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Geotechnical Investigation
New Multi-Tenant Commercial Development
2822 Carp Road
Carp, Ontario

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Submitted to:

2513287 Ontario Inc.
87 Wheatstone Crescent
Ottawa, Ontario
K2G 7C4

Geotechnical Investigation
New Multi-Tenant Commercial Development
2822 Carp Road
Carp, Ontario

October 28, 2020
Project: 65057.01

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON, Canada
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October 28, 2020 File: 65057.01

2513287 Ontario Inc.
87 Wheatstone Cresent
Ottawa, Ontario
K2G 7C4

Attention: Eric Anderson and Brad Hibbert

Re: Geotechnical Investigation, New Multi-Tenant Commercial Development, 2822 Carp Road, Carp, Ontario

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Please find enclosed our final geotechnical investigation report for the above noted project based on the scope of work provided in our proposal dated December 20, 2019. This report was prepared by Mr. Joseph Berkers, and reviewed by Mr. Brent Wiebe, P.Eng.

Do not hesitate to contact the undersigned if you have any questions or require additional information.

Joseph Berkers

Brent Wiebe, P.Eng.

JB/BW

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1.0 INTRODUCTION

This report presents the results of a subsurface investigation carried out for the new multi-tenant commercial development to be constructed at 2822 Carp Road in Carp, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a limited number of boreholes and, based on the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

The subsurface investigation was carried out in general accordance with our proposal dated December 20, 2019.

2.0 BACKGROUND

2.1 Project Description

Plans are being prepared for the new multi-tenant commercial development, which will have a footprint of less than 600 square metres per building. A geotechnical investigation is required as part of the development of the site.

The site is currently being used as a sale yard for used cars and trucks.

2.2 Review of Geology Maps and Existing Information

Surficial geology maps of the Ottawa area indicate that the site is underlain by nearshore marine sands and silts. Bedrock geology maps of the Ottawa area show that the overburden has a thickness of about 5 to 10 metres and is underlain by interbedded limestone and shale bedrock of the Verulam formation.

Previous geotechnical investigations carried out in the vicinity of the site indicate overburden materials generally composed of sand overlying glacial till.

3.0 SUBSURFACE INVESITGATION

The field work for the borehole investigation was carried out on August 21 and August 24, 2020. During that time, seven (7) boreholes, numbered 20-1 to 20-7, were advanced across the site using a truck mounted drill rig supplied and operated by George Downing Estate Drilling Ltd. of Grenville-sur-la-Rouge, Quebec. The boreholes were advanced to depths between approximately 3.0 and 5.0 metres below ground surface level.

Standard penetration tests were carried out in the boreholes at regular intervals of depth and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. The field work was supervised throughout by a member of our engineering staff.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. One (1) soil sample obtained from borehole 20-4 was sent to Paracel Laboratories Limited for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the boreholes are provided on the Record of Borehole sheets in Appendix A. The locations of the boreholes are shown on the Borehole Location Plan, Figure 1.

The borehole locations were selected by GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) personnel. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system. The elevations are referenced to geodetic datum and are considered to be accurate within the tolerance of the instrument.

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil and groundwater conditions logged in the boreholes are given on the Record of Borehole sheets in Appendix A. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. Subsurface conditions at other than the borehole locations may vary from the conditions encountered in the boreholes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this investigation.

4.2 Existing Granular Pavement Structure

A 400 millimetre thick layer of base/subbase material was encountered from ground surface at borehole 20-1. The base/subbase material can be described as grey sand and gravel with trace silt.

4.3 Topsoil

Topsoil was encountered from ground surface at boreholes 20-2, 20-5, 20-6, and 20-7. The thickness of the topsoil ranged from about 200 to 300 millimetres. The topsoil is composed of dark brown silty sand with organic material.

4.4 Fill Material

Fill material, having a thickness of about 1.0 metre, was encountered from ground surface at boreholes 20-3 and 20-4, extending to elevations of 113.6 and 114.0 metres, respectively. The fill material can be described as dark brown sandy silt, some gravel with cobbles and organics.

Standard penetration tests (SPT) carried out in the fill material gave N values ranging from 5 blows for 0.3 metres of penetration to 50 blows for 0.08 metres of penetration, which reflect a variable loose to very dense relative density.

4.5 Sandy Silt

A 0.5 metre thick native deposit of dark grey sandy silt was encountered beneath the granular pavement structure at borehole 20-1, extending from a depth of about 0.4 metres (elevation 114.7 metres) to a depth of about 0.9 metres (elevation 114.2 metres).

4.6 Sand

Native deposits of grey brown sand with some silt were encountered at all borehole locations. Where fully penetrated, the thickness of the sand deposits ranges from about 0.8 to 2.7 metres, extending from depths of about 0.2 to 1.0 metres (elevation 113.6 to 114.5 metres) to depths ranging from about 1.7 to 3.1 metres (elevation 111.7 to 113.3 metres). Borehole 20-1 was terminated within the sand deposit at 3.1 metres below surface grade.

Standard penetration tests (SPT) carried out in the sand gave N values ranging from 2 to 26 blows per 0.3 metres of penetration, which reflects a variable, very loose to compact relative density.

The results of two grain size distribution tests carried out on samples of the sand are provided in Appendix B.

4.7 Silty Sand

Silty sand deposits were encountered underlying the sand deposits at boreholes 20-3, 20-4, and 20-6, at depths ranging from about 1.7 to 1.8 metres below ground surface (elevation 112.7 to 113.3 metres) and extending to depths ranging from about 2.4 to 2.8 metres below ground surface (elevation 111.8 to 112.5 metres).

Standard penetration tests (SPT) carried out in the silty sand gave N values ranging from 11 to 30 blows per 0.3 metres of penetration, which reflects a compact relative density.

The results of a grain size distribution test carried out on a sample of the silty sand are provided in Appendix B.

4.8 Interbedded Silty Sand and Silty Clay

A layer of interbedded grey silty sand and grey silty clay was encountered underlying the silty sand and sand deposits at boreholes 20-4 and 20-5, respectively. The layer extends from depths of about 2.5 and 3.1 metres below ground surface (elevations 112.5 and 111.7 metres) to depths of about 3.6 metres below ground surface (elevations 111.4 and 111.2 metres).

Standard penetration tests (SPT) carried out in the interbedded silty sand and silty clay gave N values ranging from 1 to 6 blows per 0.3 metres of penetration, which reflects a very loose to loose relative density. For a cohesive deposit this represents a firm to very stiff consistency based on our experience with silty clay in the Ottawa area.

4.9 Glacial Till

Deposits of glacial till were encountered in boreholes 20-2 to 20-7 at depths ranging from 1.8 to 3.6 metres below ground surface (elevation 111.2 to 113.1 metres). The glacial till is generally composed of grey gravel with varying proportions of silt and sand, and probable cobbles and boulders. Auger refusal occurred within the glacial till at boreholes 20-2 to 20-5. Boreholes 20-6 and 20-7 were terminated within the glacial till. The maximum recorded thickness of the glacial till was about 2.2 metres at borehole 20-3.

Standard penetration tests (SPT) carried out in the glacial till gave N values ranging from 14 blows for 0.3 metres of penetration to 50 blows for 80 millimetres of penetration, which reflects a compact to very dense relative density. The higher N values are likely due to the presence of cobbles and boulders.

4.10 Possible Bedrock

Practical auger refusal on possible bedrock occurred at boreholes 20-2 to 20-5 at depths ranging from 3.4 to 5.0 metres below ground surface (elevation 109.6 to 111.6 metres). It should be noted that practical auger refusal can sometimes occur within cobbles and boulders and may not necessarily be representative of the upper surface of the bedrock.

4.11 Groundwater Level

The groundwater level in the well screen at borehole 20-03 was about 1.4 metres below ground surface (elevation 113.3 metres), on September 15, 2020.

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.12 Soil Chemistry Relating to Corrosion

The results of chemical testing on a soil sample recovered from borehole 20-4 are provided in Appendix C and are summarized in Table 1 below.

Table 1: Summary of Corrosion Testing

Parameter	Borehole 20-4 Sample No. 3
Chloride Content (µg/g)	<5
Resistivity (Ohm.m)	111
pH	7.76
Sulphate Content (µg/g)	23

5.0 RECOMMENDATIONS AND GUIDELINES

5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from off-site sources are outside the terms of reference for this report.

5.2 Proposed Buildings

5.2.1 Excavation

The excavation for the foundations of the two buildings will be carried out mostly through the topsoil, fill material, sandy silt, sand, and possibly the silty sand and glacial till. The sides of the excavation in overburden should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the fill material and native soils at this site can be classified as Type 3 soil and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter.

As indicated in Section 5.2.2, the existing topsoil and fill material should be removed from the building areas.

In areas where space constraints dictate, the sides of the excavation could be supported with temporary shoring. If required, geotechnical parameters for the selection and design of temporary shoring could be provided.

Excavation above the groundwater level should not pose any significant constraints. Conversely, excavation below the groundwater level in the sandy soils could result in significant sloughing of the excavation side walls and disturbance to the base of the excavation. Flatter excavation side slopes may be required to reduce sloughing; and pumping from filtered sump pits excavated in the corners of the excavations, advanced below the proposed subgrade elevation would reduce the potential for subgrade disturbance. Nevertheless, allowance should be made for subexcavation of disturbed material and replacement with imported granular fill. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

5.2.2 Footing Design

Based on the results of the current investigation, the proposed structure could be founded on footings bearing on or within native, undisturbed sandy silt, sand, silty sand, or glacial till, or on imported, compacted granular fill above the native deposits. The topsoil and fill material layers are considered to be highly compressible and should be removed from below any foundations and slabs on grade.

In areas where subexcavation of disturbed material or fill is required below proposed founding level, the grade could be raised with compacted granular material (engineered fill). The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. To provide adequate spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3 metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter. The excavations for the foundations should be sized to accommodate this fill placement.

For design purposes, footings bearing on the native, undisturbed soil, or on a pad of engineered fill above native, undisturbed soil should be sized using a geotechnical reaction at Serviceability Limit State (SLS) of 120 kilopascals and a factored geotechnical resistance at Ultimate Limit State (ULS) of 300 kilopascals.

The post construction total and differential settlement of the footings at SLS should be less than 25 millimetres, provided that all loose or disturbed soil is removed from the bearing surfaces and that any imported granular fill material below the footings is prepared as described above.

To reduce the potential for cracking in the footings, foundation walls, and concrete slabs on grade where the footings transition between different subgrade materials, the foundation walls should be reinforced for a distance of 3 metres on both sides of the transition areas or as recommended by the structural engineer.

5.2.3 Seismic Design of Proposed Structure

Based on the results of the investigation, in our opinion, the proposed structure should be designed for seismic Site Class D.

In our opinion, there is no potential for liquefaction of the overburden deposits at this site.

5.2.4 Frost Protection of the Foundations

All exterior footings in unheated portions of the proposed buildings should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated exterior footings adjacent to surfaces which are cleaned of snow cover during the winter months should be provided with a minimum of 1.8 metres of earth cover. The required depth of frost protection can be reduced by the thickness of any engineered fill beneath the foundations. Alternatively, the required frost protection could be provided by means of a combination of earth cover and extruded polystyrene insulation. An insulation detail could be provided upon request.

5.2.5 Foundation Wall Backfill and Drainage

To avoid frost adhesion and possible heaving, the foundations should be backfilled with imported, free-draining, non-frost susceptible granular material such as that meeting OPSS Granular B Type I or II requirements. The existing sand material could be excavated, where required, stockpiled on site, and tested for grain size distribution to assess whether it could be reused on the site for foundation wall backfill.

Where the backfill will ultimately support areas of hard surfacing (pavement, sidewalks or other similar surfaces), the backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment. Light, walk behind compaction equipment should be used next to foundation walls to avoid excessive compaction induced stress on the foundation walls. Where future landscaped areas will exist next to the proposed structure and if some settlement of the backfill is acceptable, the backfill could be compacted to at least 90 percent of the standard Proctor maximum dry density value.

Where areas of hard surfacing (pavement or pathways, etc.) abut the proposed structure, a gradual transition should be provided between those areas of hard surfacing underlain by non-frost susceptible granular wall backfill and those areas underlain by existing frost susceptible material to reduce the effects of differential frost heaving. It is suggested that granular frost tapers be constructed from 1.5 metres below finished grade to the underside of the granular subbase material for the hard surfaced areas. The frost tapers should be sloped at 1 horizontal to 1 vertical, or flatter.

Perimeter foundation drainage is not considered necessary for a slab on grade structures at this site, provided that the floor slab level is above the finished exterior ground surface level.

5.2.6 Slab on Grade Support

Based on the results of the investigation, the area of the proposed structures are underlain by topsoil, fill material, followed by native deposits sandy silt, sand, silty sand, or glacial till. For predictable performance of the concrete slab, the topsoil and existing fill material should be removed from below the slab on grade.

The grade within the proposed building could be raised, where necessary, with granular material meeting OPSS requirements for Granular B Type I or II. The use of Granular B Type II material is preferred under wet conditions. The granular base for the proposed slab on grade should consist of at least 150 millimetres of OPSS Granular A.

All imported granular materials placed below the proposed floor slab should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value.

Underfloor drainage is not considered necessary provided that the floor slab level is above the finished exterior ground surface level.

Thermal protection of the concrete slab on grade is required in areas that will remain unheated during the winter period.

5.3 Parking Lot and Access Roadway

In preparation for the parking lot and access roadway construction, all surficial topsoil and any soft, wet or deleterious materials should be removed. This need not include the removal of the existing fill provided that some minor post construction settlement of the flexible (asphaltic concrete) pavement can be accommodated.

Prior to placing granular material, the subgrade surface should be proof rolled with a large steel drum roller (8 to 10 tonne) under dry conditions. Any soft areas observed during the proof rolling should be subexcavated and replaced with suitable, dry earth borrow, compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Attempts should be made to use earth borrow that is frost compatible with the material on the sides of the subexcavation.

For the light duty parking areas and access roadways to be used by light vehicles (cars, etc) the following minimum pavement structure is recommended:

- 60 millimetres of Superpave 12.5 (Traffic Level B, hot mix asphalt placed in a single lift); over
- 150 millimetres of OPSS Granular A base; over
- 300 millimetres of OPSS Granular B Type II (or 450 millimetres of Granular B Type I), subbase.

For heavy duty parking areas and access roadways to be used by heavy truck traffic (including emergency vehicles) the suggested minimum pavement structure is:

- 40 millimetres of Superpave 12.5 (Traffic Level B), over;
- 60 millimetres of Superpave 19.0 (Traffic Level B), over;
- 150 millimetres of OPSS Granular A base; over
- 450 millimetres of OPSS Granular B Type II (or 525 millimetres of Granular B Type I), subbase

Performance grade PG 58-34 asphaltic concrete should be specified.

The granular base and subbase materials should be compacted in maximum 200 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density value.

The above pavement structure assumes that the foundation wall backfill is adequately compacted and that the subgrade surface is prepared as described in this report. If the subgrade surface is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or to incorporate a woven geotextile separator between the roadway subgrade surface and the granular subbase material. The adequacy of the design pavement thickness should be assessed by geotechnical personnel at the time of construction.

5.4 Proposed Services

5.4.1 Excavation

In the overburden, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil. The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the soils at this site can be classified as Type 3 soils. Therefore, for design purposes, allowance should be made for 1 horizontal to 1 vertical, or flatter, excavation slopes. As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Groundwater seepage into excavations is expected and should be controlled, as necessary, by pumping from within the excavations. An allowance should be made for a subbedding layer in the event that excavation of disturbed/water softened material is required at the pipe invert level (discussed further in Section 5.4.2). It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

5.4.2 Pipe Bedding

The bedding for sewers and watermains should be in accordance with OPSD 802.010 and 802.031 for flexible and rigid pipes in Type 3 soils, respectively.

The bedding for service pipes should consist of at least 150 millimetres of crushed stone meeting OPSS requirements for Granular A. Cover material, from spring line to at least 300 millimetres above the tops of the pipes, should consist of granular material, such as that meeting OPSS Granular A.

In areas where the subsoil is disturbed or where unsuitable material (fill or organic material) exists below the pipe subgrade level, the disturbed/unsuitable material should be removed and replaced with a subbedding layer of compacted granular material, such as that meeting OPSS Granular B Type I or II. To provide adequate support for the sewer pipes in the long term in areas where subexcavation of material is required below design subgrade level, the excavations should be sized to allow a 1 horizontal to 1 vertical or 2 vertical to 1 horizontal spread of granular material down and out from the bottom of the pipes.

The granular bedding and subbedding materials should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

The use of clear crushed stone as a bedding, subbedding or cover material should not be permitted on this project.

5.4.3 Trench Backfill

In areas where the service trench will be located below or in close proximity to existing or future areas of hard surfacing (pavement, sidewalk, etc.), acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetration in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The depth of frost penetration in exposed areas can normally be taken as 1.8 metres below finished grade. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type I or II.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill, depending on the precipitation conditions at the time of construction.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadways, sidewalks, driveways, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Rock fill should be placed in maximum 500 millimetre thick lifts and compacted with the haulage and spreading equipment. The specified density for compaction of the backfill materials may be reduced where the trench backfill is not located below or in close proximity to existing or future areas of hard surfacing and/or structures.

5.4.4 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the soil sample collected from borehole 20-4 was 23 ug/g. According to the Canadian Standards Association “Concrete Materials and Methods of Concrete Construction” (CSA A23.1-14 Table 3), the concentration of water-soluble sulphate in the soil recovered from borehole 18-1 is less than the minimum concentration for ‘Moderate’ sulfate exposure (0.10 – 0.20 percent). As such, the CSA A23.1 Class of Exposure is not a sulfate class. Other factors (structurally reinforced or non-structurally reinforced, freeze-thaw environment, chloride exposure, agricultural environment) should be considered in selecting the Class of Exposure and associated air entrainment and concrete mix proportions for any concrete.

Based on the conductivity and pH of the soil, the soil sampled from borehole 20-4 can be classified as non-aggressive toward unprotected steel. The manufacturer of any buried steel elements that will be in contact with the soil or groundwater should be consulted to ensure that the durability of the intended product is appropriate. It is noted that the corrosivity of the groundwater could vary throughout the year due to the application of de-icing chemicals.

5.5 Soil Infiltration

Based on the soils encountered within boreholes advanced at the subject site, the infiltration rates are estimated to range from 2.3 to 61.2 millimetres per hour. A mixture of shallow topsoil and fill was observed at the site with a thickness ranging from 0.18 to 1.04 metres. Infiltration rates are expected to be variable at surface based on the variability of fill material and vegetation type in the shallow topsoil and fill. Most boreholes encountered a sand layer beneath the topsoil and fill layer. The estimated infiltration rate is 61.2 millimetres per hour (refer to Table 2). A layer of silty sand and silty clay was encountered below the sand layer at depths of 1.4 metres below ground surface to over 3.05 metres below ground surface. Lower infiltration rates are expected through the silty sand and sandy silt layer, with estimated infiltration rates ranging from 2.3 to 25.9 millimetres per hour (refer to Table 2).

Table 2: Estimated infiltration Rates

Sample ID	Depth(m)	Soil Description / (Soil Classification[1])	Infiltration Rate[2] (mm/hr)	Percolation Time[3,4], T (min/cm)
BH20-3 SA2	0.76 – 1.37	Sand, some silt / (Loamy Sand)	61.2	9.8 (3) (8 – 20) (4)
BH20-3 SA3	1.52 – 2.13	Sand, some silt / (Loamy Sand)	61.2	9.8 (8 – 20)

Sample ID	Depth(m)	Soil Description / (Soil Classification[1])	Infiltration Rate[2] (mm/hr)	Percolation Time[3,4], T (min/cm)
BH20-3 SA4	2.28 – 2.89	Silty sand / (Sandy clay loam to Sandy loam)	4.3 to 25.9	139.5 to 23.2 (12 to over 50)
BH20-1 SA3	1.52 - 2.13	Sand, some silt, trace clay / (Loamy Sand)	61.2	9.8 (8 – 20)
BH20-2 SA4	2.28 – 2.89	Sandy gravel, trace silt, trace clay / (Loamy Sand)	61.2	9.8 (8 – 20)
BH20-4 SA4	2.28 – 2.89	Silty clayey sand / (Clay Loam)	2.3	260.9 (Over 50)

Notes:

1. Soil classification based on the USDA Soils Textural Triangle (Appendix D.13. Method for Designing Infiltration Structures, Figure D.13.1, Maryland Department of the Environment (MDE). 2000 – Revised May 2009. 2000 Maryland Stormwater Design Manual. Prepared by Center for Watershed Protection (CWP). Baltimore, MD)
2. Infiltration rate estimated based on soil texture and corresponding infiltration rates as classified in Table D.13.1. Hydrogeologic Soil Properties Classified by Soil Texture' (Appendix D.13. Method for Designing Infiltration Structures, Maryland Department of the Environment (MDE). 2000 – Revised May 2009. 2000 Maryland Stormwater Design Manual. Prepared by Center for Watershed Protection (CWP). Baltimore, MD).
3. Approximate percolation time converted from infiltration rate using Table C1. Approximate relationship between hydraulic conductivity, percolation time and infiltration rate (Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario).
4. Range of percolation time based on soil type; (Table 2 and Table 3 from 2012 Building Code "Supplementary Standards -6: Percolation Time and Soil Descriptions").

It should be noted the water level measured in monitoring well in borehole 20-3 was 1.4 metres below ground surface, which may influence infiltration rates. Also, the estimated infiltration rates do not include safety factors to account for lower permeability of soils encountered at depth, which would be saturated and more consolidated. The infiltration rates provided above should therefore be considered preliminary estimates since they are based on soil texture only, not factoring in other site-specific factors that may affect the rates. Given that infiltration rates may be affected by consolidation with depth and the presence of groundwater at depths below the water table, in situ infiltration testing should be conducted prior to designing infiltration structures.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Winter Construction

Provision must be made to prevent freezing of any soil below the level of any footings, slabs or services. Freezing of the soil could result in heaving related damage.

Any service trenches should be opened for as short a time as practicable and the excavations should be carried out only in lengths which allow all of the construction operations, including backfilling, to be fully completed in one working day. The materials on the sides of the trenches should not be allowed to freeze. In addition, the backfill should be excavated, stored and replaced without being disturbed by frost or contaminated by snow or ice.

6.2 Effects of Construction Induced Vibration

Some of the construction operations (such as granular material compaction, excavation, foundation construction etc.) will cause ground vibration on and off of the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. We recommend that preconstruction surveys be carried out on any adjacent structures and that vibration monitoring be carried out during the construction so that any construction related claims can be dealt with in a fair manner.

6.3 Disposal of Excess Soil

It is noted that the professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination, including naturally occurring source of contamination, are outside the terms of reference for this report.

6.4 Design Review and Construction Observation

The details for the proposed construction were not available to us at the time of preparation of this report. It is recommended that the final design drawings be reviewed by the geotechnical engineer as the design progresses to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the buildings and site services should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications. In accordance with Ontario Building Code requirements, full time compaction testing is required for engineered fill below buildings.

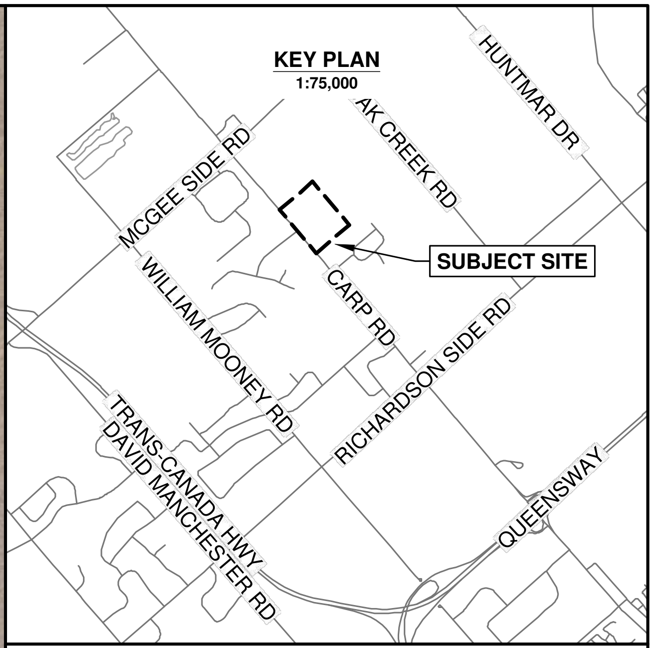
We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Joseph Berkers, B.Eng.

Brent Wiebe, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
B.D. WIEBE
100060438
28 Oct 2020
PROVINCE OF ONTARIO

KEY PLAN
1:75,000



LEGEND

⊕ **BOREHOLE LOCATION IN PLAN**
(current investigation by GEMTEC)

⊕ **MONITORING WELL LOCATION IN PLAN**
(current investigation by GEMTEC)

BH # ← BH/TP ID
XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

Scale
1:1000
0 20 40 60m

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Client 2513287 ONTARIO INC.	Project 65057.01

Location
2822 CARP ROAD, CARP, ON

Drwn by S.L.	Chkd by J.B.	BOREHOLE LOCATION PLAN

Date OCTOBER, 2020	Rev. 0	FIGURE 1

APPENDIX A

List of Abbreviations and Terminology
Record of Borehole Sheets

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

SAMPLE TYPES	
AS	Auger sample
CA	Casing sample
CS	Chunk sample
BS	Borros piston sample
GS	Grab sample
MS	Manual sample
RC	Rock core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled open shelby tube
TP	Thin-walled piston shelby tube
WS	Wash sample

SOIL TESTS	
w	Water content
PL, w_p	Plastic limit
LL, w_L	Liquid limit
C	Consolidation (oedometer) test
D_R	Relative density
DS	Direct shear test
G_S	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
UC	Unconfined compression test
γ	Unit weight

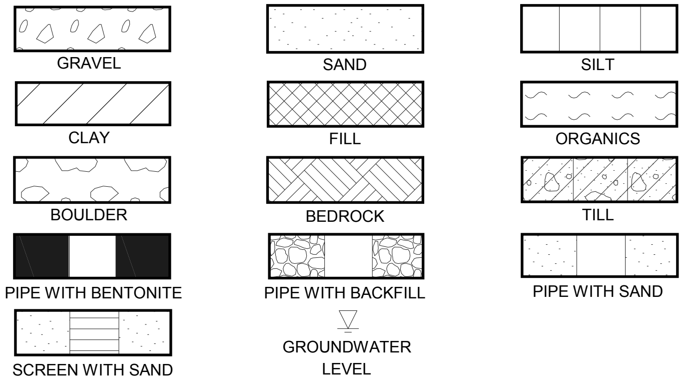
PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

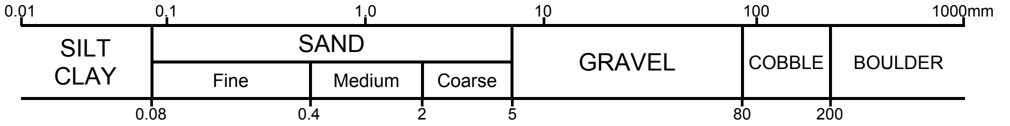
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to ‘A’ size drill rods for a distance of 300 mm (12 in.).

WH	Sampler advanced by static weight of hammer and drill rods
WR	Sampler advanced by static weight of drill rods
PH	Sampler advanced by hydraulic pressure from drill rig
PM	Sampler advanced by manual pressure

COHESIONLESS SOIL Compactness		COHESIVE SOIL Consistency	
SPT N-Values	Description	Cu, kPa	Description
0-4	Very Loose	0-12	Very Soft
4-10	Loose	12-25	Soft
10-30	Compact	25-50	Firm
30-50	Dense	50-100	Stiff
>50	Very Dense	100-200	Very Stiff
		>200	Hard



GRAIN SIZE



DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)

0 10 20 35

TRACE	SOME	ADJECTIVE	noun > 35% and main fraction
trace clay, etc	some gravel, etc.	silty, etc.	sand and gravel, etc.

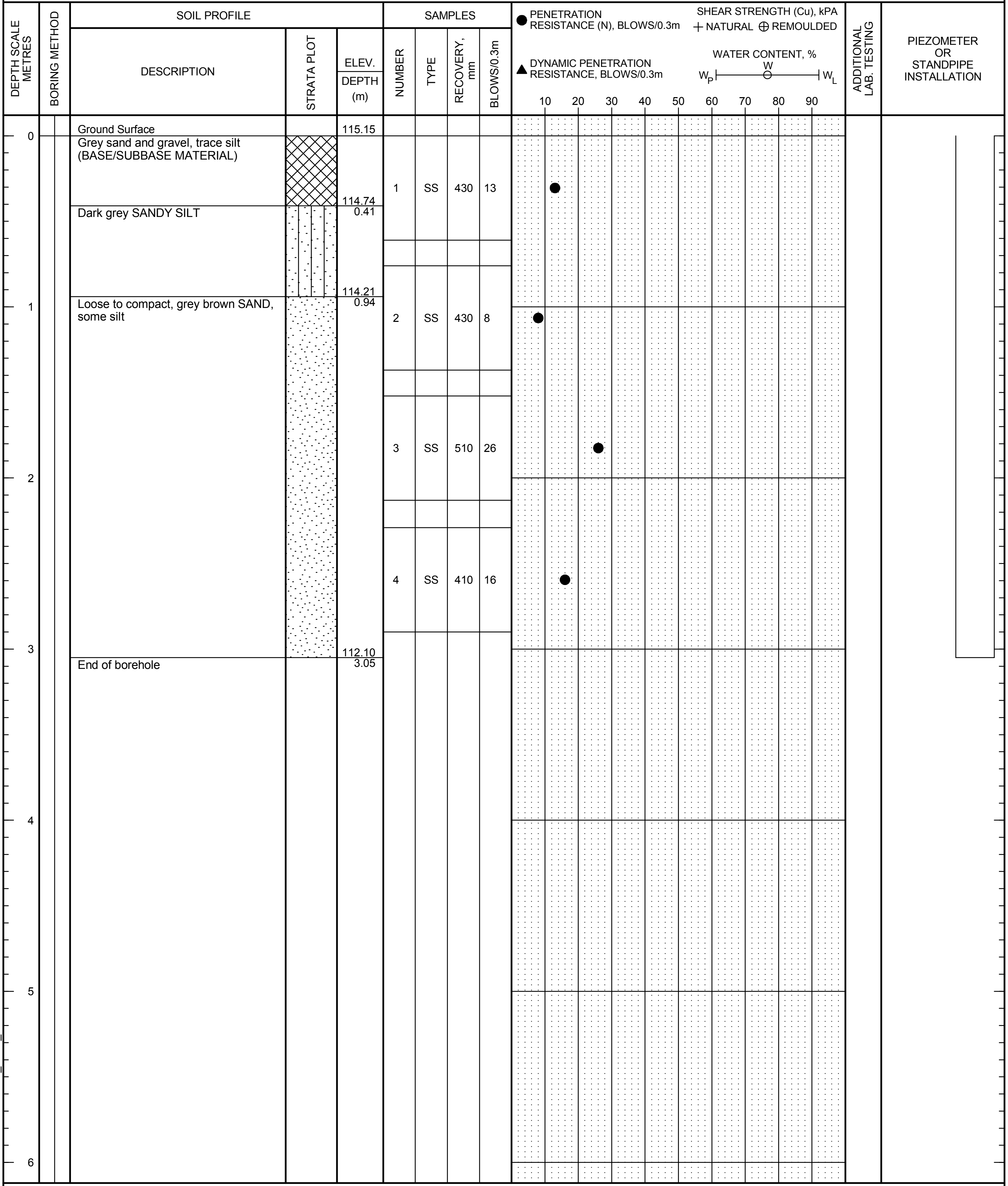
RECORD OF BOREHOLE 20-1

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

SOIL PROFILE	
DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	115.15
Grey sand and gravel, trace silt (BASE/SUBBASE MATERIAL)	
Dark grey SANDY SILT	114.74 0.41
Loose to compact, grey brown SAND, some silt	114.21 0.94
End of borehole	112.10 3.05

SAMPLES			
NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	SS	430	13
2	SS	430	8
3	SS	510	26
4	SS	410	16



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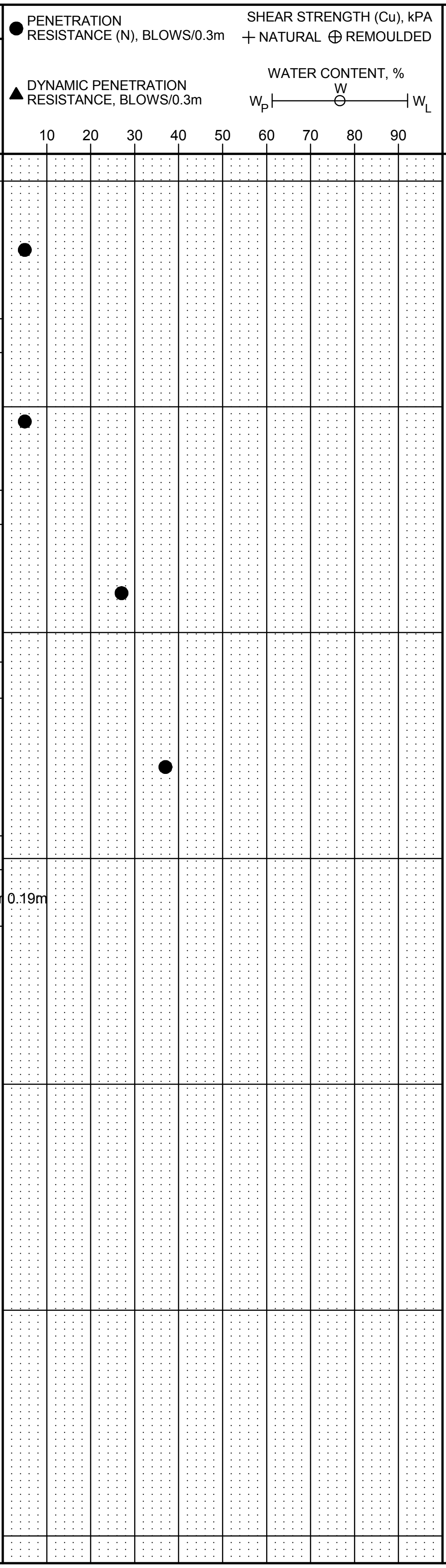
CHECKED: J.B.

RECORD OF BOREHOLE 20-2

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
	Ground Surface	114.94				
0	Dark brown silty sand with organic material (TOPSOIL)					
	Loose to compact, grey brown SAND, some silt	114.63 0.31	1	SS	360	5
1			2	SS	410	5
	Compact to very dense, grey brown silty sandy gravel with cobbles and boulders (GLACIAL TILL)	113.14 1.80	3	SS	430	27
2			4	SS	230	37
3			5	SS	130	50 for 0.19m
	End of borehole Auger refusal	111.56 3.38				
4						
5						
6						



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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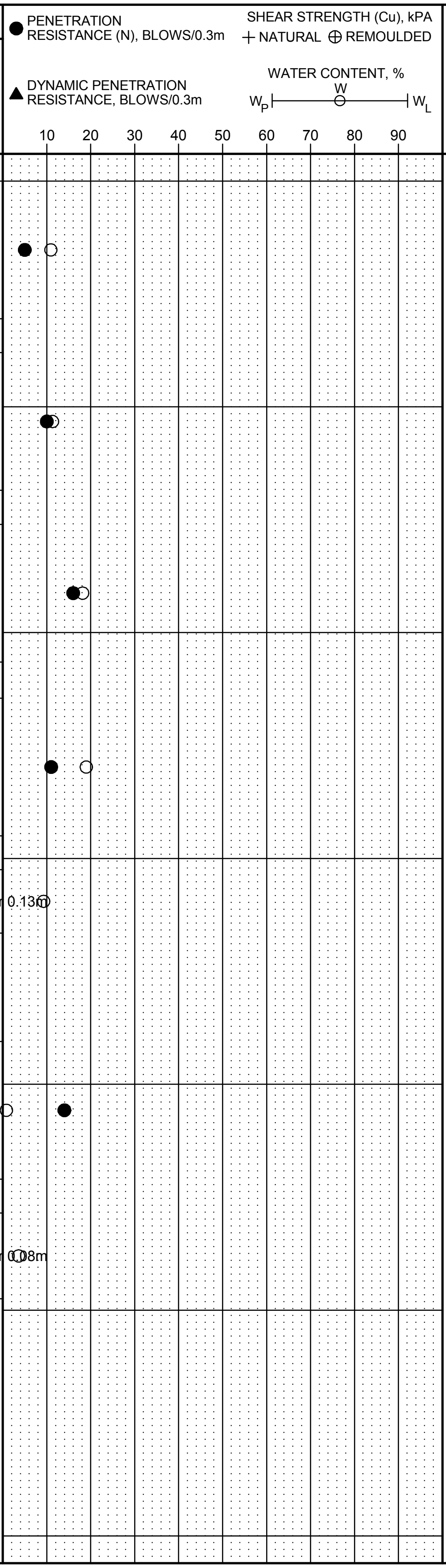
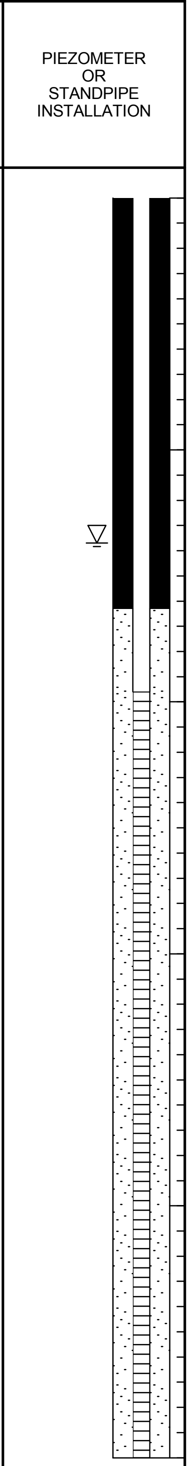
RECORD OF BOREHOLE 20-3

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	Ground Surface	114.64					
	Dark brown sandy silt, some gravel with cobbles and organics (FILL MATERIAL)		1	SS	150	5	
1	Compact, grey brown SAND, some silt	113.60 1.04	2	SS	430	10	M
	Compact, grey SILTY SAND	112.81 1.83	3	SS	310	16	M
2			4	SS	480	11	M
	Compact to very dense, grey gravel, some silt, some sand with cobbles and boulders (GLACIAL TILL)	111.80 2.84					
3			5	SS	150	50 for 0.13m	
4			6	SS	50	14	
			7	SS	200	50 for 0.08m	
5	End of borehole Auger refusal	109.64 5.00					
6							





GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20/09/15	1.4 ∇	113.3

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GEO - BOREHOLE LOG 65057.01_GINT_2020-08-28.GPJ GEMTEC 2018.GDT 22/9/20

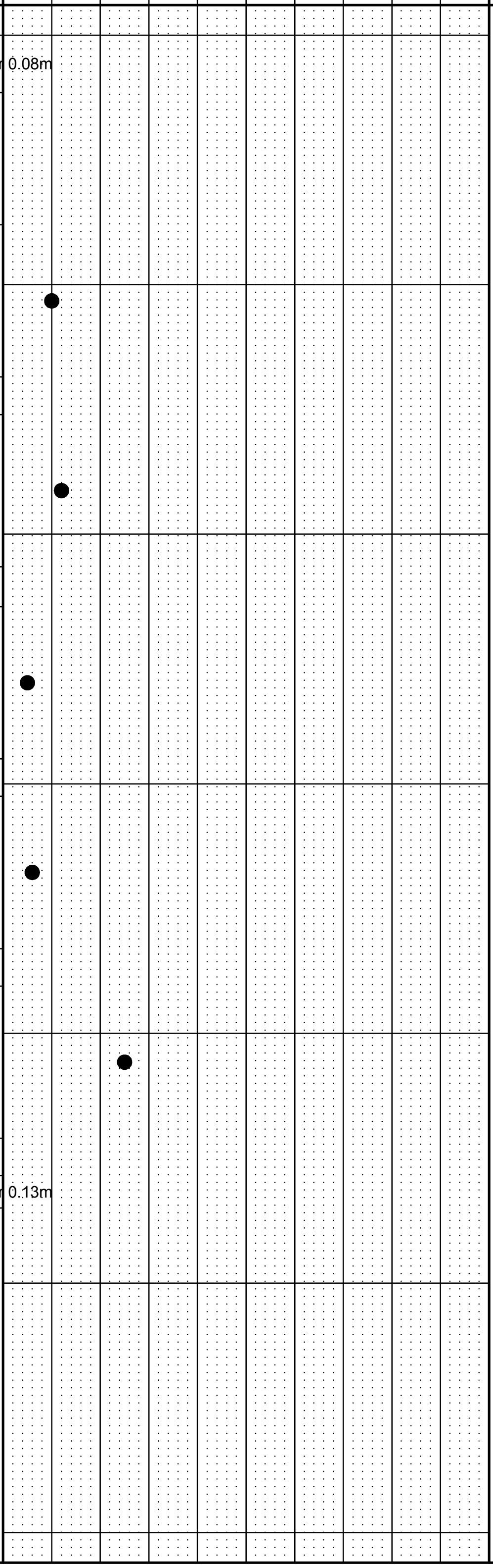
RECORD OF BOREHOLE 20-4

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

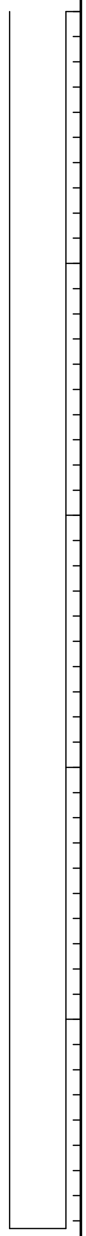
DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Ground Surface	115.00				
	Dark brown sandy silt, some gravel with cobbles and organics (FILL MATERIAL)		1	SS	180	50 for 0.08m
1	Loose to compact, grey brown SAND, some silt	114.04 0.96	2	SS	480	10
2	Loose to compact, grey SILTY SAND	113.28 1.72	3	SS	410	12
	Interbedded grey SILTY SAND and grey SILTY CLAY	112.51 2.49	4	SS	410	5
3			5	SS	460	6
4	Compact to very dense, grey gravel, some silt, some sand with cobbles and boulders (GLACIAL TILL)	111.39 3.61	6	SS	310	25
			7	SS	50	50 for 0.13m
5	End of borehole Auger refusal	110.17 4.83				
6						

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
WATER CONTENT, %
W_P ⊢ W ⊣ W_L



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



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RECORD OF BOREHOLE 20-5

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P ⊢ W ⊣ W_L
10 20 30 40 50 60 70 80 90

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Ground Surface	114.74
	Dark brown silty sand, with organic material (TOPSOIL)	114.41 0.33
	Loose to compact, grey brown SAND, some silt	111.69 3.05
3	Interbedded grey SILTY SAND and grey SILTY CLAY	111.18 3.56
	Compact to very dense, grey silty sandy gravel with cobbles and boulders (GLACIAL TILL)	110.40 4.34
	End of borehole Auger refusal	

NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	SS	330	4
2	SS	410	9
3	SS	460	21
4	SS	460	11
5	SS	380	1
6	SS	80	58 for 0.18

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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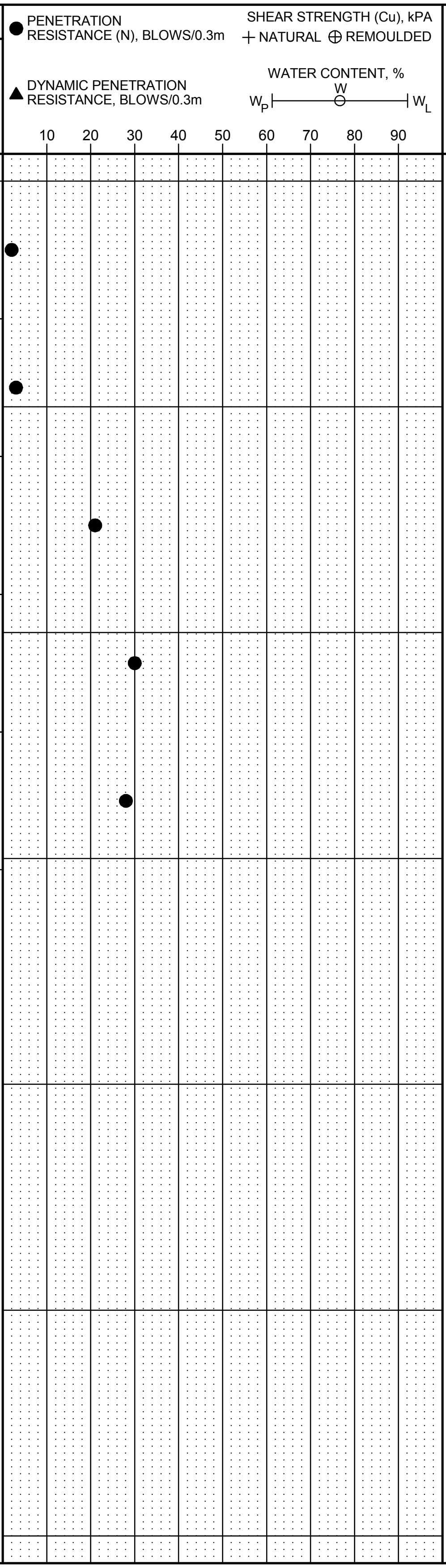
RECORD OF BOREHOLE 20-6

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

SOIL PROFILE		SAMPLES			
DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
Ground Surface	114.55				
Dark brown silty sand, with organic material (TOPSOIL)					
Very loose to compact, grey brown SAND, some silt	114.37 0.18	1	SS	610	2
		2	SS	610	3
		3	SS	480	21
Compact, grey brown SILTY SAND	112.72 1.83	4	SS	510	30
Compact, grey silty sandy gravel with cobbles and boulders (GLACIAL TILL)	112.19 2.36	5	SSS	200	28
End of borehole	111.50 3.05				



DEPTH SCALE METRES: 0, 1, 2, 3, 4, 5, 6

BORING METHOD

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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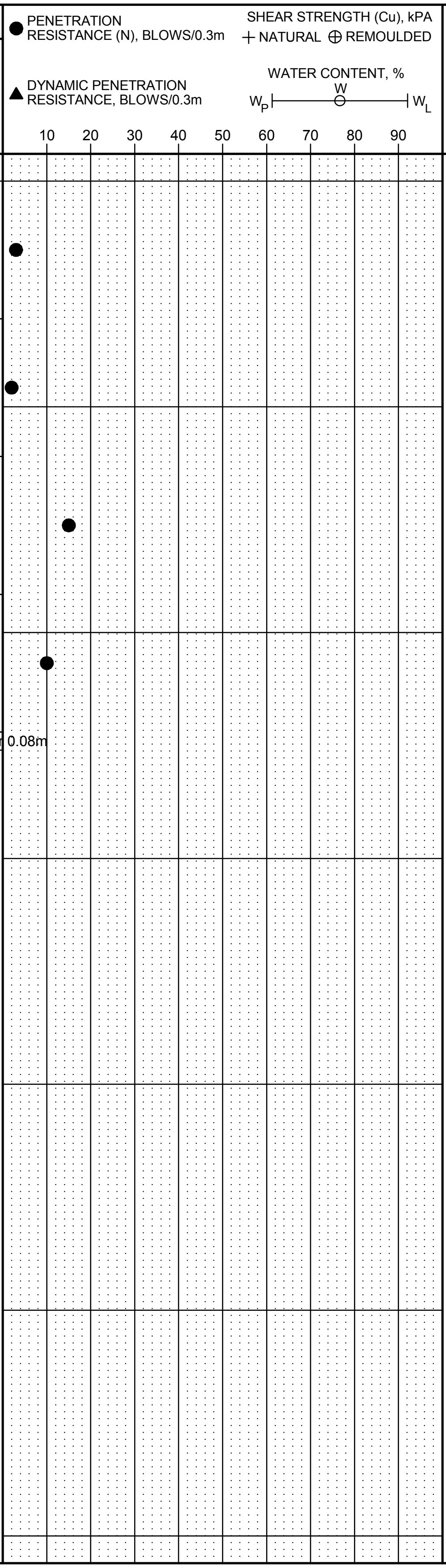
CHECKED: J.B.

RECORD OF BOREHOLE 20-7

CLIENT: 2513287 Ontario Inc.
PROJECT: Geotechnical Investigation
JOB#: 65057.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Aug 21 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0		Ground Surface		114.69				
		Dark brown silty sand, with organic material (TOPSOIL)						
		Very loose to compact, grey brown SAND, some silt		114.49 0.20	1	SS	480	3
					2	SS	530	2
1								
					3	SS	480	15
2					4	SS	480	10
		Very dense, grey silty sandy gravel with cobbles and boulders (GLACIAL TILL)		112.30 2.39	5	SS	80	50 for 0.08m
3		End of borehole		111.64 3.05				
4								
5								
6								



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

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CHECKED: J.B.

APPENDIX B

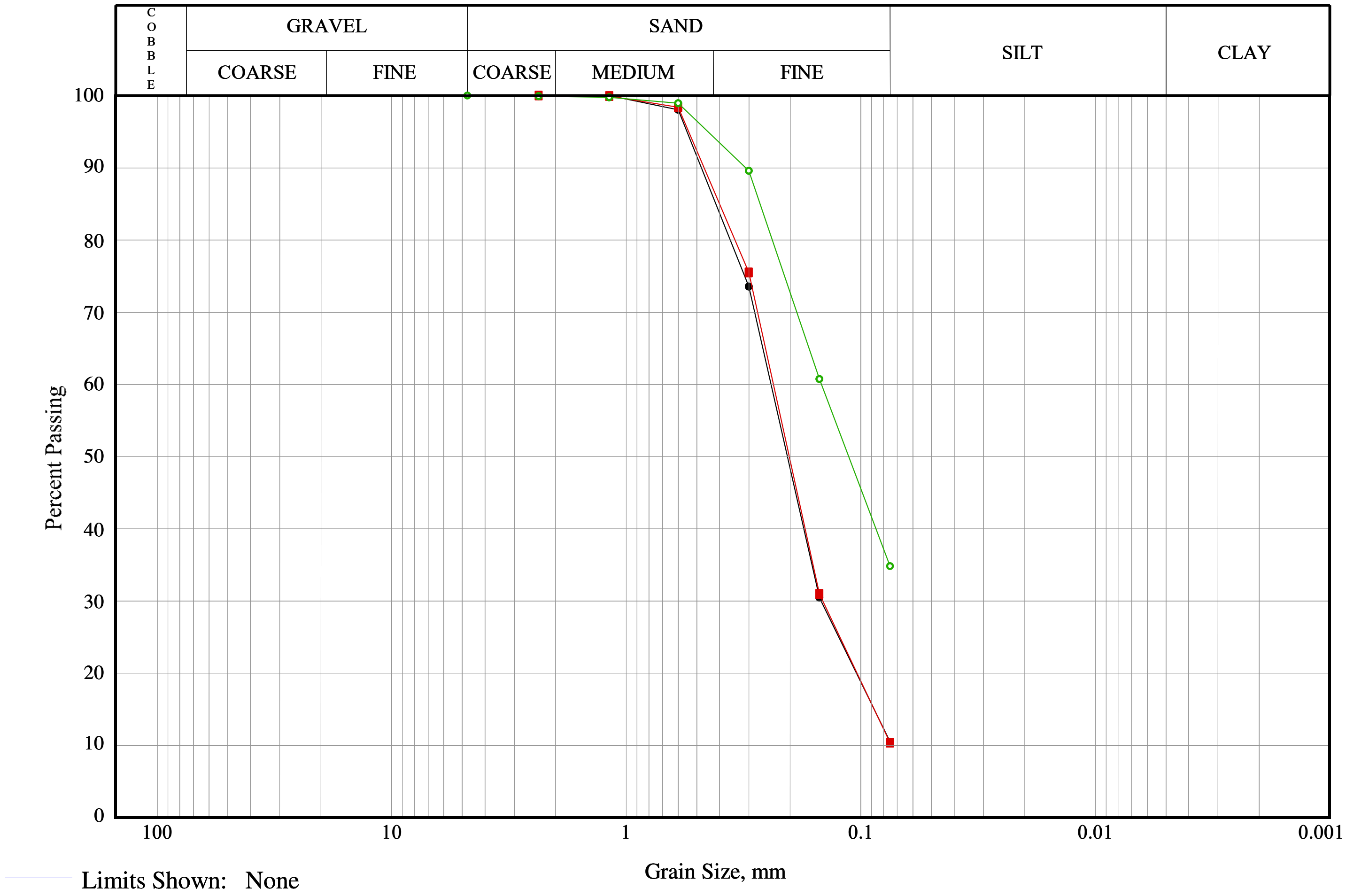
Materials Laboratory Testing
Grain Size Tests

Report to: 2513287 Ontario Inc.
Project: 65057.01 (October 28, 2020)

GEMTEC
Consulting Engineers and Scientists

Client:	2513287 Ontario Inc.
Project:	Geotechnical Investigation, 2822 Carp Road
Project #:	6505701

Soils Grading Chart



Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
—●—	Sand, some silt	20-03	SA 2	0.76-1.37	0.0	89.5	10.5	
—■—	Sand, some silt	20-03	SA 3	1.52-2.13	0.0	89.7	10.3	
—○—	Silty sand	20-03	SA 4	2.28-2.89	0.0	65.2	34.8	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
—●—	Sand , some silt	N/A	---	0.09	0.15	0.21	0.24	0.41	---
—■—	Sand , some silt	N/A	---	0.09	0.15	0.20	0.24	0.40	---
—○—	Silty sand	N/A	---	---	---	0.11	0.15	0.27	---

APPENDIX C

Laboratory Testing
Soil Chemistry Relating to Corrosion

Report to: 2513287 Ontario Inc.
Project: 65057.01 (October 28, 2020)

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Joseph Berkers

Client PO: 65057.01
Project: 65057.01
Custody: 124081

Report Date: 10-Sep-2020
Order Date: 4-Sep-2020

Order #: 2036607

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2036607-01	BH20-04 SA3

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO: 65057.01

Report Date: 10-Sep-2020

Order Date: 4-Sep-2020

Project Description: 65057.01

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	10-Sep-20	10-Sep-20
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	8-Sep-20	9-Sep-20
Resistivity	EPA 120.1 - probe, water extraction	9-Sep-20	10-Sep-20
Solids, %	Gravimetric, calculation	8-Sep-20	9-Sep-20

Certificate of Analysis

Report Date: 10-Sep-2020

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 4-Sep-2020

Client PO: 65057.01

Project Description: 65057.01

	Client ID:	BH20-04 SA3	-	-	-
	Sample Date:	21-Aug-20 12:00	-	-	-
	Sample ID:	2036607-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	84.3	-	-	-
General Inorganics					
pH	0.05 pH Units	7.76	-	-	-
Resistivity	0.10 Ohm.m	111	-	-	-
Anions					
Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	23	-	-	-

experience • knowledge • integrity

civil	civil
geotechnical	géotechnique
environmental	environnementale
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité