REPORT

Geotechnical Investigation

Proposed Residential/Commercial Development 4639 Bank Street, Ottawa, Ontario

Submitted to:

Glenview Properties Inc.

190 O'Connor Street, 11th Floor
Ottawa, Ontario

Submitted by:

Golder Associates Ltd.

1931 Robertson Road Ottawa, Ontario, K2H 5B7 Canada

+1 613 592 9600

19128449

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for a proposed residential/commercial development to be located at 4639 Bank Street in Ottawa, Ontario. The geotechnical investigation included an assessment of the general subsurface conditions on the site by means of 6 test pits and laboratory testing. Based on an interpretation of the factual information obtained, a general description of the subsurface and groundwater conditions is presented. These interpreted subsurface conditions and available project details were used to prepare 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 for a residential/commercial development to be located at 4639 Bank Street in Ottawa, Ontario. The approximate location of the site is shown on the Key Map inset on the attached Site Plan (Figure 1).

The following is understood about the project and site:

- The site is located along the east side of Bank Street and is bounded to the north by Rotary Way, to the east by the Ottawa Rotary Home, and to the south by a single-family residential properties.
- The site is approximately rectangular in shape, has a relatively flat topography and is currently vacant land. The site is about 1.2 hectares in plan area.
- The proposed development will consist of a mix of residential townhome style units and/or commercial buildings, based on the conceptual plans provided to us at the time of this report. The maximum height of the proposed buildings will be up to 4 storeys above grade. The buildings may include partial basement levels.
- At-grade parking areas and drive lanes will be provided around the site.

Based on a review of the published geological mapping, and previous investigations carried out at the adjacent developments, the subsurface conditions at this site are indicated to consist of about 2 to 4 metres of silt, sand, and glacial till overlying bedrock. The bedrock is mapped to be shale of the Carlsbad Formation and likely changes to limestone with shale interbeds of Verulam Formation at the far south end of the subject property.

3.0 PROCEDURE

The fieldwork for this investigation was carried out on September 5, 2019. At that time, six test pits (numbered 19-01 to 19-06) were put down at the approximate locations shown on Figure 1. The test pits were advanced using a hydraulic excavator supplied and operated by Glenn Wright Excavating of Ottawa, Ontario.

The test pits were advanced to a maximum depth of about 5.2 metres or to practical refusal, which was encountered in four test pits at depths ranging from about 2.4 metres to 4.8 metres below the existing ground surface. The test pits were backfilled, without compaction, with soil excavated from the test pits. The site conditions were not restored following completion of work. Grab samples were recovered during the test pitting program.

The fieldwork was supervised by personnel from our geotechnical staff who located the test pits, directed the test pitting operation, logged the test pits and samples, and took custody of the samples retrieved. On completion of the test pitting operations, soil samples from the test pits were transported to our laboratory for further examination by the project engineer and for laboratory testing.

Two samples of soil from test pits 19-03 and 19-04 were submitted to Eurofins Environmental for basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of the basic chemical lab testing will be provided in the final copy of this report.

The test pit locations were selected, marked in the field, and subsequently surveyed by Golder Associates personnel. The coordinates and ground surface elevations were determined using a GPS survey unit. The geodetic reference system used for the survey was the North American datum of 1983 (NAD83). The test pit coordinates were based on the Modified Transverse Mercator (MTM Zone 9) coordinate system. The elevations were referenced to Geodetic datum (CGVD28).

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- Record of Test Pits for the current investigation are provided in Appendix A.
- Results of the grain size distribution testing from the current investigation are provided on Figures B1 to B5 in Appendix B.
- Results of the basic chemical analyses from the current investigation are provided in Appendix C.
- The results of the water content testing on selected soil samples are provided on the respective Record of Test Pits.

In general, the subsurface conditions at this site consist of topsoil, over variable thickness of fill and sandy silt deposits underlain by glacial till, over shale or limestone with shale interbeds bedrock.

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

4.2 Topsoil Fill

Topsoil fill exists at the ground surface at all the test pit locations. The thickness of the topsoil fill ranges from about 0.15 to 0.3 metres.

4.3 Fill

A layer of fill exists below the topsoil at all test pit locations. The fill extends to depths ranging from about 0.8 to 1.9 metres below the existing ground surface. The fill consists of silty clay to clayey silt and sandy silt to silty sand with varying amounts of organic matter, rootlets, gravel, cobbles, and shale fragments. The fill at test pit 19-06 also contains concrete.

4.4 Sandy Silt to Silt

A layer of sandy silt to silt exists below the fill, which extends to depths ranging from about 1.7 to 3.8 metres below the existing ground surface. This deposit contains varying amounts of gravel, cobbles and boulders.

The measured water content of a sample from the sandy silt to silt ranged from about 16 to 22 percent.

The result of grain size distribution on one sample of the sandy silt to silt retrieved from the current investigation is provided on Figure B1 in Appendix B.

4.5 Glacial Till

Glacial till exists beneath the sandy silt to silt at all the test pit locations. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt. The glacial till extends to depths ranging between about 2.4 and greater than 5.2 metres beneath the existing ground surface.

The measured water content of samples from the glacial till ranged from about 7 to 14 percent.

The results of grain size distribution on four samples of the glacial till retrieved from the current investigation are provided on Figure B2 to B5 in Appendix B.

4.6 Refusal

Refusal to excavating was encountered at four test pit locations (19-02, 19-04, 19-05 and 19-06) at depths ranging between about 2.4 and 4.8 metres.

The following table summarizes the refusal elevations as encountered at the test pit locations.

Test pit Number	Existing Ground Surface Elevation (metre)	Depth of Test Pit (metre)	Refusal Elevation (metre)
19-01	103.8	5.0	–
19-02	103.1	4.8	98.3
19-03	103.5	5.2	–
19-04	103.4	4.8	98.6
19-05	103.2	2.4	100.8
19-06	103.7	4.3	99.4

Refusal may indicate the surface of the bedrock or boulders within the glacial till.

4.7 Groundwater

Groundwater seepage was observed in all the test pits advanced during the current investigation as summarized in table below.

Test Pit Number	Ground Surface Elevation (metre)	Water Seepage Depth (metre)	Water Seepage Elevation (metre)
19-01	103.8	3.8	100.0
19-02	103.1	2.4	100.7
19-03	103.5	3.2	100.3
19-04	103.4	3.2	100.2
19-05	103.2	2.4	100.8
19-06	103.7	3.5	100.2

Groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION

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.

5.2 Site Grading

The subsurface conditions on this site generally consist of fill over deposits of silty sand and glacial till underlain by bedrock. Refusal to excavating was encountered at depths ranging from about 2.4 to 4.8 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, preparation for filling of the site should include stripping any topsoil, fill, and organic matter from within the building footprints to improve the settlement performance of structures. 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, 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 depths ranging from about 2.4 to 3.8 metres below the existing ground surface (at about Elevations 100 to 101 metres), typically within the glacial till deposit.

Groundwater inflows should be expected for excavations that extend below about Elevation 101 metres. It may be preferable from a geotechnical perspective to limit the depths of excavations to no more than about 2.0 metres below the existing ground surface to reduce the possibility of continuous groundwater inflow to the basement drainage system.

The grading should also ideally be selected to avoid or limit bedrock excavation.

5.3 Material Reuse

The native soils are not considered to be generally suitable for reuse as structural/engineered fill. Within foundation areas, imported engineered fill should be used.

The native sandy silt and glacial till may be suitable for use as controlled fill beneath pavement areas, provided they are not too wet to place and compact. Glacial till encountered below the groundwater may be too wet to feasibly be used as controlled fill. These materials could however be reused in non-structural areas (i.e., landscaping).

5.4 Foundations

The native undisturbed, inorganic overburden soils encountered at the site are considered suitable for supporting the proposed residential buildings. Topsoil and fill would not be considered suitable to support the building foundations and therefore must be removed from underneath the building footings and slabs.

For frost protection purposes, exterior footings for buildings should be founded at least 1.5 metres below finished exterior grade. Isolated footings in unheated areas should be provided with at least 1.8 metres of soil for frost protection (see Section 5.6 below). In some areas of the site (i.e., at test pits 19-01, 19-04 and 19-06), the existing fill materials extend to depths greater than 1.5 metres and should be removed and replaced with engineered fill. The engineered fill should consist of OPSS Granular B Type II compacted to at least 95% of the materials standard Proctor maximum dry density.

Strip or pad footings, up to 3 metres in width, placed on the surface of the native soils or on engineered fill may be designed using a maximum allowable net bearing pressure of 150 kPa at serviceability limit states (SLS) and a factored bearing resistance at ultimate limit states (ULS) of 250 kPa.

The post-construction total and differential settlements of footings sized using the above maximum allowable net bearing pressure should be less than about 25 and 15 millimetres, respectively, provided that the subgrade at or below founding level is not disturbed by groundwater inflow or construction traffic.

The overburden materials on this site, in particular the glacial till deposit, contain cobbles and boulders. Any cobbles or boulders in footing areas which are loosened by the excavation process should be removed (and not pushed back into place) and the cavity filled with lean concrete or engineered fill. Otherwise, recompression of the disturbed soils could lead to larger than expected post-construction settlements.

5.5 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 D.

A more favourable Site Class value could potentially be assigned for the site if shear wave velocity testing were carried out.

The soils at this site are not considered liquefiable under earthquake loadings.

5.6 Frost Protection

The native subgrade soils on this site are considered to be highly frost susceptible. Therefore, all exterior perimeter foundation elements or foundation elements in unheated areas should be provided with a minimum of 1.5 metres of earth cover for frost protection purposes. Isolated, unheated 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.

5.7 Basement Slab

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed material should be removed from beneath the floor slabs. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs. Any fill required to raise the subgrade to the underside of the clear stone should consist of OPSS Granular A or Granular B Type II. The engineered fill should be compacted to at least 95 percent of the materials standard Proctor maximum dry density.

The recommended type of drainage system required (perimeter drains and/or underfloor drains; damp-proofing or water-proofing) depends upon the proposed basement founding elevations, soil types in the area and actual stabilized groundwater levels. As a general guideline, 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.

Permanent excavation should ideally not extend below the groundwater level at this site (see Section 5.2). If 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 100 microns, in accordance with Ontario Provincial Standard Specification (OPSS) 1860.

Based on the provided conceptual plan, it is understood that garages are not being considered for the proposed development. Recommendations on garage floor slab preparation can be provided upon request, if that changes.

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 either be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for Ontario Provincial Standard Specification (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 wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, wrapped in geotextile. It is anticipated that the subdrains will discharge by gravity drainage into an adjacent storm sewer. Alternatively, if gravity discharge to the storm sewer system is not feasible, the subdrains may discharge to a sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Basement walls made within open cut excavations, 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 magnitude of:

$$\sigma_h(z) = K_o (\gamma z + q)$$

Where: $\sigma_h(z)$ = Lateral earth pressure on the wall at depth z, kilopascals;

K_o = At-rest earth pressure coefficient, use 0.5;

γ = Unit weight of retained soil, 21.5 kilonewtons per cubic metre;

z = Depth below top of wall, metres; and,

q = Uniform surcharge at ground surface behind the wall to account for traffic, equipment, or stockpiled soil (use 12 kilopascals as a minimum).

The lateral earth pressure equation given above is in an unfactored format and will need to be factored for Limit States Design purposes. If Platon System sheeting or a 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.

These lateral earth pressures would increase under seismic loading conditions. The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution). The combined pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(z) = K_o \gamma z + (K_{AE} - K_a) \gamma (H-z)$$

Where:

K_{AE} = The seismic earth pressure coefficient, use 0.8 for a non-yielding wall,

Ka = Active earth pressure coefficient, use 0.34; and,

H = The total depth to the bottom of the foundation wall, metres.

5.9 Excavations

Excavations for basements, watermain, sewers, and service connections will be primarily through the fill, sandy silt and glacial till. No unusual problems are anticipated in excavating the overburden materials using conventional hydraulic excavating equipment, recognizing that significant cobble and boulder removal should be expected in the glacial till.

If encountered, removal of shallow depths or limited areas of bedrock could be accomplished using mechanical methods (such as hoe ramming in conjunction with line drilling). Rock removal to significant depths or over large areas could require blasting and further guidance can be provided if blasting is required.

In accordance with the Occupational Health and Safety Act (OHSA) of Ontario, the overburden materials above the groundwater table would generally be classified as a Type 3 soil and therefore, the side slopes should be stable in the short term at 1 horizontal to 1 vertical. 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.
Boulders larger than 0.3 metres in diameter should be removed from the excavation side slopes for worker safety.

Near-vertical temporary excavation side slopes in the bedrock, if encountered, should be feasible.

Trench excavations could also be carried out using steeper side slopes with all manual labour carried out within a fully braced, steel trench box for worker safety. It is expected that open-cut methods and/or braced trench box support will generally be feasible.

Stockpiling of soil beside the excavations should be avoided; the weight of the stockpiled soil could lead to slope instability of unsupported excavations. Stockpiles should be setback from the top of the slope a minimum distance equal to twice the depth of the excavation.

Where the subgrade for building 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.

The groundwater seepage at the test pit locations were measured to be between about 2.4 and 3.8 metres below the existing ground surface. Excavations deeper than about 2 metres below the existing ground surface may extend below the groundwater level. Groundwater inflow into the excavations should however be feasibly 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.

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. Based on the groundwater information collected during the current investigation as well as the type of the basement (partial basement), it is considered unlikely that a PTTW would be required during construction for this project. However, registration in the EASR may be required. The requirement for registration (i.e., if more than 50,000 litres per day is being pumped) can be assessed at the time of construction. Registration is a quick process that will not significantly disrupt the construction schedule.

5.10 Site Servicing

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 300 millimetres of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding 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 (SPMDD). The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the native soils and backfill 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 SPMDD.

It should generally be possible to re-use the sandy silt and glacial till as trench backfill. Where the trench will be covered with hard surfaced areas (e.g., pavements, sidewalks, or paving stones), 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.

All trench backfill should be placed in maximum 300 millimetre loose lifts and be uniformly compacted to at least 95 percent of the material's SPMDD using suitable compaction equipment. Backfilling operations carried out during cold weather should avoid inclusions of frozen lumps of soil, snow and ice.

5.11 Pavement Design

In preparation for pavement construction, all topsoil and any unsuitable fill (i.e., fill containing organic matter) should be excavated from the pavement areas for predictable pavement performance.

Those portions of the fill not containing organic matter may be left in place provided that some long term settlement of the pavement surface can be tolerated. However, the surface of the fill material at subgrade level should be proof rolled with a heavy smooth drum roller under the supervision of qualified geotechnical personnel to compact the surface of the existing fill and to identify soft areas requiring sub-excavation and replacement with more suitable fill.

Areas requiring grade raising to proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or OPSS Select Subgrade Material. The existing inorganic fill on site may be suitable for this purpose but that would need to be confirmed by the geotechnical engineer at the time of construction. Subgrade fill 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.

The pavement structure for car parking areas should consist of:

Pavement Component	Thickness (mm)
Asphaltic Concrete	50
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	300

The pavement structure for access roadways and truck traffic areas should consist of:

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

The granular base and subbase materials should be uniformly compacted to at least 100 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The asphaltic concrete should be compacted in accordance with Table 10 of OPSS 310.

The composition of the asphaltic concrete pavement in car parking areas should be as follows:

- Superpave 12.5 Surface Course – 50 millimetres

The composition of the asphaltic concrete pavement in access roadways and truck traffic areas should be as follows:

- Superpave 12.5 Surface Course – 40 millimetres
- Superpave 19.0 Binder Course – 50 millimetres

The pavement design should be based on a Traffic Category of Level B. The asphalt cement used on this project should be made with PG 58-34 asphalt cement on all lifts.

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 densities 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.

5.12 Impacts to Adjacent Structures or Services

Based on the distance to adjacent structures and to the existing roadways, the absence of compressible soils (i.e., clays) and relatively limited excavation depths, impacts to adjacent structures are not anticipated. This should be reviewed as the designs progress.

5.13 Trees

Based on the geotechnical investigation results, the soil types encountered at this site (i.e., fill, sandy silt and silty sand glacial till) has a low potential to undergo shrinkage as a result of water depletion by trees. Therefore, there are no restrictions on the types or sizes of trees that may be planted or tree to foundation setback distances, based on geotechnical considerations.

5.14 Corrosion

Two samples of soil from test pits 19-03 and 19-04 were subjected to basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of this testing are provided in Appendix C and are summarized in the table below.

Test Pit Number	Sample Number	Depth Interval (metres)	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (Ohm-cm)
19-03	5	4.2 – 4.4	<0.002	0.02	0.34	7.35	2,900
19-04	5	2.8 – 3.0	<0.002	0.01	0.17	7.78	5,850

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

6.0 ADDITIONAL CONSIDERATIONS

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

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.

Golder Associates Ltd.

Ali Ghirian, P.Eng.
Geotechnical Engineer

Bill Cavers, P.Eng.
Associate, Senior Geotechnical Engineer

AG/WC/hdw

https://golderassociates.sharepoint.com/sites/114589/project files/6 deliverables/geotechnical/19128449-001-r-rev1-rpt-glenview geotech investigation 4639 bank st. 2019-10-01.docx

IMPORTANT INFORMATION AND LIMITATIONS
OF THIS REPORT

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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.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

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.

KEY MAP

SCALE: 1:25,000

LEGEND

TEST PIT LOCATION

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM; NAD 83 CSRS, COORDINATE SYSTEM: UTM ONE 18, VERTICAL DATUM: CGVD28

0 25 50
1:1,000 METRES

CLIENT
GLENVIEW PROPERTIES INC.

PROJECT
GEOTECHNICAL INVESTIGATION
RESIDENTIAL COMMUNITY DEVELOPMENT
4639 BANK STREET, OTTAWA, ONTARIO

TITLE
TEST PIT LOCATION PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-16
DESIGNED	----
PREPARED	ZS
REVIEWED	AG
APPROVED	WC

PROJECT NO.	CONTROL	REV.	FIGURE
19128449	0001	A	1

Path: \\golder.gds\gal\ottawa\Active\Spatial_IM\GlenviewHomes\4639_BankSt\99_PROJ\19128449_GlenviewHomes_ResCommDevelopment\40_PROD\0001_GeotechInvestigation\ | File Name: 19128449-0001-BG-0001.dwg | Last Edited By: abrunsveld-dewar Date: 2019-09-19 Time:10:48:41 AM | Printed By: abrunsveld-dewar Date: 2019-09-19 Time:10:49:02 AM

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

APPENDIX A

List of Abbreviations and Symbols

Record of Test Pits

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	**Depth (metres)**	**Description**
TP 19-01 (103.8 metres)	0.0 – 0.3	TOPSOIL (FILL) – (ML) sandy CLAYEY SILT, trace gravel; dark brown; contains organic matter and rootlets, cohesive, w<PL
453191.6 E 5019487.5 N	0.3 – 1.6	FILL – (ML/CL) gravelly SILTY CLAY to CLAYEY SILT, some sand; grey-brown; contains organic matter, rootlets and shale fragments, cohesive, w<PL
	1.6 – 1.9	FILL – (SM) gravelly SILTY SAND; dark grey; contains cobbles, non-cohesive, moist to wet
	1.9 – 3.8	(ML) sandy SILT, trace gravel; brown to grey; contains cobbles and boulders; non-cohesive, moist
	3.8 – 5.0	(SM) gravelly SILTY SAND; grey; contains cobbles and boulders (GLACIAL TILL), non-cohesive, wet
	5.0	END OF TEST PIT
		Note: water seepage at 3.8 m depth upon completion

Sample	Depth (m)	Water Content (%)
1	0.3 – 0.6	
2	1.6 – 1.8	
3	1.9 – 2.2	
4	3.1 – 3.2	20
5	3.8 – 3.9	11
6	4.8 – 5.0	8

:

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	Depth (metres)	Description
TP 19-02 (103.1 metres)	0.0 – 0.15	TOPSOIL (FILL) – (ML) CLAYEY SILT, some sand, trace gravel; dark brown; contains organic matter and rootlets, cohesive, w<PL
453231.8 E 5019510.9 N	0.15 – 0.75	FILL – (CL/ML) gravelly CLAYEY SILT to SILTY CLAY, trace to some sand, contains large shale fragments; grey-brown; cohesive, w<PL
	0.75 – 2.2	(ML) sandy SILT, trace gravel; grey brown; contains cobbles and boulders, non-cohesive, moist to wet
	2.2 – 4.8	(SM) gravelly SILTY SAND; grey brown to grey; contains cobbles and boulders (GLACIAL TILL), non-cohesive, moist to wet
	4.8	END OF TEST PIT (Refusal)

Note: water seepage at 2.4 m depth upon completion

Sample	Depth (m)	Water Content (%)
1	0.15 – 0.75	
2	0.9 – 1.0	
3	2.3 - 2.5	
4	3.1 – 3.2	9
5	3.9 – 4.0	9
6	4.7 – 4.8	10

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	Depth (metres)	Description
TP 19-03 (103.5 metres)	0.0 – 0.25	TOPSOIL (FILL) – (ML) sandy CLAYEY SILT, trace gravel; dark brown; contains organic matter and rootlets, cohesive, w<PL
453230.8 E 5019452.0 N	0.25 – 1.5	FILL – (ML) gravelly sandy SILT; light brown to brown; contains cobbles and large shale fragments, non-cohesive, moist
	1.5 – 3.0	(ML) sandy SILT, trace gravel; brown to grey; contains cobbles, non-cohesive, moist
	3.0 – 5.2	(SM/ML) gravelly SILTY SAND to sandy SILT; grey; contains cobbles and boulders (GLACIAL TILL), non-cohesive, wet
	5.2	END OF TEST PIT

Note: water seepage at 3.2 m depth upon completion

Sample	Depth (m)	Water Content (%)
1	0.25 – 0.8	
2	1.5 – 1.6	
3	2.2 – 2.4	16
4	3.0 – 3.2	12
5	4.2 – 4.4	8
6	5.0 – 5.2	11

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	Depth (metres)	Description
TP 19-04 (103.4 metres)	0.0 – 0.23	TOPSOIL (FILL) – (ML) sandy CLAYEY SILT, trace to some gravel; dark brown; contains organic matter and rootlets, cohesive, w<PL
453234.6 E 5019408.7 N	0.23 – 1.05	FILL – (ML) gravelly sandy SILT; brown; contains cobbles, boulders, rootlets and large shale fragments, non-cohesive, moist
	1.05 – 1.5	FILL – (SM/ML) gravelly sandy SILT to SILTY SAND, dark brown; contains sand pockets, cobbles and large shale fragments, non-cohesive, moist
	1.5 – 1.7	FILL – (CL/CH) SILTY CLAY to CLAY, some sand and gravel; grey; cohesive, w>PL
	1.7 – 3.0	(ML) sandy SILT, trace gravel; brown; contains cobbles and boulders, non-cohesive, moist
	3.8 – 4.8	(SM) gravelly SILTY SAND; grey; contains cobbles and boulders (GLACIAL TILL), non-cohesive, wet
	4.80	END OF TEST PIT (Refusal)

Note: water seepage at 3.2 m depth upon completion

Sample	Depth (m)	Water Content (%)
1	0.23 - 0.75	
2	1.05 – 1.1	
3	1.5 – 1.7	
4	1.7 – 1.9	
5	2.8 – 3.0	19
6	3.0 – 3.1	12
7	4.0 – 4.3	8
8	4.6 – 4.8	9

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	Depth (metres)	Description
TP 19-05 (103.2 metres)	0.0 – 0.22	TOPSOIL (FILL) – (ML) CLAYEY SILT, trace to some sand and gravel; dark brown; contains organic matter and rootlets, cohesive, w<PL
453274.1 E 5019396.1 N	0.22 – 0.7	FILL – (ML/CL) gravelly SILTY CLAY to CLAYEY SILT, some sand; grey-brown; highly fissured, contains gravelly sand pockets, organic matter, rootlets and large shale fragments, cohesive, w<PL
	0.7 – 0.9	FILL – (ML/SM) gravelly sandy SILT to SILTY SAND; trace to some clay, contains large shale fragments; dark brown; non-cohesive, moist
	0.9 – 1.7	(ML) sandy SILT; brown; non-cohesive, moist
	1.7 – 2.4	(SM) gravelly SILTY SAND; grey; contains cobbles and boulders (GLACIAL TILL), non-cohesive, wet
	2.40	END OF TEST PIT (Refusal)
		Note: water seepage at 2.4 m depth upon completion

Sample	Depth (m)	Water Content (%)
1	0.22 – 0.7	
2	0.7 – 0.75	
3	1.3 – 1.5	22
4	2.0 – 2.1	7

TABLE 1

RECORD OF TEST PITS

Test Pit Number Elevation (Metres)	Depth (metres)	Description
TP 19-06 (103.7 metres)	0.0 – 0.3	TOPSOIL (FILL) – (ML) CLAYEY SILT, some sand, some to trace gravel; dark brown; contains organic matter and rootlets; cohesive, w<PL
453252.0 E 5019347.3 N	0.3 – 1.05	FILL – (ML) gravelly sandy SILT, brown; contains concrete, cobbles, boulders and large shale fragments, non-cohesive, moist
	1.05 – 1.8	FILL – (SM) gravelly SILTY SAND, fine to coarse; black to brown; contains silty sand pockets, non-cohesive, moist
	1.8 – 3.8	(ML) gravelly sandy SILT; brown; contains cobbles and boulders (GLACIAL TILL), non-cohesive, moist to wet
	3.8 – 4.3	(SM) gravelly SILTY SAND; black to brown; contains cobbles and boulders (GLACIAL TILL), non-cohesive, wet
	4.3	END OF TEST PIT (Refusal)
		Note: water seepage at 3.5 m depth upon completion

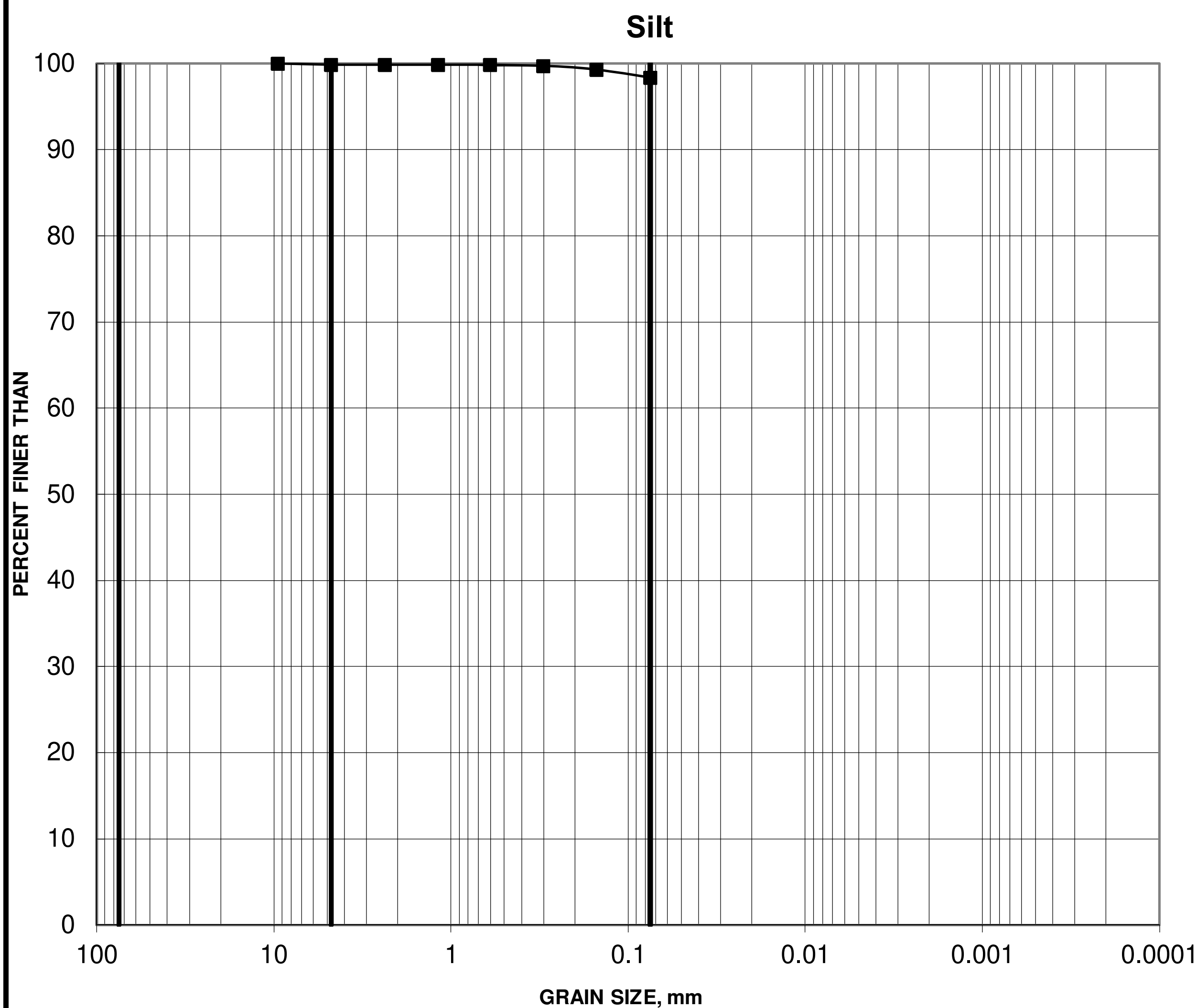
Sample	Depth (m)	Water Content (%)
1	0.3 – 1.05	
2	1.5 – 1.6	
3	2.0 – 2.4	
4	3.0 – 3.1	11
5	3.3 – 3.5	12
6	4.0 – 4.1	14

APPENDIX B

Soil Laboratory Test Results

GRAIN SIZE DISTRIBUTION

B-1



COBBLE SIZE	GRAVEL SIZE		SAND SIZE			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Testpit	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
19-01	4	3.10-3.20	0	2	98

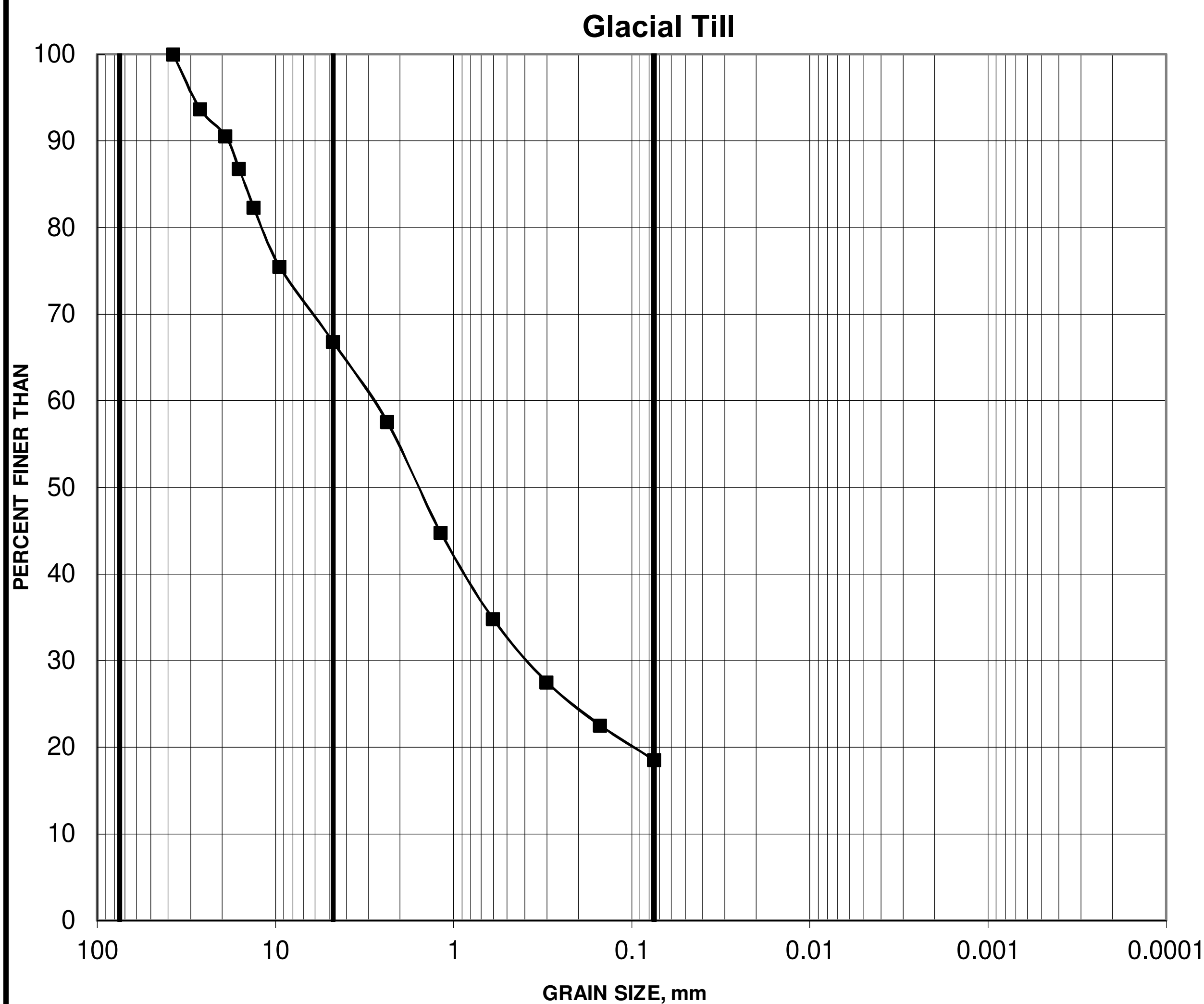
Created by: MI
Checked by: CM

Project: 19128449

Golder Associates

GRAIN SIZE DISTRIBUTION

B-2



COBBLE SIZE	GRAVEL SIZE		SAND SIZE			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Testpit	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
19-02	5	3.90-4.00	33	48	19

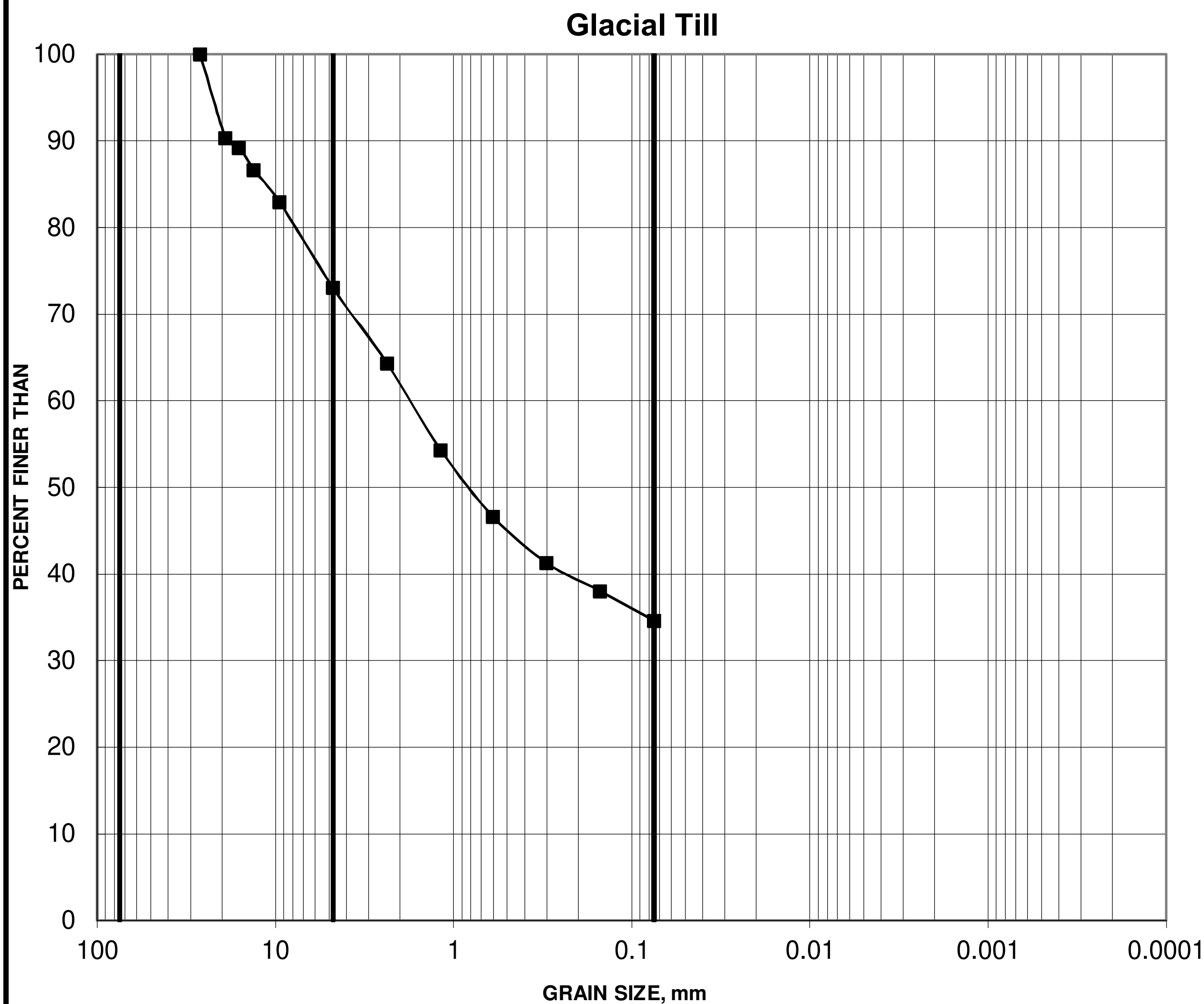
Project: 19128449

Golder Associates

Created by: MI
Checked by: CM

GRAIN SIZE DISTRIBUTION

B-3



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY
	GRAVEL SIZE		SAND SIZE			

Testpit	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
19-03	4	3.00-3.20	27	38	35

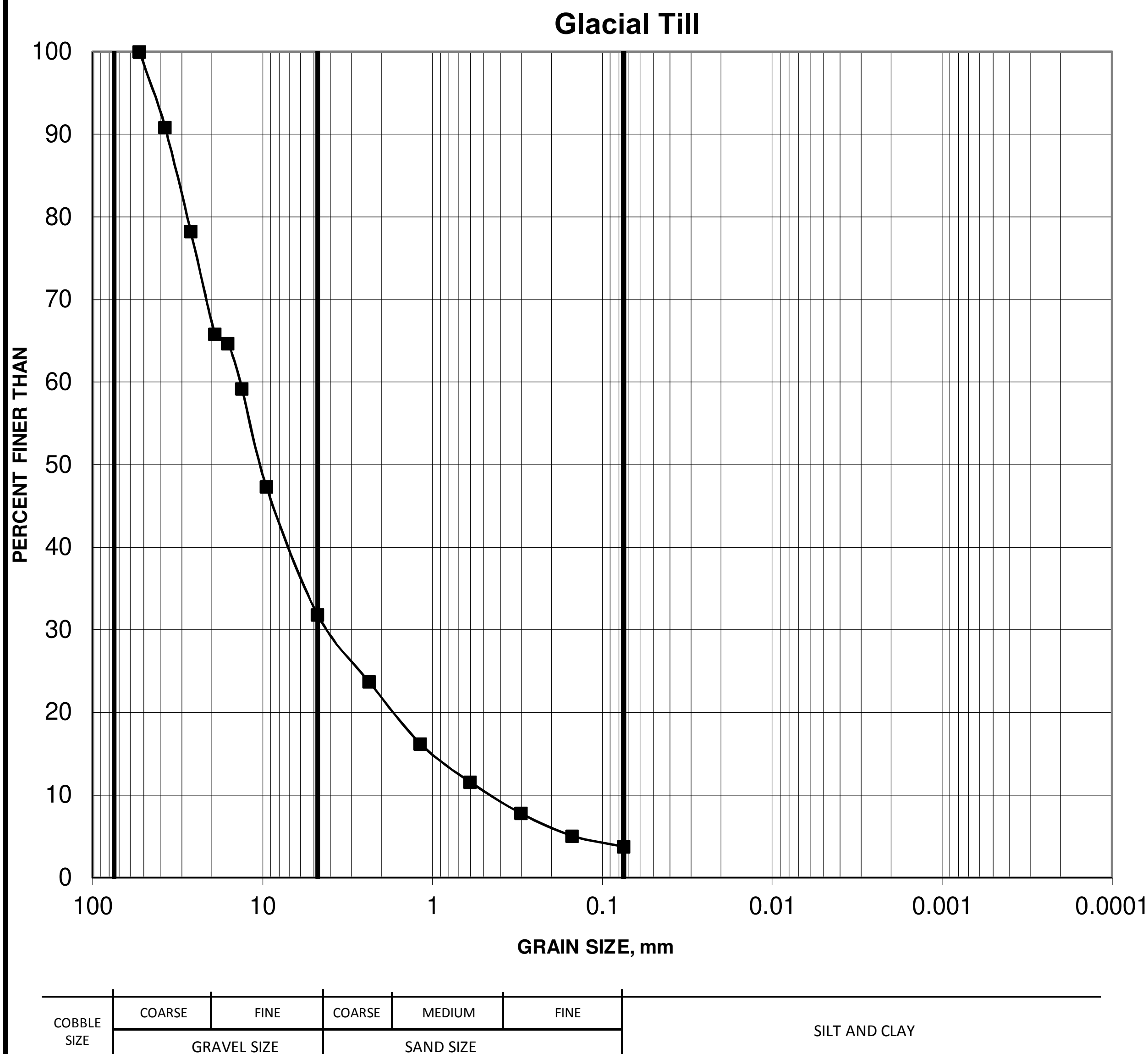
Project: 19128449

Golder Associates

Created by: MI
Checked by: CM

GRAIN SIZE DISTRIBUTION

B-4



Testpit	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
19-04	7	4.00-4.30	68	28	4

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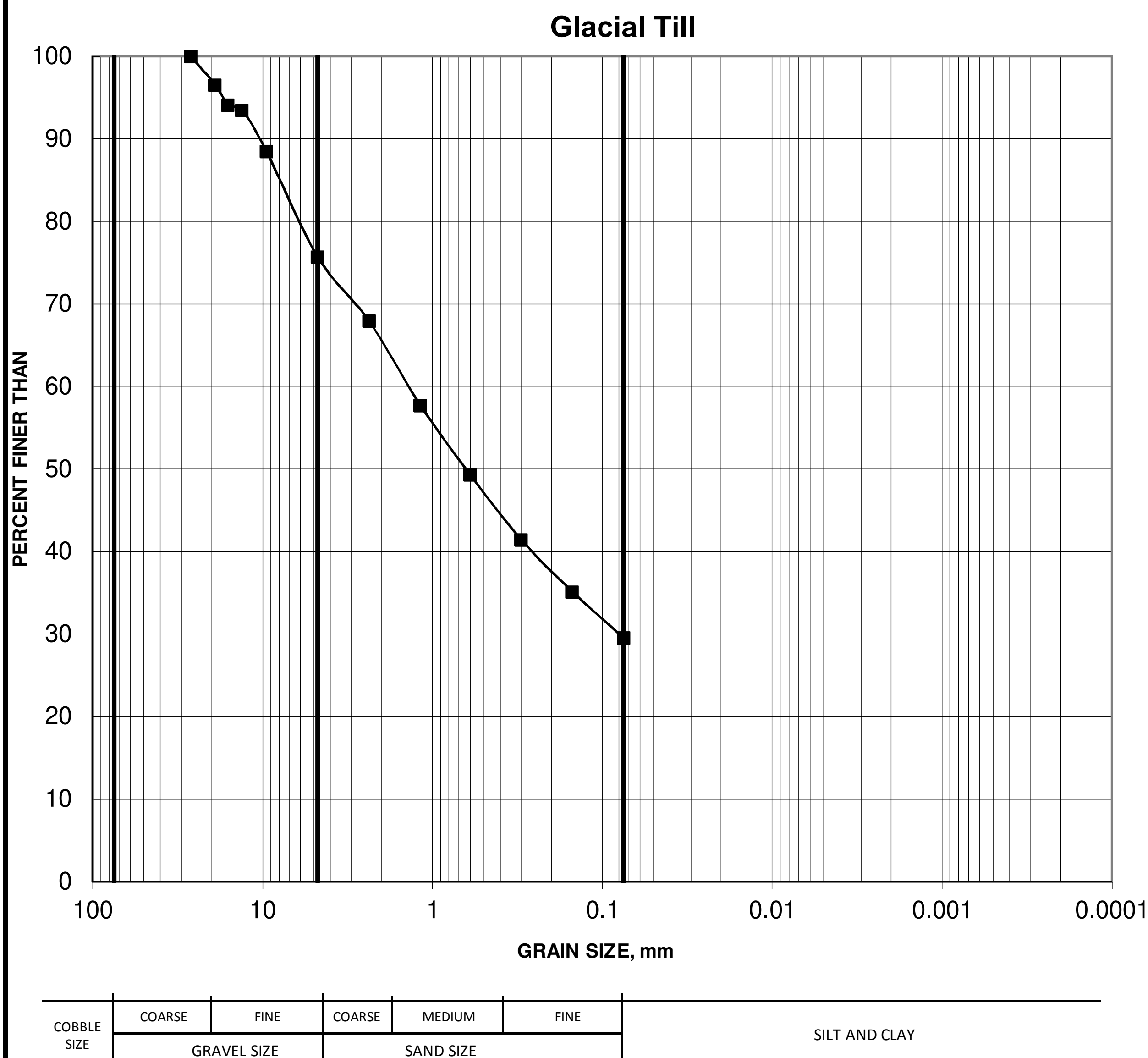
GRAIN SIZE DISTRIBUTION



Testpit	Sample	Depth (m)	Constituents (%) Gravel	Sand	Fines
19-06	5	3.30-3.50	24	46	30

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Created by: MI
Checked by: CM

APPENDIX C

Chemical Test Results

eurofins | Environment Testing

Certificate of Analysis

Client:	Golder Associates Ltd. (Ottawa) 1931 Robertson Road Ottawa, ON K2H 5B7	Report Number:	1917177
Attention:	Ms. Ali Ghirian	Date Submitted:	2019-09-19
PO#:		Date Reported:	2019-09-26
Invoice to:	Golder Associates Ltd. (Ottawa)	Project:	19128449
		COC #:	849212

				Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1454752 Soil 2019-09-05 19-03 sa5 / 4.2-4.4m	1454753 Soil 2019-09-05 19-04 sa5 / 2.8-3.0m
Group	**Analyte**	**MRL**	**Units**	**Guideline**		
Anions	Cl	0.002	%		<0.002	<0.002
	SO4	0.01	%		0.02	0.01
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.34	0.17
	pH	2.00			7.35	7.78
	Resistivity	1	ohm-cm		2900	5850

Guideline = *** = Guideline Exceedence**

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 golder.com