LANDTEK LIMITED
Consulting Engineers

205 Nebo Road, Unit 3
Hamilton, Ontario
Canada
L8W 2E1

Phone: 905-383-3733
Fax: 905-383-8433
engineering@landteklimited.com
www.landteklimited.com

Preliminary Geotechnical Investigation Report
Proposed Subdivision Development
469 Rice Road
Welland, Ontario

Prepared for:

Schout Corporation
45 Reinhart Pl
Petersburg, Ontario
N0B 2H0

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■ FOUNDATION INVESTIGATIONS ■ ENVIRONMENTAL SITE ASSESSMENTS AND CLEANUP ■ GROUNDWATER STUDIES ■ SLOPE STABILITY STUDIES
■ ASPHALT TECHNOLOGY ■ ASPHALT MIX DESIGNS ■ PAVEMENT PERFORMANCE ANALYSIS ■ CONSTRUCTION MATERIALS TESTING & INSPECTION
■ ANALYSIS OF SOIL CORROSION POTENTIAL ■ PAVEMENT REHABILITATION & TENDER SPECIFICATIONS ■ CONCRETE QUALITY ASSURANCE TESTING
■ ROOF INSPECTIONS ■ INFRASTRUCTURE NEEDS STUDIES ■ FAILURE ANALYSIS AND EXPERT WITNESS SERVICES ■ AGGREGATE EVALUATION

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Proposed Development	Schout Corporation is intending to develop the site located at 469 Rice Road in Welland, Ontario as residential properties. The development is anticipated to include paved access roads, landscaping areas and full site servicing.
Report Deliverables	The purposes of the Geotechnical Investigation were to confirm the subsurface conditions at the site and to provide design and construction recommendations with regards to building foundations, floor slabs, pavement structures, and subsurface drainage and utilities.

SITE DETAILS AND SETTING

UTM 17T Coordinates	640690, 4765044	**Site Area (approx.)**	28 acres (116,000 m^2)

Site Description	The site is the location of a relatively developed area of approximately 116,000 m^2 (28 acres). It is situated north of Quaker Road and east of Montgomery Road, and is bound to the east by Rice Road. A recreational building with associated paved parking is located on the site, with the remainder of the site covered with maintained grasses and a small number of trees.
Geology	Topsoil or organic soil and pavement granular material was encountered at the ground surface. Underlying the topsoil and granular material is fill material comprised predominately of clay and silt. The fill material extends to a depth of between 1.5 m and 3.4 m below existing ground level. Native silt to clayey silt deposits were encountered underlying the fill material and extend to the terminus of the boreholes at a maximum depth of 6.6 m below existing ground level. No bedrock was encountered during this investigation.

ENGINEERING CONSIDERATIONS

Foundations	It is considered by Landtek that bearing conditions to support the proposed structure on concrete footings can be provided by the native silt to clayey silt
Settlements	The general limiting of the total settlement of 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate for the native soils at the site.
Earthquake Considerations	The subject property is considered to be a ‘D’ Site Class
Floor Slabs	The subgrade conditions can adequately support the concrete floor slab on grade, provided that areas of softened native soils are excavated to uncover, more competent soils underlying the soft sections.

CONSTRUCTION CONSIDERATIONS

Excavations	The subsurface soils to be encountered during excavation at the site are expected, in general, to behave as Type "3" materials according to the OHSA classification in Part III.
Dewatering	It is expected that any groundwater seepage during excavation work should be able to be controlled by pumping from sumps at the base of the excavation. If construction dewatering extracts groundwater exceeding 50,000 litres per day and less than 400,000 litres per day, the requirement is to register online with the MOECC Environmental Activity and Sector Registry (EASR). For amounts greater than 400,000 litres per day a Category 3 Permit To Take Water (herein “*PTTW*”) will be required.
Material Reuse	The native soils encountered on site are considered from a geotechnical perspective as suitable for re-use as engineered backfill.
Pavements	The subgrade soil should be inspected and proof-rolled using a loaded tandem axle truck to traverse the exposed subgrade, prior to the placement of pavement granular fill.

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1.0 INTRODUCTION

Landtek Limited (herein "*Landtek*") is pleased to submit the preliminary geotechnical investigation report for the proposed subdivision development at 469 Rice Road in Welland, Ontario. The work was authorized by Mr. Mike Schout on behalf of Schout Corporation (herein "*Schout*") in December 2017. All work was completed in accordance with our proposal reference P17386, dated December 6, 2017.

Limited information regarding the proposed development was available at the time of writing this report, with only a partial conceptual design available. From this, it is understood that the development is anticipated to comprise of residential building units. It is assumed that the residential units will include either a ground-bearing floor slab or a maximum of one level of basement, together with new access roads, at-grade paved parking areas, landscaping area, and full site servicing.

The primary objectives of this investigation were:

- To confirm the subsurface soil and groundwater conditions for foundation design and construction;
- Provide design and construction recommendations with regards to building foundations, floor slabs, pavement structures, and subsurface drainage and utilities; and,
- Assess the characteristics of the soils to be excavated and their suitability for reuse on site as fill material or/and disposal.

This report has been prepared for the client, their nominated engineers, designers, and project managers for the proposed residential development project at 469 Rice Road in Welland, Ontario. 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 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 nine boreholes (boreholes BH1 to BH9) were drilled on December 15, 2017. All boreholes were logged using those standard symbols and terms defined in Appendix B. The borehole location plan, Drawing 1, and the borehole logs are provided in Appendix C.

All boreholes were drilled using a Geoprobe 7822DT track-mounted drilling rig equipped with continuous flight, solid stem augers, and were advanced to a maximum depth of approximately 6.6 m below existing ground level.

A piezometer was installed in borehole BH3, to a depth of approximately 4.6 m below existing ground surface to monitor ground water conditions. The borehole log in Appendix C presents the piezometer installation details. A water level reading was completed on January 19, 2018.

Standard Penetration Tests (SPT's) and split spoon samples were taken during drilling at selected depths. Full time supervision of drilling and soil sampling operations was carried out by a representative of Landtek. The soil samples were then transported to Landtek`s in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture contents were carried out on all samples.

Elevations at the borehole locations were established by Landtek relative to site measurements using the top elevation of the existing garage concrete floor slab as the temporary benchmark (herein *"TBM").* An assumed elevation of 100.0 m was used for the TBM.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Location

The site is located in Welland, Ontario, and is centered at approximate grid reference 640690, 4765044 (UTM 17T coordinates). The Geodetic elevation of the ground surface at the borehole locations ranges between approximately 185 m and 186 m.

The site location is shown in Figure 1 below.

Figure 1
Site Location Plan

The site is the location of a relatively developed area of approximately 116,000 m^2 (28 acres). It is situated north of Quaker Road and east of Montgomery Road, and is bound to the east by Rice Road. A recreational building with associated paved parking is located on the site, with the remainder of the site covered with maintained grasses and a small number of trees.

3.2 Subsurface Conditions

Based on published geological information[1,2] and previous geotechnical[3] experience for the area, native subsurface soil conditions in the area of the site consist of glaciolacustrine deeper water clay and silt deposits. The bedrock in the area is identified as brown or tan dolostone of the Guelph Formation.

The borehole information is generally consistent with the geological data, and the predominant native soils comprise silt and clay deposits. No bedrock was encountered during this investigation. The detailed borehole logs are presented in Appendix C, and the ground conditions encountered by the boreholes are discussed further in the following sections.

Organic Soil

Topsoil was encountered at the ground surface in boreholes BH1, BH3 and BH7 and is approximately 150 mm thick.

Fill (Granular)

Pavement granular material was encountered in boreholes BH6 and BH8 at the ground surface, and consisted of approximately 300 mm to 450 mm of sand and gravel.

Fill

Fill material comprised predominantly of silt and clay was encountered at the ground surface and underlying the topsoil in all boreholes, and extends to a depth of between 1.5 m and 3.4 m (boreholes BH1 and BH7) below existing ground level. The fill material contains varying proportions of gravel, asphalt, and organics. The fill is brown and occasionally black.

SPT ‘N’ values ranging from 4 to 14 were reported, indicating the fill material to be moderately to well compacted. Moisture contents in the fill material range between 8 % and 37 %.

Silt to Clayey Silt

Native silt to clayey silt was encountered in all the boreholes at a depth of between 1.5 m (boreholes BH4, BH5, BH6 and BH7) and 3.4 m (boreholes BH1 and BH7), and extends to the terminus of the boreholes at a maximum depth of 6.6 m below existing ground level. The silt to clayey silt is brown and occasionally grey, and contains traces of fine sand and rust staining.

SPT ‘N’ values ranging from 3 to 67 were reported, indicating the silt to clayey silt to be of a very loose to very dense, but generally compact condition. Moisture contents in the silt to clayey silt range between 17 % and 29 %.

Bedrock

Bedrock was not encountered during this investigation.

Groundwater

Groundwater was encountered in boreholes BH5 and BH6 at depths of 2.1 m and 4.0 m below existing ground level respectively. All remaining boreholes encountered groundwater seepages. One monitoring well was installed in borehole BH3 and a water level reading completed on January 19, 2018 reported a groundwater level of 2.2 m below existing ground level.

It should be noted that these groundwater levels are not considered to reflect the longer term stabilized water table. Groundwater conditions are expected to vary according to the time of the year and seasonal precipitation levels. During wet weather, an increase in water seepage is to be expected in the shallow fill deposits.

4.0 FOUNDATION DESIGN CONSIDERATIONS

4.1 Foundations in Native Soils

Based on the ground conditions observed at the borehole locations, it is considered by Landtek that bearing conditions to support the proposed structures on concrete footings can be provided by the native silt to clayey silt. In the absence of preliminary design information, it has been assumed that the proposed residential properties will include either a ground-bearing floor slab or a maximum of one level of basement. Therefore, it is anticipated that the underside of footings will be at depths of approximately 1.2 m to 3.5 m below existing ground level.

The fill encountered in the boreholes is not considered suitable as a bearing stratum due to the high risk of unacceptable settlements. It should be noted, that the fill deposits extend to a depth of between 1.5 m and 3.4 m below existing ground level. It is recommended that the footings are extended to the underlying native soils or are founded on engineered fill.

Table 1 summarizes the 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 and engineered fill. It should be noted that the design parameters have been determined by Landtek for the design stage only.

Where the bearing levels of the footings are at different design elevations, the footing base levels should be stepped along a line of 10H:7V, 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.

Table 1: Recommended Limit State Foundation Design Values

Scenario	Proposed Founding Elevations		Founding Stratum	Foundation Design Value	
	Founding Depth	Approximate Geodetic Elevation		SLS [1,2]	ULS [3,4]
With Basement	2.5 m – 3.5 m	182.5 m – 181.5 m	Native Silt to Clayey Silt	150 kPa	225 kPa
No Basement	1.5 m	183.5 m	Native Silt to Clayey Silt	100 kPa	187.5 kPa

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.

4.2 Foundations on Engineered Fill

It is anticipated that engineered fill will be required to develop the necessary foundation subgrades in areas where existing fill material is encountered below the underside of the proposed footings elevations.

It is considered by Landtek that such relatively lightly loaded structures can be adequately supported by conventional strip or pad footings founded in engineered fill for a geotechnical reaction at the SLS of 100 kPa, and a factored geotechnical resistance at the ULS of 150 kPa. It should be noted however, that this is very much dependent upon the nature and condition of the fill placed, the condition of the sub-grade upon which it is being placed, and the methods adopted for the placement and compaction of the fill materials.

Where there is a requirement to raise the existing grade and generate the necessary founding subgrade, the engineered fill must be selected with care, then placed and compacted under strictly controlled conditions. The following recommendations are provided to address the selection of fill material as well as the placement and compaction of engineered fill.

- Processed imported granular material or consistent quality imported clean earth fill, can be considered for engineered fill provided the soil moisture content is within about 2 % of the optimum value of the material. Imported fill should meet the environmental requirements established for the site;
- Engineered fill should only be placed in an area that has been satisfactorily prepared by stripping existing fill and organic soils, and proof rolling the native exposed soil with at least five passes of a minimum 10-ton static pad-foot steel drum type roller;
- Engineered fill should be placed in maximum 300 mm, loose lifts and compacted to a target value of 100 % Standard Proctor Maximum Dry Density (herein "*SPMDD*"). The placement and compaction of each lift should be monitored full time by Landtek, with in-place compaction determined using nuclear moisture/density testing equipment;
- Fill layers that do not meet the compaction requirements, or become wet or frozen, should not be approved for the placement of additional material;
- For engineered fill placement over large areas of varying elevation, the locations of quality control density tests should be recorded by total station survey; and,
- As a precautionary measure and to mitigate cracking, it is recommended that reinforcing steel be provided in footings on engineered fill, and at the top of poured concrete foundation walls. Two 15M bars (continuous) are recommended as a minimum for footing placement. The Structural Engineer should be consulted to confirm the design of such steel reinforcement.

4.3 Frost Susceptibility

The native silt and clay deposits encountered at shallow depths 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 4.1 are considered to be below the maximum depth for frost penetration of 1.2 m in the Welland 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.

4.4 Settlement Considerations

Based on the outline information provided for the nature of the proposed redevelopment of the site, it is anticipated that the loads to be applied to the ground by any such structure will be generally moderate 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.

4.5 Seismic Design Considerations

In accordance with Table 4.1.8.4.A. of the Ontario Building Code (herein "*OBC*") the subject property is considered to be a 'D' 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. 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.

Should a higher classification be required, such as a Site Class 'C', then Shear Wave Velocity Testing should be undertaken using Multichannel Analysis of Surface Waves (MASW) methodologies.

4.6 Existing Building Demolition

It is understood that the existing building located on site will be demolished prior to construction of the proposed residential structures. For the purposes of this report, it has been assumed that the existing structures and all associated substructures will be removed in full prior to development.

Should there be a need to fill excavations created by the demolition of the existing structures with engineered fill or unshrinkable backfill prior to commencing the proposed development, Landtek should be contacted to determine the most appropriate placement requirements of the fill material.

5.0 FLOOR SLAB AND PERIMETER DRAINAGE CONSIDERATIONS

Based on the borehole soil conditions and preliminary design information provided to Landtek, it should be possible to construct the floor slab level using slab-on-grade methods. However, the depth and variation in fill materials may yield high degrees of differential settlements. Therefore, it is recommended that floor slab subgrades are sub-excavated approximately 0.5 m and engineered fill placed to redevelop the subgrade. Prior to the placement of the engineered fill, it is recommended that the area be assessed by Landtek to determine if there is a need for any local, remedial work. The assessment should include visual observation and proof rolling.

Any required grade raising below floor slabs or localized, 'soft-spot' remediation to the subgrade should be completed using select subgrade material placed per Sections 4.0 and 8.0 of this report. The select subgrade materials are to be compacted to a recommended target compaction of 100 % *"SPMDD,* with no individual test below 98 % SPMDD.

It is recommended that a minimum 150 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.

Perimeter drainage should be provided around all subsurface floor areas where water may accumulate. Underfloor drains may be required depending on excavation and groundwater seepage conditions. The drainage system should comply with the current OBC and associated amendments.

6.0 EARTH PRESSURE CONSIDERATIONS ON 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 expression (1) 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:

$$p = K (\delta \, h + q) \qquad (1)$$

where:

p = 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;

δ = 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

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

Granular B backfill should meet OPSS 1010 Type I or Type II material specifications. The granular fill should be compacted to a minimum of 97 % SPMDD, or to the levels and backfilling procedures specified.

Above any stabilized groundwater levels, the subsurface walls 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 walls are appropriately waterproofed where below any stabilized groundwater levels.

7.0 SUBSURFACE CONCRETE

7.1 General Considerations

The requirements for subsurface concrete subject to a sulphate environment are presented in Canadian Standards Association (CSA) specification CAN/CSA-A3000-13. Experience in the area indicates that the native soils generally have a mild sulphate environment and are not aggressive to concrete (CSA criteria of less than 0.2 % water soluble sulphate in the soils). It is recommended that subsurface concrete at the site have the following characteristics for an S-3 exposure class:

- minimum 28-day compressive strength = 25 MPa;
- minimum 56-day strength = 30 MPa;
- maximum water to cement ratio = 0.50;
- cementing materials:
  MS hydraulic cement or MSb; as per tables 3 and 4 respectively in CSA A23.1-04; and,
- air content:
  4 – 7 % for 14 mm to 20 mm nominal size coarse aggregate
  3 – 6 % for 28 mm to 40 mm nominal size coarse aggregate

7.2 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.

8.0 EXCAVATION AND BACKFILL CONSIDERATIONS

8.1 General Excavation Considerations

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 "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the generally compact native silt to clayey silt and fill material.

Given the size of the site and the anticipated maximum depths of excavation for the proposed structure, vertical cut excavations are not anticipated during the construction phase. It should be possible to excavate the overburden soils with a hydraulic backhoe. Moist Type 3 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e. 1V:1H). Slopes in any sand seams may undergo progressive sloughing and erosion due to exposure to the elements such that the overall slope becomes flatter than 45°.

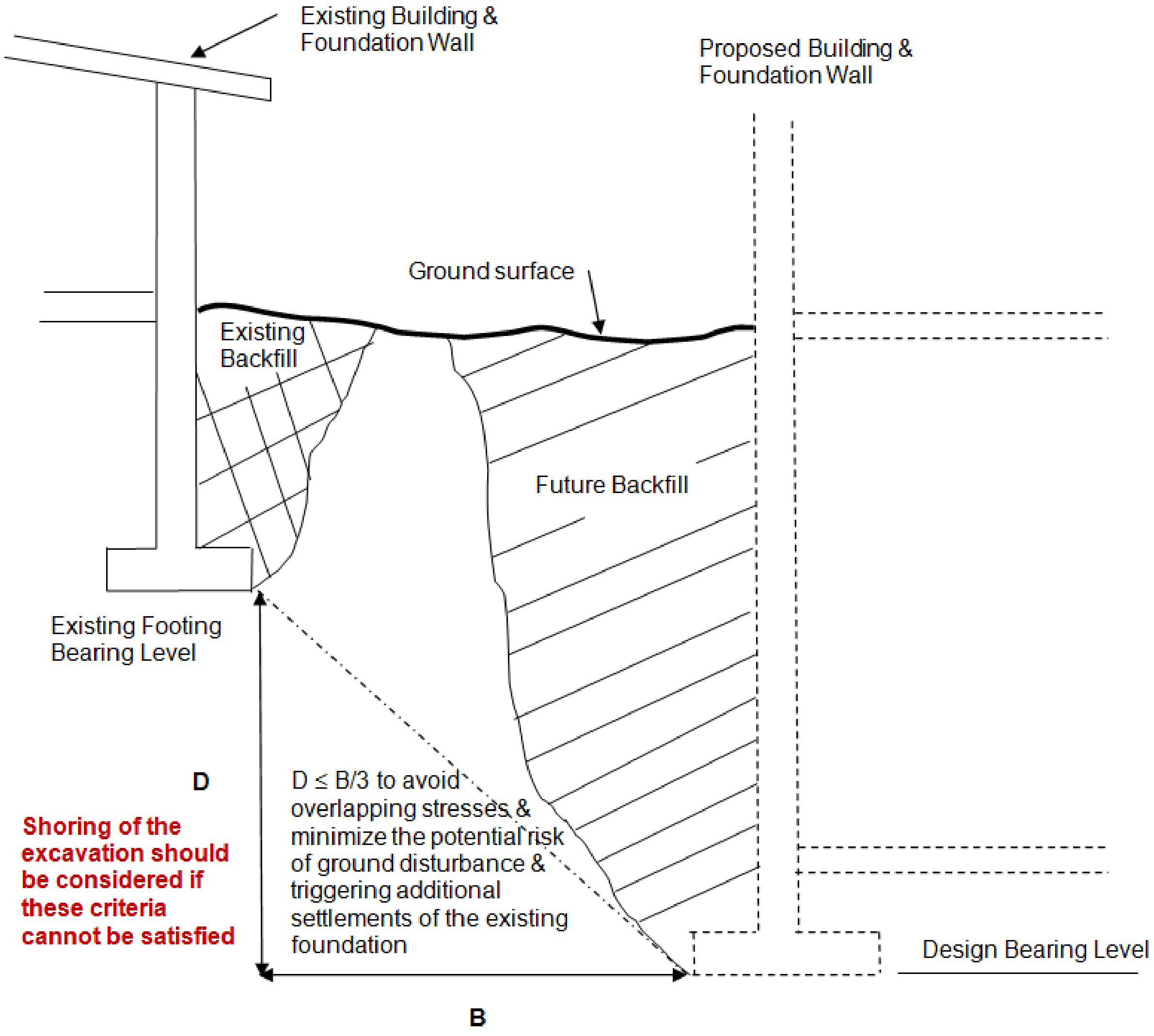
Consideration should be given to existing service trenches and backfill that may be present directly behind cut slopes within the native soils that may appear to be stable on first excavation. In these circumstances, slopes can suddenly slough or collapse due to the effects of the adjacent backfill. 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 service trench excavations, though may also apply to basement excavations etc., particularly where in close proximity to new road pavements or associated infrastructure.

It should be noted that the design of a temporary shoring system, should one be required, 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.

Groundwater seepage was encountered during this investigation in all boreholes, except boreholes BH5 and BH6, at a depth of between 2.1 m (borehole BH9) and 4.0 m (borehole BH1) below existing ground level. Groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction. It should be possible to control water seepage into excavations by pumping from sumps using perimeter drainage swales at the base of the excavations. Water seepage into open excavations is not expected to be a construction issue that would require a Permit To Take Water (herein "*PTTW*").

If groundwater dewatering volumes generated during construction are to exceed 50,000 litres per day, but are less than 400,000 litres per day, then the project will require registration online with the MOECC Environmental Activity and Sector Registry (EASR). For amounts greater than 400,000 litres per day a Category 3 Permit To Take Water (herein "*PTTW*") will be required.

Excavations for new foundations should satisfy the criteria given in the example shown in Figure 2 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.



Example: If the separation between existing and new proposed footings is 2 m the difference in bearing elevation should not exceed 0.67 m.

Figure 2
Criteria for Assessing Excavation Shoring Requirements (Not to Scale)

8.2 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 silt and clay soils 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.

9.0 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 OPSD 802.010 series (typical 150 mm for flexible pipes, OPSD 802.010, 802.013 and 802.014). The use of normal Class B type bedding is applicable for the pipe.

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 4.0 and 8.0.

10.0 PAVEMENT CONSIDERATIONS

It is anticipated that the development project will include for new access road and parking lot pavements, and new sidewalks.

10.1 Pavement Design Considerations

In the absence of anticipated traffic volumes or traffic loading requirements, the pavement structure thicknesses presented in Table 3 take 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, or as close as practicable for the given purpose of the pavement. For the Welland area, this is 1.2 m. Consideration has been also given to the Corporation of the City of Welland (herein "*City of Welland*") Engineering Standards (February 2013 update) for pavement design, Section 6.1.2

Table 2: Recommended Pavement Structure Layer Thicknesses

Pavement Layer	Road Pavement Design Section	Light Duty Parking Areas
Surface Course Asphalt OPSS HL 3	40 mm	40 mm
Binder Course Asphalt OPSS HL 8	80 mm	50 mm
Granular Base OPSS Granular A	450 mm[1]	350 mm[1]
Granular Subbase OPSS Granular A		
Total Thickness	570 mm	440 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.

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.

The following consideration should be maintained during paving:

- A tack coat should be applied to all contact surfaces prior to placing any hot mix asphalt layers or between asphaltic layers as per OPSS 308; and,
- The placing, spreading and rolling of the asphalt should be in accordance with current provincial standards.

In general, pavements that are proposed for larger scale, residential developments are constructed as two-stage paving operations. Where this is the case it is 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.

10.2 Pavement Materials

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.

Hot Mix Asphalt

The binder course and surface course asphalt should meet current specifications for HL 8 and HL 3 respectively, as prescribed by the City of Welland or, alternatively, OPSS 1150.

The standard asphalt binder grade for the climate conditions in the City of Welland is PG 58-28. Given the observed low volume of commercial truck traffic it is considered that there is no requirement for a bump up to a higher PG grade of asphalt cement.

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 City of Welland.

11.0 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

Isaac Asonya, EIT
Author

James Dann, B.Eng. (Hons)
Geotechnical Manager

LICENSED PROFESSIONAL ENGINEER
Jan. 23/18
R. DI CIENZO
PROVINCE OF ONTARIO

Ralph Di Cienzo, P. Eng.
Consulting Engineer

REFERENCES

[1] Freenstra, B.H, 1984 Quaternary Geology of Niagara-Welland Area, Map 2496, Quaternary Geology Series, Scale 1: 50 000, Geology 1969-1972.

[2] Telford, P.G., and Tarrant, G.A. Paleozoic Geology of the Welland-Fort Erie Area, Southern Ontario; Ontario Div. Mines, Prelim. Map P.989, Geol. Ser., scale 1:50,000. Geology 1974.

[3] Geotechnical Investigation Report, Proposed Subdivision Development, Webber Road and Murdoch Street, Welland, Ontario, Landtek Limited Report #17277, October 19, 2017.

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.

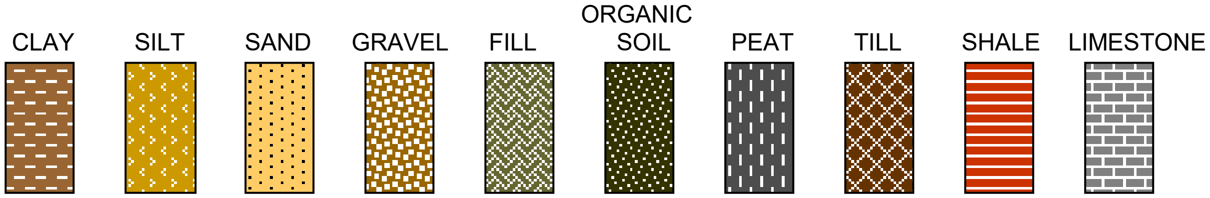
The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness 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

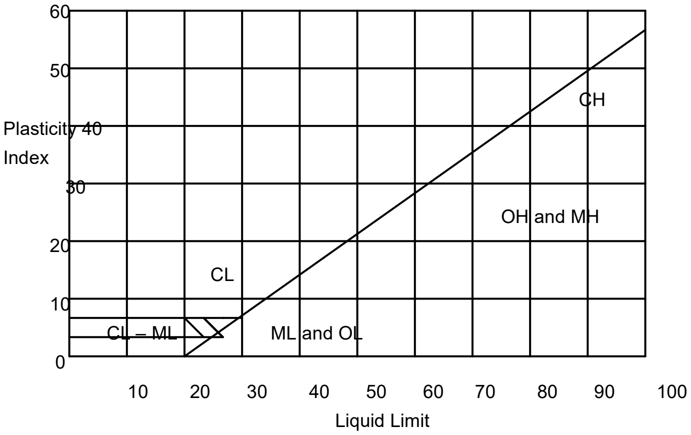
Descriptive Term	**Relative Density**	**Standard Penetration Test**
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over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

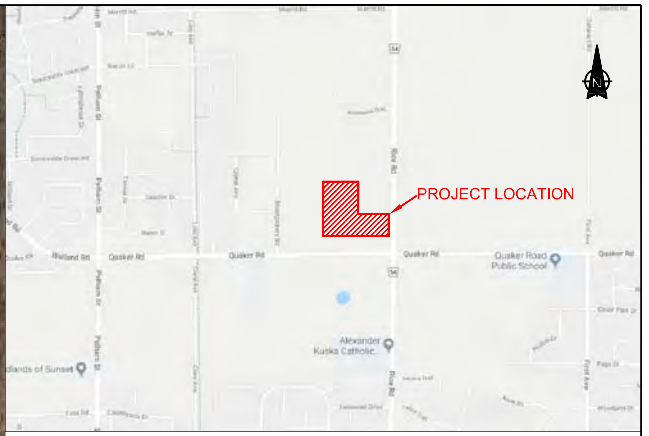
APPENDIX B CONTINUED
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

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 Less than 5% pass No. 200 sieve . . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; 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; 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 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. 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 1 - SITE PLAN SHOWING BOREHOLE LOCATIONS

LOGS OF BOREHOLES



Key Plan - NTS

LEGEND

- ● Approximate location of boreholes drilled by Landtek Limited on December 15, 2017.
- ● Approximate location of piezometer installed by Landtek Limited on December 15, 2017.
- ▲ TBM: top elevation of existing floor slab. Assumed elevation = 100.0m.

NOTES

1. Base plan provided by google maps.
2. Borehole locations are considered approximate.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING: Borehole Location Plan

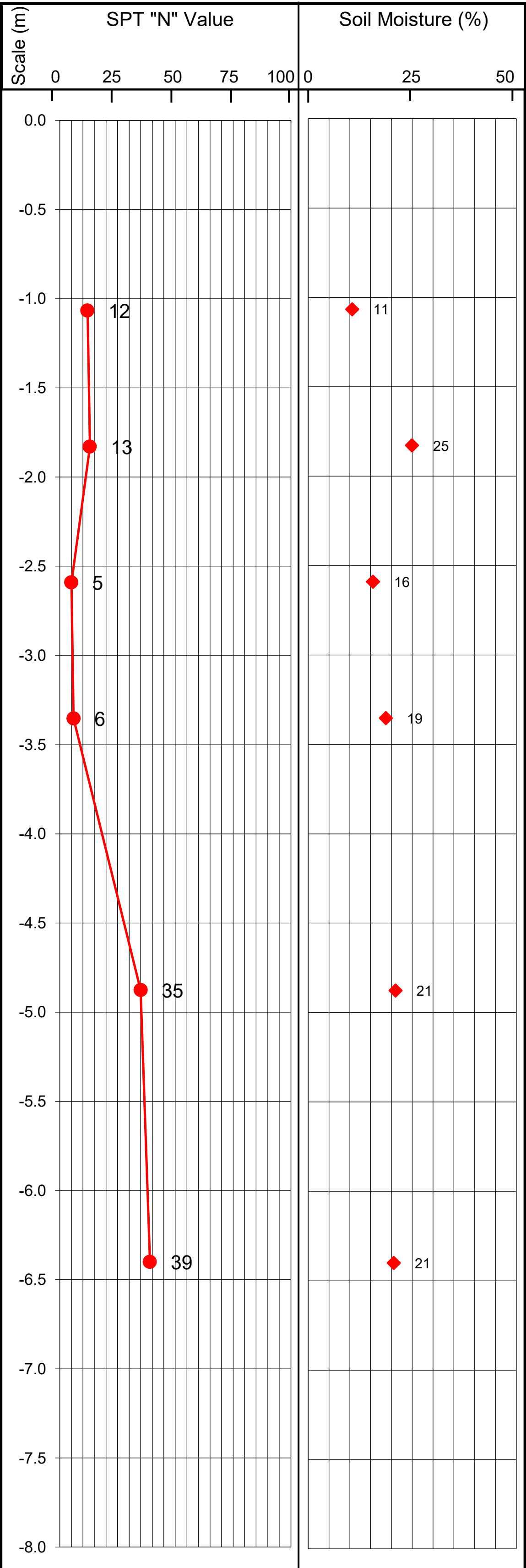
PROJECT: Preliminary Geotechnical Investigation Report
469 Rice Road, Welland, Ontario

SCALE:	NTS	**PROJECT NO.**	17480
DATE:	January, 2018	**DRAWING NO.**	1

LANDTEK LIMITED **BH 1**

Project No.: 17480
Project: Preliminary Geotechnical Investigation Report
Location: 469 Rice Road, Welland, Ontario
Drill Date: December 15, 2017
Drill Method: [ ] solid stem [x] hollow stem [ ] vibratory
Datum: TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		101.2					
±150 mm Topsoil		0.0					
FILL: clayey silt, some gravel, some asphalt, brown, stiff, moist			1	SS			
			2	SS			
		98.5	3	SS			
FILL: clayey silt, some organics, black, firm, moist		2.7 98.1					
FILL: silt, trace gravel, brown, firm, moist		3.1 97.8	4	SS			
SILT: homogeneous, trace fine sand, brown, dense, very moist at 4.0 m: wet		3.4					
			5	SS			
		94.6	6	SS			
BOREHOLE TERMINATED		6.6					



Notes: 1. On completion, borehole open to 6.0 m.
2. Groundwater seepage encountered at 4.0 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

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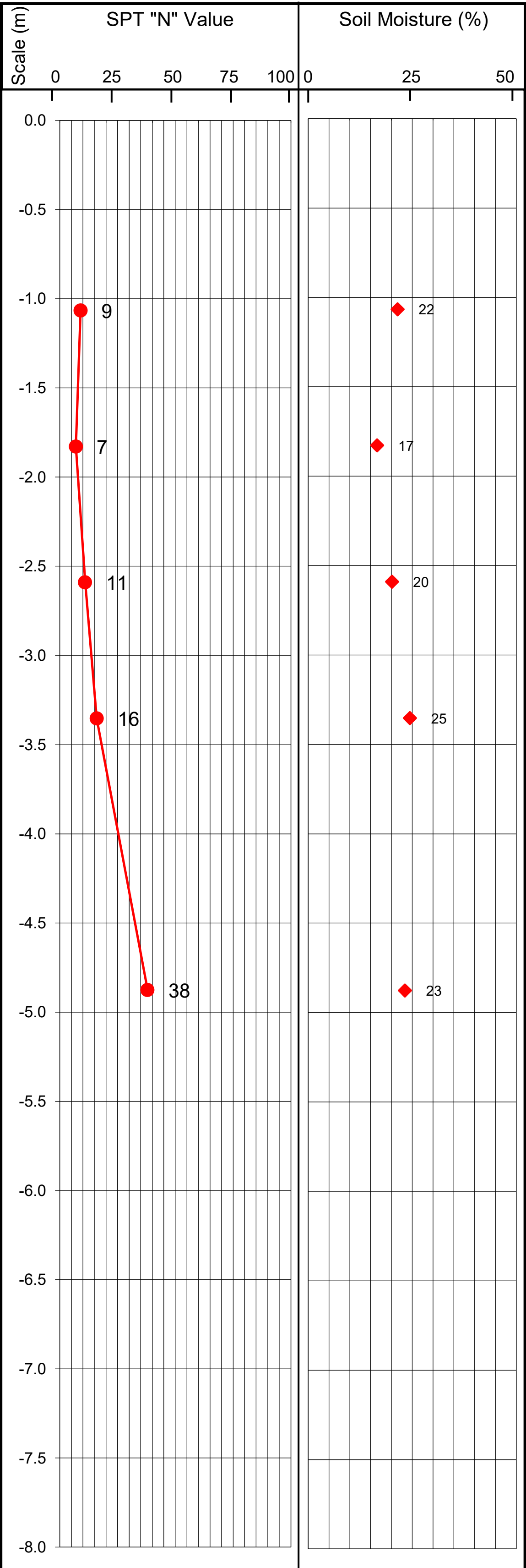
BH 2

Project No.: 17480
Project: Preliminary Geotechnical Investigation Report
Location: 469 Rice Road, Welland, Ontario

Drill Date: December 15, 2017
Drill Method: [ ] solid stem [x] hollow stem [ ] vibratory
Datum: TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		99.4					
FILL: silty clay, trace gravel, trace asphalt, brown, firm to stiff, moist	▨	0.0 97.9	1	SS			
FILL: silty clay, some gravel, brown, firm, moist at 2.1 m: wet	▨	1.5 97.1	2	SS			
SILT: homogeneous, trace fine sand, brown, compact, wet 3.0 m to 5.0 m: compact to dense, very moist	▨	2.3 94.4	3 4 5	SS SS SS			
BOREHOLE TERMINATED		5.0					



Notes:
1. On completion, borehole open to 4.5 m.
2. Groundwater seepage encountered at 2.1 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
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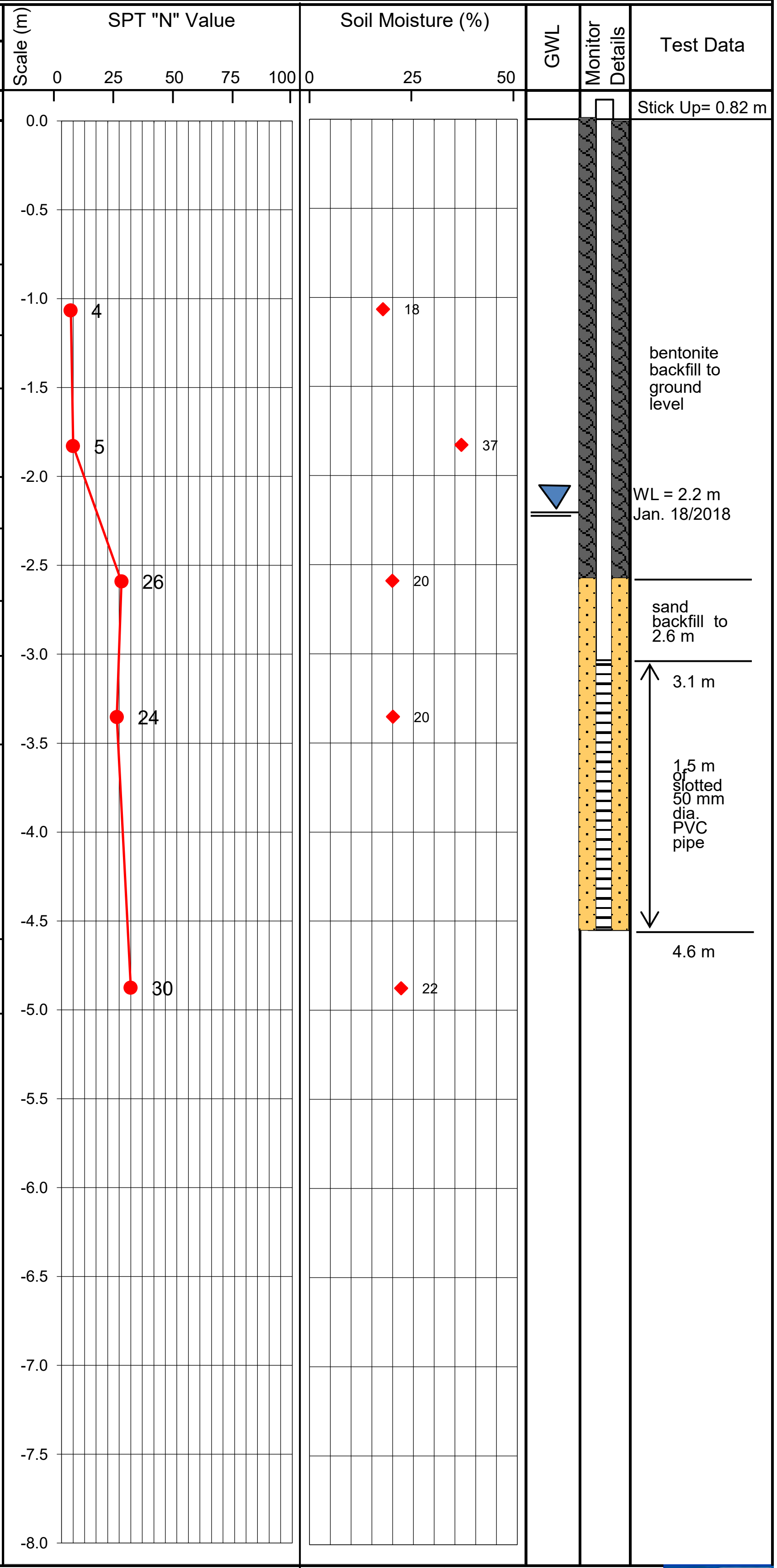
BH 3

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Elev. Depth	Samples No.	Type
Ground Surface	99.6		
±150 mm Topsoil	0.0		
FILL: clayey silt, some gravel, brown, soft, moist		1	SS
		2	SS
	97.6 2.0		
SILT (possible native): brown, firm, moist	97.3 2.3		
SILT: trace fine sand, brown, compact, very moist		3	SS
at 2.9 m: wet		4	SS
4.5 m to 5.0 m: dense		5	SS
	94.6 5.0		
BOREHOLE TERMINATED			



Notes:

1. On completion, borehole open to 4.5 m.
2. Groundwater seepage encountered at 2.9 m.
3. Water level measured at 2.2 m below ground surface on January 18, 2018

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density

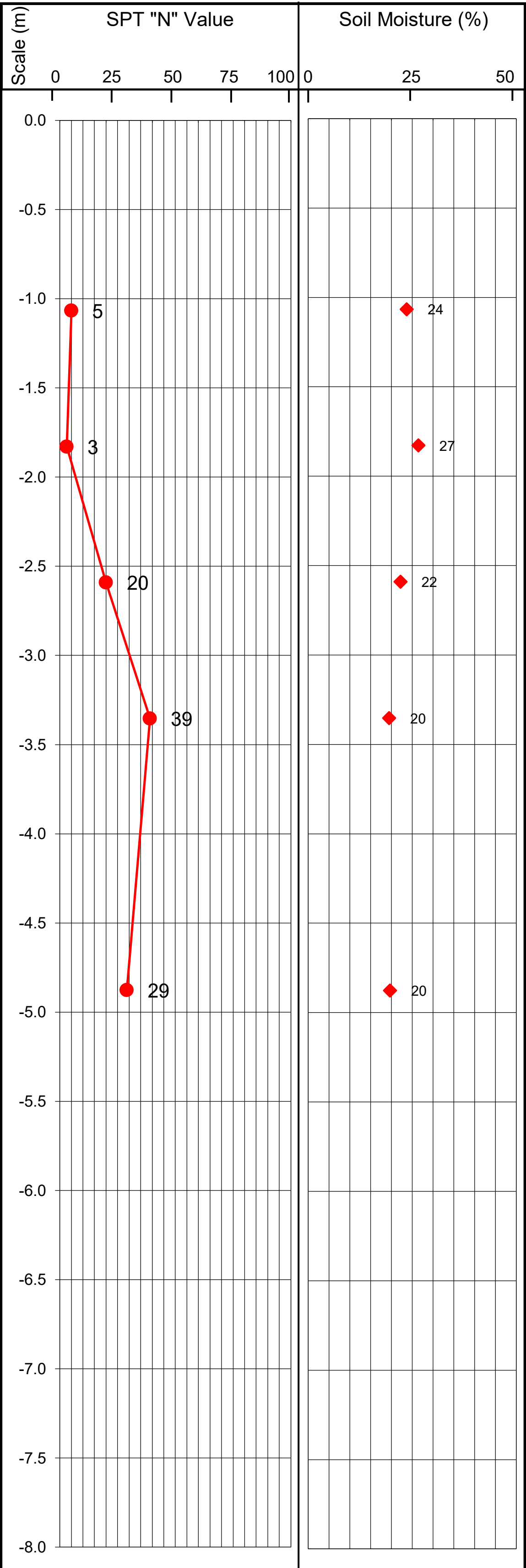
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

BH 4

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		100.0					
FILL: clayey silt, brown, firm, very moist	▨	0.0	1	SS			
		98.5					
SILT (possible native): trace fine sand, brown, very loose, very moist	▨	1.5	2	SS			
		97.4	3	SS			
SILT: homogeneous, trace fine sand, brown, compact to dense, wet 3.2 m to 5.0 m: moist to very moist	▨	2.6	4	SS			
			5	SS			
		95.0					
BOREHOLE TERMINATED		5.0					



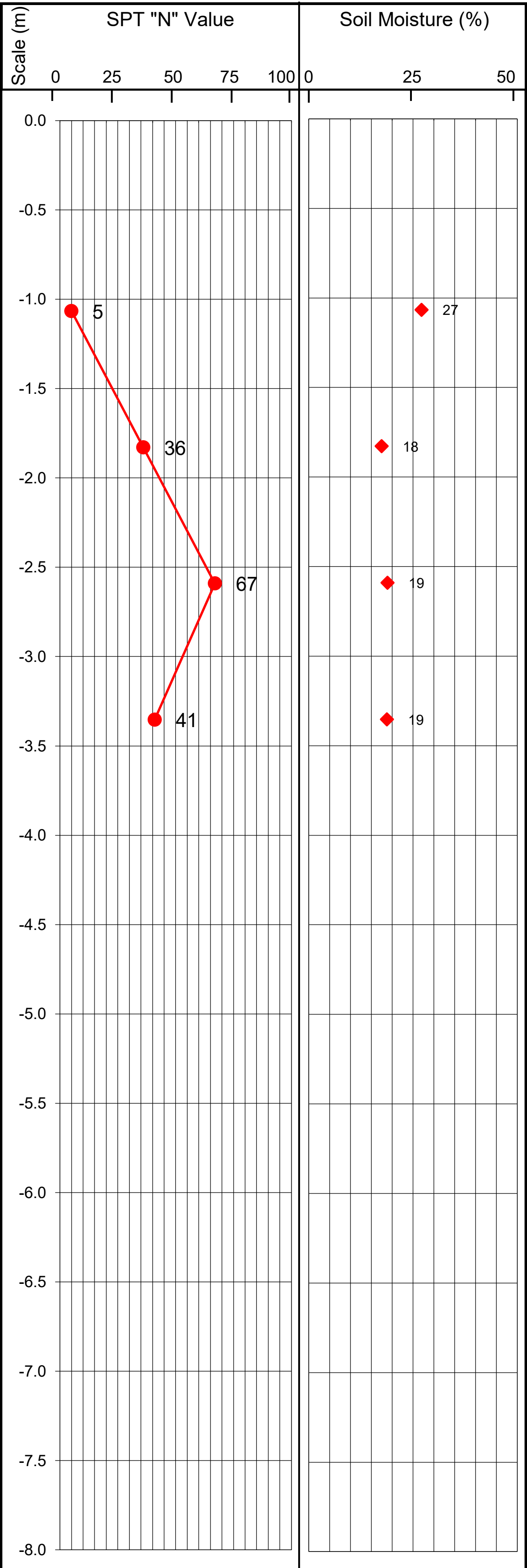
Notes: 1. On completion, borehole open to 4.5 m.
2. Groundwater seepage encountered at 2.3 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED **BH 5**

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type
Ground Surface		100.0		
FILL: silt, trace gravel, trace sand, brown, loose, very moist	▨	0.0 98.5	1	SS
SILT: homogeneous, trace fine sand, brown, dense to very dense, moist	▒	1.5 96.5	2 3 4	SS SS SS
BOREHOLE TERMINATED		3.5		



GWL | Monitor Details | Test Data

Notes:
1. On completion, borehole open to 3.0 m.
2. No groundwater seepage encountered.

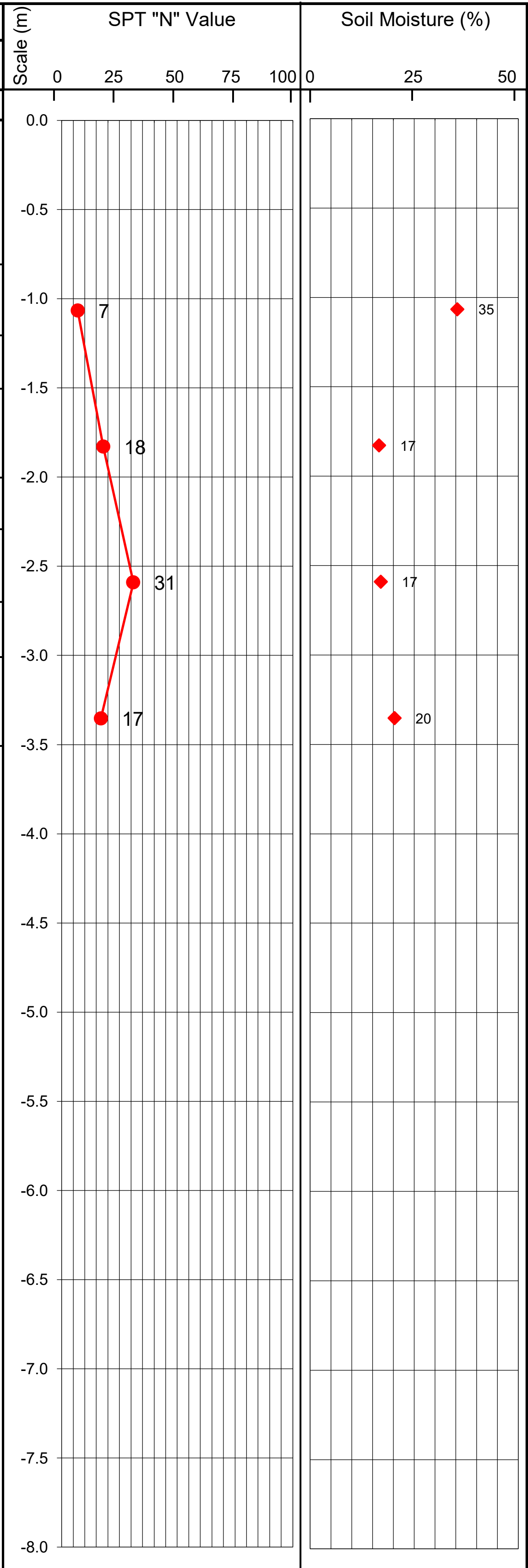
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

LANDTEK LIMITED **BH 6**

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type
Ground Surface		99.7		
FILL: sand and gravel	▨	0.0		
		99.3		
FILL: clayey silt, trace gravel, trace organics, black and brown, firm, moist	▨	0.45	1	SS
		98.2		
CLAYEY SILT: trace gravel, trace shale, brown, compact to dense, moist	▨	1.5	2	SS
			3	SS
3.0 m to 3.5 m: trace iron staining, brown and grey			4	SS
		96.2		
BOREHOLE TERMINATED		3.5		



GWL | Monitor Details | Test Data

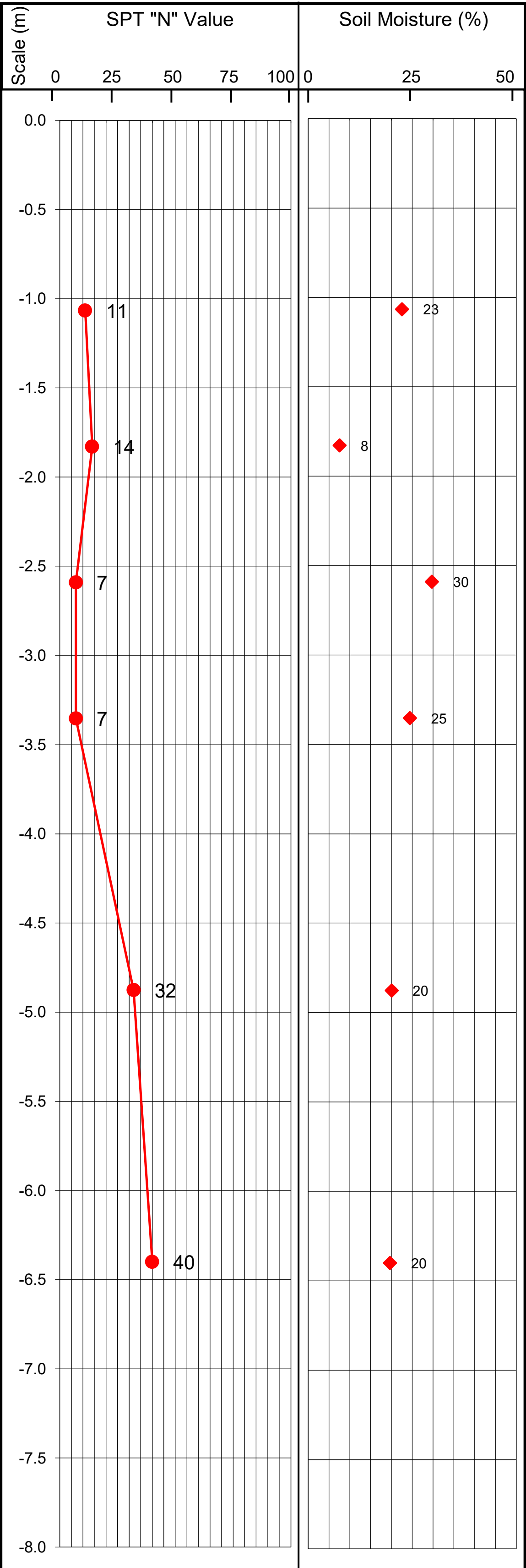
Notes: 1. On completion, borehole open to 3.0 m.
2. No groundwater seepage encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED BH 7

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		101.2					
±150 mm Topsoil	▨	0.0					
FILL: clayey silt, some gravel, some asphalt, brown, stiff, moist	▨		1	SS			
			2	SS			
FILL: clayey silt, some organics, black and grey, firm, moist	▨	98.6 2.6	3	SS			
			4	SS			
SILT: homogeneous, trace fine sand, brown, compact to dense, very moist at 3.7 m: wet	▨	97.8 3.4	5	SS			
			6	SS			
BOREHOLE TERMINATED		94.6 6.6					



Notes:
1. On completion, borehole open to 6.0 m.
2. Groundwater seepage encountered at 3.7 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

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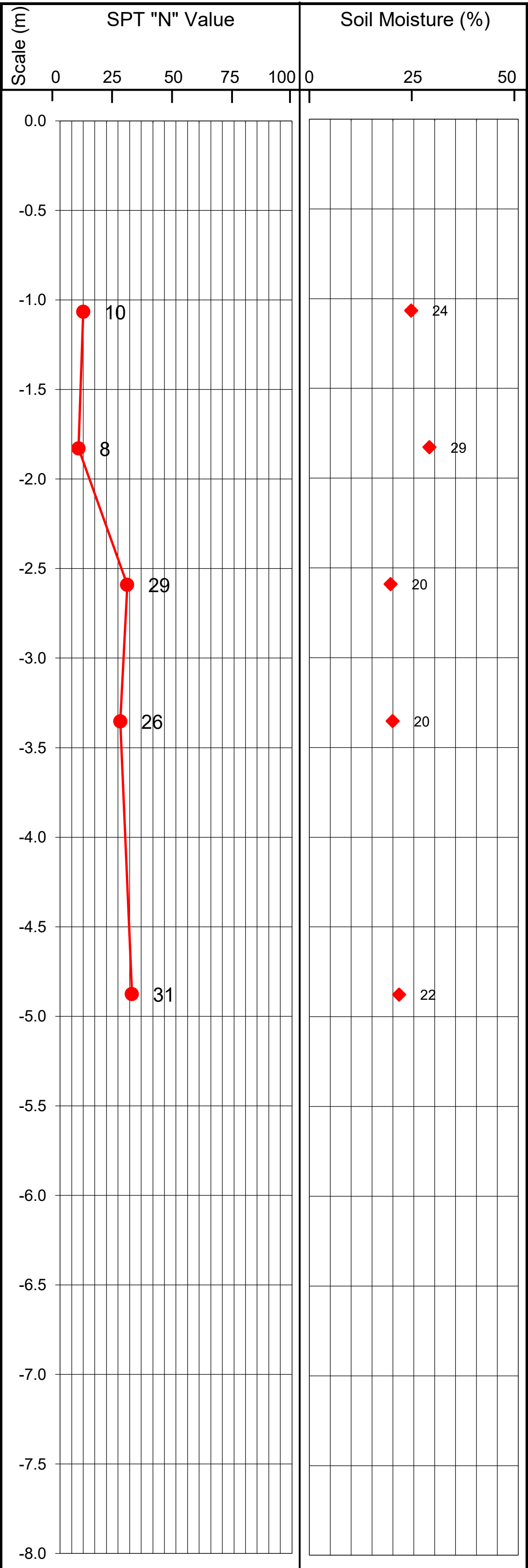
BH 8

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		99.2					
FILL: sand and gravel	▨	0.0 98.9					
FILL: clayey silt, some gravel, brown, stiff, moist	▨	0.3 97.7	1	SS			
CLAYEY SILT (possible native): some organics, black and grey, firm to stiff, moist	▨	1.5 96.6	2 3	SS SS			
SILT: homogeneous, trace fine sand, brown, compact to dense, very moist at 2.9 m: wet	▨	2.6 94.2	4 5	SS SS			
BOREHOLE TERMINATED		5.0					



Notes:
1. On completion, borehole open to 4.5 m.
2. Groundwater seepage encountered at 2.9 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

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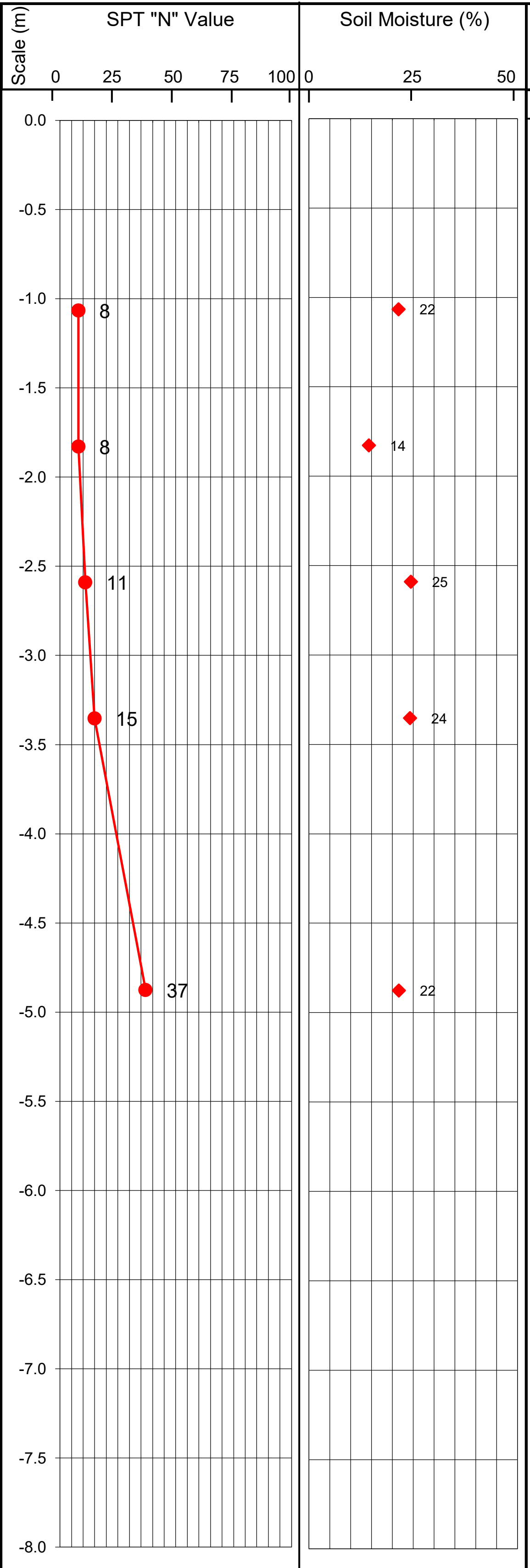
BH 9

Project No.:	17480	Drill Date:	December 15, 2017
Project:	Preliminary Geotechnical Investigation Report	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	469 Rice Road, Welland, Ontario	Datum:	TBM: assumed elevation = 100.00 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type
Ground Surface		99.4		
FILL: silty clay, trace gravel, brown, firm, moist		0.0		
			1	SS
1.5 m to 2.3 m: some gravel			2	SS
at 2.1 m: wet		97.1		
SILT: trace fine sand, brown, compact, wet		2.3	3	SS
3.0 m to 5.0 m: very moist			4	SS
4.5 m to 5.0 m: dense		94.4	5	SS
BOREHOLE TERMINATED		5.0		



GWL

Monitor Details

Test Data

Notes:
1. On completion, borehole open to 4.5 m.
2. Groundwater seepage encountered at 2.1 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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Hamilton, Ontario, Canada, L8W 2E1
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