REPORT

Geotechnical Investigation Report

Proposed Durham Hospice, Northeast of Prince of Wales Drive and Crawforth Street, Whitby, Ontario

Submitted to:

VON Community Corp.

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Distribution List

1 e-Copy - VON Community Corp.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by VON Community Corp. (VON) to provide geotechnical consulting services in support of the design of the proposed Durham Hospice building to be located at the northeast corner of Prince of Wales Drive and Crawforth Street in Whitby, Ontario as shown on the Key Plan, Figure 1. The terms of reference for the geotechnical consulting services are included in our proposal No: P18102457 dated May 18, 2018.

The purpose of the investigation is to obtain information on the general subsurface soil and groundwater conditions at the site by means of a limited number of boreholes and laboratory tests. Based on our interpretation of the factual information available for this site, this report provides preliminary engineering comments, recommendations and parameters for the geotechnical design aspects of the project.

This report provides the results of the preliminary geotechnical investigation and should be read in conjunction with the *"Important Information and Limitations of This Report"* in Appendix A which forms an integral part of this document. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report. 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 in this report are still valid.

2.0 SITE AND PROJECT DESCRIPTION

The site is bounded by grassed areas of the community park lands to north and east, Prince of Wales Drive to west and Crawforth Street to south and is proposed to be redeveloped as a new Hospice building. The site is presently grassed and slightly sloped towards the east, small berms approximately 1 m in height were observed along the southern and western boundary of the site.

We understand that the proposed new Durham Hospice building will be constructed as a slab-on-grade type of structure without a basement as well as associated site services and roadways.

3.0 INVESTIGATION PROCEDURES

The geotechnical field investigation for this assignment was carried out on July 26, 2018, during which time four boreholes (18-1 to 18-4) were advanced at the site. The boreholes were advanced using a track-mounted drill rig supplied and operated by Pontil Drilling Services Inc. of Mount Albert, Ontario. The approximate borehole locations are shown on Borehole Location Plan, Figure 2.

Borehole soil samples were obtained at regular intervals of depth using a 50 mm outer diameter split-spoon sampler driven using an automatic hammer in accordance with Standard Penetration Testing (SPT; ASTM D1586). The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 40 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 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 18-1 and 18-2, following the completion of drilling. The monitoring wells 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 Record of Borehole sheets.

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 and gradation analyses on selective samples.

It should be noted that the existing ground surface elevations at the borehole locations were not available at the time of this investigation.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

This portion of the Town of Whitby lies near the border of the physiographic regions of Southern Ontario known as the Iroquois Plain and the South Slope (Chapman and Putnam, 1984). Physiographic mapping in the vicinity of the site indicates glaciolacustrine deposits of sand and silts bordering on glacial tills (Barnett, Cowen and Henry, 1991). The study area is underlain by black shale of the Whitby Formation. The bedrock is anticipated to be at approximately 50 m depth.

The soil deposits within the project limits were deposited during the later Wisconsin period. In general, the deposits are characterized by substantial inter-fingering and inter-layering. The glacial till at the site is unsorted and unstratified glacial sediment consisting of a mixture of any or all of clay, silt, sand, gravel, cobble and boulders. The till may vary locally, with lenses or zones of soft clay, running sand or large boulders.

4.2 Previous Investigation

Golder carried out a preliminary geotechnical investigation at this site for the Town of Whitby, Report dated August 15, 1991, Number 911-8044. The purpose of the investigation at that time was to determine general subsurface soil and shallow groundwater conditions at the site for geotechnical suitability for development. A total of 5 boreholes were advanced (1 to 5) and the approximate borehole locations are shown in Borehole Location Plan, Figure 2. The borehole logs and associated List of Abbreviations and Symbols are included in Appendix B.

4.3 Subsoil 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 Record of Borehole sheets. Golder's *"Methods 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 provides an overview of the subsurface conditions encountered in the boreholes followed by more detailed descriptions of the major soil strata and groundwater conditions.

In general, the subsurface conditions at the site consist of topsoil and fill underlain by a deposit of silt and sand to silty sand till. Localized deposits of sand, silty sand, and silt and sand were also encountered at this site. The groundwater level is at about 3.6 m below ground surface (mbgs).

4.3.1 Topsoil

Topsoil was encountered at all borehole locations and was between 0.1 m and 0.25 m thick.

4.3.2 Fill

Fill material comprised of non-cohesive sandy silt to silty sand was encountered at all borehole locations below the topsoil and extended to about 0.7 mbgs. Organic inclusions and rootlets were noted within the fill.

The SPT ‘N’ values measured within the fill range from 6 to 9 blows per 0.3 m of penetration indicating loose compactness condition. The in-situ water contents measured on samples of the fill are about 13 percent.

4.3.1 Silt and Sand, Silty Sand, Sand

A non-cohesive deposit of silt and sand, silty sand or sand was encounteredin all Boreholes. In Boreholes 18-1 to 18-3, the 0.7 m to 1.1 m thick deposit was encountered below the fill and extended to 1.4 m to 1.8 mbgs. In Borehole 18-4, the sand deposit was encoountered below the till deposit at 5.5 mbgs to the borehole termination depth.

The SPT ‘N’ values measured within the silty and sand, silty sand and sand deposit range from 26 blows to 64 blows per 0.3 m of penetration indicating a compact to very dense compactness condition. The natural water contents measured on samples of this deposit ranges from about 6 percent to 18 percent. A grain size distribution curve for one sample of silt and sand is shown on Figure 3.

4.3.2 Silt and Sand to Silty Sand (Till)

A deposit of non-cohesive glacial till comprised of silt and sand to silty sand was encountered in all boreholes. The surface of the deposit was ecountered between 0.7 m and 1.8 m bgs and extended to the borehole termination depth of 6.6 m, except in Borehole 18-4 where the deposit was 4.8 m in thickness.

The SPT ‘N’ values measured within the till range from 29 to greater than 100 blows per 0.3 m of penetration suggesting a compact to very dense compactness condition, and generally very dense. The natural water contents of measured on samples of the till ranges from about 5 percent to 11 percent. A grain size distribution curve for one sample of the non-cohesive silt and sand till is shown on Figure 4.

4.4 Groundwater Conditions

Groundwater observations and measurements are shown in detail on the Record of Boreholes sheets. The groundwater level measurements in open boreholes and monitoring wells are summarized below.

Borehole	July 26, 2018	August 13, 2018
	Groundwater Depth in Borehole Upon Completion	Groundwater Depth in Monitoring Well
	Depth (m)	Depth (m)
18-1 (monitoring well)	5.9	3.6
18-2 (monitoring well)	5.8	3.7
18-3	5.5	-
18-4	4.3	-

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 (July and August 2018) and that water level is expected to fluctuate seasonally in response to changes in precipitation and snow melt.

5.0 DISCUSSION

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.

5.1 Site Preparation and Grading

The proposed site grading plans are currently unavailable; however, it is anticipated that minor site grading will be required. Fill consisting of sandy silt or silty sand containing organic inclusions was encountered at all borehole locations. The existing fill is not suitable for support of the proposed building foundations, floor slabs, any settlement sensitive structures/utilities as well as pavement structures. The existing fill should be removed to expose native, undisturbed and competent soils. The native soils should be heavilly proofrolled in conjuntion with an inspection by Golder to confirm the base is cleaned of ponded water, loosened/softened soils or any other deleterious materials and is competent to receive engineered fill. Any soft spots identified during proofrolling as directed by Golder should be subexcavated to expose competent soils prior to placement of engineered fill.

5.2 Engineered Fill Requirements

The anticipated minor site grading activities may include both lowering and raising the existing grades to meet the final design requirements. Although major quantities of the existing site soils will likely not be available for reuse, if available they can be considered for reuse as engineered fill. The excavated soils from the site (silt and sand, silty sand or silt and sand to silty sand till), which are at or near their optimum water contents for compaction and do not contain topsoil or organics or any other deleterious materials may be reused on site as engineered fill. Existing materials that contain rubble, debris, or organics inclusions should be wasted or used for landscaping purposes. Although not encountered during the investigation, cobbles larger than 150 mm in diameter should be removed from the existing soils before reuse. Frost susceptible materials should not be used within the pavement structure (see Section 5.8), re-use of the existing small soil berms along the southern and western boundaries of the site as engineered fill would require further investigation and assessment.

The natural water contents of the soils above the water table are generally near or above their estimated optimum water contents for compaction and should be suitable for reuse, however some drying may be required prior to placement.

The materials for use as engineered fill must be approved by Golder at the source(s), prior hauling to the site. In this regard, imported granular materials which meet the requirements for Ontario Provincial Standard Specification (OPSS) 1010 Select Subgrade Material (SSM) would be suitable for use as engineered fill. In any event, the approved materials for engineered fill materials should be placed in maximum 300 mm thick loose lifts and uniformly compacted to minimum 98 percent of the Standard Proctor maximum dry density (SPMDD) throughout.

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

The final surface of the engineered fill must 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.

5.3 Foundation Design

Based on the results of this investigation the proposed buildings may be founded on conventional spread/strip footings in the competent, native and undisturbed compact to very dense silt and sand to silty sand soils or in approved engineered fill. The footings founded on native undisturbed soils may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 325 KPa and a geotechnical reaction at Serviceability Limit States (SLS) of 225 KPa (for 25 mm of settlement). For footings founded on approved engineered fill compacted to 98 percent of the material’s SPMDD, a factored axial geotechnical resistance at ULS of 225 KPa and a geotechnical reaction at SLS of 150 KPa (for 25 mm of settlement) may be used.

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 (subexcavation 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. These soils must be sub excavated and replaced with concrete of the same strength as the footing.

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 3,000 mm for spread footings. Should larger footing sizes be required, Golder must be consulted to provide additional recommendations.

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 1.4 m of cover after final grading, in order to minimize the potential for damage due to frost action.

5.4 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% 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.

5.5 Slab-on-Grade

The floor slab for the proposed building 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 5.2.

Prior to the placement of engineered fill (if any), 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 1010 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 1010 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.

5.6 Excavations and Groundwater Control

Although the final grading and site servicing plans are not available, it is anticipated that services are anticipated to be founded at depths between 2 m and 4 m below the final grade. It is anticipated that excavations for the foundations and underground services will be carried out in open cut. The groundwater level at the site is at about 3.6 mbgs.

All excavations should be carried out in accordance with the OHSA and Regulations for Construction Projects. According to the OHSA, engineered fill and the native compact to very dense silt and sand to silty sand and silt and sand to silty sand till may be considered as Type 3 soils above the groundwater level and type 4 soils below the groundwater level. Temporary excavation side slopes may be formed at 1 horizontal to 1 vertical (1H:1V) in Type 3 soils and at 3H:1V in Type 4 soils. However, 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.

It is anticipated that for excavations into silt and sand to silty sand, including till, deposits groundwater can likely be handled by pumping from properly constructed and filtered sumps located within the excavations. Additionally, care should be taken to direct surface runoff away from the open excavations and all stockpiles located away from excavation edges.

It should be noted that some seasonal fluctuation of the groundwater table is anticipated and that the actual groundwater levels may differ somewhat from those measured in August 2018. Groundwater fluctuation would not be expected to result in a significant impact on construction where mostly glacial tills are present.

Water takings in excess of 50,000 L/day are regulated by the MOECC. Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total less than 400,000 L/day qualify for self-registration on the Ministry of Environment, Conservation and Parks (MECP) Environmental Activity and Sector Registry (EASR). Registry on the EASR replaces the need to obtain a PTTW for water taking and a Section 53 approval for discharge of water to the environment. A “Water Taking Plan” and a “Discharge Plan” are required by the MECP if water is taken in accordance with an EASR. In all cases, discharge under the EASR must be in accordance with a Discharge Plan (to be developed by a qualified professional). The contractor will be responsible for obtaining any required discharge approvals. A Category 3 PTTW would be required for water takings in excess of 400,000 L/day. Neither an EASR nor a PTTW is anticipated to be required at this site but this need should be confirmed after the final grading plans are made available.

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; trench liner boxes should only be used after consultation with Golder. 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, shoring could consist of braced soldier pile and lagging, braced sheet piles or potentially a slide rail system designed by a Professional Engineer including assessment of the potential for basal heave. If shoring is implemented at the site, the requirements of OPSS 539 should be followed. Design of temporary works, including dewatering, will be entirely the responsibility of the contractor.

5.7 Site Servicing

The founding soils for the proposed services, anticipated to be founded between 2 m and 4 m below the final grade, will consist of compact to very dense silt and sand to silty sand and silt and sand to silty sand till. 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 stable founding stratum.

5.7.1 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 a minimum of 150 mm of OPSS 1010 Granular ‘A’ or 19 mm crusher run limestone material. Clear stone should never be used as bedding material. Sand cover may be used from the springline 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.

5.7.2 Trench Backfill

The majority of the excavated materials from the site will generally be silt and sand to silty sand and silt and sand to silty sand till. These materials are generally at or near their optimum water content 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. Although not encountered in the boreholes at this site, cobbles and boulders are anticipated to be encountered within glacially derived materials and should be anticipated 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 granular 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.

5.8 Pavement Design

As traffic information was not available, we have made assumptions based on the number of parking spaces available and the anticipated heavy truck traffic that could be experienced at the development. Once traffic data is known, Golder could be engaged to verify that the pavement designs are suitable to support the required traffic loading at the site.

Based on the results of the geotechnical investigation and the subgrade soils encountered, the following pavement designs may be considered for the internal roads and parking areas:

<table>
<tr><th colspan="2" rowspan="2">MATERIAL</th><th colspan="2">MINIMUM THICKNESS OF PAVEMENT ELEMENTS (mm)</th></tr>
<tr><th>PARKING LOT, DRIVE LANES
LIGHT DUTY</th><th>EMERGENCY ROUTES
MEDIUM DUTY</th></tr>
<tr><td rowspan="2">Asphaltic Material (OPSS 1150)</td><td>HL 3 Surface Course</td><td>40</td><td>40</td></tr>
<tr><td>HL 8 Binder Course</td><td>50</td><td>75</td></tr>
<tr><td rowspan="2">Granular Material (OPSS 1010)</td><td>Granular A Base</td><td>150</td><td>150</td></tr>
<tr><td>Granular B Subbase</td><td>300</td><td>450</td></tr>
<tr><td colspan="2"></td><td colspan="2">Prepared and Approved Subgrade</td></tr>
</table>

5.8.1 Drainage

Adequate surface and subsurface drainage are critical if the pavement is to provide satisfactory service over the design life. The drainage system in the parking areas could consist of a system of catchbasins connected to subdrains draining to a permanent storm water outlet. In this regard, the asphalt surface should be graded to drain towards the catchbasins and the subgrade should be carefully proof-rolled to a smooth surface and sloped towards the catchbasins to prevent ponding or entrapment of water in the subbase which would lead to weakened sections. Consideration should be given to installing sub-drains 6 m in length and extending in all four directions from the catchbasins.

For the fire route, internal roads, and driving lanes, continuous subdrains should be placed at the edge of pavement along each side of the road with intermittent catchbasins. The pavement drainage system should consist of a 150 mm diameter wrapped perforated pipe, placed inside a 300 mm by 300 mm trench and surrounded by clean free draining sand, such as concrete sand. The drain invert should be at approximately 250 mm below the bottom of the granular subbase and should be sloped to drain to the catchbasins.

5.8.2 General Construction Recommendations

Subgrade Preparation

Prior to placing granular materials, the exposed subgrade should be proofrolled and inspected by Golder. Remedial work (that is, further subexcavation and replacement) should be carried out on any disturbed, softened or poorly performing areas, as directed by Golder. Additionally, subgrade soils containing organic matter should be removed and replaced with approved fill or granular material regardless of depth.

It should be noted 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 subgrade soils are wet of optimum. In this regard, the design subbase thickness may not be sufficient for a construction haul road and additional granular materials (in the order of 300 mm) may be required. The subgrade should be proofrolled and inspected by Golder prior to placing the subbase and additional material placed as required to address the subgrade soil conditions and the anticipated construction traffic.

Granular Materials

The granular base and subbase materials should be uniformly placed and compacted to 100 percent of their SPMDD. Compaction of the granular materials should be carried out at a moisture content that is between optimum moisture content and 2 percent of the optimum. Granular 'A' can be used in place of Granular 'B' Type I, but to provide adequate frost protection, the total thickness of the granular materials should not be reduced.

Hot Mix Asphalt Types and Asphalt Construction

The asphalt materials should be compacted to minimum of 92 percent of their Maximum Relative Density (MRD), as measured in the field using a nuclear density gauge; Asphalt material and placement requirements should be as per OPSS.MUNI 310 and OPSS 1150, as amended by the applicable Municipal standards.

Transverse and longitudinal joints should be cleaned, and tack coated prior to placing new asphalt. Where the new pavement abuts the existing pavement (e.g., at tie-ins to existing pavement), proper longitudinal lap joints should be constructed to key the new asphalt surface course into the existing pavement. The existing asphalt should be sawcut to provide a vertical face prior to keying-in the new asphalt surface course. Any undermined or broken edges resulting from the construction activities should be removed by the sawcut.

Performance Graded Asphalt Cement (PGAC)

It is recommended that PG 58-28 asphalt cement be used for both the HL 3 surface course and the HL 8 binder course mixes in accordance with OPSS.MUNI 1101.

5.9 Frost Susceptibility

Based on the results of this investigation, the majority of the subsurface soils encountered in the boreholes are generally considered to be low to moderately frost susceptible. As such, any exterior unheated structures such as exterior slabs, sidewalks and other concrete flatwork could be affected by frost action. To minimize the effects of frost heave on such structures, prevenative measures should be considered in the design as appropriate. Such measures may include positive subgrade grading, provision of subdrains, removal and replacement of native soils with non-frost susceptible (granular) materials, provision of frost tapers and thermal insulation. Golder will be pleased to provide further structure specific recommendations on minimizing potential damage due to frost.

6.0 ADDITIONAL CONSIDERATIONS

We trust that this geotechnical report provides sufficient geotechnical engineering information for the designers to proceed with finalization of the project. Once the final grading and servicing drawings are established and the overall development details are at final stages, Golder should be contacted to review the final design drawings and specifications and provide further input as appropriate.

The soils at this site are sensitive to disturbance from ponded water, construction traffic and frost. During construction, 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 this report provides sufficient information for your immediate requirements. 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.

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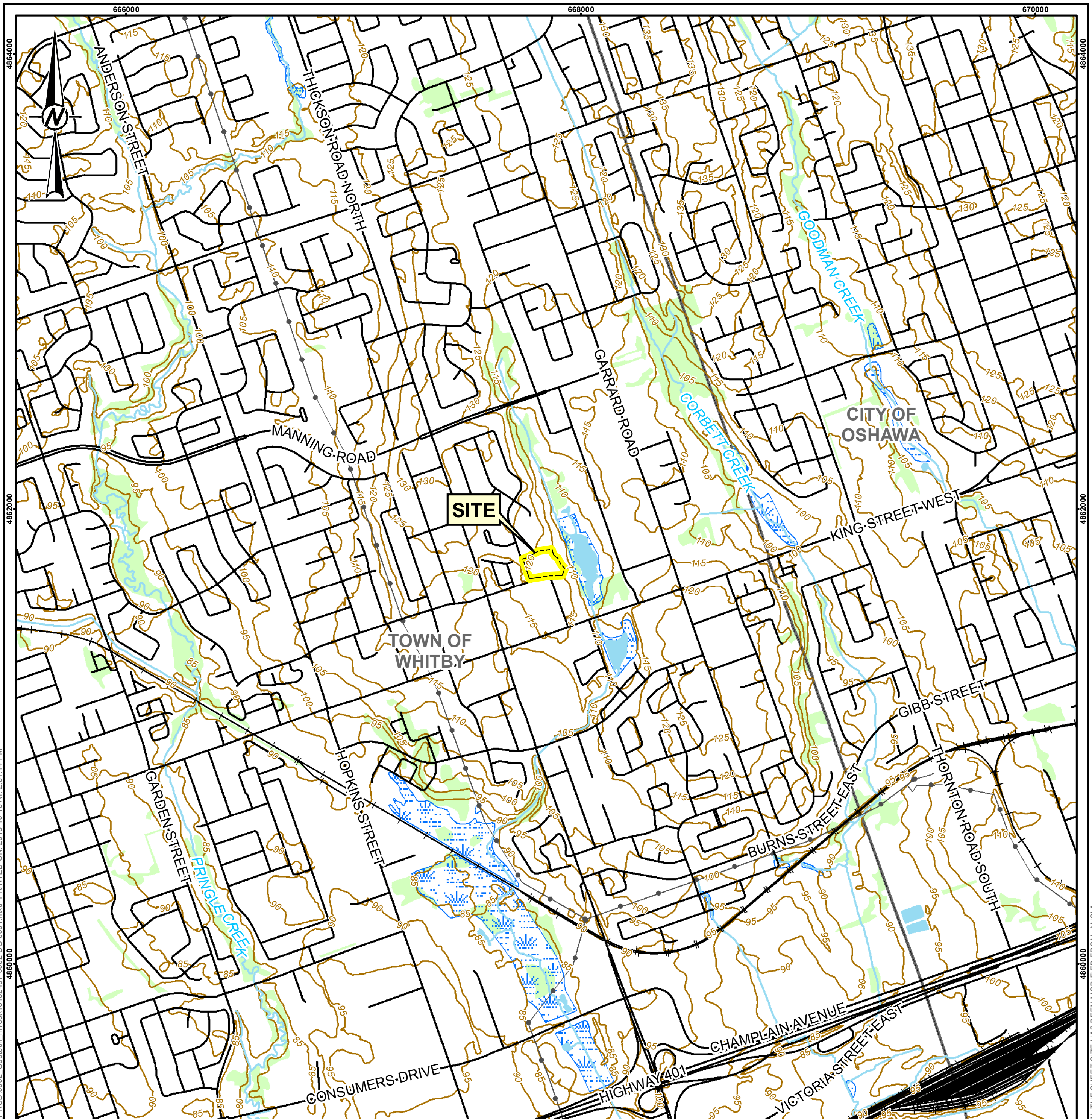
https://golderassociates.sharepoint.com/sites/27643g/reports/prelim geotech/18102457 rep 2018'10'16 preliminary geotech - durham hospice.docx



LEGEND

	CONTOURS (M)		WATERBODY
	RAILWAY		MUNICIPAL BOUNDARY
	ROAD		WETLAND
	UTILITY LINE		WOODED AREA
	WATERCOURSE		
	SITE BOUNDARY		

0 500 1,000

1:25,000 METRES

REFERENCE(S)
BASE DATA - MNR LIO, OBTAINED 2018
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2018
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
VON COMMUNITY CORP.

PROJECT
GEOTECHNICAL INVESTIGATION
DURHAM HOSPICE
WHITBY, ONTARIO

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-12
DESIGNED	JT
PREPARED	JT
REVIEWED	AM
APPROVED	SEMP

TITLE
KEY PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
18102457			1

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NOT TO SCALE
ALL LOCATIONS ARE APPROXIMATE

LEGEND

BOREHOLE LOCATION (DRILLED IN 1991)

BOREHOLE LOCATION (DRILLED IN 2018)

LEGEND

1. BASE PLAN PROVIDED BY J. SOLLY AND ASSOCIATES.

CLIENT
VON COMMUNITY CORP.

CONSULTANT

GOLDER

YYYY-MM-DD	2018-08-17
DESIGNED	
PREPARED	MK
REVIEWED	AM
APPROVED	SEMP

PROJECT
GEOTECHNICAL INVESTIGATION
DURHAM HOSPICE
WHITBY, ONTARIO

TITLE
BOREHOLE LOCATION PLAN

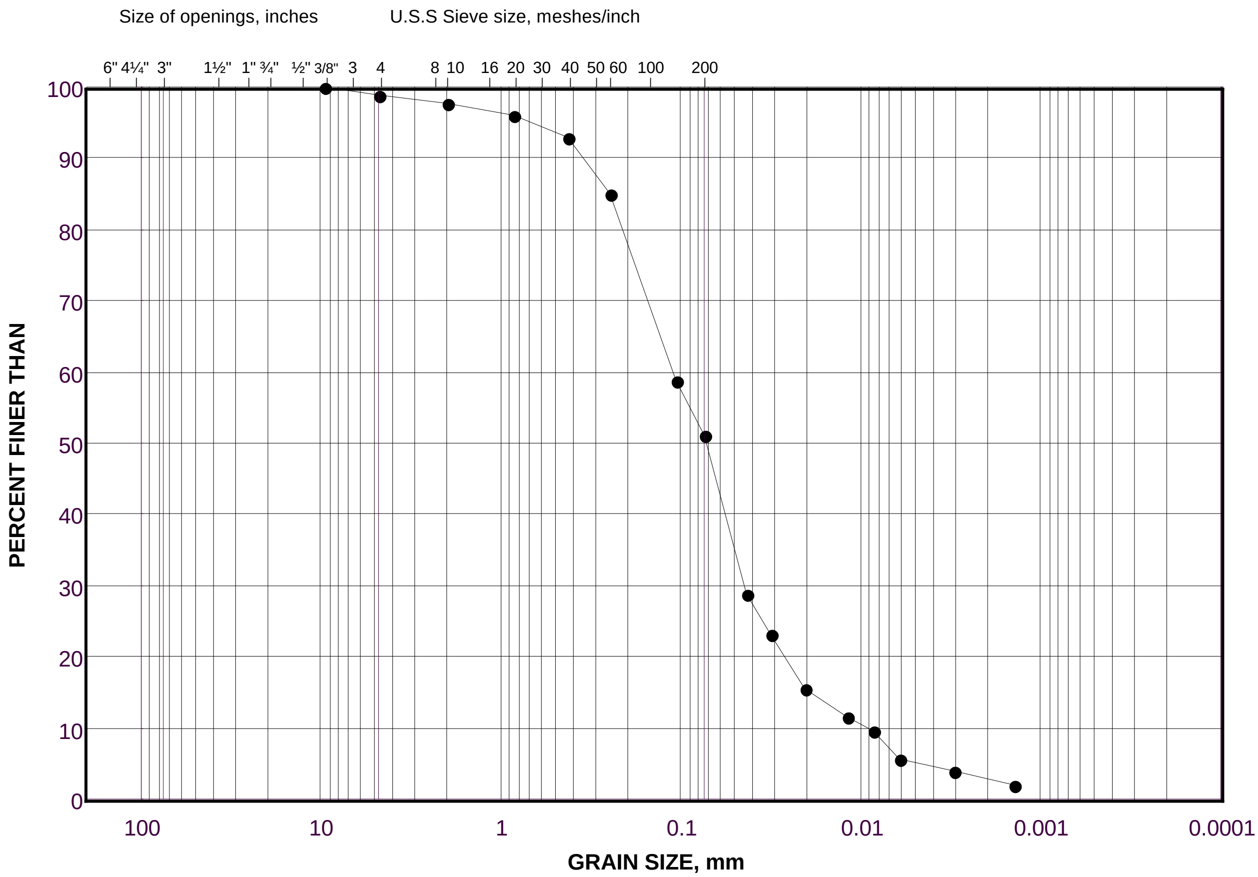
PROJECT NO.	CONTROL	REV.	FIGURE
18102457		----	2

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

GRAIN SIZE DISTRIBUTION

(ML) SILT and SAND

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)
●	18-1	2	0.75 - 1.2

Project Number: 18102457

Checked By: AM

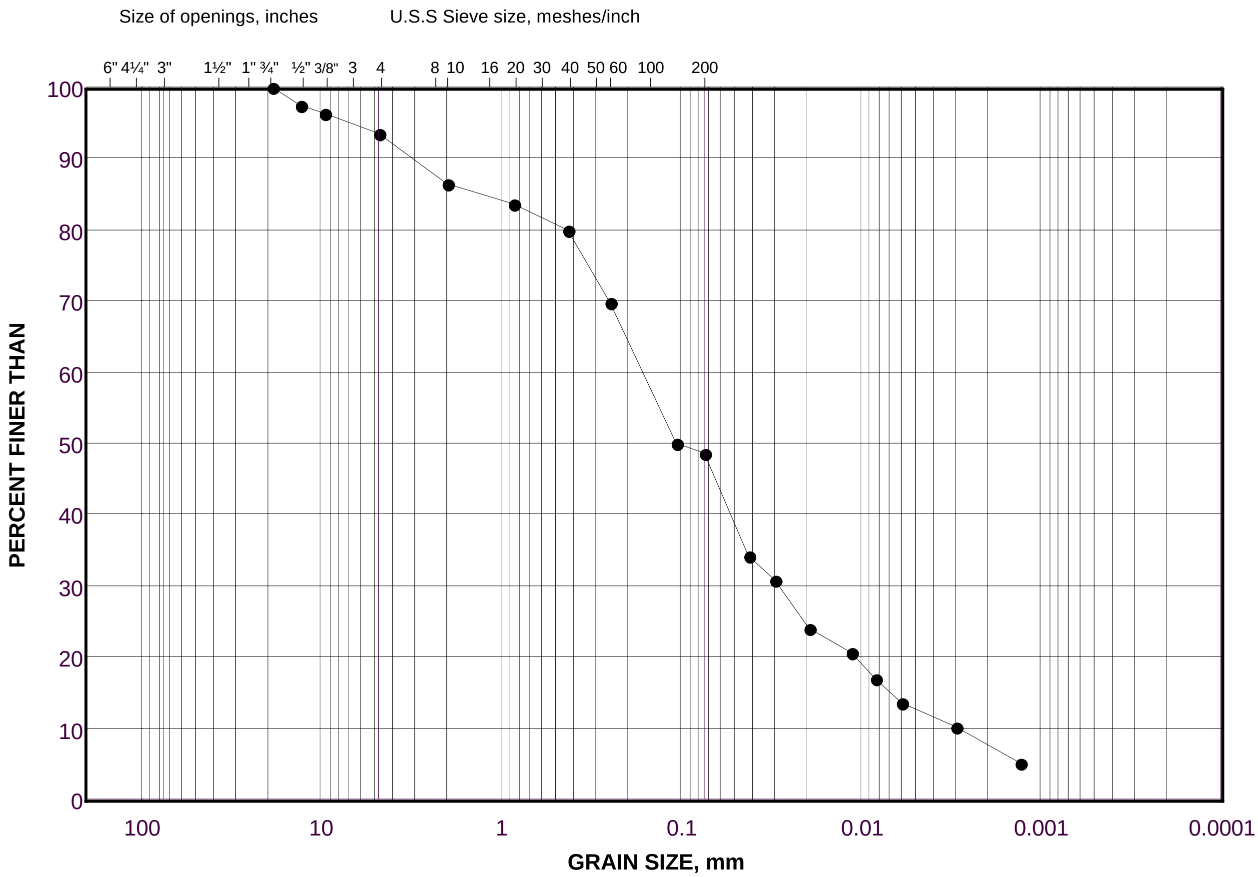
Golder Associates

Date: 12-Oct-18

GRAIN SIZE DISTRIBUTION

(ML) SILT and 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)
●	18-2	3	1.5 - 2.0

Project Number: 18102457

Checked By: AM

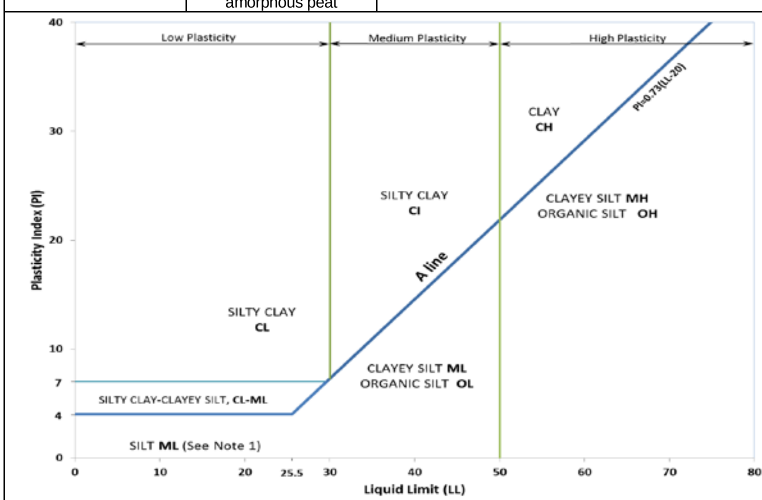
Golder Associates

Date: 12-Oct-18

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: Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)	Organic Content	USCS Group Symbol	Primary Name
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 = σ'_p / σ'_{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 δ
c′	effective cohesion
c_u, s_u	undrained shear strength (ϕ = 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

RECORD OF BOREHOLE: 18-1

PROJECT: 18102457
LOCATION: See Figure 2
BORING DATE: July 26, 2018
SHEET 1 OF 1
DATUM:

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

BORING METHOD: Track Mount Power Augering, 150mm Solid Stem

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	
TOPSOIL	0.00
FILL - (ML) sandy SILT; dark brown, organic inclusions, rootlets; non-cohesive, moist, loose	0.25
(ML) SILT and SAND, layers of sandy silt; brown, oxidation staining; non-cohesive, moist, compact to very dense	0.65
(ML) SILT and SAND, trace to some gravel; brown (TILL); non-cohesive, moist, very dense - Grey at 3.9 m - Hard augering at 3.9 m to 5.5 m	1.83
END OF BOREHOLE	6.55

SAMPLE NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1A	SS	9	
1B	SS		
2	SS	23	M
3	SS	64	
4	SS	50/0.10	
5	SS	60/0.13	
6	SS	50/0.08	
7	SS	100	

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

PIEZOMETER OR STANDPIPE INSTALLATION: Bentonite; August 13, 2018; Sand; Screen and Sand

NOTES:

1. Groundwater was measured in open borehole at a depth of 5.9 m below ground surface upon completion of drilling on July 26, 2018.

2. Groundwater was measured in monitoring well at a depth of 3.6 m below ground surface on August 13, 2018.

DEPTH SCALE 1 : 50

GOLDER

LOGGED: RV / BD
CHECKED: AM

RECORD OF BOREHOLE: 18-2

PROJECT: 18102457
LOCATION: See Figure 2
BORING DATE: July 26, 2018
SHEET 1 OF 1
DATUM:

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

BORING METHOD: Track Mount Power Augering, 150mm Solid Stem

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80)
SHEAR STRENGTH Cu, kPa (20, 40, 60, 80): nat V. + Q - ● ; rem V. ⊕ U - ○
HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3})
WATER CONTENT PERCENT: Wp ├──○W──┤ Wl (10, 20, 30, 40)

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	
TOPSOIL	0.00
FILL - (SM) SILTY SAND, trace gravel; brown, rootlets; non-cohesive, moist, loose	0.10
(SM) SILTY SAND, layers of sandy silt; brown, oxidation staining; non-cohesive, moist, dense	0.69
(ML) SILT and SAND, trace to some gravel; brown (TILL); moist, dense to very dense - Pocket of sand at 3.6 m - Grey at 3.9 m - Wet sand seam at a depth of about 5.5 m	1.37
END OF BOREHOLE	6.55

SAMPLE NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	46	
3	SS	47	M
4	SS	32	
5	SS	57	
6	SS	42	
7	SS	91	

PIEZOMETER OR STANDPIPE INSTALLATION: Bentonite; Sand; Screen and Sand; August 13, 2018

NOTES:

1. Groundwater was measured in open borehole at a depth of 5.8 m below ground surface upon completion of drilling on July 26, 2018.

2. Groundwater was measured in monitoring well at a depth of 3.7 m below ground surface on August 13, 2018.

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RV / BD
CHECKED: AM

PROJECT: 18102457

LOCATION: See Figure 2

RECORD OF BOREHOLE: 18-3

BORING DATE: July 26, 2018

SHEET 1 OF 1

DATUM:

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE - DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT PERCENT (W, approx.)
		GROUND SURFACE					
0	Track Mount Power Augering, 150mm Solid Stem	TOPSOIL	0.00				
		FILL - (ML) sandy SILT; dark brown, rootlets, organic inclusions; non-cohesive, moist, loose	0.25	1	SS	6	○
1		(SM) SILTY SAND, some to trace gravel, zones of SAND; brown, oxidation staining; non-cohesive, moist, compact	0.69	2	SS	26	○
		(ML) SILT and SAND; trace to some gravel; brown (TILL); non-cohesive, moist, dense to very dense	1.37	3	SS	38	○
2				4	SS	88	○
3				5	SS	66	○
4		- Grey at 3.9 m					
5				6	SS	71	○
6				7	SS	80	○
		END OF BOREHOLE	6.55				

Column headings also include: 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); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION; STRATA PLOT.

NOTE:

1. Groundwater was measured in open borehole at a depth of 5.5 m upon completion of drilling on July 26, 2018.

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

GTA-BHS 001 S:\CLIENTS\TOWPRINCE_OF_WALES_DR_AND_CRAWFORTH_ST\02_DATA\GINT\PRINCE_OF_WALES_DR_AND_CRAWFORTH_ST.GPJ GAL-MIS.GDT 10/16/18

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RV / BD

CHECKED: AM

PROJECT: 18102457

LOCATION: See Figure 2

RECORD OF BOREHOLE: 18-4

BORING DATE: July 26, 2018

SHEET 1 OF 1

DATUM:

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	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)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Track Mount Power Augering, 150mm Solid Stem	TOPSOIL		0.00							
		FILL - (ML) sandy SILT; dark brown, rootlets, organic inclusions; non-cohesive, moist, loose		0.25	1	SS	6				
1		(ML/SM) SILT and SAND to SILTY SAND, trace to some gravel; brown to grey (TILL), non-cohesive, moist, compact to very dense		0.69	2	SS	29				
					3	SS	71				
2		- Oxidation staining above 2.0 m depth.			4	SS	50/0.08				
3					5	SS	60/0.10				
4		- Grey at 3.9 m									
5					6	SS	50/0.13				
		(SP) SAND, some non-plastic fines; grey; non-cohesive, wet, dense		5.49							
6					7	SS	37				
		END OF BOREHOLE		6.55							
7		NOTE:									
		1. Groundwater was measured in open borehole at a depth of 4.3 m below ground surface upon completion of drilling on July 26, 2018.									
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: BD

CHECKED: AM

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.

APPENDIX B

List of Abbreviations and Symbols, Previous Boreholes (1 to 5)

LIST OF ABBREVIATIONS

The abbreviation commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance:

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 0.3 m (12 in.).

Standard Penetration Resistance, *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 0.3 m (12 in.).

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	'N' Blows/0.30m or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	'Cu' kPa	'Cu' psf.
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer[1]
Q undrained triaxial[2]
R consolidated undrained triaxial[2]
S drained triaxial
U unconfined compression
V field vane test

NOTES:
[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.
[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

LIST OF SYMBOLS

I. GENERAL

$\pi = 3.1416$

e = base of natural logarithms 2.7183

$\log_e a$ or $\ln a$, natural logarithm of a

$\log_{10} a$ or $\log a$, logarithm of a to base 10

- t time
- g acceleration due to gravity
- V volume
- W weight
- M moment
- F factor of safety

II. STRESS AND STRAIN

- u pore pressure
- σ normal stress
- σ' normal effective stress ($\bar{\sigma}$ is also used)
- τ shear stress
- ϵ linear strain
- ϵ_{xy} shear strain
- ν Poisson's ratio (μ is also used)
- E modulus of linear deformation (Young's modulus)
- G modulus of shear deformation
- K modulus of compressibility
- η coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

- γ unit weight of soil (bulk density)
- γ_s unit weight of solid particles
- γ_w unit weight of water
- γ_d unit dry weight of soil (dry density)
- γ' unit weight of submerged soil
- G_s specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
- e void ratio
- n porosity
- w water content
- S_r degree of saturation

(b) *Consistency*

- w_L liquid limit
- w_P plastic limit
- I_P plasticity index
- 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
- D_r relative density $= (e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

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

(d) *Consolidation (one-dimensional)*

- m_v coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$
- C_c compression index $= -\Delta e/\Delta \log_{10} \sigma'$
- c_v coefficient of consolidation
- T_v time factor $= c_v t/d^2$ (d, drainage path)
- U degree of consolidation

(e) *Shear strength*

- τ_f shear strength
- c' effective cohesion intercept; ϕ' effective angle of shearing resistance, or friction — in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
- c_u apparent cohesion*; ϕ_u apparent angle of shearing resistance, or friction — in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
- μ coefficient of friction
- S_t sensitivity

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

RECORD OF BOREHOLE 1

PROJECT: 911-8044 SHEET 1 OF 1

LOCATION: See Figure 2 BORING DATE: Aug.1,1991 DATUM: Geodetic

SAMPLER HAMMER, 63.5kg; DROP, 760mm PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: POWER AUGER, 114mm DIA. SOLID STEM AUGERS

Depth Scale (metres)	Soil Profile – Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.3m	Water Content, Percent	Additional Lab. Testing
0	GROUND SURFACE	120.05					
	TOPSOIL	119.95 / 0.10					
	Compact to very dense brown SILTY SAND to SANDY SILT, trace clay, some gravel, rusty oxidation stains (TILL)		1	50 DO	17	O	
1			2	50 DO	57	O	
			3	50 DO	92	O	MH
2			4	50 DO	78/300	O	
3			5	50 DO	82/280	O	
4		115.33 / 4.72					
	Very dense brown SAND, trace silt, pockets of silty fine sand	115.07 / 4.98	6	50 DO	97/280	O	
5	Very dense brown SILTY SAND to SANDY SILT, trace clay, some gravel (TILL)	114.35 / 5.70					
6	Very dense brown SAND & GRAVEL, trace silt	113.65 / 6.45	7	50 DO	100/200	O	
	Very dense grey SILTY SAND to SANDY SILT, trace clay, some gravel (TILL)						
7	END OF BOREHOLE						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

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

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

PIEZOMETER OR STANDPIPE INSTALLATION

Water Level in borehole on completion of drilling at Elev.116.01 or at a depth of 4.04 m Aug.1,1991

Borehole caved to a depth of 4.42 m on completion of drilling Aug.1,1991

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: A:\8044 1.BH

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: A.J.H

CHECKED: DGG

RECORD OF BOREHOLE 2

PROJECT: 911-8044
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING DATE: Aug.1,1991

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT, PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	POWER AUGER, 114mm DIA. SOLID STEM AUGERS	GROUND SURFACE		121.35						
		TOPSOIL		121.22 / 0.13	1	50 DO	18	o		
		Compact reddish brown SANDY SILT, some roots		120.74 / 0.61						
1		Very dense brown to grey SILTY SAND to SANDY SILT, trace clay, some gravel, rusty oxidation stains (TILL)			2	50 DO	82/300	o		
					3	50 DO	106 280	o	MH	
2					4	50 DO	92/280	o		
3					5	50 DO	102 280	o		
4					6	50 DO	60/100	o		
5										
6				115.15 / 6.20	7	50 DO	60/100	o		
		END OF BOREHOLE								Borehole dry on completion of drilling Aug.1,1991. Borehole caved to a depth of 4.95 m on completion of drilling Aug.1,1991
7										
8										
9										
10										

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

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

WATER CONTENT, PERCENT — 10 20 30 40

0 / 15 - 5 / 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: A:\8044 1.BH

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: A.J.H
CHECKED: DGG

RECORD OF BOREHOLE 3

PROJECT: 911-8044
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING DATE: Aug.1,1991

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: POWER AUGER, 114mm DIA. SOLID STEM AUGERS

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	118.67			
TOPSOIL	118.52 / 0.15			
Compact brown SANDY SILT, trace clay, trace gravel, trace organics	118.06 / 0.61	1	50 DO	24
Compact to very dense brown to grey SILTY SAND to SANDY SILT trace clay, some gravel, occasional pockets of silty fine sand, rusty oxidation stains (TILL)		2	50 DO	50
		3	50 DO	90/250
		4	50 DO	105/280
		5	50 DO	108/300
		6	50 DO	110/250
		7	50 DO	30
	110.95 / 7.72	8	50 DO	80/100
END OF BOREHOLE				

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

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

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in borehole on completion of drilling at Elev.112.35 or at a depth of 6.32 m Aug.1,1991

Borehole caved to a depth of 6.63 m on completion of drilling Aug.1,1991

15 0 10 5 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: A:\8044 1.BH

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: A.J.H
CHECKED: DJG

RECORD OF BOREHOLE 4

PROJECT: 911-8044
LOCATION: See Figure 2
SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING DATE: Aug.1,1991

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES – NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT, PERCENT (Wp–W–Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	POWER AUGER – 114mm DIA. SOLID STEM AUGERS	GROUND SURFACE		117.99						
		TOPSOIL		0.00						
		Compact dark brown SANDY SILT, trace organics		117.69 / 0.30	1	50 DO	23			
		Dense brown SILTY SAND to SANDY SILT, trace clay, some gravel (TILL)		117.38 / 0.61	2	50 DO	32			
		Very dense brown SANDY SILT, trace clay, occasional gravel		116.62 / 1.37	3	50 DO	65		MH	
					4	50 DO	55			
		Very dense brown SILTY SAND to SANDY SILT, trace clay, some gravel, occasional pockets of silty fine sand, rusty oxidation stains (TILL)		115.09 / 2.90	5	50 DO	99			
					6	50 DO	90			
		Very dense grey SANDY SILT, trace clay		112.43 / 5.56						
					7	50 DO	96/250			
		Very dense grey SILTY SAND to SANDY SILT, trace clay, some gravel (TILL)		111.69 / 6.35						
		END OF BOREHOLE								

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa (20 40 60 80) — nat V - + Q - ● rem.V - ⊕ U - O

15 – 5 PERCENT AXIAL STRAIN AT FAILURE (0, 10)

Water level in borehole on completion of drilling at Elev.112.35 or at a depth of 5.64 m Aug.1,1991

Borehole caved to a depth of 5.74 m on completion of drilling Aug.1,1991

DATA INPUT: A:\8044 1.BH

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: A.J.H
CHECKED: DJJ

PROJECT: 911-8044

RECORD OF BOREHOLE 5

SHEET 1 OF 1

LOCATION: See Figure 2

BORING DATE: Aug.1,1991

DATUM: Geodetic

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT
		GROUND SURFACE	118.50 0.00				
0	POWER AUGER 114mm DIA. SOLID STEM AUGERS	TOPSOIL	118.20 0.30	1	50 DO	17	O
1		Compact to very dense brown to grey SILTY SAND to SANDY SILT, trace clay, some gravel, occasional cobbles, occasional sand pockets at depth, rusty oxidation stains (TILL)		2	50 DO	90	O
				3	50 DO	50/75	O
2				4	50 DO	95/230	O
3				5	50 DO	100/230	O
4				6	50 DO	60/100	O
6				7	50 DO	82/200	O
7			111.78 7.72	8	50 DO	60/100	O
		END OF BOREHOLE					

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

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

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in borehole on completion of drilling at Elev.115.28 or at a depth of 4.22 m Aug.1,1991

Borehole caved to a depth of 4.32 m on completion of drilling Aug.1,1991

15 0 5 10 PERCENT AXIAL STRAIN AT FAILURE

DATA INPUT: A:\8044 1.BH

DEPTH SCALE 1 to 50

LOGGED: A.J.H

CHECKED: DGG

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