Geotechnical Investigation Commissioners Transfer Station - MRF Building Rehabilitation 400 Commissioners Street Toronto, Ontario

Client
City of Toronto

Project Number
BRM-22028009-A0

Prepared By:
EXP Services Inc.
1595 Clark Blvd.
BRAMPTON, ON

January 23, 2023
Revised February 27, 2023

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1. Introduction

As requested, EXP Services Inc. (EXP) performed a geotechnical investigation for the Commissioners Transfer Station - MRF Building Rehabilitation, located at 400 Commissioners Street in Toronto, Ontario. The existing structure comprises a concrete and block structure.

It is understood that the existing loading dock and parts of the approach ramp will be removed (to accommodate the proposed grade beams) and replaced with a new roof, and a partial slab-on-grade. The replacement structure will likely be founded on pile foundations bearing on sound bedrock.

The purpose of this investigation was to determine the general subsoil and groundwater conditions at the site by putting down two (2) boreholes and based on an assessment of the factual borehole data provide an engineering report containing geotechnical recommendations pertinent to the proposed construction.

Specifically, recommendations and/or comments regarding foundation types, pile capacities, geotechnical resistances, groundwater conditions, excavation and backfill, seismic site classification, and pavement construction are provided.

The comments and recommendations given in this report assume that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or the requirement of additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2. Site Description

The existing Material Recovery Facility building is located near the northeastern corner of the property at 400 Commissioners Street in downtown Toronto. The property lies on the northern side of Commissioners Street and is bounded to the north by McCleary Park, to the west by Bouchette Street, and the east by Logan Avenue.

A site location plan is presented as Drawing 1 in Appendix B. The area of the rehabilitation is adjacent to the south side of the existing building.

3. Procedure

The fieldwork was undertaken on January 11, 2023. At that time two boreholes were advanced by a specialist drilling subcontractor to depths of 15.26 m and 15.29 m below surface levels using continuous flight augers and mud rotary methods. Samples were retrieved at regular intervals with a split barrel sampler driven in accordance with the standard penetration test procedure.

Water level observations were made in the open boreholes during and at the completion of the drilling operations. A standpipe piezometer was installed in Borehole 02 to allow for long term water level measurements.

The fieldwork was supervised on a full-time basis by a field technician from EXP engineering staff who directed the drilling and sampling operation, logged borehole data, and retrieved soil samples for subsequent examination and testing.

In the laboratory, all samples were examined by the project engineer and then tested for moisture content and natural unit weight. Two samples of the soils were subjected to grain size analyses and to plasticity index tests (Atterberg Limits). The results of the moisture content tests are presented on the borehole logs, Drawings 2 and 3; grain size analyses and Atterberg Limits tests results are shown in Appendix B.

4. Subsurface Conditions

The borehole locations are shown on Drawing 1 and detailed subsurface conditions are presented on the borehole logs, Drawings 2 and 3. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

The "Notes on Sample Descriptions" preceding the borehole logs form an integral part and should be read in conjunction with this report.

Beneath pavement structure the site is underlain by hydraulically placed fill and then organic sandy silt to clayey silt directly over limestone and shale bedrock. The following is a brief description of the subsurface conditions encountered during the investigation.

4.1. Subsoils

4.1.1 Pavement or Surface Structure

The surface slab at Borehole 01 was found to be about 230 mm thick over 0.5 m of granular fill. The existing pavement structure at Borehole 02 comprised of 170 mm asphaltic concrete and approximately 0.5 m of pavement granular fill. The pavement granular fill consisted of silty sand and gravel with rounded to sub-rounded stone fragments.

Laboratory testing performed on the granular fill samples consisted of moisture content testing. The test results are as follows:

Moisture content:

- 4.1% to 5.1% of dry mass.

4.1.2 Fill

Beneath the granular road base in the boreholes, a layer of hydraulically placed fill was encountered, extending to depths of about 10.7 m to 11.0 m. The fill layer comprised mostly brown silt and sand with peaty interlayers and seams.

SPT “N” values of zero to 17 blows per 300 mm were obtained in the fill.

Laboratory testing performed on selected samples consisted of moisture content determinations, Atterberg Limits tests and a grain size analyses. The test results are as follows:

Moisture content:

- 3.1% to 115% of dry mass.

Atterberg limits:

- Liquid Limit: 46 to 85 % of dry mass.
- Plasticity Index: 17 to 21

Grain Size Analysis:

- Sand: 5 to 72%
- Silt: 27 to 79%
- Clay: 1.1 to 19.8%

4.1.3 Sandy Silt

A layer of sandy silt was encountered directly below the upper fill at depth of about 10.7 m to 11.0 m below ground level extending to a depth of 14.3 m to 14.5 m below ground level in the boreholes. This layer was generally grey.

SPT “N” values of 9 to 23 blows per 300 mm were obtained indicating loose to compact conditions.

Laboratory testing performed on selected samples consisted of moisture content determinations along with a grain size analysis. The test results are as follows:

Moisture content:

- 12% to 25% of dry mass.

Grain Size Analysis:

- Sand: 84%
- Silt: 15%
- Clay: 1%

4.1.4 Bedrock

Bedrock was encountered in both boreholes at about 14.3 and 14.5 m depth. The rock was identified by small fragments obtained in the SPT tests; no rock coring was performed. Based on our projects in the general area, the bedrock beneath the site comprises shale of the Georgian Bay Formation. This unit is Upper Ordovician and generally comprises interbedded grey-green to dark grey shale and fossiliferous calcareous siltstone to limestone. Upper levels of the bedrock are generally weathered to highly weathered. The weathered zone could extend to 1 to 2 m or deeper.

4.2. Groundwater Conditions

Groundwater levels were observed in the exploratory boreholes and in one observation well during the investigation and after completion of the boreholes.

A summary of the groundwater levels observed during and after the investigations is presented on the attached Record of Borehole Sheets. Nine days after the boreholes were drilled, groundwater was recorded at 3.3 m depth.

These data were reviewed and EXP’s interpretation of them is discussed in the design section of the report. It should be noted that fluctuations in the level of the groundwater may occur due to seasonal variations, (precipitation, snowmelt, rainfall, tides), local soil permeability, construction/remediation activities, and other factors not evident at the time of measurement.'

5. Discussion and Recommendations

5.1. General

The existing structure comprises a concrete structure believed to be supported on pile foundations driven to bedrock at depths of 14.3 m to 14.5 m in this investigation, but maybe as shallow as 13.5 m below existing grade based on earlier investigation in the area. As-built drawings of the facility were not available at the time of this investigation.

5.2. Foundations

Until the rehabilitation design is completed, we can only provide general comments and recommendations.

Several foundation options for support of the new structure were analysed in this report including spread footings and driven piles. Because of the presence of very loose fill layers, the use of spread footings to support the new structures is not recommended as this type of foundation would be susceptible to unacceptable total (and differential) settlement.

The subsoil conditions are suitable for structures founded on deep foundations subject to the implementation of the specific development recommendations provided in the following sections.

Water level readings were made in the exploratory borings and observation wells at the times and under the conditions stated. The ground water level was recorded in a standpipe piezometer in Borehole 02 at a depth of 3.3 m nine days after installation of the well.

5.2.1 Deep Foundations

EXP recommends the use of concrete filled steel pipe piles. For driven piles in vibration-sensitive environments, vibration monitoring should be carried out by a qualified vibration monitoring consultant.

5.2.2 Geotechnical Axial Resistance in Compression and Uplift Capacity

Table 1 below provides the estimated tip elevation and recommended geotechnical axial resistances of concrete-filled driven steel pipe piles. The pipe piles should have minimum yield strength of 400 MPa (60ksi) and filled with minimum 30 MPa concrete after driving.

The design parameters given in Table 1 are suggested for the purpose of the CHBDC/CSA S6.06. The table also provides the recommended pile tip elevations for estimating the pile lengths. The piles are estimated to reach practical set at about 1m below surface of bedrock. In areas where the surface of the rock is highly weathered to more than 1 m depth, the pile tip elevations could be lowered than indicated.

Table 1. Summary of recommended deep foundations

Pile Size	Estimated Tip Elevation (m)	Factored Axial Geotechnical Resistance at ULS (kN/pile)
254 mm diameter by 6.4 mm thick	~62	760
305 mm diameter by 6.4 mm thick	~62	920

For steel piles the driving stress shall not exceed 90 percent of the yield point of the pile material.

5.2.3 Resistance to Lateral Loads

The resistance to lateral load in front of a vertical pile may be calculated using subgrade reaction theory. EXP can help with the calculation of lateral loads if this is a concern.

5.2.4 Pile Installation

Piles should be installed in accordance with OPSS 903. The piles will likely encounter hard driving near completion (into bedrock). In view of this, closed ended pipe piles should be suited with a P-13006 Conical Point, as per ASTM A27-65/35 or with a 25 mm thick steel flat plate to minimize damage to the piles in anticipation of heavy driving conditions. Care must be taken to avoid overdriving and damaging the pile tip (i.e., the structural capacity of the piles should not be exceeded).

Prior to driving piles, a wave equation (WEAP) analysis should be performed in order to assess the driving stresses and the anticipated penetration resistance required to develop the required pile capacity. This analysis considers the complete driving system. The piles should be driven to adequate set cognizant of the pile driving equipment chosen for the particular piles. Development of the design capacity will depend on the chosen pile dimensions and driving techniques. Accordingly, a pile hammer will be required that can develop sufficient energy to efficiently drive the piles to the requisite driving resistance compatible with the design loads, yet limit the input energy so as not to overstress the pile during driving. For the conditions at this site, piles shall be driven with an approved hammer with a manufacturer's maximum rated potential energy of not less than 95 kJ (70,000 ft-lbs) per hammer blow and measured energy >50 kJ. The final driving resistance required to achieve the design load can be determined by the Pile Driving Analyzer. Dynamic testing (PDA testing) on a number of piles with the Pile Driving Analyser must be performed near the beginning of the pile driving phase of construction to confirm the pile capacities. Alternatively, static load tests can be performed, although these are typically much more difficult to set up and are costlier.

In addition, all piles should be visually monitored by a geotechnical engineer retained by the Contractor during installation to check for plumbness, set, damage, etc. All damaged piles should be rejected and if the damage is considered to be minor, the pile can be dynamically tested to determine the available pile capacity.

All piles should be checked for heaving during the driving of the adjacent piles.

5.3 Earthquake Consideration

The recommendations for the geotechnical aspects to determine the earthquake loading are presented below.

5.3.1 Subsoil Conditions

The subsoil information at this site has been examined in relation to Section 4.1.8.4 of OBC 2012.

The subsoil consisted of fill, silty sand, and bedrock. The proposed structure will be supported on piles driven to the surface of the rock.

There have been no shear wave velocity measurements carried out at this site.

5.3.2 Depth of Boreholes

Table 4.1.8.4.A Site Classification for Seismic Site Response in OBC 2012 indicated that to determine the site classification, the average properties in the top 30 m are to be used. The boreholes were advanced to depths of about 15.2 m below existing grade. Bedrock was encountered at about 14.3 to 14.5 m depths.

5.3.3 Site Classification

Based on the known soil conditions, the Site Class for this site is "E" as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2012.

5.4 Static Lateral Earth Pressure on Structures

Retaining walls should be designed for the lateral earth pressure given by:

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

where P = earth pressure intensity at depth h, kPa

K = earth pressure coefficient

γ = unit weight of retained soil, kN/m^3

q = surcharge near wall, kPa

h = depth to point of interest, m

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

The effect of compaction surcharge should be taken into account in the calculations of active and at- rest earth pressures. The lateral pressure due to compaction should be taken as at least 12 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the depth where the active (or at rest) pressure is equal to 12 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to walls to prevent overstressing.

For design purposes, the unfactored static earth pressure parameters given in Table 4 can be used (assuming wall friction is neglected, the back wall is vertical and the ground surface is horizontal both on the retained side as well as in front of the toe):

Table 4: Material types and unfactored earth pressure properties under static conditions

Material	Unfactored Friction Angle ϕ' (°)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)	Coefficient of Earth Pressure at Rest (K_o)	Unit Weight γ (kN/m³)
Compacted Granular A or Granular B Type II	35	0.27	3.69	0.43	22.0
Compacted Granular B Type I	32	0.31	3.25	0.47	21.0

5.5 Excavation

Only minor excavations for pile caps and grade beams are expected. All excavations must be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety (OHSA) and good construction practice. For the purpose of OHSA, the existing fill materials can be classified as Type 3 soils above groundwater table, and Type 4 soils below groundwater table.

5.6 Frost Protection

Ontario Provincial Standard Drawing (OPSD) 3090.101 indicates that the frost penetration for the area is 1.2 m. Therefore, the bottom of all pile caps should be provided with a minimum of 1.2 m of earth cover for frost protection.

6 Closure

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the team responsible for the design of the works described herein.

A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

Yours truly,

EXP Services Inc.

James K. Farquharson, P.Eng.
Senior Engineer
Earth & Environment

James Ng, P.Eng.
Geotechnical Manager, Infrastructure Projects
Earth & Environment

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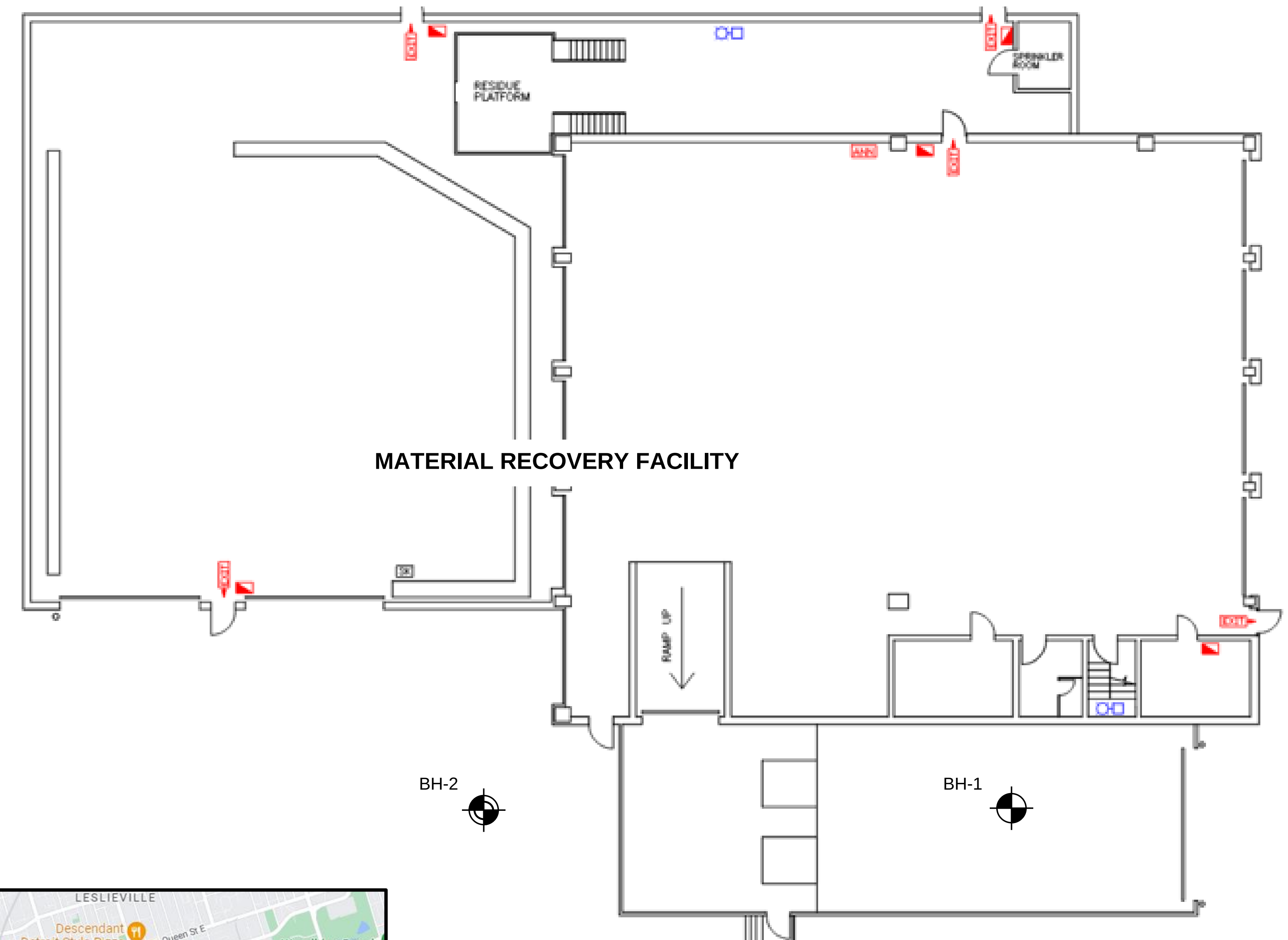
Appendix A: Drawings Borehole Location Plan and Borehole Logs



Legend:

Borehole Location (approximate)

Monitoring Well Location (approximate)

Note:

The boundaries and soil types have been established only at the borehole locations. Between boreholes the boundaries are assumed and may be subject to considerable error.

Soil samples will be retained in storage for 3 months and then destroyed unless the client advises otherwise.

Topsoil quantities and/or volumes of unsuitable fill should not be established from the information provided at the borehole locations.

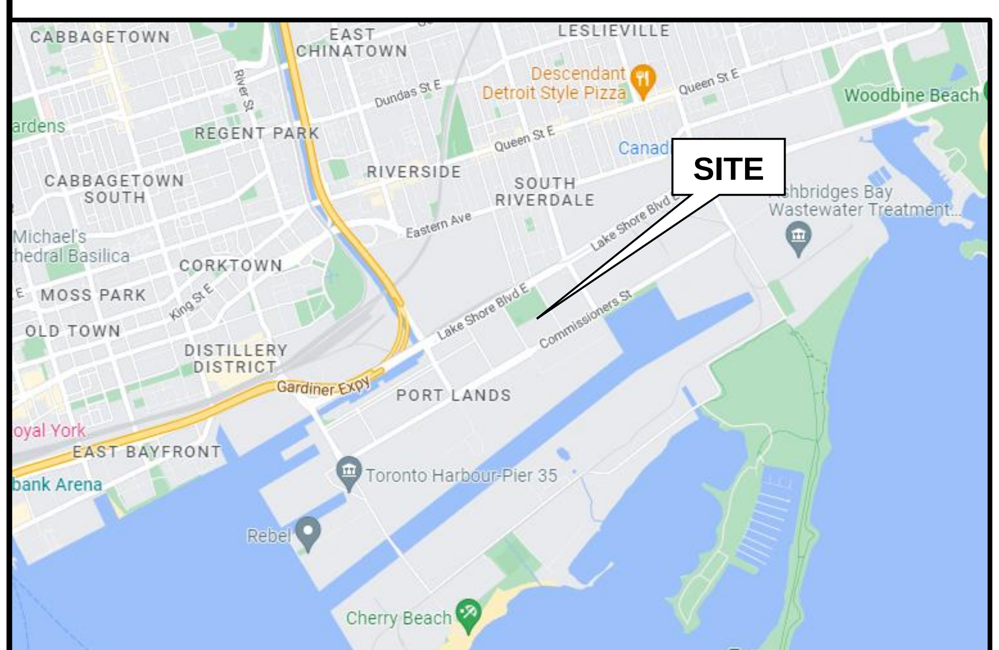
Borehole elevations should not be used to design building(s), or floor slab(s), or parking lot(s) grades.

This drawing to be read with subject report, project number as shown below.

Boreholes located and elevated using portable GPS equipment.

Test hole locations are approximate.

Dimensions shown on this drawing are in metric units, unless otherwise noted.



EXP Services Inc.
1595 Clark Blvd.
Brampton, ON L6T 4V1
www.exp.com

DRAWN:	hal
CHECKED:	JKF
P.M.:	JKF
SCALE	N.T.S.

Borehole Location Plan
Geotechnical Investigation
400 Commissioners Street
Toronto, Ontario

Reference: BRM 22028009-A0
Drawing: 1

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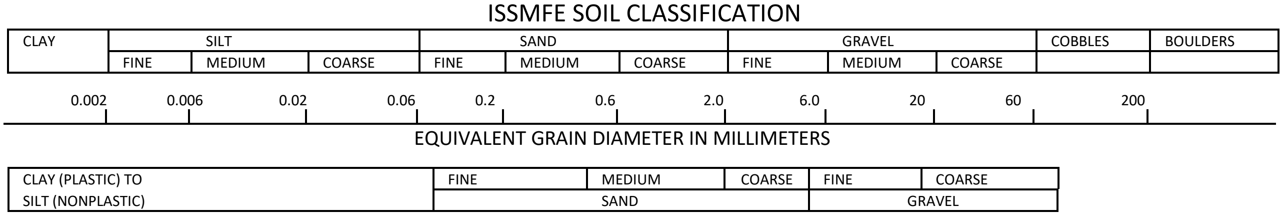
Notes on Sample Descriptions and Soil Types — Drawing 1A

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by EXP also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION



UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advice of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

4. Excerpt from "OHSA Regulations for Construction Projects," Part III, Section 226:

Soil Types

Type 1 Soil

a) is hard, very dense and only able to be penetrated with difficulty by a small sharp object;

b) has a low natural moisture content and a high degree of internal strength;

c) has no signs of water seepage; and

d) can be excavated only by mechanical equipment.

Type 2 Soil

a) is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;

b) has a low to medium natural moisture content and a medium degree of internal strength; and

c) has a damp appearance after it is excavated.

Type 3 Soil

a) is stiff to firm and compact to loose in consistency or is previously excavated soil;

b) exhibits signs of surface cracking;

c) exhibits signs of water seepage;

d) if it is dry, may run easily into a well-defined conical pile; and

e) has a low degree of internal strength.

Type 4 Soil

a) is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;

b) runs easily or flows, unless it is completely supported before excavating procedures;

c) has almost no internal strength;

d) is wet or muddy; and

e) exerts substantial fluid pressure on its supporting system. O. Reg. 213/91, s. 22

Log of Borehole 01

Project No. BRM-22028009-A0
Drawing No. 2

Project: Commissioners Transfer Station - MRF Building Rehabilitation
Sheet No. 1 of 2

Location: 400 Commissioners Street, Toronto, Ontario

Ramp to Loading Dock

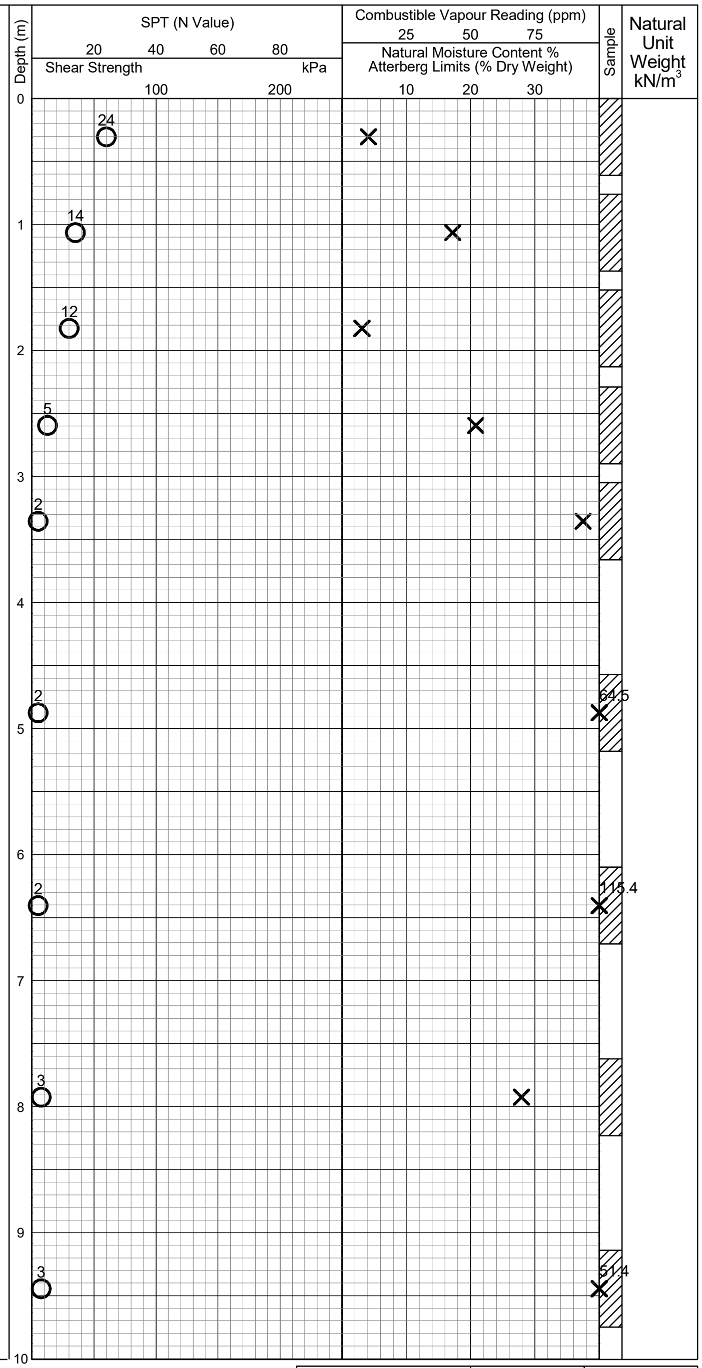
Date Drilled: January 11, 2023

Drill Type: CME Truck Mounted

Datum: Geodetic

Auger Sample	⊠	Combustible Vapour Reading	□
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	——	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	S	Penetrometer	▲

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m
			77.62
		CONCRETE	~77.4
		GRANULAR FILL	~76.9
		FILL - hydraulically placed silt and sand, peat interlayers and seams, brown to grey, moist to wet, compact to very loose	



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Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	dry	full depth

exp.

Log of Borehole 01

Project No. BRM-22028009-A0 | Drawing No. 2

Project: Commissioners Transfer Station - MRF Building Rehabilitation | Sheet No. 2 of 2

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength (kPa)	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Sample	Natural Unit Weight kN/m³
	F		67.62	10				
		SILTY SAND - grey, wet, loose to compact	~66.9	11	10	X		
				12	23	X		
				14	20	X		
		BEDROCK - weathered to highly weathered limestone and shale, grey (GEORGIAN BAY FORMATION)	~63.1		50/125mm			
			~62.4	15	50/250mm			

END OF BOREHOLE

Notes:
1. Borehole advanced by continuous flight hollow stemmed augers and mud rotary drilling to spoon refusal on bedrock using a specialist drilling contractor under the direct supervision of a geotechnical technician from EXP.
2. For borehole definitions, see notes prior to logs.
3. This drawing forms part of and must be read in conjunction with the subject report Ref. BRM-22028009-A0; borehole data requires interpretation assistance by EXP professional staff before use by others.
4. Borehole backfilled to surface on completion.

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	dry	full depth

exp.

Log of Borehole 02

Project No. BRM-22028009-A0 | Drawing No. 3

Project: Commissioners Transfer Station - MRF Building Rehabilitation | Sheet No. 1 of 2

Location: 400 Commissioners Street, Toronto, Ontario

North of Loading Dock

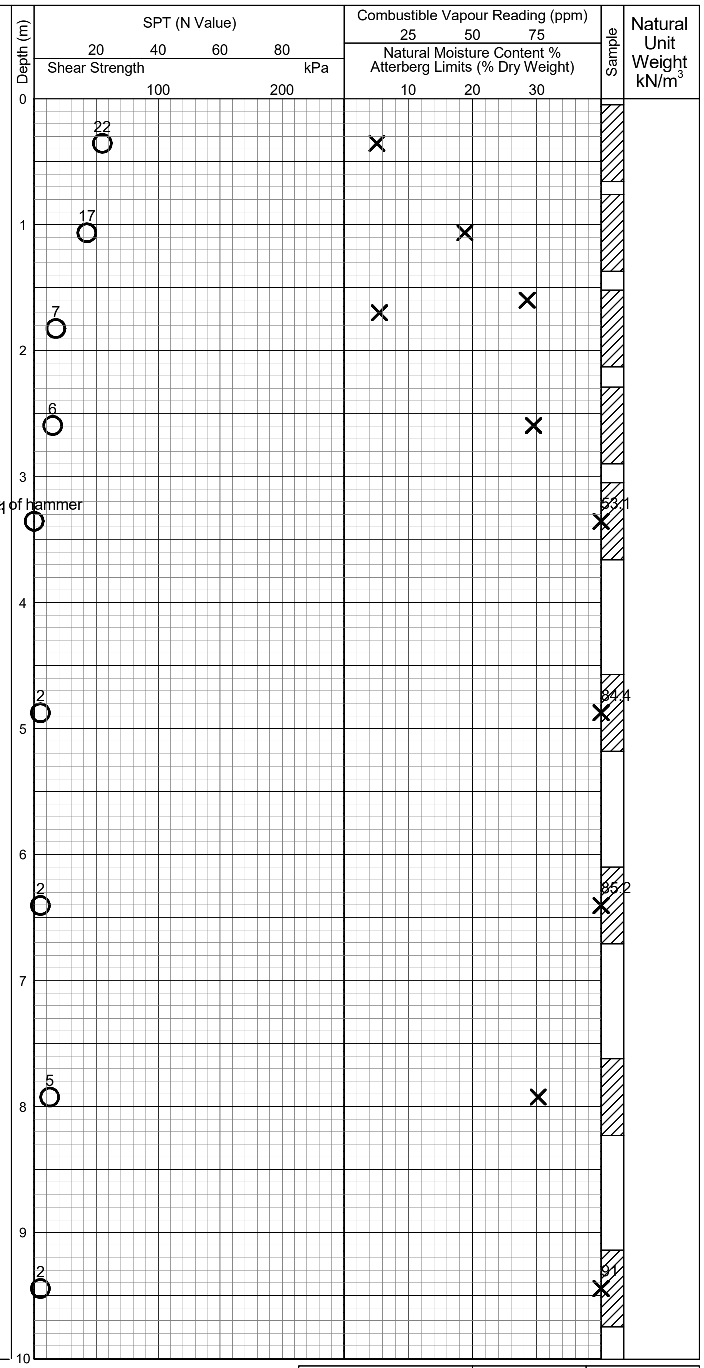
Date Drilled: January 11, 2023

Drill Type: CME Truck Mounted

Datum: Geodetic

Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	——
Shelby Tube	■
Field Vane Test	✚ S
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	├──○
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

Soil Description	ELEV. m
	77.38
ASPHALTIC CONCRETE	~77.2
GRANULAR FILL	~76.7
FILL - hydraulically placed silt and sand, peat interlayers and seams, brown to grey, moist to wet, compact to very loose	
Groundwater level	~74.1



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Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	dry	full depth
9 days	3.31	well

exp.

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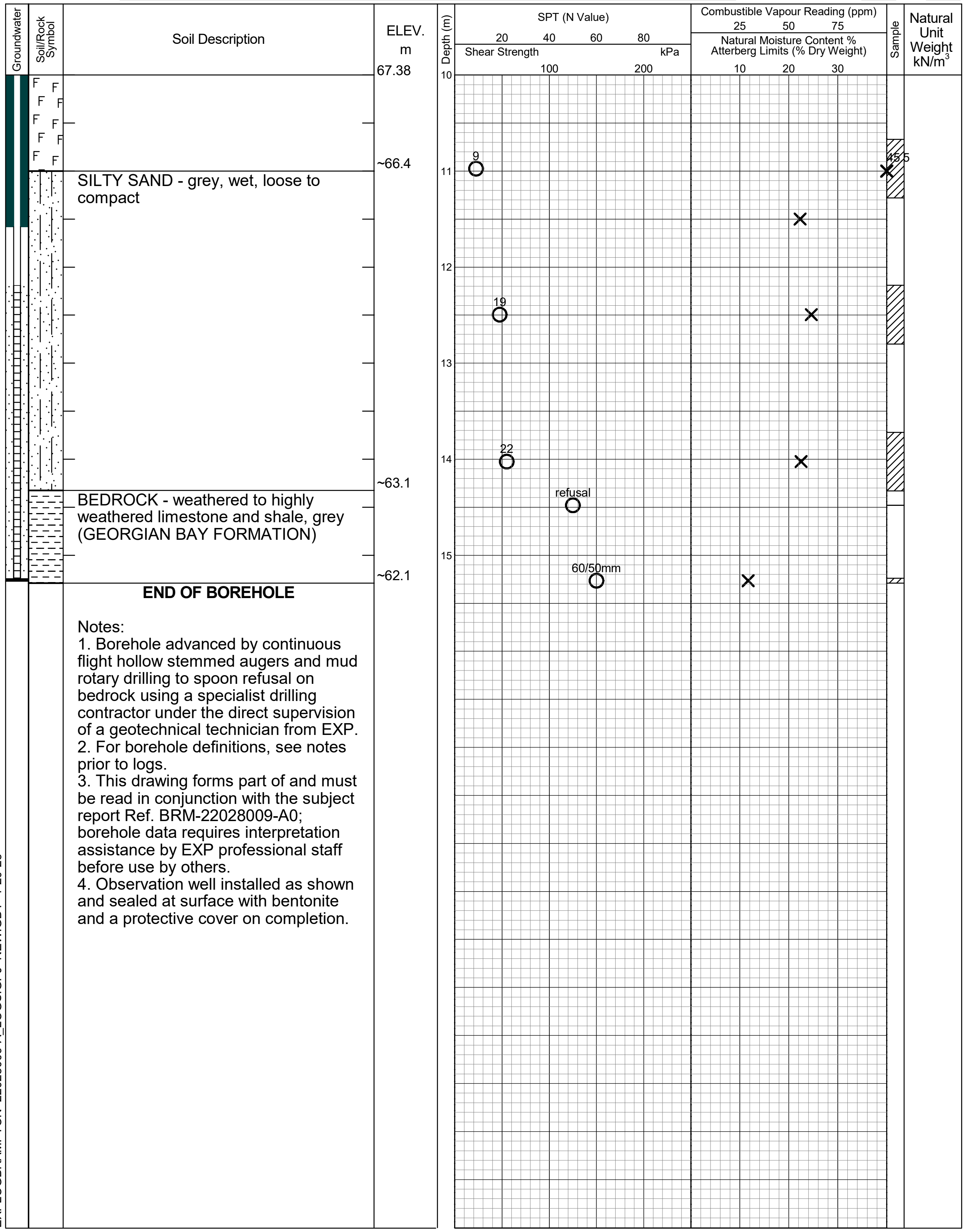
Log of Borehole 02

Project No. BRM-22028009-A0 | Drawing No. 3

Project: Commissioners Transfer Station - MRF Building Rehabilitation | Sheet No. 2 of 2

Soil Description	ELEV. m	Depth (m)
	67.38	10
SILTY SAND - grey, wet, loose to compact	~66.4	11
BEDROCK - weathered to highly weathered limestone and shale, grey (GEORGIAN BAY FORMATION)	~63.1	
END OF BOREHOLE	~62.1	



Notes:
1. Borehole advanced by continuous flight hollow stemmed augers and mud rotary drilling to spoon refusal on bedrock using a specialist drilling contractor under the direct supervision of a geotechnical technician from EXP.
2. For borehole definitions, see notes prior to logs.
3. This drawing forms part of and must be read in conjunction with the subject report Ref. BRM-22028009-A0; borehole data requires interpretation assistance by EXP professional staff before use by others.
4. Observation well installed as shown and sealed at surface with bentonite and a protective cover on completion.

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	dry	full depth
9 days	3.31	well

exp.

Appendix B: Laboratory Data

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 413625-3 **Report No.:** 1 **Date Reported:** 19-Jan-23

Project No.: brm-22028009-a0 0200 0205
Project Name: Civil

Grain Size Proportion (%)

Gravel (> 4.75mm):	
Sand (> 75µm, < 4.75mm):	**4.7**
Silt (> 2µm), < 75µm):	**75.5**
Clay (< 2µm):	**19.8**
Total:	**100.0**

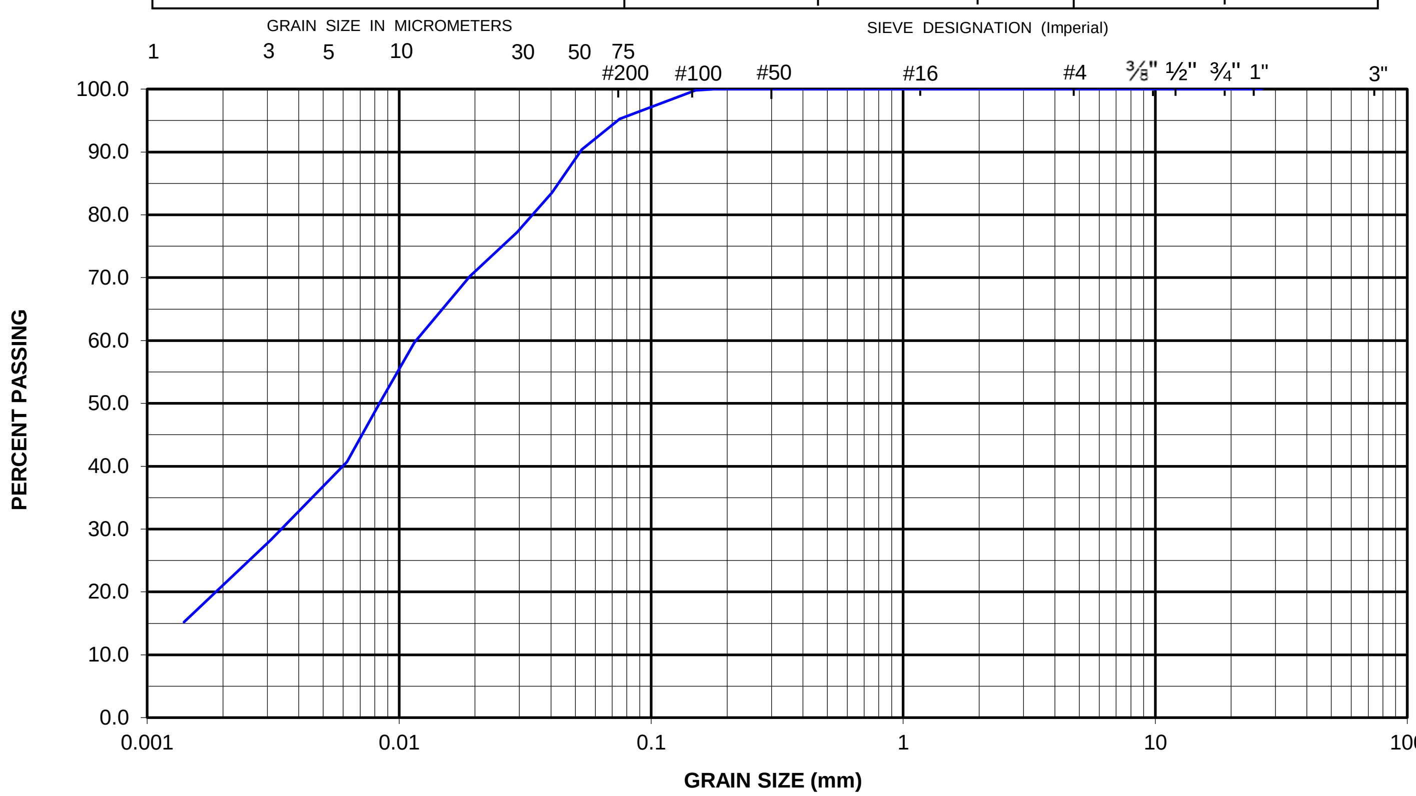
Sample Information

Location: BH 1
Sample Method: SS
Sample No.: 6
Depth: 4.6 - 5.2 m
Sample Description: Silt, some Clay, trace Sand; Grey
Sampled By: D. P.
Sampling Date: 2023-01-11
Date Received: 2023-01-11
Client Sample ID:
Comments:

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0404**	83.5
22.4	100.0	**0.0294**	77.2
19	100.0	**0.0191**	70.2
16	100.0	**0.0115**	59.7
13.2	100.0	**0.0084**	50.2
12.5	100.0	**0.0062**	40.7
9.5	100.0	**0.0031**	28.3
6.7	100.0	**0.0014**	15.2
4.75	100.0		
2	100.0		
0.85	100.0		
0.425	100.0		
0.25	100.0		
0.18	100.0		
0.15	99.8		
0.075	95.3		
0.053	90.4		

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Project Manager: Jordan Stern **Approved By:** *Original Signed By* Arcadio Petrola, CET **Date Approved:** 19-Jan-23

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 413631-2 **Report No.:** 2 **Date Reported:** 19-Jan-23

Project No.: brm-22028009-a0 0200 0205
Project Name: Civil

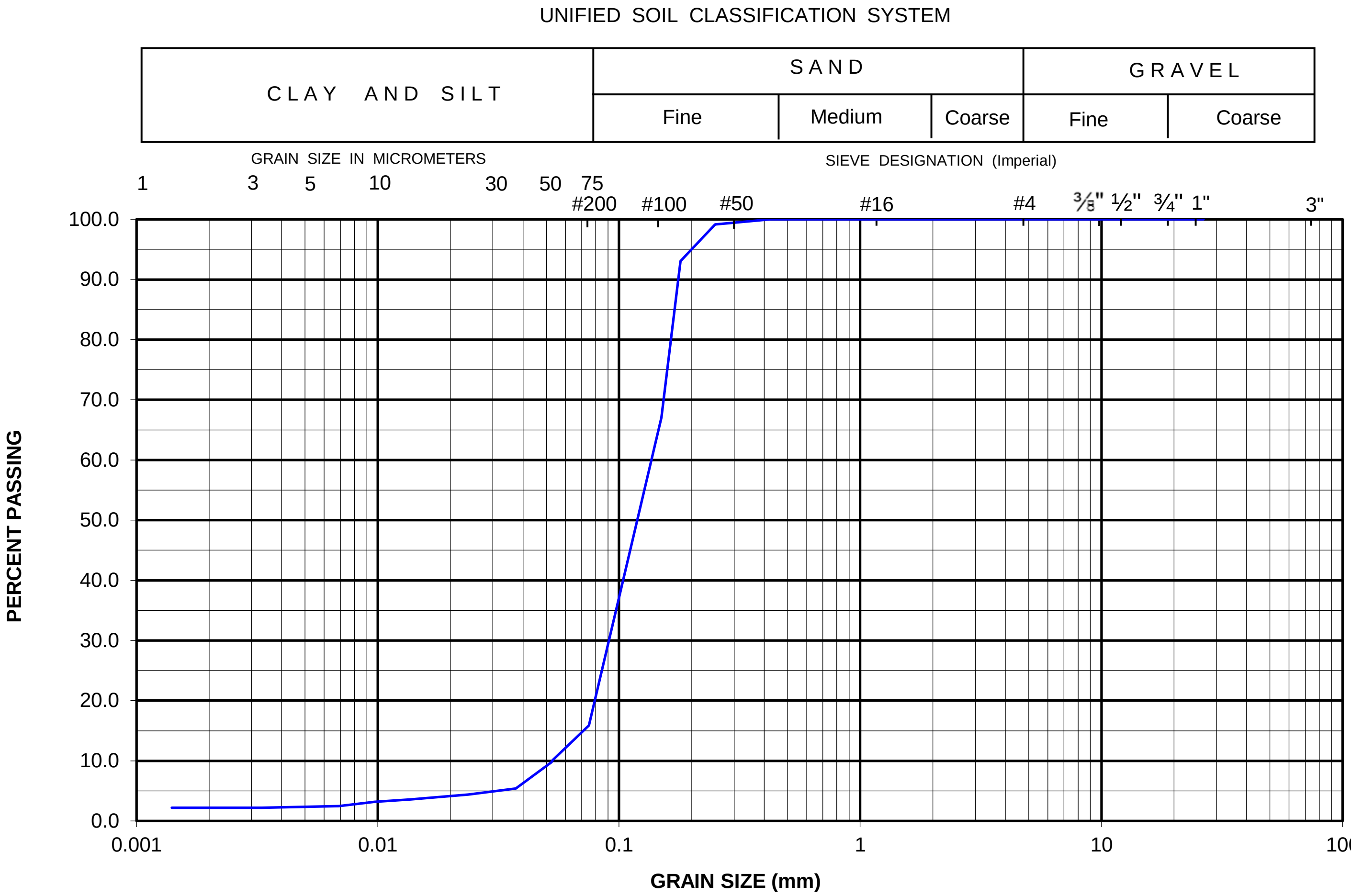
Grain Size Proportion (%)

Gravel (> 4.75mm):	
Sand (> 75µm, < 4.75mm):	**84.1**
Silt (> 2µm), < 75µm):	**15.2**
Clay (< 2µm):	**0.7**
Total:	**100.0**

Sample Information

Location:	BH 1
Sample Method:	SS
Sample No.:	12
Depth:	13.7 - 14.3 m
Sample Description:	Sand, some Silt, trace Clay; Brown
Sampled By:	D. P.
Sampling Date:	2023-01-11
Date Received:	2023-01-11
Client Sample ID:	
Comments:	

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0525**	9.8
22.4	100.0	**0.0374**	5.4
19	100.0	**0.0237**	4.4
16	100.0	**0.0137**	3.6
13.2	100.0	**0.0097**	3.2
12.5	100.0	**0.0069**	2.5
9.5	100.0	**0.0033**	2.2
6.7	100.0	**0.0014**	
4.75	100.0		
2	100.0		
0.85	100.0		
0.425	100.0		
0.25	99.2		
0.18	93.0		
0.15	67.1		
0.075	15.9		
0.053	10.1		



Project Manager: Jordan Stern **Approved By:** *Original Signed By* **Date Approved:** 19-Jan-23

Arcadio Petrola, CET

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 413636-3 **Report No.:** 3 **Date Reported:** 19-Jan-23

Project No.: brm-22028009-a0 0200 0205
Project Name: Civil

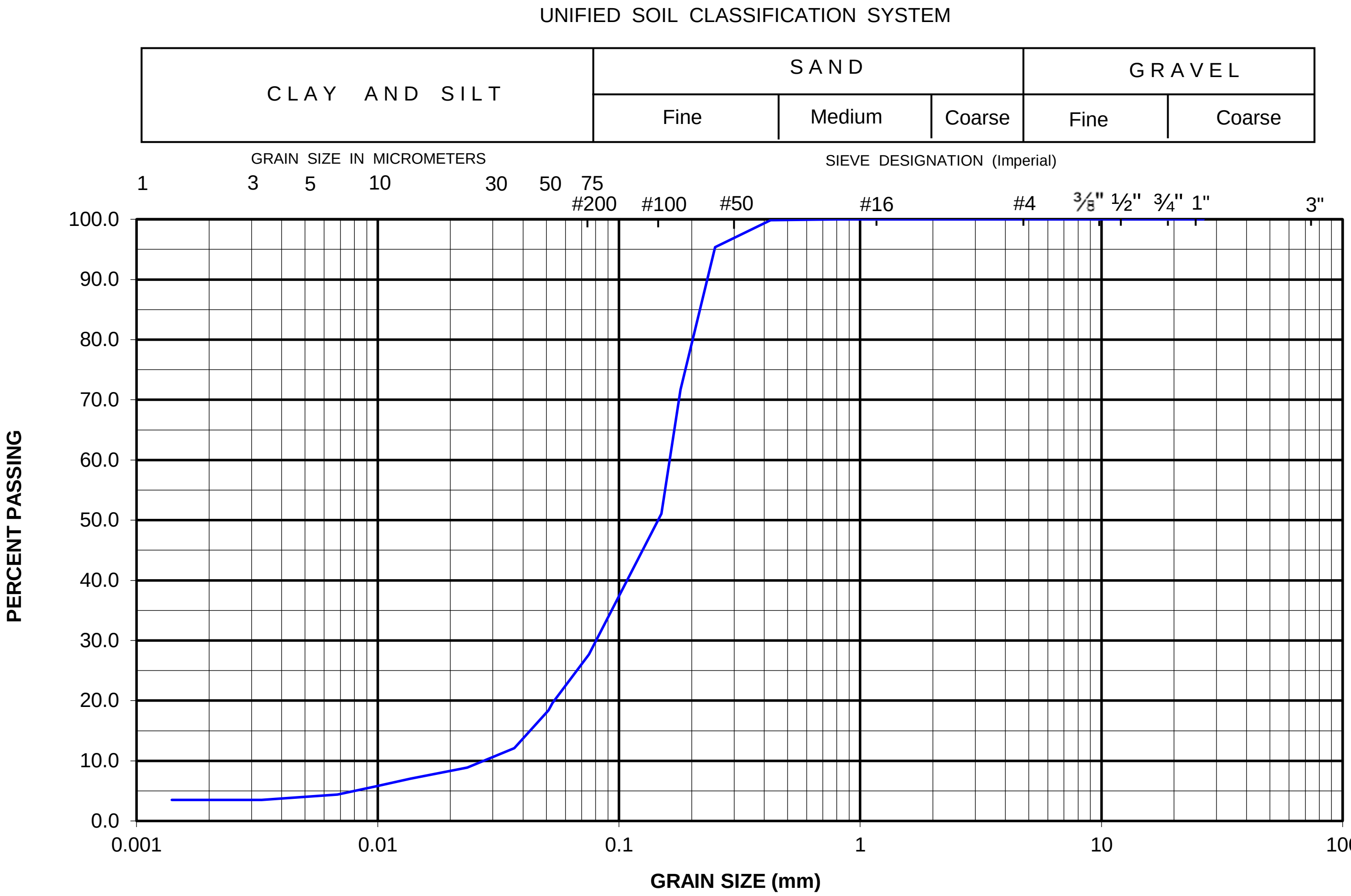
Grain Size Proportion (%)

Gravel (> 4.75mm):	
Sand (> 75µm, < 4.75mm):	**72.3**
Silt (> 2µm), < 75µm):	**26.6**
Clay (< 2µm):	**1.1**
Total:	**100.0**

Sample Information

Location:	BH 2
Sample Method:	SS
Sample No.:	4
Depth:	2.3 - 2.9 m
Sample Description:	Silty Sand, trace Clay; Grey
Sampled By:	D. P.
Sampling Date:	2023-01-11
Date Received:	2023-01-11
Client Sample ID:	
Comments:	

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0511**	18.4
22.4	100.0	**0.0368**	12.1
19	100.0	**0.0235**	8.9
16	100.0	**0.0136**	7.0
13.2	100.0	**0.0097**	5.7
12.5	100.0	**0.0068**	4.4
9.5	100.0	**0.0033**	3.5
6.7	100.0	**0.0014**	
4.75	100.0		
2	100.0		
0.85	100.0		
0.425	99.8		
0.25	95.4		
0.18	71.7		
0.15	51.1		
0.075	27.7		
0.053	19.6		



Project Manager: Jordan Stern **Approved By:** *Original Signed By* Arcadio Petrola, CET **Date Approved:** 19-Jan-23

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 413639-3 **Report No.:** 4 **Date Reported:** 19-Jan-23

Project No.: brm-22028009-a0 0200 0205
Project Name: Civil

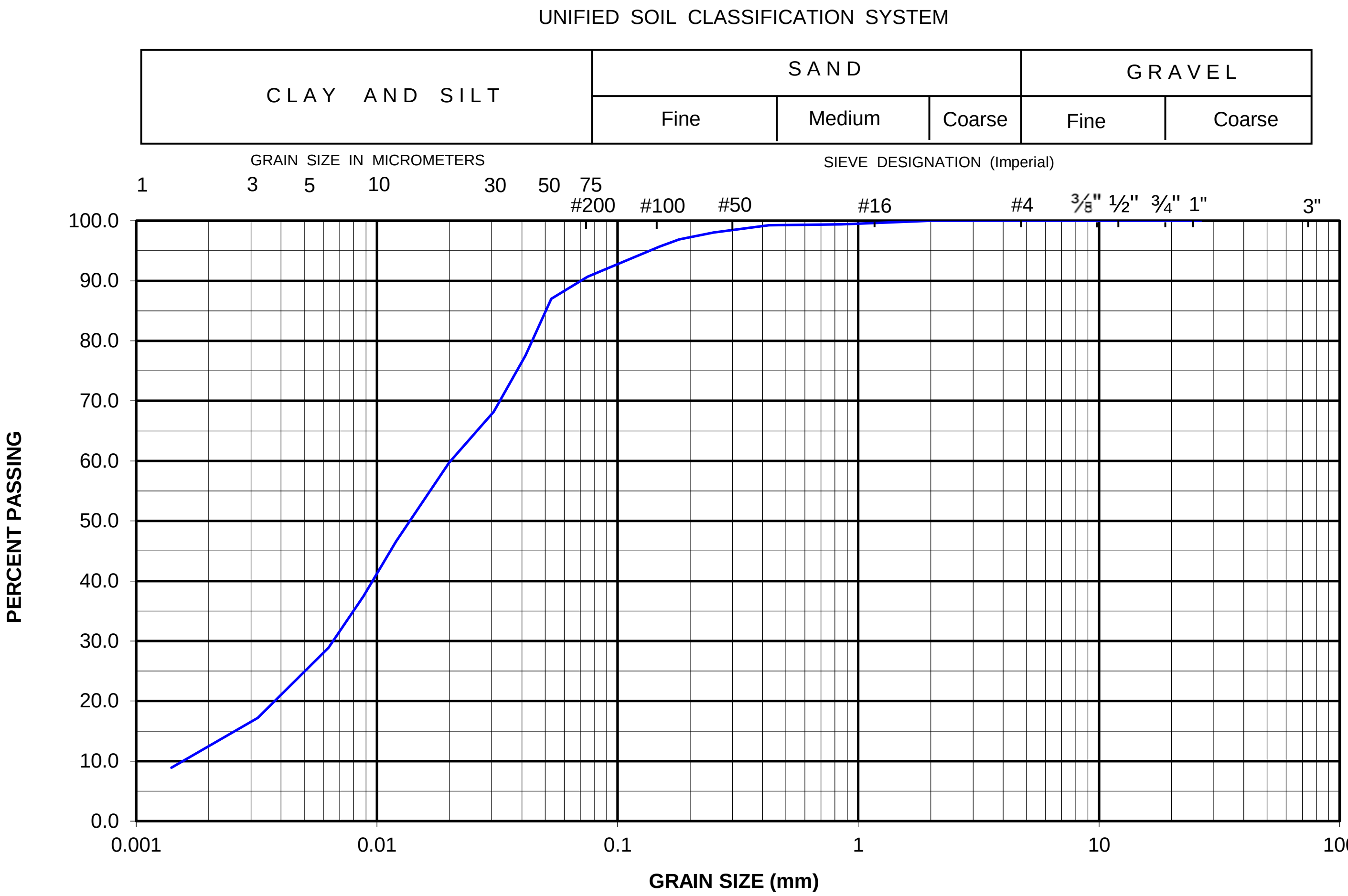
Grain Size Proportion (%)

Gravel (> 4.75mm):	
Sand (> 75µm, < 4.75mm):	9.3
Silt (> 2µm), < 75µm):	79.0
Clay (< 2µm):	11.7
Total:	100.0

Sample Information

Location: BH 2
Sample Method: SS
Sample No.: 7
Depth: 6.1 - 6.7 m
Sample Description: Silt, some Clay, trace Sand; Grey
Sampled By: D. P.
Sampling Date: 2023-01-11
Date Received: 2023-01-11
Client Sample ID:
Comments:

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	0.0415	77.6
22.4	100.0	0.0306	68.2
19	100.0	0.0199	59.7
16	100.0	0.0120	46.6
13.2	100.0	0.0088	37.5
12.5	100.0	0.0063	28.9
9.5	100.0	0.0032	17.2
6.7	100.0	0.0014	8.9
4.75	100.0		
2	100.0		
0.85	99.4		
0.425	99.2		
0.25	98.1		
0.18	96.9		
0.15	95.7		
0.075	90.7		
0.053	87.0		



Project Manager: Jordan Stern **Approved By:** *Original Signed By* Arcadio Petrola, CET **Date Approved:** 19-Jan-23

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Plasticity Index Test Report

ST03

Project No.: Brm-22028009-A0
Sample Number: 413639-2
Date Sampled: January 11, 2023
Date Received: January 12, 2023
Date Reported: January 19, 2022
Borehole No: BH 2 / SS7
Sample Depth: 6.1 - 6.7 m

Liquid Limit

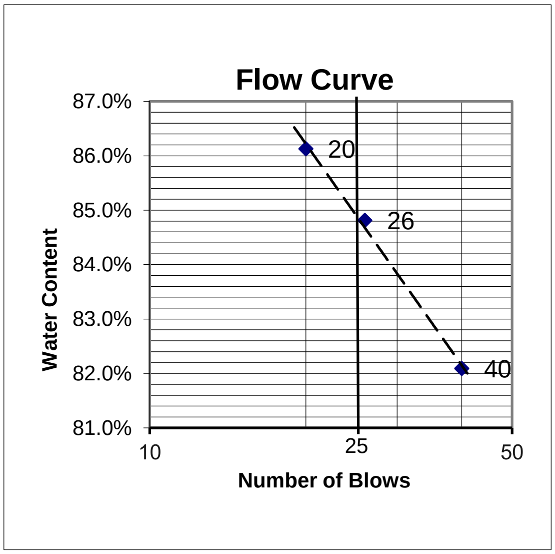
Trial Number	1	2	3	4	5
Number of Blows	40	26	20		
Moisture Tin No.	34	35	36		
Mass of Soil and Tin, g	32.429	30.162	29.347		
Mass of Dry Soil and Tin, g	25.286	23.486	23.068		
Mass of Tin, g	16.585	15.615	15.778		
Mass of Water, g	7.143	6.676	6.279		
Mass of Dry Soil, g	8.701	7.871	7.290		
Water Content	82.1%	84.8%	86.1%		

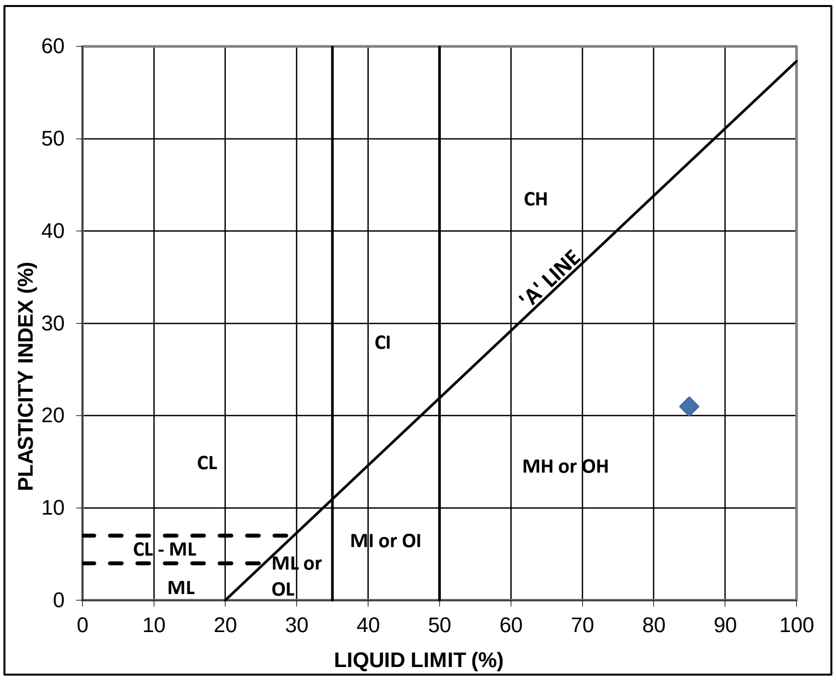
Plastic Limit

Trial Number	1	2	3
Moisture Tin No.	28	29	30
Mass of Soil and Tin, g	28.465	29.465	28.376
Mass of Dry Soil and Tin, g	23.397	24.487	23.816
Mass of Tin, g	15.600	16.677	16.625
Mass of Water, g	5.068	4.978	4.560
Mass of Dry Soil, g	7.797	7.810	7.191
Water Content	65.0%	63.7%	63.4%

Summary of Results

Liquid Limit *(LL)* : 85
Plastic Limit *(PL)* : 64
Plasticity Index *(PI)* 21
Classification: **MH or OH**





Tested By: **Carlito Picache**

Checked By: **Arcadio Petrola, CET**
Senior Lab. Technician

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Plasticity Index Test Report

ST03

Project No.: Brm-22028009-A0
Date Reported: January 19, 2022
Sample Number: 413625-2
Borehole No: BH 1 / SS6
Date Sampled: January 11, 2023
Sample Depth: 4.6 - 5.2 m
Date Received: January 12, 2023

Liquid Limit

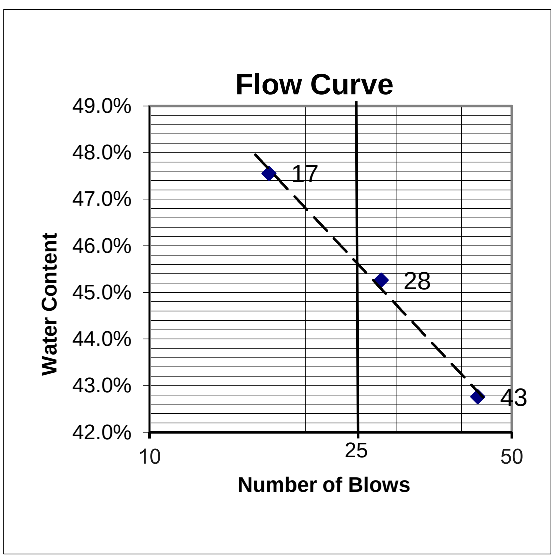
Trial Number	1	2	3	4	5
Number of Blows	43	28	17		
Moisture Tin No.	11	20	25		
Mass of Soil and Tin, g	32.291	31.507	31.930		
Mass of Dry Soil and Tin, g	27.633	26.887	26.999		
Mass of Tin, g	16.741	16.681	16.630		
Mass of Water, g	4.658	4.620	4.931		
Mass of Dry Soil, g	10.892	10.206	10.369		
Water Content	42.8%	45.3%	47.6%		

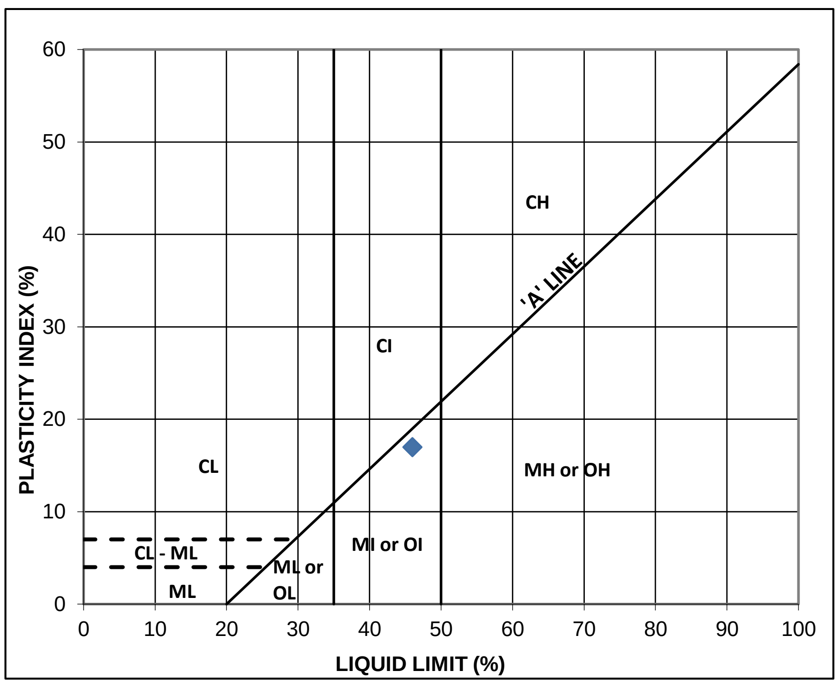
Plastic Limit

Trial Number	1	2	3
Moisture Tin No.	1	2	6
Mass of Soil and Tin, g	30.705	31.026	31.062
Mass of Dry Soil and Tin, g	27.559	27.819	27.845
Mass of Tin, g	16.763	16.826	16.721
Mass of Water, g	3.146	3.207	3.217
Mass of Dry Soil, g	10.796	10.993	11.124
Water Content	29.1%	29.2%	28.9%

Summary of Results

Liquid Limit *(LL)* : 46
Plastic Limit *(PL)* : 29
Plasticity Index *(PI)* 17
Classification: **MI or OI**





Tested By: **Carlito Picache**

Checked By: **Arcadio Petrola, CET**
Senior Lab. Technician