REPORT

Geotechnical Investigation

Lebovic - Seaton Whitevale East Development, Pickering, Ontario

Submitted to:

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by 1133373 Ontario Inc. (Lebovic) to conduct Geotechnical and Hydrogeological Investigations for the proposed Seaton Whitevale East Development in Pickering, Ontario (the Site). This report provides the results of the geotechnical investigation only; the results of the hydrogeological investigation will be submitted under separate cover.

The purpose of the geotechnical investigation was to obtain information on the general subsurface soil and groundwater conditions at the Site by means of a limited number of boreholes and, based on our interpretation of the borehole data, provide geotechnical recommendations in support of the Site development.

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen months of the date of the report, Golder should be given an opportunity to confirm that the recommendations are still valid. In addition, this report should be read in conjunction with the attached "*Important Information and Limitations of This Report*" which are included in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2.0 SITE AND PROJECT DESCRIPTION

The site is located east of Sideline 22 and south of Whitevale Road in Pickering, Ontario as shown on the Key Map and Borehole Location Plan provided on Figure 1. The property consists of undeveloped agricultural lands and cultivated farmlands. The property is currently bordered by agricultural lands to the north, south, east, and west.

Based on the topographic survey prepared by J.D. Barnes Ltd. dated January 5, 2017, the ground surface slopes downwards from north to south, and from west to east. The approximate ground surface elevations range from about 157 m to 183 m across the Site. Site grading activities and hauling of in situ materials were on-going during the field investigation.

Details of the proposed development (i.e. site grading, building structures, servicing depths, etc.) have been provided to Golder and are shown in the drawings described as follows:

- Proposed Draft Plan, Drawing No. WEDP-1 entitled "*1133373 Ontario Inc., Whitevale East SP-2015-05*" prepared by GHD, dated February 2019.
- Drawing No. GR-01 entitled "*Functional Grading Plan, 1133373 Ontario Inc. Whitevale East (SP-2015-05, A-10-15)*" prepared by Cole Engineering Ltd., dated May 2019.
- Drawing No. SER-1 entitled "*Functional Servicing Plan, 1133373 Ontario Inc. Whitevale East (SP-2015-05, A-10-15)*" prepared by Cole Engineering Ltd., dated May 2019.
- Figure No. LANDUSE-2 entitled "*Post-Development Land Use Plan, 1133373 Ontario Inc. Seaton Whitevale East*" dated February 2019.

Based on the provided drawings, it is understood that the overall development area is to be comprised of low to medium density residential buildings, a storm water management facility (SWMF), open space, and internal roads. The geotechnical recommendations for the SWMF #25 have been provided under separate cover.

3.0 INVESTIGATION PROCEDURES

The geotechnical field investigation for this assignment was carried out between May 21 and 25, 2020, during which time nine boreholes (designated as Boreholes BH20-1 to BH20-9) were advanced to depths ranging from 3.3 m to 8.1 m below ground surface (mbgs). The borehole locations are shown on the Borehole Location Plan, Figure 1.

The boreholes were advanced using a conventional track-mounted drill rig supplied and operated by George Downing Estate Drilling Limited of Greenville-Sur-La-Rouge, Quebec. Standard penetration testing (SPT) and sampling in the overburden soils were carried out at regular intervals of depth using conventional 50 mm external diameter split spoon sampling equipment driven by an automatic hammer in accordance with ASTM D1586. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions. The results of the in-situ field tests (i.e. SPT ‘N’-values) as presented on the Record of Borehole Sheets (i.e. borehole records) and in Section 4 of this report are uncorrected.

The groundwater conditions were noted in the open boreholes during and upon completion of drilling. Monitoring wells were installed in Boreholes BH20-1, BH20-4, BH20-5, BH20-6, BH20-7 and BH20-8 following the completion of drilling to allow for further groundwater measurements. Each monitoring well consisted of a 50 mm diameter PVC pipe with a slotted screen sealed at a selected depth within the boreholes. A sand filter pack surrounded the screen, and above the screen the annulus was backfilled to the surface with bentonite. The well installation details, and water level readings are presented on the Borehole records.

The field work was observed by a member of our technical staff, who located the boreholes in the field, arranged for the clearance of underground utility services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and took custody of the recovered soil samples. The samples were identified in the field, placed in appropriate containers, labelled, and transported to our Whitby geotechnical laboratory for further examination and selected laboratory testing. Index and classification tests, consisting of water content determinations as well as selective gradation and Atterberg limit testing were carried out on the recovered soil samples. The results of the geotechnical laboratory tests are presented on Figures 2 to 6 and on the borehole records.

The locations of the boreholes and the corresponding geodetic ground surface elevations were surveyed by J.D. Barnes Ltd. and provided to Golder.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

The surficial geology aspects of the general site area are referenced from: Chapman, L.J., and Putnam, D.F., 2007, *“The Physiography of Southern Ontario”*; 4th Edition, Ontario Geological Survey. Based on the physiographic mapping tor the vicinity of the site, the site lies within the physiographic regions of Southern Ontario known as the South Slope.

The South Slope region slopes gradually downward towards Lake Ontario. The overburden immediately below ground surface within the South Slope generally consists of silty clay to clayey silt till and at depth consists of alternating deposits of dense lacustrine sands and silts and over consolidated lacustrine clays and clay tills overlying the bedrock.

4.2 Subsurface Conditions

The subsurface soil and shallow groundwater conditions encountered in the boreholes, as well as the results of the field and laboratory testing are shown on the Borehole records and on Figures 2 to 6, respectively, following the text of this report. Golder's "*Method of Soil Classification*", "*Abbreviations and Terms Used on Records of Boreholes and Test Pits*" and "*List of Symbols*" are attached to assist in the interpretation of the borehole logs. It should be noted that the boundaries between the soil strata have been inferred from drilling observations and non-continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Further, conditions will vary between and beyond the boreholes.

The following is a summarized account of the subsurface conditions encountered in the boreholes advanced at the Site, followed by more detailed descriptions of the major soil strata and shallow groundwater conditions.

In general, the subsurface conditions at the site consist of topsoil and reworked native materials underlain by a glacial till deposit. Layers of gravelly sand, silty sand, sand, and silt deposits were interlayered within the glacial till deposit. The groundwater levels measured in the monitoring wells ranged between 1.1 mbgs and 6.0 mbgs.

4.2.1 Topsoil

Between approximately 300 mm and 690 mm of topsoil was encountered in all boreholes at ground surface. As presented in the table below. It should be noted that due to current Site activities, these thicknesses may no longer be representative.

Borehole	Thickness (mm)
20-1	300
20-2	480
20-3	480
20-4	300
20-5	690
20-6	690
20-7	690
20-8	690
20-9	690

4.2.2 Fill/Reworked Native

Fill/reworked native soils consisting of cohesive clayey silt to silty clay were encountered in Boreholes BH20-1, BH20-2, BH20-3, BH20-4 and BH20-7. The cohesive fill was encountered underlying the topsoil and extended to depths between 0.7 m and 1.4 mbgs. The fill contained organic inclusions, rootlets, and oxidation staining and are assumed to be reworked native soils.

The SPT 'N'-values measured within the cohesive fill ranges from 3 blows to 23 blows per 0.3 m of penetration indicating a soft to very stiff consistency. The in-situ water contents measured on the cohesive fill samples ranges from about 12 percent to 19 percent.

4.2.3 Glacial Till

A deposit of glacial till was encountered in all boreholes advanced at the site. The till ranges in composition from non-cohesive silty sand to cohesive sandy silty clay to clayey silt and sand. The deposit generally extends to the borehole termination depths and contains non-cohesive interlayers. Although cobbles and boulders were not noted during drilling through the till deposits at this site, cobbles and boulders are commonly encountered in glacially derived materials and should be expected within these deposits. Further, the presence of cobbles and/or boulders in the cohesive and non-cohesive till deposits can be inferred from the multiple instances of auger grinding during drilling as well as the split-spoon sampler not advancing the full sample depth.

(CL-ML) Silty Clay to Clayey Silt (Till)

A cohesive till deposit consisting of silty clay to clayey silt, sand to sandy, containing trace to some gravel and rock fragments was encountered in Boreholes BH20-1 to BH20-6. The cohesive till deposit was generally encountered underlying fill/reworked native soil with the exception of Borehole BH20-5 which underlies a silty sand till deposit. Sand seams and pockets were observed in Boreholes BH20-2 and BH20-6.

The SPT 'N'-values measured within the silty clay to clayey silt till deposits ranges from 18 blows per 0.3 m of penetration to 50 blows per 0.1 m of penetration, indicating a very stiff to hard consistency, and generally is considered to be hard. The natural water contents measured on selected samples ranges from about 6 percent to 14 percent and generally less than 10 percent.

Atterberg limits testing was performed for a single sample of the silty clay to clayey silt and sand till deposit and is shown on a plasticity chart on Figure 2. The results of the Atterberg limit test indicate the material is classified as a silty clay to clayey silt of low plasticity. A grain size distribution curve for a single sample of the silty clay to clayey silt and sand till is shown on Figure 3.

(SM) Silty Sand (Till)

A silty sand till deposit, gravelly to trace gravel, containing rock fragments was encountered in Boreholes BH20-5, BH20-7, BH20-8, and BH20-9. Oxidation staining was observed in some of the boreholes.

The SPT 'N'-values measured within the silty sand till deposit ranges from 41 blows per 0.3 m of penetration to 50 blows per 0.08 m of penetration, indicating a dense to very dense state of compactness. The natural water contents measured on samples of the silty sand till ranges from about 6 percent to 12 percent.

A grain size distribution curve for a single sample of the silty sand till deposit is shown on Figure 4.

4.2.4 (SM) Silty Sand

A silty sand deposit, gravelly to trace gravel, were encountered in Boreholes BH20-5, BH20-6, BH20-7, and BH20-9, typically interlayered within the till deposits. Oxidation staining was observed in some of the boreholes. The presence of cobbles and/or boulders can be inferred from the multiple instances of auger grinding during drilling.

The SPT ‘N’-values measured within the silty sand deposit ranges from 15 blows per 0.3 m of penetration to 69 blows per 0.25 m of penetration, indicating a compact to very dense state of compactness. The natural water contents measured on samples of the silty sand deposit ranges from about 6 percent to 21 percent, typically being higher at depth within the borehole.

A grain size distribution curve for a single sample of the silty sand deposit is shown on Figure 5.

4.2.5 (SP) Sand

Sand deposits ranging in composition from gravelly sand to sand, containing trace to some fines were encountered in Boreholes BH20-6 and BH20-8 underlying the glacial till deposit.

The SPT ‘N’-values measured within the sand deposit ranges from 37 blows per 0.3 m of penetration to 50 blows per 0.13 m of penetration, indicating a dense to very dense state of compactness. The natural water content measured on four samples of the sand deposit ranges from about 9 percent to 17 percent.

A grain size distribution curve for a single sample of the gravelly sand deposit is shown on Figure 6.

4.2.6 (ML) Silt

A 0.7 m thick silt deposit, containing some sand and slightly plastic, was encountered in Borehole BH20-8 below the topsoil.

One SPT ‘N’-value measured within the silt deposit was about 21 blows per 0.3 m of penetration, indicating a compact state of compactness. The natural water content measured on a single sample of the silt deposit is about 14 percent.

4.2.7 Groundwater

Groundwater observations during or upon completion of drilling ranged from 0.8 m to 6.0 mbgs or dry in three boreholes and are shown on the borehole records. The groundwater level measurements in the monitoring wells ranged between 1.1 m and 6.0 mbgs (Elevations 153.7 m and 177.9 m) and are summarized in the table below.

Borehole	Existing Ground Surface Elevation (m)	June 5, 2020	
		Depth (m)	Elevation (m)
20-1	179.1	1.2	177.9
20-4	169.2	1.1	168.1
20-5	168.4	1.9	166.5
20-6	163.9	5.6	158.3

Borehole	Existing Ground Surface Elevation (m)	June 5, 2020	
		Depth (m)	Elevation (m)
20-7	160.6	3.5	157.1
20-8	159.3	4.8	154.4

It should be noted that these observations and measurements reflect the shallow groundwater conditions encountered in the boreholes during the time of the field investigation and that water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt.

5.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides engineering information and recommendations for the geotechnical design aspects of the project based on our interpretation of the borehole information, the laboratory test data and our understanding of the project requirements. The information in this portion of the report is provided for planning and design purposes for the design guidance of the design engineers and architects. Where comments are made on construction, they are provided only in order to highlight those aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

Based on the result of the investigation, the subsurface soil conditions encountered at the site are considered to be generally suitable for the proposed low to medium density residential buildings utilizing conventional shallow strip/spread footings, with slab-on-grade construction and serviced shallow underground utilities.

The proposed site development consist of low to medium density residential buildings, stormwater facility, open space, overland flow and internal roads. Based on the functional grading plan, the finished floor elevation (i.e. FFE) and relevant boreholes for residential buildings along the proposed streets is as follows:

Street	House/Block Numbers	Proposed Finish Floor Elevations (FFE), (m)		Closest Borehole(s)
		From	To	
Street A	1 to 29 and Blocks 89 to 91	159.2	176.6	BH20-4, BH20-5, BH20-6, BH20-7, BH20-9
Street B	30 to 52	166.2	169.5	BH20-5, BH20-6
Street C	53 to 62	168.6	169.4	BH20-5, BH20-6
Street D	63 to 88	175.1	184.2	BH20-1, BH20-2, BH20-3

5.1 Site Preparation

5.1.1 Topsoil Stripping and Reuse

Topsoil, soil containing organics and reworked native soils should be stripped from the site prior to placement of engineered fill. The reworked native soils should not be reused as engineered fill. Outside of road allowances and building envelopes, the topsoil may be reused as general lot fill to raise grades above the engineered fill.

Where the topsoil is used as general lot fill, its thickness should be limited to about 1.5 m. The topsoil fill should be placed in maximum 300 mm loose lifts and uniformly compacted to 95 percent of standard Proctor maximum dry density (SPMDD). To have any success in placing topsoil as lot grading fill, it must be placed at or very close to its optimum water content to achieve workability and adequate compaction, in order to minimize post-construction settlements and/or lateral movements (e.g. of fences, etc.).

5.1.2 Subgrade Preparation

Based on the site grading plan, it is understood that grade raise up to 6 m is required across the Site. Finished floor elevations for the proposed structures are detailed in Section 5.0 and ranges from about Elevations 159 m to 185 m and the existing ground surface (at the time of the investigation) ranges from Elevations 157.4 m to 179.1 m. As such, any filling carried out at the Site in conjunction with re-grading (with exception of future green spaces) should be carried out as engineered fill. Recommendations for the placement of engineered fill are outlined in Section 5.1.3.

5.1.3 Engineered Fill

Where cut (if any) and fill are required to achieve final grade within the Site, the silty clay to clayey silt and sand till, silty sand till, sand and silty sand deposits can be reused as engineered fill. Based on the soil classification and frost group described in Table 13.1 of the Canadian Foundation Engineering Manual (CFEM), the cohesive fill/reworked native material, native silty clay to clayey silt till, and silt deposits encountered on the site are regarded as being susceptible to frost. This should be considered for any design elements exposed to freezing temperatures (concrete flatworks, exterior concrete slabs, and the like).

Based on the measured natural water contents, the predominant soils within the Site consisting of glacial till deposit are generally below or slightly above their estimated laboratory optimum water contents for compaction. However, the lower silty sand encountered in Boreholes BH20-7 and BH20-9 have their natural water contents above their estimated laboratory optimum water contents for compaction. However, this lower deposit is not expected to be disturbed or excavated based on the site grading plan.

Alternatively, imported materials may be used for engineered fill and must be approved by Golder at the source(s), prior to hauling to the site. In this regard, imported granular materials which meet the requirements for OPSS.PROV 1010 (Aggregates) Select Subgrade Material (SSM) would be suitable for use as engineered fill. In any event, the approved materials for engineered fill should be placed in maximum 300 mm loose lifts and uniformly compacted to 98 percent SPMDD.

All oversize cobbles and boulders (i.e. greater than 150 mm in size) or any other deleterious materials should be removed from engineered fill materials.

Prior to placement of engineered fill and fill/reworked native soils must first be removed from the development area. The exposed native subgrade area(s) should then be heavily proofrolled in conjunction with an inspection by geotechnical personnel from Golder to confirm the base is free of ponded water, loosened/softened or any other deleterious materials. Remedial work (further sub-excavation, replacement, etc.) might be needed as per recommendations from Golder during proofrolling.

Full-time monitoring and in situ density testing must be carried out by Golder during placement of engineered fill below all structures and settlement sensitive areas.

The final surface of the engineered fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water prior to construction. During periods of freezing weather, additional soil cover should be placed above final subgrade to provide for temporary frost protection.

5.2 Residential Foundation Design

Based on the FFE within the residential development, we recommend that the proposed buildings be supported on conventional spread/strip footings founded on the competent engineered fill or native soils (if encountered) consisting of compact to very dense silty sand, very stiff to hard cohesive till and dense non-cohesive till.

Spread and strip footings founded on the native deposits at a minimum depth 1.2 m below finished grade may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 300 kPa and a geotechnical reaction at Serviceability Limit States (SLS) of 200 kPa for 25 mm of settlement.

For footings founded on approved engineered fill compacted to 98 percent of material’s SPMDD at a minimum depth of 1.2 m below finished grade, a factored axial geotechnical resistance at ULS of 225 kPa and an axial geotechnical reaction at SLS of 150 kPa (for 25 mm of settlement) may be used for design.

For the soil reactions listed above, the footings must have widths ranging from 450 mm to 900 mm for strip footings and 1,000 mm to 2,500 mm for spread footings. Should larger footing sizes be required, Golder must be consulted to provide additional recommendations.

The foundation subgrade for footings founded on engineered fill or native soils is subject to inspection and approval by Golder prior to pouring concrete. Remedial action (sub-excavation and replacement, etc.) may be required during excavations of footings especially when footing design elevations coincide with softened or loosened soils or any deleterious material in engineered fill or native soils. These soils must be sub-excavated and replaced with lean mix concrete or engineered fill as directed by geotechnical personnel from Golder.

In general, for any structures placed wholly or in part on engineered fill, it is recommended that the foundation walls be provided with nominal reinforcement with reinforcing steel at the top and bottom of the foundation walls. This could typically consist of two 10 M bars in the top and two 10 M bars in the bottom of the walls. The bars should be placed as close as possible allowing for at least 50 mm of cover. Corner bars should have proper factory bends and all tied steel should have at least 600 mm of overlap. At window well locations, two 10 M bars should be placed in the foundation wall as close to the sill as possible (allowing for 50 mm of cover). The bars should extend laterally at least 600 mm beyond the edge of the window opening. The actual design should be approved by the home builder’s structural engineer.

The perimeter house basement walls should be backfilled with a free draining, non-frost susceptible granular material carefully placed and compacted in lifts. The walls should be designed using a lateral earth pressure coefficient at rest of 0.5 and a unit weight of backfill of 21 kN/m^3. Alternatively, where site excavated material is to be reused for exterior basement wall backfill, an approved geocomposite drainage system should be used directly against the wall. The upper 0.3 m of backfill should be clayey material to provide a relatively impermeable cap and should be sloped away from the house. Properly filtered perimeter drains at foundation level leading to a permanent outlet, such as a continuously pumped sump or a direct outlet to a sewer line, should be provided.

It is suggested that finalized basement floor elevations should be set above the local water table. Based on the final grade elevations and the measured groundwater levels, the proposed basement elevations are above the measured groundwater table. As such, underfloor drains and upgraded level of waterproofing would not be required. Such conditions should be identified in the field by the geotechnical engineer.

If stepped spread footings are constructed at different founding levels, the difference in elevation between individual footings should not be greater than one half the clear distance between the footings. Should this not be possible, Golder should be consulted to provide field inspection to ensure that the footings exceeding the above requirement are stable and the bearing for the upper footing is not compromised. In addition, the lower footings should be constructed first so that if it is necessary to construct the lower footings at a greater depth than anticipated, the elevations of the upper footings can be adjusted accordingly. Stepped strip footings, if required, should be constructed in accordance with the 2012 Ontario Building Code (2012 OBC), Section 9.15.3.9.

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 bearing strata, including engineered fill. Prior to pouring concrete for the footings, the foundation excavations must be inspected by Golder to confirm that the footings are located in a competent bearing stratum, which has been cleaned of ponded water and loosened or softened material. If the concrete for the footings on the soil cannot be poured immediately after excavation and inspection, it is recommended that a working mat of lean concrete be placed in the excavation to protect the integrity of the bearing strata. The bearing soil and fresh concrete must be protected from freezing during cold weather construction.

All exterior footings and footings in unheated areas must be provided with at least 1.2 m of cover after final grading, in order to minimize the potential for damage due to frost action.

5.2.1 Seismic Design

The 2012 Ontario Building Code (2012 OBC) came into effect on January 1, 2014 and contains updated seismic analysis and design methodology. Seismic hazard is defined for an earthquake with a 2 per cent probability of exceedance in 50 years (i.e. a return period of 2,400 years) which encompasses a larger earthquake hazard than in prior editions of the OBC. Design earthquakes are commonly defined by an earthquake magnitude, distance, and peak ground acceleration (PGA). The 2012 OBC uses the uniform hazard spectra (UHS) to define the response of the structure to the design earthquake and also considers the effects of the localized site conditions on the structural response. The 2012 OBC also uses a refined site classification system defined by the average soil/bedrock properties in the top 30 metres of the subsurface profile beneath the structure(s). There are six site classes designated as A to F related to decreasing ground stiffness from A for hard rock to E for soft soil and Site Class F for problematic soils (e.g. sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain acceleration- and velocity-based site coefficients, Fa and Fv, respectively, used to modify the reference UHS to account for the effects of site-specific soil conditions in design.

Based on the results of the investigation, the building foundations may be designed using a Site Class D designation. It is possible that the site class could be improved by in situ testing. Should optimization of the site class be recommended by the structural engineer, in situ geophysical testing should be carried out at the site, although a higher site class is not guaranteed.

5.2.2 Slab-on-Grade

The floor slab for the proposed residential buildings can be designed as a concrete slab-on-grade. The floor slab may be placed on approved engineered fill or native subgrade. The engineered fill should be placed and compacted as per the requirements of Section 5.1.3.

Prior to the placement of engineered fill, the exposed subgrade should be inspected by Golder. Remedial work should be carried out on any softened, disturbed, wet or poorly performing zones as directed by Golder. Any low areas may then be brought up to within at least 200 mm of the underside of the floor slab, as required, using OPSS Granular ‘B’, Type I material or other approved material, placed in maximum 200 mm loose lifts and uniformly compacted to at least 100 percent of the material’s SPMDD.

The final lift of granular fill beneath floor slab should consist of a minimum thickness of 200 mm of OPSS Granular ‘A’, uniformly compacted to at least 100 percent of SPMDD. This should provide a modulus of subgrade reaction, for a 1-foot square plate placed directly on the subgrade material, k_{v1}, of approximately 40 MPa/m. Special care should be taken to ensure adequate compaction around columns and adjacent to foundation walls. Any filling operations should be monitored and tested by Golder.

The floor slabs should be structurally separate from the foundation walls and columns and sawcut control joints should be provided at regular intervals and along column lines to minimize shrinkage cracking and to allow for any differential settlement of the floor slabs.

In general, where the floor slab is at or above the exterior final grade, no perimeter drainage at the footing level is required. Where the finished floor slab will be below exterior grade, a perimeter drainage system should be provided. The footing drainage system should be provided with a permanent frost-free outlet.

5.3 Site Servicing

The proposed sanitary sewer, storm sewer and roof drain collectors for the residential development have been finalized and details are shown on the functional servicing plan.

Based on the servicing plan, the proposed storm sewer has obverts ranging between Elevations 159.1 m and 180.7 m (approximate depths between 3.0 m and 5.2 m below road grade). The proposed sanitary sewer has obverts ranging between Elevations 153.3 m and 180.7 m (approximate depths between 3.0 m and 14.5 m below road grade). The proposed roof drain collector has obverts ranging between Elevations 156.3 m and 180.7 m (approximate depths between 3.0 m and 9.4 m below road grade).

The founding levels for the proposed services are anticipated to be in engineered fill, very dense silty sand, very dense silty sand till and hard silty clay to clayey silt till deposits. In general, these soils are considered to be suitable for supporting sewers and watermains, provided that the integrity of the base can be maintained during construction. However, if softened/loose, organic soil/topsoil or deleterious materials are encountered at the proposed founding level, these materials must be removed and replaced with approved engineered fill to provide a suitable founding stratum.

5.3.1 Excavations

Trench excavations for foundations and site servicing are generally anticipated to extend into engineered fill, and native soils at varying depths approximately between 3.2 m and 15.0 m below road grade or approximately between the existing ground surface and 9.0 m below existing ground surface. Based on the grading plan, the pipe inverts are deepest along the west side of Street A. Conventional excavation equipment can be used to excavate through the Site soils. However, it should be noted that borehole drilling using conventional drilling equipment through these very dense/hard and dry deposits was very difficult in some locations and some difficulty using conventional excavation equipment should also be anticipated. Further, multiple instances of auger grinding were noted during drilling at a variety of depths in the till and as such, excavation equipment should be chosen that can handle removal of any cobbles/boulders.

It is anticipated that the majority of the excavations will likely consist of conventional temporary open cuts. All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Based on the OHSA, the engineered fill is generally classified as Type 3 soils and all excavations in excess of 1.2 m in depth through these soils should be sloped no steeper than 1 horizontal to 1 vertical above the groundwater level. The dense silty sand, very dense silty sand till and hard silty clay to clayey silt till deposits are generally classified as Type 2 soils with a 1 horizontal to 1 vertical to 1.2 m or less from its bottom. In addition, depending upon the construction procedures adopted by the contractor, the success of the contractor’s groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required.

In accordance with the Occupational Health and Safety Act (OHSA), where excavation exceeds depths of 6 m, temporary protection systems will be required to support the excavations. Based on the grading plan, the pipe inverts are deepest along the west side of Street A. It is therefore recommended that the underground services be installed prior to placement of engineered fill to reduce the depth of excavation.

Where side slopes of excavations are required to be steepened to limit the extent of the excavation, then some form of trench support system may be required. It must be emphasized that a trench liner box provides protection for construction personnel but does not provide any lateral support for the adjacent excavation walls, underground services, or existing structures. It is imperative that any underground services or existing structures adjacent to the excavations be accurately located prior to construction and adequate support provided where required. In addition, steepened excavations should be left open for as short a duration as possible and completely backfilled at the end of each working day.

If required to support adjacent services or structures, a temporary shoring system will be required (see Section 5.3.6).

5.3.2 Groundwater Control

The groundwater level in the monitoring wells installed in selected boreholes across the Site varied between a depth of 0.8 m and 6.0 mbgs (between Elevations 153.7 m and 177.9 m). As such, it is anticipated that trench excavations will mostly be at or below the groundwater level. It is anticipated that seepage can be handled from pumping from properly filtered sumps, as required, and that pro-active dewatering from wells will not be required across majority of the site. However, where excavations extend into a silty sand or gravelly sand deposit at the southwest corner of the Site to support installation of underground services, active dewatering will be required. There is also a potential for sloughing of excavation side slopes and/or disturbance of the base of the excavations. In this regard, it is recommended that test pits be carried out prior to construction activities to further assess dewatering requirements at the time of construction. Care should be taken to direct surface runoff away from the open excavations.

The rate and volume required for dewatering will be dependent on the depth of the required excavations, the groundwater levels at the time of construction and the construction methods and staging chosen by the Contractor. An application under the Environmental Activity Section Registry (EASR) of the Ontario Ministry of the Environment, Conservation and Parks (MECP) should be submitted in the event that the pumping volumes exceed 50,000 L/day. Under the EASR, a Permit to Take Water (PTTW) is not required for water taking for construction site dewatering for volumes less than 400,000 L/day. It is unlikely that an EASR or PTTW will be required at this Site.

5.3.3 Pipe Bedding and Cover

The bedding for watermains and sewers should be compatible with the size, type and class of pipe, surrounding soil and loading conditions and should be designed in accordance with the Regional and Municipal standards. Where granular bedding is deemed to be acceptable, it should consist of at least 150 mm of OPSS Granular ‘A’ or 19 mm crusher run limestone material. Clear stone should never be used as bedding material or to stabilize the base. Sand cover may be used from the spring line to 300 mm above the obvert of the pipes. All bedding material and cover should be placed in maximum 150 mm loose lifts and uniformly compacted to a minimum of 98 percent of the material's SPMDD.

5.3.4 Trench Backfill

The majority of the excavated materials from the site will generally consist of sandy silt, silty sand till and silty clay to clayey silt till deposits, and/or engineered fill materials, with the majority of soils excavated during underground service installation anticipated to be at or slightly above their estimated optimum water contents for compaction.

The excavated materials at suitable water contents may be reused as trench backfill provided, they are free of significant amounts of topsoil, organic or other deleterious materials. As inferred from auger grinding/refusal and split spoon refusal, cobbles and potentially boulders are anticipated to be widespread in the excavation spoils. Oversized cobbles and boulders (i.e. greater than 150 mm in size) should be removed from the backfill. All trench backfill from the top of the cover material to 1.0 m below subgrade elevation should be uniformly compacted to at least 95 percent of the material’s SPMDD. From 1.0 m below subgrade to subgrade elevation, the materials should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 98 percent of material’s SPMDD.

Alternatively, if placement water content at the time of construction are too high, or if there is a shortage of suitable in situ materials, then an approved imported sandy material which meets the requirements for SSM may be used. Backfilling during cold weather must avoid inclusions of frozen lumps of material, snow and ice.

Normal post-construction settlement of the compacted trench backfill should be anticipated, with majority of such settlement taking place within about six months following the completion of trench backfilling operations. This settlement will be reflected at the ground surface and in pavement construction areas, may be compensated for where necessary by placing additional granular material prior to asphalt paving. However, since it is anticipated that the asphalt binder course will be placed shortly following the completion of trench backfilling operations, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding. In any event, it is recommended that the surface course asphalt should not be placed over the binder course asphalt (across the full road width) for at least twelve months. Post-construction settlement of the restored ground surface in any boulevard/ditch trench areas is also expected and should be topped-up and re-landscaped, as required.

It is recommended that, where the utility trench encounters high permeability non-cohesive soils, trench plugs should be constructed to prevent preferential water flow through the granular bedding and trench backfill. These clay plugs could be constructed using excavated cohesive material or manufactured clay plugs. The need for and frequency of trench plugs must be evaluated in the field during construction and/or once the servicing details are known. As such, it should be included in the contract as a provisional item.

5.3.5 Soil Bulking

Soil bulking is the increase in total volume of soil over the volume of the same material in the undisturbed state. Bulking of native soils occurs when they are excavated from undisturbed ground. Based on the site grading plan and considering the predominant native silty sand till and silty clay to clayey silt till soils at this site, bulking of about 10 percent (increase in total volume) would be expected after excavation and prior to re-compaction. After re-compaction, bulking of about 5 percent would be expected.

5.4 Temporary Shoring System

Considering that excavation for installation of underground utilities will exceed a depth of 6 m in some locations, it is recommended that temporary shoring system be used to support the excavation and control groundwater within the site. The use of braced soldier pile and lagging, braced sheet piles or an engineered slide rail system could be considered for ground support during the excavations at this site. These shoring elements should extend through engineered fill, silty sand, and sandy silt deposits and into the lower cohesive and/or non-cohesive till deposits to provide adequate wall/soil stiffness at the embedment toe and reduce the amount of active dewatering required.

The temporary shoring system should be designed to account for horizontal earth loads, groundwater pressure, and surcharge loads.

Lateral pressures for design of the temporary structures will depend on the temporary structure design and the nature of the lateral support provided. However, it is recommended that shoring walls should be designed using the coefficient of lateral earth pressure at rest. For preliminary purposes, the coefficient of lateral earth pressure at rest, active and passive lateral earth pressure have been provided below:

Soil Type	Angle of Friction	Undrained Shear Strength (kPa)	Coefficient of earth pressure at rest, Ko	Active lateral earth pressure, Ka	Passive lateral earth pressure, Kp
Silty Clay to Clayey Silt Fill	-	40	1.0	1.0	1.0
Silty Sand and gravelly Sand	32	-	0.47	0.31	3.3
Silty Sand to Sandy Silt Till	35	-	0.43	0.27	3.7
Silty Clay to Clayey Silt Till	35	-	0.43	0.27	3.7

The shoring system must be designed by a Professional Engineer including assessment of the potential for basal heave following the requirements of OPSS.PROV 539. Design of temporary works will be entirely the responsibility of the contractor.

5.5 Slope Stability Assessment

Based on the functional grading plan, a grade raise up to 6 m is anticipated along the east side of the Site and as such, long term slope stability analyses of the side slopes have been carried out for two critical cross-sections along Street A and Street D.

The geotechnical stability of the proposed slope cross sections is governed by the existing surface and subsurface conditions, groundwater levels, and long-term loading conditions. Limit equilibrium slope stability analyses were undertaken to analyse the global factor of safety of the proposed slopes using the commercially available program SLIDE (Version 8.0), produced by Rocscience Inc., employing the Morgenstern-Price method of analysis.

The slope stability factor of safety is defined as the ratio of the forces tending to resist failure relative to the driving forces tending to cause failure. A factor of safety near unity suggests instability is imminent, whereas a factor of safety equal to 1.5 or greater is generally considered acceptable for long term global stability of conventional slopes.

Slope stability analyses were carried out along two proposed critical cross-sectional profiles and were evaluated for long term stability of the proposed grade raise. A 2.5 horizontal to 1 vertical (2.5H:1V) slope cross-section was analysed based on a proposed grade raise located at the east side of Street A and Street D as shown in the table below.

Cross section	Vertical Height (m)	Location	Proposed Gradient	Relevant Borehole
A	4.2	West of Block 91	2.5H:1V	BH20-4
B	5.9	Between House 84 and 85	2.5H:1V	BH20-1

The soil parameters for the slope assessment were selected based on our understanding of the existing ground conditions and geotechnical investigation carried out within the site. The parameters are summarized in the table below.

Soil Type	Unit Weight (kN/m^3)	Effective Friction Angle (ϕ')
Engineered Fill	19	30 º
Compact to Very Dense Silty Sand	19	32 º
Dense to Very Dense Silty Sand Till	20	35 º
Very Stiff to Hard Silty Clay to Clayey Silt Till	20	35 º

Slope stability analysis results for cross sections A and B are shown in Figures 7 and 8. In general, the analyses indicate Factor of Safety (FOS) values for the 2.5H:1V side slopes to be 1.5 or greater for the proposed slopes for the long term (drained) analysis, which is generally considered acceptable for slope design.

In order to avoid surficial instability of the slopes during and following construction, the slope surfaces must be protected from disturbance and erosion. Erosion control blankets are recommended to be installed in order to minimize erosion and maintain slope stability.

5.6 Pavement Design

This section of the report provides preliminary engineering information for the pavement structures within the residential development. Based on the drawing provided entitled "*Post-Development Land Use Plan, 1133373 Ontario Inc. Seaton Whitevale East*" dated February 2019, the proposed local roads within the Site consist of the following:

- 15.5 m ROW Road;
- 17.0 m ROW Road; and
- 21.5 m ROW Road.

Based on the results of the geotechnical investigation and on the City of Pickering, Engineering Design Guidelines and Standard Drawings, the following pavement designs may be considered for the internal roads:

Material	Thickness of Pavement Elements (mm)
HL 3 (Surface)[1]	40
HL 8 Binder (Base)[1]	50
Granular A Base[2]	150
Granular B, Type 1 Subbase[2]	300
Subgrade	Prepared and Approved Subgrade

Notes:

[1] Asphaltic Material shall be in accordance with OPSS 310, 1150 (November 2010), and 1003 (November 2017)

[2] Granular Materials shall be in accordance with OPSS.MUNI 1010 (November 2013)

The granular subbase and base materials should be uniformly compacted to 100 percent of their SPMDD. The asphalt materials should be compacted to 92 to 96.5 percent of their Marshall Maximum Relative Density according to OPSS 310, as measured in the field using a nuclear density gauge. In addition, in order to preserve the integrity of the pavement, continuous subdrains should be placed along both sides of the roads. The invert of the subdrains should be at least 300 mm below the bottom of the Granular B subbase and should be sloped to drain to the catchbasins. The subdrains should consist of perforated pipe wrapped in a suitable geotextile and surrounded on all sides with a minimum thickness of 150 mm of clean free draining sand such as concrete sand.

Where new pavement abuts existing pavement, proper longitudinal lap joints should be constructed to key the new asphalt into the existing surface. The existing asphalt edges should be provided with a proper saw cut edge prior to keying in the new asphalt. Any undermining or broken edges resulting from the construction activities are removed by the saw cut.

As previously indicated that in some cases, even though the compaction requirements have been met, the subgrade strength may not be adequate to support heavy construction loading especially during wet weather or where backfill materials wet of optimum have been placed. In this regard, the design Granular B subbase thickness may not be sufficient as a construction haul road and additional Granular B (in the order of 300 mm to 600 mm) may be required. In any event, the subgrade should be proofrolled and inspected by the geotechnical engineer prior to placing the Granular B subbase and additional granular placed, as required and as determined in the field by the geotechnical engineer, consistent with the prevailing weather conditions and anticipated use by construction traffic.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Monitoring Well Decommissioning

Monitoring wells have been installed in selected boreholes to permit monitoring of the groundwater levels at the site. Ontario Regulation (O.Reg.) 903, as amended, of the Ontario Water Resources Act, requires that these wells be properly abandoned/decommissioned by an MECP licensed Water Well Contractor. It is recommended that the decommissioning of the wells be carried out as part of the construction activities at the site so that water level measurements can be taken immediately prior to construction. If requested, Golder could provide assistances to the owner in arranging for the decommissioning of the monitoring wells by a licensed water well drilling contractor.

6.2 Inspection and Material Testing

The soils at this site are sensitive to disturbance from ponded water, construction traffic and frost. During construction, full-time engineered fill monitoring, sufficient foundation inspections, subgrade inspections and in situ material 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. All bearing surfaces must be inspected by Golder prior to concreting to ensure that strata having adequate bearing capacity have been reached and that the bearing surfaces have been properly prepared.

7.0 CLOSURE

We trust that this geotechnical report provides sufficient geotechnical engineering information for the designers to proceed with finalization of the project. This report is intended to summarise available data on subsurface soil and groundwater conditions and provide geotechnical comments and recommendations for the proposed residential buildings and overall development.

If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Signature Page

Yours truly,

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER

T. A. OLUMUYIWA

100523453

December 10, 2020

PROVINCE OF ONTARIO

Timi Olumuyiwa, M.Sc., P.Eng.
Geotechnical Engineer

Sarah E.M. Poot, P.Eng.
Associate - Senior Geotechnical Engineer

TO/SP/sv/to/ljv/mlk

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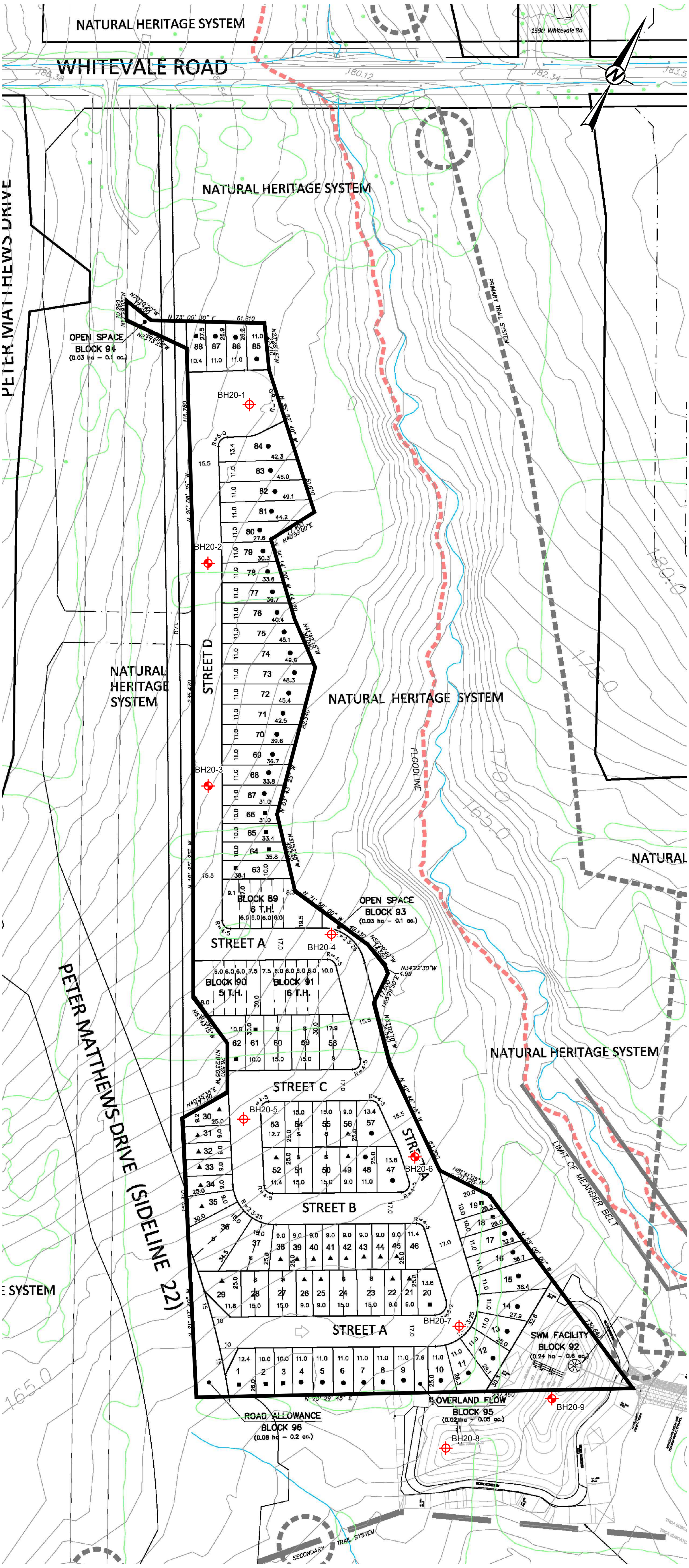


KEY MAP

LEGEND

⌖	BOREHOLE LOCATION
⌖	BOREHOLE LOCATION WITH MONITORING WELL
▬	PROPERTY LINE

NOTE(S)

1. ALL BOREHOLE LOCATION ARE APPROXIMATED.
2. 2020 BOREHOLES WERE STAKED OUT AND SURVEYED BY J.D. BARNES LTD.

REFERENCE(S)

BASE MAP TAKEN FROM GHD, DATED FEBRUARY 2019, DELIVERED IN FORMAT PDF.

CLIENT
1133373 ONTARIO INC. (LEBOVIC ENTERPRISE)

PROJECT
GEOTECHNICAL INVESTIGATION
SEATON WHITEVALE EAST DEVELOPMENT, PICKERING, ONTARIO

CONSULTANT

GOLDER

YYYY-MM-DD	2020-07-30
DESIGNED	TO
PREPARED	JL
REVIEWED	TO
APPROVED	SEMP

TITLE
BOREHOLE LOCATION PLAN

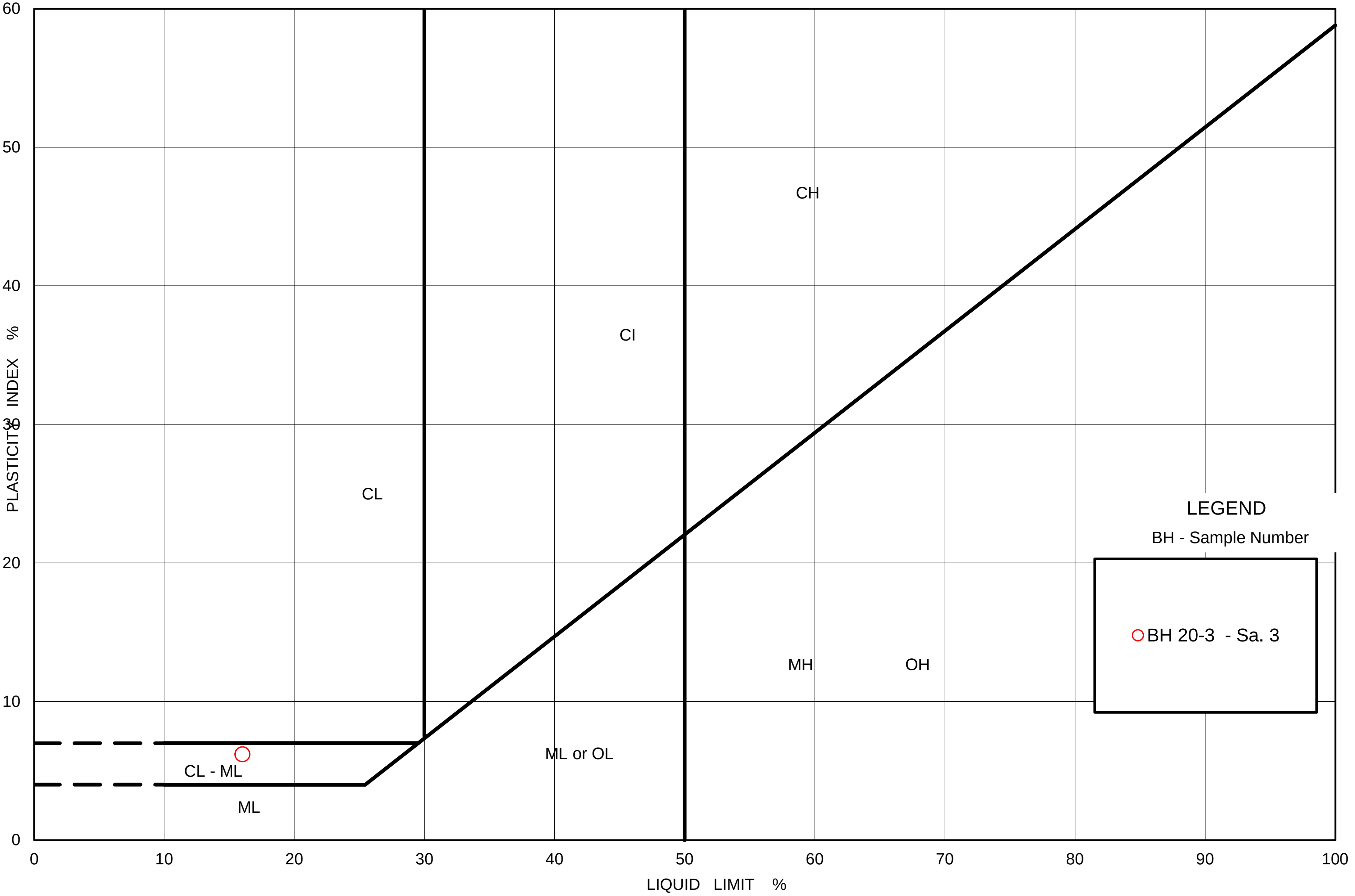
PROJECT NO.	CONTROL	REV.	FIGURE
20140088	0001	A	1

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

25 mm

0

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

(CL-ML) SILTY CLAY to CLAYEY SILT and SAND (TILL)

Figure No.: 2

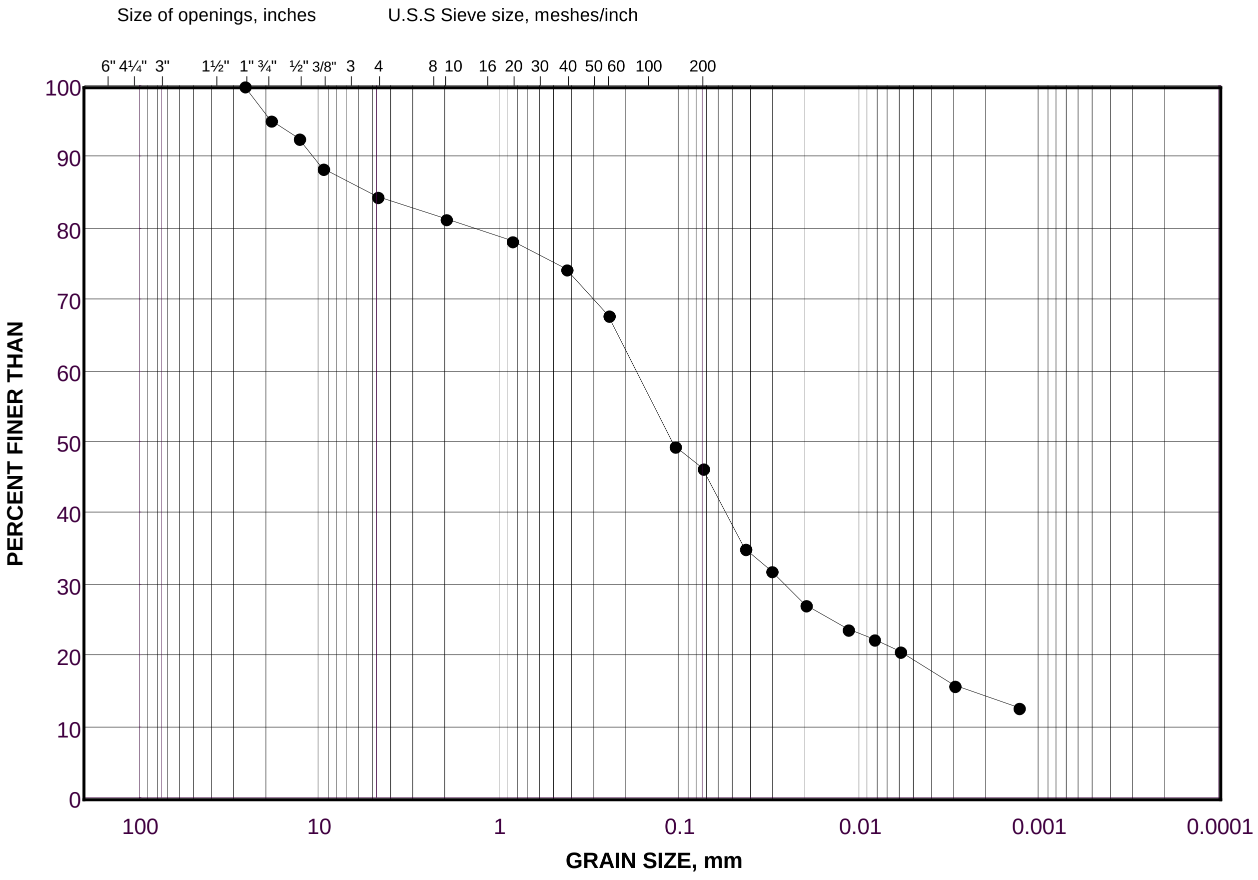
Project No.: 20140088

Checked By: TO

GRAIN SIZE DISTRIBUTION

(CL-ML) SILTY CLAY to CLAYEY SILT and SAND (TILL)

FIGURE 3



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	20-3	3	1.50 - 1.95

Project Number: 20140088

Checked By: TO

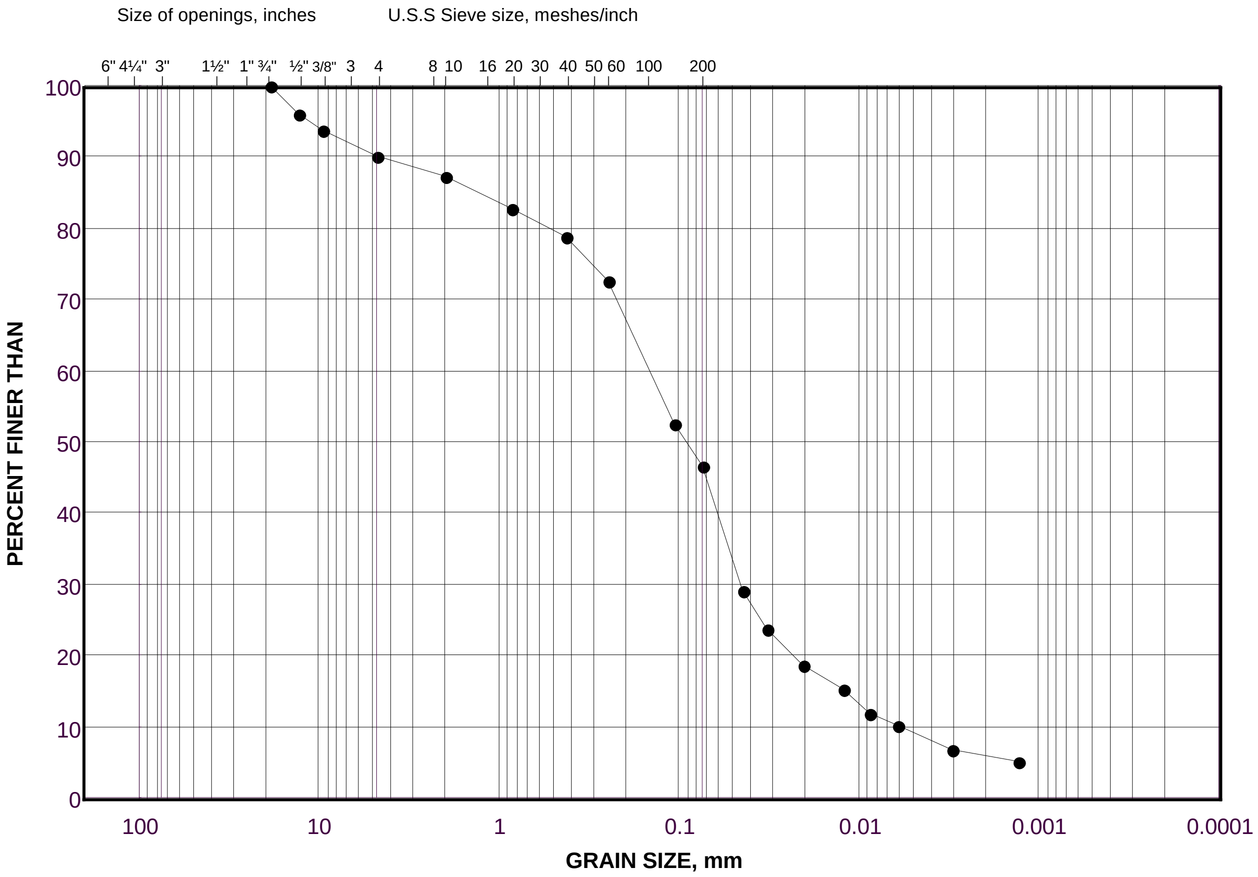
Golder Associates

Date: 30-Jun-20

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND (TILL)

FIGURE 4



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	20-9	4	2.25 - 2.70

Project Number: 20140088

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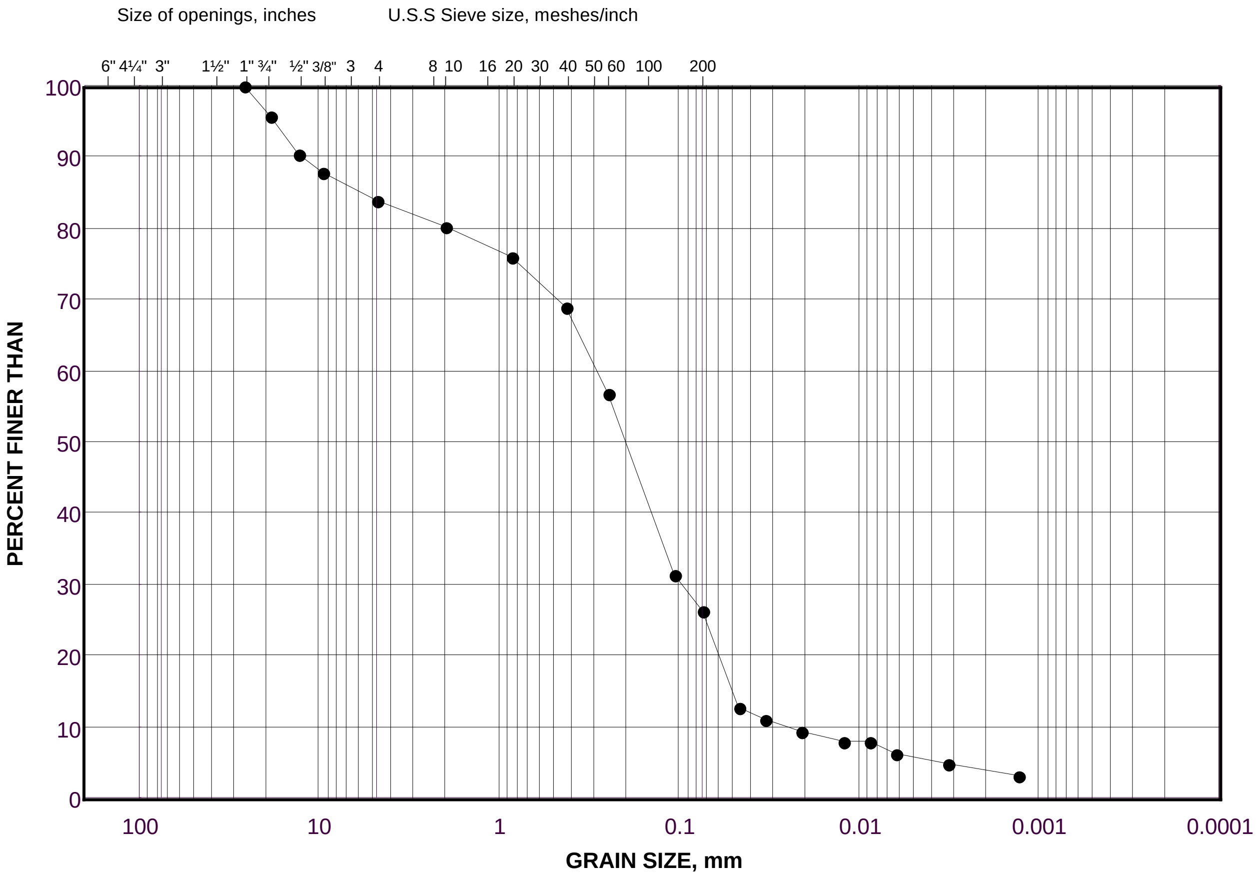
Golder Associates

Date: 30-Jun-20

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND

FIGURE 5



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	20-7	6	4.50 - 4.95

Project Number: 20140088

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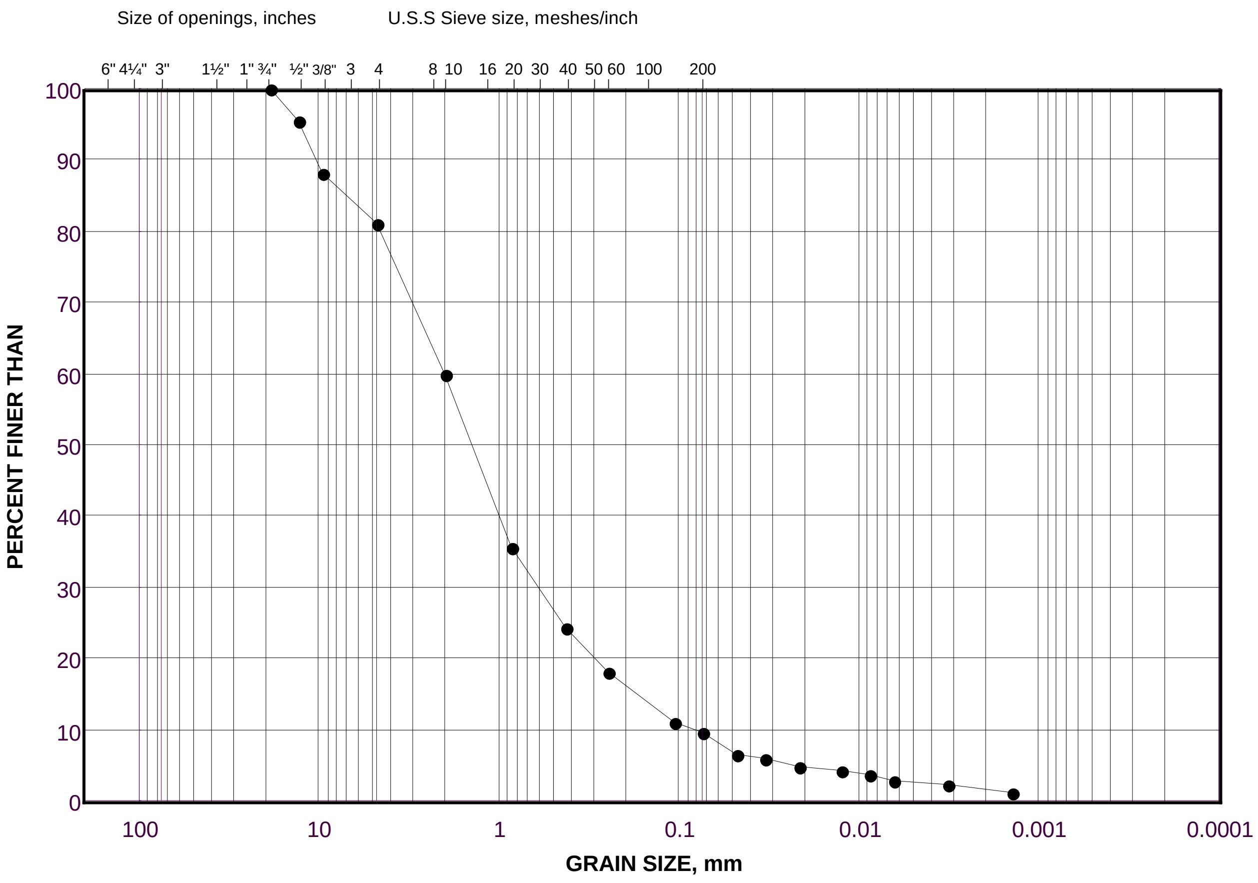
GRAIN SIZE DISTRIBUTION

(SP-SM) gravelly SAND

FIGURE 6



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

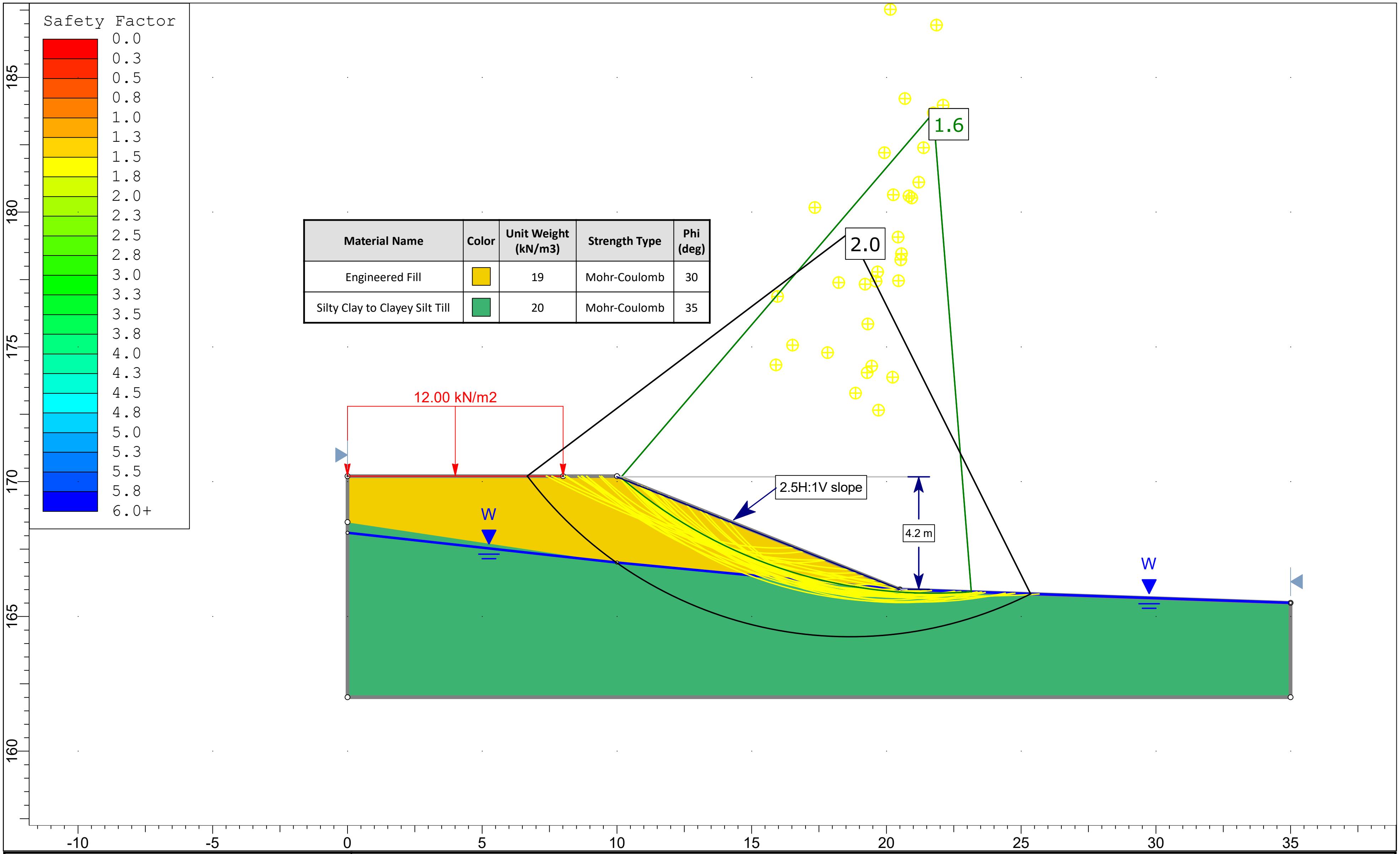
SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	20-6	7	6.0 - 6.28

Project Number: 20140088

Checked By: TO

Golder Associates

Date: 30-Jun-20



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Phi (deg)
Engineered Fill	🟨	19	Mohr-Coulomb	30
Silty Clay to Clayey Silt Till	🟩	20	Mohr-Coulomb	35

Project

20140088

LONG TERM SLOPE STABILITY ASSESSMENT

Analysis Description

Figure 7: 2.5H:1V SLOPE - 4.2 m Grade Raise

Drawn By

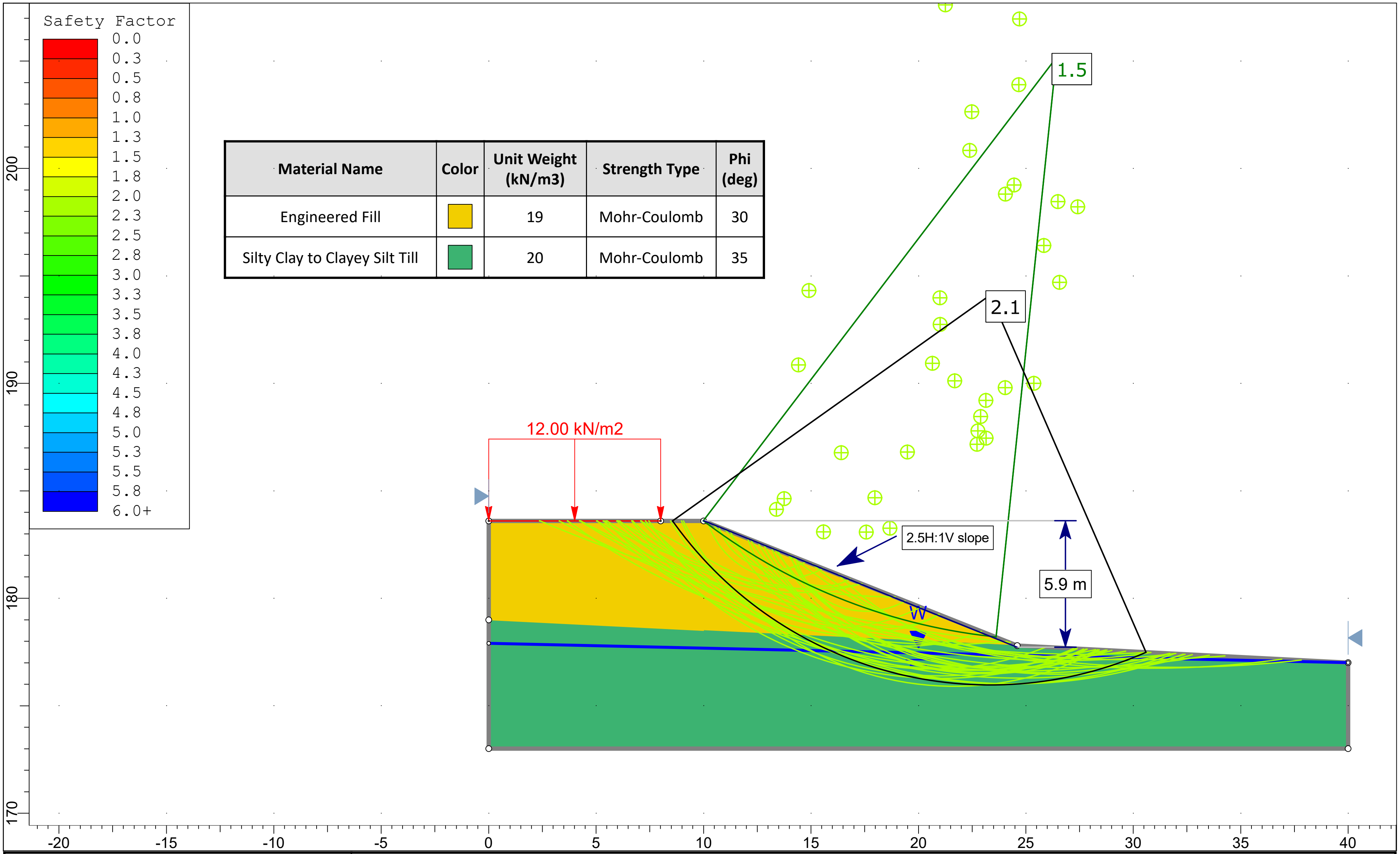
Scale 1:199

Company

Date

File Name Cross section A.slmd

SLIDEINTERPRET 8.014



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Phi (deg)
Engineered Fill	🟨	19	Mohr-Coulomb	30
Silty Clay to Clayey Silt Till	🟩	20	Mohr-Coulomb	35

GOLDER

SLIDEINTERPRET 8.014

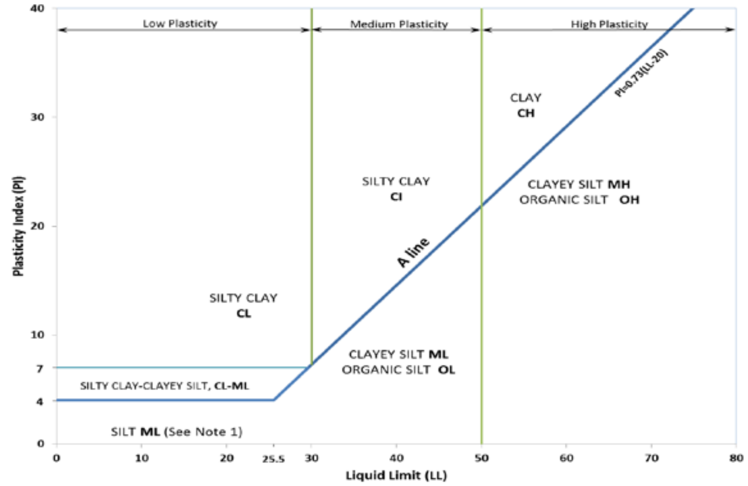
Project 20140088	LONG TERM SLOPE STABILITY ASSESSMENT
Analysis Description	Figure 8: 2.5H:1V SLOPE - 5.6 m Grade Raise
Drawn By	*Scale* 1:250
Company	
Date	*File Name* Cross section B.slmd

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); 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.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson’s ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 20140088

RECORD OF BOREHOLE: BH20-1

SHEET 1 OF 1

LOCATION: N 4862080.55; E 651355.51

BORING DATE: May 21, 2020

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

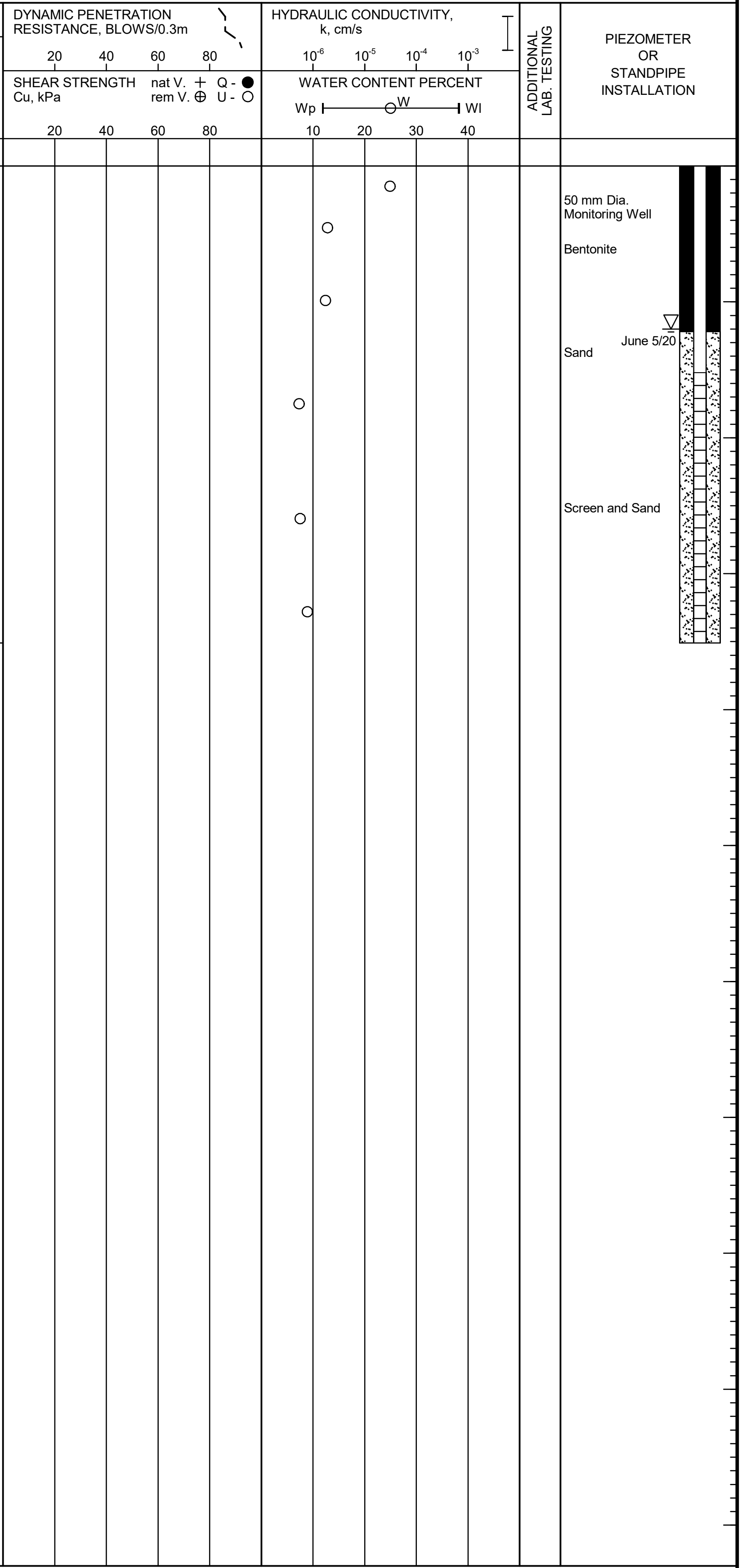
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	179.13			
0	CME 55 Track Mounted Rig 200 mm O.D. Hollow Stem Augers	TOPSOIL	0.00	1A	SS	3
		FILL/REWORKED NATIVE - (CL-ML) sandy SILTY CLAY to CLAYEY SILT, trace gravel; brown, organic inclusions, oxidation staining, sand pockets; trace rootlets; cohesive, w>PL, soft to very stiff	178.83 0.30	1B		
1				2	SS	23
		(CL-ML) SILTY CLAY to CLAYEY SILT and SAND, some to trace gravel; brown, oxidation staining, containing rock fragments (TILL); cohesive, w<PL, hard to very stiff	177.76 1.37	3	SS	76
2				4	SS	48
3		- Auger grinding at a depth of 3.1 m		5	SS	22
		END OF BOREHOLE	175.62 3.51			

NOTES:

1. Borehole dry upon completion of drilling.

2. Groundwater level was measured at 1.2 mbgs (El. 177.9 m) on June 5, 2020.



DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088

LOCATION: N 4861991.58; E 651363.55

RECORD OF BOREHOLE: BH20-2

BORING DATE: May 21, 2020

SHEET 1 OF 1

DATUM: Geodetic

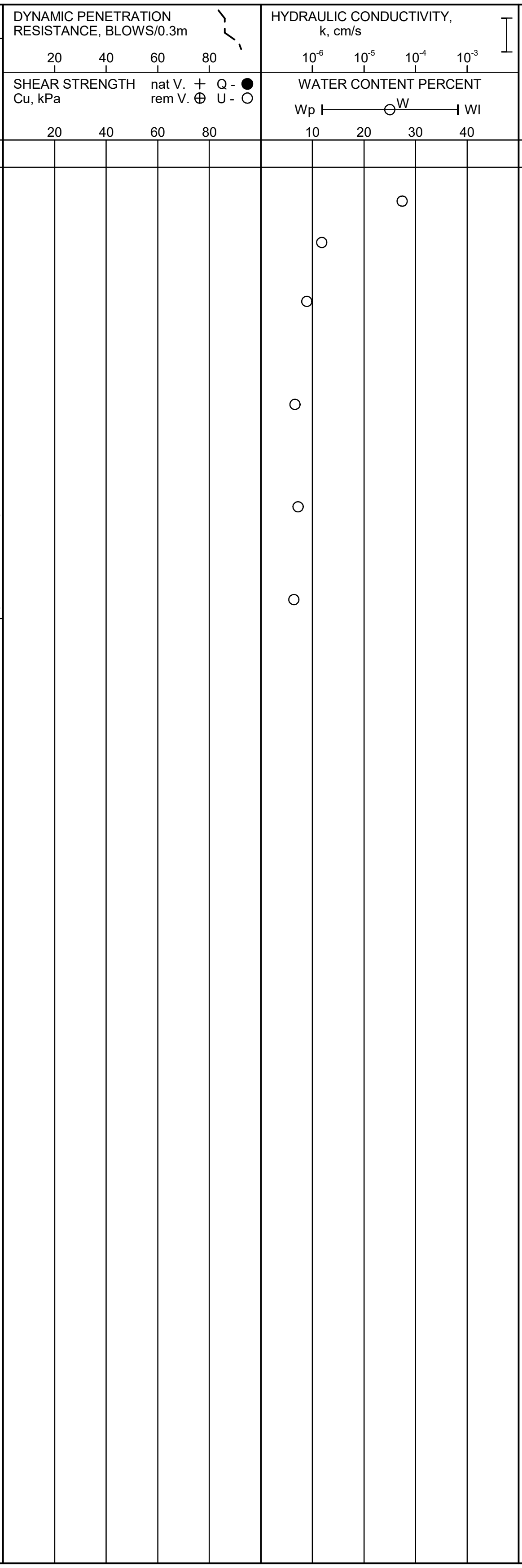
SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		178.13			
0	CME 55 Track Mounted Rig 200 mm O.D. Hollow Stem Augers	TOPSOIL		0.00	1A	SS	3
		FILL/REWORKED NATIVE - (CL-ML) SILTY CLAY to CLAYEY SILT and SAND, trace gravel; brown; sand pockets; cohesive, w~PL, soft		177.65 0.48	1B		
1		(CL-ML) SILTY CLAY to CLAYEY SILT and SAND, trace to some gravel; brown; oxidation staining (TILL); cohesive, w<PL, very stiff to hard		177.44 0.69	2	SS	24
					3	SS	54
2		- Sand pockets between 0.8 m and 2.0 m			4	SS	90/ 0.28
3		- Auger grinding at a depth of 3.1 m		174.80	5	SS	50/ 0.13
		END OF BOREHOLE		3.33			

NOTE:

1. Borehole dry upon completion of drilling.



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088

RECORD OF BOREHOLE: BH20-3

SHEET 1 OF 1

LOCATION: N 4861877.23; E 651401.63

BORING DATE: May 24, 2020

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

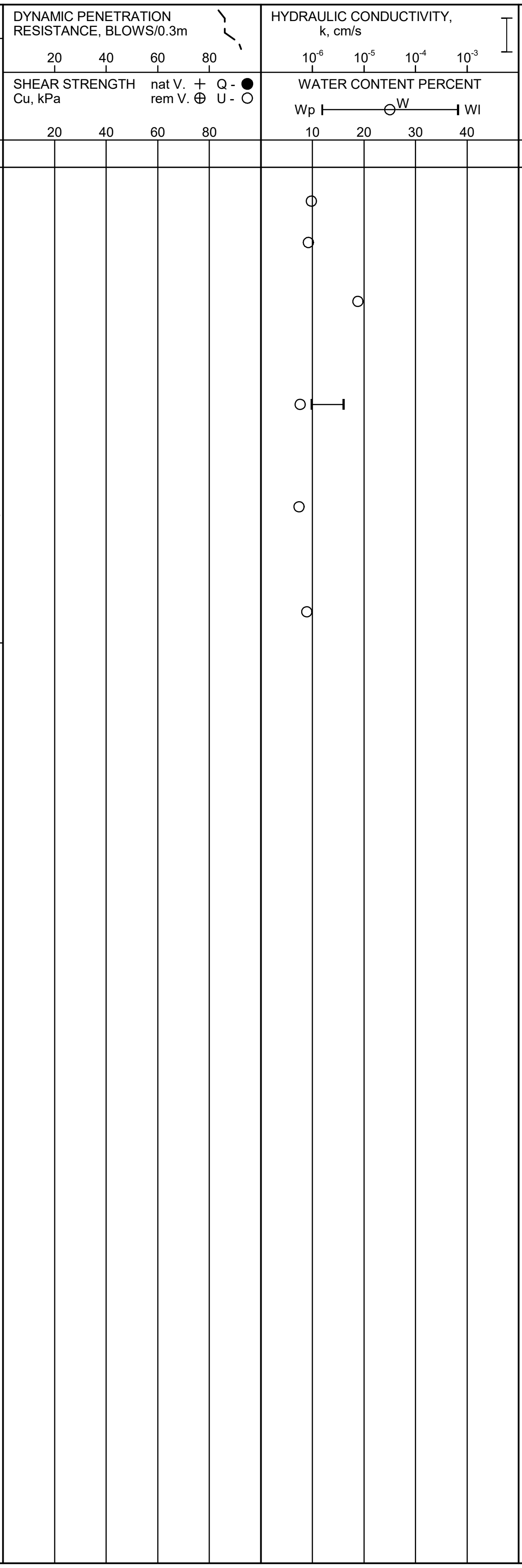
HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	176.00				
TOPSOIL	0.00	1A	SS	6	
	175.52				
FILL/REWORKED NATIVE - (CL) sandy SILTY CLAY, trace gravel; brown; trace organics; cohesive, w>PL, firm	0.48	1B			
		2	SS	8	
	174.63				
(CL-ML) SILTY CLAY to CLAYEY SILT and SAND, some gravel; brown, oxidation staining, containing rock fragments (TILL); cohesive, w<PL, hard	1.37	3	SS	90	MH
		4	SS	83/ 0.28	
		5	SS	55	
	172.49				
END OF BOREHOLE	3.51				

NOTE:

1. Borehole dry upon completion of drilling.



PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088

LOCATION: N 4861815.46; E 651498.13

RECORD OF BOREHOLE: BH20-4

BORING DATE: May 22, 2020

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC

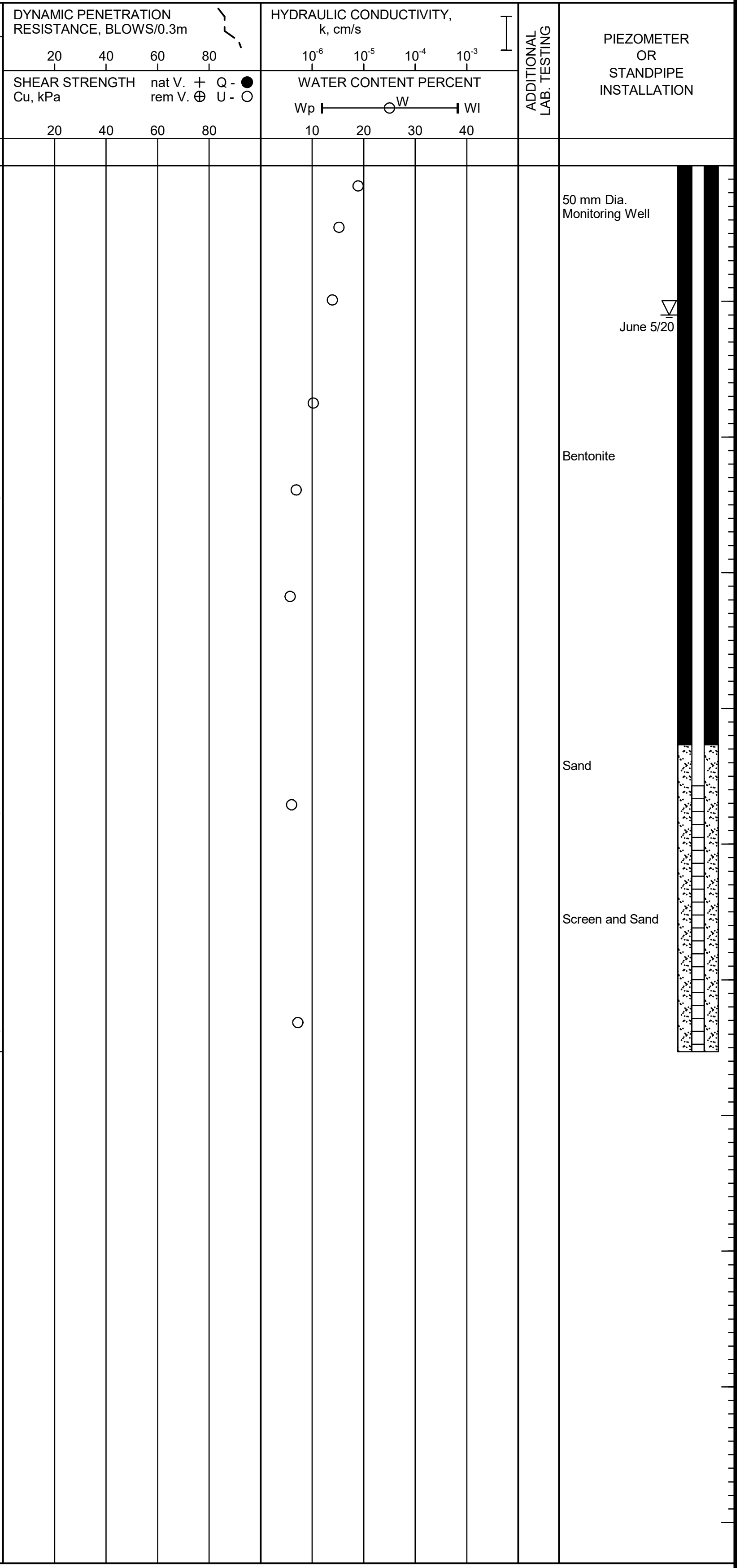
BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	169.20			
0	TOPSOIL	0.00	1A	SS	5
	FILL - (CL) SILTY CLAY, some sand, brown; cohesive, w>PL, firm	168.90 0.30	1B		
	(CL-ML) sandy SILTY CLAY to CLAYEY SILT, some gravel; brown to grey, containing rock fragments (TILL); cohesive, w<PL, very stiff to hard	168.51 0.69			
1			2	SS	20
			3	SS	57
2	- Auger grinding at a depth of 2.3 m		4	SS	50/ 0.05
3	- Auger grinding at a depth of 3.1 m		5	SS	50/ 0.1
4	- Grey at a depth of 4.6 m		6	SS	50/ 0.13
6	- Auger grinding at a depth of 6.1 m		7	SS	92/ 0.28
	END OF BOREHOLE	162.67 6.53			

NOTES:

1. Borehole dry upon completion of drilling.

2. Groundwater was measured at 1.1 mbgs (El. 168.1 m) on June 5, 2020.



DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088

LOCATION: N 4861708.90; E 651479.10

RECORD OF BOREHOLE: BH20-5

BORING DATE: May 25, 2020

SHEET 1 OF 1

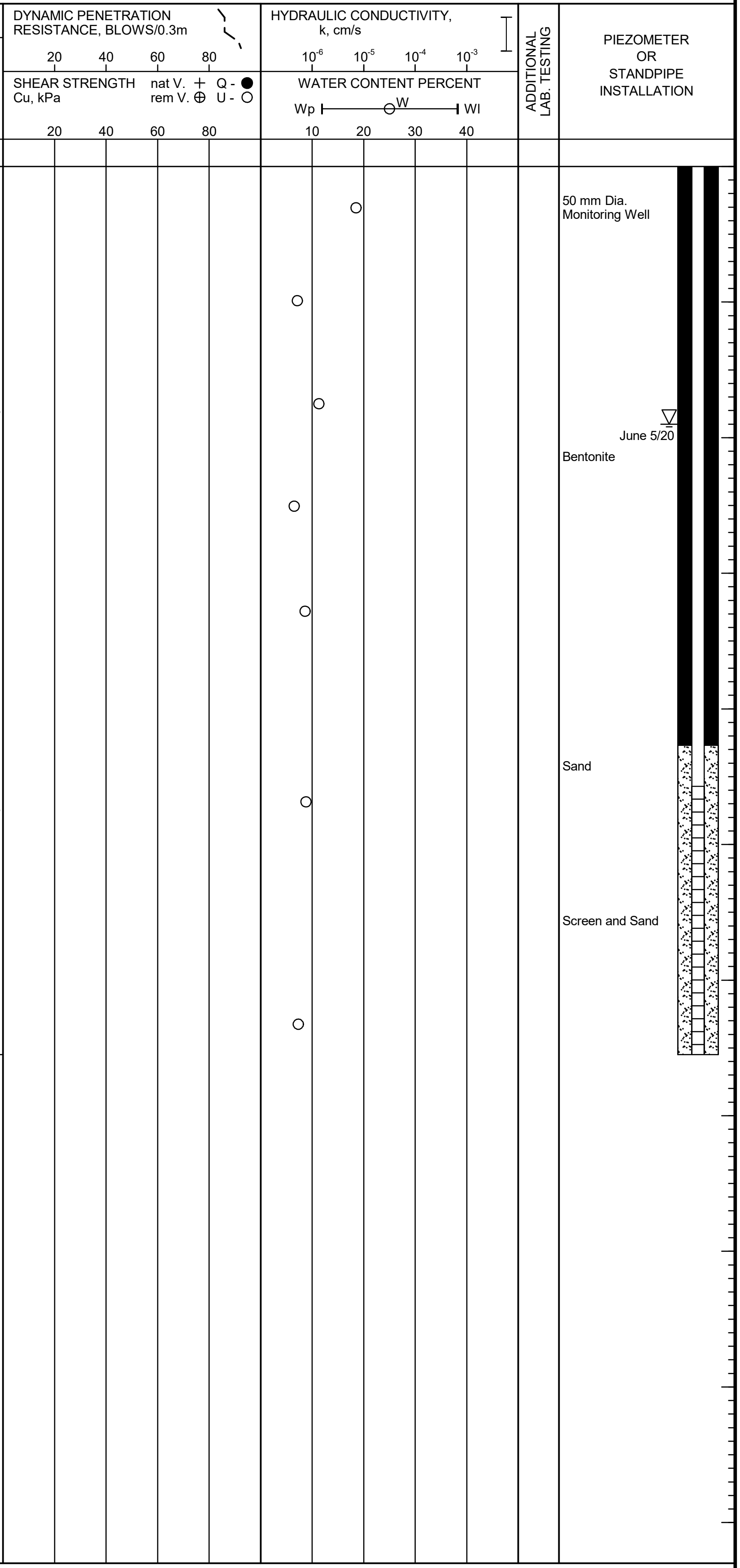
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	168.42			
TOPSOIL	0.00	1	SS	3
(SM) SILTY SAND, trace gravel to gravelly; brown, oxidation staining; non-cohesive, moist, compact to very dense	167.73 0.69	2	SS	24
		3	SS	69/ 0.25
- Auger grinding at a depth of 2.3 m		4	SS	66
(SM) SILTY SAND, trace to some gravel; brown, oxidation staining, containing rock fragments (TILL); non-cohesive, moist, very dense - Auger grinding at a depth of 3.1 m	165.52 2.90	5	SS	66
- Grey at a depth of 4.6 m - Auger grinding at a depth of 4.6 m		6	SS	50/ 0.08
(CL-ML) sandy SILTY CLAY to CLAYEY SILT, trace gravel; grey (TILL); cohesive, w<PL, hard - Auger grinding at a depth of 6.1 m	162.86 5.56	7	SS	64
END OF BOREHOLE	161.87 6.55			



NOTES:

1. Water encountered at a depth of 6.0 mbgs during drilling.

2. Groundwater level was measured in monitoring well at 1.9 mbgs (El. 166.5 m) on June 5, 2020.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088
LOCATION: N 4861719.99; E 651574.38

RECORD OF BOREHOLE: BH20-6

BORING DATE: May 22, 2020

SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	163.90
TOPSOIL	0.00
(CL-ML) SILTY CLAY to CLAYEY SILT and SAND, some gravel; brown, oxidation staining; containing rock fragments (TILL); cohesive, w<PL, very stiff to hard - Sand seam between 0.8 m and 1.2 m	163.21 0.69
(SP-SM) gravelly SAND, some fines; grey; non-cohesive, wet, very dense - Auger grinding at a depth of 7.6 m	158.34 5.56
(SM) SILTY SAND, trace gravel; grey; non-cohesive, wet, very dense	155.97 7.93
END OF BOREHOLE	8.08

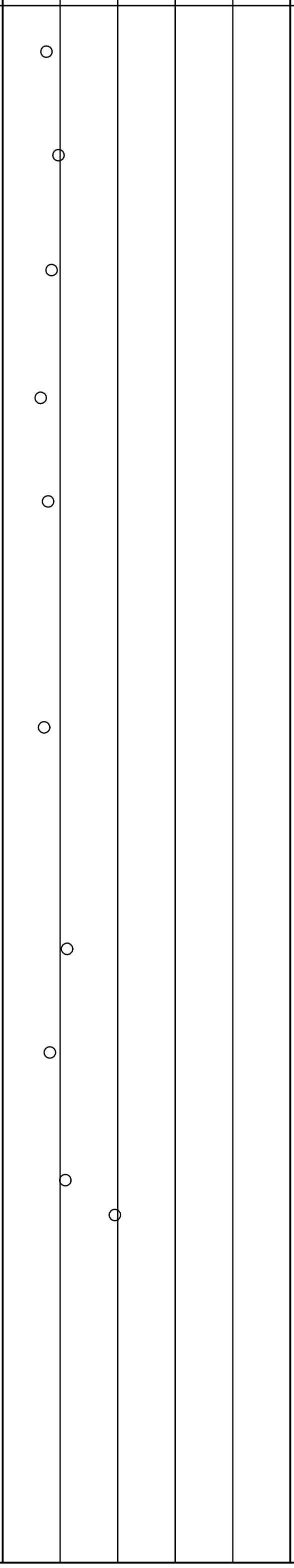
SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	4	
2	SS	18	
3	SS	71	
4	SS	57	
5	SS	57	
6	SS	95/ 0.25	
7	SS	50/ 0.13	MH
8	SS	50/ 0.13	
9A	SS	73	
9B			

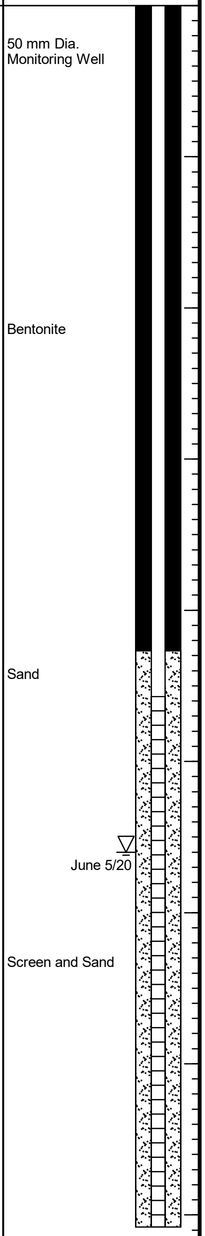
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 10 20 30 40





NOTES:

1. Water was encountered at 6.1 mbgs during drilling.

2. Groundwater level was measured in monitoring well at 5.6 mbgs (El. 158.3 m) on June 5, 2020.

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JK
CHECKED: SEMP

PROJECT: 20140088
LOCATION: N 4861640.03; E 651619.53

RECORD OF BOREHOLE: BH20-7

BORING DATE: May 25, 2020

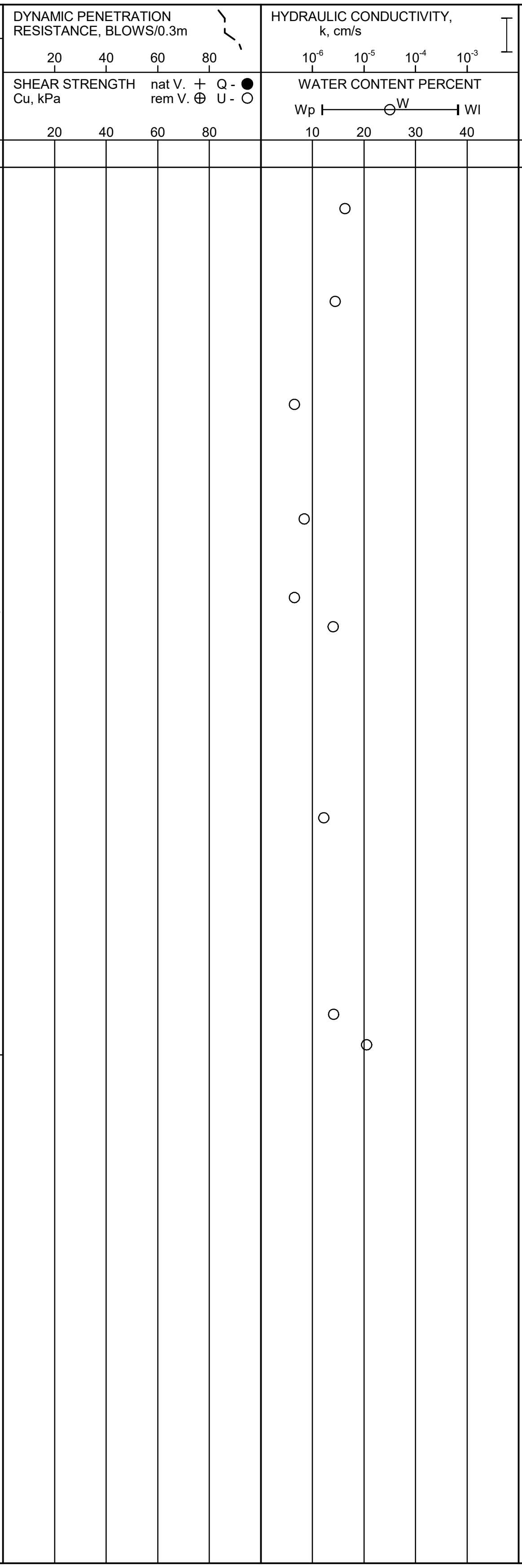
SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm
HAMMER TYPE: AUTOMATIC

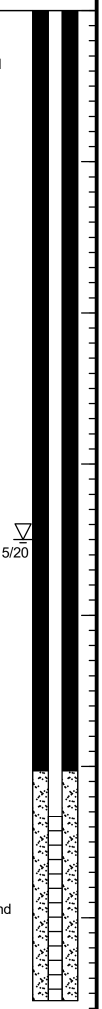
BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	160.63
TOPSOIL	0.00
FILL/REWORKED NATIVE - (CL) SILTY CLAY, some sand, trace gravel; brown; organic inclusion; cohesive, w>PL, firm	159.94 0.69
(SM) SILTY SAND, trace gravel; brown, oxidation staining (TILL); non-cohesive, moist, very dense	159.26 1.37
(SM) SILTY SAND, trace gravel to gravelly; brown; non-cohesive, moist to wet, very dense to dense - Wet at a depth of 6.1 m	158.34 2.29
END OF BOREHOLE	154.08 6.55

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	7	
2	SS	7	
3	SS	68	
4	SS	48	
5A	SS	85/ 0.28	
5B			
6	SS	66	MH
7A	SS	37	
7B			



PIEZOMETER OR STANDPIPE INSTALLATION



NOTES:

1. Water encountered at 4.9 mbgs during drilling.

2. Groundwater level was measured in monitoring well at 3.5 mbgs (El. 157.1 m) on June 5, 2020.

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JK
CHECKED: SEMP

PROJECT: 20140088

LOCATION: N 4861577.18; E 651642.45

RECORD OF BOREHOLE: BH20-8

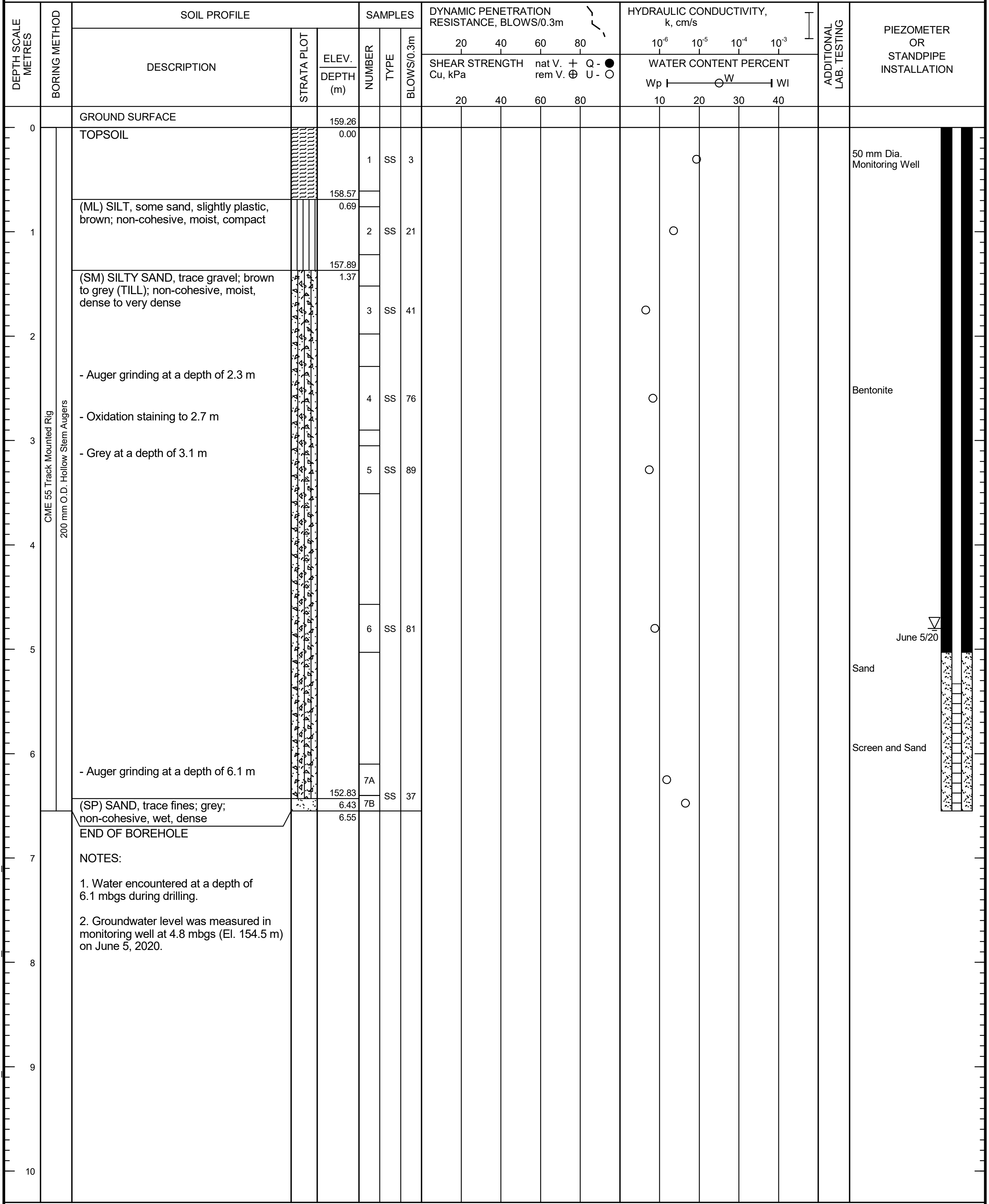
BORING DATE: May 25, 2020

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC



DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	159.26
TOPSOIL	0.00
(ML) SILT, some sand, slightly plastic, brown; non-cohesive, moist, compact	158.57 0.69
(SM) SILTY SAND, trace gravel; brown to grey (TILL); non-cohesive, moist, dense to very dense - Auger grinding at a depth of 2.3 m - Oxidation staining to 2.7 m - Grey at a depth of 3.1 m - Auger grinding at a depth of 6.1 m	157.89 1.37
(SP) SAND, trace fines; grey; non-cohesive, wet, dense	152.83 6.43
END OF BOREHOLE	6.55

NUMBER	TYPE	BLOWS/0.3m
1	SS	3
2	SS	21
3	SS	41
4	SS	76
5	SS	89
6	SS	81
7A 7B	SS	37

NOTES:

1. Water encountered at a depth of 6.1 mbgs during drilling.

2. Groundwater level was measured in monitoring well at 4.8 mbgs (El. 154.5 m) on June 5, 2020.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

PROJECT: 20140088

LOCATION: N 4861618.48; E 651685.51

RECORD OF BOREHOLE: BH20-9

BORING DATE: May 25, 2020

SHEET 1 OF 1

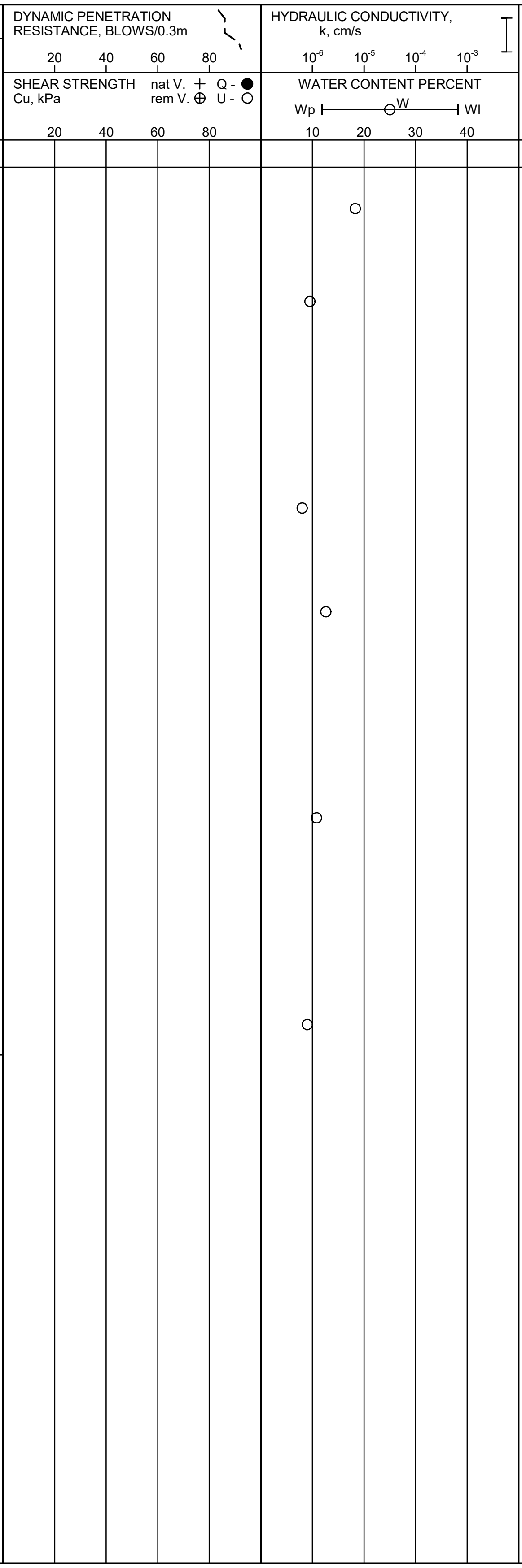
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 762mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 55 Track Mounted Rig; 200 mm O.D. Hollow Stem Augers

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	157.39				
TOPSOIL	0.00	1	SS	4	
(SM) SILTY SAND, trace gravel; brown; non-cohesive, moist, compact to dense	156.70 0.69	2	SS	15	
		3	SS	41	
(SM) SILTY SAND, some gravel; brown, oxidation staining; containing rock fragments (TILL); non-cohesive, moist, dense	155.26 2.13	4	SS	41	MH
(SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, dense - Auger grinding at a depth of 3.1 m - Auger grinding at a depth of 4.6 m	154.49 2.90	5	SS	41	
		6	SS	44	
(SM) SILTY SAND, trace gravel; brown, oxidation staining; containing rock fragments (TILL); non-cohesive, moist, very dense	151.67 5.72	7	SS	69	
END OF BOREHOLE	150.84 6.55				



NOTES:

1. Water encountered at a depth of 4.6 mbgs during drilling.

2. Borehole dry upon completion of drilling.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JK

CHECKED: SEMP

APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

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

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

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

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

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

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

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

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

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