Houle Chevrier Engineering

Geotechnical Investigation
Proposed Commercial Building
1795 Montreal Road
Ottawa, Ontario

a GEMTEC company

Submitted to:

cdrg+RedTeam
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Geotechnical Investigation
Proposed Commercial Building
1795 Montreal Road
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September 6, 2017
Project: 64504.01

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out at the site of a proposed commercial building located at 1795 Montreal Road in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a limited number of test holes 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.

This investigation was carried out in general accordance with our proposal dated November 7, 2016.

2.0 PROJECT DESCRIPTION AND SITE GEOLOGY

2.1 Project Description

It is understood that plans are being prepared to construct a 20,000 square foot office building at 1795 Montreal Road in Ottawa (see Key Plan, Figure 1). The existing site is currently undeveloped and is not connected to the municipal sanitary sewer network, thus either the connection to these services or the construction of an onsite septic system will be required. It is understood that the building will be a two storey structure with no basement (slab on grade construction) and will contain a single storey warehousing area in the rear area of the building. The site will have a paved access road/entrance and parking area. The exact location and design details of the building, access way and potential septic system were not available at the time of submission of this report.

The site is approximately 0.4 hectares and is bounded to the south by Montreal Road, to the west by a commercial development and to the north and east by residential developments. The site is currently vacant and contains grasses, shrubs and small trees.

2.2 Review of Geology Maps

Surficial geology maps of the area indicate that the site is underlain by glacial till deposits. Bedrock geology and drift thickness maps indicate that the overburden is underlain by interbedded limestone and dolostone bedrock of the Gull River Formation at depths ranging from about 5 to 10 metres.

3.0 SUBSURFACE INVESTIGATION

The field work for this investigation was carried out on November 22, 2016. At that time, six (6) test pits, numbered 16-1 to 16-6, inclusive, were advanced at the site using a backhoe supplied and operated by Maurice Yelle Excavation Ltd. of Gloucester, Ontario. The test pits were advanced to practical refusal at depths ranging from about 0.4 to 1.4 metres below ground surface (elevations ranging from 92.5 to 99.2 metres, geodetic datum).

The field work was observed by a member of our engineering staff who directed the excavation operations and logged the samples and test pits.

Following completion of the excavation, the soil samples were returned to our laboratory for examination by a geotechnical engineer. Selected samples were submitted for moisture content grain size distribution and Atterberg limit testing. One (1) sample of the soil recovered from test pit 16-1 was sent to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the test pits are provided on the Record of Test Pit sheets in Appendix A. The approximate locations of the test pits are shown on the Test Pit Location Plan, Figure 2. The results of the laboratory classification tests on the soil samples are provided on Figures B1 to B3, inclusive, in Appendix B and on the Record of Test Pit sheets. The results of the chemical analysis of a sample of soil relating to corrosion of buried concrete and steel are provided in Appendix C.

The test pit locations were selected by Houle Chevrier Engineering Limited (HCEL) and positioned on site relative to existing features. The ground surface elevation at the location of the test pits was 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

As previously indicated, the soil and groundwater conditions identified in the test pits are given on the Record of Test Pit sheets in Appendix A. The 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. The precision with which subsurface conditions are indicated depends on the method of excavation, the recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the test pits. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities in the area.

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 HCEL 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 test pits advanced during this investigation.

4.2 Topsoil

A surficial layer of topsoil was encountered in test pits 16-1 to 16-5, inclusive. The topsoil can generally be described as dark brown silty sand with roots. The thickness of the topsoil ranges from about 50 to 200 millimetres.

4.3 Fill Material

Topsoil fill was encountered in test pit 16-6. The topsoil fill consists of dark brown silty sand with roots and has a thickness of about 80 millimetres. A layer of fill material was encountered underlying the surficial topsoil in test pit 16-6. The fill material can be described as dark brown clayey silt with trace sand and contains roots, pieces of wood and brick and weathered bedrock fragments.

4.4 Silty Sand/Sand

Native deposits of sand and silty sand were encountered below the topsoil fill in test pits 16-1 and 16-2. The silty sand deposit is dark brown in colour and contains roots in test pit 16-1 and fragments of weathered bedrock in test pit 16-2. The thickness of the silty sand deposit in test pits 16-1 and 16-2 is about 0.1 and 0.4 metres, respectively.

A native deposit of brown sand with trace silt and fragments of weathered bedrock was found underlying the silty sand layer in test pit 16-1 at a depth of about 0.2 metres below ground surface (elevation 96.0 metres, geodetic datum). The sand deposit has a thickness of about 0.7 metres.

The results of grain size distribution analysis carried out on a sample of sand recovered from test pit 16-1 is provided on Figure B1 in Appendix B. The moisture content of the sand is 9 percent.

4.5 Clay and Silt

A native deposit of weathered, very stiff, dark grey brown clay and silt with trace sand and weathered bedrock fragments was encountered below the topsoil layer in test pit 16-3. The clay and silt deposit was encountered at a depth of 0.2 metres below ground surface (elevation 93.7 metres, geodetic datum) and has a thickness of about 1.2 metres.

The results of grain size distribution analysis carried out on a sample of the weathered clay and silt deposit recovered from test pit 16-3 is provided on Figure B2 in Appendix B. The moisture content of the weathered clay and silt is 38 percent.

The results of the Atterberg limit test carried out a sample of weathered clay and silt recovered from test pit 16-3 are provided on Figure B3 in Appendix B. The results are summarized in Table 4.1.

Table 4.1 – Summary of Atterberg Limit Test Results

Test Pit	Material	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
16-3 (Sample No. 1)	Weathered Clay and Silt	38	52	32	20

This testing indicates that the sample of weathered clay and silt from test pit 16-3 has high plasticity. The water content of the sample tested is between the measured plastic and liquid limit values.

4.6 Bedrock

Weathered, fractured limestone bedrock was encountered at all test pit locations. The test pits were advanced through areas of weathered bedrock, where possible, until practical refusal. The depth and elevation of the inferred bedrock surface encountered in each test pit is summarized in Table 4.2.

Table 4.2 – Inferred Bedrock Surface Depth and Elevation

Test Pit	Inferred Bedrock Depth (metres)	Inferred Bedrock Surface Elevation (metres)
16-1	0.8	95.4
16-2	0.5	97.2
16-3	1.4	92.5
16-4	0.8	96.0
16-5	0.4	98.4
16-6	0.7	99.2

It should be noted that the type and quality of the bedrock was not confirmed through coring.

4.7 Groundwater Level

The groundwater conditions in the open test pits were observed upon completion of excavation. No groundwater seepage was observed in the test pits.

It should be noted that the groundwater conditions were observed during the relatively short period of time that the test pits were left open upon completion of excavation and do not represent stabilized groundwater conditions. Groundwater levels may be higher during wet periods of the year such as early spring or following periods of precipitation.

4.8 Soil Chemistry Relating to Corrosion

The results of chemical testing of a sample of soil from test pit 16-1 are provided in Appendix C and summarized below:

- pH 6.19
- Sulphate Content Not detected (less than 8 micrograms per gram (µg/g))
- Chloride Content Not detected (less than 8 micrograms per gram (µg/g))
- Resistivity 264 Ohm metre (Ohm·m)

5.0 PROPOSED COMMERCIAL DEVELOPMENT

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 Excavation

5.2.1 Overburden Excavation

The excavation for the proposed building will be carried out through topsoil, fill material, and native deposits of sand, and clay and silt. All fill material should be removed from the building areas and, where required, replaced with imported granular material, such as Ontario Provincial Standard Specification (OPSS) Granular B Type II.

The sides of the excavations in the 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 overburden soils 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.

5.2.2 Bedrock Excavation

In the case that some of the footings for the proposed building will be founded below the existing bedrock surface, the bedrock could be removed using large hydraulic excavation equipment (i.e. 40 tonne or larger) in combination with hoe ramming techniques. Prior to hoe ramming, line drilling on close centers should be considered in locations where fracture spacing is greater than 200 millimeters in order to reduce over break and/or under break of the bedrock. The vibration effects of hoe ramming are usually minor and localized. Monitoring of the hoe ramming could be carried out, at least initially, to measure the vibrations to ensure that they are below acceptable threshold values.

Provided that good bedrock excavation techniques are used, the limestone bedrock could be excavated using vertical side walls.

The bedrock below founding level will likely break at a horizontal bedding plane below the design depth of the footings, which may necessitate thickening of the footings, lowering of the footings or raising the grade below the proposed footings with imported granular material.

5.3 Grade Raise Restrictions

Based on the soils and depths of bedrock encountered in this investigation, there are no grade raise restrictions at this site from a geotechnical perspective.

5.4 Groundwater Pumping

If encountered, groundwater inflow from the fill and sand deposits should be controlled by pumping from filtered sumps within the excavation. Suitable detention and filtration will be required before discharging the water to any sewers. The contractor should be required to prepare and submit an excavation and groundwater management plan for review and approval as part of the contract.

5.5 Foundation Design

Based on the results of the investigation, the proposed structure could be founded on conventional spread footings placed either directly on the bedrock or on a pad of compacted granular material (engineered fill) over native sand or silt deposits.

In areas where subexcavation of the bedrock or native overburden deposits is required or the bedrock breaks at a bedding plane below foundation depth, the grade below the proposed building could be raised with imported granular material conforming to OPSS Granular B Type II compacted in maximum 200 millimeter thick lifts to at least 95 percent of the Standard Proctor dry density value. It is suggested that any granular materials used beneath the proposed building be composed of virgin material only for environmental reasons. To provide adequate spread of load below the footings, the material should extend at least 0.5 metres horizontally beyond the edge of the footings and down and out from the point at a slope of 1 horizontal to 1 vertical or flatter. The excavation for the building should be sized to accommodate this fill placement.

Depending on the groundwater level at the time of construction, it may be necessary to install a layer of nonwoven geotextile on the subgrade surface to minimize disturbance and pumping of the subgrade during placement and compaction of the engineered fill material.

For preliminary design purposes, the net geotechnical reaction at Serviceability Limit State (SLS) and factored net geotechnical resistance at Ultimate Limit State (ULS) summarized in Table 5.1 may be used.

Table 5.1 – Summary of Preliminary Bearing Values

Subgrade	SLS Reaction (kPa)	Factored ULS Resistance (kPa)
Native Overburden	100	200
Weathered Bedrock	150	300
Competent Bedrock	500	2000
Engineering Fill over Native Soil or Bedrock	150	300

The post construction total and differential settlement of footings at SLS for the overburden deposits should be less than 25 and 20 millimeters, respectively, provided that all loose or disturbed soil is removed from the bearing surfaces and from below the granular fill. The post construction settlement for foundations bearing on or within the competent bedrock should be negligible, provided that all loose rock is removed from the bearing surfaces.

The foundation walls should be suitably reinforced in areas where the subgrade transitions from overburden to bedrock. The reinforcing should extend at least 3 metres in each direction from the zone of transition.

5.6 Frost Protection of Foundations

All exterior footings for heated portions of the proposed building should be provided with at least 1.5 meters of earth cover for frost protection purposes. Isolated footings located outside of the building footprint or footings located within unheated areas of the building should be provided with at least 1.8 meters of frost cover. If the required depth of earth cover is not practicable, a combination of earth cover and polystyrene insulation could be considered. An insulation detail could be provided upon request. The required depth of frost protection can be reduced by the thickness of any engineered fill material beneath the foundations since engineered fill is non frost susceptible.

The frost cover may not be reduced for footings founded directly on bedrock, since the bedrock is generally weathered and possibly frost susceptible. If weathered bedrock is removed as part of the construction, the exposed competent bedrock subgrade could be assessed for frost susceptibility.

5.7 Foundation Wall Backfill and Drainage

The overburden soils at this site may be frost susceptible and should not be used as backfill against foundation walls. 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.

Where the backfill will ultimately support areas of hard surfacing (pavement, sidewalks or other similar surfaces), the Granular B Type I or II backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor dry density value using suitable vibratory compaction equipment. Light, walk behind compaction equipment should be used next to the foundation walls to avoid excessive compaction induced stress on the foundation walls.

In landscaped areas the backfill material could be compacted to 90 percent of the standard Proctor dry density value, provided that some settlement is acceptable.

Where areas of hard surfacing (concrete, sidewalk, pavement, etc.) abut the proposed building, 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 materials to reduce the effects of differential frost heaving. It is suggested that granular frost tapers be constructed from 1.8 metres below finished grade to the underside of the granular base/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 the slab-on-grade structure provided that the finished floor slab elevation is set above the exterior surface grades.

5.8 Seismic Site Class

Based on the results of the subsurface investigation, together with our experience in the area and published geology maps, the seismic site classification for seismic site response may be taken as Site Class C.

In our opinion, there is no potential for liquefaction of the soils below founding level.

5.9 Slab on Grade Support

To provide predictable settlement performance of the floor slab, all topsoil, fill material, organic material or disturbed soil and debris should be removed from the slab area. The base for the floor slab should consist of at least 300 millimetres of OPSS Granular A. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular A materials be composed of 100 percent crushed rock only, for environmental reasons.

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 using suitable vibratory equipment.

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

The floor slab should be wet cured to minimize shrinkage cracking and slab curling. The slab should be saw cut to about 1/3 the thickness of the slab as soon as curing of the concrete permits, in order to minimized shrinkage cracks.

Proper moisture protection with a vapour retarder should be used for any slab on grade where the floor will be covered by moisture sensitive flooring material or where moisture sensitive equipment, products or environments will exist. The “Guide for Concrete Floor and Slab Construction”, ACI 302.1R-04 should be considered for the design and construction of vapour retarders below the floor slab. The sulphate content of any imported granular material placed below the floor slab should be assessed to determine the appropriate exposure class for the concrete.

5.10 Septic Disposal Bed

It is understood that the proposed septic bed would likely be situated on the northeast corner of the site in the area of the clay and silt deposit. As such, one (1) grain size distribution test was carried out on a sample of the clay and silt deposit recovered from test pit 16-3 from 0.6 to 0.8 metres below ground surface The result of the grain size distribution test is provided on Figure B2 in Appendix B.

Based on an empirical correlation between grain size distribution and percolation rate, the estimated percolation rate, T-time for the sample tested is greater than 50 minutes per centimetre.

5.11 Excavation for Site Services

Excavation for any site services should be carried out as described in Section 5.2.1.

5.12 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the sample of soil recovered from test pit 16-1 was less than 5 micrograms per grams. According to Canadian Standards Association (CSA) “Concrete Materials and Methods of Concrete Construction”, the concentration of sulphate can be classified as low. Therefore any concrete in contact with the native soil could be batched with General Use (GU) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) use on the roadway should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

Based on the resistivity and pH of the sample, the soil in this area can be classified as very aggressive towards unprotected steel. It should be noted that the corrosivity of the soil/groundwater could vary throughout the year due to the application sodium chloride for de-icing.

5.13 Access Roadways and Parking Areas

5.13.1 Subgrade Preparation

In preparation for the construction of the access roadway and parking areas at this site, all topsoil, and any disturbed, wet, organic or deleterious materials should be removed from the proposed subgrade surface. It is not necessary to remove the fill material.

Prior to placing granular fill for the parking areas and access roadway, the exposed subgrade should be proof rolled with a large (minimum 10 tonne) vibratory steel drum roller under dry conditions and assessed and approved by geotechnical personnel. Any soft areas that are evident from the proof rolling should be subexcavated and replaced with suitable, dry earth borrow.

Should it be necessary to raise the roadway/parking area grades, the grade raise fill for the roadway/parking areas could consist of material which meets OPSS specifications for Granular B Type I or II, Select Subgrade Material, or suitable earth borrow. The grade raise fill should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment. It is noted, however, that silty earth borrow materials are sensitive to changes in moisture content, precipitation and frost heaving. As such, unless the earth material placement is planned during the dry period of the year (June to September), precipitation and freezing conditions may restrict or delay adequate compaction of these materials. Based on our experience, the sand, and silt and clay earth borrow materials should be compacted within 4 percent of the optimum moisture content, as defined by the standard Proctor test, to reduce the post construction settlement of the fill material. Depending on the weather conditions, it may be necessary to allow the material to dry prior to compaction.

5.13.2 Flexible Pavement Structures for the Parking Areas and Access Roadway

It is suggested that parking areas and access roadways to be used by light vehicles (cars, etc.) be constructed using the following minimum pavement structure:

- 50 millimetres of asphaltic concrete, over
- 150 millimetres of OPSS Granular A base, over
- 375 millimetres of OPSS Granular B Type II subbase.

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

- 90 millimetres of asphaltic concrete, over
- 150 millimetres of OPSS Granular A base, over
- 450 millimetres of OPSS Granular B Type II subbase.

In the event that the granular pavement structure is constructed directly above the bedrock surface, the suggested minimum pavement structure is:

- 90 millimetres of asphaltic concrete, over
- 150 millimetres of OPSS Granular A base, over
- 150 millimetres of OPSS Granular B Type II subbase.

The above pavement structures assume that the roadway subgrade surface is prepared as described in this report. If the roadway subgrade surface is disturbed or wetted due to construction operations or precipitation, the granular thickness 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.

If the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the Granular B Type II, install a woven geotextile separator between the roadway subgrade surface and the granular subbase material, or a combination of both, to prevent pumping and disturbance to the subbase material. The contractor should be made responsible for their construction access.

Where the new pavement will abut existing pavement, the depths of the granular materials should taper up or down at 5 horizontal to 1 vertical, or flatter to match the depths of the granular material(s) exposed in the existing pavement.

5.13.3 Asphaltic Concrete Type

The asphaltic concrete for the light vehicle areas should consist of 50 millimetres of Superpave 12.5. For heavy vehicle areas the asphaltic concrete surfacing thickness should be increased to 90 millimetres (40 millimetres of Superpave 12.5 over 50 millimetres of Superpave 12.5).

Performance grade PG 58-34 asphaltic cement should be specified for Superpave asphaltic concrete mixes (Traffic Level A or B).

5.13.4 Granular Material Compaction

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

5.13.5 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. The subgrade surfaces should be crowned and shaped to drain to the ditches and/or catch basins to promote drainage of the pavement granular materials.

5.14 Additional Considerations

5.14.1 Effects of Construction Induced Vibration

Some of the construction operations (such as excavation, hoe-ramming, granular material compaction, 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. Assuming that any excavating is carried out in accordance with the guidelines in this report, the magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services in good condition, but may be felt at the nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during the construction so that any damage claims can be addressed in a fair manner.

5.14.2 Winter Construction

In the event that construction is required during freezing temperatures, the subgrade should be protected immediately from freezing using straw, propane heaters and insulated tarpaulins, or other suitable means.

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.

5.14.3 Excess Soil Management Plan

This report does not constitute an excess soil management plan. The disposal requirements for excess soil from the site have not been assessed.

5.14.4 Design Review

It is noted that the information provided in this report pertain only to the geotechnical aspects of the project. 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.

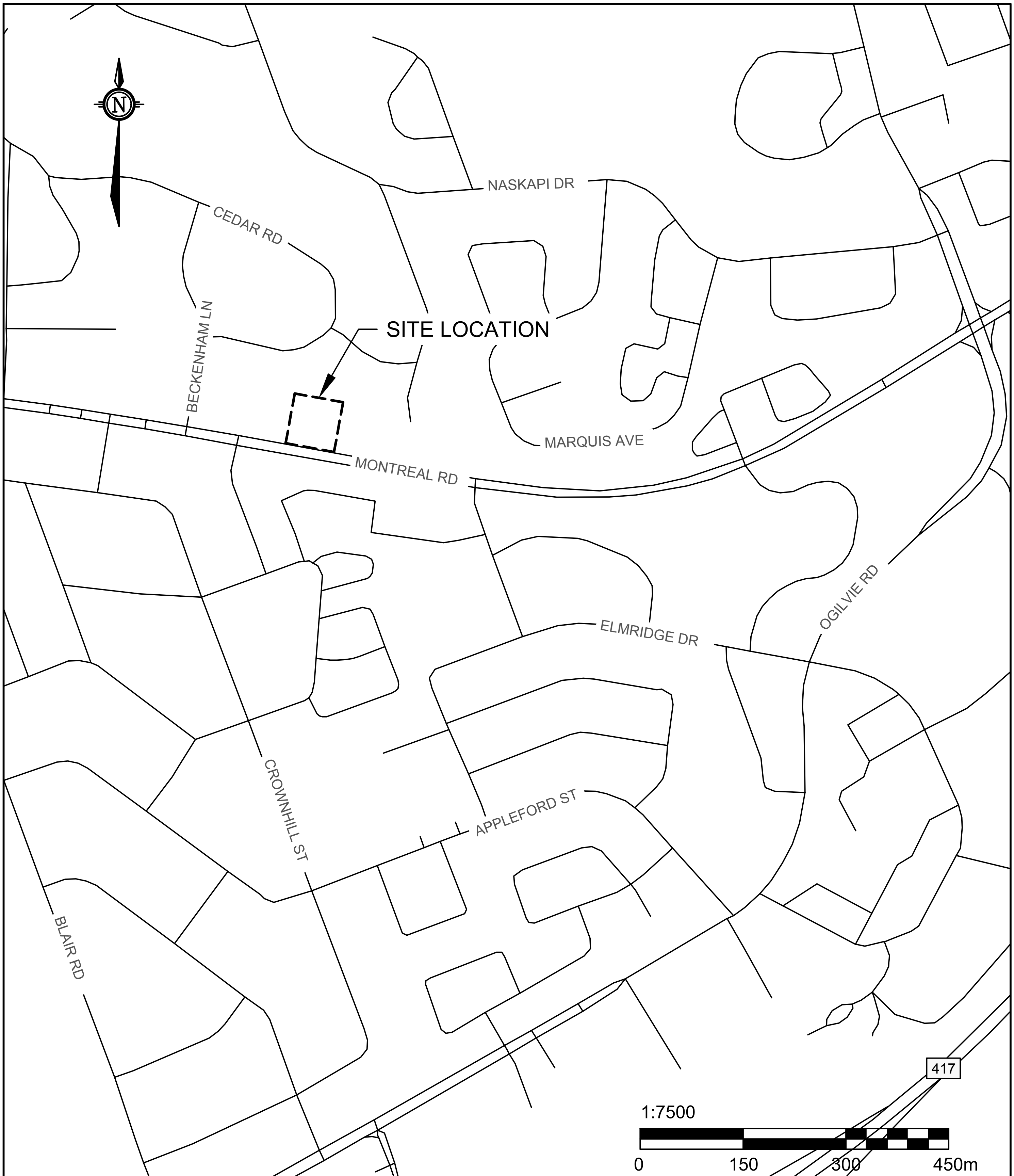
Final details for the proposed development were not available to us at the time of preparation of this report. It is recommended that the final design drawings be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

In accordance with Section 4.2.2.2 of the Ontario Building Code (2015), 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 proposed building, roadways and any 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.

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.

Kelsey Holkestad, B.Eng, E.I.T.

Brent Wiebe, P.Eng.
Senior Geotechnical Engineer



Houle Chevrier Engineering 32 Steacie Drive, Ottawa, ON T: (613) 836-1422 | www.hceng.ca | ottawa@hceng.ca	Project 1795 MONTREAL ROAD, OTTAWA, ON			Drawing KEY PLAN		
	Drwn By K.H.	Chkd By B.W.	Date DECEMBER 2016	Project No. 64504.01	Revision No. 0	FIGURE 1

LEGEND

TP #
ELEV.
TEST PIT LOCATION IN PLAN
(current investigation by Houle Chevrier Engineering Ltd.)

Scale 1:400

0 8 16 24m

Houle Chevrier Engineering

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Client	CDRG+REDTEAM
Project	64504.01
Location	1795 MONTREAL ROAD, OTTAWA, ON
Drwn by	K.H.
Chkd by	B.W.
Title	TEST PIT LOCATION PLAN
Date	DECEMBER 2016
Rev.	0
	FIGURE 2

APPENDIX A

Record of Test Pit Sheets

List of Abbreviations and Terminology

RECORD OF BOREHOLE 16-1

PROJECT: 64504.01

LOCATION: See Test Pit Location Plan, Figure 2

BORING DATE: November 22, 2016

SHEET 1 OF 1

DATUM: Geodetic

SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat. V - + Q - ● rem. V - ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}); WATER CONTENT, PERCENT (Wp W Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Backhoe Tooth Bucket	Ground Surface		96.16							
		Dark brown silty sand TOPSOIL with roots		96.11 0.05							
		Dark brown SILTY SAND with roots		96.01 0.15	1	GS					Backilled with excavated material
		Brown SAND, trace silt with fragments of weathered bedrock		95.35 0.81	2	GS			○	M, See Fig. B1	
		End of Test Pit Refusal on inferred bedrock									No groundwater seepage observed
1											
2											

DEPTH SCALE

1 to 10

Houle Chevrier Engineering

LOGGED: M.L.

CHECKED:

RECORD OF BOREHOLE 16-2

PROJECT: 64504.01
LOCATION: See Test Pit Location Plan, Figure 2
BORING DATE: November 22, 2016

SHEET 1 OF 1
DATUM: Geodetic
SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa nat. V - + Q - ● rem. V - ⊕ U - ○ (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}); WATER CONTENT, PERCENT Wp W Wl (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Backhoe Tooth Bucket	Ground Surface		97.66							
		Dark brown silty sand TOPSOIL with roots		97.61 0.05							Backkilled with excavated material
		Dark brown SILTY SAND with fragments of weathered bedrock		97.21 0.45							
		End of Test Pit									No groundwater seepage observed
		Refusal on inferred bedrock									
1											
2											

DEPTH SCALE
1 to 10

Houle Chevrier Engineering

LOGGED: M.L.
CHECKED:

BOREHOLE LOG GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER 2015.GDT 9/12/16

RECORD OF BOREHOLE 16-3

PROJECT: 64504.01
LOCATION: See Test Pit Location Plan, Figure 2
BORING DATE: November 22, 2016

SHEET 1 OF 1
DATUM: Geodetic
SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80) / SHEAR STRENGTH Cu, kPa (nat. V - +, Q - ●, rem. V - ⊕, U - ○) (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}) / WATER CONTENT, PERCENT Wp —○W— Wl (20, 40, 60, 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		93.88							
0	Backhoe, Tooth Bucket	Dark brown silty sand TOPSOIL with roots		93.68 0.20							Backfilled with excavated material
		Very stiff, dark brown CLAY AND SILT, trace sand with weathered bedrock fragments (Weathered Crust)		92.53 1.35	1	GS				MH, See Fig. B2	
1											
		End of Test Pit Refusal on inferred bedrock									No groundwater seepage observed
2											

DEPTH SCALE
1 to 10

Houle Chevrier Engineering

LOGGED: M.L.
CHECKED:

BOREHOLE LOG GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER 2015.GDT 9/12/16

RECORD OF BOREHOLE 16-4

PROJECT: 64504.01
LOCATION: See Test Pit Location Plan, Figure 2
BORING DATE: November 22, 2016

SHEET 1 OF 1
DATUM: Geodetic
SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat. V - + Q - ● rem. V - ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}); WATER CONTENT, PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		96.76							
0	Backhoe Tooth Bucket	Dark brown silty sand TOPSOIL with roots		96.61 0.15							
		Fractured, weathered limestone BEDROCK		95.95 0.81							Backilled with excavated material
		End of Test Pit Refusal on inferred bedrock									No groundwater seepage observed
1											
2											

DEPTH SCALE
1 to 10

Houle Chevrier Engineering

LOGGED: M.L.
CHECKED:

BOREHOLE LOG GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER 2015.GDT 9/12/16

RECORD OF BOREHOLE 16-5

PROJECT: 64504.01
LOCATION: See Test Pit Location Plan, Figure 2
BORING DATE: November 22, 2016

SHEET 1 OF 1
DATUM: Geodetic
SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat. V - + Q - ● rem. V - ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-4} 10^{-3} 10^{-2}); WATER CONTENT, PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		98.81							
0	Backhoe Tooth Bucket	Dark brown silty sand TOPSOIL with roots		98.76 0.05							Backilled with excavated material
		Fractured, weathered limestone BEDROCK		98.38 0.43	1	GS					
		End of Test Pit Refusal on inferred bedrock									No groundwater seepage observed
1											
2											

DEPTH SCALE
1 to 10

Houle Chevrier Engineering

LOGGED: M.L.
CHECKED:

BOREHOLE LOG GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER 2015.GDT 9/12/16

RECORD OF BOREHOLE 16-6

PROJECT: 64504.01
LOCATION: See Test Pit Location Plan, Figure 2
BORING DATE: November 22, 2016

DATUM: Geodetic
SPT HAMMER:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Backhoe Tooth Bucket	Ground Surface	99.91				
		Dark brown silty sand with roots (TOPSOIL FILL)	99.83 0.08				Backilled with excavated material
		Dark brown clayey silt, trace sand with roots, pieces of wood and brick, and weathered bedrock fragments (FILL MATERIAL)	99.22 0.69	1	GS		
		End of Test Pit Refusal on inferred bedrock					No groundwater seepage observed
1							
2							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat. V - + Q - ● rem. V - ⊕ U - ○ : 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-5} 10^{-4} 10^{-3} 10^{-2}
WATER CONTENT, PERCENT: Wp W Wl: 20 40 60 80
ADDITIONAL LAB. TESTING

DEPTH SCALE
1 to 10

Houle Chevrier Engineering

LOGGED: M.L.
CHECKED:

BOREHOLE LOG GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER 2015.GDT 9/12/16

LIST OF ABBREVIATIONS AND TERMINOLOGY

SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
MS manual sample
RC rock core
ST slotted tube
TO thin-walled open Shelby tube
TP thin-walled piston Shelby tube
WS wash sample

PENETRATION RESISTANCE

Standard Penetration Resistance, N

The number of blows by a 63.5 kg hammer dropped 760 millimetres required to drive a 50 mm drive open sampler for a distance of 300 mm. 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 hammer dropped 760 mm to drive a 50 mm diameter, 60^{o} cone attached to 'A' size drill rods for a distance of 300 mm.

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.

SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH sieve and hydrometer analysis
U unconfined compression test
Q undrained triaxial test
V field vane, undisturbed and remoulded shear strength

SOIL DESCRIPTIONS

Relative Density	'N' Value
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

Consistency	Undrained Shear Strength (kPa)
Very soft	0 to 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very Stiff	over 100

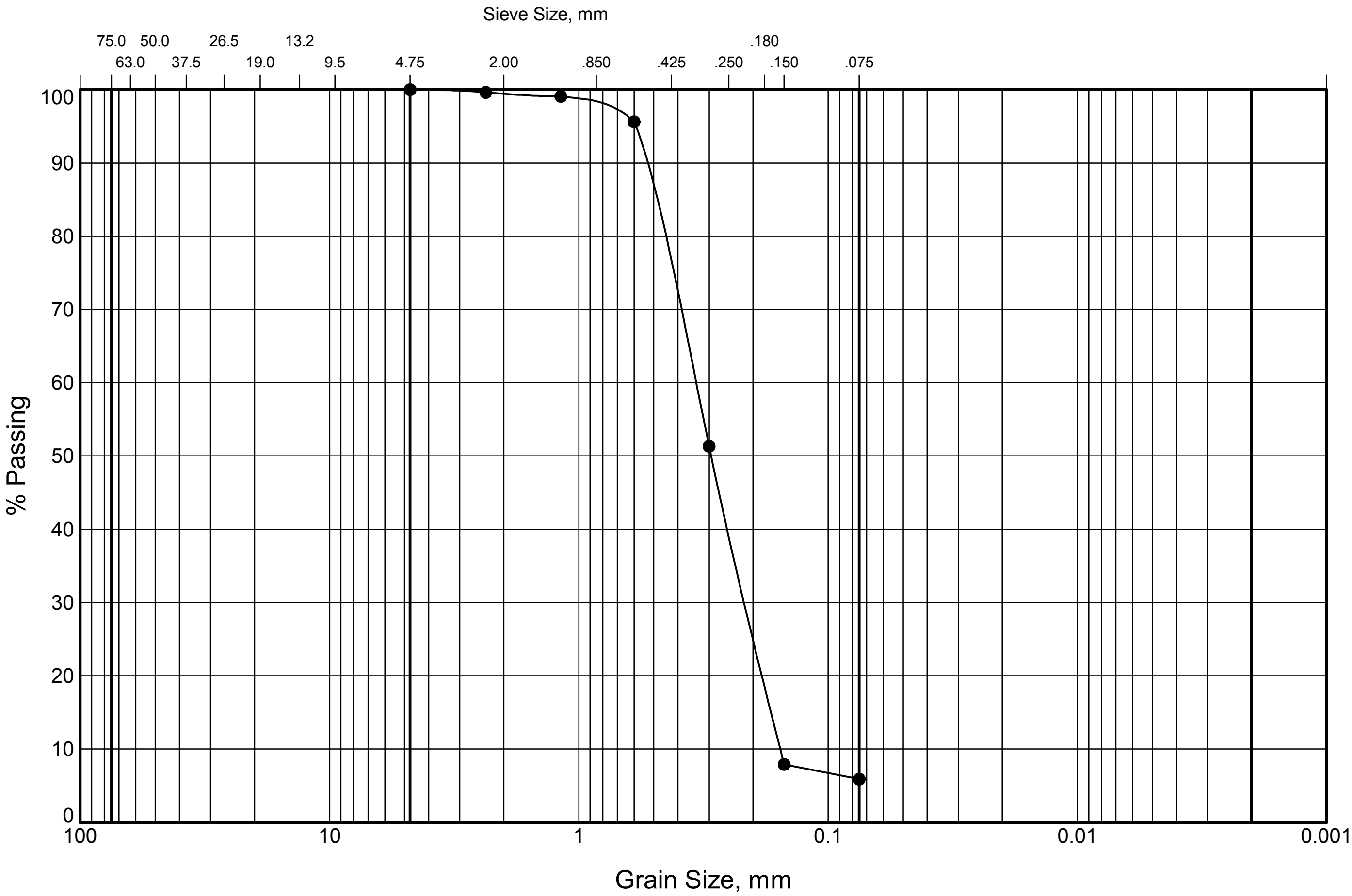
LIST OF COMMON SYMBOLS

c_u undrained shear strength
e void ratio
C_c compression index
c_v coefficient of consolidation
k coefficient of permeability
I_p plasticity index
n porosity
u pore pressure
w moisture content
w_L liquid limit
w_P plastic limit
ϕ^1 effective angle of friction
γ unit weight of soil
γ^1 unit weight of submerged soil
σ normal stress

APPENDIX B

Laboratory Test Results
Figures B1 to B3

GRAIN SIZE DISTRIBUTION Sand	FIGURE B1



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL		SAND			

Legend	Test pit	Sample	Depth (m)	% Gravel	% Sand	% Silt & Clay
●	16-1	2	0.4 - 0.5	0	94	6

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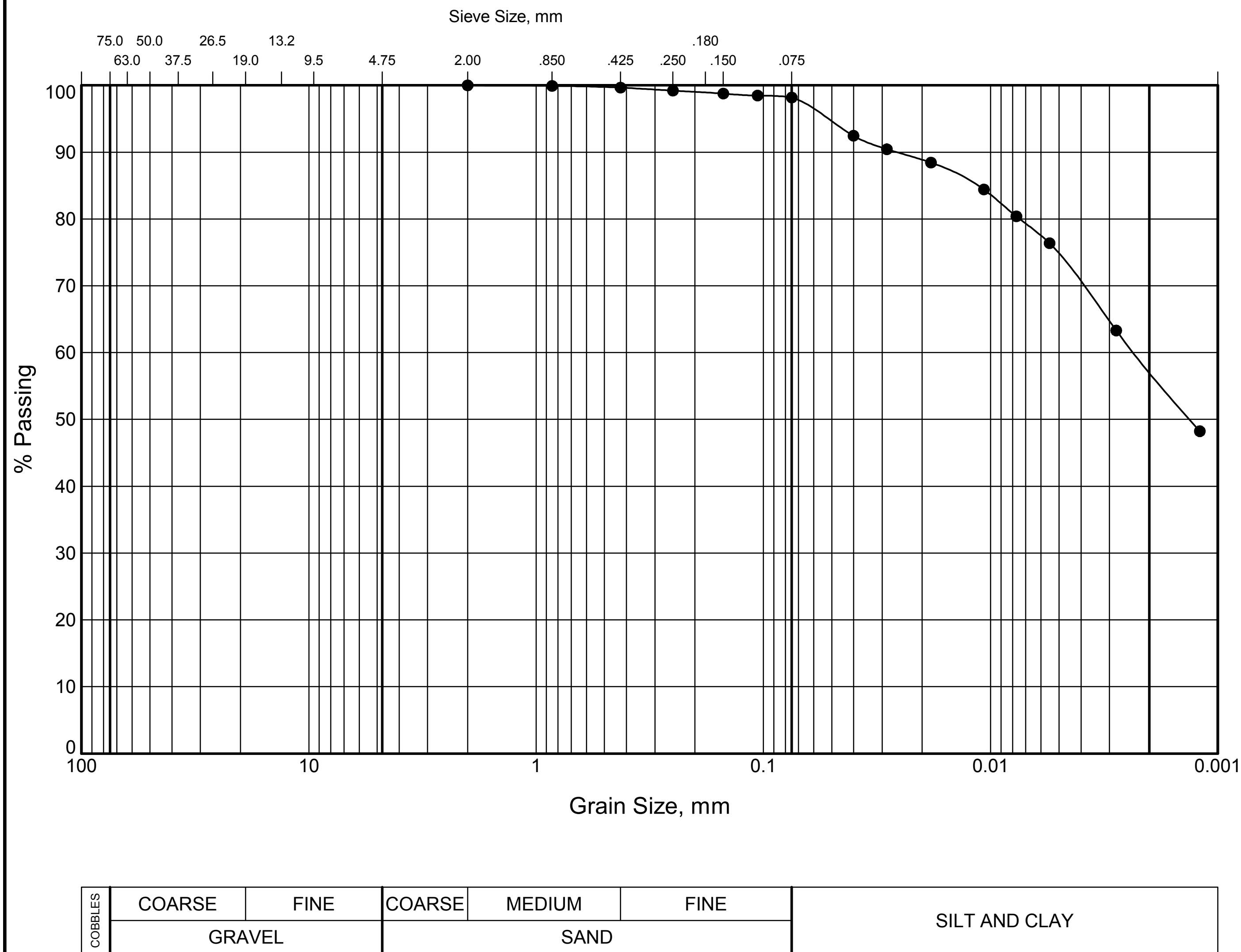
Date: December 2016

Project: 64504.01

GRAIN SIZE DISTRIBUTION

Clay and Silt

FIGURE B2



Legend	Test pit	Sample	Depth (m)	% Gravel	% Sand	% Silt	% Clay
●	16-3	1	0.6 - 0.8	0	2	41	57

SOILS GRAIN SIZE GRAPH UNIFIED % (SIEVE) GINT_6450401_TESTPITS_V01_22-11-2016.GPJ HOULE CHEVRIER FEB 9 2011.GDT 2/12/16

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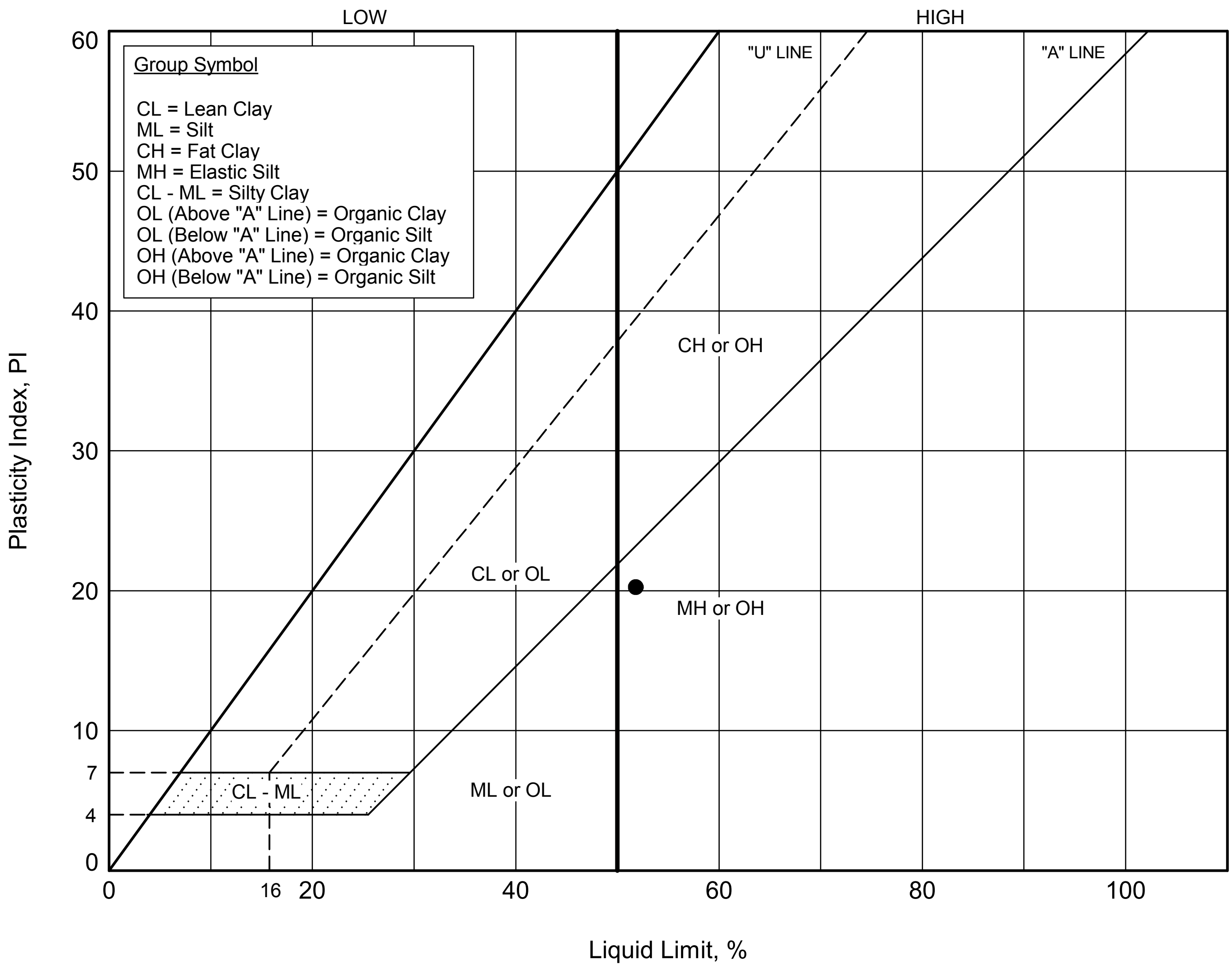
Date: December 2016

Project: 64504.01

PLASTICITY CHART

FIGURE B3



Legend	Test pit	Sample	Depth (m)	Water Content %	LL %	PL %	PI %
●	16-3	1	0.6 - 0.8	38.1	51.8	31.5	20.3

Houle Chevrier Engineering

Date: December 2016

Project: 64504.01

APPENDIX C

Chemical Test Results on Soil Sample
Corrosion of Buried Concrete and Steel
Paracel Laboratories Ltd. Order No. 106371

Certificate of Analysis
Client: Houle Chevrier
Client PO:

Report Date: 06-Dec-2016
Order Date: 1-Dec-2016
Project Description: 64504.01

	Client ID:	TP16-1 SA-2	-	-	-
	Sample Date:	22-Nov-16	-	-	-
	Sample ID:	1649393-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	91.9	-	-	-
General Inorganics					
pH	0.05 pH Units	6.19	-	-	-
Resistivity	0.10 Ohm.m	264	-	-	-
Anions					
Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	<5	-	-	-

geotechnical

environmental

hydrogeology

materials testing & inspection

experience • knowledge • reliability