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Geotechnical Investigation
Proposed Commercial Building
4 Campbell Reid Court

Ottawa, Ontario

experience • knowledge • integrity   expérience • connaissance • intégrité

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Submitted to:

TSH Custom Homes
26 Leaver Avenue
Ottawa, Ontario
K2E 5P6

Geotechnical Investigation Proposed Commercial Building 4 Campbell Reid Court
Ottawa, Ontario

August 19, 2022
Project: 65103.01

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON, Canada
K2K 2A9

August 19, 2022

File: 65103.01 – R01

TSH Custom Homes
26 Leaver Avenue
Ottawa, Ontario
K2E 5P6

Attention: Mr. Tim Streek

**Re: Geotechnical Investigation
Proposed Commercial Building
4 Campbell Reid Court
Ottawa, Ontario**

Enclosed is our geotechnical investigation report for the above noted project. This report was prepared in accordance with the scope of the geotechnical work provided in our proposal dated April 13, 2021. This report was prepared by Gregory Davidson, P.Eng. and Daire Cummins, M.Sc.E and reviewed by Brent Wiebe, P.Eng.

Daire Cummins

p.p. Greg Davidson, P.Eng.
Geotechnical Engineer

Daire Cummins, M.Sc.E.

GD/DC/BW

Enclosures
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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the proposed commercial building located at 4 Campbell Reid Court in the City of 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 pits 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 the geotechnical aspects of our proposal dated April 13, 2021.

2.0 PROJECT DESCRIPTION AND SITE GEOLOGY

2.1 Project Description

In preparation for an application to construct, a geotechnical investigation is required for the proposed commercial building to be located at 4 Campbell Reid Court, in the City of Ottawa, Ontario.

Based on a preliminary drawing provided to GEMTEC Consulting Engineers and Scientists Limited (GEMTEC), it is understood that a commercial building is to be constructed on the west side of the existing property at 4 Campbell Reid Court. It is understood that the existing dwelling on the property will remain.

The proposed building will have a footprint of about 557 metres square and will be slab-on-grade (i.e., basementless) construction. The development will also include an asphalt surfaced access road and gravel surfaced parking section.

2.2 Site Geology

Surficial geology maps of the Ottawa area indicate that the proposed site has an overburden thickness of about 0 to 1 metres.

Given the relatively shallow depth to bedrock a soil type is not provided on the maps. Available record of previous investigations in the wider area indicate bedrock and thin layers of fine grained soils (described as clay) over bedrock. In addition, fill material associated with the past and current development the site should be anticipated.

Bedrock geology maps of the area show that the overburden deposits are underlain by Paleozoic aged sandstone and dolostone bedrock of the March Foundation at depths of about 0 to 1 metres.

3.0 METHODOLOGY

3.1 Geotechnical Investigation

The field work for this investigation was carried out on June 23, 2021. At that time, five (5) test pits numbered 21-1 to 21-5, inclusive, were advanced at the site by C&C Services of Renfrew, Ontario to depths ranging from about 1.0 to 1.3 metres below existing grade (elevations 91 to 92 metres, geodetic). The test pits were advanced using a 3.5 tonne rubber track excavator using a toothed bucket.

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

Following completion of the test pitting, the soil samples were returned to our laboratory for examination by a geotechnical engineer and for classification testing. One (1) sample of the soil recovered from test pit 2 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 and ground surface elevations of the test pits are shown on the Test Pit Location Plan, Figure 1. The laboratory testing results are provided on the Soil Grading and Plasticity charts in Appendix B. The results of the chemical analysis of soil sample relating to corrosion of buried concrete and steel are provided in Appendix C.

The test pit locations were selected by GEMTEC and positioned on site relative to existing features. The ground surface elevations at the location of the test pits were determined using a Trimble R10 global positioning system. The coordinates and elevations of the ground surface at the test pit locations 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 test pitting, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test pit locations may vary from the conditions encountered in the boreholes and 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 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 groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. Groundwater conditions may vary seasonally or as a consequence of construction activities in the area.

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

4.2 Fill Material

A surficial layer of uncontrolled fill material was encountered at all test pit locations. The fill material is variable across the site but can generally be described as dark brown/grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders, and construction debris. The thickness of the fill material ranges from 0.3 to 1.0 metres at the test pit locations, noting that greater or lesser thickness of fill may be present at other locations. The fill material at test pit 21-1 transitions to dark brown silty clay with trace to some sand and gravel with organic material at about 0.3 metres depth.

The results of grain size distribution testing on a sample of the fill material from test pit 21-1 are provided on the Soils Grading Charts in Appendix B and summarized in Table 4.1.

Table 4.1 – Summary of Grain Size Distribution Testing (Fill Material)

Borehole	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt and Clay (%)
21-1	1	0.0-0.9	25.9	32.4	41.7

Moisture content testing carried out on samples of the fill material indicate moisture contents of between about 11 and 17 percent.

Note that fill material associated with the existing structure on site is also present, but could not be investigated.

4.3 Former Topsoil

A layer of former topsoil material was encountered at all test pit locations below the surficial fill material with the exception of test pit 21-1. The former topsoil consists of dark brown silty clay with organic material. The thickness of the former topsoil material is about 0.2 metres.

4.4 Glacial Till

Native deposits of glacial till were encountered at test pit locations 21-1, 21-2, 21-3, and 21-5 below the former topsoil layer at depths ranging from about 0.9 to 1.2 metres below existing grade (elevation 91.9 to 92.1 metres). Glacial till is a heterogeneous mixture of all grain sizes; however, at this site the glacial till can generally be described brown silty sand with trace to some clay and trace amounts of gravel. Cobbles and boulder size fragments of rock can also frequently be encountered in glacial till. The thickness of the glacial till ranges from about 0.1 to 0.2 metres and extends to depths ranging from about 1.0 to 1.3 metres below existing grade (elevation 91.8 to 92.0 metres).

The results of grain size distribution testing on samples of the glacial till from test pit 21-1 and 21-5 are provided on the Soil Grading Charts in Appendix B and summarized in Table 4.2.

Table 4.2 – Summary of Grain Size Distribution Testing (Glacial Till)

Borehole	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt and Clay (%)
21-1	3	1.1-1.3	3.7	53.3	43.0
21-5	3	1.2-1.3	4.7	61.8	33.5

Moisture content testing carried out on samples of the glacial till indicate moisture contents of between about 18 and 26 percent.

4.5 Shovel Refusal

Practical shovel refusal to excavation occurred at depths ranging from about 1.0 to 1.3 metres below existing grade (elevation 91.8 to 92.0 metres) at all test pit locations on the inferred surface of bedrock.

It should be noted that the depth to shovel refusal is not necessarily an indication of the depth to bedrock, and may occur on for instance, on nested boulders or rock, or on a zone of fractured / weathered bedrock above the rock head level. The depth that shovel refusal occurs is also a function of the excavation equipment used.

4.6 Groundwater

Minor groundwater seepage was observed at the bottom of test pit 21-3 at a depth of about 1.0 metres below existing grade during the relatively short period the test pit was open. All other test pits were dry prior to backfilling. No standpipe piezometers were installed as part of this investigation.

It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

Also a perched groundwater level may be present within the fill material.

4.7 Soil and Groundwater Chemistry Relating to Corrosion

The results of chemical testing of a soil sample from test pit 21-2 are provided in Appendix C and summarized in Table 4.3.

Table 4.3 – Chemical Testing of Soil Samples

TP	Sample	pH	Sulphate Content (micrograms per gram)	Chloride Content (micrograms per gram)	Resistivity (Ohm metres)
21-2	3	6.9	119	10	58.2

5.0 GEOTECHNICAL GUIDELINES AND RECOMMENDATIONS

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the test pits advanced as part of this investigation and the project requirements. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for 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 offsite sources are outside the terms of reference for this report and have not been investigated or addressed.

5.2 Grade Raise Restrictions

Based on the subsurface conditions encountered in the test pits grade raise filling is not of concern from a geotechnical perspective and therefore no practical restrictions are applicable.

5.3 Excavation

Based on the test pits advanced across the property, the excavations for the proposed building will be carried out mostly through uncontrolled fill, topsoil, and glacial till which should not present unusual constraints.

The test pits excavated at site were stable on completion at depth of 1.0 to 1.3 metres which suggests good conditions for excavations.

The sides of the excavation 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 material 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.

In the event that a granular pad is necessary below the foundations, the excavations should be sized to accommodate a pad of imported granular material which extends at least 0.5 metres horizontally beyond the edge of the footings and down and out from this point at 1 horizontal to 1 vertical, or flatter. Excavated topsoil may be stockpiled for landscaping.

5.4 Bedrock Excavation

At the time of preparation of this report, the underside of footing level is unknown, however, bedrock excavation may be required for the proposed development (for foundation or service trench excavations). To reduce construction costs we suggest that the foundation levels and site grading be selected to reduce the potential for bedrock to be encountered within the depth of excavation.

If bedrock removal is to be carried out, weathered / fractured bedrock is likely excavatable to shallow depth using large hydraulic excavation equipment. In competent bedrock this typically requires hoe ramming techniques in conjunction with line drilling on close centres. The sides of the bedrock excavation should stand near vertical, however, to protect workers, the sides of the excavation should be scaled to remove all loose rock material.

It is noted that the bedrock typically contains near vertical joints and bedding planes. Therefore, some vertical and horizontal over break of the bedrock should be expected. In order to reduce over break and/or under break of the bedrock in areas where the excavation will be carried out next to an existing site service and along the perimeter of the excavation, it is suggested that the limit of excavation be defined by line drilling on close centres. For the bedrock at this site, it is suggested that allowance be made for line drilling 75 to 100 millimetre diameter holes on 200 to 300 millimetre centres.

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 the acceptable threshold value.

5.5 Groundwater Pumping

Groundwater inflow from the overburden deposits into the excavations could be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant effect on nearby structures and services.

Due to the limited extent of this investigation, the potential groundwater in flow from the bedrock is currently unknown to us. If the depth of excavation at the site extends below the depth of refusal of the test pits, into for instance, weathered / fractured rock or more competent bedrock, a groundwater monitoring well could be installed and sealed within the bedrock in order to determine the dewatering requirements for bedrock excavation. Groundwater inflow into (for instance) trench excavations through fractured rock can be significant.

5.6 Footing Design

Based on the results of the investigation, the proposed building could be founded on or within glacial till or bedrock or on an engineered pad above the glacial till and/or bedrock. The foundations could consist of conventional concrete spread footing foundations or an integrated concrete slab with a thickened perimeter.

The fill material, former topsoil materials are not considered suitable for support of the foundations. All fill material and former topsoil should be removed below the proposed foundations and floor slabs. In addition any existing controlled fill material associated with the existing structure should be removed. Given the relatively thin, nature of the glacial till, and as the glacial till may not be present as a continuous layer, to reduce the potential for differential settlement to occur consideration should be given to removing this layer and founding the structure on inferred bedrock or engineered fill over bedrock.

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 0.5 metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter. The excavation for the foundation should be sized to accommodate this fill placement.

The spread footing foundations should be sized using the bearing pressures provided in Table 5.1.

Table 5.1 – Foundation Bearing Pressures

Subgrade Material	Geotechnical Reaction at Servicability Limit State (kilopascals)	Factored Geotechnical Resistance at Ultimate Limit State (kilopascals)
Native, undisturbed glacial till or a pad of engineered fill above native glacial till	120[1]	250
Pad of engineered fill above competent bedrock	250[1]	450

Notes:

1. Provided that the subgrade surface and engineered fill are prepared as described in this report, the post construction total and differential settlement of the footings at SLS should be less than 25 and 15 millimetres, respectively.
2. The geotechnical reaction at SLS for 25 millimetres of settlement will be greater than the factored resistance at ULS; as such, ULS conditions will govern for footings founded directly on the competent bedrock surface.

5.7 Seismic Site Class and Liquefaction Potential

Based on the results of the site investigation and in accordance with Table 4.1.8.4.A of the Ontario Building Code, 2012, Site Class C could be used for the seismic design of the proposed building.

Consideration could be given to carrying out shear wave velocity testing to evaluate whether a more favourable Site Class (i.e., A or B) can be obtained. Further details regarding shear wave velocity testing could be provided upon request.

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

5.8 Frost Protection of the Foundations and Slab

The native soils at this site are frost susceptible. All exterior footings in unheated portions of the proposed structures or slabs should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated exterior footings adjacent to surfaces that 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.

It should be noted that fractured bedrock can also in some instances be susceptible. The bedrock surface should be inspected by a suitably qualified person to verify the frost susceptibility of the rock.

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.

5.9 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.

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 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 structure at this site, provided that the floor slab level is above the finished exterior ground surface level.

5.10 Slab on Grade Support

Based on the results of the investigation, the area in the vicinity of the proposed building is generally underlain by uncontrolled fill and former topsoil followed by relatively thin native overburden deposits over inferred bedrock. The existing fill and former topsoil and any disturbed soil should be removed from the slab on grade area. In addition any existing engineered fill material associated with the existing structure should also be removed. It may be possible to reuse some of these materials, subject to testing and inspection.

The grade below the concrete slab on grade 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. A similar approach could be taken to any filling required within the footprint of the existing structure.

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.

5.11 Curing

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 minimize shrinkage cracks.

5.12 Moisture Protection

Proper moisture protection with a vapour retarder should be used for the slabs 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 slabs.

5.13 Access Roadway/Parking Lot Areas

5.13.1 Subgrade Preparation

In preparation for access roadway/parking lot construction at this site, all surficial topsoil, fill material and any soft, wet or deleterious materials should be removed from the proposed roadway areas.

Prior to placing granular material the exposed subgrade should be inspected and approved by geotechnical personnel. Any soft areas should be subexcavated and replaced with suitable (dry) earth borrow or well shattered and graded rock fill material that is frost compatible with the materials exposed on the sides of the area of subexcavation.

Similarly, should it be necessary to raise the roadway/parking lot grades at this site, material which meets OPSS specifications for Select Subgrade Material, Earth Borrow or well shattered and graded rock fill material may be used.

The Select Subgrade material or Earth Borrow 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. Rock fill should also be placed in maximum 500 millimetre thick lifts and suitably compacted either with a large drum roller, the haulage and spreading equipment, or a combination of both.

Truck traffic should be avoided on the native soil subgrade or the trench backfill within the roadways/parking lot areas especially under wet conditions.

5.13.2 Pavement Structure

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

- 60 millimetres of hot mix asphaltic concrete (40 millimetres of Superpave 12.5 (Traffic Level B) over 40 millimetres of Superpave 19.0 (Traffic Level B)), over
- 150 millimetres of OPSS Granular A base over
- 300 millimetres of OPSS Granular B, Type II subbase

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

- 90 millimetres of hot mix asphaltic concrete (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 subbase

It is noted that, if a gravel parking lot is being considered, the above pavement structures could be used, excluding the hot mix asphalt concrete layers.

If bedrock is encountered at subgrade level, it may be possible to reduce the granular subbase thickness provided above to 150 millimetres.

The above pavement structures assume that the access roadway and parking lot subgrade surfaces are prepared as described in this report. If the subgrade surfaces become disturbed or wetted due to construction operations or precipitation, the granular subbase thicknesses given above may not be adequate and it may be necessary to increase the thickness of the subbase and/or to incorporate a woven geotextile separator between the subgrade surfaces and the granular subbase material. The adequacy of the design pavement thicknesses 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 subbase layer, 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.

5.13.3 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified for Superpave asphaltic concrete mixes.

5.13.4 Pavement Transitions

As part of the access roadway/parking lot construction, the new pavement will abut the existing pavement at Dunrobin Road. The following is suggested to improve the performance of the joint between the new and the existing pavements:

- Neatly saw cut the existing asphaltic concrete;
- Remove the asphaltic concrete and slope the bottom of the excavation within the existing granular base and subbase at 1 horizontal to 1 vertical, or flatter, to avoid undermining the existing asphaltic concrete.
- To avoid cracking of the asphaltic concrete due to an abrupt change in the thickness of the roadway granular materials where new pavement areas join with the existing pavements, the granular depths should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the existing pavement structure.
- Remove (mill off) 40 to 50 millimetres of the existing asphaltic concrete to a distance of 300 millimetres at the joint and tack coat the asphaltic concrete at the joint in accordance with the requirements in OPSS 310.

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.

Catch basins should be equipped with minimum 3 metre long stub drains extending in two directions at the subgrade level.

5.13.6 Granular Material Compaction

The granular base and subbase materials should be compacted in maximum 300 millimetre thick lifts to at least 99 percent of the standard Proctor maximum dry density value.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Supplemental Investigation

It should be noted that if bedrock removal is required based on proposed grades, a supplemental geotechnical investigation should be carried out to determine type and quality of bedrock and the groundwater level within the bedrock.

6.2 Disturbed Ground

The test pits excavated at the site represent areas of disturbed soil. Any test pits which are within the building footprint or pavement areas (or will otherwise support structures) should be subexcavated and backfilled with appropriate compacted engineered fill material. The sides of the test pit should be excavated and benched to an overall batter of 1 horizontal to 1 vertical, or flatter.

6.3 Effects of Construction Induced Vibration

Some of the construction operations (such as excavation, 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.

6.4 Corrosion of Buried Concrete and Steel

The measured sulphate concentration from the sample of soil recovered from test pit 21-2 is 119 micrograms per gram. 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 in the vicinity of the building 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 non-aggressive towards unprotected steel. It should be noted that the corrosivity of the soil could vary throughout the year due to the application of sodium chloride for de-icing.

6.5 Winter Construction

The soils and also the upper portion of any weathered / fractured bedrock at this site are highly frost susceptible and are prone to significant ice lensing. In the event that construction is required during freezing temperatures, the soil below the footings and floor slabs should be protected immediately from freezing using straw, propane heaters and insulated tarpaulins, or other suitable means.

6.6 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.

6.7 Design Review

It is recommended that the design drawings be reviewed by GEMTEC 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 surface for the proposed structure 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.

7.0 CLOSURE

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.

LICENSED PROFESSIONAL ENGINEER
B.D. WIEBE
100060438
19 Aug 2022
PROVINCE OF ONTARIO

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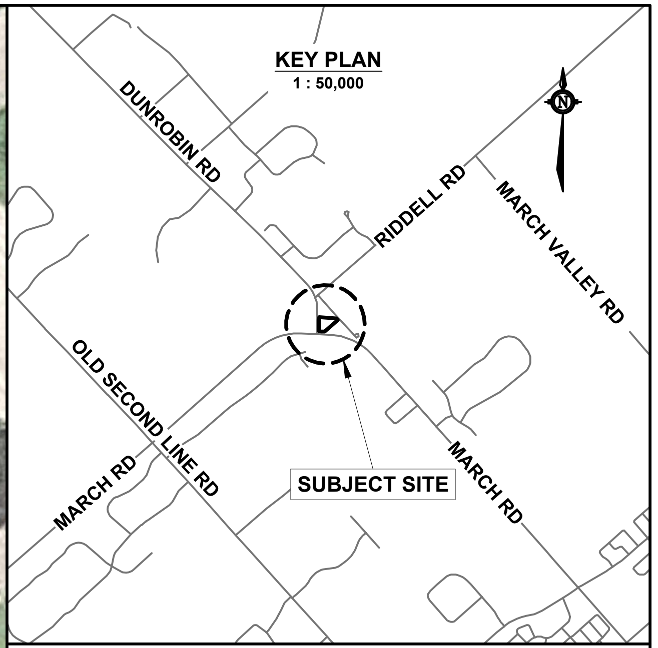

LEGEND

TP # ◄—— TEST PIT ID

XX.XX ◄—— GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

▚ **TEST PIT LOCATION** (current investigation by GEMTEC)

— - — - — APPROXIMATE PROPERTY BOUNDARY

Scale

1:500

0 10 20 30m

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and Scientists

32 Steacie Drive
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Drawing

TEST PIT LOCATION PLAN

Client

TSH CUSTOM HOMES

Project
65103.01

Drwn by
S.L.

Chkd by
G.D.

GEOTECHNICAL INVESTIGATION
4 CAMPBELL REID CRT OTTAWA
ONTARIO

Date
JULY, 2021

Rev.
0

FIGURE 1

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APPENDIX A

List of Abbreviations and Terminology
Record of Test Pit Sheets

Report to: TSH Custom Homes
Project: 65103.01 (August 19, 2022)

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

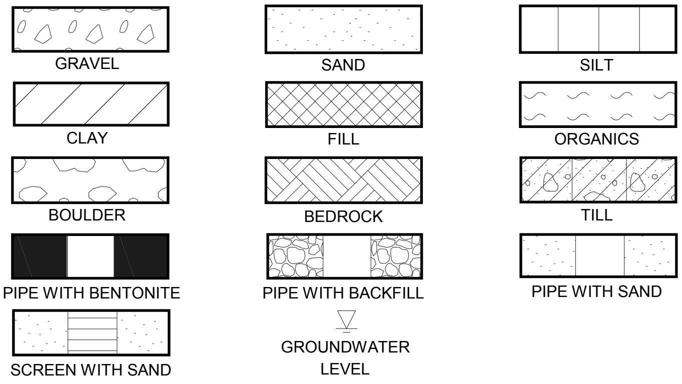
PENETRATION RESISTANCE

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.

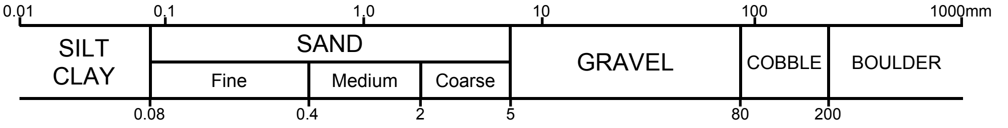
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

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.

GEMTEC

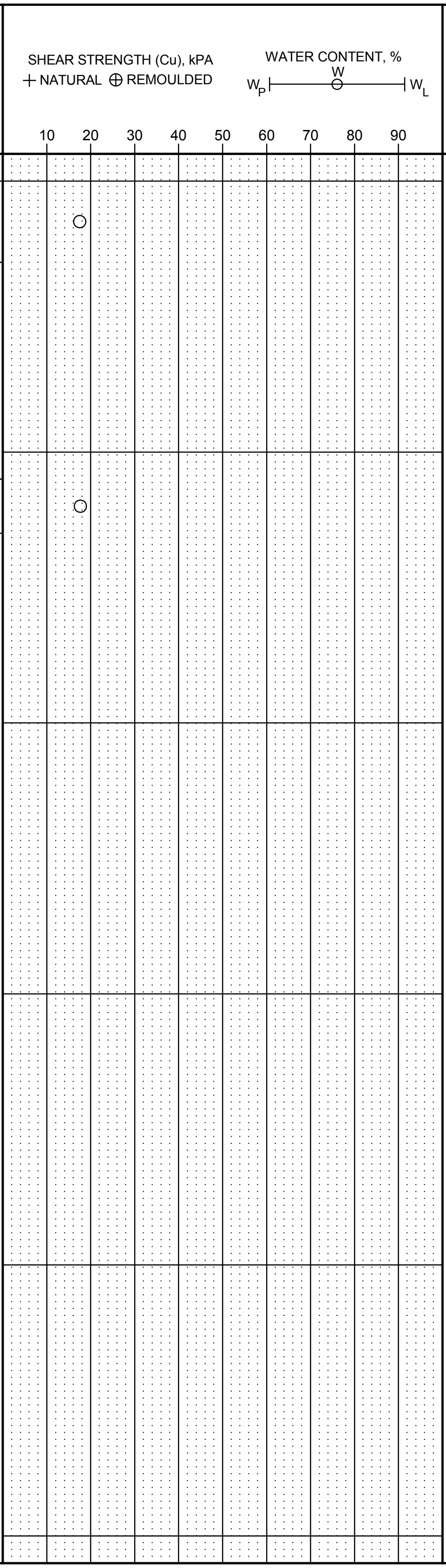
descriptive terms.pub
Modified May 2018

RECORD OF TEST PIT 21-1

CLIENT: TSH Custom Homes
PROJECT: Proposed Commercial Building-4 Campbell Reid Court
JOB#: 65103.01
LOCATION: See Test Pit Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jun 23 2021

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		93.12				
	Dark brown to grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders and construction debris (FILL MATERIAL)	▨	92.82 0.30	1	GS	M	Backfilled with excavated material
1	Dark brown silty clay, trace to some sand and gravel with organic material (FILL MATERIAL)	▨	92.02 1.10	2	GS		
	Brown silty sand, trace to some clay, trace gravel (GLACIAL TILL)		91.82 1.30	3	GS	M	
	Test pit terminated due to practical shovel refusal on inferred bedrock surface						
2							
3							
4							
5							



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Consulting Engineers and Scientists

LOGGED: P.B.

CHECKED: G.D.

RECORD OF TEST PIT 21-2

CLIENT: TSH Custom Homes
PROJECT: Proposed Commercial Building-4 Campbell Reid Court
JOB#: 65103.01
LOCATION: See Test Pit Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jun 23 2021

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA ┼ NATURAL ⊕ REMOULDED WATER CONTENT, % W_P ⊢—W ○—⊣ W_L 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		92.89					
	Dark brown to grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders and construction debris (FILL MATERIAL)	▨	92.19 0.70	1	GS			Backfilled with excavated material
	Dark brown silty clay with organic material (FORMER TOPSOIL)	▨	92.04 0.85	2	GS			
	Brown silty sand, trace to some clay, trace gravel (GLACIAL TILL)	▨	91.89 1.00	3	GS			
1	Test pit terminated due to practical shovel refusal on inferred bedrock surface							
2								
3								
4								
5								

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LOGGED: P.B.

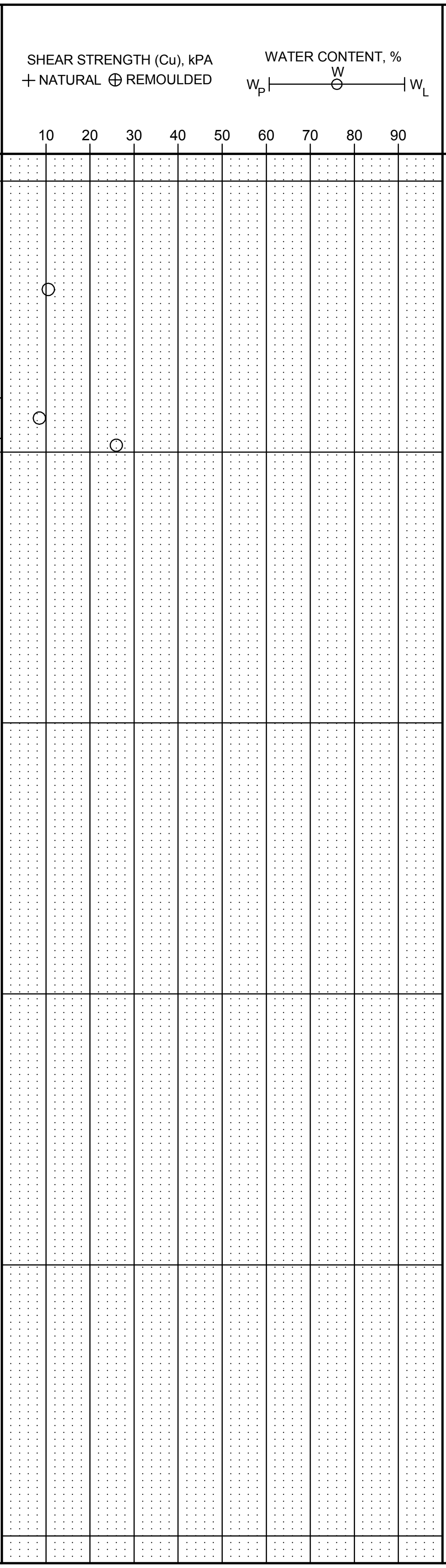
CHECKED: G.D.

RECORD OF TEST PIT 21-3

CLIENT: TSH Custom Homes
PROJECT: Proposed Commercial Building-4 Campbell Reid Court
JOB#: 65103.01
LOCATION: See Test Pit Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jun 23 2021

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		92.86				
	Dark brown to grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders and construction debris (FILL MATERIAL)		92.06 0.80	1	GS		Backfilled with excavated material
	Dark brown silty clay with organic material (FORMER TOPSOIL)		91.91 0.95	2	GS		
1	Brown silty sand, trace to some clay, trace gravel (GLACIAL TILL)		1.00	3	GS		
	Test pit terminated due to practical shovel refusal on inferred bedrock surface						Groundwater seepage observed at about 1.0 metres below existing grade on June 23, 2021.
2							
3							
4							
5							



GEO - TESTPIT LOG 65103.01_GINT_V01_2021_07_05.GPJ GEMTEC 2018.GDT 9/7/21

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LOGGED: P.B.
CHECKED: G.D.

RECORD OF TEST PIT 21-4

CLIENT: TSH Custom Homes
PROJECT: Proposed Commercial Building-4 Campbell Reid Court
JOB#: 65103.01
LOCATION: See Test Pit Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jun 23 2021

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		93.21					
	Dark brown to grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders and construction debris (FILL MATERIAL)	▨		1	GS			Backfilled with excavated material
1	Dark brown silty clay with organic material (FORMER TOPSOIL)		92.21 1.00	2	GS			
	Test pit terminated due to practical shovel refusal on inferred bedrock surface		92.01 1.20					
2								
3								
4								
5								

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LOGGED: P.B.

CHECKED: G.D.

RECORD OF TEST PIT 21-5

CLIENT: TSH Custom Homes
PROJECT: Proposed Commercial Building-4 Campbell Reid Court
JOB#: 65103.01
LOCATION: See Test Pit Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jun 23 2021

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P ⊢ W ○ ⊣ W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface	93.26					
	Dark brown to grey gravelly sandy silt with organics, rootlets, roots, cobbles, boulders and construction debris (FILL MATERIAL)		1	GS			Backfilled with excavated material
1	Dark brown silty clay with organic material (FORMER TOPSOIL)	92.26 1.00	2	GS			
	Brown silty sand, trace to some clay, trace gravel (GLACIAL TILL)	92.06 1.20	3	GS	○	M	
	Test pit terminated due to practical shovel refusal on inferred bedrock surface	91.96 1.30					
2							
3							
4							
5							

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LOGGED: P.B.

CHECKED: G.D.

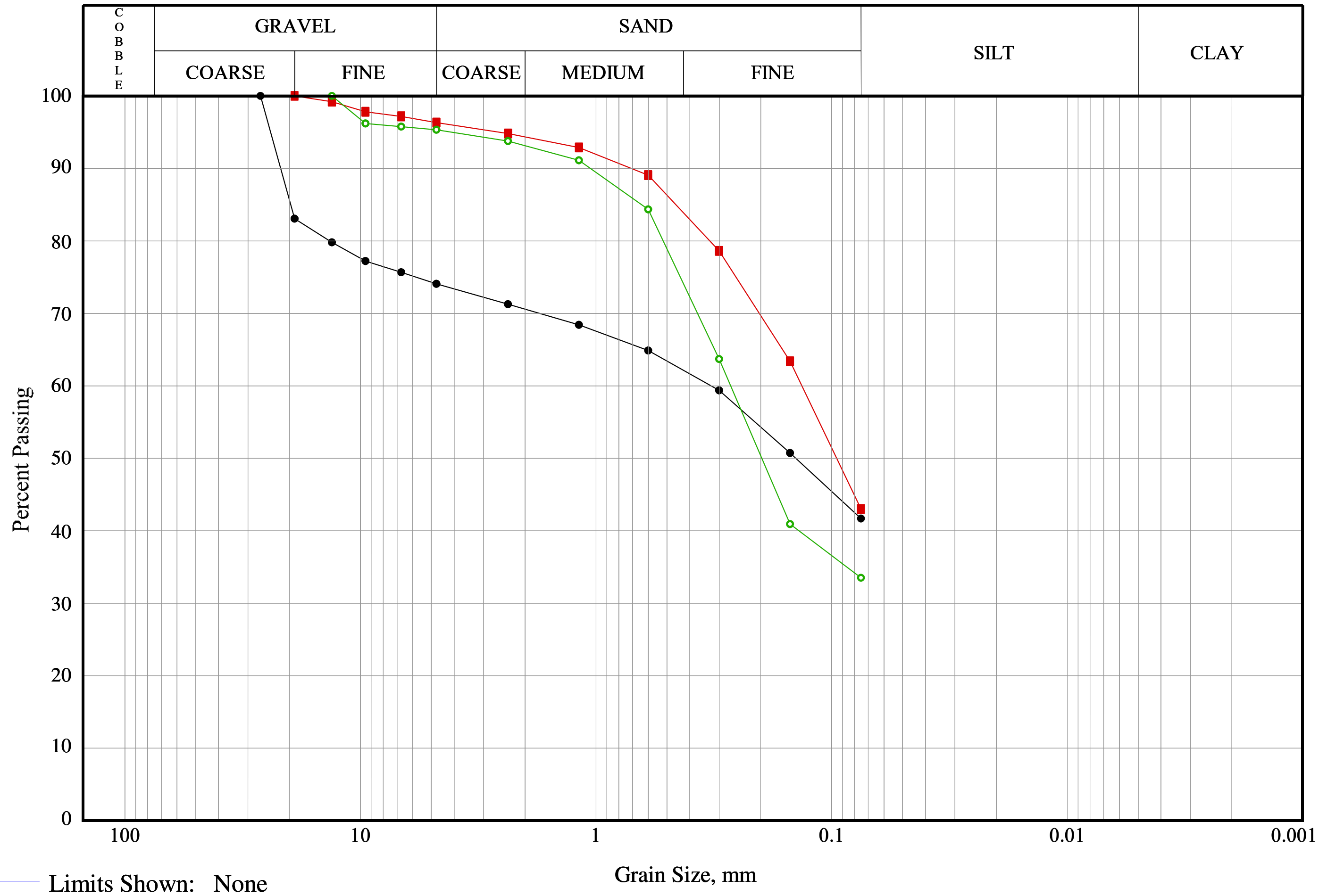
APPENDIX B

Laboratory Testing Results
Soils Grading Chart

GEMTEC
Consulting Engineers and Scientists

Client: TSH Custom Homes
Project: 4 Campbell Reid Court
Project #: 65103.01

Soils Grading Chart



Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●	Fill Material	21-1	GS1	0-0.9	25.9	32.4	41.7	
■	Glacial Till	21-1	GS3	1.1-1.3	3.7	53.3	43.0	
○	Glacial Till	21-5	GS3	1.2-1.3	4.7	61.8	33.5	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Gravelly sandy silt	N/A	---	---	---	0.14	0.33	19.74	---
■	Sand and silt , trace gravel	N/A	---	---	---	0.10	0.13	0.46	---
○	Silty sand , trace gravel	N/A	---	---	---	0.20	0.27	0.64	---

APPENDIX C

Chemical Analysis of Soil Relating to Corrosion (Paracel Laboratories Ltd. Order No. 2126503)

Certificate of Analysis

Client: **GEMTEC Consulting Engineers and Scientists Limited**

Client PO: **65103.01**

Report Date: 28-Jun-2021

Order Date: 24-Jun-2021

Project Description:

	Client ID:	TP 2 GS 3	-	-	-
	Sample Date:	23-Jun-21 12:00	-	-	-
	Sample ID:	2126503-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	78.2	-	-	-
General Inorganics					
Conductivity	5 uS/cm	172	-	-	-
pH	0.05 pH Units	6.92	-	-	-
Resistivity	0.10 Ohm.m	58.2	-	-	-
Anions					
Chloride	5 ug/g dry	10	-	-	-
Sulphate	5 ug/g dry	119	-	-	-

experience • knowledge • integrity

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

expérience • connaissance • intégrité