April 2018

REPORT ON

Geotechnical Investigation
Proposed Residential Development
Maple Grove Road
Ottawa, Ontario

Submitted to:
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REPORT

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out at the site of a proposed residential development to be located on the north side of the western end of Maple Grove Road in Ottawa, Ontario.

The purpose of this geotechnical investigation was to assess the general subsurface conditions at the site by means of a limited number of test pits. Based on an interpretation of the factual information obtained, a general description of the soil, bedrock, and groundwater conditions is presented. These interpreted subsurface conditions and available project details were used to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The reader is referred to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared to construct a residential development to be located north of Maple Grove Road in Ottawa, Ontario. The project limits for the proposed development are shown on Figure 1.

The following is known about the site and proposed development:

- The site is located at the west end of Maple Grove Road.
- The site measures about 310 metres by 280 metres in plan area.
- The site has a relatively flat topography, is currently undeveloped, and is mostly vegetated with brush and mature trees.
- It is understood that the development will include a combination of single family homes and townhouse blocks.
- A City park will be located within the northeast corner of the site.

Based on a review of published geological maps and previous subsurface investigations carried out in the vicinity of the site, the subsurface conditions on this site are expected to consist of glacial till, with the bedrock surface generally no more than at about 3 metres depth. Based on geologic mapping, the bedrock is indicated to consist of limestone of the Bobcaygeon Formation and limestone with dolomite interbeds of the Gull River Formation.

3.0 PROCEDURE

The fieldwork for the geotechnical investigation was carried out on November 6, 2017. On that day, 9 test pits (numbered 17-01 to 17-09, inclusive) were excavated at the approximate locations shown on Figure 1.

The test pits were advanced using a track mounted hydraulic excavator supplied and operated by Glenn Wright Excavating of Ottawa, Ontario. The test pits were excavated practical refusal to excavating which occurred at depths ranging from about 0.3 to 2.1 metres below the existing ground surface.

The soils exposed on the sides of the test pits were classified by visual and tactile examination. Grab samples were obtained from the major soil strata encountered in the test pits. The groundwater seepage conditions were observed in the open test pits and the test pits were loosely backfilled upon completion of excavating and sampling.

The fieldwork was supervised by an experienced technician from our staff who logged the soils encountered and collected the soil samples. The soil samples obtained during the fieldwork were brought to our laboratory for further examination by the project engineer.

One soil sample from test pit 17-05 was submitted to Eurofins Environmental Testing Canada for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The test pit locations were selected and picketed in the field by Golder Associates personnel. The positions and ground surface elevations at the test pit locations were subsequently determined by Annis, O'Sullivan, Vollebekk Ltd. It is understood that the elevations are referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered in the test pits are shown on the Record of Test Pits in Table 1. The results of the basic chemical analyses on the selected soil sample from test pit 07-05 are provided in Appendix A.

In general, the subsurface conditions at this site consists of silty sand and sand over limestone bedrock. Practical refusal to excavating was encountered in all test pits at depths varying from about 0.3 to 2.1 metres below the existing ground surface.

The following sections present a more detailed overview of the subsurface conditions encountered in the test pits.

4.2 Topsoil

A surficial layer of topsoil exists at the ground surface at all of the test pit locations. The topsoil ranges from about 130 to 400 millimetres in thickness.

4.3 Silty Sand and Sand

Deposits of sand and silty sand exist below the topsoil at all of the test pit locations, except test pits 17-07 and 17-08. Where encountered, these sandy layers were found to have thicknesses varying from about 0.4 to 2.0 metres.

At test pit 17-03, cobbles and boulders were encountered at depths between about 0.7 and 2.1 metres below the existing ground surface. The boulders were noted to be between about 0.5 and 1.5 metres in diameter.

4.4 Bedrock

Refusal to excavating was encountered at all of the test pit locations at depths ranging from about 0.3 to 2.1 metres below the existing ground surface. At test pits 17-01, 17-02, 17-05, 17-07, 17-08, and 17-09, the bedrock could be excavated between about 0.1 and 0.9 metres below the bedrock surface.

The following table summarizes the ground surface, depth to refusal, and refusal elevations as encountered at the test pit locations.

Test Pit Number	Ground Surface Elevation (m)	Bedrock Surface Depth	Refusal Depth (m)	Refusal Elevation (m)
17-01	107.5	1.2	2.1	105.4
17-02	107.2	1.1	2.0	105.2
17-03	107.8	2.1	2.1	105.7
17-04	107.2	1.3	1.3	105.9
17-05	107.9	1.0	1.3	106.6
17-06	108.1	0.8	0.8	107.3
17-07	111.1	0.3	0.3	110.8
17-08	109.4	0.4	0.4	109.0
17-09	108.9	1.5	1.8	107.1

4.5 Groundwater

Groundwater seepage and wet soil conditions were generally present at depths of about 1 to 2.1 metres below the existing ground surface.

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

4.6 Corrosion

One soil sample from borehole 17-05 was submitted to Eurofins Environmental Testing Canada for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The results of this testing are provided in Appendix A and are summarized below.

Test Pit Number	Sample Depth (m)	Chloride (%)	SO_4 (%)	pH	Resistivity (Ohm-cm)
17-05	0.5	<0.002	<0.01	8.2	8,330

5.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

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 available information described herein and project requirements. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

Reference should be made to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

5.2 Site Grading

The subsurface conditions on this site generally consist of deposits of silty sand and sand, underlain by bedrock. Refusal to excavating was encountered at depths ranging from about 0.3 to 2.1 metres below the existing ground surface.

No practical restrictions apply to the thickness of grade raise fill which may be placed on the site from a foundation design perspective. As a general guideline regarding the site grading, the preparation for filling of the site should include stripping any topsoil, fill, and organic matter to improve the settlement performance of structures and services. Topsoil, fill, and organic matter are not suitable as general fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no proposed structures, services, or roadways, these materials may be left in-place provided some settlement of the ground surface following filling can be tolerated.

Groundwater seepage was generally encountered at the bedrock surface or within the bedrock. More significant groundwater flow should be expected for excavations that extend below the groundwater level in these areas. Therefore, in these areas, consideration should be given to setting the grading in order to limit the required depths of excavation (particularly for basements) since groundwater management requirements and costs increase with excavation depth below the groundwater level.

5.3 Foundations

With the exception of the topsoil, the native undisturbed soils and bedrock on this site are considered suitable for the support of conventional wood frame houses on spread footing foundations. For design purposes, strip footing foundations, up to 1 metre in width, can be designed using a maximum allowable bearing pressure of 100 kilopascals for the overburden soils, consistent with design in accordance with Part 9 of the Ontario Building Code. For footings founded on or within bedrock, an allowable bearing pressure of 250 kilopascals may be used.

The post-construction total and differential settlements of footings supported on soil and sized using the above maximum allowable bearing pressure should be less than 25 and 15 millimetres, respectively, provided that the soil at or below founding level is not disturbed before or during construction. Footings on bedrock should experience negligible settlements.

Some of the overburden soils on this site contain cobbles and boulders. Any cobbles or boulders in footing areas which have been loosened by the excavation process should be removed and the cavity filled with lean concrete.

At some locations on the property, and depending on the amount of proposed grade raise (i.e., filling), the inorganic subgrade elevation may be lower than the underside of footing elevation. At these locations, the subgrade may be raised to the footing elevation using suitable engineered fill. The engineered fill should consist of Ontario Provincial Standard Specification (OPSS) Granular B Type II. All fill material should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the material's standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment. The engineered fill material must be placed within the full zone of influence of the house foundations. The zone of influence is considered to extend out and down from the edge of the perimeter footings at a slope of 1 horizontal to 1 vertical. The same bearing pressures provided above may be used on properly constructed engineered fill pads.

Where the subgrade at footing level changes from bedrock to overburden, differential settlement could result at this transition due to the different settlement properties of these materials. To limit the magnitude of the differential settlement, transition details (such as placing additional reinforcing steel in the foundation walls) may be required. Where sloping bedrock is encountered, stepped footings may also need to be considered. The structural engineering consultant should be contacted for input on these issues.

5.4 Seismic Design Considerations

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. Based on the 2012 Ontario Building Code methodology, this site can be assigned a Site Class of C.

Although the seismic Site Class is not directly applicable to structures designed in accordance with Part 9 of the OBC (i.e., conventional housing), this assessment is provided to address City of Ottawa requirements that relate to housing on Site Class E sites.

The soils at this site are not considered liquefiable.

5.5 Frost Protection

The soils at this site are frost susceptible. For frost protection purposes, all exterior footings or interior footings in unheated areas should be provided with a minimum of 1.5 metres of earth cover. Isolated, exterior footings adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover. Houses with conventional depth basements would satisfy these requirements.

Shallow bedrock may be frost susceptible especially if there is an upper fractured zone that contains joints filled with frost susceptible soil. Therefore, if/where the earth cover requirements over the rock bearing surface cannot be provided, the absence of soil-filled seams in the underlying rock should be confirmed at the time of construction. This assessment can be carried out by drilling 50 millimetre diameter probe holes within the footing areas at a 3 metre spacing and to at least 1.8 metres below the finished grade level. In the case that soil-filled seams are encountered, then the following two options could be considered:

- The footing and bearing surface could be insulated; or,
- The potentially frost-susceptible bedrock could be removed (sub-excavated) and replaced with mass concrete, or the footing founded at that new lower depth.

Further geotechnical guidance can be provided regarding insulation of the bearing surface if and when required.

5.6 Basement Excavations

Excavations for basements will be made through overburden deposits. Bedrock is also expected to be encountered for standard house foundations, but will depend on the proposed grading for the site.

No unusual problems are anticipated with excavating the overburden materials using large hydraulic excavating equipment, recognizing that significant cobble and boulder removal can be expected in areas of the site. Boulders larger than 0.3 metres in diameter should be removed from the excavation side slopes for worker safety.

If required, shallow depths of bedrock removal could be accomplished using mechanical methods (such as hoe ramming in conjunction with line drilling). Deeper excavations into bedrock would likely require blasting. Further details on blasting are provided in Section 5.9.1 of this report.

Above the water table, side slopes should be stable in the short term at 1 horizontal to 1 vertical (Type 3 soil in accordance with the Occupational Health and Safety Act of Ontario (OHSA)). Below the water table, side slopes of 3 horizontal to 1 vertical (Type 4 soil in accordance with the OHSA) will be required to prevent sloughing of the sandier soils.

Near-vertical excavation side slopes in the bedrock should be feasible.

Based on present groundwater levels, excavations deeper than about 1.0 to 1.5 metres will extend below the groundwater level. Groundwater inflow into the excavations should feasibly be handled by pumping from sumps within the excavations. The actual rate of groundwater inflow will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where significant volumes of precipitation, surface runoff and/or groundwater collects in an open excavation, and must be pumped out.

Where the subgrade is found to be wet and sensitive to disturbance, consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel) or a 150 millimetre thick layer of OPSS Granular A underlain by a non-woven geotextile, to protect the subgrade from construction traffic.

Under the new regulations, a Permit-To-Take-Water (PTTW) is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 litres per day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 litres per day, but more than 50,000 litres per day, the water taking will not require a PTTW, but will need to be registered in the Environmental Activity and Sector Registry (EASR) as a prescribed activity. Considering the size of the development and the groundwater information collected during the investigation, it is considered likely that a PTTW would be required for this project. Assistance with carrying out the PTTW application can be provided, if requested.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed material should be removed from beneath the floor slab. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs. The underslab fill should be compacted to at least 95 percent of the materials standard Proctor maximum dry density.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base for the floor slabs be positively drained. This can be achieved by providing a hydraulic link between the underfloor fill and exterior drainage system.

The groundwater level was generally observed to be at about 1 to 2.1 metres depth. Although not required from a geotechnical perspective, raising of site grades in areas with a high water table would be beneficial in reducing the water control measures for foundation construction. Similarly, since significant and sustained groundwater inflow into the foundation drainage system would ideally be avoided, the founding depths should be set above the groundwater level.

Where the groundwater level is encountered above subgrade level, a geotextile could be required between the clear stone underslab fill and the sandy subgrade soils, to avoid loss of fine soil particles from the subgrade soil into the voids in the clear stone and ultimately into the drainage system. In the extreme case, loss of fines into the clear stone could cause ground loss beneath the slab and plugging of the drainage system. Where a geotextile is required, it should consist of a Class II non-woven geotextile with a Filtration Opening Size (FOS) not exceeding about 100 microns, in accordance with Ontario Provincial Standard Specification (OPSS) 1860.

The garage backfill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

The granular base for the garage floor slabs should consist of at least 150 millimetres of Granular A compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

5.8 Basement Walls and Foundation Wall Backfill

The soils at this site are highly frost susceptible and should not be used as backfill directly against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, these foundation elements should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I or, alternatively, a bond break such as the Platon system sheeting could be placed against the foundation walls.

Drainage of the basement wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Where design of basement walls in accordance with Part 4 of the 2012 Ontario Building Code is required, walls backfilled with granular material and effectively drained as described above should be designed to resist lateral earth pressures calculated using a triangular distribution of the stress with a base magnitude of $K_o\gamma H$, where:

K_o = The lateral earth pressure coefficient in the 'at rest' state, use 0.5;

γ = The unit weight of the granular backfill, use 21.5 kilonewtons per cubic metre; and,

H = The height of the basement wall in metres.

If Platon System sheeting or similar water barrier product is used against the foundation walls, then hydrostatic groundwater pressures should also be considered in the calculation of the lateral earth pressures.

5.9 Site Servicing

5.9.1 Excavations

Excavations for the installation of site services will be made through silty sands, sands, and into the underlying bedrock.

No unusual problems are anticipated with trenching in the overburden using conventional hydraulic excavating equipment, recognizing that cobbles and boulders can be expected in areas. Boulders larger than 0.3 metres in size should be removed from excavation side slopes for worker safety.

The soils above the groundwater table would generally be classified as a Type 3 soil in accordance with the Occupational Health and Safety Act of Ontario. As such, these excavations may be made with side slopes at 1 horizontal to 1 vertical. Where trenches for the installation of services extend below the water table, the excavation side slopes would need to be no steeper than 3H:1V (Type 4 soil). Alternatively, the excavations could be carried out using steeper side slopes with all manual labour carried out within a fully braced, steel trench box for worker safety.

Some groundwater inflow into the trenches should be expected. However, it should be possible to handle the groundwater inflow by pumping from well filtered sumps established in the floor of the excavations, provided suitably sized pumps are used.

The actual rate of groundwater inflow into the trench will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, and the time of year at which the excavation is carried out. There may also be instances where significant volumes of precipitation collect in an open excavation, and must be pumped out.

A PTTW is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 litres per day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 litres per day, but more than 50,000 litres per day, the water taking will not require a PTTW, but will need to be registered in the EASR as a prescribed activity. It is anticipated, due to the size of the project, that the contractor may have several trenches open at one time and that a PTTW will need to be obtained for the overall project.

If required, it is expected that the bedrock removal for this project will be carried out using drill and blast techniques. Mechanical methods of rock removal (such as hoe ramming) can likely be carried out for depths of about one metre; however, this work would likely be slow and tedious.

Near vertical trench walls in the bedrock should stand unsupported for the construction period.

If blasting is used, it should be controlled to limit the peak particle velocities at all adjacent structures or services such that blast induced damage will be avoided. This will require blast designs by a specialist in this field.

A pre-blast survey should be carried out of all of the surrounding structures. Selected existing interior and exterior cracks in the structures should be identified during the pre-blast survey and should be monitored for lateral or shear movements by means of pins, glass plate telltales and/or movement telltales.

The contractor should be limited to only small controlled shots. The following frequency dependent peak vibration limits at the nearest structures and services are suggested.

Frequency Range (Hertz)	Vibration Limits (millimetres/second)
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

These limits should be practical and achievable on this project.

It is recommended that the monitoring of ground vibration intensities (peak ground vibrations and accelerations) from the blasting operations be carried out both in the ground adjacent to the closest structures and within the structures themselves.

If excavations are made through the bedrock, the groundwater inflow from the bedrock could at first be relatively significant. That inflow may potentially diminish with time and continued pumping.

5.9.2 Bedding and Backfill

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should in all cases extend to the spring line of the pipe and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or silty/sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the sand, and silty sand as trench backfill, provided that they are not too wet to handle, place, and compact. Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

It should be possible to use the bedrock as trench backfill, provided the bedrock is well broken and broadly graded (maximum size of 300 millimetres). The rock fill, however, should only be placed from at least 300 millimetres above the pipes to minimize damage due to impact or point load. The rock fill should be limited to a maximum of 300 millimetres in size.

5.10 Pavement Design

In preparation for pavement construction, all topsoil, fill, disturbed, or otherwise deleterious materials (i.e., those materials containing organic material) should be removed from the roadway areas.

Pavement areas requiring grade raising to proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or OPSS Select Subgrade Material. These materials should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the materials standard Proctor maximum dry density using suitable compaction equipment.

The surface of the pavement subgrade should be crowned to promote drainage of the roadway granular structure. Perforated pipe sub-drains should be provided at subgrade level extending from the catch basins for a distance of at least 3 metres longitudinally, parallel to the curb in two directions.

The pavement structure for the interior 'local' roadways which will not experience bus or truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	375

The pavement structure for the interior roadway(s) with bus and truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	450

For arterial roadways, the subbase thickness should be increased to 600 millimetres.

The granular base and subbase materials should be uniformly compacted as per OPSS 310, Method A. The asphaltic concrete should be compacted in accordance with the procedures outlined in OPSS 310.

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 mm Surface Course – 40 millimetres
- Superpave 19 mm Base Course – 50 millimetres

The asphaltic cement should consist of PG 58-34 and the design of the mixes should be based on a Traffic Category B for local roadways and Category D for collector roadways.

The above pavement designs are based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.11 Corrosion & Cement Type

One soil sample from test pit 17-05 was submitted to Eurofins Environmental Testing Canada for chemical analysis related to potential corrosion of buried steel elements and sulphate attack on buried concrete elements. The results of this testing are provided in Appendix A.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a moderate potential for corrosion of exposed ferrous metal, which should be considered in the design of substructures.

5.12 Pools, Decks and Additions

5.12.1 Above Ground and In Ground Pools

No special geotechnical considerations are necessary for the installation of above-ground or in-ground pools.

5.12.2 Decks

There are no special geotechnical considerations for decks on this site.

5.12.3 Additions

Any proposed addition to a house (regardless of size) will require a geotechnical assessment. Written approval from a geotechnical engineer should be required by the City prior to the building permit being issued.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic, and frost.

The test pits excavated and filled on site constitute zones of disturbance to the surficial soils. These could affect the performance of surface structures/foundations. The test pit locations were generally selected to be outside of proposed building areas (i.e., within the roadways); however, there may be instances where a test pit underlies a proposed structure. In that case, the backfill soil in the test pit will need to be removed and replaced with engineered fill.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction point of view.

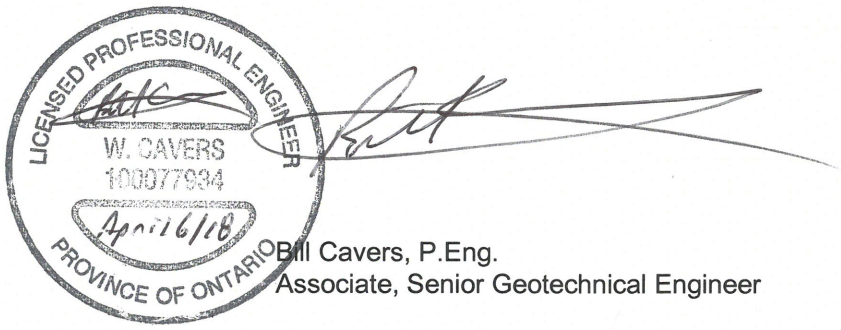
At the time of the writing of this report, only preliminary details for the proposed development were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

7.0 CLOSURE

We trust that this report contains sufficient information for your present purposes. If you have any questions regarding this report or if we can be of further service to you on this project, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.



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WT/TMS/WC/mvrd
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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. 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 professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

TABLE 1

RECORD OF TEST PITS

TEST PIT NUMBER (ELEVATION – METRES)	DEPTH (METRES)	DESCRIPTION
17-01 (107.49)	0.00 – 0.35 0.35 – 1.20 1.20 – 2.10 2.10	TOPSOIL – (SM) SILTY SAND; dark brown; moist (SM) SILTY SAND, trace gravel; brown; non-cohesive, moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Groundwater inflow at 1.2 metres depth Sample: 1 — Depth (m): 0.9
17-02 (107.22)	0.00 – 0.40 0.40 – 1.05 1.05 – 1.95 1.95	TOPSOIL – (SM) SILTY SAND; dark brown; moist (SM) SILTY SAND, trace gravel; brown; non-cohesive; moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Groundwater inflow at 1.1 metres depth Sample: 1 — Depth (m): 0.6

TABLE 1

RECORD OF TEST PITS

TEST PIT NUMBER (ELEVATION – METRES)	DEPTH (METRES)	DESCRIPTION
17-03 (107.80)	0.00 – 0.13 0.13 – 0.72 0.72 – 2.10 2.10	TOPSOIL – (SM) SILTY SAND; dark brown; moist (SM) SILTY SAND; brown; non-cohesive, moist (SM) SILTY SAND, some gravel; grey-brown, contains cobbles and boulders; non-cohesive, moist End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: 1) Groundwater inflow at 2.10 metres depth 2) Boulders: 0.5 to 1.5 metres in diameter Samples: 1, 2 — Depth (m): 0.5, 1.5
17-04 (107.16)	0.00 – 0.32 0.32 – 1.00 1.00 – 1.30 1.30	TOPSOIL – (SM) SILTY SAND; dark brown, moist (SM) SILTY SAND, trace gravel; brown; non-cohesive, moist (SM) SILTY SAND, some gravel; grey-brown; non-cohesive, moist End of Test Pit – Refusal to excavating on slightly weathered LIMESTONE BEDROCK Note: Water seeping in from top of bedrock Samples: 1, 2 — Depth (m): 0.50, 1.20

TABLE 1

RECORD OF TEST PITS

TEST PIT NUMBER (ELEVATION – METRES)	DEPTH (METRES)	DESCRIPTION
17-05 (107.90)	0.00 – 0.35 0.35 – 0.97 0.97– 1.25 1.25	TOPSOIL – (SM) SILTY SAND; dark brown, moist (SP) SAND, some fines; brown; non-cohesive, moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Water seeping in from top of weathered bedrock at 0.97 metres depth Samples: 1 — Depth (m): 0.5
17-06 (108.10)	0.00 – 0.35 0.35 – 0.63 0.63 – 0.75 0.75	TOPSOIL – (SM) SILTY SAND; dark brown; moist (SP) SAND, some fines, trace gravel; brown; non-cohesive, moist (SM) SILTY SAND, trace gravel; grey-brown; non-cohesive; moist End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Samples: 1, 2 — Depth (m): 0.6, 0.7

TABLE 1

RECORD OF TEST PITS

TEST PIT NUMBER (ELEVATION – METRES)	DEPTH (METRES)	DESCRIPTION
17-07 (111.07)	0.00 – 0.24 0.24 – 0.33 0.33	TOPSOIL – (SM) SILTY SAND; dark brown, moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Test pit dry upon completion Samples Depth (m) No Samples Taken
17-08 (109.38)	0.00 – 0.24 0.24 – 0.42 0.42	TOPSOIL – (SM) SILTY SAND; dark brown; moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Test pit dry upon completion Samples Depth (m) No Samples Taken

TABLE 1
RECORD OF TEST PITS

TEST PIT NUMBER (ELEVATION – METRES)	DEPTH (METRES)	DESCRIPTION
17-09 (108.85)	0.00 – 0.35 0.35 – 1.20 1.20 – 1.50 1.50 – 1.80 1.80	TOPSOIL – (SM) SILTY SAND; dark brown; moist (SM) SILTY SAND; brown; non-cohesive, moist (SP) SAND, trace fines; grey-brown; non-cohesive, moist Weathered LIMESTONE BEDROCK End of Test Pit – Refusal to excavating on LIMESTONE BEDROCK Note: Test pit dry upon completion Samples: 1, 2 Depth (m): 0.45, 1.4

https://golderassociates.sharepoint.com/sites/16628g/deliverables/geotechnical/final/1776275 record of test pits final.docx

KEY MAP

SCALE 1:50,000

LEGEND

- APPROXIMATE TEST PIT LOCATION
- ROADWAY
- SITE BOUNDARY

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

DRAFT

0 20 40 80

1:1,750 METRES

CLIENT
CLARIDGE HOMES CORPORATION

PROJECT
GEOTECHNICAL INVESTIGATION
1981 MAPLE GROVE ROAD, STITTSVILLE, ONTARIO

TITLE
SITE PLAN

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-11-20
DESIGNED	----
PREPARED	JEM
REVIEWED	----
APPROVED	----

PROJECT NO.	CONTROL	REV.	FIGURE
1776275	0005	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

Path: \\golder.gds\gal\Ottawa\Active\Spatial\MICh\of\Ottawa\1983_MapleGrove_Rd\99_PRO\1776275_Claridge_GeoEnv\mxd\40_PROD\0005_Geotech_Investigation\1776275-0005-BG-0001.mxd

APPENDIX A

Results of Chemical Analysis
Eurofins Environmental Testing, Report No. 1722519

Certificate of Analysis

eurofins | Environment Testing

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario
K2H 5B7
Attention: Ms. Will Thomas
PO#:
Invoice to: Golder Associates Ltd

Report Number: 1722519
Date Submitted: 2017-11-20
Date Reported: 2017-11-23
Project: 1776275/1000
COC #: 825984

Group	Analyte	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sampling Date / Sample I.D.
					1333804 / Soil / / 2017-11-06 / 17-05 sa1 0.5m
Agri. - Soil	pH	2.0			8.2
	SO4	0.01	%		<0.01
General Chemistry	Cl	0.002	%		<0.002
	Electrical Conductivity	0.05	mS/cm		0.12
	Resistivity	1	ohm-cm		8330

Guideline = *** = Guideline Exceedence**
All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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