-21. Where fully penetrated, the thickness of the sandy silt till and silty sand till ranged from 1.6 m to 7.6 m. In Boreholes HF-17 and HF-18(MW), the cohesionless till was 11.1 m and 13.1 m thick, respectively.

A 1.5-m thick layer of brown clayey sand till was contacted at 4.1 m (Elevation 271.6) in Borehole HF-21.

The depth to the base of the silty sand till varied from 11.7 m to 13.3 m (Elevations 255.9 m to 247.5 m) in Boreholes HF-06, HF-17 and HF-18(MW), and locally at 19.4 (Elevation 242.5 m) in Borehole HF-16(A).

Boreholes HF-05, HF-10, HF-11, HF-12, HF-13, HF-14, HF-15, HF-20, HF-21 and HF-22 were terminated within the sandy silt till and silty sand till at depths ranging from 9.8 m to 15.8 m (Elevations 267.3 m to 239.2 m).

The SPT 'N' values recorded in the cohesionless till generally ranged from 10 to 42 blows per 0.3 m of penetration, indicating a compact to dense state. An SPT 'N' value of 51 blows per 0.3 m of penetration, indicating a very dense state, was measured in Borehole HF-11, near Elevation 266.8. Lower SPT 'N' values varying from 2 to 9 blows per 0.3 m of penetration, indicating very loose to loose state were also measured within the sandy silt till and silty sand till in Boreholes HF-05, HF-06, HF-10, HF-13, HF-14, HF-15, HF-17, HF-18(MW), HF-21, and HF-22.

The natural moisture contents measured on samples of the cohesionless till ranged from 6 percent to 35 percent.

The results of grain size distribution analyses carried out on selected samples of the sandy silt till and silty sand till are shown on Figures 7A to 7C in Appendix E. The results are summarized in Table 5.6.

Table 5.6 Grain Size Distribution of Silty Sand Till, Sandy Silt Till, Clayey Sand Till

Particle Size	Percentage (%)	
	Silty Sand Till Sandy Silty Till	Clayey Sand Till
Gravel	1 to 7	1
Sand	43 to 55	54
Silt	34 to 44	34
Clay	6 to 13	11

The results of Atterberg Limits tests conducted on samples of the sandy silt till and silty sand till are presented on the Record of Borehole sheets in Appendix C and illustrated in Figure 8 of Appendix E. The results are summarized in Table 5.7.

Table 5.7 Atterberg Limits of Silty Sand Till Sandy Silt Till, Clayey Sand Till

Parameter	Value	
	Silty Sand Till Sandy Silty Till	Clayey Sand Till
Liquid Limit	12	22
Plastic Limit	9 to 10	11
Plasticity Index	2 to 3	10

The results of the Atterberg Limits testing indicate that the sandy silt till and silty sand till is considered non-plastic with a group symbol of ML.

Glacial tills inherently contain cobbles and boulders.

5.6 Silty Clay Till, Sandy Silty Clay Till, Sandy Clay Till, and Clay with Sand Till (CL, CL-ML)

A deposit of native brown to grey cohesive till consisting of silty clay, sandy silty clay, sandy clay, and clay with sand containing occasional cobbles was encountered in Boreholes DC-27, DC-28, DC-29, DC-30, HF-01, HF-02, HF-05, HF-06, HF-09, HF-15, and HF-16 at depths ranging from 0.1 m to 5.6 m (Elevations 275.3 m to 254.7 m), and at 9.1 m (Elevation 252.8 m) in Borehole HF-16(A). It must be noted that interbedded layers of clay, silty clay, clay with sand, silty sand, sandy silt and sand with silt were encountered within the cohesive till in some boreholes.

Where fully penetrated, the thickness of the silty clay till, sandy silty clay till, sandy clay till, and clay with sand till ranged from 0.6 m to 9.4 m, and locally 12.6 m in Borehole DC-28.

The depth to the base of the sandy silty clay till was 13.3 m and 10.2 m (Elevations 262.5 and 261.8) in Boreholes DC-28 and DC-30, respectively.

Boreholes DC-27, DC-29, HF-01, HF-02, and HF-16 were terminated within the silty clay till, sandy silty clay till and clay with sand till at depths varying from 9.8 m to 15.8 m (Elevations 260.2 m to 249.0 m), and at 22.9 m (Elevation 239.0 m) in Borehole HF-16(A).

SPT ‘N’ values measured in the cohesive till ranged from 8 to 98 blows per 0.3 m penetration, to greater than 100 blows for less than 0.3 m of penetration, indicating a stiff to hard consistency. Some of the higher “N” values may be attributed to the presence of cobbles. An SPT ‘N’ value of 6 blows per 0.3 m of penetration, indicating a firm consistency, was measured in Borehole DC-30, below the fill. Moisture contents measured in the cohesive till ranged approximately from 5 percent to 22 percent.

The results of grain size distribution analyses carried out on selected samples of the silty clay till, sandy silty clay till, sandy clay till, clayey sand till and clay with sand till are presented on the Record of Borehole sheets included in Appendix C. Grain size distribution curves of samples tested are presented on Figures 9A to 9C in Appendix E. The results of the grain size distribution analyses are summarized in Table 5.8.

Table 5.8 Grain Size Distribution of Silty Clay Till, Sandy Silty Clay Till, Sandy Clay Till, and Clay with Sand Till

Particle Size	Percentage (%)
Gravel	0 to 4
Sand	4 to 48
Silt	33 to 79
Clay	11 to 30

The results of Atterberg Limits tests conducted on samples of the silty clay till, sandy silty clay till, sandy clay till, clayey sand till and clay with sand till are presented on the Record of Borehole sheets in Appendix C and illustrated in Figures 10A and 10B of Appendix E. The results are summarized in Table 5.9.

Table 5.9 Atterberg Limits of Silty Clay Till, Sandy Silty Clay Till, Sandy Clay Till, and Clay with Sand Till

Parameter	Value
Liquid Limit	15 to 29
Plastic Limit	10 to 15
Plasticity Index	4 to 15

The results of the Atterberg Limits testing indicate that the silty clay till, sandy silty clay till, sandy clay till, and clay with sand till is of slight plasticity to low plasticity with group symbols CL-ML and CL.

Augers grinding was noted in the cohesive till in Borehole DC-29 and HF-11 near Elevations 273.5 m and 267.0 m respectively. These occurrences are indication of possible obstructions such as cobbles or boulders.

Glacial tills inherently contain cobbles and boulders.

5.7 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Monitoring wells were installed in Boreholes DC-28, DC-30, HF-02, HF-06, HF-11, HF-14, HF-18(MW) and HF-20 to permit monitoring of groundwater levels.

Water levels measured in the monitoring wells and open boreholes are presented in Table 5.10 below.

Table 5.10: Groundwater Level Measurements

Borehole	Date	Groundwater Level		Comments
		Depth (m)	Elevation (m)	
DC-28	11/6/2024	4.0	271.8	Monitoring well
	11/14/2024	7.4	268.4	Monitoring well
	12/11/2024	5.8	270.0	Monitoring well
	4/3/2025	0.4	275.4	Monitoring well
	5/29/2025	2.7	273.1	Monitoring well
	9/8/2025	4.5	271.3	Monitoring well
	11/25/2025	4.4	271.4	Monitoring well
DC-30	4/1/2025	-0.3	272.3	Monitoring well
	4/3/2025	0.2	271.8	Monitoring well
	5/29/2025	0.7	271.3	Monitoring well
	9/8/2025	1.9	270.1	Monitoring well
	11/25/2025	1.2	270.8	Monitoring well
HF-01	10/10/2024	4.4	256.6	During drilling
HF-02	10/9/2024	4.9	256.6	During drilling
	10/31/2024	2.8	258.7	Monitoring well
	5/30/2025	1.4	260.1	Monitoring well
	9/9/2025	4.5	257.0	Monitoring well
	11/26/2025	6.1	255.4	Monitoring well
HF-06	11/1/2024	2.4	256.8	Monitoring well
	5/30/2025	1.1	258.2	Monitoring well
	9/10/2025	2.5	256.7	Monitoring well
	11/26/2025	0.4	258.8	Monitoring well
HF-10	10/31/2024	1.7	251.8	During drilling
HF-11	11/4/2024	2.4	272.2	Monitoring well
	5/29/2025	0.9	273.7	Monitoring well
	9/8/2025	2.0	272.6	Monitoring well
	11/25/2025	1.2	273.4	Monitoring well
HF-12	10/30/2024	6.3	267.5	During drilling
HF-13	10/16/2024	5.1	253.9	During drilling

Table 5.11: Groundwater Level Measurements

Borehole	Date	Groundwater Level		Comments
		Depth (m)	Elevation (m)	
HF-14	10/16/2024	5.2	255.2	During drilling
	10/31/2024	2.3	258.1	Monitoring well
	5/30/2025	0.8	259.6	Monitoring well
	9/9/2025	4.1	256.3	Monitoring well
	11/26/2025	5.4	255.0	Monitoring well
HF-15	10/16/2024	5.4	255.9	During drilling
HF-16	10/10/2024	4.4	257.4	During drilling
HF-18	10/28/2024	0.6	268.6	During drilling
	11/1/2024	0.8	268.4	Monitoring well
	5/29/2025	0.5	268.7	Monitoring well
	8/29/2025	0.8	268.4	Monitoring well
	9/9/2025	0.9	268.3	Monitoring well
	11/25/2025	0.8	268.4	Monitoring well
HF-20	10/24/2024	8.5	267.0	Upon completion of drilling
	11/4/2024	3.0	272.5	Monitoring well
	5/29/2025	1.7	273.8	Monitoring well
	9/9/2025	2.1	273.4	Monitoring well
	11/25/2025	2.2	273.3	Monitoring well
HF-21	10/24/2024	6.8	268.9	During drilling

Artesian conditions were observed in Borehole DC-30 on April 1, 2025, with the groundwater level measured 0.3 m above the ground surface (Elevation 272.3). Subsequent groundwater readings indicated levels below the ground surface.

The groundwater levels measured in the monitoring wells in Table 5.10 are short term readings where seasonal fluctuations are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation. Seasonal fluctuations of the groundwater levels are to be expected.

5.8 Seismic Cone Penetration Testing

The results of shear wave velocity, v_s, from the seismic cone penetration testing are presented in Appendix D and summarized in Table 5.12 below.

Table 5.12: Summary of Seismic Cone Penetration Testing

Test Location	Depth (m)	Elevation (m)	Shear Wave Velocity, v_s (m/s)	Average Shear Wave Velocity, v_s (m/s)
HF-01(sCPTu)	2.9 to 20.6	258.1 to 240.4	312 to 830	546
HF-07(sCPTu)	1.9 to 22.9	255.9 to 234.9	344 to 687	518
HF-08(sCPTu)	2.9 to 16.9	252.1 to 238.1	244 to 553	418
HF-021(sCPTu)	2.8 to 9.8	271.0 to 264.0	543 to 786	637

5.9 Pore Water Pressure Dissipation Testing

The results of pore water pressure dissipation testing carried out as part of the seismic cone penetration testing are presented in Appendix D and summarized in Table 5.13 below.

Table 5.13: Summary of Pore Water Pressure Dissipation Testing

Test Location	Depth (m)	Elevation (m)	Soil Condition	Horizontal Coefficient of Consolidation, c_h (cm^2/min)
HF-07(sCPTu)	6.0	251.8	Silty sand till	18.7
	7.0	250.8	Silty sand till	18.6
	16.0	241.8	Silty sand till	7.2
HF-08(sCPTu)	5.1	249.9	Clay	0.8
	10.0	245.0	Clay	15.4
	12.9	242.1	Clay	1.8
HF-21(sCPTu)	3.2	270.7	Silty sand till	18.5
	4.8	269.0	Silty sand till	21.3
	9.9	263.9	Silty sand till	5.5

6. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. AECOM obtained the co-ordinates and ground surface elevations of the as-drilled borehole locations in the field.

The seismic cone penetration tests (SCPTu) were carried out by ConeTec of Brampton, Ontario, who supplied and operated the CPT equipment.

3D Drilling of Uxbridge, Ontario and Walker Drilling of Utopia, Ontario supplied and operated the drilling and sampling equipment for the field program.

Full time supervision of the field activities was carried out by Messrs. Charles Jin, Abdul Basit, and Kamil Feszak of Thurber. The coordination and management of the field program was carried out by Messrs. Rod de Castro, P.Eng. and Joshua Alexander, P.Eng. of Thurber.

7. CLOSURE

Interpretation of the field data and preparation of the report was carried out by Ms. Rocio Palomeque Reyna, P.Eng., a Senior Geotechnical Engineer. This report was reviewed by Mr. Mohamed Hosney, P.Eng., and Mr. Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Date: ***March 30, 2026***
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PART B: FOUNDATION DESIGN REPORT

8. GENERAL

This report provides an interpretation of the geotechnical data obtained from the field investigations and provides design recommendations for the proposed high fills and deep cut associated with the western portion of the proposed Bradford Bypass in the Town of Bradford West Gwillimbury, Ontario.

The discussions and recommendations presented in this report are intended for the use of the Ministry of Transportation, Ontario and their designers AECOM, but should not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The contractor undertaking the work must make their own interpretation based on the information presented in the factual sections of the report (Part A of this report). Where comments are made on construction, they are provided to highlight those aspects which could affect the design of the project. The contractor must make their own interpretation of the data provided as it may affect equipment selection, proposed construction methods, scheduling, and the like.

Highway 400 is currently a six-lane highway oriented in a north to south direction, with three lanes in each NBL and SBL direction, separated by a concrete median. It is understood that four ramps are proposed to facilitate the connection between Highway 400 and the new Bradford Bypass (BBP). Based on the highway and ramp cross section drawings provided by AECOM in June, 2025, the alignments of the new ramps and structures include high fill embankments in some areas. In addition, due to the proposed widening of Highway 400 south of 9th Line, a deep cut is proposed on the west side of Highway 400 SBL. A summary of the planned high fill and deep cut areas are summarized below:

Table 8.1: Summary of High Fill and Deep Cut Sections

Embankment Work	Location	Approximate Station Limits*	Borehole / sCPTu	Approx. Maximum Fill Height/Cut Depth (m)	Reference Drawing Under Appendix B
High Fill	Highway 400 N-E Ramp south of 9th Line	10+270 to 10+410	HF-11 HF-12	5.8 (at Station No. 10+380)	Drawing 2
High Fill	Highway 400 N-E Ramp (east of flyover)	11+000 to 11+280	HF-13 HF-14 HF-15 HF-16 HF-16(A)	17.0 (at Station No.11+000)	Drawing 3

Embankment Work	Location	Approximate Station Limits*	Borehole / sCPTu	Approx. Maximum Fill Height/Cut Depth (m)	Reference Drawing Under Appendix B
High Fill	Highway 400 E-N Ramp south of 9th Line	10+620 to 10+890	HF-17 HF-18	8.2 (at Station No.10+810)	Drawing 4
High Fill	Highway 400 E-N Ramp north of 9th Line	10+950 to 11+170	HF-20 HF-21(sCPTu) HF-21 HF-22	7.6 (at Station No.10+950)	Drawing 5
High Fill	Highway 400 E-S Ramp at BBP (east of flyover)	11+520 to 11+670	HF-05 HF-06 HF-07(sCPTu)	10.5 (at Station No.11+670)	Drawing 6
High Fill	Highway 400 E-S Ramp at BBP (west of flyover)	11+950 to 12+210	HF-08(sCPTu) HF-09 HF-10	10.5 (at Station No.11+950)	Drawing 7
High Fill	Highway 400 S-E Ramp to Bradford Bypass EBL	10+400 to 10+640	HF-01(sCPTu) HF-01 HF-02	5.1 (at Station No.10+560)	Drawing 8
Deep Cut	Highway 400 SBL	18+350 to 18+570	DC-27 DC-28 DC-29 DC-30	9.1 (at Station No.18+480)	Drawing 9

* The limits for the high fill and deep cut areas are zones with new embankment and cut height of more than 4 m.

9. SEISMIC CONSIDERATIONS

9.1 Seismic Site Classification

In accordance with Clause 4.4.3.2 of the *CHBDC (2019)*, the section of the seismic site classification is based on the soil deposits within the upper 30 m of the stratigraphy. Based on the shear wave velocity test results from in the CPT within the silty sand till deposit and the inferred shear strength of the underlying clay deposit from SPT N-values, the site classification for the seismic site response is C (i.e., Site Class C) in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC (2019).

The site-specific peak ground acceleration, PGA, for a 2,475-year return period earthquake at the project site is 0.102 g as per the 2020 National Building Code of Canada (see Appendix F).

9.2 Liquefaction

Liquefaction is a phenomenon whereby seismically induced shaking generates shear stresses within the soil under undrained conditions. These stresses tend to densify the soil which may lead to potentially large surface deformations, and under undrained conditions generate excess pore water pressures that can lead to sudden temporary losses in strength. Where existing static shear stresses are present, the loss of strength can lead to significant lateral movements (analogous to slope failure) often referred to as “lateral spreading” or under certain conditions even catastrophic failure of slopes often referred to as “flow slides”. Lateral spreading and flow slide often accompany liquefaction along rivers and other shorelines.

Based on the relative density of the fill and native soils and the low site-specific PGA, the soils at this site are considered to have a low potential for liquefaction during a seismic event.

10. ENGINEERING ANALYSIS AND METHODOLOGY

The slope stability and time dependent settlements, their impact on the construction schedule and the long-term performance of the proposed construction have been analyzed for selected high fill and deep cut sections. The embankment fill heights, deep cut depths, and slope geometry used for analysis noted in this report are based on the vertical profile and cross-section drawings provided by AECOM in June, 2025.

The subsurface conditions at the high fills and deep cut locations were investigated to assess the stability of the proposed high fills and deep cut slopes, potential settlement issues under the embankments and anticipated construction concerns. Analyses were carried out at critical sections based on embankment heights, gradient of cut slopes, and subsurface conditions.

Subsurface models were prepared for stability and settlement analyses of the critical high fills and deep cut locations based on analysis of all borehole logs. Engineering parameters were selected based on the results of the field and laboratory testing (e.g., SCPTus), and correlations with index testing results. The groundwater level in our analysis was based on readings obtained from the monitoring wells installed in the boreholes.

Limit equilibrium global slope stability analyses were carried out for the proposed high fills and deep cut using the commercially available program Slide2 (Version 9.031), developed by Rocscience Inc., employing the Morgenstern-Price method of analysis.

Major geotechnical factors governing high fill and deep cut designs that should be taken into account for this project include the following:

- Thickness, extent, and engineering properties of the foundation soils, with consideration to the extent and thickness of topsoil, organics and loose/soft soils within the proposed embankment footprints.
- Depth to competent layer (hard or dense soils).
- Depth of refusal materials.
- Embankment material type (earth fill, granular fill, rock fill, Select Subgrade Material, or materials extracted from within the cut areas).
- Embankment/earth cut geometry including embankment height/cut depth, gradient of side slopes, footprint, and requirements for stabilizing berms.
- Groundwater conditions, involving temporary and long-term drainage requirements and erosion control for cut slopes.
- The need to maintain embankment or cut stability during all stages of construction and in the long term.
- The maximum permissible settlements during embankment construction and after construction.
- Staging of construction.

The geotechnical analyses summarized in this report include assessment of the global stability of the selected embankment geometries and material types for both static and seismic conditions. Assessment of immediate and long-term settlements was also carried out. The analyses were based on profiles and cross sections, and soil properties established at selected, representative locations.

The analyses presented herein and foundation design recommendations have been developed based on assumptions that are consistent with MTO's standard highway design practices:

- In accordance with OPSS.PROV 206, peat, topsoil, organic deposits, and other deleterious materials will be stripped prior to constructing embankments.
- Where new fill is placed against an existing earth or granular embankment slope or on a sloping ground surface steeper than 3H:1V, the existing slope will be benched as per OPSD 208.010.
- It is understood that for this project the high fill embankments will be constructed using earth fill material. Silt and clay borrow materials including highly frost susceptible materials and medium/high plastic clay will not be used.
- High fills and deep cut will be constructed with side slopes of 2H:1V or flatter.

- A 2 m wide mid-height berm will be incorporated into the overall slope profile for every successive 8 m of embankment fill and 6 m of deep cut.
- Permanent drainage and erosion protection will be provided for all high fill and deep cut slopes.

11. HIGH FILLS

Global stability and settlement analyses were carried out for high fill sections at selected stations with varying soil conditions and fill height. The design cross sections shown in the drawings provided by AECOM in July 2025 have an overall slope inclination of 2H:1V or flatter.

11.1 Global Stability

Limit equilibrium global slope stability analyses were carried out for the proposed high fills and deep cut using the commercially available program Slide2 (Version 9.031), developed by Rocscience Inc., employing the Morgenstern-Price method of analysis. The Factors of Safety (FOS) of numerous potential failure surfaces were computed for each examined critical cross section to establish the minimum FOS. The Factor of Safety is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. The Factor of Safety is equal to the inverse of the product of the consequence factor, Ψ, and the geotechnical resistance factor, ϕ_{gu} (i.e., $FoS = 1/(\Psi \cdot \phi_{gu})$). Accordingly, minimum FOS of 1.3, 1.5, and 1.1 have been used for the design of the proposed high fills for the temporary (short-term / undrained), permanent (long-term / drained), and seismic condition, respectively.

The analyses under seismic loading were performed using a pseudo-static slope stability analysis. with a horizontal seismic coefficient, k_h, of 0.051g (one-half of the corresponding site peak ground acceleration in accordance with Section 6.14.9.1 of CHBDC 2019).

Stability analyses were carried out on critical sections corresponding to the greatest new high fills and/or where loose/soft soils are present at shallow depths. For the purpose of the analyses, an embankment fill consisting of compacted earth fill with friction angle (Phi) of 32 degree was assumed.

The stability analyses assume that all topsoil/organic matter, very loose to loose embankment fill, very soft to soft clay deposits and other deleterious materials at the base of the embankment/excavation are removed and replaced approved earth / granular fill prior to the construction of the new embankments.

Based on the available information the heights of high fill embankments will range from 5.1 m to 17.0 m. At locations where the height of high fills exceeds 8 m, 2 m mid-slope benches should be incorporated into the uninterrupted side slope profile of the high fill embankments.

The computed FOS are as shown in Table 11.1. Graphical outputs of these analyses are included in Appendix G.

Table 11.1: Results of Stability Analyses of High Fills

High Fill and Associated Structure	Boreholes	Station[2]	Slope Gradient [1]	Condition	Minimum Factor of Safety-Earth Fill	Figure Number
Highway 400 N-E Ramp south of 9th Line	HF-11 HF-12	10+380	3.3H:1V to 2H:1V	Permanent	1.6 - East side 2.1 - West side	G1
				Temporary	2.3 - East side 3.4 - West side	G2
				Seismic	2.3 - East side 2.8 - West side	G3
Highway 400 N-E Ramp (west of flyover)	HF-13 HF-14 HF-15 HF-16 HF-16(A)	11+000	2H:1V	Permanent	1.7 - North side 1.6 - South side	G4
				Temporary	1.8 - North side 1.9 - South side	G5
				Seismic	1.6 - North side 1.7 - South side	G6
		11+130	2H:1V	Permanent	1.9 - North side 1.7 - South side	G7
				Temporary	1.9 - North side 1.6 - South side	G8
				Seismic	1.6 - North side 1.4 - South side	G9
		11+230	4H:1V to 3H:1V	Permanent	2.5 - North side	G10
				Temporary	2.7 - North side	G11
				Seismic	2.0 - North side	G12
Highway 400 E-N Ramp south of 9th Line	HF-17 HF-18	10+810	3.6H:1V to 2H:1V	Permanent	1.6 - East side 2.1 - West side	G13
				Temporary	1.6 - East side 2.1 - West side	G14
				Seismic	1.4 - East side 1.8 - West side	G15
Highway 400 E-N Ramp north of 9th Line	HF-20 HF-21 HF-22	10+950	4H:1V to 2H:1V	Permanent	1.5 - East side 2.8 - West side	G16
				Seismic	1.3 - East side 2.3 - West side	G17

High Fill and Associated Structure	Boreholes	Station[2]	Slope Gradient [1]	Condition	Minimum Factor of Safety- Earth Fill	Figure Number
Highway 400 E-S Ramp at Bradford Bypass (east of flyover)	HF-05 HF-06	11+670	2H:1V	Permanent	1.5 - North side 1.5 - South side	G18
				Temporary	2.1 - North side 2.1 - South side	G19
				Seismic	1.8 - North side 1.8 - South side	G20
Highway 400 E-S Ramp at Bradford Bypass (west of flyover)	HF-09 HF-10	11+950	2H:1V	Permanent	1.6 - East side 1.7 - West side	G21
				Temporary	1.6 - East side 1.7 - West side	G22
				Seismic	1.4 - East side 1.5 - West side	G23
Ramp S-E to Bradford Bypass	HF-01 HF-02	10+560	4H:1V to 3H:1V	Permanent	2.7 – North/West side 2.3 – South/East side	G24
				Temporary	4.2 – North/West side 4.3 – South/East side	G25
				Seismic	3.3 –North/West side 3.4 – South/East side	G26

Notes: 1. Side slopes were based on cross-sections provided by AECOM on June 15, 2025.
2. Highest High Fill cross section/station

The computed Factors of Safety against slope instability at the above high fill sites meet the minimum FOS required by MTO for typical degree of understanding of approximately 1.3 and 1.5 for static analysis of temporary (short-term) and permanent (long-term) slopes, respectively. The computed FOS for pseudo-static seismic analyses was greater than the minimum acceptable FOS of 1.1. Therefore, the results of the slope stability analyses indicate that the proposed high fill embankments are anticipated to be stable at the slope geometries shown in Appendix G.

11.2 Settlement

11.2.1 Embankment Settlement

Placement of new fill for the proposed high fill embankments will induce settlements within both the native foundation soils and the newly placed embankment fills. The total settlement of the embankment will consist of settlement within the foundation soils and compression of the embankment fill itself.

Settlement analyses were carried out using the commercially available program Settle3 (Version 5.024), developed by Rocscience Inc., to estimate the magnitude of settlements associated with the proposed high fills. The modelling was based on the results of the field and laboratory program, as well as engineering experience with other high-fill embankments constructed on similar soil conditions. The sources of foundation settlement at these sites include immediate (short-term) settlement of the cohesionless deposits and time-dependent consolidation (longer-term) settlement of the cohesive till deposits.

It should be noted that the estimated foundation settlements may differ from the magnitude of settlement observed during and/or after construction due to variability of the soil thicknesses and characteristics along the high fill embankment alignments. Therefore, the results of the settlement analyses should be considered as a likely response of the foundation soils due to embankment loads.

For the purpose of the analyses, an embankment fill consisting of compacted earth fill with unit weight of 21 kN/m³ was assumed. Settlement due to fill compression was estimated to be approximately 0.5% of the fill height for compacted earth fill (excluding any moderately to highly plastic local clay) compacted to a minimum of 95% of SPMDD at a moisture content within ±2% of optimum.

In accordance with MTO's Embankment Settlement Criteria for Design (July 2, 2010), one of the criteria adopted for embankment design is to limit post-construction settlement to maximum permissible settlement of 100 mm or less, within 20 years following paving, with a differential settlement allowance of 200:1. For bridge approach areas, the following post-construction settlement criteria (within 20 years following paving) have been adopted for the design:

- No more than 25 mm within 20 m behind the bridge abutment;
- 25 mm to 50 mm from 20 m to 50 m from the bridge abutment;
- 50 mm to 75 mm from 50 m to 75 m from the bridge abutment; and
- 75 mm to 100 mm greater than 75 m from the bridge abutment.

Results of the settlement analysis are provided in Table 11.2. Total estimated settlements have been provided for the critical sections of high fill embankments which were selected based on the embankment heights and subsurface conditions.

Table 11.2 Total Estimated Settlement at Critical Sections of High Fill Embankments

High Fill and Associated Structure	Approx. Station	Maximum Fill Height (m)	Estimated Foundation Settlement (mm)	Embankment Compression (mm)	Total Estimated Settlement (mm)
Highway 400 E-N Ramp north of 9th Line	10+950	7.6	100-130	38	140 - 170
Highway 400 E-N Ramp south of 9th Line	10+810	8.2	105-135	41	150 - 180
Highway 400 N-E Ramp south of 9th Line	10+380	5.8	70 - 90	29	100 - 120
Highway 400 E-S Ramp at BBP (east of flyover)	11+670	10.5	120 - 150	53	175 - 205
Highway 400 N-E Ramp (east of flyover)	10+950	17	170 - 200	85	255 - 285
Ramp S-E to Bradford Bypass	10+560	5.1	75 – 100	26	100 - 125
Highway 400 E-S Ramp at BBP (west of flyover)	11+950	9.5	90 - 120	48	140 - 170

The results of settlement analyses indicate that approximately 75% to 90% of the foundation settlement is estimated to occur during construction assuming a construction rate of 1.5 m of fill placement per week. It is expected that roughly 50% of the total fill compression will occur during embankment construction, with the remaining 50% occurring post-construction. Accordingly, the post-construction settlements are summarized in Table 11.3.

Table 11.3 Post-Construction Settlement at Critical Sections of High Fill Embankments

High Fill and Associated Structure	Approx. Station	Maximum Fill Height (m)	Estimated Post Construction Foundation Settlement (mm)	Estimated Post Construction Embankment Compression (mm)	Approx. Total Post Construction Settlement (mm)
Highway 400 E-N Ramp north of 9th Line	10+950	7.6	10 - 30	19	30 - 50
Highway 400 E-N Ramp south of 9th Line	10+810	8.2	10 - 35	21	30 - 55
Highway 400 N-E Ramp south of 9th Line	10+380	5.8	10 - 25	15	25 - 40
Highway 400 E-S Ramp at BBP (east of flyover)	11+670	10.5	10 - 40	27	40 -70
Highway 400 N-E Ramp (east of flyover)	10+950	17	20 - 60	43	65 - 105
Ramp S-E to Bradford Bypass	10+560	5.1	10 - 25	26	35 - 50
Highway 400 E-S Ramp at BBP (west of flyover)	11+950	9.5	10 - 30	24	35 - 55

The results above indicate that the estimated post construction settlements for most of the sites are within the MTO settlement guidelines of 100 mm of post-construction settlement over 20 years following paving. However, some of these estimated settlements do not meet the post-construction settlement criteria for bridge approach areas. For settlement mitigation in the bridge approaches, it is recommended that foundation preloading be carried out in the following areas prior to abutment pile installation and paving. Details of the embankment preloading, including the locations of the preload areas and the preload waiting times are summarized in Table 11.4.

Table 11.4 Embankment Preload Details

Preload Area	Longitudinal Extent of Preload	Anticipated Preload Time (months)
Highway 400 E-S Ramp at BBP (east of flyover)	From abutment to 75 m behind abutment	3
Highway 400 N-E Ramp (east of flyover)	From abutment to 75 m behind abutment	3
Highway 400 E-S Ramp at BBP (west of flyover)	From abutment to 75 m behind abutment	3

The actual preload durations may vary among embankment sections; therefore, it is recommended to implement instrumentation and monitoring as part of construction quality control to confirm settlement progress prior to pile installation and pavement construction. The NSSPs of Foundation Preloading, Supply and Installation of Monitoring Equipment and Monitoring Program have been prepared and provided in Appendix H.

11.2.2 Settlement at Non-Structural Culvert at BBP N-E Flyover Ramp East Approach at Station 11+070

At a non-structural culvert (#19) at the Bradford Bypass N-E Flyover Ramp at Station 11+070, the estimated foundation settlement under approximately 14 m of embankment fill is in the order of 140 to 170 mm. To accommodate for the foundation settlement and meet hydraulic requirements, it is understood from AECOM's designers that the proposed culvert is designed to be oversized.

11.3 High Fill Construction

11.3.1 Subgrade Preparation

The subgrade must be inspected and approved by qualified geotechnical personnel and it should be adequately prepared prior to the embankment fill placement. All vegetation, topsoil, organics, soft/loosened or wet soils encountered within the new embankment footprint should be stripped in accordance with OPSS.PROV 206. Any exposed soil that contains organics and/or other compressible, weak, and deleterious materials should be sub-excavated, as per OPSD 203.010, and replaced with suitable earth fill/granular material compacted as per OPSS.PROV 501. The subgrade preparation and placement and compaction of the earth fill / granular material must be carried out in the dry.

11.3.2 Embankment Materials and Construction

The new fill embankments may be constructed with granular fill and/or earth fill (reused soil) compacted as per OPSS.PROV 501 and constructed with side slopes inclined at 2H:1V or flatter. All fills must be free of organics, frozen soils, and deleterious materials. Careful selection and/or treatment of the earth fill prior to reuse will be required. Within one metre of the pavement subgrade level, the earth fill material should consist of non-frost susceptible soils. Suggested wording for an NSSP in this regard is included in Appendix H.

For every 8 m of height of embankments, a 2 m wide mid-height bench should be incorporated into the embankment slope. Mid-height benches should maintain a 2 percent slope to shed surface runoffs.

Embankment construction should be carried out in accordance with OPSS.PROV 206 and OPSS.PROV 501 requirements. Backfill placed behind the abutments should consist of free-draining, non-frost susceptible granular materials such as OPSS.PROV 1010 Granular A or B Type II and placed in accordance with OPSS.PROV 902, as amended by Special Provision 109S61. The granular backfill should be placed to the extents as shown on OPSD 3101.150.

To prevent surface runoff from eroding and gullying the embankment side slopes, consideration should be given to installing an asphalt barrier curb in accordance with OPSD 601.010.

It is recommended that a vegetative cover be placed on all exposed slope surfaces in accordance with OPSS.PROV 803.

Design and construction of erosion protection measures should include consideration of the surficial stability under heavy, prolonged rainfall and spring thaw conditions. Vegetation must be adequately established before the onset of winter with reference to OPSS.PROV 804.

Where embankment fill is placed against existing embankment or earth cuts, benching of the existing slope should be carried out in accordance with OPSD 208.010.

11.4 Settlement Monitoring and Instrumentation

Installation of embankment monitoring instrumentation should be completed by Contractor's geotechnical personnel prior to commencing embankment construction. During construction, the Contract Administrator should employ an experienced foundation engineering specialist to implement the foundation monitoring program and to observe construction activities related to embankment construction. It is also Contractor's responsibility to provide access for installation and monitoring of instruments (settlement rods/plates and settlement pins) during and after embankment construction.

The end of preload periods will be determined based on the results of the settlement monitoring program. Although not expected, it should be noted that there is a low risk that the settlement will occur at a slower rate than estimated. If this occurs, the preload period may need to be extended which may impact the overall construction schedule. It is recommended that provisions be included in the contract to allow for a flexible construction schedule to accommodate longer than expected preload periods. To determine the end of preload periods, it is recommended that the results of the monitoring program be assessed throughout construction. The NSSPs of Foundation Preloading, Supply and Installation of Monitoring Equipment and Monitoring Program have been prepared and provided in Appendix H.

12. DEEP CUT

Earth cut is required for the proposed widening of Highway 400 SBL from approximate Station 18+350 to 18+570. The maximum depth of excavation is approximately 9.1 m at Station No. 18+480. The cut will be mainly advanced through very stiff to hard sandy silty clay till and occasional layers of very dense silty sand. It is anticipated that the base of the cut will consist of very stiff to hard sandy silty clay till.

The groundwater levels measured in the monitoring wells installed in Boreholes DC-28 and DC-30 varied from 0.5 m to 8.5 m below the existing ground surface (Elevations 273.8 to 251.8). The cut slope construction will be extended below the groundwater table. Therefore, water seepage from water-bearing silty sand layer, perched water from the fills, accumulation of surface runoff

and precipitation should be expected.

Suggested wording for an NSSP in this regard is included in Appendix H.

12.1 Slope Stability Analyses

Global stability analysis has been carried out for the critical deep cut cross-section to evaluate the stable inclination of the cut slopes. The depth of the cut at the critical section is 9.1 m and the cut section side slope is 2H:1V with a 2m mid-height bench. The computed factors of safety are as shown in Table 12.1. Graphical outputs of these analyses are included in Appendix G.

Table 12.1: Results of Stability Analyses of Deep Cut

Deep Cut	Boreholes	Station[2]	Slope Gradient [1]	Condition	Minimum Factor of Safety	Figure Number
Highway 400 SBL	DC-27 DC-28 DC-29 DC-30	18+480	2H:1V	Permanent	1.5	G27
				Temporary	4.7	G28
				Seismic	4.2	G29

Notes: 1. Side slopes were based on cross-sections provided by AECOM on June 15, 2025.
2. Highest Deep Cut cross section/station

The results of the analysis indicate a FOS of greater than 1.3 under short-term conditions and equal to 1.5 under long-term conditions. A factor of safety of greater than 1.1 was obtained under seismic loading conditions. Therefore, the cut slopes are expected to be stable at 2H:1V inclination or flatter.

12.2 Deep Cut Slope Construction

Excavation for cut slope construction should be carried out in accordance with OPSS.PROV 206.

Where fine-grained silt and clay soils are exposed on a cut slope, the native soils are moisture sensitive and may become negatively impacted after spring thaw and/or ingress of surface water and/or changes in the water table. The properties of the soils are such that the fluctuation in moisture content is likely to soften the soils and to result in erosion and/or sloughing of the soils and resulting in instability of the cut slopes. The exposed earth cut slopes must be protected from erosion both on a temporary and permanent basis. Treatment of cut slopes should be completed as per OPSS.PROV 803 and OPSS.PROV 804 to minimize the potential for erosion due to surface water run-off/ snow melt and to provide protection against future sloughing and instability. Vegetation must be sufficiently established before the winter season.

Slope inclination of earth cuts should not be steeper than 2H:1V. A 2 m wide mid-height bench should be incorporated along the length of earth cut with depths at or exceeding 6 m. The bench should maintain a 2% slope to shed surface runoff. Interceptor ditches should be constructed at the top of the cut slopes as per OPSD 200.020.

12.3 Temporary Excavation and Groundwater Control

All temporary excavations at this site must be carried out in accordance with the Occupational Health and Safety Act (OHSA). Earth excavations required at this site will penetrate through the embankment fill, the native firm to hard sandy silty clay till and occasional layers of very dense silty sand.

The very stiff hard sandy silty clay till is classified as Type 2 soils above the groundwater level, and Type 3 soils below the groundwater level. In accordance with O.Reg. 213, temporary cut slopes for Type 3 soils should have a minimum gradient of 1H:1V.

The till deposit in the cut sections is typically very stiff to hard and often contain cobbles and boulders. Excavation in this deposit will be arduous and may require use of heavy duty excavators or dozers.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. It is anticipated that the excavations be inspected periodically to confirm stability at all stages. Provision must be made for the handling of potential obstructions in the existing fill materials, and cobbles and boulders in the till. Laboured excavation should be anticipated in the hard native soils. Suggested wording for an NSSP in this regard is included in Appendix H.

The deep cut excavation will be extended below the groundwater level. To maintain a relatively dry, stable excavation during construction, temporary drainage consisting of ditching on both sides of the highway should be provided to remove water originating from below the natural groundwater table, from seepage from within water-bearing soils (as such silty sand) along the cut slopes. It is important that construction be sequenced in such a way as to promote positive drainage away from the cut and avoid ponding of water within the excavation. Perimeter ditches and pumping from filtered sumps are expected to be adequate to remove the water accumulated at the excavation base. Surface runoff and precipitation must be diverted away from the excavations. Flow of perched groundwater from the embankment fill into the excavations should also be expected.

Permanent drainage will be required to remove water originating from surface runoff, precipitation and seepage from the sides of the cut and cohesionless interlayers. It is recommended that the

water be controlled by means of surface roadside ditching and permanent sub-drains incorporated, where required, within the corridor widening design.

The design of a dewatering system that may be required during construction is the responsibility of the Contractor, and the Contract Documents must alert him to this responsibility. Filtered sumps must be properly designed to control loss of fines and ground loss.

Dewatering of all excavations should be carried out in accordance with OPSS.PROV 517, SP 517F01 Amendment to OPSS 517. A design engineer for dewatering is not required at this site.

Suggested wording for an NSSP in this regard is included in Appendix H.

13. CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to, the following:

- Confirmation is required that all peat, topsoil, and organic deposits within the proposed embankment footprint are stripped/sub-excavated and replaced with approved compacted backfill material.
- The till deposit is generally firm to hard and typically contains cobbles and boulders. The existing fills may also contain obstructions. The Contractor must be equipped and prepared to remove, penetrate or otherwise handle these obstructions during construction.
- Where new embankments are constructed directly adjacent to existing embankments, settlement of the existing embankment may occur. Maintenance measures such as placement of asphalt overlay may be required to compensate the settlement.
- Regular visual inspection of the existing highway pavement surface must be carried out in the vicinity of the construction works. If cracks form in the pavement or settlement is observed to occur, these matters must immediately be brought to the attention of the CA for determining if further action is required.
- Trafficability of construction equipment may be difficult in areas of soft, loosened, and/or saturated subgrade. Disturbance of the subgrade by construction traffic should be minimized, which may require adjustments to construction operations. In addition, provisions for adequate drainage will be critical to maintain stable subgrade.
- There are inherent risks that the rate of settlement of the foundation soils may be slower than estimated, requiring longer preload periods. As such, it is recommended that some flexibility be incorporated in the overall construction schedule to allow for delays associated with slower than anticipated settlements.

- Based on water levels measured in the monitoring wells, deep cut excavation will be extended below the groundwater level. Therefore, seepage and perched groundwater is expected to be encountered within the excavation. Effective sump pumping amongst other measures of groundwater and surface water control should be implemented to maintain a reasonably dry excavation. The impact of seepage or surface water could destabilize the sides and or base of the cut/excavation.

- The permanent cut slopes should be inspected after construction for surficial disturbance. Where necessary, remedial measures such as re-vegetation and/or placement of gravel sheeting may be required.

- Effective long term erosion protection should be provided to the final cut slopes.

Achieving the target performance is largely dependent on good workmanship and quality control during construction. Subgrade inspection should be carried out by qualified geotechnical personnel to confirm subgrade conditions are consistent with the construction specifications. In addition, the material used as fill as well as the density of the fill should be verified to conform with the material and construction specifications, respectively.

14. CLOSURE

Preparation of the design report and engineering analysis was carried out by Mr. Ali Ahmed and Ms. Rocio Palomeque Reyna, P.Eng. This report was reviewed by Dr. Mohamed Hosney, P.Eng., and Mr. Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Commercial Software:

Slide2 (Version 9.031) by Rocscience Inc.

Settle3 (Version 5.024) by Rocscience Inc.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213 Construction Projects (as amended)

Ontario Provincial Standard Specifications (OPSS):

OPSS.PROV 206 Construction Specification for Grading

OPSS.PROV 501 Construction Specification for Compacting

OPSS.PROV 902	Construction Specification for Excavating and Backfilling – Structures
OPSS.PROV 803	Construction Specification for Vegetative Cover/Sodding
OPSS.PROV 804	Construction Specification for Temporary Erosion Control
OPSS.PROV 517	Construction specification for dewatering
SP 517F01	Amendment to OPSS 517
SP 109S61	Amendment to OPSS 902

Ontario Provincial Standard Drawings (OPSD):

OPSD 200.020	Earth/Shale Grading
OPSD 203.010	Embankment over Swamp, New Construction
OPSD 208.010	Benching of Earth Slopes
OPSD 601.010	Asphalt Curb and Asphalt Curb and Gutter
OPSD 3101.150	Walls, Abutment, Backfill – Minimum Granular Requirement

Ontario Regulations:

R.R.O. 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40

THURBER

STATEMENT FOR USE AND INTERPRETATION OF REPORT

1. STANDARD OF CARE

This Report has been prepared in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under similar circumstances at the same time and in the same or similar locality and in compliance with all applicable laws.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment, including this Statement For Use and Interpretation of Report, are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT, AS DESCRIBED ABOVE. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE OF THE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives, and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client for the development, design objectives, and/or purposes described to Thurber by the Client. **NO OTHER PARTY MAY USE OR RELY ON THE REPORT OR ANY PORTION THEREOF FOR OTHER THAN THE CLIENT'S BENEFIT IN CONNECTION WITH THE PURPOSES DESCRIBED IN THE REPORT**. Any use which a third party makes of the Report is the sole responsibility of such third party and is always subject to this Statement for Use and Interpretation of Report. Thurber accepts no liability or responsibility for damages suffered by any third party resulting from use of the Report for purposes outside the reasonable contemplation of Thurber at the time it was prepared or in any manner unintended by Thurber.

5. INTERPRETATION OF THE REPORT

a) **Nature and Exactness of Soil and Contaminant Description:** Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors is inherently judgement-based. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other parties making use of such documents or records with or without our express written consent need to be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other parties. Some conditions are subject to change over time and those making use of the Report need to be aware of this possibility and understand that the Report only presents the interpreted conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client must disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) **Reliance on Provided Information:** The evaluation and conclusions contained in the Report have been prepared based on conditions in evidence at the time of site inspections and based on information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report resulting from misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other parties providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) **Design Services:** The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber is recommended to be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design need to be reported to Thurber immediately so that Thurber can address potential conflicts.

d) **Construction Services:** During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or other parties who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes, but is not limited to, decisions made to develop, purchase, or sell land, unless such decisions expressly form part of the stated purpose of the Report as described in Paragraph 3.

APPENDIX A

Site Photographs



Photograph #1 – At Borehole HF-01, looking west. East of Highway 400. (October 2024)



Photograph #2 – At Borehole HF-02, looking north. East of Highway 400. (October 2024)



Photograph #3 – At Borehole HF-05, looking northeast. East of Highway 400. (October 2024)



Photograph #4 – At Borehole HF-06, looking east. East of Highway 400. (October 2024



Photograph #5 - At Borehole HF-09, looking north. (November 2024)



Photograph #6 - At Borehole HF-11, looking south of 9th Line, west of Highway 400. (November 2024)



Photograph #7 – At Borehole HF-11, looking south. West of Highway 400. (November 2024)



Photograph #8 – At Borehole HF-12, looking south. West of Highway 400. (November 2024)



Photograph #9 – At Borehole HF-13, looking south, east of Highway 400. (November 2024)



Photograph #10 – At Borehole HF-14, looking north. East of Highway 400. (November 2024)



Photograph #11 – At Borehole HF-15, looking west, east of Highway 400. (October 2024)



Photograph #12 – At Borehole HF-16, looking north. East of Highway 400. (October 2024)



Photograph #13 – At Borehole HF-18, looking south. South of 9th Line. (October 2024)



Photograph #14 – South of Borehole HF-20, looking north. North of 9th Line and east of Highway 400. (October 2024)



Photograph #15 – At Borehole HF-22, looking north. East of Highway 400. (October 2024)

APPENDIX B

Borehole Locations Plan and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

200 0 200 400m

SCALE 1:10,000

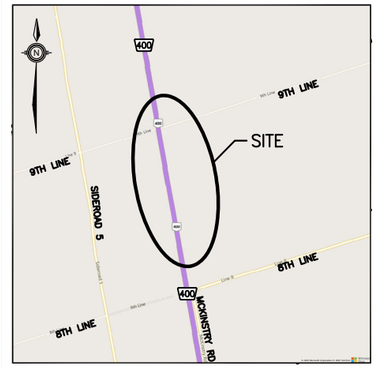
CONT No
WP No

BRADFORD BYPASS
HIGHWAY 400
HIGH FILL AND DEEP CUT
BOREHOLE LOCATIONS PLAN

SHEET

AECOM

THURBER



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▽	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

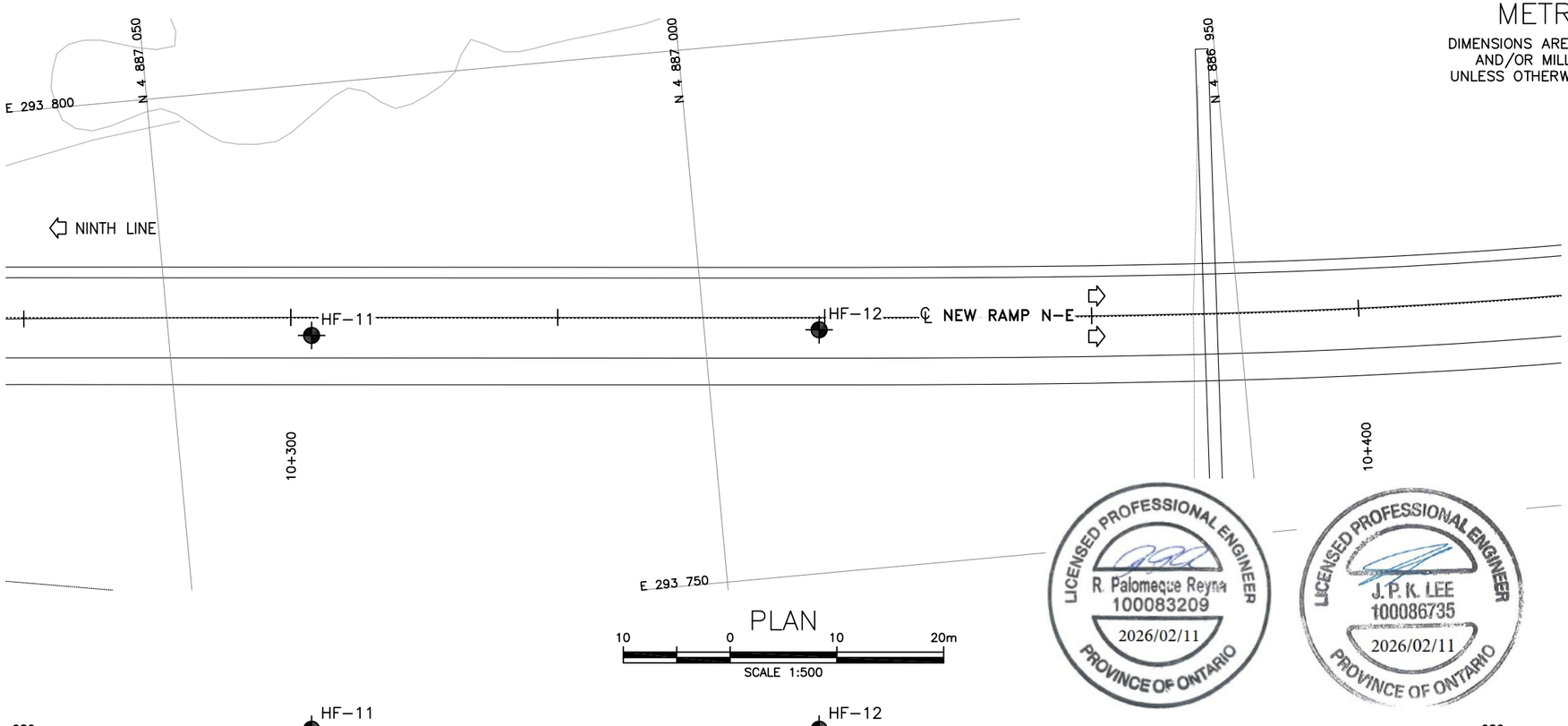
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



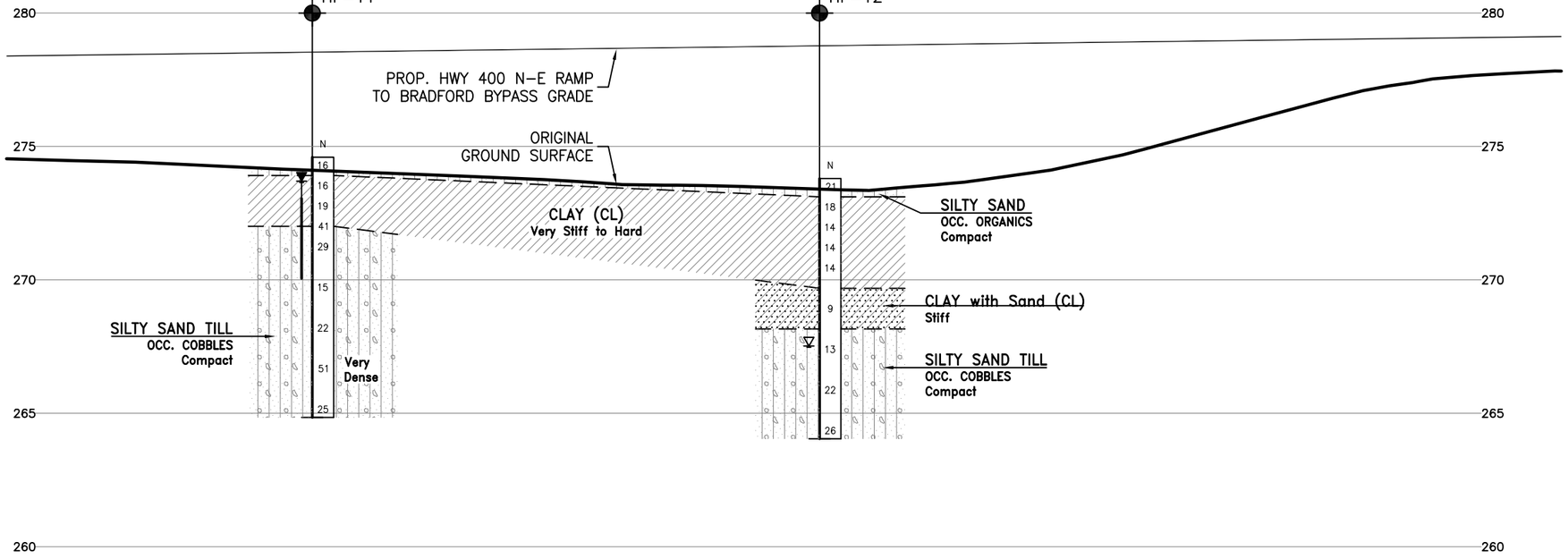
PLAN

10 0 10 20m

SCALE 1:500

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
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PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO



PROFILE ALONG ℄ NEW RAMP N-E

10 0 10 20m H 1:500

4 0 4 8m V 1:200

CONT No
WP No

BRADFORD BYPASS-HIGH FILL
HIGHWAY 400 N-E RAMP
SOUTH OF 9TH LINE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

●	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
┃	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF-11	274.6	4 887 036.7	293 776.6
HF-12	273.8	4 886 989.3	293 772.7

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 10+270 to 10+410. See Drawing 1 – High Fill Area Highway 400 N-E Ramp South of 9th Line.

GEOCRES No. 31D04-022

REVISIONS		
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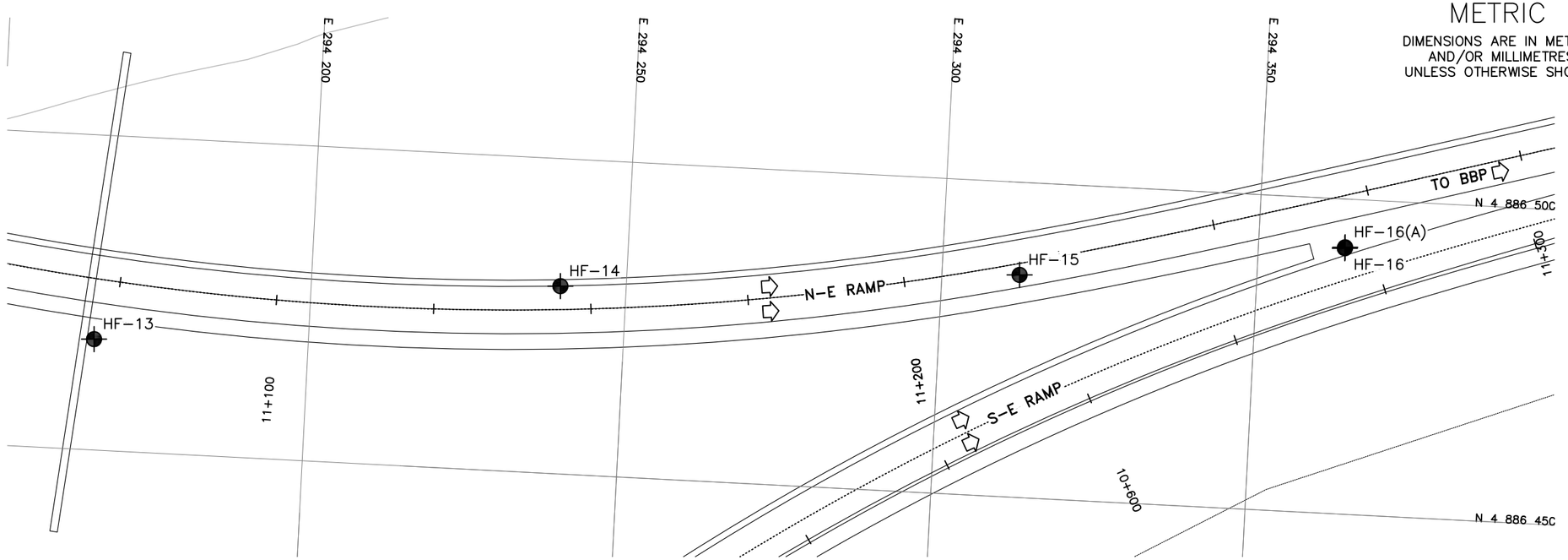
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

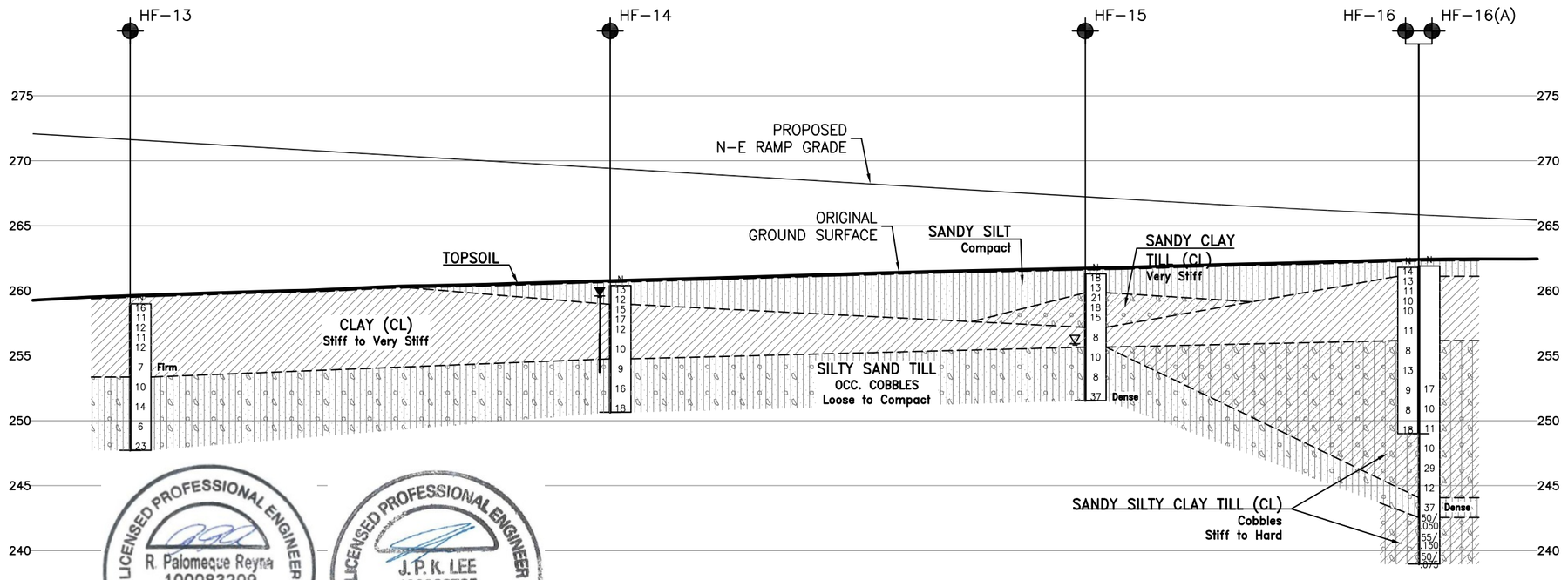
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

16 0 16 32m

SCALE 1:800



PROFILE ALONG ℄ NEW RAMP N-E

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
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LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
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PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400 N–E RAMP
EAST OF FLYOVER
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

⊕	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▯	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF-13	259.0	4 886 467.6	294 166.0
HF-14	260.4	4 886 479.8	294 239.5
HF-15	261.3	4 886 485.3	294 312.3
HF-16	261.8	4 886 492.2	294 363.7
HF-16(A)	261.9	4 886 492.4	294 363.8

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 11+000 to 11+280. See Drawing 1 – High Fill Area Highway 400 N–E Ramp (East of Flyover).
5) High Fills up to 4.0m in height extent to Station 11+000.

GEOCRES No. 31D04-022

REVISIONS		
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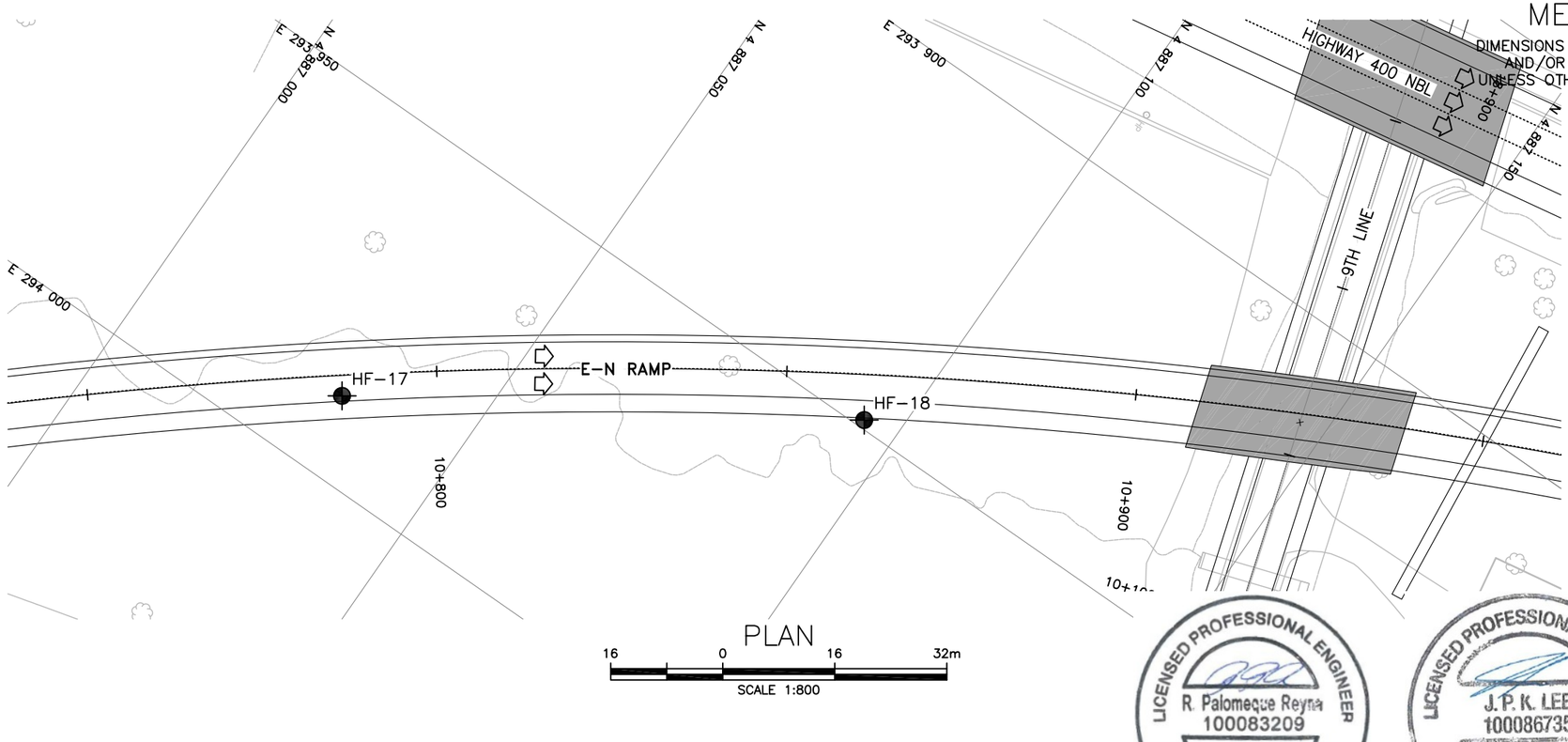
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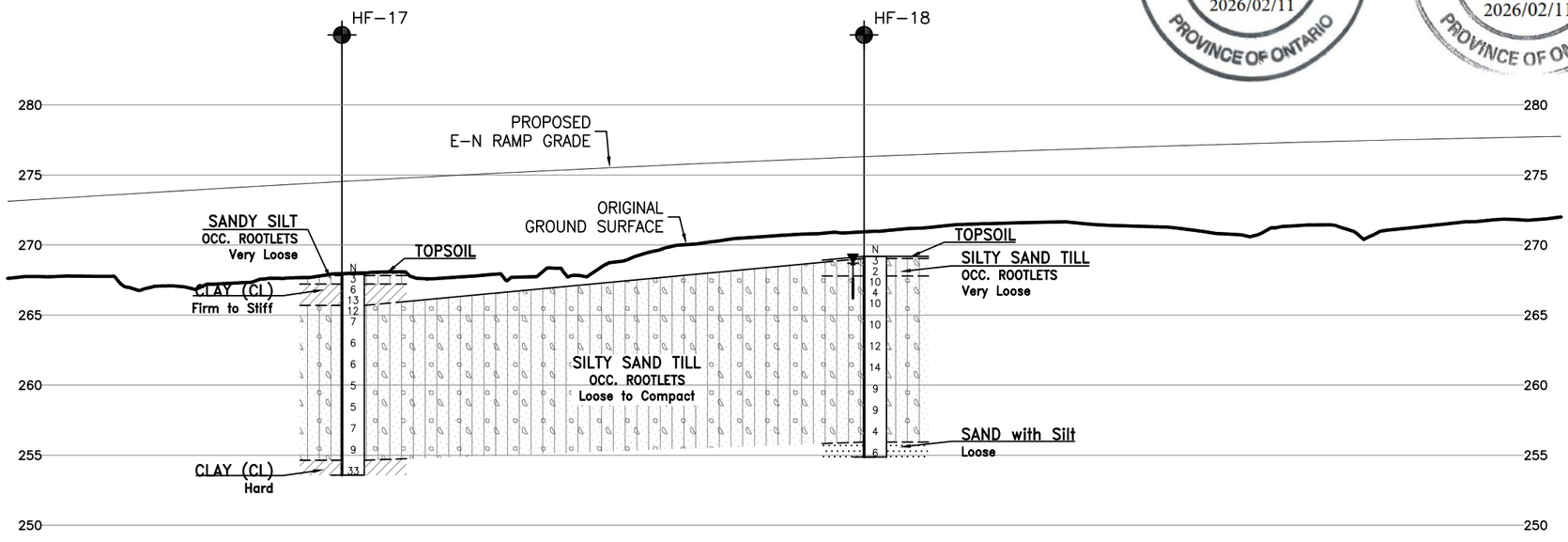
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN





PROFILE ALONG ℄ NEW RAMP E-N (SOUTH OF 9TH LINE)

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
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2026/02/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
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2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS-HIGH FILL
HIGHWAY 400 E-N RAMP
SOUTH OF 9TH LINE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
⧩	Water Level Upon Completion of Drilling
⧩	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF-17	267.9	4 887 031.8	293 988.6
HF-18	269.2	4 887 095.0	293 948.8

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 10+620 to 10+890. See Drawing 1 – High Fill Area Highway 400 E-N Ramp South of 9th Line.
5) High Fills up to 4.0m in height extent to Station 10+620.

GEOCRES No. 31D04-022

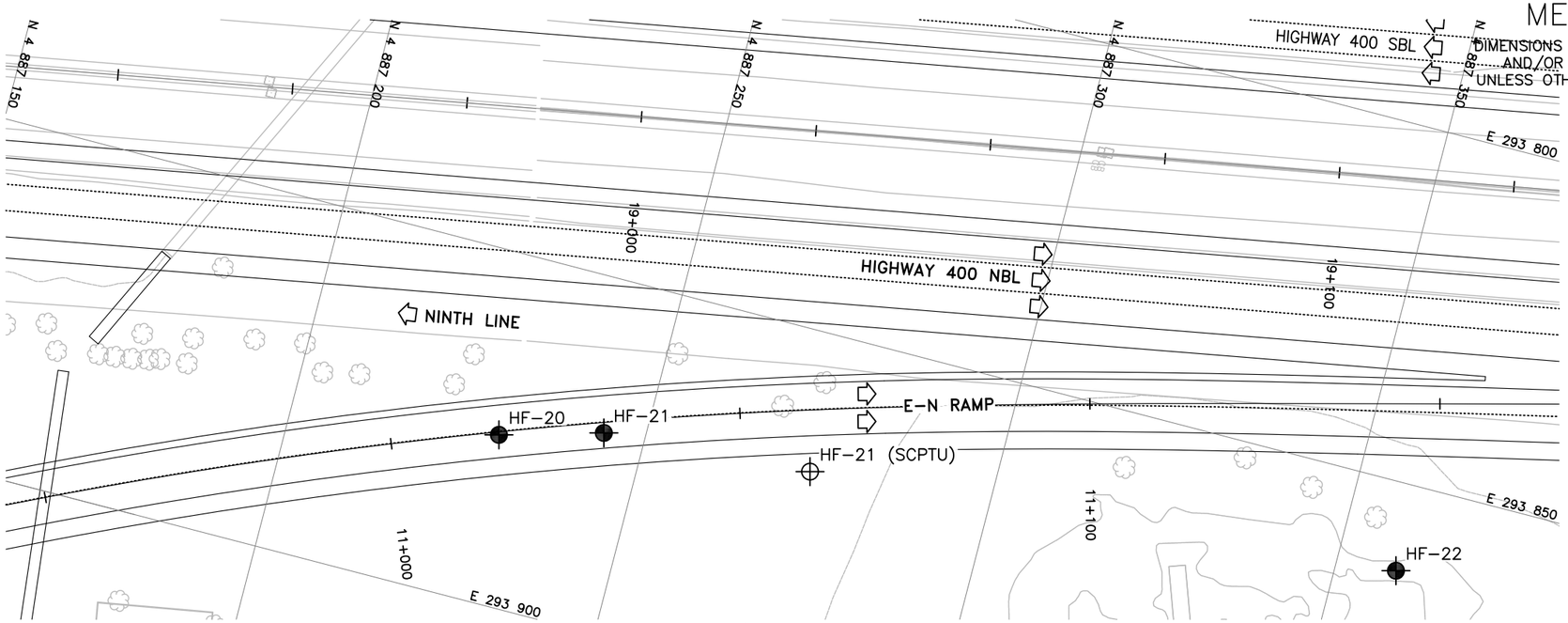
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MINISTRY OF TRANSPORTATION, ONTARIO

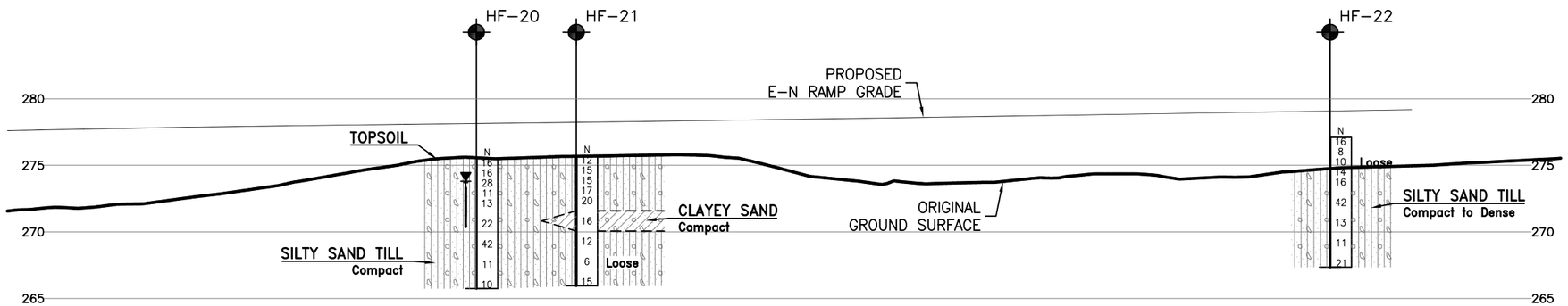
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

16 0 16 32m

SCALE 1:800



PROFILE ALONG ℄ NEW RAMP E–N (NORTH OF 9TH LINE)

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
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2026/02/11
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LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400 E–N RAMP
NORTH OF 9TH LINE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

●	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF–20	275.5	4 887 229.7	293 875.9
HF–21	275.7	4 887 244.1	293 871.9
HF–21 (SCPTU)	273.8	4 887 274.0	293 869.8
HF–22	277.1	4 887 358.6	293 862.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 10+950 to 11+170. See Drawing 1 – High Fill Area Highway 400 E–N Ramp North of 9th Line.

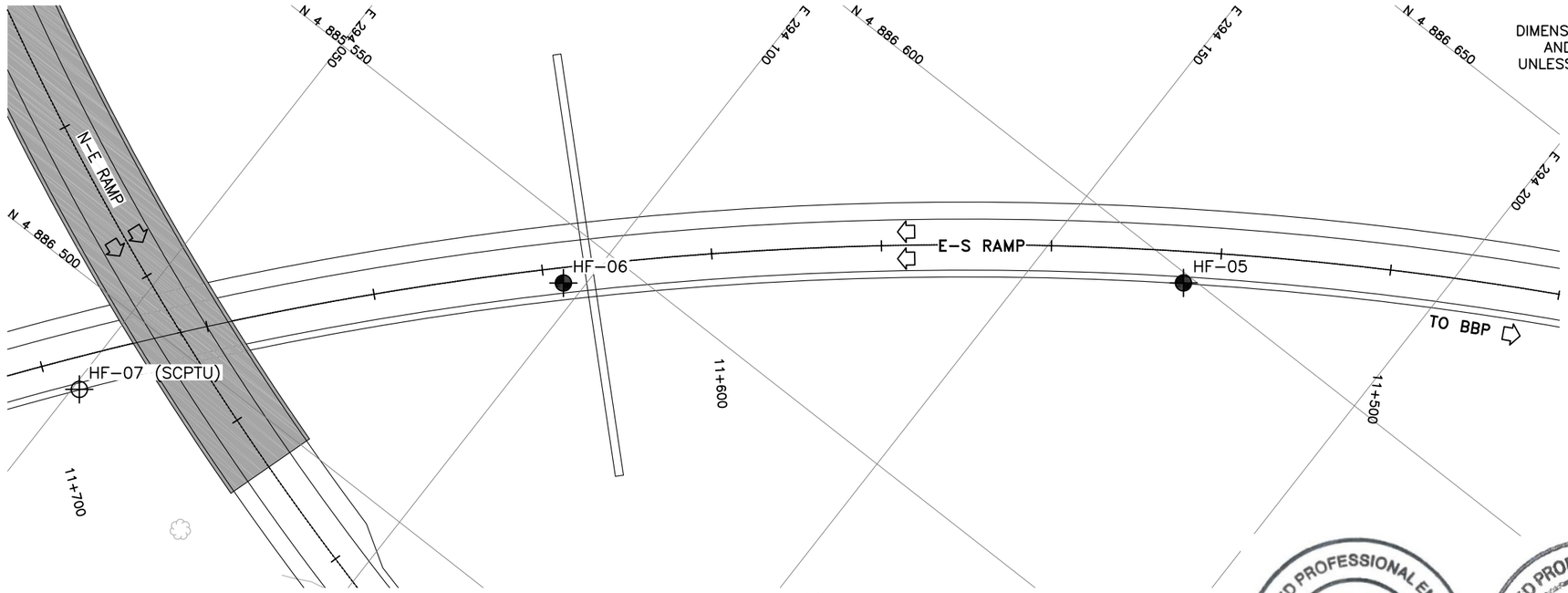
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MINISTRY OF TRANSPORTATION, ONTARIO



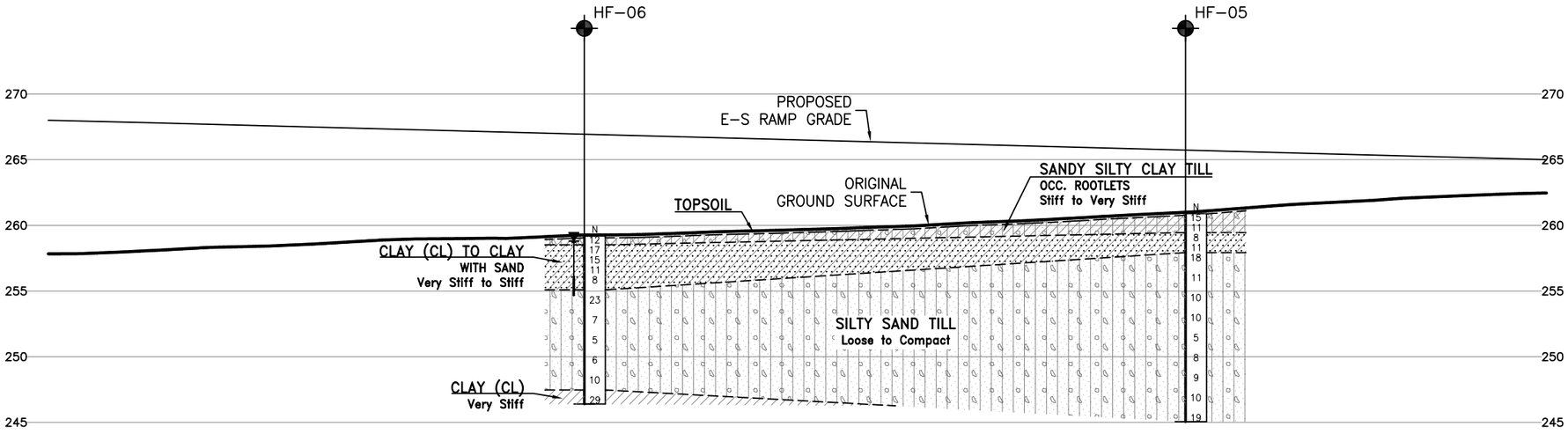
PLAN

16 0 16 32m

SCALE 1:800

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PROFILE ALONG ℄ NEW RAMP E-S (EAST OF FLYOVER)

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
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LICENSED PROFESSIONAL ENGINEER
J. P. K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400 E–S RAMP
EAST OF FLYOVER
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

⊕	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF–05	260.9	4 886 598.7	294 169.1
HF–06	259.2	4 886 542.5	294 097.3
HF–07 (SCPTU)	257.8	4 886 486.4	294 050.9

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 11+520 to 11+670. See Drawing 1 – High Fill Area Highway 400 E–S Ramp at BBP (East of Flyover).

GEOCRES No. 31D04-022

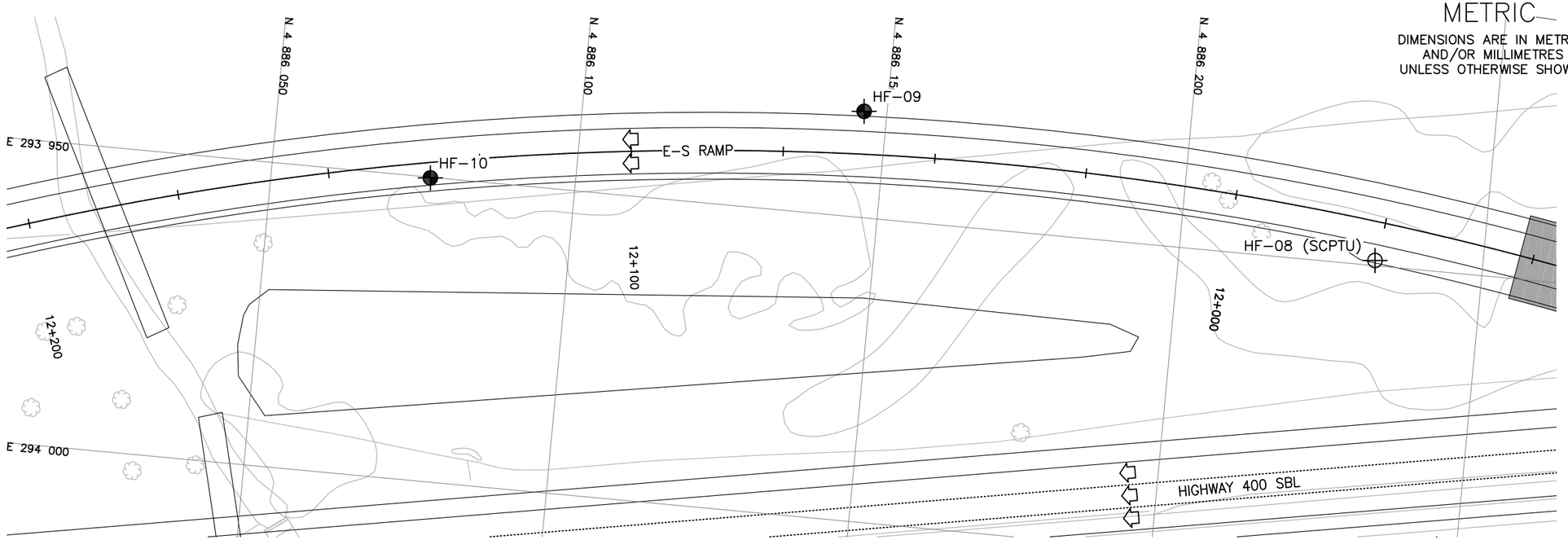
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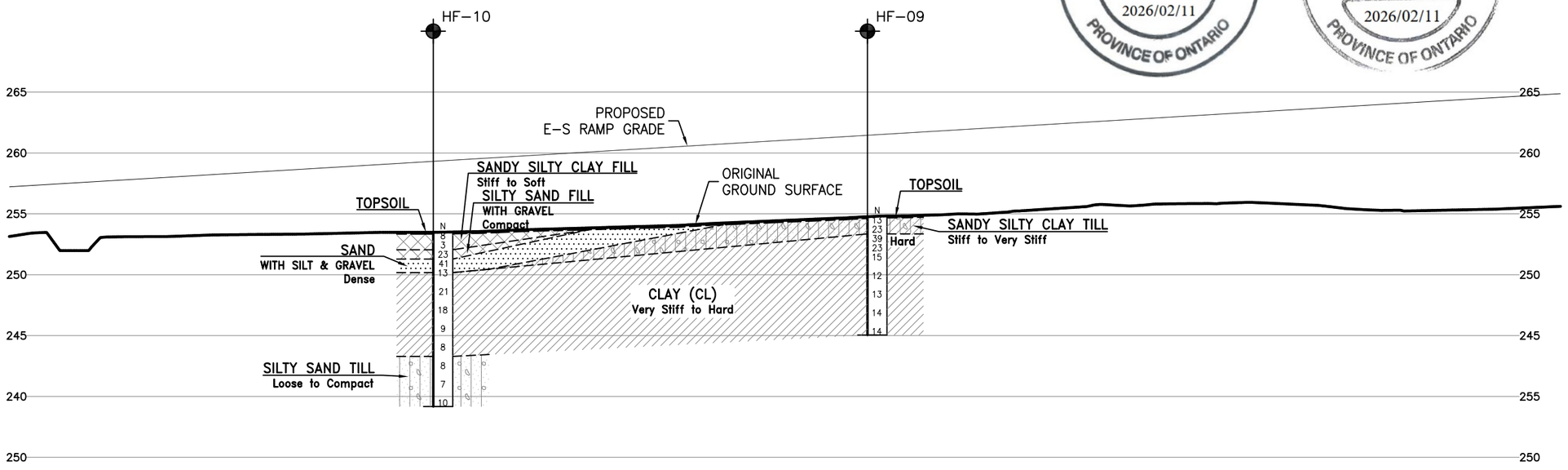
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN
16 0 16 32m
SCALE 1:800



PROFILE ALONG ℄ NEW RAMP E-S (WEST OF FLYOVER)
16 0 16 32m H 1:800
8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
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2026/02/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS-HIGH FILL
HIGHWAY 400 E-S RAMP
WEST OF FLYOVER
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

✱	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF-08 (SCPTU)	255.0	4 886 232.3	293 949.2
HF-09	254.8	4 886 146.2	293 932.6
HF-10	253.5	4 886 076.2	293 950.1

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 11+950 to 12+210. See Drawing 1 – High Fill Area Highway 400 E-S Ramp at BBP (West of Flyover).

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

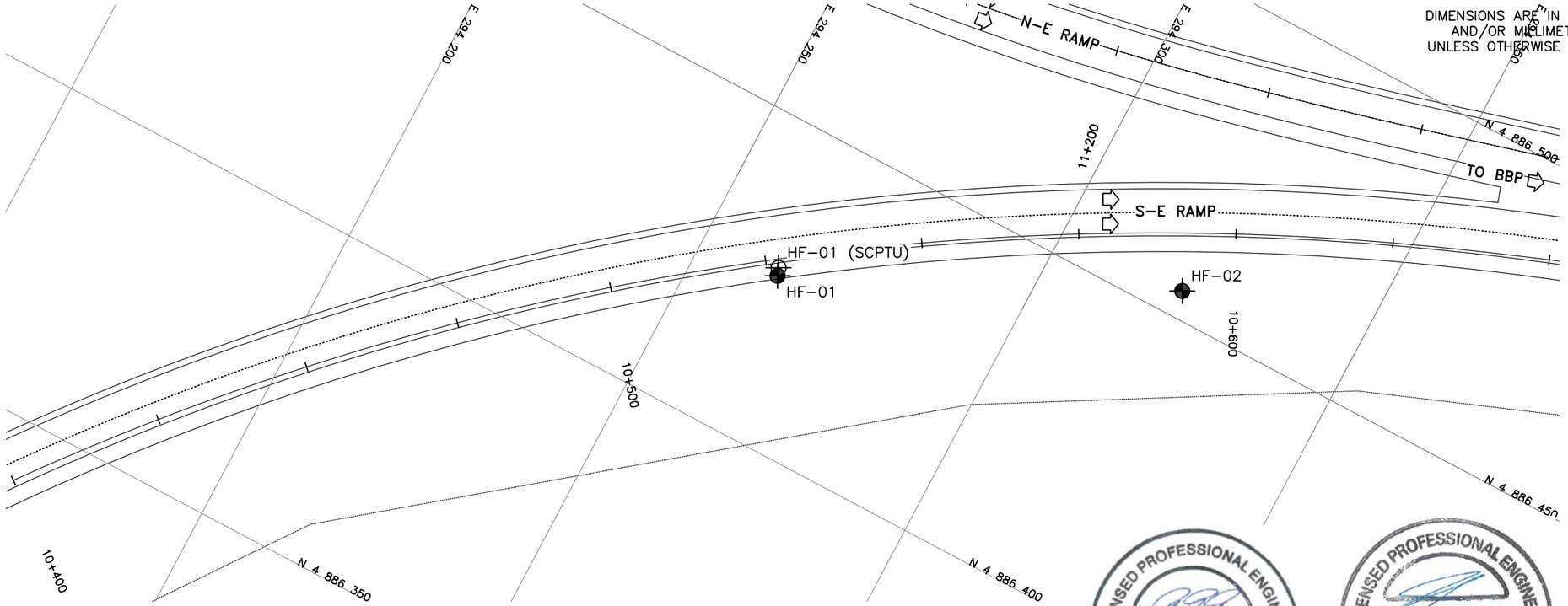
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

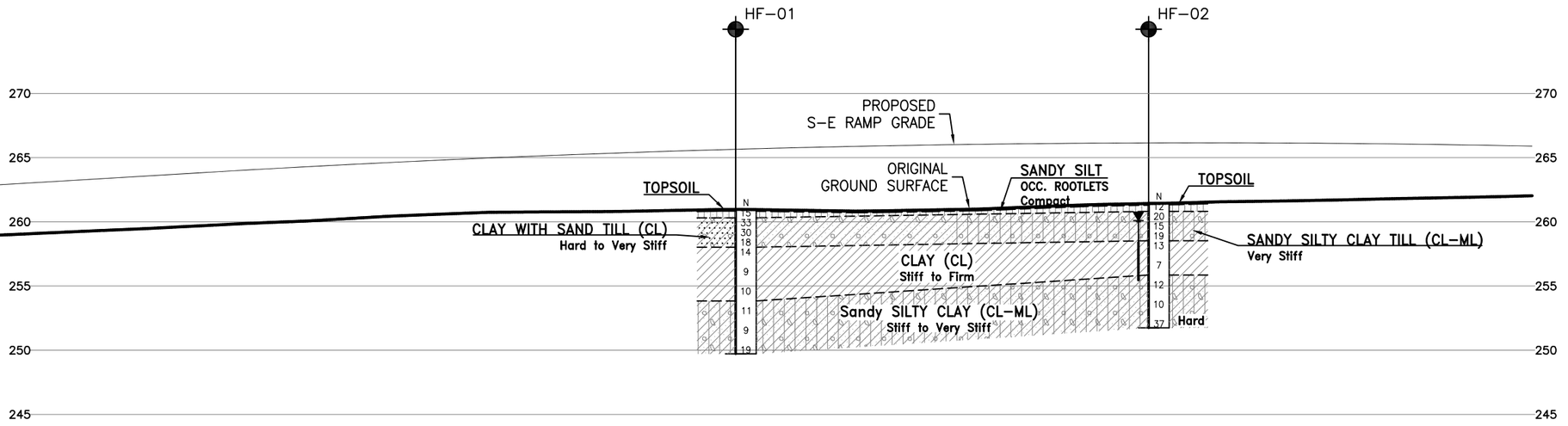
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

16 0 16 32m

SCALE 1:800



PROFILE ALONG ℄ NEW RAMP S-E (TO BBP EBL)

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
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2026/02/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS-HIGH FILL
HIGHWAY 400 S-E RAMP
TO BBP EBL
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF-01 (SCPTU)	261.0	4 886 427.5	294 262.7
HF-02	261.5	4 886 454.3	294 321.1

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of High Fill Stations 10+400 to 10+640. See Drawing 1 – High Fill Area Ramp S-E to BBP EBL.

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

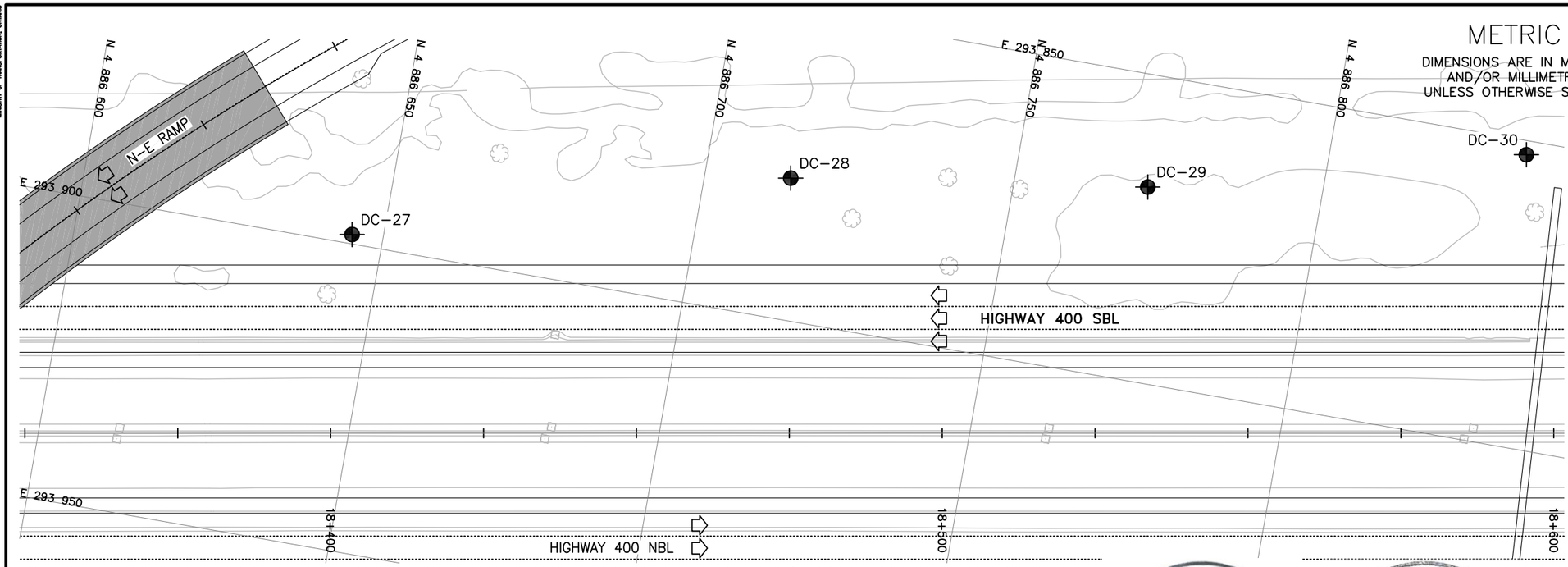
DESIGN	RPR	CHK CN	CODE	LOAD	DATE JAN 2026
DRAWN	AN	CHK RPR	SITE	STRUCT	DWG 8

FILENAME: H:\Drafting\48000\48856\TED-48856-PLPR-HWY400 DC-HF.dwg
PLOTDATE: 1/22/2026 11:42 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

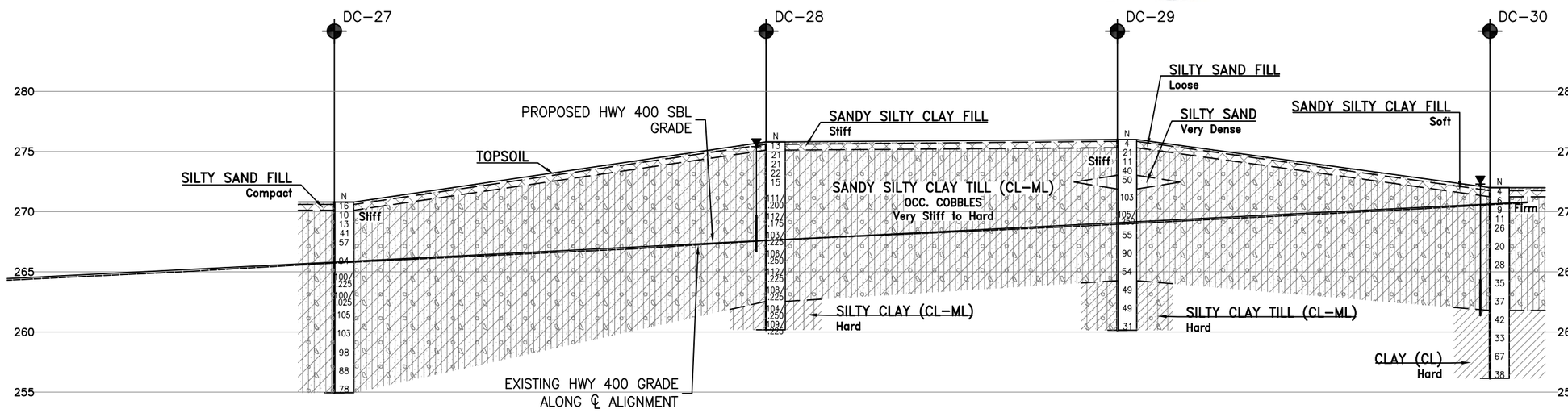
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

16 0 16 32m

SCALE 1:800



PROFILE ALONG ℄ HIGHWAY 400 (DEEP CUT)

16 0 16 32m H 1:800

8 0 8 16m V 1:400

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
2026/02/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.P.K. LEE
100086735
2026/02/11
PROVINCE OF ONTARIO

CONT No
WP No

SHEET

BRADFORD BYPASS
HIGHWAY 400 SBL
DEEP CUT
BOREHOLE LOCATIONS AND SOIL STRATA

AECOM

THURBER



KEYPLAN

	LEGEND
●	Borehole
⊕	Cone Penetration Test (CPT)
⊕	Previous Investigation (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▏	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
DC-27	270.8	4 886 644.9	293 898.5
DC-28	275.8	4 886 714.0	293 876.9
DC-29	276.0	4 886 771.7	293 868.2
DC-30	272.0	4 886 831.8	293 852.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.
4) Approx. Limits of Deep Cut Stations 18+350 to 18+570. See Drawing 1 – Deep Cut Area Highway 400 SBL.

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	CN	CODE	LOAD	DATE	JAN 2026
DRAWN	AN	CHK	RPR	SITE	STRUCT	DWG	9

FILENAME: H:\Drafting\48000\48856\TED-48856-PLPR-HWY400 DC-HF.dwg
PLOTDATE: 1/22/2026 11:43 AM

APPENDIX C

Record of Borehole Sheets – Current Investigation

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

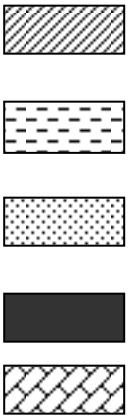
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

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RECORD OF BOREHOLE No DC-27 1 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 644.9 E 293 898.5 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.119718 LONGITUDE -79.636206 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
270.8	GROUND SURFACE										
0.0	**TOPSOIL:** (210mm)										
0.2	Silty **SAND** Compact Brown Moist (FILL)		1	SS	16				○		
270.1											
0.7	Sandy **SILTY CLAY** (CL-ML) Stiff to Hard Grey Moist to Wet (TILL)		2	SS	10		270		○		1 30 53 16
			3	SS	13		269		○		
			4	SS	41		268		○		
			5	SS	57		267		○		Mud rotary and tricone used from 3.0 m to 15.8 m.
			6	SS	94		266		○⊢		0 48 33 19
	Occasional cobbles		7	SS	100/ 0.225		265		○		
			8	SS	100/ 0.025		264				
			9	SS	105		263		○		
							262				
							261		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC-27 2 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 644.9 E 293 898.5 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.119718 LONGITUDE -79.636206 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Sandy **SILTY CLAY** (CL-ML) Hard Grey Moist to Wet (TILL)										
			10	SS	103		260		○⊣		1 42 40 17
							259				
			11	SS	98				○		
							258				
			12	SS	88		257		○		
							256				
255.0			13	SS	78		255		○		
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No DC-28 1 OF 2 METRIC

W.P. | LOCATION Deep Cut: N 4 886 714.0 E 293 876.9 | ORIGINATED BY AB

DIST Central HWY 400 | BOREHOLE TYPE Hollow Stem Auger/Mud Rotary | COMPILED BY JW

DATUM Geodetic | DATE 2024.10.17 - 2024.10.17 | LATITUDE 44.120339 | LONGITUDE -79.636477 | CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
275.8	GROUND SURFACE						
0.0	**TOPSOIL:** (210mm)						
0.2	Sandy **SILTY CLAY** (CL-ML) Stiff Brown Moist (FILL)		1	SS	13		
275.1							
0.7	Sandy **SILTY CLAY** (CL-ML) Very Stiff to Hard Brown to Grey Moist to Wet (TILL)		2	SS	21		275
			3	SS	21		274
			4	SS	22		273
			5	SS	15		272
			6	SS	111/ 0.200		271
			7	SS	112/ 0.175		270
			8	SS	103/ 0.225		268
			9	SS	106/ 0.250		267
							266

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

3 45 38 14

Mud rotary and tricone used from 3.0 m to 15.6 m.

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC-28 2 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 714.0 E 293 876.9 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.10.17 - 2024.10.17 LATITUDE 44.120339 LONGITUDE -79.636477 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Sandy **SILTY CLAY** (CL-ML) Hard Brown to Grey Moist to Wet (TILL)										
			10	SS	112/ 0.225		265		○		
							264		○		
			11	SS	108/ 0.225						
262.5							263				
13.3	**SILTY CLAY** (CL-ML) Hard Grey Wet						262		○		
			12	SS	104/ 0.250						
							261				
			13	SS	109/ 0.225				○		0 0 81 19
260.2											
15.6	END OF BOREHOLE AT 15.6m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.11.06	4.0	271.8
2024.11.14	7.4	268.4
2024.12.11	5.8	270.0
2025.04.03	0.4	275.4
2025.05.29	2.7	273.1
2025.09.08	4.5	271.3
2025.11.25	4.4	271.4

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC-29 1 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 771.7 E 293 868.2 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.10.18 - 2024.10.18 LATITUDE 44.120858 LONGITUDE -79.636587 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
276.0	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	Silty **SAND** Loose Brown Moist (FILL)		1	SS	4				○		
275.3							275				
0.7	Sandy **SILTY CLAY** (CL-ML) Stiff to Hard Grey Moist to Wet (TILL)		2	SS	21				○		
			3	SS	11		274		○		
	Auger grinding at 2.1m Occasional cobbles		4	SS	40				○		
273.0							273				Mud rotary and tricone used from 3.0 m to 15.8 m.
3.0	Silty **SAND** Very Dense Grey Moist to Wet		5	SS	50				○		0 53 35 12 Non-plastic
271.9							272				
4.1			6	SS	103				○		
							271				
			7	SS	105/ 0.250		270		○		
							269				
	Auger grinding at 7.6m		8	SS	55		268		⊖		0 36 47 17
	Possible cobbles or boulders										
							267				
	Auger grinding at 9.1m		9	SS	90				○		

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+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC-29 2 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 771.7 E 293 868.2 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.10.18 - 2024.10.18 LATITUDE 44.120858 LONGITUDE -79.636587 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **SILTY CLAY** (CL-ML) Hard Grey Moist to Wet (TILL)										
			10	SS	54		265		○		
264.3											
11.7	**SILTY CLAY** (CL-ML) Hard Grey Wet (TILL)						264				
			11	SS	49				○		0 4 79 17
							263				
			12	SS	49		262		○		
							261				
			13	SS	31				○		
260.2											
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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THURBER

RECORD OF BOREHOLE No DC-30 1 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 831.8 E 293 852.3 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.11.28 - 2024.11.28 LATITUDE 44.121399 LONGITUDE -79.636787 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
272.0	GROUND SURFACE										
0.0 / 271.7	**TOPSOIL:** (260mm)		1	SS	4						5 36 49 10
0.3 / 271.2	Sandy **SILTY CLAY** (CL-ML) Soft Brown Moist (FILL)										
0.8	Sandy **SILTY CLAY** (CL-ML) Firm to Hard Brown to Grey Moist to Wet (TILL)		2	SS	6		271				
			3	SS	9		270				4 43 40 13
			4	SS	11		269				
			5	SS	26		268				Mud rotary and tricone used from 3.0 m to 15.6 m.
	Occasional clay pockets		6	SS	20		267				1 44 40 15
			7	SS	28		266				
			8	SS	35		265				
			9	SS	37		264				
							263				
							262				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No DC-30 2 OF 2 METRIC

W.P. _____ LOCATION Deep Cut: N 4 886 831.8 E 293 852.3 ORIGINATED BY AB

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger/Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2024.11.28 - 2024.11.28 LATITUDE 44.121399 LONGITUDE -79.636787 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
261.8	Sandy **SILTY CLAY** (CL-ML) Hard Brown to Grey Moist to Wet (TILL)										
10.2	**CLAY** (CL) Hard Grey Wet		10	SS	42		261				
			11	SS	33		260				
			12	SS	67		259				
			13	SS	38		258				
256.2							257				0 0 62 38
15.8	END OF BOREHOLE AT 15.6m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2025.04.01	-0.3	272.3
2025.04.03	0.2	271.8
2025.05.29	0.7	271.3
2025.09.08	1.9	270.1
2025.11.25	1.2	270.8

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-01 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 426.3 E 294 263.2 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.10 - 2024.10.10 LATITUDE 44.117755 LONGITUDE -79.631646 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
261.0	GROUND SURFACE										
0.0	**TOPSOIL:** (175mm)										
0.2	Sandy **SILT**, occasional rootlets Compact Brown		1	SS	15				○		
260.3	Moist										
0.7	**CLAY** with sand (CL) Hard to Very Stiff Brown Moist (TILL)		2	SS	33		260		○		
	Occasional cobbles		3	SS	30		259		○		2 20 48 30
			4	SS	18				○		
258.0							258				
3.0	**CLAY** (CL) Stiff Grey Moist		5	SS	14				○		
			6	SS	9		257		○		
							256	+			
			7	SS	10		255		○		0 6 59 35
253.8							254				
7.2	Sandy **SILTY CLAY** (CL-ML) Stiff Grey Wet (TILL)		8	SS	11		253		○		
			9	SS	9		252		○		
							251				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF-01 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 426.3 E 294 263.2 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.10 - 2024.10.10 LATITUDE 44.117755 LONGITUDE -79.631646 CHECKED BY RR/JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
249.7	Sandy **SILTY CLAY** (CL-ML) Very Stiff Grey Wet (TILL)		10	SS	19		250				2 43 44 11
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL OBSERVED AT 4.4m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-02 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 454.3 E 294 321.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.09 - 2024.10.09 LATITUDE 44.118008 LONGITUDE -79.630922 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
261.5	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1	Sandy **SILT**, occasional rootlets Compact Brown		1	SS	12		261				
260.8	Moist										
0.7	Sandy **SILTY CLAY** (CL-ML) Very Stiff Brown Moist (TILL)		2	SS	20						
			3	SS	15		260				
			4	SS	19		259				
258.5											
3.0	**CLAY** (CL) Stiff to Firm Brown Moist		5	SS	13		258				0 2 44 54
	Grey		6	SS	7		257				
255.9							256	1.5			
5.6	Sandy **SILTY CLAY** (CL-ML) Stiff to Hard Grey Wet (TILL)		7	SS	12		255				
			8	SS	10		254				
							253				
			9	SS	37		252				4 46 39 11
251.7											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF-02 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 454.3 E 294 321.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.09 - 2024.10.09 LATITUDE 44.118008 LONGITUDE -79.630922 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 4.9m DURING DRILLING. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.10.31 2.8 258.7 2025.05.30 1.4 260.1 2025.09.09 4.5 257.0 2025.11.26 6.1 255.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-05 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 598.7 E 294 169.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.15 - 2024.10.15 LATITUDE 44.119306 LONGITUDE -79.632825 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.9	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	Sandy **SILTY CLAY,** occasional rootlets Stiff to Very Stiff Brown Moist (TILL)		1	SS	15						
			2	SS	11		260				
259.5											
1.4	**CLAY** (CL) Stiff Brown Moist		3	SS	8		259				
			4	SS	11						0 13 53 34
257.9							258				
3.0	Silty **SAND** Compact to Loose Grey Moist (TILL)		5	SS	18						1 49 38 12
							257				
			6	SS	11		256				
							255				
			7	SS	10						
							254				
			8	SS	10		253				3 47 39 11
							252				
			9	SS	5						
							251				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-05 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 598.7 E 294 169.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.15 - 2024.10.15 LATITUDE 44.119306 LONGITUDE -79.632825 CHECKED BY RR/JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Loose to Compact Grey Moist (TILL)										
			10	SS	8		250		○		
							249				
			11	SS	9				○		
							248				
			12	SS	10		247		○		
							246				
245.1			13	SS	19				○		
15.8	END OR BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No HF-06 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 542.5 E 294 097.3 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.15 - 2024.10.15 LATITUDE 44.118799 LONGITUDE -79.633720 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
259.2	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1	Sandy **SILTY CLAY** Stiff Brown Moist (TILL)		1	SS	12		259				
258.5											
0.7	**CLAY** (CL) to **CLAY** with sand Very Stiff to Stiff Brown Moist		2	SS	17		258				0 1 57 42
			3	SS	15						
							257				
			4	SS	11						
			5	SS	8		256				1 27 42 30
255.1											
4.1	Silty **SAND** Compact to Loose Grey Moist (TILL)		6	SS	23		255				
							254				
			7	SS	7		253				
							252				
			8	SS	5		251				
			9	SS	6		250				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-06 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 542.5 E 294 097.3 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.15 - 2024.10.15 LATITUDE 44.118799 LONGITUDE -79.633720 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Compact Grey Moist (TILL)						249				
			10	SS	10		248		○		
247.5											
11.7	**CLAY** (CL) Very Stiff Grey Moist						247				
			11	SS	29				○⊢		1 11 57 31
246.4											
12.8	END OF BOREHOLE AT 12.8m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.11.01	2.4	256.8
2025.05.30	1.1	258.1
2025.09.10	2.5	256.7
2025.11.26	0.4	258.8

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF-09 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 146.2 E 293 932.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.31 - 2024.10.31 LATITUDE 44.115230 LONGITUDE -79.635770 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.8	GROUND SURFACE										
0.0	**TOPSOIL** (125mm)										
0.1	Sandy **SILTY CLAY** Stiff to Very Stiff Brown Moist (TILL)		1	SS	13		254				
			2	SS	23						
253.4							253				
1.4	**CLAY** (CL) Hard to Stiff Brown to Grey Moist		3	SS	39						
			4	SS	23		252				1 9 55 35
			5	SS	15						
							251				
			6	SS	12		250				
							249				
			7	SS	13						1 5 51 43
							248				
			8	SS	14		247				
							246				
			9	SS	14						
245.0											
9.8	END OF BOREHOLE AT 9.8m.										

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+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF-09 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 146.2 E 293 932.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.31 - 2024.10.31 LATITUDE 44.115230 LONGITUDE -79.635770 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-10 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 076.2 E 293 950.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.31 - 2024.10.31 LATITUDE 44.114599 LONGITUDE -79.635550 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
253.5	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	Sandy **SILTY CLAY** Stiff to Soft Brown Moist (FILL)		1	SS	8		253				
			2	SS	3						
252.1							252				
1.4	Silty **SAND** with gravel Compact Brown to Grey Moist		3	SS	23						24 52 19 5
251.3	(FILL)										
2.2	**SAND** with silt and gravel Dense Brown Wet		4	SS	41		251				
250.2			5	SS	13		250				
3.3	**CLAY** (CL) Very Stiff to Stiff Grey Wet										
			6	SS	21		249				
							248				
			7	SS	18		247				
							246				
			8	SS	9						0 2 61 37
							245	2.0 +			
			9	SS	8		244				

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$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-10 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 076.2 E 293 950.1 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.31 - 2024.10.31 LATITUDE 44.114599 LONGITUDE -79.635550 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
243.3	**CLAY** (CL) Very Stiff to Stiff Grey Wet						243	+ 2.0			
10.2	Silty **SAND** Loose to Compact Grey Wet (TILL)		10	SS	8		242		○		
			11	SS	7		241		○		
			12	SS	10		240		○		7 43 42 8
239.2											
14.3	END OF BOREHOLE AT A DEPTH OF 14.3m. WATER LEVEL OBSERVED AT 1.7m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF-11 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 036.7 E 293 776.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.123242 LONGITUDE -79.637738 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
274.6	GROUND SURFACE										
0.0	**TOPSOIL:** (200mm)										
0.2	Silty **SAND**, occasional organics Compact Brown		1	SS	16		274				
273.9	Moist										
0.7	**CLAY** (CL) Very Stiff to Hard Brown Moist		2	SS	16						0 3 53 44
			3	SS	19		273				
272.0			4	SS	41		272				
2.6	Silty **SAND**, occasional cobbles Compact to Very Dense Brown to Grey Moist to Wet (TILL)		5	SS	29		271				
			6	SS	15		270				3 48 36 13
			7	SS	22		269				
	Auger grinding		8	SS	51		268				
			9	SS	25		267				
264.8							266				
9.8	END OF BOREHOLE AT 9.8m.						265				

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$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-11 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 036.7 E 293 776.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.123242 LONGITUDE -79.637738 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE DRY UPON COMPLETION OF DRILLING. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.11.04 2.4 272.2 2025.05.29 0.9 273.7 2025.09.08 2.0 272.6 2025.11.25 1.2 273.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-12 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 989.3 E 293 772.7 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.122815 LONGITUDE -79.637785 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
273.8	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	Silty **SAND**, occasional organics Compact Brown		1	SS	21						
273.1	Moist										
0.7	**CLAY** (CL) Very Stiff to Stiff Brown Moist		2	SS	18		273				
			3	SS	14		272				
			4	SS	14		271				0 3 48 49
			5	SS	14						
269.7							270				
4.1	**CLAY** with sand (CL) Stiff Grey Wet		6	SS	9		269				1 26 43 30
268.2											
5.6	Silty **SAND**, occasional cobbles Compact Brown to Grey Moist to Wet (TILL)		7	SS	13	▽	268				
			8	SS	22		267				
			9	SS	26		266				7 45 35 13
264.0							265				
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF-12 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 989.3 E 293 772.7 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.122815 LONGITUDE -79.637785 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 6.3m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-13 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 467.6 E 294 166.0 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118126 LONGITUDE -79.632861 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
259.0	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	**CLAY** (CL) Very Stiff to Firm Brown Moist		1	SS	16				○		
			2	SS	11		258		○		
			3	SS	12		257		○		0 0 49 51
			4	SS	11				○		
			5	SS	12		256		○		
	Grey		6	SS	7		255		○		
253.4							254	+			
5.6	Silty **SAND** Compact to Loose Grey Wet (TILL)		7	SS	10		253		○		
			8	SS	14		252		○		
			9	SS	6		251		H		2 55 35 8
							250				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-13 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 467.6 E 294 166.0 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118126 LONGITUDE -79.632861 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Compact Grey Wet (TILL)										
247.7			10	SS	23		248				
11.3	END OF BOREHOLE AT A DEPTH OF 11.3m. WATER LEVEL OBSERVED AT 5.1m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-14 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 479.8 E 294 239.5 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118237 LONGITUDE -79.631942 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.4	GROUND SURFACE										
0.0	**TOPSOIL:** (100mm)										
0.1	Sandy **SILT**, occasional organics Compact Brown Moist		1	SS	13		260				
	Sand seam (25 mm)		2	SS	12						
259.0							259				
1.4	**CLAY** (CL) Very Stiff to Stiff Brown Moist		3	SS	15						
			4	SS	17		258				
			5	SS	12		257				
							256				
	Grey		6	SS	10						0 10 52 38
254.8							255				
5.6	Sandy **SILT** Loose to Compact Grey Wet (TILL)		7	SS	9		254				
							253				
	Occasional cobbles		8	SS	16						3 44 43 10
							252				
			9	SS	18		251				
250.6											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-14 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 479.8 E 294 239.5 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118237 LONGITUDE -79.631942 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 5.2m DURING DRILLING. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.10.31 2.3 258.1 2025.05.30 0.8 259.6 2025.09.09 4.1 256.3 2025.11.26 5.4 255.0										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-15 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 485.3 E 294 312.3 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118287 LONGITUDE -79.631032 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	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) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
261.3	GROUND SURFACE										
0.0	**TOPSOIL:** (100mm)										
0.1	Sandy **SILT** Compact Brown Moist		1	SS	18		261		○		
			2	SS	13				○		
259.9							260				
1.4	Sandy **CLAY** (CL) Very Stiff Brown Moist (TILL)		3	SS	21				⊖		2 31 47 20
			4	SS	18		259		○		
			5	SS	15		258		○		
257.2											
4.1	**CLAY** (CL) Stiff Grey Moist		6	SS	8	▽	257		⊖		0 3 58 39
255.7							256	1.5			
5.6	Sandy **SILT** Loose to Dense Brown Wet (TILL)		7	SS	10		255		○		0 47 44 9
							254				
	Grey		8	SS	8				○		
							253				
			9	SS	37		252		○		
251.5											
9.8	END OF BOREHOLE AT 9.7m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-15 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 485.3 E 294 312.3 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 44.118287 LONGITUDE -79.631032 CHECKED BY RR/JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 5.4m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-16 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 492.2 E 294 363.7 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.10 - 2024.10.10 LATITUDE 44.118350 LONGITUDE -79.630391 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
261.8	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	Sandy **SILT**, occasional rootlets Compact Brown		1	SS	14						
261.1	Moist										
0.7	**CLAY** (CL) Stiff Brown Moist		2	SS	13		261				0 20 45 35
			3	SS	11		260				
			4	SS	10		259				0 10 50 40
			5	SS	10		258				
	Grey Wet		6	SS	11		257				
256.2											
5.6	Sandy Silty **CLAY** Stiff Grey Wet (TILL)		7	SS	8		256				
							255				
			8	SS	13		254				1 46 41 12
							253				
			9	SS	9		252				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-16 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 886 492.2 E 294 363.7 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.10 - 2024.10.10 LATITUDE 44.118350 LONGITUDE -79.630391 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy Silty **CLAY** Stiff to Very Stiff Grey Wet (TILL)										
			10	SS	8		251		○		
							250				
249.0			11	SS	18				○		
12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL OBSERVED AT 4.4m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.						249				

+ ³, × ³: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-16(A) 1 OF 3 METRIC

W.P. _____ LOCATION High Fill: N 4 886 492.4 E 294 363.8 ORIGINATED BY SP

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2025.03.18 - 2025.03.18 LATITUDE 44.118351 LONGITUDE -79.630390 CHECKED BY RR/JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
261.9 GROUND SURFACE											
0.0	Borehole augered to 9.1m below ground surface. No soil samples collected. Borehole HF-16 is associated with borehole HF-16(A). Therefore refer to the Record of Borehole HF-16 for the soil description.						261				
							260				
							259				
							258				
							257				
							256				
							255				
							254				
252.8							253				
9.1	Sandy Silty **CLAY** to Silty Clayey **SAND** Very Stiff Grey Wet (TILL)		1	SS	17				○		
							252				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-16(A) 2 OF 3 METRIC

W.P. _____ LOCATION High Fill: N 4 886 492.4 E 294 363.8 ORIGINATED BY SP

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2025.03.18 - 2025.03.18 LATITUDE 44.118351 LONGITUDE -79.630390 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy Silty **CLAY** to Silty Clayey **SAND** Stiff to Very Stiff Grey Wet (TILL)		2	SS	10		251		⊕		1 50 38 11
			3	SS	11		250		○		
			4	SS	10		249		⊕		1 49 41 9
			5	SS	29		248		○		
			6	SS	12		247		○		
244.1							246				
17.8	Silty **SAND,** occasional cobbles Dense Grey Moist (TILL)		7	SS	37		245		○		5 51 37 7
242.5							244				
19.4	Sandy Silty **CLAY** (CL), occasional cobbles Hard Grey		8	SS	50/		243				
							242		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\oplus^{20}_{15\ 10\ 5}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-16(A) 3 OF 3 METRIC

W.P. _____ LOCATION High Fill: N 4 886 492.4 E 294 363.8 ORIGINATED BY SP

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2025.03.18 - 2025.03.18 LATITUDE 44.118351 LONGITUDE -79.630390 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy Silty **CLAY** (CL), occasional cobbles Hard Grey Wet (TILL)				0.050						
			9	SS	55/ 0.150		241		○		0 48 40 12
							240				
239.0			10	SS	50/ 0.075		239		○		
22.9	END OF BOREHOLE AT 22.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-48856.GPJ 1-22-26

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-17 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 031.8 E 293 988.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.22 - 2024.10.22 LATITUDE 44.123201 LONGITUDE -79.635088 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
267.9	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1	Sandy **SILT**, occasional rootlets Very Loose Brown		1	SS	3				○		
267.2	Moist										
0.7	**CLAY** (CL) Stiff Brown Moist		2	SS	6		267		○		
			3	SS	13		266		○		
265.7											
2.2	Silty **SAND** Compact to Loose Grey Wet (TILL)		4	SS	12		265		○		
			5	SS	7				○		6 49 37 8
							264				
			6	SS	6		263		○		
							262				
			7	SS	6				○		
							261				
			8	SS	5		260		○		
							259				
			9	SS	5				○		2 52 39 7 Non-plastic
							258				

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+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF-17 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 031.8 E 293 988.6 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.22 - 2024.10.22 LATITUDE 44.123201 LONGITUDE -79.635088 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Loose Grey Wet (TILL)						257				
			10	SS	7						
							256				
			11	SS	9						
254.6							255				
13.3	**CLAY** (CL) Hard Grey Moist										
			12	SS	33		254				0 11 51 38
253.6											
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

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RECORD OF BOREHOLE No HF-18 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 095.0 E 293 948.8 ORIGINATED BY GA

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.28 - 2024.10.28 LATITUDE 44.123769 LONGITUDE -79.635586 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
269.2	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.2	Silty **SAND**, occasional rootlets Very Loose Dark Brown Wet (TILL)		1	SS	3		269				
			2	SS	2		268				2 45 43 10
	Loose to Compact Grey		3	SS	10		267				
			4	SS	4						2 50 40 8
			5	SS	10		266				
			6	SS	10		265				
			7	SS	12		264				
			8	SS	14		263				
			9	SS	9		262				
							261				
							260				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No HF-18 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 095.0 E 293 948.8 ORIGINATED BY GA

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.28 - 2024.10.28 LATITUDE 44.123769 LONGITUDE -79.635586 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	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 (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Loose Grey Wet (TILL)						259				
			10	SS	9				○		
							258				
							257				
			11	SS	4				⊞		1 50 39 10
255.9							256				
13.3	**SAND** with silt Loose Grey Wet										
			12	SS	6				○		
254.9							255				
14.3	END OF BOREHOLE AT 14.3m. WATER LEVEL MEASURED AT 0.6m UPON COMPLETION OF DRILLING. A MONITORING WELL WAS INSTALLED ADJACENT TO BOREHOLE HF-18(MW). Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.11.01 0.7 268.5 2025.05.29 0.5 268.7 2025.08.29 0.8 268.4 2025.09.09 0.9 268.3 2025.11.25 0.8 268.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-20 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 229.7 E 293 875.9 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.24 - 2024.10.24 LATITUDE 44.124981 LONGITUDE -79.636501 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.5	GROUND SURFACE										
0.0	**TOPSOIL:** (50mm)										
0.0	Silty **SAND** Compact to Dense Brown Moist (TILL)		1	SS	16		275		○		
			2	SS	16				○		
	Sand seam (25 mm)		3	SS	28		274		○		2 55 34 9
			4	SS	11		273		○		
			5	SS	13		272		○		
			6	SS	22		271		○		1 50 39 10
	Occasional cobbles Grey		7	SS	42		270				
							269		○		
			8	SS	11		268		○		
							267				
			9	SS	10		266		○		
265.7											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-20 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 229.7 E 293 875.9 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.24 - 2024.10.24 LATITUDE 44.124981 LONGITUDE -79.636501 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 8.5m DURING DRILLING. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.11.04 3.0 272.5 2025.05.29 1.7 273.8 2025.09.09 2.1 273.4 2025.11.25 2.2 273.3										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF-21 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 244.1 E 293 871.9 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.24 - 2024.10.24 LATITUDE 44.125110 LONGITUDE -79.636552 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.7	GROUND SURFACE										
0.0	**TOPSOIL:** (25mm)		1	SS	12		275		○		
	Silty **SAND** Compact Brown Moist (TILL)		2	SS	15				○		1 52 38 9
			3	SS	15		274		○		
	No recovery		4	SS	17		273				
271.6			5	SS	20		272		○		
4.1	Clayey **SAND** Compact Brown Moist to Wet (TILL)		6	SS	16		271		⊖		1 54 34 11
270.1							270				
5.6	Silty **SAND** Compact to Loose Grey Wet (TILL)		7	SS	12				○ ○		
			8	SS	6		269				
			9	SS	15		268		○		
265.9							267				2 53 38 7
9.8	END OF BOREHOLE AT 9.7m.						266				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-21 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 244.1 E 293 871.9 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.24 - 2024.10.24 LATITUDE 44.125110 LONGITUDE -79.636552 CHECKED BY RR/JA

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 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL OBSERVED AT 6.8m DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF-22 1 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 358.6 E 293 862.4 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.25 - 2024.10.25 LATITUDE 44.126140 LONGITUDE -79.636672 CHECKED BY RR/JA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
277.1	GROUND SURFACE						277				
0.0	**TOPSOIL:** (225mm)										
0.2	Silty **SAND** Loose to Dense Brown Moist (TILL)		1	SS	16				○		
			2	SS	8		276		○		
			3	SS	10				○		
			4	SS	14		275		○		2 52 36 10
	Occasional clay pockets		5	SS	16		274		○		
			6	SS	42		273		○		
			7	SS	13		272		○		1 51 42 6
			8	SS	11		271		○		
			9	SS	21		270		○		
267.3	Grey						269				
9.8	END OF BOREHOLE AT 9.7m.						268				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF-22 2 OF 2 METRIC

W.P. _____ LOCATION High Fill: N 4 887 358.6 E 293 862.4 ORIGINATED BY KF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW

DATUM Geodetic DATE 2024.10.25 - 2024.10.25 LATITUDE 44.126140 LONGITUDE -79.636672 CHECKED BY RR/JA

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 (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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APPENDIX D

Seismic Cone Penetration Tests (SCPTu)

Seismic Cone Penetration Test
HF01

CONETEC

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	2025-03-25	948:T1000F10U35	15	2.1	20.600	4885865	609489	
SCPT25-HF07	25-05-29237_SP07	2025-03-25	948:T1000F10U35	15	0.2	23.300	4885920	609280	
SCPT25-HF08	25-05-29237_SP08	2025-03-31	765:T1500F15U35	15	1.4	17.425	4885664	609176	3
SCPT25-HF19	25-05-29237_SP19	2025-03-26	948:T1000F10U35	15	0.1	14.675	4886597	609121	
SCPT25-HF21	25-05-29237_SP21	2025-03-26	948:T1000F10U35	15	0.4	9.900	4886702	609081	
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	2025-03-27	948:T1000F10U35	15	1.3	12.725	4886562	608981	
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	2025-03-28	948:T1000F10U35	15	2.8	19.250	4886521	609045	
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	2025-03-27	948:T1000F10U35	15	2.4	18.050	4886530	609093	
SCPT25-HWY400-21	25-05-29237_SPHWY400-21	2025-03-26	948:T1000F10U35	15	1.1	22.575	4886558	609141	
SCPT25-HWY400-34	25-05-29237_SPHWY400-34	2025-03-28	948:T1000F10U35	15		2.850	4886072	609084	4, 5
SCPT25-HWY400-34B	25-05-29237_SPHWY400-34B	2025-03-28	765:T1500F15U35	15		2.925	4886079	609081	4, 5

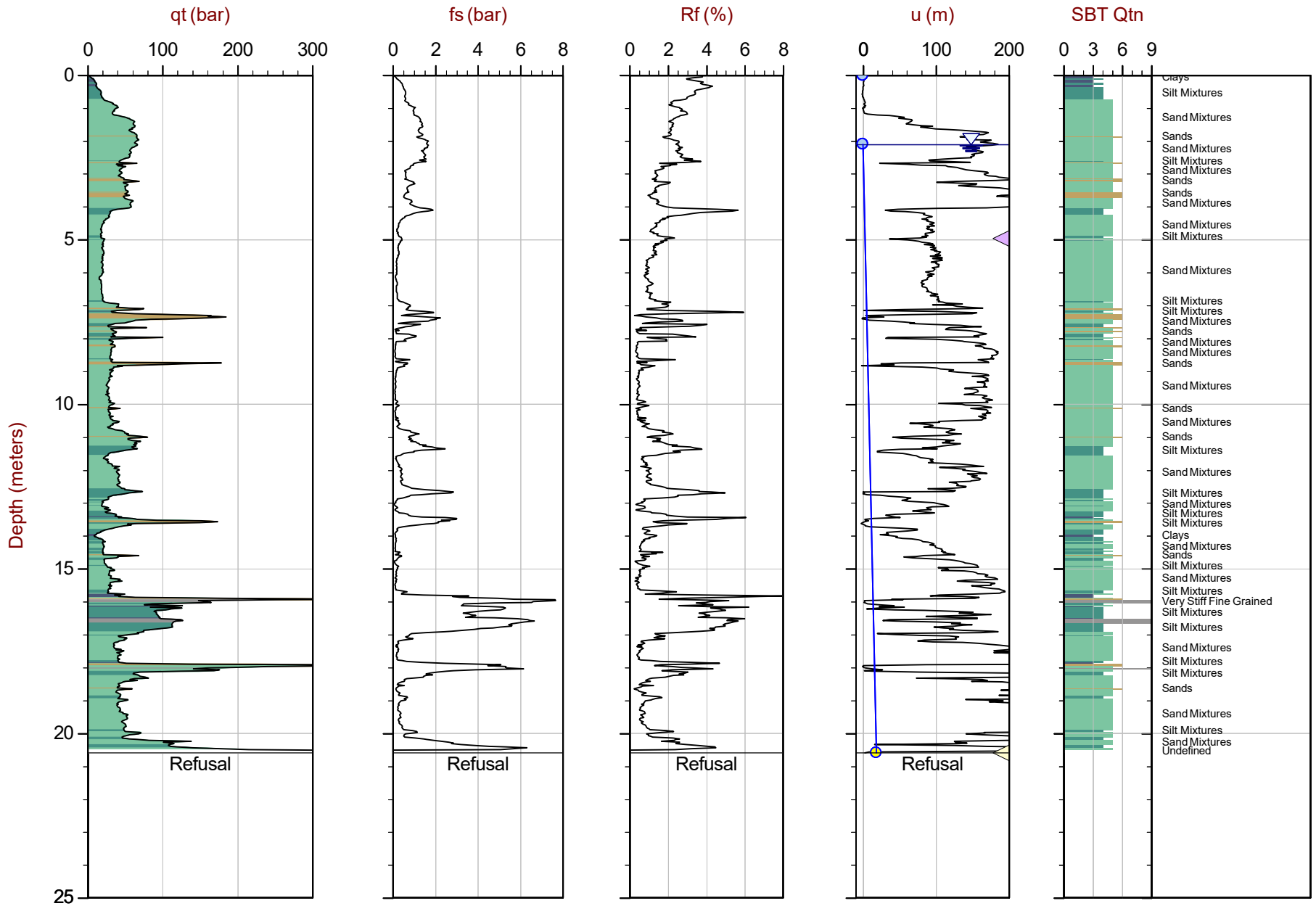
1. The assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device in datum WGS84/UTM Zone 17 North .
3. The assumed phreatic surface was based on the dynamic pore pressure response.
4. No clear phreatic surface detected due to shallow refusal.
5. No seismic data reported due to shallow refusal.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885865m E: 609489m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

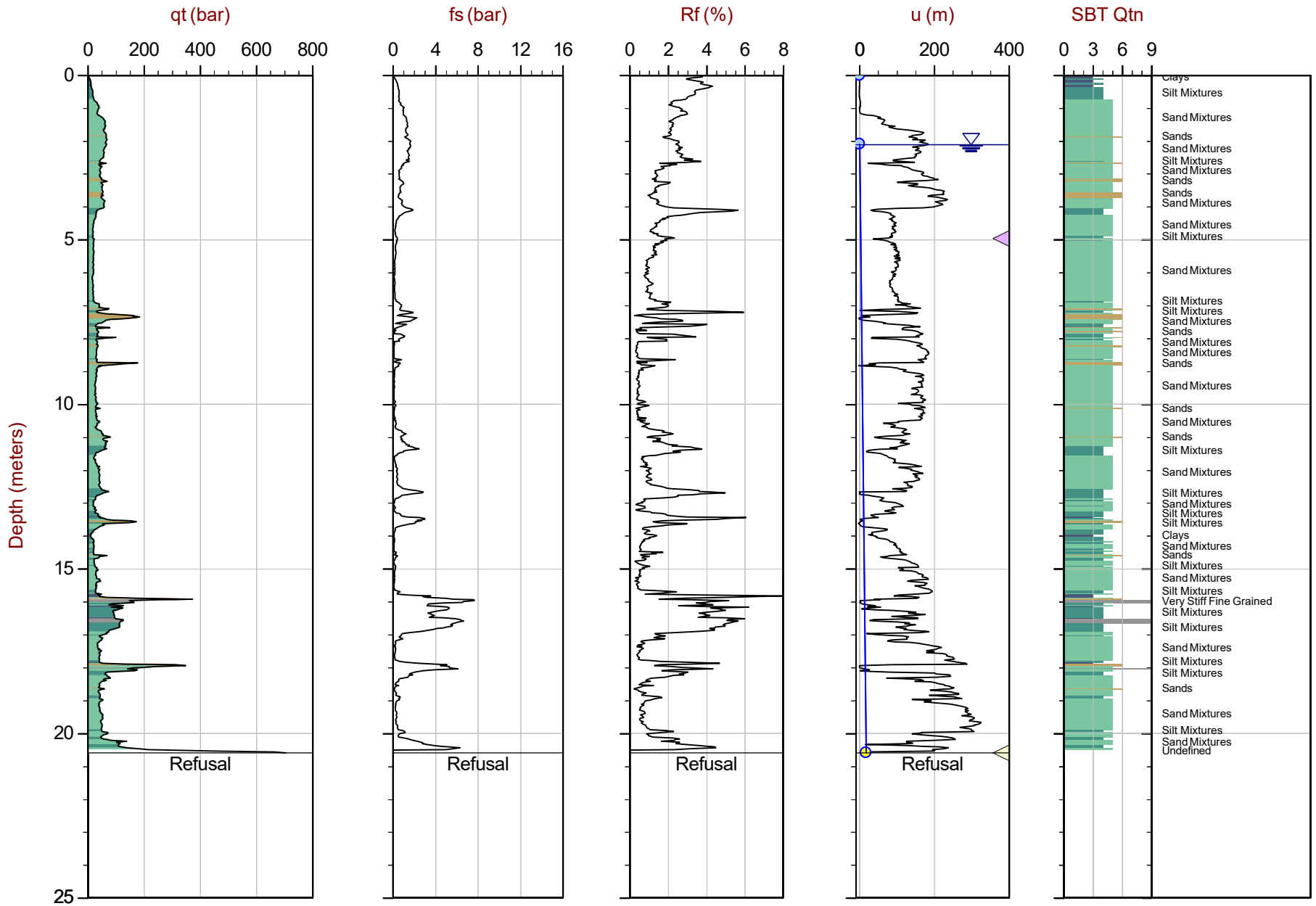
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885865m E: 609489m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

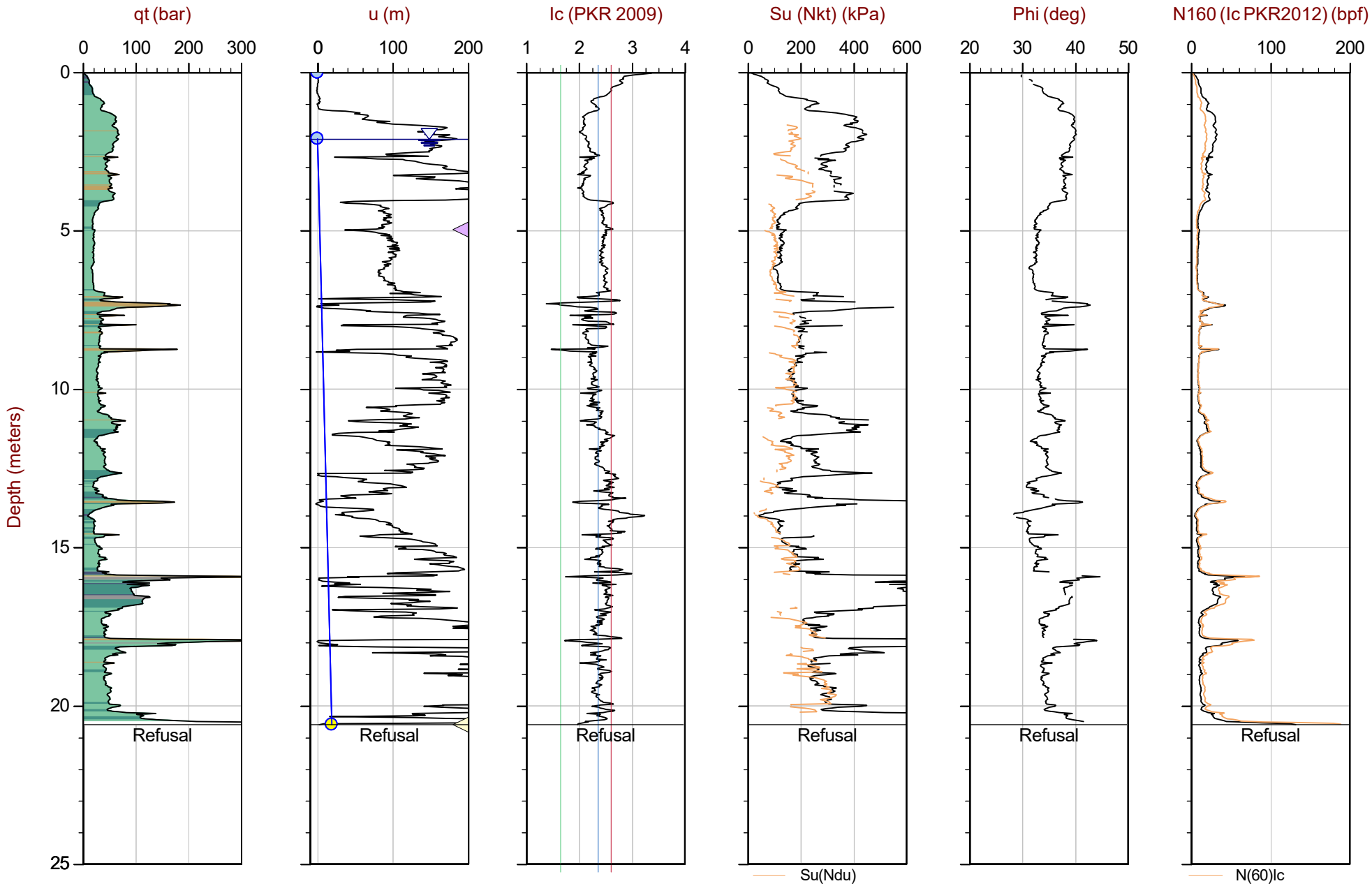
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP01.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885865m E: 609489m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

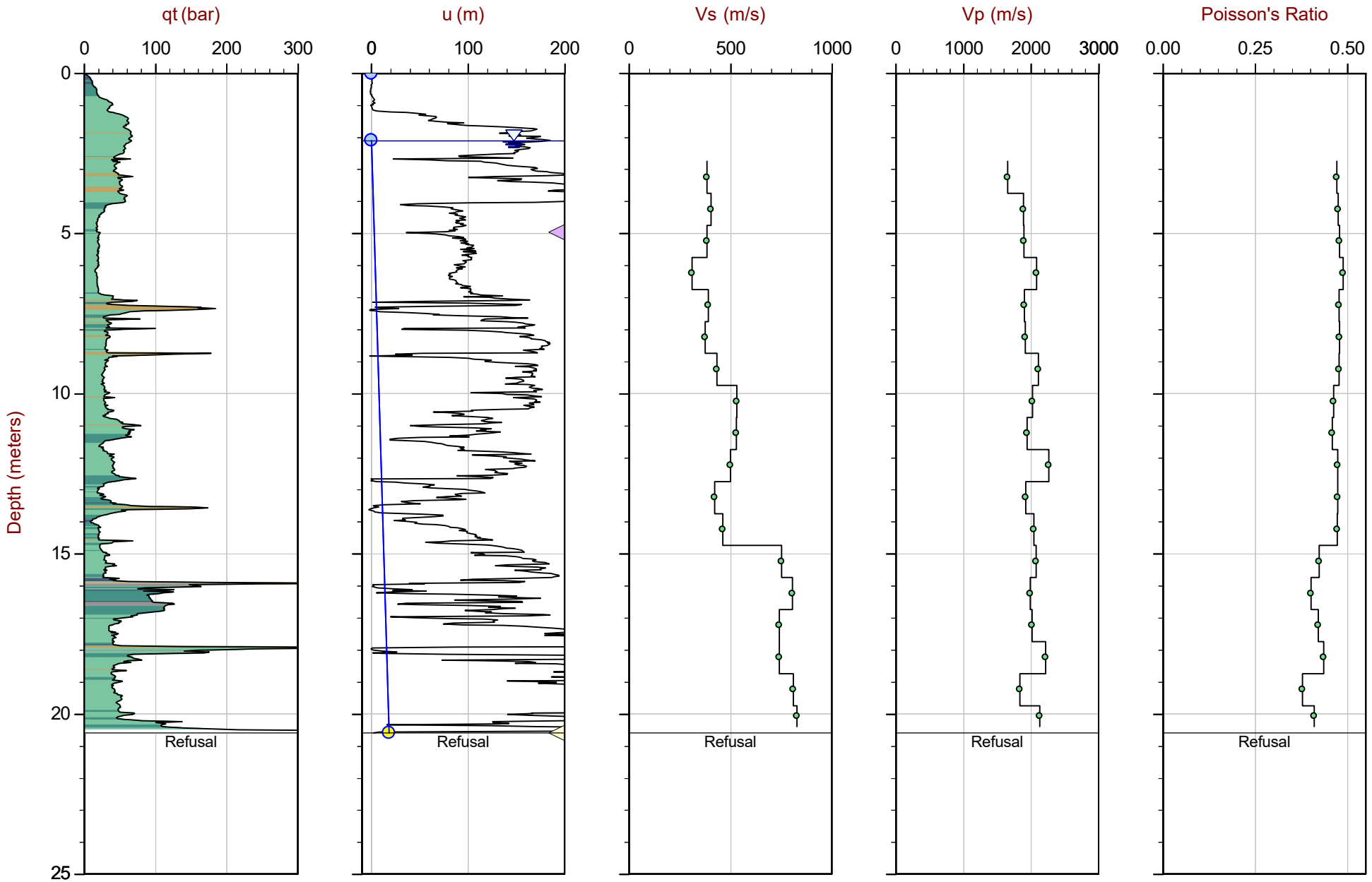
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885865m E: 609489m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

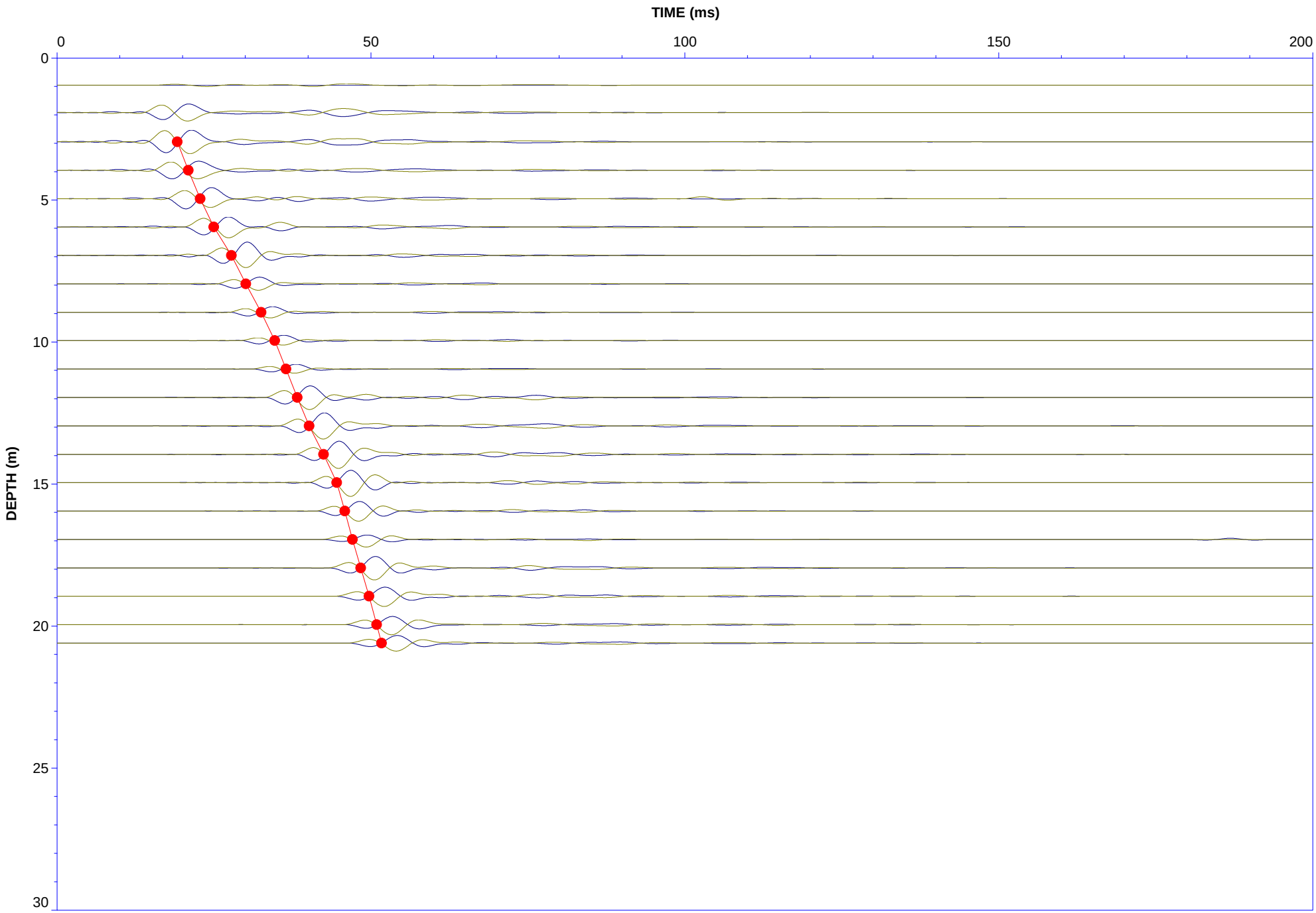
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF01
Date:	2025-03-25
Seismic Source:	Beam
Source Offset (m):	3.50
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.95	2.75	4.45			
3.95	3.75	5.13	0.68	1.77	384
4.95	4.75	5.90	0.77	1.90	406
5.95	5.75	6.73	0.83	2.16	384
6.95	6.75	7.60	0.87	2.80	312
7.95	7.75	8.50	0.90	2.30	392
8.95	8.75	9.42	0.92	2.45	376
9.95	9.75	10.36	0.94	2.15	435
10.95	10.75	11.31	0.95	1.78	531
11.95	11.75	12.26	0.96	1.80	531
12.95	12.75	13.22	0.96	1.92	501
13.95	13.75	14.19	0.97	2.28	424
14.95	14.75	15.16	0.97	2.10	462
15.95	15.75	16.13	0.97	1.29	754
16.95	16.75	17.11	0.98	1.21	807
17.95	17.75	18.09	0.98	1.32	741
18.95	18.75	19.07	0.98	1.32	743
19.95	19.75	20.06	0.98	1.21	812
20.60	20.40	20.70	0.64	0.77	830

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF01 Filter: 0-200Hz Date: 2025-03-25
Analysis: S Wave - Geo X

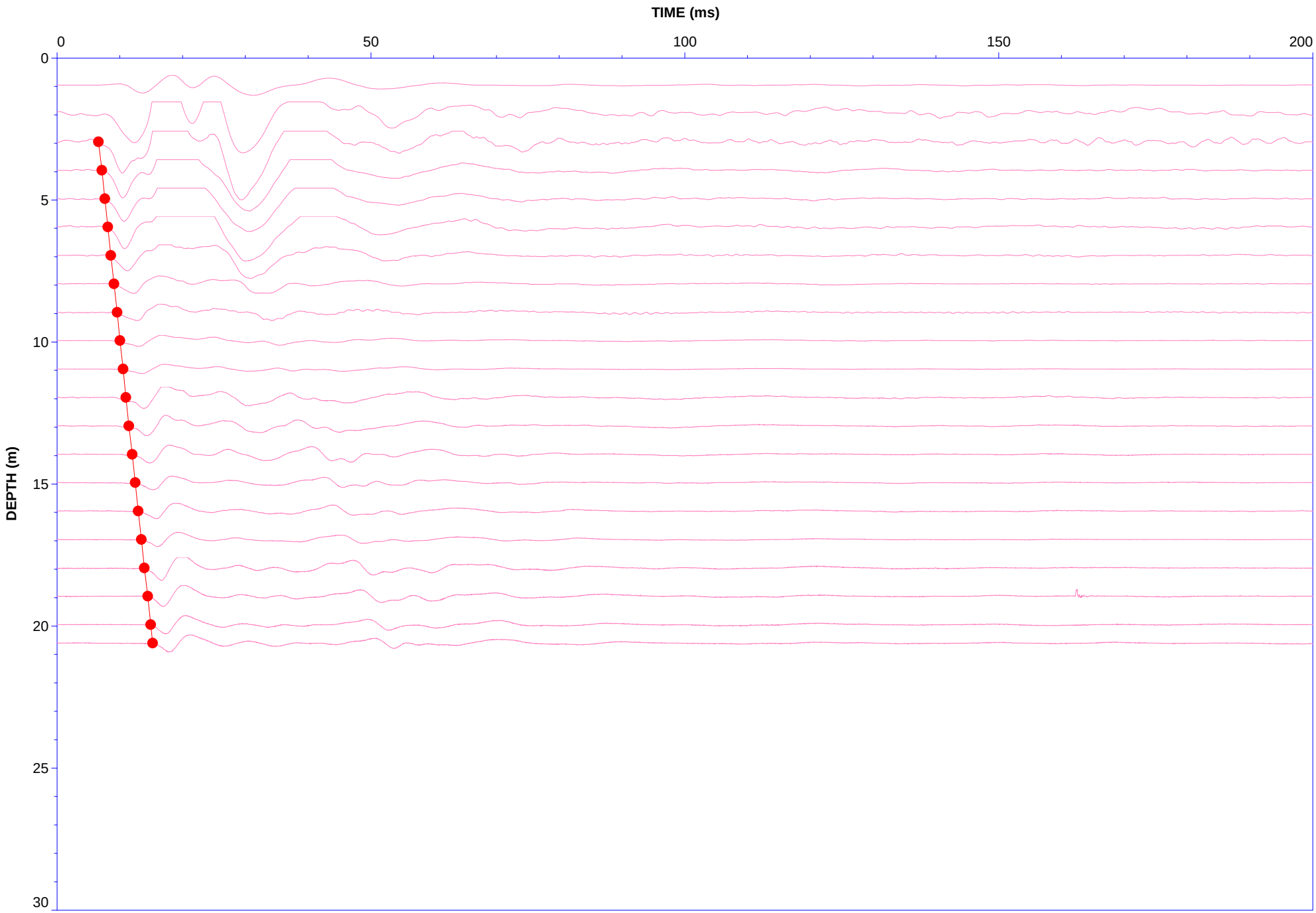


Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF01
Date:	2025-03-25
Seismic Source:	Plate
Source Offset (m):	2.00
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.95	2.75	3.40			
3.95	3.75	4.25	0.85	0.51	1658
4.95	4.75	5.15	0.90	0.48	1893
5.95	5.75	6.09	0.93	0.49	1901
6.95	6.75	7.04	0.95	0.46	2088
7.95	7.75	8.00	0.96	0.51	1905
8.95	8.75	8.98	0.97	0.51	1921
9.95	9.75	9.95	0.98	0.46	2111
10.95	10.75	10.93	0.98	0.48	2026
11.95	11.75	11.92	0.99	0.51	1948
12.95	12.75	12.91	0.99	0.44	2269
13.95	13.75	13.90	0.99	0.51	1928
14.95	14.75	14.89	0.99	0.48	2044
15.95	15.75	15.88	0.99	0.48	2079
16.95	16.75	16.87	0.99	0.50	1989
17.95	17.75	17.86	0.99	0.49	2019
18.95	18.75	18.86	0.99	0.45	2217
19.95	19.75	19.85	1.00	0.54	1837
20.60	20.40	20.50	0.65	0.30	2133

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF01 Filter: No Filter Date: 2025-03-25
Analysis: P Wave - Geo Z



Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF01
Date:	2025-03-25

SCPTu POISSON'S RATIO RESULTS

Depth From (m)	Depth To (m)	Vs Interval Velocity (m/s)	Vp Interval Velocity (m/s)	Poisson's Ratio
2.75	3.75	384	1658	0.47
3.75	4.75	406	1893	0.48
4.75	5.75	384	1901	0.48
5.75	6.75	312	2088	0.49
6.75	7.75	392	1905	0.48
7.75	8.75	376	1921	0.48
8.75	9.75	435	2111	0.48
9.75	10.75	531	2026	0.46
10.75	11.75	531	1948	0.46
11.75	12.75	501	2269	0.47
12.75	13.75	424	1928	0.48
13.75	14.75	462	2044	0.47
14.75	15.75	754	2079	0.42
15.75	16.75	807	1989	0.40
16.75	17.75	741	2019	0.42
17.75	18.75	743	2217	0.44
18.75	19.75	812	1837	0.38
19.75	20.40	830	2133	0.41

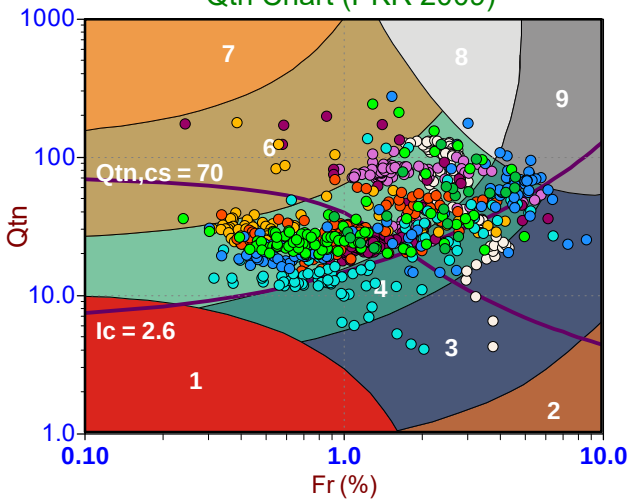
CONETEC

Thurber Engineering

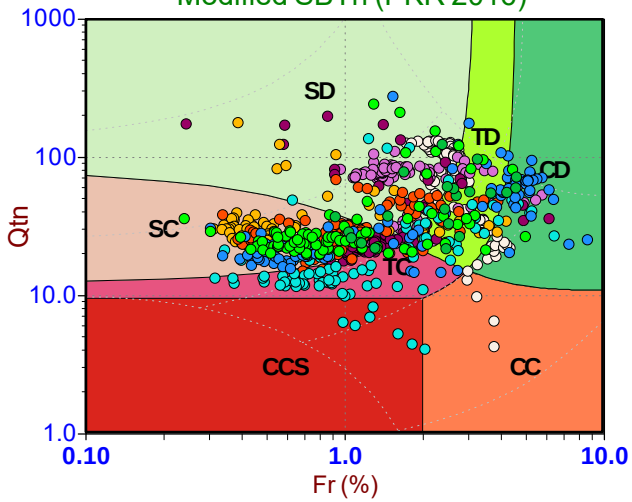
Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²

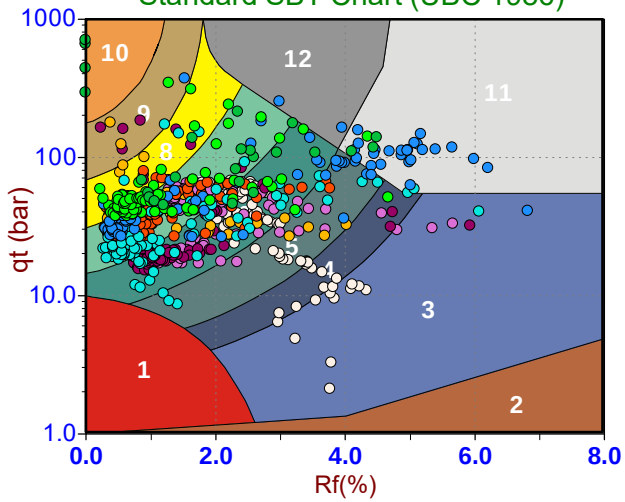
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- 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

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

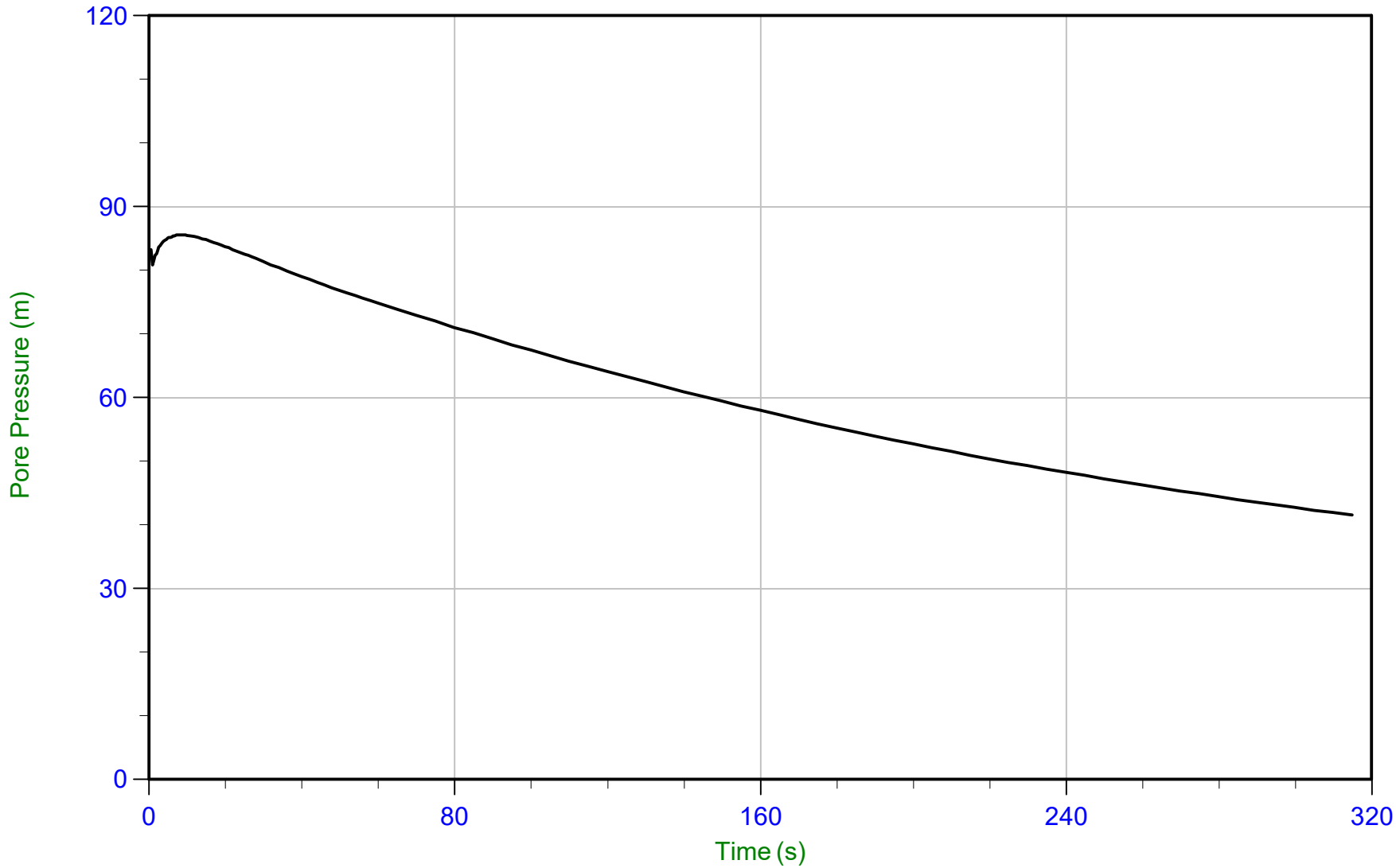
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	15	315	4.950							
SCPT25-HF01	25-05-29237_SP01	15	225	20.600	18.5		2.1				
SCPT25-HF07	25-05-29237_SP07	15	305	2.975							
SCPT25-HF07	25-05-29237_SP07	15	1020	4.000	3.8		0.2				
SCPT25-HF07	25-05-29237_SP07	15	300	5.975		5.8	0.2	37.5	100	18.7	3
SCPT25-HF07	25-05-29237_SP07	15	305	6.975		6.8	0.2	37.8	100	18.6	3
SCPT25-HF07	25-05-29237_SP07	15	340	9.975							
SCPT25-HF07	25-05-29237_SP07	15	210	10.975							
SCPT25-HF07	25-05-29237_SP07	15	320	15.975		15.8	0.2	97.8	100	7.2	3
SCPT25-HF07	25-05-29237_SP07	15	220	23.300							
SCPT25-HF08	25-05-29237_SP08	15	220	4.900							
SCPT25-HF08	25-05-29237_SP08	15	3150	5.100		3.7	1.4	891.7	100	0.8	3
SCPT25-HF08	25-05-29237_SP08	15	270	7.900							
SCPT25-HF08	25-05-29237_SP08	15	380	8.900							
SCPT25-HF08	25-05-29237_SP08	15	1060	10.025		8.6	1.4	45.6	100	15.4	3
SCPT25-HF08	25-05-29237_SP08	15	1000	12.900		11.5	1.4	395.7	100	1.8	3
SCPT25-HF08	25-05-29237_SP08	15	630	17.425							
SCPT25-HF19	25-05-29237_SP19	15	385	0.850							
SCPT25-HF19	25-05-29237_SP19	15	300	2.850	2.8		0.1				
SCPT25-HF19	25-05-29237_SP19	15	250	3.850							
SCPT25-HF19	25-05-29237_SP19	15	300	6.825							
SCPT25-HF19	25-05-29237_SP19	15	400	11.850	13.4		-1.6				
SCPT25-HF19	25-05-29237_SP19	15	300	12.850	14.3		-1.5				
SCPT25-HF19	25-05-29237_SP19	15	180	13.850	15.0		-1.2				

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP01.PPF2
Depth: 4.950 m / 16.240 ft
Duration: 315.0 s

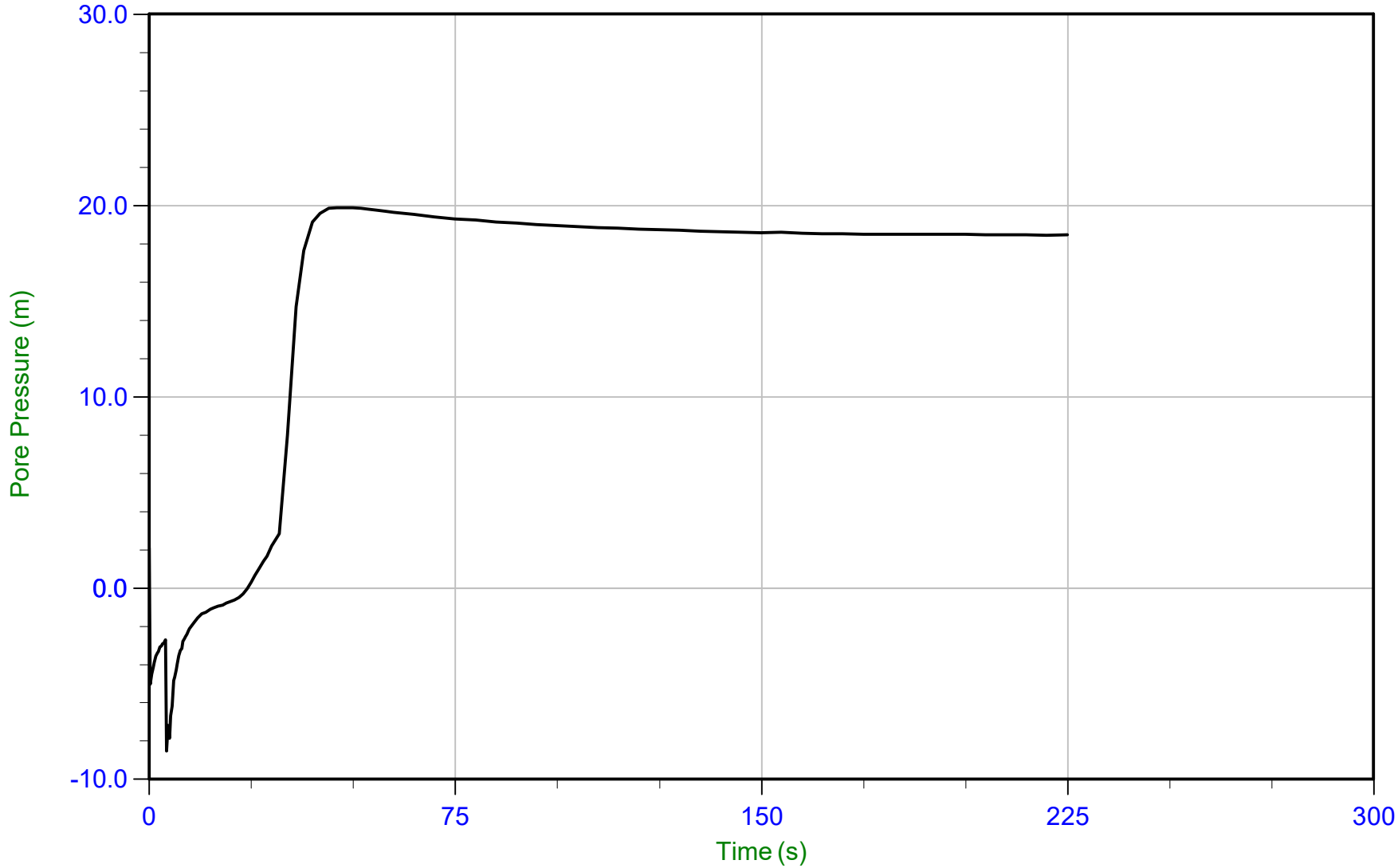
u Min: 41.6 m
u Max: 85.6 m
u Final: 41.6 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 10:11
Site: Bradford Bypass

Sounding: SCPT25-HF01
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP01.PPF2
Depth: 20.600 m / 67.584 ft
Duration: 225.0 s

u Min: -8.5 m
u Max: 19.9 m
u Final: 18.5 m

WT: 2.1 m / 6.9 ft
Ueq: 18.5 m

Seismic Cone Penetration Test
HF07

CONETEC

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	2025-03-25	948:T1000F10U35	15	2.1	20.600	4885865	609489	
SCPT25-HF07	25-05-29237_SP07	2025-03-25	948:T1000F10U35	15	0.2	23.300	4885920	609280	
SCPT25-HF08	25-05-29237_SP08	2025-03-31	765:T1500F15U35	15	1.4	17.425	4885664	609176	3
SCPT25-HF19	25-05-29237_SP19	2025-03-26	948:T1000F10U35	15	0.1	14.675	4886597	609121	
SCPT25-HF21	25-05-29237_SP21	2025-03-26	948:T1000F10U35	15	0.4	9.900	4886702	609081	
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	2025-03-27	948:T1000F10U35	15	1.3	12.725	4886562	608981	
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	2025-03-28	948:T1000F10U35	15	2.8	19.250	4886521	609045	
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	2025-03-27	948:T1000F10U35	15	2.4	18.050	4886530	609093	
SCPT25-HWY400-21	25-05-29237_SPHWY400-21	2025-03-26	948:T1000F10U35	15	1.1	22.575	4886558	609141	
SCPT25-HWY400-34	25-05-29237_SPHWY400-34	2025-03-28	948:T1000F10U35	15		2.850	4886072	609084	4, 5
SCPT25-HWY400-34B	25-05-29237_SPHWY400-34B	2025-03-28	765:T1500F15U35	15		2.925	4886079	609081	4, 5

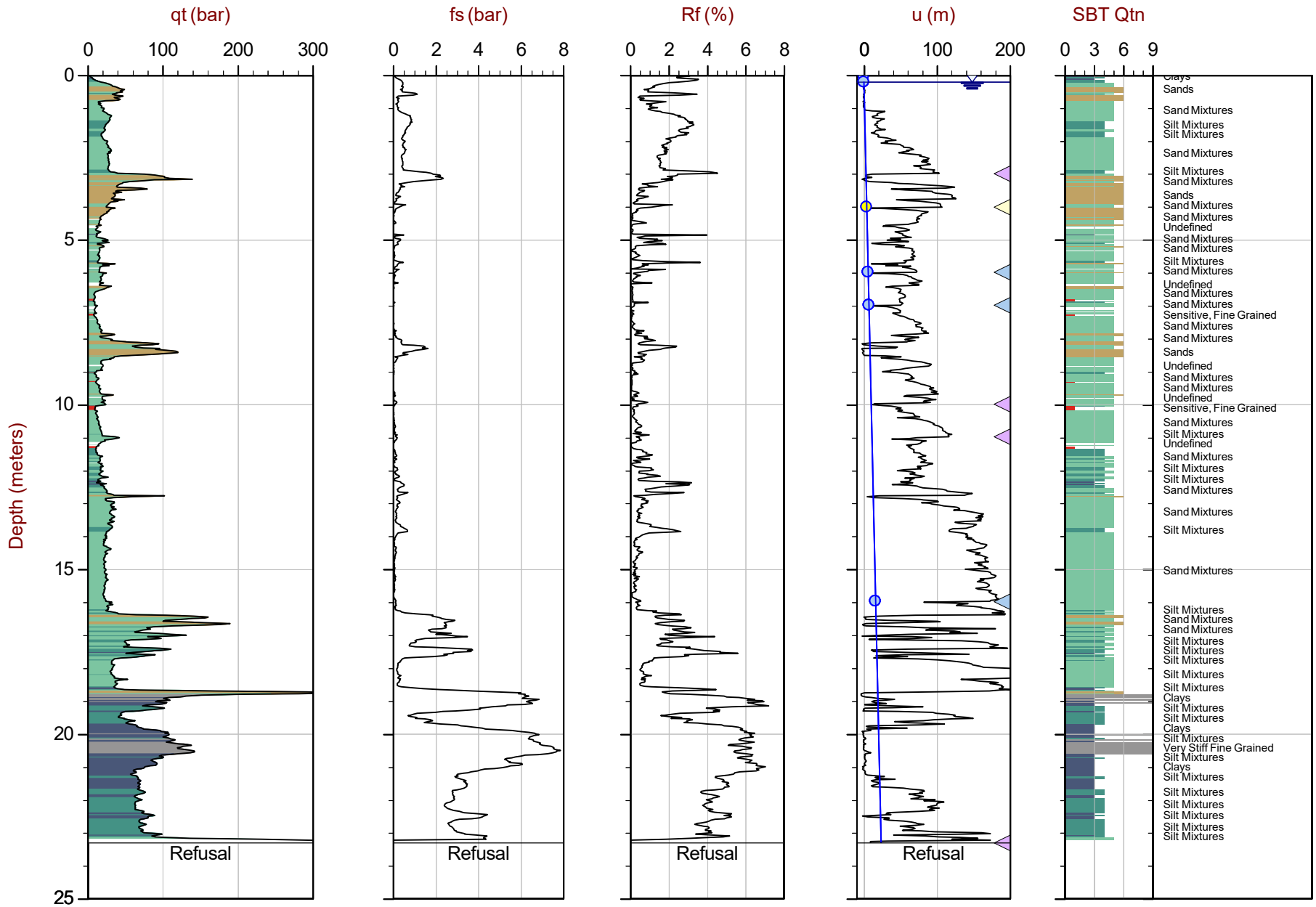
1. The assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device in datum WGS84/UTM Zone 17 North .
3. The assumed phreatic surface was based on the dynamic pore pressure response.
4. No clear phreatic surface detected due to shallow refusal.
5. No seismic data reported due to shallow refusal.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 23.300 m / 76.44 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885920m E: 609280m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

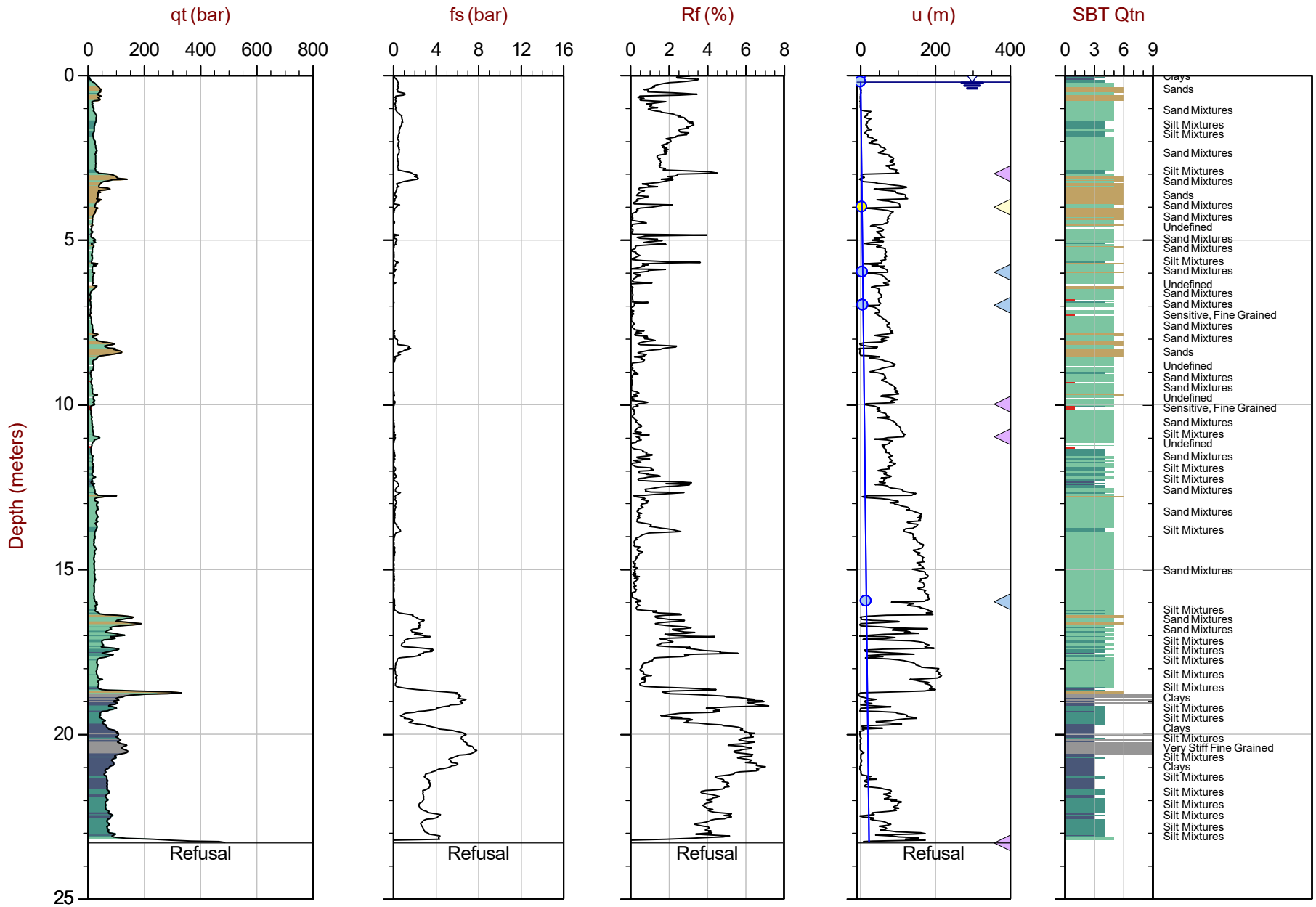
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 23.300 m / 76.44 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885920m E: 609280m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

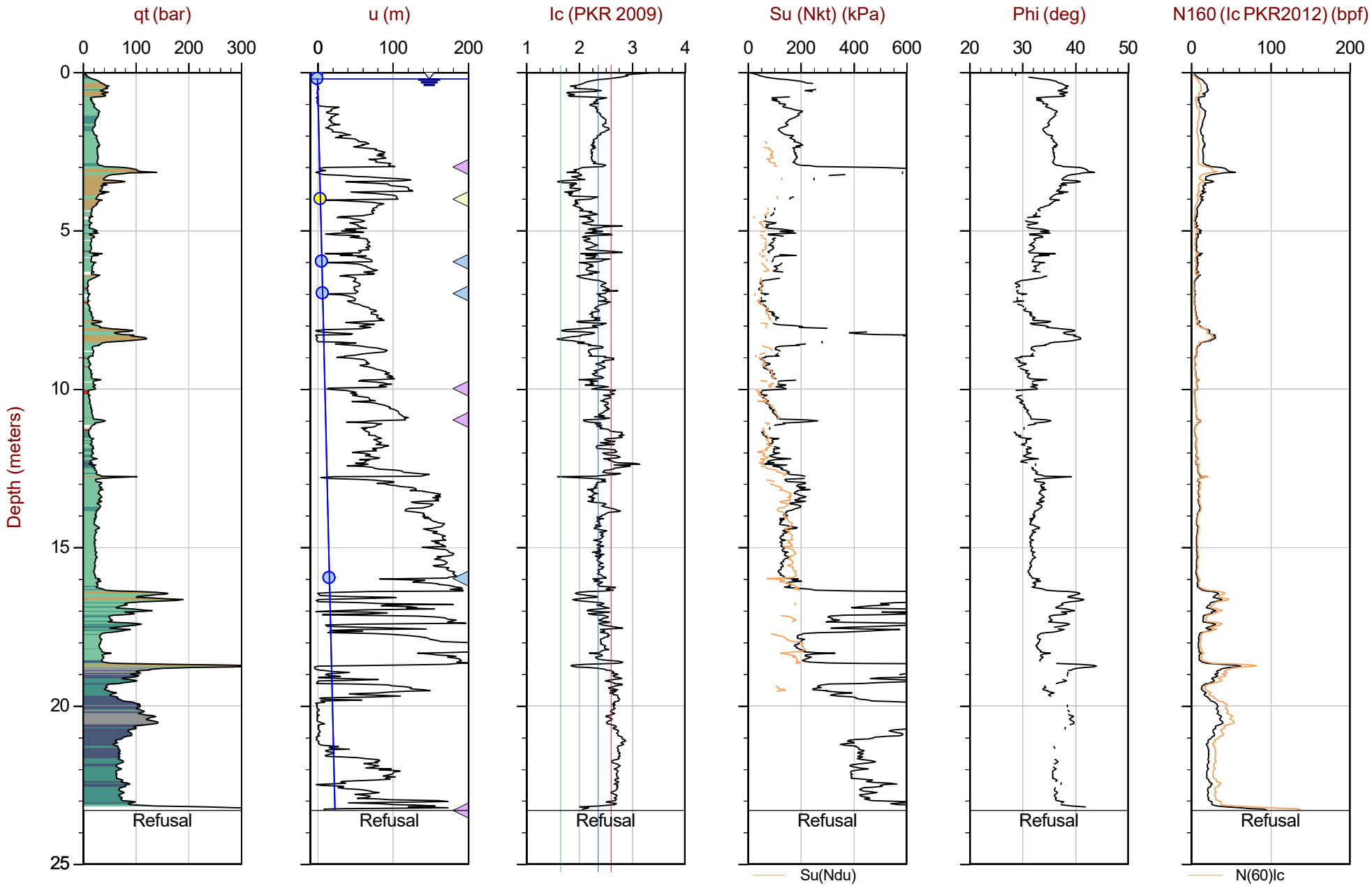
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 23.300 m / 76.44 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP07.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885920m E: 609280m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

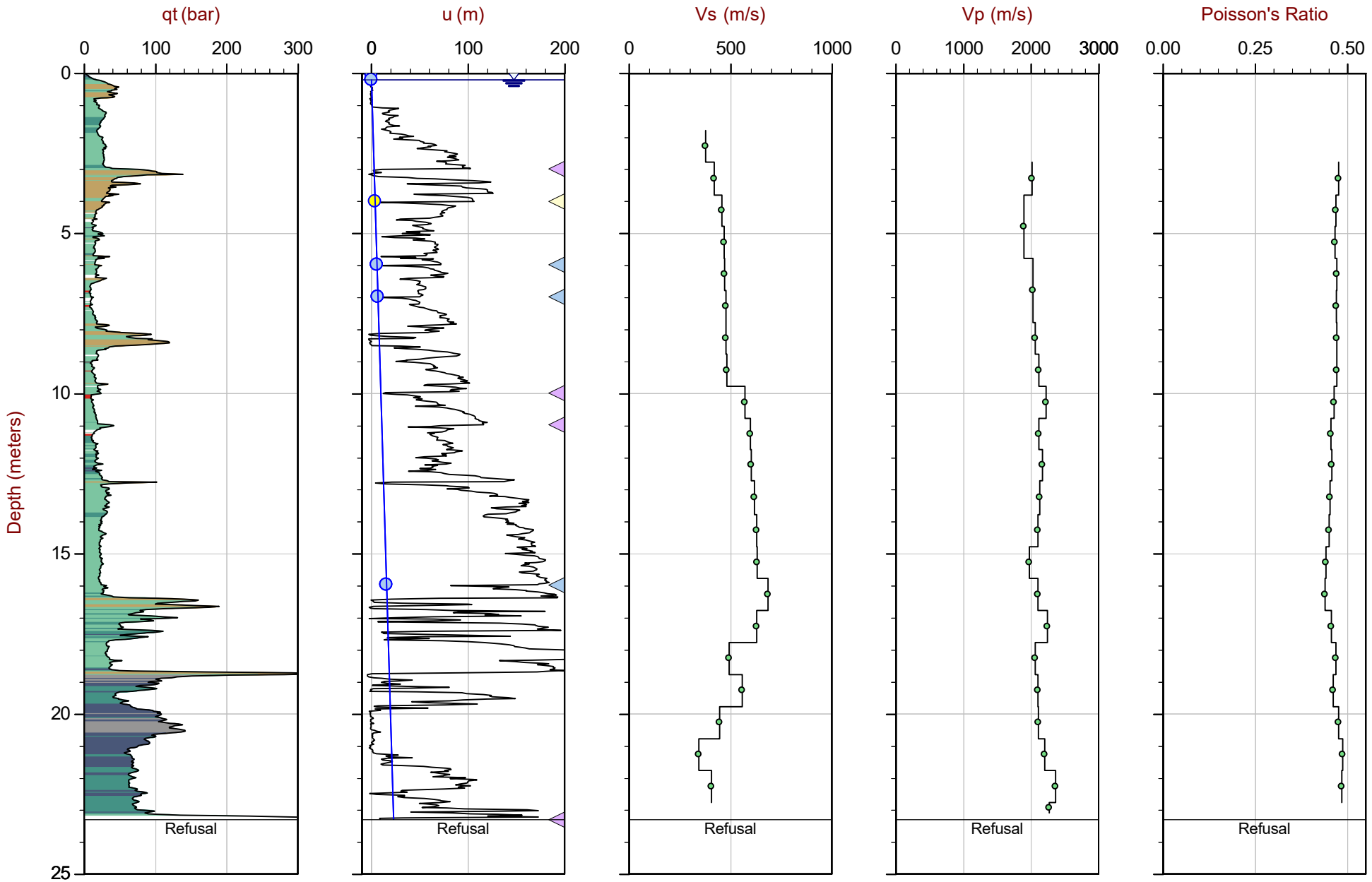
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 23.300 m / 76.44 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885920m E: 609280m
Sheet No: 1 of 1

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

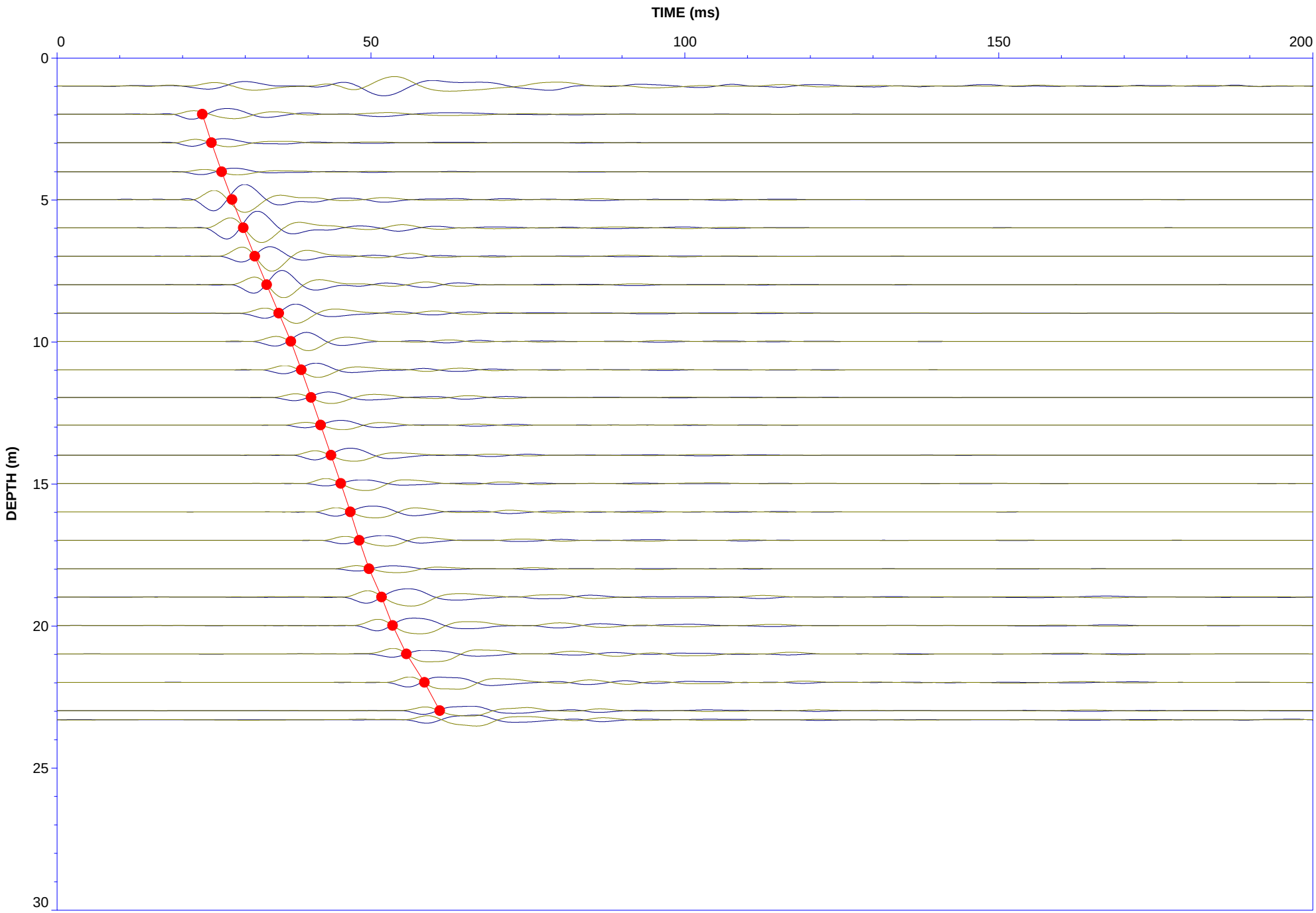
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF07
Date:	2025-03-25
Seismic Source:	Beam
Source Offset (m):	3.50
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
1.98	1.78	3.93			
2.98	2.78	4.47	0.54	1.43	379
4.00	3.80	5.17	0.70	1.65	421
4.98	4.78	5.92	0.76	1.65	459
5.98	5.78	6.76	0.83	1.77	470
6.98	6.78	7.63	0.87	1.85	471
7.98	7.78	8.53	0.90	1.88	478
8.98	8.78	9.45	0.92	1.92	479
9.98	9.78	10.39	0.94	1.93	484
10.98	10.78	11.33	0.95	1.65	573
11.95	11.75	12.26	0.93	1.54	600
12.92	12.72	13.19	0.93	1.54	605
13.98	13.78	14.22	1.03	1.65	620
14.98	14.78	15.19	0.97	1.54	630
15.98	15.78	16.16	0.97	1.54	632
16.98	16.78	17.14	0.98	1.42	687
17.98	17.78	18.12	0.98	1.55	631
18.98	18.78	19.10	0.98	1.98	495
19.98	19.78	20.09	0.98	1.76	558
20.98	20.78	21.07	0.99	2.21	447
21.98	21.78	22.06	0.99	2.86	344
22.98	22.78	23.05	0.99	2.43	408

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF07 Filter: 0-200Hz Date: 2025-03-25
Analysis: S Wave - Geo X

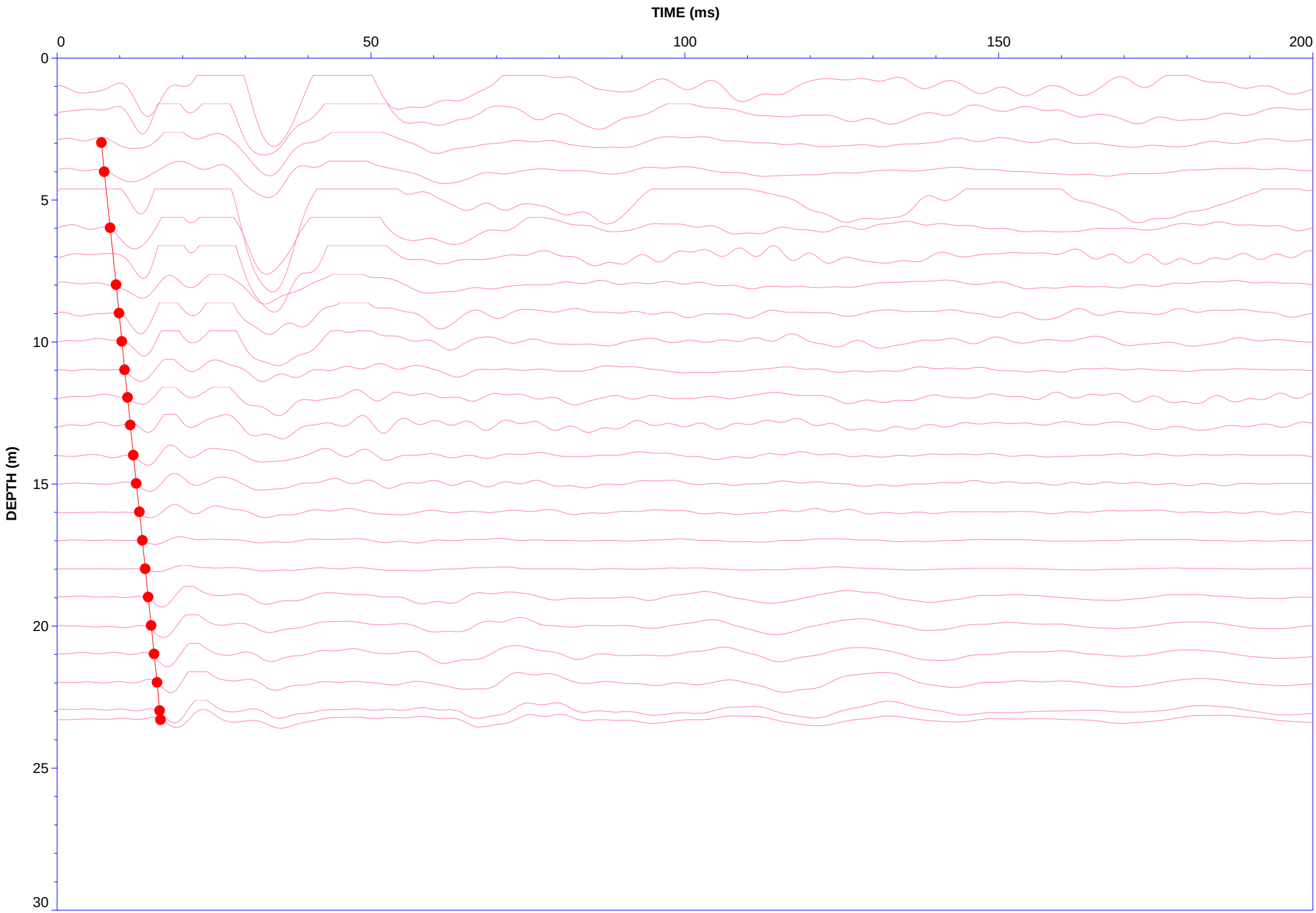


Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF07
Date:	2025-03-25
Seismic Source:	Plate
Source Offset (m):	2.00
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.98	2.78	3.42			
4.00	3.80	4.29	0.87	0.43	2019
5.98	5.78	6.12	1.82	0.96	1896
7.98	7.78	8.03	1.92	0.94	2033
8.98	8.78	9.01	0.97	0.47	2063
9.98	9.78	9.98	0.98	0.46	2118
10.98	10.78	10.96	0.98	0.44	2225
11.95	11.75	11.92	0.96	0.45	2116
12.92	12.72	12.88	0.96	0.44	2170
13.98	13.78	13.92	1.05	0.49	2132
14.98	14.78	14.92	0.99	0.47	2104
15.98	15.78	15.91	0.99	0.50	1976
16.98	16.78	16.90	0.99	0.47	2105
17.98	17.78	17.89	0.99	0.44	2250
18.98	18.78	18.89	0.99	0.48	2067
19.98	19.78	19.88	1.00	0.47	2109
20.98	20.78	20.88	1.00	0.47	2112
21.98	21.78	21.87	1.00	0.45	2206
22.98	22.78	22.87	1.00	0.42	2365
23.30	23.10	23.19	0.32	0.14	2273

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF07 Filter: BP 0-200Hz Date: 2025-03-25
Analysis: P Wave - Geo Z



Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF07
Date:	2025-03-25

SCPTu POISSON'S RATIO RESULTS

Depth From (m)	Depth To (m)	Vs Interval Velocity (m/s)	Vp Interval Velocity (m/s)	Poisson's Ratio
2.78	3.80	421	2019	0.48
3.80	4.78	459	1896	0.47
4.78	5.78	470	1896	0.47
5.78	6.78	471	2033	0.47
6.78	7.78	478	2033	0.47
7.78	8.78	479	2063	0.47
8.78	9.78	484	2118	0.47
9.78	10.78	573	2225	0.47
10.78	11.75	600	2116	0.46
11.75	12.72	605	2170	0.46
12.72	13.78	620	2132	0.45
13.78	14.78	630	2104	0.45
14.78	15.78	632	1976	0.44
15.78	16.78	687	2105	0.44
16.78	17.78	631	2250	0.46
17.78	18.78	495	2067	0.47
18.78	19.78	558	2109	0.46
19.78	20.78	447	2112	0.48
20.78	21.78	344	2206	0.49
21.78	22.78	408	2365	0.49

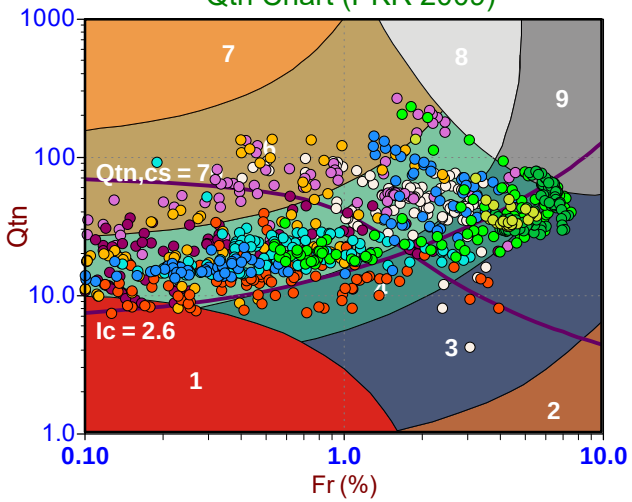
CONETEC

Thurber Engineering

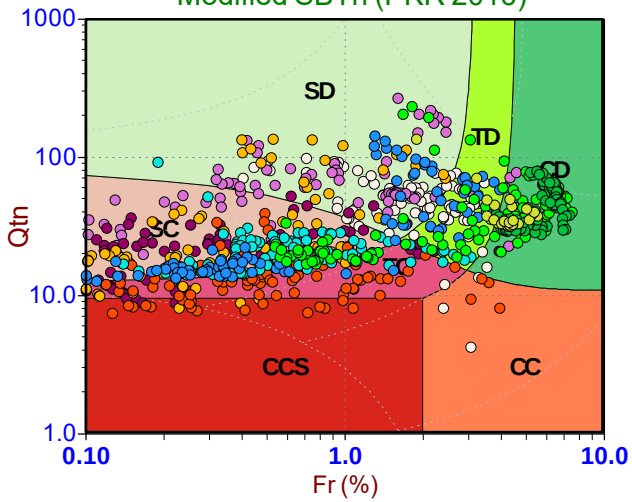
Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²

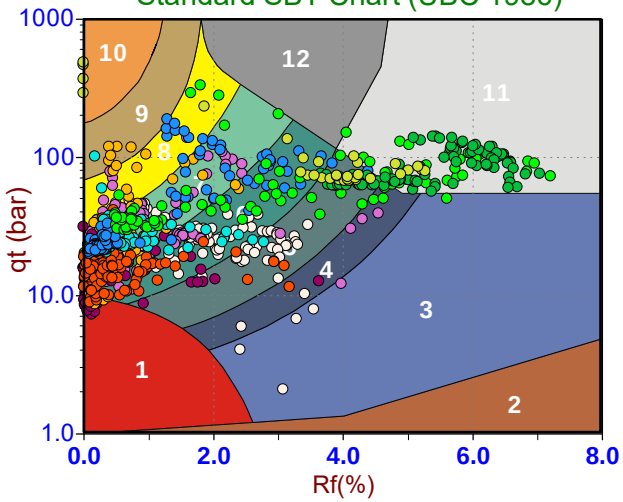
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- 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

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

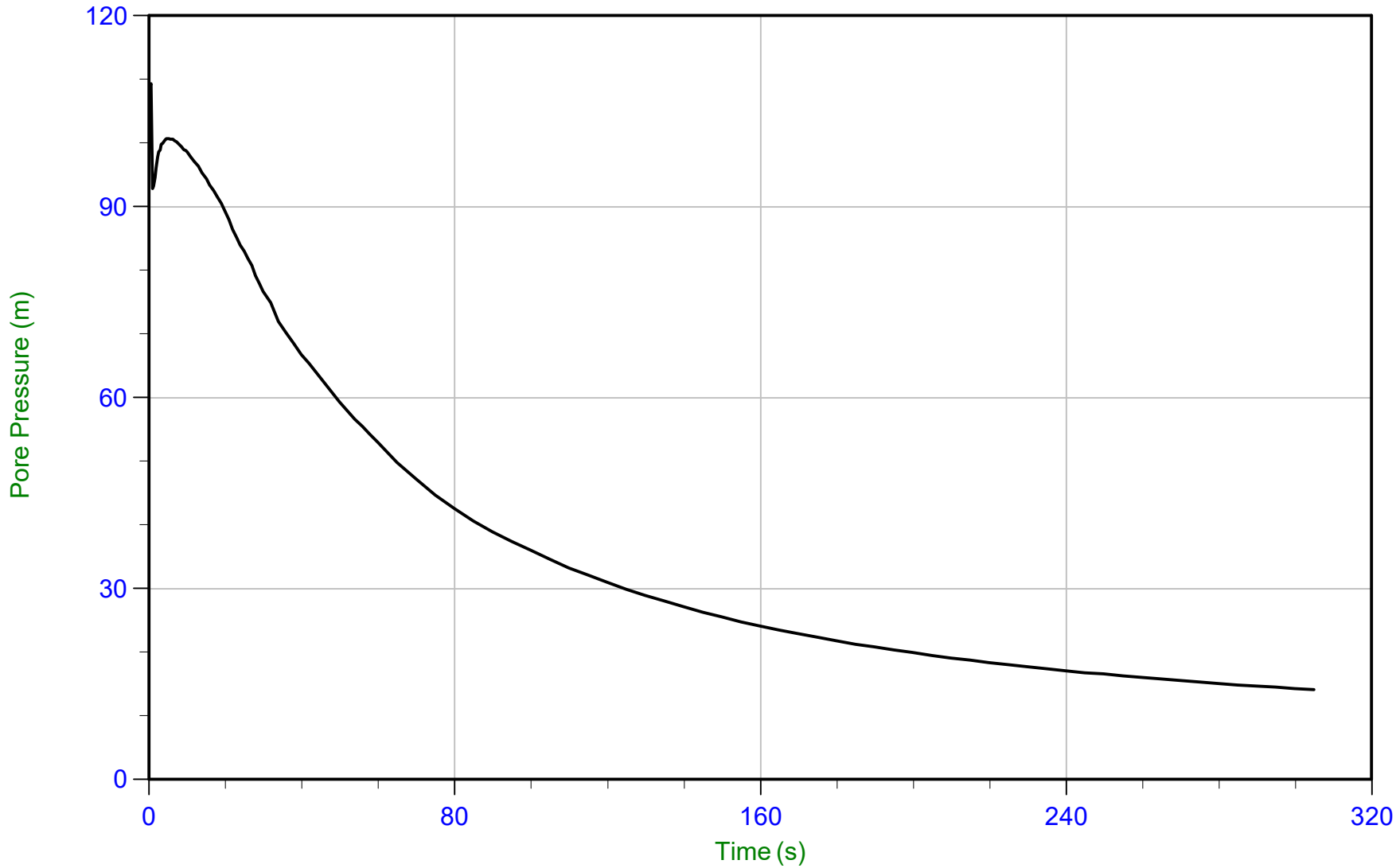
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	15	315	4.950							
SCPT25-HF01	25-05-29237_SP01	15	225	20.600	18.5		2.1				
SCPT25-HF07	25-05-29237_SP07	15	305	2.975							
SCPT25-HF07	25-05-29237_SP07	15	1020	4.000	3.8		0.2				
SCPT25-HF07	25-05-29237_SP07	15	300	5.975		5.8	0.2	37.5	100	18.7	3
SCPT25-HF07	25-05-29237_SP07	15	305	6.975		6.8	0.2	37.8	100	18.6	3
SCPT25-HF07	25-05-29237_SP07	15	340	9.975							
SCPT25-HF07	25-05-29237_SP07	15	210	10.975							
SCPT25-HF07	25-05-29237_SP07	15	320	15.975		15.8	0.2	97.8	100	7.2	3
SCPT25-HF07	25-05-29237_SP07	15	220	23.300							
SCPT25-HF08	25-05-29237_SP08	15	220	4.900							
SCPT25-HF08	25-05-29237_SP08	15	3150	5.100		3.7	1.4	891.7	100	0.8	3
SCPT25-HF08	25-05-29237_SP08	15	270	7.900							
SCPT25-HF08	25-05-29237_SP08	15	380	8.900							
SCPT25-HF08	25-05-29237_SP08	15	1060	10.025		8.6	1.4	45.6	100	15.4	3
SCPT25-HF08	25-05-29237_SP08	15	1000	12.900		11.5	1.4	395.7	100	1.8	3
SCPT25-HF08	25-05-29237_SP08	15	630	17.425							
SCPT25-HF19	25-05-29237_SP19	15	385	0.850							
SCPT25-HF19	25-05-29237_SP19	15	300	2.850	2.8		0.1				
SCPT25-HF19	25-05-29237_SP19	15	250	3.850							
SCPT25-HF19	25-05-29237_SP19	15	300	6.825							
SCPT25-HF19	25-05-29237_SP19	15	400	11.850	13.4		-1.6				
SCPT25-HF19	25-05-29237_SP19	15	300	12.850	14.3		-1.5				
SCPT25-HF19	25-05-29237_SP19	15	180	13.850	15.0		-1.2				

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 2.975 m / 9.760 ft
Duration: 305.0 s

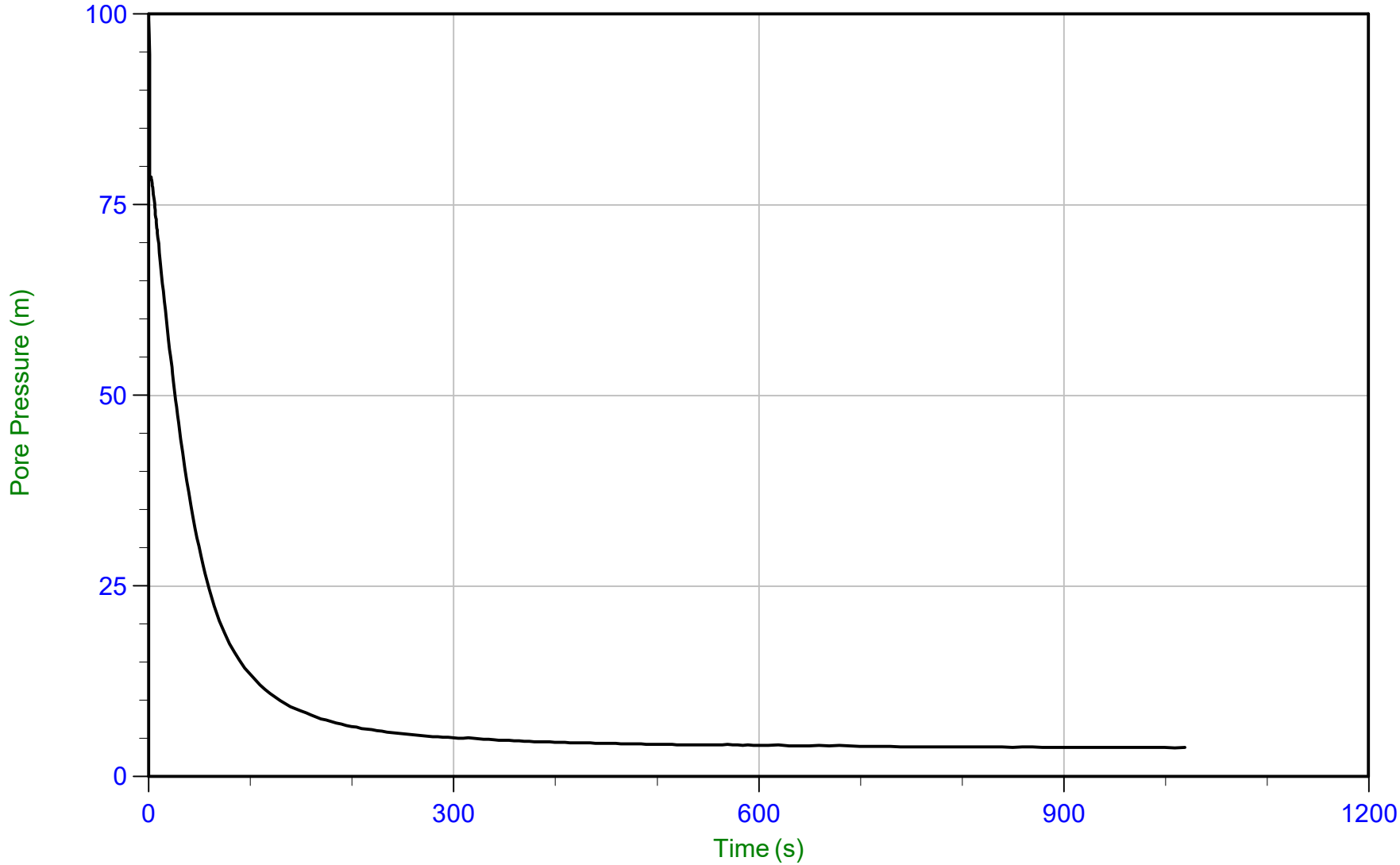
u Min: 14.1 m
u Max: 109.3 m
u Final: 14.1 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 4.000 m / 13.123 ft
Duration: 1020.0 s

u Min: 3.8 m
u Max: 102.7 m
u Final: 3.8 m

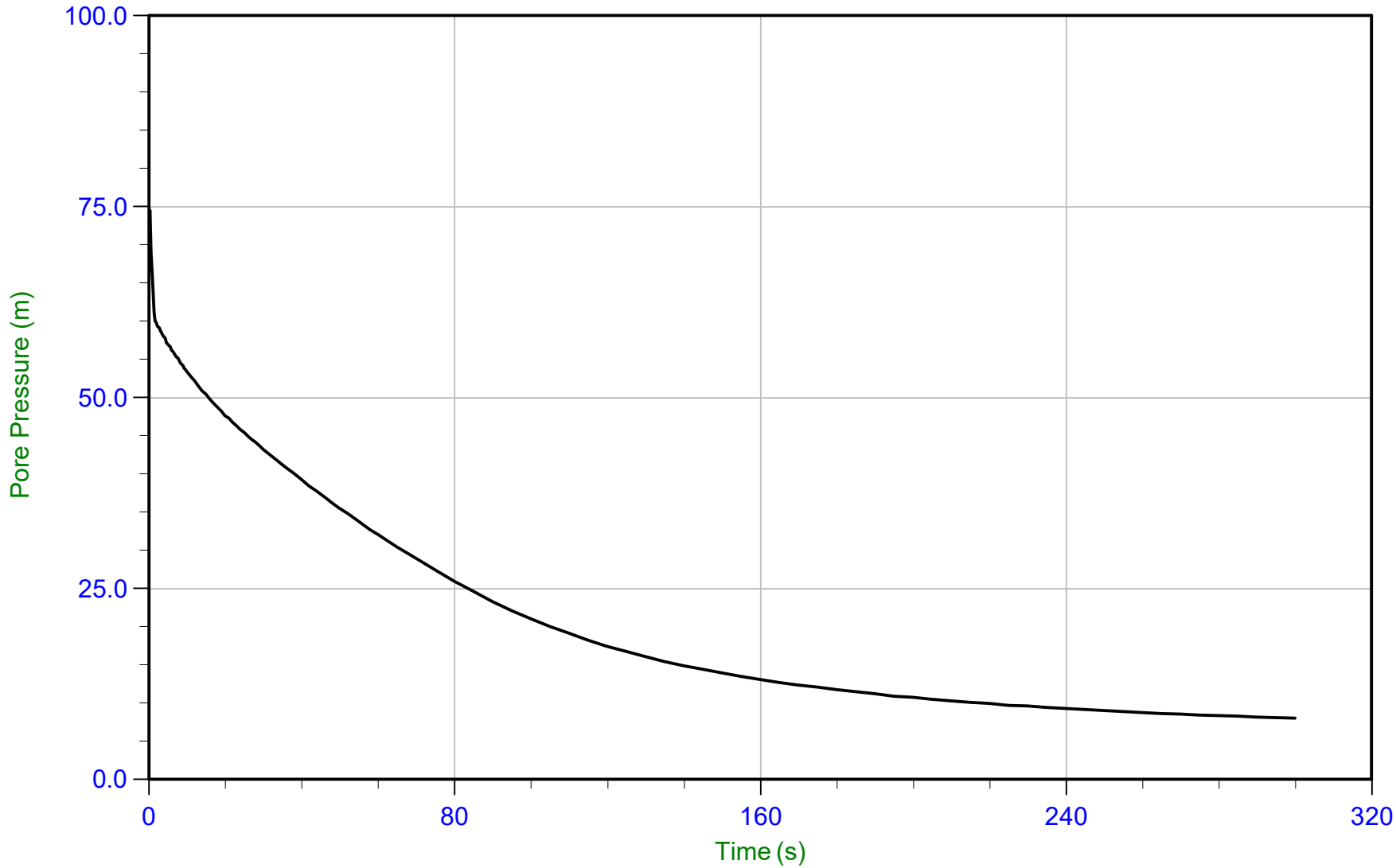
WT: 0.2 m / 0.7 ft
Ueq: 3.8 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 5.975 m / 19.603 ft
Duration: 300.0 s

u Min: 8.0 m
u Max: 74.5 m
u Final: 8.0 m

WT: 0.2 m / 0.7 ft
Ueq: 5.8 m
U(50): 40.13 m

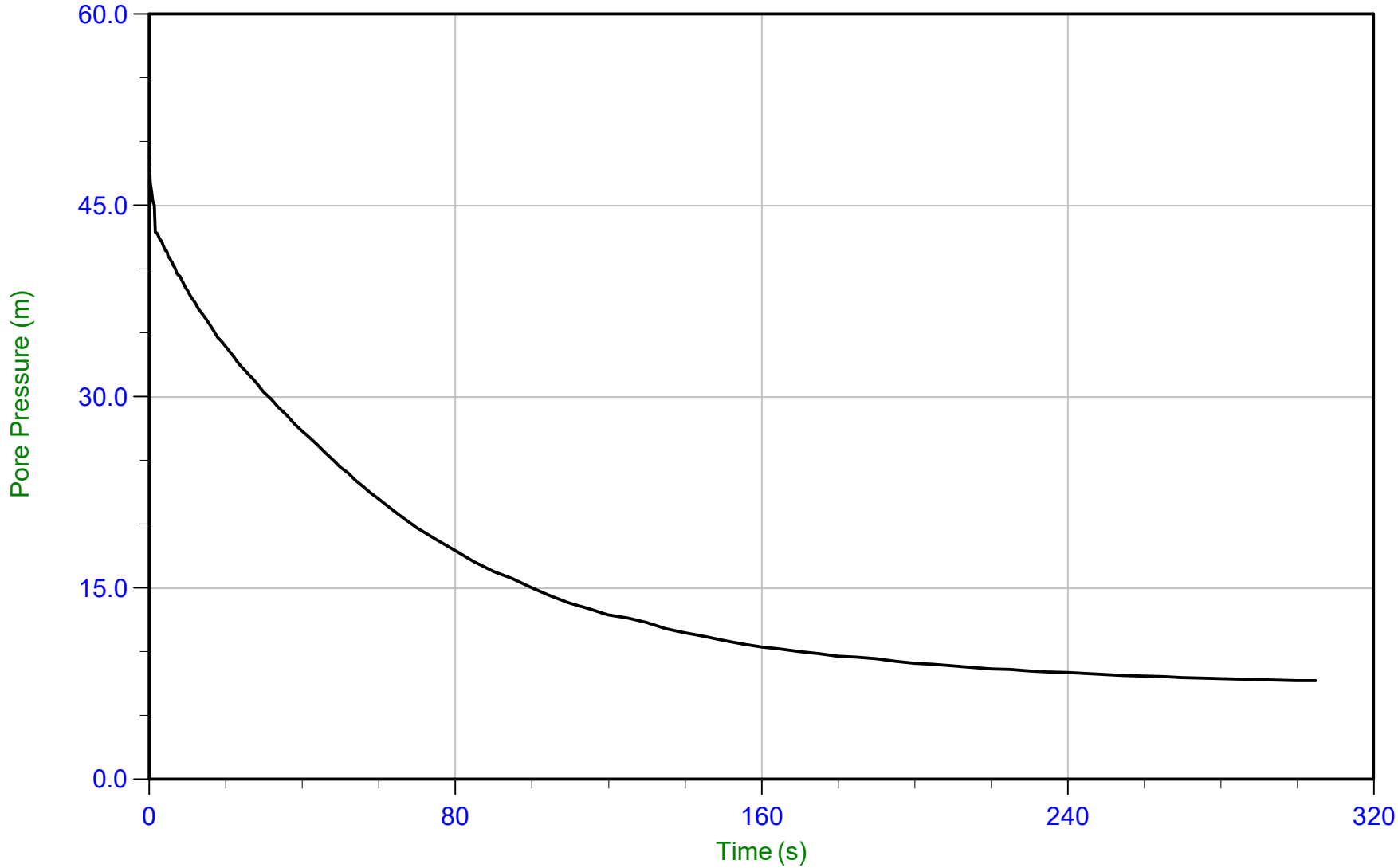
T(50): 37.5 s
Ir: 100
Ch: 18.7 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 6.975 m / 22.884 ft
Duration: 305.0 s

u Min: 7.7 m
u Max: 49.1 m
u Final: 7.7 m

WT: 0.2 m / 0.7 ft
Ueq: 6.8 m
U(50): 27.93 m

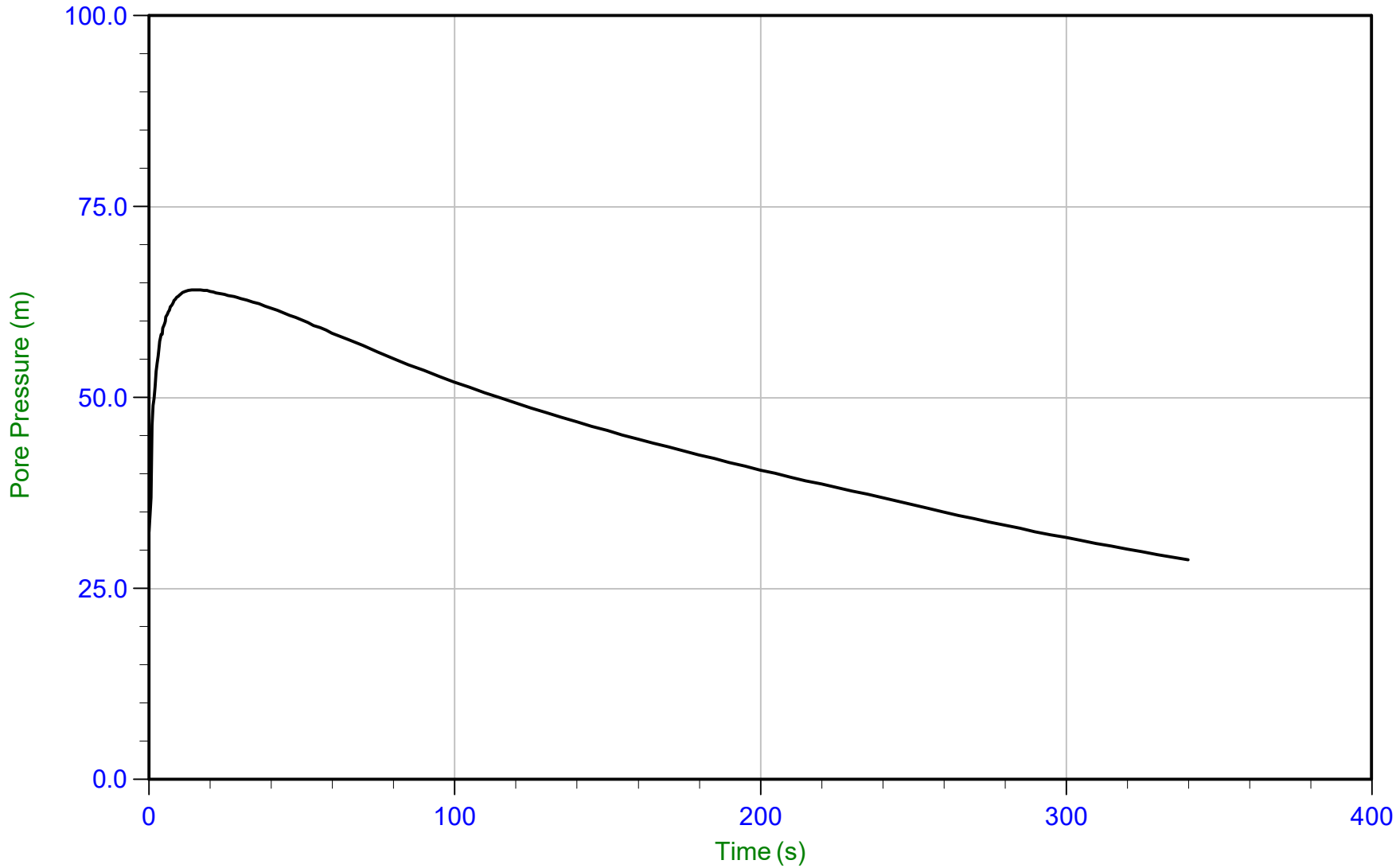
T(50): 37.8 s
Ir: 100
Ch: 18.6 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 9.975 m / 32.726 ft
Duration: 340.0 s

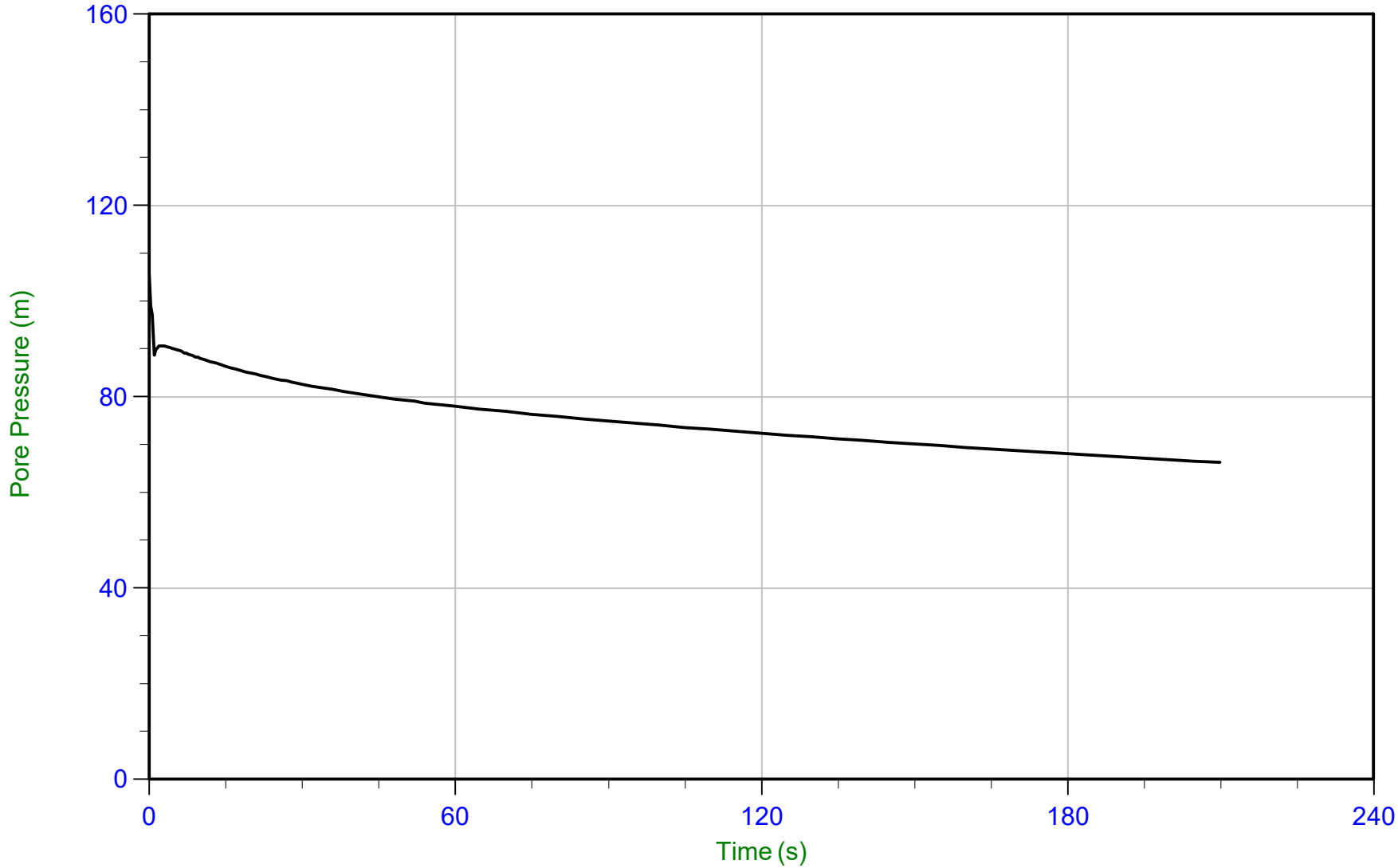
u Min: 28.7 m
u Max: 64.1 m
u Final: 28.7 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 10.975 m / 36.007 ft
Duration: 210.0 s

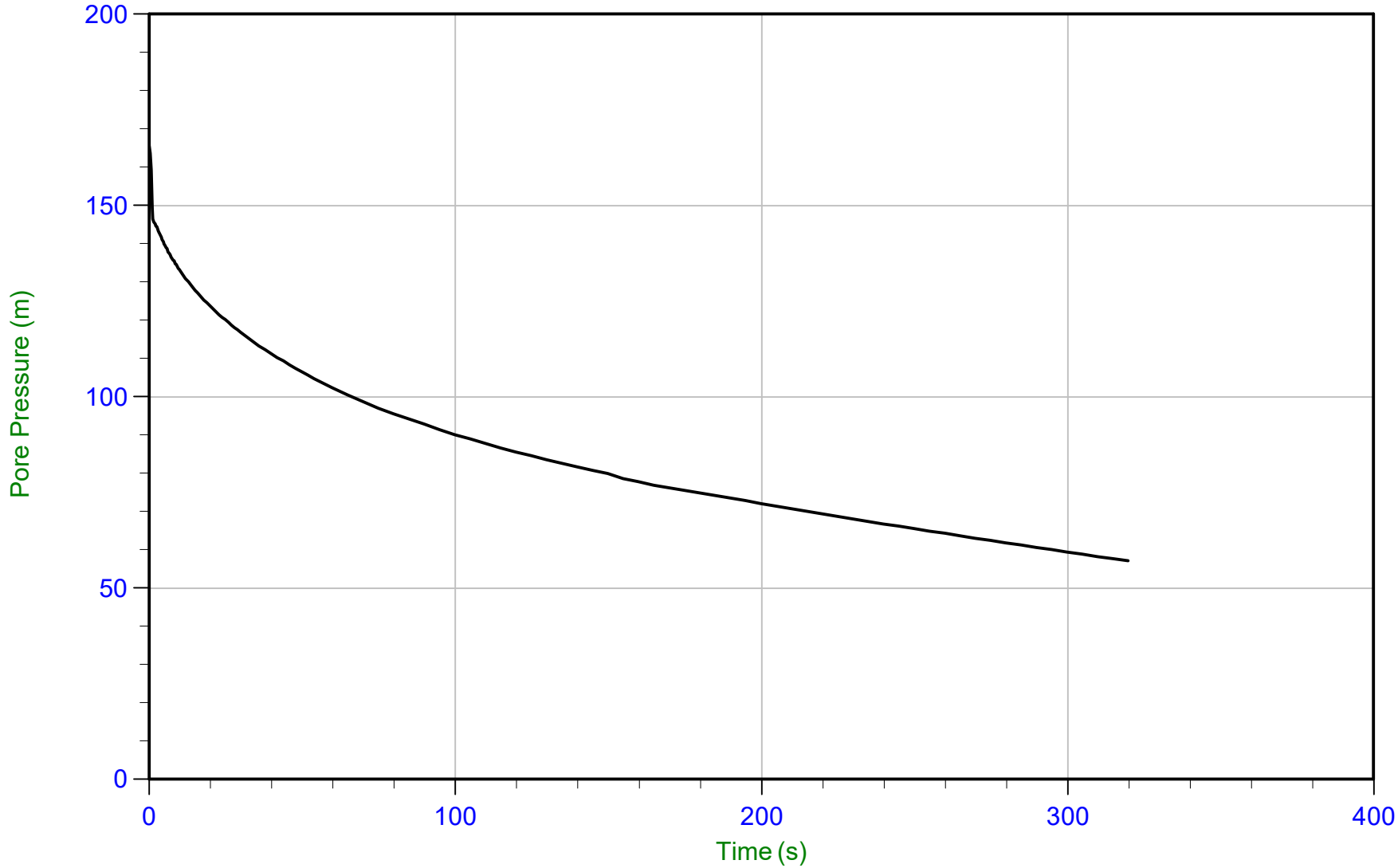
u Min: 66.2 m
u Max: 105.6 m
u Final: 66.2 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 15.975 m / 52.411 ft
Duration: 320.0 s

u Min: 57.1 m
u Max: 165.5 m
u Final: 57.1 m

WT: 0.2 m / 0.7 ft
Ueq: 15.8 m
U(50): 90.65 m

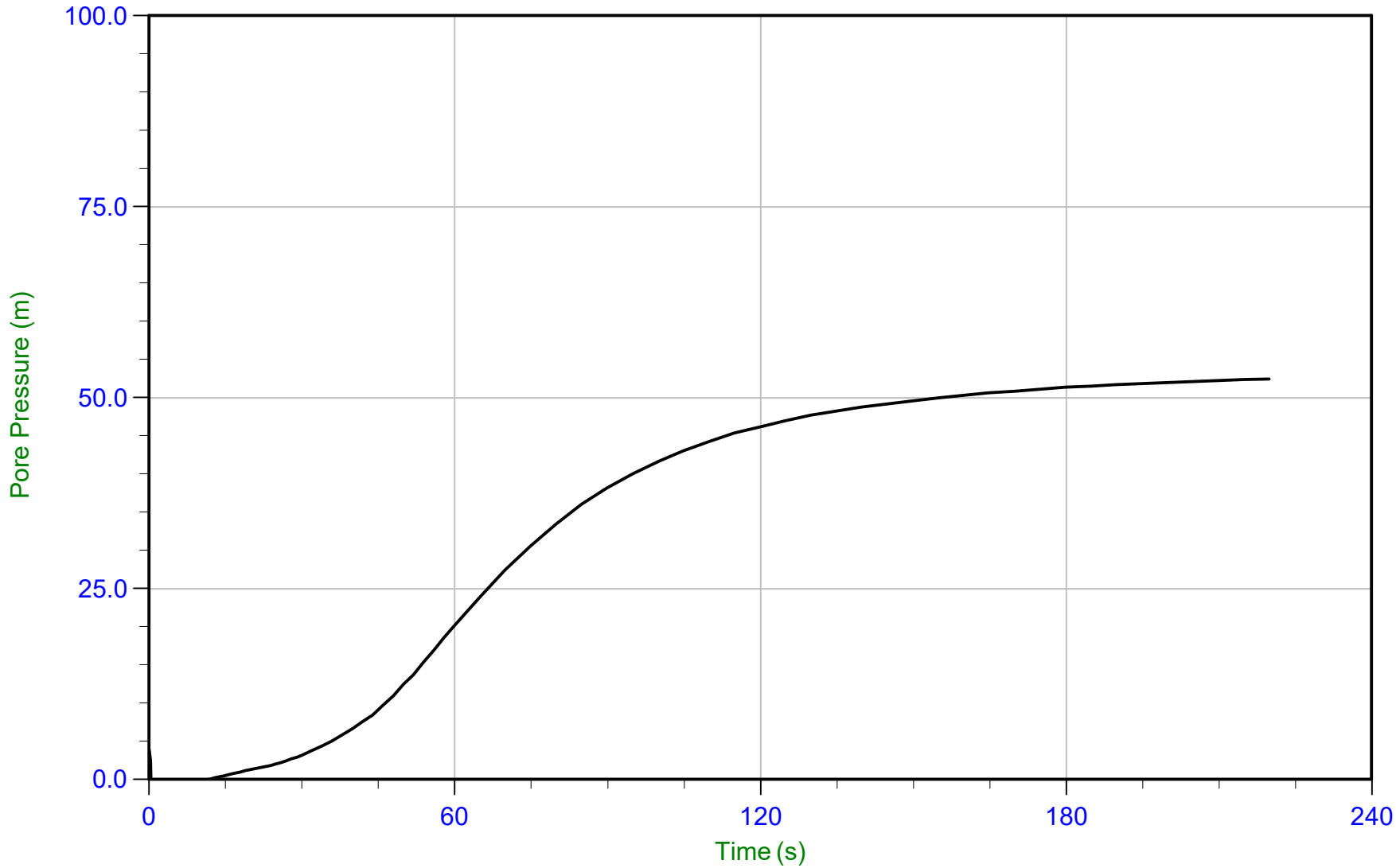
T(50): 97.8 s
Ir: 100
Ch: 7.2 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-25 11:33
Site: Bradford Bypass

Sounding: SCPT25-HF07
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP07.PPF2
Depth: 23.300 m / 76.443 ft
Duration: 220.0 s

u Min: -8.7 m
u Max: 52.4 m
u Final: 52.4 m

Seismic Cone Penetration Test
HF08

CONETEC

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	2025-03-25	948:T1000F10U35	15	2.1	20.600	4885865	609489	
SCPT25-HF07	25-05-29237_SP07	2025-03-25	948:T1000F10U35	15	0.2	23.300	4885920	609280	
SCPT25-HF08	25-05-29237_SP08	2025-03-31	765:T1500F15U35	15	1.4	17.425	4885664	609176	3
SCPT25-HF19	25-05-29237_SP19	2025-03-26	948:T1000F10U35	15	0.1	14.675	4886597	609121	
SCPT25-HF21	25-05-29237_SP21	2025-03-26	948:T1000F10U35	15	0.4	9.900	4886702	609081	
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	2025-03-27	948:T1000F10U35	15	1.3	12.725	4886562	608981	
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	2025-03-28	948:T1000F10U35	15	2.8	19.250	4886521	609045	
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	2025-03-27	948:T1000F10U35	15	2.4	18.050	4886530	609093	
SCPT25-HWY400-21	25-05-29237_SPHWY400-21	2025-03-26	948:T1000F10U35	15	1.1	22.575	4886558	609141	
SCPT25-HWY400-34	25-05-29237_SPHWY400-34	2025-03-28	948:T1000F10U35	15		2.850	4886072	609084	4, 5
SCPT25-HWY400-34B	25-05-29237_SPHWY400-34B	2025-03-28	765:T1500F15U35	15		2.925	4886079	609081	4, 5

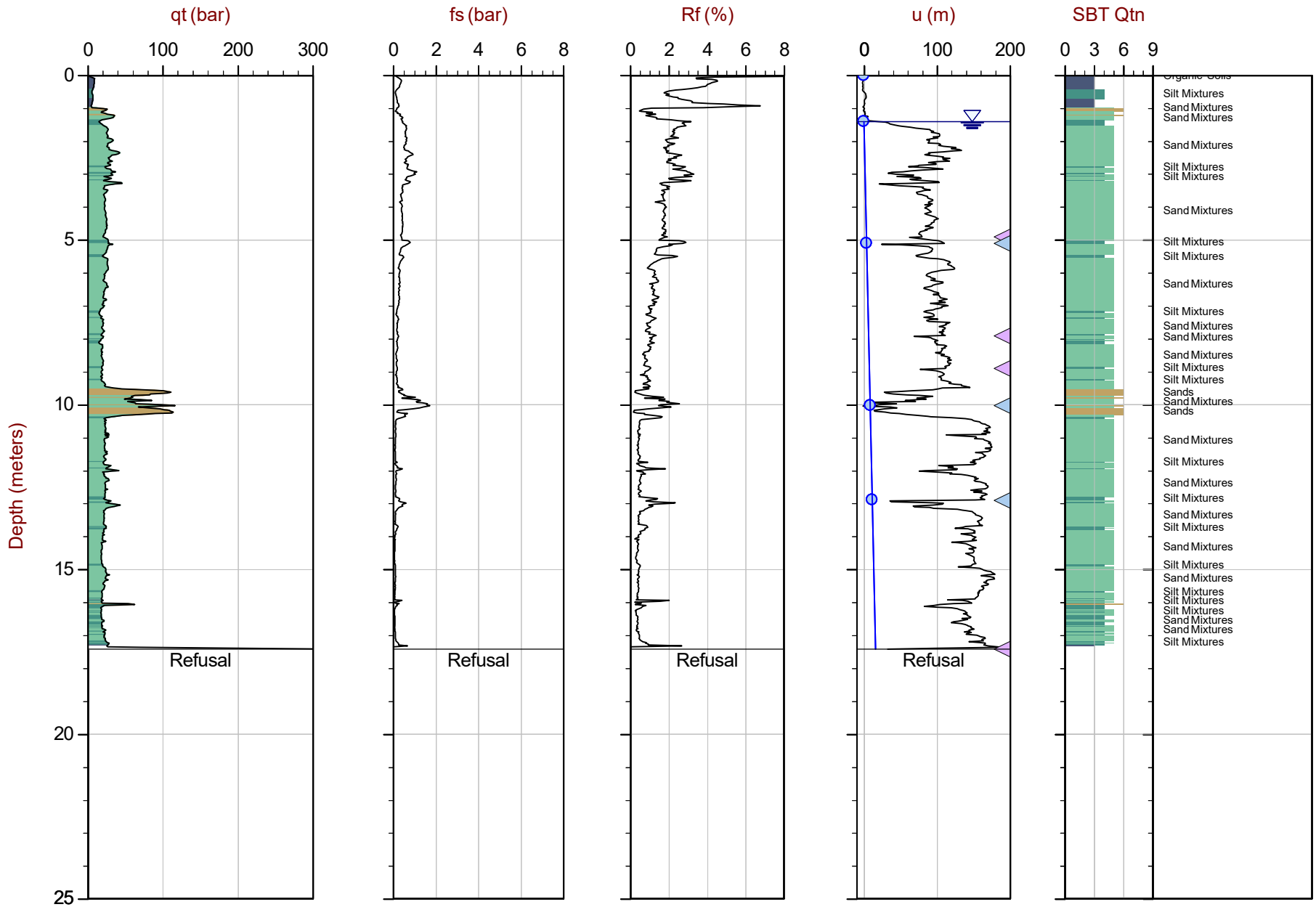
1. The assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device in datum WGS84/UTM Zone 17 North .
3. The assumed phreatic surface was based on the dynamic pore pressure response.
4. No clear phreatic surface detected due to shallow refusal.
5. No seismic data reported due to shallow refusal.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Max Depth: 17.425 m / 57.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885664m E: 609176m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

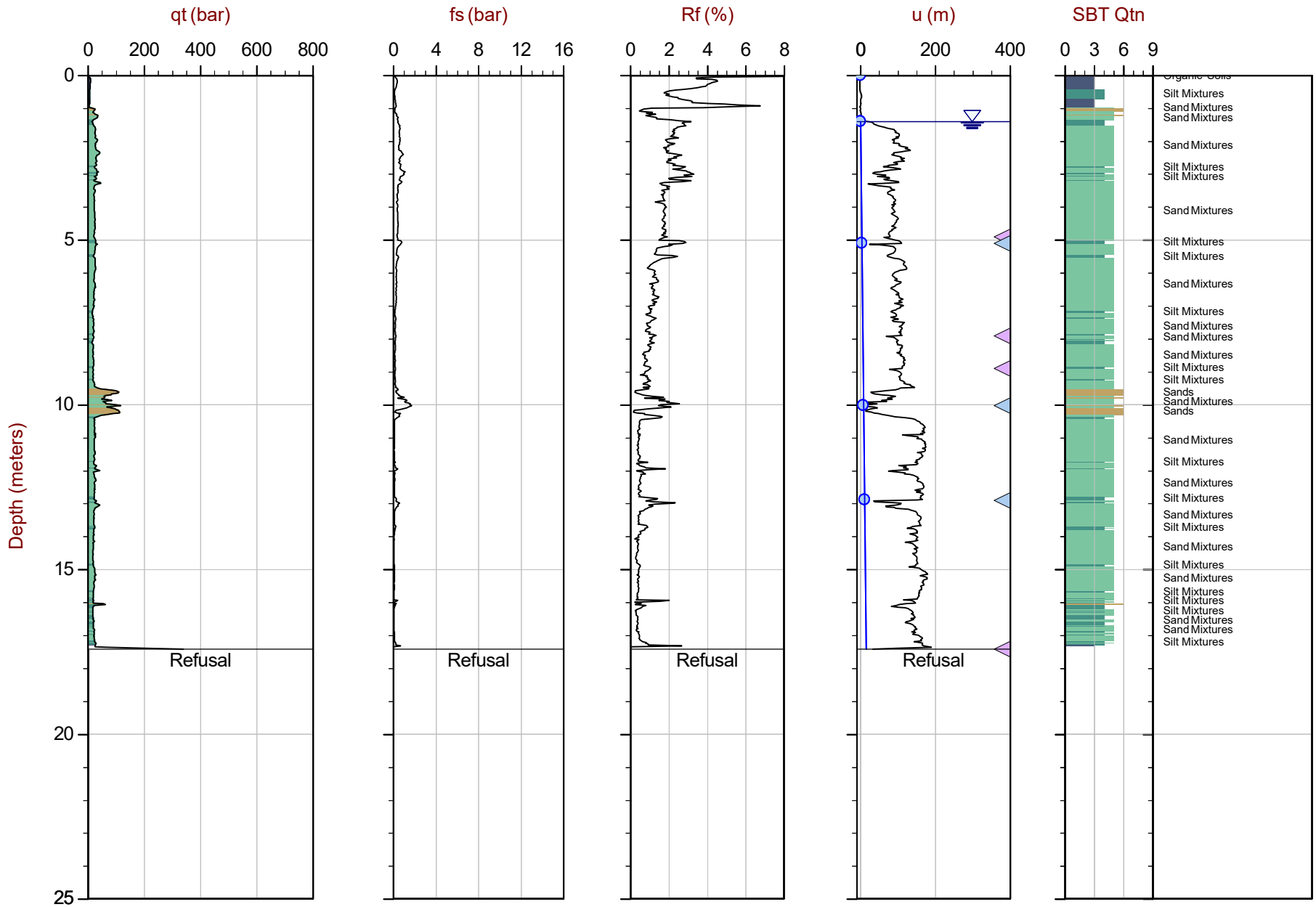
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Max Depth: 17.425 m / 57.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885664m E: 609176m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

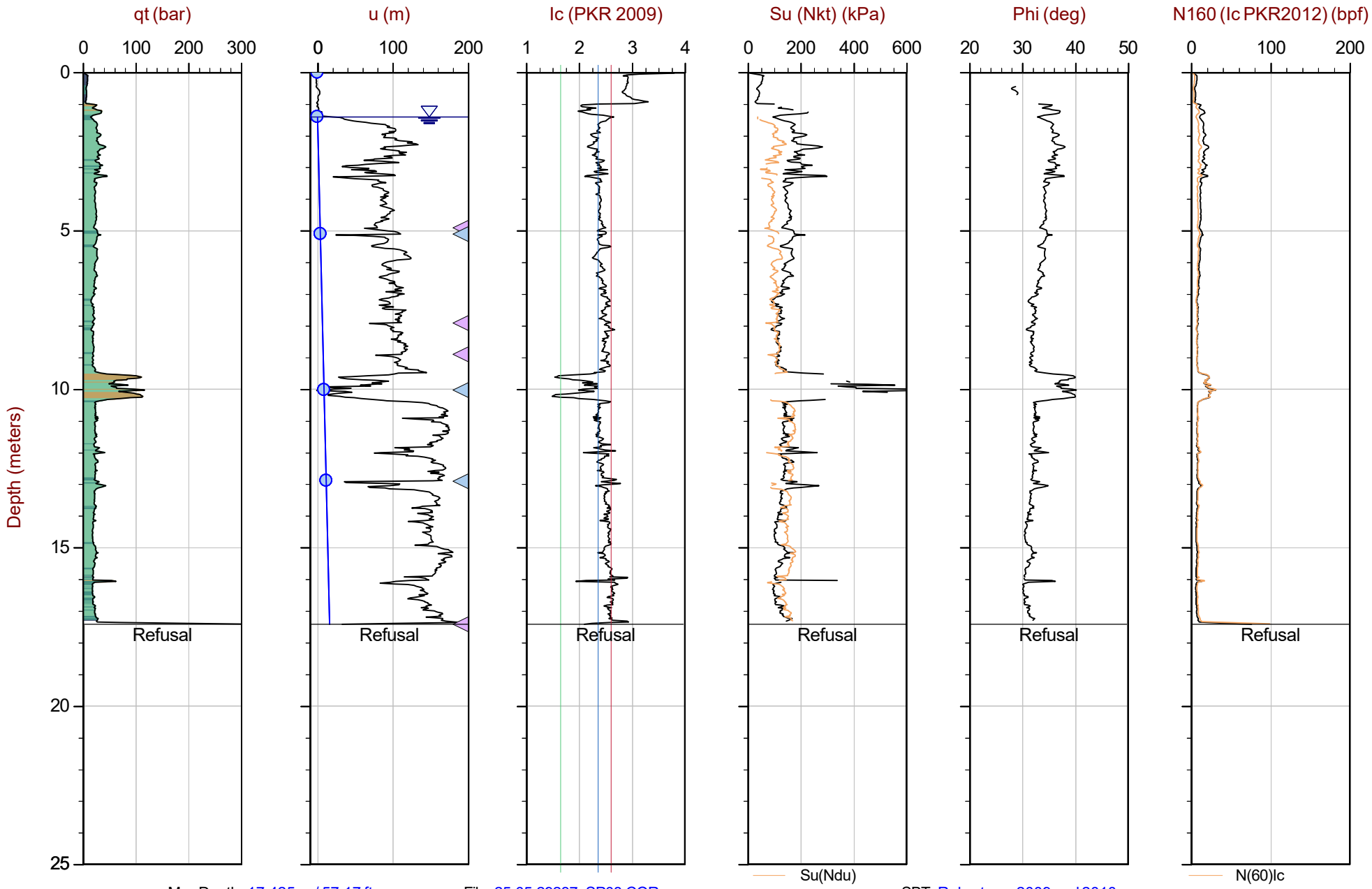
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Max Depth: 17.425 m / 57.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP08.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885664m E: 609176m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

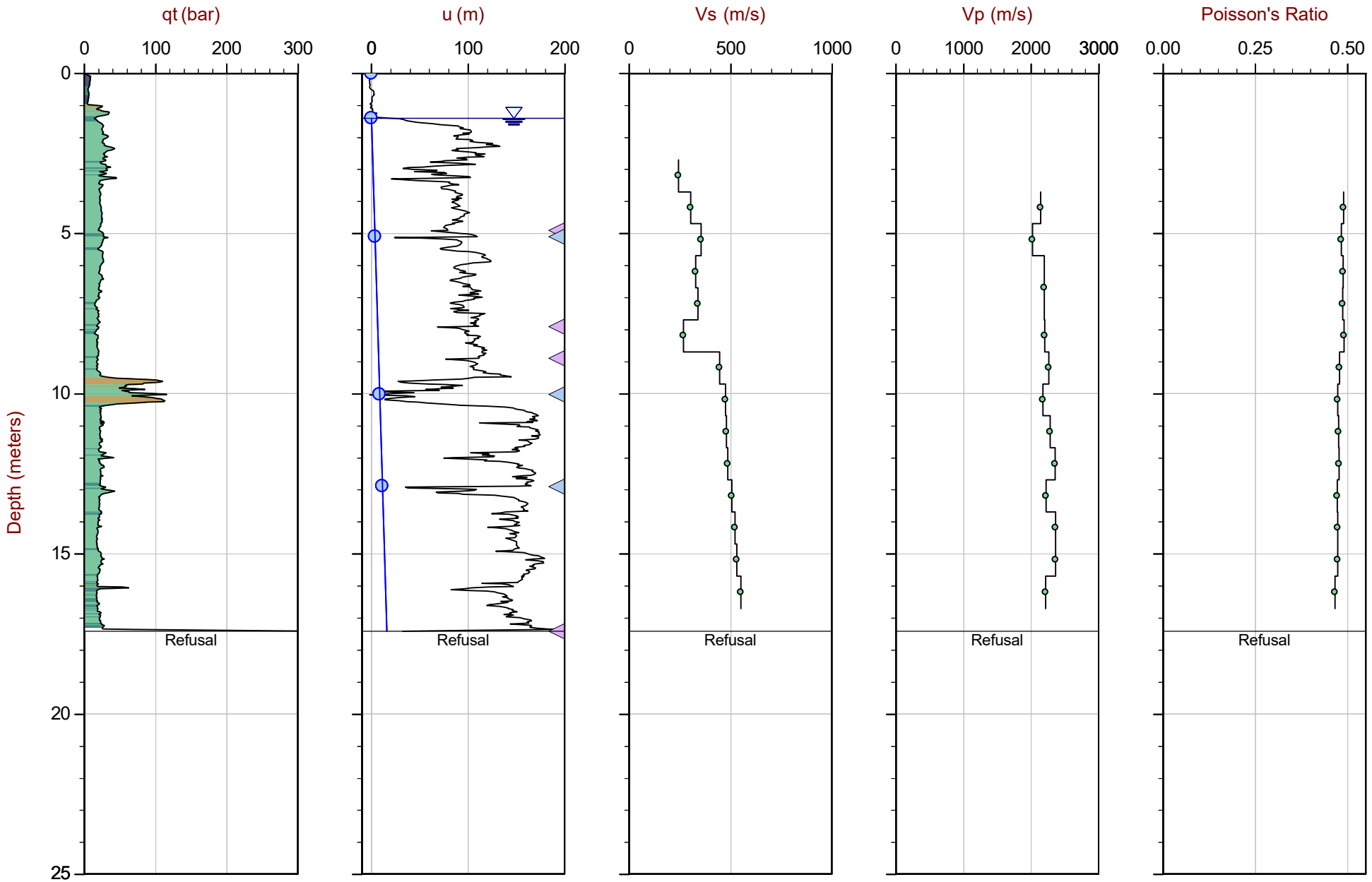
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Max Depth: 17.425 m / 57.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4885664m E: 609176m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

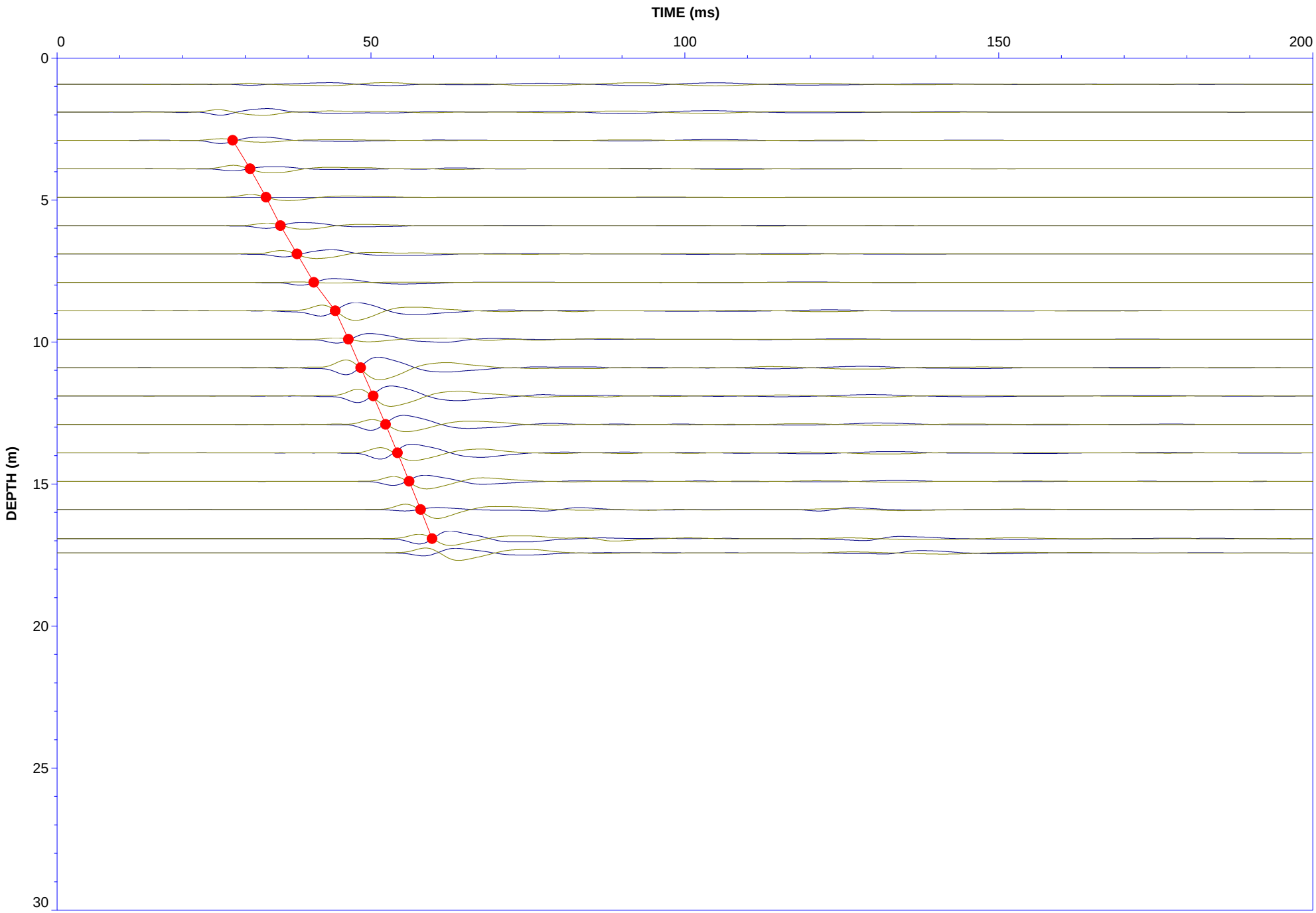
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF08
Date:	2025-03-31
Seismic Source:	Beam
Source Offset (m):	3.50
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.90	2.70	4.42			
3.90	3.70	5.09	0.67	2.76	244
4.90	4.70	5.86	0.77	2.53	304
5.90	5.70	6.69	0.83	2.33	357
6.90	6.70	7.56	0.87	2.64	329
7.90	7.70	8.46	0.90	2.65	340
8.90	8.70	9.38	0.92	3.43	268
9.90	9.70	10.31	0.93	2.08	449
10.90	10.70	11.26	0.95	1.98	477
11.90	11.70	12.21	0.95	1.98	481
12.90	12.70	13.17	0.96	1.97	487
13.90	13.70	14.14	0.97	1.91	508
14.90	14.70	15.11	0.97	1.85	524
15.90	15.70	16.09	0.97	1.83	532
16.92	16.72	17.08	1.00	1.80	553

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF08 Filter: 0-200Hz Date: 2025-03-31
Analysis: S Wave - Geo X

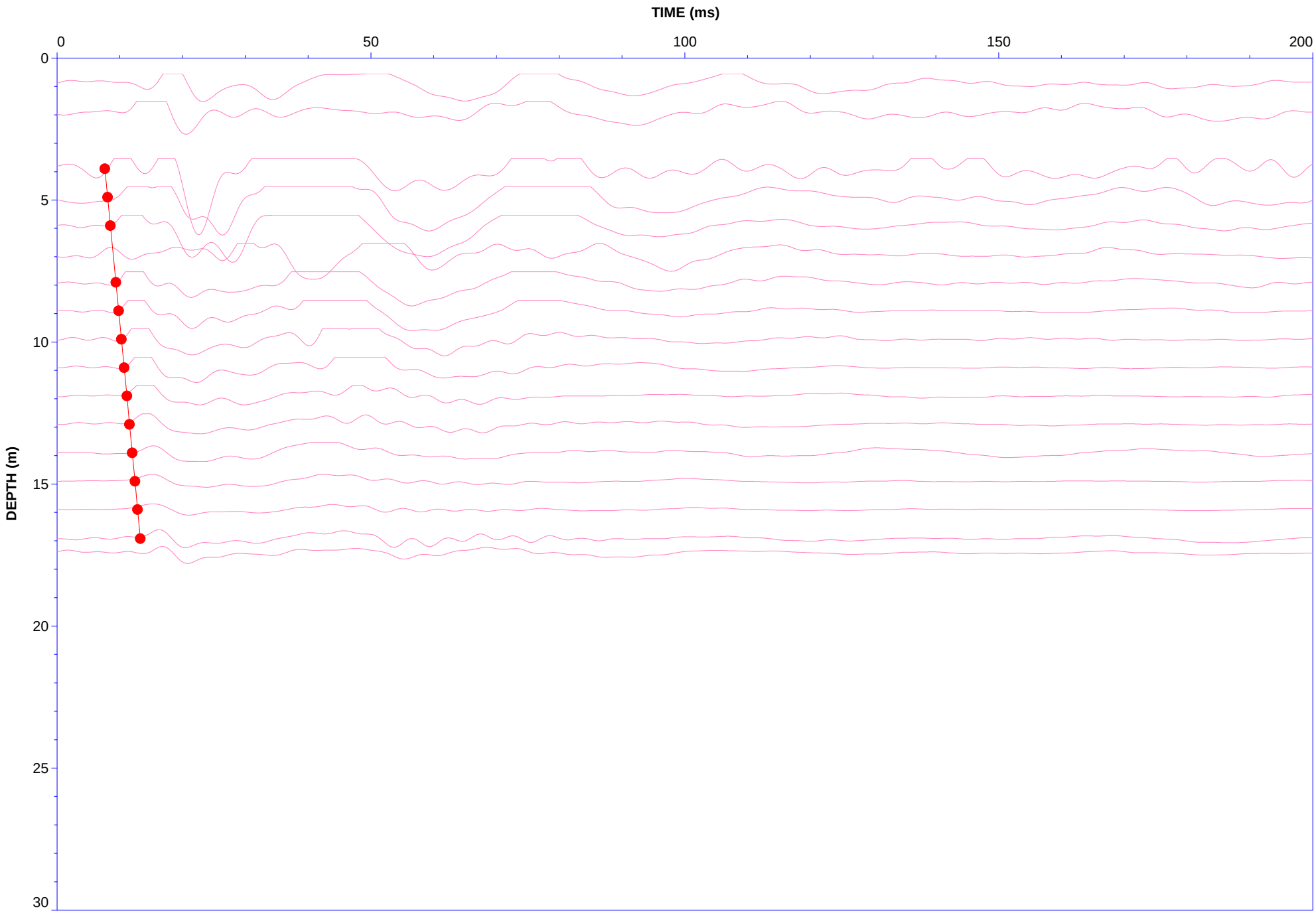


Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF08
Date:	2025-03-31
Seismic Source:	Plate
Source Offset (m):	2.00
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.90	3.70	4.21			
4.90	4.70	5.11	0.90	0.42	2145
5.90	5.70	6.04	0.93	0.46	2023
7.90	7.70	7.96	1.92	0.87	2198
8.90	8.70	8.93	0.97	0.44	2204
9.90	9.70	9.90	0.98	0.43	2269
10.90	10.70	10.89	0.98	0.45	2180
11.90	11.70	11.87	0.99	0.43	2287
12.90	12.70	12.86	0.99	0.42	2359
13.90	13.70	13.85	0.99	0.44	2225
14.90	14.70	14.84	0.99	0.42	2367
15.90	15.70	15.83	0.99	0.42	2370
16.92	16.72	16.84	1.01	0.46	2218

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF08 Filter: BP 0-200Hz Date: 2025-03-31
Analysis: P Wave - Geo Z



Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF08
Date:	2025-03-31

SCPTu POISSON'S RATIO RESULTS

Depth From (m)	Depth To (m)	Vs Interval Velocity (m/s)	Vp Interval Velocity (m/s)	Poisson's Ratio
3.70	4.70	304	2145	0.49
4.70	5.70	357	2023	0.48
5.70	6.70	329	2198	0.49
6.70	7.70	340	2198	0.49
7.70	8.70	268	2204	0.49
8.70	9.70	449	2269	0.48
9.70	10.70	477	2180	0.48
10.70	11.70	481	2287	0.48
11.70	12.70	487	2359	0.48
12.70	13.70	508	2225	0.47
13.70	14.70	524	2367	0.47
14.70	15.70	532	2370	0.47
15.70	16.72	553	2218	0.47

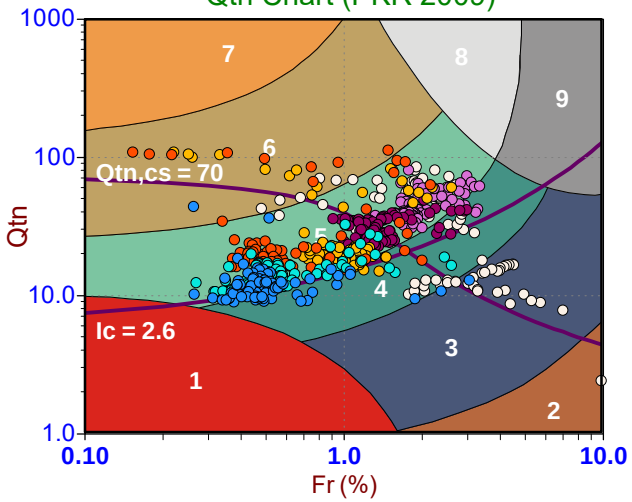
CONETEC

Thurber Engineering

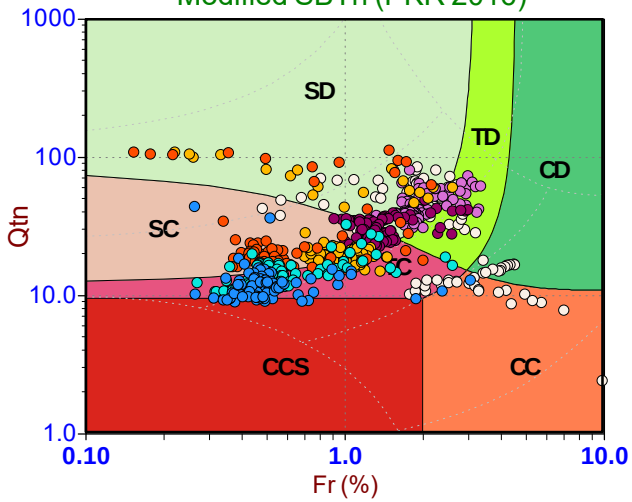
Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²

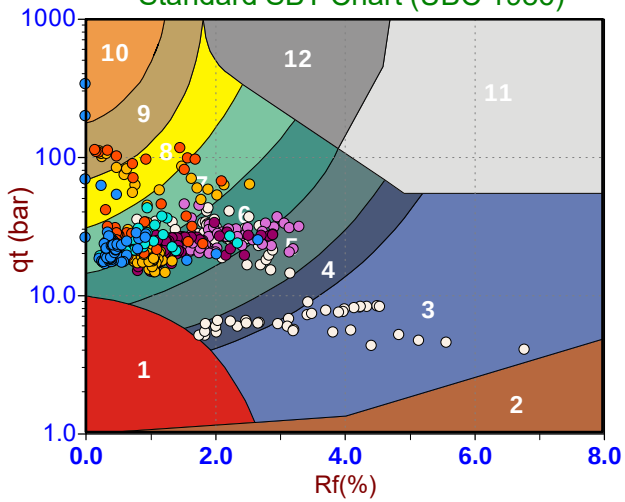
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- 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

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

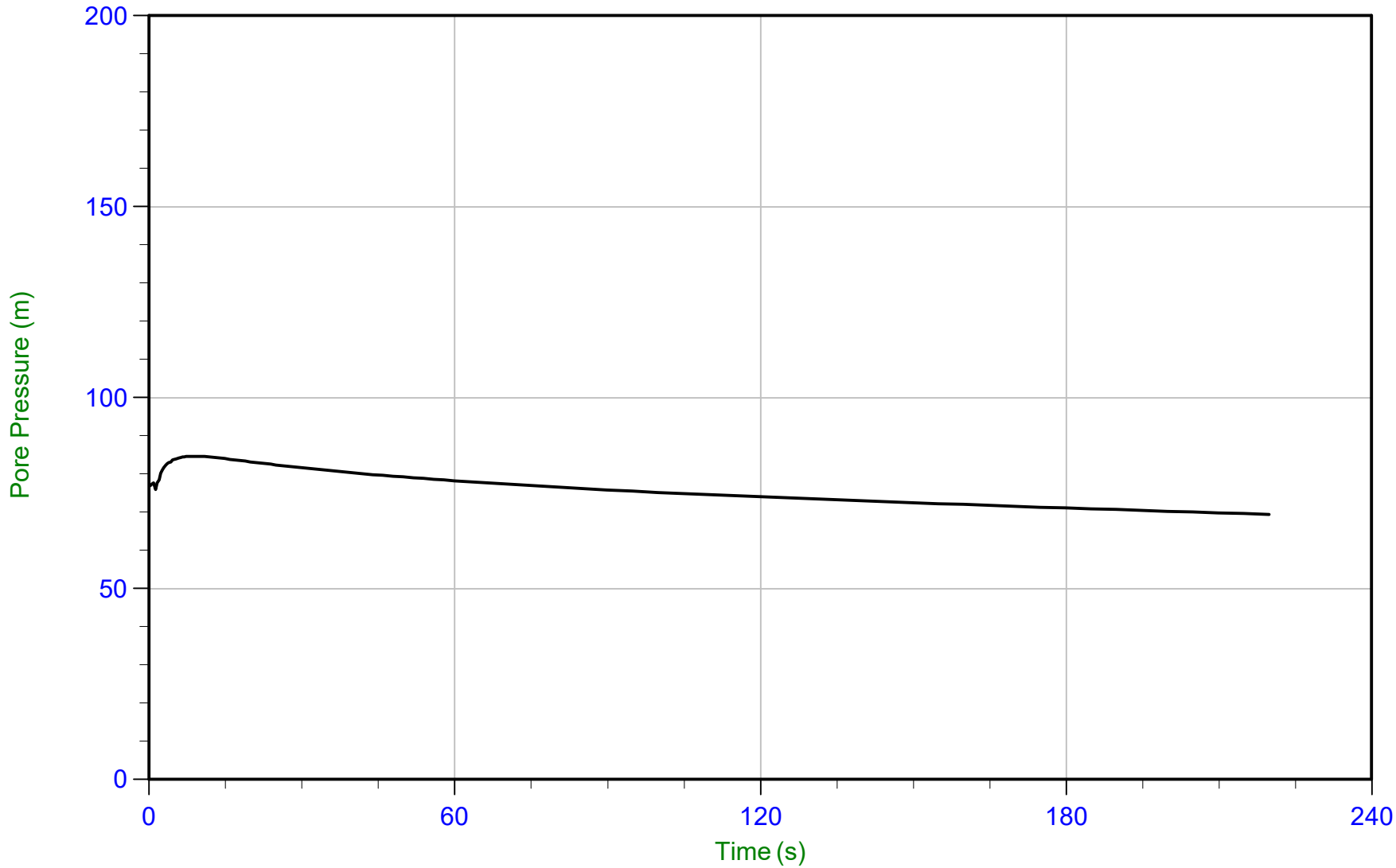
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	15	315	4.950							
SCPT25-HF01	25-05-29237_SP01	15	225	20.600	18.5		2.1				
SCPT25-HF07	25-05-29237_SP07	15	305	2.975							
SCPT25-HF07	25-05-29237_SP07	15	1020	4.000	3.8		0.2				
SCPT25-HF07	25-05-29237_SP07	15	300	5.975		5.8	0.2	37.5	100	18.7	3
SCPT25-HF07	25-05-29237_SP07	15	305	6.975		6.8	0.2	37.8	100	18.6	3
SCPT25-HF07	25-05-29237_SP07	15	340	9.975							
SCPT25-HF07	25-05-29237_SP07	15	210	10.975							
SCPT25-HF07	25-05-29237_SP07	15	320	15.975		15.8	0.2	97.8	100	7.2	3
SCPT25-HF07	25-05-29237_SP07	15	220	23.300							
SCPT25-HF08	25-05-29237_SP08	15	220	4.900							
SCPT25-HF08	25-05-29237_SP08	15	3150	5.100		3.7	1.4	891.7	100	0.8	3
SCPT25-HF08	25-05-29237_SP08	15	270	7.900							
SCPT25-HF08	25-05-29237_SP08	15	380	8.900							
SCPT25-HF08	25-05-29237_SP08	15	1060	10.025		8.6	1.4	45.6	100	15.4	3
SCPT25-HF08	25-05-29237_SP08	15	1000	12.900		11.5	1.4	395.7	100	1.8	3
SCPT25-HF08	25-05-29237_SP08	15	630	17.425							
SCPT25-HF19	25-05-29237_SP19	15	385	0.850							
SCPT25-HF19	25-05-29237_SP19	15	300	2.850	2.8		0.1				
SCPT25-HF19	25-05-29237_SP19	15	250	3.850							
SCPT25-HF19	25-05-29237_SP19	15	300	6.825							
SCPT25-HF19	25-05-29237_SP19	15	400	11.850	13.4		-1.6				
SCPT25-HF19	25-05-29237_SP19	15	300	12.850	14.3		-1.5				
SCPT25-HF19	25-05-29237_SP19	15	180	13.850	15.0		-1.2				

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 4.900 m / 16.076 ft
Duration: 220.0 s

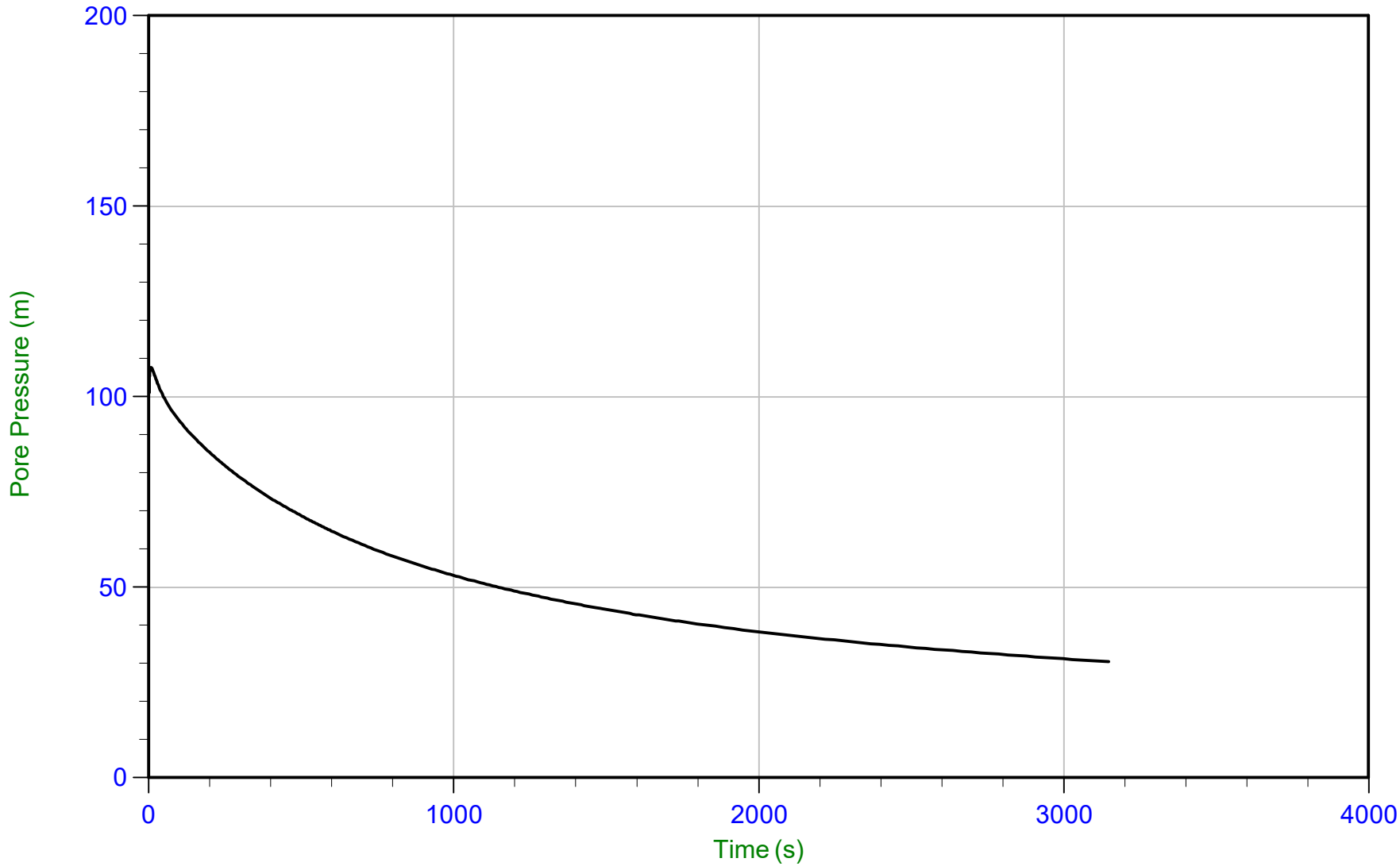
u Min: 69.5 m
u Max: 84.6 m
u Final: 69.5 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 5.100 m / 16.732 ft
Duration: 3150.0 s

u Min: 30.5 m
u Max: 107.7 m
u Final: 30.5 m

WT: 1.4 m / 4.6 ft
Ueq: 3.7 m
U(50): 55.71 m

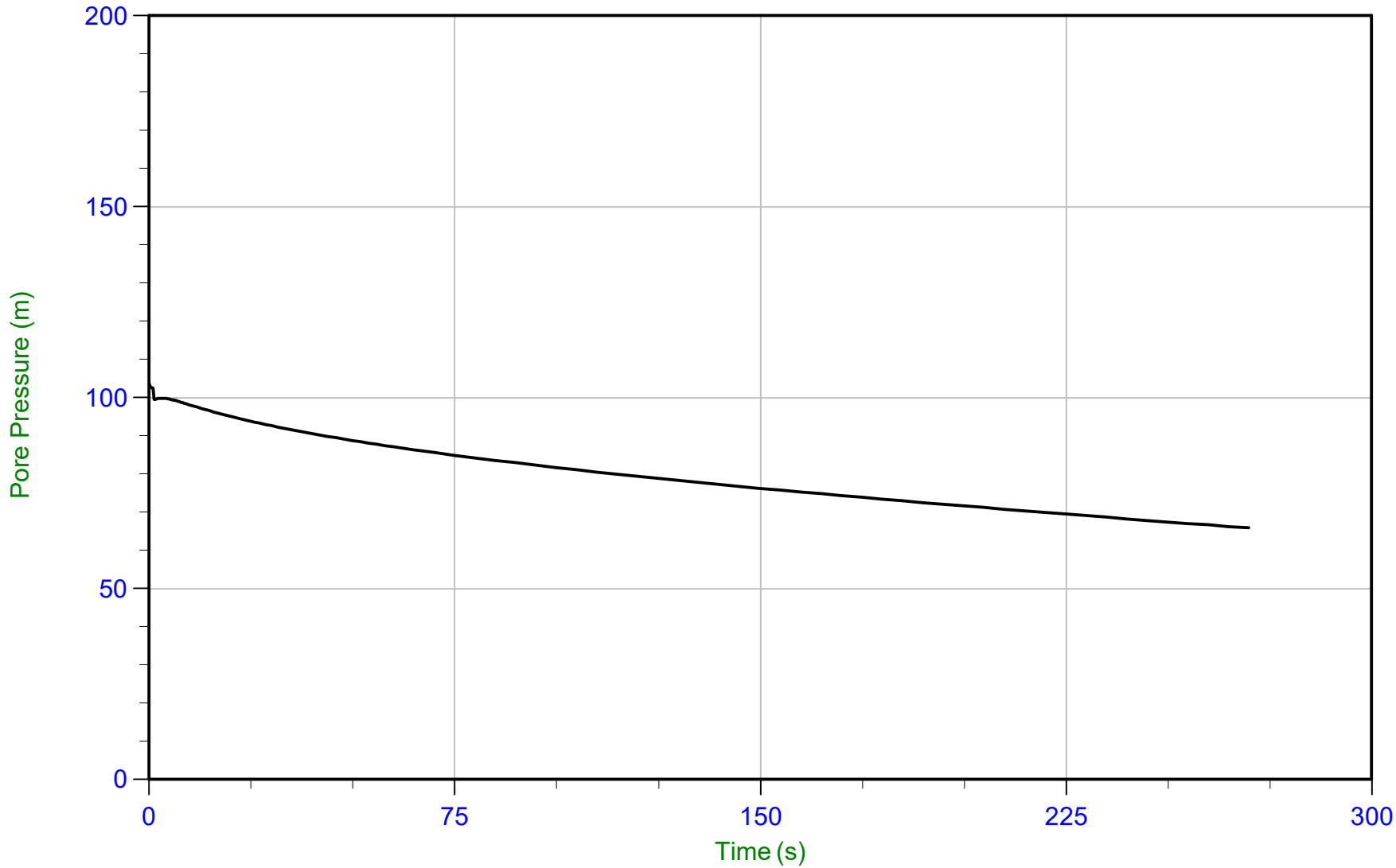
T(50): 891.7 s
Ir: 100
Ch: 0.8 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 7.900 m / 25.918 ft
Duration: 270.0 s

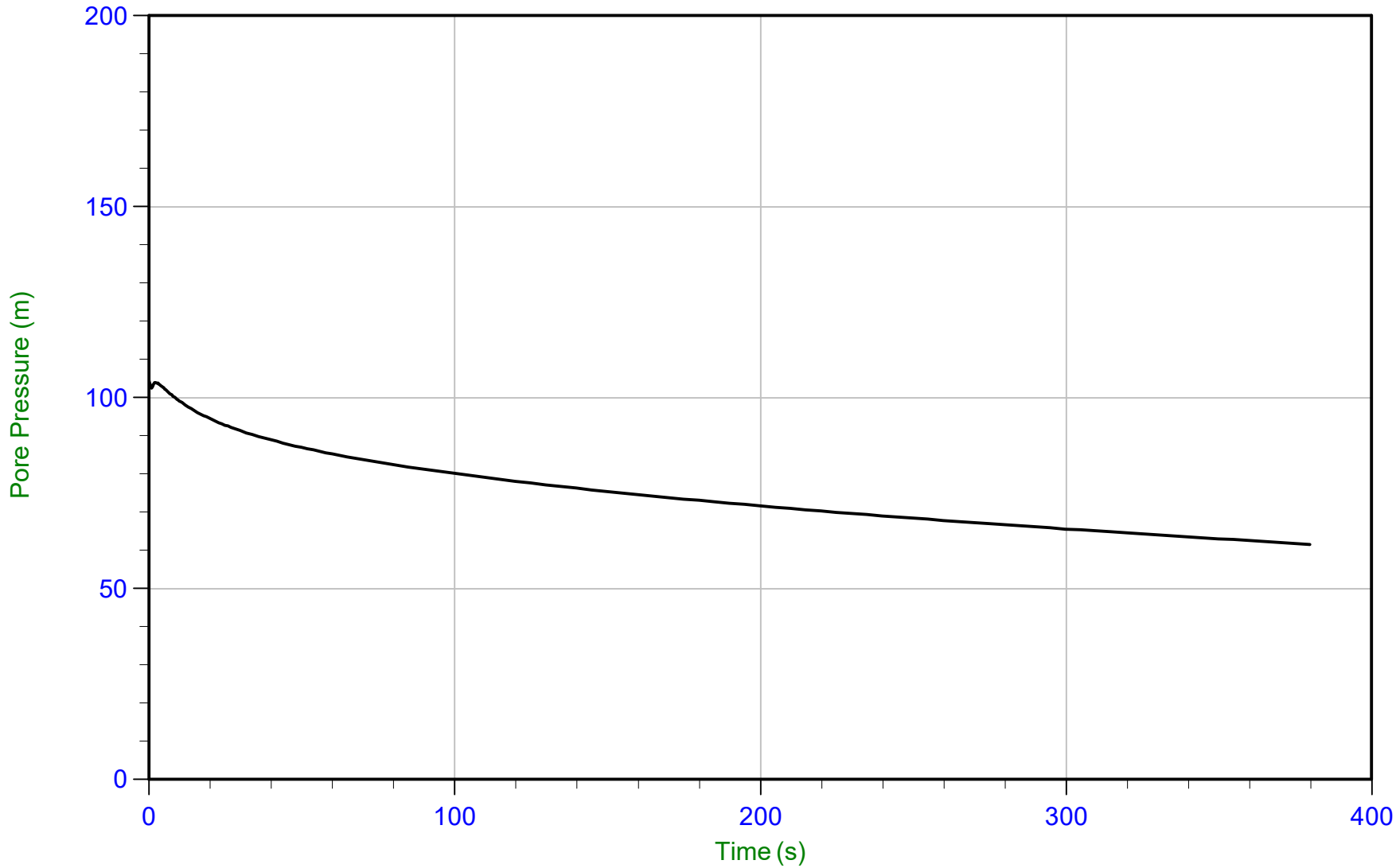
u Min: 65.9 m
u Max: 103.8 m
u Final: 65.9 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 8.900 m / 29.199 ft
Duration: 380.0 s

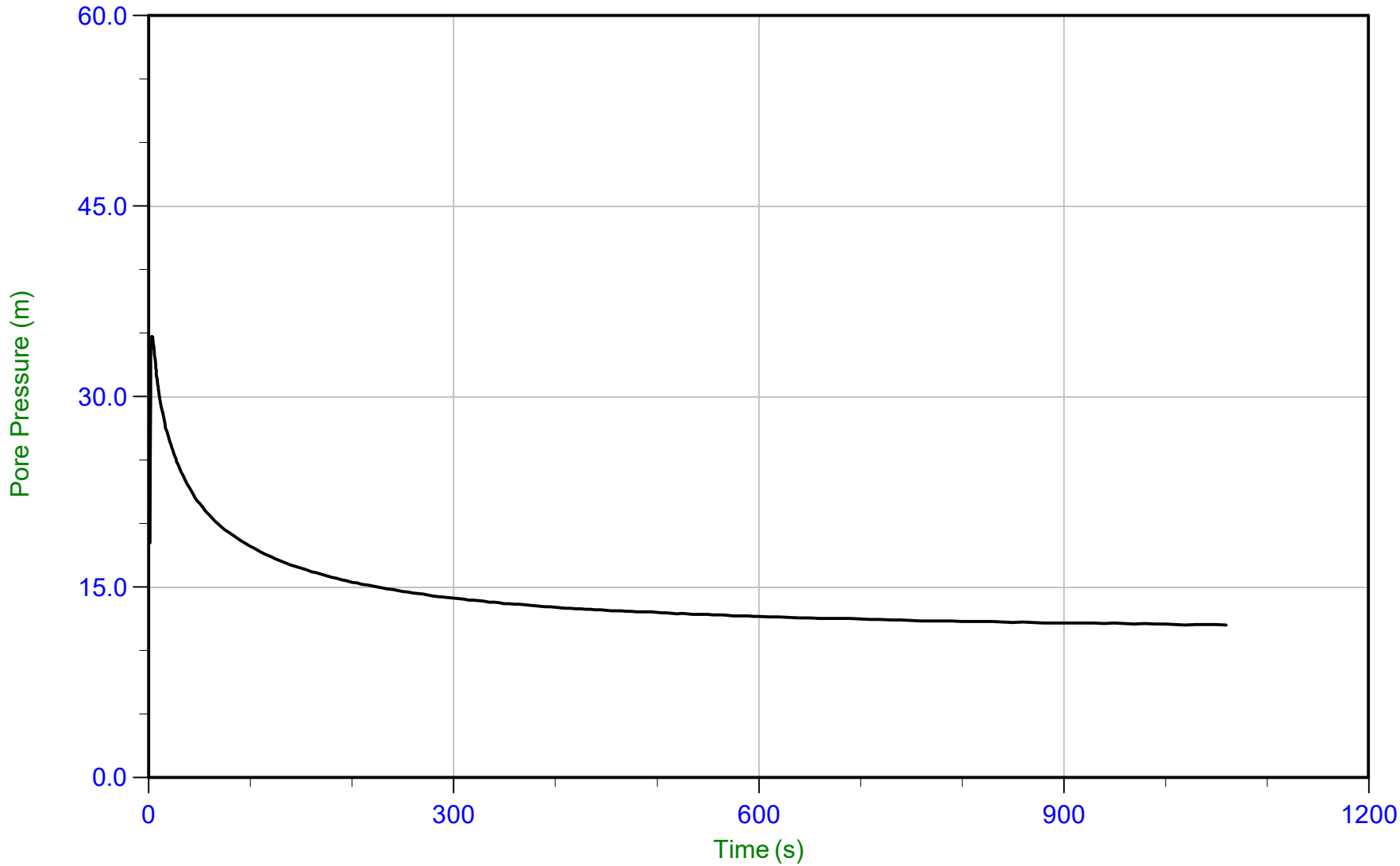
u Min: 61.6 m
u Max: 104.5 m
u Final: 61.6 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 10.025 m / 32.890 ft
Duration: 1060.0 s

u Min: 12.0 m
u Max: 34.8 m
u Final: 12.0 m

WT: 1.4 m / 4.6 ft
Ueq: 8.6 m
U(50): 21.69 m

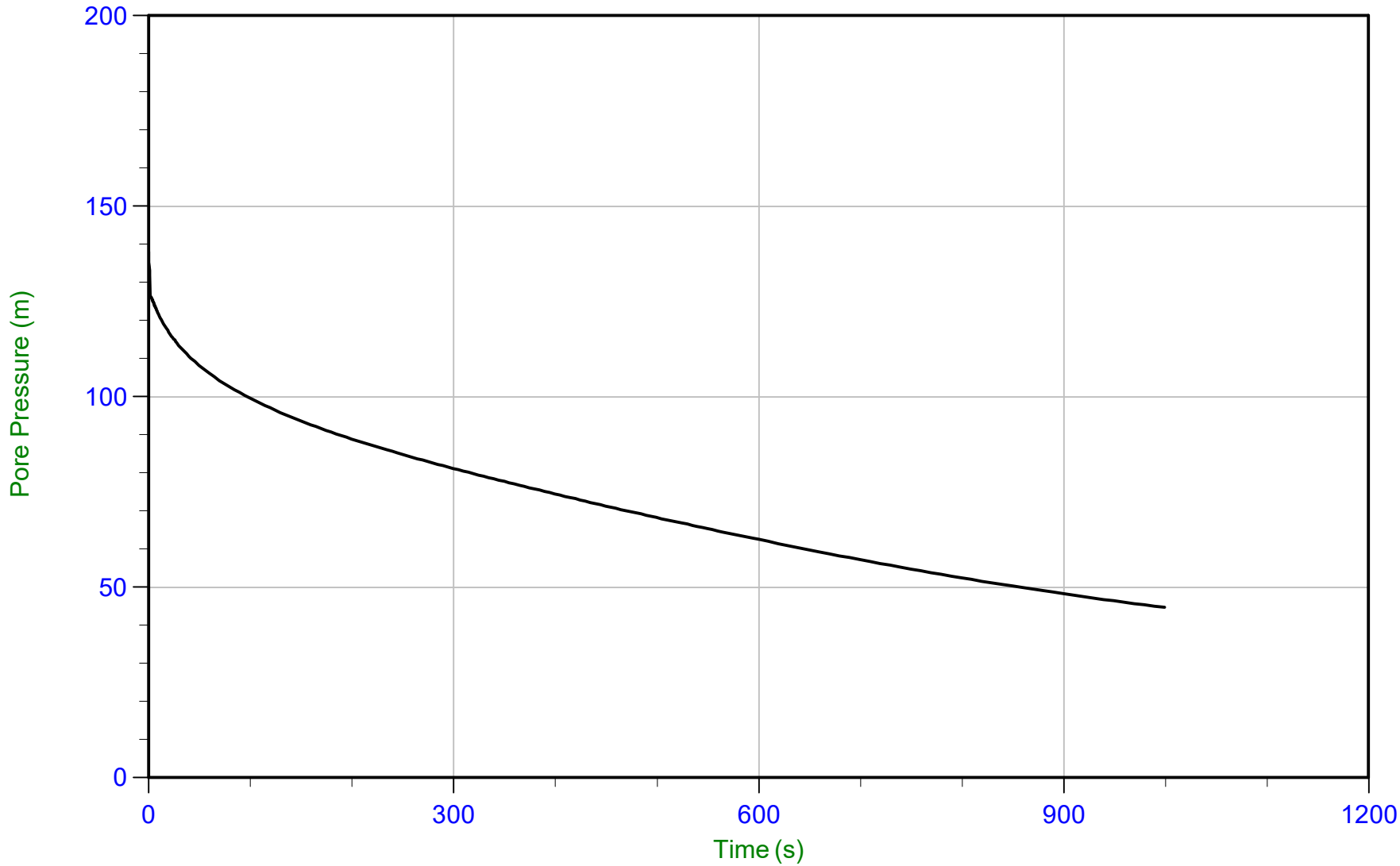
T(50): 45.6 s
Ir: 100
Ch: 15.4 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 12.900 m / 42.322 ft
Duration: 1000.0 s

u Min: 44.7 m
u Max: 138.1 m
u Final: 44.7 m

WT: 1.4 m / 4.6 ft
Ueq: 11.5 m
U(50): 74.78 m

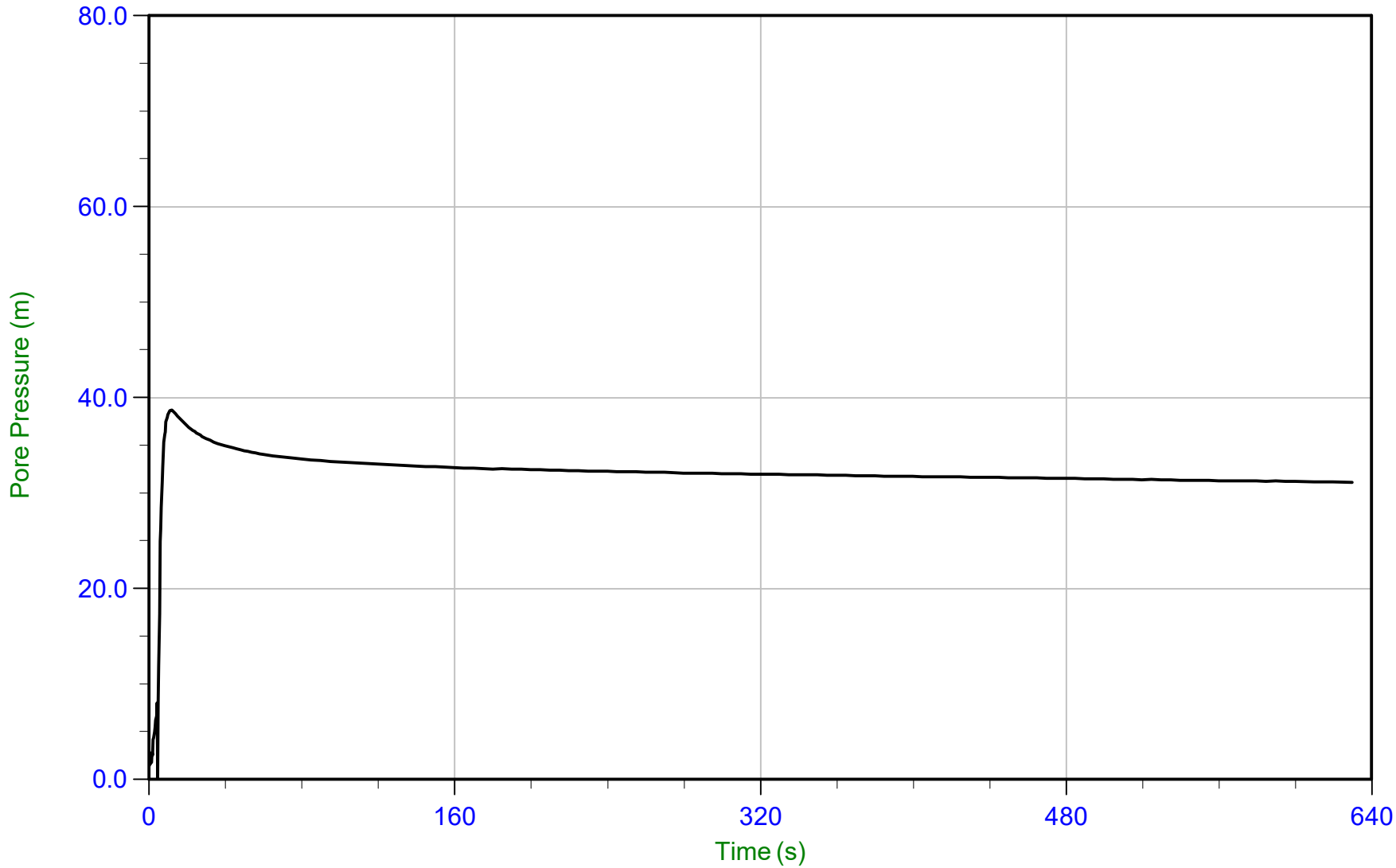
T(50): 395.7 s
Ir: 100
Ch: 1.8 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-31 09:29
Site: Bradford Bypass

Sounding: SCPT25-HF08
Cone: 765:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP08.PPF2
Depth: 17.425 m / 57.168 ft
Duration: 630.0 s

u Min: -0.2 m
u Max: 38.7 m
u Final: 31.1 m

Seismic Cone Penetration Test
HF19

CONETEC

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	2025-03-25	948:T1000F10U35	15	2.1	20.600	4885865	609489	
SCPT25-HF07	25-05-29237_SP07	2025-03-25	948:T1000F10U35	15	0.2	23.300	4885920	609280	
SCPT25-HF08	25-05-29237_SP08	2025-03-31	765:T1500F15U35	15	1.4	17.425	4885664	609176	3
SCPT25-HF19	25-05-29237_SP19	2025-03-26	948:T1000F10U35	15	0.1	14.675	4886597	609121	
SCPT25-HF21	25-05-29237_SP21	2025-03-26	948:T1000F10U35	15	0.4	9.900	4886702	609081	
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	2025-03-27	948:T1000F10U35	15	1.3	12.725	4886562	608981	
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	2025-03-28	948:T1000F10U35	15	2.8	19.250	4886521	609045	
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	2025-03-27	948:T1000F10U35	15	2.4	18.050	4886530	609093	
SCPT25-HWY400-21	25-05-29237_SPHWY400-21	2025-03-26	948:T1000F10U35	15	1.1	22.575	4886558	609141	
SCPT25-HWY400-34	25-05-29237_SPHWY400-34	2025-03-28	948:T1000F10U35	15		2.850	4886072	609084	4, 5
SCPT25-HWY400-34B	25-05-29237_SPHWY400-34B	2025-03-28	765:T1500F15U35	15		2.925	4886079	609081	4, 5

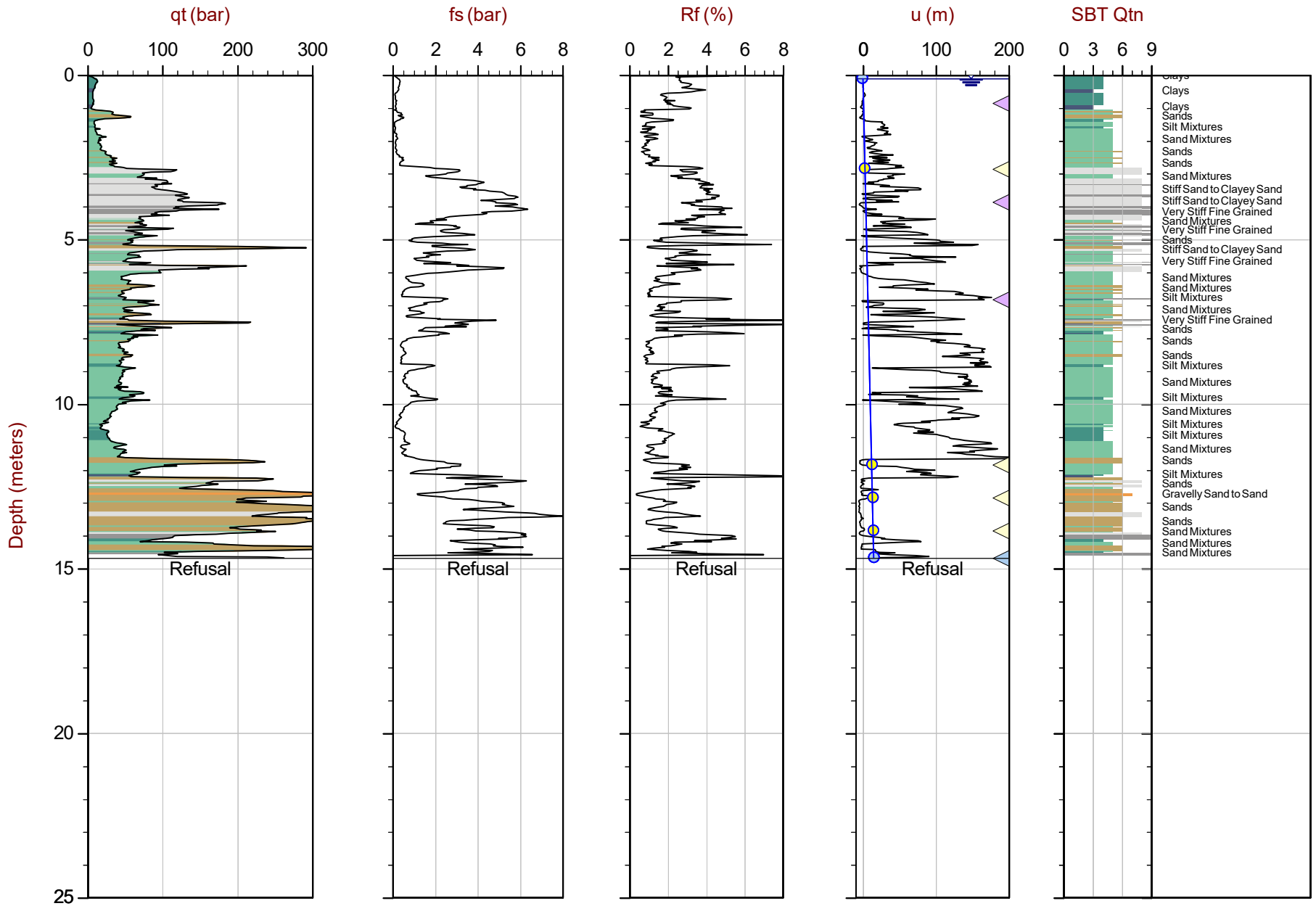
1. The assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device in datum WGS84/UTM Zone 17 North .
3. The assumed phreatic surface was based on the dynamic pore pressure response.
4. No clear phreatic surface detected due to shallow refusal.
5. No seismic data reported due to shallow refusal.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 14.675 m / 48.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP19.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886597m E: 609121m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

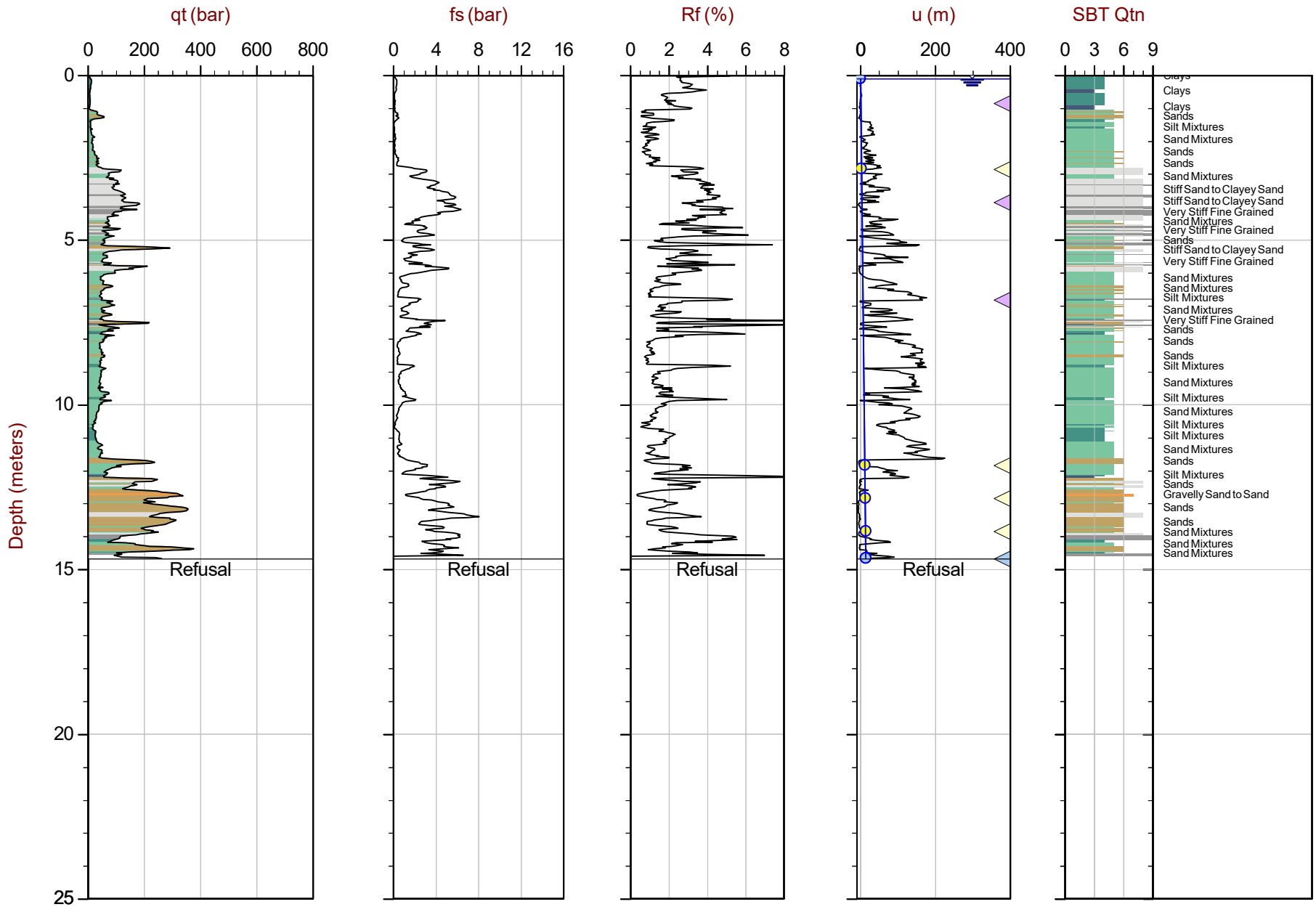
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 14.675 m / 48.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP19.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886597m E: 609121m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

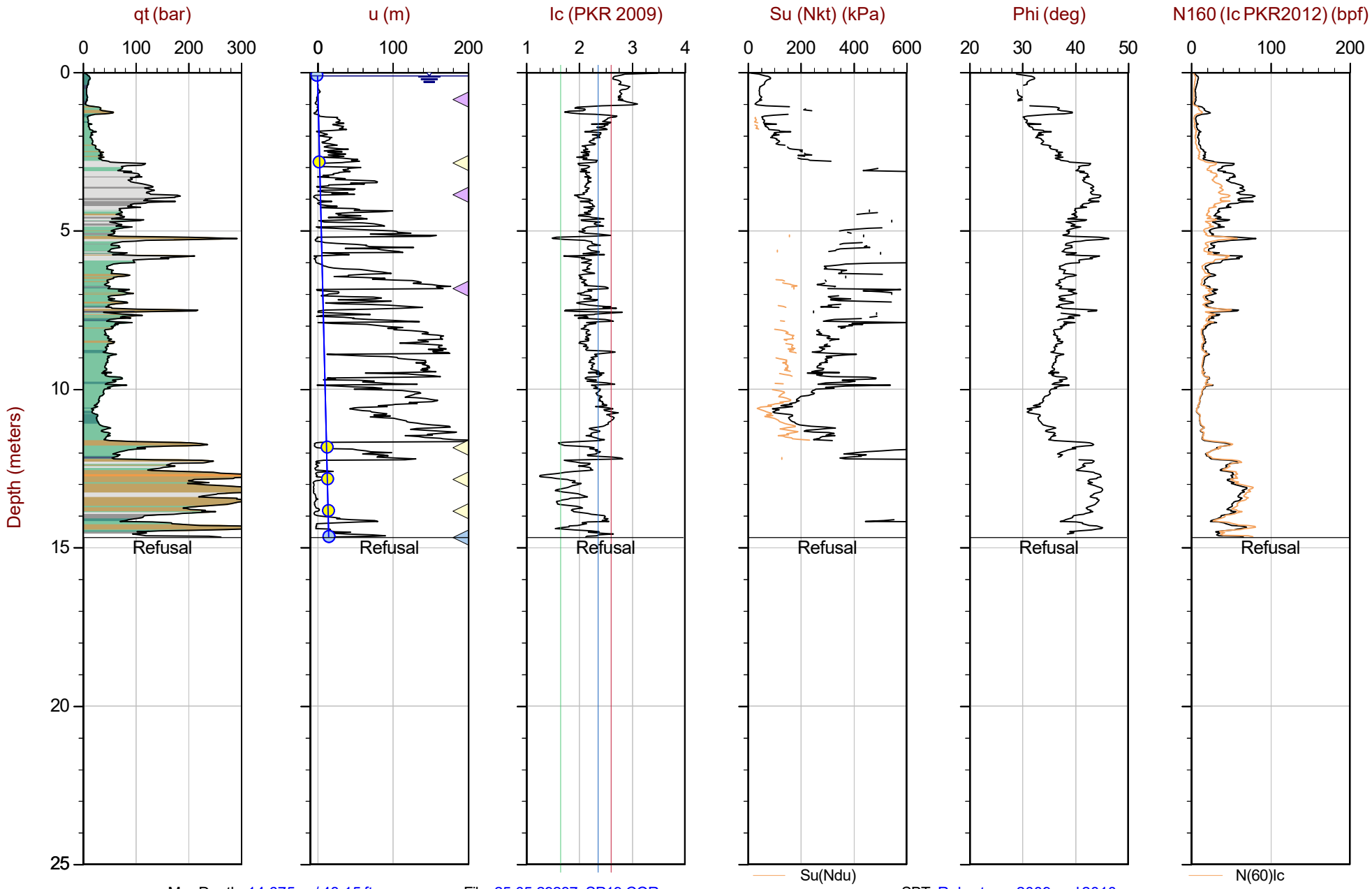
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 14.675 m / 48.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP19.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886597m E: 609121m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

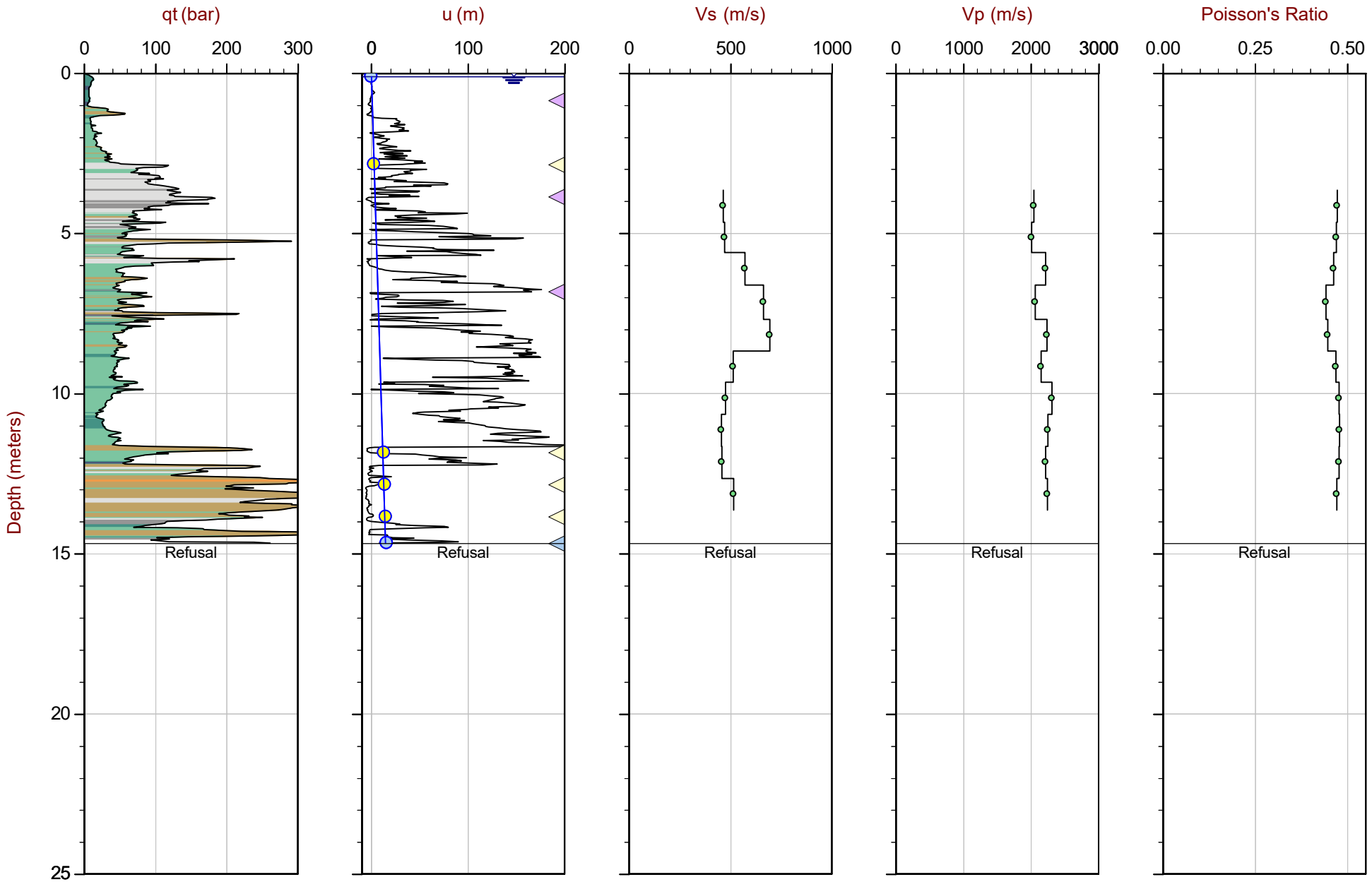
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 14.675 m / 48.15 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP19.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886597m E: 609121m
Sheet No: 1 of 1

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

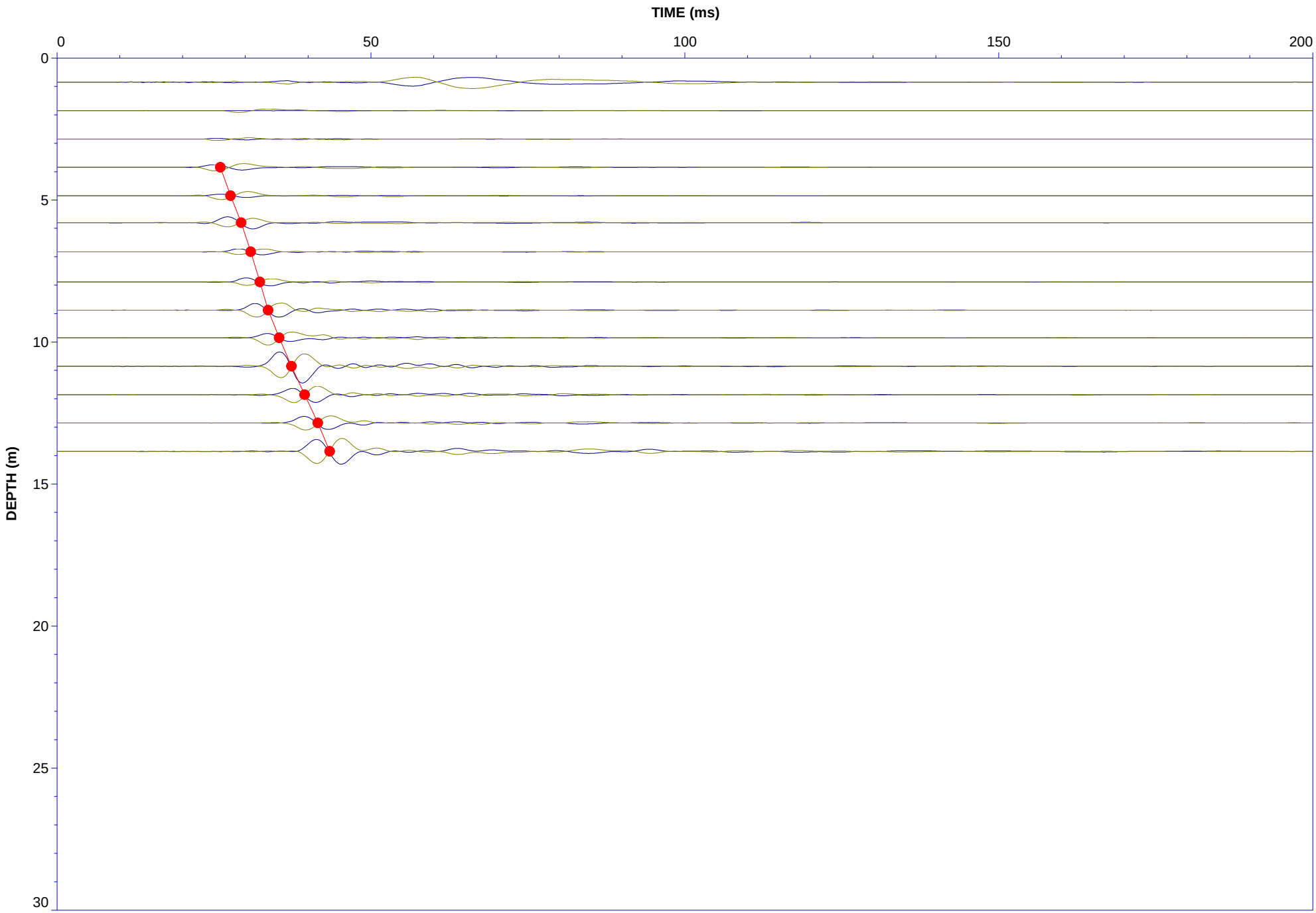
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF19
Date:	2025-03-26
Seismic Source:	Beam
Source Offset (m):	3.50
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.85	3.65	5.06			
4.85	4.65	5.82	0.76	1.64	465
5.80	5.60	6.60	0.78	1.66	471
6.82	6.62	7.49	0.88	1.54	573
7.88	7.68	8.44	0.95	1.43	664
8.88	8.68	9.36	0.92	1.32	695
9.85	9.65	10.27	0.91	1.76	514
10.85	10.65	11.21	0.95	1.98	477
11.85	11.65	12.16	0.95	2.09	456
12.85	12.65	13.13	0.96	2.09	459
13.85	13.65	14.09	0.97	1.88	516

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF19 Filter: 0-200Hz Date: 2025-03-26
Analysis: S Wave - Geo X

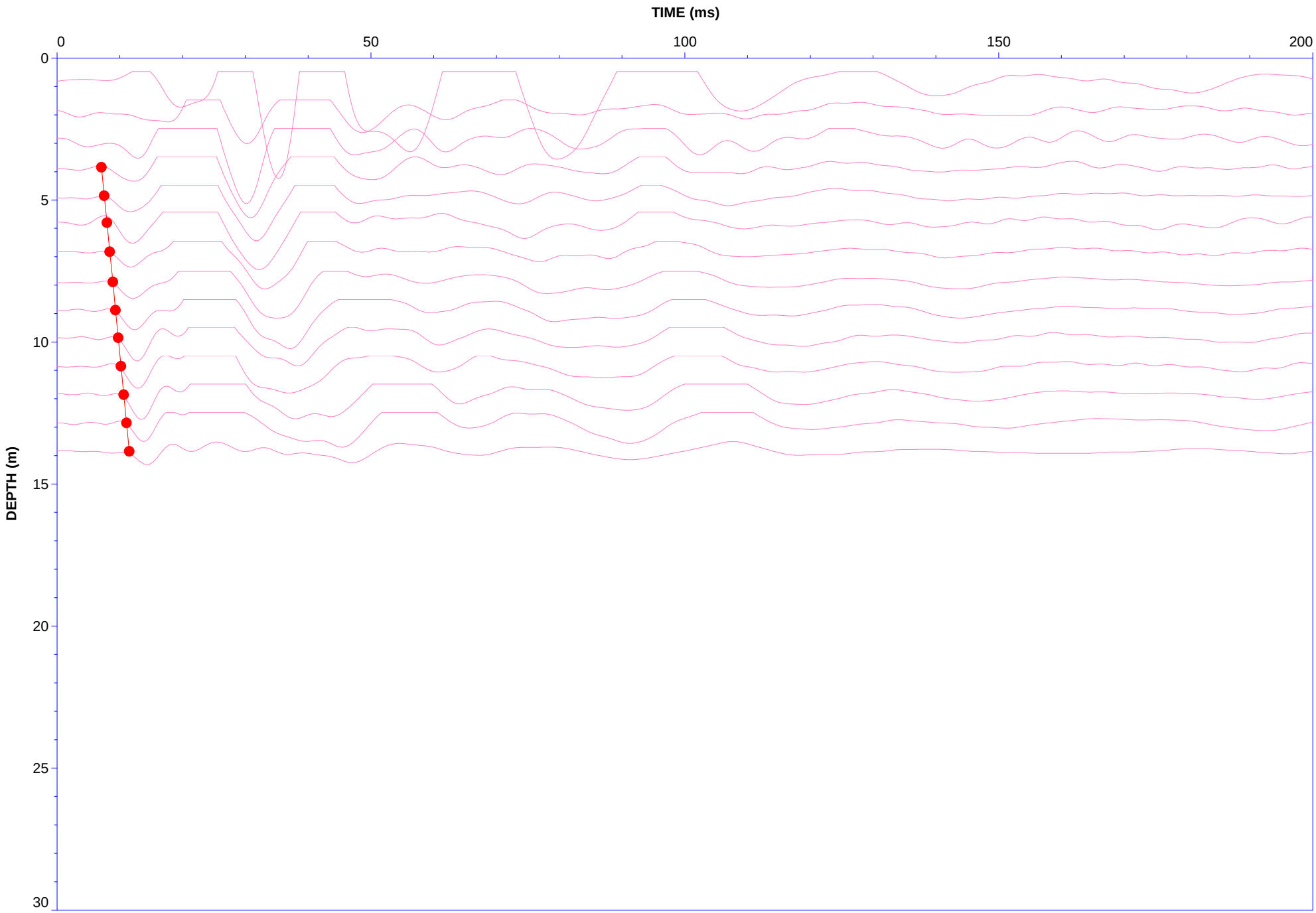


Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF19
Date:	2025-03-26
Seismic Source:	Plate
Source Offset (m):	2.00
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.85	3.65	4.16			
4.85	4.65	5.06	0.90	0.44	2044
5.80	5.60	5.95	0.88	0.44	2009
6.82	6.62	6.92	0.97	0.44	2219
7.88	7.68	7.94	1.02	0.49	2066
8.88	8.68	8.91	0.97	0.43	2243
9.85	9.65	9.86	0.95	0.44	2152
10.85	10.65	10.84	0.98	0.42	2311
11.85	11.65	11.82	0.98	0.44	2254
12.85	12.65	12.81	0.99	0.44	2222
13.85	13.65	13.80	0.99	0.44	2245

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF19 Filter: BP 0-200Hz Date: 2025-03-26
Analysis: P Wave - Geo Z



Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF19
Date:	2025-03-26

SCPTu POISSON'S RATIO RESULTS

Depth From (m)	Depth To (m)	Vs Interval Velocity (m/s)	Vp Interval Velocity (m/s)	Poisson's Ratio
3.65	4.65	465	2044	0.47
4.65	5.60	471	2009	0.47
5.60	6.62	573	2219	0.46
6.62	7.68	664	2066	0.44
7.68	8.68	695	2243	0.45
8.68	9.65	514	2152	0.47
9.65	10.65	477	2311	0.48
10.65	11.65	456	2254	0.48
11.65	12.65	459	2222	0.48
12.65	13.65	516	2245	0.47

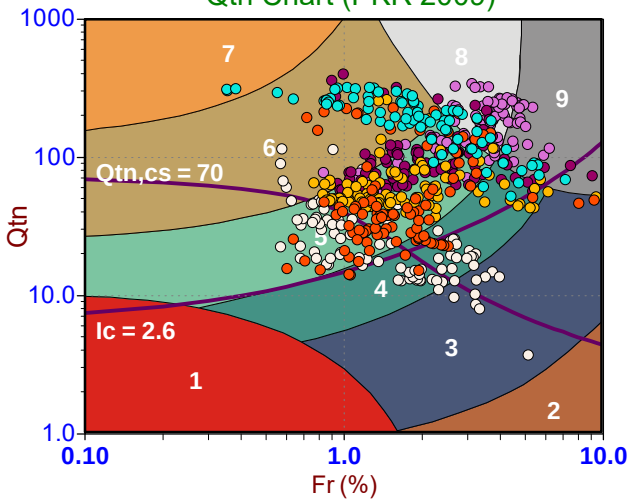
CONETEC

Thurber Engineering

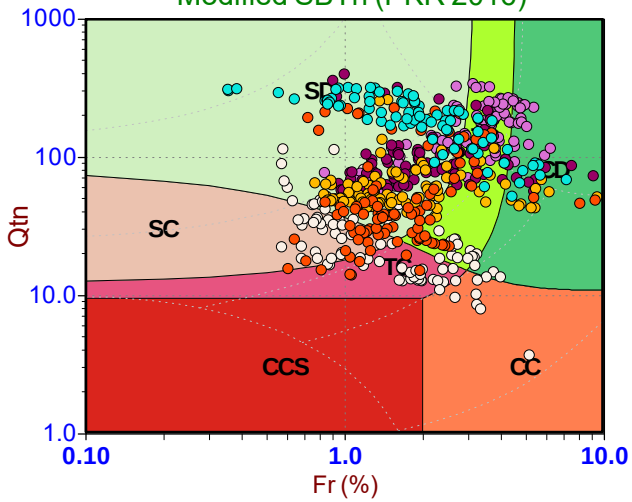
Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²

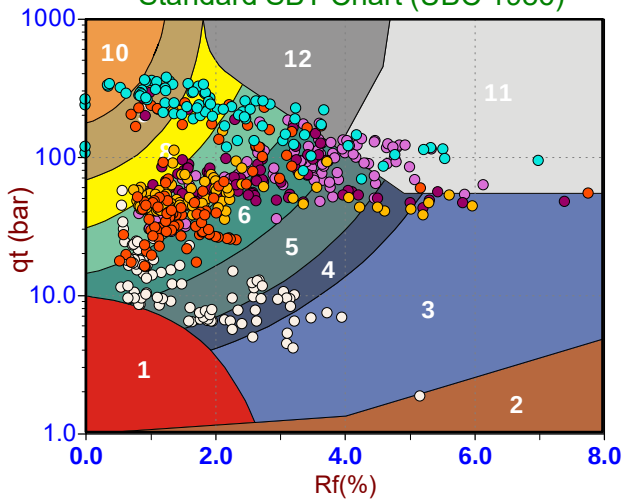
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- 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

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	15	315	4.950							
SCPT25-HF01	25-05-29237_SP01	15	225	20.600	18.5		2.1				
SCPT25-HF07	25-05-29237_SP07	15	305	2.975							
SCPT25-HF07	25-05-29237_SP07	15	1020	4.000	3.8		0.2				
SCPT25-HF07	25-05-29237_SP07	15	300	5.975		5.8	0.2	37.5	100	18.7	3
SCPT25-HF07	25-05-29237_SP07	15	305	6.975		6.8	0.2	37.8	100	18.6	3
SCPT25-HF07	25-05-29237_SP07	15	340	9.975							
SCPT25-HF07	25-05-29237_SP07	15	210	10.975							
SCPT25-HF07	25-05-29237_SP07	15	320	15.975		15.8	0.2	97.8	100	7.2	3
SCPT25-HF07	25-05-29237_SP07	15	220	23.300							
SCPT25-HF08	25-05-29237_SP08	15	220	4.900							
SCPT25-HF08	25-05-29237_SP08	15	3150	5.100		3.7	1.4	891.7	100	0.8	3
SCPT25-HF08	25-05-29237_SP08	15	270	7.900							
SCPT25-HF08	25-05-29237_SP08	15	380	8.900							
SCPT25-HF08	25-05-29237_SP08	15	1060	10.025		8.6	1.4	45.6	100	15.4	3
SCPT25-HF08	25-05-29237_SP08	15	1000	12.900		11.5	1.4	395.7	100	1.8	3
SCPT25-HF08	25-05-29237_SP08	15	630	17.425							
SCPT25-HF19	25-05-29237_SP19	15	385	0.850							
SCPT25-HF19	25-05-29237_SP19	15	300	2.850	2.8		0.1				
SCPT25-HF19	25-05-29237_SP19	15	250	3.850							
SCPT25-HF19	25-05-29237_SP19	15	300	6.825							
SCPT25-HF19	25-05-29237_SP19	15	400	11.850	13.4		-1.6				
SCPT25-HF19	25-05-29237_SP19	15	300	12.850	14.3		-1.5				
SCPT25-HF19	25-05-29237_SP19	15	180	13.850	15.0		-1.2				

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

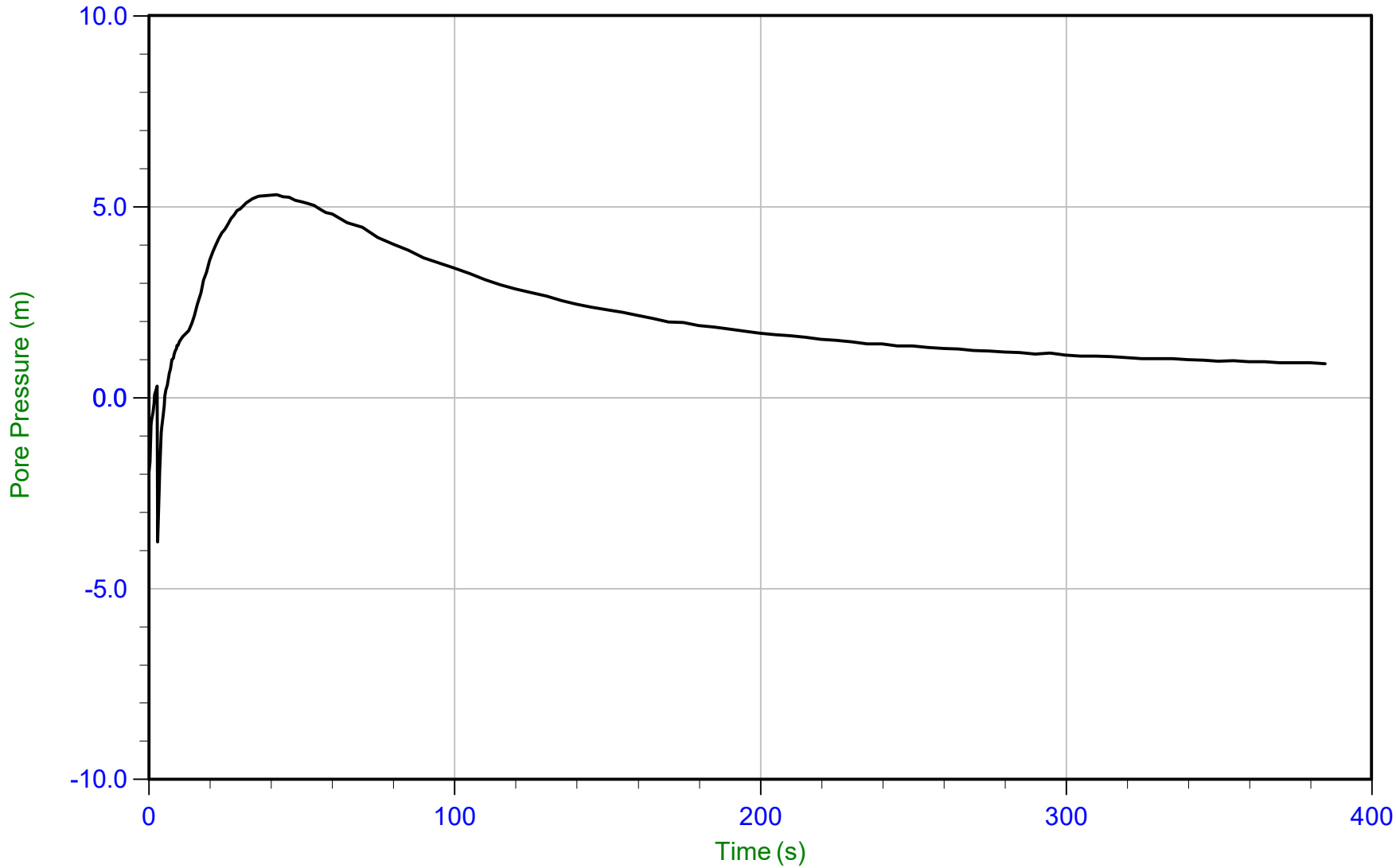
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF19	25-05-29237_SP19	15	545	14.675		15.9	-1.2	90.8	100	7.7	4
SCPT25-HF21	25-05-29237_SP21	15	400	2.825	2.4		0.4				
SCPT25-HF21	25-05-29237_SP21	15	150	3.150		2.8	0.4	38.0	100	18.5	3
SCPT25-HF21	25-05-29237_SP21	15	180	4.825		4.4	0.4	33.0	100	21.3	3
SCPT25-HF21	25-05-29237_SP21	15	520	5.825	5.7		0.1				
SCPT25-HF21	25-05-29237_SP21	15	265	9.850							
SCPT25-HF21	25-05-29237_SP21	15	500	9.900		9.5	0.4	128.6	100	5.5	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	300	3.975		2.7	1.3	78.8	100	8.9	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	240	6.025							
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	600	9.975	8.7		1.3				
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	1630	11.975		10.7	1.3	549.3	100	1.3	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	300	12.725	10.5		2.2				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	375	5.875		3.1	2.8	150.6	100	4.7	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	295	6.875		4.4	2.8	162.5	100	4.3	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	600	10.100	7.3		2.8				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	1050	14.000		11.2	2.8	401.2	100	1.7	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	170	18.850	15.3		3.5				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	550	19.250	15.9		3.4				
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	600	5.825							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	230	7.775							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	220	11.800	9.4		2.4				
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	245	15.900		13.5	2.4	44.5	100	15.8	3
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	180	16.800							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	380	18.050							

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 0.850 m / 2.789 ft
Duration: 385.0 s

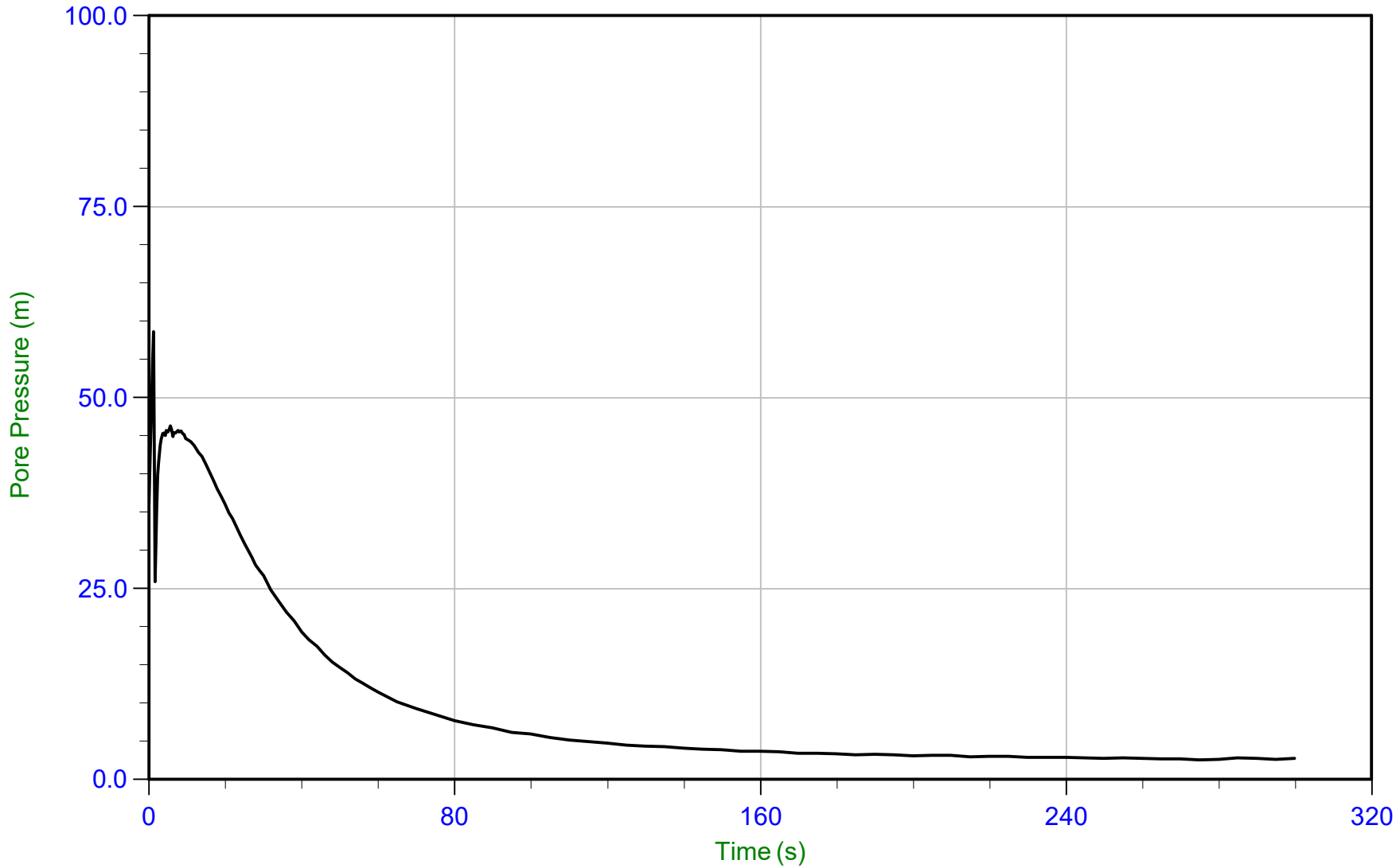
u Min: -3.8 m
u Max: 5.3 m
u Final: 0.9 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 2.850 m / 9.350 ft
Duration: 300.0 s

u Min: 2.6 m
u Max: 58.6 m
u Final: 2.8 m

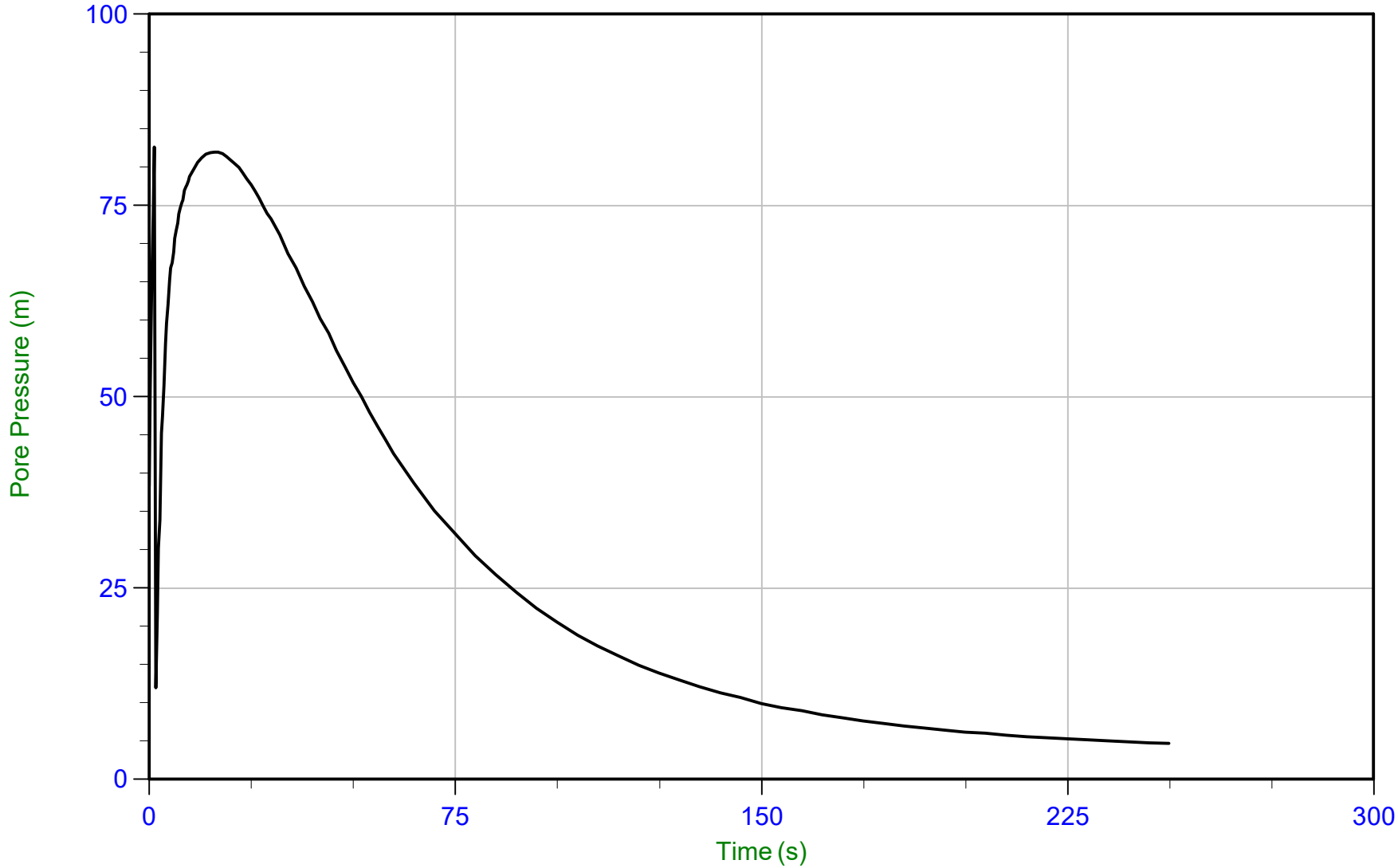
WT: 0.1 m / 0.2 ft
Ueq: 2.8 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 3.850 m / 12.631 ft
Duration: 250.0 s

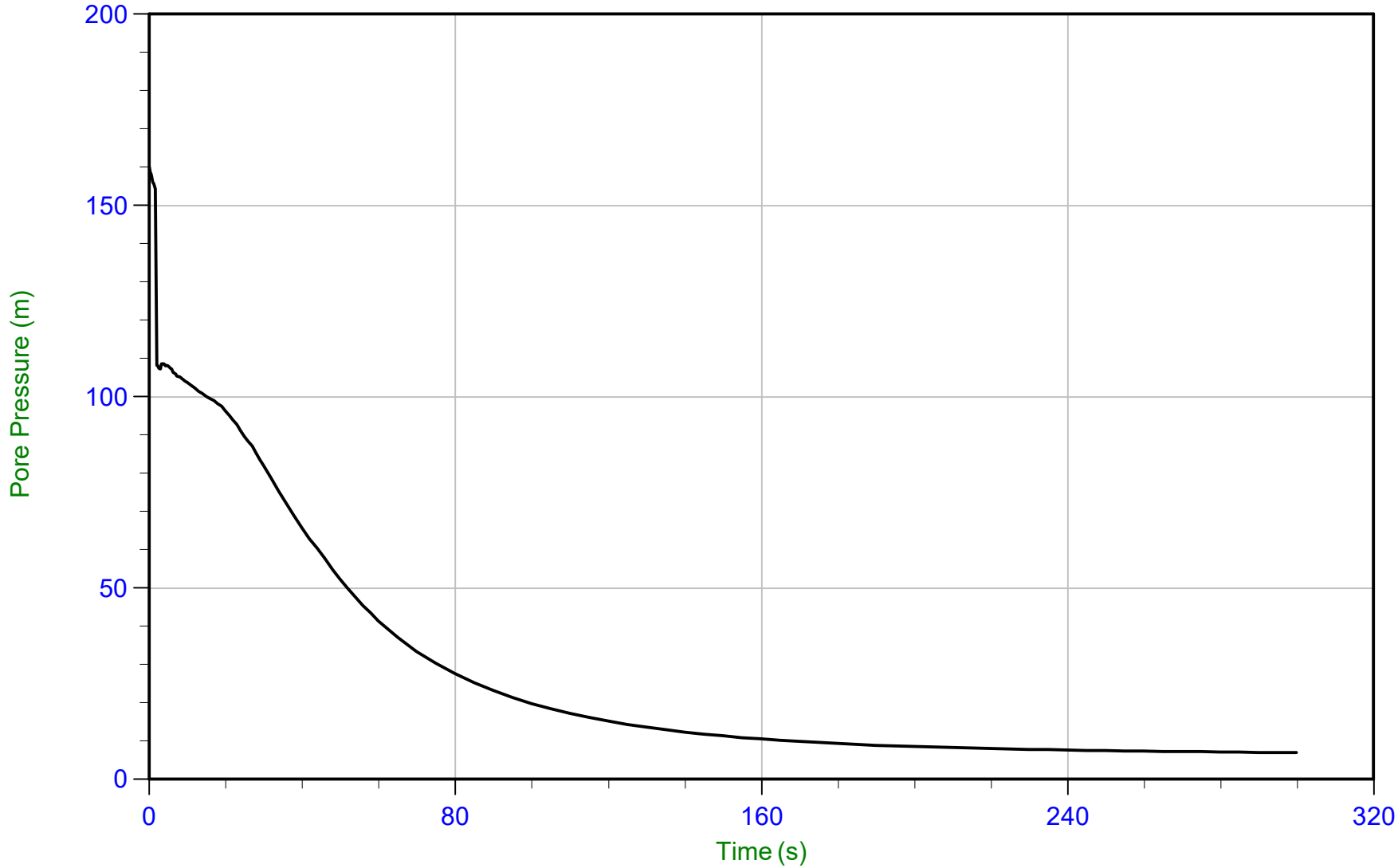
u Min: 4.7 m
u Max: 82.7 m
u Final: 4.7 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 6.825 m / 22.391 ft
Duration: 300.0 s

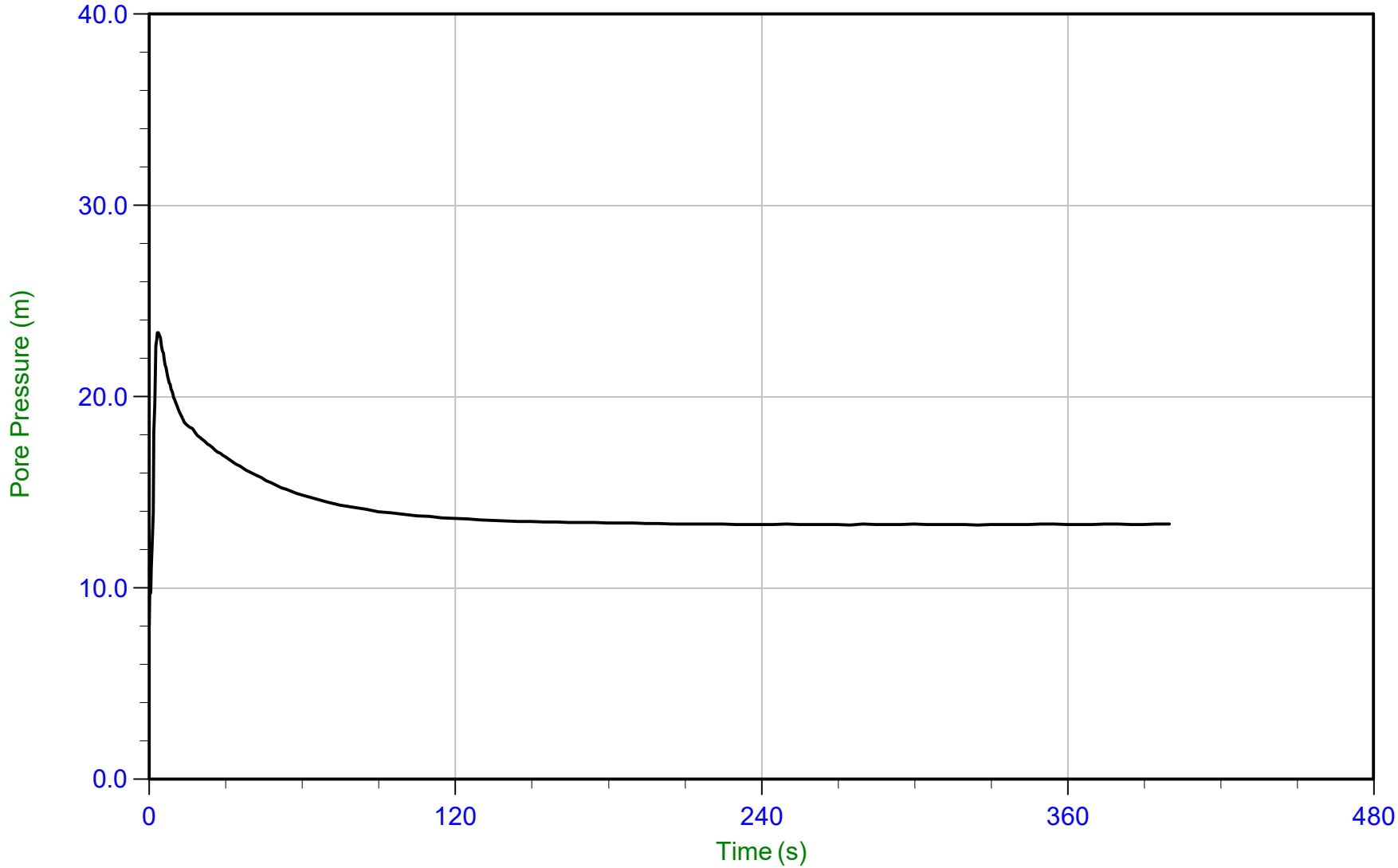
u Min: 7.0 m
u Max: 160.2 m
u Final: 7.0 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 11.850 m / 38.877 ft
Duration: 400.0 s

u Min: 8.0 m
u Max: 23.4 m
u Final: 13.4 m

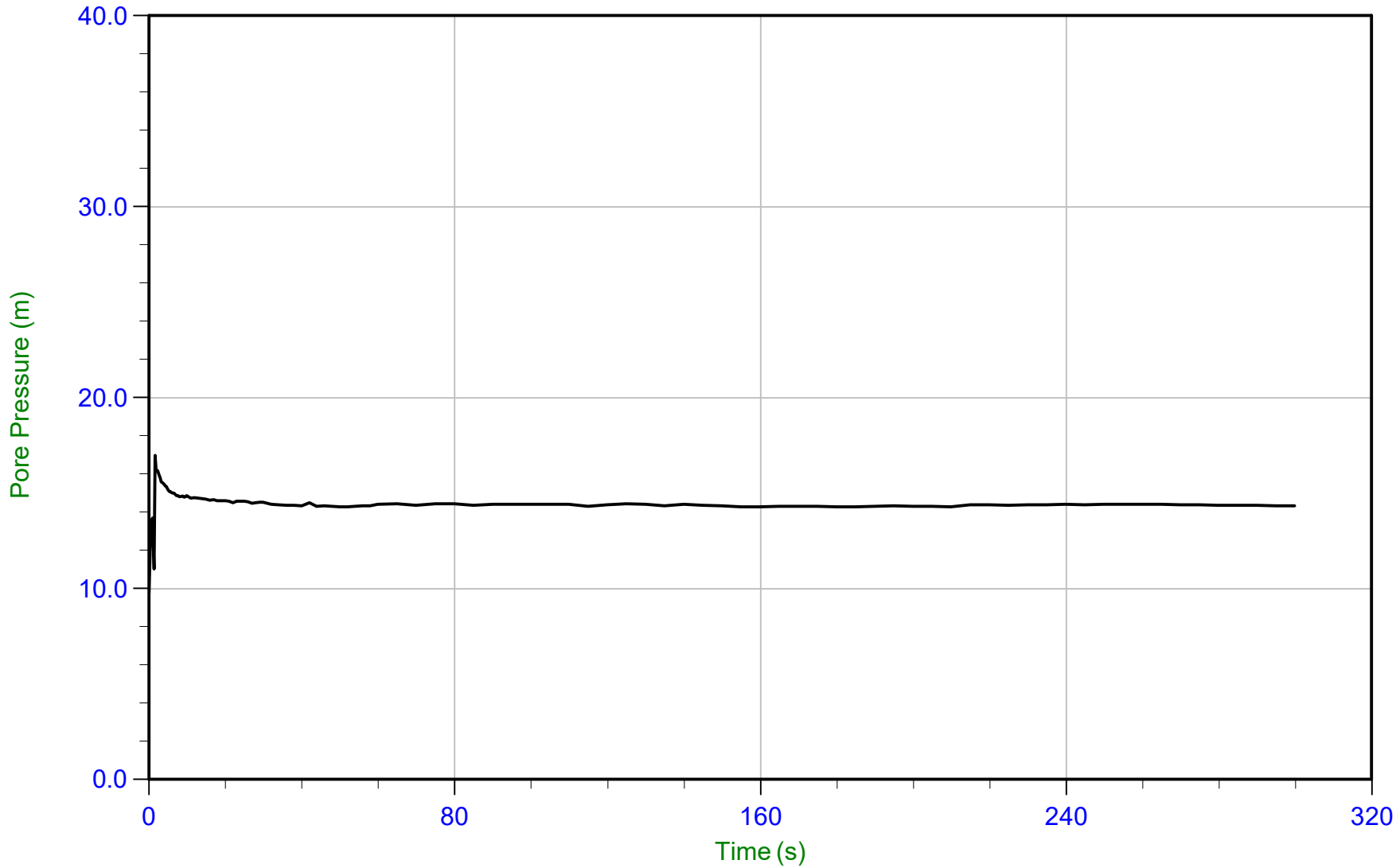
WT: -1.6 m / -5.1 ft
Ueq: 13.4 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 12.850 m / 42.158 ft
Duration: 300.0 s

u Min: 9.7 m
u Max: 17.0 m
u Final: 14.3 m

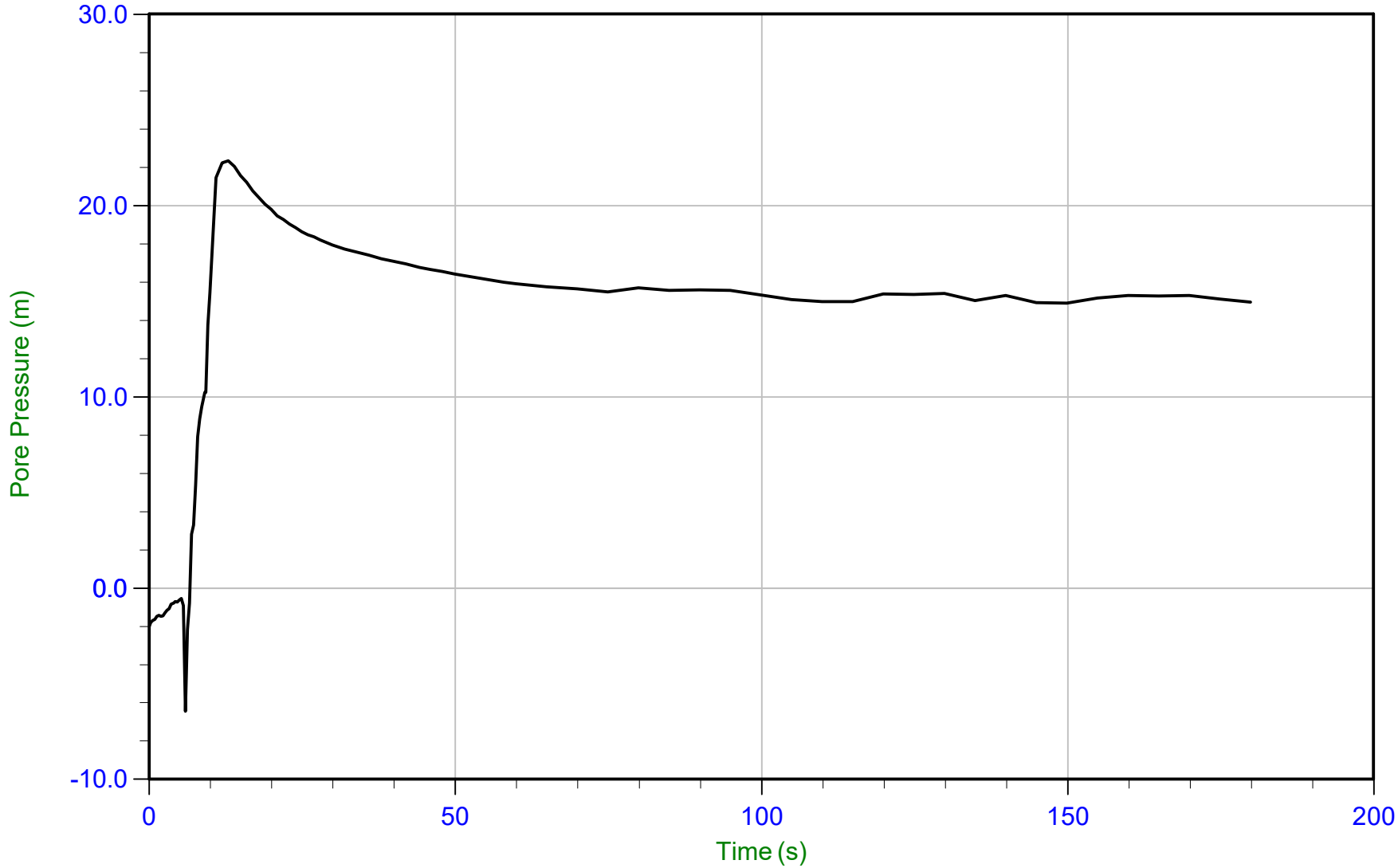
WT: -1.4 m / -4.8 ft
Ueq: 14.3 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 13.850 m / 45.439 ft
Duration: 180.0 s

u Min: -6.4 m
u Max: 22.3 m
u Final: 15.0 m

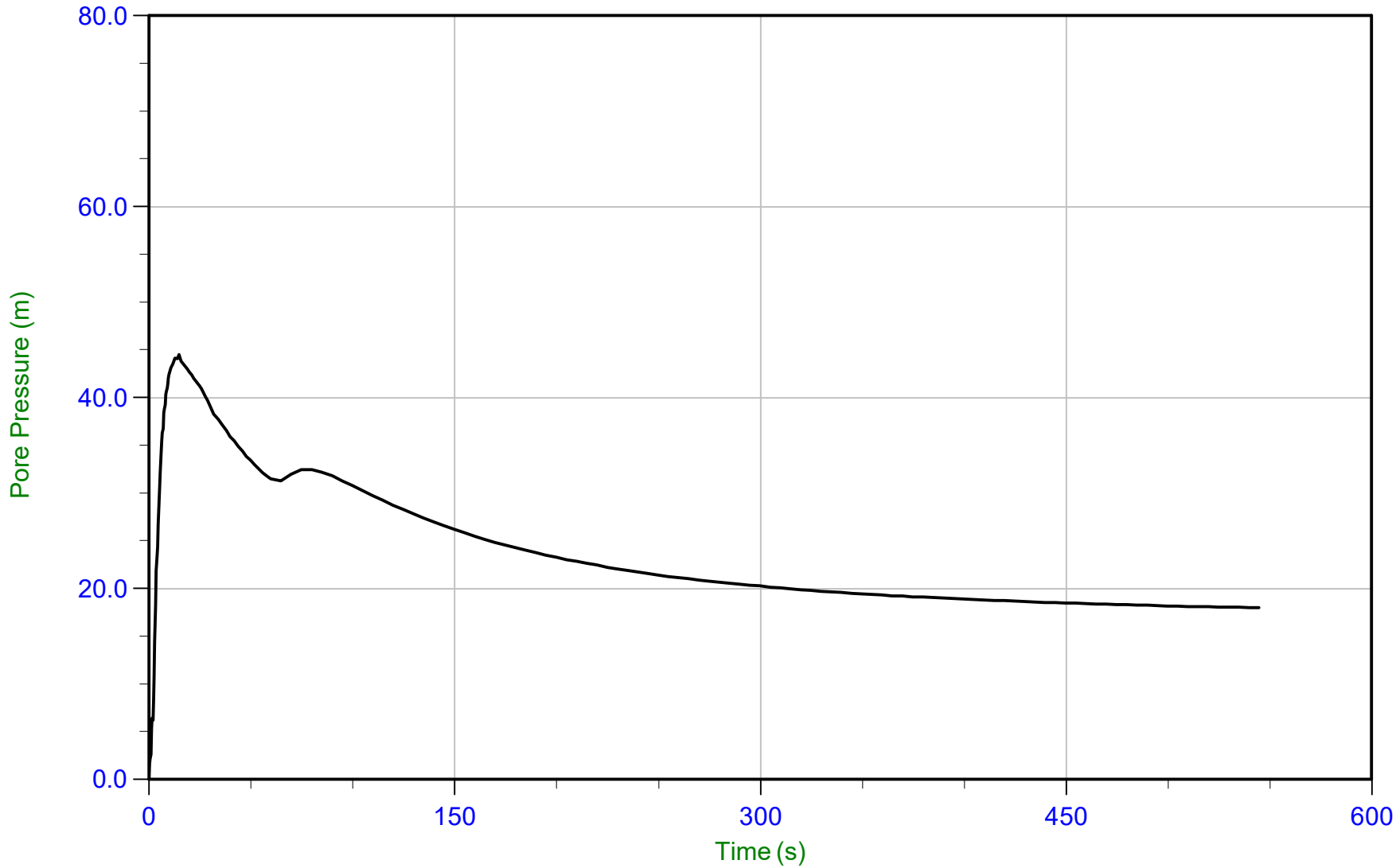
WT: -1.1 m / -3.8 ft
Ueq: 15.0 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 09:25
Site: Bradford Bypass

Sounding: SCPT25-HF19
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP19.PPF2
Depth: 14.675 m / 48.146 ft
Duration: 545.0 s

u Min: 0.0 m
u Max: 44.5 m
u Final: 18.0 m

WT: -1.2 m / -3.9 ft
Ueq: 15.9 m
U(50): 30.18 m

T(50): 90.8 s
Ir: 100
Ch: 7.7 cm²/min

Seismic Cone Penetration Test
HF21

CONETEC

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT25-HF01	25-05-29237_SP01	2025-03-25	948:T1000F10U35	15	2.1	20.600	4885865	609489	
SCPT25-HF07	25-05-29237_SP07	2025-03-25	948:T1000F10U35	15	0.2	23.300	4885920	609280	
SCPT25-HF08	25-05-29237_SP08	2025-03-31	765:T1500F15U35	15	1.4	17.425	4885664	609176	3
SCPT25-HF19	25-05-29237_SP19	2025-03-26	948:T1000F10U35	15	0.1	14.675	4886597	609121	
SCPT25-HF21	25-05-29237_SP21	2025-03-26	948:T1000F10U35	15	0.4	9.900	4886702	609081	
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	2025-03-27	948:T1000F10U35	15	1.3	12.725	4886562	608981	
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	2025-03-28	948:T1000F10U35	15	2.8	19.250	4886521	609045	
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	2025-03-27	948:T1000F10U35	15	2.4	18.050	4886530	609093	
SCPT25-HWY400-21	25-05-29237_SPHWY400-21	2025-03-26	948:T1000F10U35	15	1.1	22.575	4886558	609141	
SCPT25-HWY400-34	25-05-29237_SPHWY400-34	2025-03-28	948:T1000F10U35	15		2.850	4886072	609084	4, 5
SCPT25-HWY400-34B	25-05-29237_SPHWY400-34B	2025-03-28	765:T1500F15U35	15		2.925	4886079	609081	4, 5

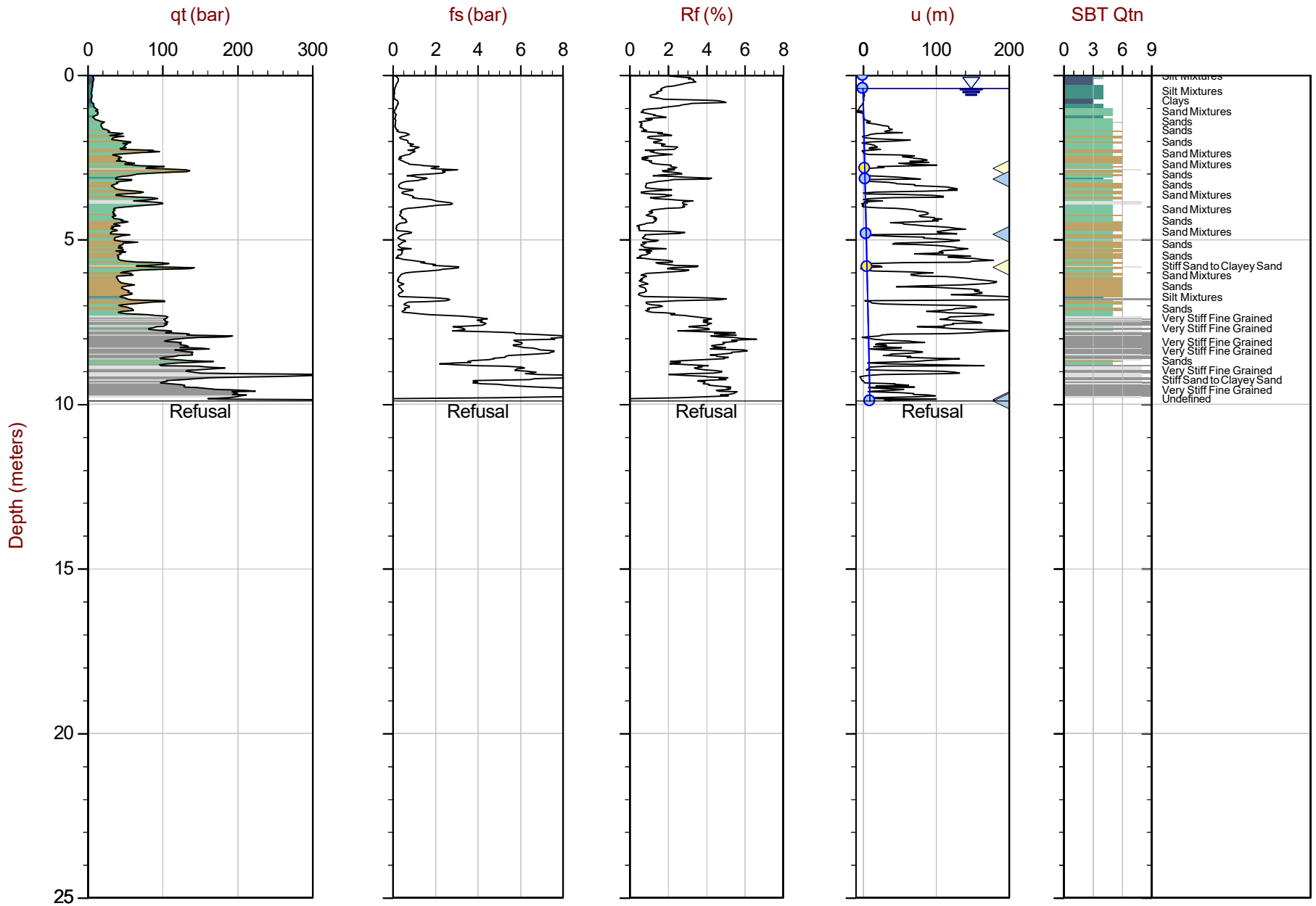
1. The assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device in datum WGS84/UTM Zone 17 North .
3. The assumed phreatic surface was based on the dynamic pore pressure response.
4. No clear phreatic surface detected due to shallow refusal.
5. No seismic data reported due to shallow refusal.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP21.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886702m E: 609081m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

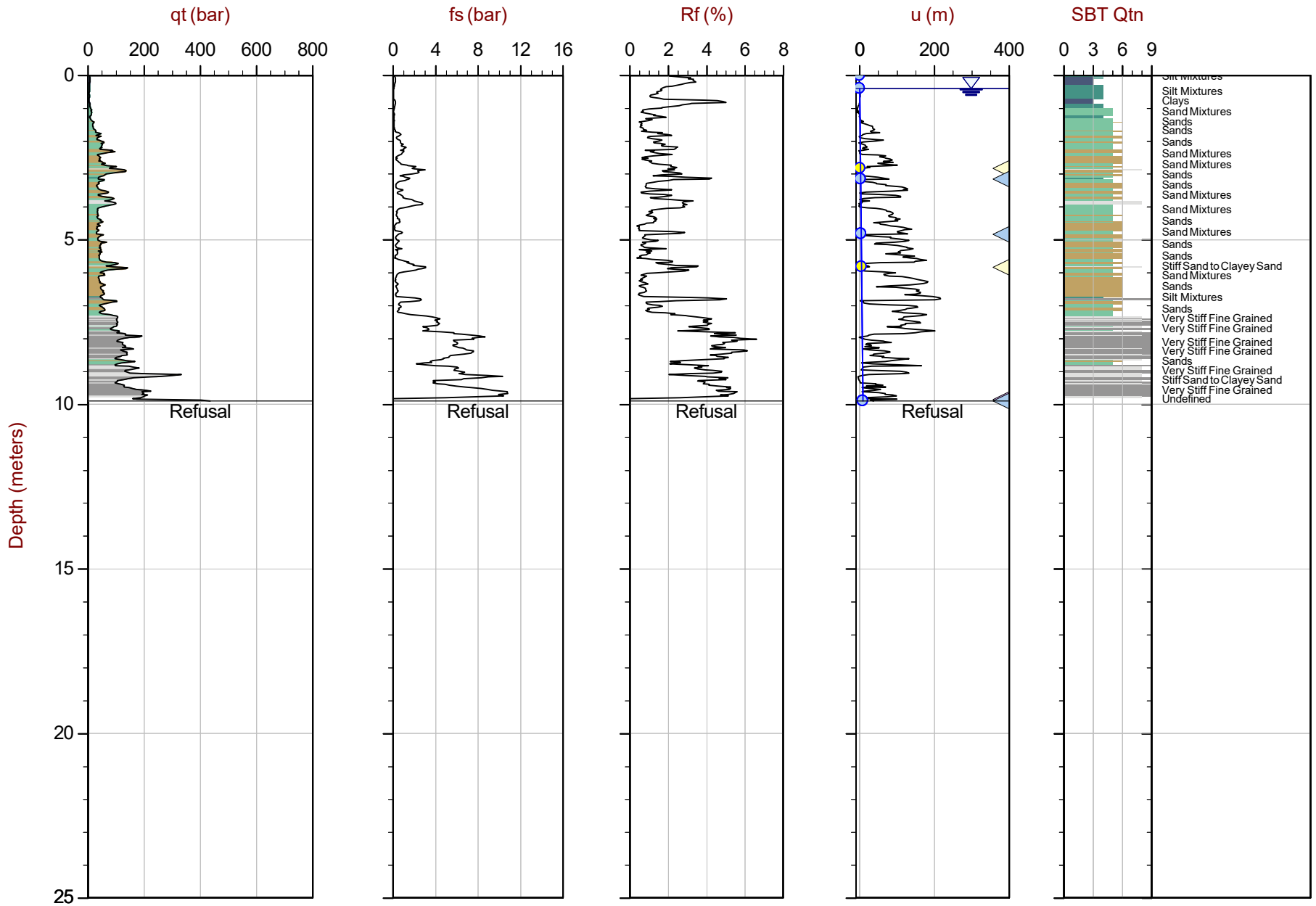
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP21.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886702m E: 609081m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

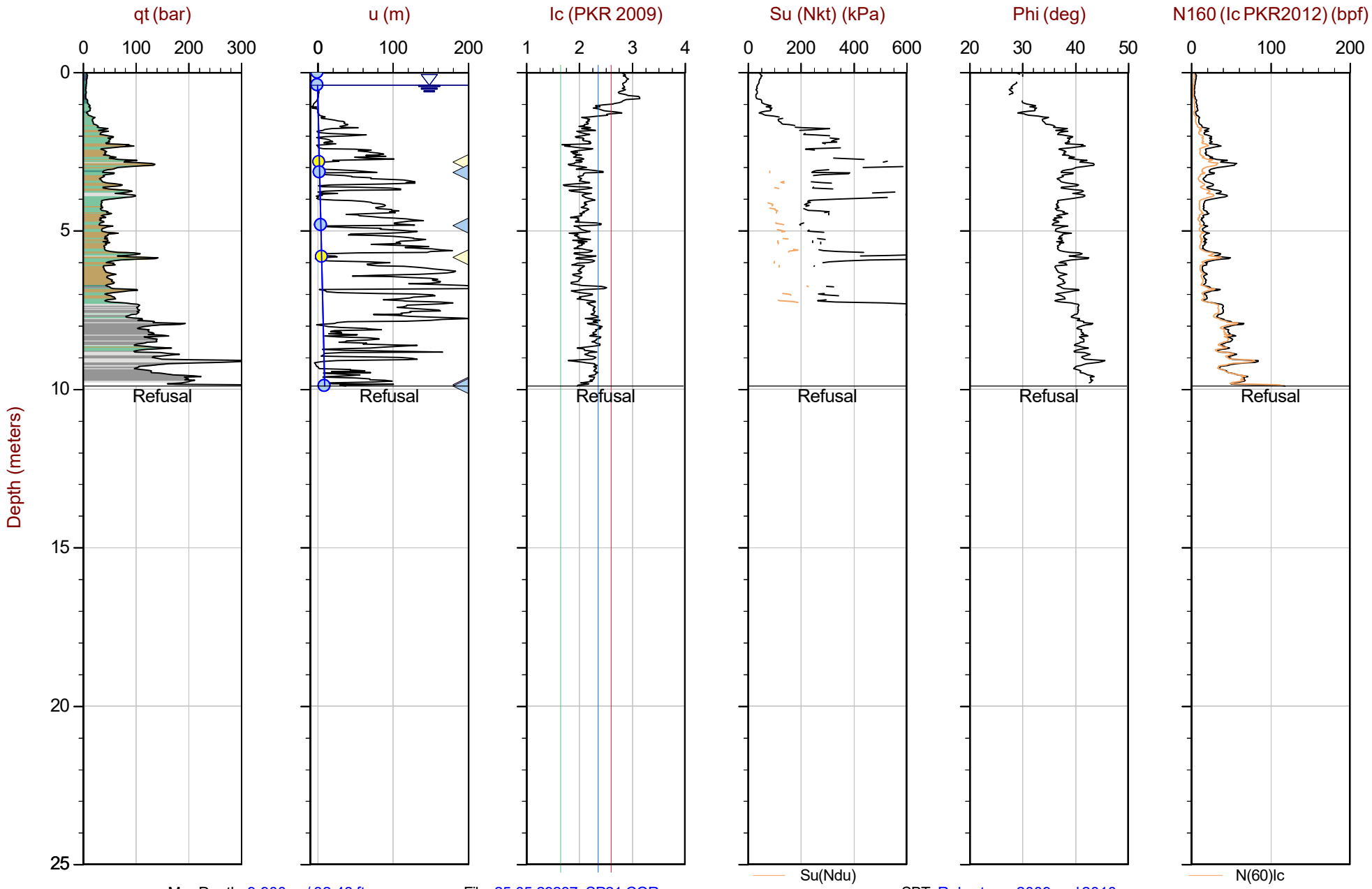
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP21.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886702m E: 609081m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

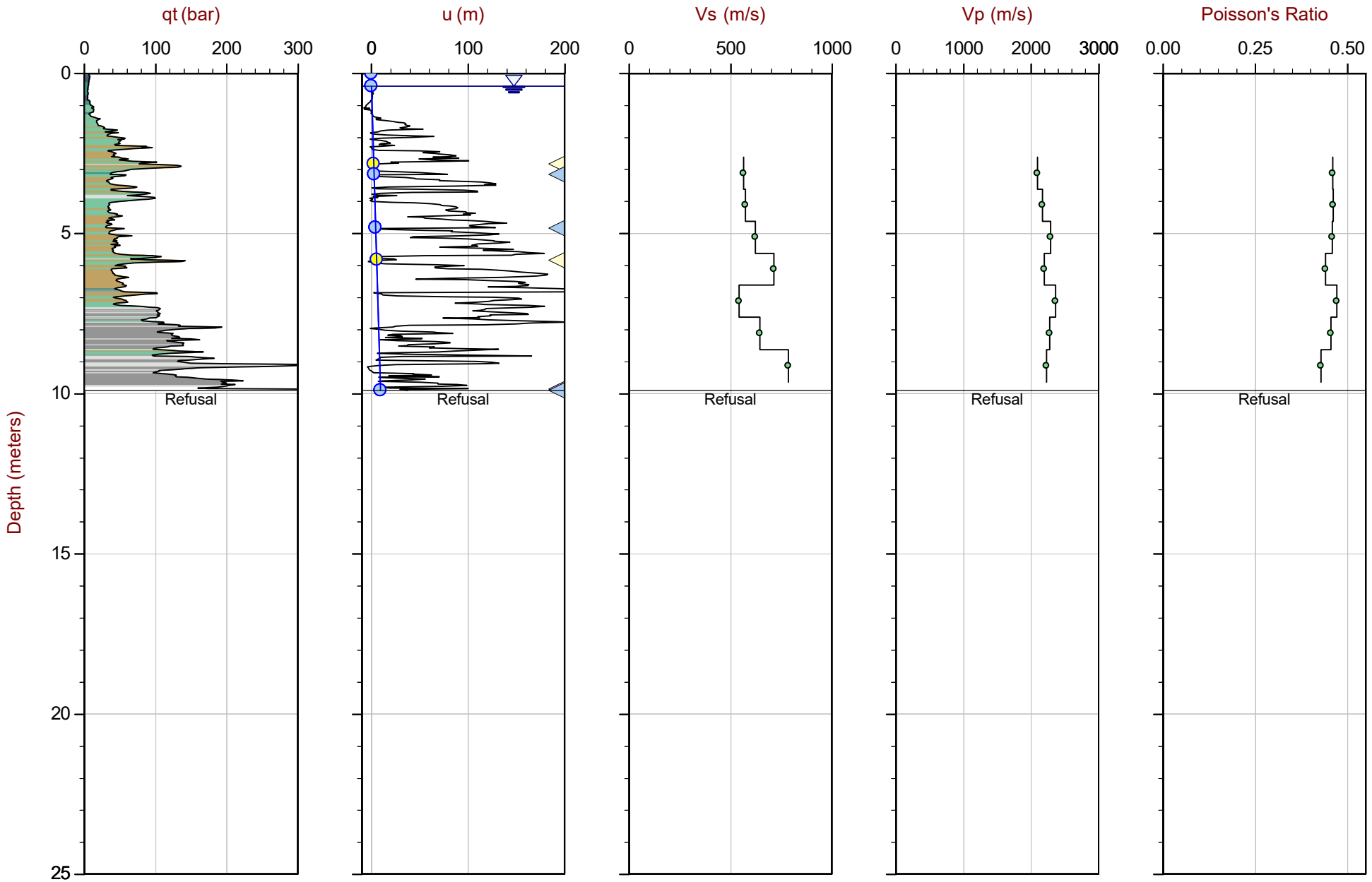
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Max Depth: 9.900 m / 32.48 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 25-05-29237_SP21.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 17N N: 4886702m E: 609081m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

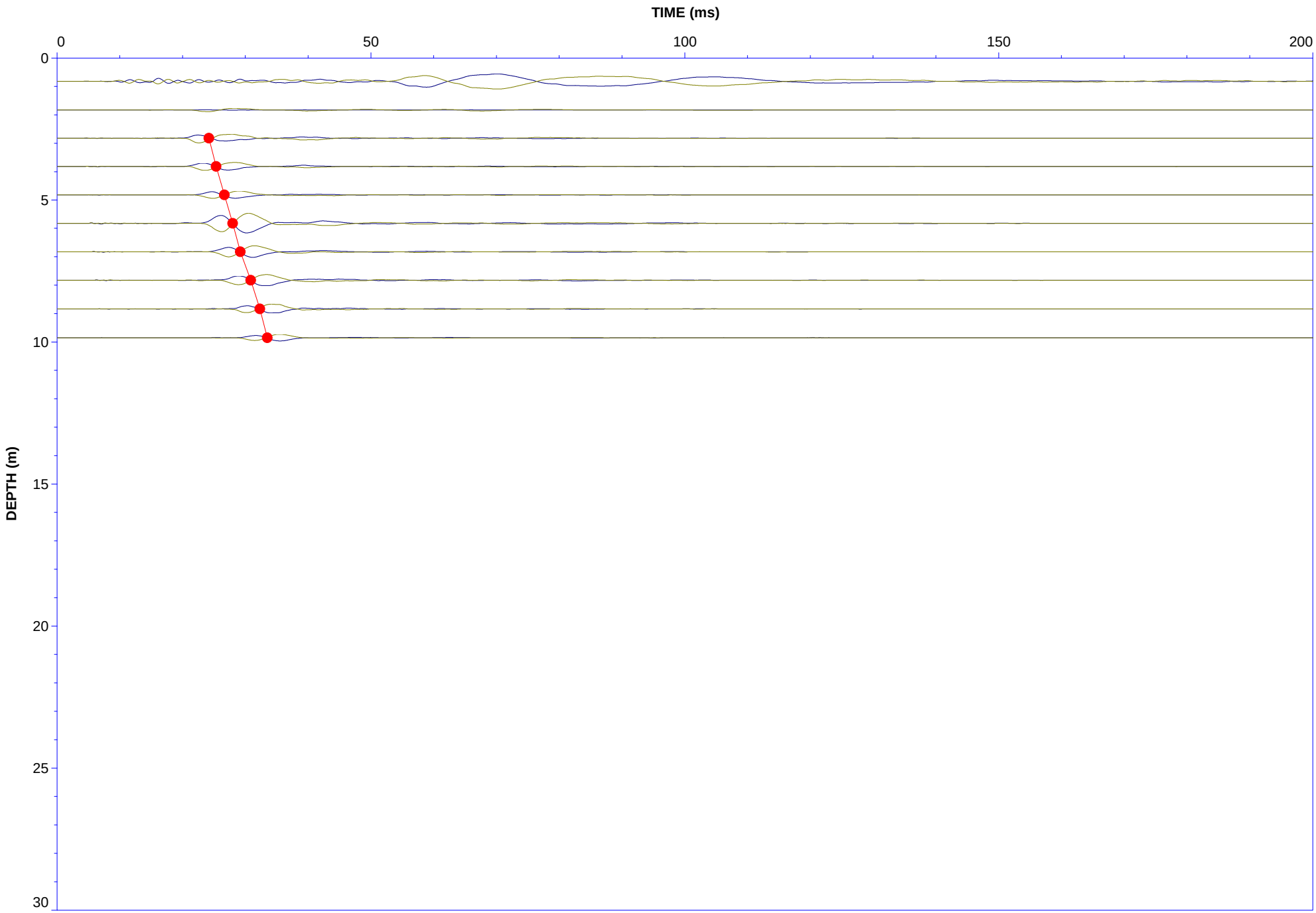
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF21
Date:	2025-03-26
Seismic Source:	Beam
Source Offset (m):	3.50
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.82	2.62	4.37			
3.82	3.62	5.04	0.66	1.17	566
4.82	4.62	5.80	0.76	1.32	575
5.82	5.62	6.62	0.83	1.32	624
6.82	6.62	7.49	0.87	1.21	716
7.82	7.62	8.39	0.90	1.65	543
8.83	8.63	9.31	0.93	1.43	647
9.85	9.65	10.27	0.95	1.21	786

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF21 Filter: 0-200Hz Date: 2025-03-26
Analysis: S Wave - Geo X

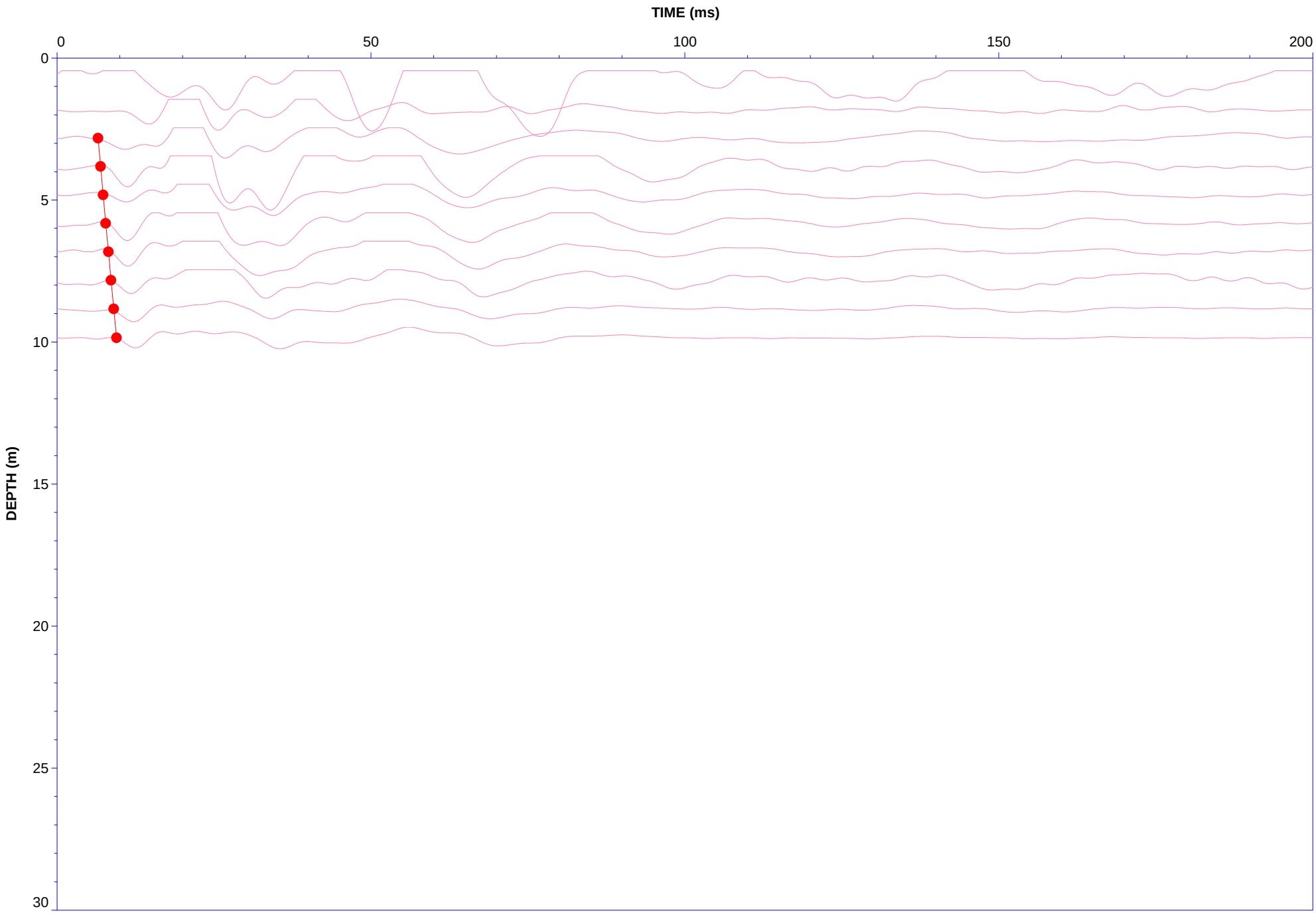


Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF21
Date:	2025-03-26
Seismic Source:	Plate
Source Offset (m):	2.00
Source Depth (m):	0.00
Sensor Type:	Geophone
Sensor Offset (m):	0.20

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Tip Depth (m)	Sensor Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.82	2.62	3.30			
3.82	3.62	4.14	0.84	0.40	2099
4.82	4.62	5.03	0.90	0.41	2175
5.82	5.62	5.97	0.93	0.41	2291
6.82	6.62	6.92	0.95	0.43	2198
7.82	7.62	7.88	0.96	0.41	2369
8.83	8.63	8.86	0.98	0.43	2280
9.85	9.65	9.86	1.00	0.45	2234

Job No: 25-05-29237 Client: Thurber Engineering Project: Bradford Bypass Sounding: SCPT25-HF21 Filter: BP 0-200Hz Date: 2025-03-26
Analysis: P Wave - Geo Z



Job No:	25-05-29237
Client:	Thurber Engineering
Project:	Bradford Bypass
Sounding ID:	SCPT25-HF21
Date:	2025-03-26

SCPTu POISSON'S RATIO RESULTS

Depth From (m)	Depth To (m)	Vs Interval Velocity (m/s)	Vp Interval Velocity (m/s)	Poisson's Ratio
2.62	3.62	566	2099	0.46
3.62	4.62	575	2175	0.46
4.62	5.62	624	2291	0.46
5.62	6.62	716	2198	0.44
6.62	7.62	543	2369	0.47
7.62	8.63	647	2280	0.46
8.63	9.65	786	2234	0.43

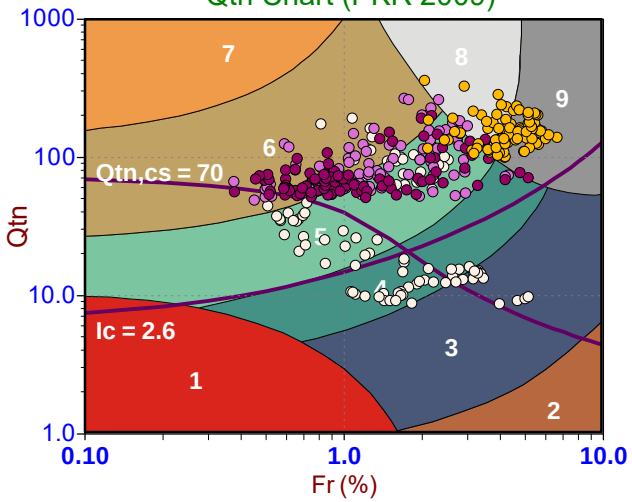
CONETEC

Thurber Engineering

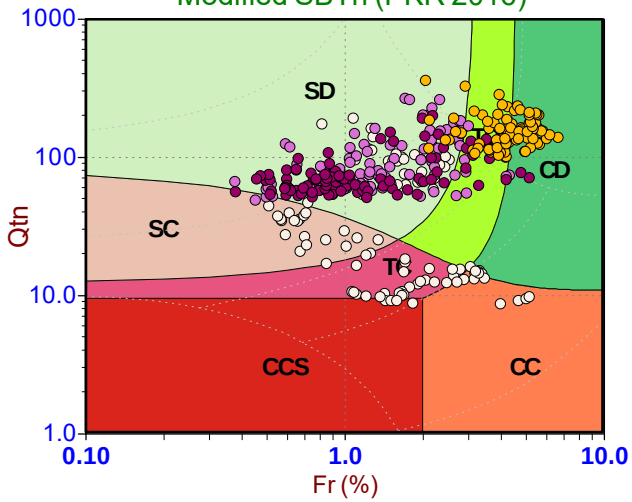
Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²

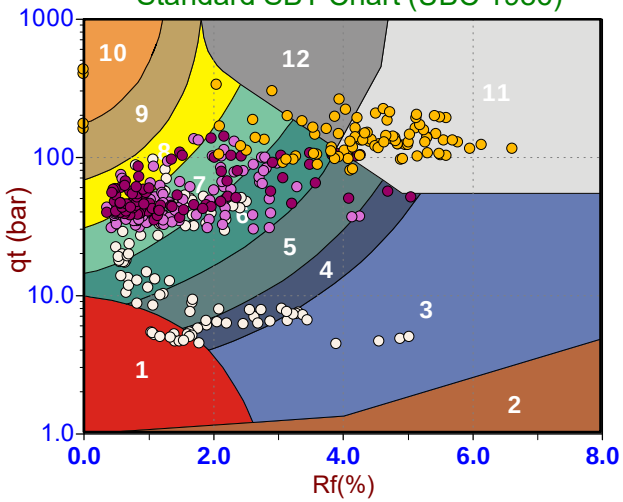
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 2.5 m
- >2.5 to 5.0 m
- >5.0 to 7.5 m
- >7.5 to 10.0 m
- >10.0 to 12.5 m
- >12.5 to 15.0 m
- >15.0 to 17.5 m
- >17.5 to 20.0 m
- >20.0 to 22.5 m
- >22.5 to 25.0 m
- >25.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- 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

Job No:	25-05-29237
Client:	Thurber Engineering Ltd.
Project:	Bradford Bypass
Start Date:	2025-03-25
End Date:	2025-03-31

CPTu PORE PRESSURE DISSIPATION SUMMARY

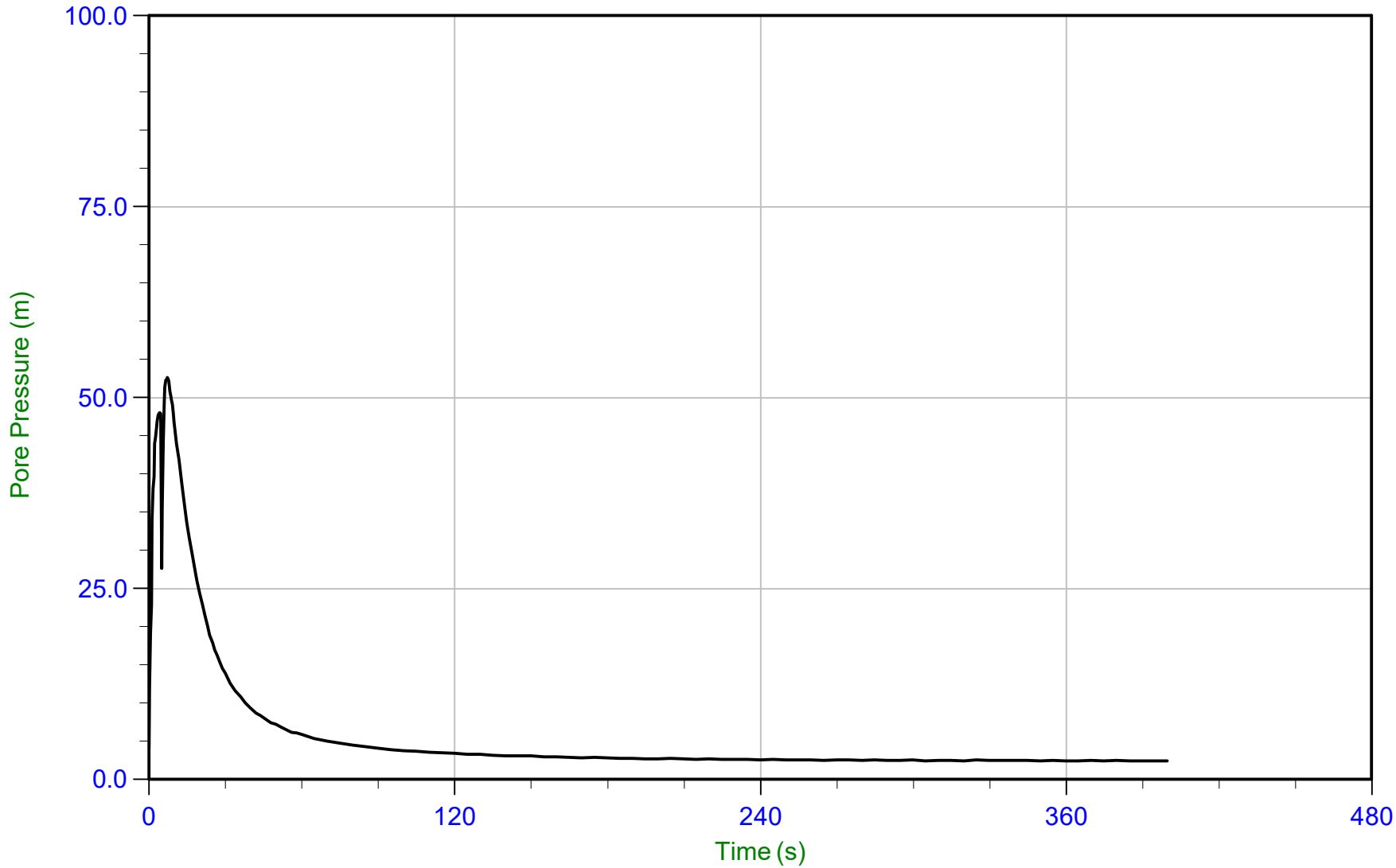
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Observed Equilibrium Pore Pressure U_{eq} (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Assumed Phreatic Surface (m)	t_{50} $(s)_1$	Assumed Rigidity Index (I_r)	c_h $(cm^2/min)_2$	Refer to Notation Number
SCPT25-HF19	25-05-29237_SP19	15	545	14.675		15.9	-1.2	90.8	100	7.7	4
SCPT25-HF21	25-05-29237_SP21	15	400	2.825	2.4		0.4				
SCPT25-HF21	25-05-29237_SP21	15	150	3.150		2.8	0.4	38.0	100	18.5	3
SCPT25-HF21	25-05-29237_SP21	15	180	4.825		4.4	0.4	33.0	100	21.3	3
SCPT25-HF21	25-05-29237_SP21	15	520	5.825	5.7		0.1				
SCPT25-HF21	25-05-29237_SP21	15	265	9.850							
SCPT25-HF21	25-05-29237_SP21	15	500	9.900		9.5	0.4	128.6	100	5.5	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	300	3.975		2.7	1.3	78.8	100	8.9	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	240	6.025							
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	600	9.975	8.7		1.3				
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	1630	11.975		10.7	1.3	549.3	100	1.3	3
SCPT25-HWY400-01	25-05-29237_SPHWY400-01	15	300	12.725	10.5		2.2				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	375	5.875		3.1	2.8	150.6	100	4.7	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	295	6.875		4.4	2.8	162.5	100	4.3	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	600	10.100	7.3		2.8				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	1050	14.000		11.2	2.8	401.2	100	1.7	3
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	170	18.850	15.3		3.5				
SCPT25-HWY400-14	25-05-29237_SPHWY400-14	15	550	19.250	15.9		3.4				
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	600	5.825							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	230	7.775							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	220	11.800	9.4		2.4				
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	245	15.900		13.5	2.4	44.5	100	15.8	3
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	180	16.800							
SCPT25-HWY400-16	25-05-29237_SPHWY400-16	15	380	18.050							

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 2.825 m / 9.268 ft
Duration: 400.0 s

u Min: 2.4 m
u Max: 52.6 m
u Final: 2.4 m

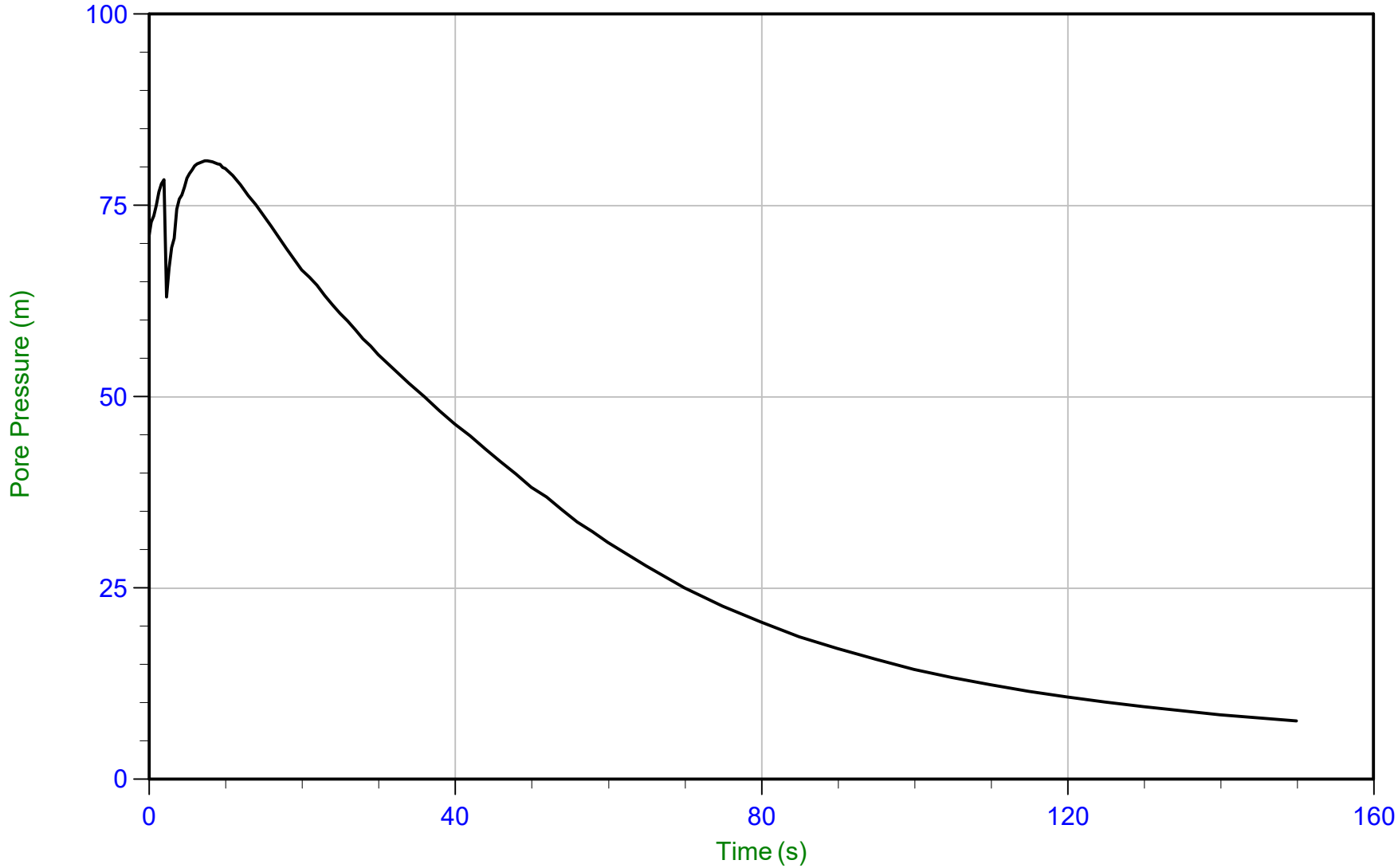
WT: 0.4 m / 1.4 ft
Ueq: 2.4 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 3.150 m / 10.335 ft
Duration: 150.0 s

u Min: 7.6 m
u Max: 80.8 m
u Final: 7.6 m

WT: 0.4 m / 1.3 ft
Ueq: 2.8 m
U(50): 41.79 m

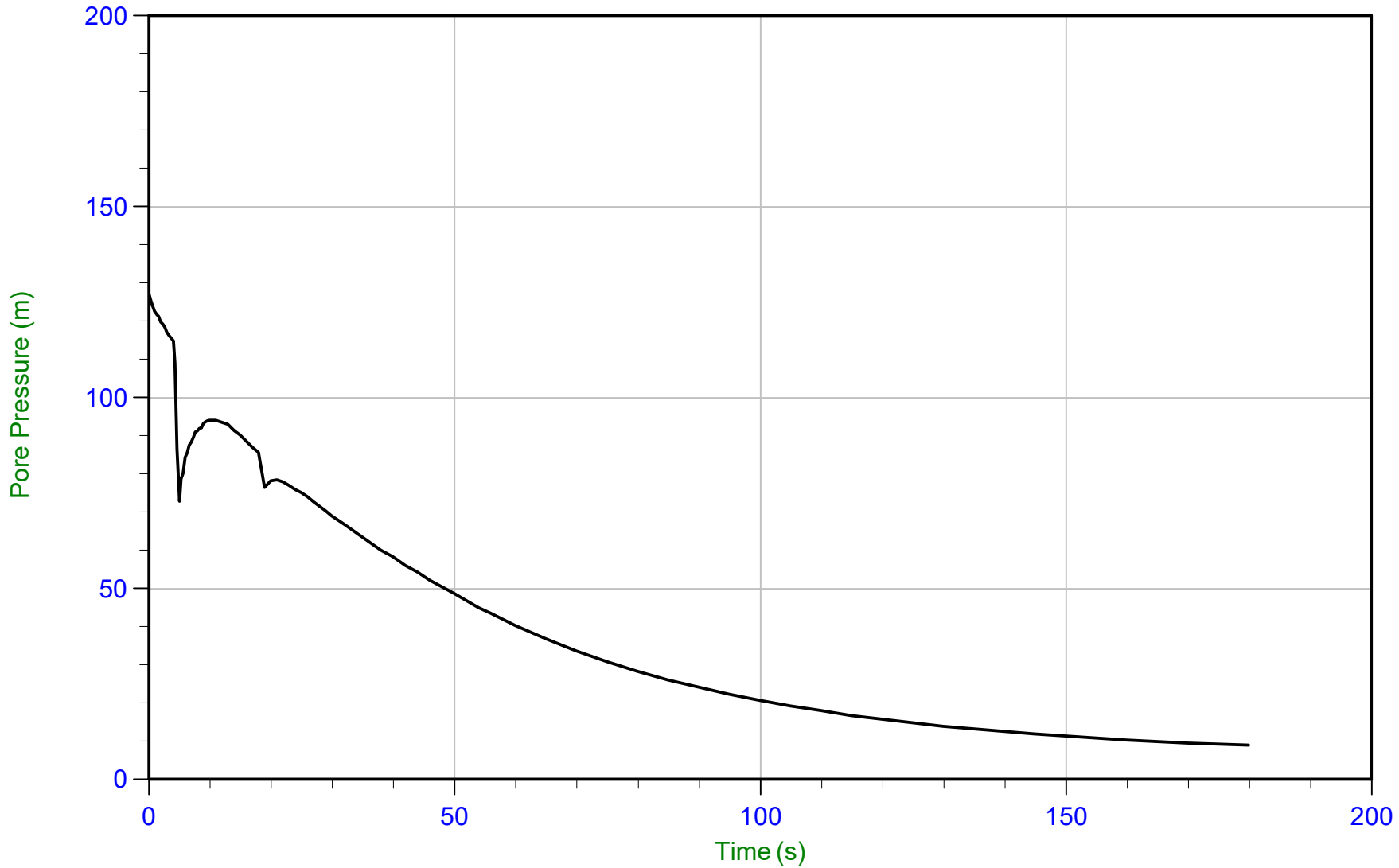
T(50): 38.0 s
Ir: 100
Ch: 18.5 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 4.825 m / 15.830 ft
Duration: 180.0 s

u Min: 9.0 m
u Max: 127.1 m
u Final: 9.0 m

WT: 0.4 m / 1.3 ft
Ueq: 4.4 m
U(50): 65.77 m

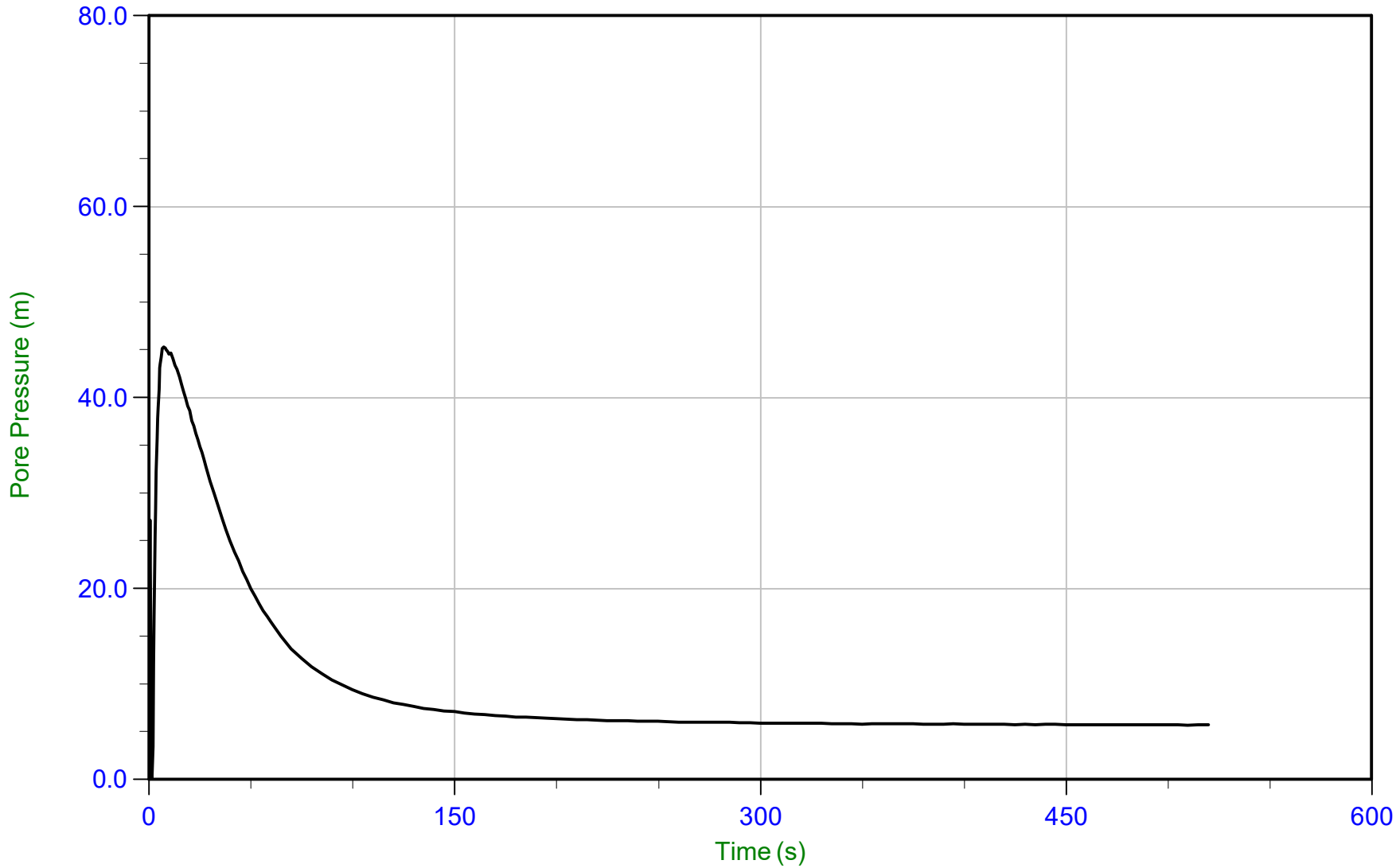
T(50): 33.0 s
Ir: 100
Ch: 21.3 cm²/min

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 5.825 m / 19.111 ft
Duration: 520.0 s

u Min: -1.1 m
u Max: 45.3 m
u Final: 5.7 m

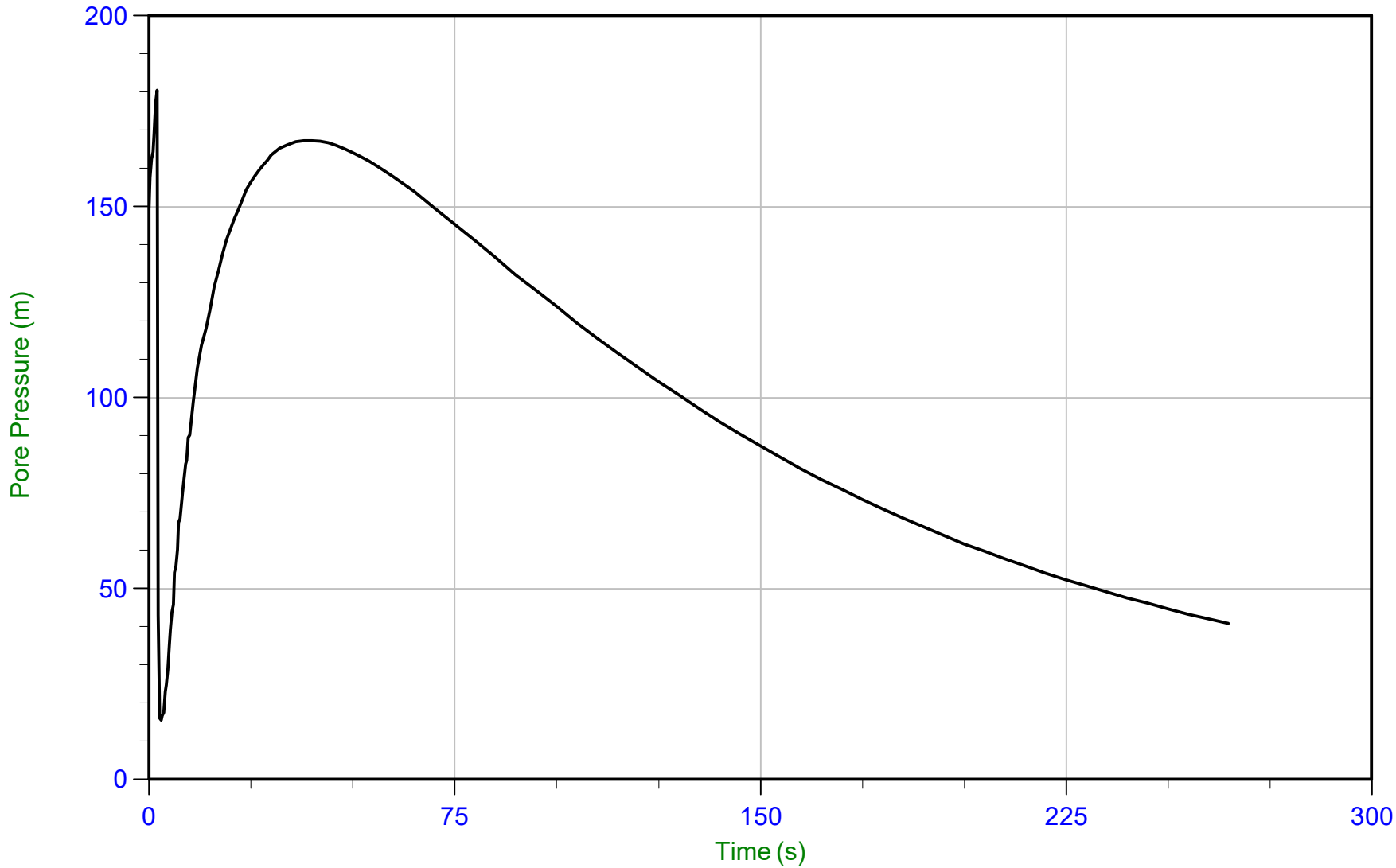
WT: 0.1 m / 0.4 ft
Ueq: 5.7 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 9.850 m / 32.316 ft
Duration: 265.0 s

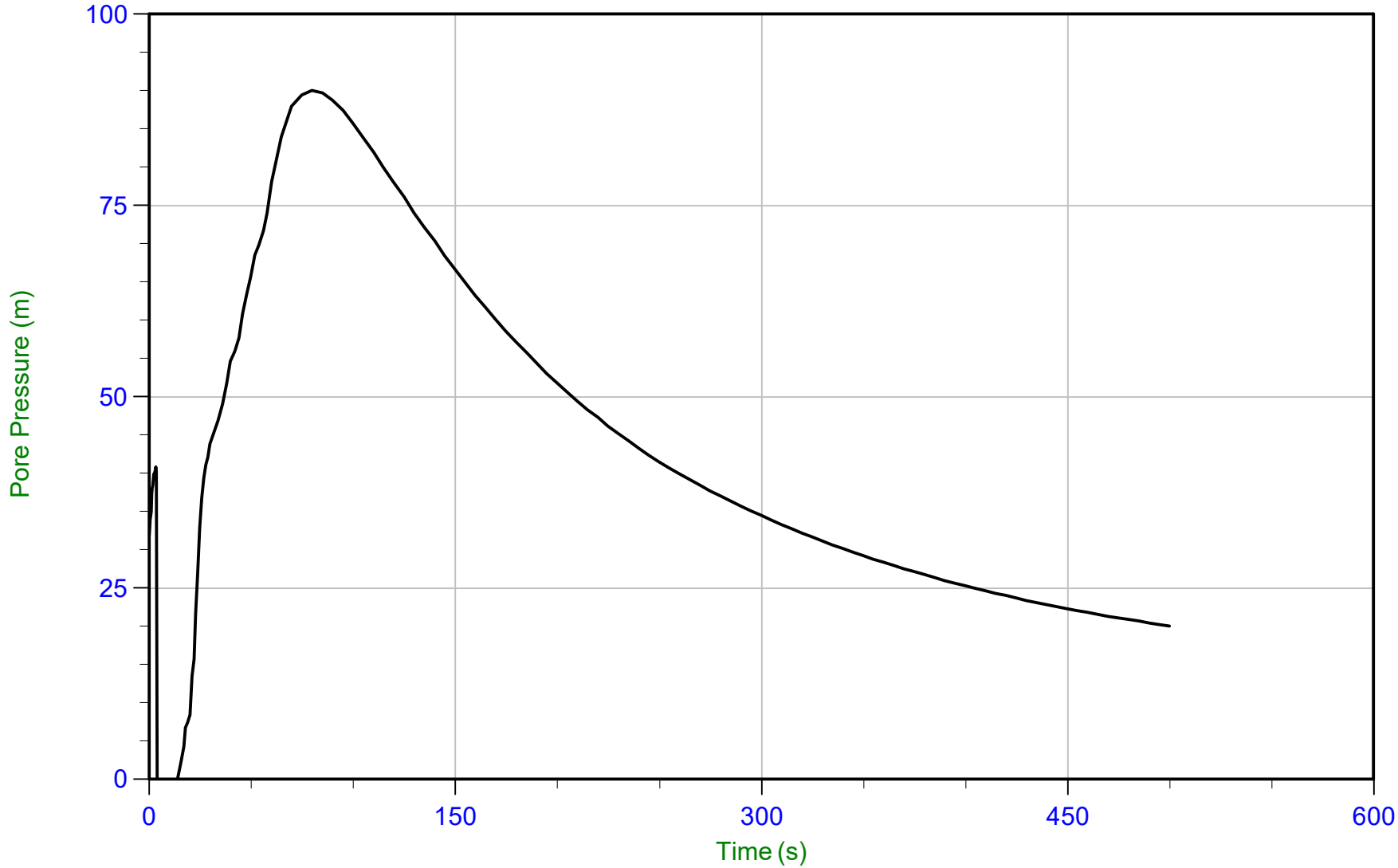
u Min: 15.5 m
u Max: 180.5 m
u Final: 40.8 m

CONETEC

Thurber Engineering

Job No: 25-05-29237
Date: 2025-03-26 12:14
Site: Bradford Bypass

Sounding: SCPT25-HF21
Cone: 948:T1000F10U35 Area=15 cm²



Trace Summary:

Filename: 25-05-29237_SP21.PPF2
Depth: 9.900 m / 32.480 ft
Duration: 500.0 s

u Min: -9.4 m
u Max: 90.0 m
u Final: 20.0 m

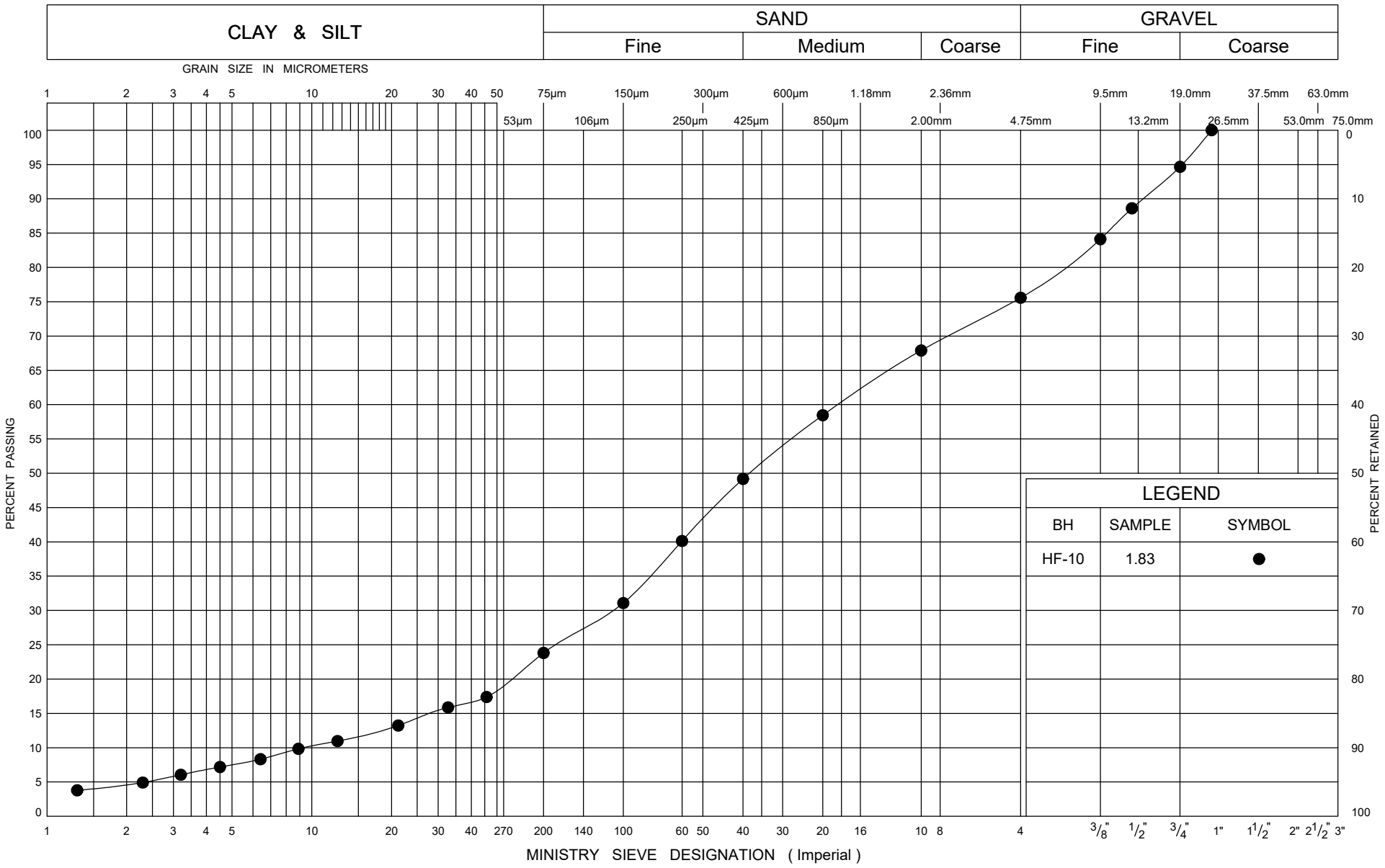
WT: 0.4 m / 1.3 ft
Ueq: 9.5 m
U(50): 49.76 m

T(50): 128.6 s
Ir: 100
Ch: 5.5 cm²/min

THURBER

APPENDIX E

Geotechnical Laboratory Test Results



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

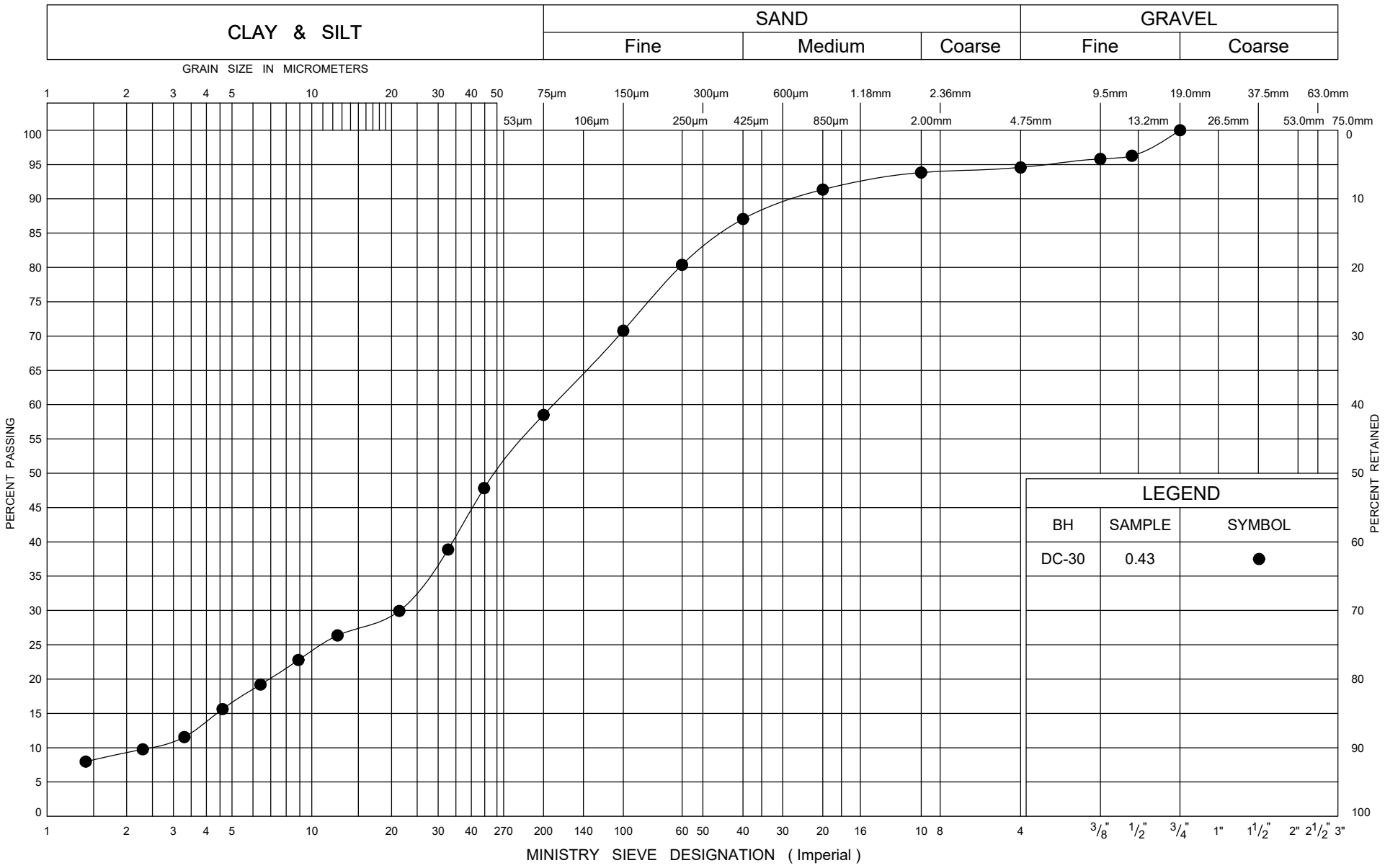
Silty SAND FILL

FIG No 1

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Sandy Silty CLAY FILL

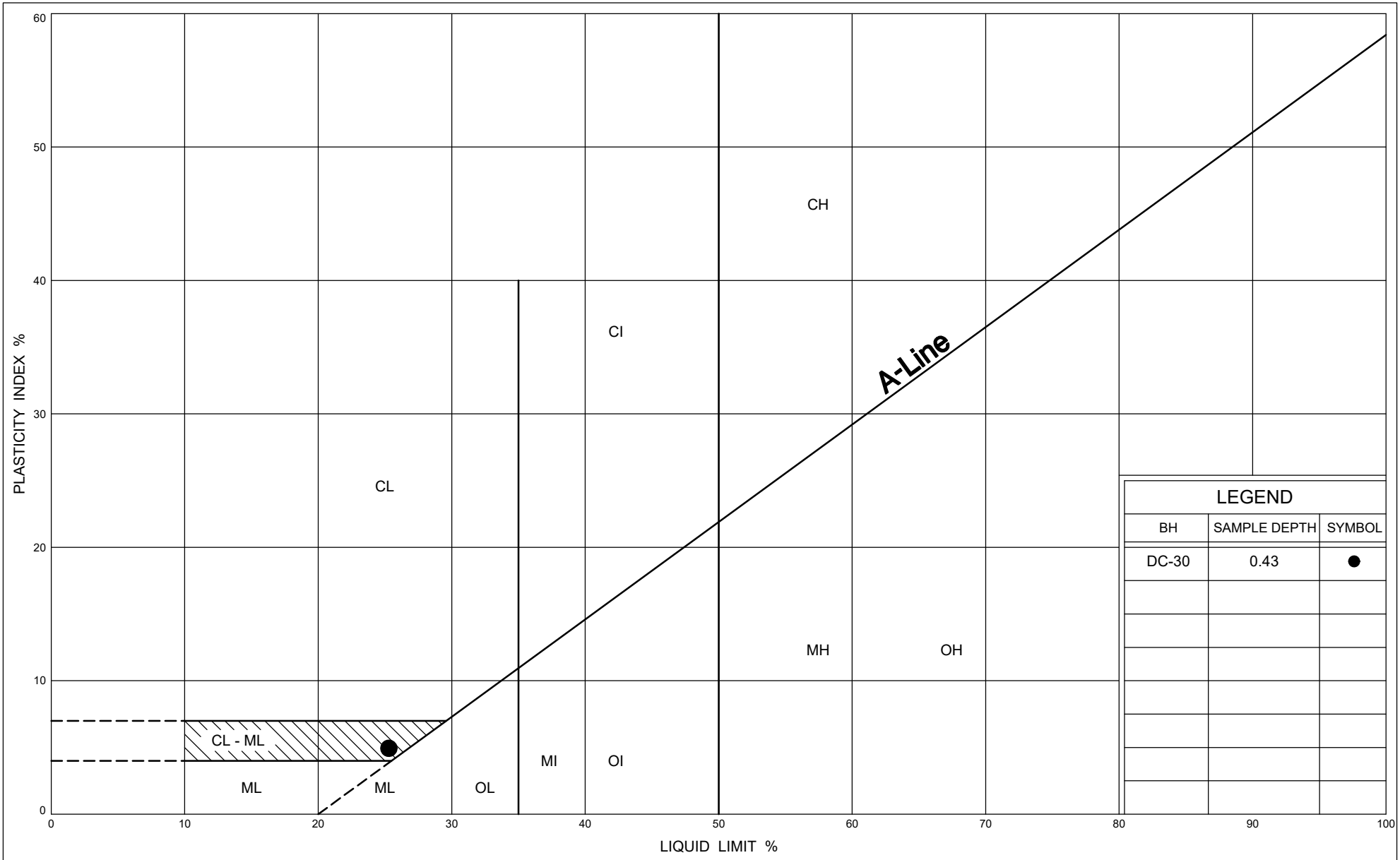
FIG No 2

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25

Ministry of Transportation
Ontario

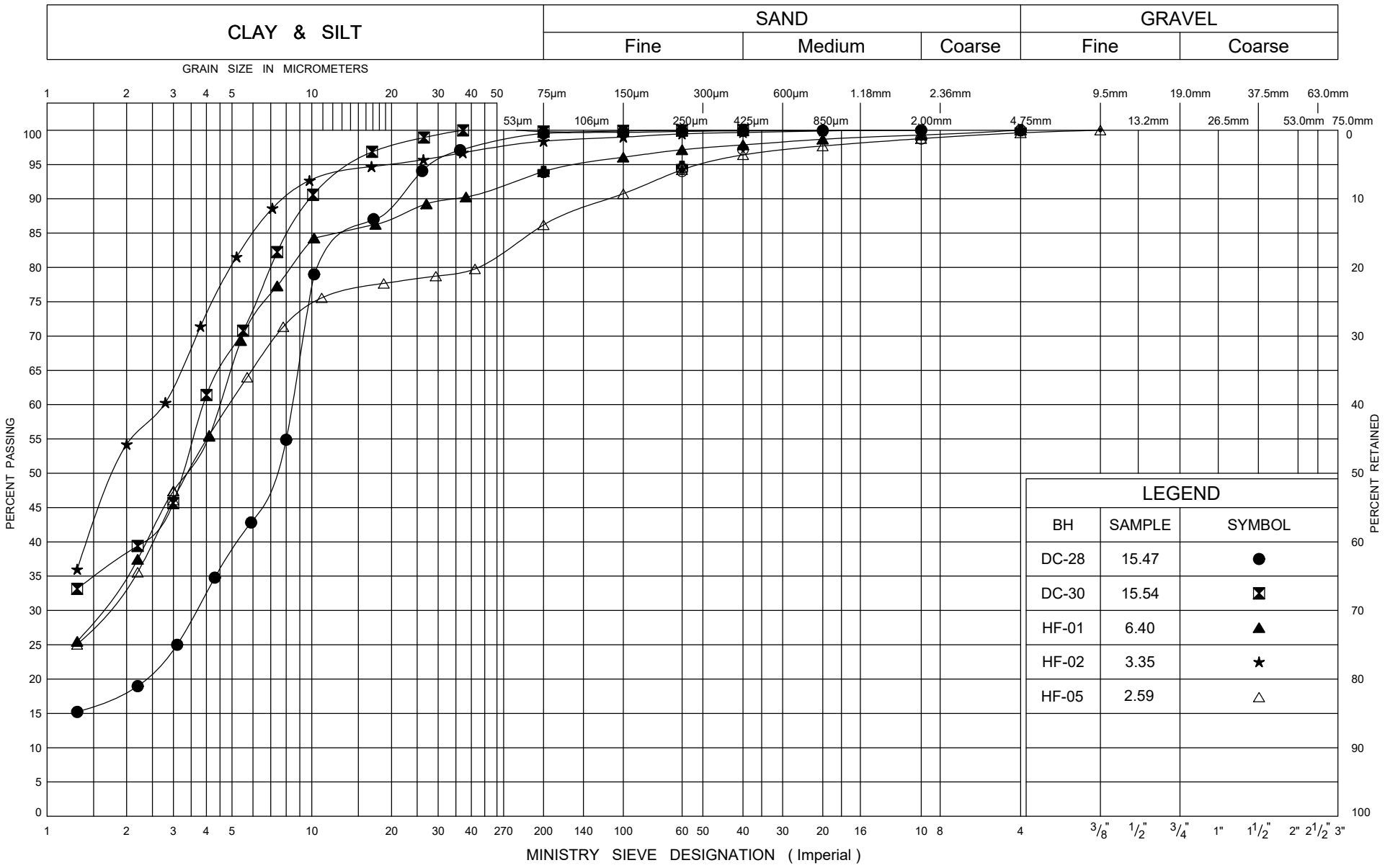
PLASTICITY CHART

Sandy Silty CLAY FILL

FIG No 3

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.



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GRAIN SIZE DISTRIBUTION

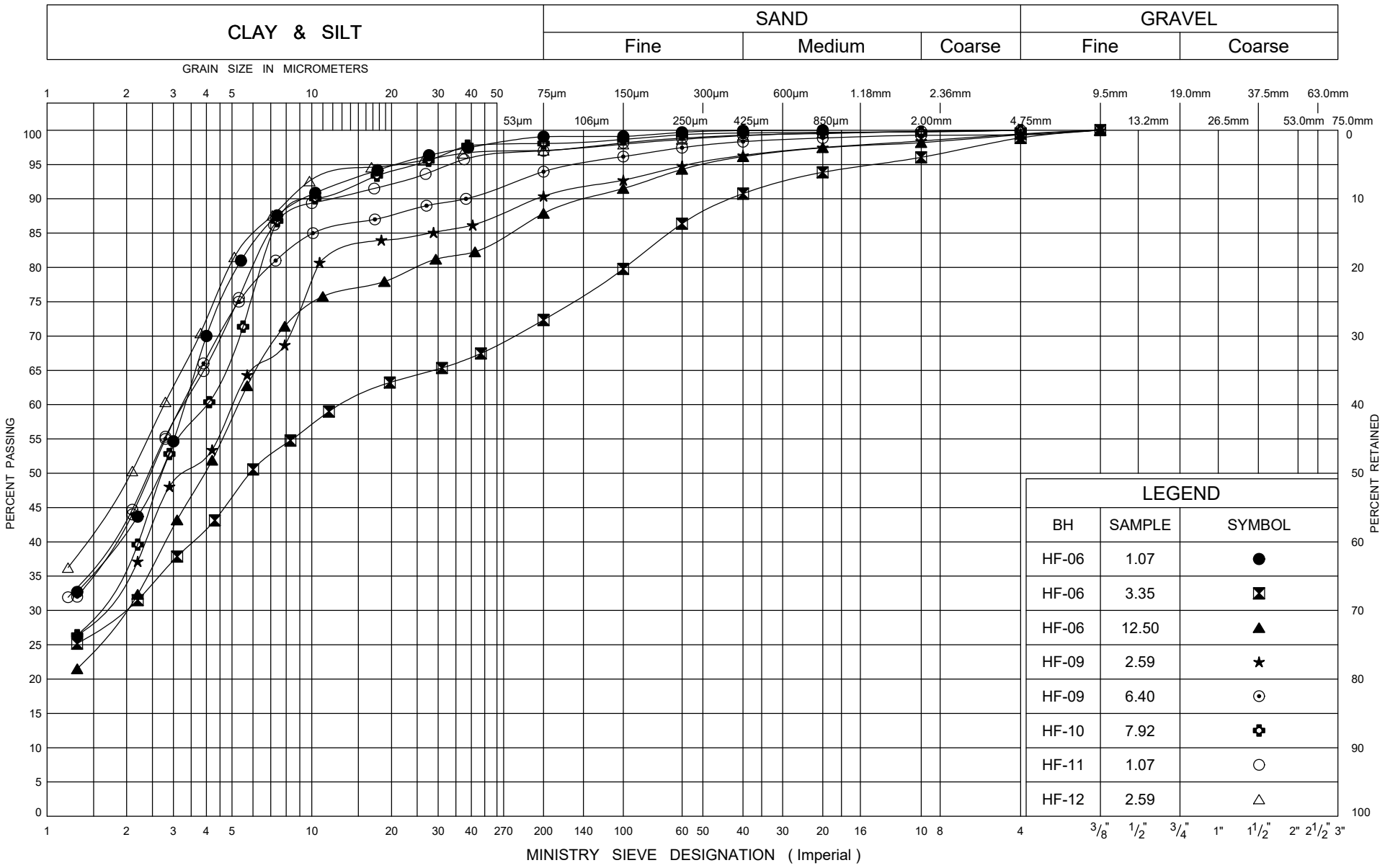
CLAY, Silty CLAY and CLAY with SAND

FIG No 4A

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/14/25



Ministry of Transportation
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GRAIN SIZE DISTRIBUTION

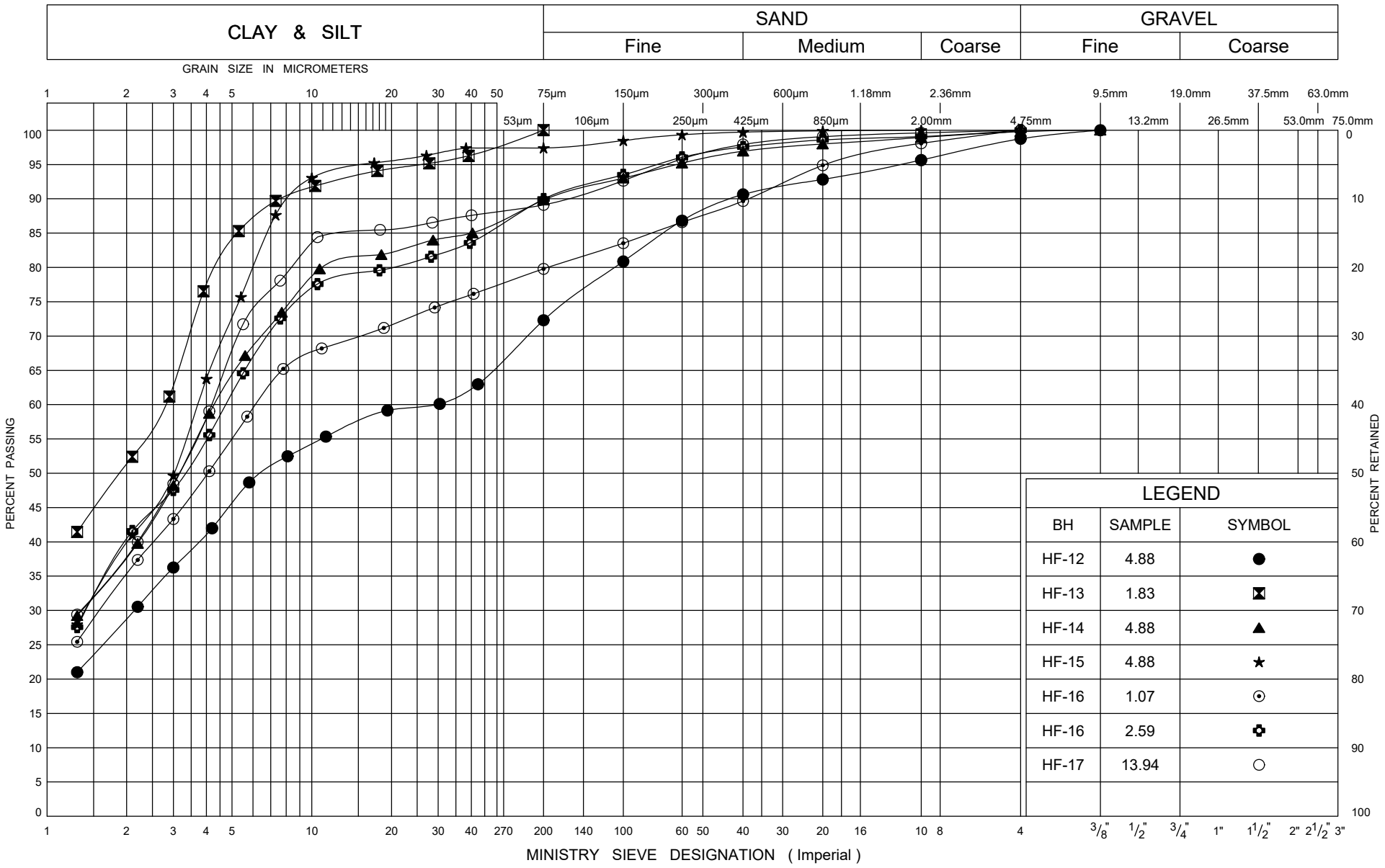
CLAY, Silty CLAY and CLAY with SAND

FIG No 4B

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/14/25



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

CLAY, Silty CLAY and CLAY with SAND

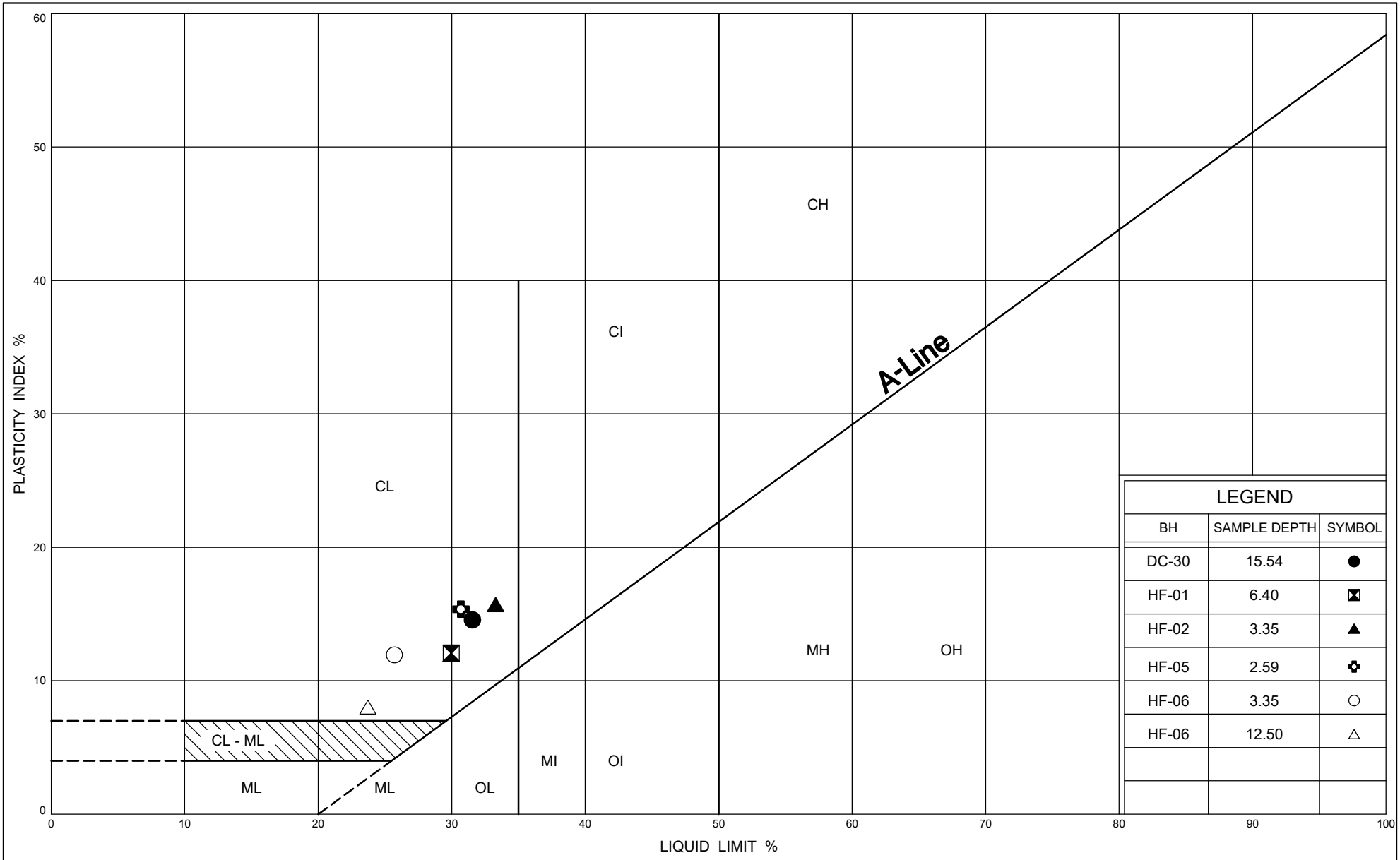
FIG No 4C

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 8/5/25

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
DC-30	15.54	●
HF-01	6.40	⊠
HF-02	3.35	▲
HF-05	2.59	✿
HF-06	3.35	○
HF-06	12.50	△

Ministry of Transportation
Ontario

PLASTICITY CHART

CLAY, Silty CLAY and CLAY with SAND

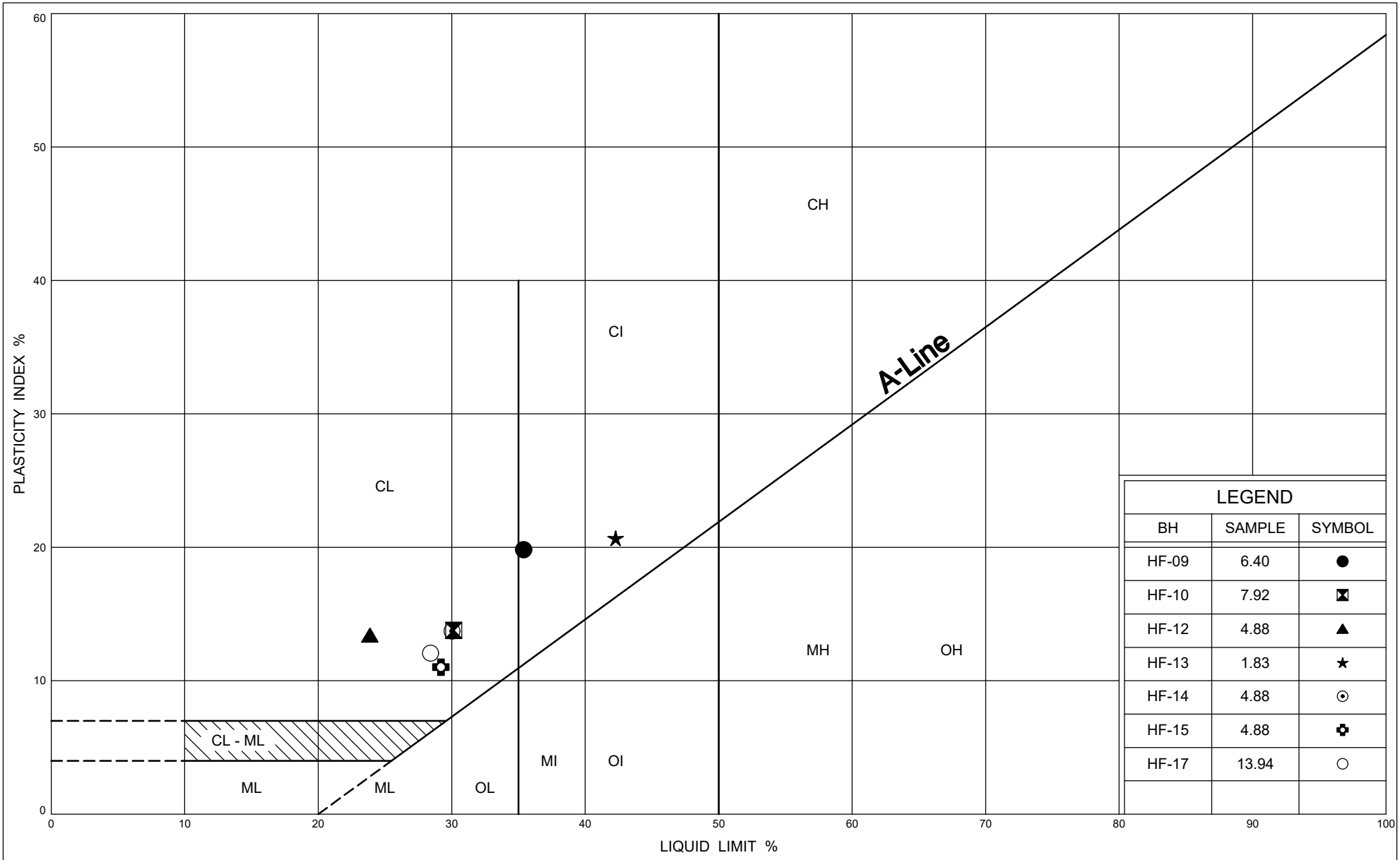
FIG No 5A

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT PLASTICITY CHART 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-48856.GPJ ONTARIO MOT.GDT 8/5/25

Ministry of Transportation
Ontario

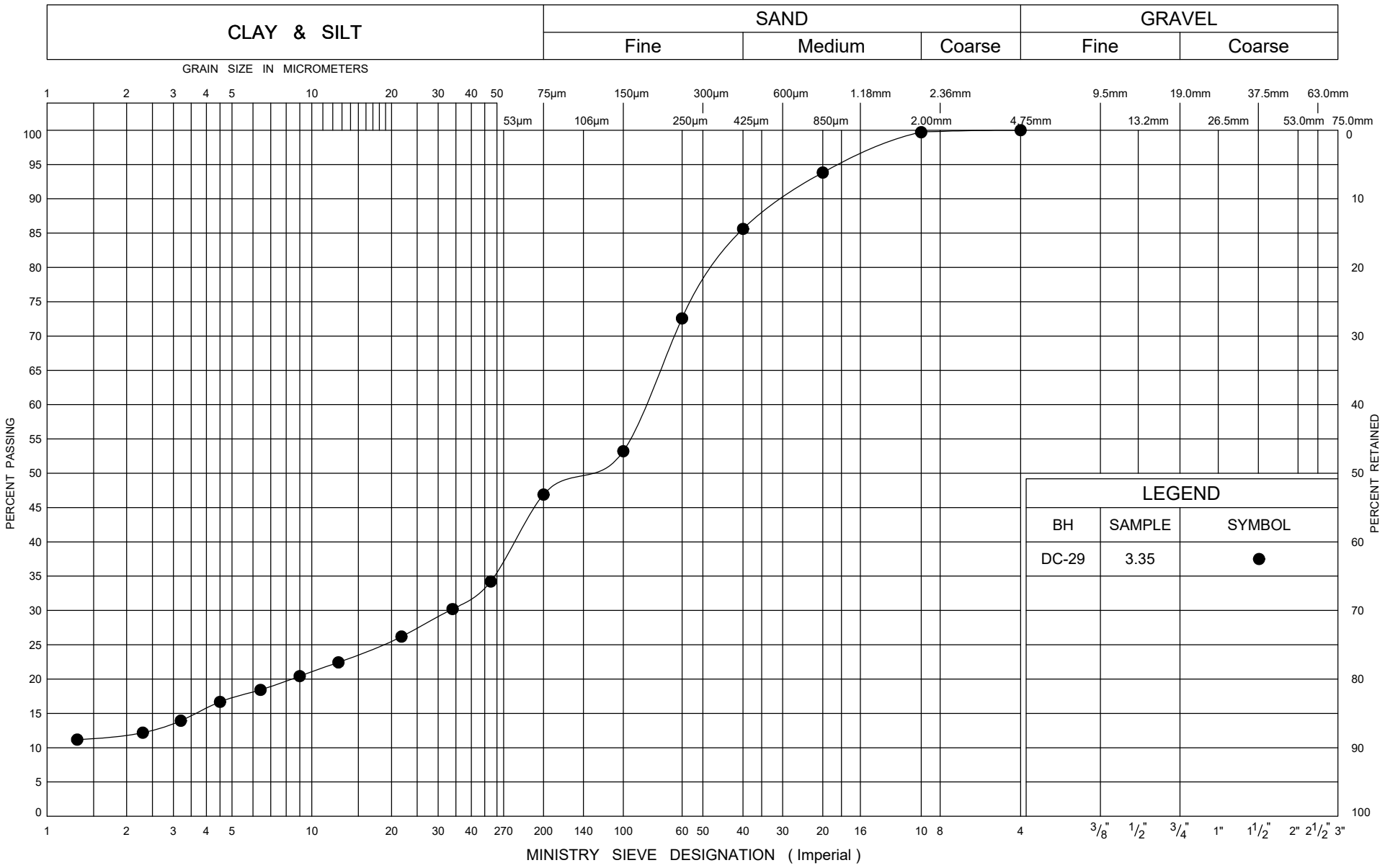
PLASTICITY CHART

CLAY, Silty CLAY and CLAY with SAND

FIG No 5B

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

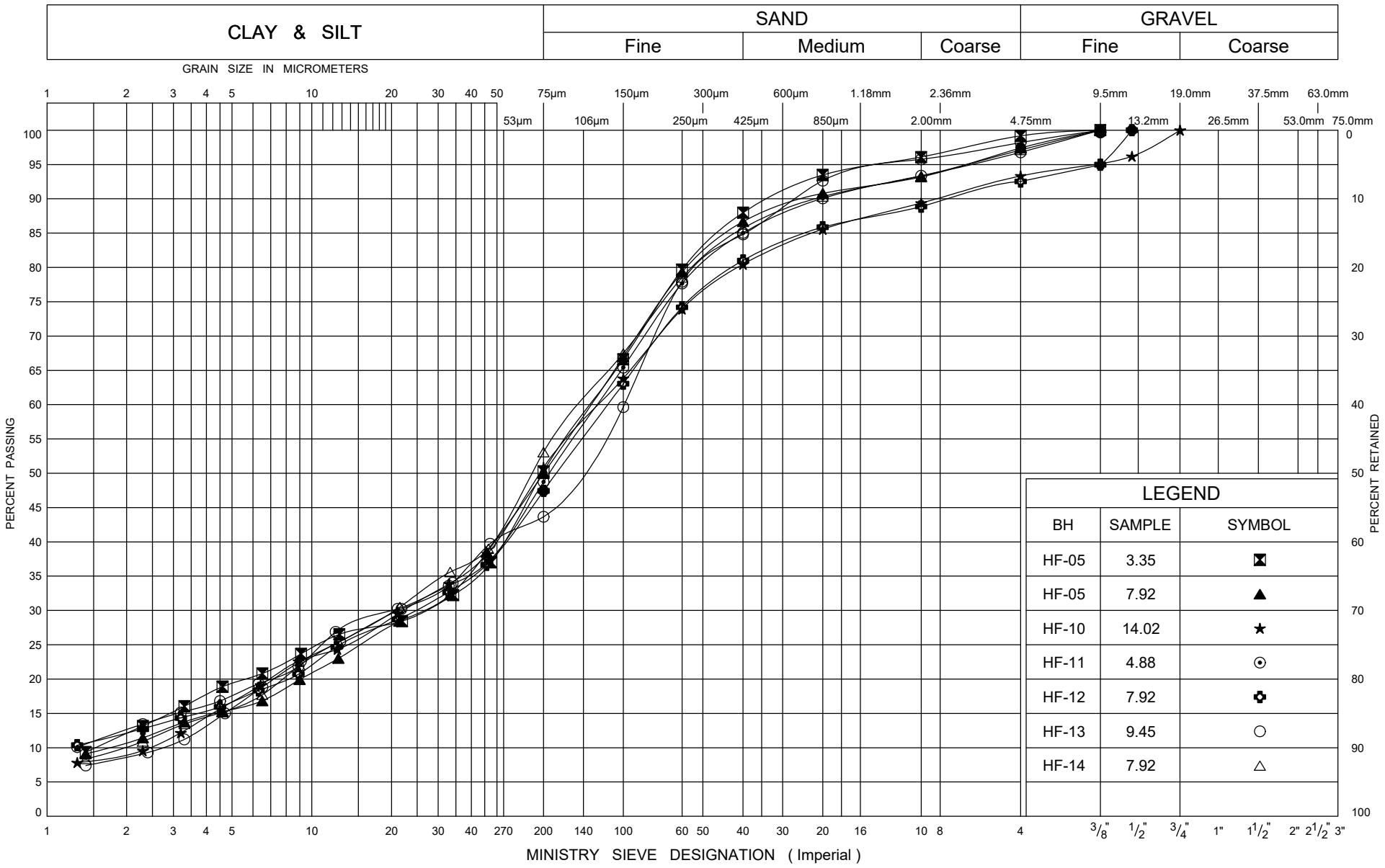
SILTY SAND

FIG No 6

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

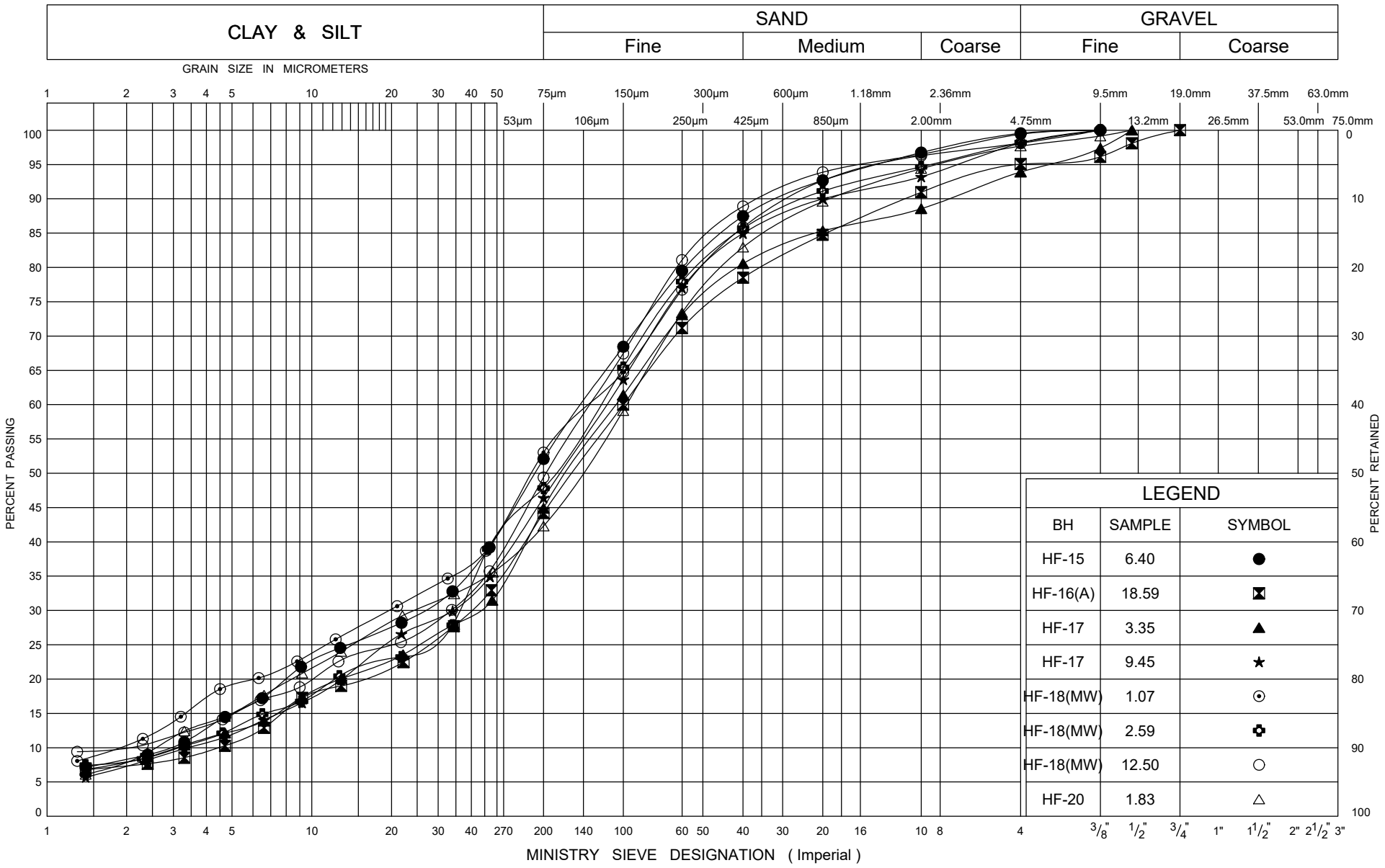
Sandy SILT TILL, Silty SAND TILL, Clayey SAND TILL

FIG No 7A

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 9/22/25



ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 9/22/25

Ministry of Transportation
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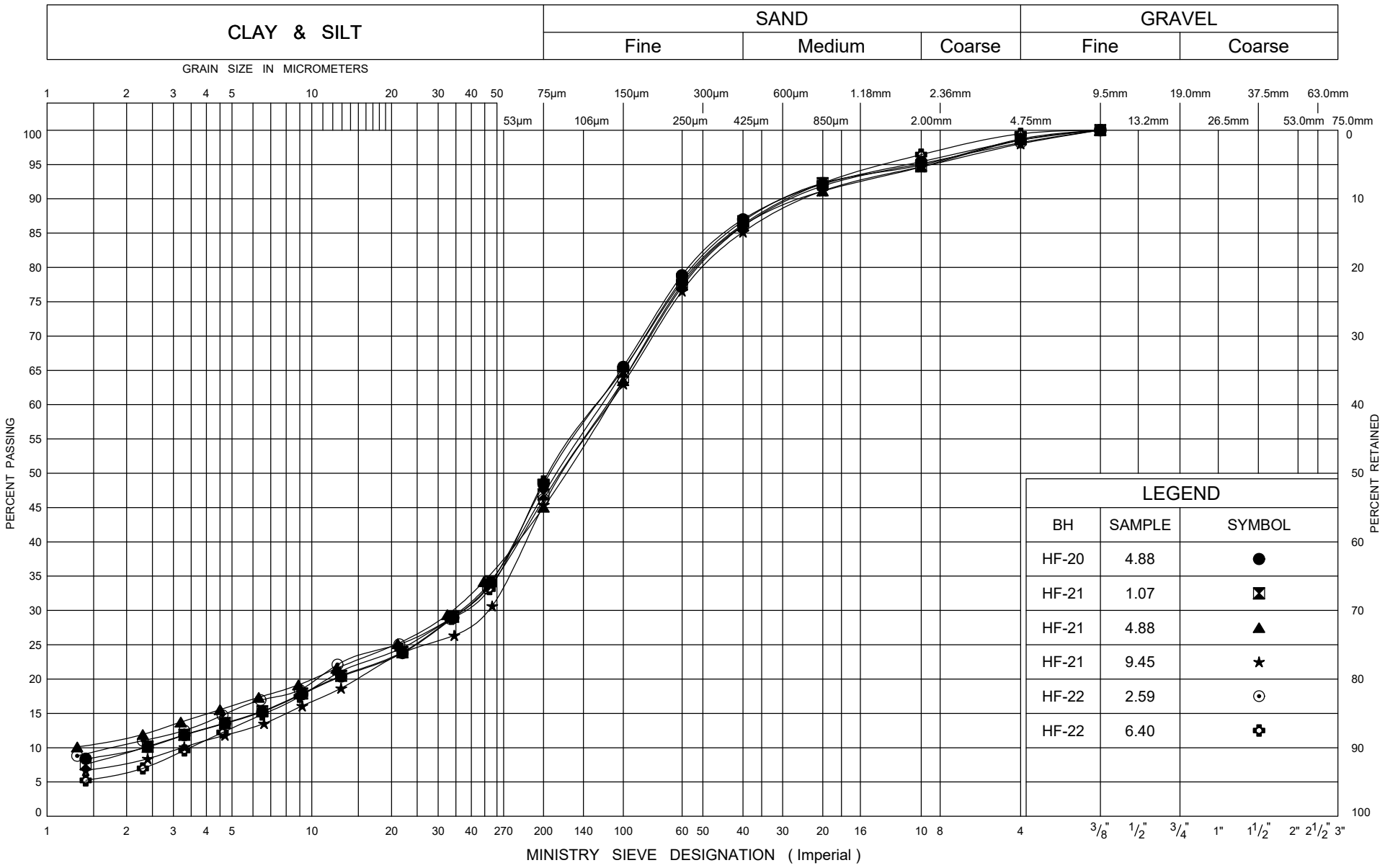
GRAIN SIZE DISTRIBUTION

Sandy SILT TILL, Silty SAND TILL, Clayey SAND TILL

FIG No 7B

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.



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GRAIN SIZE DISTRIBUTION

Sandy SILT TILL, Silty SAND TILL, Clayey SAND TILL

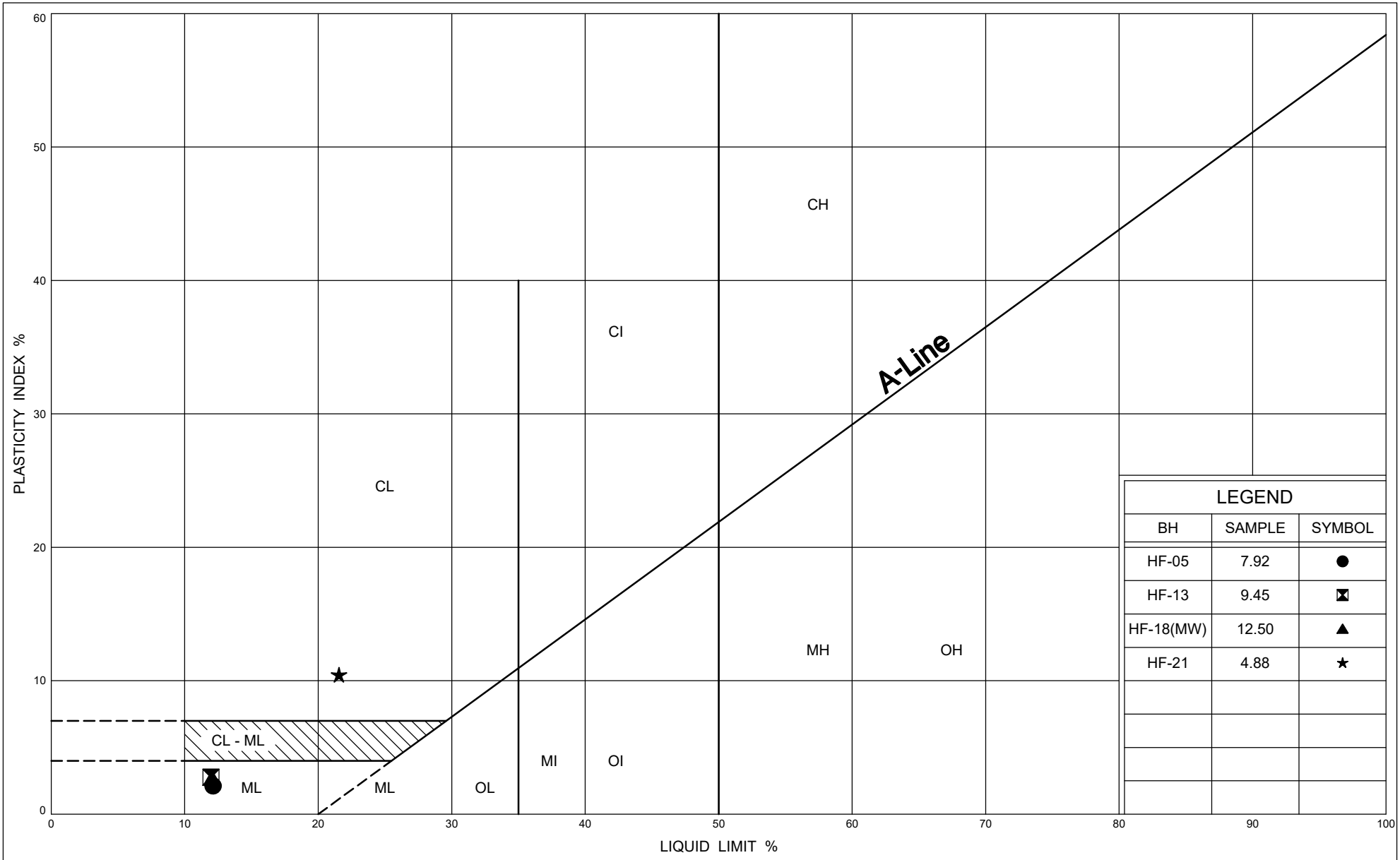
FIG No 7C

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 9/30/25

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-48856.GPJ ONTARIO MOT.GDT 9/30/25

Ministry of Transportation
Ontario

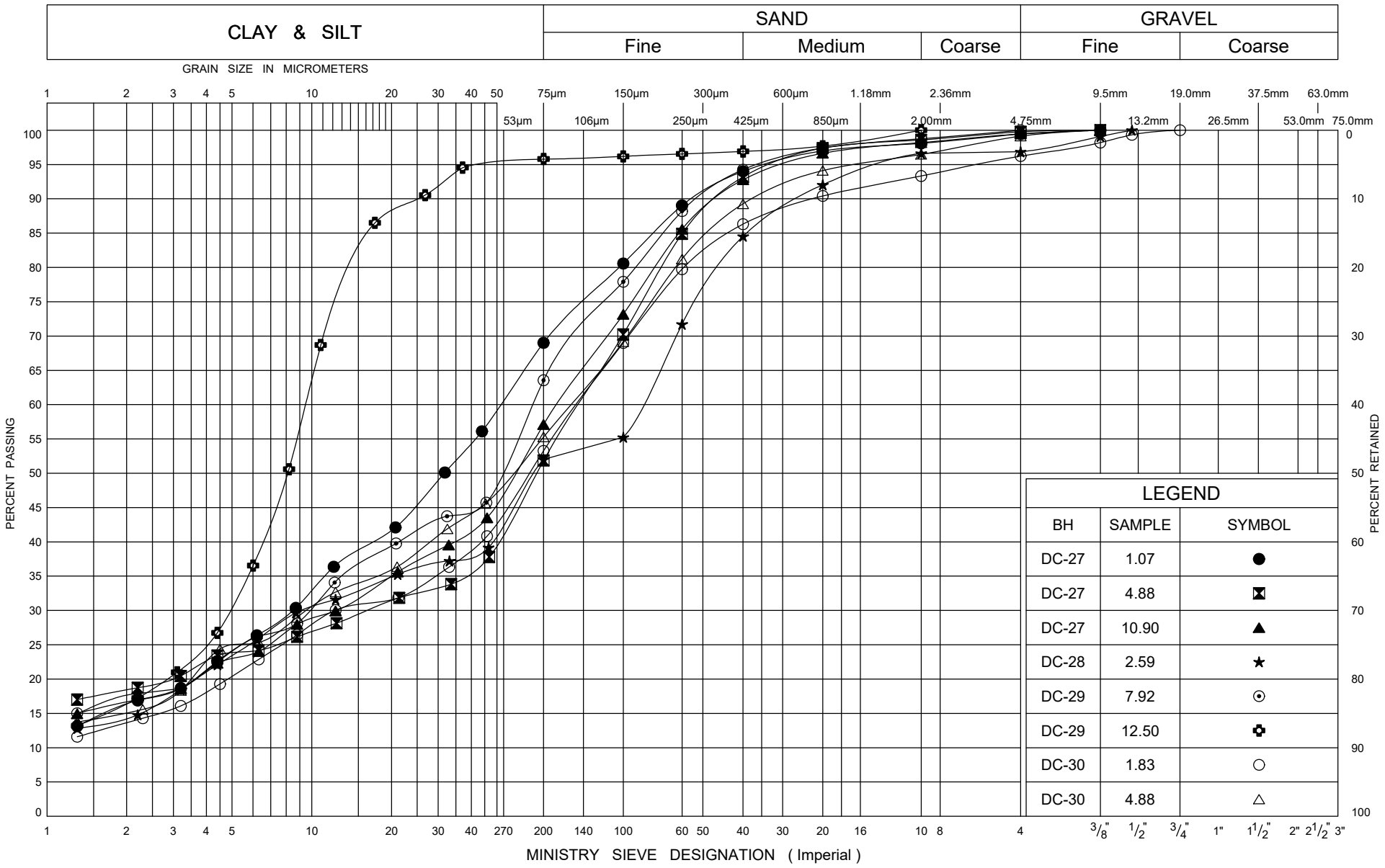
PLASTICITY CHART

Sandy SILT TILL, Silty SAND TILL, Clayey SAND TILL

FIG No 8

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.



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GRAIN SIZE DISTRIBUTION

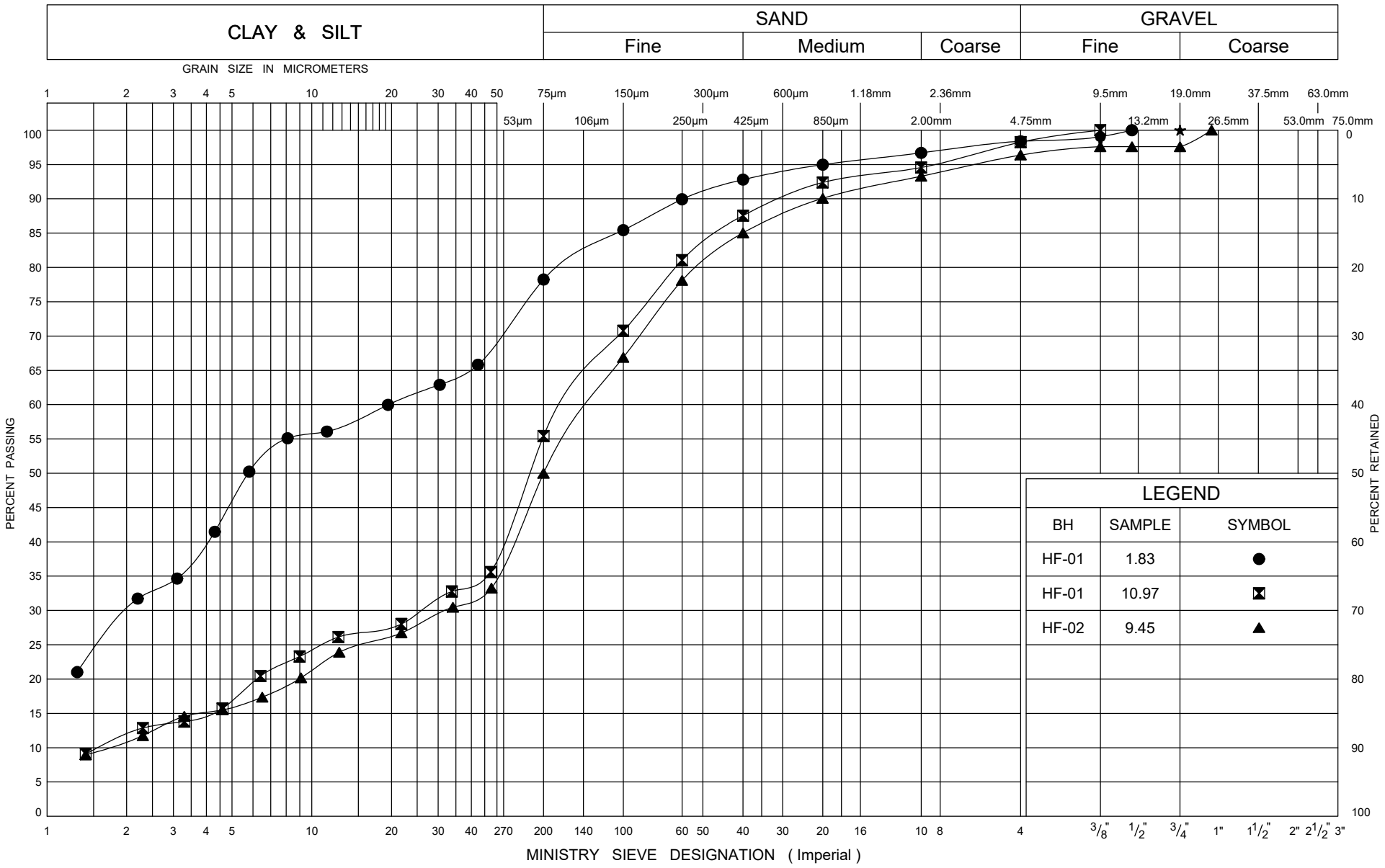
Silty CLAY TILL, Sandy Silty CLAY TILL,
CLAY with SAND TILL and Sandy CLAY TILL

FIG No 9A

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/14/25



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GRAIN SIZE DISTRIBUTION

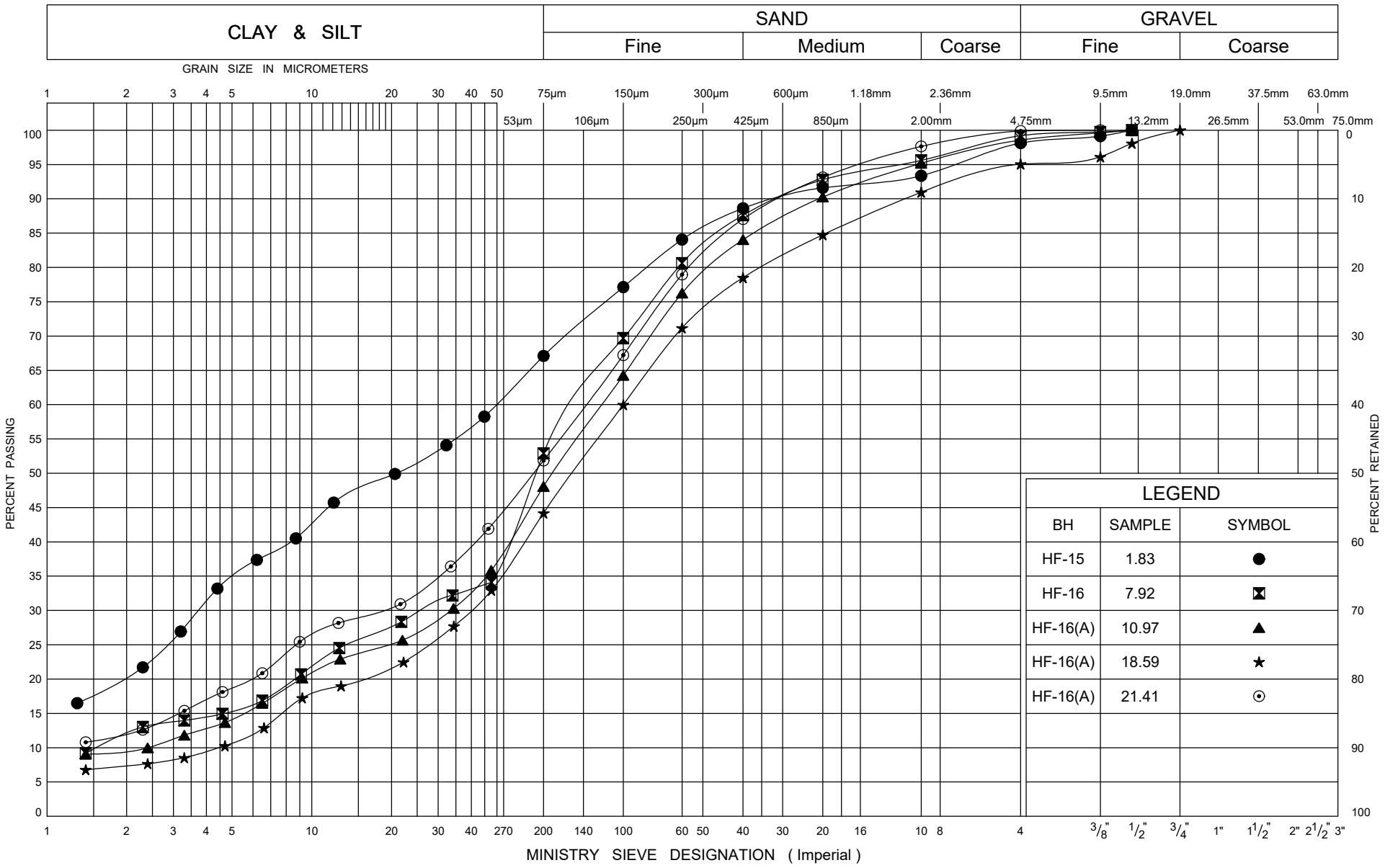
Silty CLAY TILL, Sandy Silty CLAY TILL,
CLAY with SAND TILL and Sandy CLAY TILL

FIG No 9B

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/14/25



ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 9/30/25

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

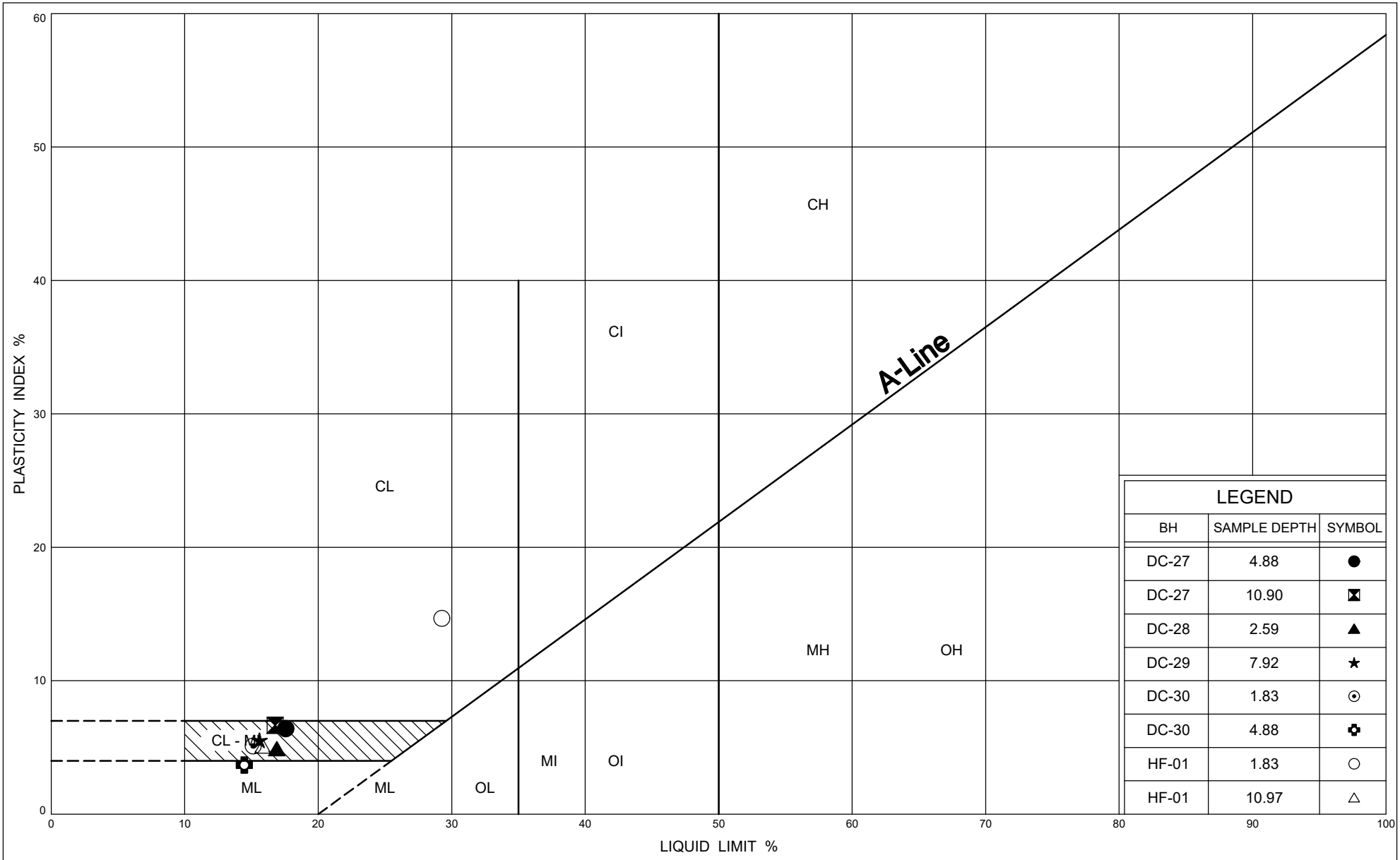
Silty CLAY TILL, Sandy Silty CLAY TILL,
CLAY with SAND TILL and Sandy CLAY TILL

FIG No 9C

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
DC-27	4.88	●
DC-27	10.90	⊠
DC-28	2.59	▲
DC-29	7.92	★
DC-30	1.83	⊙
DC-30	4.88	✿
HF-01	1.83	○
HF-01	10.97	△

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Ontario

PLASTICITY CHART

Silty CLAY TILL, Sandy Silty CLAY TILL,
CLAY with SAND TILL and Sandy CLAY TILL

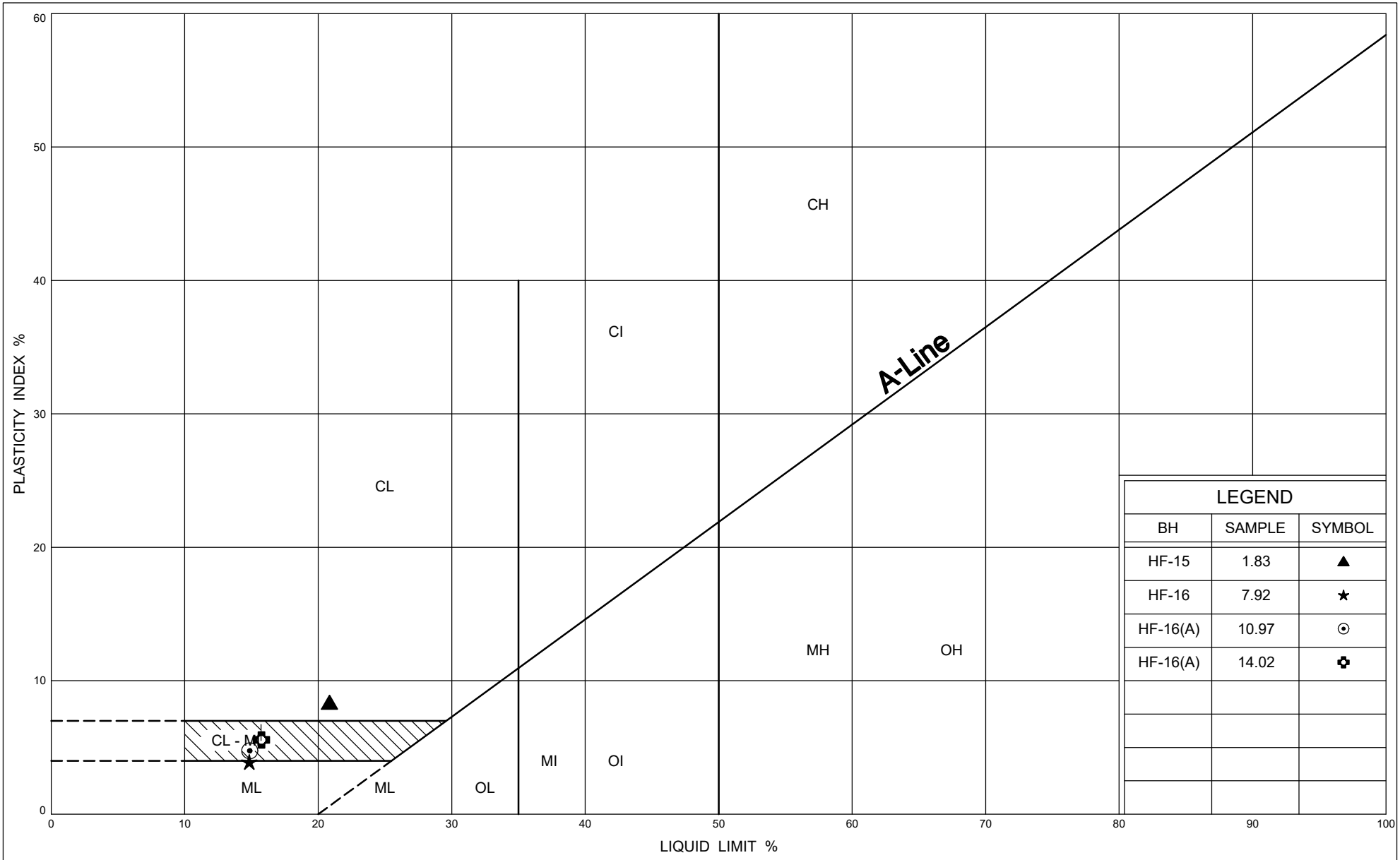
FIG No 10A

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

ONTARIO MOT PLASTICITY CHART 2 MTO-48856.GPJ ONTARIO MOT.GDT 7/11/25

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-48856.GPJ ONTARIO MOT.GDT 9/30/25

Ministry of Transportation
Ontario

PLASTICITY CHART

Silty CLAY TILL, Sandy Silty CLAY TILL,
CLAY with SAND TILL and Sandy CLAY TILL

FIG No 10B

W.P.

High Fills and Deep Cut-Hwy 400, 9th L.

THURBER

APPENDIX F

Seismic Hazard Values (2020 National Building Code of Canada)

Government of Canada / Gouvernement du Canada

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_S	X_C
Latitude (°)	44.118
Longitude (°)	-79.632

Please select one of the tabs below.

NBC 2020 | Additional Values | Plots | API | Background Information

The 5%-damped spectral acceleration (S_a(T,X), where T is the period, in s, and X is the site designation) and peak ground acceleration (PGA(X)) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak

ground velocity (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.221	0.154	0.0876	0.0424	0.0114	0.00397	0.102	0.0995

The log-log interpolated 2%/50 year $S_a(4.0, X_C)$ value is : **0.0157**

▶ Tables for 5% and 10% in 50 year values

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06

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APPENDIX G

Slope Stability Outputs/Figures

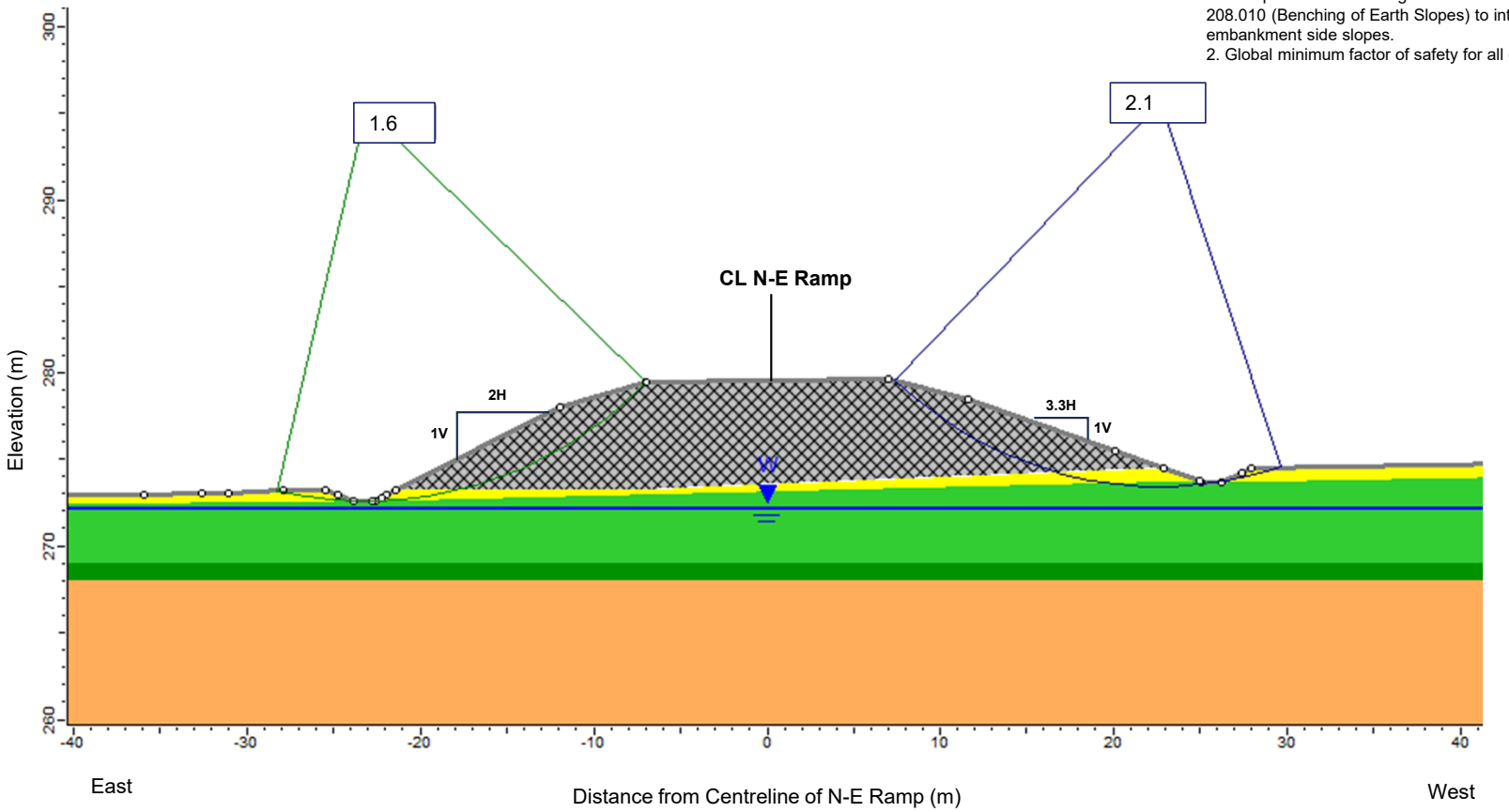
THURBER

HIGH FILL-Highway 400 N-E Ramp South of 9th Line
Global Slope Stability – Permanent Condition
Approximate Station 10+380

Figure G1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Silty Sand		21	Mohr-Coulomb	0	32
Upper Clay (drained)		20	Mohr-Coulomb	0	32
Clay with Sand (Drained)		21	Mohr-Coulomb	0	30
Silty Sand Till		21	Mohr-Coulomb	0	33

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

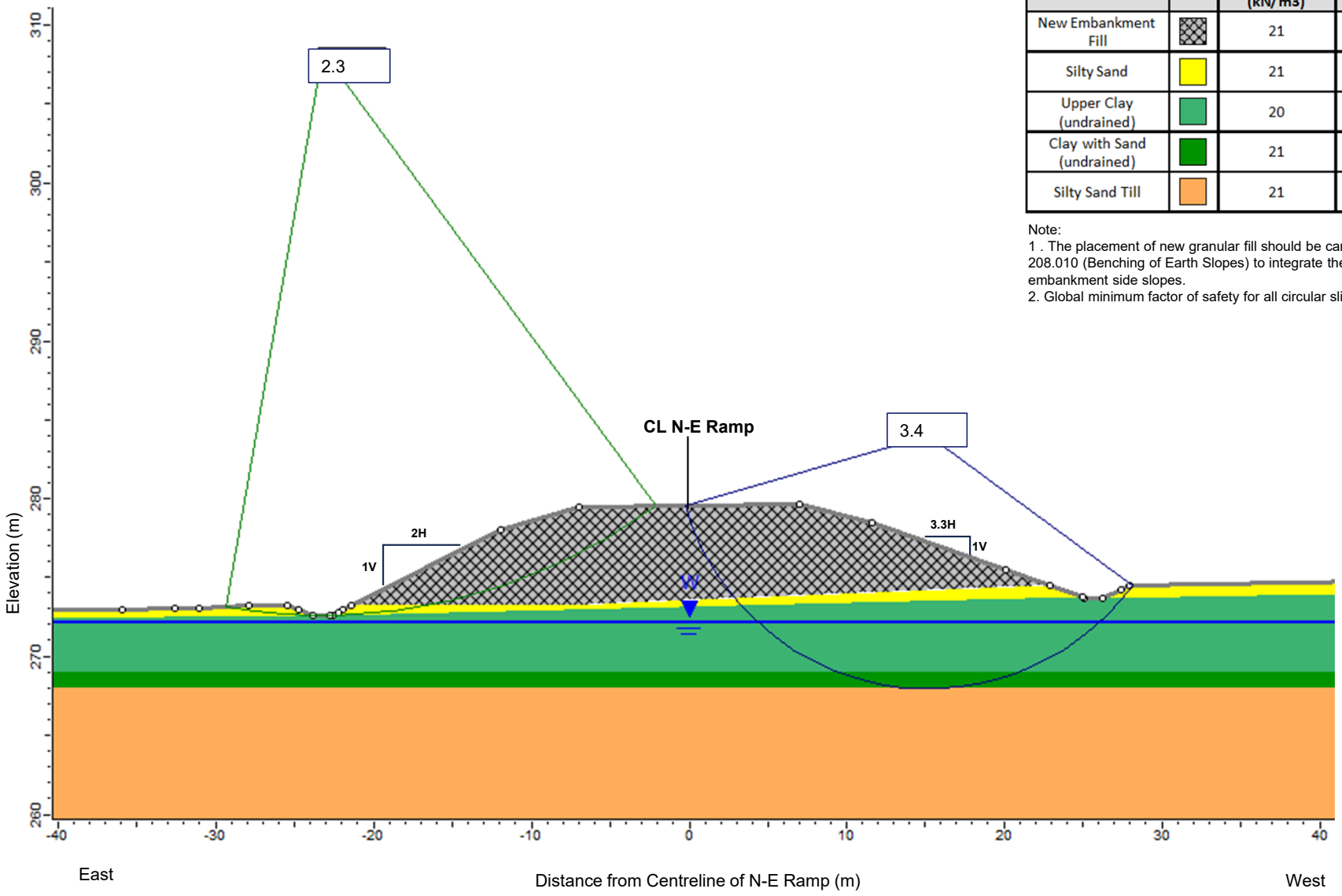
THURBER

HIGH FILL-Highway 400 N-E Ramp South of 9th Line
Global Slope Stability - Temporary Condition
Approximate Station 10+380

Figure G2

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Silty Sand		21	Mohr-Coulomb	0	32
Upper Clay (undrained)		20	Undrained	85	0
Clay with Sand (undrained)		21	Undrained	55	0
Silty Sand Till		21	Mohr-Coulomb	0	33

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

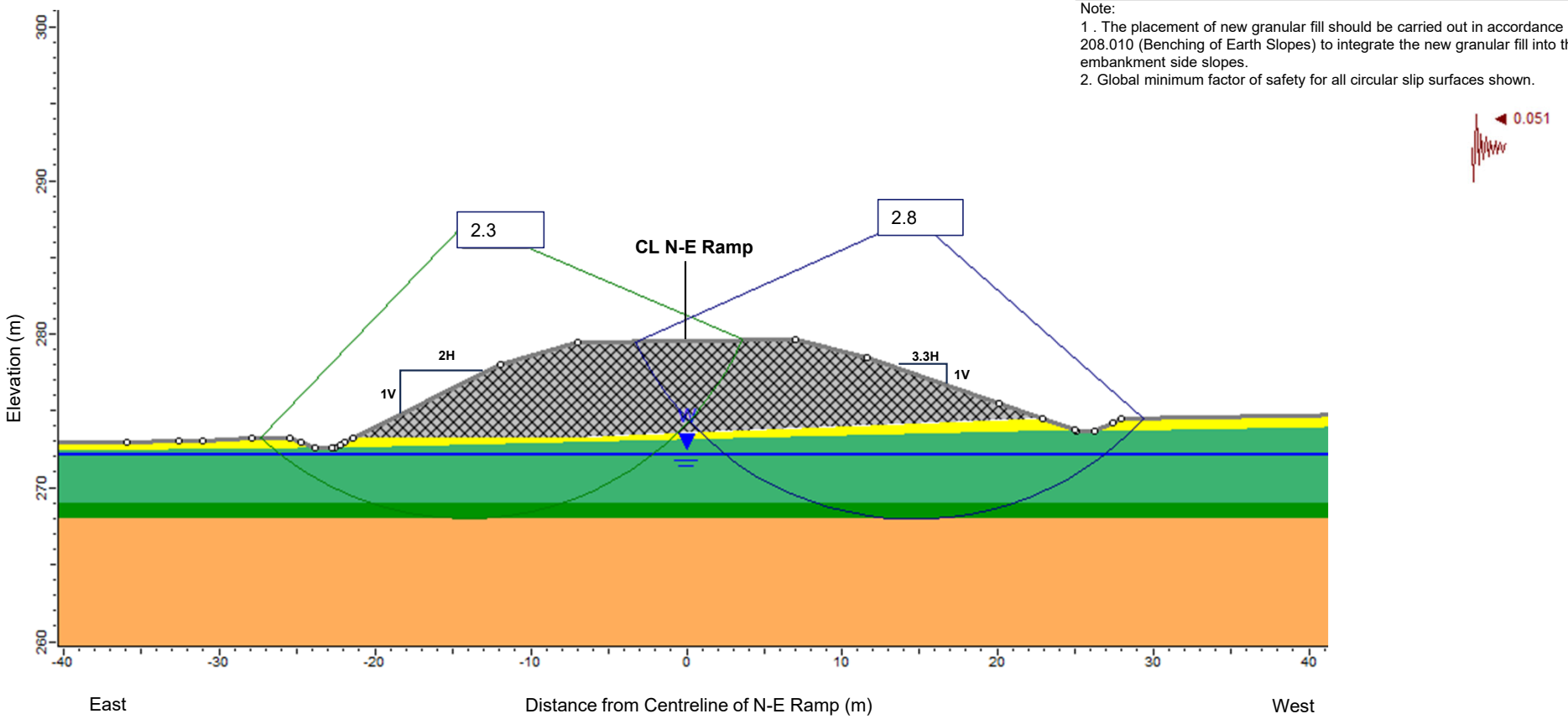
THURBER

HIGH FILL-Highway 400 N-E Ramp South of 9th Line
Global Slope Stability – Seismic Condition
Approximate Station 10+380

Figure G3

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Silty Sand		21	Mohr-Coulomb	0	32
Upper Clay (undrained)		20	Undrained	85	0
Clay with Sand (undrained)		21	Undrained	55	0
Silty Sand Till		21	Mohr-Coulomb	0	33

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



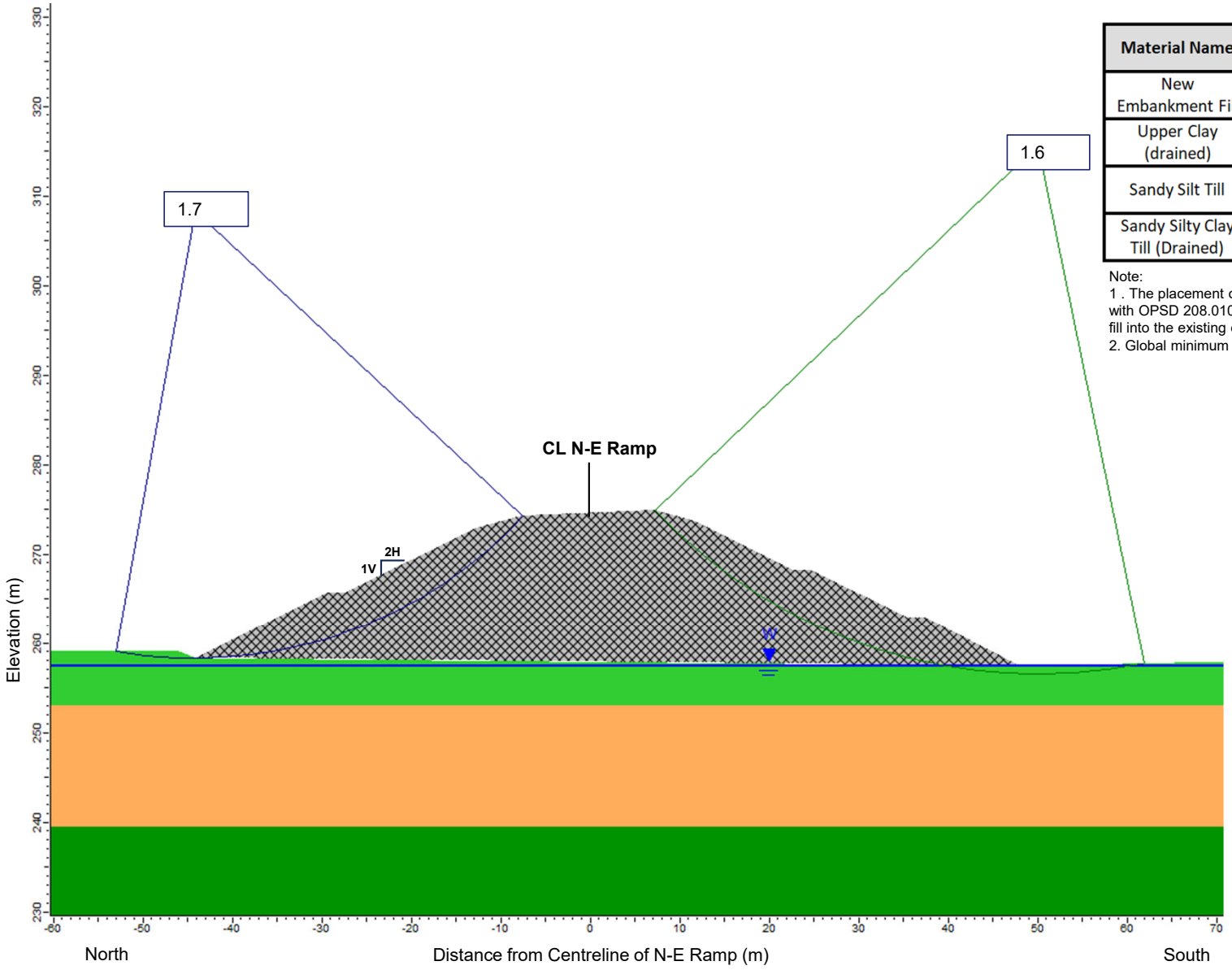
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Permanent Condition
Approximate Station 11+000

Figure G4



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (drained)		20	Mohr-Coulomb	0	31
Sandy Silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (Drained)		21	Mohr-Coulomb	0	32

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.

Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

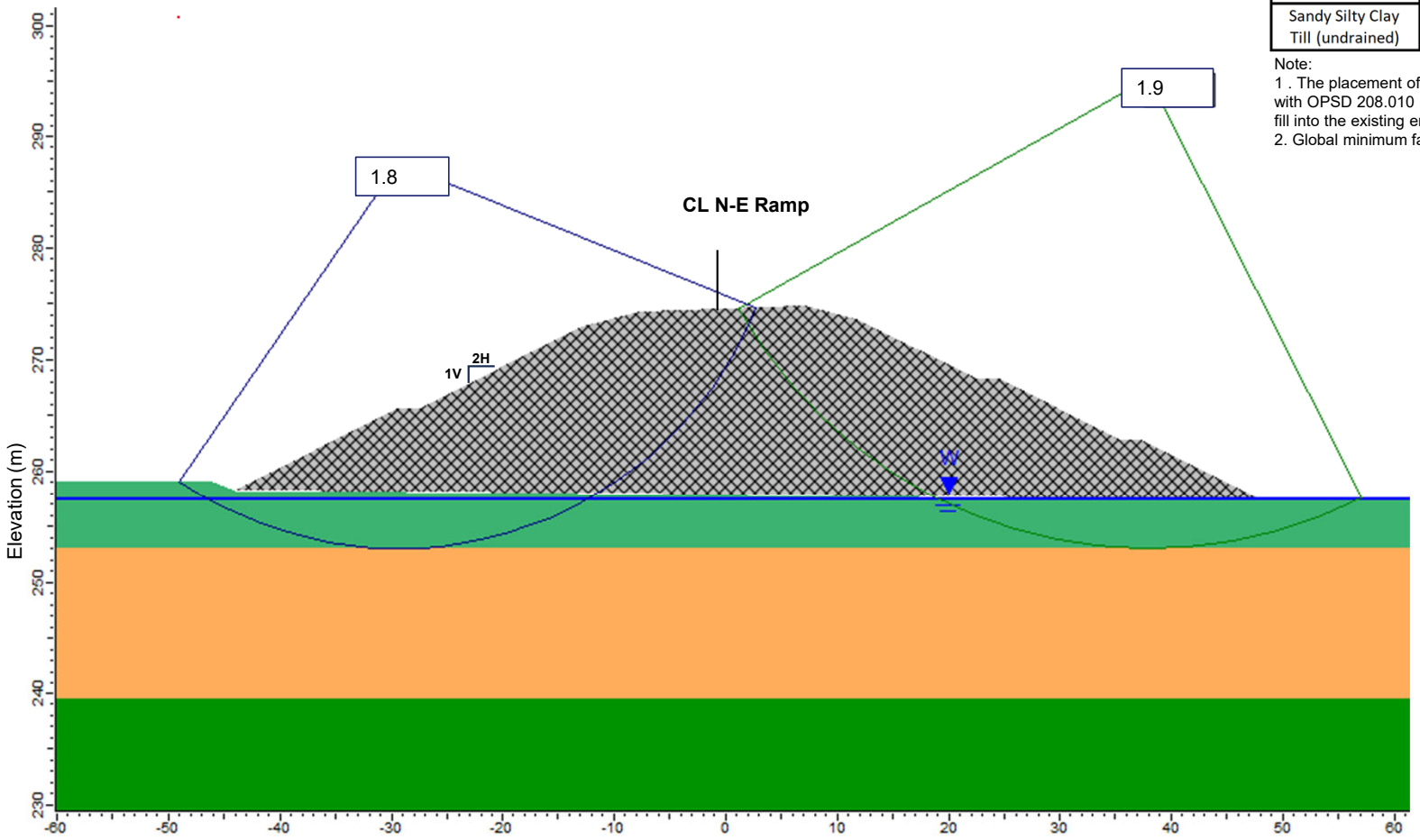
THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Temporary Condition
Approximate Station 11+000

Figure G5

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (undrained)		20	Undrained	90	0
Sandy Silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (undrained)		21	Undrained	200	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

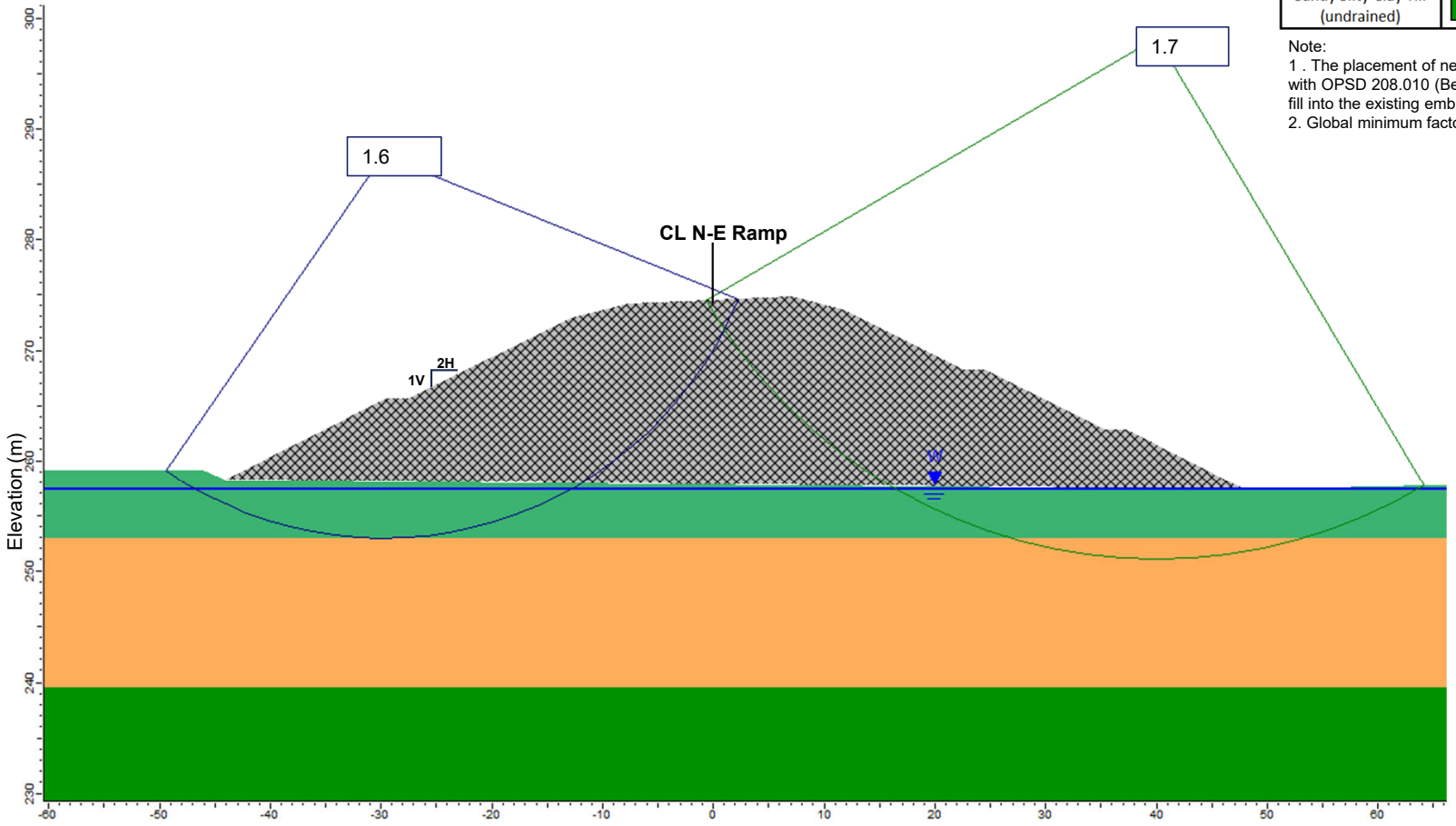
THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Seismic Condition
Approximate Station 11+000

Figure G6

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (undrained)		20	Undrained	90	0
Sandy Silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (undrained)		21	Undrained	200	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

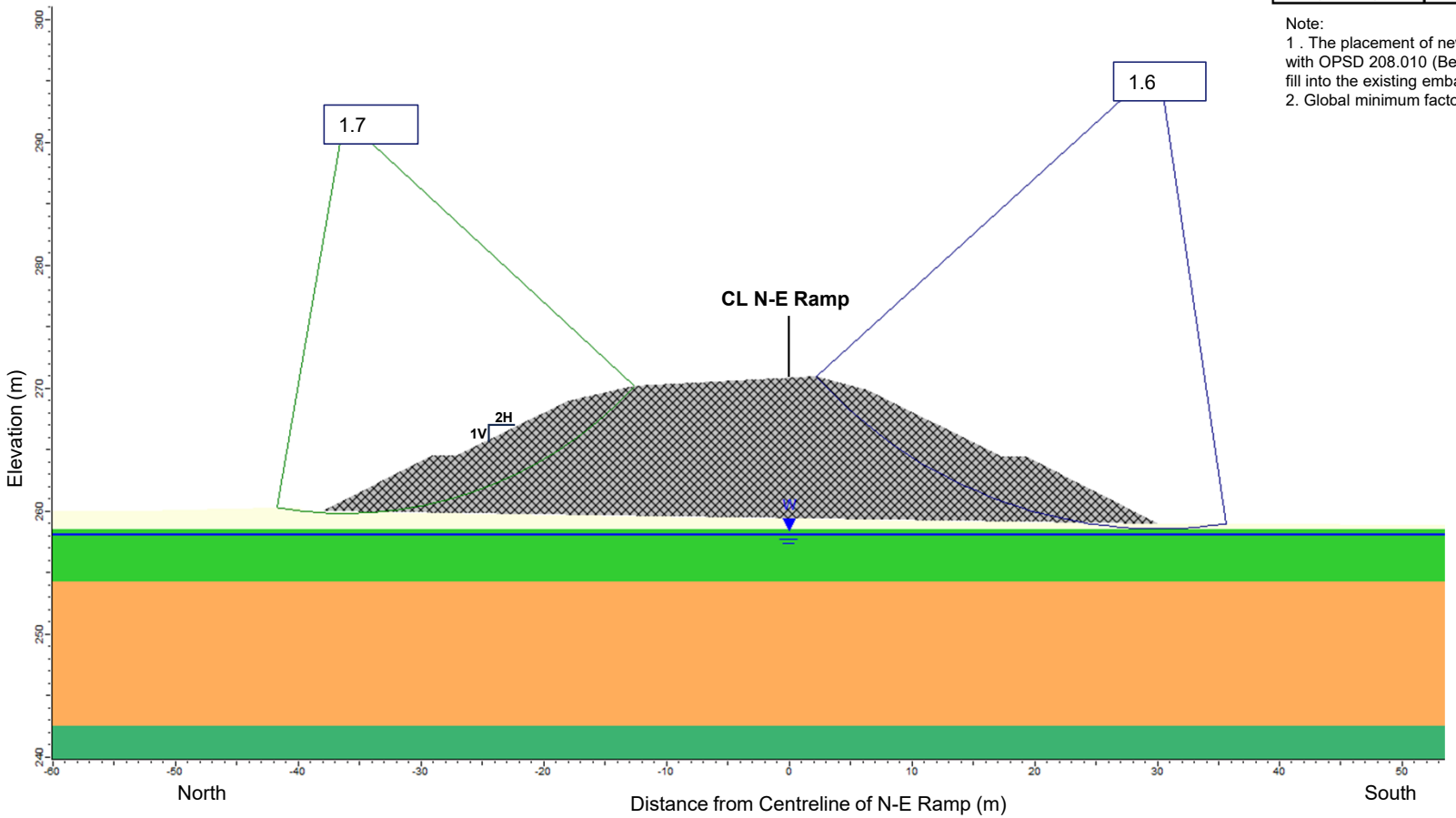
THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Permanent Condition
Approximate Station 11+130

Figure G7

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay (drained)		20	Mohr-Coulomb	0	31
Sandy silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (Drained)		21	Mohr-Coulomb	0	32

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



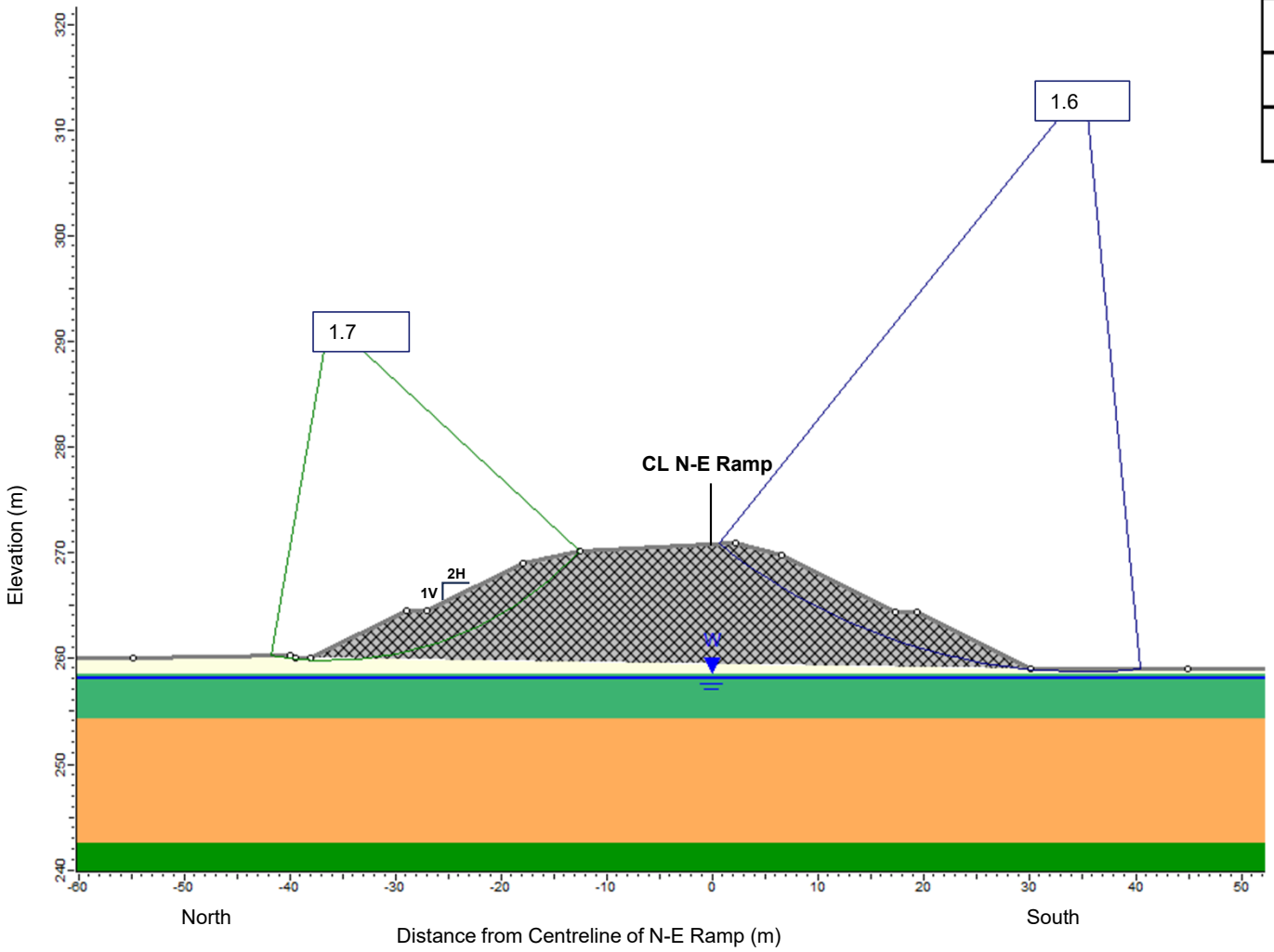
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Temporary Condition
Approximate Station 11+130

Figure G8



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay (undrained)		20	Undrained	90	0
Sandy silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (Undrained)		21	Undrained	200	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.

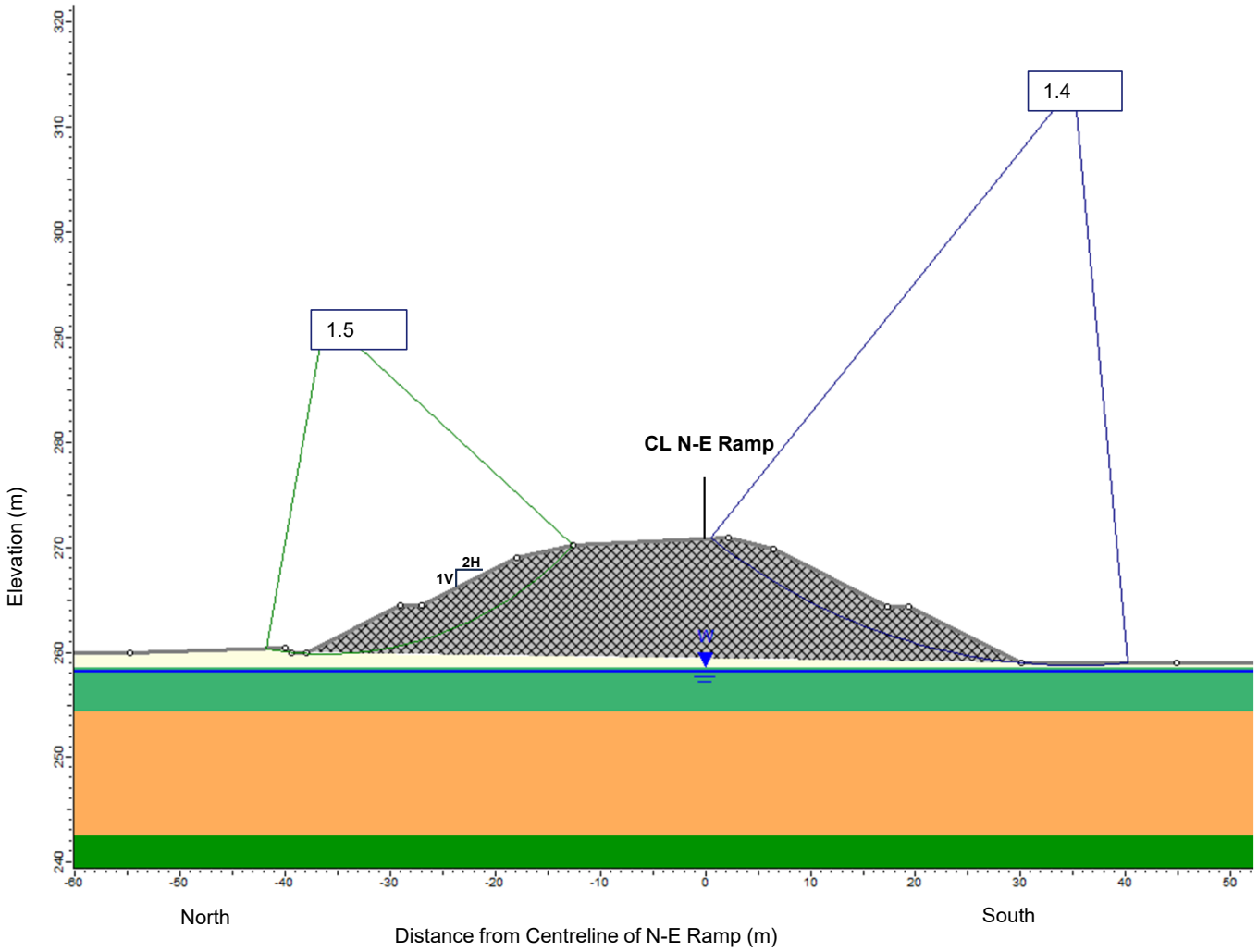
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Seismic Condition
Approximate Station 11+130

Figure G9



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay (undrained)		20	Undrained	90	0
Sandy silt Till		21	Mohr-Coulomb	0	31
Sandy Silty Clay Till (Undrained)		21	Undrained	200	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



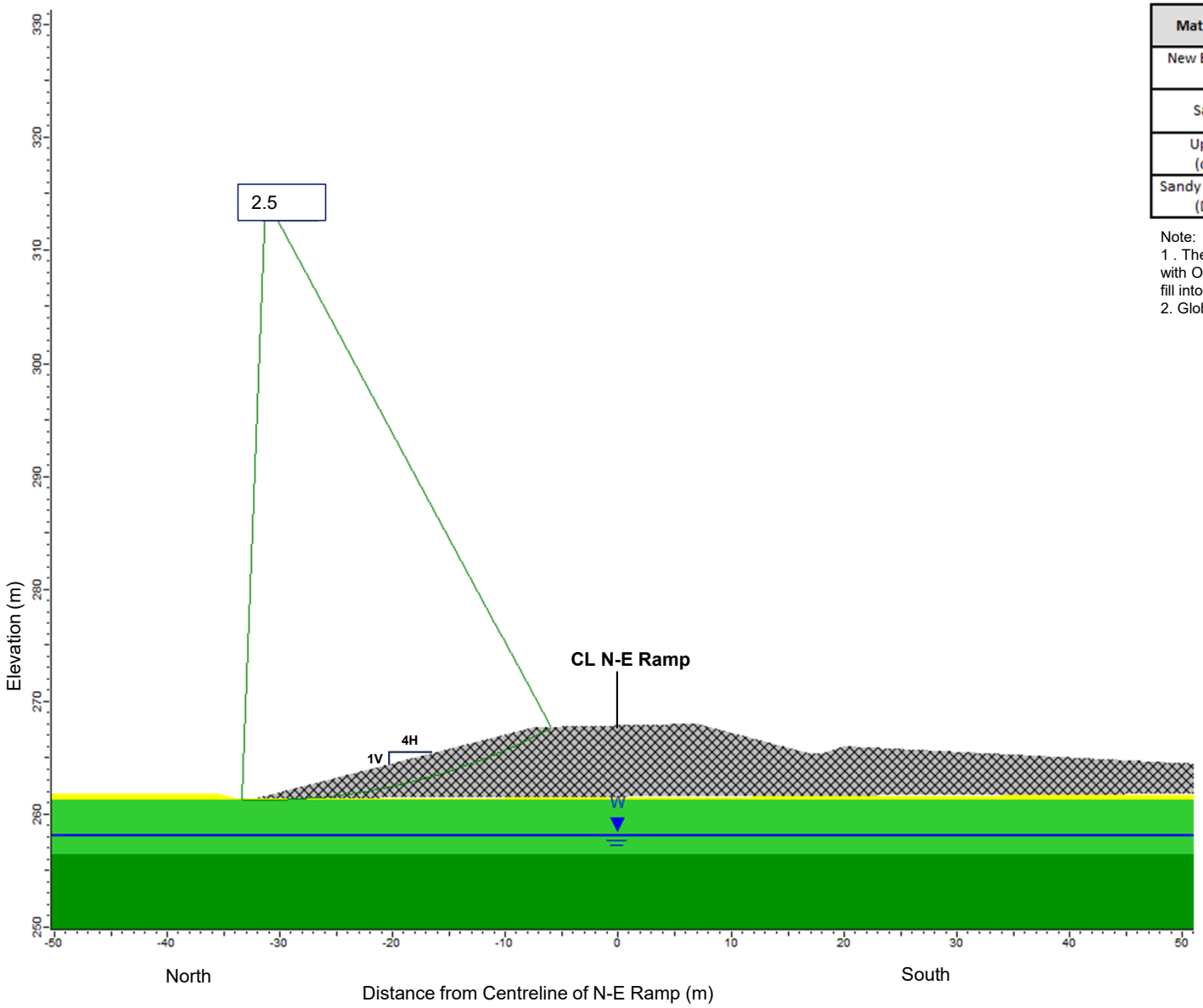
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Permanent Condition
Approximate Station 11+230

Figure G10



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		21	Mohr-Coulomb	0	30
Upper Clay (drained)		20	Mohr-Coulomb	0	31
Sandy silty clay Till (Drained)		21	Mohr-Coulomb	0	31

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.

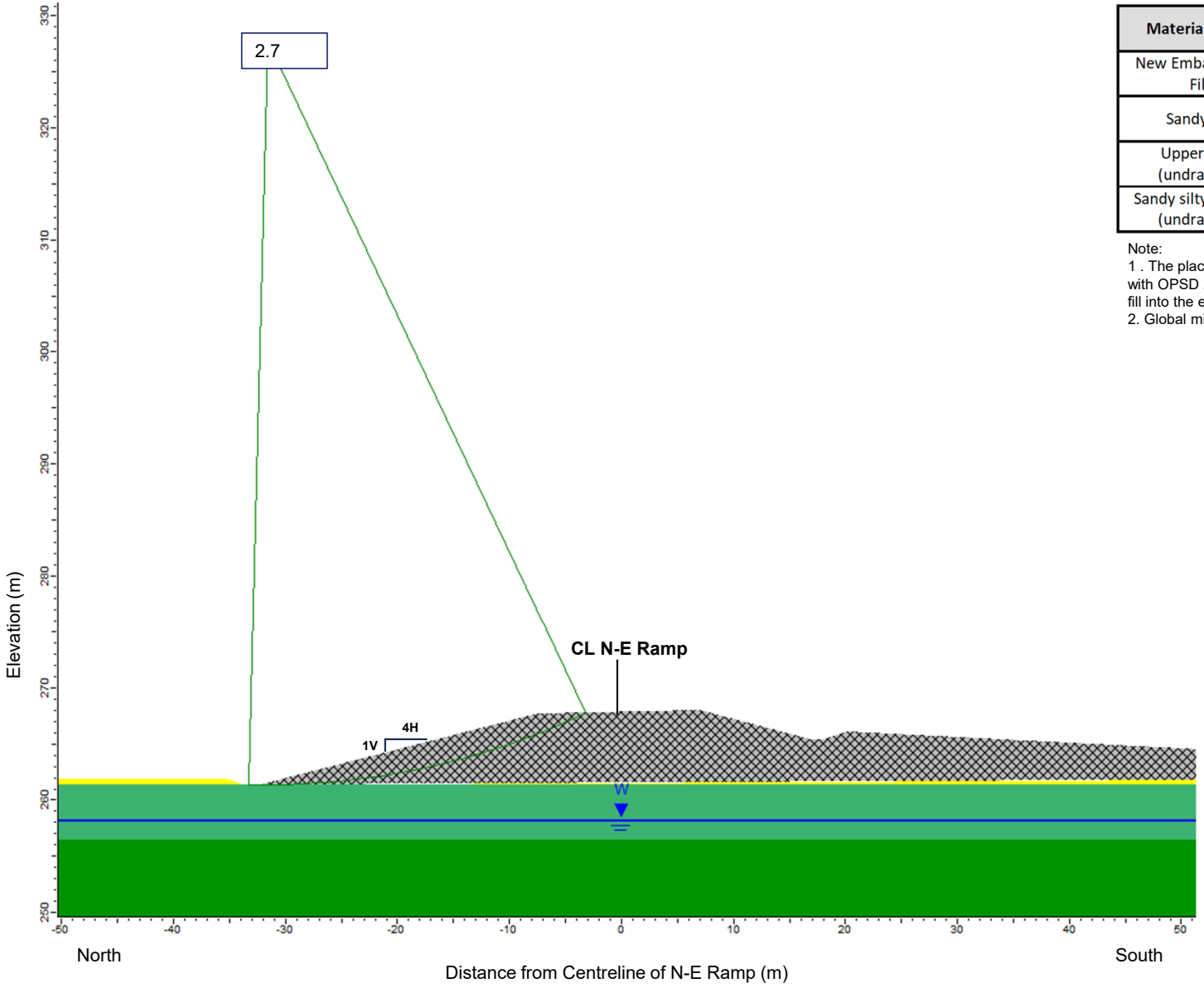
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Temporary Condition
Approximate Station 11+230

Figure G11



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		21	Mohr-Coulomb	0	30
Upper Clay (undrained)		20	Undrained	90	0
Sandy silty clay Till (undrained)		21	Undrained	75	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.

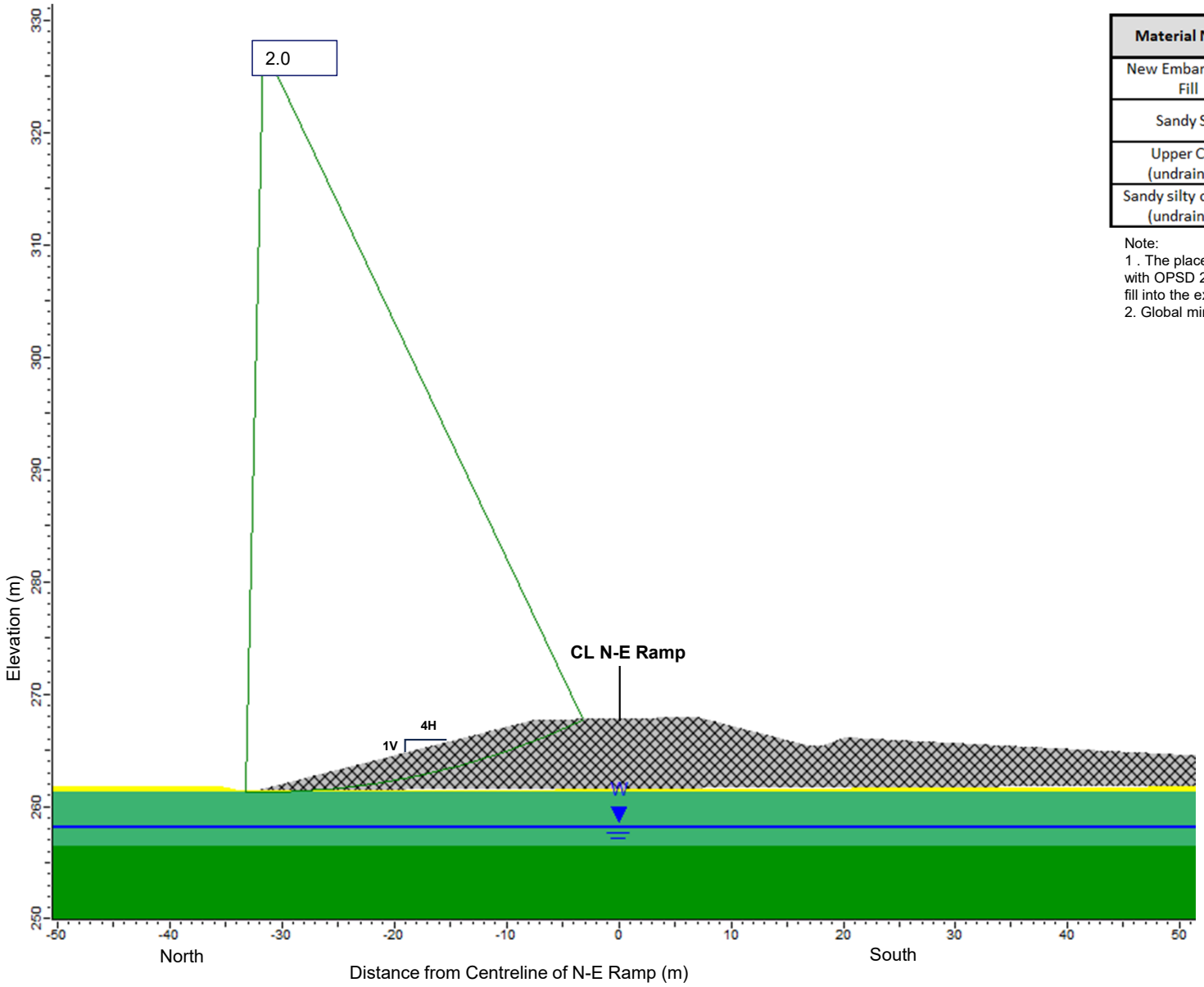
Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

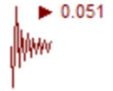
HIGH FILL-Highway 400 N-E Ramp – East of flyover
Global Slope Stability – Seismic Condition
Approximate Station 11+230

Figure G12



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		21	Mohr-Coulomb	0	30
Upper Clay (undrained)		20	Undrained	90	0
Sandy silty clay Till (undrained)		21	Undrained	75	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

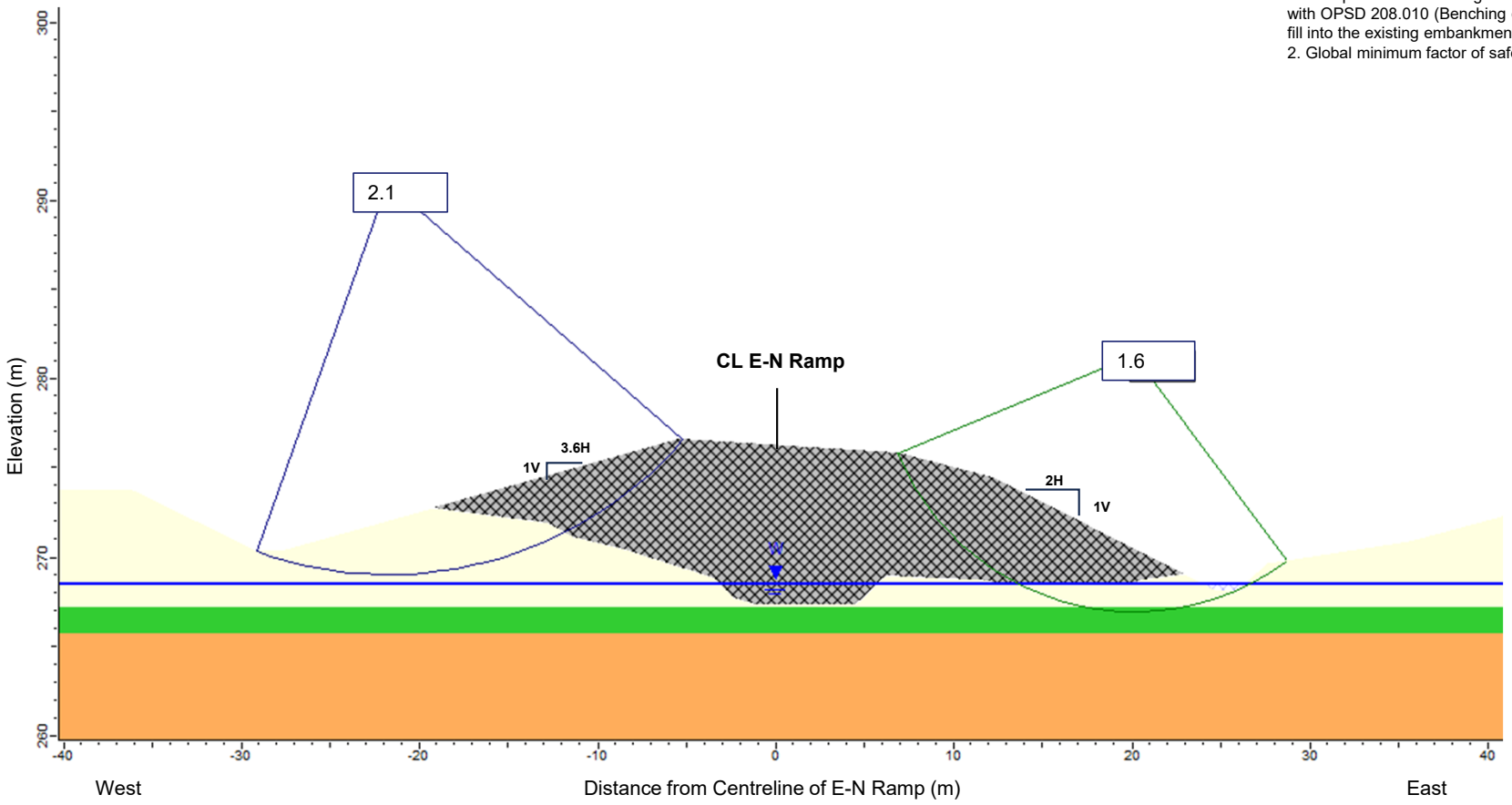
THURBER

HIGH FILL-Highway 400 E-N Ramp South of 9th Line
Global Slope Stability – Permanent Condition
Approximate Station 10+810

Figure G13

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		17.5	Mohr-Coulomb	0	28
Upper Clay (drained)		20	Mohr-Coulomb	0	30
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

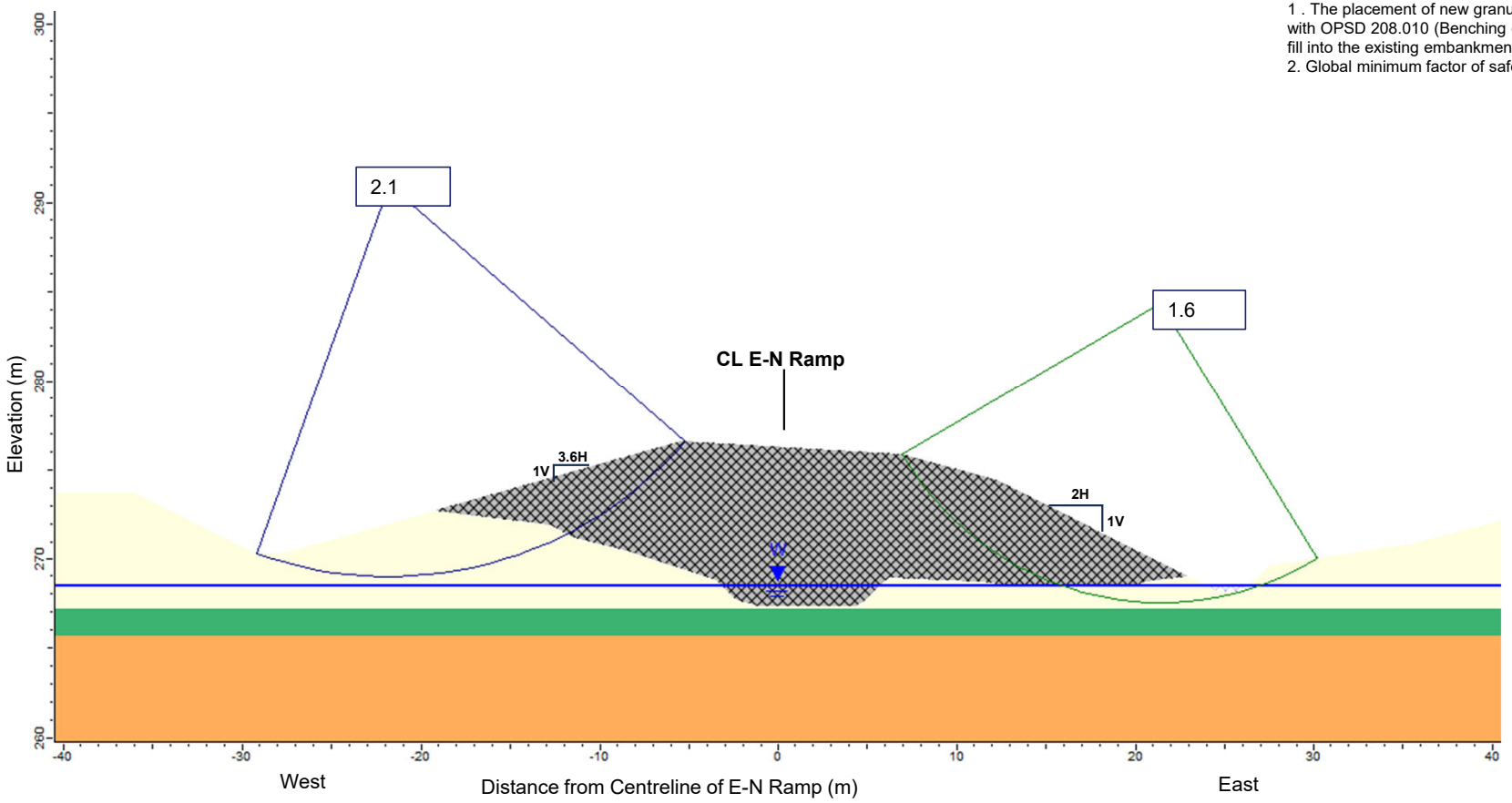
THURBER

HIGH FILL-Highway 400 E-N Ramp South of 9th Line
Global Slope Stability – Temporary Condition
Approximate Station 10+810

Figure G14

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		17.5	Mohr-Coulomb	0	28
Upper Clay (undrained)		20	Undrained	60	0
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

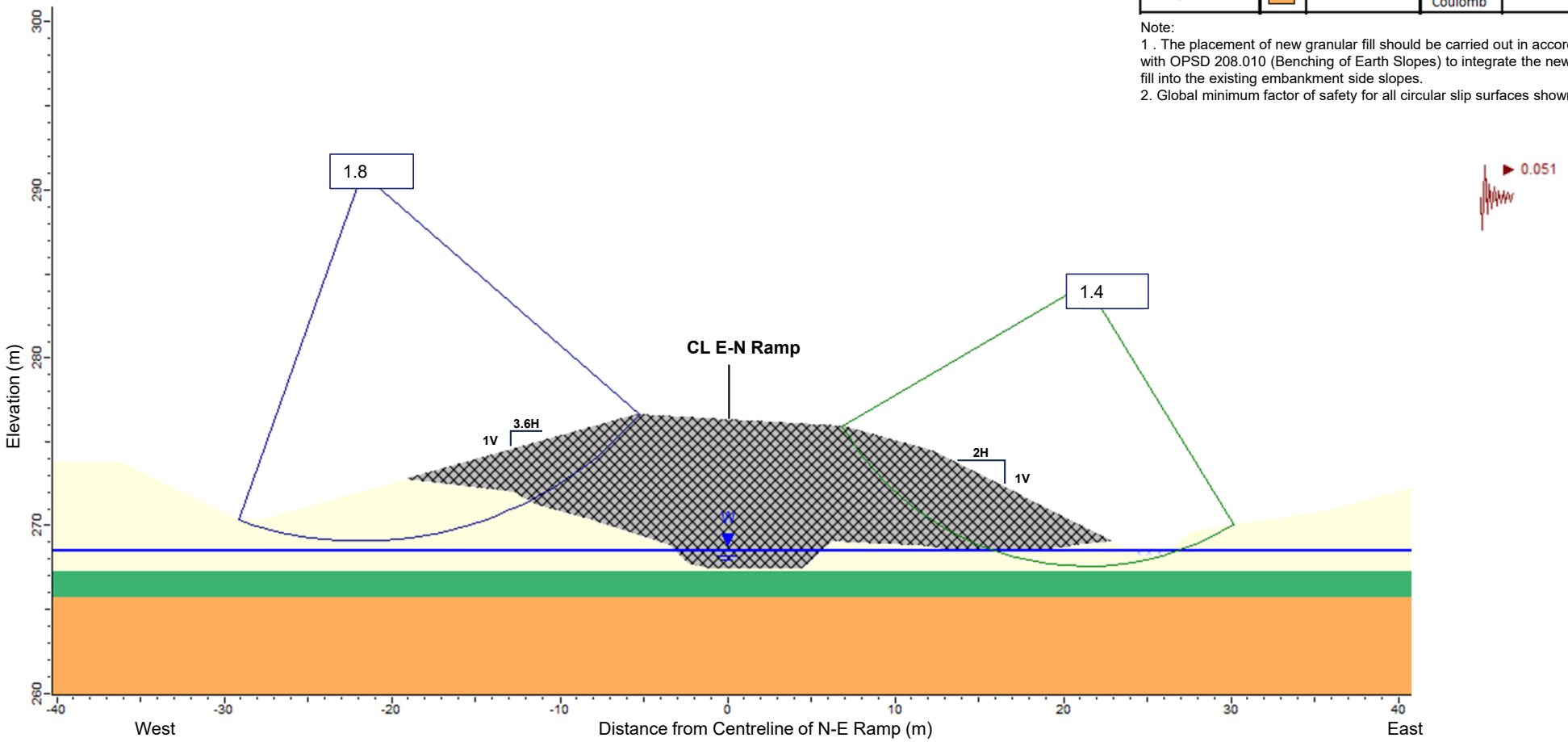
THURBER

HIGH FILL-Highway 400 E-N Ramp South of 9th Line
Global Slope Stability – Seismic Condition
Approximate Station 10+810

Figure G15

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		17.5	Mohr-Coulomb	0	28
Upper Clay (undrained)		20	Undrained	60	0
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

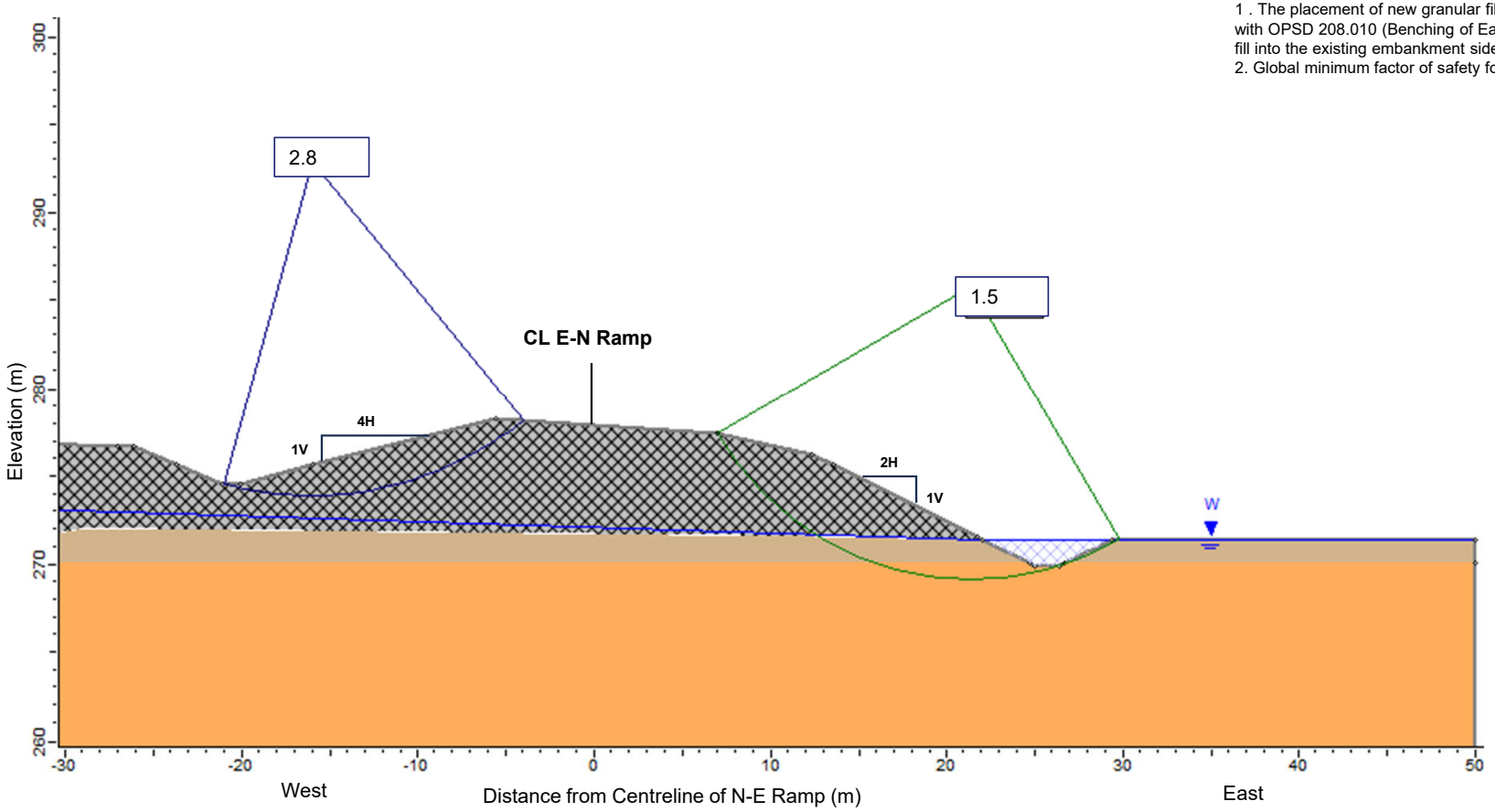
THURBER

HIGH FILL-Highway 400 E-N Ramp North of 9th Line
Global Slope Stability – Permanent Condition
Approximate Station 10+950

Figure G16

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Clayey Sand Till		20	Mohr-Coulomb	0	30
Silty Sand Till		20	Mohr-Coulomb	0	31

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

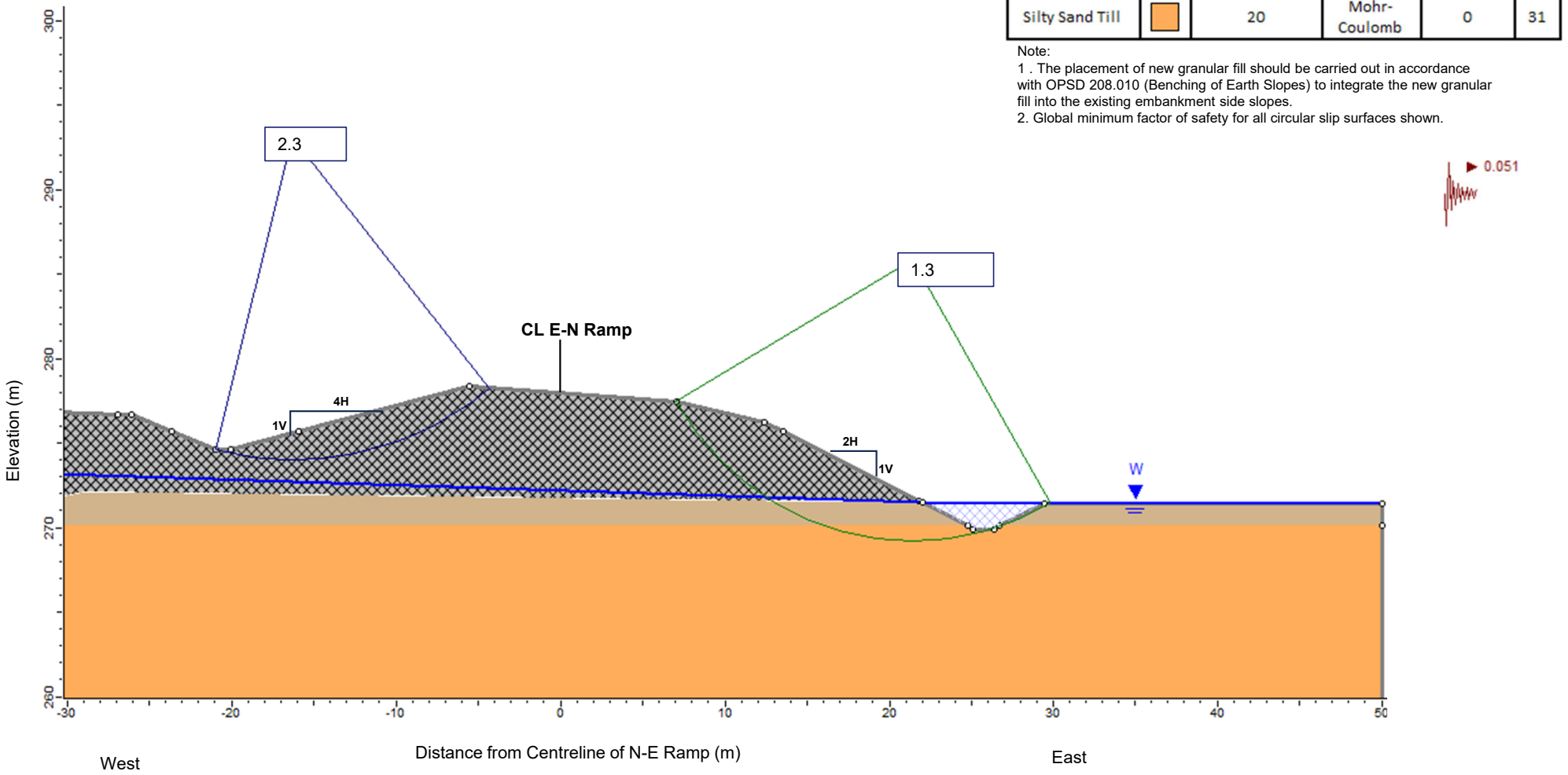
THURBER

HIGH FILL-Highway 400 E-N Ramp North of 9th Line
Global Slope Stability – Seismic Condition
Approximate Station 10+950

Figure G17

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Clayey Sand Till		20	Mohr-Coulomb	0	30
Silty Sand Till		20	Mohr-Coulomb	0	31

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

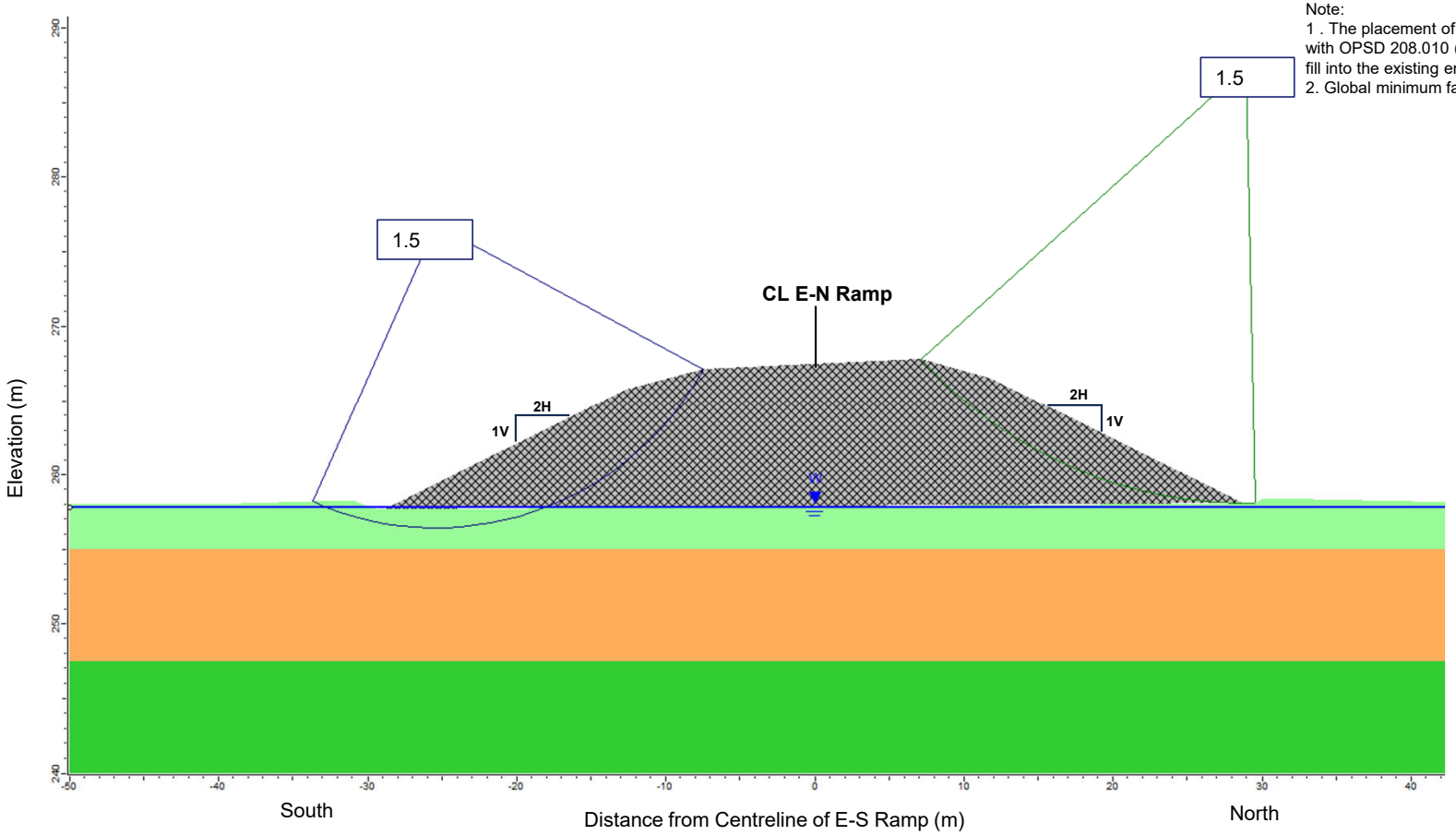
THURBER

HIGH FILL - E-S Ramp at BBP, East of flyover
Global Slope Stability – Permanent Condition
Approximate Station 11+670

Figure G18

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (Drained)		20	Mohr-Coulomb	0	31
Silty Sand Till		20	Mohr-Coulomb	0	28
Lower Clay (drained)		21	Mohr-Coulomb	0	31

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

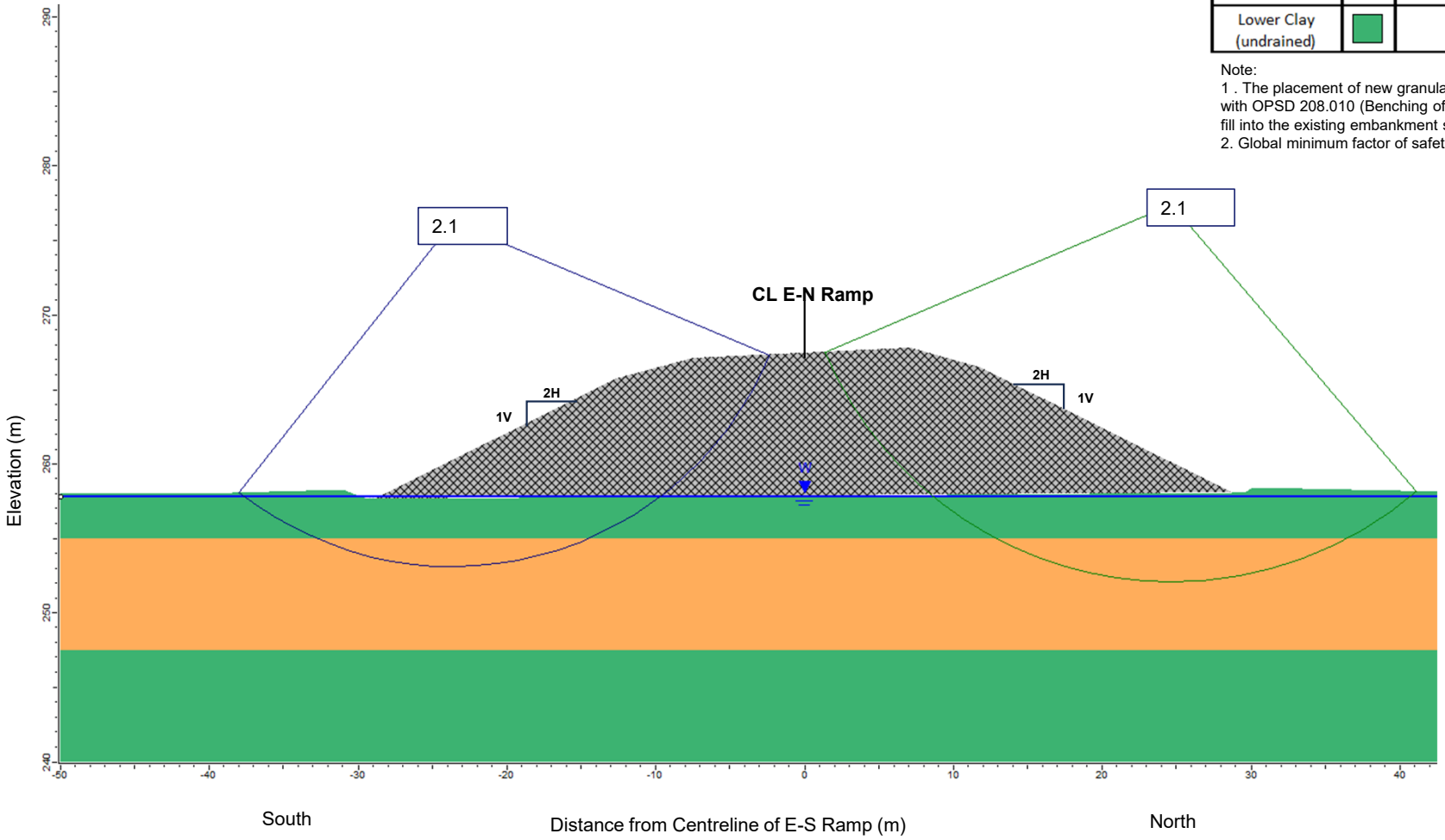
THURBER

HIGH FILL - E-S Ramp at BBP, East of flyover
Global Slope Stability – Temporary Condition
Approximate Station 11+670

Figure G19

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (Undrained)		20	Undrained	80	0
Silty Sand Till		20	Mohr-Coulomb	0	28
Lower Clay (undrained)		21	Undrained	150	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

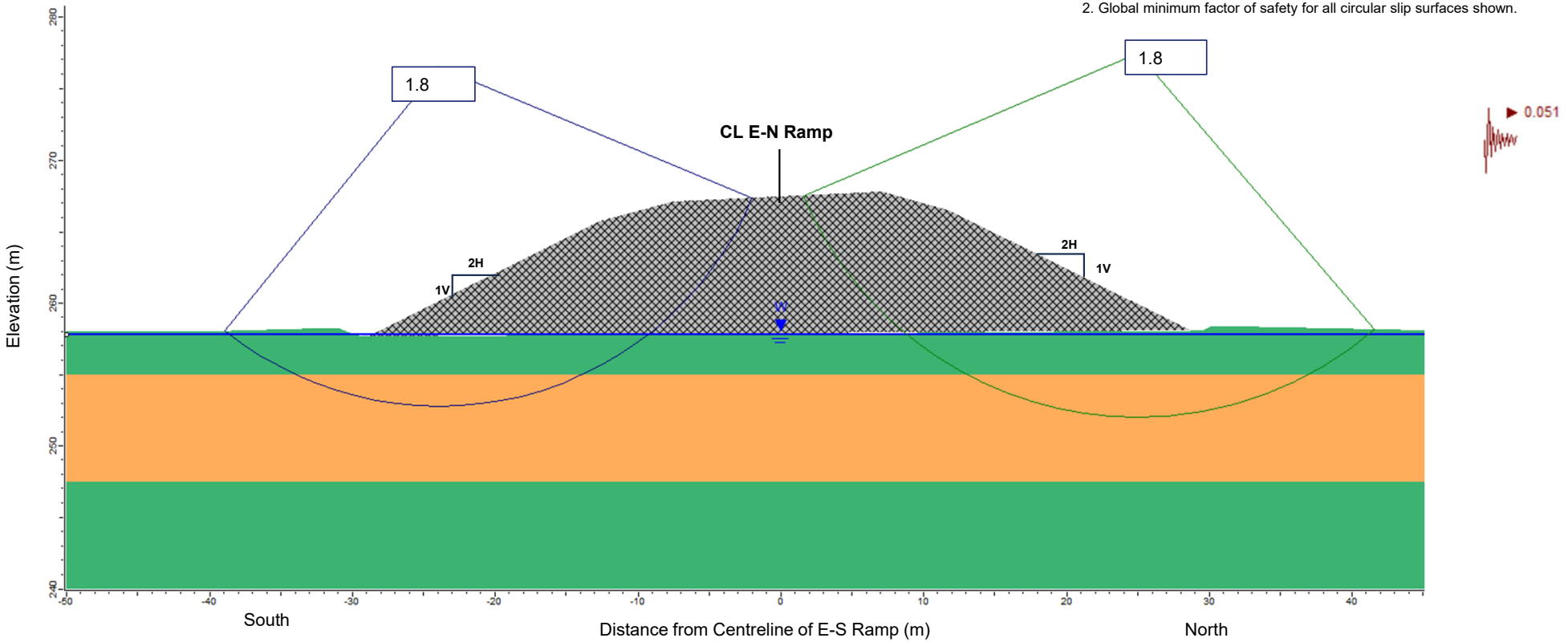
THURBER

HIGH FILL - E-S Ramp at BBP, East of flyover
Global Slope Stability – Seismic Condition
Approximate Station 11+670

Figure G20

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Upper Clay (Undrained)		20	Undrained	80	0
Silty Sand Till		20	Mohr-Coulomb	0	28
Lower Clay (undrained)		21	Undrained	150	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

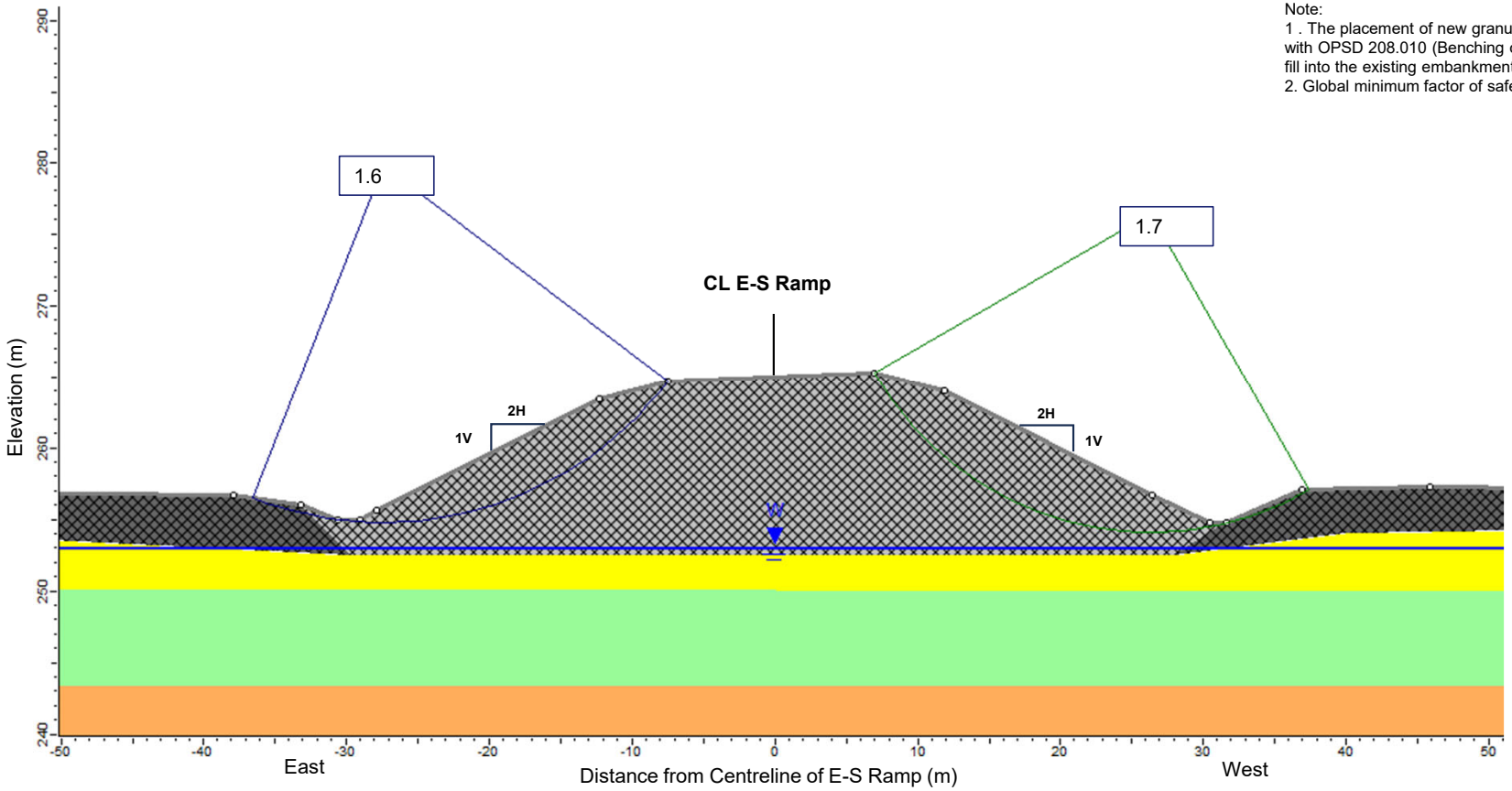
THURBER

HIGH FILL - E-S Ramp at BBP, West of flyover
Global Slope Stability – Permanent Condition
Approximate Station 11+950

Figure G21

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Fill		19	Mohr-Coulomb	0	28
Sand		21	Mohr-Coulomb	0	34
Clay (Drained)		20	Mohr-Coulomb	0	31
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

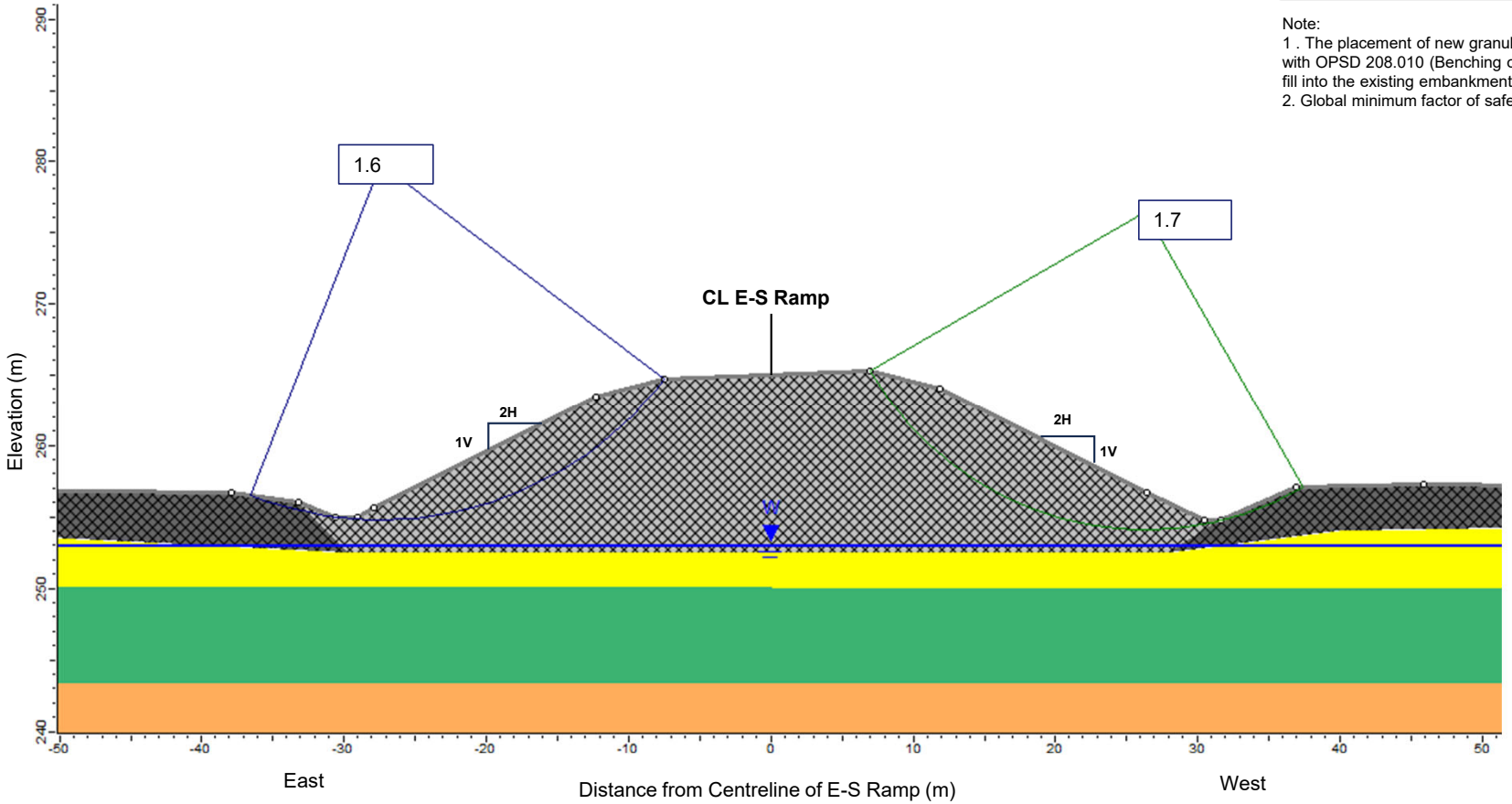
THURBER

HIGH FILL - E-S Ramp at BBP, West of flyover
Global Slope Stability – Temporary Condition
Approximate Station 11+950

Figure G22

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Fill		19	Mohr-Coulomb	0	28
Sand		21	Mohr-Coulomb	0	34
Clay (Undrained)		20	Undrained	75	0
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

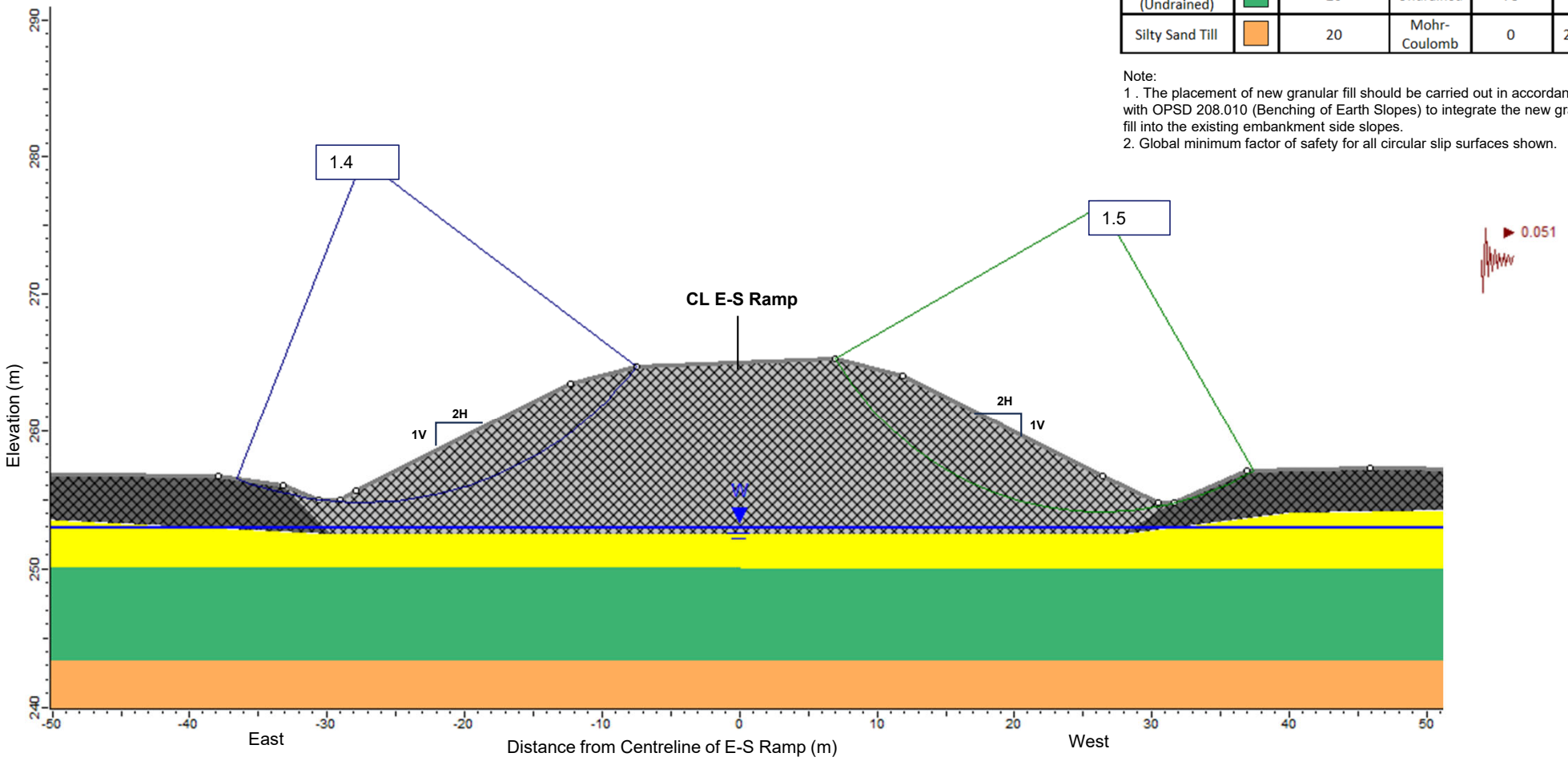
THURBER

HIGH FILL - E-S Ramp at BBP, West of flyover
Global Slope Stability – Seismic Condition
Approximate Station 11+950

Figure G23

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Fill		19	Mohr-Coulomb	0	28
Sand		21	Mohr-Coulomb	0	34
Clay (Undrained)		20	Undrained	75	0
Silty Sand Till		20	Mohr-Coulomb	0	29

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

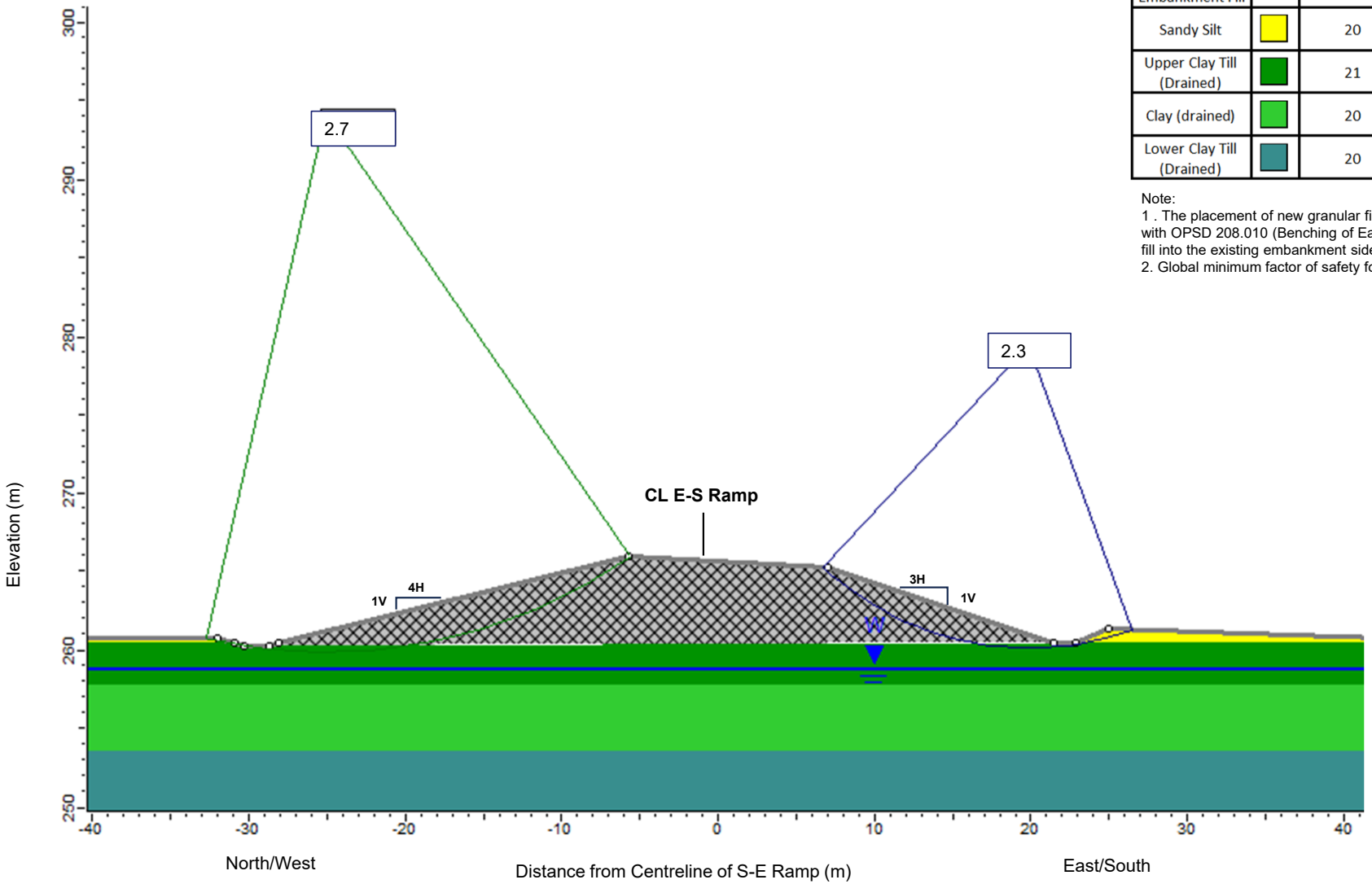
THURBER

HIGH FILL – S-E Ramp to BBP
Global Slope Stability – Permanent Condition
Approximate Station 10+560

Figure G24

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay Till (Drained)		21	Mohr-Coulomb	0	31
Clay (drained)		20	Mohr-Coulomb	0	30
Lower Clay Till (Drained)		20	Mohr-Coulomb	0	30

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

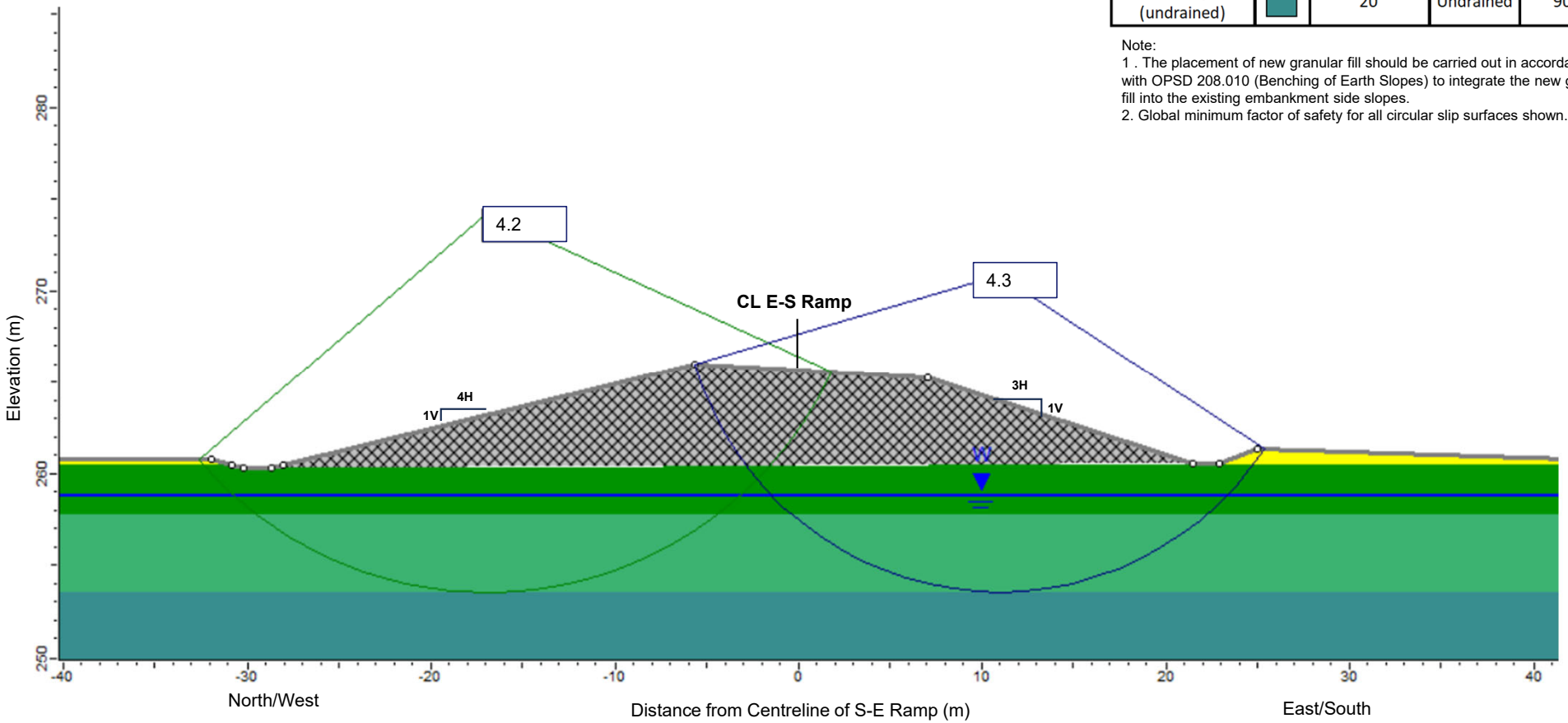
THURBER

HIGH FILL – S-E Ramp to BBP
Global Slope Stability – Temporary Condition
Approximate Station 10+560

Figure G25

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay Till (undrained)		21	Undrained	130	0
Clay (undrained)		20	Undrained	65	0
Lower Clay Till (undrained)		20	Undrained	90	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

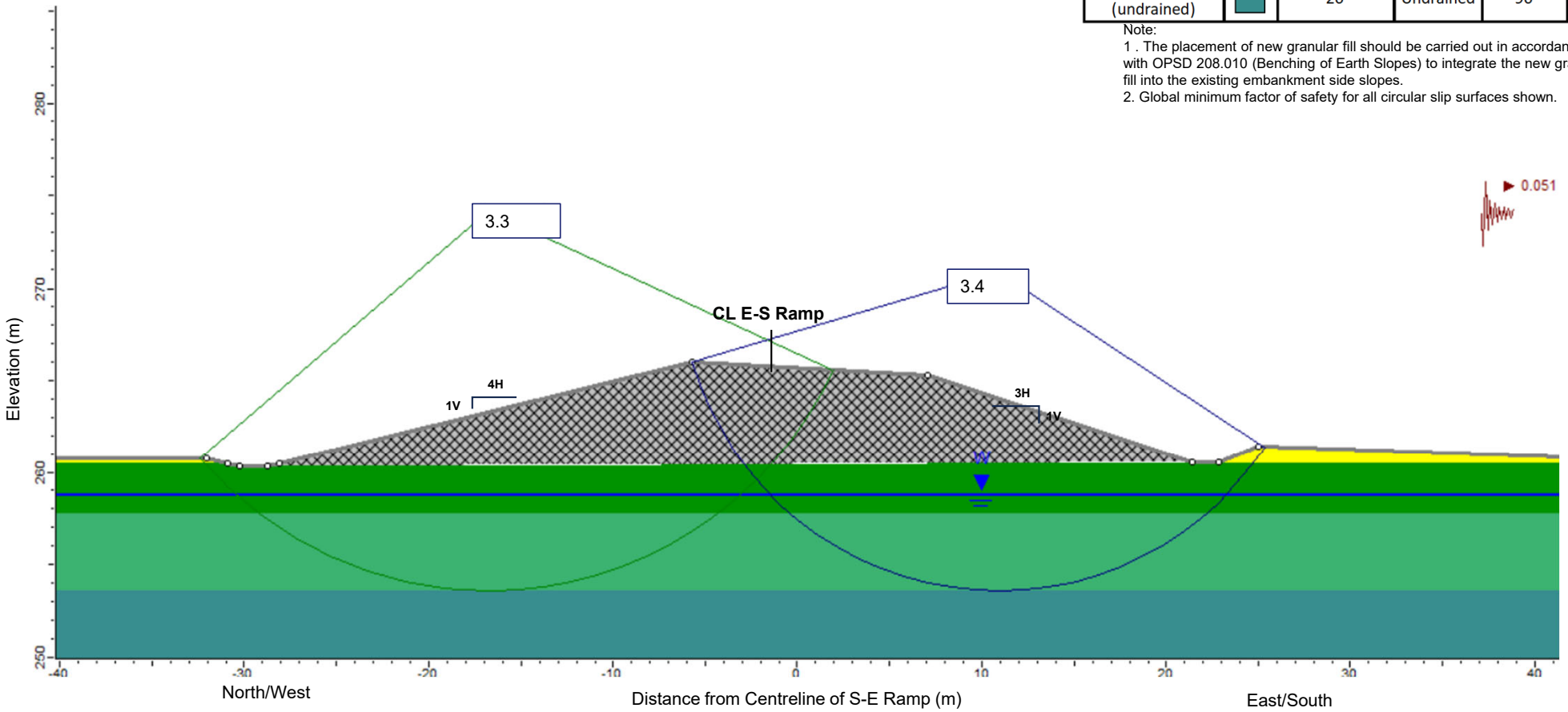
THURBER

HIGH FILL – S-E Ramp to BBP
Global Slope Stability – Seismic Condition
Approximate Station 10+560

Figure G26

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
New Embankment Fill		21	Mohr-Coulomb	0	32
Sandy Silt		20	Mohr-Coulomb	0	30
Upper Clay Till (undrained)		21	Undrained	130	0
Clay (undrained)		20	Undrained	65	0
Lower Clay Till (undrained)		20	Undrained	90	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
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Checked By: JL

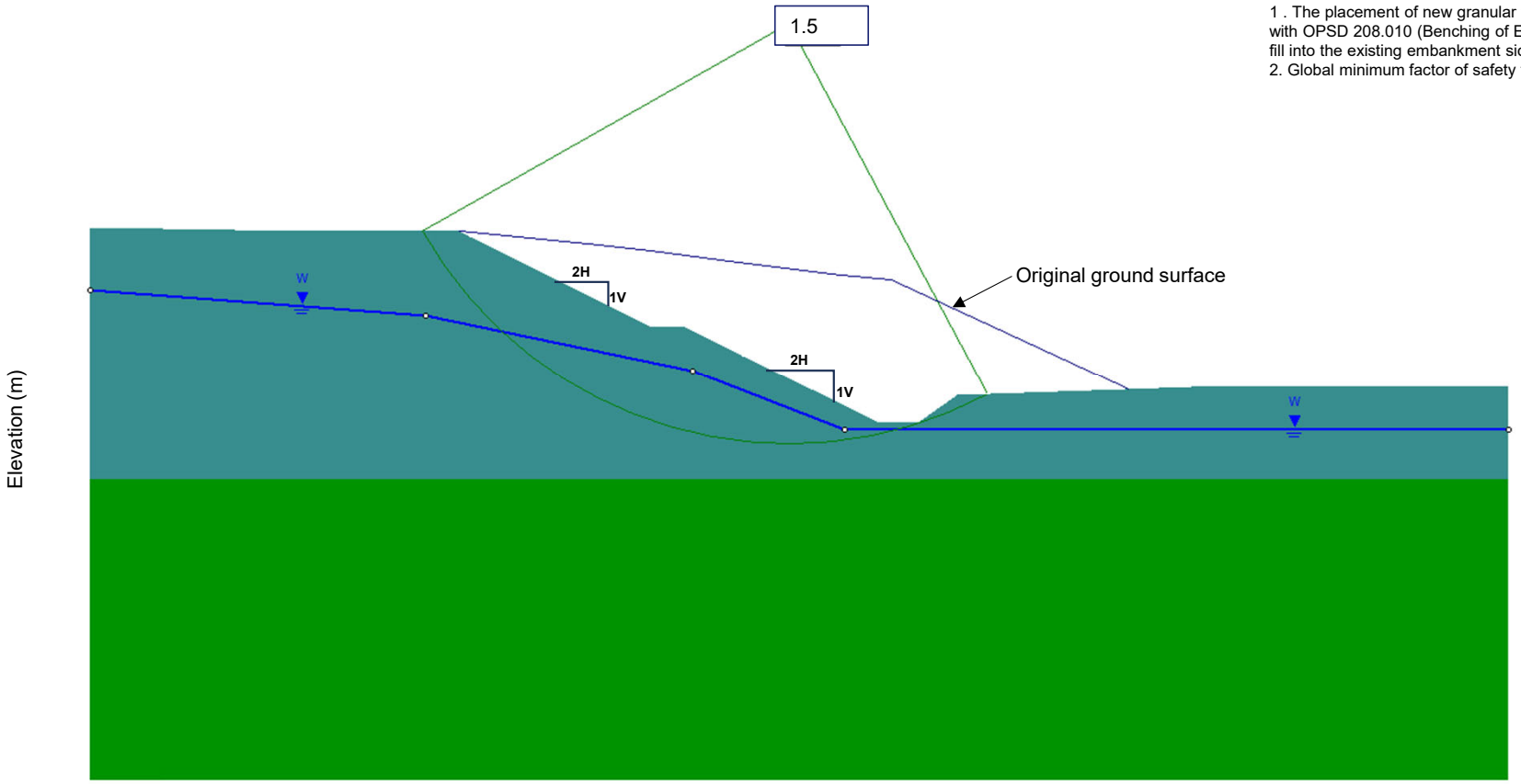
THURBER

DEEP CUT–WEST SIDE OF HIGHWAY 400 SBL
Global Slope Stability – Permanent Condition
Approximate Station 18+480

Figure G27

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
Upper Sandy Silty Clay Till (Drained)		21	Mohr-Coulomb	0	31
Lower Sandy Silty Clay Till (Drained)		22	Mohr-Coulomb	0	32
Lower Clay (Drained)		20.5	Mohr-Coulomb	0	31

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

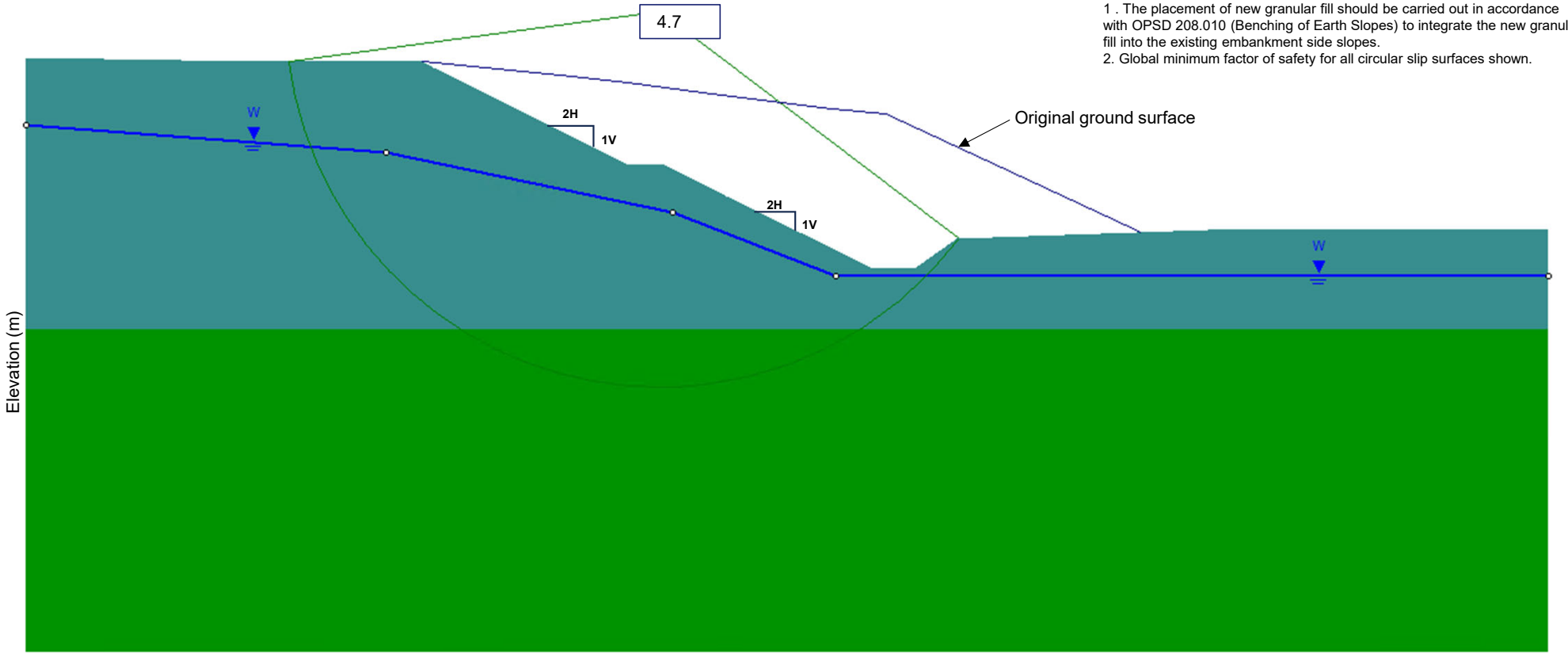
THURBER

DEEP CUT–WEST SIDE OF HIGHWAY 400 SBL
Global Slope Stability – Temporary Condition
Approximate Station 18+480

Figure G28

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
Upper Sandy Silty Clay Till (Undrained)		21	Undrained	100	0
Lower Sandy Silty Clay Till (Undrained)		20	Undrained	200	0
Lower clay (undrained)		20.5	Undrained	150	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

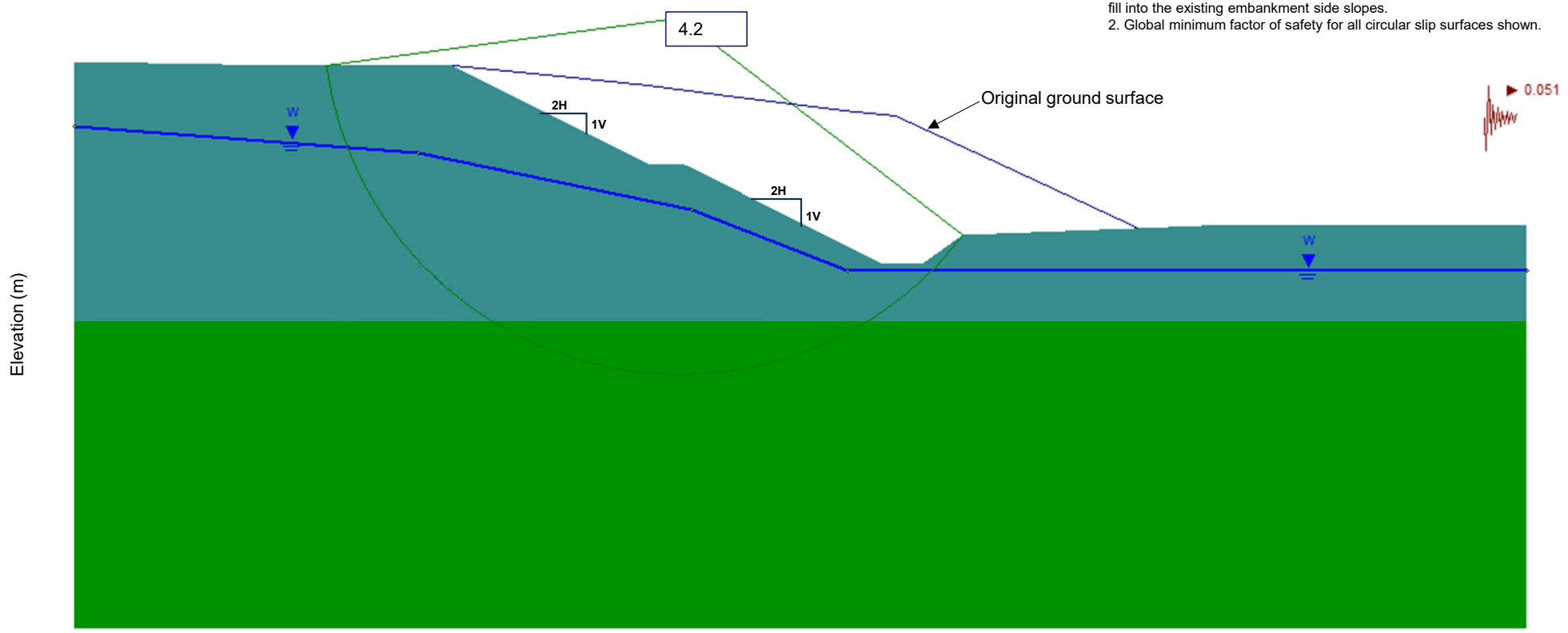
THURBER

DEEP CUT–WEST SIDE OF HIGHWAY 400 SBL
Global Slope Stability – Seismic Condition
Approximate Station 18+480

Figure G29

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
Upper Sandy Silty Clay Till (Undrained)		21	Undrained	100	0
Lower Sandy Silty Clay Till (Undrained)		20	Undrained	200	0
Lower clay (undrained)		20.5	Undrained	150	0

Note:
1 . The placement of new granular fill should be carried out in accordance with OPSD 208.010 (Benching of Earth Slopes) to integrate the new granular fill into the existing embankment side slopes.
2. Global minimum factor of safety for all circular slip surfaces shown.



Date: September 2025
Thurber Project: 48856

Analysis By: RPR
Checked By: JL

THURBER

APPENDIX H

NSSPs and Notice to Contractor

PRESENCE OF COBBLES, BOULDERS, AND OTHER OBSTRUCTIONS

Notice to Contractor

The Contractor shall be alerted to the potential presence of cobbles, boulders, and construction debris within the existing embankment fill and native glacial tills. Laboured excavation and installation should be anticipated in the very dense or hard native soils. Considerations of the presences of such obstructions must be made in the selection of appropriate equipment and procedures for excavations, and installation of temporary protection systems. Contractor's equipment must be able to advance through any such obstructions. The excavations shall be inspected periodically to confirm stability at all stages.

GROUNDWATER CONTROL

Notice to Contractor

The deep cuts will extend below the groundwater level. Water inflow/seepage should be anticipated from the embankment fill and native sands, silts and clays, and surface runoff and precipitation will accumulate within the excavation. Exposed silt/clay soils are moisture sensitive. The Contractor must implement effective dewatering measures during construction and prior to excavating below the water level. Effective dewatering shall be designed and provided by the Contractor. Groundwater control measures such as perimeter ditches and pumping from filtered sumps will need to be employed to remove any accumulation of water from the excavation base.

EMBANKMENT MATERIAL RESTRICTIONS

Notice to Contractor

Embankment construction shall be carried out in accordance with OPSS.PROV 206. All earth and granular fills shall be compacted as per OPSS.PROV 501. Medium and/or high plastic silts/clays shall not be used as Earth Fill embankment material. Within one metre of the pavement subgrade level, the earth fill material shall consist of low frost susceptible soils.

SUPPLY AND INSTALLATION OF EMBANKMENT MONITORING EQUIPMENT- Item No.

Special Provision

1.0 GENERAL

1.1 Scope

This special provision contains the requirements for the supply and installation of the following geotechnical instruments:

- Survey Benchmarks (BM)
- Settlement Rods (SR)
- Settlement Pin (SP)
- Vibrating Wire Piezometers (VWP)
- Reference VWPs (RVWP)
- Weather Station (WS)

All instrumentation shall be supplied, installed, protected, and commissioned in accordance with this Special Provision, the Contract Drawings, and the manufacturer's most current published installation specifications.

1.2 Purpose

The purpose of the instrumentation is to monitor vertical settlement and associated geotechnical performance of the foundation soils during construction of the structural culverts, high fills and embankments at the proposed Bradford Bypass Freeway to Freeway Interchange. The monitoring program covers the N-E, S-E, E-N, and E-S Ramps, as well as the Bradford Bypass eastbound and westbound lanes, and is intended to assess ground response during embankment/culvert construction within Bradford West Gwillimbury, Ontario.

The instrumentation provided herein pertains to the following Sections:

- Highway 400 N-E Ramp Flyover Ramp Bridge (30X-0868/B0) East Approach Approximate Stations 10+985 to 11+185
- Highway 400 E-S Ramp Flyover Ramp Bridge (30X-0869/B0) East Approach Approximate Stations. 11+530 to 11+730 and West Approach Approximate Stations 11+950 to 12+150
- Bradford Bypass WBL (Culvert Site No.30X-0878/C0), E-N Ramp Approaches Approximate Stations 10+060 to: 10+090 and E-S Ramp Approaches Approximate Stations 11+050 to 11+080
- Bradford Bypass EBL (Culvert Site No.30X-0879/C0), Approximate Stations 10+735 to 10+815

The rate of fill placement, the timing for the completion of preload, the timing for pile installation, the construction of permanent Culverts and commencement of paving shall be controlled by the instrumentation readings.

Monitoring of selected instruments will be carried out by others after installation by the Contractor.

No instrument shall be decommissioned prior to receipt of written confirmation from the Contract Administrator.

1.3 Personnel

The Contractor shall retain a Geotechnical Consultant with MTO classification “Geotechnical (Structures and Embankments) - High Complexity” to undertake the supply and installation of geotechnical instruments.

For the purposes of this Special Provision, the term “Contractor” shall be understood to include both the Contractor and their Geotechnical Consultant.

1.4 Or equal

The term “or equal” indicates that an alternative product shall be demonstrably equivalent or superior to the specified product in function, performance, reliability, durability, and general configuration.

Only one manufacturer shall be selected for all vibrating wire piezometers to ensure full hardware and software compatibility.

1.5 Submission Requirements

The Contractor shall submit the following to the Contract Administrator a minimum of 30 days prior to commencement of instrument installation:

- Proposed installation procedures
- Proposed locations of all instruments
- Types and configurations of data-acquisition systems
- Survey benchmark layout
- Detailed installation schedule
- Manufacturer datasheets for all proposed instrumentation and accessories
- Details of any proposed telemetry-enabled data acquisition system, where applicable

All submissions shall be reviewed and accepted by the Contract Administrator prior to ordering equipment.

1.6 Notification

The Contractor shall notify the Contract Administrator a minimum of 15 working days before commencing instrumentation installation.

1.7 Drawings

Reference shall be made to the following drawings:

- Geotechnical Instrumentation and Monitoring Plans:
- Highway 400 N-E Ramp Flyover Ramp Bridge (30X-0868/B0) East Approach Approximate Stations 10+985 to 11+185
- Highway 400 E-S Ramp Flyover Ramp Bridge (30X-0869/B0) East Approach

Approximate Stations. 11+530 to 11+730 and West Approach Approximate Stations 11+950 to 12+150

- Bradford Bypass WBL (East of Highway 400) Arch Culvert (30X-0878/C0), E-N Ramp Approaches Approximate Stations 10+060 to: 10+090 and E-S Ramp Approaches Approximate Stations 11+050 to 11+080
- Bradford Bypass EBL (East of Highway 400) Arch Culvert (30X-0879/C0), Approximate Stations 10+735 to 10+815
- Typical Monitoring Sections:
  - Type A
  - Type B
  - Type C
- Monitoring Instrument Details

1.8 Equipment Operation and Weather Conditions

All installation and monitoring equipment shall be capable of withstanding the full range of anticipated ground and atmospheric temperatures at the site. Instruments shall meet the manufacturer's stated accuracy requirements throughout the operating temperature range.

Monitoring shall be conducted year-round.

The Contractor shall repair monitoring instruments as required at no cost to the Owner. A credit shall be given to the Ministry if the Contract Administrator omits any specified instrument.

1.9 Subsurface Conditions

The subsurface conditions at the sites are described in the reports:

- Foundation Investigation Report High Fills and Deep Cuts Highway 400 / Bradford Bypass Freeway to Freeway Interchange, Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-022*. Including Highway 400 Main Alignment, 9th Line Main Alignment, N-E Ramp, E-N Ramp, S-E Ramp And E-S Ramp Bradford West Gwillimbury, Ontario, dated February 11, 2026.
- Foundation Investigation Report Bradford Bypass N-E Ramp over Highway 400 (Site No. 30X-0868-B0), Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-024, dated February 11, 2026*.
- Foundation Investigation Report Bradford Bypass E-S Ramp over Highway 400 (Site No. 30X-0869-B0), Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-025*, dated February 11, 2026.
- Foundation Investigation Report BBP WB and EB Culverts East of Highway 400 Sites No. 30X-0878/C0 And 30X-0879/C0 Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-020*, dated February 11, 2026.

The Contractor shall review the referenced reports and familiarize themselves with the ground conditions prior to commencing work.

2.0 INSTALLATION

2.1 Instrument Location

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

Survey coordinates and elevations shall be referenced to the project control network.

Table 1 - Instrument Quantities and Locations

Location		Section Type	Approx. Embankment Height (m)*	Number of Instruments **		
Area	Station			SR	SP	VWP
Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) East Approach	10+993	A	15.8	1	3	-
	11+018	A	14.7	1	3	-
	11+043	A	13.5	1	3	-
	11+093	A	11.0	1	3	-
	11+143	A	8.7	1	3	-
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) East Approach	11+526	A	4.5	1	3	-
	11+576	A	6.4	1	3	-
	11+626	A	7.8	1	3	-
	11+676	A	9.3	1	3	-
	11+701	A	10.1	1	3	-
	11+726	A	10.5	1	3	-
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) West Approach	11+954	A	9.2	1	3	-
	11+979	A	8.6	1	3	-
	12+004	A	7.3	1	3	-
	12+054	A	6.8	1	3	-
	12+104	A	6.3	1	3	-
	12+154	A	5.3	1	3	-
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches	10+744	A	4.7	1	3	-
	10+765	C	7.7	**5**	**5**	1
	10+783	C	7.6	**5**	**5**	1
	10+804	A	8.1	1	3	-
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S	10+083/11+076	B	3.0	**3**	**3**	1
	10+065/11+058	B	3.0	**3**	**3**	1

*. Approximate embankment height at centreline of the specified ramp measured from the existing ground surface to top of pavement.

**. In addition to the instruments listed above, instrument include four (4) Benchmarks as per Section 3.0, four (4) RVWP as per Section 6.0, and one (1) weather station as per Section 7.0.

2.2 Survey Benchmarks (BM)

The Contractor shall provide a minimum of four (4) survey benchmarks (BM). Proposed benchmark locations are shown on the Contract Drawings. Prior to installation, the Contractor shall confirm and refine the location of each benchmark in the field to ensure that direct sighting is achievable from all survey instruments, including SRs and SPs, to at least two (2) benchmarks, allowing for proper resection, redundancy, and verification of survey accuracy.

Benchmarks shall be located outside the Zone of Influence (ZOI) and at sufficient offsets from embankments, excavations, and construction activities to ensure they remain stable and non-yielding throughout construction and monitoring. Locations shall also consider site access, line-of-sight constraints, topography, vegetation, and long-term protection from disturbance.

Where site constraints, obstructions, or visibility limitations are identified, the Contractor may propose adjustments to benchmark locations or the installation of additional benchmarks, as required to satisfy the intent of the monitoring program and survey accuracy requirements.

The locations of the benchmarks and all monitoring instruments must be approved by the Contract Administrator prior to the installation of monitoring instruments.

2.3 Survey Personnel

Surveying to establish the Benchmarks and other elevations shall be carried out by a registered Ontario Land Surveyor (OLS), using calibrated survey equipment and accepted surveying practices.

Survey work shall comply with applicable MTO and professional standards.

2.3.1 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of ± 2 mm or better.

2.4 Materials and Equipment

The Contractor shall supply all materials and equipment required for the installation of instrumentation unless noted otherwise. All materials shall be new and free of defects.

2.5 Underground Utilities

The Contractor shall be responsible for locating and protecting all underground utilities prior to any ground disturbance, including drilling of boreholes for the installation of instruments or survey benchmarks. Any damage to underground utilities resulting from the Contractor's operations shall be repaired by the Contractor at no cost to the Owner. Utility locates shall be obtained and verified prior to any ground disturbance.

2.6 Marking and Labelling

The location of any above-ground monitoring instrument shall be made clearly visible to nearby traffic before, during, and after embankment construction. Markings shall be of sufficient size to be visible from

a reversing vehicle and after heavy snowfall.

Instruments or their data cables shall be clearly labelled in the field, each instrument having a unique identifier. The labelling shall remain legible for at least five (5) years.

2.7 Protection of Instruments

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any instrument damaged by the Contractor's work shall be immediately replaced by the Contractor at the Contractor's cost.

Instruments shall also be protected by the Contractor from natural effects such as lightning strikes. This protection shall follow the instrument manufacturer's recommendations and shall include the use of appropriate grounding and transient protection systems.

Grounding and surge protection details shall be included in the Contractor's submittals.

2.8 Boreholes

The Contractor shall prepare a basic stratigraphic log of each borehole during drilling. Standard Penetration Test (SPT) sampling shall be carried out as required to identify soil stratigraphy and to confirm the depth and presence of competent soil suitable for benchmark anchorage. No additional in situ testing or laboratory testing is required.

Boreholes shall be advanced using conventional drilling methods and shall be as straight and vertical as practical.

Boreholes shall be cleared of loose cuttings and drilling fluids prior to instrument installation.

2.9 Installation Program

Instrument installation shall commence prior to embankment construction and before placement of any embankment fill. No material stockpiling shall be allowed within the embankment construction area during instrument installation activities. Table 2 provides a summary of the required installation schedule.

Table 2 - Installation Program

Type	Start Installation	Complete Installation
WS	When access is obtained to the site	Before any construction
SR	After site grading is complete and prior to any grade raise or placement of embankment fill, all settlement plates and initial settlement rods shall be fully installed. Installation of settlement rods at later stages of embankment construction is not permitted. All installed settlement rods shall be ready for extension as embankment construction proceeds.	At completion of embankment construction, all settlement rods shall be extended to the top of the embankment. This item includes the extension of existing settlement rods only and does not include the installation of new settlement rods. Installation of new settlement rods at this stage shall be considered non-compliant and may result in rejection of the work and associated monitoring data

SP	When the embankment at the instrument location reaches the maximum design elevation	At the completion of embankment construction
VWP and RVWP	After site grading is completed and before placing any material for embankment construction	Before any embankment construction

3.0 BENCHMARKS (BM) – SUPPLY & INSTALLATION

3.1 General

3.1.1 Scope

This Section contains the requirements for the supply and installation of benchmarks (BM).

The benchmarks form part of the project survey control network and are required to provide stable, non-settling reference points for surveying instruments (e.g., SP and SR) and other monitoring instrumentation installed for the embankment works.

3.1.2 General Procedure

Benchmarks shall be installed prior to embankment construction and before any settlement-sensitive work begins.

BM benchmarks shall consist of steel rods anchored in competent soil exhibiting Standard Penetration Test (SPT) values greater than 50 blows per 300 mm of penetration. These benchmarks shall serve as stable, non-yielding control points for all monitoring activities.

BM rods shall be embedded to a depth sufficient to extend below the local frost penetration depth and below any peat or compressible soil layers to ensure long-term stability and resistance to construction-induced movements.

The locations of the benchmarks and all monitoring instruments must be approved by the Contract Administrator prior to the installation of monitoring instruments.

3.1.3 Number and Location

The minimum number and approximate benchmark locations are shown on the Contract Drawings and summarized in Table 3. Prior to installation, benchmark locations shall be refined in the field to:

- Maintain intervisibility between adjacent benchmarks where practicable.
- Ensure that a minimum of two (2) benchmarks are visible from each survey instrument.
- Address restricted sight lines due to curvature, vegetation, structures, or other site constraints by adjusting benchmark locations or providing additional benchmarks, as required.
- The Contractor may propose adjustments to benchmark locations, or the installation of additional benchmarks, where topography, access limitations, or obstructions affect

visibility or survey accuracy. The final number and locations of benchmarks shall be such that direct sighting is possible from all survey instruments to at least two (2) benchmarks.

- Benchmarks shall be installed a minimum of 50 m away from the embankment toe, measured perpendicular to the embankment.
- Benchmarks shall be located outside the Zone of Influence.
- The greater of the above two criteria shall govern the required benchmark offset.
- The locations of the benchmarks and all monitoring instruments must be approved by the Contract Administrator prior to the installation of monitoring instruments.

Table 3 - Approximate Benchmark Locations

BM ID	Approximate Coordinate	Approx. Existing Ground Elev. (m)*	Estimated Top of Competent Soil Elevation (m) **
BM-1	E: 609295.00 m, N:4886085.00 m	260	238
BM-2	E: 609655.00 m, N: 4886036.00 m	262	238
BM-3	E: 609478.00 m, N: 4885581.00 m	256	234
BM-4	E: 609132.00 m, N: 4885261.00 m	253	234

*. Approximate Existing Ground Elevations shall be confirmed by field survey at the benchmark installation location.

**. Top of Competent Soil elevations are based on available boreholes located away from the benchmark locations and are provided for guidance only. Final elevations shall be confirmed in the field based on drilling observations and Standard Penetration Test (SPT) results, identifying competent soil (SPT > 50 blows per 300 mm of penetration).

3.2 MATERIALS

3.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the benchmarks.

3.2.2 BM Materials

3.2.2.1 Rod

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4 mm (1"), supplied in lengths as required to complete the installation.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

3.2.2.2 Sand

The Contractor shall supply clean, washed sand. The sand shall be Sakcrete washed general-purpose sand or equivalent.

3.2.2.3 Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 23 kg of

bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type 10 - OPSS 1301).

3.2.2.4 Rod Anchor Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 14 kg of bentonite (OPSS 1205), 49 litres of water and 40 kg of cement (Type 10 - OPSS 1301).

3.2.2.5 Friction Reducing Sleeve

The Contractor shall supply a friction-reducing sleeve consisting of Schedule 40 - 50.8mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe.

3.3 INSTALLATION

3.3.1 General

3.3.2 BM benchmarks shall be installed according to the drawings and the requirements of this document.

3.3.3 Borehole Installation

Boreholes shall:

- Be advanced to the specified rod anchor elevation using appropriate drilling methods
- Have sufficient diameter to house the rod, friction-reducing sleeve, and rod anchor grout
- Be stable and free of debris, bentonite slurry, or loose material

3.3.4 Rod Coupling

Rod sections shall be coupled:

- With threads aligned to maintain a common axis
- So that no separation, loosening, or contraction occurs during installation or monitoring

3.3.5 Rod Anchor

The rod shall be installed vertically with its bottom resting at the borehole base.

The anchoring procedure shall include:

- Grouting the bottom 3 m of the borehole to form the soil anchor.
- Allowing the anchor grout to set.
- Placing 0.5 m of clean sand above the anchor grout to provide a bedding layer for the friction-reducing sleeve.

The elevation of the rod anchor bottom shall be determined from rod length and ground elevation.

3.3.6 Friction-Reducing Sleeve

The friction-reducing sleeve shall:

- Extend continuously from the top of the sand layer to ground surface
- Be installed concentrically around the rod to minimize shaft resistance.

3.4 COORDINATION WITH MONITORING

3.4.1 Notification

Within 3 days of installing a benchmark, the Contractor shall notify the Contract Administrator and provide:

- Elevations of rod anchors
- Elevation of rod top (i.e., benchmark elevation)
- Dates of installation
- Stratigraphic log of subsurface conditions, including drilling method
- Installation notes and sketches
- Description of benchmark type, sleeve, and anchoring details.

3.5 Monitoring Access

Monitoring of the benchmarks shall be performed by others.

The Contractor shall:

- Ensure clear access to each benchmark
- Remove snow or debris as needed
- Provide power or lighting if required for nighttime or low visibility monitoring

3.6 REPORTING

The Contractor shall record and report relevant installation details to the Contract Administrator, including but not limited to:

- Easting and northing of benchmark
- Elevations of rod anchor and top of benchmark
- Dates of installation
- Installation notes and sketches
- Any deviations from planned location and justification

4.0 SETTLEMENT RODS (SR) - SUPPLY & INSTALLATION

4.1 General

4.1.1 Scope

This Section contains the requirements for the supply, installation, and extension of settlement rods (SR). Settlement rods are intended to monitor settlement of the foundation soils from the onset of embankment construction. Settlement shall be measured by survey of the top of the settlement rod with reference to stable, non-settling benchmarks.

Settlement rods installed after commencement of embankment fill placement do not satisfy the intent of

this monitoring program and shall be considered non-compliant.

4.1.2 General Procedure

Settlement rods shall be installed by fixing the rod to a settlement plate placed at the existing ground surface prior to any grade raise or placement of embankment fill. All settlement plates and initial settlement rods shall be fully installed before embankment construction begins and shall remain in place for the duration of embankment construction.

As embankment construction proceeds, settlement rods shall be extended, such that the top of the rod remains above the surrounding fill in accordance with this Special Provision. Installation of new settlement rods after commencement of embankment fill placement is not permitted.

Friction-reducing sleeves shall be installed to allow uninhibited vertical movement of the rod with the settlement plate. Protective surrounds shall be installed with the initial settlement rod installation and extended concurrently with rod extensions as embankment construction progresses.

4.1.3 Location

The locations of the settlement rods are shown on the attached drawings and are given in Table 4.

Table 4 - Approximate Settlement Rod Locations

Location **		Section Type	Approx. Embankment Height (m)*	Number of Instruments
Area	**Station**			
Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) East Approach	10+993	A	15.8	1
	11+018	A	14.7	1
	11+043	A	13.5	1
	11+093	A	11.0	1
	11+143	A	8.7	1
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) East Approach	11+526	A	4.5	1
	11+576	A	6.4	1
	11+626	A	7.8	1
	11+676	A	9.3	1
	11+701	A	10.1	1
	11+726	A	10.5	1
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) West Approach	**11+954**	A	9.2	1
	11+979	A	8.6	1
	12+004	A	7.3	1
	12+054	A	6.8	1
	12+104	A	6.3	1
	12+154	A	5.3	1
Bradford Bypass EBL East of Highway	10+744	A	4.7	1

Location **		Section Type	Approx. Embankment Height (m)*	Number of Instruments
Area	**Station**			
400 Arch Culvert (30X-0879/C0) East and West Approaches	10+765	C	7.7	**5**
	10+783	C	7.6	**5**
	10+804	A	8.1	1
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S	10+083/11+076	B	3.0	**3**
	10+065/11+058	B	3.0	**3**

*. Approximate embankment height at the centreline of the specified ramp measured from the existing ground surface to the top of the pavement.

**. Instrument locations shall be as per drawings plan. The exact offsets and locations of the settlement rods shall be determined on-site based on the Monitoring Section Types.

4.2 Materials

4.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the settlement rods.

4.2.2 Plate

The Contractor shall supply a steel plate with a thickness of at least 6.35 mm. The plate shall be at least 0.5 m by 0.5 m.

4.2.3 Rod

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4mm (1"), supplied in lengths as required to complete the installation.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

4.2.4 Friction-Reducing Sleeve

The Contractor shall supply a friction-reducing sleeve consisting of Schedule 40 - 50.8mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe.

4.2.5 Protective Surround

The Contractor shall supply a protective surround for the portion of the rod within the embankment.

The surround shall consist of a 300 mm diameter corrugated steel pipe (CSP - OPSS 1801) with the ends

cut perpendicular to the axis of the pipe and free of sharp edges. The space between the CSP and the Friction Reducing Sleeve (PVC pipe) shall be filled with medium to coarse sand.

4.3 Installation

4.3.1 General

The Contractor shall install settlement rods as per the contract drawings provided in addition to what is stated below.

4.3.2 Settlement Plate

The settlement plate shall be installed horizontally on undisturbed native soil just below the existing ground surface.

The elevation of the base of the plate shall be surveyed before backfilling.

4.3.3 Rod

The rod shall be fixed to the centre of the plate and perpendicular to the plate.

The coupling of the rods shall be such that all sections have the same axis, and no separation or contraction to occur at the couplings.

4.3.4 Friction-Reducing Sleeve

The friction-reducing sleeve shall extend over the entire length of the rod that is below ground and within the embankment fill, except that the cap on top of the settlement rod shall extend 25 mm above the top of the friction-reducing sleeve at all times.

4.3.5 Extension of Rod

The settlement rods shall be extended upwards as the embankment is constructed so that the top of the rod is always at least 0.3 m but no more than 2 m above the surrounding fill. The top of the rod shall be surveyed before and after each rod extension is added.

4.3.6 Protective Surround

The CSP, Friction Reducing Sleeve and sand protective surround shall be extended with the rods.

The settlement rod shall be in the centre of the CSP and friction reducing sleeve.

The annulus between the CSP and the friction-reducing sleeve shall be filled with sand to a level not higher than the top of the sleeve.

4.3.7 Installation Details

The elevation, easting and northing of the centre of the base of the plate shall be surveyed. The total

distance from the base of the plate to the top of the rod shall be measured to an accuracy of ± 2 mm or better.

4.4 Coordination with Monitoring

4.4.1 Notification

The Contractor shall notify the Contract Administrator no later than 3 days after installing a settlement rod. At this time, the Contractor shall also supply the following information to the Contract Administrator:

- Elevations of plate and the top of rod
- Dates of installation
- Installation notes/sketches
- Description of settlement rods, sleeve, plate
- Installation Photos

During the embankment construction, the Contractor shall extend all settlement rods, friction protective sleeves and CSP protective surrounds simultaneously prior to next fill lift placement. The Contractor shall notify the Contract Administrator no less than 3 days prior to extending any settlement rod. Adjustments in the length of any settlement rod shall be coordinated with the Contract Administrator to allow surveying by others of the elevation of the top of rod immediately before and immediately after adjustment. This surveying is necessary to accurately track the settlement data.

4.4.2 Monitoring

Monitoring of the settlement rods shall be done by others. Monitoring shall be conducted during the embankment construction. The Contractor shall provide installation information as specified above and provide access to the settlement rods for monitoring, including, but not limited to a scaffolding platform and ladder if required and snow clearing in the winter. The Contractor shall provide electric power and general area lighting as needed for reading the instruments.

4.5 Reporting

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- Settlement rod easting, northing
- Elevations of the plate and the top of the rod
- Distance between the base of the plate and the top of rod
- Dates of installation
- Installation notes/sketches

5.0 SETTLEMENT PIN (SP) - SUPPLY & INSTALLATION

5.1 General

5.1.1 Scope

This non-standard special provision contains the requirements for the supply and installation of settlement

pins.

The purpose of the settlement pin is to monitor the settlement at the top of the embankment. Settlement is measured by surveying the top of the pin with reference to stable, non-settling benchmarks.

5.1.2 General Procedure

For other Monitoring Sections, settlement pins shall be installed on the top of the embankment (if applicable) upon completion of embankment construction.

5.1.3 Location

The locations of the settlement pin monitoring sections are given Table 5.

Table 5 - Approximate Settlement Pin (SP) Locations

Location **		Section Type	Approx. Embankment Height (m)*	Number of Instruments
Area	**Station**			
Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) East Approach	10+993	A	15.8	3
	11+018	A	14.7	3
	11+043	A	13.5	3
	11+093	A	11.0	3
	11+143	A	8.7	3
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) East Approach	11+526	A	4.5	3
	11+576	A	6.4	3
	11+626	A	7.8	3
	11+676	A	9.3	3
	11+701	A	10.1	3
	11+726	A	10.5	3
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) West Approach	**11+954**	A	9.2	3
	11+979	A	8.6	3
	12+004	A	7.3	3
	12+054	A	6.8	3
	12+104	A	6.3	3
	12+154	A	5.3	3
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches	10+750	A	4.7	3
	10+765	C	7.7	**5*** **
	10+783	C	7.6	**5*** **
	10+800	A	8.1	3
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S	10+083/11+077	B	3.0	**3*** **
	10+065/11+059	B	3.0	**3*** **

*. Approximate embankment height at the centreline of the specified ramp measured from the existing ground surface to top of pavement.

**. Instrument locations shall be as per drawings plan. The exact offsets and locations of the settlement pins shall be determined on-site based on the Monitoring Section Types.

***. Instruments need to be reinstalled once the final embankment is constructed prior to paving

5.2 Materials

5.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the culvert and embankment settlement pins.

5.2.2 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut 0.4 m long or equal for settlement pins.

The top of the reinforcing steel bar shall be angled or rounded in such a way that a single survey point can be clearly identified and repeated.

5.2.3 Concrete

The Contractor shall supply concrete (OPSS 1350) with strength and set time sufficient to secure the pin within two (2) days of placement.

5.3 Installation

5.3.1 General

The Contractor shall install settlement pins as per the Contract Drawings. Pins shall be installed plumb and securely embedded in concrete or the embankment surface as shown on the details.

5.4 Notification

The Contractor shall notify the Contract Administrator no later than 3 days after installing a settlement pin. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- Settlement pin location, easting and northing
- Elevation of top of pin
- Dates of installation and datum readings
- Installation notes/sketches and photographs

5.5 Monitoring

Monitoring of the settlement pins shall be done by others. Monitoring shall be conducted during the embankment construction. The Contractor shall provide installation information as specified above and provide access to the settlement pins for settlement monitoring.

6.0 VIBRATING WIRE PIEZOMETER (VWP) & REFERENCE VWP (RVWP)- SUPPLY & INSTALLATION

6.1 General

6.1.1 Scope

This Section contains the requirements for the supply and installation of vibrating wire piezometers (VWP) and reference vibrating wire piezometers (RVWP).

The purpose of the piezometers is to monitor the piezometric head and pore pressure at depth within the foundation soil. Piezometer data may also be used to confirm embankment performance and to support any required design review during construction.

6.1.2 General Procedure

The piezometers shall be installed in boreholes prior to any embankment construction.

The VW signal cables shall be extended out of the embankment footprint area through a metal or plastic conduit buried in trenches, as shown in the detail drawings. The routing of conduits and cables shall be coordinated with the grading and embankment Contractor to avoid damage during construction.

6.1.3 Locations

Contractor shall install VWP and RVWP sensors at the locations and depths given in Table 6 and Table 7

Table 6 – Vibrating Wire Piezometer (VWP) Locations

Location		Approx. Existing Ground Elev. (m)	Section Type	No. of VWP	VWP Tip Elevation (m)
Area	**Station**				
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches	10+765	256	C	1	248
	10+783	257	C	1	247
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S	10+083/11+076	259	B	1	248
	10+065/11+058	259	B	1	245

Table 7 – Reference VWP (RVWP) Locations

Location		Approx. Existing Ground Elev. (m)	Instrument ID*	No. of RVWP	RVWP Tip Elevation (m)
Area	**Approximate Coordinate**				
Near Arch Culvert (30X-0878/C0)	E:609742 m, N:4886092 m	262	RVWP-1	1	247
	E: 609988 m, N:4886132 m	262	RVWP-2	1	248

6.2 Materials

6.2.1 Vibrating Wire Piezometers

The Contractor shall supply VW borehole piezometers (e.g., Geokon model 4500S, rated for a minimum operating range of 350 kPa, or equal). All VWP shall be compatible with the data logger (e.g., Geokon model 8002-1, 8002-4, 8002-16 data logger, or equal). At sites with known artesian condition, a push-in type piezometer (e.g., Geokon model 4500DP, or equal) shall be used instead of a standard VWP. All VW piezometers and data loggers shall be of the same make.

All piezometers shall be calibrated prior to installation and the calibration data for each piezometer shall be provided to the Contract Administrator.

Lightning protection for VWPs shall be provided by the Contractor. If the instrument is damaged by lightning, the Contractor shall replace it within 2 days. Lightning protection shall include, as a minimum, proper grounding of enclosures and the use of surge protection devices compatible with the selected data logger system.

6.2.2 Bentonite

The Contractor shall supply bentonite (OPSS 1205) in pellet form in sufficient quantity to form borehole plugs as required.

6.2.3 Filter Sand

The Contractor shall supply clean, washed sand for the filter around the VW sensors. The sand shall be Sakcrete washed general-purpose sand, or equal. Filter sand shall be uniformly graded and free of organics or deleterious materials.

6.2.4 Grout

The annular space between the vibrating wire cables and the borehole shall be filled with cement-bentonite grout prepared as follows: 17.7 kg of bentonite (OPSS 1205), 284 liters of water and 42.6 kg of cement (Type 10 - OPSS 1301). The grout shall be mixed to a uniform consistency and placed from the base of the borehole upward using a tremie pipe to prevent segregation.

6.2.5 Signal Cable

The Contractor shall supply signal cable compatible with the VWP sensors. The VWPs shall withstand all of the temperature variations. The length of cable for each piezometer shall be carefully estimated from the construction drawings to ensure that there is enough signal cable for each piezometer to provide enough slack in the borehole and along the trenches until each cable is out of the embankment footprint area where they shall be protected from construction equipment.

Cable splices shall be minimized and, where unavoidable, shall be made using manufacturer-approved waterproof splice kits and procedures.

6.2.6 Trench Burial and Conduit

The signal cable for each piezometer shall be buried in a shallow trench as shown in the attached detail drawings and taken out of the embankment footprint area. The Contractor shall supply suitable conduits (e.g. Schedule 40 - 75mm - 3" rigid PVC pipe) to protect the signal cables in the trenches and above ground surface. If appropriate, several signal cables may be housed in a single conduit and laid in a common trench. Before trenches are backfilled, the VWPs shall be tested.

The conduit terminations at data logger enclosures shall be sealed to prevent water ingress and rodent entry.

6.2.7 VWP Data Recorder

The Contractor shall supply a vibrating wire readout unit suitable for manual verification of VWP and RVWP sensors (for example, Geokon Model GK-404, or equal). The readout shall be fully compatible with the supplied instruments and shall include all required leads, connectors, and software to allow field personnel to confirm readings, perform diagnostics, and verify calibration factors.

The VWP data recorder is intended for spot checks and field verification only and shall not be considered a substitute for the automated data logger system specified in the following section. All VWPs, RVWPs, and readout units shall be of the same make or demonstrated to be fully compatible.

6.2.8 Data Logger

The signal cables from the VWPs and RVWPs shall be connected to the nearest data logger suitable for long-term automated monitoring. The data logger shall be fully compatible with vibrating-wire sensors and may include, for example, Geokon GeoNet Series data loggers (such as the 8940 Series or 8921 Cellular Logger), or an approved equal.

The data logger system shall include all components required for full operation, including vibrating-wire interface modules, terminal interfaces, communication cables, data retrieval software, weatherproof enclosures, power supplies, solar panels, charge regulators, and batteries designed to support uninterrupted monitoring for the duration of the project. All data loggers used on the project shall be of the same make and fully compatible with the supplied VWP and RVWP instruments.

The Contractor shall submit a detailed data-logger configuration plan, including the number of loggers, proposed locations, wiring layout, telemetry components (if applicable), power system design, and

enclosure details, for review and approval prior to procurement. The quantity of data loggers shall be minimized to simplify data retrieval and system maintenance.

The Contractor shall program each data logger according to the following:

- VWP and RVWP readings shall be recorded a minimum two (2) times per day (one reading every 12 hours).
- A "test mode" shall be provided to allow manual verification and on-site real-time data checks.

Data shall be retrievable on site through direct cable connection (USB, RS-232, or equivalent) using the portable laptop computer supplied under this Contract.

The data logger shall be configured with an online or telemetry-based data acquisition system using manufacturer-supported communication hardware such as Geokon GeoNet cellular, wireless mesh, or Ethernet gateways, or approved equal. Any proposed telemetry system shall be submitted as part of the Contractor's data-logger configuration plan and shall only be considered if it provides demonstrated cost savings or equivalent total cost compared to the base (non-telemetry) system, while maintaining or improving overall functionality and reliability. When telemetry is provided, the system shall automatically upload data to a secure server or cloud hosting service with password-protected access for the Owner's representatives.

The online system shall, as a minimum:

- Allow remote configuration of data loggers
- Provide viewing of current and historical readings in tabular format
- Allow export of data files for analysis

All communication hardware, SIM cards, data plans, software licenses, cloud hosting fees, and other services required to operate the online monitoring system for the full monitoring period shall be supplied by the Contractor.

6.2.9 Data Retrieval

The Contractor shall supply and configure a portable laptop computer as specified in Section 8.1. The laptop shall be fully configured with all required data logger software, communication drivers and VWP calibration files prior to handover.

6.2.10 Wooden Posts

Wooden posts for the support of the data acquisition system enclosures shall be 100 mm by 100 mm in cross-section, minimum 3 m long, pressure-treated lumber, installed a minimum of 1.5 m into the ground. Posts shall be plumb and braced as required to prevent movement due to frost heave or vehicle impact.

6.3 Installation

6.3.1 General

Installation of the VWPs shall be as per the manufacturer's recommendations in addition to what is stated

or emphasized below. The Contractor shall ensure that all installation personnel are familiar with the manufacturer's instructions and this Specification before commencing work.

6.3.2 Borehole Installation

The borehole shall be advanced to 500 mm below the lowest tip elevation using suitable drilling techniques. The sides of the borehole shall be stable and free of drilling mud and debris.Filter sand, bentonite pellets and grout shall be placed in the borehole in distinct lifts to achieve the design filter and seal configuration around each sensor elevation, as shown on the drawings.

It shall be noted that Artesian conditions are anticipated at VWP locations. Proper installation as per the manufacturer's recommendations shall be followed.

6.3.3 Data Logger Boxes and Monitoring Shed

The Data Logger Boxes shall be lockable and weatherproofed and securely attached inside the Monitoring Shed. The terminal boxes and data logger accessories shall be properly grounded.

The Contractor shall provide appropriate protection against natural hazards including but not limited to lightning strike. The Monitoring Shed shall be lockable. The Monitoring Shed shall be seated on a gravel pad and securely tied down to ground. The location of the Monitoring Shed shall not be susceptible to ground settlement. The Contractor shall submit a detailed proposal of the Monitoring Shed (i.e., materials and locations) to the Contract Administrator for review, prior to construction.

The Contractor shall ensure safe access to the Monitoring Shed at all times including, but not limited to, snow clearing in the winter. Where monitoring is expected during hours of darkness, the Contractor shall provide adequate exterior lighting to allow safe access to the Monitoring Shed.

6.3.4 Completion of Installation

It is known that the process of installing VW piezometers can temporarily alter the pore water pressure acting on the piezometer tip. The installation of a VW piezometer shall not be considered to be complete until the pore pressure acting on the piezometer has returned to and stabilized at the value prevailing in the surrounding, unaffected soil mass. The Contractor shall take daily readings of the pore pressures until the value has stabilized. Stabilization shall be deemed to have occurred:

a. When no change in the measured value has occurred over a period of 5 days and the measured value is within 10% of the anticipated hydrostatic value
b. When the daily rate of change is less than (3) kPa per day for three consecutive days and the measured value is within 5% of the anticipated hydrostatic value
c. Failing either of the two above conditions, as determined by the Contract Administrator
    - The Contractor shall be prepared to wait for a period of 15 days after completion of the installation of instruments for the baseline readings to stabilize.
    - If stabilization is not achieved within this period, the Contractor shall notify the Contract Administrator and continue monitoring at a frequency directed by the Contract Administrator.

6.4 COORDINATION WITH MONITORING

6.4.1 Notification and As-built information

The Contractor shall notify the Contract Administrator no later than three (3) days after installing each VW piezometer. At the time of notification, the Contractor shall submit the following information for review and incorporation into the project instrumentation records:

- VWP/RVWP location, including easting and northing coordinates
- Elevation(s) of all VWP and RVWP sensor tips
- Stratigraphic log of subsurface conditions encountered during drilling, including drilling method notes
- Date(s) of installation
- Installation notes, including grounding method, borehole completion details, sketches, and photographs
- Model, make, and serial numbers of all VW sensors, data loggers, and signal cables
- Calibration certificates and calibration factors for each VW sensor

All as-built information shall be provided in both PDF format and an editable spreadsheet or database format suitable for incorporation into the project's instrumentation registry.

6.4.2 Monitoring

Monitoring of the VW piezometers, including collection of baseline readings. Monitoring activities will occur throughout embankment construction, surcharge placement, and subsequent consolidation periods. The Contractor shall provide all installation information specified above and shall ensure safe and unobstructed access to the Monitoring Shed for data retrieval at all times during the monitoring program.

The Contractor shall provide electrical power and general area lighting as required to support monitoring activities.

Upon completion of installation, the Contractor shall transfer the portable laptop computer and VWP data recorder to the Contract Administrator, together with all associated data-logging software, hardware, operating instructions, communication drivers, and calibration constants. The Contractor shall also provide the keys for all Monitoring Shed(s) and instrument enclosures.

The Contractor shall participate in one (1) handover meeting with the Contract Administrator to review system setup, verify proper operation of the installed instrumentation, and answer any questions regarding the data-logging system.

If an online or telemetry-based data collection system has been provided, the Contractor shall, at the handover meeting:

- Demonstrate user access to the online platform
- Review data visualization and data export procedures
- Confirm configuration of notification/alarm settings (if applicable)
- Provide all usernames, passwords, API keys, software licenses, and communication service information required for continued operation of the system by others

7.0 WEATHER STATION

7.1 General

This Section contains the requirements for the supply and installation of a dedicated Weather Station (WS). The purpose of the Weather Station is to monitor local environmental conditions, such as rainfall to capture key changes in environmental conditions which may affect various measurements across the site.

7.1.1 Location

The weather station shall be installed within the project limits, outside the embankment construction footprint, and at a safe location to avoid damage from construction equipment, prior to the commencement of any embankment construction. Consideration shall be given to installing the weather station near the Monitoring Shed within the chain link fence.

7.2 Material

The Contractor shall supply a weather station (e.g., Campbell Scientific model# RGWS100) and all materials and equipment required for the installation of the weather station to monitor local conditions. At a minimum the following parameters shall be measured:

- Barometric Pressure
- Wind Direction and Speed
- Rainfall (Intensity, Duration, Minimum, Maximum and Average)
- Relative Humidity
- Temperature

7.2.1 Power Supply

Solar panels, a smart power supply and controller, and batteries must be provided for the weather station. Batteries are to be sized according to power drain and location.

7.2.2 Data recorder logger

The weather station shall be connected to a compatible data logger (for example, CR1000 or equal) for continuous data collection. The data logger may be shared with other environmental or geotechnical sensors, provided sufficient channels and power are available.

The weather station data logger shall be integrated into a telemetry-based system consistent with the requirements for telemetry in Sections 6.2.8

7.2.3 Mounting Stand

Mounting tripod (e.g., CM110 10-ft Stainless Steel Tripod) or stand must be supplied to mount all the sensors, measurement and control data logger as per the manufacturer's recommendations. The Mounting Stand must be properly secured to the ground and protected at the site.

7.3 Installation

7.3.1 General

Installation of the WS shall be as per the manufacturer's recommendations in addition to what is stated or emphasized below.

7.3.2 Data Logger Boxes and Monitoring Shed

The data logger boxes shall be lockable and weatherproof and securely attached inside the Monitoring Shed. The terminal boxes and data logger accessories shall be properly grounded.

The Contractor shall provide appropriate protection against natural hazards, including but not limited to lightning strikes.

The Contractor shall ensure safe access to the Monitoring Shed at all times, including, but not limited to, snow removal in the winter.

7.4 COORDINATION WITH MONITORING

7.4.1 Notification

The Contractor shall notify the Contract Administrator no later than 3 days after installing the weather station. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- WS location, easting, northing
- Elevations of sensors
- Dates of installation
- Installation notes, grounding method, sketches and photographs
- Model, make and serial number of WS sensors, data logger and signal cable
- Calibration details of WS sensors

7.4.2 Monitoring

Monitoring shall be conducted during the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the Monitoring Shed for data retrieval.

The Contractor shall transfer the portable laptop computer specified in Section 8.1 and the WS data recorder or data logger configuration files to the Contract Administrator, including all of the data logging software and hardware, operating instructions and calibration constants. The Contractor shall also transfer the keys for the locks of the Monitoring Sheds. The Contractor shall be available for one site meeting with the Contract Administrator to transfer the items and answer any questions the Contract Administrator may have regarding the data logging system.

Where telemetry is provided, the Contractor shall demonstrate access to online weather station data, data export procedures and provide all access credentials and licences required for continued operation by

others.

8.0 DATA LOGGER AND DATA RETRIEVAL

The signal cables from the VWP, RVWP and other automated geotechnical instruments shall be connected to the nearest data logger as specified in Sections 6.0 and 7.0. Data loggers shall be purpose-designed for geotechnical and environmental monitoring and shall include, but not be limited to, interface modules, interface cables, data logger retrieval computer software, power supplies, solar panels, charge regulators and batteries that will allow for the anticipated duration of the monitoring program (a minimum of 3 years). All data loggers shall be of the same make and shall be compatible with their corresponding VWP, RVWP, and WS instruments.

The Contractor shall submit a detailed proposal on the setup of the data logger system (that is, numbers and locations of the data logger units) to the Contract Administrator for review and approval, prior to ordering the data loggers. An effort should be made to minimize the number of data loggers at each site location to ease data retrieval.

Each data logger shall be configured with sampling and recording intervals that meet the minimum requirements stated in the relevant instrument Sections (6.0, and 7.0) and as approved by the Contract Administrator.

The data shall be retrieved on site by direct wire (for example, RS232 or USB cable) with a portable laptop computer supplied under Section 8.1, or via the approved telemetry or online system where such an option has been provided and accepted.

8.1 Portable Computer

The Contractor shall supply a single laptop computer for use with all data logger systems under this Contract. The laptop shall be a current model business-grade computer equipped with:

- A solid-state drive with a minimum capacity of 256 gigabytes (GB)
- A minimum of 8 GB of RAM
- Two batteries or equivalent extended battery capacity suitable for full-day field use
- Microsoft Windows 11 Professional
- A current version of Microsoft Office or equivalent office suite
- PDF viewing and editing software
- All data logger and instrument communication drivers and software required for VWP, RVWP, and WS systems

A vehicle power adaptor suitable for field charging of the laptop shall be supplied.

The portable laptop computer shall be handed to the Contract Administrator after the installation of instruments for the Monitoring Program and following successful verification of communication with all installed data loggers.

The calibration factors for all vibrating wire instruments shall be entered in the portable laptop computer by the Contractor for initialization of the instruments. The Contractor shall verify that the displayed engineering units, calibration factors and instrument serial numbers in the data acquisition software

correspond to the manufacturer calibration certificates and as-built records prior to handover. A summary of this verification shall be provided to the Contract Administrator.

8.2 Protection for Long-Term Monitoring (Monitoring Shed)

At each site, the data logger and all associated accessories shall be installed in a walk-in Monitoring Shed with a plan dimension not less than 1.5 m by 1.5 m to prevent vandalism and wear of the data loggers due to extreme weather. The Monitoring Shed shall have a shelf to support the laptop computer during data download. The solar panel shall be securely mounted to the top of the Monitoring Shed in a way that maximizes the hours of daylight.

The Monitoring Shed shall be a lockable and weatherproof enclosure surrounded by a 1.8 m high chain link fence and lockable gate. The Monitoring Shed shall also be seated on a stable gravel pad and secured to the ground. All data loggers and associated accessories shall be properly grounded and protected from lightning strike.

The Contractor shall submit a detailed proposal of the Monitoring Sheds (that is, materials, locations, layout and security provisions) to the Contract Administrator for review and approval, prior to construction. The Contractor shall maintain safe, year round access to each Monitoring Shed, including snow removal and provision of local lighting where required for nighttime or low visibility access.

9.0 DECOMMISSIONING OF INSTRUMENTS

The Contractor shall decommission all the Settlement Rods (SR) and Settlement Pins (SP) at the end of the monitoring program following construction unless advised otherwise by the Contract Administrator. Vibrating Wire Piezometers (VWP), Reference Vibrating Wire Piezometers (RVWP), and the Weather Station (WS) shall not be decommissioned unless advised otherwise by the Contract Administrator.

Decommissioning of instrumentation shall be carried out according to the Ontario Water Resources Act, R.R.O. 1990, Regulation 903. Where boreholes or casings are to be abandoned, the Contractor shall submit a brief decommissioning plan for review by the Contract Administrator prior to the start of decommissioning work.

10.0 PAYMENT

10.1 Basis of Payment

Payment at the Lump Sum price for this tender item shall be full compensation for all labour, monitoring equipment and materials to do the work including all data loggers, telemetry or online systems (where provided), the portable laptop computer, Monitoring Sheds, power supplies, solar panels, decommissioning activities and all incidental work necessary to provide a complete and functioning embankment monitoring system in accordance with this Special Provision.

EMBANKMENT MONITORING PROGRAM - Item No. #

Special Provision

EMBANKMENT MONITORING PROGRAM

1. GENERAL

Requirements specified for Specialist Qualifications, Services, Deliverables and Records, and the Foundation Monitoring Plan apply to all instrumentation monitoring. Instrumentation monitoring is required for the following items installed under the Special Provision entitled *"Supply and Installation of Embankment Monitoring Equipment"*:

- Survey Benchmarks (BM)
- Settlement Rods (SR)
- Settlement Pin (SP)
- Vibrating Wire Piezometers (VWP)
- Reference VWP (RVWP)
- Weather Station (WS)

The instrumentation monitoring services include:

- Data collection, data reduction and reporting.
- Adherence to the criteria used to assess the embankment performance based on the monitoring data collected from the instrumentation installed by others.
- Interpretation of instrumentation readings for the purpose of providing geotechnical input for ongoing embankment construction.

1.1 Or equal

The term, "*or equal*", shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general configuration.

1.2 Specialist Qualifications

The Foundation Engineering Consultant services required for this assignment have been categorized as ***Geotechnical*** specialty – **High Complexity**.

The Foundation Engineering Consultants that are registered in MTO's consultant acquisition system (RAQS) at complexity ratings in the required specialty that meet or exceed the identified complexity requirement for this assignment are eligible to provide Foundation Engineering services for this project.

The Foundation Monitoring Consultant shall not be the same Geotechnical Consultant retained by the Contractor for the supply and installation of embankment monitoring equipment.

The Foundation Monitoring services shall be provided by the Foundation Engineering Designer (Service Provider) for this project to allow for timely management of the ground improvement works and minimize any delays.

1.3 Services, Deliverables and Records

The Foundation Monitoring Consultant shall:

- Review the Monitoring Program and, if deemed necessary, submit in writing to the Contract Administrator recommendations for modifications, as necessary.
- Review the Contractor's proposed installation procedures for BM, SR, SP, VWP, RVWP, WS, and data logger setup.
- Review the reading frequency (i.e., number of readings taken per day per instrument) to be programmed and saved in the data loggers.
- Meet with the Contractor to receive the Data Recorders, Portable Readout Units, Portable Laptop Computer and all associated software.
- Review all installation reports provided under the supply and installation Special Provision, including calibration certificates.
- Establish baseline readings for all instruments. The Contract Administrator staff may take additional readings after baseline, provided results are forwarded immediately to the Monitoring Consultant.
- Supply all monitoring equipment not provided by the Contractor (excluding laptop, recorders, and readouts).
- Calibrate and maintain monitoring equipment.
- Take selected instrument readings, reduce data, prepare reports.
- Provide transmittal of instrumentation readings and reports to the Contract Administrator;
- Interpret instrumentation readings as needed for construction control.
- Notify the Contract Administrator, if modifications to the construction procedures are required. Interpretation shall include making correlations between instrumentation data and specific construction activities
- Notify the Contract Administrator within 24 hours if Review Level or Alert Level are reached.
- Discuss within 48 hours with the Contract Administrator response action(s), and submit a plan of actions, to prevent the critical instrument readings (i.e., review/Alert Levels) from being exceeded.
- Perform closed-loop differential levelling surveys of all BM benchmarks as part of a network-wide loop at a frequency consistent with the monitoring plan or whenever anomalous readings are suspected.
- Ensure survey closure error does not exceed 2 mm. Any exceedance requires immediate re-survey.
- Any benchmark exhibiting instability, heave, settlement, or loss of intervisibility shall be immediately reported to the Contract Administrator along with recommendations for corrective action or replacement
- Confirm internal consistency of the BM network prior to interpreting any settlement-based monitoring data.
- Document all survey observations, adjustments and adopted benchmark elevations in the monthly report.
- Ensure WS data are recorded continuously and downloaded concurrently with VWP/RVWP reporting.
- Where telemetry is provided, WS data shall remain accessible in real-time to the Foundation Monitoring Consultant and Contract Administrator.

1.3.1 A monthly progress report:

A monthly progress report shall be submitted to the Contract Administrator, MTO Contract Control Officer and MTO Foundation Engineer from the start of monitoring until the end of the monitoring period. Reports shall summarize:

- Instrument installation status
- Monitoring completed during the month
- Relevant construction progress
- Observed or anticipated performance issues
- Review and Alert Levels reached, if any

The Contract Administrator shall maintain a Foundations Monitoring Diary documenting:

- Work in progress
- Fill placement quantities and heights
- Any unusual or problem situations
- Contractor's corrective actions
- Supporting photographs

The diary shall be made available to the Foundation Monitoring Consultant.

1.3.2 Submission of Foundation Monitoring Plan

The Foundation Monitoring Consultant shall, in a brief narrative, discuss the applicable experience and qualifications of specialist staff, the role that each shall play in administration of the contract, the authority to be assumed, and the reporting relationships with the construction administration staff.

The Consultant shall also complete the Foundation Monitoring Plan table in the format provided below.

Table 1: Foundation Monitoring Plan

Major Monitoring Tasks	Level of Monitoring	Deliverable Record(s)
List major monitoring tasks associated with foundation monitoring.	State frequency/level of monitoring.	List associated Deliverable Records for each task.

The instrumentation provided herein pertains to the following Sections:

- Highway 400 N-E Ramp Flyover Ramp Bridge (30X-0868/B0) East Approach Approximate Stations 10+985 to 11+185
- Highway 400 E-S Ramp Flyover Ramp Bridge (30X-0869/B0) East Approach Approximate Stations. 11+530 to 11+730 and West Approach Approximate Stations 11+950 to 12+150
- Bradford Bypass WBL (East of Highway 400) Arch Culvert (30X-0878/C0), E-N Ramp Approaches Approximate Stations 10+060 to: 10+090 and E-S Ramp Approaches Approximate Stations 11+050 to 11+080
- Bradford Bypass EBL (East of Highway 400) Arch Culvert (30X-0879/C0), Approximate Stations 10+735 to 10+815

The fill placement rates, waiting periods, surcharge removal timing, and construction of permanent

culvert shall be controlled by instrumentation readings.

Benchmark surveying shall incorporate closed-loop survey procedures forming a network-wide loop between all BM benchmarks, at a defined monitoring frequency, to verify stability, detect survey errors, and confirm that all benchmarks remain non-yielding reference points. Any discrepancies detected shall be corrected immediately and reported to the Contract Administrator.

Instrumentation shall remain active for the full monitoring period and shall not be decommissioned unless written authorization is provided by the Contract Administrator.

1.4 DRAWINGS

Reference shall be made to the drawings titled Embankment Monitoring Equipment- Plan, Sections and Details included in the Contract Package.

1.5 SUBSURFACE CONDITIONS

The subsurface conditions at the sites are described in the reports:

- Foundation Investigation Report High Fills and Deep Cuts Highway 400 / Bradford Bypass Freeway to Freeway Interchange, Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-022*. Including Highway 400 Main Alignment, 9th Line Main Alignment, N-E Ramp, E-N Ramp, S-E Ramp And E-S Ramp Bradford West Gwillimbury, Ontario, dated February 11, 2026.
- Foundation Investigation Report Bradford Bypass N-E Ramp over Highway 400 (Site No. 30X-0868-B0), Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-024, dated February 11, 2026*.
- Foundation Investigation Report Bradford Bypass E-S Ramp over Highway 400 (Site No. 30X-0868-B0), Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-025*, dated February 11, 2026.
- Foundation Investigation Report BBP WB and EB Culverts East of Highway 400 Sites No. 30X-0878/C0 And 30X-0879/C0 Bradford West Gwillimbury, Ontario. Assignment No. 2023-E-0068, GEOCRES No. *31D04-020*, dated February 11, 2026.

Any subsurface conditions encountered during construction that differ materially from those described in the report shall be documented and considered when interpreting BM, SR, and SP readings.

The Foundation Monitoring Consultant shall review the subsurface information and incorporate the applicable stratigraphic, groundwater and material behaviour characteristics into the assessment and interpretation of all instrumentation readings.

1.6 EQUIPMENT OPERATION

Monitoring shall occur year-round. All equipment shall remain fully operational for continuous data collection throughout the monitoring period. This includes automated instruments (VWP, RVWP, WS), which shall record continuously at the programmed intervals.

Benchmark stability shall be verified through closed-loop surveys; unstable benchmark(s) shall be replaced by the Contractor upon receipt of direction/authorization from the Contract Administrator.

Any equipment malfunction shall be investigated, and attempts shall be made to remedy the

malfunction. Notification of any malfunction or equipment that cannot be repaired shall be made to the Contract Administrator. Documentation of the possible causes and suggested remedial measures shall be forwarded to the Contract Administrator.

1.7 READING SCHEDULE AND FREQUENCY

Monitoring shall commence immediately after the installation of each instrument. Minimum monitoring frequencies, along with the anticipated number of readings, are provided in

Table 3 through 6. Additional readings may be required at the direction of the Contract Administrator.

The Foundation Monitoring Consultant shall save and archive raw data in electronic and hard copy formats.

It should be noted that the following number of readings are approximate and may vary due to uncertainties associated with the embankment performance. The minimum monitoring frequency for the instruments is summarized in the following tables.

Table 2 Minimum Monitoring Frequency for Settlement Rods (SRs) and Settlement Pins (SPs) for the following:
- Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) – East Approach (10+960 to 11+160)
- Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) – East Approach (11+530 to 11+730) and West Approach (11+950 to 12+150)

Stage	Frequency	Anticipated Number of Readings per Monitoring Section*
Baseline Reading**	3 readings on 3 consecutive days, no sooner than 7 days following installation	3
Immediately prior to start of embankment construction	Once	1
During embankment construction	Once every 1.5 m lift and following placement of last lift	Minimum once per 1.5 m lift, but not less than 5 readings over the period of embankment construction
During preload period (anticipated duration: 3 months)	• Weekly: For Month 1 • Once every 2 Weeks: For Months 2 and 3	8

*. Due to the uncertainty of the construction schedule, or the possibility that the embankments at various locations may be constructed independently at various times, the number of readings may be greater than shown above.

**. Baseline Readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of ground and changes in piezometric head.

Table 3 Minimum Monitoring Frequency for Settlement Rods (SRs), Settlement Pins (SPs) for Preload Embankment:

- **Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) E-N Ramp Approaches (10+060 to 10+090), E-S Ramp Approaches (11+050 to 11+080)**
- **Bradford Bypass EBL East of Hwy 400 Arch Culvert (30X-0879/C0) East and West Approaches (10+735 to 10+815)**

Stage	Frequency	Anticipated Number of Readings per Monitoring Section*
Baseline Reading**	3 readings on 3 consecutive days, no sooner than 7 days following installation	3
Immediately prior to start of preload embankment construction	Once	1
During preload embankment construction	Once every 1.5 m lift and following placement of last lift	Minimum once per 1.5 m lift, but not less than 5 readings over the period of embankment construction
During preload period (anticipated duration: 1 months)	• Weekly: For Month 1	4

*. Due to the uncertainty of the construction schedule, or the possibility that the embankments at various locations may be constructed independently at various times, the number of readings may be greater than shown above.

**. Baseline Readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of ground and changes in piezometric head.

Table 4 Minimum Monitoring Frequency Settlement Pins (SPs) for Completed Embankment:

- **Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) E-N Ramp Approaches (10+060 to 10+090), E-S Ramp Approaches (11+050 to 11+080)**

- **Bradford Bypass EBL East of Hwy 400 Arch Culvert (30X-0879/C0) East and West Approaches (10+735 to 10+815)**

Stage	Frequency	Anticipated Number of Readings per Monitoring Section*
Upon Completion of Embankment (anticipated duration: 1 months prior to Paving)	• Weekly: For Month 1	4

*. Due to the uncertainty of the construction schedule, or the possibility that the embankments at various locations may be constructed independently at various times, the number of readings may be greater than shown above.

2. INSTRUMENTATION INDIVIDUAL SPECIFIC REQUIREMENTS

2.1 SETTLEMENT RODS (SR) AND SETTLEMENT PINS (SP)

2.1.1 Surveying

The elevations of the survey target settlement rods (SR) and settlement pins (SP) shall be surveyed to an accuracy of +/- 2 mm or better and reported to the nearest millimetre.

During each reading event, the elevations of the top of the embankment and top of the berm (if applicable) shall be surveyed to an accuracy of +/- 10 mm or better.

During the embankment construction, the Contractor shall extend all settlement rods, friction protection sleeves and CSP protective surrounds simultaneously prior to the placement of the next lift. The Contractor shall notify the Contract Administrator no less than 3 days prior to extension. Surveying of the elevations of the top of the rod immediately before and after the extension of SRs to an accuracy of +/- 2 mm shall be obtained. The survey of SR length adjustments shall be coordinated with the Contract Administrator and the Contractor.

Surveying for settlement monitoring shall be conducted by a registered surveyor with appropriate equipment and experience. The surveyor shall be retained by the Contract Administrator.

2.1.2 Reporting

The Contract Administrator shall be notified within 24 hours if a Review or Alert Level is reached. A brief interpretation of the updated monitoring data shall be reported to the Contract Administrator within five (5) working days after each set of readings is obtained. A full set of up-to-date and processed monitoring data shall be presented in tabular and graphical form in the monthly progress report.

As a minimum, the following shall be submitted for SR and SPs to the Contract Administrator in the monthly progress report after each set of readings is obtained:

- Settlement plots of SR and SP versus time
- Fill height/top of fill elevation within 20 m of the instruments versus time
- Plan view, cross section and profile sketches showing the top of fill location of the embankment and berm (if applicable) while the instrument data is collected.

2.1.3 Review and Alert Levels

Typically, embankment failures result from an acceleration of settlements after placement of a lift of fill. If any of these conditions are observed or the maximum settlement measured exceeds the Review Levels in Table 5, the Foundation Monitoring Consultant shall immediately inform the Contractor and Contract Administrator. The Contractor is to submit a plan of action to prevent Alert Levels from being reached. The Foundation Monitoring Consultant shall review the Contractor's plan with the Contract Administrator and provide appropriate recommendations to the Contract Administrator. Construction work may continue.

If the settlement measured exceeds the Alert Levels, the Consultant shall immediately inform the Contract Administrator, and the Contract Administrator shall instruct the Contractor to stop all construction activities on and within the embankment. No construction shall take place on the affected embankment until all the following conditions are satisfied:

- The cause of the accelerated settlement has been identified and analyzed by the Foundation Monitoring Consultant
- The Contractor submits a corrective-action plan
- The Consultant reviews the Contractor's proposed plan of corrective action and provides recommendations on the appropriate course of action to the Contract Administrator.
- Any corrective action deemed necessary by the Contract Administrator, and the Consultant has been implemented.
- The Contract Administrator, with input from the Consultant, deems it is safe to proceed with construction of the remainder of the embankment, and any revised monitoring and staging requirements have been defined.

No Review or Alert Levels are assigned to the settlement points (SP) located at the top of the embankment. These instruments are intended solely to confirm stabilization of fill compression and to support assessment of the timing for pavement construction. Readings from SR shall be reviewed for trends and stabilization.

For this Special Provision, settlements measured at SR shall be considered stabilized when both of the following criteria are satisfied at each instrument location:

- The rate of settlement is less than 2 mm per week and ≤ 5 mm/month, based on survey readings over a continuous period of at least 4 weeks.
- The cumulative settlement over this same period is less than 1 percent of the total settlement recorded at that SP location since completion of embankment construction and surcharge placement.

Table 5 Review and Alert Levels for Settlement Plates (SR)

Location *		Section Type	Vertical Displacement (mm)**	
Area	Station		Review Level	Alert Level
Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) East Approach	10+993	A	135	185
	11+018	A	135	185
	11+043	A	115	155
	11+093	A	95	130
	11+143	A	80	110
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) East Approach	11+526	A	70	90
	11+576	A	70	95
	11+626	A	80	105
	11+676	A	95	125
	11+701	A	105	145
	11+726	A	115	155
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) West Approach	**11+954**	A	95	125
	11+979	A	95	130
	12+004	A	80	105
	12+054	A	75	105
	12+104	A	70	95

Location *			Section Type	Vertical Displacement (mm)**	
Area		Station		Review Level	Alert Level
		12+154	A	70	95
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches		10+744	A	65	90
		10+765	C	80	105
		10+783	C	80	105
		10+804	A	80	105
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S		10+083/11+076	B	60	80
		10+065/11+058	B	60	80

*. Instrument locations shall be as per the plan drawings. The exact offsets and locations of the settlement rods shall be determined on-site based on the Monitoring Section Types.

**. The waiting period for preload and construction of the road pavement shall be determined based on the review of settlement progress. Pavement construction following the preload or waiting period shall not take place until settlement has stabilized and no further significant movement is observed.

2.2 VIBRATING WIRE PIEZOMETERS (VWP) AND REFERENCE VIBRATING WIRE PIEZOMETERS (RVWP)

2.2.1 Data Collection

VWPs and RVWPs shall be read using the VWP data loggers and portable readout units supplied under the Supply and Installation Special Provision. All loggers shall be tested before baseline readings are taken.

VWPs and RVWPs shall record automatically at the programmed interval. If telemetry is provided, real-time or near-real-time VWP/RVWP data shall be available online.

2.2.2 Coordination of Readings

The Consultant shall verify the logger function, battery status, and time synchronization regularly.

Excess pore pressure (EPP) shall be calculated using the points (SP) measured by the corresponding VWP and compared with the RVWP near each section.

2.2.3 Reporting

The Contract Administrator shall be notified within 24 hours if a Review or Alert Level is reached. A brief interpretation of the updated monitoring data shall be reported to the Contract Administrator within five (5) working days after each set of readings is obtained. A full set of up-to-date and processed monitoring data shall be presented in tabular and graphical form in the monthly progress report.

As a minimum, the following shall be submitted to the Contract Administrator in the monthly progress report based on the readings collected from VWP and RVWP instruments:

- Plots of piezometric elevation versus time for VWPs located in the same monitoring

section
- Same as above for excess pore pressure (EPP)
- Plot of hydrostatic groundwater elevation (RVWPs) versus time
- Fill elevation in the vicinity of the VWP versus time
- Plan view, cross section and profile sketches showing the top of fill location while the VWP and RVWP readings were being taken.

2.2.4 Review and Alert Levels

The Review Level is the value of instrumentation readings at which the Consultant shall assess the necessity of altering the method, rate, or sequence of construction. The Review Level is generally taken as 80 percent of the corresponding Alert Level.

The increase in pore water pressure in the foundation soils associated with the placement of fill lifts should be equal to or lower than the increase in the total vertical stress due to fill placement. During construction, the Consultant shall compare measured excess pore pressures to the expected increase in vertical stress associated with the actual fill height at each VWP location. This ongoing comparison ensures that the rate and magnitude of excess pore pressure generation remain within acceptable limits for the embankment loading conditions during construction.

The Alert Level is the value of instrument readings at which the Contract Administrator can order the Contractor to cease construction operations, make the site and affected properties secure, and take necessary and agreed-upon measures to mitigate unacceptable movements and assure the safety of the work and the public. In this case, the Alert Level of each VWP shall be defined as the baseline pore water pressure plus 0.9 times the total vertical stress of new grading and surcharge fill placed above the original ground elevation at the monitoring instrument location.

The Consultant shall verify, at each stage of embankment construction, that measured excess pore pressures remain below Review Levels corresponding to the current height of fill. Table 6 represents trigger levels associated with the maximum embankment height. Trigger levels shall therefore be dynamically evaluated throughout construction based on the actual fill height relative to the VWP elevation.

If any of the above conditions are observed, or if the maximum excess pore pressure measured exceeds the Review Levels corresponding to the current height at the VWP location, the following actions shall be taken:

1. The Foundation Monitoring Consultant shall immediately inform the Contractor and the Contract Administrator.
2. The Contractor shall submit a plan of action to prevent the excess pore pressure from reaching the Alert Level.
3. The Foundation Monitoring Consultant shall review the Contractor's plan with the Contract Administrator and provide appropriate recommendations to the Contract Administrator.
4. All construction work shall continue if instrument Alert Levels are not reached.

The Review and Alert Levels corresponding to the maximum height of fill and surcharge (if applicable) at each VWP location are provided in Table 6.

If the maximum excess pore pressure measured during construction exceeds the interim Review and

Alert Levels or exceeds the values provided in Table 6, the Consultant shall immediately inform the Contract Administrator. The Contract Administrator shall instruct the Contractor to stop all construction activities on and within the embankment. No construction shall take place on the affected embankment until all the following conditions are satisfied:

- The cause of the excess pore pressure has been identified and analyzed by the Foundation Monitoring Consultant.
- The Contractor submits a corrective-action plan
- Foundation Monitoring Consultant to review the Contractor's plan of corrective action and provide recommendations for corrective actions to the Contract Administrator
- Any corrective action deemed necessary by the Contract Administrator and the Foundation Monitoring Consultant has been implemented
- The Contract Administrator, with input from the Foundation Monitoring Consultant, deems it is safe to proceed with construction of the remainder of the embankment, and any revised monitoring and staging requirements have been defined.

Table 6 Review and Alert Levels for VWP Excess Pore Pressures

Location			Approx. Existing Ground Elev. (m)	Approx. Embankment Height (m)	Section Type	VWP Tip Elevation (m)	Excess Pore Pressure (EPP) (kPa)*, **	
Area	Drawing	Station					Review Level	Alert Level
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches	4	10+765	256	7.7	C	248	105	135
		10+783	257	7.6	C	247	105	135
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) Ramps E-N / E-S		10+082.7/11+077	259	3.0	B	248	40	55
		10+064.7/11+059	259	3.0	B	245	40	55

*. The Review and Alert Levels presented in Table 6 correspond to the maximum embankment height at each VWP location. During construction, interim Review and Alert Levels shall be evaluated based on the actual fill height above each VWP relative to its baseline pore water pressure. Measured excess pore pressures shall be compared to the expected increase in total vertical stress associated with the placed fill height to ensure that excess pore pressures remain within acceptable limits at all stages of embankment construction.

**. The VWP data shall be used to determine the timing for installation of the culvert and its corresponding foundation.

3. CONTROL MONITORING LEVELS

3.1 General

The monitoring program shall provide the technical basis for determining the appropriate timing of fill

placement, surcharge placement and removal, and the installation of the culvert. All monitoring results shall be reviewed in relation to actual construction progress to assess compliance with Review and Alert Levels and to ensure the safety of construction progress. Settlement data shall also be used to confirm stabilization of settlements associated with primary consolidation before proceeding with subsequent construction activities.

3.2 Stabilization of Settlements due to Primary Consolidation

Settlement data from SR and SP shall be used to assess the magnitude and rate of primary consolidation settlement. The Consultant shall determine:

- The total anticipated settlement at each monitoring section
- The rate of settlement and time required for primary consolidation to stabilize
- The degree of consolidation achieved at each stage of embankment construction

Settlement stabilization assessments shall be based on appropriate analytical methods, including but not limited to:

- Time–settlement plots
- Settlement rate analyses
- Comparison with predicted settlement curves

Stabilization criteria shall be used to recommend waiting periods between lifts, surcharge duration, and timing of surcharge removal.

4. FINAL REPORT

At the completion of the monitoring program, a final monitoring report shall be issued to the Contract Administrator. The monitoring results shall be presented in tabular and graphical form as described above for each instrument type. Interpretation of the monitoring readings shall be included in the report.

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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PLAN

100 0 100 200m

SCALE 1:5000

CONT No
WP No

BRADFORD BYPASS
HIGHWAY 400
HIGH FILL
SITE LOCATIONS PLAN

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

▲	Benchmark (BM)

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

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REVISIONS		
DATE	BY	DESCRIPTION

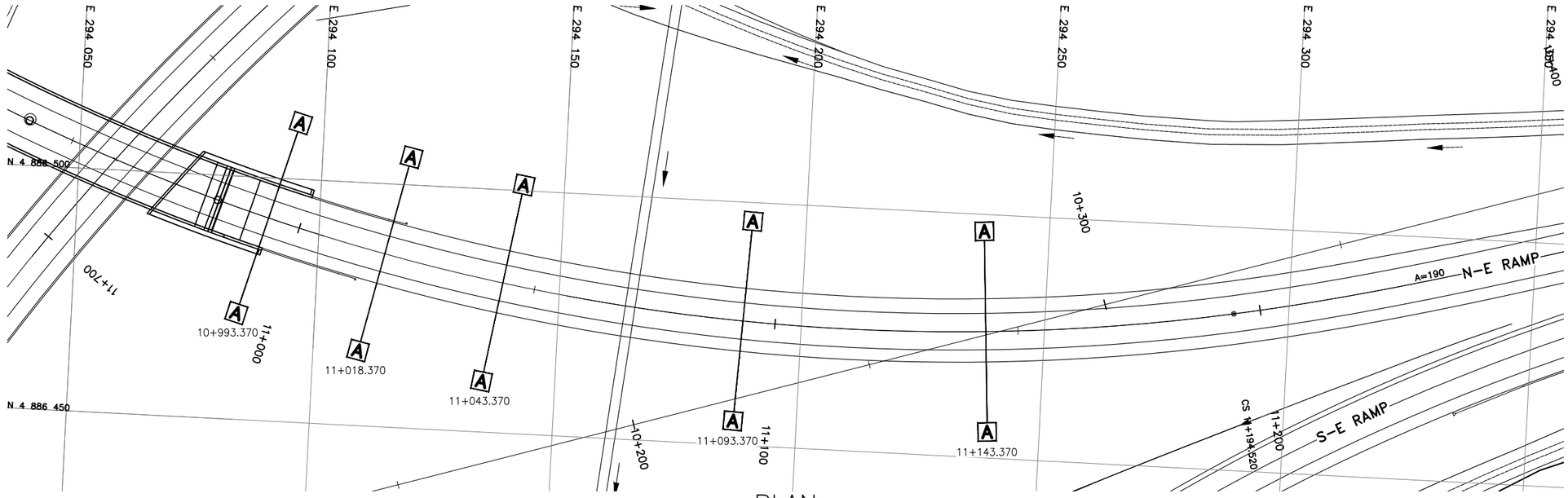
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METRIC

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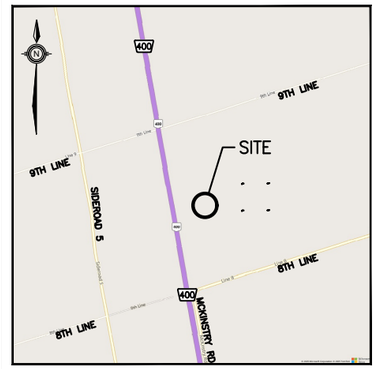
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BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
N–E RAMP
INSTRUMENTATION AND MONITORING PLAN

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

Section Location

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

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DATE	BY	DESCRIPTION

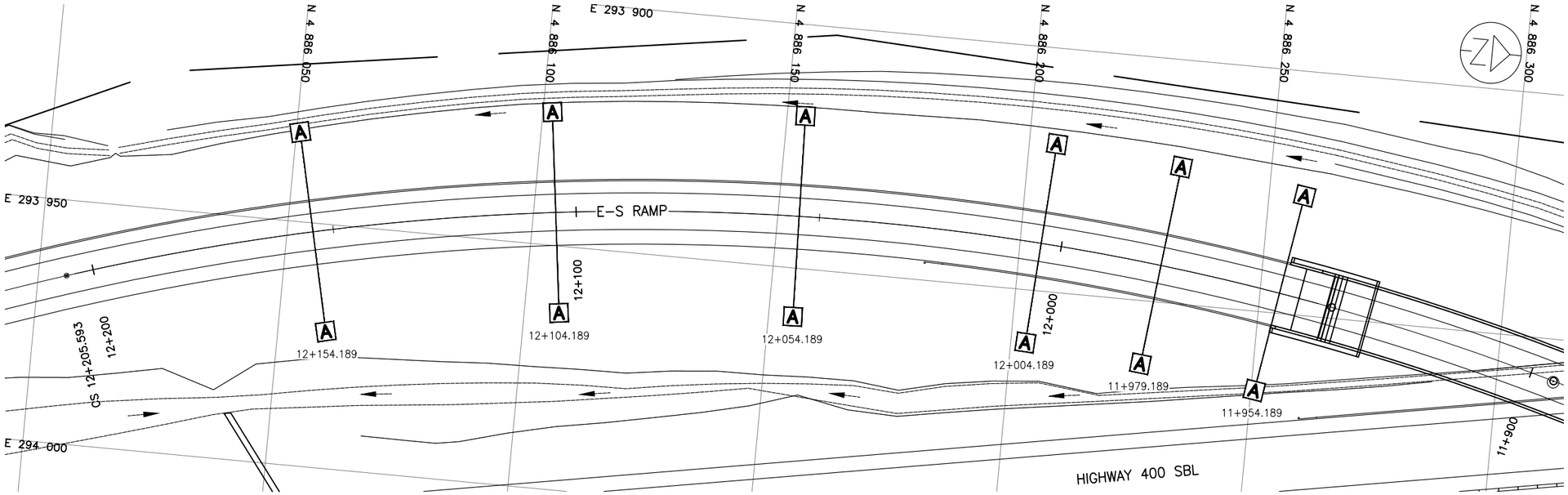
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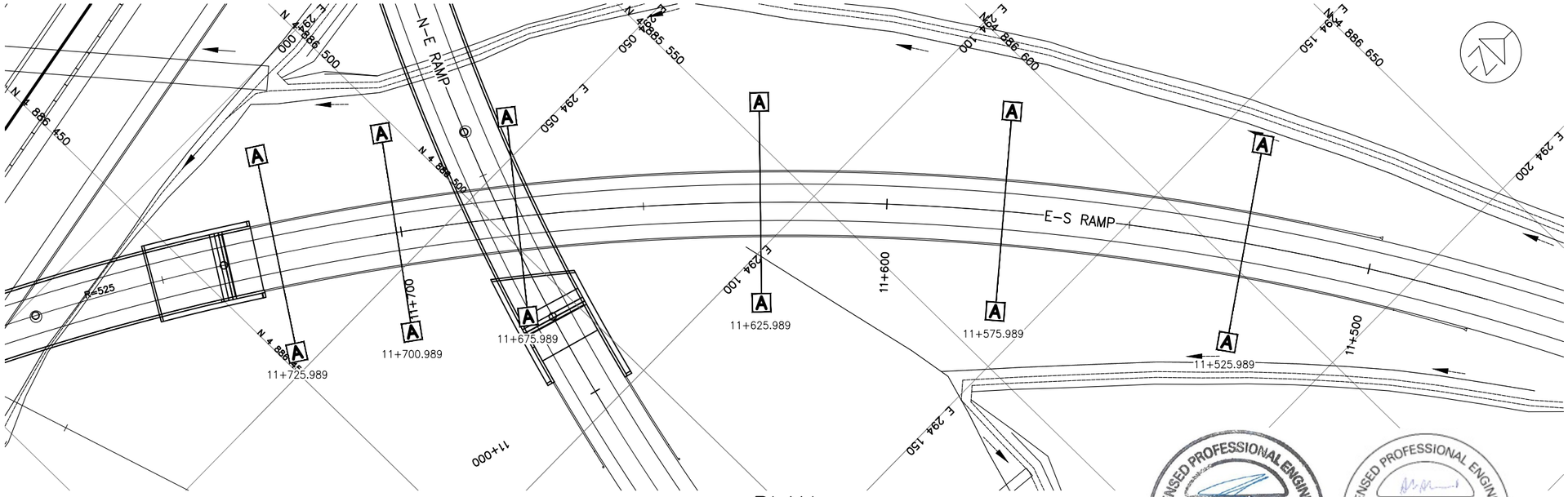
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SCALE 1:1000



PLAN

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SCALE 1:1000

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
E–S RAMP
INSTRUMENTATION AND MONITORING PLAN

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

Section Location

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

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REVISIONS		
DATE	BY	DESCRIPTION

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METRIC
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N 4 886 750

N 4 886 700

N 4 886 650

N 4 886 600

10+082.870 E-N RAMP

10+064.868 E-N RAMP

E-N RAMP

E-S RAMP

11+076.026 E-S RAMP

11+057.957 E-S RAMP

11+100

11+000

10+900

10+890

OHS No. 13

BRADFORD BYPASS WBL

BRADFORD BYPASS EBL

RVWP-1

RVWP-2

FOOTPRINT OF THE CULVERT AT PERMANENT CONDITION IS SHOWN FOR INFORMATION ONLY. DURING THE PRELOADING STAGE, TEMPORARY PIPE(S) ARE EXPECTED TO BE USED UNTIL THE PRELOADING EMBANKMENT IS REMOVED AND THE PILE CAPS AND ARCH CULVERT ARE CONSTRUCTED.

10+800

10+700

10+600

10+804.085

10+744.085

10+783.828

10+764.347

N-E RAMP

S-E RAMP

PLAN

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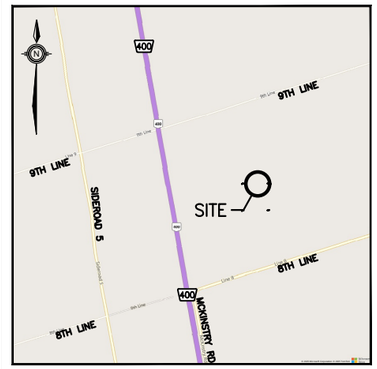
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BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
ARCH CULVERTS
INSTRUMENTATION AND MONITORING PLAN

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

Section Location

Reference Vibrating Wire Piezometer (RVWP)

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

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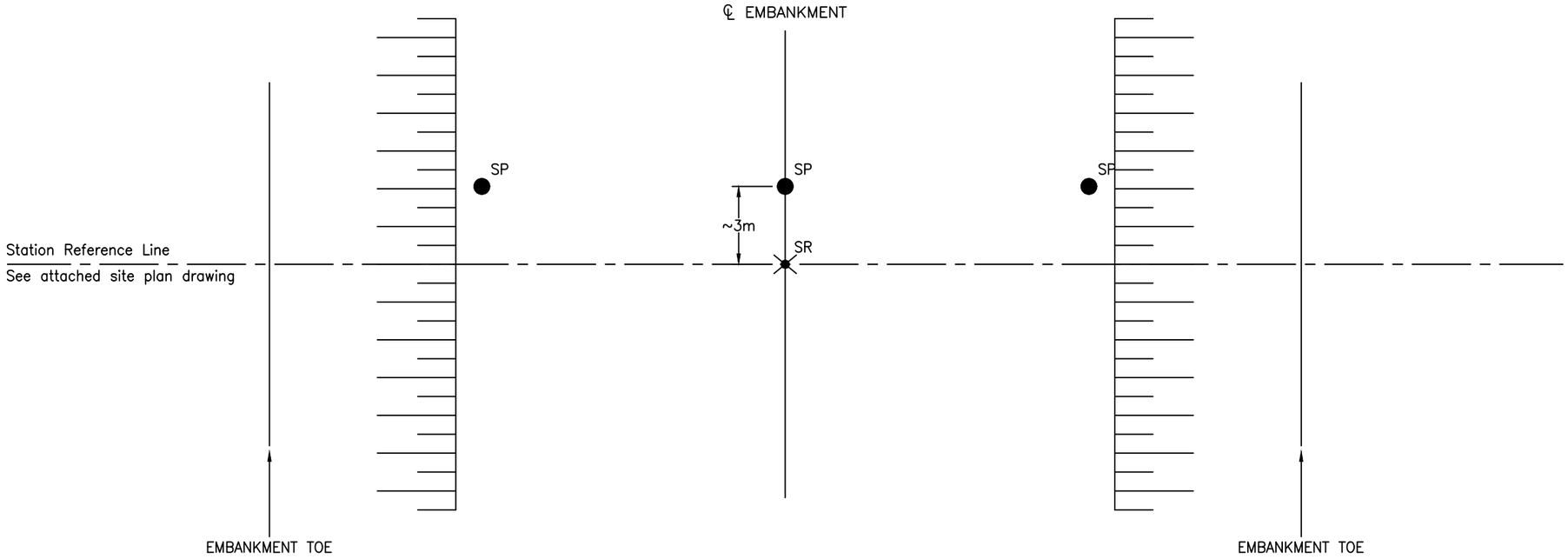
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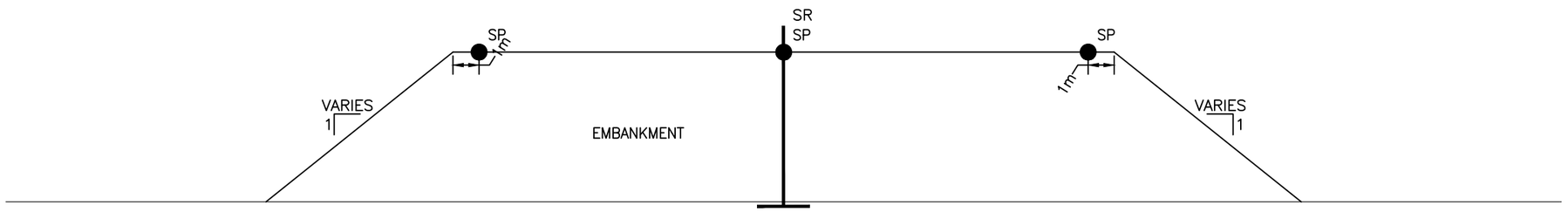
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METRIC

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PLAN
N.T.S.



CROSS–SECTION A
N.T.S.

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
SECTION A
TYPICAL MONITORING SECTION

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

- Settlement Rod (SR)
- Settlement Pin (SP)

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-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

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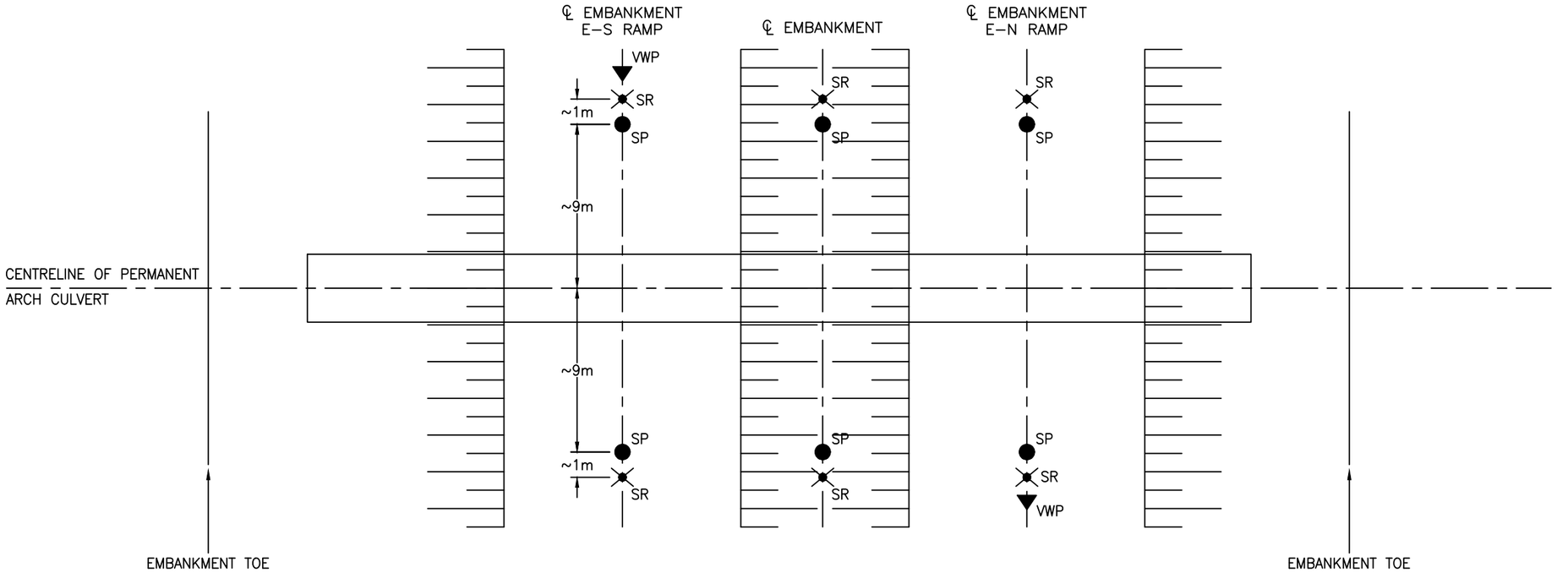
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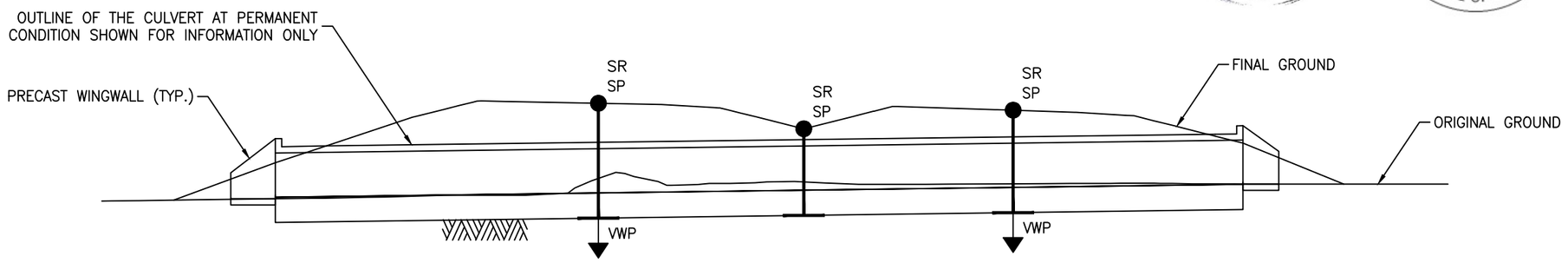
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METRIC

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PLAN
N.T.S.



CROSS–SECTION B
N.T.S.

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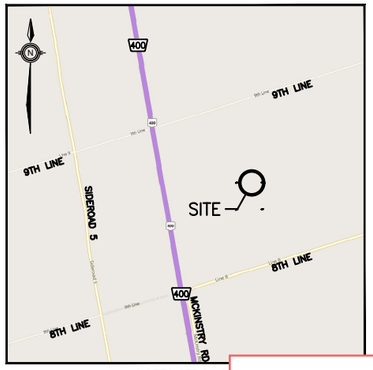
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BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
SECTION B
TYPICAL MONITORING SECTION

SHEET

AECOM

THURBER



KEYPLA

LEGEND

- Settlement Rod (SR)
- Settlement Pin (SP)
- Vibrating Wire Piezometer (VWP)

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

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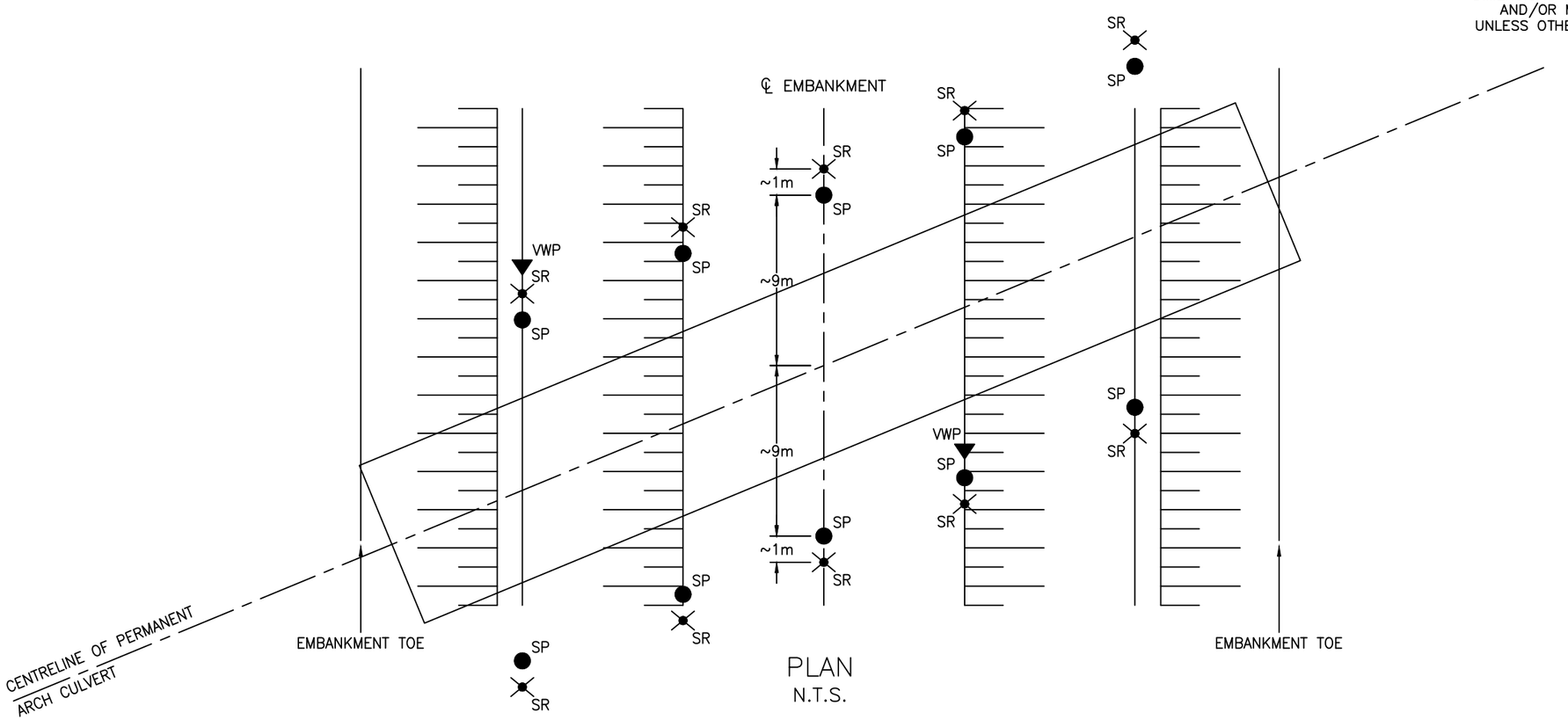
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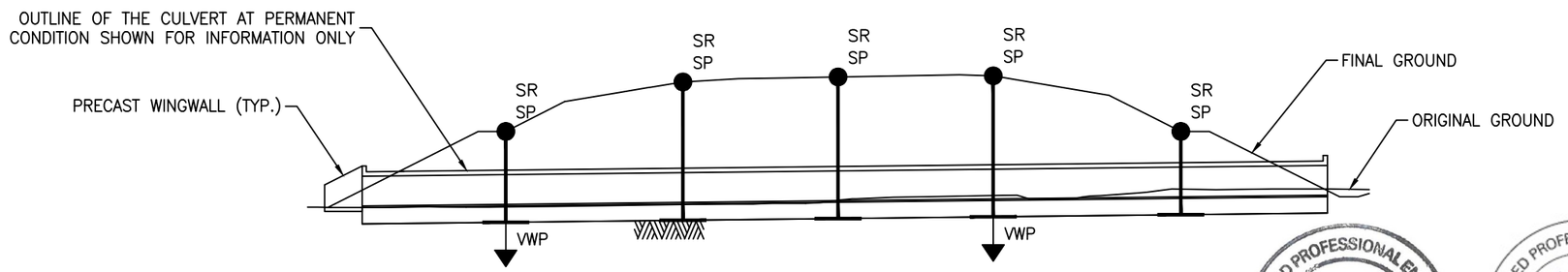
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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PLAN
N.T.S.



CROSS–SECTION C
N.T.S.

CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
SECTION C
TYPICAL MONITORING SECTION

SHEET

AECOM

THURBER



KEYPLAN

	LEGEND
✕	Settlement Rod (SR)
●	Settlement Pin (SP)
▼	Vibrating Wire Piezometer (VWP)

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

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REVISIONS		
DATE	BY	DESCRIPTION

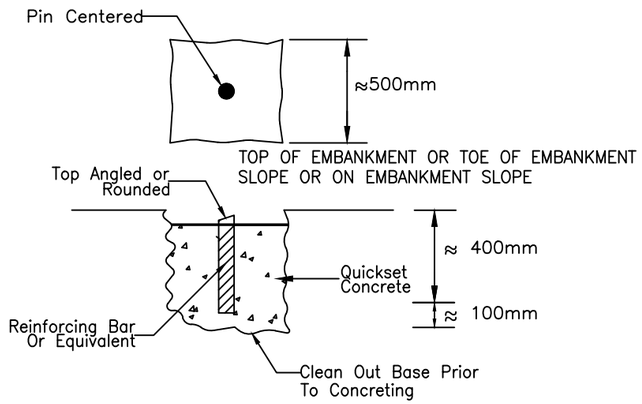
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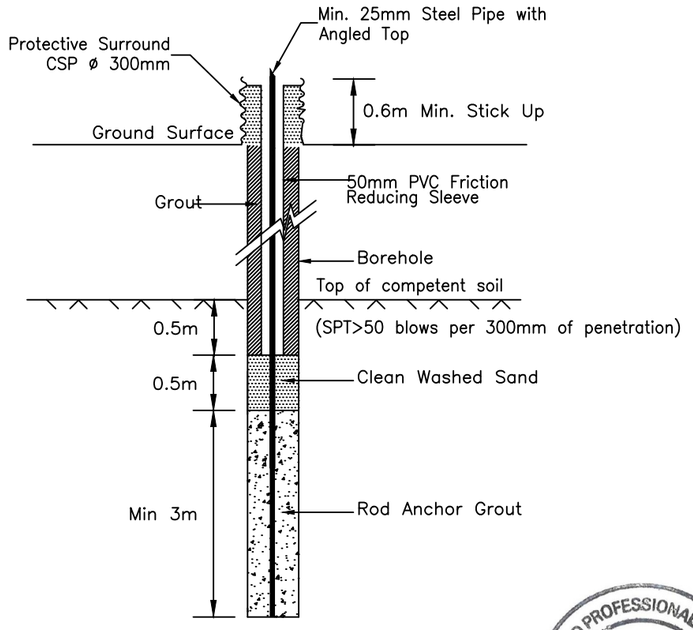
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

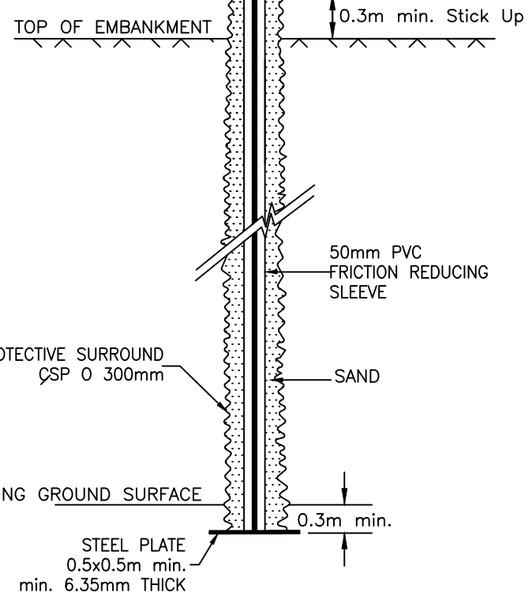
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



SETTLEMENT PIN (SP)
N.T.S.



BENCHMARK (BM)
N.T.S.



SETTLEMENT ROD (SR)
N.T.S.

LICENSED PROFESSIONAL ENGINEER
J. P. K. LEE
100086735
2026/02/20
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
A. AHMAD
100218388
2026/02/20
PROVINCE OF ONTARIO

CONT No
WP No

BRADFORD BYPASS–HIGH FILL HIGHWAY 400 DETAILS
MONITORING INSTRUMENT DETAILS 1

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

-NOTES-

1) Coordinate system is MTM NAD 83 Zone 10.

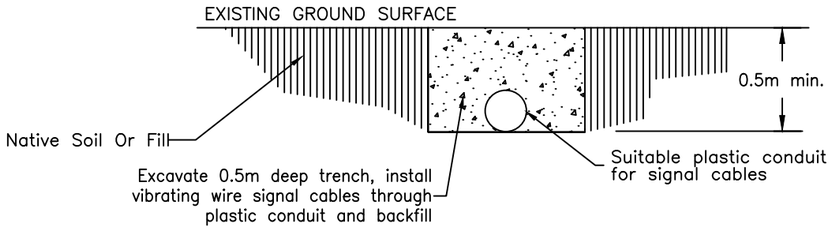
GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

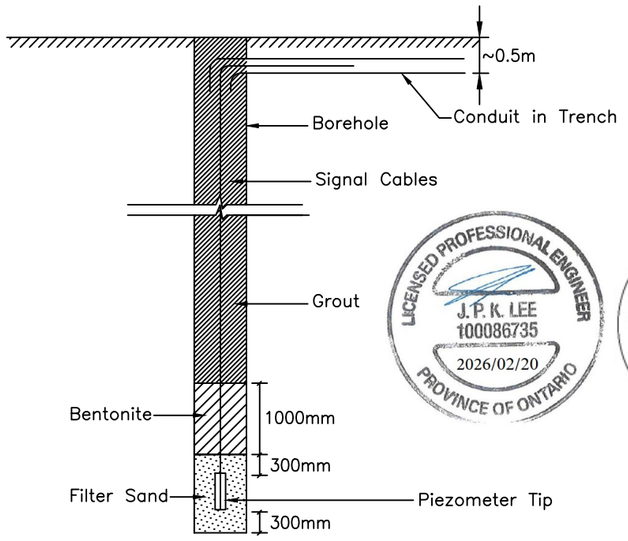
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DRAWN	MFA	CHK	AA	SITE	STRUCT	DWG	8

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MINISTRY OF TRANSPORTATION, ONTARIO

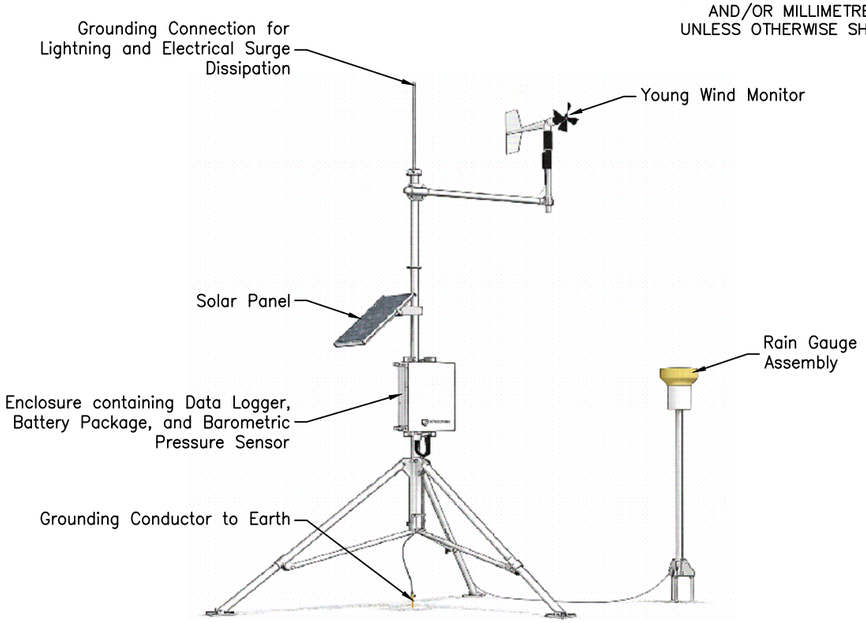


TRENCH FOR SIGNAL CABLES
N.T.S.

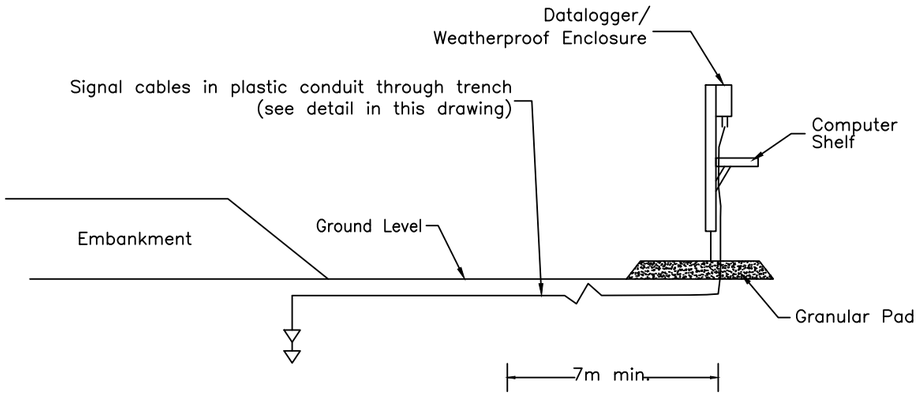


Note: Filter sand is not required if the borehole is to be grouted in accordance with the VWP manufacturerer's recommendations and an approved grout mix.

VIBRATING WIRE PIEZOMETER (VWP)
N.T.S.



WEATHER STATION (WS)
N.T.S.



DATA ACQUISITION SETUP FOR VIBRATING WIRE PIEZOMETERS
N.T.S.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

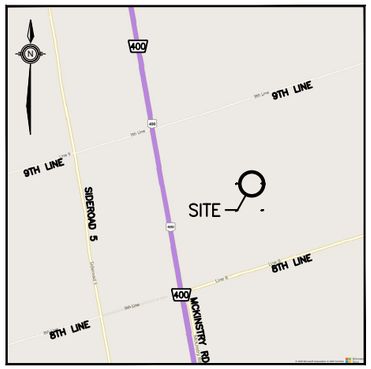
CONT No
WP No

BRADFORD BYPASS–HIGH FILL
HIGHWAY 400
DETAILS
MONITORING INSTRUMENT DETAILS 2

SHEET

AECOM

THURBER



KEYPLAN

LEGEND

-NOTES-
1) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 31D04-022

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AA	CHK	JPL	CODE	LOAD
DRAWN	MFA	CHK	AA	SITE	STRUCT

DATE FEB 2026
DWG 9

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Foundation Preloading – Item No.

Special Provision

1.0 SCOPE

The construction of the following embankment areas shall be subject to preload and a waiting period as described below:

Structure	Sta. to Sta.	Wait Period	Additional Notes
Highway 400 N-E Flyover Ramp Bridge (30X-0868/B0) East Approach	10+985 to 11+185	Minimum 3 Months prior to foundation construction / See settlement monitoring program requirements elsewhere in Contract	Minimum 1 Month wait period after completion of embankment construction prior to paving
Highway 400 E-S Flyover Ramp Bridge (30X-0869/B0) East Approach West Approach	11+730 to 11+530 11+950 to 12+150	Minimum 3 Months prior to foundation construction / See settlement monitoring program requirements elsewhere in Contract	Minimum 1 Month wait period after completion of embankment construction prior to paving
Bradford Bypass WBL East of Highway 400 Arch Culvert (30X-0878/C0) E-N Ramp Approaches E-S Ramp Approaches	10+060 to 10+090 11+050 to 11+080	Minimum1 Month prior to foundation construction / See settlement monitoring program requirements elsewhere in Contract	Minimum 1 Month wait period after completion of embankment construction prior to paving
Bradford Bypass EBL East of Highway 400 Arch Culvert (30X-0879/C0) East and West Approaches	10+735 to 10+815	Minimum1 Month prior to foundation construction / See settlement monitoring program requirements elsewhere in Contract	Minimum 1 Month wait period after completion of embankment construction prior to paving

2.0 DEFINITIONS – N/A

3.0 MATERIALS

Preload with the full height of the embankment specified in the Contract shall be defined as Granular A in accordance with OPSS.PROV 1010 and compacted in accordance with OPSS.PROV 501. The preload embankment shall be constructed at the following locations and stations:

Flyover Ramp Abutment Approaches

- Highway 400 N-E Ramp Flyover Ramp Bridge (30X-0868/B0) East Approach Approximate Stations 10+960 to 11+035
- Highway 400 E-S Ramp Flyover Ramp Bridge (30X-0869/B0) East Approach Approximate

Stations. 11+655 to 11+730 and West Approach Approximate Stations 11+930 to 12+005
- For the above three bridge approach areas, the forward slope of the preload embankments shall be constructed to cover the footprint of the approach embankment and its top should be extended 1 m beyond the pile location with a stable side slope of 2H:1V.

BBP Arch Culverts

- Bradford Bypass WBL (East of Highway 400) Arch Culvert (30X-0878/C0), E-N Ramp Approaches Approximate Stations 10+060 to: 10+090 and E-S Ramp Approaches Approximate Stations 11+050 to 11+080
- Bradford Bypass EBL (East of Highway 400) Arch Culvert (30X-0879/C0), Approximate Stations 10+735 to 10+815.
- For the above two arch culverts preload areas, diversion of the creek channels and instrumentation installation shall be completed prior to placement of preload embankments to the full height covering the footprints of the highway embankments.

A portion of the preload material may be left in place as road subbase.

4.0 CONSTRUCTION

4.1 Embankment Construction Restrictions

The timing for placement of the embankment and preload material in the above areas is critical to the overall schedule. The Contractor shall schedule their operations to ensure the wait period for preloads described herein are met.

In the preload areas, fill shall not be placed on frozen ground.

Stockpiling of materials (aside from the preload limits) within these stations shall not be permitted.

Traffic between these stations shall be restricted to monitoring activities during the preload period.

The preload shall not be removed for during the specified preload period at each embankment area without prior approval from the Contract Administrator.

4.2 Construction Equipment

Construction Equipment or traffic shall avoid all installed instruments. Non monitoring activity traffic shall not be permitted during preload period.

4.3 Embankment Construction

The construction of the embankments shall be in accordance with the Contract Documents. The preload embankment construction shall start only after the following construction sequence:

a) Complete removal of topsoil, organics within the embankment footprint in accordance with the Contract Documents.

b) Backfilling the above excavated materials to original ground levels.

c) Completion of installation of monitoring instruments and subject to the determination by the Contract Administrator that the baseline readings have stabilized.

Following completion of the above, the Contractor shall construct the embankment to the top of pavement subgrade elevations as prescribed elsewhere in the Contract, after which the wait period shall begin.

The Contractor shall not remove the preload material or commence construction of the bridge / culvert foundations and pavement structure prior to completion of the above noted waiting period.

4.4 Embankment Monitoring Program

The Contractor is advised that an Embankment Monitoring Program will be carried out to monitor settlements of the foundation soils at selected locations identified in the Special Provision titled “Supply and Installation of Embankment Monitoring Equipment” in order to assess on-going foundation performance as a result of embankment preload construction. The timing for partial removal of the preload and subsequent construction activities shall be determined by the Contract Administrator based on the results of the embankment monitoring program.

Following the completion of the waiting period, the Contractor shall obtain written approval from the Contract Administrator prior to proceeding to the removal of the preload, foundation construction, and road paving.