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# Preliminary Geotechnical Investigation
# Future Mid- to High-Rise Development
3275 Trafalgar Road
Oakville, Ontario

Prepared for:

**New Horizon Development Group**
3170 Harvester Road #200
Burlington, Ontario
L7N 3W8

Landtek File: 21261
May 22, 2024

# EXECUTIVE SUMMARY

## SCOPE OF SERVICES

| | |
|---|---|
| **Proposed Development** | Though no conceptual development plan was available at the time of authoring this report, it is understood that any future development at the site would likely be of a medium to high density (i.e., mid- to high-rise structures), residential or mixed residential/commercial end use. Such a development would include for two to four levels of underground basement, localised landscaping, new site services and at-grade, private and/or Municipally-adopted pavement structures. |
| **Report Deliverables** | The Preliminary Geotechnical Investigation Report is required to provide an outline understanding of the subsurface conditions underlying the site and to provide preliminary design considerations for the proposed residential development concept. |

## SITE DETAILS AND SETTING

| | | | |
|---|---|---|---|
| **Coordinates** | 602900, 4816725 | **Geodetic Elevation** | 177.0 m to 183.0 m |
| **Site Description** | The site is approximately 38,600 m2 (3.86 hectares) in plan area and is rectangular in shape. The site is situated on Trafalgar Road and is bound to the east by a soon-to-be-developed area, and to the north and west by agricultural land. The topography of the site is variable, with a number of shallow valleys and plateaus across the site. Shallow ponds and wetland areas are also noted in the central and southern areas of the site area. | | |
| **Geology** | Organic soil and existing pavement materials were encountered at the ground surface. Interbedded deposits of silty clay, clayey silt, silt till and clayey silt till were encountered below the topsoil and fill materials, and extend to depths of between approximately 1.5 to 6.0 m below the ground surface. Red shale of the Queenston Formation was encountered in all boreholes extends to the terminus of the boreholes at a maximum drill depth of approximately 18.7 m. | | |
| **Groundwater** | Groundwater was encountered during drilling only in boreholes BH/MW101-'20, BH2-'23, BH/MW103, BH116 and BH/MW121 at depths between approximately 2.7 m and 5.2 m below the ground surface. Twenty-two return, groundwater monitoring well visits have been completed at the site to date since 2021, the most recent results of which are presented in Table 4.9.1. | | |

## ENGINEERING CONSIDERATIONS

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|---|---|
| **Foundations** | The fill materials encountered at the site are not considered suitable as bearing strata. It is considered by Landtek that the anticipated moderate-to high-loading of the proposed mid- and high-rise structures can be supported by the native soils or shallow bedrock underlying the site using conventional, concrete strip or pads foundations. |
| **Settlements** | The general limiting of the total settlement to 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate for foundations in native soils. Ordinarily, the SLS condition would not govern foundation design in bedrock, however, the associated settlements should be taken as those for soils. |
| **Earthquake Considerations** | Based on the soil conditions encountered, and in accordance with Table 4.1.8.4.A. of the current Ontario Building Code (*OBC*), the site is considered to be a 'C' Site Class. |
| **At-grade Floor Slabs** | It should be possible to construct the lowest (i.e., basement) floor slab level using slab-on-grade methods. The subgrade support conditions are anticipated to be clayey silt till, silt till or weathered red shale, which should provide competent conditions for placing the vapour barrier material. |

## CONSTRUCTION CONSIDERATIONS

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| **Excavations** | The subsurface soils to be encountered during excavation at the site are expected to behave as "Type 2" and "Type 3" materials according to the OHSA classification in Part III. Type 2 soils are characteristic of the generally very stiff "clayey silt till" and the generally dense "silt till", with the previously excavated "fill materials" behaving as Type 3 soils. |
| **Subsurface Concrete** | Experience in the area indicates that the native soils generally have a mild sulphate environment and a low chloride concentration. It is recommended that subsurface concrete at the site have general use (GU) characteristics for normal Portland cement mixes. For the parking garage decks and ramps it is recommended that the concrete exposure class be C-1. |
| **Construction Dewatering** | Considerations regarding groundwater levels, construction dewatering, dewatering rates and requirements towards project registration with the Environmental Activity and Sector Registry (ESAR) or a Permit To Take Water (PTTW) are provided by the Hydrogeological Assessment for the site, as reported under separate cover. |

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## 1.0 INTRODUCTION

Landtek Limited (herein "*Landtek*") is pleased to submit this Preliminary Geotechnical Investigation report for the proposed new residential subdivision development located at the site identified as civic addresses 3275 Trafalgar Road in Oakville, Ontario. Authorization to proceed with the work was received from New Horizon Development Group (herein "*NHDG*") on August 25, 2021.

Though no conceptual development plan was available at the time of authoring this report, it is understood that any future development at the site would likely be of a medium to high density (i.e., mid- to high-rise structures), residential or mixed residential/commercial end use. Such a development would include for two to four levels of underground basement, localised landscaping, new site services and at-grade, private and/or Municipally-adopted pavement structures.

The primary objectives of this investigation are:

- To provide a preliminary understanding of the subsurface soil and groundwater conditions for outline foundation design;
- Provide preliminary design recommendations with regards to building foundations, at-grade floor slabs, deck and at-grade pavement structures, and subsurface drainage and utilities; and,
- Assess the characteristics of the soils to be excavated and their anticipated impact on excavatability, reuse and shoring systems.

This Preliminary Geotechnical Investigation report has been prepared for the Client, the nominated engineers, designers, and project managers pertaining to the proposed residential subdivision development at the site identified as civic addresses 3275 Trafalgar Road in Oakville, Ontario. Reliance on this report is also extended to Municipalities and other such Regulatory Authorities for zoning and permitting purposes, but only to the same extents and purposes of the report. Further dissemination of this report is not permitted without Landtek's prior written approval.

Further details of the limitations of this report are presented in Appendix A.

## 2.0 SITE SETTING

### 2.1 Site Location and Description

The site is located in Oakville, Ontario, and is centered at approximate grid reference 602900, 4816725 (UTM 17T coordinates). The Geodetic elevation of the ground surface at the site is approximately 177 m to 183 m.

The site location is shown in Figure 2.1.1 below.


***Figure 2.1.1:*** *Site Location and Surrounding Area*

The site is approximately 38,600 $m^2$ (3.86 hectares) in plan area and is rectangular in shape. The site is situated on Trafalgar Road and is bound to the east by a soon-to-be-developed area, and to the north and west by agricultural land.

The topography of the site is variable, with a number of shallow valleys and plateaus across the site. Shallow ponds and wetland areas are also noted in the central and southern areas of the site area.

### 2.2 Published Geology

Anecdotal evidence indicates that the area is covered by variable thicknesses of fill materials that are associated with the excavation and construction works for the ETR Highway 407 approximately 2 km northeast of the site.

Based on previous geotechnical experience for the area and a review of the existing geological publications for the site area, Ontario Geological Survey (herein "*OGS*") Map 2605 "*Quaternary Geology of the Hamilton Area*", the site is underlain by clay and silt glacial till deposits of the Halton Till.

The Ontario Department of Mines (herein "*ODM*") Map 2336 "*Paleozoic Geology of the Hamilton Area*" indicates that the superficial geology is underlain by a sequence of interbedded red shales of the Queenston Formation. The OGS Map P0495 "*Hamilton Sheet, Southern Ontario, Drift Thickness Series*" indicates bedrock to subcrop the site at a relatively shallow depth, in the order of approximately 3.0 m to 5.0 m below existing ground level.

Information provided by historical borehole records from within the vicinity of the site, and held by the OGS, generally confirms the anticipated geological conditions beneath the site. Based on the data from a number of records within a 1.5 km radius of the site, the soil profile comprises of a veneer of organic material overlying clay and silt till deposits to depths between approximately 5.5 m and 8.4 m, with red shale bedrock underlying.

### 2.3 Hydrology and Hydrogeology

The nearest surface water body is a tributary of the Joshua's Creek watershed, as regulated Halton Conservation, that passes north-south through the central area of the site. A regulated wetland is also located in the central and southern area of the site, with area of local ponding also present.

It is anticipated that any shallow groundwater regime beneath the site will be associated with the shallow Queenston Formation shale bedrock, though limited, local groundwater sources may be encountered within the overlying Halton Till.

## 3.0 FIELDWORK AND INVESTIGATION METHODOLOGY

Fieldwork undertaken at the site by Landtek included clearance of underground services, borehole layout, borehole drilling and soil sampling, and field supervision. A total of fifteen boreholes were drilled as part of an initial phase of investigation between August 9 and 12, 2021, and a second phase of investigation completed between March 20 to 27, 2023. All boreholes were logged using those standard symbols and terms defined in Appendix B. The Borehole Location Plan, Drawing 21261-01, and associated borehole logs are provided in Appendix C.

The boreholes were drilled using a Dietrich D-50 track mounted drill rig equipped with continuous flight, solid and hollow stem augers and were extended to depths between approximately 3.1 m and 18.7 m below existing ground level. Full time supervision of drilling and soil sampling operations was carried out by a representative of Landtek. Standard Penetration Tests (SPT's) and split spoon samples were taken during drilling at selected depths. Boreholes encountering ultimate auger refusal were extended from bedrock refusal using NQ-gauge, rotary coring methodologies.

Boreholes identified as BH1D-23, BH4-23, BH120S/D, BH121S/D and BH122D-23 were completed as monitoring wells and reidentified as monitoring wells BH/MW1D-23, BH/MW4-23, BH/MW120S/D (nested), BH/MW121S/D (nested) and BH/MW122D-23 respectively. The monitoring wells consisted of new 50 mm poly-vinyl chloride (PVC) screen with No.10 slots threaded onto a matching riser. The screens and risers were pre-threaded including o-ring seals such that no glues or solvents were used to connect the pipe sections. The annular space between the PVC well and the borehole was backfilled to approximately 0.3 m above the top of the screen section with sand pack, and then with bentonite to existing ground level. A J-Plug lockable air-tight cap was installed on the riser.

All soil samples were transported to the Landtek's in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture content testing was carried out on all samples. No chemical testing was completed as part of this investigation.

The borehole locations were established by Landtek relative to site measurements and site features. Borehole Geodetic elevations were established relative to the information provided by the Topographical Survey drawing for the site, "*Lot 12, Concession 1, North of Dundas Street*" as completed by A. T. McLaren Limited, reference no. 36729-T.r1, dated January 6th, 2021.

# 4.0 SUBSURFACE CONDITIONS

## 4.1 Overview

The borehole information is generally consistent with the geological data identified in Section 2.2, with the predominant soils comprising of clay and silt till underlain by red shale.

The detailed borehole logs are presented in Appendix C, with the ground conditions encountered by the boreholes discussed in the following sections.

## 4.2 Existing Pavement Structure

Boreholes BH114 and BH115 were located within the existing pavement structure at the site. The pavement structure comprises of an approximately 300 mm asphaltic concrete cover with 300 mm of pavement granular materials. The pavement granular materials generally comprise of a sand and gravel product.

## 4.3 Organic Soils

Organic soil was encountered all boreholes, except boreholes BH114 and BH115, at the ground surface and comprised of an approximately 150 mm to 600 mm thick layer of topsoil.

It should be noted that topsoil thicknesses may vary across the site and the thicknesses encountered at the borehole locations may not be representative of the site-wide, organic soil cover.

## 4.4 Fill Material

Fill material was encountered in all boreholes except boreholes BH/MW1D-23, BH2-23 and BH3-23 underlying the surface materials and extends to depths of approximately 0.6 m to 1.8 m below existing ground level. The fill generally comprises of silt, clay, and sand, and includes variable fractions of gravel and cobbles, and is generally brown in colour.

SPT ‘‘N’’ values ranging from 7 to 20 were reported within the fill materials, indicating their compactness condition to be variable from poor to moderate, but generally moderately compacted. This is as expected for historical fill materials placed in an uncontrolled manner.

## 4.5 Silty Clay and Clayey Silt

Silty clay and clayey silt deposits were encountered in boreholes BH/MW1D-23, BH2-23, BH3-23 and BH119 and BH/MW122D-23 below the fill material and organic materials, ranging in depth between approximately 1.5 m and 2.3 m below existing ground level. The silty clay and clayey silt deposits encountered are primarily brown in colour and include trace fractions of gravel and sand.

SPT ‘‘N’’ values ranging from 5 to 24 were reported, indicating the silty clay and clayey silt deposits to be of a firm to very stiff, but generally stiff consistency.

Moisture contents in the silty clay/clayey silt deposits range between 14 % and 17 %, which are representative of a moist soil with clay and silt as primary constituents. The moisture content testing results are presented on the borehole logs in Appendix C.

### 4.6 Silt Till

Silt till deposits were encountered in boreholes BH/MW1D-23, BH2-23, BH3-23, BH/MW4-23 and BH122D-23 below the fill material and silty clay/clayey silt deposits. The till deposits range in depth between approximately 0.7 m to 6.0 m below the ground surface. The till deposits encountered are primarily brown in colour and include trace fractions of sand, clay, grey shale fragments and gravel.

SPT ‘‘N’’ values ranging from 22 to 50 blows for 75 mm penetration of the split-spoon sampler were reported, indicating the till to be of a compact to dense, but generally dense consistency. Moisture contents in the silt till deposits range between 8 % and 23 %, which are representative of a moist to very moist soil with silt and clay as primary constituents.

The moisture content testing results are presented on the borehole logs in Appendix C.

### 4.7 Clayey Silt Till

Clayey silt till deposits were encountered in all boreholes except boreholes BH/MW1D-23, BH2-23, BH3-23, BH/MW4-23, BH/MW121S/D, BH122 and BH123 below the organic material and fill material. The till deposits range in depth between approximately 1.5 m to 3.5 m below the ground surface. The till deposits encountered are primarily brown in colour and include variable fractions of sand and gravel and trace cobbles.

SPT ‘‘N’’ values ranging from 19 to 57 were reported, indicating the till to be of a very stiff to hard, but generally hard consistency. Moisture contents in the clayey silt till deposits range between 8 % and 23 %, which are representative of a moist to very moist soil with silt and clay as primary constituents.

The moisture content testing results are presented on the borehole logs in Appendix C.

### 4.8 Bedrock

Red shale of the Queenston Formation was encountered in all boreholes at depths of between approximately 1.5 m (borehole BH123) and 6.7 m (boreholes BH103) below existing ground level, and extends to the terminus of the boreholes at a maximum drill depth of approximately 18.7 m.

The Queenston Formation is a layered sedimentary bedrock deposit with widely spaced jointing and sub-horizontal bedding planes, interbedded with slightly weathered to fresh, grey, fine grained strong to extremely strong calcareous siltstone and limestone seams and tend to be much sounder and harder than the shale strata.

Rotary coring was conducted to confirm bedrock quality in boreholes BH1D-’23, BH2-23, BH3-’23, BH4-’23 and BH122D-‘23, and along with previous geotechnical investigations conducted in the vicinity of the site, the information indicates that the shale is generally very weak and completely weathered in the upper layers and becomes more competent at depth. The competent shale in the vicinity of the site is typically classified under the Canadian Foundation Engineering Manual classification rating criteria as being a Grade R3 to R4 rock which is medium strong rock. It should be noted that, with the Queenston Formation being a layered sedimentary bedrock deposit, discontinuous layers of siltstone and occasional limestone seams will likely be encountered and tend to be much sounder and harder than the shale strata.

## 4.9 Groundwater

Groundwater was encountered during drilling **only** in boreholes BH/MW101-'20, BH2-'23, BH/MW103, BH116 and BH/MW121 at depths between approximately 2.7 m and 5.2 m below the ground surface.

Twenty-two return, groundwater monitoring well visits have been completed at the site to date since 2021, the most recent results of which are presented in Table 4.9.1 following.

**Table 4.9.1: Summary of Water Level Measurements**

| MW ID | Well Details | | | Water Strike | Groundwater Monitoring Results | |
|---|---|---|---|---|---|---|
| | Surface Geodetic | Depth | Screen | | June 26, 2023 | |
| | | | | | Depth | Geodetic |
| BH/MW101-'20 | 179.97 m | 5.0 m | 2.0 m – 5.0 m | 5.0 m | - | - |
| BH/MW1D-'23 | 179.6 m | 18.7 m | 15.7 m – 18.7 m | Dry | - | - |
| BH/MW103 | 184.19 m | 10.0 m | 7.0 m – 10.0 m | 5.2 m | 5.37 m | 178.82 m |
| BH/MW4-'23 | 178.9 m | 18.6 m | 15.6 m – 18.6 m | Dry | - | - |
| BH/MW111-'20 | 179.25 m | 8.3 m | 6.8 m – 8.3 m | Dry | - | - |
| BH/MW117-'20 | 180.3 m | 17.4 m | 14.4 m – 17.4 m | Dry | 6.90 m | 173.36 m |
| BH/MW118-'20 | 179.7 m | 8.6 m | 7.1 m – 8.6 m | Dry | 3.52 m | 176.15 m |
| BH/MW119-'20 | 180.65 m | 8.5 m | 7.0 m – 8.5 m | Dry | 6.99 m | 173.66 m |
| BH/MW120 | 178.49 m | 7.5 m | 4.5 m –7.5 m | Dry | 1.27 m | 177.22 m |
| BH/MW121D | 178.28 m | 6.5 m | 5.0 m – 6.5 m | 5.0 m | 3.68 m (Oct. '22) | 174.60 m (Oct. '22) |
| BH/MW122D-'23 | 178.9 m | 18.5 m | 15.5 m – 18.5 m | Dry | - | - |

Where bedrock is encountered, the groundwater is considered to be responding to exposure by rising in the monitoring well through pressurization until it reaches a static equilibrium; what is referred to as the "*piezometric level*". Transmission of groundwater through the bedrock is predominantly fracture-controlled.

It should be noted though, that groundwater conditions and surface water flow conditions are expected to vary according to the time of the year and seasonal precipitation levels. Water seepage is also expected from soil fissures above the water table.

Further information pertaining to groundwater conditions is provided by Landtek's Hydrogeological Assessment for the site, as reported under separate cover.

# 5.0 FOUNDATION DESIGN CONSIDERATIONS

## 5.1 Shallow Foundation Considerations

The fill materials encountered at the site are not considered suitable as bearing strata due to their lateral and vertical variability in strength and the unacceptable level of risk associated with the associated variability in settlements.

Based on the ground conditions observed at the borehole locations, it is considered by Landtek that the anticipated moderate-to high-loading of the proposed mid- and high-rise structures can be supported by the native soils or shallow bedrock underlying the site using conventional, concrete strip or pads foundations. It is understood that all elements of the proposed development will include for a maximum or two to four levels of underground basement parking. On this basis, it is anticipated that foundations for structures with two to four levels of basement will be seated at depths between approximately 7.0 m and 13.0 m below existing ground level.

Table 5.1.1 summarizes the preliminary, recommended geotechnical reactions at the Serviceability Limit State (herein "*SLS*") and factored geotechnical resistances at the Ultimate Limit State (herein "*ULS*") for the native soils. It should be noted that the design parameters have been determined by Landtek for the design stage only.

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. As such, the preliminary design parameters have been determined by Landtek for preliminary purposes only, and that more specific investigation will be required for the design stage of the development.

**Table 5.1.1: Preliminary Limit State Foundation Design Values**

| Approximated Founding Depth Ranges | | Founding Stratum | Foundation Design Value | |
|---|---|---|---|---|
| Depth | Geodetic Elevation | | SLS [1,2] | ULS [3,4] |
| ±1.5 m to ±4.4 m | 182.7 m – 173.9 m | Silty Clay to Clayey Silt | 100 kPa | 150 kPa |
| ±1.5 m to ±6.6 m | 182.7 m – 171.7 m | Clayey Silt Till | 350 kPa | 525 kPa |
| ±1.5 m to ±6.6 m | 182.7 m – 171.7 m | Weathered Red Shale Bedrock | 1 MPa | 1.5 MPa |

Notes:
1. The National Building Code general safety criterion for the serviceability limit states is: SLS resistance ≥ effect of service loads.
2. Recommended SLS bearing values conform to Estimated Values based on soil types given in Tables K-8 and K-9 of the National Building Codes User's Guide.
3. The ULS resistance factor for shallow foundations is 0.5, as given in Table K-1 of the National Building Code User's Guide.
4. The National Building Code general safety criterion for the ultimate limit states is: factored ULS resistance ≥ effect of factored loads.

Design factors related to structural loads will determine the most cost-effective foundation system for the proposed development. The impact on foundation size and soil bearing pressure is illustrated in Figure 5.1.1 and emphasizes that foundation design sizes, bearing pressures, and bearing levels must be taken into account to avoid excessive consolidation settlements.

Where the bearing levels of the footings are at different design elevations, the footing base levels should be stepped along a line of 7V:10H, drawn upwards from the lowest footing, to avoid overlapping stresses.

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. Therefore, a Geotechnical Engineer should be engaged during construction to examine the exposed sub-soil quality and condition, and confirm the subsurface conditions are consistent with

design assumptions. This is in compliance with field review requirements in the National Building Code, Volume 1, Clause 4.2.2.3.

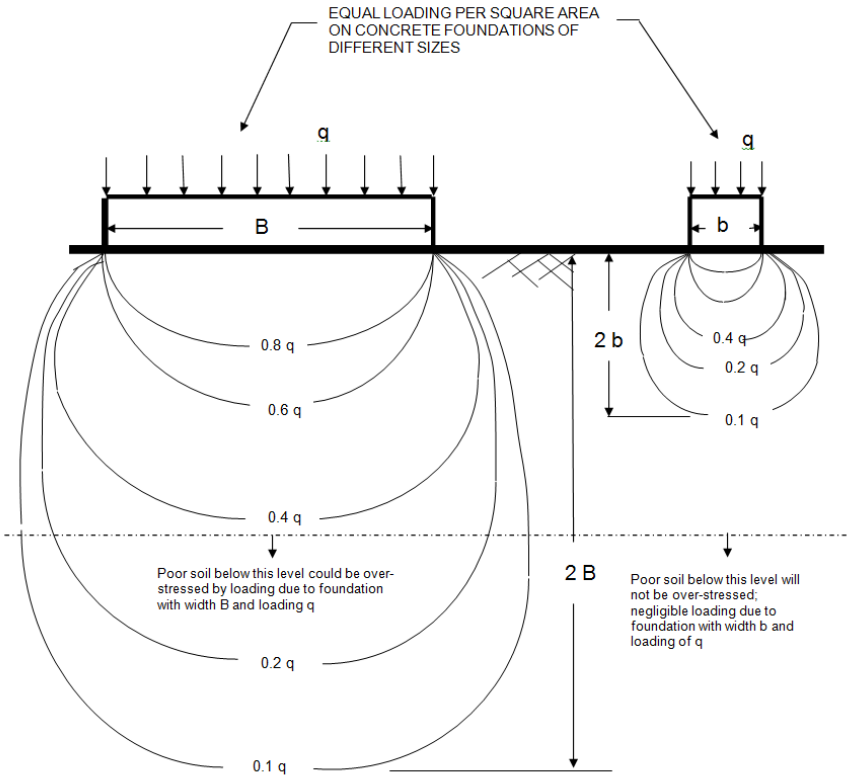



***Figure 5.1.1:*** *Illustration of Load Distribution below Variable Size Foundations with the Same Applied Loading*

Footing foundations may be considered an appropriate option, though the acceptability of footings will depend upon design issues such as the elevation of the lowest floor level and the structural loading. If the footing design criteria provided in this report cannot be satisfied then an alternative solution may be considered, such as a piled solution, particularly if the proposed structures are of a generally high loading than anticipated.

## 5.2 Frost Susceptibility

The shallow soils encountered across the site are considered sensitive to water and frost, and their physical and mechanical properties are dependent on in-situ moisture content. As such, the founding soils at the site are considered to have a moderate to high frost susceptibility, being classified as Frost Group "*F4*" (Table 13.1 of the "*Canadian Foundation Engineering Manual*", 4th Edition). However, the identified depths for foundations, as given in Section 5.1 are considered to be below the maximum extents of influence from frost penetration in the Oakville area.

Should any re-grading be required as part of the proposed development and adjacent to the new structures, it will be important to ensure that the associated exterior footings will have a minimum of 1.2 m of soil cover, or equivalent suitable insulation, for frost protection.

## 5.3 Deep Foundation Considerations

### 5.3.1 Piled Foundations

If higher bearing capacities are required to support the building loads, then an alternative, deeper founding solution may be required, such as the following:

- "*Cast in Place*" concrete caissons, which could be constructed without any unexpected difficulties, but, based on the conditions of deeper groundwaters, should incorporate the use of liners. It is anticipated that a dewatering system will not be required provided that liners are used appropriately to control the piezometric water level conditions encountered at depth; or,
- Continuous Flight Auger (CFA) piles.

For piles seated within the native till soils, the point resistance at the bottom is 150 kPa at the SLS. The frictional resistance (skin friction) developed in the drilled shaft may be calculated as follows:

$$Q_s = 0.42 D_s \, [100 L_1]$$

Where:
$D_s$ = Diameter of drilled shaft
$L_1$ = Length of pile within the silty clay to silt till
$Q_s$ = value in kN

Alternatively, the piles may be extended to bedrock, and Table 5.1.1.1 provides the factored geotechnical resistances at the ULS for piled foundation solutions seated within the shale. Any piled foundation should be seated at a depth to provide a minimum 1.5 m rock socket (i.e., founded at a minimum of 1.5 m penetration depth into the weathered shale).

The following parameters should be applied for the bedrock when considering lateral pressures on loaded piles:

$K_p$ = Rankine passive pressure coefficient = $\tan^2(45 + \phi/2)$

For the completely and highly weathered shale (residual soil):
$\phi$ = Internal angle of friction should be taken as 26°; and,
$\gamma$ = Bulk unit weight should be taken as 22 kN/m$^3$.

For the weathered shale:
$\phi$ = Internal angle of friction should be taken as 26°; and,
$\gamma$ = Bulk unit weight should be taken as 25.5 kN/m$^3$.

It should be noted however, that the final design and seating depths for any piled foundation solution is to be based on the findings of the additional investigation required, specific pile-driving and pile load tests undertaken at the site prior to construction.

### 5.3.2 Settlement Considerations for Piled Foundations

Settlement considerations for piles seated in the clayey silt till or silt till deposits are as per those defined in Section 5.1.3 of this report.

For piles seated in weathered shale bedrock, the SLS condition will not govern the foundation design as the stresses required to induce 25 mm of movement (typical settlement criteria for SLS) is anticipated to exceed ULS. Therefore, any anticipated settlements for foundations seated within shale bedrock underlying the site should be considered negligible (i.e., less than 15 mm).

### 5.4 Settlement Considerations

Based on the outline information provided for the nature of the proposed development of the site, it is anticipated that the loads to be applied to the ground by any such structure will be generally moderate to high intensity. As such, associated settlements are not expected to be large. Therefore, the general limiting of the total settlement to 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate.

Ordinarily, the SLS condition would not govern foundation design in bedrock as the stress required to induce the typical 25 mm settlement criteria at the SLS is anticipated to exceed the ULS. However, the completely weathered nature of the shale is such that it behaves more as a soil and, as such, the associated settlements should be taken as those for soils.

### 5.5 Seismic Design Considerations

Based on the soil conditions encountered, and in accordance with Table 4.1.8.4.A. of the current Ontario Building Code (herein "*OBC*"), the site is considered to be a 'C' Site Class. The acceleration and velocity-based site coefficients, $F_a$ and $F_v$, should be determined from Tables 4.1.8.4.B. and 4.1.8.4.C. respectively of the OBC for the above recommended Site Class.

An improved seismic site classification (i.e., Class 'B' or 'A') may be achieved through the completion of a shear wave velocity test at the site using Multi-channel Analysis of Surface Waves (herein "*MASW*") methodologies, particularly as the foundations are likely to be seated within the bedrock strata.

The seismic design data given in Table 1.2 of Supplementary Standard SB-1 in Volume 2 of the OBC, for selected Municipal locations, should be used to complete the seismic analysis.

### 5.6 Damp Proofing and Waterproofing Considerations

The subsurface areas should be damp proofed and comply with the OBC requirements. As a minimum it is recommended that the damp proofing system include a Delta Drainage Board or MiraDrain 2000 series product, or an approved alternative, along with an asphalt-based spray-on wall coating.

It is recommended that all subsurface structures and areas (i.e., basement walls and floor slabs etc.) are appropriately waterproofed below groundwater, where encountered, plus the required buffer zone (nominally 1.0 m to 1.5 m) above the stabilized or "*seasonally highest groundwater level*" defined by the Hydrogeological Assessment, as provided under separate cover.

## 6.0 FLOOR SLAB AND PERIMETER DRAINAGE CONSIDERATIONS

Based on the borehole soil conditions and development information provided to Landtek, it should be possible to construct the lowest (i.e., basement) floor slab level using slab-on-grade methods. The subgrade support conditions are anticipated to be clayey silt till, silt till or weathered red shale, which should provide competent conditions for placing the vapour barrier material. However, after the subgrade has been prepared to the underfloor design elevation it is recommended that the area be assessed by Landtek to determine if there is a need for any remedial work.

It is recommended that a minimum 200 mm layer of clear, 19 mm crushed quarried stone be used as the vapour barrier under the floor slab. The vapour barrier stone should meet the requirements of Ontario Provincial Standard Specifications (herein "*OPSS*") 1004 for 19 mm Type II clear stone. If a graded crushed stone is substituted for clear stone, the material should be limited to a maximum of 5 % fines (passing the 0.075 mm sieve). The floor slab thickness should meet the specifications of the project based on anticipated floor loadings.

The finished exterior ground surface should be sloped away from the buildings at a grade in the order of 2 %.

The concrete properties should meet the requirements of OPSS 1350. Contraction and isolation jointing practices should be in accordance with current Portland Cement Association recommendations, as given in the engineering bulletin "*Concrete Floors on Ground*", second edition, by R. E. Spears, and W. C. Panarese.

The design of concrete slabs on native soils may be made on the basis of a value of modulus of subgrade reaction of 40 MPa/m for native till soils and 120 MPa/m for weathered shale.

Unless the proposed structures are to be waterproofed as prescribed in Section 5.6, perimeter drainage should be provided around all subsurface floor areas where only storm water may accumulate. Municipal approval is required for allowing for the discharge of groundwater into the Municipal storm system where the perimeter drainage is going to be installed at a depth below the established groundwater level.

Underfloor drains may be also required depending on the provision of waterproofing, or excavation and groundwater seepage conditions, particularly if below the groundwater level. Based on the anticipated foundation elevations for the one basement level, and when considering the groundwater monitoring data, groundwater is to be expected within the excavation profile for proposed structures, specifically where foundations are seated within weathered bedrock.

The drainage system should comply with the OBC and associated amendments. Further details pertaining to perimeter and underfloor drainage systems are provided in Drawings 21261-02 and 21261-03 respectively, in Appendix D.

After the subgrade has been prepared to the underfloor design elevation it is recommended that the area be proof-rolled with a loaded tandem axle dump truck to delineate if there are soft or unstable ground conditions that require repair. This operation should be completed before the underfloor vapour barrier granular material is placed.

## 7.0 EARTH PRESSURE CONSIDERATIONS FOR SUBSURFACE WALLS

The earth pressure, p, acting on subsurface walls at any depth, h, in metres below the ground surface assumes an equivalent triangular fluid pressure distribution and may be calculated using the expression below. It is assumed that granular material is used as backfill. Allowances for pressure due to compaction operations should be included in the earth pressure determinations and a value of 12 kPa is applicable for a vibratory compactor and granular material.

If the structure retaining soil can move slightly, the active earth pressure case can be used in determining the lateral earth pressure. For restrained structures and no yielding an "at rest" earth pressure condition should be used. The determination of the earth pressures should be based on the following expression:

$$P_1 = K (\delta h + q)$$

where:

$P_1$ = the pressure in kPa acting against any subsurface wall at depth, h, in metres (feet) below the ground surface;

K = the at rest earth pressure coefficient considered appropriate for subsurface walls; OPSS 1010 Granular B Type 1 (pit-run sand and gravel) material has an effective angle of friction estimated to be 32° with a corresponding at rest earth pressure coefficient, $K_o$, of 0.45; and,

$\delta$ = the moist bulk unit weight of the retained backfill; 21.5 kN/m$^3$.

and,

q = the value for any adjacent surcharge in kPa, which may be acting close to the wall; and,

h = the depth, in m, at which the pressure is calculated

For any subsurface walls below groundwater, the pressure distribution on the wall should include the hydrostatic pressure. The determination of hydrostatic pressure should be based on the following expression:

$$P_2 = \delta_w h_w$$

where:

$P_2$ = hydrostatic pressure;

$\delta_w$ = unit weight of water; 9.8 kN/m$^3$; and,

$h_w$ = depth of wall, below reported water level.

Backfill materials required for behind the retaining structure is assumed to meet an OPSS 1010 Granular B Type 1 pit-run sand and gravel material or OPSS 1010 Granular A. The granular fill should be compacted to a minimum of 98 % of the material's Standard Proctor Maximum Dry Density (herein "*SPMDD*"), or to the levels and backfilling procedures specified. Table 7.1 below provides those lateral earth pressure parameters for the predominant soils anticipated at the site.

**Table 7.1: Recommended Lateral Earth Pressure Parameters**

| Parameter | Site Soils (Generalized) | OPSS 1010 Granular A | OPSS 1010 Granular B Type I |
|---|---|---|---|
| Angle of Internal Friction, $\phi$ | 32° | 35° | 32° |
| Unit Weight (KN/m$^3$) | 20 | 23 | 22 |
| Passive Earth Pressure Coefficient, $K_p$ | 4.20 | 3.70 | 3.25 |
| At-Rest Earth Pressure Coefficient, $K_o$ | 0.38 | 0.43 | 0.47 |
| Active Earth Pressure Coefficient, $K_a$ | 0.24 | 0.27 | 0.31 |

Given the presence of shale bedrock beneath the site, the following parameters should be applied for the bedrock when considering lateral pressures on subsurface walls:

- Internal angle of friction ($\phi$) should be taken as 28°; and,
- Bulk unit weight ($\Upsilon$) should be taken as 25.5 kN/m$^3$.

In designing a temporary or permanent subsurface wall within bedrock, a uniform pressure distribution is assumed and is consistent with the maximum earth pressure calculated for the wall where in soil. However, below the weathered bedrock zone, the design does not accommodate for lateral rock swell.

Lateral rock swell will be of concern as fresh bedrock will be exposed in the excavation faces and will be more prone to swell than the shallower, more weathered bedrock zone. No real rate of swell can be put on the bedrock as it is very variable.

There are various approaches to overcome rock swell in design and excavation. There is a generally accepted industry practice which assumes that bedrock exposed for a period of more than 120 days will have swelled such that no significant stresses will be exerted upon foundation walls. Alternatively, a number of methods of mitigation are generally accepted to include:

- The limiting of bedrock exposure to no more than 7 days;
- The application of a mud-mat/shotcrete onto the exposed rock face once excavated;
- The installation of a layer of compressible fill material (e.g. Ethafoam Plank products) between the rock face and the back of the structural wall; and/or,
- The over-excavation of the bedrock ±0.6 m and backfilling the void space with 19 mm Clear Stone.

It should be noted that the variability of the Queenston Formation shale means that, without site-specific testing, no definitive time at which point the swell becomes negligible can be assigned.

## 8.0 SUBSURFACE CONCRETE

### 8.1 Concrete Class Considerations

The requirements for subsurface concrete subject to a sulphate and chloride environment are presented in Canadian Standards Association specification, CSA A23.1-14 *"Concrete Materials and Methods of Concrete Construction, Tables 1-4"*. Experience in the area indicates that the native soils generally have a mild sulphate environment and a low chloride concentration. It is recommended that subsurface concrete at the site have general use (GU) characteristics for normal Portland cement mixes.

For the parking garage decks and ramps it is recommended that the concrete exposure class be C-1 and the concrete have the following minimum properties:

- minimum 56-day compressive strength: 35 MPa;
- maximum water to cement ratio: 0.40;
- chloride ion penetrability requirement: < 1500 coulombs (within 91 days)
- cementing materials: GU (general use hydraulic cement) or GUb (blended general use)
- air content: as per CSA A23.1-14 Table 4, air content category 1 (freeze-thaw environment)

The concrete should be placed without segregation and should be consolidated to achieve a uniform dense mass.

### 8.2 Methods for Specifying Concrete

Alternative methods of specifying concrete for a project are outlined in CSA A23.1-14 and allow for "*Performance*" or "*Prescription*" based methods. Each method attaches different levels of responsibility to the owner, the contractor, and the concrete supplier. The pros and cons of each method should be examined prior to completion of the specifications for the project.

## 9.0 EXCAVATION AND BACKFILL CONSIDERATIONS

### 9.1 Excavation Considerations for Soils

All temporary excavations and unbraced side slopes in the soils should conform to standards set out in the Occupational Health and Safety Act, Ontario Regulation 213/91 "*Construction Projects*" (herein "*OHSA*"). The subsurface soils to be encountered during excavation at the site are expected to behave as "*Type 2*" and "*Type 3*" materials according to the OHSA classification in Part III. Type 2 soils are characteristic of the generally very stiff "*clayey silt till*" and the generally dense "*silt till*", with the previously excavated "*fill materials*" behaving as Type 3 soils.

It should be possible to excavate the overburden soils with a hydraulic backhoe. Moist Type 2 and Type 3 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e., 1V:1H).

Excavations for new foundations should satisfy the criteria given in the example shown in Figure 9.1.1 to avoid overlapping stresses and minimize the risk of undermining existing adjacent structures, including utilities, and/or triggering additional settlements of the existing structures due to soil disturbance.

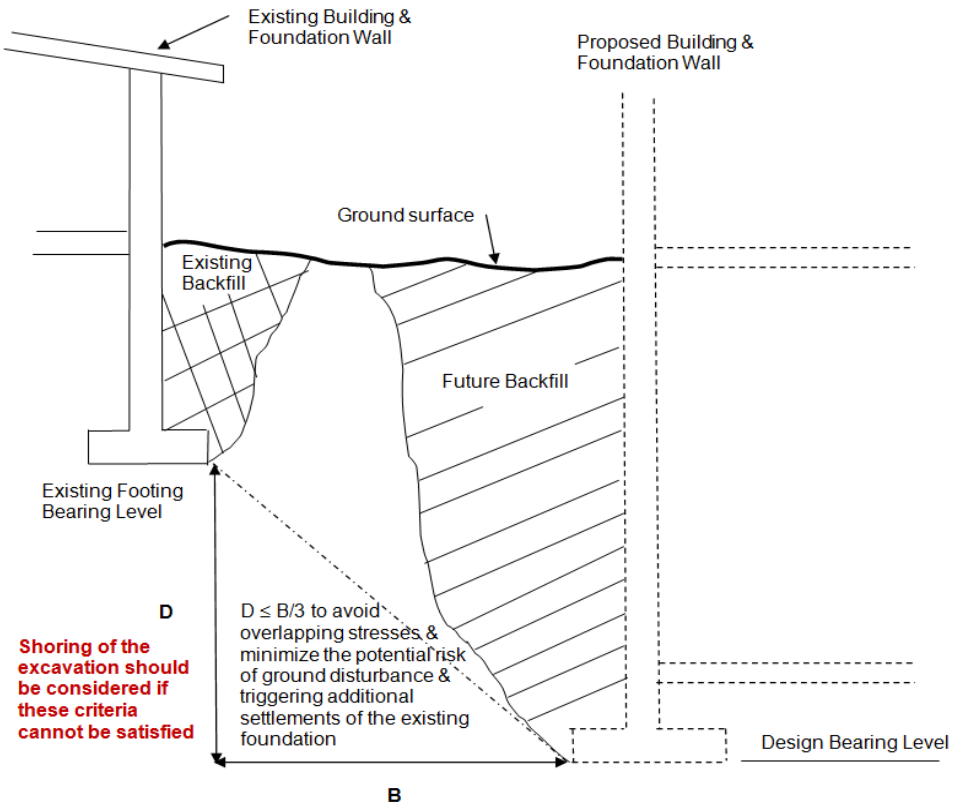



***Figure 9.1.1:*** *Criteria for Assessing Excavation Shoring Requirements (Not to Scale)*

Consideration should be given to any existing trench excavations and associated backfill that may be present directly behind cut slopes within the native soils that may appear to be stable on first

excavation. In these circumstances, slopes can suddenly slough or collapse due to the effects of the adjacent backfill.

Consequently, for excavation conditions that cannot satisfy the OHSA requirements for unbraced 1H:1V side slopes, a trench box system should be used, or temporary shoring should be installed to maintain safe working conditions. This may be more applicable to basement excavations, though may also apply to service trench excavations etc., particularly when in close proximity to new road pavements or associated infrastructure.

It should be noted that the design of any temporary shoring system is the responsibility of the Contractor. Therefore, a specialist shoring contractor should be consulted to provide the most appropriate shoring type method and associated installation procedures. In any event, the shoring design should be based on the procedures outlined in the latest edition of the Canadian Foundation Engineering Manual.

### 9.2 Excavation Considerations for Bedrock

In accordance with the standards set out in the OHSA, the more competent "*shale bedrock*" encountered underlying the site has strength properties that exceed a Type 1 soil, though may be encountered on site at relatively shallow depths as a "*residual soil*".

For any required bedrock excavation, a backhoe equipped with a hydraulic breaker and/or a bucket with rock-ripping 'tiger teeth' may be required in the shale bedrock, particularly when encountering harder siltstone or limestone bands. The blasting of bedrock will not be permitted by the Corporation of the Town of Oakville (herein "*Town of Oakville*"). Significant ground vibrations resulting from excavation works are not anticipated, though may be elevated above those associated with normal construction activities. As such, a period of ground vibration monitoring may be required to determine the peak vibration levels and any remedial measures or limitations required.

A backhoe equipped with a hydraulic breaker and/or a bucket with rock-ripping 'tiger teeth' may be required in the shale strata. Significant ground vibrations resulting from excavation works are not anticipated other than those associated with normal construction activities.

The shale is expected to remain relatively stable at near vertical slopes for short periods of time. It is recommended that any excavation slopes be scaled of loose rock pieces and overhang and cut back to about 10V:1H.

Slightly weathered and competent shale of the Queenston Formation has the characteristics of becoming soft or degraded after excavation and subsequent exposure to the elements, the results of which would be basal heaving and compression from rock squeezing along excavation side walls. As such, these effects should be minimized during construction, and requires a well-planned construction program to ensure that the exposure of the shale bedrock is kept to a minimum, as identified in Section 7.0.

Methane gas is known to be present within the fracture networks of the Queenston Formation shale, normally below the top 1 m and becoming more concentrated with depth. As such, the potential could exist for the development of an explosive or oxygen-depleted air environment. Therefore, Landtek recommends that the appropriate air space monitoring is undertaken within all confined excavations, particularly those located close to or within bedrock, as defined by the OHSA.

### 9.3 Short-Term (Construction) Dewatering Considerations

Considerations regarding groundwater levels, construction dewatering, dewatering rates and requirements towards project registration with the Environmental Activity and Sector Registry (*ESAR*) or a Permit To Take Water (*PTTW*) are provided by the Hydrogeological Assessment for the site, as reported under separate cover.

### 9.4 General Backfill Considerations

Backfill next to foundation walls and in service trenches should be selected to be compactable in narrow trench conditions. The on-site clayey silt till and silt till are expected to be reusable as trench backfill and backfill around the proposed structures on the site. Any variation in the moisture contents of the soils encountered may require selective separation of material to avoid the use of wet soil.

Site servicing trench backfill should be uniformly compacted to a density that minimizes the risk of long-term settlements. It is recommended that the target compaction specification for trench backfill be 97 % SPMDD with no individual test below 95 % SPMDD.

During inclement weather the native soils may become too wet to achieve satisfactory compaction. If construction is proposed for late in the year, a reduced level of trench compaction with a higher risk of future settlements is to be anticipated, and it is recommended that provisional contract quantities be established for the supply and placement of imported granular fill under such circumstances. The imported granular should meet the requirements of OPSS 1010 for Granular B Type I material as a minimum requirement.

## 10.0 TEMPORARY SHORING CONSIDERATIONS

The installation of temporary shoring is also recommended to maintain safe working conditions and eliminate the possibility of loss of ground and damage to nearby structures and buried utilities on the adjacent road allowances during excavation for the basement construction.

The requirement and application of shoring to support excavation side slopes will be dependent on the required excavation depth and the proximity of existing or newly constructed infrastructure adjacent to the excavation.

The preferred method of shoring will consist of a concrete caisson wall. This type of system is expected to provide the additional benefit of sealing the excavation from water penetration and loss of soil fines into the open excavation. Soldier piles and timber lagging may be considered as an option for a shoring system, though this type of system may require measures to prevent the loss of soil between the spaces of lagging boards where a wet or flowing soil layer may be present.

The shoring methods may provide lateral restraining force through the use of rakers or tieback anchors. Tieback anchors provide additional advantage since they do not protrude into the excavations as rakers would. However, the use of tieback anchors is also dependent upon whether permission is needed or whether it is physically possible to extend the anchors to the required distance into neighbouring properties.

It should be noted that the design of any temporary shoring system is the responsibility of the Contractor. Therefore, a specialist shoring contractor should be consulted to provide the most appropriate shoring type method and associated installation procedures. In any event, the shoring design should be based on the procedures outlined in the latest edition of the Canadian Foundation Engineering Manual. It is also recommended that lateral and vertical movement of the shoring system be monitored during construction to ensure that movements are within the acceptable range.

## 11.0 SITE SERVICING CONSIDERATIONS

There is no indication that special pipe bedding materials or procedures are required for the installation of services. All bedding cover and backfill materials should be selected in accordance with OPSS 1010 Aggregates – Base, Subbase, Select Subgrade, and Backfill Material.

The pipes should be placed with a minimum bedding thickness in conformance of Ontario Provincial Standard Drawing (herein "*OPSD*") 802.010, 802.013 and 802.014 for flexible pipe and OPSD 802.030, 031, 032, 033 and 034 for rigid pipes. The type of bedding shall be selected to suit the applicable pipe strength and site conditions.

Bedding material shall be placed in layers not exceeding 300 mm in thickness, loose measurement, and compacted to 95 % of the SPMDD before a subsequent layer is placed. Site servicing trench backfill should be uniformly compacted to a density that minimizes the risk of long-term settlements. Bedding on each side of the pipe shall be completed simultaneously. At no time shall the levels on each side differ by more than the 300 mm uncompacted layer. The remainder of the trench should be backfilled as per the requirements defined in Sections 9.0 of this report.

It is assumed all services will have a minimum of 1.2 m of soil cover for frost protection. For services installed at shallower depths, suitable insulation for frost protection is recommended.

## 12.0 SOIL MANAGEMENT CONSIDERATIONS

From a geotechnical perspective, and in order to optimize the use of the on-site soils, a Soil Management Plan should be established in accordance with the requirements of Ontario Regulation (herein "*O. Reg.*") 406/19 for excess soils and O. Reg. 153/04 for soil stockpiles.

The plan objective should be to achieve a self-sustainable development with respect to excavated materials and control the placement of organic soils so that there is negligible impact on the settlement performance of the compacted fill material. The soil management criteria should be per the following sections, as a minimum:

### 12.1 Organic and Deleterious Materials

Surface vegetation, topsoil and organic soils should not be placed within the proposed roadways, below finished subgrade level for pavement construction or building limits. These materials should be placed in landscaped areas where settlements are not critical.

### 12.2 Materials Reuse Management

#### 12.2.1 Fill Compaction Requirements

Excavated soils for structural fill in pavement areas and building floor slab areas, which do not have topsoil or organic matter and are compactable with moisture contents within 2 % to 3 % of the optimum value, should be placed and compacted to a target density of 97 % of the SPMDD with no individual test result below 95 % SPMDD.

If engineered fill is required to support building foundations:

- the engineered fill should be placed and compacted in lifts to a target density of 100 % SPMDD with no individual tests below 98 % SPMDD; and,
- the soil should be placed in a loose lift thickness not exceeding 250 mm and should be compacted using a large (10 ton or larger) pad-foot type roller with vibratory capability.

If engineered fill to support building foundations is being considered it is recommended that a pre-construction meeting be scheduled to review the proposed fill materials, fill placement and compaction procedures, and the testing and inspection requirements.

Soils to be placed in landscaped areas where settlements are not critical should receive nominal compaction effort in order to achieve at least 90 % of the SPMDD.

#### 12.2.2 Structural Fill Subgrades

Prior to the placement of any structural fill materials, the exposed subgrade soil should be inspected and proof-rolled using a loaded tandem axle truck and traversing the exposed subgrade for full coverage. The proof-rolling should be monitored by a geotechnical representative of this office to delineate any soft areas which may require repair.

# 13.0 PAVEMENT CONSIDERATIONS

## 13.1 At-Grade Pavement Design Considerations

The proposed development is anticipated to include new access road pavements and parking areas. Recommended pavement structure layer thicknesses are provided in Table 13.1.1. Site specific development requirements set out by the Town of Oakville may override the recommendations of this report, particularly for the sections of pavement that are to be adopted by the Town of Oakville.

The recommended pavement design section takes into account the accepted design practice that the total pavement structure thickness should meet or exceed one-half the anticipated depth of frost penetration for the geographical area (i.e., 1.2 m) or as close as practicable.

**Table 13.1.1: Recommended Pavement Structure Layer Thicknesses**

| Pavement Layer | Access and Fire Routes | Light Duty Pavement Areas |
|---|---|---|
| Surface Course Asphalt<br>OPSS HL 3 | 40 mm | 40 mm |
| Binder Course Asphalt<br>OPSS HL 8 | 60 mm | 50 mm |
| Granular Base<br>OPSS Granular A | 150 mm | 150 mm |
| Granular Subbase<br>OPSS Granular B, Type II | 350 mm[1] | 300 mm[1] |
| Total Thickness | 600 mm | 540 mm |

Notes:
1. If construction proceeds late in the year (i.e., November and December), the design thickness of pavement granular materials may have to be increased to address potential problems with subgrade instability and facilitate construction vehicle and truck access.

## 13.2 Sub-grade Preparation and Drainage

The overall performance of the pavement structure will greatly depend upon the support provided by the developed subgrade. A number of factors should be considered at the construction stages to ensure that an acceptable subgrade condition is developed and maintained:

- Sub-drains should be installed and should be 100 mm diameter perforated plastic pipe, with outfalls to catch basins at a continuous and uniform grade. The sub-drains should conform to OPSD 216.01;
- Any soft areas of notable deflection to the subgrade should be sub-excavated and replaced with a suitable backfill material approved by a qualified geotechnical engineer and compacted to 98 % of its SPMDD;
- The subgrade should be properly shaped, crowned and then proof-rolled under the full-time observation of a geotechnical representative of this office to delineate any soft areas which may require repair before placing the granular materials; and,
- Surface water should not be allowed to pond on the surface of or adjacent to the outside edges of any developed subgrade.

Should the pavements proposed for the development be constructed as a two-stage paving operation it will important to ensure that the following is undertaken to develop the surface of the binder course being used as a "*temporary*" surface during the construction phase:

- The surface is thoroughly cleaned and power washed to remove all residual contaminants;

- All deficiencies are corrected to meet the required design specifications; and,
- A suitable tack coat is appropriately applied immediately prior to the placement of the upper asphaltic concrete course(s).

Such preparatory works are to be completed in accordance with the appropriate OPSS, as required.

## 13.3 Pavement Materials

### 13.3.1 Granular Base Course and Subbase

The granular base course materials should meet OPSS Granular “A” specifications. Quarried 20 mm limestone crushed to Granular "A" gradation specifications is recommended. Granular subbase material should meet OPSS Granular B Type II requirements for 100 % crushed quarried bedrock (50 mm crusher-run limestone).

### 13.3.2 Hot Mix Asphalt

The surface course asphalt should meet current specifications for HL 3, as prescribed by the Town of Oakville or, alternatively, OPSS 1150.

### 13.3.3 Compaction

Granular base course and subbase course fill material should be compacted to 100 % SPMDD. Hot mix asphalt should be compacted to the criteria set out by the Town of Oakville.

## 13.4 Sidewalk Considerations

The construction of the concrete sidewalks at the site should be completed to the satisfaction of the Town of Oakville’s Engineering Standards, and as detailed in Table 13.4.1. The concrete and aggregates should be produced and placed to meet those standards also stipulated by the Town of Oakville’s Engineering Standards.

**Table 13.4.1: Recommended Minimum Concrete Sidewalk Specifications**

| Materials | Compaction Requirements | Layer Thickness |
|---|---|---|
| Normal Portland GU (32 MPa) (CAN3-CSA A23.1) - Class C-2 | N/A | 125 mm |
| Granular “A” Base | 95 % SPMDD* | 150 mm |

* Standard Proctor Maximum Dry Density

Where finished sidewalks are on level ground, and to ensure that they remain free of ponding water, a final slope/gradient of the concrete sidewalk surface of at least 2 % should be maintained. In addition, construction joints in the sidewalk concrete should be properly sealed (e.g., bitumen filler) to minimize the water migration.

## 14.0 CLOSURE

The Limitations of Report, as stated in Appendix A, are an integral part of this report.

Soil samples will be retained and stored by Landtek for a period of three months after the report is issued. The samples will be disposed of at the end of the three-month period unless a written request from the client to extend the storage period is received.

We trust this report will be of assistance with the design and construction of the proposed development. Should you have any questions, please do not hesitate to contact our office.

Yours sincerely,

**LANDTEK LIMITED**

LICENSED PROFESSIONAL ENGINEER
R. DI CIENZO
May 17/24
PROVINCE OF ONTARIO

.....
James Dann, B.Eng. (Hons.), ACSM
*Manager, Geotechnical Projects*

.....
Ralph Di Cienzo, P. Eng.
*Consulting Engineer*

# APPENDIX A
# LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

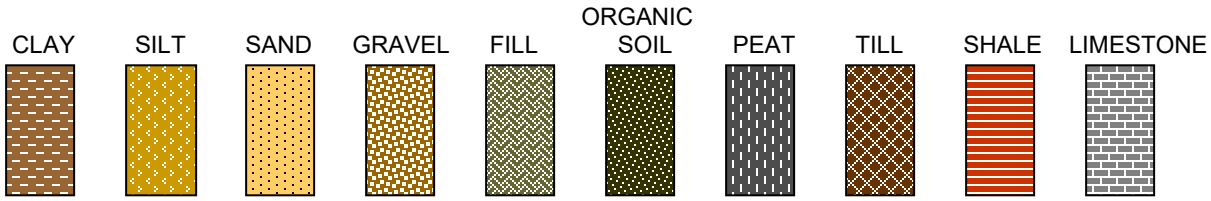
The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

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

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

# APPENDIX B
## SYMBOLS AND TERMS USED IN THE REPORT




### *RELATIVE PROPORTIONS*

| Term | Range |
|---|---|
| Trace | 0 - 5% |
| A Little | 5 – 15% |
| Some | 15 – 30% |
| With | 30 – 50% |

### *CLASSIFICATION BY PARTICLE SIZE*

Boulder ---------- > 200 mm
Cobble ---------- 80 mm – 200 mm
Gravel -
Coarse ---------- 19 mm – 80 mm
Fine ---------- 4.75 mm – 19 mm
Sand -
Coarse ---------- 4.75 mm – 2 mm
Medium -------- 2 mm – 0.425 mm
Fine ---------- 0.425 mm – 0.75 mm
Silt ---------- 0.075 mm – 0.002 mm
Clay ---------- < 0.002 mm

## DENSITY OF NON-COHESIVE SOILS

| Descriptive Term | Relative Density | Standard Penetration Test |
|---|---|---|
| Very Loose | 0 – 15% | 0 – 4 Blows Per 300 mm Penetration |
| Loose | 15 – 35% | 4 – 10 Blows Per 300 mm Penetration |
| Compact | 35 – 65% | 10 – 30 Blows Per 300 mm Penetration |
| Dense | 65 – 85% | 30 – 50 Blows Per 300 mm Penetration |
| Very Dense | 85 – 100% | Over 50 Blows Per 300 mm Penetration |

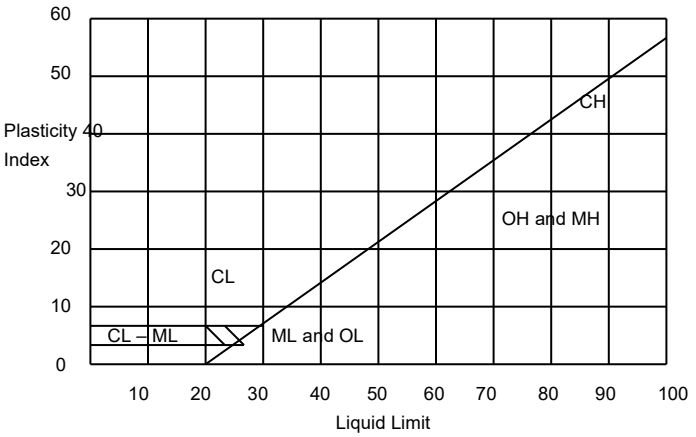
## CONSISTENCY OF COHESIVE SOILS

| Descriptive Term | Undrained Shear Strength kPa (psf) | N Value Standard Penetration Test | Remarks |
|---|---|---|---|
| Very Soft | < 12 (< 250) | < 2 | Can penetrate with fist |
| Soft | 12 – 25 (250 – 500) | 2 – 4 | Can indent with fist |
| Firm | 25 – 50 (500 –1000) | 4 – 8 | Can penetrate with thumb |
| Stiff | 50 – 100 (1000 – 2000) | 8 – 15 | Can indent with thumb |
| Very Stiff | 100 – 200 (2000 – 4000) | 15 – 30 | Can indent with thumb-nail |
| Hard | > 200 (> 4000) | > 30 | Can indent with thumb-nail |

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

## APPENDIX B CONTINUED
## CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
## ASTM Designation: D 2487 - 69 AND D 2488 – 69
## (Unified Soil Classification System)

| Major Divisions | | | Group Symbols | Typical Names | Classification Criteria | | |
|---|---|---|---|---|---|---|---|
| Coarse-grained soils More than 50% retained on No. 200 sieve * | Gravels 50% or more of coarse fraction retained on No. 4 sieve | Clean gravels | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | Classification on basis of percentage of fines<br>Less than 5% pass No. 200 sieve . . . . . GW, GP, SW, SP<br>More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC<br>5 to 12% pass No.200 sieve . . . . . Borderline classifications requiring use of dual symbols | $C_u$=D60/D10 greater than 4;<br>$C_z$ = $(D30)^2$/(D10xD60) between 1 and 3 | |
| | | | GP | Poorly graded gravels and gravel-sand mixtures, little or no fines | | Not meeting both criteria for GW | |
| | | Gravels with fines | GM | Silty gravels, gravel-sand-silt mixtures | | Atterberg limits below "A" line or P.I. less than 4 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | Atterberg limits above "A" line with P.I. greater than 7 | |
| | Sands More than 50% of coarse fraction passes No. 4 sieve | Clean Sands | SW | Well-graded sands and gravelly sands, little or no fines | | $C_u$=D60/D10 greater than 6;<br>$C_z$ = $(D30)^2$/ (D10xD60) between 1 and 3 | |
| | | | SP | Poorly graded sands and gravelly sands, little or no fines | | Not meeting both criteria for SW | |
| | | Sands with fines | SM | Silty sands, sand-silt mixtures | | Atterberg limits below "A" line or P.I. less than 4 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols |
| | | | SC | Clayey sands, sand-clay mixtures | | Atterberg limits above "A" line with P.I. greater than 7 | |
| Fine-grained soils 50% or more passes No. 200 sieve * | Silts and clays Liquid limit 50% or less | | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | Plasticity Chart<br>For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.<br>Equation of A-line: PI=0.73 (LL-20) | | |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts | | | |
| | | | OL | Organic silts and organic silts of low plasticity | | | |
| | Silts and clays Liquid limit greater than 50% | | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | |
| | | | CH | Inorganic clays of high plasticity, fat clays | | | |
| | | | OH | Organic clays of medium to high plasticity | | | |
| | Highly organic soils | | Pt | Peat, much and other highly organic soils | * Based on the material passing the 3 in. (76mm) sieve. | | |



# APPENDIX C

## DRAWING 21261-01 – BOREHOLE LOCATION PLAN
## BOREHOLE LOGS



**LANDTEK LIMITED**

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engineering@landtek.ca
www.landtek.ca


project location

Location plan an extract from Google Earth®

Legend:

- Approximate location of boreholes drilled by Landtek Limited on August 10th to 12th, 2021.
- Approximate location of boreholes drilled by Landtek Limited on August 10th to 12th, 2021.
- Approximate location of boreholes drilled by Landtek Limited on March 20th to 27th, 2023.
- Approximate location of boreholes drilled by MTE in 2020.

Notes:

Base plan an extract of the Topographical Survey *"Lot 12, Concession 1, North of Dundas Street"* completed by A. T. McLaren Limited, reference no. 36729-T.r1, dated January 6th, 2021.

revisions

| # | date | revision/comment |
|---|---|---|
| 1 | 2022-02-25 | issued for report |

client

New Horizon Development Group

municipality

The Corporation of the Town of Oakville

project

Preliminary Geotechnical Investigation
3275 and 3301 Trafalgar Road

sheet

Borehole Location Plan

date: may, 2024
drawn: MD
checked: JDC
project #: 21260
scale: NTS

21263-01

# LOG OF BOREHOLE MW101-20



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road,Oakville

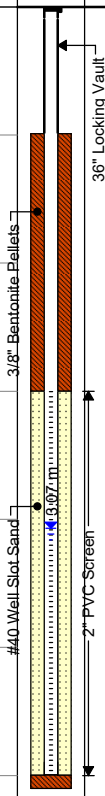
**Drill Date:** 2020-09-23
**Drilling Method:** Hollow Stem - Tri-Phase Group
**Datum:** Geodetic Elevation

**Northing:** 43.497419
**Easting:** -79.726269
**Ground Surface Elevation:** 179.97

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| 0 | | 180.0 | **Organic Material**<br>250 mm | | | | | |
| | | | **Fill**<br>Silty Sand. | | | | | |
| 1 | | 179.0 | Clayey Silt. | | | | | |
| | | | **Shale**<br>Highly weathered, very weak, red, dry. | | | | | |
| 2 | | 178.0 | | | | | | Monitoring Well Dry<br>August 2021 |
| 3 | | 177.0 | | | | | | GW Monitoring Level<br>Sept 2021 |
| 4 | | 176.0 | | | | | | |
| 5 | | 175.0 | End of Log | | | | | |
| 6 | | 174.0 | | | | | | |
| 7 | | 173.0 | | | | | | |
| 8 | | 172.0 | | | | | | |
| 9 | | 171.0 | | | | | | |
| 10 | | 170.0 | | | | | | |

**Penetration / Strength Results**
Undrained Shear Strength Values (kPa): 40 80 120 160
Penetration Test Values (Blows / 0.3m): 20 40 60 80

**Moisture / Plasticity**
PL MC LL
Moisture / Plasticity: 10 20 30 40

**Well Details**



**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
**1.** Borehole open to approximately 5.1 m depth upon completion.
**2.** Monitoring well installed at 5.0 m depth below ground surface.
**3.**
**4.**

LANDTEK LIMITED
205 Nebo Road, Unit 4B
Hamilton, Ontario, L8W 2E1
Ph: (905) 383-3733

# LOG OF BOREHOLE BHMW1D-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-23
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.497758
**Easting:** -79.726512
**Ground Surface Elevation:** 179.6

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| | 180.0 | | | | | | |
| 0 | | **Organic Material** ~250 mm Topsoil | 1 | SS | 3 3 5 5 | 8 | |
| | 179.0 | **Silty Clay** trace gravel. Brown, firm to stiff, moist. | | | | | |
| 1 | | **Silt Till** trace gravel, trace sand, trace clay. Brown, very stiff, moist. | 2 | SS | 6 13 16 | 29 | |
| | 178.0 | ...very stiff to hard. | 3 | SS | 7 12 18 | 30 | |
| 2 | | | | | | | |
| | 177.0 | | | | | | |
| 3 | | **Shale** TCR = 100% RQD = 0% | 4 | SS | 50-3" | 50 | |
| | | | 5 | CORE | | | |
| | 176.0 | TCR = 100% RQD = 46% | 6 | CORE | | | GW Monitoring Level August 2021 |
| 4 | | | | | | | |
| | 175.0 | | | | | | |
| 5 | | TCR = 100% RQD = 55% | 7 | CORE | | | |
| | 174.0 | | | | | | |
| 6 | | | | | | | |
| | 173.0 | TCR = 100% RQD = 94% | 8 | CORE | | | |
| 7 | | | | | | | |
| | 172.0 | | | | | | |
| 8 | | TCR = 100% RQD = 83% | 9 | CORE | | | |
| | 171.0 | | | | | | |
| 9 | | | | | | | |
| | 170.0 | | | | | | |
| 10 | | | | | | | |

**Undrained Shear Strength Values** (kPa): 40, 80, 120, 160

**Penetration Test Values** (Blows / 0.3m): 20, 40, 60, 80

**Moisture / Plasticity**: PL, MC, LL; 10, 20, 30, 40

**Well Details**: 3/8" Bentonite Pellets; 1.4 m; 36" Locking Vault

**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
1. Borehole open to approximately 18.7 m depth on completion.
2. Groundwater or water seepage not encountered during drilling.
3.
4.

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# LOG OF BOREHOLE BHMW1D-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-23
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.497758
**Easting:** -79.726512
**Ground Surface Elevation:** 179.6

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| | | 169.0 | TCR = 98%<br>RQD = 83% | 10 | CORE | | | |
| 11 | | 168.0 | TCR = 100%<br>RQD = 91% | 11 | CORE | | | |
| 12 | | 167.0 | TCR = 100%<br>RQD = 96% | 12 | CORE | | | |
| 13 | | 166.0 | TCR = 100%<br>RQD = 93% | 13 | CORE | | | |
| 14 | | 165.0 | TCR = 100%<br>RQD = 99% | 14 | CORE | | | |
| 15 | | 164.0 | TCR = 100%<br>RQD = 91% | 15 | CORE | | | |
| 16 | | 163.0 | End of Log | | | | | |
| 17 | | 162.0 | | | | | | |
| 18 | | 161.0 | | | | | | |
| 19 | | 160.0 | | | | | | |
| 20 | | 159.0 | | | | | | |
| 21 | | | | | | | | |

**Penetration / Strength Results**

**Undrained Shear Strength Values** (kPa)
40 80 120 160

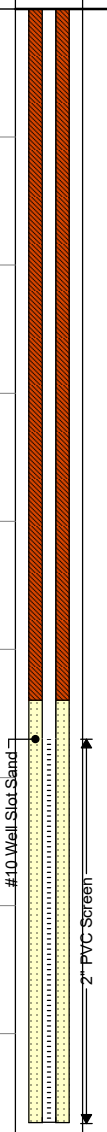
**Penetration Test Values** (Blows / 0.3m)
20 40 60 80

**Moisture / Plasticity**

PL MC LL

**Moisture / Plasticity**
10 20 30 40

**Well Details**




**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
**1.** Borehole open to approximately 18.7 m depth on completion.
**2.** Groundwater or water seepage not encountered during drilling.
**3.**
**4.**

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# LOG OF BOREHOLE BH2-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-22
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic

**Northing:** 43.49694
**Easting:** -79.72735
**Ground Surface Elevation:** 179

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Organic Material** ~250 mm Topsoil | | | | | | | | | | |
| | | | **Clayey Silt** trace sand. Brown, firm, moist. | 1 | SS | 2 2 3 4 | 5 | | 10.0 | | | | |
| 1 | | 178.0 | ...very stiff. | 2 | SS | 8 12 12 | 24 | | 10.0 | | | | |
| | | | **Silt Till** trace gravel, trace sand. Brown, dense, moist. | 3 | SS | 8 19 20 | 39 | | 10.0 | | | | |
| 2 | | 177.0 | | | | | | | | | | | |
| | | | | 4 | SS | 10 20 28 | 48 | | 10.0 | | | | |
| 3 | | 176.0 | ...trace clay. Very moist to wet. | 5 | SS | 23 30 31 | 61 | | 10.0 | | | | |
| 4 | | 175.0 | | | | | | | | | | | |
| | | | **Shale** TCR = 100% RQD = 36% | 6 | CORE | 50-2" | 50 | | 10.0 | | | | |
| 5 | | 174.0 | | | | | | | | | | | |
| | | | TCR = 100% RQD = 63% | 7 | CORE | | | | | | | | |
| 6 | | 173.0 | | | | | | | | | | | |
| 7 | | 172.0 | TCR = 100% RQD = 68% | 8 | CORE | | | | | | | | |
| 8 | | 171.0 | | | | | | | | | | | |
| | | | TCR = 100% RQD = 65% | 9 | CORE | | | | | | | | |
| 9 | | 170.0 | | | | | | | | | | | |
| 10 | | 169.0 | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 18.5 m depth on completion.
**2.** Groundwater or water seepage encountered during drilling at approximately 3.2 m below the ground surface.
**3.**
**4.**

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# LOG OF BOREHOLE BH2-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-22
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic

**Northing:** 43.49694
**Easting:** -79.72735
**Ground Surface Elevation:** 179

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Penetration / Strength Results | Moisture / Plasticity | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TCR = 100%<br>RQD = 78% | 10 | CORE | | | Undrained Shear Strength Values (kPa) ▲ 40 80 120 160 ▲<br>Penetration Test Values (Blows / 0.3m) × 20 40 60 80 × | PL MC LL<br>Moisture / Plasticity ○ 10 20 30 40 ○ | | | | |
| 11 | | 168.0 | | | | | | | | | | | |
| | | | TCR = 100%<br>RQD = 86% | 11 | CORE | | | | | | | | |
| 12 | | 167.0 | | | | | | | | | | | |
| | | | TCR = 94%<br>RQD = 87% | 12 | CORE | | | | | | | | |
| 13 | | 166.0 | | | | | | | | | | | |
| | | | TCR = 97%<br>RQD = 91% | 13 | CORE | | | | | | | | |
| 14 | | 165.0 | | | | | | | | | | | |
| | | | TCR = 100%<br>RQD = 90% | 14 | CORE | | | | | | | | |
| 15 | | 164.0 | | | | | | | | | | | |
| | | | TCR = 100%<br>RQD = 90% | 15 | CORE | | | | | | | | |
| 16 | | 163.0 | | | | | | | | | | | |
| | | | End of Log | | | | | | | | | | |
| 17 | | 162.0 | | | | | | | | | | | |
| 18 | | 161.0 | | | | | | | | | | | |
| 19 | | 160.0 | | | | | | | | | | | |
| 20 | | 159.0 | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 18.5 m depth on completion.
**2.** Groundwater or water seepage encountered during drilling at approximately 3.2 m below the ground surface.
**3.**
**4.**

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# LOG OF BOREHOLE MW103



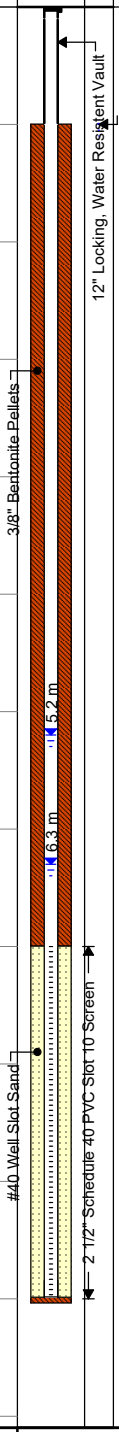
**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-11
**Drilling Method:** Hollow Stem - Elements
**Datum:** Geodetic Elevation

**Northing:** 43.497308
**Easting:** -79.728122
**Ground Surface Elevation:** 184.19

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| 0 | 185.0 | | | | | | |
| | 184.0 | **Organic Material** 350 mm | 1 | SS | 2 4 6 | 10 | SS1 - PHCs, VOCs, PAHs and M&I |
| | | **Fill** Silty sand, trace clay, trace gravel. brown, loose, moist. | | | | | |
| 1 | 183.0 | Clayey silt, trace sand, trace gravel. brown, stiff, moist. | 2 | SS | 3 6 7 | 13 | |
| | | | 3 | SS | 3 3 5 | 8 | |
| 2 | 182.0 | | 4 | SS | 4 4 7 | 11 | |
| 3 | 181.0 | | 5 | SS | 4 4 10 | 14 | SS5 - PHCs, VOCs, PAHs and M&I |
| 4 | 180.0 | **Clayey Silt Till** Trace sand, trace gravel. brown, hard, moist. | | | | | |
| 5 | 179.0 | | 6 | SS | 6 13 19 | 32 | |
| 6 | 178.0 | | 7 | SS | 8 20 27 | 47 | GW Monitoring Level August 2021<br>SS7 - PHCs, VOCs, PAHs, M&I and OC Pesticides |
| 7 | 177.0 | **Shale** Weathered bedrock.. red, hard, dry to moist. | 8 | AUG | | | |
| 8 | 176.0 | | | | | | |
| 9 | 175.0 | | | | | | |
| 10 | 174.0 | End of Log | | | | | |
| 11 | | | | | | | |

Undrained Shear Strength Values (kPa): 40, 80, 120, 160
Penetration Test Values (Blows / 0.3m): 20, 40, 60, 80
Moisture / Plasticity: PL, MC, LL; 10, 20, 30, 40




**Additional Notes:**
**1.** Borehole open to approximately 10 m upon completion.
**2.** Groundwater or water seepage encountered at approximately 5.2 m below ground surface.
**3.**
**4.**

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# LOG OF BOREHOLE BH3-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-20
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.495378
**Easting:** -79.728858
**Ground Surface Elevation:** 180.6

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Organic Material** ~250 mm Topsoil | | | | | | | | | | |
| | | | **Clayey Silt** trace gravel. Brown, stiff, moist. | 1 | SS | 7 6 4 4 | 10 | | 15.0 | | | | |
| | | 180.0 | | | | | | | | | | | |
| 1 | | | ...very stiff. | 2 | SS | 7 9 10 | 19 | | 13.1 | | | | |
| | | | | | | | | | | | | | |
| | | 179.0 | **Silt Till** trace gravel, trace sand, trace clay. Brown, hard, moist. | 3 | SS | 7 12 21 | 33 | | 13.2 | | | | |
| 2 | | | | | | | | | | | | | |
| | | | | 4 | SS | 11 25 29 | 54 | | 10.1 | | | | |
| | | 178.0 | | | | | | | | | | | |
| 3 | | | | 5 | SS | 14 22 27 | 49 | | 11.1 | | | | |
| | | | | | | | | | | | | | |
| | | 177.0 | | 6 | SS | 16 18 20 | 38 | | 9.2 | | | | |
| 4 | | | | | | | | | | | | | |
| | | | | 7 | SS | 17 23 21 | 44 | | 9.0 | | | | |
| | | 176.0 | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| | | 175.0 | | | | | | | | | | | |
| 6 | | | **Shale** TCR = 100% RQD = 56% | 8 | SS | 50-2" | 50 | | 2.8 | | | | |
| | | | | 9 | CORE | | | | | | | | |
| | | 174.0 | | | | | | | | | | | |
| 7 | | | TCR = 98% RQD = 63% | 10 | CORE | | | | | | | | |
| | | 173.0 | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| | | 172.0 | TCR = 98% RQD = 67% | 11 | CORE | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| | | 171.0 | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 18.7 m depth on completion.
**2.** Groundwater or water seepage not encountered during drilling.
**3.**
**4.**

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# LOG OF BOREHOLE BH3-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-20
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.495378
**Easting:** -79.728858
**Ground Surface Elevation:** 180.6

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| 11 | | 170.0 | TCR = 100%<br>RQD = 78% | 12 | CORE | | | |
| 12 | | 169.0 | TCR = 100%<br>RQD = 67% | 13 | CORE | | | |
| 13 | | 168.0 | TCR = 100%<br>RQD = 78%<br>UCS = 45.6 MPa | 14 | CORE | | | |
| 14 | | 167.0 | | | | | | |
| 15 | | 166.0 | TCR = 100%<br>RQD = 80% | 15 | CORE | | | |
| 16 | | 165.0 | TCR = 100%<br>RQD = 84% | 16 | CORE | | | |
| 17 | | 164.0 | | | | | | |
| 18 | | 163.0 | TCR = 100%<br>RQD = 92% | 17 | CORE | | | |
| 19 | | 162.0 | End of Log | | | | | |
| 20 | | 161.0 | | | | | | |

Penetration / Strength Results: Undrained Shear Strength Values (kPa) ▲ 40 80 120 160 ▲; Penetration Test Values (Blows / 0.3m) × 20 40 60 80 ×

Moisture / Plasticity: PL MC LL; Moisture / Plasticity ○ 10 20 30 40 ○

Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm

**Additional Notes:**
**1.** Borehole open to approximately 18.7 m depth on completion.
**2.** Groundwater or water seepage not encountered during drilling.
**3.**
**4.**

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# LOG OF BOREHOLE BHMW4-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-22
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.495439
**Easting:** -79.727801
**Ground Surface Elevation:** 178.9

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength (kPa) / Penetration Test Values (Blows / 0.3m) | Moisture / Plasticity (PL, MC, LL) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 179.0 | **Fill**<br>Sand, some gravel. Brown, compact, moist. | 1 | SS | 2<br>10<br>10<br>9 | 20 | | 10.6 | |
| 1 | 178.0 | ...silty clay, trace gravel. Stiff. | 2 | SS | 2<br>5<br>6 | 11 | | 26.2 | |
| 2 | 177.0 | **Silt Till**<br>trace gravel, trace clay. Brown, very stiff, moist. | 3 | SS | 4<br>10<br>12 | 22 | | 14.3 | |
| 3 | 176.0 | ...trace sand. Hard. | 4 | SS | 7<br>15<br>24 | 39 | | 14.4 | |
| 4 | 175.0 | ...no clay, trace cobbles. Dense. | 5 | SS | 12<br>19<br>27 | 46 | | 10.3 | GW Monitoring Level<br>August 2021 |
| 5 | 174.0 | ...trace clay. Hard. | 6 | SS | 9<br>14<br>32 | 46 | | 9.4 | |
| 6 | 173.0 | **Shale**<br>TCR = 100%<br>RQD = 33% | 7 | SS | 50-2" | 50 | | 7.8 | |
| 7 | 172.0 | TCR = 98%<br>RQD = 83% | 8 | CORE | | | | | |
| 8 | 171.0 | TCR = 100%<br>RQD = 84% | 9 | CORE | | | | | |
| 9 | 170.0 | | | | | | | | |
| 10 | 169.0 | | | | | | | | |

Penetration / Strength Results: Undrained Shear Strength Values (kPa) ▲ 40 80 120 160; Penetration Test Values (Blows / 0.3m) × 20 40 60 80

Moisture / Plasticity: PL MC LL; Moisture / Plasticity ○ 10 20 30 40

Well Details: 36" Locking Vault; 3/8" Bentonite Pellets; 4 m

Groundwater Conditions

Headspace / PID (ppm) [LEL(%)] / ppm

**Additional Notes:**
**1.** Borehole open to approximately 18.7 m depth on completion.
**2.** Groundwater or water seepage not encountered during drilling.
**3.**
**4.**

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Ph: (905) 383-3733

# LOG OF BOREHOLE BHMW4-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-22
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.495439
**Easting:** -79.727801
**Ground Surface Elevation:** 178.9

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| 11 | | 168.0 | TCR = 99%<br>RQD = 76%<br><br>UCS = 41.5 MPa | 10 | CORE | | | |
| 12 | | 167.0 | TCR = 100%<br>RQD = 95% | 11 | CORE | | | |
| 13 | | 166.0 | TCR = 97%<br>RQD = 74% | 12 | CORE | | | |
| 14 | | 165.0 | TCR = 100%<br>RQD = 94% | 13 | CORE | | | |
| 15 | | 164.0 | TCR = 98%<br>RQD = 98% | 14 | CORE | | | |
| 16 | | 163.0 | TCR = 98%<br>RQD = 98% | 15 | CORE | | | |
| 17 | | 162.0 | End of Log | | | | | |
| 18 | | 161.0 | | | | | | |
| 19 | | 160.0 | | | | | | |
| 20 | | 159.0 | | | | | | |
| 21 | | 158.0 | | | | | | |

**Penetration / Strength Results**
Undrained Shear Strength Values (kPa)
40 80 120 160
Penetration Test Values (Blows / 0.3m)
20 40 60 80

**Moisture / Plasticity**
PL MC LL
Moisture / Plasticity
10 20 30 40

**Well Details**
#10 Well Slot Sand
2" Schedule 40 PVC Slot 10' Screen

**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
1. Borehole open to approximately 18.7 m depth on completion.
2. Groundwater or water seepage not encountered during drilling.
3.
4.

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# LOG OF BOREHOLE MW111-20



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2020-09-23
**Drilling Method:** Hollow Stem - Landshark
**Datum:** Geodetic Elevation

**Northing:** 43.4967758989496
**Easting:** -79.7276524809264
**Ground Surface Elevation:** 179.25

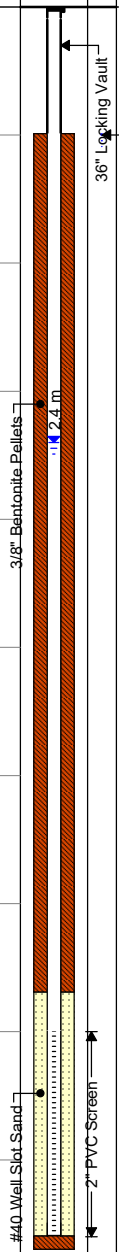
| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description |
|---|---|---|---|
| 0 | | 180.0 | |
| | | 179.0 | **Organic Material** 150 mm<br>**Fill** Clayey silt, trace sand, trace gravel. |
| 1 | | 178.0 | |
| 2 | | 177.0 | **Shale** Highly weathered, very weak, red, dry. |
| 3 | | 176.0 | |
| 4 | | 175.0 | |
| 5 | | 174.0 | |
| 6 | | 173.0 | |
| 7 | | 172.0 | |
| 8 | | 171.0 | End of Log |
| 9 | | 170.0 | |
| 10 | | | |

Samples: Number | Type | Blow Counts/150 mm | N Value

Penetration / Strength Results: Undrained Shear Strength Values (kPa) 40 80 120 160; Penetration Test Values (Blows / 0.3m) 20 40 60 80

Moisture / Plasticity: PL MC LL; Moisture / Plasticity 10 20 30 40

Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments




GW Monitoring Level
August 2021

**Additional Notes:**
1. Well installed to 8.6 m depth below ground surface.
2.
3.
4.

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# LOG OF BOREHOLE BH114



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-12
**Drilling Method:** Hollow Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.495868
**Easting:** -79.728381
**Ground Surface Elevation:** 179.3

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 179.0 | **Granular** 300 mm | | | | | | | | | | |
| | | | **Fill** Clayey silt, trace gravel. brown, hard, moist. | 1 | SS | 26<br>24<br>14<br>14 | 38 | | 1.0 | | | | SS1 - PAHs and M&I |
| 1 | | 178.0 | | | | | | | | | | | |
| | | | | 2 | SS | 6<br>7<br>12 | 19 | | 8.0 | | | | SS2 - PHCs, VOCs, and OC Pesticides |
| 2 | | 177.0 | **Clayey Silt** Trace sand, trace gravel. brown, very stiff, moist. | | | | | | | | | | |
| | | | **Shale** Highly weathered, very weak, red, dry. | | | | | | | | | | |
| 3 | | 176.0 | | 3 | AUG | 50 | 50 | | 10.0 | | | | |
| | | | End of Log | | | | | | | | | | |
| 4 | | 175.0 | | | | | | | | | | | |
| 5 | | 174.0 | | | | | | | | | | | |
| 6 | | 173.0 | | | | | | | | | | | |
| 7 | | 172.0 | | | | | | | | | | | |
| 8 | | 171.0 | | | | | | | | | | | |
| 9 | | 170.0 | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**

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# LOG OF BOREHOLE BH115



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road,Oakville

**Drill Date:** 2021-08-12
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.496284
**Easting:** -79.728048
**Ground Surface Elevation:** 179

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity (PL MC LL) / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Asphalt** 300 mm | | | | | | | | | | |
| | | **Fill** Silty sand, trace gravel, trace clay. brown, hard, moist. | 1 | SS | 23 27 13 15 | 40 | | 4.0 | | | | SS1 - PHCs, VOCs, and Metals |
| 1 | 178.0 | | | | | | | | | | | |
| | | | 2 | SS | 7 8 11 | 19 | | 10.0 | | | | SS2 - PHCs, VOCs, PAHs, and OC Pesticides |
| 2 | 177.0 | **Clayey Silt Till** Trace sand, trace gravel. brown, very stiff, moist. | | | | | | | | | | |
| | | **Shale** Highly weathered, very weak, red, hard, dry. | | | | | | | | | | |
| 3 | 176.0 | | 3 | AUG | | | | 9.0 | | | | |
| | | End of Log | | | | | | | | | | |
| 4 | 175.0 | | | | | | | | | | | |
| 5 | 174.0 | | | | | | | | | | | |
| 6 | 173.0 | | | | | | | | | | | |
| 7 | 172.0 | | | | | | | | | | | |
| 8 | 171.0 | | | | | | | | | | | |
| 9 | 170.0 | | | | | | | | | | | |
| 10 | 169.0 | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**

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# LOG OF BOREHOLE BH116



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-11
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.496486
**Easting:** -79.727345
**Ground Surface Elevation:** 178.3

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 178.0 | **Organic Material** 250 mm | | | | | | | | | | |
| | | | **Fill** Silty clay, trace sand. brown, firm, moist. | 1 | SS | 2 3 4 5 | 7 | | 43.0 | | | | SS1 - PHCs, VOCs, PAHs, M&I, and OC Pesticides |
| 1 | | 177.0 | | | | | | | | | | | |
| | | | **Clayey Silt Till** Trace sand, trace gravel. brown, hard, moist. | 2 | SS | 7 11 19 | 30 | | 18.0 | | | | |
| 2 | | 176.0 | | | | | | | | | | | |
| | | | **Shale** Highly weathered, very weak, red, dry. | | | | | | | | | | |
| 3 | | 175.0 | | 3 | SS | 22 39 50 | 50 | | 12.0 | | | | |
| | | | End of Log | | | | | | | | | | |
| 4 | | 174.0 | | | | | | | | | | | |
| 5 | | 173.0 | | | | | | | | | | | |
| 6 | | 172.0 | | | | | | | | | | | |
| 7 | | 171.0 | | | | | | | | | | | |
| 8 | | 170.0 | | | | | | | | | | | |
| 9 | | 169.0 | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** Groundwater or water seepage encountered at approximately 2.7 m below ground surface.
**3.**
**4.**

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# LOG OF BOREHOLE BH117



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

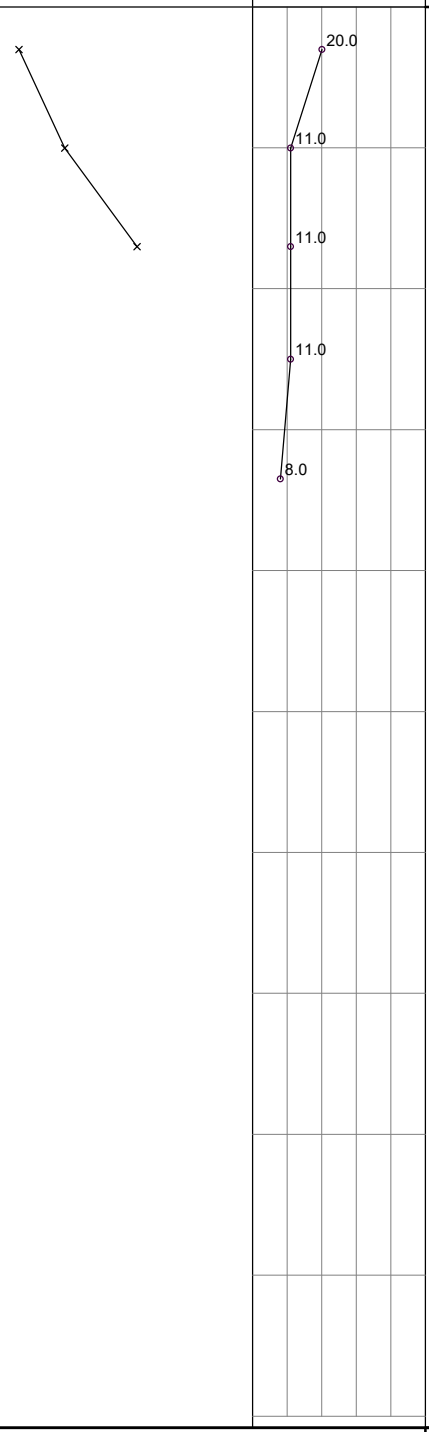
**Drill Date:** 2021-08-12
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.4970050055183
**Easting:** -79.7271432861035
**Ground Surface Elevation:** 179.1

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| | 179.0 | **Organic Material** 275 mm | | | | | |
| | | **Fill** Silty sand to clayey silt, trace sand, trace gravel. brown, stiff, moist. | 1 | SS | 4 5 8 8 | 13 | SS1 - M&I and OC Pesticides |
| 1 | 178.0 | **Clayey Silt Till** Trace sand, trace gravel, trace grey shale fragments. brown, very stiff, moist. | 2 | SS | 6 13 17 | 30 | |
| | | | 3 | SS | 8 22 29 | 57 | |
| 2 | 177.0 | **Shale** Highly weathered, very weak, red, dry. | | | | | |
| | | | 4 | AUG | | | |
| 3 | 176.0 | | 5 | AUG | | | |
| | | End of Log | | | | | |
| 4 | 175.0 | | | | | | |
| 5 | 174.0 | | | | | | |
| 6 | 173.0 | | | | | | |
| 7 | 172.0 | | | | | | |
| 8 | 171.0 | | | | | | |
| 9 | 170.0 | | | | | | |
| 10 | | | | | | | |

Penetration / Strength Results: Undrained Shear Strength Values (kPa) 40 80 120 160; Penetration Test Values (Blows / 0.3m) 20 40 60 80

Moisture / Plasticity: PL MC LL; Moisture / Plasticity 10 20 30 40




Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**

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# LOG OF BOREHOLE MW117-20



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-09-23
**Drilling Method:** Hollow Stem
**Datum:** Geodetic Elevation

**Northing:** 43.495751
**Easting:** -79.728563
**Ground Surface Elevation:** 180.3

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Penetration / Strength Results | Moisture / Plasticity | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 181.0 | | | | | | Undrained Shear Strength Values (kPa) ▲ 40 80 120 160 ▲ | PL MC LL | | | | |
| 0 | | 180.0 | **Asphalt** 400 mm | | | | | Penetration Test Values (Blows / 0.3m) × 20 40 60 80 × | Moisture / Plasticity ○ 10 20 30 40 ○ | 36" Locking Vault | | | |
| 1 | | 179.0 | **Fill** Clayey silt. | | | | | | | | | | |
| 2 | | 178.0 | **Clayey Silt Till** trace gravel. Brown, moist. | | | | | | | | | | |
| 3 | | 177.0 | **Shale** Highly weathered, very weak, red, dry. | | | | | | | | | | |
| 4 | | 176.0 | | | | | | | | 3/8" Bentonite Pellets | | | |
| 5 | | 175.0 | | | | | | | | | | | |
| 6 | | 174.0 | | | | | | | | | | | |
| 7 | | 173.0 | | | | | | | | | | | |
| 8 | | 172.0 | | | | | | | | | | | |
| 9 | | 171.0 | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | GW Monitoring Level August 2021 |

**Additional Notes:**
**1.** Monitoring Well installed at 17.3 m depth below ground surface.
**2.**
**3.**
**4.**

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# LOG OF BOREHOLE MW117-20



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-09-23
**Drilling Method:** Hollow Stem
**Datum:** Geodetic Elevation

**Northing:** 43.495751
**Easting:** -79.728563
**Ground Surface Elevation:** 180.3

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | | 170.0 | | | | | | | | | | | |
| 12 | | 169.0 | | | | | | | | | | | |
| 13 | | 168.0 | | | | | | | | | | | |
| 14 | | 167.0 | | | | | | | | | | | |
| 15 | | 166.0 | | | | | | | | #40 Well Slot Sand | | | |
| 16 | | 165.0 | | | | | | | | | 2" PVC Screen | | |
| 17 | | 164.0 | | | | | | | | | | | |
| 18 | | 163.0 | End of Log | | | | | | | | | | |
| 19 | | 162.0 | | | | | | | | | | | |
| 20 | | 161.0 | | | | | | | | | | | |
| 21 | | 160.0 | | | | | | | | | | | |

**Additional Notes:**
1. Monitoring Well installed at 17.3 m depth below ground surface.
2.
3.
4.

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# LOG OF BOREHOLE BH118



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-11
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.497598
**Easting:** -79.726429
**Ground Surface Elevation:** 179.4

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 179.0 | **Organic Material** 150 mm<br>**Fill** Clayey silt, trace gravel, trace sand. brown, stiff, moist. | 1 | SS | 5<br>6<br>6<br>6 | 12 | | 15.0 | | | | SS1 - PHCs, VOCs, M&I, and OC Pesticides |
| 1 | | 178.0 | **Clayey Silt Till** Trace sand, trace gravel. brown, hard, moist. | 2 | SS | 4<br>15<br>16 | 31 | | 12.0 | | | | |
| 2 | | 177.0 | **Shale** Highly weathered. red, hard, dry | 3 | SS | 8<br>14<br>16 | 30 | | 10.0 | | | | |
| 3 | | 176.0 | | 4 | AUG | | | | 8.0 | | | | |
| | | | | 5 | AUG | | | | 6.0 | | | | |
| 4 | | | End of Log | | | | | | | | | | |
| 5 | | 175.0 | | | | | | | | | | | |
| 6 | | 174.0 | | | | | | | | | | | |
| 7 | | 173.0 | | | | | | | | | | | |
| 8 | | 172.0 | | | | | | | | | | | |
| 9 | | 171.0 | | | | | | | | | | | |
| 10 | | 170.0 | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**

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# LOG OF BOREHOLE MW118-20

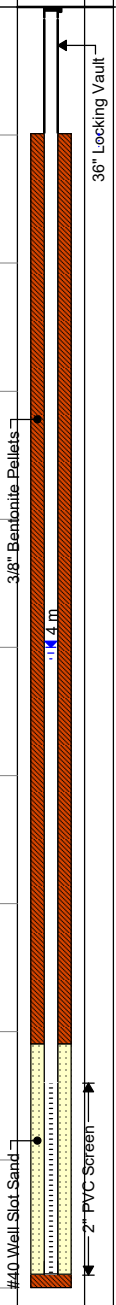


**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road,Oakville

**Drill Date:** 2020-09-23
**Drilling Method:** Hollow Stem
**Datum:** Geodetic Elevation

**Northing:** 43.495434
**Easting:** -79.727865
**Ground Surface Elevation:** 179.7

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 180.0 | **Organic Material** 250 mm | | | | | | | | | | |
| 1 | 179.0 | **Fill** Clayey silt, trace gravel. | | | | | | | | | | |
| 2 | 178.0 | **Clayey Silt Till** Trace sand, trace gravel. | | | | | | | | | | |
| 3 | 177.0 | **Shale** Highly weathered, very weak, red, dry.. | | | | | | | | | | |
| 4 | 176.0 | | | | | | | | | | | GW Monitoring Level August 2021 |
| 5 | 175.0 | | | | | | | | | | | |
| 6 | 174.0 | | | | | | | | | | | |
| 7 | 173.0 | | | | | | | | | | | |
| 8 | 172.0 | | | | | | | | | | | |
| 9 | 171.0 | End of Log | | | | | | | | | | |
| 10 | 170.0 | | | | | | | | | | | |




**Additional Notes:**
**1.** Monitoring well installed at 8.9 m depth below ground surface.
**2.**
**3.**
**4.**

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# LOG OF BOREHOLE BH119



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road,Oakville

**Drill Date:** 2021-08-12
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.49514
**Easting:** -79.728288
**Ground Surface Elevation:** 180.9

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| | | **Organic Material** 250 mm | | | | | |
| | | **Fill** Sandy silt, trace gravel, trace clay. brown, compact, moist. | 1 | SS | 5 8 9 7 | 17 | SS1 - PHCs, VOCs, and PAHs |
| 1 | 180.0 | | 2 | SS | 4 4 5 | 9 | |
| | | **Silty Clay** Trace sand, trace gravel. brown, firm to stiff, moist. | 3 | SS | 3 3 5 | 8 | |
| 2 | 179.0 | | | | | | |
| | | **Clayey Silt Till** Trace sand, trace gravel. brown, very stiff, moist. | 4 | SS | 7 11 13 | 24 | |
| 3 | 178.0 | | 5 | SS | 11 19 26 | 45 | SS5 - PHCs and VOCs |
| | | End of Log | | | | | |
| 4 | 177.0 | | | | | | |
| 5 | 176.0 | | | | | | |
| 6 | 175.0 | | | | | | |
| 7 | 174.0 | | | | | | |
| 8 | 173.0 | | | | | | |
| 9 | 172.0 | | | | | | |
| 10 | 171.0 | | | | | | |

**Undrained Shear Strength Values** (kPa): 40 80 120 160
**Penetration Test Values** (Blows / 0.3m): 20 40 60 80
**Moisture / Plasticity**: PL MC LL; 10 20 30 40
Moisture values: 17.0, 14.0, 18.0, 13.0, 10.0

**Well Details** | **Groundwater Conditions** | **Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
**1.** Borehole open to approximately 3.1 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**

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# LOG OF BOREHOLE MW119-20



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2020-09-23
**Drilling Method:** Hollow Stem
**Datum:** Geodetic Elevation

**Northing:** 43.494846
**Easting:** -79.728314
**Ground Surface Elevation:** 180.65

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity PL MC LL / Moisture / Plasticity 10 20 30 40 | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 181.0 | **Organic Material** 250 mm | | | | | | | 36" Locking Vault | | | |
| 1 | | 180.0 | **Fill** Clayey silt, trace sand, trace gravel. | | | | | | | 3/8" Bentonite Pellets | | | |
| 2 | | 179.0 | | | | | | | | | | | |
| 3 | | 178.0 | **Clayey Silt Till** Trace sand, trace gravel. | | | | | | | 5.75 m | | | |
| 4 | | 177.0 | **Shale** Highly weathered, very weak, red, dry. | | | | | | | | | | GW Monitoring Level August 2021 |
| 5 | | 176.0 | | | | | | | | | | | |
| 6 | | 175.0 | | | | | | | | | | | |
| 7 | | 174.0 | | | | | | | | | | | |
| 8 | | 173.0 | | | | | | | | #40 Well Slot Sand | | | |
| 9 | | 172.0 | End of Log | | | | | | | 2" PVC Screen | | | |
| 10 | | 171.0 | | | | | | | | | | | |

**Additional Notes:**
1. Monitoring well installed at 8.9 m depth below ground surface.
2.
3.
4.

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# LOG OF BOREHOLE MW120

**SHEET** 1 of 1

**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-12
**Drilling Method:** Solid Stem
**Datum:** Geodetic Elevation

**Northing:** 43.496104
**Easting:** -79.727559
**Ground Surface Elevation:** 178.49

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| 0 | 179.0 | | | | | | |
| | 178.0 | **Organic Material** ~600 mm. Clayey silt, trace sand. brown, loose, moist. | 1 | SS | 3 3 2 3 | 5 | SS1 - PHCs, VOCs, Metals, and OC Pesticides |
| 1 | | **Fill** Silty clay, trace sand, trace gravel. brown, very stiff, moist. | | | | | |
| | 177.0 | | 2 | SS | 3 9 14 | 23 | Monitoring Well Dry Aug 2021 |
| 2 | | **Clayey Silt** Trace sand, trace gravel. brown, very stiff, moist. | | | | | |
| | 176.0 | **Shale** Highly weathered, very weak, reddish grey, dry to moist. | | | | | GW Monitoring Level Sept 2021 |
| 3 | | | 3 | AUG | | | SS3 - PHCs, VOCs, Metals, and OC Pesticides |
| | 175.0 | | | | | | |
| 4 | | | | | | | |
| | 174.0 | | 4 | AUG | | | |
| 5 | | | | | | | |
| | 173.0 | | | | | | |
| 6 | | | 5 | AUG | | | |
| | 172.0 | | | | | | |
| 7 | | | | | | | |
| | 171.0 | | | | | | |
| 8 | | End of Log | | | | | |
| | 170.0 | | | | | | |
| 9 | | | | | | | |
| | 169.0 | | | | | | |
| 10 | | | | | | | |

Penetration / Strength Results: Undrained Shear Strength Values (kPa) 40 80 120 160; Penetration Test Values (Blows / 0.3m) 20 40 60 80

Moisture / Plasticity: PL MC LL; Moisture / Plasticity 10 20 30 40

Moisture / Plasticity values: 19.0, 23.0, 11.0, 5.0, 4.0

Well Details: 36" Locking Vault; 2.4 m; 3/8" Bentonite Pellets; #40 Well Slot Sand; 2" Schedule 40 PVC Slot 10 Screen

Groundwater Conditions

Headspace / PID (ppm) [LEL(%)] / ppm

**Additional Notes:**
**1.** Borehole open to approximately 8.1 m depth upon completion.
**2.** No groundwater or water seepage encountered.
**3.**
**4.**


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# LOG OF BOREHOLE MW121



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-12
**Drilling Method:** Solid Stem
**Datum:** Geodetic Elevation

**Northing:** 43.496256
**Easting:** -79.726848
**Ground Surface Elevation:** 178.28

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| 0 | | 179.0 | | | | | | |
| | | 178.0 | **Organic Material** ~600 mm. Clayey silt, trace sand, trace gravel. brown, firm, moist. | 1 | SS | 2 2 3 3 | 5 | SS1 - PHCs, VOCs, and Metals |
| 1 | | | **Fill** Clayey silt, trace sand, trace gravel. brown, firm to stiff, moist. | | | | | |
| | | 177.0 | | 2 | SS | 3 6 8 | 14 | |
| 2 | | | | | | | | GW Monitoring Level Aug 2021 |
| | | 176.0 | **Shale** Highly weathered, very weak, red, dry to moist. | | | | | |
| 3 | | | | 3 | AUG | | | SS3 - PHCs, VOCs, Metals, and OC Pesticides |
| | | 175.0 | | | | | | |
| 4 | | | | | | | | |
| | | 174.0 | | 4 | AUG | | | |
| 5 | | | | | | | | |
| | | 173.0 | | | | | | |
| 6 | | | | | | | | |
| | | 172.0 | | 5 | AUG | | | |
| | | | End of Log | | | | | |
| 7 | | | | | | | | |
| | | 171.0 | | | | | | |
| 8 | | | | | | | | |
| | | 170.0 | | | | | | |
| 9 | | | | | | | | |
| | | 169.0 | | | | | | |
| 10 | | | | | | | | |

**Penetration / Strength Results**
Undrained Shear Strength Values (kPa): 40 80 120 160
Penetration Test Values (Blows / 0.3m): 20 40 60 80

**Moisture / Plasticity**
PL MC LL
Moisture / Plasticity: 10 20 30 40
20.0
14.0
7.0
6.0
5.0

**Well Details**
36" Locking Vault
3/8" Bentonite Pellets
2.1 m
#40 Well Slot Sand
2" PVC Screen

**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
1. Borehole open, with cave, to approximately 5.8 m depth upon completion.
2. Groundwater or water seepage encountered at approximately 5.0 m depth below ground surface.
3.
4.

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# LOG OF BOREHOLE BHMW122D-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-24
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.497477
**Easting:** -79.726035
**Ground Surface Elevation:** 178.9

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | **Subsurface Conditions** | **Samples** | | | | |
| 0 | | 179.0 | **Organic Material**<br>~250 mm Topsoil | 1 | SS | 4<br>4<br>5<br>6 | 9 | |
| | | | **Silty Clay**<br>trace gravel, trace sand. Brown, stiff, moist. | | | | | |
| 1 | | 178.0 | ...very stiff. | 2 | SS | 5<br>7<br>9 | 16 | |
| | | | **Silt Till**<br>trace gravel, trace sand, trace grey shale fragments. Red and brown, dense, moist. | 3 | SS | 10<br>19<br>33 | 52 | |
| 2 | | 177.0 | | | | | | |
| | | | | 4 | SS | 48<br>50-3" | 50 | |
| 3 | | 176.0 | **Shale**<br>TCR = 100%<br>RQD = 0% | 5 | SS | 50-5" | 50 | |
| | | | | 6 | CORE | | | |
| 4 | | 175.0 | TCR = 100%<br>RQD = 49% | 7 | CORE | | | GW Monitoring Level<br>August 2021 |
| 5 | | 174.0 | TCR = 100%<br>RQD = 86% | 8 | CORE | | | |
| 6 | | 173.0 | | | | | | |
| 7 | | 172.0 | TCR = 100%<br>RQD = 66% | 9 | CORE | | | |
| 8 | | 171.0 | TCR = 100%<br>RQD = 78% | 10 | CORE | | | |
| 9 | | 170.0 | | | | | | |
| 10 | | 169.0 | | | | | | |

**Penetration / Strength Results**
Undrained Shear Strength Values (kPa): 40 80 120 160
Penetration Test Values (Blows / 0.3m): 20 40 60 80

**Moisture / Plasticity**
PL MC LL
Moisture / Plasticity: 10 20 30 40

**Well Details**
36" Locking Vault
3/8" Bentonite Pellets
4 m

**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
1. Borehole open to approximately 18.7 m depth on completion.
2. Groundwater or water seepage not encountered during drilling.
3.
4.

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# LOG OF BOREHOLE BHMW122D-23



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2023-03-24
**Drilling Method:** Hollow Stem/Coring
**Datum:** Geodetic Elevation

**Northing:** 43.497477
**Easting:** -79.726035
**Ground Surface Elevation:** 178.9

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|---|
| 11 | | 168.0 | TCR = 100%<br>RQD = 100% | 11 | CORE | | | |
| 12 | | 167.0 | TCR = 100%<br>RQD = 91% | 12 | CORE | | | |
| 13 | | 166.0 | TCR = 100%<br>RQD = 91%<br>UCS = 68.1 MPa | 13 | CORE | | | |
| 14 | | 165.0 | TCR = 100%<br>RQD = 71% | 14 | CORE | | | |
| 15 | | 164.0 | TCR = 100%<br>RQD = 71 % | 15 | CORE | | | |
| 16 | | 163.0 | TCR = 100%<br>RQD = 82% | 16 | CORE | | | |
| 17 | | 162.0 | End of Log | | | | | |
| 18 | | 161.0 | | | | | | |
| 19 | | 160.0 | | | | | | |
| 20 | | 159.0 | | | | | | |
| 21 | | 158.0 | | | | | | |

**Penetration / Strength Results**
Undrained Shear Strength Values (kPa): 40 80 120 160
Penetration Test Values (Blows / 0.3m): 20 40 60 80

**Moisture / Plasticity**
PL MC LL
Moisture / Plasticity: 10 20 30 40

**Well Details**
#10 Well Slot Sand
2" PVC Screen

**Groundwater Conditions**

**Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
1. Borehole open to approximately 18.7 m depth on completion.
2. Groundwater or water seepage not encountered during drilling.
3.
4.

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# LOG OF BOREHOLE BH122



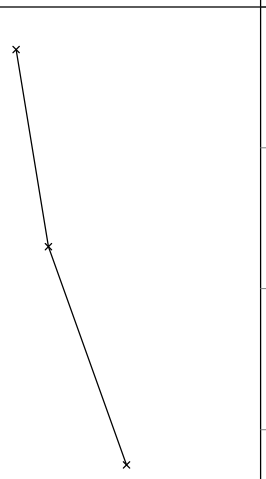
**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-11
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

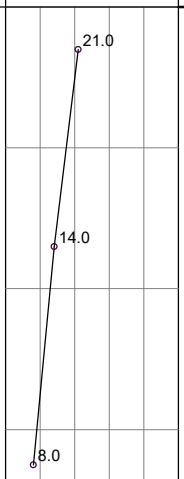
**Northing:** 43.496809
**Easting:** -79.726672
**Ground Surface Elevation:** 178.4

| Depth Scale (m) | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Comments |
|---|---|---|---|---|---|---|---|
| | 178.0 | **Organic Material** 250 mm<br>**Fill**<br>Clayey silt, trace sand, trace gravel. brown, firm, moist. | 1 | SS | 5<br>4<br>5<br>5 | 9 | SS1 - PHCs, VOCs, PAHs, M&I, and OC Pesticides |
| 1 | 177.0 | **Clayey Silt Till**<br>Trace sand, trace gravel. brown, very stiff, moist. | 2 | SS | 5<br>10<br>11 | 21 | |
| 2 | 176.0 | **Shale**<br>Highly weathered, very weak, red, dry. | | | | | |
| 3 | 175.0 | | 3 | SS | 16<br>50 | 50 | |
| | | End of Log | | | | | |
| 4 | 174.0 | | | | | | |
| 5 | 173.0 | | | | | | |
| 6 | 172.0 | | | | | | |
| 7 | 171.0 | | | | | | |
| 8 | 170.0 | | | | | | |
| 9 | 169.0 | | | | | | |
| 10 | | | | | | | |

**Penetration / Strength Results**




**Moisture / Plasticity**




**Well Details** | **Groundwater Conditions** | **Headspace / PID (ppm) [LEL(%)] / ppm**

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** Groundwater or water seepage not encountered.
**3.**
**4.**

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# LOG OF BOREHOLE BH123



**Project No.:** 21261
**Project Name:** Proposed Residential Development
**Location:** 3275 Trafalgar Road, Oakville

**Drill Date:** 2021-08-11
**Drilling Method:** Solid Stem - Elements Drilling
**Datum:** Geodetic Elevation

**Northing:** 43.497433
**Easting:** -79.726099
**Ground Surface Elevation:** 179

| Depth Scale (m) | Stratigraphic Symbol | Depth/Elevation (m) | Description | Number | Type | Blow Counts/150 mm | N Value | Undrained Shear Strength Values (kPa) 40 80 120 160 / Penetration Test Values (Blows / 0.3m) 20 40 60 80 | Moisture / Plasticity (PL MC LL; 10 20 30 40) | Well Details | Groundwater Conditions | Headspace / PID (ppm) [LEL(%)] / ppm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Organic Material** 250 mm | | | | | | | | | | |
| | | | **Fill** Silty sand. brown, compact, moist. | 1 | SS | 5 6 7 13 | 13 | | 11.0 | | | | SS1 - PHCs, VOCs, PAHs, M&I, and OC Pesticides |
| 1 | | 178.0 | | 2 | SS | 3 3 4 | 7 | | 10.0 | | | | |
| | | | **Shale** Highly weathered, very weak, red, dry to moist. | 3 | SS | 17 39 50 | 50 | | 6.0 | | | | |
| 2 | | 177.0 | | | | | | | | | | | |
| 3 | | 176.0 | | 4 | AUG | | | | 8.0 | | | | |
| | | | End of Log | | | | | | | | | | |
| 4 | | 175.0 | | | | | | | | | | | |
| 5 | | 174.0 | | | | | | | | | | | |
| 6 | | 173.0 | | | | | | | | | | | |
| 7 | | 172.0 | | | | | | | | | | | |
| 8 | | 171.0 | | | | | | | | | | | |
| 9 | | 170.0 | | | | | | | | | | | |
| 10 | | 169.0 | | | | | | | | | | | |

**Additional Notes:**
**1.** Borehole open to approximately 3.5 m depth upon completion.
**2.** Groundwater or water seepage not encountered.
**3.**
**4.**

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# APPENDIX D

# ROCK STRENGTH LABORATORY TESTING REULTS

Geomechanica Inc.
Unit 14 – 1240 Speers Rd.
Oakville Ontario
Canada L6L 2X4

May 29, 2023

Mr. Joey DiCenzo
Landtek Limited
205 Nebo Road
Hamilton, Ontario
Canada, L8W 2E1

Re: UCS and PLT Testing
(Landtek Project No. 21261)

Dear Mr. DiCenzo:

On May 15th, 2023, a total of six (6) HQ-sized core samples were received by Geomechanica Inc. via drop-off by Landtek personnel. These samples were identified as being from Landtek project 21261. From these samples, three (3) Uniaxial Compressive Strength (UCS) tests and three (3) Point Load Tests (PLT) were completed.

Details regarding the steps of specimen preparation and testing along with the test results are presented in the accompanying laboratory report and summary spreadsheet.

Sincerely,

Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

GEOMECHANICA

# Rock Laboratory Testing Results

**A report submitted to:**

Joey Di Cenzo
Landtek Limited
205 Nebo Road
Hamilton, Ontario
Canada, L8W 2E1

**Prepared by:**

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**May 29, 2023**
Project number: 21261

**Abstract**

This document summarizes the results of rock laboratory testing, including 3 Uniaxial Compressive Strength (UCS) tests and 3 Point Load Tests (PLT). The results for each test type are presented in seperate sub-sections herein.

**In this document:**

1 Uniaxial Compressive Strength Tests 1
2 Point Load Testing 3
Appendices 6

# 1 Uniaxial Compressive Strength Tests

## 1.1 Overview

This section summarizes the results of uniaxial compressive strength testing. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.15 mm/min (Figure 1). The preparation and testing procedure for each specimen included the following:

1. Unwrapping the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture and potential damage during subsequent specimen preparation.
2. Diamond cutting the core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within $\pm 0.025$ mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimen to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS).

Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C.

## 1.2 Results

The results of UCS testing are summarized in Table 1. Additional specimen and testing details are provided in the summary spreadsheet that accompanies this report.

Table 1: Summary of Uniaxial Compression test results.

| Sample | Depth (ft' in") | Bulk density $\rho$ (g/cm$^3$) | UCS (MPa) | Lithology | Failure description |
|---|---|---|---|---|---|
| BH122D-'23-R8 | 41'2" - 42'0" | 2.614 | 68.1 | Red Shale and Limestone | 1, 2 |
| BH3-'23-R6 | 43'1.5" - 43'8.5" | 2.564 | 45.6 | Red Shale and Limestone | 1 |
| BH4-'23-R4 | 31'5" - 32'2" | 2.587 | 41.5 | Red Shale and Limestone | 1 |

[1] Inclined shear failure
[2] Partial hourglass failure

## 1.3 Specimen photographs

Photographs of the specimens before and after testing are presented in the Appendix of this report.

# 2 Point Load Testing

## 2.1 Overview

This section summarizes the results of Point Load Testing (PLT). Tests were performed using a Carver 12-ton hydraulic press with point load test platens and equipped with a 0-5000 psi digital pressure gauge with a peak pressure holding capability (Figure 2). Testing was completed on rock core samples. Both axial and diametric tests were performed according to ASTM D5731-16.


Figure 2: Point load tester equipped with digital pressure gauge.

## 2.2 Results

The results of the PLT tests are summarized in Table 2. Note that the load, *P*, in kN was calculated from the measured peak pressure, as:

$$P = p \times A_{ram} \tag{1}$$

where, $p$ is the peak pressure in kPa and $A_{ram}$ is the effective cross-sectional area of the hydraulic ram in square metres. The effective diameter of the ram of the employed tester was 52 mm.

The uncorrected point load strength ($I_s$) is calculated as:

$$I_s = \frac{P}{{D_e}^2} \tag{2}$$

where, $D_e$ is the equivalent core diameter in mm calculated as:

$${D_e}^2 = D^2 \quad \text{for diameteral tests} \tag{3}$$

$$= \frac{4A}{\pi} \quad \text{for axial tests} \tag{4}$$

where $D$ is the distance between platens in mm and $A$ is the minimum cross sectional area of a plane through the platen contact points. The value of $A$ is given by:

$$A = W \times D \tag{5}$$

where $W$ is the width of the specimen.

The size correction factor ($F$) is obtained from the expression:

$$F = \left(\frac{D_e}{50}\right)^{0.45} \tag{6}$$

and the size-corrected point load strength ($I_{s(50)}$) for a core with $D$ = 50 mm was calculated as:

$$I_{s50} = F \times I_s. \tag{7}$$

Table 2: Summary of PLT results.

| Sample | Depth (ft' in") | Test type A-axial D-diametric | Distance Between Platens, $D$ (mm) | Failure Load $P$ (kN) | Effective Diameter $De$ (mm) | Uncorrected Point Strength, Strength, $I_s$ (MPa) | Size Correction Factor, $F$ | Size-Corrected Point Load Strength, $I_{s(50)}$ (MPa) |
|---|---|---|---|---|---|---|---|---|
| BH2-'23-R3 | 24'5" - 24'9" | D [1, 2] | 60.00 | 0.28 | 60.00 | 0.08 | 1.09 | 0.08 |
| | | D [1, 2] | 60.00 | 2.96 | 60.00 | 0.82 | 1.09 | 0.89 |
| | | D [1, 2] | 60.00 | 2.43 | 60.00 | 0.68 | 1.09 | 0.73 |
| | | A [1, 2] | 35.00 | 5.67 | 51.92 | 2.10 | 1.02 | 2.14 |
| | | A [1, 2] | 33.00 | 3.94 | 50.41 | 1.55 | 1.00 | 1.56 |
| | | A [1, 2] | 28.00 | 2.31 | 46.44 | 1.07 | 0.97 | 1.04 |
| | | A [1, 2] | 28.00 | 4.88 | 46.44 | 2.26 | 0.97 | 2.19 |
| | | | | Axial Mean | | 1.75 | | 1.73 |
| | | | | Diametric Mean | | 0.52 | | 0.57 |
| BH3-'23-R2 | 23'7" - 24'1.5" | D [1] | 61.00 | 1.41 | 61.00 | 0.38 | 1.09 | 0.41 |
| | | D [1] | 61.00 | 2.64 | 61.00 | 0.71 | 1.09 | 0.77 |

*Continued on next page*

Table 2 – Summary of PLT results. (continued from previous page)

| Sample | Depth (ft' in") | Test type A-axial D-diametric | Distance Between Platens, $D$ (mm) | Failure Load $P$ (kN) | Effective Diameter $De$ (mm) | Uncorrected Point Strength, Strength, $I_s$ (MPa) | Size Correction Factor, $F$ | Size-Corrected Point Load Strength, $I_{s(50)}$ (MPa) |
|---|---|---|---|---|---|---|---|---|
| | | D [1] | 61.00 | 2.11 | 61.00 | 0.57 | 1.09 | 0.62 |
| | | D [1] | 61.00 | 4.26 | 61.00 | 1.15 | 1.09 | 1.25 |
| | | A [1] | 41.00 | 6.47 | 56.26 | 2.04 | 1.05 | 2.16 |
| | | A [1] | 35.00 | 8.29 | 51.98 | 3.07 | 1.02 | 3.12 |
| | | A [1] | 30.00 | 5.80 | 48.12 | 2.50 | 0.98 | 2.46 |
| | | A [1] | 27.00 | 4.10 | 45.65 | 1.97 | 0.96 | 1.89 |
| | | A [1] | 28.00 | 1.32 | 46.49 | 0.61 | 0.97 | 0.59 |
| | | | | Axial Mean | | 2.04 | | 2.04 |
| | | | | Diametric Mean | | 0.70 | | 0.76 |
| BH10-'23-R6 | 33'6.5" - 34'0.5" | D [1] | 61.00 | 1.70 | 61.00 | 0.46 | 1.09 | 0.50 |
| | | D [1] | 61.00 | 0.51 | 61.00 | 0.14 | 1.09 | 0.15 |
| | | D [1] | 61.00 | 1.45 | 61.00 | 0.39 | 1.09 | 0.43 |
| | | D [1] | 61.00 | 2.43 | 61.00 | 0.65 | 1.09 | 0.71 |
| | | D [1] | 61.00 | 1.76 | 61.00 | 0.47 | 1.09 | 0.52 |
| | | A [1] | 33.00 | 4.13 | 50.44 | 1.62 | 1.00 | 1.63 |
| | | A [1] | 36.00 | 4.67 | 52.68 | 1.68 | 1.02 | 1.72 |
| | | A [1] | 29.00 | 5.64 | 47.28 | 2.52 | 0.98 | 2.46 |
| | | A [1] | 29.00 | 6.53 | 47.28 | 2.92 | 0.98 | 2.85 |
| | | A [1] | 26.00 | 3.95 | 44.77 | 1.97 | 0.95 | 1.88 |
| | | | | Axial Mean | | 2.14 | | 2.11 |
| | | | | Diametric Mean | | 0.42 | | 0.46 |

[1] Queenston Formation - red shale

[2] Short sample length. Limited testing possible

# Appendices

## Specimen sheets

- BH122D-’23-R8
- BH3-’23-R6
- BH4-’23-R4

## Uniaxial Compression Test

| | | | |
|---|---|---|---|
| **Client** | Landtek Limited | **Project** | 21261 |
| **Sample** | BH122D-’23-R8 | **Depth** | 41’2” - 42’0” |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.48 |
| Length (mm) [a] | 127.49 |
| Bulk density $\rho$ (g/cm$^3$) | 2.614 |
| UCS (MPa) | 68.1 |
| Lithology | Red Shale and Limestone |
| Failure description [b] | 1, 2 |

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear failure; [2] Partial hourglass failure;

Prior to testing

After testing

Remarks: Loading rate: 0.15 mm/min.

| | | | |
|---|---|---|---|
| **Performed by** | GF/AB | **Date** | 2023-05-23 |

## Uniaxial Compression Test

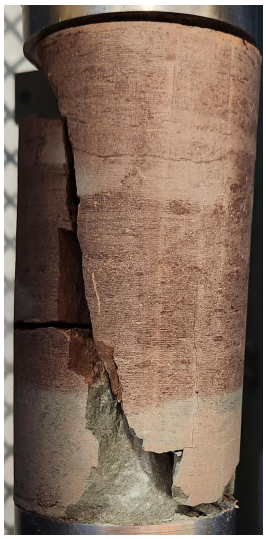
| | | | |
|---|---|---|---|
| **Client** | Landtek Limited | **Project** | 21261 |
| **Sample** | BH3-’23-R6 | **Depth** | 43’1.5” - 43’8.5” |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.45 |
| Length (mm) [a] | 128.97 |
| Bulk density $\rho$ (g/cm$^3$) | 2.564 |
| UCS (MPa) | 45.6 |
| Lithology | Red Shale and Limestone |
| Failure description [b] | 1 |

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear failure;

Prior to testing

After testing



Remarks: Loading rate: 0.15 mm/min.

| | | | |
|---|---|---|---|
| **Performed by** | GF/AB | **Date** | 2023-05-23 |

GEOMECHANICA

## Uniaxial Compression Test

| | | | |
|---|---|---|---|
| **Client** | Landtek Limited | **Project** | 21261 |
| **Sample** | BH4-’23-R4 | **Depth** | 31’5” - 32’2” |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.66 |
| Length (mm) [a] | 128.46 |
| Bulk density $\rho$ (g/cm$^3$) | 2.587 |
| UCS (MPa) | 41.5 |
| Lithology | Red Shale and Limestone |
| Failure description [b] | 1 |

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear failure;

Prior to testing

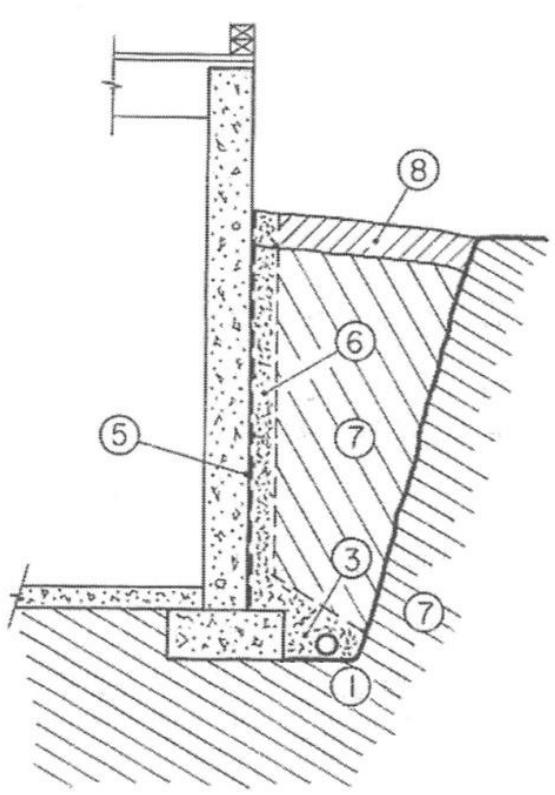
After testing

Remarks: Loading rate: 0.15 mm/min.

| | | | |
|---|---|---|---|
| **Performed by** | GF/AB | **Date** | 2023-05-23 |

# APPENDIX E

## DRAWING 21261-02 – ENGINEERING COMMENTARIES – GENERAL REQUIREMENTS FOR DRAINAGE TO BASEMENT STRUCTURES
## DRAWING 21261-03 – ENGINEERING COMMENTARIES – GENERAL REQUIREMENTS FOR UNDERFLOOR DRAINAGE SYSTEM




① 100 mm, perforated or slotted pipe placed below the upper level of the floor slab.;
③ Filter material that is compatible with the grain size characteristics of the fine grained foundation and backfill soils, as well as with the perforations of the pipe;
④ Filter material continuously or intermittently placed next to the foundation wall to intercept water draining from window wells, down exterior walls and from low areas near the building;
⑤ Damp-proofing on wall – optional depending on the quality of the concrete wall;
⑥ Optional use of sheet drain, or synthetic fire blanket, next to the foundation wall to replace the soil filter according to ④;
⑦ Foundation and backfill soils, which may contain fine grained and erosion-susceptible materials;
⑧ "*Topping off*" material is to be graded such that it slopes outwards to lead surface water away from the building. It is usually desirable to use low permeability topsoil to reduce the risk of overloading the drainage pipe.

*Based on Figure 12.1, Canadian Foundation Engineers Manual, Fourth Edition, 2006.*

**Additional Notes:**

1. The perforated or slotted drainage pipe is to lead to a positive drainage sump or outlet. The invert of the pipe is to be a minimum of 150 mm below the underside of the proposed floor slab.
2. Backfill materials to the interior of the foundation walls may be clean, organic-free soils that can be compacted to the specified density within in a confined space.
3. Heavy, vibratory compaction equipment should not be used within 450 mm of the foundation wall. Fill is not to be placed or compacted within 1.8 m of the wall unless fill is being placed simultaneously on both sides of the wall.
4. The moisture barrier beneath the floor slab is to comprise at least 200 mm of compacted19mm clear stone or an equivalent free-draining material.
5. Should the 19 mm clear stone require surface blinding then 6mm stone chips are to be used.
6. The slab on grade should not be structurally connected to the foundation wall or footing.

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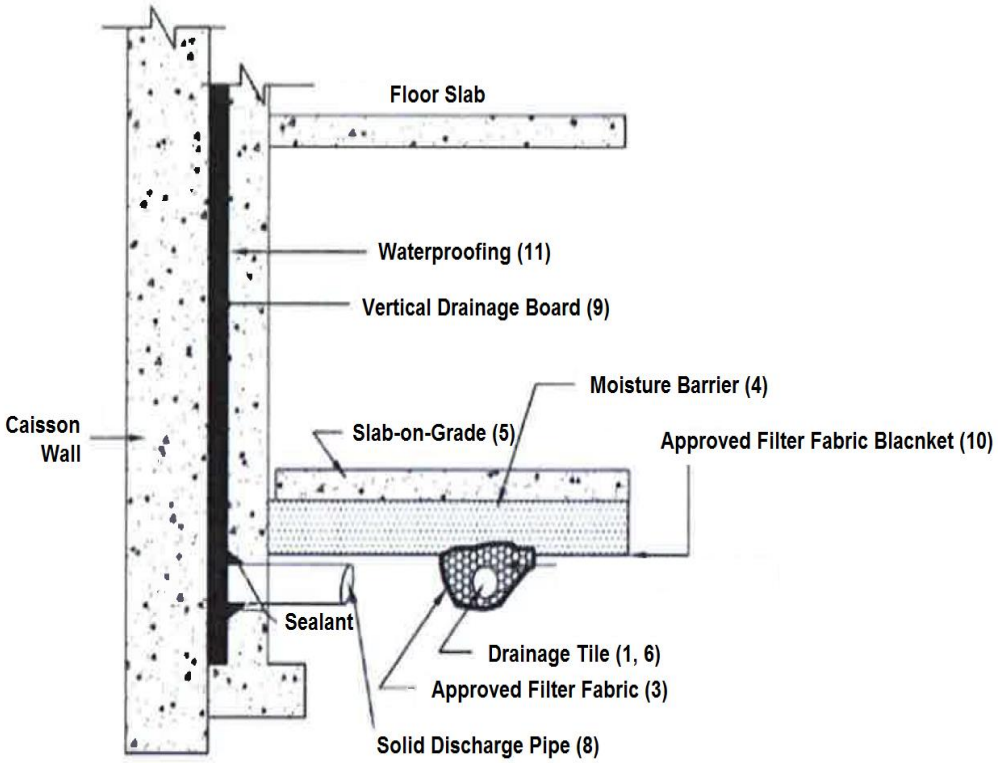
www.landteklimited.com

| General Requirements for Drainage to Basement Structures | | | |
|---|---|---|---|
| client | **New Horizon Development Group** | | |
| project | 23775 Trafalgar Road, Oakville, Ontario | | |
| project # | 21261 | drawing # | 21261-02 |




**Notes:**

1. Drainage tile, if required for permanent dewatering, to consist of 100 mm diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns;
2. 19 mm clear stone – 150 mm top and side of drain. If the drain is not on the footing then place 100 mm of 19 mm clear stone below the drain;
3. Wrap the clear stone with an approved filter fabric (e.g., Terrafix 270R or equivalent);
4. Moisture barrier to be at least 200 mm of compacted, 19 mm clear stone or equivalent (and approved), free-draining material. A vapour barrier may be required for specialty floor coverings;
5. Typically, the slab-on-grade is not structurally connected to the wall or footing. However, if it is connected to the walls it should be designed accordingly;
6. Underfloor drain invert, where to be installed, to be at least 300 mm below underside of floor slab. Drainage tile should be placed in parallel rows 6 m to 8 m centres one way. Place drains on 100 mm of 19 mm clear stone and 150 mm of 19 mm clear stone on top and sides. Enclose clear stone with filter fabric as prescribed in Note (3);
7. Do not connect any underfloor drainage to perimeter drainage. The two systems are to remain separate.
8. Locate solid discharge at the middle of each bay between soldier piles;
9. Vertical drainage board (e.g., MiraDrain 6000 or equivalent) with filter cloth should be continuous from bottom to 1.2 m below exterior finished grade;
10. The entire subgrade is to be sealed with an approved filter fabric as in Note (3) where non-cohesive (silty/sandy/granular) soils are encountered below the groundwater table;
11. Where no permanent dewatering is proposed, the basement walls must be waterproofed below the seasonally highest groundwater level (plus 1.0 m to 1.5 m buffer) using bentonite or an equivalent waterproofing system;
12. The Geotechnical Report should be reviewed for site-specific details. Final detail must be approved before system is considered acceptable.

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| General Requirements for Underfloor Drainage Systems | | | |
|---|---|---|---|
| client | **New Horizon Development Group** | | |
| project | 3275 Trafalgar Road, Oakville, Ontario | | |
| project # | 21261 | drawing # | 21261-03 |