Geotechnical Investigation

Proposed Two Detached Houses

4 Walker Road West, Town of Caledon, Ontario

Prepared For:

Weston Consulting c/o Enio D'Amato

GeoPro Project No.: 19-2702G

Report Date: June 2, 2019

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1. INTRODUCTION

GeoPro Consulting Limited (GeoPro) was retained by Weston Consulting c/o Enio D'Amato (the Client) to conduct a geotechnical investigation for the proposed two detached houses located at 4 Walker Road West, Town of Caledon, Ontario.

The purpose of this geotechnical investigation was to obtain information on the existing subsurface conditions by means of a limited number of boreholes, in-situ tests and laboratory tests of soil samples to provide required geotechnical design information. Based on GeoPro's interpretation of the data obtained, geotechnical comments and recommendations related to the project designs are provided.

The report is prepared with the condition that the design will be in accordance with all applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practice. Further, the recommendations and opinions in this report are applicable only to the proposed project as described above. On-going liaison and communication with GeoPro during the design stage and construction phase of the project are strongly recommended to confirm that the recommendations in this report are applicable and/or correctly interpreted and implemented. Also, any queries concerning the geotechnical aspects of the proposed project shall be directed to GeoPro for further elaboration and/or clarification.

This report is provided on the basis of the terms of reference presented in our approved proposal prepared based on our understanding of the project. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this report can be relied upon.

This report deals with geotechnical issues only. The geo-environmental (chemical) aspects of the subsurface conditions, including the consequences 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, were not investigated and were beyond the scope of this assignment.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. Laboratory testing follows ASTM or CSA Standards or modifications of these standards that have become standard practice in Ontario.

This report has been prepared for the Client. Third party use of this report without GeoPro's consent is prohibited. The limitations to the report presented in this report form an integral part of the report and they must be considered in conjunction with this report.

2. INVESTIGATION PROCEDURE

The field work for the geotechnical investigation was carried out on April 3, 2019, during which time four (4) boreholes (Boreholes BH1 to BH4) were advanced to a depth of about 5.0 m below the existing ground surface. The borehole locations are shown on attached Drawings.

A proposed borehole location plan prepared by GeoPro was provided to Client for review prior to the filed investigation work. The approved borehole locations were staked in the field by GeoPro; the borehole locations in the field were adjusted according to the drill rig accessibility and the underground utility conditions. The field work for this investigation was monitored by a member of our engineering staff who logged the boreholes and cared for the recovered samples.

The boreholes were advanced using a continuous flight auger drilling equipment supplied by a drilling specialist subcontracted to GeoPro. Samples were retrieved with a 51 mm (2 inches) O.D. split-barrel (split spoon) sampler driven with a hammer weighing 624 N and dropping 760 mm (30 inches) in accordance with the Standard Penetration Test (SPT) method.

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. Boreholes BH1, BH3 and BH4 were backfilled and sealed upon completion of drilling. A monitoring well (51 mm in diameter) was installed in Borehole BH2 to measure the groundwater table.

All soil samples obtained during this investigation were brought to our laboratory for further examination. These soil samples will be stored for a period of three (3) months after the day of issuing draft report, after which time they will be discarded unless we are advised otherwise in writing. Geotechnical classification testing (including water content, grain size distribution and Atterberg Limits, when applicable) was carried out on selected soil samples. The laboratory test results are attached to Figures.

The ground surface elevations at the as drilled borehole locations were not available at the time of preparing this report. Therefore, the stratigraphy at each borehole location has been referenced to the current grade level. Contractors performing the work should confirm the elevations prior to construction. The borehole locations plotted on Borehole Location Plan were based on the measurements of the site features and should be considered to be approximate.

3. SUBSURFACE CONDITIONS

Notes on sample descriptions are presented in Enclosure 1A. Explanations of terms used in the borehole logs are presented in Enclosure 1B. The subsurface conditions in the boreholes are presented in the individual borehole logs. Detailed descriptions of the major soil strata encountered in the boreholes drilled at the site are provided as follows.

3.1 Soil Conditions

Topsoil

Topsoil with thicknesses ranging from about 370 mm to 580 mm was encountered surficially in all boreholes. In general, the topsoil consists of high contents of organics with trace to some rootlets. It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Fill Materials

Fill materials consisting of fine sand and silt and silty fine sand were encountered below the topsoil in all boreholes, and extended to depths ranging from about 0.7 m to 1.4 m below the existing ground surface. SPT N values ranging from 3 to 19 blows per 300 mm penetration indicated a very loose to compact compactness. The in-situ moisture content measured in the soil samples ranged from approximately 9% to 18%.

Silty Fine Sand and Fine to Medium Sand

Silty fine sand and fine to medium sand deposits were encountered below the fill materials in all boreholes, and extended to a depth of about 5.0 m below the existing ground surface. Boreholes BH2 to BH4 were terminated in these deposits. SPT N values ranging from 11 to 25 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil samples ranged from approximately 7% to 19%.

Silt

Silt deposit was encountered below the silty fine sand deposit in Borehole BH1, and extended to a depth of about 5.0 m below the existing ground surface. Borehole BH1 was terminated in this deposit. An SPT N value of 22 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 20%.

3.2 Groundwater Conditions

Groundwater condition observations made in the boreholes during and immediately upon completion of drilling are shown in the borehole logs and are also summarized in the following table.

BH No.	BH Depths (m)	Water Level during Drilling (mBGS)	Water Level on Completion of Drilling (mBGS)	Cave-in Depth on Completion of Drilling (mBGS)
BH1	5.0	2.5	3.7	4.0

BH2	5.0	3.1	3.5	4.3
BH3	5.0	4.6	3.4	3.7
BH4	5.0	2.5	3.5	3.7

Note: mBGS = meter below ground surface

The monitoring well construction details and measured groundwater level are shown in the following table.

Monitoring Well ID	Screen Interval (mBGS)	Water Level (mBGS)
		April 23, 2019
BH2	3.1 – 4.6	3.32

Note: mBGS = meters below ground surface

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

4. DISCUSSION AND RECOMMENDATIONS

This report contains the findings of GeoPro's geotechnical investigation, together with geotechnical engineering recommendations and comments. These recommendations and comments are based on factual information and are intended only for use by the design engineers. The number of boreholes may not be sufficient to determine all factors that may affect construction methods and costs. Subsurface conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the site investigation. The anticipated construction conditions are also discussed, but only to the extent that they may influence design decisions. The construction methods discussed, however, express GeoPro's opinion only and are not intended to direct contractors on how to carry out construction. Contractors should also be aware that the data and interpretation presented in this report may not be sufficient to assess all factors that may have an effect on construction.

The detail design drawings of the project are not available at the time of preparing this report. Once the design drawings and detail site plan are available, this report should be reviewed by GeoPro and further recommendations be provided as appropriate.

4.1 Foundation Design Considerations

Footings founded on approved engineered fill, the geotechnical bearing resistance may be taken as 100 kPa at Serviceability Limit States (SLS), and a factored bearing resistance of 150 kPa at Ultimate Limit States (ULS), provided that all requirements on Appendix A are adhered to. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the construction must be considered.

The topsoil and existing fill materials are not suitable to support any foundations. The native competent subsoils at the site are considered to be suitable for supporting conventional shallow foundations for light residential houses with basement. A geotechnical bearing resistance at Serviceability Limit States (SLS) and a factored geotechnical bearing resistance at Ultimate Limit States (ULS), may be considered for conventional shallow spread and/or strip footings bearing in the native, undisturbed, competent subsoils, subject to the inspection by a geotechnical engineer from GeoPro. The bearing resistance values and the corresponding founding depths at the borehole locations are provided in the following table.

Borehole No.	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Anticipated Bearing Soil
BH1	100	150	1.7	Compact Silty Fine Sand
BH2	150	225	1.7	Compact Silty Fine Sand
BH3	100	150	1.2	Compact Silty Fine Sand
BH4	150	225	1.7	Compact Silty Fine Sand

Variations in the soil conditions are expected between and beyond the borehole locations, and during construction, the actual subgrade and its bearing capacity should be carefully inspected and evaluated by the geotechnical engineer from GeoPro.

In general, for any houses placed wholly or in part on engineered fill, it is recommended that the foundations be provided with nominal reinforcement using steel rebar. Once the final thicknesses and extent of engineered fill are known, the need for and design of any reinforcement can be determined on a lot-by-lot basis by the builder's structural engineer, in consultation with the geotechnical engineer.

All foundation excavations at the site should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The founding materials are susceptible to disturbance by construction activity especially during wet weather and care should be taken to preserve the integrity of the materials as bearing strata. Prior to pouring concrete for the footings, the foundation excavations **must** be inspected by GeoPro to confirm that the footings are founded on an undisturbed and competent bearing stratum that has been cleaned of ponded water and all disturbed, softened, loosened, organic and other deleterious material.

All footings exposed to seasonal freezing and thawing must be provided with a minimum earth cover of 1.4 meters or equivalent insulation to satisfy frost protection requirements.

For the foundations designed to the specified bearing resistance values at the serviceability limit states (SLS), the anticipated maximum total and differential settlements of the foundations are expected to be less than 25 mm and 20 mm, respectively.

Where it is necessary to place foundations at different levels, the upper foundation must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower foundation. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

It is suggested that finalized basement floor elevations should be set at least 1.0 m above the local water table. Underfloor drains and upgraded level of water-proofing would be necessary in areas of the site if basements are proposed to be located below the local groundwater table and in potentially water bearing soils. Under-floor-slab drainage may be required for basements under such conditions and these conditions should be identified in the field by GeoPro on a lot-by-lot basis. The drainage tiles consisting of 100 mm diameter perforated pipes with filter fabric, should discharge into a positive frost-free outlet, as shown on Drainage and Backfill Recommendations, Drawing No. 2. Exterior basement walls should be damp-proofed above the water table and water-proofed below the water table. The backfill against the footing and foundation walls should consist of free-draining, non-frost-susceptible granular or equivalent. The on-site materials such as fine grained silty/fine sandy soils have adfreezing potential; if these soils are used to backfill against the perimeter foundation walls, a polyethylene slip-membrane should be placed below ground surface on the perimeter foundations walls. Vertical drains should be installed at the window wells and connected to the perimeter drains to reduce basement dampness. GeoPro recommends that 'dimple board' be used on all below ground surfaces.

4.2 Earth Pressures on Basement Walls

The lateral earth pressures acting on basement walls may be calculated from the following expression:

$$p = K(\gamma h + q)$$

where p = Lateral earth pressure in kPa acting at depth h

K = Earth pressure coefficient equal to 0.40 for vertical walls and horizontal backfill used for permanent construction. Water pressure must be considered, if continuous wall drains are not used.

γ = Unit weight of backfill, a value of 21 kN/m^3 may be assumed

h = Depth to point of interest in meters

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the walls.

4.3 Excavations and Groundwater Control

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the loose to compact existing fill materials and compact native soils can be classified as Type 3 soils above the groundwater table and Type 4 soils below the groundwater table.

It should be noted that some difficulties may be encountered in excavating the native soils at some locations. In addition, these native are inferred to contain cobbles and boulders. Obstruction should be expected in the existing fill materials. It is recommended that provisions should be made in the excavation contract for the removal of such obstructions.

Groundwater control at the site should be required to allow for construction of foundation elements in a dry condition. Groundwater control during excavation within the fill materials and native cohesionless silty/sandy deposits above the groundwater table at the site can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant seepage will be expected once the excavations extend below the prevailing groundwater tables in the fill materials and native cohesionless silty/sandy soils. Due to the extensive cohesionless silty/sandy soils encountered at the site, some form of positive groundwater control (well points or eductors) may be required to maintain the stability of the excavations in addition to pumping from sumps. The groundwater level should be lowered to at least 1 m below the excavation base prior to excavations. It should be noted that any construction dewatering or water taking in Ontario is governed by Ontario Regulation 387/04 - Water Taking and Transfer, made under the Ontario Water Resources Act (OWRA), and/or Ontario Regulation 63/16 – Registrations under Part II.2 of the Act – Water Taking, made under Environmental Protection Act. Based on these regulations, water taking of more than 400,000 L/day is subject to a Permit to Take Water (PTTW), while water taking of 50,000 L/day to 400,000 L/day is to be registered through the Environmental Activity and Sector Registry (EASR).

Care should be taken to direct surface water away from the open excavations and all temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. In addition, care must be taken during excavation to ensure that adequate support is provided for any existing structures or underground services located adjacent to the excavations.

It is anticipated that shallow excavations at the site will consist of temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical (1.5H:1V). However, depending on the construction procedures adopted by the contractor and weather conditions at the time of construction, some local flattening of the slopes might be required.

The selected inorganic soils free from topsoil and organics with suitable water contents can be used as general construction backfill where it can be compacted by sheep foot roller with loose lifts of soil not exceeding 300 mm. Imported granular fill, which can be compacted with small compacting equipment with loose lifts of soil not exceeding 200 mm, should be used in confined

areas. Any fill materials should be compacted to at least 98 % of Standard Proctor Maximum Dry Density (SPMDD). Due to the fine grained silty/fine sandy soils encountered at the site, the excavated soils at the site are anticipated to the difficult to compact to the required density. Should it be required, imported soils, such as Select Subgrade Materials (SSM) may be considered.

Depending on the time of construction and weather, the excavated soil below groundwater tables would be too wet to compact and will require aeration prior to its use. The existing soils are not considered to be free drained materials. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

Where the backfill against the exterior walls is to support settlement sensitive structures, such as concrete slabs, pavements or walkways, it should be uniformly compacted to at least 98% of SPMDD.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

5. MONITORING AND TESTING

The geotechnical aspects of the final design drawings and specifications should be reviewed by GeoPro prior to tendering and construction, to confirm that the intent of this report has been met. During construction, full-time engineered fill monitoring and sufficient foundation inspections, subgrade inspections, in-situ density tests and materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes, and to monitor conformance to the pertinent project specifications.

6. CLOSURE

We appreciate the opportunity to be of service to you and trust that this report provides sufficient geotechnical engineering information to facilitate the detail design of this project. We look forward to providing you with continuing service during the construction stage. Please do not hesitate to contact our office should you wish to discuss, in further detail, any aspects of this project.

Yours very truly,

GEOPRO CONSULTING LIMITED

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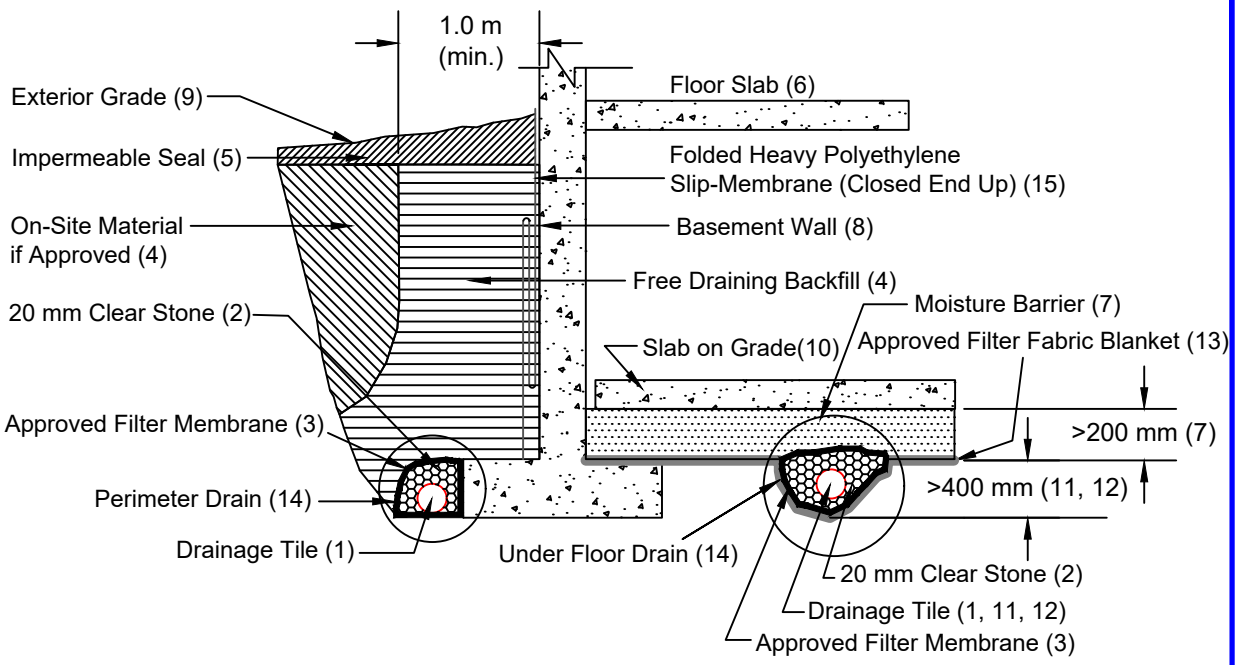
DRAWINGS

Legend:

- Borehole Location
- Monitoring Well Location

Client:	Weston Consulting c/o Enio D'Amato			Project No.: 19-2702G	Drawing No.: 1
Drawn:	YZ	Approved:	DL	Title:	Borehole Location Plan
Date:	May 2019	Scale:	N.T.S	Project:	Geotechnical Investigation Proposed Two Detached Houses 4 Walker Road West, Town of Caledon, Ontario
Original Size:	Letter	Rev:	DX		GeoPro Consulting Limited

Project: 19-2702G Drawing No. 2



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Externally Applied Folded Heavy Polyethylene Drainage Membrane.
16. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Basement with Underfloor Drainage

(not to scale)

ENCLOSURES

Enclosure 1A: Notes on Sample Descriptions

1. Each soil stratum is described according to the *Modified Unified Soil Classification System*. The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined according to Canadian Foundation Engineering Manual, 4th Edition. Different soil classification systems may be used by others. Please note that a description of the soil stratums is based on visual and tactile examination of the samples augmented with field and laboratory test results, such as a grain size analysis and/or Atterberg Limits testing. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Enclosure 1B: Explanation of Terms Used in the Record of Boreholes

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
NR	No recovery
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube Sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

PM – Samples advanced by manual pressure
WR – Samples advanced by weight of sampler and rod
WH – Samples advanced by static weight of hammer

Dynamic Cone Penetration Resistance, N_d:

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

Piezo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60 degree conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurement of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

Textural Classification of Soils (ASTM D2487)

Classification	Particle Size
Boulders	> 300 mm
Cobbles	75 mm - 300 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm – 4.75 mm
Silt	0.002 mm-0.075 mm
Clay	<0.002 mm(*)

(*) Canadian Foundation Engineering Manual (4th Edition)

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils(*)

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT "N" value
5. Pocket penetrometer

b) Cohesionless Soils

Compactness Condition (Formerly Relative Density)	SPT "N" Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
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
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

LOG OF BOREHOLE BH1

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses
CLIENT: Weston Consulting c/o Enio D'Amato
PROJECT LOCATION: 4 Walker Road West, Town of Caledon, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: HW
SAMPLE REVIEW: DX
CHECKED: DL
DIAMETER: 155 mm
DATE: 2019-04-03
REF. NO.: 19-2702G
ENCL. NO.: 2

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m) & SHEAR STRENGTH (kPa)	Plastic Limit w_P / Natural Moisture Content w / Liquid Limit w_L — WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (530 mm)	1	SS	14					
0.5	**FILL:** fine sand and silt to silty fine sand, organic inclusions, rootlet inclusions, layers of organic silt, containing ceramic fragments, dark brown to brown, moist, compact								
0.7	**FILL:** silty fine sand, organic inclusions, rootlet inclusions, layers of organic silt, containing nail fragments, brown, moist, loose	2	SS	6					
1.4	**SILTY FINE SAND:** layers of fine sandy silt, brown, moist to wet, compact	3	SS	13					0 65 33 2
		4	SS	21					
		5	SS	24					0 71 27 2
		6A	SS	22					
5.0	**SILT:** trace clay, some fine sand, brown, wet, compact	6B	SS						
5.0	**END OF BOREHOLE**								

Notes:

1) Water encountered at a depth of 2.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.0 mBGS upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ε=3%: Strain at Failure

LOG OF BOREHOLE BH2

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses

CLIENT: Weston Consulting c/o Enio D'Amato

PROJECT LOCATION: 4 Walker Road West, Town of Caledon, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HW | DATE: 2019-04-03

SAMPLE REVIEW: DX | REF. NO.: 19-2702G

CHECKED: DL | ENCL. NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION
0.0	**TOPSOIL:** (580 mm)	1	SS	19	
0.6	**FILL:** silty fine sand, organic inclusions, rootlet inclusions, layers of organic sandy silt, brown, moist, compact	2	SS	14	Bentonite
1.4	**SILTY FINE SAND:** layers of silt, layers of fine sandy silt, brown, moist to wet, compact	3	SS	25	
		4	SS	17	
		5	SS	18	3.3 mBGSApr 23 Sand Screen
		6	SS	18	Natural Pack
5.0	**END OF BOREHOLE**				

Notes:

1) Water encountered at a depth of 3.1 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.3 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading

Date	W. L. Depth (mBGS)
Apr. 23, 2019	3.32

DYNAMIC PENETRATION TEST: ○ SPT, ≳ Cone, blows/0.3m; 20 40 60 80

SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane; 20 40 60 80

Plastic Limit (w_P) | Natural Moisture Content (w) | Liquid Limit (w_L)

WATER CONTENT (%): 10 20 30 40

UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH3

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses

CLIENT: Weston Consulting c/o Enio D'Amato

PROJECT LOCATION: 4 Walker Road West, Town of Caledon, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HW | DATE: 2019-04-03

SAMPLE REVIEW: DX | REF. NO.: 19-2702G

CHECKED: DL | ENCL. NO.: 4

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (○ SPT, ≳ Cone, blows/0.3m) / SHEAR STRENGTH (kPa) (● Unconfined, ▲ Quick Triaxial, ✕ Field Vane & Sensitivity, ⊠ Penetrometer, + Lab Vane)	Plastic Limit w_P / Natural Moisture Content w / Liquid Limit w_L — WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (510 mm)		1	SS	3		○ at 20	○ at 10		
0.5	**FILL:** silty fine sand, organic inclusions, rootlet inclusions, brown, moist, very loose									
0.7	**SILTY FINE SAND:** trace gravel, layers/zones of fine sandy silt, zones of silt, brown, moist to wet, compact		2	SS	12		○ at 20	○ at 10		
			3	SS	14		○ at 20	○ at 20		
			4	SS	11		○ at 20	○ at 10		
			5	SS	16		○ at 20	○ at 20		
	--- zones of fine sandy silt		6	SS	16		○ at 20	○ at 30		
5.0	**END OF BOREHOLE**									

Notes:

1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.4 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.7 mBGS upon completion of drilling.

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +³, ×³: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH4

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses

CLIENT: Weston Consulting c/o Enio D'Amato

PROJECT LOCATION: 4 Walker Road West, Town of Caledon, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HW | DATE: 2019-04-03

SAMPLE REVIEW: DX | REF. NO.: 19-2702G

CHECKED: DL | ENCL. NO.: 5

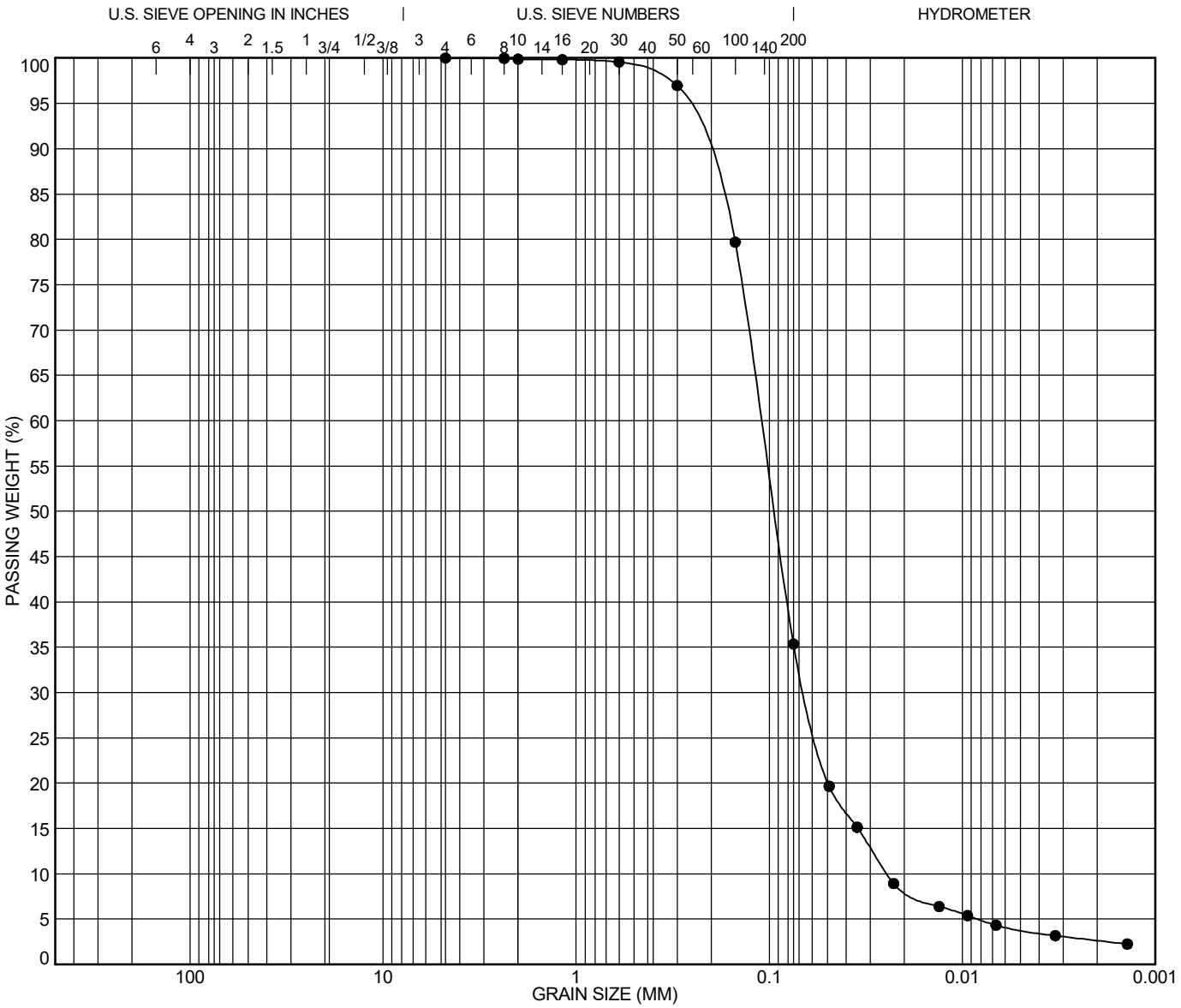
ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST: SPT / Cone blows/0.3m (20 40 60 80)	SHEAR STRENGTH (kPa): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane (20 40 60 80)	Plastic Limit w_P / Natural Moisture Content w / Liquid Limit w_L — WATER CONTENT (%) (10 20 30 40)	UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
0.0	**TOPSOIL:** (370 mm)		1	SS	4			○		○		
0.4	**FILL:** silty fine sand, organic inclusions, rootlet inclusions, pockets of organic silt, brown, moist, loose		2	SS	6			○		○		
1.4	**SILTY FINE SAND:** trace gravel, organic inclusions, rootlet inclusions, layers of fine sandy silt, brown, moist, compact		3	SS	16			○		○		
			4	SS	18			○		○		
2.9	**FINE TO MEDIUM SAND:** layers of fine sandy silt, brown, wet, compact		5	SS	18			○		○		
4.0	**NO SAMPLE RECOVERY:** likely silty fine sand		6	NR	18			○				
5.0	**END OF BOREHOLE** Notes: 1) Water encountered at a depth of 2.5 m below ground surface (mBGS) during drilling. 2) Water was at a depth of 3.5 mBGS upon completion of drilling. 3) Borehole caved at a depth of 3.7 mBGS upon completion of drilling.											

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

FIGURES



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH1**	**SS3**	**1.52**					**1.56**	**4.50**

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH1**	**SS3**	**1.52**	**4.75**	**0.11**	**0.065**	**0.024**	**0.0**	**64.6**	**32.7**	**2.6**

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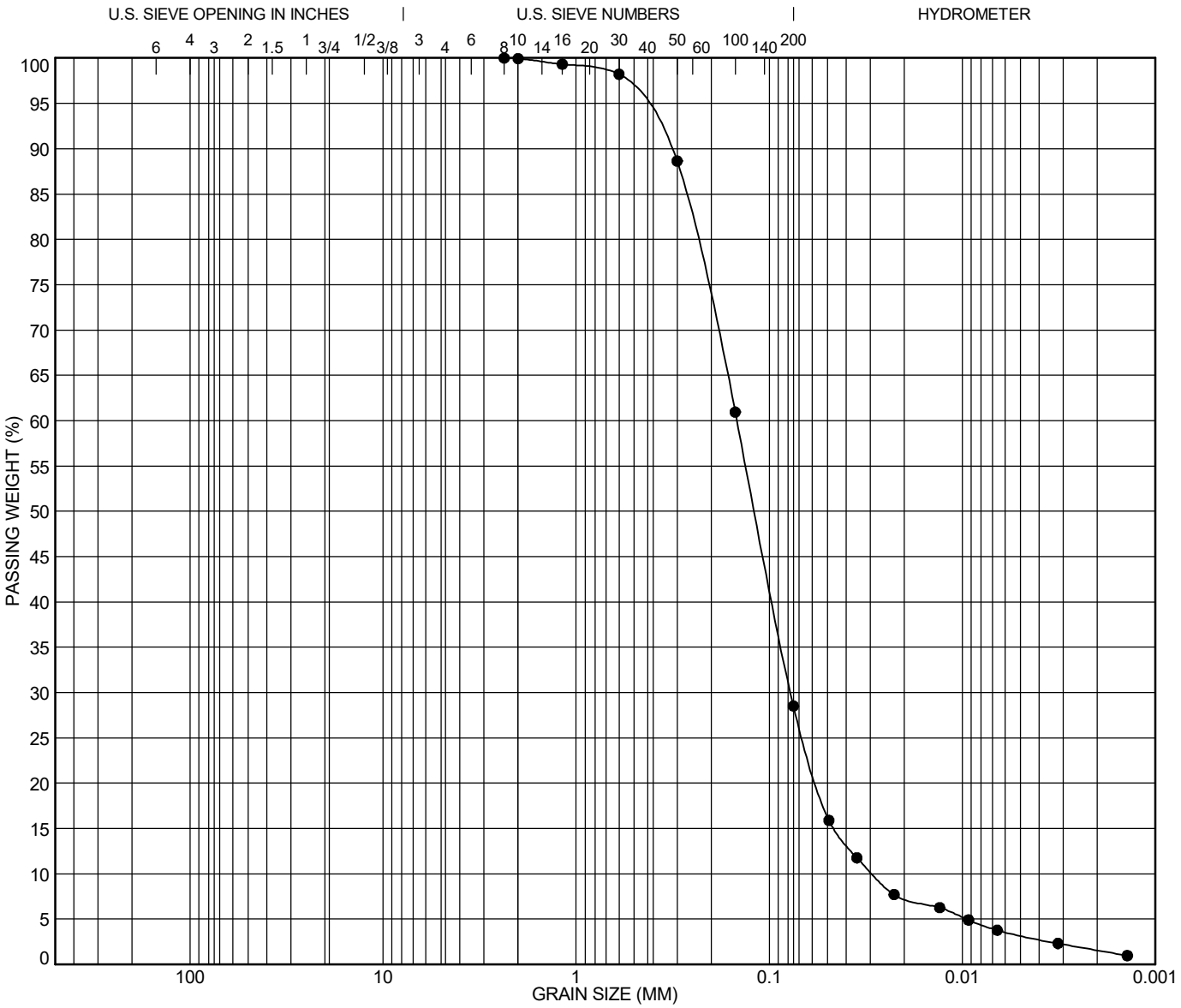
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses

LOCATION: 4 Walker Road West, Town of Caledon, Ontario

PROJECT NO.: 19-2702G	SAMPLED ON: 2019-04-03
FIGURE NO.: 1	TESTED ON: 2019-05-23



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH1**	**SS5**	**3.05**					**1.40**	**5.06**

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH1**	**SS5**	**3.05**	**2.36**	**0.147**	**0.077**	**0.029**	**0.0**	**71.5**	**27.0**	**1.5**

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GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical Investigation for Proposed Two Detached Houses

LOCATION: 4 Walker Road West, Town of Caledon, Ontario

PROJECT NO.: 19-2702G	SAMPLED ON: 2019-04-03
FIGURE NO.:2	TESTED ON: 2019-05-23

APPENDIX A

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted, imported soil that meets specific engineering requirements that is free of organics, topsoil, debris and any other deleterious materials, and that has been continually monitored on a full-time basis by a qualified geotechnical representative under the supervision of the geotechnical engineer is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other site(s). In general, most Ontario soils are too wet to achieve 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be used for engineered fill. Imported non-cohesive granular soils, such as well-graded sandy/granular soils, are preferred for all engineered fill. We recommend that OPSS Granular 'B' sand and gravel materials be used for the engineered fill material.

Adverse weather conditions, such as rain or subzero temperatures, make the placement of engineered fill to the required degree of compaction difficult or impossible; engineered fill cannot be placed during freezing conditions (i.e. normally between December 15 and April 1 in Southern Ontario).

The locations and elevations of the foundations on the engineered fill pad are critical, and certification by a qualified surveyor, to ensure that the proposed foundations are to be located within the stipulated boundaries, is mandatory. Since layout stakes are often damaged or removed during engineered fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same engineered fill as the original pad.

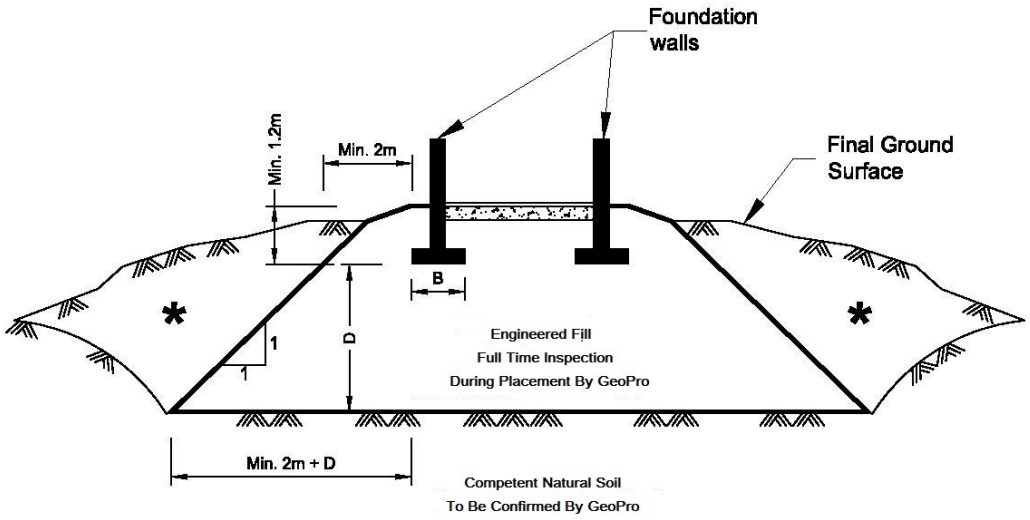
To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, and contractors, and all parties must be aware of the requirements. The minimum requirements are as follows; however, the geotechnical report must be reviewed for specific information and requirements.

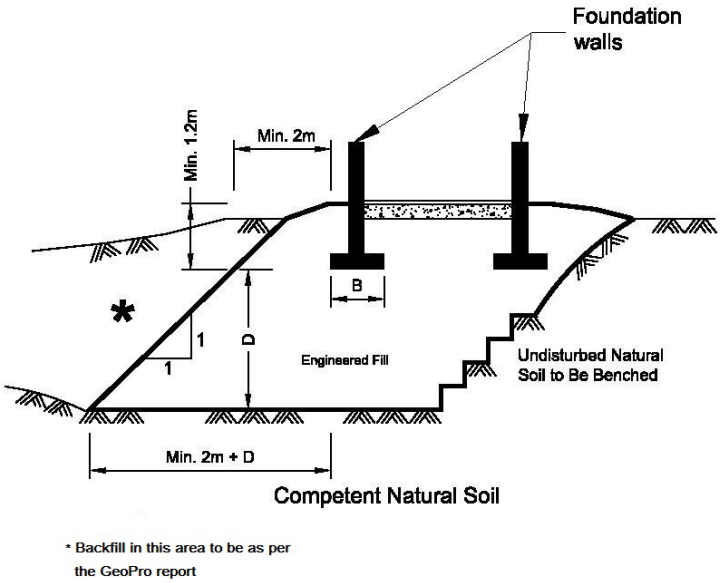
1. Prior to the site work involving engineered fill, a kick-off site meeting, to discuss all aspects of the engineered fill placement, must be carried out with all parties. The surveyor, contractor, design engineers and geotechnical engineer must attend the kick-off meeting. At the meeting, the construction schedule and the detailed design information regarding the engineered fills (such as the boundaries, thickness, competent subgrade elevations, specifications, and any special requirements from the engineers) will be discussed and determined. The contractor must provide the construction schedule including the source site(s) of the fill materials, which will have to be reviewed by the geotechnical engineer. The geotechnical engineer will arrange for soil sampling at the source site(s) and carry out the related laboratory testing. No soils can be hauled to the site prior to approval by the geotechnical engineer.
2. Detailed design drawings, such as grading drawings and other relevant drawings indicating the proposed structures or utilities as well as the underside and finished elevations of the engineered fill, should be provided in advance, and any concerns from a geotechnical perspective can be discussed at the kick-off site meeting and then approved by the engineers and other relevant parties.
3. The building footprint and base of the pad (including basements, garages, etc.) must be defined by offset stakes that will remain in place until the footings and service connections are all constructed. Confirmation, such as that the footings are within the pad, the service lines are in place, and the

grade conforms to drawings, must be obtained (by the owner) in writing from the surveyor and GeoPro. Without this confirmation in writing, no responsibility for the performance of the engineered fill can be accepted by GeoPro. Survey drawings of the pre and post fill location and elevations will also be required.

4. The subgrade area must be stripped of all topsoil, existing fill materials, loosened/softened native soils and any other deleterious materials. The subgrade must be proof-rolled by a qualified engineering representative from GeoPro. Any soft/loose spots revealed by proof-rolling must be subexcavated and replaced with engineered fill. The stripped subgrade must be examined and approved by a geotechnical engineer prior to the placement of engineered fill.
5. The approved engineered fill must be compacted to 98% SPMDD throughout. Granular fill materials consisting of well-graded, cohesionless sand and gravel are preferred. Engineered fill should not be placed (where it will support foundations) during the winter months. Engineered fill compacted to 98% SPMDD will settle under its own weight to approximately 0.25% to 0.75% of the fill height, and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement, due to consolidation of the underlying soils from the structures and fill loads, will occur and should be evaluated prior to placing the engineered fill.
6. Full-time geotechnical inspection and compaction testing by GeoPro during the placement of engineered fill must be required. The placement of the engineered fill must not commence or continue without the presence of GeoPro's representative.
7. Excavations must be carried out in accordance with the Occupational Health and Safety Regulations of Ontario.
8. Surface water cannot be allowed to pond in any area of the engineered fill footprint.
9. Clear stone backfill must not be used in any portion of the engineered fill unless it is approved by GeoPro in writing.
10. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for the minimum requirements. Take careful note that the projection of the compacted pad beyond the footing (at footing level) is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.
11. A bearing resistance of 75 kPa to 125 kPa at SLS (125 kPa to180 kPa at a factored ULS), or that being specified in the geotechnical report, can be used provided that all conditions outlined are adhered to. A minimum footing width of 500 mm (20 inches) is suggested, and footings must be provided with nominal steel reinforcement.
12. The owner may choose the same contractor or a different contractor for the foundation construction after completion of the engineered fill pad. In any case, the prepared footing bases must be inspected and evaluated by an engineering representative from GeoPro prior to pouring footing concrete. All excavations must be backfilled, under full-time supervision by GeoPro, to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in the excavations. Clear stone backfill is not allowed unless it is approved by GeoPro.
13. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends, and at any stoppage in work, in order to promote rapid runoff of rainwater and to avoid any ponding of surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take-up.

14. If the engineered fill placement is suspended for a long period of time, the engineered fill pad must be inspected by the geotechnical engineer prior to resuming the engineered fill placement. The locations of the proposed structures must be reconfirmed by the project surveyor, and the offset stakes should be reinstated by the project surveyor prior to resuming the engineered fill placement.
15. The geometry of the engineered fill, as illustrated in these General Requirements, is general and generic in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.
16. These guidelines are to be read in conjunction with GeoPro's report.





LIMITATIONS TO THE REPORT

This report is intended solely for the Client named. The report is prepared based on the work has been undertaken in accordance with normally accepted geotechnical engineering practices in Ontario.

The comments and recommendations given in this report are based on information determined at the limited number of the test hole and test pit locations. The boundaries between the various strata as shown on the borehole logs are based on non-continuous sampling and represent an inferred transition between the various strata and their lateral continuation rather than a precise plane of geological change. Subsurface and groundwater conditions between and beyond the test holes and test pits may differ significantly from those encountered at the test hole and test pit locations. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole and test pit locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

It should be noted that the results of the designated substance and chemical analysis refer only to the sample analyzed which was obtained from specific sampling location and sampling depth, and the presence of designated substance and soil chemistry may vary between and beyond the location and depth of the sample taken. Please note that the level of chemical testing outlined herein is meant to provide a broad indication of soil quality based on the limited soil samples tested. The analytical results contained in this report should not be considered a warranty with respect to the soil quality or the use of the soil for any specific purpose or the acceptability of the soils for any excess soil receiving sites.

The report reflects our best judgment based on the information available to GeoPro Consulting Limited at the time of preparation. Unless otherwise agreed in writing by GeoPro Consulting Limited, it shall not be used to express or imply warranty as to any other purposes. No portion of this report shall be used as a separate entity, it is written to be read in its entirety. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated.

The design recommendations given in this report are applicable only to the project designed and constructed completely in accordance with the details stated in this report. Otherwise, our responsibility is limited to interpreting the subsurface information at the borehole or test pit locations.

Should any comments and recommendations provided in this report be made on any construction related issues, they are intended only for the guidance of the designers. The number of test holes and test pits may not be sufficient to determine all the factors that may affect construction activities, methods and costs. Such as, the thickness of surficial topsoil or fill layers may vary significantly and unpredictably; the amount of the cobbles and boulders may vary significantly than what described in the report; unexpected water bearing zones/layers with various thickness and extent may be encountered in the fill and native soils. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and make their own conclusions as to how the subsurface conditions may affect their work and determine the proper construction methods.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GeoPro Consulting Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.