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FOUNDATION INVESTIGATION AND DESIGN REPORT
PENNVILLE CREEK DIVERSION CULVERT

SITE NO. 30X-0890/C0
BRADFORD WEST GWILLIMBURY, ONTARIO
Assignment No. 2023-E-0068
GEOCRES No. 31D04-027

Client Name: AECOM
Date: March 26, 2026
File: 48856

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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 a 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 and this report only addresses the investigation carried out for the new Pennville Creek Diversion Culvert in the Town of Bradford West Gwillimbury, Ontario.

The purpose of this investigation is to establish the subsurface conditions at the proposed culvert location by borehole drilling, in situ testing, and laboratory testing on 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

Highway 400 is currently a six-lane highway oriented in a north to south direction, with three lanes in each direction, separated by a concrete median. Project site is north of the Simcoe Road 88 interchange overpass which is orientated in the west-east direction and allows flow of traffic onto and over Highway 400.

The existing Pennville Creek Culvert (Site No. 30X-0556-C0) consists of a concrete box culvert orientated in the west-east direction with the current highway grade at approximate Elev. 260.5 m at the centreline of Highway 400, approximately 1.7 km north of the Simcoe Road 88 interchange in the Town of Bradford West Gwillimbury, Ontario. In order to accommodate the creek re-routing, the proposed Pennville Creek Diversion Culvert (Site No. 30X-0890/C0) is to be located at approximately 400 m north of the existing culvert and 2.1 km north of the Simcoe Road 88 interchange. General site photographs obtained during the field investigation for the Pennville Creek Diversion Culvert are presented in Appendix A.

The land adjacent to the site generally consists of farmland and the vegetative cover is comprised of tall grass, shrubs, and crop residue. The topography of Highway 400 and the general project area is elevated and generally slopes downwards towards the south. The site is void of overhead utilities, but a median sewer is located along the centreline of Highway 400, immediately adjacent to the concrete median.

2.1 Site Geology

Based on published geological information, The Physiography of Southern Ontario by Chapman and Putnam (1984)[1], 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.

Bedrock geology mapping prepared by the Ontario Geological Survey indicates that 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[2]. These formations are typically softer, more thinly bedded, and less massive than the older Gull River Formation, which lies stratigraphically below.

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[1] Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario, Ontario Geological Survey Special Volume 2, Third Edition. Accompanied by Map P2715, Scale 1:600,000.

[2] Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release-Data 219

3. SITE INVESTIGATION AND FIELD TESTING

The site investigation and field-testing program completed for the Pennville Creek Diversion Culvert were carried out between July 23 and 29, 2025, and August 15, 2025 and consisted of drilling five (5) boreholes, designated as PEN25-01, PEN25-02, PEN25-03, PEN25-04, and PEN25-05. Boreholes ranged in depths from 15.8 m to 29.6 m (Elev. 230.3 to 242.5 m).

Eleven (11) boreholes were completed for the original location of the Pennville Creek Culvert near the location of the existing culvert. These boreholes are designated as Boreholes PEN-01 to PEN-11. The site investigation and field-testing program for these boreholes were carried out within the overall investigation of the Bradford Bypass design between July 11, 2024 and December 1, 2024. Those borehole depths ranged from 9.8 m to 18.9 m below ground surface (Elev. 234.3 m to 245.6 m). These boreholes are not discussed within this report and are included within Appendix D.

At the currently proposed culvert alignment, the five boreholes were drilled near the locations of the inlet, outlet and middle sections under the highway.

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

Table 3-1: Borehole Locations

Structure	Borehole	Co-ordinates MTM [1] NAD 83 Zone 10		Ground Surface Elevation (m)	Borehole Termination Depth (m)	Borehole Termination Elevation (m)
		Northing	Easting			
Pennville Creek Culvert	PEN25-01[2]	4886472.2	294013.7	257.6	21.9	235.7
	PEN25-02	4886460.4	293978.0	260.5	26.5	234.0
	PEN25-03	4886457.2	293961.3	260.5	28.2	232.3
	PEN25-04	4886457.4	293951.8	259.9	29.6	230.3
	PEN25-05[2]	4886427.9	293923.6	258.4	15.8	242.5

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

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata drawing in Appendix B. The Record of Borehole sheets of the investigation are provided in Appendix C.

It should be noted that the surveying of the as-drilled borehole locations was completed by AECOM in accordance with MTO's requirements for the horizontal and vertical accuracy. The coordinates

and elevations of the boreholes are given on the Borehole Locations and Soil Strata drawing and Record of Borehole sheets in Appendices B and C, respectively.

Lane and/or shoulder closures for traffic control outlined by Ontario Traffic Manual (OTM) Book 7 were implemented for drilling the boreholes located on the roadways. Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The boreholes were advanced using track-mounted and truck-mounted drill rigs. Hollow stem augers and mud rotary with casing were used to advance the boreholes to final depths. Soil samples were obtained at selected depth intervals 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. A Dynamic Cone Penetration Test (DCPT) was also conducted below the sampling depth in Borehole PEN25-03 to provide additional information about the strength of the soil.

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. Two (2) monitoring wells (50 mm diameter Schedule 40 PVC) were installed and enclosed with filter sand in Boreholes PEN25-01 and PEN25-05 to permit groundwater level monitoring. Details of the monitoring well installations are shown in Table 3.2 below.

Table 3-2: Monitoring Well Installation Details

Foundation Unit	Borehole	Monitoring Well Tip Depth / Elevation (m)	Completion Details
Pennville Creek Culvert	PEN25-01	6.1 / 251.5	Monitoring well was installed in Borehole PEN25-01 with 3.0 m slotted screen within sand filter from 6.4 m to 2.7 m, then backfilled with bentonite holeplug from 2.7 m to ground surface.
	PEN25-05	6.1 / 252.3	Monitoring well was installed in Borehole PEN25-05 with 3.0 m slotted screen within sand filter from 6.4 m to 2.7 m, then backfilled with bentonite holeplug from 2.7 m 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 and is to be decommissioned by the Contractor in accordance with O.Reg. 903.

4. LABORATORY TESTING

The recovered soil samples were subjected to visual identification and natural moisture content determination. Selected 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.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for metal corrosion associated with the structure, samples of the native soils were collected and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing for corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix E.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered subsurface stratigraphy from the investigation area are presented on the Record of Borehole sheets included in Appendix C, and on the Borehole Locations and Soil Strata drawing 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.

5.1 General

In general, the subsurface stratigraphy at the site consists of a surficial layer of topsoil (beyond the highway) or pavement structure (on highway platform) overlying an extensive deposit of native silty sand till with interbedded clay and clay till deposits.

The groundwater was measured in the monitoring wells at depths generally ranging from 1.7 m to 2.1 m (Elevations 255.6 to 256.7) below the existing ground surface.

More detailed descriptions of the individual stratum are presented below.

5.1.1 Surficial Materials (Topsoil, Asphalt)

Topsoil was encountered at ground surface in Boreholes PEN25-01 and PEN25-05, with thicknesses of 75 mm and 125 mm, respectively.

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

Asphalt was encountered at ground surface in Boreholes PEN25-02 and PEN25-03 with a thickness of 150 mm.

5.1.2 Granular Fill

Pavement granular fill materials were encountered in all road boreholes (PEN25-02 to PEN25-04) either below the asphalt or at the highway shoulder. The fill layer was generally described as brown sand with gravel.

SPT 'N' values of the fill varied from 8 to 48 blows per 0.3 m of penetration, indicating a loose to dense state. The natural moisture content measured on the granular fill samples varied from 2 to 8 percent.

The results of two grain size analyses conducted on samples of the sand fill are provided on the Record of Borehole sheets in Appendix C and illustrated on Figure 1 in Appendix E. The results are summarized as follows:

Table 5-1: Grain Size Distribution of Fill

Soil Particle	Percentage (%)
Gravel	19 to 22
Sand	67 to 74
Silt and Clay	7 to 11

5.1.3 Silt

A thin layer of brown, moist silt was encountered below the topsoil in Borehole PEN25-05. The silt was encountered between 0.1 m and 0.7 m depths (Elev. 258.3 m to 257.7 m).

SPT 'N' value recorded in the silt was 5 blows per 0.3 m of penetration indicating a loose condition. The natural moisture content measured on the sample was 17 percent.

5.1.4 Clay

Interbedded clay layers were found within or underlying the silty sand till in all five boreholes. The clay varied in composition ranging from silty clay to clay with sand.

The upper silty clay deposit in Borehole PEN25-01 was encountered between depths of 0.1 m and 3.0 m (Elev. 257.5 m and Elev. 254.6 m). The borehole was terminated in the lower clay deposit at a depth of 21.9 m (Elev. 235.7 m).

The interbedded clay deposits in Borehole PEN25-02 were encountered at depths of 5.3 m, 16.3m and 21.6 m below ground surface. The upper two clay interbeds were between 1.5 m and 1.9 m

thick and were penetrated at depths of 7.2 m and 17.8 m (Elev. 253.3 m and 242.7 m). The borehole was terminated in the lower clay deposit at a depth of 26.5 m (Elev. 234.0 m).

Interbedded clay deposits in Borehole PEN25-03 were encountered at depths of 14.8 m and 20.0m below ground surface. The upper clay deposit was penetrated at a depth of 16.3 m (Elev. 244.2 m). Sampling was terminated in the lower clay deposit at a depth of 22.9 m (Elev. 237.6m). A DCPT was conducted below the sampling depth to refusal at 28.2 m depth (Elev. 232.3 m).

Boreholes PEN25-04 and PEN25-05 had a single clay deposit observed below the silty sand till at depths of 24.7 m and 14.8 m (Elev. 235.2 and 243.6), respectively. Both boreholes were terminated in this unit at depths of 29.6 m and 15.8 m (Elev. 230.3 m and 242.6 m).

SPT 'N' values recorded in the clay ranged from 10 to 66 blows per 0.3 m of penetration, indicating a stiff to hard consistency. The natural moisture content measured on the clay samples varied from 6 to 26 percent.

The result of a grain size analyses conducted on selected samples of the clay are provided on the Record of Borehole sheets in Appendix C and illustrated on Figure 2 in Appendix E. The results are summarized as follows:

Table 5-2: Grain Size Distribution of Clay

Soil Particle	Percentage (%)
Gravel	0 to 2
Sand	3 to 25
Silt	31 to 65
Clay	24 to 50

The results of Atterberg Limits tests conducted on selected samples of the clay are presented on the Record of Borehole sheets in Appendix C and illustrated in Figure 6 of Appendix E. The results are summarized as follows:

Table 5-3: Atterberg Limits of Clay

Index Property	Percentage (%)
Liquid Limit	23 to 27
Plastic Limit	11 to 17
Plasticity Index	11

The results of the Atterberg Limits tests indicate that the clay is of low plasticity with a group symbol CL.

5.1.5 Silty Sand Till

An extensive deposit of silty sand till was encountered in all the boreholes, with interbedded clay and clay till layers. The silty sand till was generally described as brown to grey in colour.

The silty sand till was encountered at various depths and elevations as presented on the Record of Borehole sheets in Appendix C and outlined in the table below.

Table 5-4: Silty Sand Till Contact Depths and Elevations

Borehole	Top of Silty Sand Till Deposit - m (Elev)	Bottom of Silty Sand Till Deposit – m (Elev)
PEN25-01	3.0 (254.6)	19.4 (238.2)
PEN25-02	0.9 (259.6) 7.2 (253.3) 17.8 (242.7)	2.2 (258.3) 16.3 (244.2) 21.6 (238.9)
PEN25-03	1.4 (259.1) 5.6 (254.9) 16.3 (244.2)	2.2 (258.3) 14.8 (245.7) 20.0 (240.5)
PEN25-04	0.7 (259.2)	24.7 (235.2)
PEN25-05	4.1 (254.3)	14.8 (243.6)

SPT ‘N’ values recorded in the silty sand till ranged from 3 to 26 per 0.3 m of penetration, indicating a very loose to compact condition. The natural moisture content measured on the silty sand till samples varied from 6 to 19 percent.

The results of grain size analysis conducted on selected samples of the till are provided on the Record of Borehole sheets in Appendix C and illustrated on Figures 3 and 4 in Appendix E. The results are summarized as follows:

Table 5-5: Grain Size Distribution of Silty Sand Till

Soil Particle	Percentage (%)
Gravel	0 to 6
Sand	40 to 66
Silt	22 to 40
Clay	12 to 17

The results of several Atterberg Limits tests conducted on selected samples of the silty sand till indicated that the unit was non-plastic.

Glacial tills inherently contain cobbles and boulders.

5.1.6 Clay Till

A deposit of clay till was encountered in all boreholes except Borehole PEN25-04. In Boreholes PEN25-02 and PEN25-03, the sandy clay till was encountered between 2.2 m and 5.6 m depths, with base of deposit at Elev. 255.2 m to 254.9 m, respectively. Borehole PEN25-05 encountered the clay till between 0.7 m and 4.1 m depths with the base of deposit at Elev. 254.3. In Borehole PEN25-01, the clay till was encountered below the silty sand till between 19.4 and 21.6 depths, with base of deposit at Elev. 236.0.

SPT 'N' values recorded in the clay till ranged from 8 to 17 per 0.3 m of penetration indicating a stiff to very stiff consistency. The natural moisture content measured on the cohesive samples varied from 7 to 28 percent.

The results of the grain size analyses conducted on selected samples of the clay till are provided on the Record of Borehole sheets in Appendix C and illustrated on Figure 5 in Appendix E. The results are summarized as follows:

Table 5-6: Grain Size Distribution of Clay Till

Soil Particle	Percentage (%)
Gravel	0 to 2
Sand	24 to 43
Silt	33 to 50
Clay	22 to 33

The results of Atterberg Limits tests conducted on selected samples of the clay till are presented on the Record of Borehole sheets in Appendix C and illustrated in Figure 7 of Appendix E. The results are summarized as follows:

Table 5-7: Atterberg Limits of Clay Till

Index Property	Percentage (%)
Liquid Limit	18
Plastic Limit	10 to 11
Plasticity Index	7 to 8

The results of the Atterberg Limits tests indicate that the samples have low to slight plasticity with group symbols of CL to CL-ML.

Glacial tills inherently contain cobbles and boulders.

5.1.7 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Monitoring wells were installed in PEN25-01 and PEN25-05 to permit monitoring of groundwater levels. Water levels measured in the monitoring wells are presented in Table 5-9 below.

Table 5-8: Groundwater Level Measurements

Foundation Element	Borehole	Date	Groundwater Level		Comments
			Depth (m)	Elevation (m)	
Pennville Creek Culvert	PEN25-01	August 6, 2025	2.0	255.6	Monitoring well
		August 22, 2025	1.8	255.8	
		September 8, 2025	1.8	255.8	
	PEN25-05	August 7, 2025	-0.2*	258.6*	Monitoring well
		August 22, 2025	2.1	256.3	
		August 27, 2025	1.7	256.7	
		September 8, 2025	1.7	256.7	

* Possibly unstabilized reading

The groundwater levels measured in the monitoring wells in Table 5-9 are short term readings and seasonal fluctuations are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation such as rainstorm and snowmelt.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Selected soil samples were submitted for analytical testing of corrosivity parameters including sulphate content. The corrosivity testing was carried out by SGS Canada Inc. of Lakefield, Ontario, a CALA accredited analytical laboratory. The results of the analytical tests are shown in Table 6-1. The laboratory certificates of analysis are presented in Appendix E.

Table 6-1: Analytical Corrosivity Test Results

Sample ID	Depth (m)	Soil Sample Description	Sulphide (percent)	Chloride (µg/g)	Sulphate (µg/g)	pH	Resistivity (ohm.cm)	Redox Potential (mV)	Electrical Conductivity (µS/cm)
PEN25-02 SS5	3.0 - 3.6	Clay Till	< 0.01	510	31	8.91	778	279	1,280
PEN25-05 SS3	1.5 – 2.1	Clay Till	< 0.01	1,000	35	9.59	543	230	1,840

7. 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.

3D Drilling Inc. from Uxbridge, Ontario supplied and operated the drilling and sampling equipment for the field program.

Full-time observation of the field activities was carried out by Ms. Fernanda Croce and Mr. Ahmed Kitmitto of Thurber. Overall supervision of the field program was performed by Messrs. Rod de Castro, P.Eng. and Joshua Alexander, P.Eng. of Thurber.

8. CLOSURE

Interpretation of the field data and preparation of the report was carried out by Ms. Madisan Chiarotto, P.Eng., a Geotechnical Engineer, Mr. Rod de Castro, P.Eng., a Senior Geotechnical Engineer, and Ms. Rocio Palomeque Reyna, M.Eng., P.Eng., a Senior Geotechnical Engineer. This report was reviewed by Messrs. Sydney Pang, P.Eng. and Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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PART B: FOUNDATION DESIGN REPORT

9. GENERAL

This report provides an interpretation of the subsurface information obtained from the foundation investigation and provides foundation recommendations for the installation of the new Pennville Creek Diversion Culvert (Site No. 30X-0890/C0) 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, and scheduling.

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

Based on a General Arrangement (GA) drawing dated January 2025 provided by AECOM, the existing Pennville Creek Culvert will be replaced with a 6.0 m wide, 3.5 m high concrete rigid frame box culvert with a founding elevation of approximately 254.9 m at the outlet and 255.3 at the inlet. In order to accommodate re-routing of Pennville Creek, the culvert replacement will be located at approximately 400 m north of the current existing culvert. The water will flow in an east to west direction in the new culvert. Within the highway platform, the new culvert will consist of three precast sections with an approximate overall length of 82 m. The outlet (westerly limit) and inlet (easterly limit) are designed to be at Elevations 255.6 m and 256.1 m, respectively. The General Arrangement drawing for the new Pennville Creek Diversion Culvert (Site No. 30X-0890/C0) is included in Appendix F.

9.1 Summary of Subsurface Conditions

In general, the subsurface stratigraphy at the site consists of a surficial layer of topsoil (beyond the highway) or pavement structure (on highway platform) overlying an extensive deposit of native silty sand till with interbedded clay and clay till deposits. The groundwater was measured in the monitoring wells at depths generally ranging from 1.7 m to 2.1 m (Elevations 255.6 to 256.7 m) below the existing ground surface.

Details of the encountered subsurface conditions from the investigation area are presented on the Record of Borehole sheets included in Appendix C, and on the Borehole Locations and

Soil Strata drawing in Appendix B.

10. CULVERT DESIGN

10.1 Culvert Alternatives

This section presents discussions on alternate types of culverts for the proposed culvert replacement, foundation alternatives, and provides recommendations for feasible and/or preferred foundation options. Based on the GA drawing dated August 2025, it is understood that the proposed Pennville Creek Diversion Culvert is a precast concrete box culvert.

Several common culvert types that may be considered for the culvert replacement and extension at this site are listed below:

- Concrete box (closed) culvert
- Concrete open frame culvert on strip footings
- Circular pipe culvert

Discussions on feasible culvert alternatives are presented in the following paragraphs.

10.1.1 Precast Concrete Box (Closed) Culvert

A concrete box culvert is considered feasible for replacing the existing culvert. Precast sections, rather than cast-in-place construction, can be installed rapidly with less potential for disturbance of the founding soils during installation. A segmental box structure can accommodate some potential differential settlement along the culvert axis. Effective groundwater control will be required at this site to maintain dry excavations during the course of the staged construction. Dewatering and temporary protection (shoring), where required, must be implemented at this site prior to excavation. Open cut construction may be possible along some sections but should be co-ordinated with the staging operations.

10.1.2 Concrete Open Frame Culvert on Strip Footings

Concrete, open frame, culvert is a typical alternative to a concrete box culvert. At this site, however, very loose to loose zones within the silty sand till deposit are frequently present below the proposed culvert invert. These soils will provide lower geotechnical resistance. Therefore, deeper excavations and/or wider footings may be required to provide adequate foundation support. Additionally, due to the presence of permeable soils (sands and silts) and relatively high groundwater table, more extensive temporary protection and effective dewatering efforts will be required. This is likely a less cost-effective and riskier option than a box culvert. The feasibility of this option needs to be further assessed by the designers and recommendations for this option have not been developed.

10.1.3 Circular Pipes

From a foundation engineering standpoint, concrete, steel and HDPE pipes are technically feasible alternatives provided that other design issues including flow capacity, hydraulic properties and durability can be satisfied. Multiple pipes may be required to provide adequate hydraulic capacity.

Trenchless installation technique is typically considered in conjunction with circular pipes. Due to the high invert level and the relatively large pipe diameter that will be required, there is likely insufficient crown cover above the pipe to satisfy the minimum cover criteria acceptable to MTO.

It is understood that this option is not considered at this site and therefore foundation recommendations for pipe culverts are not further developed.

10.1.4 Recommended Approach

Given the existing soil and groundwater conditions at this site, and from a foundation technical, constructability and cost effectiveness perspective, the recommended culvert type for the new Pennville Creek Diversion Culvert is the precast concrete box culvert. This report focuses on providing foundation recommendations for the design and construction of a concrete box culvert at this site. A comparison of alternative culvert types is summarized in Appendix H.

10.2 Foundation Design for Culvert

The proposed design invert elevation of the Pennville Culvert is approximately 256.1 m along the centerline.

Foundation design aspects for the replacement culvert include subgrade conditions and preparation, geotechnical resistances, lateral earth pressures, groundwater control, cofferdams, temporary stream diversion, temporary roadway protection system design, and restoration of the roadway embankment.

10.2.1 Concrete Box Culvert

Based on Boreholes 25-01 to 25-05 advanced near the relocated Pennville Creek Diversion and the new culvert founding elevations, it is anticipated that the subgrade soils within the culvert footprint will not be subjected to any significant additional loading.

Dimensions and invert elevations for the proposed culvert and recommended geotechnical resistances for the design of a box culvert, based on the width of the culvert founded on a 300 mm thick compacted granular pad over the native loose to compact silty sand till, are presented in Table 10-1.

Table 10-1: Geotechnical Resistances for Box Culvert

Culvert	Proposed Dimensions (L x W x H)	Invert Elev. (m) / Underside of Bedding Elev. (m)[1]	Founding Material	Factored Geotechnical Resistance at ULS	Factored Geotechnical Resistance at SLS[2]
Pennville Creek Diversion Culvert	82.0 m x 6.0 m x 3.8 m	Inlet 255.3 / 255.0 Outlet 254.9 / 254.6	Native Loose to Compact Silty Sand Till (occ. stiff to very stiff clay to clay till)	250 kPa	125 kPa

1. Approximations from GA drawing
2. For up to 25 mm settlement

A consequence factor of 1.0 was utilized in this design adopting the typical consequence level. The geotechnical resistance factor of 0.5 for bearing and 0.8 for settlement, both adopted for typical degree of understanding, were used to obtain the above values, as per Canadian Highway Bridge Design Code (CHBDC) 2019, Section 6.9.

The factored ultimate resistance and settlement are dependent on the culvert size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the culvert width or founding/invert elevation differs significantly from that quoted above.

The above geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance values used in design must be reduced in accordance with CHBDC 2019, Clause 6.10.5.3.

Resistance to sliding should be calculated assuming ultimate coefficients of friction of 0.45 between the precast concrete and the underlying Granular A or B Type II bedding material.

The culvert should be designed to resist external loadings including frost forces, lateral earth pressures, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment.

10.3 Static Lateral Earth Pressures

The lateral earth pressures acting on the culvert box and wingwalls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls.

Backfill placed behind the walls 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 802.010 (as applicable). Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS.PROV 501.

Earth pressures acting on the structures may be assumed to impose a triangular distribution governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC (2019) but generally are given by the expression:

$$p_h = K(\gamma h + q)$$

Where: p_h = horizontal pressure on the wall at depth h (kPa)
K = coefficient of lateral earth pressure (see Table 10-22 below)
γ = unit weight of retained soil (see Table 10-22 below)
h = depth below top of fill where pressure is computed (m)
q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment walls are dependent on the material used as backfill. Typical values are provided below.

Table 10-2: Static Coefficient of Lateral Earth Pressures

Loading Condition	Granular A or B Type II ϕ = 35°, γ = 22.8 kN/m^3		Granular B Type I ϕ = 32°, γ = 21.2 kN/m^3	
	Horizontal Backfill	2H : 1V Sloping Backfill	Horizontal Backfill	2H : 1V Sloping Backfill
Active, K_a [1] (Unrestrained Wall)	0.27	0.40	0.31	0.48
At-rest K_o (Restrained Wall)	0.43	0.62	0.47	0.70
Passive, K_p [1]	3.7	-	3.3	-

Note: 1. The values of K_a and K_p correspond to full mobilization of active and passive earth pressures and require certain relative movements between the wall and adjacent soil to produce these conditions. Figures C6.27 and Table C6.12 of the Commentary to the CHBDC (2019) indicate relative movement required to fully mobilize the active earth pressures.

For rigid structures such as concrete box culverts, at-rest horizontal earth pressures should be used for design. Active earth pressures should be used for any unrestrained wall.

The use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular Type II) is preferred as it results in lower earth pressures acting on the culvert.

In accordance with Clause 6.12.3 of the CHBDC (2019), a compaction surcharge should be added.

10.4 Seismic Lateral Earth Pressures

In accordance with Clause 6.14.7 of the CHBDC (2019), structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in the following table may be used:

Table 10-3: Seismic Coefficient of Lateral Earth Pressures

Condition	Earth Pressure Coefficient (K_E) (1,2)	
	Granular A or B Type II ϕ = 35°, γ = 22.8 kN/m^3	Granular B Type I ϕ = 32°, γ = 21.2 kN/m^3
Active (K_{AE})	0.33	0.37
Passive (K_{PE})	3.48	3.05

Notes:
1. After Mononobe and Okabe (1924).
2. Site specific- PGA is 0.154

10.5 Frost Cover

Frost cover requirements do not apply to precast box culverts.

11. SUB-EXCAVATION AND BACKFILLING

11.1 Sub-Excavation

All topsoil/organic matter, embankment fill, soft to firm clay deposits and other deleterious materials should be removed from the area of the proposed culvert footprint. The exposed subgrade should be proofrolled and be inspected by qualified geotechnical engineer. Any softened/loosened or poorly performing areas of the subgrade should be subexcavated and replaced with compacted engineered fill as directed by a qualified geotechnical engineer but must be approved by the Contract Administrator.

11.2 Subgrade Preparation and Bedding Materials

After the excavation reaches the design founding elevation of the bedding, any remaining fill, topsoil, alluvial deposits, soft/loose or disturbed soils, organic or other deleterious materials encountered during subgrade preparation should be sub-excavated and replaced with compacted

granular material to provide a uniformly competent subgrade condition. Subgrade preparation, placement and compaction of the bedding material should be carried out in the dry. Adequate preparation of the subgrade will be essential for performance of the culvert.

To provide a uniform foundation subgrade, a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A requirements should be provided under the base of the box culvert. The bedding material should be placed on the native, undisturbed, prepared subgrade as soon as practicable following its inspection and approval, and be compacted as per OPSS.PROV 501. OPSS.PROV 1004, 19 mm clear stones may be used as a substitute for the first lift of compacted granular materials, should the subgrade be considered too wet for granular placement and compaction. The underside of the bedding layer for the replacement culvert should be in contact with the generally compact, native silty sand till, or occasional stiff to very stiff clay deposits, at or below the elevations quoted in Table 10-1. A 75 mm thick uncompacted Granular A levelling course should be placed above the compacted granular pad.

Construction equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction.

11.3 Culvert Backfill

Backfill to the culverts should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 802.010 or 803.010, as appropriate. Backfilling for the culverts should be in accordance with OPSS.PROV 401 for a SPCSP and OPSS.PROV 902 for a box culvert. All fills should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501.

The backfill should be placed and compacted in simultaneous lifts on both sides of the culvert, and the top of backfill elevation should not differ by more than 400 mm on each side of the culverts at all times.

11.4 Backfill Behind Wing Walls

Based on the GA provided, the Pennville Culvert is expected to have wing walls. Granular backfill behind the retaining structures should meet the specifications of OPSS.PROV 1010 Granular A or Granular B Type II, constructed in accordance with OPSS.PROV 902, as amended by Special Provision 109S61, and OPSD 3101.150. Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with OPSS.PROV 501 as amended by Special Provision 105S22.

12. TEMPORARY EXCAVATIONS AND PROTECTION SYSTEMS

It is anticipated that culvert construction will be carried out as part of a staged construction sequence. Details of the staging are currently unavailable.

12.1 Excavations

Excavation into the existing embankment fill, the native silty sand till, clay to clay till deposits will be required for culvert installation. The temporary excavations are anticipated to extend to depths of up to 5 to 6 m. The undersides of the granular pad are some 1 m to 2 m below the groundwater level. Dewatering in conjunction with temporary protection systems (TPS) will be required during construction.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) of Ontario and OPSS.PROV 902, as amended by Special Provision 109S61. A summary of soil types has been provided below.

Table 12-1: Excavation Soil Types

	Material	Above Groundwater Table	Below Groundwater Table
Pennville Culvert Site No. 30X-0566/C0	Dense to Compact Embankment fill	Type 3	Type 4
	Compact to Loose Silty Sand Till	Type 3	Type 4
	Stiff to Very Stiff Clay to Clay Till	Type 3	Type 4

In accordance with O.Reg. 213, temporary cut slopes for Type 3 and Type 4 soils should have a minimum gradient of 1H : 1V and 3H : 1V, respectively.

As an alternative to temporary cut slopes for the excavation, temporary protection systems may be designed and constructed as described in Section 12.2.

Excavations should regularly be inspected for evidence of instability if they have been left open for extended periods of time and following periods of heavy rain or thawing. If required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers.

12.2 Protection Systems

Temporary protection systems, where required, shall be designed and constructed for Performance Level 2 in accordance with OPSS.PROV 539 as amended by Special

Provision 105S09. All protection systems shall be designed by a licensed Professional Engineer in Ontario with experience in design of shoring systems with consideration for adjacent traffic loads and placement of new engineered embankment fill.

The following engineering parameters may be used for design of the temporary protection systems with horizontal backfill:

Table 12-2: Engineering Parameters for the Design of Temporary Protection Systems

Stratigraphic Unit	Unit Weight of Material, γ' (kN/m^3)	Angle of Internal Friction, φ (kN/m^3)	Coefficient of Static Lateral Earth Pressure	
			Active, K_a	Passive, K_p
New Embankment Widening (Earth) Fill	21	32	0.31	3.25
Existing Embankment Fill	21	32	0.31	3.25
Loose to Compact Silty Sand Till	21	30	0.33	3.0
Clay to Clay Till	21	30	0.33	3.0

Notes:
1. The lateral earth pressure coefficients presented above are based on static loading conditions and level backfill/ground surface behind the protection system. Where there is sloping ground behind the protection system, the coefficient of lateral earth pressure must be adjusted to consider the slope as a surcharge.
2. The total passive resistance below the base of excavation, if required, may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (2019 CHBDC).

In accordance with OPSS.PROV 539, should the temporary protection systems be left in place after completion of construction, the top of the system shall be removed to at least 1.2 m below the finished grade or ground level.

13. CONTROL OF GROUNDWATER AND SURFACE WATER

Groundwater is expected to be encountered during construction and dewatering measures will be required for construction in dry conditions. Dewatering operations should be carried out and managed in accordance with OPSS.PROV 517, as amended by Special Provision SP517F01.

The design of the dewatering system is the responsibility of the Contractor, and the Contract Documents must alert them to this responsibility. Seasonal fluctuations of the groundwater level are to be expected.

Surface water from runoff and precipitation events should be directed away from any excavations and low-lying construction areas.

14. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site class is based on the soil conditions encountered in the upper 30 m of the stratigraphic profile. In general, the subsurface stratigraphy encountered at the site consists of topsoil or pavement structure and sand to silty sand embankment fill, overlying typically compact silty sand till with some stiff to very stiff clay to clay till interlayers.

As per Table 4.1, Clause 4.4.3.2 of the CHBDC (2019), the site may be classified as Seismic Site Class D.

Based on the National Building Code of Canada (NBCC 2020), the peak horizontal ground acceleration (PGA), corresponding to a design earthquake having a 2 percent probability of being exceeded in 50 years (i.e. 2,475 year return period) is 0.154 g at the site. Appendix G presents the results obtained from the NBCC Seismic Hazard Tool for the project area.

The new structure is considered as Seismic Performance Category 1 based on Table 4.10 of the CHBDC 2019.

Based on review of the SPT data, seismically-induced liquefaction of foundation soils is not anticipated under the design earthquake.

15. COFFERDAMS

Where required, construction of cofferdams may be carried out to allow construction of the culvert replacement in the dry. Given the subsurface conditions at the vicinity of the culvert inlet and outlet, the preferred option for cofferdams is the use of interlocking sheet piles followed by sump pumping inside a sheet pile enclosure. The design of cofferdams is the responsibility of the Contractor. Sheet pile cofferdams are anticipated to be feasible at this site as they can be driven to sufficient depth into the native silty sand till. The recommendations provided in Section 12 for Temporary Protection Systems are also applicable to sheet pile cofferdams.

16. SLOPE STABILITY

Slope stability analyses were conducted for the east embankment side slope at the location of the new Pennville Creek Diversion Culvert. The stability assessments assume the embankment fill will consist of Granular B Type II, constructed at the proposed 3H : 1V slope.

The analyses were carried out utilizing the commercially available slope stability analysis program Slope/W (Version 2024) of the GeoStudio software package developed by Geo-Slope

International with the option for Morgenstern-Price method of slices for the limit equilibrium analyses. Analyses were completed for both static and seismic loading conditions.

The soil parameters used in the analyses were estimated from empirical correlations using the results of the in situ Standard Penetration Tests (SPTs) and geotechnical laboratory testing. The groundwater level in our analysis was based on readings obtained to date from monitoring wells. The stability of the embankment was also checked under seismic loading of 0.077 g (0.5 PGA).

For the purposes of factor of safety on this project, the geotechnical resistance factors specified in the CHBDC 2019 have been adopted. Results of the slope stability analyses are presented in figures in Appendix I and summarized in the following table.

Table 16-1: Summary of Stability Assessments

Culvert	Slope Gradient	Condition	Factor of Safety Result	Figure
Pennville	Proposed 3H : 1V	Undrained	1.9	I1
		Drained	1.9	I2
		Seismic	1.5	I3

Based on the above table, the slope stability assessments exceed the minimum acceptable Factor of Safety for undrained, drained, and seismic conditions and therefore instability mitigation measures are not required.

17. SETTLEMENT

New fill will be placed around the new culvert for the highway widening. The top of fill will be up approximately 0.5 m to 3 m in height above the existing ground. It is anticipated that immediate (elastic) settlement will be induced in the underlying silty sand till as the fill is placed and should be essentially completed by the end of construction. Total settlement is expected to be less than 25 mm.

The magnitude of the embankment self-compression constructed with granular materials is in the order of 0.5 percent of the newly reconstructed embankment height, or up to about 25 mm, and is expected to occur predominantly during fill placement.

18. EMBANKMENT RESTORATION AND WIDENING

Embankment restoration after completion of the culvert replacement should be carried out in accordance with OPSS.PROV 206. The embankment reconstruction material should consist of imported Granular A or Granular B Type II. The restored embankment beyond the culvert should be reinstated at the existing slope inclination, but no steeper than 2H : 1V if constructed with

granular fill. Soils generated from the culvert excavation should not be used for reinstatement of the embankment.

In general, surface vegetation, peat, topsoil, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the areas around the culvert inlets and outlets, and within the embankment footprints. Inspection and approval of the foundation surfaces by qualified geotechnical personnel should be conducted.

Depending upon the finished highway road grades, sections of the approach embankments may require widening to accommodate the widened roadway. Embankment widening or restoration may also be required for traffic staging and/or backfilling of foundation excavations.

Embankment widening and restoration should be carried out in accordance with OPSS.PROV 206. Granular A or Granular B Type II material in compliance with OPSS.PROV 1010 would be suitable. Compaction of these materials should be carried out in general accordance with OPSS.PROV 501. Where new embankment fill is placed against the existing embankment slopes, the existing fill slope must be benched in accordance with OPSD 208.010.

Preparation of the embankment subgrade for widening should include stripping of any topsoil, organic deposits and deleterious materials from within the proposed footprint of the embankment widening followed by proofrolling of the exposed subgrade with a heavy roller under visual observation to ensure adequate uniform support. Excessively loose, soft or compressible materials revealed during the proofrolling operations should be subexcavated and replaced with well compacted approved material.

Embankment slopes must be provided with erosion protection in accordance with OPSS.PROV 804. Vegetation must be sufficiently established before the onset of winter.

19. ADJACENT STRUCTURES AND BURIED UTILITIES

The potential presence of underground utilities at the site should be confirmed prior to construction. It is recommended that the exact locations and elevations of any utilities be established by the designer and compared with the extent of the potential work zones related to the proposed culvert replacement and extension, new fills and associated works. Protection and/or relocation of utilities, if necessary, should be provided. Underground utilities should not be undermined or damaged during the culvert construction and fill placement.

20. SCOUR AND EROSION PROTECTION

Erosion protection should be provided at the culvert box inlet and/or outlet areas, Design of the erosion protection measures must consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field.

Within the culvert and extension inlet and outlet areas, waterbody materials in accordance with OPSS.PROV 1005 may be used.

As per the GA provided, a concrete cut-off/apron wall will be used to minimize the potential for erosion near the inlet area around the culvert. The concrete structure will extend approximately 1.3 m below the culvert invert/outlet locations.

21. CORROSION POTENTIAL

Analytical testing was carried out to determine the pH, water soluble sulphate, sulphide, chloride concentration, resistivity, and electrical conductivity of selected soil samples. The analytical test results for the soils are presented in Appendix E and summarized in Section 6. The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the subsurface environment. The test results may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects. The corrosive effects of road deicing salts/brine should also be considered. Based on the test results, the following statements can be made:

- The potential for sulphate attack on concrete from the surrounding native soils is considered to be negligible due to the low concentration of sulphate and slightly alkaline pH values.
- The overall potential for corrosion on metal is considered high for the native soil (Clay and Clay Till) samples taken at depths ranging from 1.5 m to 3.6 m.
- The effects of road de-icing salts should also be considered when selecting the class of concrete and corrosion mitigation measures.

22. CONSTRUCTION CONCERNS

A qualified geotechnical engineer (Foundation Engineering Specialist) should be retained to observe activities during construction including and advise the Contract Administrator on construction issues related to performance of the dewatering and temporary protection systems and the construction of the culvert and approach embankments.

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

- Effective groundwater control measures must be implemented during construction and prior to excavating below the groundwater level.
- Temporary Protection Systems (TPS) will be required at some locations during all stages of construction. The TPS may be used as a means of surface water and groundwater control, and may be implemented in conjunction with other water control requirements.
- All works are to be carried out in the dry. Effective means of dewatering should be developed in conjunction with the dewatering assessment which is to be reported under separate cover. Contingency plans for construction in the wet should be developed if the effectiveness of the dewatering system is in doubt.
- Daily visual inspection of the highway pavement surface must be carried out in the vicinity of the construction works. If cracks form in the pavement or settlement is observes, these matters must immediately be brought to the attention of the Contract Administrator for determining if further action is required.
- The embankment slopes should be inspected after construction for surficial disturbance. All exposed slopes should be re-vegetated.
- Removal of peat, organics, soft soils and alluvial deposits near creek channels particularly in the inlet and outlet areas.
- Confirmation that the culvert backfills ad embankment fills are adequately placed and compacted to specifications.

23. CLOSURE

Preparation of the design report and engineering analysis was carried out by Ms. Madisan Chiarotto, P.Eng., a Geotechnical Engineer and Mr. Rod de Castro, P.Eng. a Senior Engineer. This report was reviewed by Messrs. Sydney Pang, P.Eng. and Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

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Associate, Senior Geotechnical Engineer

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Designated MTO Contact

Date: ***March 26, 2026***
File: ***48856***

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.

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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.

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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.

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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.

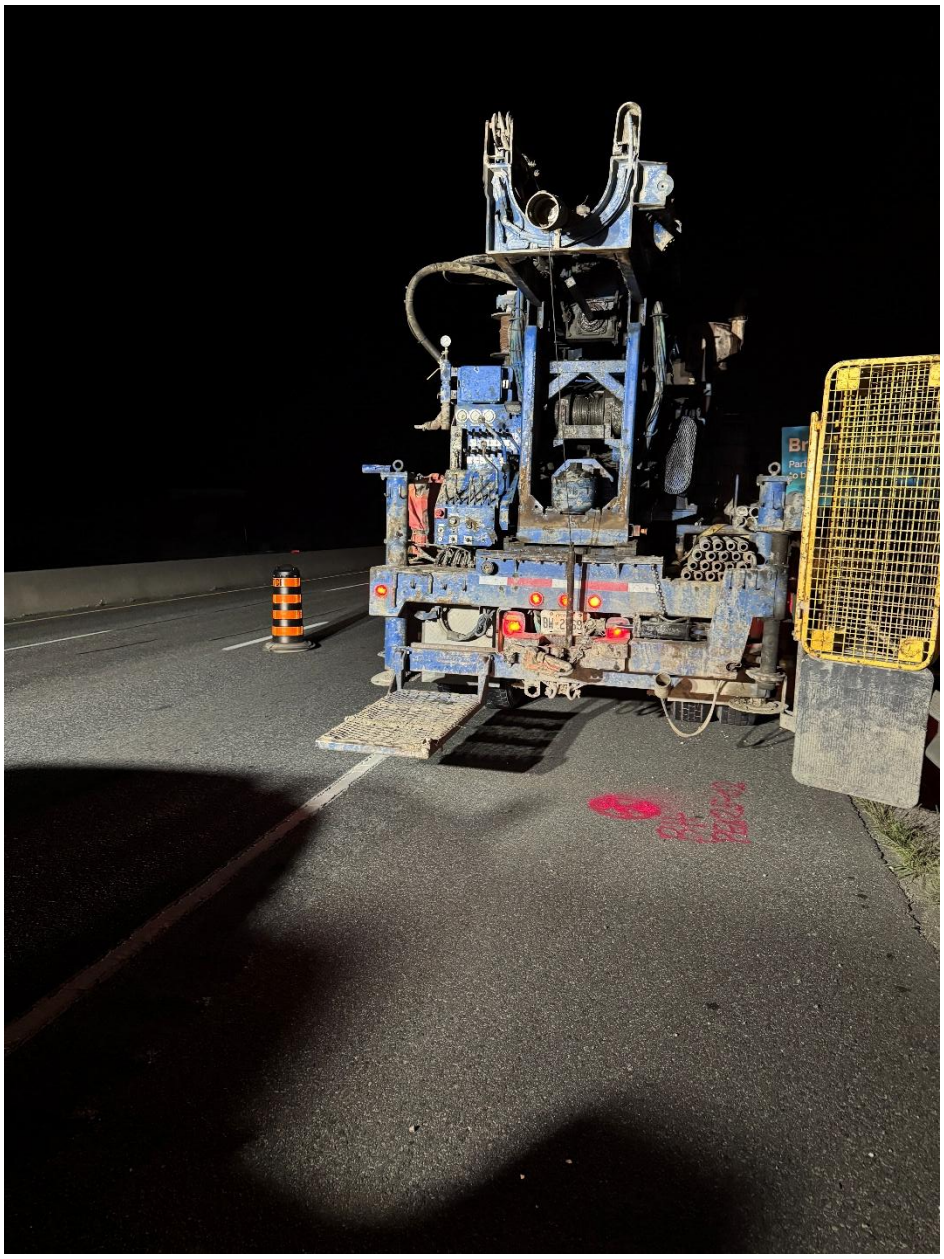
6. INDEPENDENT JUDGEMENTS OF CLIENT

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: Borehole PEN25-01 after Monitoring Well Installation, Looking West



Photograph 2: Borehole PEN25-02 during Field Investigation, Looking North

Photograph 3: Borehole PEN25-02 upon completion, Looking North

Photograph 4: Traffic Control and Set-up at Borehole Location PEN25-03, Looking North

Photograph 5: Borehole PEN25-04 during Field Investigation, Looking South

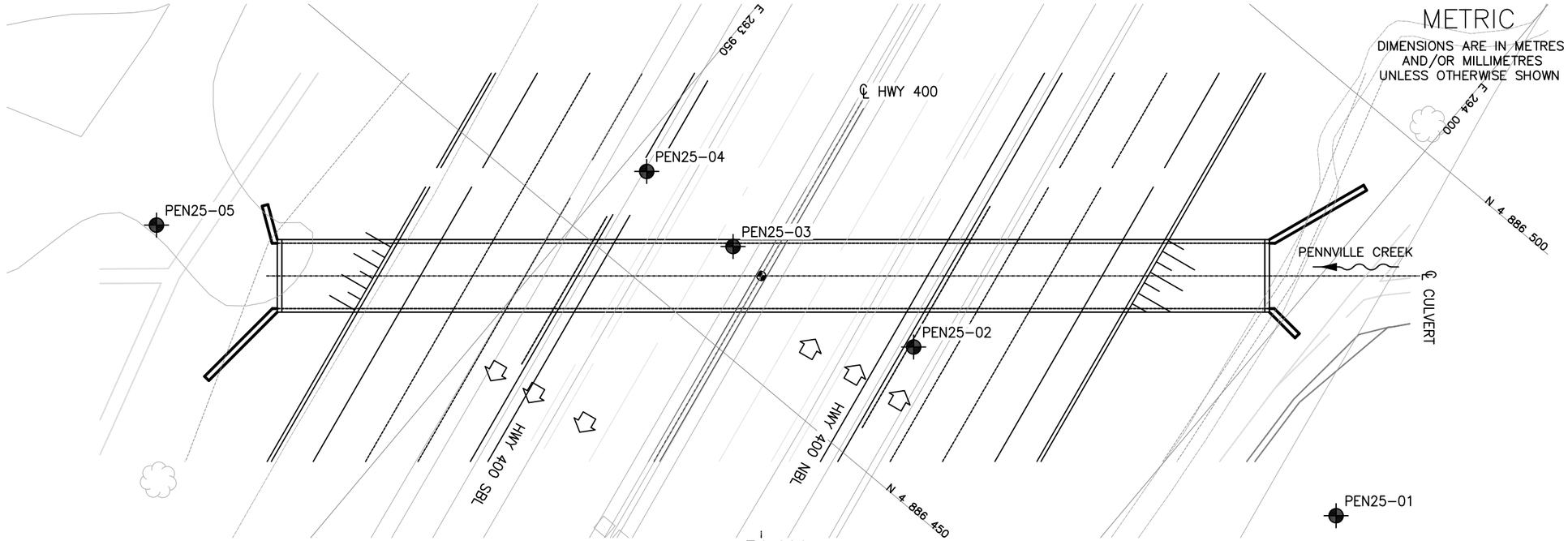
Photograph 6: Borehole PEN25-05 after Monitoring Well Installation, Looking West

APPENDIX B

Borehole Location Plans and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

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



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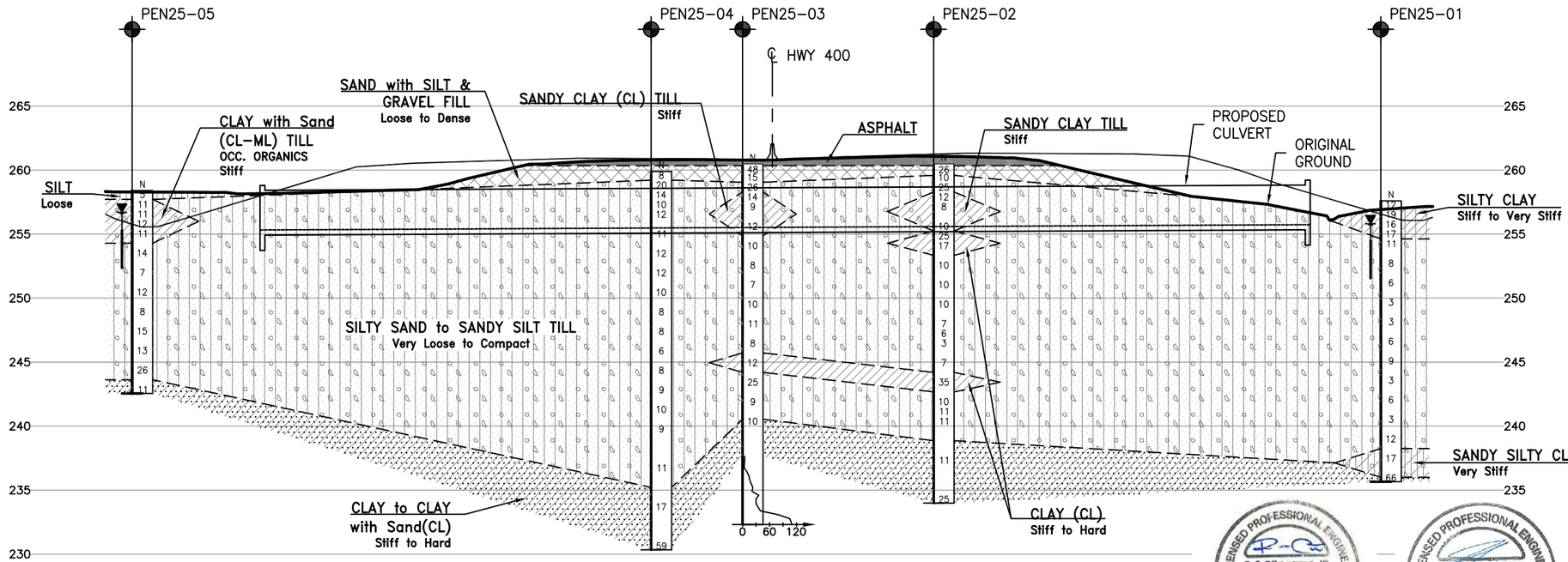


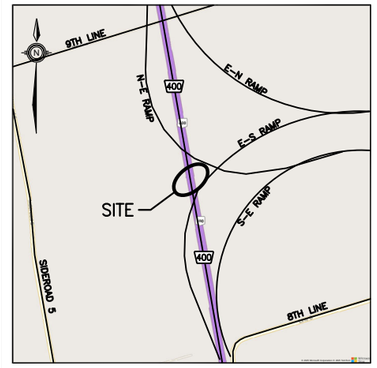
PROFILE ALONG ℄ CULVERT
8 0 8 16m
SCALE 1:400

CONT No
WP No

BRADFORD BYPASS
PENNVILLE CREEK
DIVERSION CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	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
PEN25–01	257.6	4 886 472.2	294 013.7
PEN25–02	260.5	4 886 460.4	293 978.0
PEN25–03	260.5	4 886 457.2	293 961.3
PEN25–04	259.9	4 886 457.4	293 951.8
PEN25–05	258.4	4 886 427.9	293 923.6

-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. 31D04-027

LICENSED PROFESSIONAL ENGINEER
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REVISIONS		
DATE	BY	DESCRIPTION

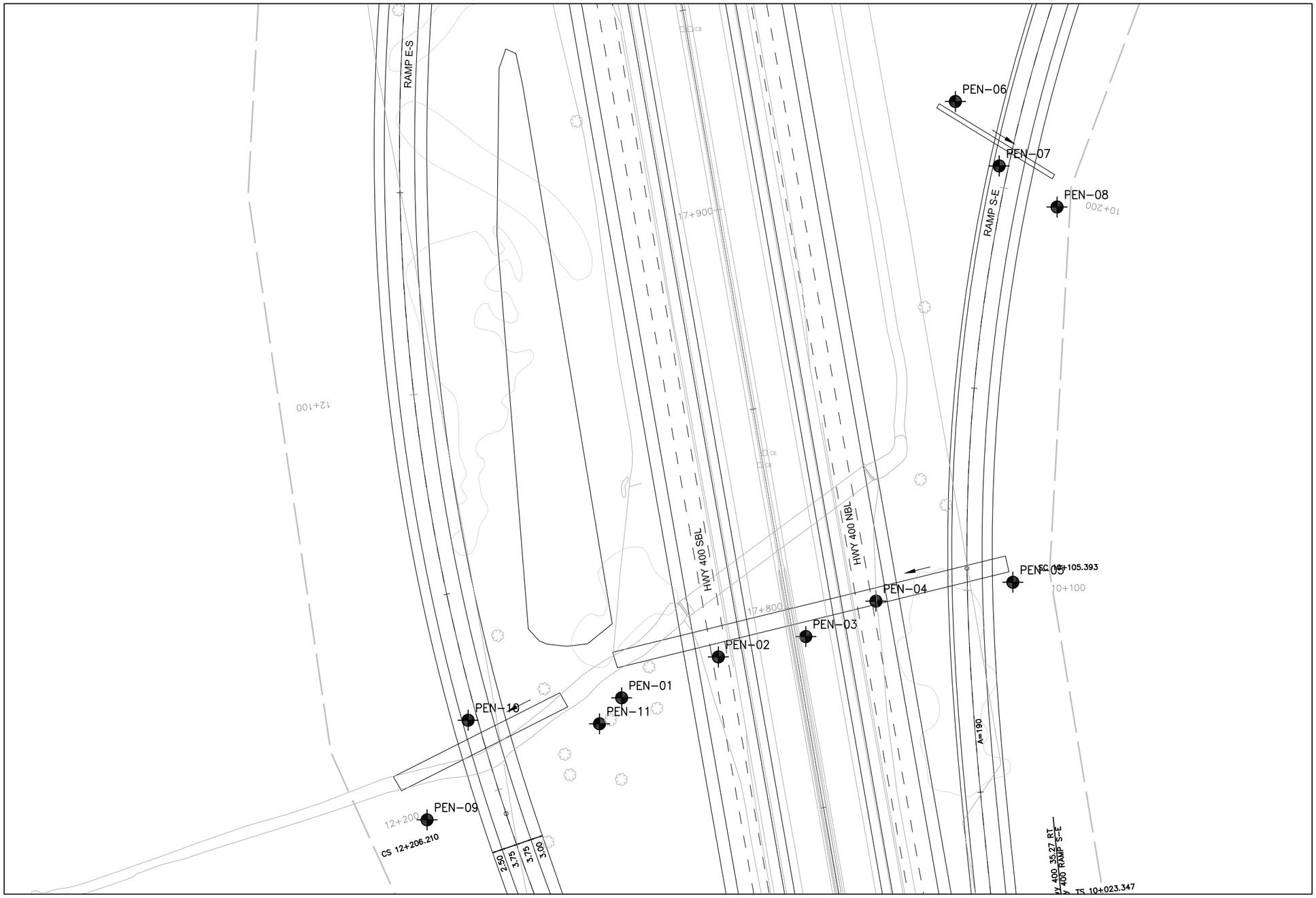
DESIGN	MC	CHK	RdC	CODE		LOAD	DATE JAN 2026
DRAWN	AN	CHK	MC	SITE 30X–0890/C0		STRUCT	DWG 1

FILENAME: H:\Drafting\48000\48856\TED–48856–PLPR–Pennville Creek Culvert.dwg
PLOTDATE: 1/28/2026 2:02 PM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



20 0 20 40m

SCALE 1:1000

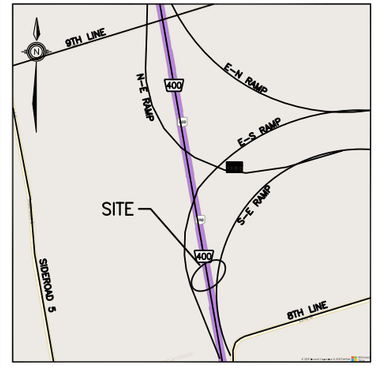
CONT No

WP No

BRADFORD BYPASS
PENNVILLE CREEK
CULVERT
BOREHOLE LOCATION PLAN

SHEET

THURBER



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	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
PEN-01	253.6	4 886 034.4	293 994.0
PEN-02	254.7	4 886 044.5	294 017.9
PEN-03	255.2	4 886 049.5	294 039.5
PEN-04	254.3	4 886 058.3	294 056.8
PEN-05	255.4	4 886 062.9	294 090.6
PEN-06	254.6	4 886 181.7	294 076.4
PEN-07	254.6	4 886 165.8	294 087.3
PEN-08	254.8	4 886 155.6	294 101.6
PEN-09	252.9	4 886 004.3	293 945.9
PEN-10	253.2	4 886 028.8	293 956.0
PEN-11	253.7	4 886 028.0	293 988.5

-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.

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MC	CHK	RdC	CODE	LOAD	DATE	NOV 2025
DRAWN	JW	CHK	MC	SITE	STRUCT	DWG	1

FILENAME: C:\Users\jneganer\Downloads\TED-48856-PLPR-Pennville333333.dwg
PLOTDATE: 11/6/2025 1:52 PM

APPENDIX C

Record of Borehole Sheets – Current Investigation

THURBER

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORD OF BOREHOLES

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS:

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in size from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	greater than 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	less than 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. Where insufficient penetration was achieved, the number of blows are reported over the sampler penetration in metres (e.g. 50/0.15).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60-degree apex cone connected to “A” size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

WATER LEVELS:

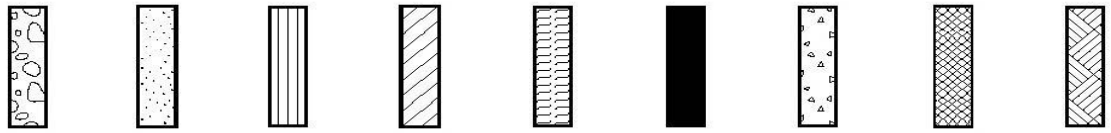

Water level upon completion of drilling


Water level in monitoring well / piezometer

Monitoring well / piezometer screen

THURBER

STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravels | Sands | Silts | Clays | Organics | Asphalt | Concrete | Fill | Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Clay	Less than 0.002 mm
Silt	0.002 mm – 0.075 mm
Sand	0.075 mm – 4.75 mm
Gravel	4.75 mm – 75 mm
Cobbles	75 mm – 300 mm
Boulders	Greater than 300 mm

TERMS DESCRIBING CONSISTENCY (FINE GRAINED SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	Less than 12
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split-spoon samples
TW	Thin-wall (Shelby) tube sample
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING DENSITY (COARSE GRAINED SOILS ONLY)

Descriptive Term	SPT 'N' Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

THURBER

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Division		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS LL < 35	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS 35 ≤ LL < 50	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS LL ≥ 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		PT	Peat and other organic soils.

Note – LL = Liquid Limit

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THURBER

RECORD OF BOREHOLE No PEN25-01 1 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 472.2 E 294 013.7 ORIGINATED BY FC

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

DATUM Geodetic DATE 2025.07.29 - 2025.07.29 LATITUDE 44.118165 LONGITUDE -79.634763 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
257.6	GROUND SURFACE										
0.0 / 0.1	**TOPSOIL:** (75mm)										
	Silty **CLAY** Stiff to Very Stiff Brown Moist		1	SS	12		257	○	○		0 11 65 24
			2	SS	19				○		
			3	SS	16	▼	256		○		
	No recovery		4	SS	17		255				
254.6											Mud rotary and tricone used from 3.0 m to 21.9 m.
3.0	Silty **SAND** Compact to Very Loose Brown to Grey Moist to Wet (TILL)		5	SS	11		254		○		0 57 28 15 Non Plastic
			6	SS	8		253		○		
			7	SS	6		252		○		
			8	SS	3		251		○		0 57 29 14 Non Plastic
			9	SS	3		250		○		
							249				
							248				

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 PEN25-01 2 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 472.2 E 294 013.7 ORIGINATED BY FC

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

DATUM Geodetic DATE 2025.07.29 - 2025.07.29 LATITUDE 44.118165 LONGITUDE -79.634763 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 to Very Loose Brown to Grey Moist to Wet (TILL)						247				
			10	SS	6				○		
							246				
			11	SS	9				○		
							245				
							244				
			12	SS	3				○		0 62 24 14
							243				
			13	SS	6				○		
							242				
							241				
			14	SS	3				○		
							240				
									○		
			15	SS	12		239		○		
238.2											
19.4	Sandy Silty **CLAY** Very Stiff Grey Moist						238				

Continued Next Page

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

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

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RECORD OF BOREHOLE No PEN25-01 3 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 472.2 E 294 013.7 ORIGINATED BY FC

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

DATUM Geodetic DATE 2025.07.29 - 2025.07.29 LATITUDE 44.118165 LONGITUDE -79.634763 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy Silty **CLAY** Very Stiff Grey Moist (TILL)		16	SS	17		237	○	○		
236.0			17	SS	66		236		○		0 6 44 50
21.6 235.7	**CLAY**(CL) Hard Grey Moist										
21.9	END OF BOREHOLE AT 21.9m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2025.08.06 2.0 255.6 2025.08.22 1.8 255.8 2025.09.08 1.8 255.8										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 PEN25-02 1 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 460.4 E 293 978.0 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.07.25 - 2025.07.25 LATITUDE 44.118058 LONGITUDE -79.635209 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
260.5	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND**, with gravel Compact Brown Moist		1	SS	26				○		19 74 7 (SI+CL)
259.6	(FILL)						260				
0.9	Silty **SAND** Compact Brown Moist (TILL)		2	SS	10				○		
			3	SS	25		259		○		0 53 32 15
258.3											
2.2	Sandy **CLAY** Stiff Grey Moist to Wet (TILL)		4	SS	12		258		○		
			5	SS	8		257		○		Mud rotary and tricone used from 3.0 m to 26.5 m.
	Layer of gravel (100 mm)		6	SS	10		256		○		
255.2											
5.3	**CLAY** (CL) Very Stiff Grey Moist to Wet		7	SS	25		255		○		0 13 43 44
			8	SS	17		254		○		
253.3											
7.2	Silty **SAND** Compact to Very Loose Grey Wet (TILL)		9	SS	10		253		○		
							252				
			10	SS	10		251				
250.5											

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN25-02 2 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 460.4 E 293 978.0 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.07.25 - 2025.07.25 LATITUDE 44.118058 LONGITUDE -79.635209 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										
10.0	Silty **SAND** Compact to Very Loose Grey Wet (TILL)						250				
			11	SS	10				o		2 62 24 12 Non Plastic
							249				
			12	SS	7		248		o		
			13	SS	6				o		
			14	SS	3		247		o		
			15	SS	7		246		o		0 58 26 16 Non Plastic
244.2							245				
16.3	**CLAY** Hard Grey Wet		16	SS	35		244		o		
242.7							243				
17.8	Silty **SAND** Compact Grey Wet (TILL)		17	SS	10		242		o		
			18	SS	11		241		o		0 61 24 15 Non Plastic

Continued Next Page

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No PEN25-02 3 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 460.4 E 293 978.0 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.07.25 - 2025.07.25 LATITUDE 44.118058 LONGITUDE -79.635209 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 (O), 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** Compact Grey Wet (TILL)		19	SS	11		240 239	O		
238.9 21.6	**CLAY** with sand (CL) Stiff to Very Stiff Grey Moist		20	SS	11		238 237 236 235	O		
234.0 26.5	END OF BOREHOLE AT 26.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 26.5m TO 1m, SAND AND GRAVEL TO 0.7m, CONCRETE TO 0.45m, THEN ASPHALT COLD PATCH TO GROUND SURFACE.		21	SS	25		234	⊖		0 25 31 44 Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

+ ³, × ³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No PEN25-03 1 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.2 E 293 961.3 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.23 - 2025.08.23 LATITUDE 44.118029 LONGITUDE -79.635418 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.5	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND**, with silt and gravel Dense to Compact Brown Moist (FILL)		1	SS	48		260		○		22 67 11 (SI+CL)
			2	SS	15				○		
259.1							259				
1.4	Silty **SAND** Compact Brown Moist (TILL)		3	SS	26				○		
258.3							258		⊖		2 43 33 22
2.2	Sandy **CLAY** (CL) Stiff Brown Moist (TILL)		4	SS	14						
			5	SS	9		257		○		Mud rotary and tricone used from 3.0 m to 20.4 m.
							256				
			6	SS	12				○		
254.9							255				
5.6	Silty **SAND** Loose to Compact Grey Wet (TILL)		7	SS	10				○		4 48 31 17 Non-plastic
							254				
			8	SS	8		253		○		
							252				
			9	SS	7						
							251		○		5 46 32 17 Non-plastic

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 PEN25-03 2 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.2 E 293 961.3 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.23 - 2025.08.23 LATITUDE 44.118029 LONGITUDE -79.635418 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 kN/m^3	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		GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Loose to Compact Grey Wet (TILL)						250				
			10	SS	10				○		
							249				
			11	SS	11		248		○		
							247				
			12	SS	8				○		
245.7							246				
14.8	**CLAY** (CL) Stiff Grey Wet										
			13	SS	12		245				2 3 63 32
244.2											
16.3	Silty **SAND** Compact to Loose Grey Wet (TILL)						244				
			14	SS	25				○		
							243				
			15	SS	9		242		○		
240.5							241				

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN25-03 3 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.2 E 293 961.3 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.23 - 2025.08.23 LATITUDE 44.118029 LONGITUDE -79.635418 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	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
20.0	**CLAY**, with sand Stiff Grey Wet		16	SS	10		240 239 238 237 236 235 234 233				
237.6											
22.9	END OF SAMPLING AND START OF DCPT										
232.3											
28.2	END OF DCPT AT 28.2m UPON REFUSAL BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 28.2m TO 1.0m, SAND AND GRAVEL TO 0.7m, CONCRETE TO 0.45m, THEN ASPHALT COLD PATCH TO GROUND SURFACE.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

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

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No PEN25-04 1 OF 4 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.4 E 293 951.8 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.15 - 2025.08.15 LATITUDE 44.118030 LONGITUDE -79.635536 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
259.9	GROUND SURFACE										
0.0	**SAND**, with gravel Loose Brown Moist (FILL)		1	SS	8						
259.2											
0.7	Silty **SAND** to Sandy **SILT** Loose to Compact Brown to Grey Moist (TILL)		2	SS	20		259				5 49 30 16
			3	SS	14		258				
			4	SS	10		257				
			5	SS	12		256				Mud rotary and tricone used from 3.0 m to 29.5 m.
			6	SS	11		255				
			7	SS	12		254				4 50 30 16 Non plastic
			8	SS	12		253				
			9	SS	10		252				5 40 40 15 Non plastic
							251				
							250				

Continued Next Page

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

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

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THURBER

RECORD OF BOREHOLE No PEN25-04 2 OF 4 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.4 E 293 951.8 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.15 - 2025.08.15 LATITUDE 44.118030 LONGITUDE -79.635536 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										
	Silty **SAND** to Sandy **SILT** Loose to Compact Brown to Grey Wet (TILL)										
			10	SS	8		249		○		
							248				
			11	SS	8				○		6 48 32 14 Non plastic
							247				
			12	SS	6		246		○		
							245				
			13	SS	8				○		
							244				
			14	SS	9		243		○		
							242				
			15	SS	10				○		
							241				
							240				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-48856.GPJ 12/5/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN25-04 3 OF 4 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.4 E 293 951.8 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.15 - 2025.08.15 LATITUDE 44.118030 LONGITUDE -79.635536 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** to Sandy **SILT** Loose to Compact Brown to Grey Wet (TILL)		16	SS	9				○		
							239				
							238				
			17	SS	11		237		○		
235.2							236				
24.7	**CLAY**, with sand (CL) Very Stiff to Hard Grey Wet						235				
			18	SS	17		234		⊢○⊣		1 21 37 41
							233				
							232				
			19	SS	59		231		○		
230.3											
29.6	END OF BOREHOLE AT 29.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM										Drilling mud added to borehole during

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 PEN25-04 4 OF 4 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 457.4 E 293 951.8 ORIGINATED BY AK

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

DATUM Geodetic DATE 2025.08.15 - 2025.08.15 LATITUDE 44.118030 LONGITUDE -79.635536 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)	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										
	29.6m to 0.3m, THEN CONCRETE TO GROUND SURFACE.										drilling, therefore water level was not established upon completion of drilling.

○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No PEN25-05 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 427.9 E 293 923.6 ORIGINATED BY FC

DIST Central HWY 400 BOREHOLE TYPE Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2025.07.28 - 2025.07.28 LATITUDE 44.117765 LONGITUDE -79.635888 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
258.4	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	**SILT** Loose Brown Moist		1	SS	5		258		○		
257.7											
0.7	**CLAY**, with sand, occasional organics (CL-ML) Stiff Brown Moist (TILL)		2	SS	11		257		○		
			3	SS	11	▼			○		0 24 50 26
			4	SS	12		256		⊳⊢		0 28 39 33
			5	SS	11		255		○		Mud rotary and tricone used from 3.0 m to 15.8 m.
254.3											
4.1	Silty **SAND** Compact to Loose Brown to Grey Moist (TILL)		6	SS	14		254		○		
			7	SS	7		253				
							252		○		0 66 22 12 Non Plastic
			8	SS	12		251		○		
							250				
			9	SS	8		249		○		
	Auger grinding at a depth of 9.7m										

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No PEN25-05 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 427.9 E 293 923.6 ORIGINATED BY FC

DIST Central HWY 400 BOREHOLE TYPE Mud Rotary COMPILED BY JW

DATUM Geodetic DATE 2025.07.28 - 2025.07.28 LATITUDE 44.117765 LONGITUDE -79.635888 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										
	Silty **SAND** Compact to Loose Brown to Grey Moist (TILL)						248				
			10	SS	15				○		
							247				
			11	SS	13		246				0 61 25 14 Non Plastic
							245				
			12	SS	26				○		
243.6							244				
14.8	**CLAY** (CL) Stiff Grey Moist										
			13	SS	11		243		⊢○⊣		0 3 47 50
242.5											
15.8	END OF BOREHOLE AT 15.8m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2025.08.07 -0.2 258.6 2025.08.22 2.1 256.3 2025.08.27 1.7 256.7 2025.09.08 1.7 256.7										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

+ ³, × ³: Numbers refer to Sensitivity

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

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APPENDIX D

Record of Borehole Sheets – Current Investigation (Old Design Location)

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SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORD OF BOREHOLES

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS:

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in size from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	greater than 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	less than 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. Where insufficient penetration was achieved, the number of blows are reported over the sampler penetration in metres (e.g. 50/0.15).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60-degree apex cone connected to “A” size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

WATER LEVELS:

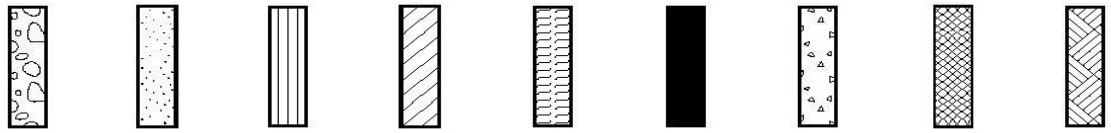

Water level upon completion of drilling


Water level in monitoring well / piezometer

Monitoring well / piezometer screen

THURBER

STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravels | Sands | Silts | Clays | Organics | Asphalt | Concrete | Fill | Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Clay	Less than 0.002 mm
Silt	0.002 mm – 0.075 mm
Sand	0.075 mm – 4.75 mm
Gravel	4.75 mm – 75 mm
Cobbles	75 mm – 300 mm
Boulders	Greater than 300 mm

TERMS DESCRIBING CONSISTENCY (FINE GRAINED SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	Less than 12
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split-spoon samples
TW	Thin-wall (Shelby) tube sample
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING DENSITY (COARSE GRAINED SOILS ONLY)

Descriptive Term	SPT 'N' Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

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MODIFIED UNIFIED SOIL CLASSIFICATION

Major Division		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS LL < 35	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS 35 ≤ LL < 50	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS LL ≥ 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		PT	Peat and other organic soils.

Note – LL = Liquid Limit

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RECORD OF BOREHOLE No PEN-01 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 034.4 E 293 994.0 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.07.11 - 2024.07.11 LATITUDE 44.114224 LONGITUDE -79.635001 CHECKED BY 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
253.6	GROUND SURFACE									
0.0 / 0.1	**TOPSOIL:** (75mm)									
	Silty **SAND,** occasional rootlets Compact to Loose Brown Moist		1	SS	12		253			
			2	SS	5					
252.2 / 1.4	**CLAY** (CL) Very Stiff to Firm Brown to Grey Moist to Wet		3	SS	16		252			
			4	SS	17		251			
			5	SS	19		250			0 12 53 35
			6	SS	14		249			
			7	SS	13		248			
			8	SS	7		247			
244.9 / 8.7	Silty **SAND** Loose Grey Wet (TILL)		9	SS	5		246	2.3		
							245			
							244			

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 PEN-01 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 034.4 E 293 994.0 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.07.11 - 2024.07.11 LATITUDE 44.114224 LONGITUDE -79.635001 CHECKED BY 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): O 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										
	Silty **SAND** Loose to Very Loose Grey Wet (TILL)						243				
			10	SS	7				o		3 47 42 8 Non-plastic
							242				
			11	SS	2		241		o		
	Possible cobbles or boulders from 13.7 to 14.6m						240				
							239				
237.8			12	SS	5		238		o		3 46 43 8 Non-plastic
15.8	END OF BOREHOLE AT 15.8m. 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) 2025.04.03 0.4 253.2 2025.05.29 1.1 252.5 2025.09.10 1.3 252.3										

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

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

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RECORD OF BOREHOLE No PEN-02 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 044.5 E 294 017.9 ORIGINATED BY AB

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

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.114315 LONGITUDE -79.634703 CHECKED BY 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
254.7	GROUND SURFACE										
0.0	**TOPSOIL:** (155mm)										
0.2	Silty **SAND** with gravel Compact Brown		1	SS	14						22 64 14 (SI+CL)
254.0	Moist (FILL)						254				
0.7	**CLAY** (CL) Stiff to Very Stiff Brown to Grey Moist to Wet		2	SS	9						
			3	SS	16		253				0 2 64 34
			4	SS	9						
							252				
			5	SS	24						Mud rotary and tricone used from 3.0m to 15.8m.
							251				
			6	SS	14		250				
249.1											
5.6	**CLAY** (CL) with sand Stiff to Very Stiff Grey Wet (TILL)		7	SS	13		249				0 26 50 24
							248				
			8	SS	18		247				
							246				
			9	SS	10						
244.7							245				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-02 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 044.5 E 294 017.9 ORIGINATED BY AB

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

DATUM Geodetic DATE 2024.10.30 - 2024.10.30 LATITUDE 44.114315 LONGITUDE -79.634703 CHECKED BY 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) 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										
10.0	Silty **SAND** Loose to Compact Grey Wet (TILL)										
			10	SS	7		244		○		
							243		○		
			11	SS	9						
							242				
			12	SS	14		241		○		
							240				
			13	SS	14				○		
238.9							239				
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE ELEVATION AND COORDINATES ARE APPROXIMATE. LOCATION COULD NOT BE SURVEYED DUE TO ACCESS RESTRICTIONS. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG 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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RECORD OF BOREHOLE No PEN-03 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 049.5 E 294 039.5 ORIGINATED BY AB

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

DATUM Geodetic DATE 2024.12.01 - 2024.12.02 LATITUDE 44.114361 LONGITUDE -79.634433 CHECKED BY 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
255.2	GROUND SURFACE										
0.0	**ASPHALT:** (210mm)						255				
0.2	**SAND** with silt Compact Brown Moist (FILL)		1	SS	22						
			2	SS	14		254				1 72 19 8 Non-plastic
253.4			3	SS	14						
1.8	**CLAY** (CL) Stiff Grey						253				
253.0											
2.2	Moist (FILL)		4	SS	6						
	CLAY (CL) with sand Stiff to Very Stiff Brown to Grey Moist to Wet (TILL)		1	TW			252				Mud rotary and tricone used from 3.0m to 15.8m.
			5	SS	17		251				1 21 50 28
			6	SS	11		250				
			7	SS	10		249				Non-plastic
			8	SS	9		248				
							247				
							246				Non-plastic

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 PEN-03 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 049.5 E 294 039.5 ORIGINATED BY AB

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

DATUM Geodetic DATE 2024.12.01 - 2024.12.02 LATITUDE 44.114361 LONGITUDE -79.634433 CHECKED BY 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
	Continued From Previous Page										
	CLAY (CL) with sand Stiff Grey Wet (TILL)						245				
			9	SS	10				○		
243.5							244				
11.7	Sandy **SILT** Loose to Compact Grey Wet (TILL)						243		○		2 43 43 12
			10	SS	6						
							242				
			11	SS	19				○		
							241				
							240				
239.4			12	SS	29				○ ⊢		
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE ELEVATION AND COORDINATES ARE APPROXIMATE. BOREHOLE BACKFILLED WITH CEMENT BENTONITE GROUT TO 3.0m, BENTONITE FROM 3.0m TO 0.2m THEN COLDPATCH TO GROUND SURFACE.										Drilling mud added to borehole during drilling, therefore water level was not established upon completion of drilling.

+ ³, × ³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No PEN-04 1 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 058.3 E 294 056.8 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.07 - 2024.10.07 LATITUDE 44.114440 LONGITUDE -79.634216 CHECKED BY 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
254.3	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1	**SILT** with sand, occasional rootlets, occasional decayed wood pieces Compact Brown Moist (FILL)		1	SS	10		254				
253.6											
0.7			2	SS	9		253				0 2 60 38
	CLAY Firm to Very Stiff Brown to Grey Moist to Wet		3	SS	6						
			4	SS	8		252				
			5	SS	12		251				0 2 56 42
			6	SS	22		250				
			7	SS	16		249				Non-plastic
247.1							248				
7.2	**CLAY** (CL) with sand Very Stiff to Stiff Grey Wet (TILL)		8	SS	17		247				2 29 46 23 Non-plastic
			9	SS	13		246				
244.5							245				
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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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-04 2 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 058.3 E 294 056.8 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.07 - 2024.10.07 LATITUDE 44.114440 LONGITUDE -79.634216 CHECKED BY 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.										Non-plastic

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-04 3 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 058.3 E 294 056.8 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.07 - 2024.10.07 LATITUDE 44.114440 LONGITUDE -79.634216 CHECKED BY 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										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-05 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 062.9 E 294 090.6 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.07 - 2024.10.07 LATITUDE 44.114482 LONGITUDE -79.633794 CHECKED BY 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
255.4	GROUND SURFACE									
0.0	**TOPSOIL:** (75mm)									
0.1	**SILT** with sand, occasional rootlets Compact Brown Moist (FILL)		1	SS	14		255			
254.7										
0.7	**CLAY** Very Stiff Brown Moist		2	SS	23		254			
			3	SS	25					0 0 60 40
			4	SS	24		253			
			5	SS	24		252			
251.3										
4.1	**CLAY** (CL) with sand Very Stiff to Stiff Brown to Grey Moist (TILL)		6	SS	27		251			1 17 42 40
							250			
	Occasional cobbles		7	SS	20		249			
							248			
			8	SS	11					
							247			
			9	SS	11		246			
245.6										
9.8	END OF BOREHOLE AT 9.8m.									

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 PEN-05 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 062.9 E 294 090.6 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.07 - 2024.10.07 LATITUDE 44.114482 LONGITUDE -79.633794 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O 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										
	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	2.6	252.8
2024.11.07	2.6	252.8
2024.11.25	2.6	252.8
2025.04.09	0.9	254.5
2025.05.30	1.4	254.0
2025.09.10	3.6	251.8

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-06 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 181.7 E 294 076.4 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.08 - 2024.10.08 LATITUDE 44.115551 LONGITUDE -79.633974 CHECKED BY 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
254.6	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	**SILT** with sand, occasional organics Compact Brown Moist (FILL)		1	SS	13	▼	254				
253.8											
0.8	**CLAY** Stiff to Firm Brown to Grey Moist		2	SS	9		253				
			3	SS	12						
			4	SS	10		252				0 12 51 37
			5	SS	11		251				
			6	SS	4		250				
							249	1,3			
248.2			7	SS	5						
6.4	Sandy **SILT** Loose Grey Wet (TILL)						248				1 45 40 14
			8	SS	6		247				
							246				
			9	SS	5		245				5 45 39 11

Continued Next Page

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No PEN-06 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 181.7 E 294 076.4 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.08 - 2024.10.08 LATITUDE 44.115551 LONGITUDE -79.633974 CHECKED BY 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										
	Sandy **SILT** Compact Grey Wet (TILL)						244				
243.3			10	SS	17				○		
11.3	END OF BOREHOLE AT 11.3m. 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	1.5	253.1
2024.11.07	1.5	253.1
2025.04.09	0.7	253.9
2025.05.30	1.0	253.6
2025.09.10	3.8	250.8

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

(%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No PEN-07 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 165.8 E 294 087.3 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.08 - 2024.10.08 LATITUDE 44.115408 LONGITUDE -79.633838 CHECKED BY 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
254.6	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	**SILT** with sand, occasional organics Compact Brown		1	SS	13		254		○		
253.9	Moist										
0.7	(FILL)		2	SS	15				○		
	CLAY (CL) Very Stiff to Stiff Brown to Grey Moist		3	SS	23		253		○		
			4	SS	20		252		○		
			5	SS	17		251		○		
			6	SS	8		250		⊢○⊣		0 1 48 51
							249	2.5 +			
			7	SS	9		248		○		
247.4											
7.2	Sandy **SILT** Loose Grey Wet (TILL)		8	SS	9		247		○		
							246				
			9	SS	6		245		○		2 48 41 9

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-07 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 165.8 E 294 087.3 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.10.08 - 2024.10.08 LATITUDE 44.115408 LONGITUDE -79.633838 CHECKED BY 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	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **SILT** Compact Grey Wet (TILL)						244				
243.3			10	SS	11				○		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.										

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

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No PEN-08 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 155.6 E 294 101.6 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 44.115317 LONGITUDE -79.633659 CHECKED BY 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
254.8	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	**SILT** with sand, occasional organics Compact Brown		1	SS	14						
254.1	Moist						254				
0.7	(FILL)		2	SS	11						
	CLAY with sand Stiff to Very Stiff Brown to Grey Moist (TILL)		3	SS	21		253				0 19 45 36
			4	SS	17		252				
			5	SS	17		251				
			6	SS	9		250				
249.2											
5.6	**CLAY** (CL) Stiff Grey Wet						249				
	Trace sand		7	SS	9		248				0 6 55 39
247.6											
7.2	Silty **SAND** with gravel Loose Grey Wet (TILL)		8	SS	7		247				
			9	SS	7		246				
							245				

Continued Next Page

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

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-08 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 155.6 E 294 101.6 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 44.115317 LONGITUDE -79.633659 CHECKED BY 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 / NATURAL MOISTURE CONTENT / LIQUID LIMIT — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					γ kN/m^3	GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** with gravel Dense Grey Wet (TILL)										
243.5			10	SS	34		244		o		26 52 18 4 Non-plastic
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CEMENT/GROUT MIXTURE TO GROUND SURFACE. A MONITORING WELL WAS INSTALLED NEXT TO BOREHOLE PEN-08. 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 2.0 252.8 2024.11.07 2.1 252.7 2025.04.09 0.5 254.3 2025.05.30 0.6 254.2 2025.09.10 3.3 251.5										

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

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No PEN-09 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 004.3 E 293 945.9 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.08 - 2024.11.09 LATITUDE 44.113952 LONGITUDE -79.635601 CHECKED BY 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
252.9	GROUND SURFACE											
0.0	**TOPSOIL:** (50mm)											
0.0	Silty **SAND,** occasional rootlets Compact Brown Moist (FILL)		1	SS	13							
			2	SS	12		252					
251.5												
1.4	**CLAY** (CL) with sand Very Stiff Brown to Grey Moist (TILL)		3	SS	16		251					
			4	SS	24							1 25 50 24
			5	SS	21		250					
248.8							249					
4.1	**CLAY** (CL) Firm Grey Wet		6	SS	6							
			1	TW			248					0 0 63 37
			7	SS	6		247					
245.7							246		1 3			
7.2	Sandy **SILT** Loose to Compact Grey Moist (TILL)		8	SS	9		245					
			9	SS	5		244					5 44 44 7
							243					

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 PEN-09 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 004.3 E 293 945.9 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.08 - 2024.11.09 LATITUDE 44.113952 LONGITUDE -79.635601 CHECKED BY 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, FIELD VANE, QUICK TRIAXIAL, 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										
241.6	Sandy **SILT** Loose to Compact Grey Wet (TILL)		10	SS	10		242				
11.3	END OF BOREHOLE AT 11.3m. 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)
2025.04.01	0.6	252.3
2025.04.03	0.3	252.6
2025.05.29	1.3	251.6
2025.09.10	1.7	251.2

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

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-10 1 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 028.8 E 293 956.0 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.04 - 2024.11.04 LATITUDE 44.114173 LONGITUDE -79.635475 CHECKED BY 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
253.2	GROUND SURFACE										
0.0	**TOPSOIL:** (100mm)										
0.1	Silty **SAND,** occasional rootlets Compact to Loose Brown Moist (FILL)		1	SS	11		253		○		
	No Recovery		2	SS	9		252		○		
251.8											
1.4	**CLAY** (CL) Firm to Very Stiff Brown to Grey Moist		3	SS	8				○		
			4	SS	20		251		⊖		1 12 56 31
	No recovery		5	SS	24		250				
			6	SS	13		249		○		
			7	SS	5		248		⊖		0 0 60 40
							247	2.0 +			
245.3			8	SS	6		246		○		
7.9	Sandy **SILT** Loose Grey Wet (TILL)						245		○		
			9	SS	6		244		○		

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO) - COPY.GLB MTO-48856.GPJ 10/16/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-10 2 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 028.8 E 293 956.0 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.04 - 2024.11.04 LATITUDE 44.114173 LONGITUDE -79.635475 CHECKED BY 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										
	Sandy **SILT** Loose to Very Loose Grey Wet (TILL)						243				
			10	SS	5		242		○		4 44 41 11 Non-plastic
			11	SS	3		241		○		
			12	SS	3		240		○		
			13	SS	6		239		○		
			14	SS	2		238		○		1 41 46 12
			15	SS	6		237		○		
234.3							236				
18.9	END OF BOREHOLE AT 18.9m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.						235				

Continued Next Page

+ 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 PEN-10 3 OF 3 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 028.8 E 293 956.0 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.04 - 2024.11.04 LATITUDE 44.114173 LONGITUDE -79.635475 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O 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 READINGS DATE DEPTH(m) ELEV.(m) 2025.04.01 0.6 252.6 2025.04.03 0.3 252.9 2025.05.29 0.9 252.3 2025.09.10 1.4 251.8										

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-11 1 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 028.0 E 293 988.5 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.08 - 2024.11.11 LATITUDE 44.114166 LONGITUDE -79.635069 CHECKED BY 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
253.7	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	Silty **SAND,** occasional rootlets Loose Brown Moist (FILL)		1	SS	9						6 50 34 10
253.0							253				
0.7	**CLAY** (CL) Firm to Very Stiff Brown to Grey Moist		2	SS	7						
			3	SS	22		252				
			4	SS	16		251				
			5	SS	19						0 8 50 42
							250				
			6	SS	14		249				
							248				
			7	SS	7						
							247	1.1			
			8	SS	6		246				0 1 59 40
245.0								1.6			
8.7	Sandy **SILT** Loose Grey Wet (TILL)		9	SS	4		245				
							244				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-48856.GPJ 10/14/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PEN-11 2 OF 2 METRIC

W.P. _____ LOCATION Bradford Bypass N 4 886 028.0 E 293 988.5 ORIGINATED BY KF

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

DATUM Geodetic DATE 2024.11.08 - 2024.11.11 LATITUDE 44.114166 LONGITUDE -79.635069 CHECKED BY 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									
	Sandy **SILT** Compact to Loose Grey Wet (TILL)									
			10	SS	10		243	○ at WATER CONTENT ≈ 20		
							242			
240.9			11	SS	8		241	○ at WATER CONTENT ≈ 20		
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE.									

+ ³, × ³: Numbers refer to Sensitivity

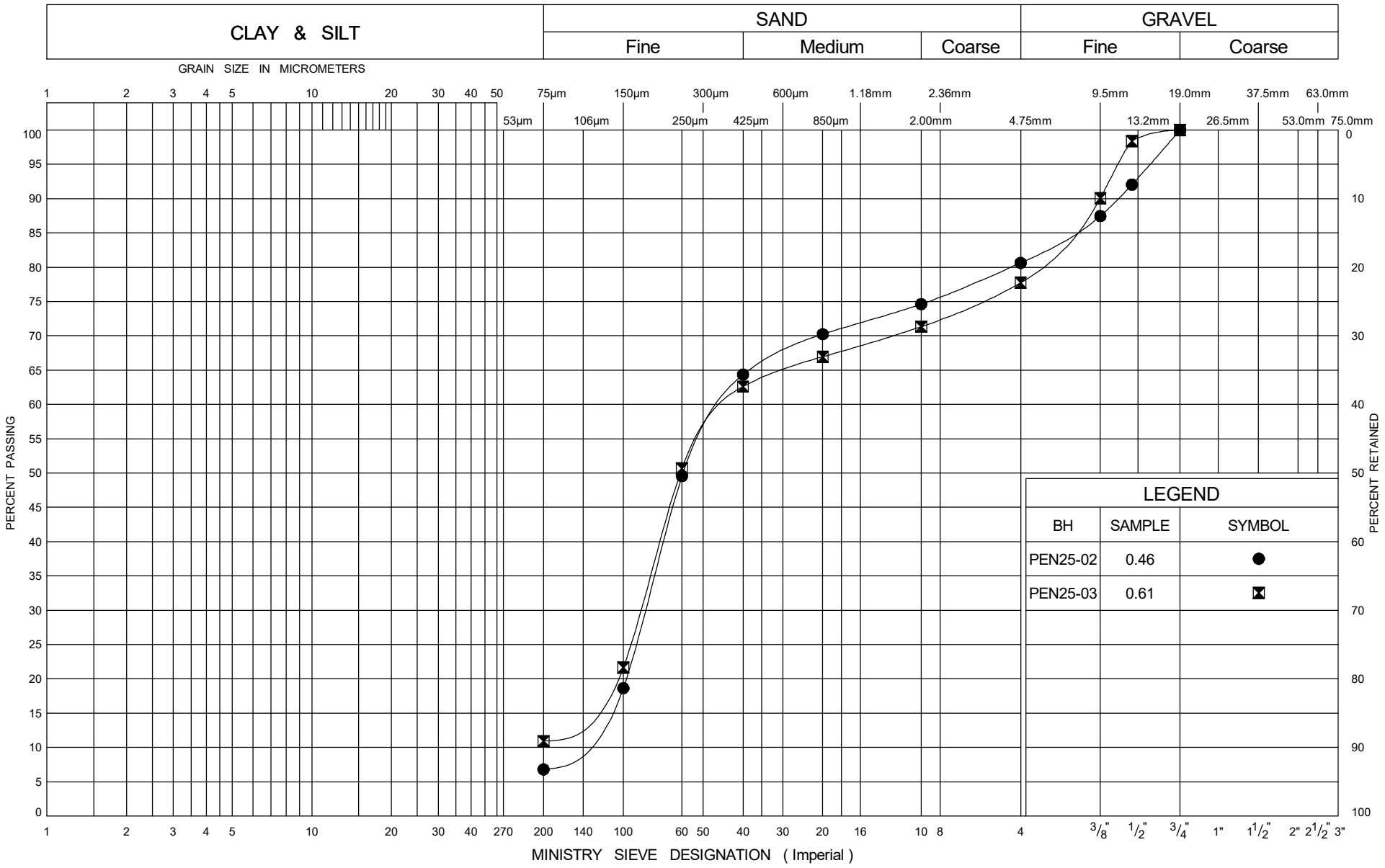
15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-48856.GPJ 10/14/25

THURBER

APPENDIX E

Geotechnical and Analytical Laboratory Test Result



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

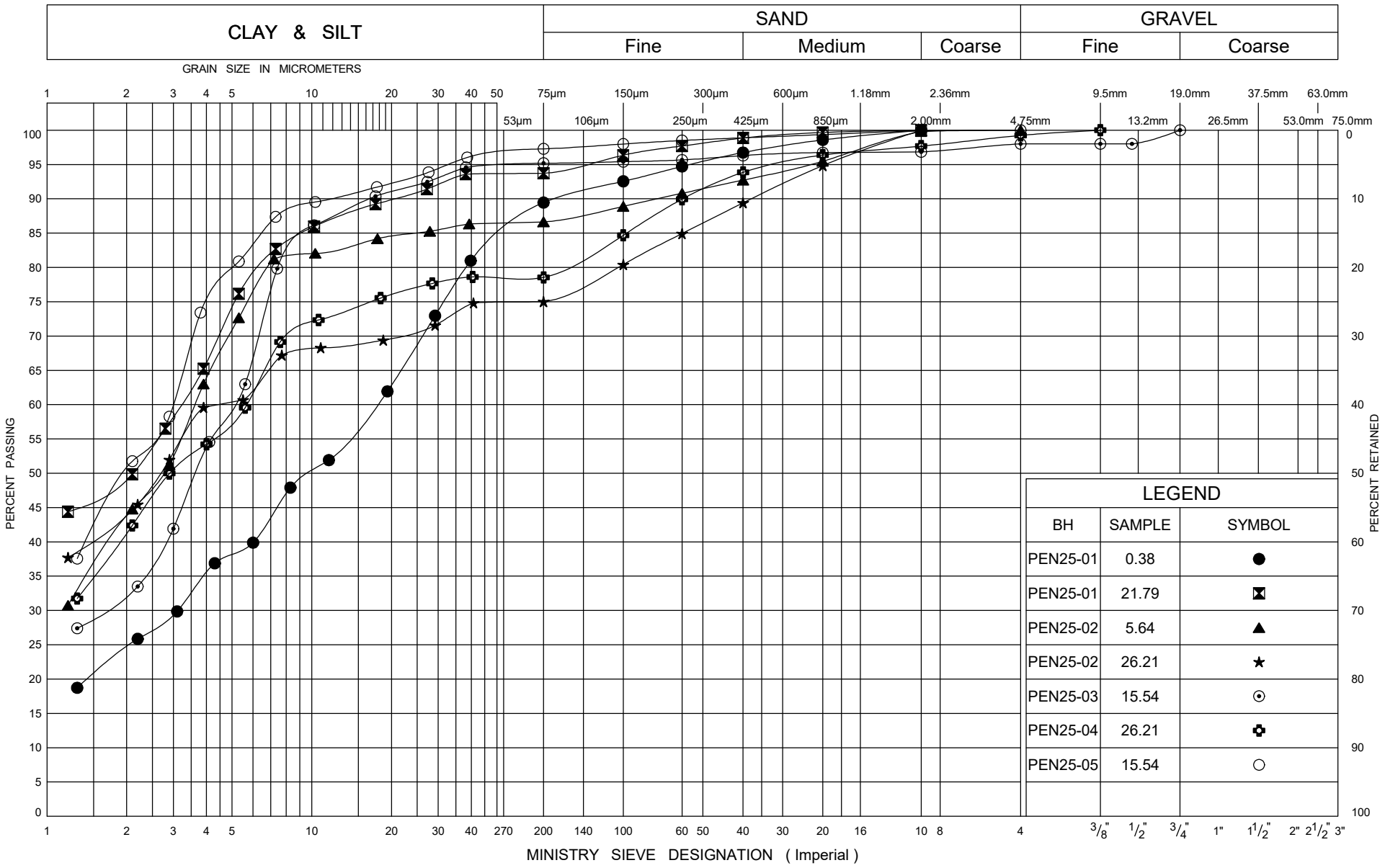
SAND FILL

FIG No 1

W.P.

Bradford Bypass

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 12/5/25



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Ontario

GRAIN SIZE DISTRIBUTION

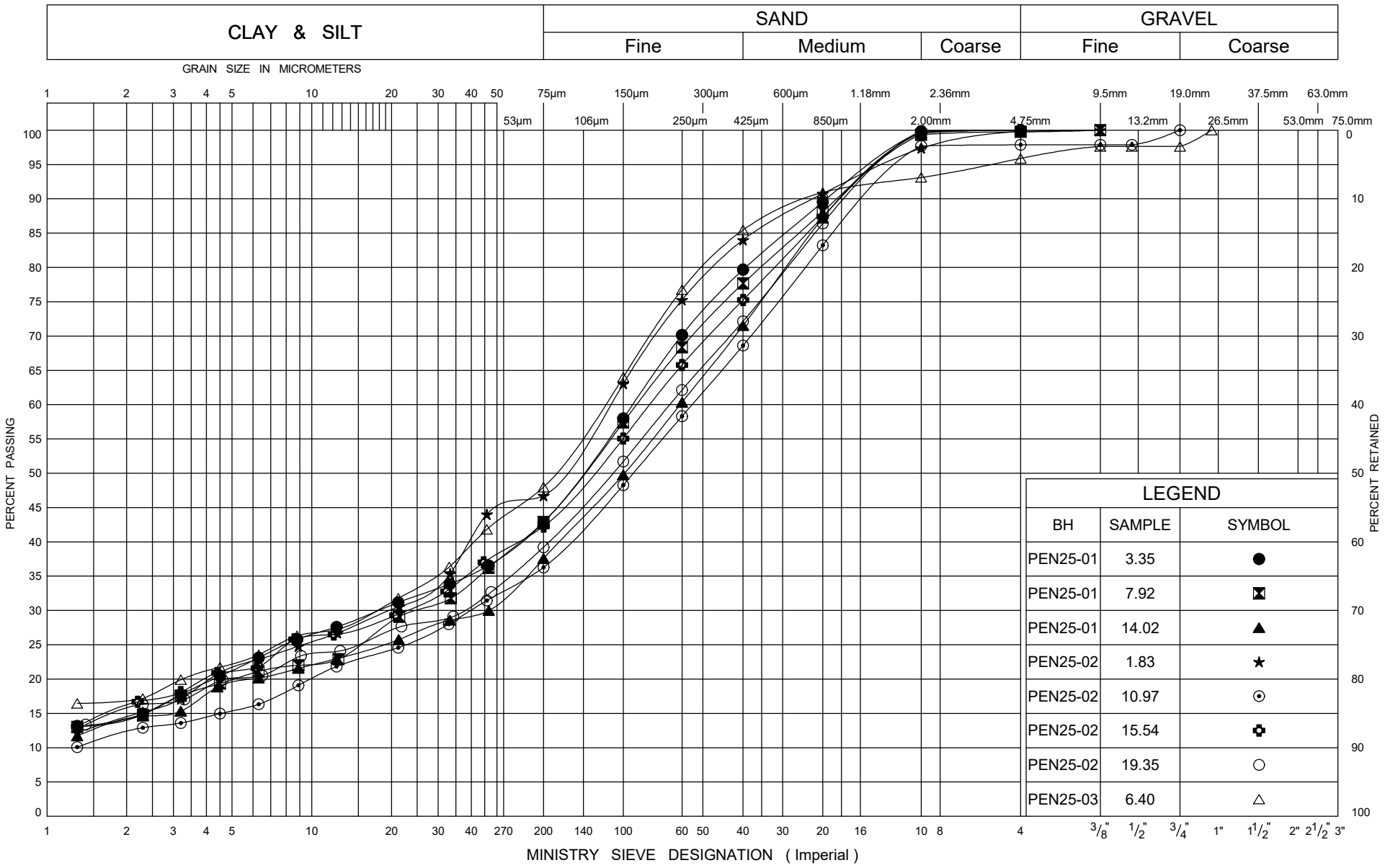
CLAY

FIG No 2

W.P.

Bradford Bypass

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 11/4/25



ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 11/4/25

Ministry of Transportation
Ontario

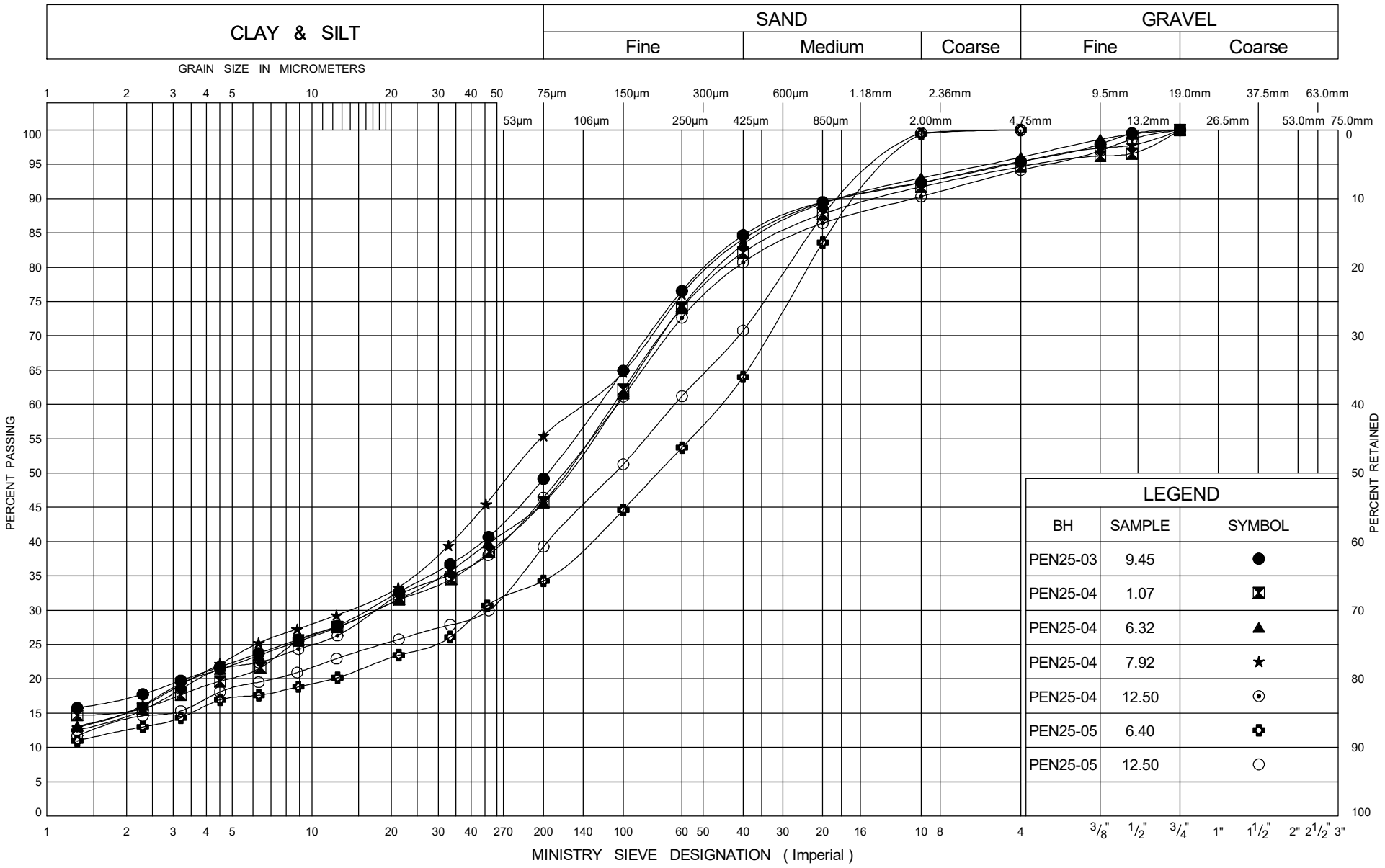
GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

FIG No 3

W.P.

Bradford Bypass



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GRAIN SIZE DISTRIBUTION

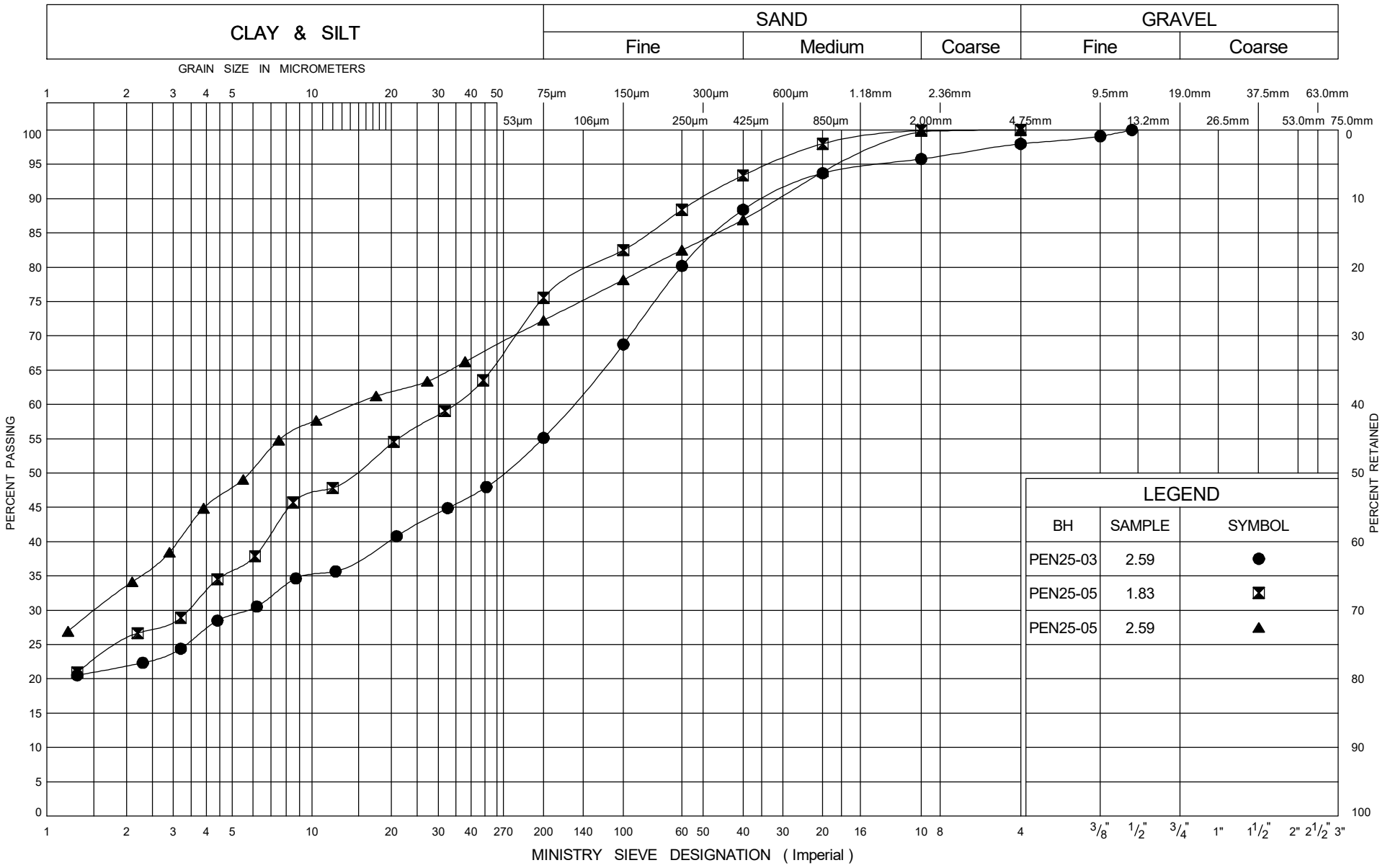
SILTY SAND TILL

FIG No 4

W.P.

Bradford Bypass

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 12/5/25



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Ontario

GRAIN SIZE DISTRIBUTION

CLAY TILL

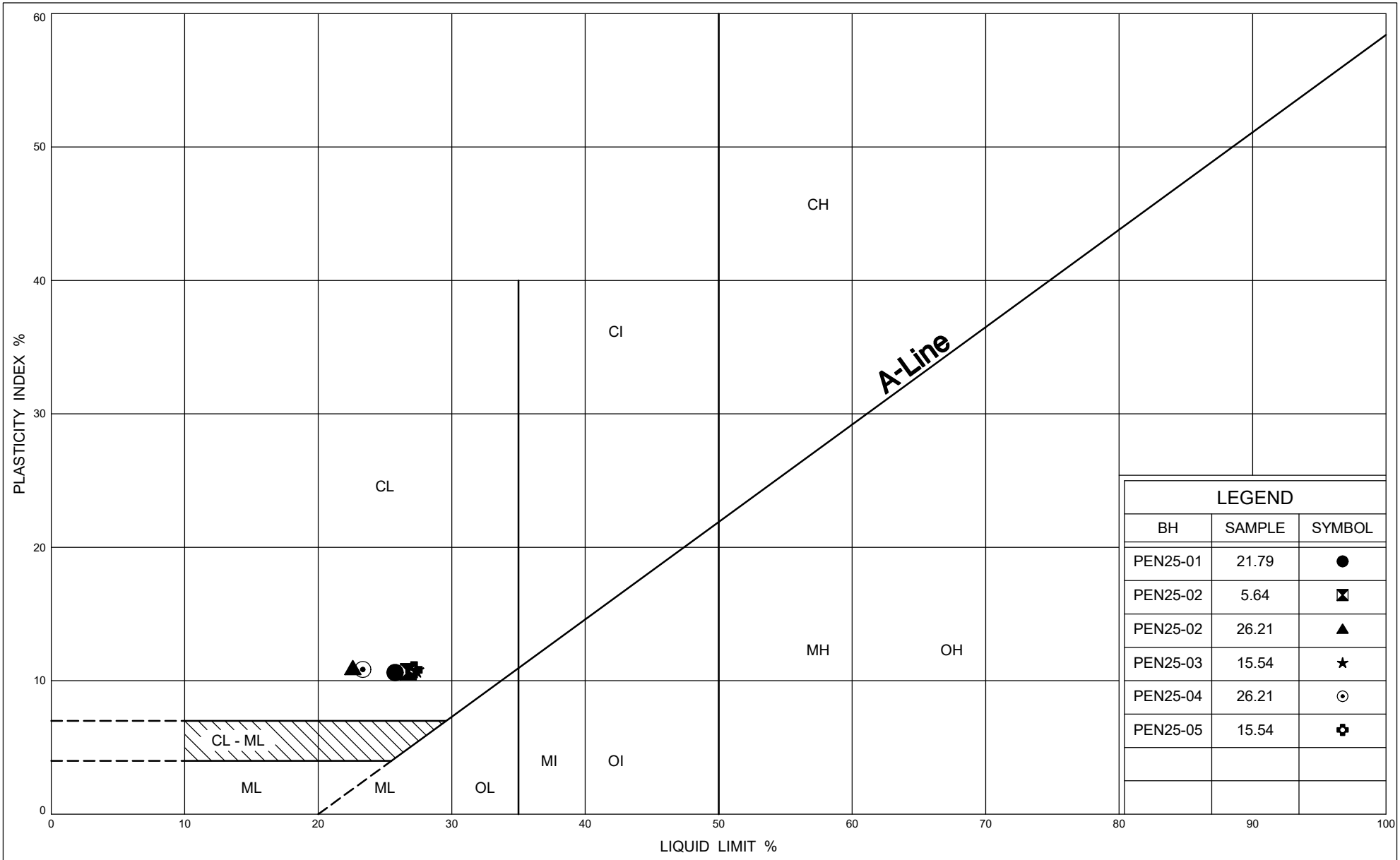
FIG No 5

W.P.

Bradford Bypass

ONTARIO MOT GRAIN SIZE 2 MTO-48856.GPJ ONTARIO MOT.GDT 12/5/25

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
PEN25-01	21.79	●
PEN25-02	5.64	⊠
PEN25-02	26.21	▲
PEN25-03	15.54	★
PEN25-04	26.21	⊙
PEN25-05	15.54	✿

Ministry of Transportation
Ontario

PLASTICITY CHART
CLAY

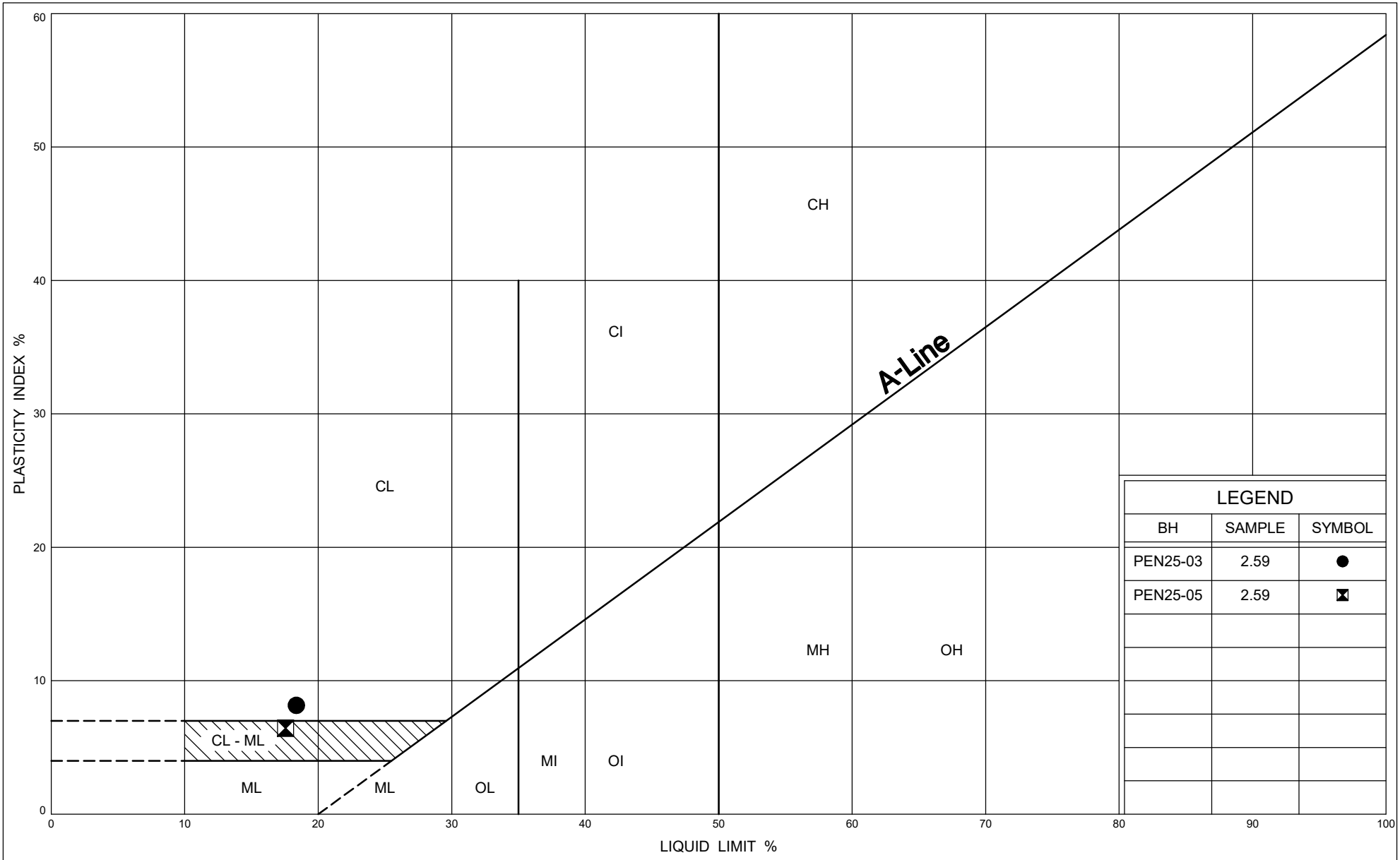
FIG No 6

W.P.

Bradford Bypass

ONTARIO MOT PLASTICITY CHART MTO-48856.GPJ ONTARIO MOT.GDT 11/4/25

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-48856.GPJ ONTARIO MOT.GDT 11/4/25

Ministry of Transportation
Ontario

PLASTICITY CHART
CLAY TILL

FIG No 7

W.P.

Bradford Bypass

FINAL REPORT

CA40115-AUG25 R1

48858, Bradford Bypass West Contract

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	1908 Ironoak Way, Suite 202 Oakville, ON L6H 0N1. Canada
Contact	Joshua Alexander
Telephone	613-606-7303
Facsimile	
Email	jalexander@thurber.ca
Project	48858, Bradford Bypass West Contract
Order Number	
Samples	Soil (3)

LABORATORY DETAILS

Project Specialist	Jill Campbell, B.Sc.,GISAS
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	2165
Facsimile	705-652-6365
Email	jill.campbell@sgs.com
SGS Reference	CA40115-AUG25
Received	08/12/2025
Approved	08/19/2025
Report Number	CA40115-AUG25 R1
Date Reported	08/19/2025

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present:yes
Custody Seal Present:yes

Chain of Custody Number:1

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

FINAL REPORT

CA40115-AUG25 R1

Client: Thurber Engineering Ltd.
Project: 48858, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Smit Patel

MATRIX: SOIL

			Sample Number	5	6	7
			Sample Name	PEN25-02 SS5	PEN25-05 SS3	RCULV25-02 SS3
			Sample Matrix	Soil	Soil	Soil
			Sample Date	25/07/2025	21/07/2025	31/07/2025
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**
Corrosivity Index						
Corrosivity Index	none	1		14	13	4
pH	pH Units	0.05		8.91	9.59	8.78
Soil Redox Potential	mV	no		279	230	279
Sulphide (Na2CO3)	%	0.01		< 0.01	< 0.01	< 0.01
Resistivity (calculated)	ohms.cm	-9999		778	543	10200
General Chemistry						
Conductivity	uS/cm	2		1280	1840	98
Metals and Inorganics						
Sulphate	µg/g	0.4		31	35	3.8
Other (ORP)						
Chloride	µg/g	0.4		510	1000	4.5

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0259-AUG25	µg/g	0.4	<0.4	4	35	101	80	120	104	75	125
Sulphate	DIO0259-AUG25	µg/g	0.4	<0.4	10	35	100	80	120	105	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0043-AUG25	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0325-AUG25	uS/cm	2	< 2	1	20	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0325-AUG25	pH Units	0.05	NA	0		100			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Request for Laboratory Services and CHAIN OF CUSTODY

No: 1

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page 1 of 2

Laboratory Information Section / Lab use only

Received By: Mageed Almanfaloti
Received Date: AUG 12 2025 (mm/dd/yy)
Received Time: ____ : ____ (hr : min)
Received By (signature): Mageed Almanfaloti
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☐ No ☐ Type: ____
Temperature Upon Receipt (°C) ____, 8.0
CA 40115 AUG25
LAB LIMS #: ____

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering Ltd.	☑ (same as Report Information)
Contact: Joshua Alexander	Company:
Address: 202 - 1908 Ironoak Way, Oakville, ON L6H 7G4	Contact:
Phone: 613-606-7303	Address:
Fax:	Phone:
Email: jalexander@thurber.ca	Email: accountingON@thurber.ca

Quotation #: ____ P.O. #: 48856
Project #: 48856 Site Location/ID: Bradford Bypass West Contract

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days) — TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: ____

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Com ☐ Agri/Other Soil Texture: ☐ Coarse ☐ Medium/Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: ____ ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality: ____

RECORD OF SITE CONDITION (RSC) ☐ YES ☑ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	PEN25-02 SS5	Jul 25, 2025	-	1	soil
2	PEN25-05 SS3	Jul 21, 2025	-	1	soil
3	RCULV25-02 SS3	Jul 31, 2025	-	1	soil
4					
5					
6					
7					
8					
9					
10					
11					
12					

M & I				SVOC		PCB	PHC		VOC		Pest	Other (please specify)							TCLP	COMMENTS:
Field Filtered (Y/N)	Metals & Inorganics incl CrVI, CN, Hg pH,(B(HWS),EC,SAR-soil) (Cl, Na-water)	Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	ICP Metals only Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni, Se,Ag,Tl,U,V,Zn	PAHs	SVOCs all incl PAHs, ABNs, CPs	PCBs Total ☑ Aroclor ☐	F1-F4 + BTEX	F1-F4 only no BTEX	VOCs all incl BTEX	BTEX only	Pesticides Organochlorine or specify other	Corrosivity Suite	1,4-dioxane	Dioxins and furans	PHC F1		Sewer Use: Specify pkg:	Water Characterization Pkg General ☐ Extended ☐	Specify TCLP tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	
												✓								
												✓								
												✓								

Observations/Comments/Special Instructions

Sampled By (NAME): Smit Patel **Signature:** Smit Patel Date: 05 /08 /25 (mm/dd/yy)

Relinquished by (NAME): Joshua Alexander **Signature:** ____ Date: ____ / ____ / ____ (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.3
Date of Issue: 13 Oct, 2019

FINAL REPORT

CA40222-DEC24 R1

48856, Bradford Bypass West Contract

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	1908 Ironoak Way, Suite 202 Oakville, ON L6H 0N1. Canada
Contact	Joshua Alexander
Telephone	613-606-7303
Facsimile	
Email	jalexander@thurber.ca
Project	48856, Bradford Bypass West Contract
Order Number	
Samples	Soil (14)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA40222-DEC24
Received	12/18/2024
Approved	12/24/2024
Report Number	CA40222-DEC24 R1
Date Reported	12/24/2024

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C
Cooling Agent Present: yes
Custody Seal Present: yes

Chain of Custody Number: N/A

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

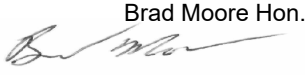


TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 48856, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Kamil Feszak/Josh Alexander

MATRIX: SOIL

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	RW1-02 SS-4	PEN-01 SS-4	PEN-03 SS-5	HWY400-01 SS-8	HWY400-10 SS-6	HWY400-11 SS-7	HWY400-20 SS-4B	HWY400-22 SS-3
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	08/12/2024	07/11/2024	01/12/2024	17/11/2024	30/10/2024	01/12/2024	07/11/2024	21/11/2024
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index											
Corrosivity Index	none	1		3	14	12	4	4	14	4	1
pH	pH Units	0.05		7.37	8.62	8.46	7.90	8.36	9.04	8.22	7.90
Soil Redox Potential	mV	no		161	258	288	227	204	294	266	315
Sulphide (Na2CO3)	%	0.01		0.01	0.01	0.02	0.03	0.02	0.01	0.02	< 0.01
Resistivity (calculated)	ohms.cm	-9999		2360	1120	1680	4420	3800	623	3600	7630
General Chemistry											
Conductivity	uS/cm	2		424	892	597	226	263	1600	278	131
Metals and Inorganics											
Sulphate	µg/g	0.4		16	19	19	73	51	50	55	9.1
Other (ORP)											
Chloride	µg/g	0.4		110	380	330	17	42	770	55	5.4

Client: Thurber Engineering Ltd.
Project: 48856, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Kamil Feszak/Josh Alexander

MATRIX: SOIL

Sample Number			13	14	15	16	17	18
Sample Name			HWY400-29 SS-3	HWY400-39 SS-7	HWY400-42 SS-2	RCULV-01 SS-4	BBPCULV-01 SS-3	BBPCUULV-07 SS-3
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			16/10/2024	12/08/2024	22/11/2024	24/10/2024	14/11/2024	11/11/2024
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index								
Corrosivity Index	none	1	1	1	1	4	1	4
pH	pH Units	0.05	7.56	8.01	8.48	8.42	8.11	8.15
Soil Redox Potential	mV	no	324	330	347	256	327	348
Sulphide (Na2CO3)	%	0.01	< 0.01	0.01	0.01	0.04	0.01	0.02
Resistivity (calculated)	ohms.cm	-9999	3450	4440	7140	5260	8930	5180
General Chemistry								
Conductivity	uS/cm	2	290	225	140	190	112	193
Metals and Inorganics								
Sulphate	µg/g	0.4	3.5	22	14	45	8.2	22
Other (ORP)								
Chloride	µg/g	0.4	59	54	13	8.8	1.2	9.8

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0460-DEC24	µg/g	0.4	<0.4	2	35	102	80	120	117	75	125
Sulphate	DIO0460-DEC24	µg/g	0.4	<0.4	0	35	101	80	120	102	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0056-DEC24	%	0.01	< 0.01								

QC SUMMARY

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0395-DEC24	uS/cm	2	2	5	20	103	90	110	NA		
Conductivity	EWL0419-DEC24	uS/cm	2	2	0	20	101	90	110	NA		

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0395-DEC24	pH Units	0.05	NA	1		99			NA		
pH	EWL0455-DEC24	pH Units	0.05	NA	1		100			NA		

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This report supersedes all previous versions.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 1 Page 1 of 2

Laboratory Information Section - Lab use only

Received By: ED
Received Date: 12/18/24 (mm/dd/yy)
Received Time: 11:35 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☐ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Temperature Upon Receipt (°C): 7 x 3
LAB LIMS #: CA40222 Dec 24

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering Ltd.	☑ (same as Report Information)
Contact: Joshua Alexander	Company:
Address: 202 - 1908 Ironoak Way, Oakville, ON L6H 7G4	Contact:
Phone: 613-606-7303	Address:
Fax:	Phone:
Email: jalexander	Email: accountingON@thurber.ca

Quotation #: P.O. #: 48856
Project #: 48856 Site Location/ID: Bradford Bypass West Contract

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days) TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Com ☐ Agri/Other Soil Texture: ☐ Coarse ☐ Medium/Fine

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☑ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	M&I: Field Filtered (Y/N)	M&I: Metals & Inorganics incl CrVI, CN, Hg pH (B(HWS),EC,SAR--soil) (Cl, Na-water)	M&I: Full Metals Suite ICP metals plus B(HWS-soil only), Hg, CrVI	M&I: ICP Metals only Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn	SVOC: PAHs	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs Total ☑ Aroclor ☐	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: Corrosivity Suite	Other: 1,4-dioxane	Other: Dioxins and furans	Other: PHC F1	Other:	Other: Sewer Use: Specify pkg:	Other: Water Characterization Pkg ☐ General ☐ Extended	TCLP: Specify TCLP tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ gnit.	COMMENTS:
1	RW1-02 SS-4	12/08/24	-	1	soil													✓							
2	PEN-01 SS-4	11/07/24	-	1	soil													✓							
3	PEN-03 SS-5	12/01/24	-	1	soil													✓							
4	HWY400-01 SS-8	11/17/24	-	1	soil													✓							
5	HWY400-10 SS-6	10/30/24	-	1	soil													✓							
6	HWY400-11 SS-7	12/01/24	-	1	soil													✓							
7	HWY400-20 SS-4B	11/07/24	-	1	soil													✓							
8	HWY400-22 SS-3	11/21/24	-	1	soil													✓							
9	HWY400-29 SS-3	10/16/24	-	1	soil													✓							
10	HWY400-39 SS-7	08/12/24	-	1	soil													✓							
11	HWY400-42 SS-2	11/22/24	-	1	soil													✓							
12	RCULV-01 SS-4	10/24/24	-	1	soil													✓							

Observations/Comments/Special Instructions

Sampled By (NAME): Kamil Feszak / Josh Alexander Signature: Joshua Alexander Digitally signed by Joshua Alexander Date: 2024.12.16 11:25:15 -05'00' Date: 12/16/24 (mm/dd/yy)

Relinquished by (NAME): Kamil Feszak Signature: Date: 12/18/24 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.3
Date of Issue: 13 Oct, 2019

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 1 Page 2 of 2

Laboratory Information Section - Lab use only

Received By: CO Received By (signature): [signature]
Received Date: 12 18 24 (mm/dd/yy) Custody Seal Present: Yes ☑ No ☐ Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Received Time: 1131 (hr : min) Custody Seal Intact: Yes ☐ No ☐ Temperature Upon Receipt (°C) 7x3 LAB LIMS #: CA40222 Dec24

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering Ltd.	☑ (same as Report Information)
Contact: Joshua Alexander	Company:
Address: 202 - 1908 Ironoak Way, Oakville, ON L6H 7G4	Contact:
Phone: 613-606-7303	Address:
Fax:	Phone:
Email: jalexander	Email: accountingON@thurber.ca

Quotation #: P.O. #: 48856
Project #: 48856 Site Location/ID: Bradford Bypass West Contract

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days) TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse ☐ Table 2 ☐ Ind/Com ☐ Medium/Fine ☐ Table 3 ☐ Agri/Other ☐ Table _____

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☑ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	BBPCULV-01 SS-3	11/14/22	-	1	soil
2	BBPCUULV-07 SS-3	11/11/24	-	1	soil
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

	M & I				SVOC		PCB	PHC		VOC		Pest	Other (please specify)							TCLP	
	Field Filtered (Y/N)	Metals & Inorganics incl CrVI, CN, Hg pH, (B(HWS),EC,SAR–soil) (Cl, Na–water)	Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	ICP Metals only Sb,As, Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni, Se,Ag,Ti,U,V,Zn	PAHs	SVOCs all incl PAHs, ABNs, CPs	PCBs Total ☑ Aroclor ☐	F1-F4 + BTEX	F1-F4 only no BTEX	VOCs all incl BTEX	BTEX only	Pesticides Organochlorine or specify other	Corrosivity Suite	1,4-dioxane	Dioxins and furans	PHC F1		Sewer Use: Specify pkg:	Water Characterization Pkg ☐ General ☐ Extended	Specify TCLP tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	COMMENTS:
1													✓								
2													✓								

Observations/Comments/Special Instructions

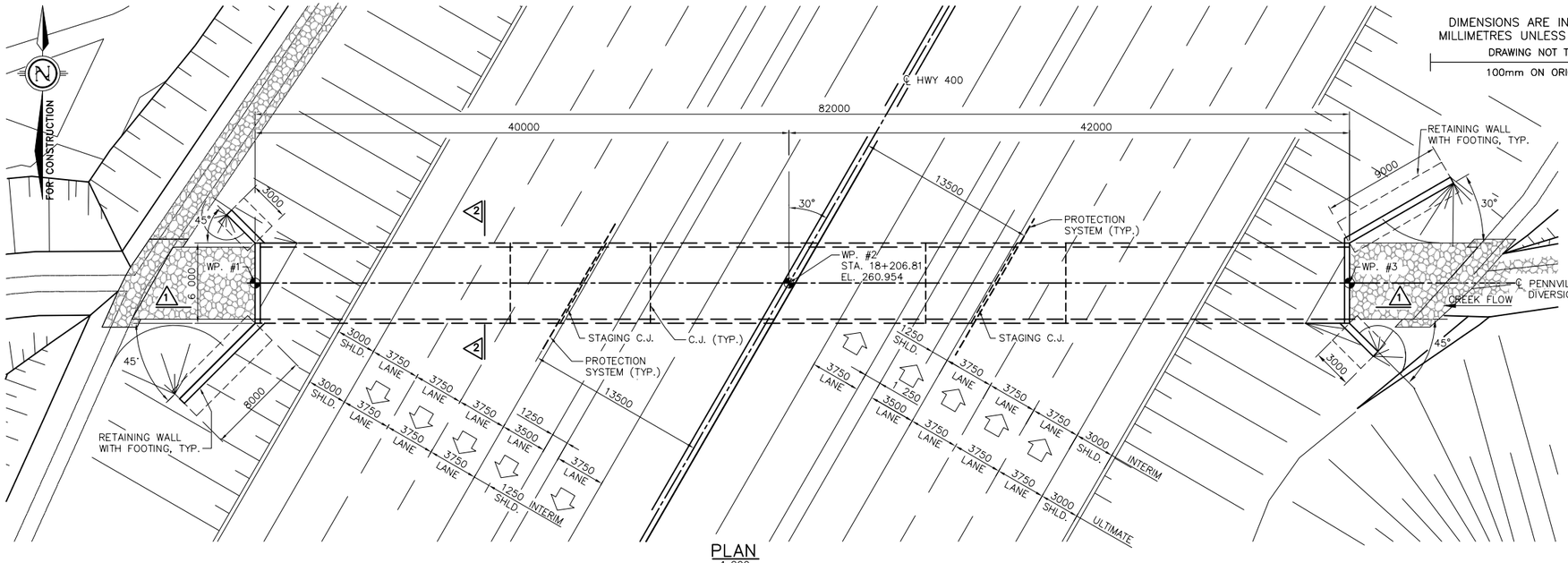
Sampled By (NAME):	Kamil Feszak / Josh Alexander	Signature: Joshua Alexander (Digitally signed by Joshua Alexander Date: 2024.12.16 11:14:17 -05'00')	Date: 12 / 16 / 24 (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME):	Kamil Feszak	Signature: [signature]	Date: 12 / 18 / 24 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.3
Date of Issue: 13 Oct, 2019

THURBER

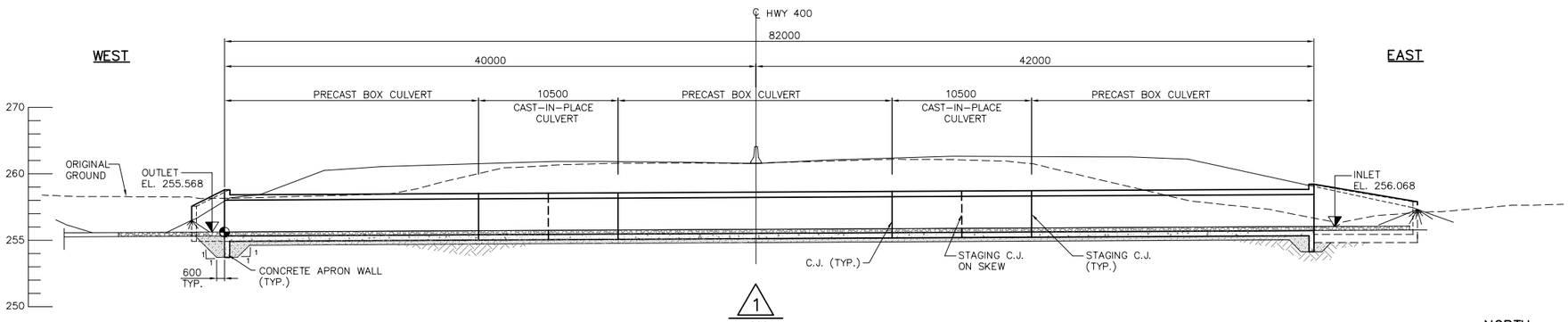
APPENDIX F

90% Design General Arangment (GA) Drawings



PLAN
1:200

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING



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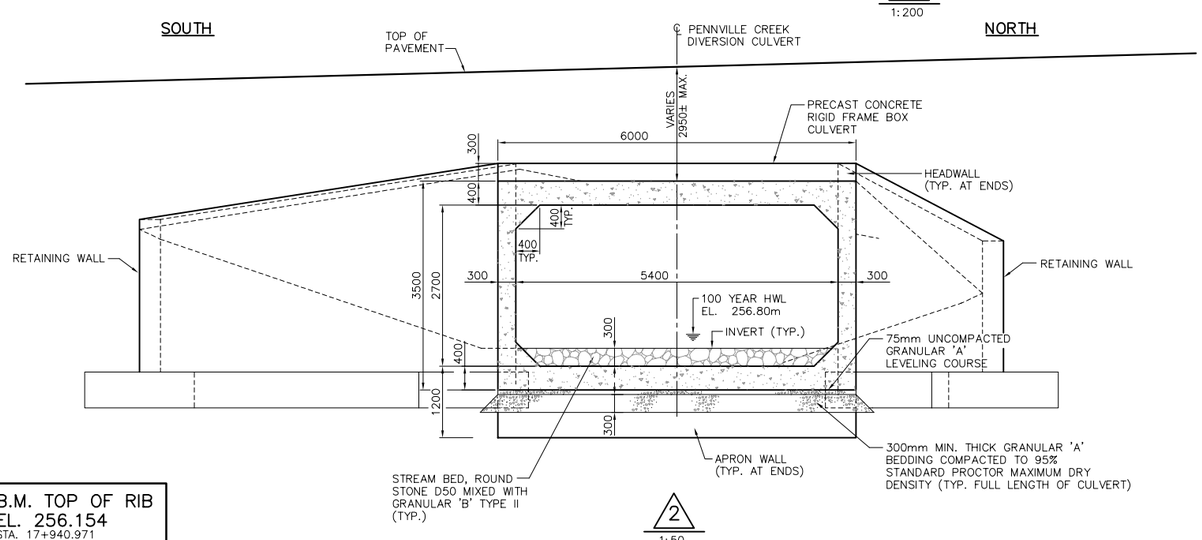
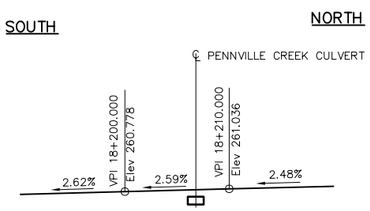


2
1:50



PROFILE OF HWY 400
N.T.S.

STATION	ELEVATION (m)	COORDINATES
WP #1	255.068	N 4886431.129 E 293933.967
WP #2	255.312	N 4886456.842 E 293964.608
WP #3	255.568	N 4886483.840 E 293996.781

B.M. TOP OF RIB
EL. 256.154
STA. 17+940.971
N. 4886162.004
E. 293993.538

Ontario Ministry of Transportation

CONT 2026-2005
GWP 2026-23-00

BRADFORD BYPASS
PENNVILLE CREEK DIVERSION CULVERT
GENERAL ARRANGEMENT

SHEET 1206

AECOM

GENERAL NOTES:

1. SPECIFIED 28-DAYS COMPRESSIVE STRENGTH:
   PRECAST CONCRETE.....45MPa
   REMAINDER.....30MPa
2. CLEAR COVER TO REINFORCING STEEL:
   FOOTING..... 100 ± 25
   CULVERT..... 50 ± 10
   REMAINDER..... 70 ± 20
   UNLESS NOTED OTHERWISE.

REINFORCING STEEL:

1. REINFORCING STEEL SHALL BE GRADE 500W UNLESS OTHERWISE SPECIFIED.
2. UNLESS SHOWN OTHERWISE TENSION LAP SPLICES SHALL BE CLASS B.
3. BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL BARS.
4. STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE MINIMUM YIELD STRENGTH OF 500MPa UNLESS OTHERWISE SPECIFIED.
5. BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWINGS SS112-1 UNLESS INDICATED OTHERWISE.

CONSTRUCTION NOTES:

1. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
2. THE CONTRACTOR SHALL ENSURE THE STABILITY OF THE PRECAST SEGMENTS DURING CONSTRUCTION.
3. ROADWAY PROTECTION SYSTEMS SHALL BE DESIGNED FOR PERFORMANCE LEVEL 2.

LIST OF DRAWINGS:

LIST OF ABBREVIATIONS:

C.J.	DENOTES CONSTRCUTION JOINT
EL.	DENOTES ELEVATION
MIN.	DENOTES MINIMUM
MAX.	DENOTES MAXIMUM
N.T.S.	DENOTES NOT TO SCALE
SHLD.	DENOTES SHOUDER
STA.	DENOTES STATION
TYP.	DENOTES TYPICAL
WP	DENOTES WORKING POINT
HWL	DENOTES HIGH WATER LEVEL

APPLICABLE STANDARD DRAWINGS:

OPSD 803.010	BACKFILL AND COVER FOR CONCRETE CULVERTS
OPSD 3190.100	WALLS RETAINING, AND ABUTMENT WALL DRAIN
OPSD 3370.100	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD 3941.200	FIGURES IN CONCRETE, SITE NUMBER AND DATE LAYOUT
OPSD 3950.100	JOINTS CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN K.S.	CHK P.O.	CODE CSA S6-19	LOAD CL 625-ONT	DATE JAN. 2026
DRAWN W.K.	CHK K.S.	SITE 30X-0890/CO		DWG 1

CADD FILE NAME : 0566-01

THURBER

APPENDIX G

Seismic Hazard Values (2020 National Building Code of 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_D
Latitude (°)	44.118
Longitude (°)	-79.636

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

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	$PGA(X_D)$	$PGV(X_D)$
0.271	0.273	0.165	0.0795	0.0211	0.00664	0.154	0.173

The log-log interpolated 2%/50 year $S_a(4.0, X_D)$ value is : **0.0291**

▶ Tables for 5% and 10% in 50 year values

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06

THURBER

APPENDIX H

Comparison of Foundation Alternatives

COMPARISON OF ALTERNATIVE CULVERT TYPES

Concrete Box Culvert	Concrete Open Footing Culvert	Steel Pipe Culvert
Advantages: i. Relatively rapid installation and less disturbance to subgrade soils ii. Segmental option can accommodate limited amount of potential differential settlement along culvert axis. iii. Less requirement for soil geotechnical resistances as loading is spread over a larger width. iv. Can accommodate differential settlement. v. Shallower depth of excavation compared to open footing culvert. ***Disadvantages:*** i. Culvert subgrade preparation and bedding placement must be carried out in the dry. ii. Dewatering is required. iii. Requires subexcavation of soft or organic materials if encountered. iv. Temporary protection systems will be required.	***Advantages:*** i. Conventional construction. ii. Eliminates bedding requirement. iii. May have less environmental issues such as those involving spawning fish species. ***Disadvantages:*** i. Requires deeper excavation below the groundwater level. ii. Potentially longer and more extensive dewatering requirements. iii. Limited tolerance of differential settlement. iv. Temporary protection systems will be required.	***Advantages:*** i. May be installed using trenchless methods. ii. Steel pipes are likely to be more cost effective than concrete box or open footing culverts. iii. May require less co-ordination with staged construction. ***Disadvantages:*** i. Multiple pipes may be needed to meet hydraulic and hydrologic requirements. ii. Requires sufficient crown cover if installed using trenchless methods. iii. Culvert subgrade preparation and bedding placement must be carried out in the dry. iv. Dewatering is required. v. Requires subexcavation of soft or organic material if encountered. vi. Temporary protection systems will be required.
RECOMMENDED	**NOT RECOMMENDED**	**NOT RECOMMENDED**

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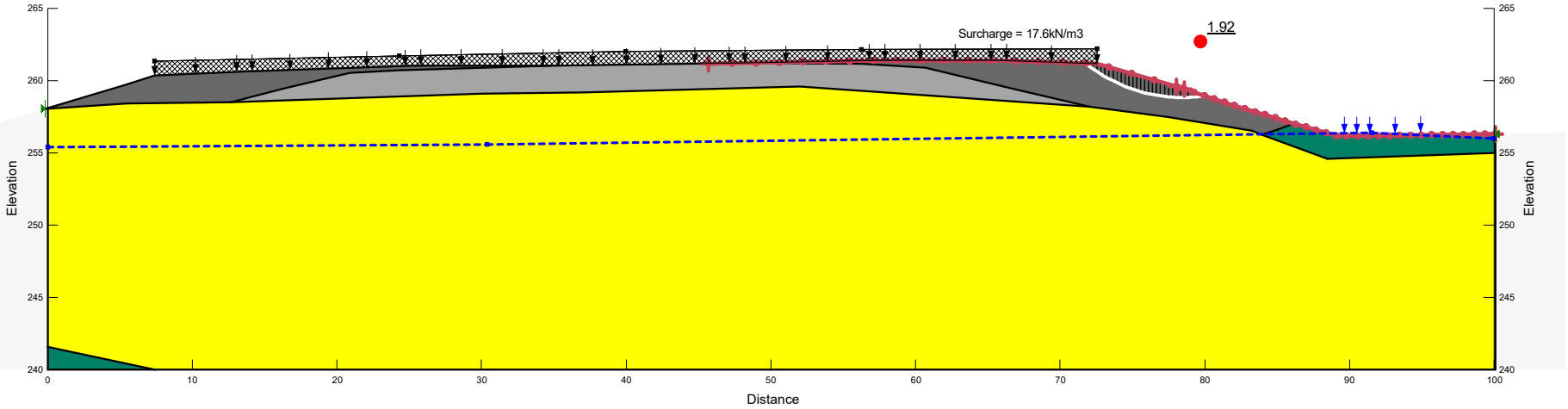
APPENDIX I

Stability Figures

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay (Undrained)	21	100	0
	Existing Fill	21	0	32
	New Fill	20	0	30
	Silty Sand Till	21	0	30



THURBER

48856 - Bradford Bypass West - Pennville Culvert
Site 30X-0566/C0

Analysis: SLOPE/W Analysis - East Undrained

Seismic Coefficient: H: g, V: g

Last Run: 12/05/2025, 12:55:25 PM

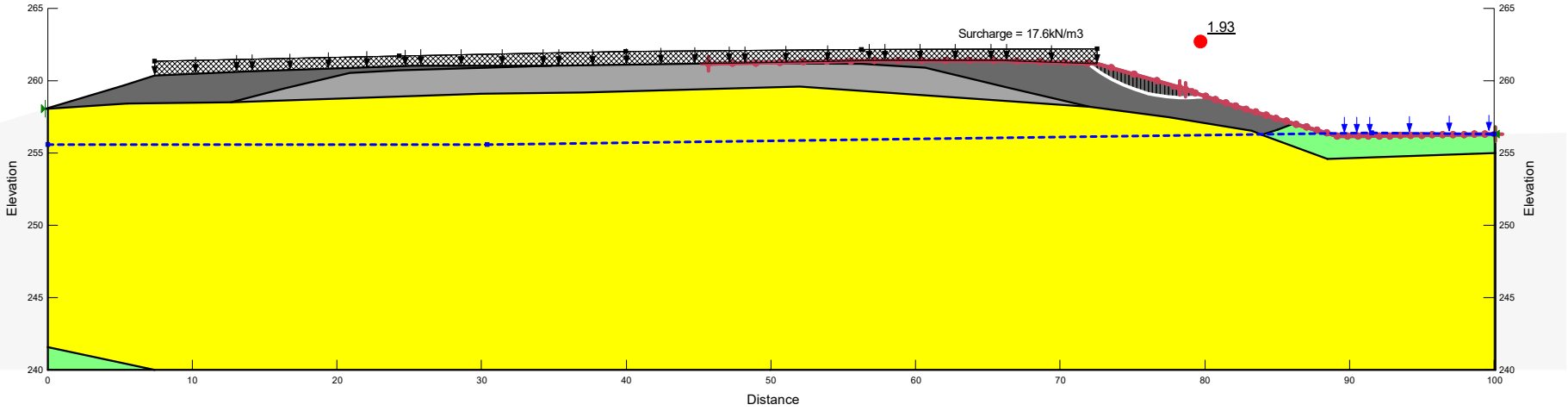
Scale: 1:450

Additional Details

Name: 2D Geometry
Comments:
Method: Morgenstern-Price, Half-Sine
Entry: (71.765153, 261.20341) m, Exit: (79.964246, 258.94855) m
Center: (78.436265, 269.42671) m, Radius: 10.588974 m

Figure I1

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay (Drained)	21	10	30
	Existing Fill	21	0	32
	New Fill	20	0	30
	Silty Sand Till	21	0	30



THURBER

48856 - Bradford Bypass West - Pennville Culvert
Site 30X-0566/C0

Analysis: SLOPE/W Analysis - East Drained

Seismic Coefficient: H: g, V: g

Last Run: 12/05/2025, 12:55:24 PM

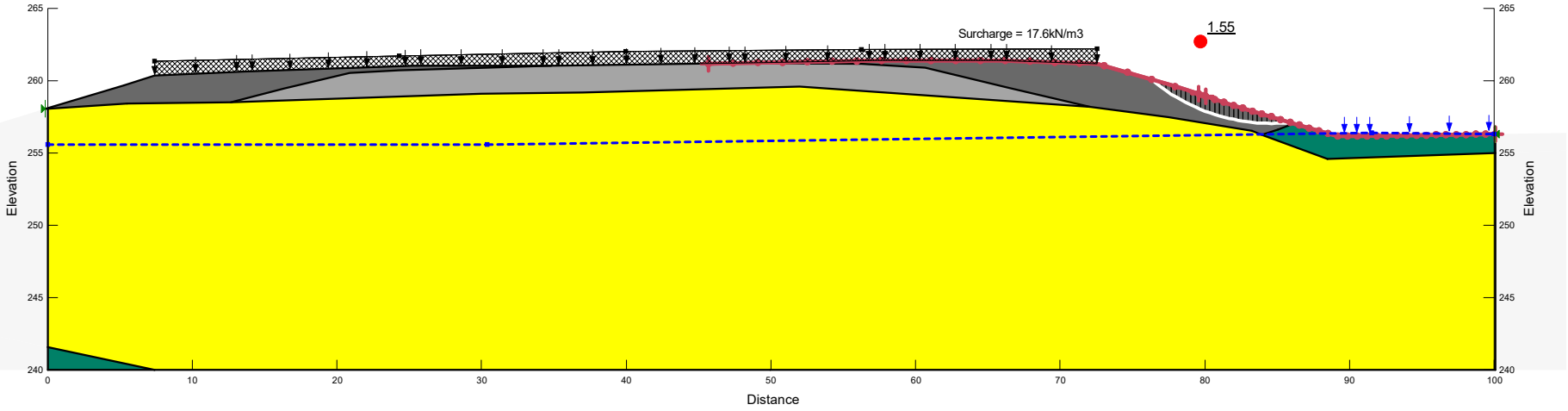
Scale: 1:450

Additional Details

Name: 2D Geometry
Comments:
Method: Morgenstern-Price, Half-Sine
Entry: (71.934439, 261.19801) m, Exit: (80.058483, 258.91774) m
Center: (78.612559, 269.3784) m, Radius: 10.560121 m

Figure I2

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay (Undrained)	21	100	0
	Existing Fill	21	0	32
	New Fill	20	0	30
	Silty Sand Till	21	0	30



THURBER

48856 - Bradford Bypass West - Pennville Culvert
Site 30X-0566/C0

Analysis: SLOPE/W Analysis - East Seismic

Seismic Coefficient: H: 0.077g, V: g

Last Run: 12/05/2025, 12:55:26 PM

Scale: 1:450

Additional Details

Name: 2D Geometry
Comments:
Method: Morgenstern-Price, Half-Sine
Entry: (76.309665, 260.08342) m, Exit: (85.910266, 257.11142) m
Center: (84.624017, 269.94906) m, Radius: 12.901912 m

Figure I3

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APPENDIX J

List of OPSS Documents and NSSP Wordings

1. List of OPSS and OPSD Referenced in this Report

- OPSS PROV 206 — Construction specification for grading
- OPSS PROV 422 — Construction Specification for Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut
- OPSS PROV 501 — Construction Specification for Compacting
- OPSS.PROV 517 — Construction Specification for Dewatering
- SP 517F01 — Amendment to OPSS 517
- OPSS PROV 539 — Construction Specification for Temporary Protection Systems
- OPSS PROV 804 — Construction Specification for Temporary Erosion Control
- OPSS PROV 902 — Construction Specification for Excavating and backfilling – Structures
- NSSP FOUN0003 — Amendment to OPSS.PROV 902
- OPSS PROV 1004 — Material Specification for Aggregates – Miscellaneous
- OPSS PROV 1005 — Material Specification for Aggregates – Waterbody
- OPSS PROV 1010 — Material Specification for Aggregates - base, subbase, select subgrade, and backfill material
- OPSS PROV 1205 — Material Specification for Clay
- OPSD 803.010 — Backfill and Cover for Concrete Culverts with Spans less than or equal to 3.0 m.
- OPSD 208.010 — Benching of Earth Slope
- OPSS PROV 401 — Construction specification for Trenching, Backfilling, and Compacting
- OPSS PROV 912 — Construction specifications for precast concrete culverts with spend greater than 3.0 m.
- OPSD 3101.150 — Walls, Abutment, Backfill, Minimum Granular Requirement

2. Suggested Text for NSSP on Groundwater Control

High groundwater levels and permeable soils are present at this site. Therefore, water inflow/seepage should be anticipated from the embankment fill and underlying native sands and silts, and surface runoff and precipitation will accumulate within the excavation. Excavation into the wet cohesionless soils below the water level will encounter sloughing of unsupported excavation sidewalls, caving and subgrade loosening/softening. 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 during structure excavation, bedding placement and backfilling to allow the work to proceed in the dry. A combination of interlocking sheetpiles along the culvert alignment where required, cofferdam enclosures at the inlet and outlet areas, surface water diversion, vacuum well-points where required, and pumping from filtered sumps may be warranted. The dewatering system must be effective to maintain the water level at a minimum depth of 0.5 m below the final subgrade level throughout construction. The dewatering system must remain operational and effective until the culvert is installed and backfilled.

It is recommended that a Professional Engineer with more than 5 years of experience in designing dewatering systems be retained to design and implement a dewatering system.

3. Suggested Wording for NSSP on Obstructions

Excavations and installation of cofferdams and roadway protection systems could encounter obstructions embedded in the fill and native soils. Such obstructions may impede excavation progress and/or sheet pile installation. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions to achieve the design depths.