



Foundation Investigation Report

Terrace Bay Rest Stop

Washroom Facilities

Township of Trey

Station 15+957 to Station 15+969

Station 15+963, o/s 73.8 m, Lat: 48.792472, Lon: -87.088456

District of Thunder Bay

Highway 17

GWP 60017-20-00

GEOCRES No. 42D-70

Prepared for:

Ontario Ministry of Transportation NWR

615 James Street South

Thunder Bay, ON

P7E 6P6

Prepared By:

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December 2, 2022

TBTE Ref. No. 20-656-13

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Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ontario Ministry of Transportation Northwest Region (MTO) to provide foundation investigation and design services under the Northwest Region (NWR) Geotechnical Retainer Assignment. This assignment covers the proposed Terrace Bay Rest Area along Highway 17. This report provides factual information and the results of the investigation for the proposed Washroom Facilities.

The site is located along Highway 17 between Mill Road South and an unnamed side road northeast of Terrace Bay. The site coordinates are as follows:

- Station 15+963, o/s 73.8 m, Lat: 48.792472, Lon: -87.088456

A Google Earth image illustrating the site location can be seen in Figure 1.1.

This foundation investigation was carried out to investigate subsurface conditions for the proposed washroom facilities, which consisted of four boreholes. Multiple other boreholes were advanced on site for a Geotechnical Investigation and Factual Memorandum. Results of those investigations are covered under a separate report.

All initial borehole locations were determined through consultation with MTO, while final borehole locations were adjusted to suit field conditions. This report (Part A) describes the subsurface conditions encountered during the investigation for the washroom facilities.

The MTO Foundations Section has assigned GEOCREs No. 42D-70 to this site.



Figure 1.1: A Google Earth Image Illustrating the Site Location.

2 Site Description

The site is located southwest of Highway 17. The site was previously densely vegetated but was completely cleared prior to the field investigation. The terrain is generally flat.

2.1 Surficial Geology

As defined by the Ontario Ministry of Natural Resources' Northern Ontario Engineering Geology Terrain Study (NOEGTS), 1979, Map No. 5092 "Schreiber", the site is in an area of a glaciolacustrine delta which consists primarily of thick deposits of fine to medium sands overlying deep silts and clays, with bedrock at depths often greater than 30 m. Gravels are the secondary material encountered in the area.

The terrain is flat (plain), with low local relief and is generally dry. The surface sand materials should be suitable for re-use and shallow excavations should encounter minimal problems.

Presence of sand and some gravels are confirmed from the field investigation.

3 Investigation Procedures

A geotechnical site investigation was undertaken from October 3 to October 5, 2022. The field investigation consisted of advancing four boreholes to a depth of 6.6 m for the washroom facilities. Multiple other boreholes were advanced for a Geotechnical Investigation and Factual Memorandum. Initial borehole locations were established through consultation with MTO, while final borehole locations were adjusted to suit field conditions. Borehole locations are illustrated on the Borehole Location and Soil Strata Drawings provided in Appendix C.

The borehole locations were identified in the field by TBTE personnel and service clearances were completed prior to mobilizing the drill rig to site. The boreholes were advanced using a drill rig mounted on an all terrain carrier equipped with hollow stem augers and an apparatus to carry out Standard Penetration Testing. During the drilling operations for the boreholes, soil samples were obtained by using the techniques of the Standard Penetration Test (SPT). SPTs are typically taken at a frequency of every 0.75 m for the first 3 m of the borehole, and every 1.5 m afterwards, to the termination depth of the borehole. Sample frequency may vary due to circumstances experienced in the field.

Borehole locations and elevations are taken from the Site Plan and cross section drawings provided by the MTO. A hand-held GPS device was used in the field to locate borehole locations. A summary of the borehole location data is provided in the table below, and on the enclosed Borehole Location and Soil Strata drawings in Appendix C.

Table 3.1: Summary of Borehole Information.

Borehole Number	Station	Offset (m)	Co-ordinates	Surface Elevation (m)	Depth of Exploration (m)
22-BH-19	15+957	68.2	Lat: 48.792453112 Lon: -87.088595315	275.9	6.6
22-BH-20	15+959	78.3	Lat: 48.792429025 Lon: -87.088458908	275.9	6.6
22-BH-21	15+969	71.2	Lat: 48.792531726 Lon: -87.088484774	276.4	6.6
22-BH-22	15+969	79.3	Lat: 48.792496817 Lon: -87.088387773	276.3	6.6
22-BH-16*	15+944	76.5	Lat: 48.792313102 Lon: -87.088582797	275.7	3.0
22-BH-52*	16+218	85.1	Lat: 48.794443962 Lon: -87.086690346	277.2	3.0

* Not advanced for Washroom Facility Investigation. Used for water level information only.

Temporary standpipe piezometers were installed at Boreholes 22-BH-16 and 22-BH-52 (advanced for Geotechnical Investigation and Factual Memorandum) to depths of 2.9 m. Data from these boreholes have been provided in Appendix D in the standard form used for a Geotechnical Investigation and Factual Memorandum.

All boreholes (including temporary standpipe piezometers), have been backfilled and/or decommissioned with auger cuttings and bentonite in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the water well regulation under the Ontario Water Resources Act).

4 Laboratory Testing

Soil samples obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content and grain size analysis. Typically, 100% of the recovered soil samples are tested for natural moisture content determination, and 25% of the recovered soil samples are chosen for grain size analysis and/or Atterberg limits testing, as applicable. The following test methods/standards are followed for the above testing: LS 602, LS 701, ASTM C136, ASTM D4318, ASTM D2216. The results of this testing are shown on the borehole logs (Appendix A) and on the laboratory data reports (Appendix B).

5 Subsurface Conditions

Details of the subsurface conditions are provided on the borehole logs in Appendix A and on the Borehole Location and Soil Strata Drawings in Appendix C.

The generalized subsurface soils at this site consist of sand with various mixtures of silt and gravel to the termination of the boreholes.

5.1 Sand

The material ranged from sand with a trace of gravel and some silt to sand with a trace of silt. This material was encountered at the surface of all four boreholes and extended to a depth of 5.6 m (elevation 232.5 m to 234.0 m). The results of seven grain size analyses indicate the sand consists of 0-5% gravel, 88-96% sand and 2-10% silt/clay sized particles. This material is in a loose to compact condition based on SPT N-values ranging from 4 to 22 blows per 0.3 m. At Borehole 22-BH-20 at a depth of 1.5 m, one N-value of 2 blows per 0.3 m was recorded, indicating a very loose condition.

5.2 Silt and Sand

Silt and sand was encountered below the sand at all four boreholes at a depth of 5.6 m (elevation 232.5 m to 234.0 m) and extended to the limits of the boreholes at 6.6 m (elevation 231.5 m to 233.0 m). The results of one grain size analysis indicate the silt and sand consists of 0% gravel, 40% sand and 60% silt/clay sized particles. This material is in a compact condition based on SPT N-values ranging from 17 to 21 blows per 0.3 m.

5.3 Groundwater

Standpipe piezometers were installed at Boreholes 22-BH-16 and 22-BH-52 (advanced for Geotechnical Investigation and Factual Memorandum) to depths of 2.9 m. The groundwater levels were read 36 hours after completion of drilling within the standpipe piezometers.

Observed groundwater levels have been provided below. Groundwater levels may vary from season to season and from the effects of heavy precipitation events.

Table 5.1: Observed Groundwater Levels.

Borehole	Surface Elevation (m)	Groundwater Level, 36 hrs after completion, Depth (m)
22-BH-16	275.7	Dry
22-BH-52	277.2	Dry

6 Miscellaneous

Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The drill equipment for this investigation was operated by TBT Engineering Limited. The field operations were supervised by Glen Hephner. Laboratory testing was supervised by Forch Valela, C.Tech. This report was prepared and reviewed by Steven Anderson, P.Eng. and Steven Seller, P.Eng. (TBTE's designated principal contact identified for MTO Foundation Engineering).

7 Limitations

Conclusions presented in this report are based on the information determined at a limited number of borehole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of the dewatering procedures which may be considered during construction cannot readily be determined from site investigation or boreholes. These conditions include local and seasonal fluctuations of the groundwater level, changes in soil conditions between borehole locations, thin and/or discontinuous layers of highly permeable soils, etc.

In no way does the information contained within this report reflect any environmental aspect of the site or soil.

8 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate to contact us at your convenience.

Yours truly,
For TBT ENGINEERING



Steven Anderson, P.Eng.
Project Engineer



Steven Seller, P.Eng.
Senior Engineer
Principal Contact for MTO Foundations

APPENDIX A

Borehole Logs

EXPLANATION OF TERMS

N-Value: The Standard Penetration Test (SPT) N-value is the number of blows required to cause a standard 51 mm O.D. split barrel sampler to penetrate 0.3 m into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kg, falling freely a distance of 0.76 m. For penetrations of less than 0.3 m N-values are indicated as the number of blows for the penetration achieved. Average N-value is denoted thus \bar{N} .

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51 mm O.D. 60° cone angle) driven by 475 J impact energy on 'A' size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3 m advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency/condition.

Consistency: Cohesive soils are described on the basis of their undrained shear strength (c_u) as follows:

C_u (kPa)	0-12	12-25	25-50	50-100	100-200	>200
	Very Soft	Soft	Firm	Stiff	Very Stiff	Hard

Condition: Cohesionless soils are described on the basis of denseness as indicated by SPT N-values as follows:

N (Blows/0.3 m)	0-4	4-10	10-30	30-50	>50
	Very Loose	Loose	Compact	Dense	Very Dense

Minor Soil Components: Terminology used to represent the amount of minor components based on their percent of the sample by weight as follows:

% by weight	0-10	10-20	20-35	35-50
	Trace	Some	"ey" or "y"	And

ABBREVIATIONS AND SYMBOLS

Field Sampling, Insitu Testing, Laboratory Testing

S S	Split Spoon	T P	Thin Wall Piston
A S	Auger	O S	Osterberg
W S	Wash	R C	Rock Core
S T	Slotted Tube	P H	T W Advanced Hydraulically
B S	Block	P M	T W Advanced Manually
C S	Chunk	F S	Foil
VT	Vane Test (kPa)	P P	Pocket Penetrometer (kg/cm ²)
T W	Thin Wall Shelby Tube		

EXPLANATION OF TERMS Cont'd.

Stress and Strain

u_w	kPa	Pore Water Pressure
u		Pore Pressure Ratio
σ	kPa	Total Normal Stress
σ'	kPa	Effective Normal Stress
τ	kPa	Shear Stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal Stress
ϵ	%	Linear Strain
$\epsilon_1, \epsilon_2, \epsilon_3$	%	Principal Strains
E	MPa	Young's Modulus
G	kPa	Modulus of Shear Deformation
m	MPa	Constrained Modulus
μ		Coefficient of Friction

Mechanical Properties of Soil

m_v	kPa ⁻¹	Coefficient of Volume Change
C_c		Compression Index
C_s		Swelling Index
C_a		Rate of Secondary Consolidation
c_v	m ² /s	Coefficient of Consolidation
H	m	Drainage Path
T_v		Time Factor
U	%	Degree of Consolidation
P'_o	kPa	Effective Overburden Pressure
P'_c	kPa	Preconsolidation Pressure
τ_f	kPa	Shear Strength
c'	kPa	Effective Cohesion Intercept
ϕ'	°	Effective Angle of Internal Friction
c_u	kPa	Undrained Shear Strength
s		Sensitivity

Physical Properties of Soil

ρ_s	kg/m ³	Density of Solid Particles	e	%	Void Ratio	e_{min}	%	Void Ratio in Densest State
γ_s	kN/m ³	Unit Weight of Solid Particles	n	%	Porosity	I_D		Density Index $= \frac{e_{max}-e}{e_{max}-e_{min}}$
ρ_w	kg/m ³	Density of Water	w	%	Water Content	D	mm	Grain Diameter
γ_w	kN/m ³	Unit Weight of Water	s_r	%	Degree of Saturation	D_n	mm	n Percent Diameter
ρ	kg/m ³	Density of Soil	w_L	%	Liquid Limit	C_u		Uniformity Coefficient
γ	kN/m ³	Unit Weight of Soil	w_p	%	Plastic Limit	h	m	Hydraulic Head or Potential
ρ_d	kg/m ³	Density of Dry Soil	w_s	%	Shrinkage Limit	q	m ³ /s	Rate of Discharge
γ_d	kN/m ³	Unit Weight of Dry Soil	I_p	%	Plasticity Index = $w_L - w_p$	v	m/s	Discharge Velocity
ρ_{sat}	kg/m ³	Density of Saturated Soil	I_L		Liquidity Index = $\frac{w-w_p}{I_p}$	i		Hydraulic Gradient
γ_{sat}	kN/m ³	Unit Weight of Saturated Soil	I_c		Consistency Index = $\frac{w_L-w}{I_p}$	k	m/s	Hydraulic Conductivity
ρ'	kg/m ³	Density of Submerged Soil	e_{max}	%	Void Ratio in Loosest State	j	kN/m ³	Seepage Force
γ'	kN/m ³	Unit Weight of Submerged Soil						

RECORD OF BOREHOLE No 22-BH-019

1 OF 1

METRIC

G.W.P. 60017-20-00 LOCATION Station 15+957 o/s 68.2 Lt of C/L N:5406009.946; E:298291.081 MTM Zone:14 ORIGINATED BY L.D.
 DIST NWR HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.G.
 DATUM Geodetic DATE 2022.10.03 - 2022.10.03 LATITUDE 48.792453112 LONGITUDE -87.088595315 CHECKED BY S.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L				GR	SA	SI	CL														
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)																									
275.9 0.0	SAND - trace organics to 1.4 m, trace silt, trace gravel, brown, loose to compact ----- - brown/grey		1	AS			275																											
			2	SS	6																													
			3	SS	4																													
			4	SS	17																													
	5	SS	22																															

ONTARIO MTO MOD GWP 20-656-13 MTO TERRACE BAY REST STOP.GPJ ONTARIO MTO.GDT 22-11-4

METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

RECORD OF BOREHOLE No 22-BH-021

1 OF 1

METRIC

G.W.P. 60017-20-00 LOCATION Station 15+969 o/s 71.2 Rt of C/L N:5406018.678; E:298299.212 MTM Zone:14 ORIGINATED BY L.D.
 DIST NWR HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.G.
 DATUM Geodetic DATE 2022.10.03 - 2022.10.03 LATITUDE 48.792531726 LONGITUDE -87.088484774 CHECKED BY S.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W					
276.4 0.0	SAND - trace organics to 0.7 m, trace silt, trace gravel, brown, loose		1	AS															
			2	SS	4														
			3	SS	6														
			4	SS	15														
	----- - brown/grey, compact																		
</																			

ONTARIO MTO MOD GWP 20-656-13 MTO TERRACE BAY REST STOP.GPJ ONTARIO MTO.GDT 22-11-4

RECORD OF BOREHOLE No 22-BH-022

1 OF 1

METRIC

G.W.P. 60017-20-00 LOCATION Station 15+969 o/s 79.3 Rt of C/L N:5406014.788; E:298306.334 MTM Zone:14 ORIGINATED BY L.D.
 DIST NWR HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.G.
 DATUM Geodetic DATE 2022.10.03 - 2022.10.03 LATITUDE 48.79496817 LONGITUDE -87.088387773 CHECKED BY S.S.

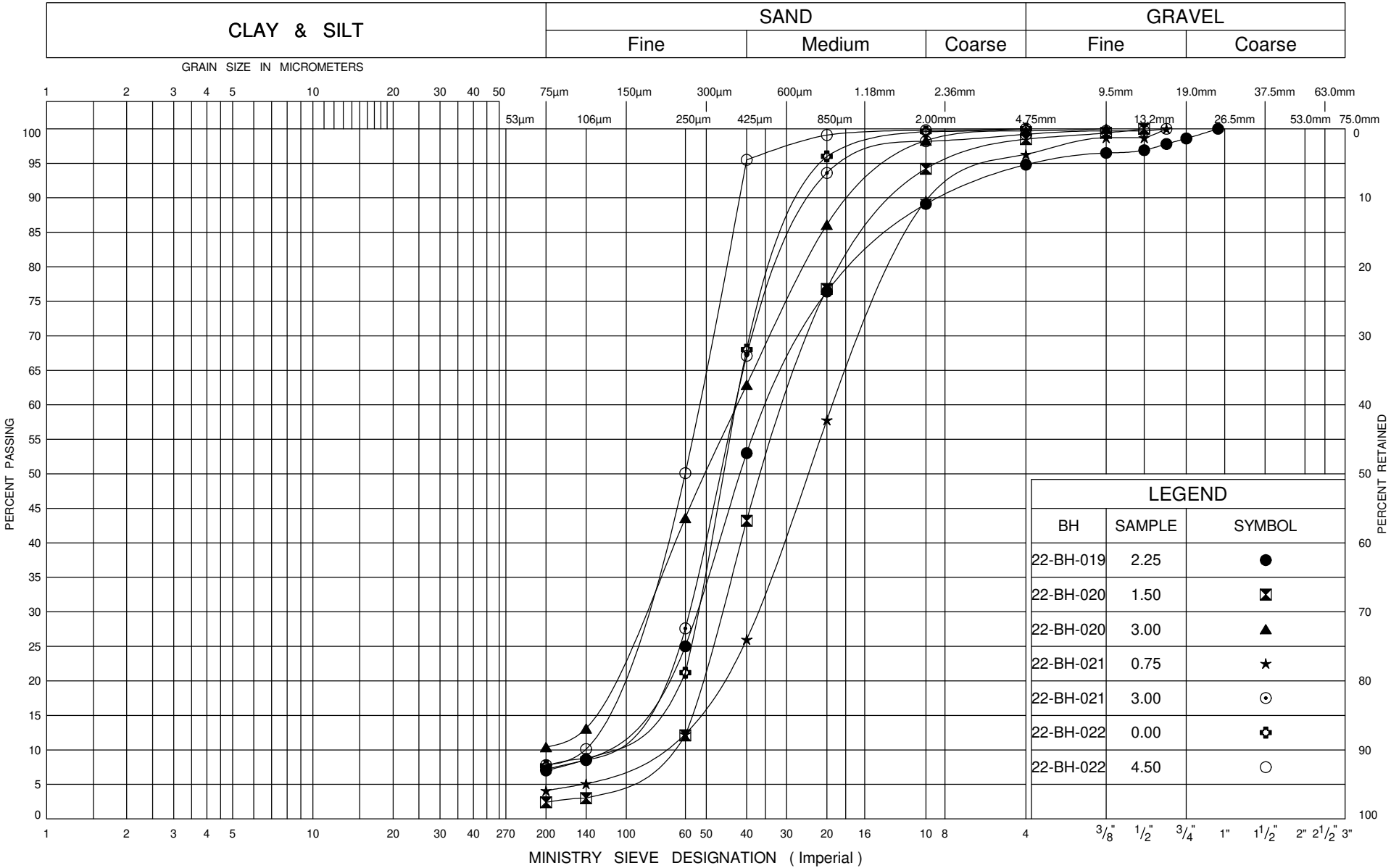
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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276.3 0.0	SAND - trace organics to 0.5 m, trace silt, trace gravel, brown, loose to compact ----- - brown/grey		1	AS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

ONTARIO MTO MOD GWP 20-656-13 MTO TERRACE BAY REST STOP.GPJ ONTARIO MTO.GDT 22-11-4

APPENDIX B

Laboratory Test Data

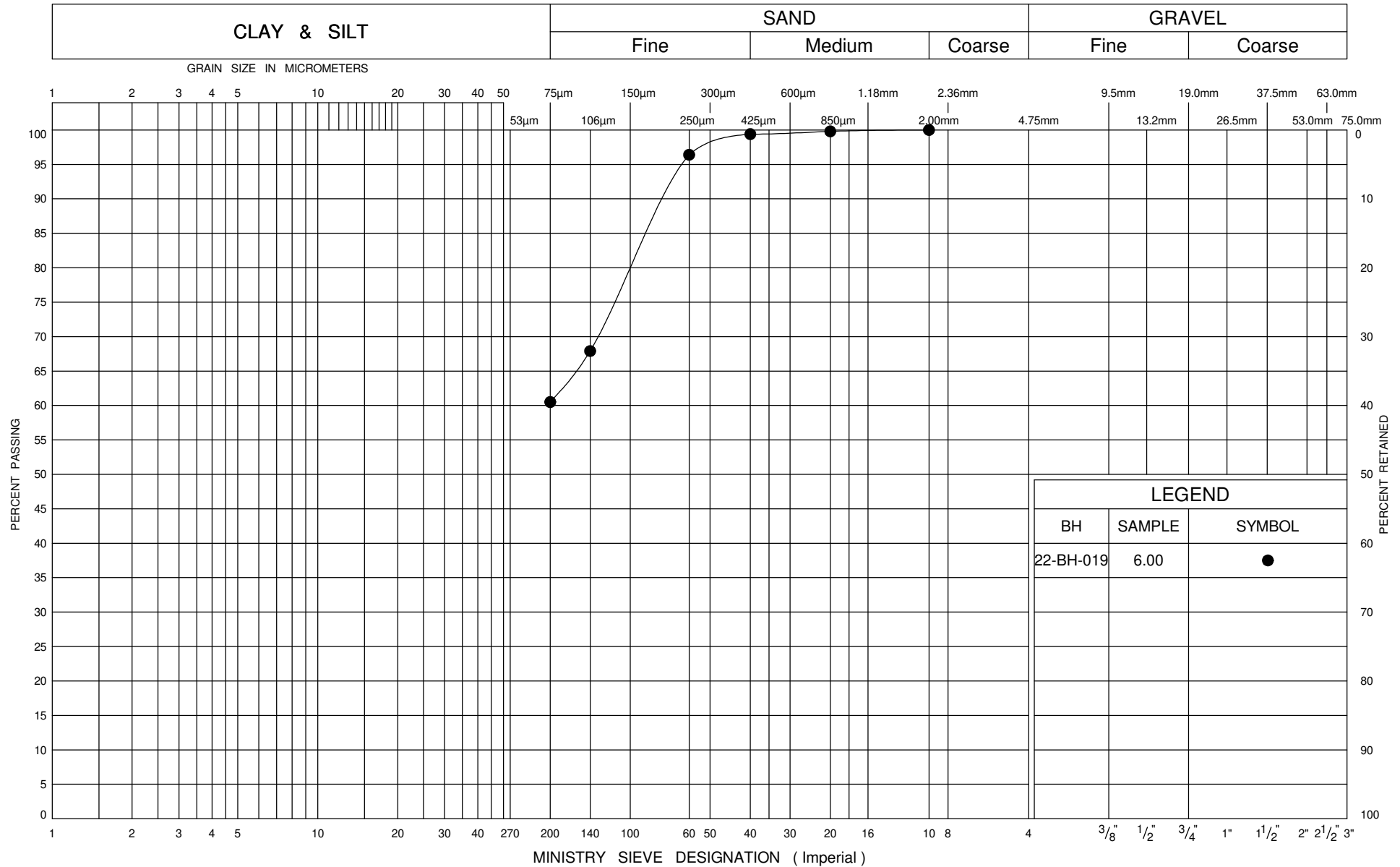
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SAND

FIG No 1
W P 60017-20-00
Terrace Bay Rest Stop

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SILT & SAND

FIG No 2

W P 60017-20-00

Terrace Bay Rest Stop

APPENDIX C
Borehole Location and Soil Strata Drawings

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

Ontario

Ministry of Transportation

GEOCRES

CONT

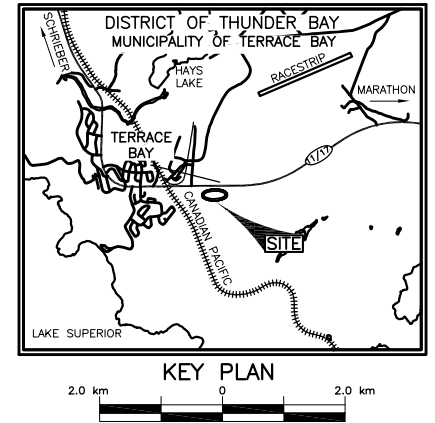
GWP

60017-20-00

BOREHOLE LOCATIONS
AND SOIL STRATA
TERRACE BAY REST STOP

SHEET
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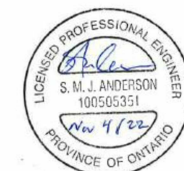
TBT ENGINEERING
CONSULTING GROUP



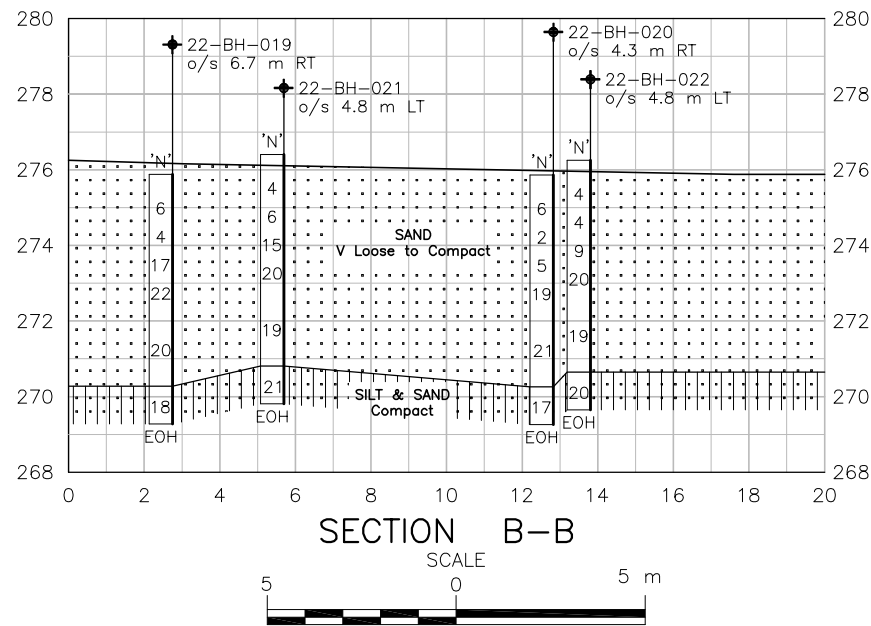
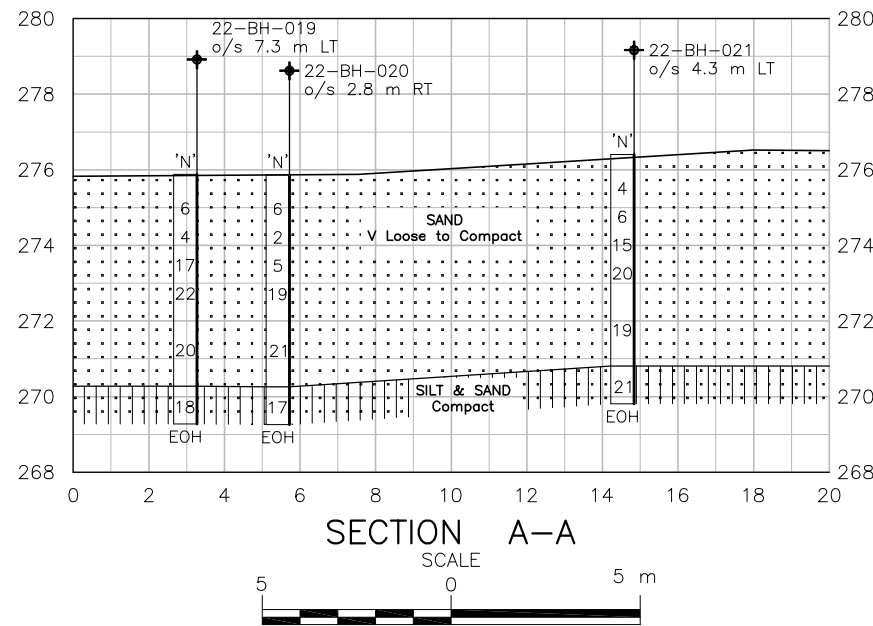
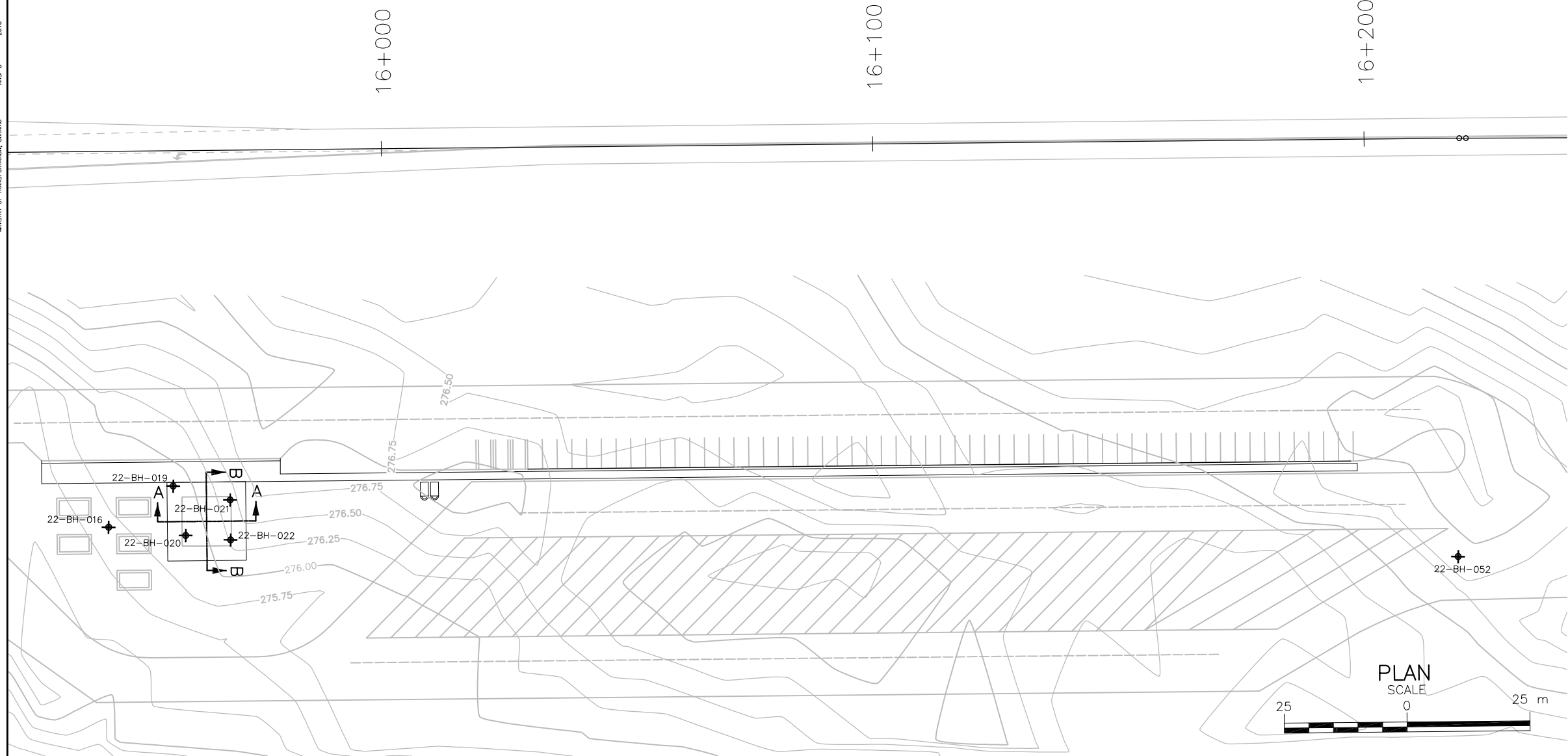
SOIL STRATA SYMBOLS	
	SAND
	SILT & SAND

LEGEND			
	Borehole		
'N'	Std Pen Test (Blows/0.3m)		
EOH	End Of Hole		
No	ELEVATION	CO-ORDINATES (MTM)	
		NORTH	EAST
22-BH-019	275.9	14 5 406 010	298 291
22-BH-020	275.9	14 5 406 007	298 301
22-BH-021	276.4	14 5 406 019	298 299
22-BH-022	276.3	14 5 406 015	298 306
22-BH-016	275.7	14 5 405 994	298 292
22-BH-052	277.2	14 5 406 231	298 431

—NOTE—
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.



REVISIONS		ISSUED FOR FINAL	
1	SS	ISSUED FOR DRAFT	
0	SS		
DESIGN	CHK	SS	CODE
DRAWN	TG	CHK	SITE
		LOAD	DATE 02/12/22
		DWG	1



APPENDIX D
Borehole Data from Geotechnical Investigation
and Factual Memorandum

TERRACE BAY REST STOP
STREY TOWNSHIP

Station 15+944 76.5 Rt

22-BH-016

MTM14 5405994 N 298292 E

Lat 48.7923° Lon -87.0886°

0	-	100	Br F-Med Sa W Si Tr Org (Moist)
100	-	900	Br F-Med Sa Tr Si (Moist)
900	-	3.0	Br F-Med Sa Tr Gr & Si (Moist)
		3.0	EOH

Station 15+944 76.5 Rt

22-BH-016

Sample No. 22-LD-0112 (700 – 900)

% Passing 4.75 mm 99.9 %

% Passing 75 um 3.1 %

FMC @ 900 7.2 %

Group Symbol SP

NAGM Gran 'B' Type III – Due to fineness of gradation

AGM Gran 'B' Type I

Station 16+218 84.2 Rt

22-BH-052

MTM14 5406231 N 298430 E

Lat 48.7944° Lon -87.0867°

0	-	50	Br F-Med Sa Tr Gr & Org (Moist)
50	-	1.5	Br F-Med Sa Tr Si (Moist)
1.5	-	3.0	Br F-Med Sa W Si (Moist)
		3.0	EOH

Station 16+218 84.2 Rt

22-BH-052

Sample No. 22-LD-0148 (1.2 – 1.4)

% Passing 4.75 mm 99.4 %

% Passing 75 um 4.2 %

FMC @ 1.4 4.2 %

Group Symbol SP

NAGM Gran 'B' Type III – Due to fineness of gradation

AGM Gran 'B' Type I

Station 16+218 84.2 Rt

22-BH-052

Sample No. 22-LD-0149 (2.6 – 2.9)

% Passing 4.75 mm 99.9 %

% Passing 75 um 11.3 %

FMC @ 2.9 6.6 %

Group Symbol SP-SM

NAGM Gran 'B' Type III – Due to fineness of gradation

BLAGM Gran 'B' Type I – Due to excess fines