**Soil Engineers Ltd.**
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE 100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

| BARRIE | MISSISSAUGA | OSHAWA | NEWMARKET | GRAVENHURST | HAMILTON |
|---|---|---|---|---|---|
| TEL: (705) 721-7863 | TEL: (905) 542-7605 | TEL: (905) 440-2040 | TEL: (905) 853-0647 | TEL: (705) 684-4242 | TEL: (905) 777-7956 |
| FAX: (705) 721-7864 | FAX: (905) 542-2769 | FAX: (905) 725-1315 | FAX: (905) 881-8335 | FAX: (705) 684-8522 | FAX: (905) 542-2769 |

**A REPORT TO**
**CEDAR CITY DEVELOPMENTS**

# PRELIMINARY GEOTECHNICAL INVESTIGATION FOR

# PROPOSED DEVELOPMENT

## 5916 TRAFALGAR ROAD NORTH

## TOWN OF ERIN (HILLSBURGH)

**REFERENCE NO. 2009-S020**

**OCTOBER 2020**

## DISTRIBUTION

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## 1.0 INTRODUCTION

In accordance with an email authorization dated September 2, 2020, from Mr. Steven Silverberg, President of Cedar City Developments, a geotechnical investigation was carried out at 5916 Trafalgar Road North in the Town of Erin (Hillsburgh).

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for a future development. Detailed design of the development is not available; the geotechnical findings and preliminary recommendations for development are presented in this report.

## 2.0 SITE AND PROJECT DESCRIPTION

The Town of Erin is located in a physiographical region known as Hillsburgh Sandhills where the topography is rough with flat-bottomed swampy valleys running through sandy knolls. Lacustrine sands, silts and clays, reworked till, and glaciolacustrine sediments were deposited on drift and ground moraines which had been partly eroded by the past glaciation.

The subject property at 5916 Trafalgar Road North in the Town of Erin (Hillsburgh) is approximately 47 hectares in area. It is located on the west side of Trafalgar Road North, approximately 650 m south of Sideroad 27. At the time of the investigation, the property was mostly a farm field, with farm buildings fronting Trafalgar Road North. The existing site gradient is undulating, having a difference in elevation of more than 20 m across the property.

Detailed design of the proposed development is not available at the time or report preparation. It is understood that it will likely be a mixed use residential subdivision development with municipal services and roadways.

## 3.0 FIELD WORK

The field work, consisting of twelve (12) sampled boreholes extending to depths ranging from 6.2 to 6.6 m from the prevailing ground surface, was performed on September 22 and 23, 2020, at the locations shown on the Borehole Location Plan, Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The test results are recorded as the Standard Penetration

Resistance (or 'N' values) of the subsoil. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

The ground elevation at each borehole location was obtained using a hand-held Global Navigation Satellite System (GNSS) equipment.

## 4.0 SUBSURFACE CONDITIONS

The investigation has disclosed that beneath a topsoil veneer, with a layer of earth fill and topsoil fill at one location, the site is generally underlain by strata of sandy silt till, silty sand till and sand. In place, a localized deposit of silt was also encountered.

Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 12, inclusive. The revealed stratigraphy is plotted in the Subsurface Profiles, Drawing Nos. 2 and 3. The engineering properties of the disclosed soils are discussed herein.

### 4.1 **Topsoil** (All Boreholes)

Boreholes were drilled in the farm field or open areas. The revealed topsoil ranges from 25 to 33 cm in thickness. Due to active farming activities, thicker topsoil layers can be anticipated in places, especially in low-lying areas. Diligent control of the stripping operation will be required to prevent overstripping for the development.

The topsoil is dark brown in colour, with appreciable amounts of roots and humus. It is considered to be void of engineering value and must be removed for development.

Due to its humus content, the topsoil will produce volatile gases and may generate an offensive odour under anaerobic conditions. It must not be buried within the building envelope or deeper than 1.2 m below the finished grade so it will not have an adverse impact on the environmental well-being of the developed area.

### 4.2 **Earth Fill and Topsoil Fill** (Borehole 6)

A layer of earth fill and topsoil fill was contacted in Borehole 6, extending to a depth of 3.0 m from grade. The earth fill consists of silty sand with organic inclusions while the topsoil fill is sandy in texture, with appreciable topsoil content.

The water content values of the earth fill samples are 9% and 12%; while the water content values for the topsoil fill are 11%, 13% and 19%, indicating damp to very moist conditions. The high water content value of 19% indicates the presence of topsoil in the fill.

The obtained 'N' values range from 4 to 11 blows per 30 cm of penetration. This indicates that the fill was non uniform in compaction.

The existing earth fill is not suitable for supporting structures. It must be subexcavated, sorted free of organics and deleterious material, inspected, and properly compacted. If it is impractical to sort the fill, then it must be wasted. The topsoil fill encountered on site should be further assessed to determine its suitability for reuse.

One must be aware that the samples retrieved from boreholes may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

### 4.3 **Sandy Silt Till and Silty Sand Till** (All Boreholes, except Boreholes 6 and 7)

The sandy silt till and silty sand till predominate the soil stratigraphy at the site. They consist of a random mixture of particle sizes ranging from clay to gravel, with either sand or silt being the dominant fractions. Hard resistance to augering was encountered occasionally, inferring the occurrence of cobbles and boulders in the till mantle. Grain size analyses were performed on 4 representative samples and the results are plotted on Figures 13 and 14.

The natural water content values of the till samples were determined; the results are plotted on the Borehole Logs. The obtained values range from 3% to 15%, with a median of 7%. This indicates that the tills are in a dry to very moist condition.

The obtained 'N' values range from 3 to more than 100, with a median of 39 blows per 30 cm of penetration. These values show that the relative density is very loose to very dense, being generally dense. The loose tills generally occur in the weathered zone near the ground surface, extending to a depth of 0.8 to 1.8 m from grade.
The engineering properties of the till deposit are listed below:

- High frost susceptibility and moderately low water erodibility.
- Relatively low to low permeability, with an estimated coefficient of permeability of $10^{-5}$ to $10^{-6}$ cm/sec, an estimated percolation rate of 30 to 50 min/cm and runoff coefficients of:

| Slope | |
|---|---|
| 0% - 2% | 0.11 to 0.15 |
| 2% - 6% | 0.16 to 0.20 |
| 6% + | 0.23 to 0.28 |

- The shear strength is primarily derived from internal friction and is augmented by cementation.
- The till deposit will generally be stable in relatively steep cuts; however, under prolonged exposure, localized sheet collapse may occur.
- Fair pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 8%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

## 4.4 **Sand** (All Boreholes, except Borehole 1)

The sand deposit was interstratified with the till deposit in 11 of the 12 boreholes. It is fine to medium grained, with a variable amount of silt. The sand is laminated with silt seams, showing a lacustrine deposit. Grain size analyses were performed on 3 representative samples and the results are plotted on Figure 15.

The obtained 'N' values range from 2 to over 100, with a median of 35 blows per 30 cm of penetration, indicating the sand is very loose to very dense, being generally dense in relative density. The natural water content of the sand samples was determined to range from 1% to 17%, with a median of 4%., indicating a dry to wet, generally damp condition.

The deduced engineering properties of the sand deposit are given below:

- Moderate to low frost susceptibility.
- High water erodibility.
- Pervious, with an estimated coefficient of permeability of $10^{-2}$ to $10^{-3}$ cm/sec, a percolation rate of 5 to 10 min/cm, and runoff coefficients of:

| Slope | |
|---|---|
| 0% - 2% | 0.04 |
| 2% - 6% | 0.09 |
| 2% - 6% | 0.13 |

- The shear strength is derived from internal friction and is directly dependent on soil density.
- In excavation, the sand will slough in a relatively steep slope. It will run with water seepage and boil under a piezometric head of 0.3 m.

- A fair pavement-supportive structure, with an estimated CBR value of 10%.
- Low corrosivity to buried metal, with an estimated electrical resistivity of 6500 ohm·cm.

## 4.5 **Silt** (Boreholes 1 and 2)

The silt stratum was contacted beneath the topsoil in the southwest sector of the property. It is very fine grained, with sand and clay seams and layers.

The natural water content of the soil samples was determined; the values range from 8% to 16%, with a median of 13%, indicating moist to very moist conditions.

The obtained 'N' values range from 6 to 27, with a median of 8 blows per 30 cm of penetration, indicating the deposit is loose to compact, being generally loose in relative density. The loose silt is the result of weathering near the ground surface, which extends up to a depth of 1.8 m from grade.

The engineering properties relating to the project are given below:

- High frost susceptibility, with high soil-adfreezing potential.
- High water erodibility; it is susceptible to migration through small openings under seepage pressure.
- Relatively low permeability, with an estimated coefficient of permeability of $10^{-5}$ cm/sec, a percolation rate of 30 to 40 min/cm and the runoff coefficients of:

| **Slope** | |
|---|---|
| 0% - 2% | 0.11 |
| 2% - 6% | 0.16 |
| 6% + | 0.23 |

- The shear strength is derived from internal friction, which is density dependent.
- In excavation, the silt will slough and run slowly with seepage bleeding from the cut face. It will boil with a piezometric head of 0.4 m.
- Poor pavement-supportive material, with an estimated CBR value of 3%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4500 ohm·cm.

## 4.6 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

**Table 1** - Estimated Water Content for Compaction of On-Site Material

| **Soil Type** | **Determined Natural Water Content (%)** | **Water Content (%) for Standard Proctor Compaction** | |
|---|---|---|---|
| | | **100% (optimum)** | **Range for 95% or +** |
| Existing Earth Fill | 9 and 12 | 12 to 15 | 8 to 18 |
| Silt/Sand | 1 to 17 (median 4 and 13) | 11 and 12 | 6 to 15 |
| Silt Till/Sand Till | 3 to 15 (median 7) | 12 | 8 to 15 |

The above values show that part of the in situ soils are either too dry or too wet and will require aeration or wetting for a 95% or + Standard Proctor compaction. The wet materials must be aerated by spreading them thinly on the ground in dry and warm weather, prior to structural compaction. Alternatively, the wet sand and silt can be mixed with the drier tills.

Weathered soils and earth fill should be screened, segregated the organics and deleterious material before reuse as structural backfill. The earth fill must be sorted free of topsoil and deleterious materials prior to reuse as structural fill. If it is impractical to sort the fill, then it must be wasted. The topsoil fill must be further assessed to determine its suitability for reuse.

When compacting the very dense till on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts of these soils must be limited to 20 cm or less (before compaction). The presence of boulders will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders is mixed with the material, it must either be sorted or must not be used for structural backfill.

If the compaction of the soils is carried out with the water content within the range for 95% Standard Proctor dry density but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for road construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement. The foundations or bedding of the sewer and slab-on-grade, on the other hand, will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.

One should be aware that 90%± Standard Proctor compaction of the wet organic sand and silt is achievable. Further densification is prevented by the pore pressure induced by the compactive effort; however, large random voids will have been expelled, and with time the pore pressure will dissipate and the percentage of compaction will increase. There are many cases on record where after a few weeks to months of rest, the density of the compacted mantle has increased to over 95% of its maximum Standard Proctor dry density.

## 5.0 GROUNDWATER CONDITIONS

All boreholes remained dry and open upon completion of drilling. Minor seepage was encountered in the sand deposit in Borehole 9 at a depth of 6.0 m from grade. The groundwater level will fluctuate with seasons.

In excavation, where groundwater seepage is encountered, the yield is expected to be small to some in the till and appreciable and maybe persistent in the sand and silt.

## 6.0 DISCUSSION AND RECOMMENDATIONS

This investigation has disclosed that beneath a topsoil veneer, with a layer of earth fill and topsoil fill at Borehole 6, the site is underlain by strata of sandy silt till, silty sand till and sand, very loose to very dense, generally dense in relative density. A localized deposit of loose to compact silt was contacted near the ground surface. The very loose to loose condition in the revealed soil stratigraphy is the result of weathering near the ground surface, which extends up to a depth of 0.8 to 1.8 m from grade.

All boreholes remained dry and open upon completion of the borehole drilling. Minor seepage was contacted in Borehole 9 at a depth of 6.0 m from grade. The groundwater level will fluctuate with the seasons.

The future development at the property will likely be a mixed use residential subdivision development with municipal services and roadways. The geotechnical findings warranting special consideration for the proposed project are presented below:

1. The existing site gradient is undulating. The site will have to be regraded for the proposed development. Prior to site grading with cut and fill, the topsoil veneer

should be completely removed. The earth fill and topsoil fill should be excavated, examined, sorted free of topsoil and deleterious material before reuse for filling. If it is impractical to sort the fill, then it must be wasted.

2. After demolition of the existing structures and foundations, the debris must be removed and disposed off-site.
3. In areas where earth fill is required to raise the site, it is generally more economical to place an engineered fill for normal footing, underground services and pavement construction.
4. The proposed structures can be constructed on conventional footings founded in the engineered fill or sound natural soils.
5. The footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer to assess its suitability for bearing the foundations.
6. Additional boreholes may be required to elaborate the subsoil and groundwater conditions once the design for the proposed development is finalized.

The recommendations appropriate for the design of the development are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should subsurface variances become apparent during construction, a geotechnical engineer must be consulted.

## 6.1 Site Preparation

The existing site gradient is undulating. The site will have to be regraded for the proposed development.

Prior to site grading with cut and fill, the existing topsoil should be completely removed. The earth fill and topsoil fill should be excavated, examined, sorted free of topsoil and deleterious material before reuse for filling, otherwise they have to be removed.

The existing structures and foundations must be demolished and the debris must be removed and disposed off-site. The backfill must be free of topsoil or deleterious material, placed and compacted to engineered fill specifications.

The existing earth fill, topsoil fill, disturbed soils and weathered soils must be sub-excavated, sorted free of topsoil and organics or further assessed for suitability of engineered fill uses.

The requirements for the engineered fill are presented below:

1. After removal of topsoil, earth fill, topsoil fill and unsuitable material, the native soil subgrade must be inspected and proof-rolled prior to any fill placement.
2. Inorganic soils must be used for the fill, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of the maximum Standard Proctor dry density up to the proposed finished grade. The soil moisture must be properly controlled near the optimum. If the foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% of the maximum Standard Proctor compaction.
3. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not begin until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
4. If imported fill is to be used, it should be inorganic soils, free of any deleterious material with environmental issue (contamination). Any potential imported earth fill from off-site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
5. The engineered fill must not be placed during the period from late November to early April when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
6. The fill operation must be fully supervised and monitored by a technician under the direction of a geotechnical engineer.
7. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
8. The engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented.
9. Foundations founded on engineered fill must be reinforced by at least two 15-mm steel reinforcing bars in the footings and in the upper section of the foundation walls, or be designed by a structural engineer, to properly distribute the stress induced by the abrupt differential settlement (about 15 mm) between the natural soil and engineered fill.
10. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who supervised the fill placement in order to document the locations of excavation and/or to supervise reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
11. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that supervised the engineered fill placement. This is to ensure that the

foundations and service pipes are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.

## 6.2 Foundation

The proposed structures can be supported on conventional spread and strip footings, founded on the undisturbed native soil or engineered fill. The recommended soil bearing pressures for the design of conventional footings are provided below:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 240 kPa

The total and differential settlements of structures designing for the bearing pressure at SLS are estimated within 25 mm and 20 mm, respectively.

Foundations exposed to weathering or in unheated areas should have at least 1.5 m of earth cover for protection against frost action. In heated areas, the earth cover can be reduced to 1.2 m.

During construction, the subgrade soils of foundations should be inspected by the geotechnical engineer to ensure that the conditions are compatible with the design of the foundations.

If water seepage is encountered in excavation, the foundation must be poured immediately after subgrade inspection or the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification of the bearing subsoil.

The building foundation should meet the requirements specified in the latest Ontario Building Code and the structures should be designed to resist an earthquake force using Site Classification ‘D’ (stiff soil).

## 6.3 Basement Structures

All boreholes remained dry upon completion of the fieldwork. In conventional basement construction, the basement structures should be provided with perimeter drainage system (Drawing No. 4), connecting into a positive outlet or sewer system. The subdrains should be encased in a fabric filter to protect them against blockage by silting. If the basement structure is within 1.0 m above the high groundwater regime, underfloor subdrain should be placed in the slab bedding, with a 6 mil vapour barrier above the obvert of the subdrain to prevent upfiltrating moisture from dampening the floor slab.

Both the perimeter and underfloor subdrain systems should be drained into the municipal storm sewer system by gravity or into a sump pit where the water can be removed by pumping. In addition, the external grading should be designed to drain the surface runoff away from the building structures.

The soil parameters stated in Section 6.8 can be used to evaluate the earth pressure on the foundation walls. The exterior must be graded to direct runoff away from the structures.

The basement floor slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm clear limestone, or equivalent. The subgrade for the slab-on-grade floor should consist of sound natural soils or properly compacted inorganic earth fill, compacted to 98% of the maximum Standard Proctor dry density.

A Modulus of Subgrade Reaction of 35 MPa/m can be used for the design of the floor slab.

## 6.4 Underground Services

The underground services should be founded on sound natural soil or properly compacted inorganic earth fill. Where incompetent or weathered soil is encountered, it should be subexcavated and replaced with the bedding material, compacted to at least 95% Standard Proctor dry density.

A Class ‘B’ bedding is recommended for the underground services construction. It should consist of compacted 20-mm Crusher-Run Limestone, or equivalent, as approved by a geotechnical engineer. Where the subgrade consists of saturated soil, with continuous seepage of groundwater, a Class ‘A’ concrete bedding is recommended.

The sewer joints into the manholes and catch basins must be leak-proof to prevent the migration of fines through the joints. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

In order to prevent pipe floatation when the sewer trench is deluged with water derived from infiltrated precipitation, a soil cover of at least two times the diameter of the pipe should be in place at all times after completion of the pipe installation.

The subgrade of the underground services may consist of soils which are considered to have moderately high electrical corrosivity to ductile iron pipes and metal fittings; therefore, the underground services should be protected against soil corrosion. For estimation for the anode weight requirements, the electrical resistivities of the disclosed soils can be used. The proposed anode weight must meet the minimum requirements as specified by the Town of Erin and/or Wellington County Standard.

## 6.5 **Backfilling in Trenches and Excavated Areas**

The backfill in service trenches should be compacted to at least 95% of its maximum Standard Proctor Dry Density (SPDD). Below concrete floor subgrade and in the zone within 1.0 m below the pavement, the material should be compacted with the water content 2% to 3% drier than the optimum; compacted to 98% of the respective SPDD.

Selected on site inorganic soils are suitable for use as trench backfill. The till should be sorted free of large cobbles and boulders (over 15 cm in size). In addition, some of the in situ soils are either too wet or too dry for 95% or + Standard Proctor compaction and will require aeration, wetting or proper mixing prior to its use as structural backfill.

In normal construction practice, the problem areas of pavement settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns, it is recommended that a sand backfill should be used.

The narrow trenches for services crossings should be cut at 1 vertical:2 horizontal so that the backfill in the trenches can be effectively compacted. Otherwise, soil arching in the trenches will prevent achievement of the proper compaction. In confined areas where the desired slope cannot be achieved or the operation of a proper kneading-type roller cannot be facilitated, imported sand fill, which can be appropriately compacted by using a smaller vibratory compactor, must be used. The interface of the native soils and the sand backfill will have to be flooded for a period of several days.

One must be aware of the possible consequences during trench backfilling and exercise caution as described below:

- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the sides is flattened to 1 vertical:2 horizontal, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% SPDD, with the moisture content on the wet side of the optimum.

- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand and the compaction must be carried out diligently prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.
- In areas where groundwater movement is expected in the pipe bedding or trench backfill mantle, anti-seepage collars (OPSS 802.095) should be provided.
- When construction is carried out in freezing weather, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent wetting of the backfill or when it is required, such as when the trench box is removed. The above will invariably cause backfill settlement in the next few years.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement.

## 6.6 **Slab-On-Grade, Garages and Driveways**

The on-site soils are mostly frost susceptible and the ground will be subject to frost heaving during cold weather. The pavement and sidewalk in open areas, thus, should be designed to tolerate the ground movement.

In areas where ground movement due to frost heave cannot be tolerated, the slab-on-grade, pavement, barrier free ramps and/or sidewalk can be constructed on a free-draining granular base of 0.3 to 1.2 m thick, depending on the degree of tolerance for settlement. These measures, with proper drainage, will prevent water from accumulating in the granular base.

Alternatively, they can be insulated with 50-mm Styrofoam, or its thermal equivalent.

The slab-on-grade in open areas should be designed to tolerate frost heave, and the grading around the slab-on-grade must be such that it directs runoff away from the surface.

## 6.7 **Pavement Design**

The pavement design for local and collector roads is presented in Table 2.

**Table 2** - Pavement Design

| Course | Thickness (mm) | OPS Specifications |
|---|---|---|
| Asphalt Surface | 40 | HL-3 |
| Asphalt Binder | | HL-8 |
| Local Road | 50 | |
| Collector Road | 65 | |
| Granular Base | 150 | OPSS Granular 'A' or equivalent |
| Granular Sub-base | | OPSS Granular 'B' or equivalent |
| Local Road | 300 | |
| Collector Road | 400 | |

In preparation of pavement subgrade, all topsoil and compressible material should be removed. The final subgrade must be proof-rolled using a heavy roller or loaded dump truck. Any soft spot as identified must be rectified by subexcavation and replacing with selected dry inorganic material. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum.

All the granular bases should be compacted in 150 to 200 mm lifts to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to saturate the mantle. The following measures should, therefore, be incorporated in the construction procedures and road design:

- The subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Lot areas adjacent to the roads should be properly graded to prevent ponding of large amounts of water. Otherwise, the water will seep into the subgrade mantle and induce a regression of the subgrade strength, with costly consequences for the pavement construction.
- Fabric filter-encased curb subdrains connecting to a positive outlet of catch basin, will be required on both sides of the roadway.

## 6.8 **Soil Parameters**

The recommended soil parameters for the project design are given in Table 3.

**Table 3** - Soil Parameters

| **Unit Weight and Bulk Factor** | **Unit Weight $\gamma$ ($kN/m^3$)** | | **Estimated Bulk Factor** | |
|---|---|---|---|---|
| | **Bulk** | **Submerged** | **Loose** | **Compacted** |
| Sandy Silt Till and Silty Sand Till | 22.5 | 12.5 | 1.30 | 1.05 |
| Earth Fill, Weathered Soil, Silt and Sand | 20.5 | 11.5 | 1.25 | 0.98 |
| **Lateral Earth Pressure Coefficients** | | **Active $K_a$** | **At Rest $K_o$** | **Passive $K_p$** |
| Compacted Earth Fill | | 0.40 | 0.55 | 2.50 |
| Native Till, Sand or Silt | | 0.30 | 0.45 | 3.30 |
| **Coefficients of Friction** | | | | |
| Between Concrete and Granular Base | | | | 0.50 |
| Between Concrete and Sound Natural Soils | | | | 0.35 |
| **Maximum Allowable Soil Pressure (SLS) For Thrust Block Design** | | | | |
| Engineered Fill and Sound Natural Soils | | | | 75 kPa |

## 6.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 4.

**Table 4** - Classification of Soils for Excavation

| Material | Type |
|---|---|
| Sound Till | 1 to 2 |
| Earth Fill, Weathered Soils, Sand or Silt in drained condition | 3 |
| Saturated Soils | 4 |

Groundwater derived from infiltrated surface water or precipitation may be encountered in excavation. Any groundwater seepage in shallow excavation can be controlled by normal pumping from sumps. In excavation extending into the saturated silt or sand, if encountered, the possibility of flowing sides and bottom boiling dictates that the ground be pre-drained or depressurized by pumping from closely spaced sump-wells or well points.

## 7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Cedar City Developments and for review by the designated consultants, contractors, financial institutions, and government agencies. The material in the report reflects the judgment of Kelvin Hung, P.Eng., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation.

Prospective contractors may be asked to assess the subsurface conditions for soil cuts and dewatering by digging test pits to the intended depth of trench excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions and to assess the proper dewatering scheme for the planned excavations.

**SOIL ENGINEERS LTD.**

LICENSED PROFESSIONAL ENGINEER
10/28/2020
K. W. K. HUNG
100124295
PROVINCE OF ONTARIO

Kelvin Hung, P.Eng.
KH/BL:dd

LICENSED PROFESSIONAL ENGINEER
Oct 28, 2020
B. P. Y. LEE
100104558
PROVINCE OF ONTARIO

Bernard Lee, P.Eng.

# LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

## SAMPLE TYPES

| | |
|---|---|
| AS | Auger sample |
| CS | Chunk sample |
| DO | Drive open (split spoon) |
| DS | Denison type sample |
| FS | Foil sample |
| RC | Rock core (with size and percentage recovery) |
| ST | Slotted tube |
| TO | Thin-walled, open |
| TP | Thin-walled, piston |
| WS | Wash sample |

## PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—•—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

| | |
|---|---|
| WH | Sampler advanced by static weight |
| PH | Sampler advanced by hydraulic pressure |
| PM | Sampler advanced by manual pressure |
| NP | No penetration |

## SOIL DESCRIPTION

Cohesionless Soils:

| 'N' (blows/ft) | Relative Density |
|---|---|
| 0 to 4 | very loose |
| 4 to 10 | loose |
| 10 to 30 | compact |
| 30 to 50 | dense |
| over 50 | very dense |

Cohesive Soils:

| Undrained Shear Strength (ksf) | 'N' (blows/ft) | Consistency |
|---|---|---|
| less than 0.25 | 0 to 2 | very soft |
| 0.25 to 0.50 | 2 to 4 | soft |
| 0.50 to 1.0 | 4 to 8 | firm |
| 1.0 to 2.0 | 8 to 16 | stiff |
| 2.0 to 4.0 | 16 to 32 | very stiff |
| over 4.0 | over 32 | hard |

Method of Determination of Undrained Shear Strength of Cohesive Soils:

| | |
|---|---|
| x 0.0 | Field vane test in borehole; the number denotes the sensitivity to remoulding |
| △ | Laboratory vane test |
| ☐ | Compression test in laboratory |

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

## METRIC CONVERSION FACTORS

1 ft = 0.3048 metres

1lb = 0.454 kg

1 inch = 25.4 mm

1ksf = 47.88 kPa

**Soil Engineers Ltd.**
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 1

**FIGURE NO.:** 1

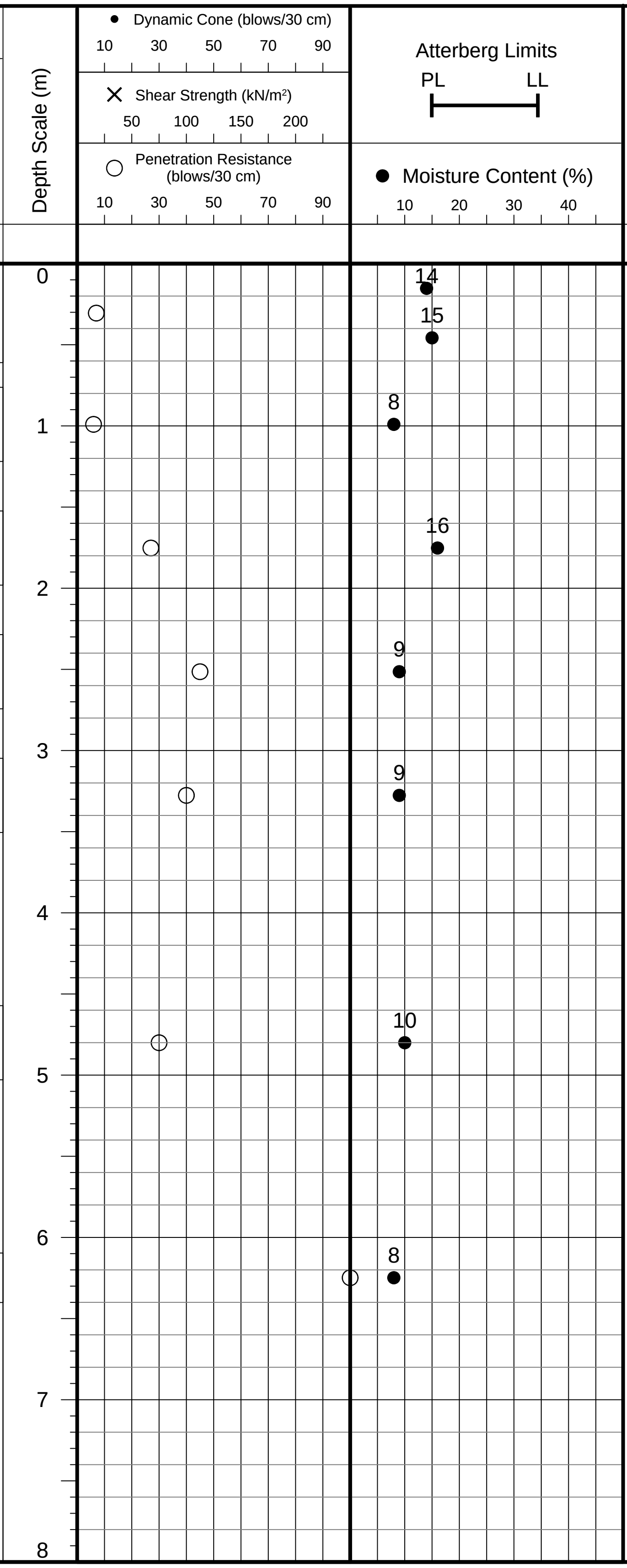
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 465.0 | Ground Surface | | | |
| 0.0 | **30 cm TOPSOIL** | 1A | DO | 7 |
| | Brown, loose to compact | 1B | | |
| | **SILT** | 2 | AS | 6 |
| | a trace of clay<br>a trace to some sand<br>occ. sand layer<br>weathered | 3 | DO | 27 |
| 462.7<br>2.3 | Brown, compact to very dense<br>sand pockets | 4 | DO | 45 |
| | | 5 | DO | 40 |
| | **SILTY SAND/SILTY SAND TILL** | | | |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles, boulders and rock fragments | 6 | DO | 30 |
| 458.6<br>6.4 | rock fragments | 7 | DO | 50/15 |
| | **END OF BOREHOLE** | | | |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 10

**FIGURE NO.:** 10

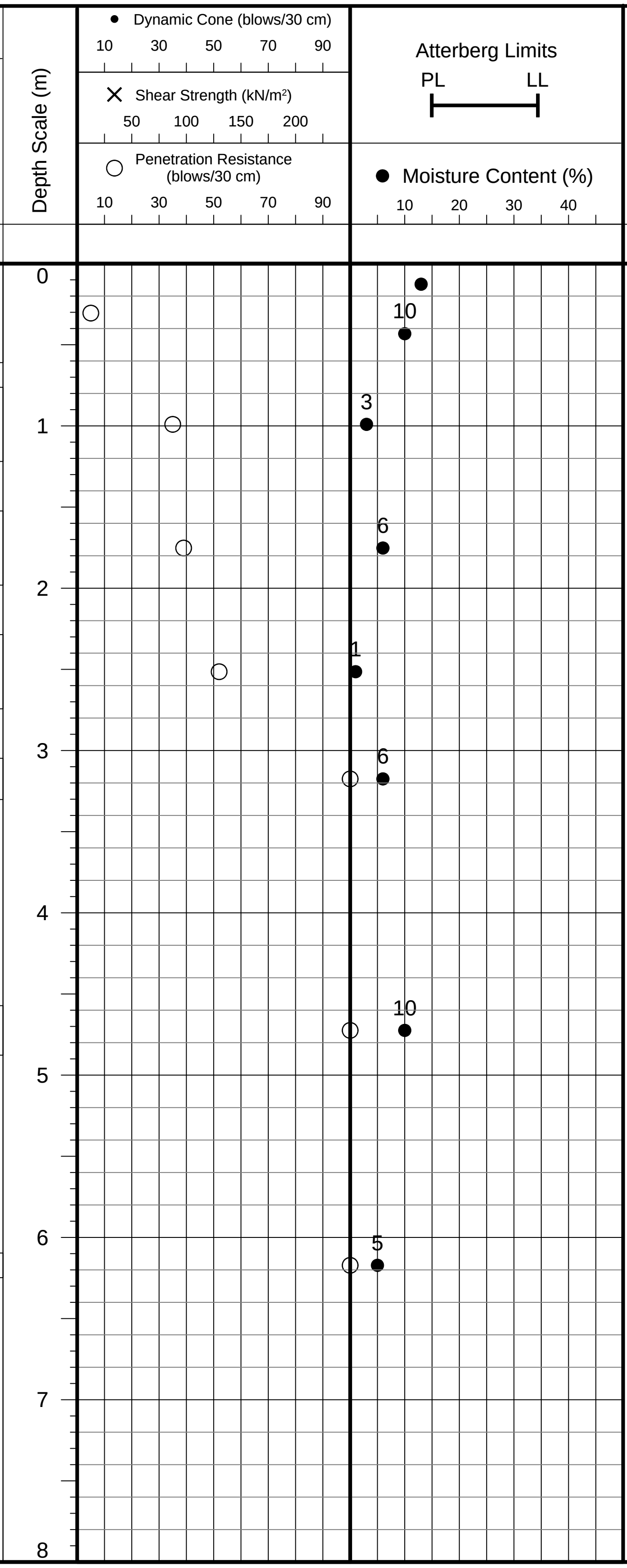
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 466.4 | Ground Surface | | | |
| 0.0 | **25 cm TOPSOIL** | 1A | DO | 5 |
| | Brown, loose to dense | 1B | | |
| | weathered<br>**SILTY SAND/SILTY SAND TILL** | 2 | DO | 35 |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 3 | DO | 39 |
| 464.1<br>2.3 | Brown, very dense<br>**SAND**<br>fine to medium grained<br>a trace of silt | 4 | DO | 52 |
| 463.4<br>3.0 | rock fragments<br>Brown, very dense | 5 | DO | 50/10 |
| | **SILTY SAND/SILTY SAND TILL** | | | |
| | boulder<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 6 | DO | 50/15 |
| 460.2<br>6.2 | **END OF BOREHOLE** | 7 | DO | 50/15 |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 11

**FIGURE NO.:** 11

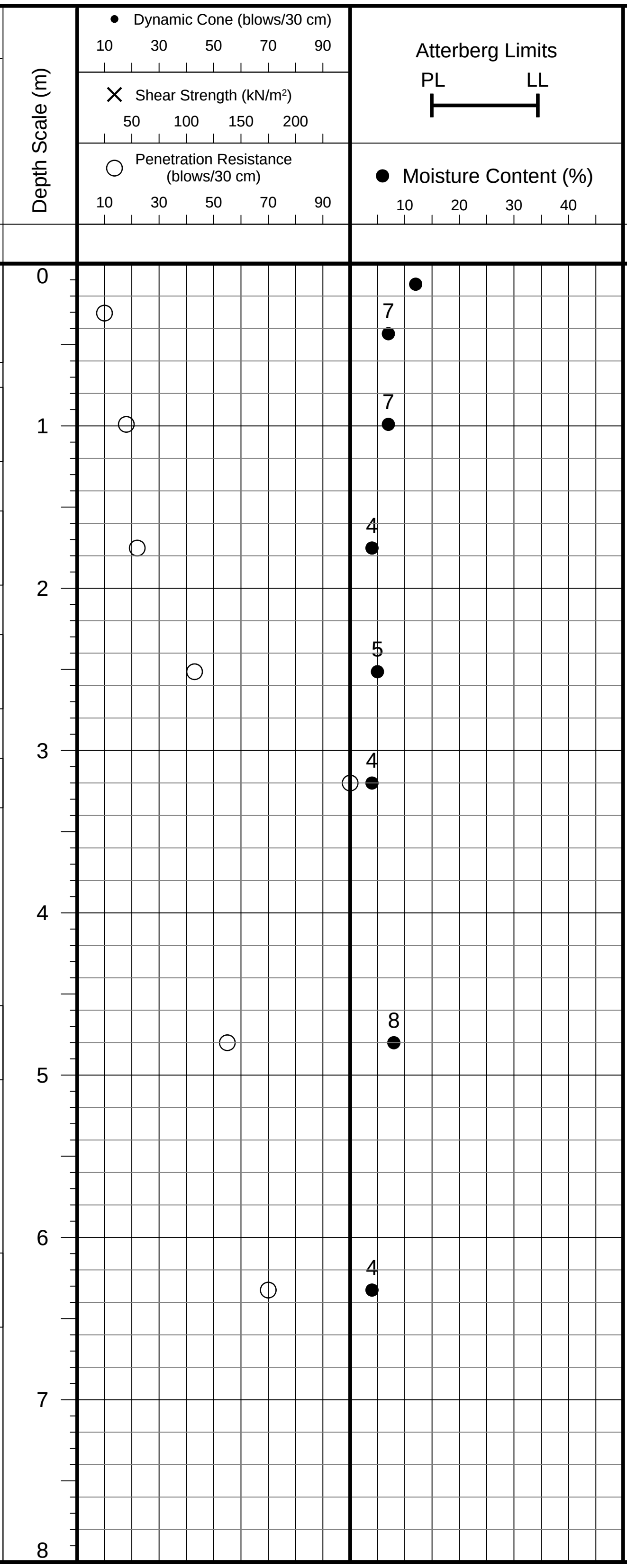
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | SAMPLES Type | SAMPLES N-Value | WATER LEVEL |
|---|---|---|---|---|---|
| 465.2 | Ground Surface | | | | |
| 0.0 | **25 cm TOPSOIL** | 1A | DO | 10 | Dry and open upon completion of the field work |
| | Brown, compact to very dense | 1B | | | |
| | weathered | | | | |
| | | 2 | DO | 18 | |
| | | 3 | DO | 22 | |
| | **SILTY SAND/SILTY SAND TILL** | | | | |
| | rock fragments | 4 | DO | 43 | |
| | rock fragments | 5 | DO | 50/15 | |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | | | | |
| | | 6 | DO | 55 | |
| 459.1<br>6.1 | Brown, very dense<br>**SAND**<br>fine to medium grained<br>some silt, a trace of gravel | 7 | DO | 70 | |
| 458.6<br>6.6 | **END OF BOREHOLE** | | | | |



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**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 12

**FIGURE NO.:** 12

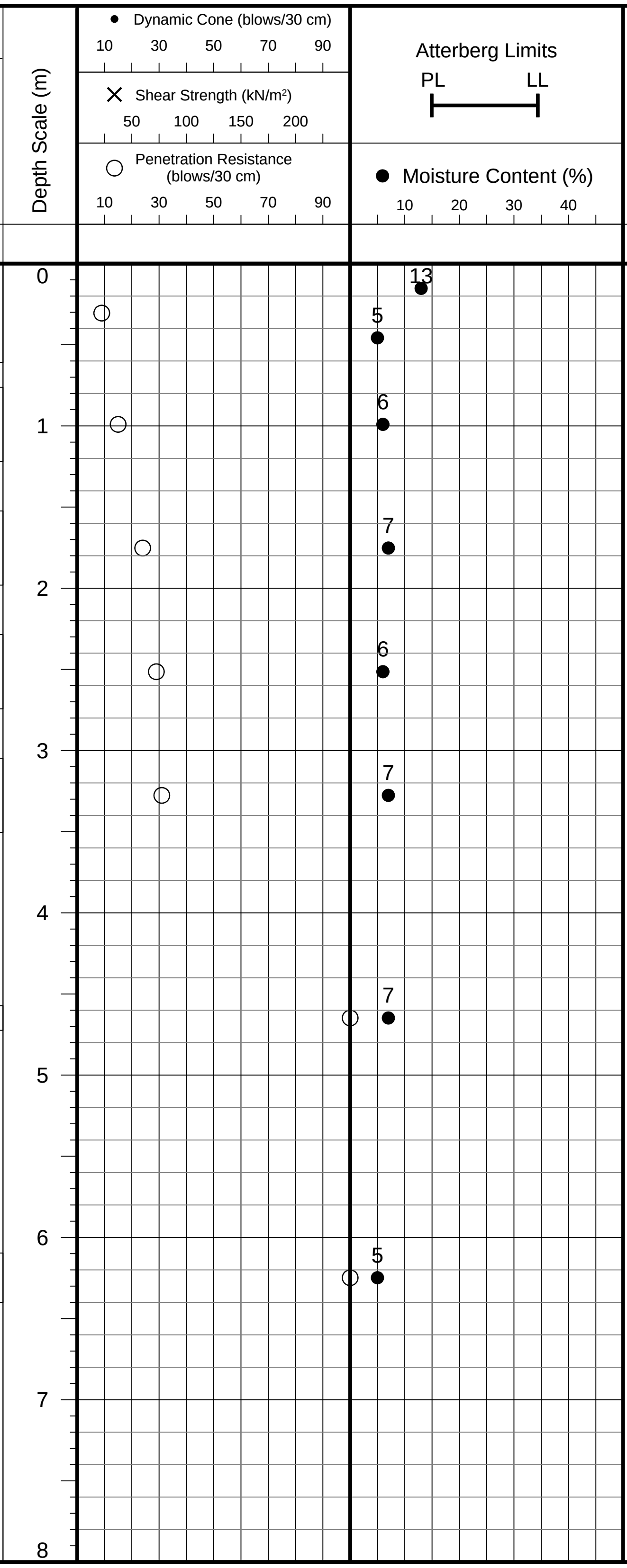
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 460.7<br>0.0 | Ground Surface<br>**30 cm TOPSOIL** | 1A | DO | 9 |
| | Brown, loose to very dense | 1B | | |
| | weathered | | | |
| | | 2 | DO | 15 |
| | | 3 | DO | 24 |
| | **SILTY SAND/SILTY SAND TILL** | 4 | DO | 29 |
| | | 5 | DO | 31 |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | | | |
| | | 6 | DO | 50/15 |
| 454.6<br>6.1 | Brown, very dense<br>**SAND**<br>fine to medium grained<br>a trace of silt | 7 | DO | 50/15 |
| 454.3<br>6.4 | **END OF BOREHOLE** | | | |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 2

**FIGURE NO.:** 2

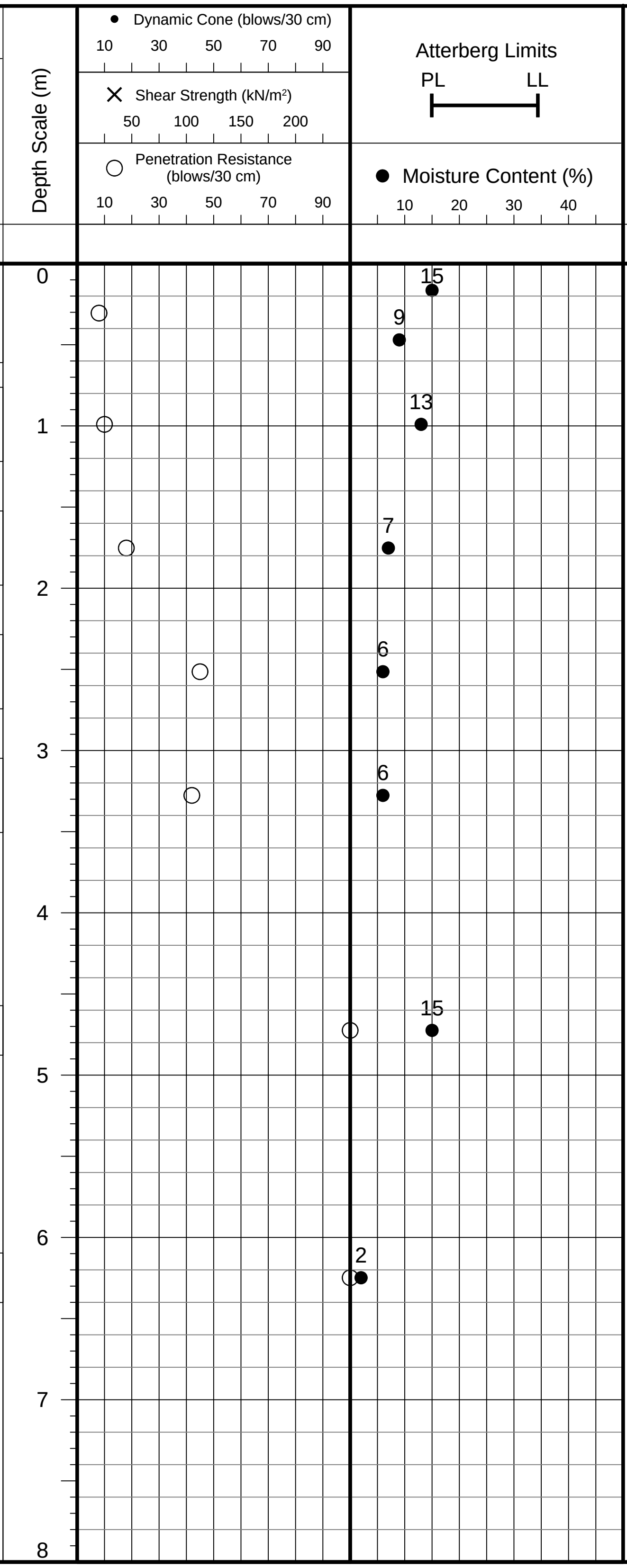
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | SAMPLES Type | SAMPLES N-Value | WATER LEVEL |
|---|---|---|---|---|---|
| 462.0 | Ground Surface | | | | |
| 0.0 | **33 cm TOPSOIL** | 1A | DO | 8 | Dry and open upon completion of the field work |
| | Brown, loose to compact, weathered<br>**SILT**<br>traces to some sand and clay<br>occ. clay layer | 1B | | | |
| | | 2 | DO | 10 | |
| 460.5<br>1.5 | Brown, compact to very dense<br>weathered | 3 | DO | 18 | |
| | rock fragments | 4 | DO | 45 | |
| | **SILTY SAND/SILTY SAND TILL**<br>rock fragments | 5 | DO | 42 | |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers,<br>cobbles, boulders and rock fragments | 6 | DO | 50/15 | |
| 455.9<br>6.1 | Brown, very dense<br>**SAND**<br>fine to medium grained, a trace of silt | 7 | DO | 50/15 | |
| 455.6<br>6.4 | **END OF BOREHOLE** | | | | |



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**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 3

**FIGURE NO.:** 3

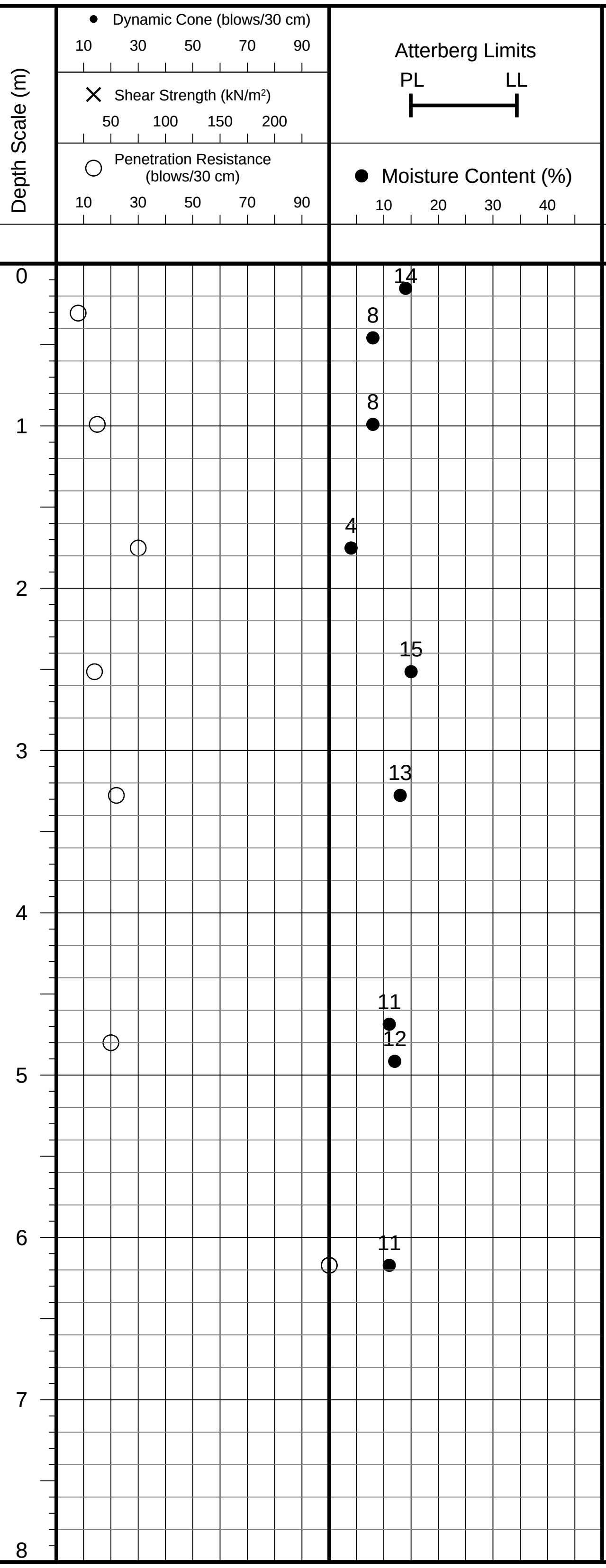
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 472.0 | Ground Surface | | | |
| 0.0 | **30 cm TOPSOIL** | 1A<br>1B | DO | 8 |
| | Brown, loose, weathered<br>**SAND**<br>fine to medium grained<br>a trace to some silt | | | |
| 471.2<br>0.8 | Brown, compact to dense | 2 | DO | 15 |
| | **SILTY SAND/SILTY SAND TILL**<br>weathered<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 3 | DO | 30 |
| 469.7<br>2.3 | Brown, compact | 4 | DO | 14 |
| | **SAND**<br>fine to mediuim grained<br>a trace to some silt<br>occ. silt layers | 5 | DO | 22 |
| 467.4<br>4.6 | Brown, compact to very dense<br>**SILTY SAND/SILTY SAND TILL**<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 6A<br>6B | DO | 20 |
| | | 7 | DO | 50/15 |
| 465.8<br>6.2 | **END OF BOREHOLE** | | | |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 4

**FIGURE NO.:** 4

**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

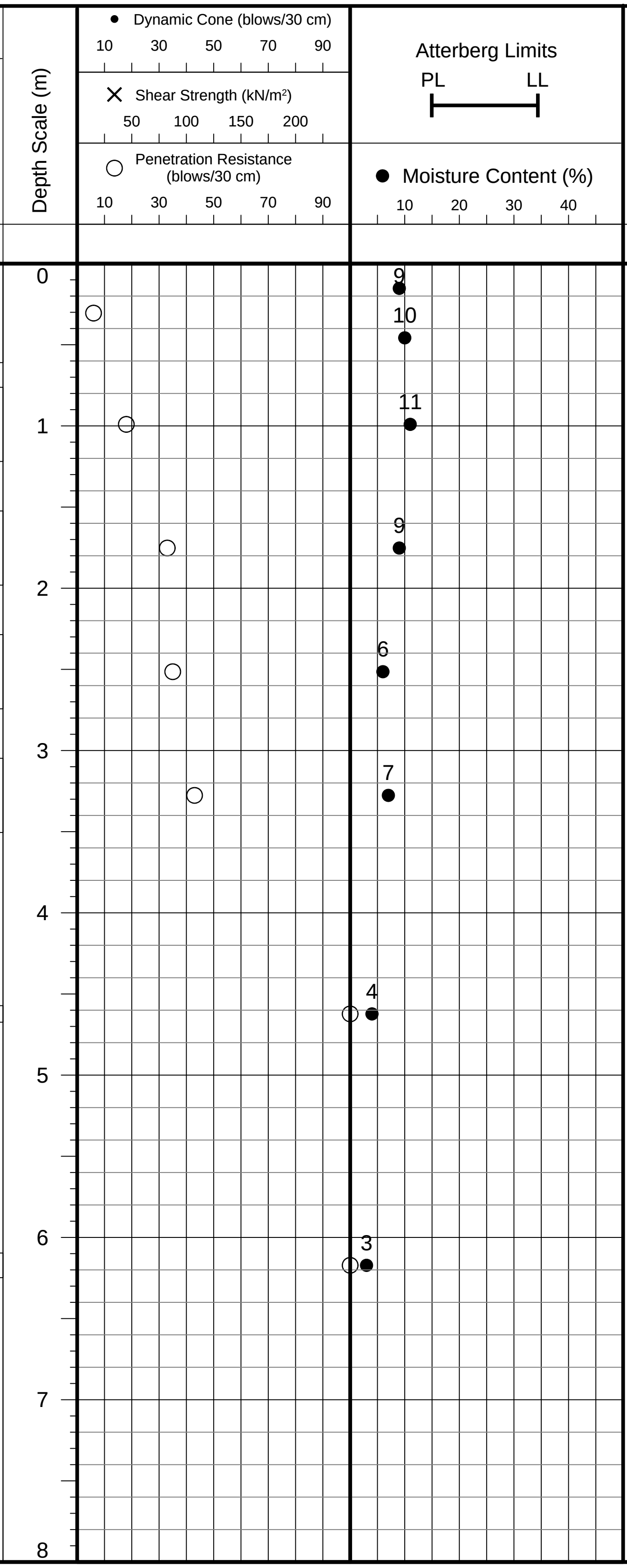
**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION |
|---|---|
| 469.6 | Ground Surface |
| 0.0 | **30 cm TOPSOIL** |
| | Brown, loose to dense<br>weathered clay layers<br>**SILTY SAND/SILTY SAND TILL**<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders |
| 467.2<br>2.4 | Brown, dense<br>**SAND**<br>fine to medium grained<br>a trace to some silt |
| 466.2<br>3.4 | Brown, very dense<br>**SILTY SAND/SILTY SAND TILL**<br>rock fragments<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles, boulders and rock fragments |
| 463.4<br>6.2 | **END OF BOREHOLE** |

SAMPLES

| Number | Type | N-Value |
|---|---|---|
| 1A<br>1B | DO | 6 |
| 2 | DO | 18 |
| 3 | DO | 33 |
| 4 | DO | 35 |
| 5 | DO | 43 |
| 6 | DO | 50/10 |
| 7 | DO | 55/15 |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 5

**FIGURE NO.:** 5

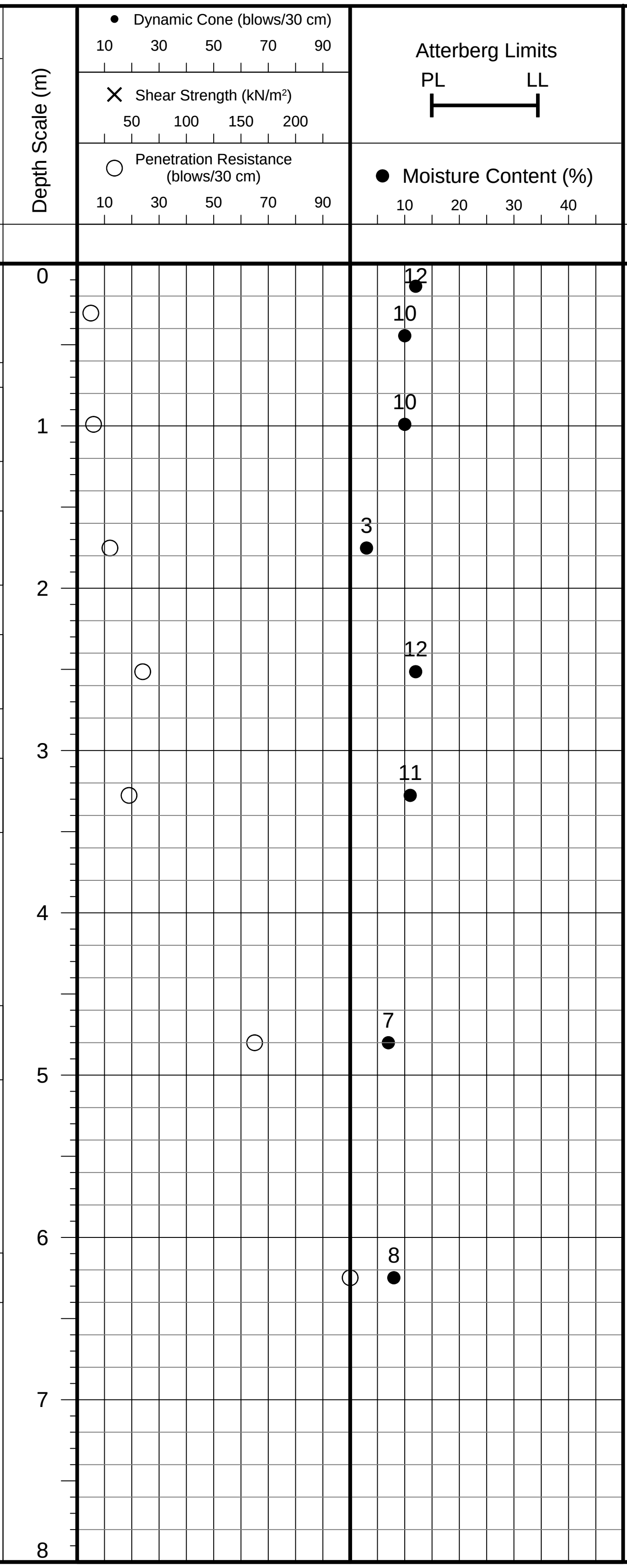
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | SAMPLES Type | SAMPLES N-Value |
|---|---|---|---|---|
| 476.0 | Ground Surface | | | |
| 0.0 | **28 cm TOPSOIL** | 1A | DO | 5 |
| | Brown, loose, weathered | 1B | | |
| | **SILTY SAND/SILTY SAND TILL**<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 2 | DO | 6 |
| 474.5<br>1.5 | Brown, compact<br>**SAND**<br>fine to medium grained<br>a trace to some silt | 3 | DO | 12 |
| | silt layers | 4 | DO | 24 |
| 473.0<br>3.0 | Brown, compact to very dense | 5 | DO | 19 |
| | **SILTY SAND/SILTY SAND TILL** | 6 | DO | 65 |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. clay seams and layers, cobbles and boulders | 7 | DO | 50/15 |
| 469.6<br>6.4 | **END OF BOREHOLE** | | | |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 6

**FIGURE NO.:** 6

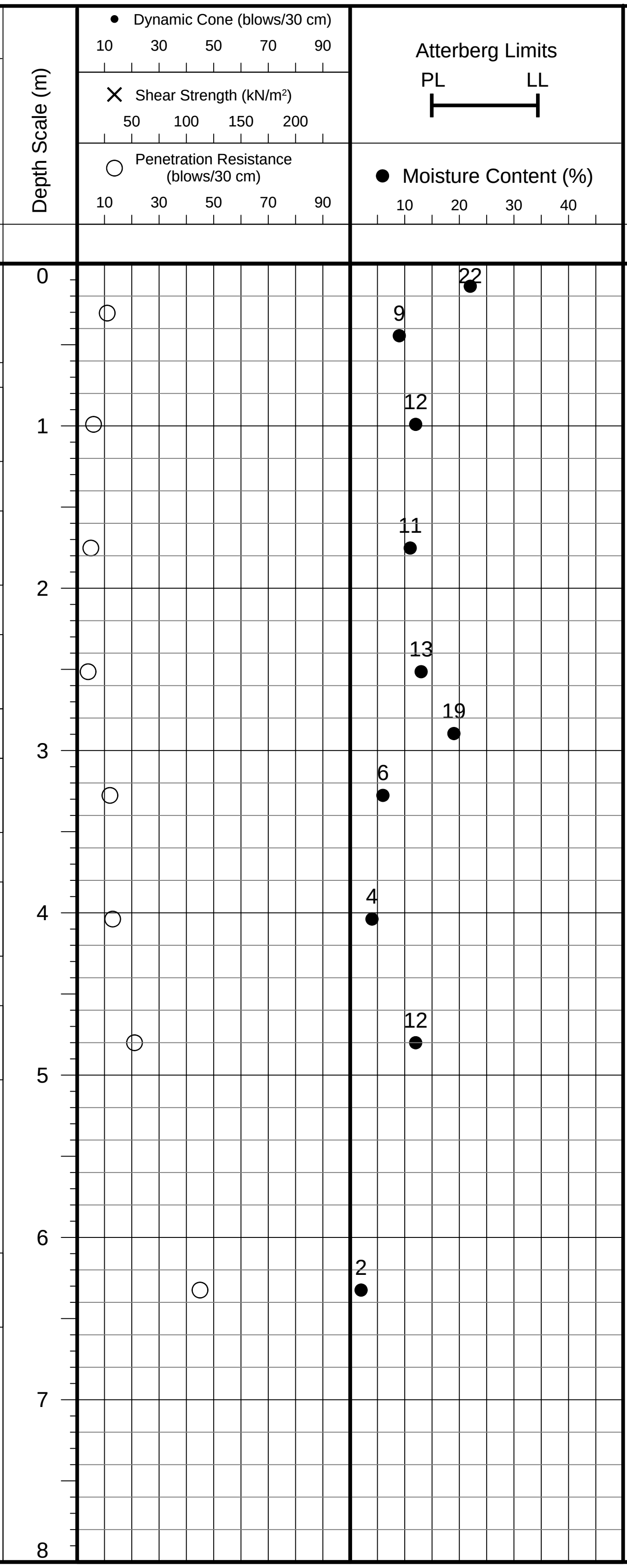
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES | | | WATER LEVEL |
|---|---|---|---|---|---|
| | | Number | Type | N-Value | |
| 462.4 | Ground Surface | | | | |
| 0.0 | **28 cm TOPSOIL** | 1A | DO | 11 | Dry and open upon completion of the field work |
| | Brown<br>**EARTH FILL (Silty Sand)**<br>with organic inclusions | 1B | | | |
| | | 2 | DO | 6 | |
| 460.9<br>1.5 | Dark brown<br>**TOPSOIL FILL**<br>sandy | 3 | DO | 5 | |
| | | 4 | DO | 4 | |
| | | 5 | AS | - | |
| 459.4<br>3.0 | Brown, compact to dense<br>silty sand till layer | 6 | DO | 12 | |
| | **SAND** | 7 | DO | 13 | |
| | | 8 | DO | 21 | |
| | fine to medium grained<br>a trace of silt | 9 | DO | 45 | |
| 455.8<br>6.6 | **END OF BOREHOLE** | | | | |



**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 7

**FIGURE NO.:** 7

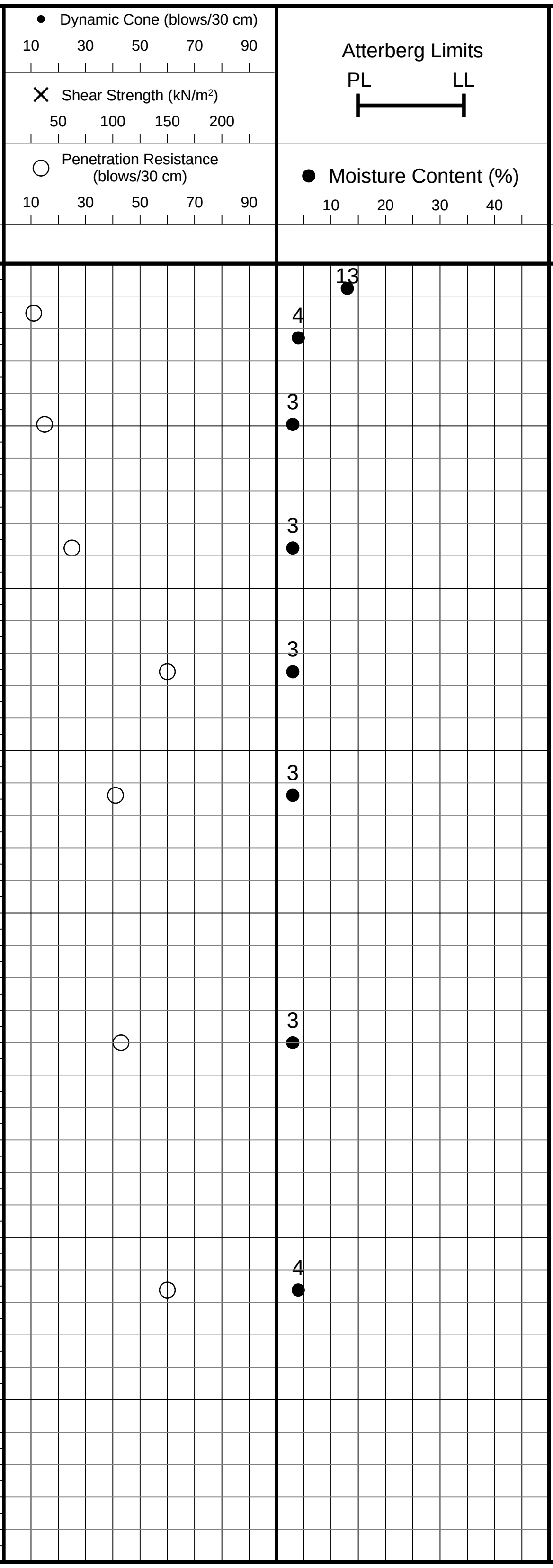
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | SAMPLES Type | SAMPLES N-Value | Depth Scale (m) | Moisture Content (%) | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| 477.9 | Ground Surface | | | | | | |
| 0.0 | **30 cm TOPSOIL**<br>rock fragments | 1A | DO | 11 | 0 | 13 | Dry and open upon completion of the field work |
| | Brown, compact to very dense | 1B | | | | 4 | |
| | weathered silty sand till layer | 2 | DO | 15 | 1 | 3 | |
| | | 3 | DO | 25 | 2 | 3 | |
| | **SAND** | 4 | DO | 60 | | 3 | |
| | | 5 | DO | 41 | 3 | 3 | |
| | fine to medium grained<br>a trace of silt<br>occ. gravel | | | | 4 | | |
| | | 6 | DO | 43 | 5 | 3 | |
| | | 7 | DO | 60 | 6 | 4 | |
| 471.3<br>6.6 | **END OF BOREHOLE** | | | | 7 | | |
| | | | | | 8 | | |



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Page: 1 of 1

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 8

**FIGURE NO.:** 8

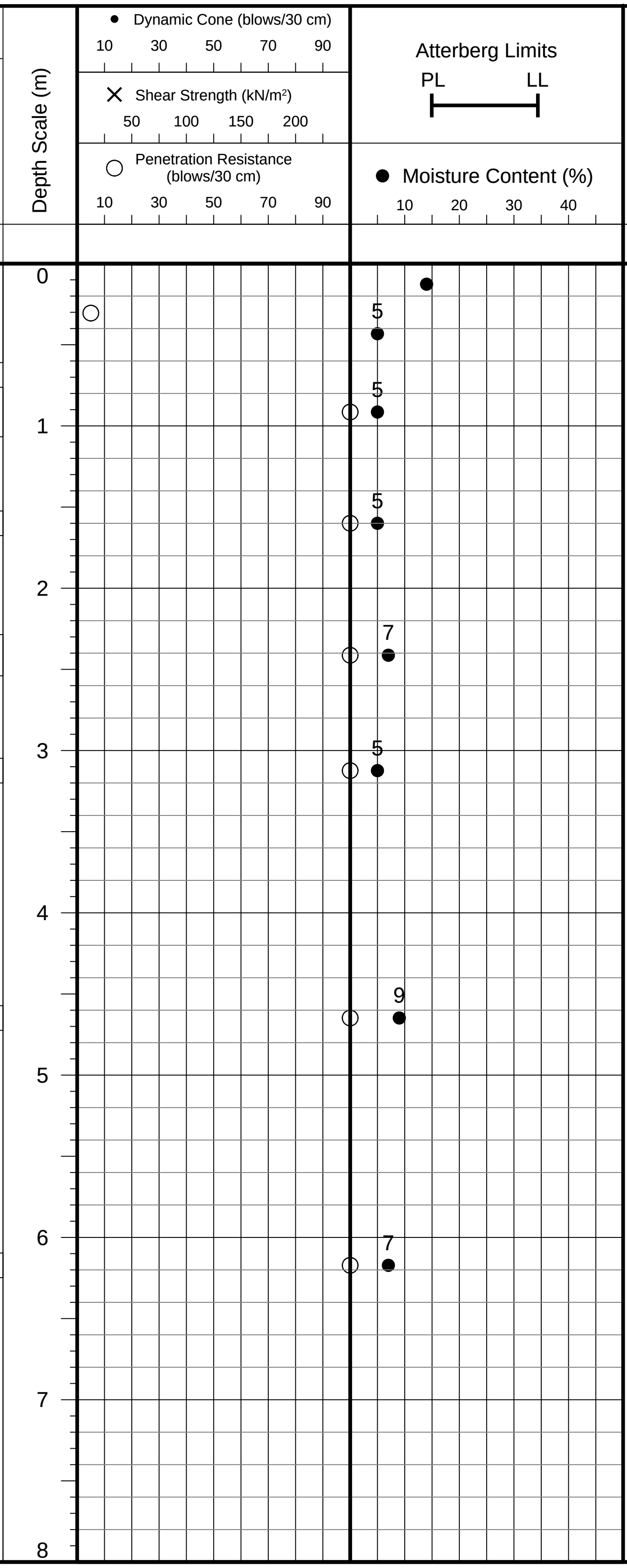
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 22, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 464.4 | Ground Surface | | | |
| 0.0 | **25 cm TOPSOIL** | 1A | DO | 5 |
| | Brown, loose, weathered<br>**SAND**<br>fine to medium grained<br>a trace to some silt | 1B | | |
| 463.6<br>0.8 | Brown, very dense<br>boulder | 2 | DO | 50/15 |
| | rock fragments | 3 | DO | 50/15 |
| | **SILTY SAND/SILTY SAND TILL**<br>rock fragments | 4 | DO | 50/10 |
| | | 5 | DO | 60/15 |
| | a trace of clay<br>a trace of gravel to gravelly<br>occ. sand seams and layers, cobbles and boulders | | | |
| | silt layers | 6 | DO | 50/15 |
| | | 7 | DO | 50/15 |
| 458.2<br>6.2 | **END OF BOREHOLE** | | | |



WATER LEVEL

Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**JOB NO.:** 2009-S020

# LOG OF BOREHOLE NO.: 9

**FIGURE NO.:** 9

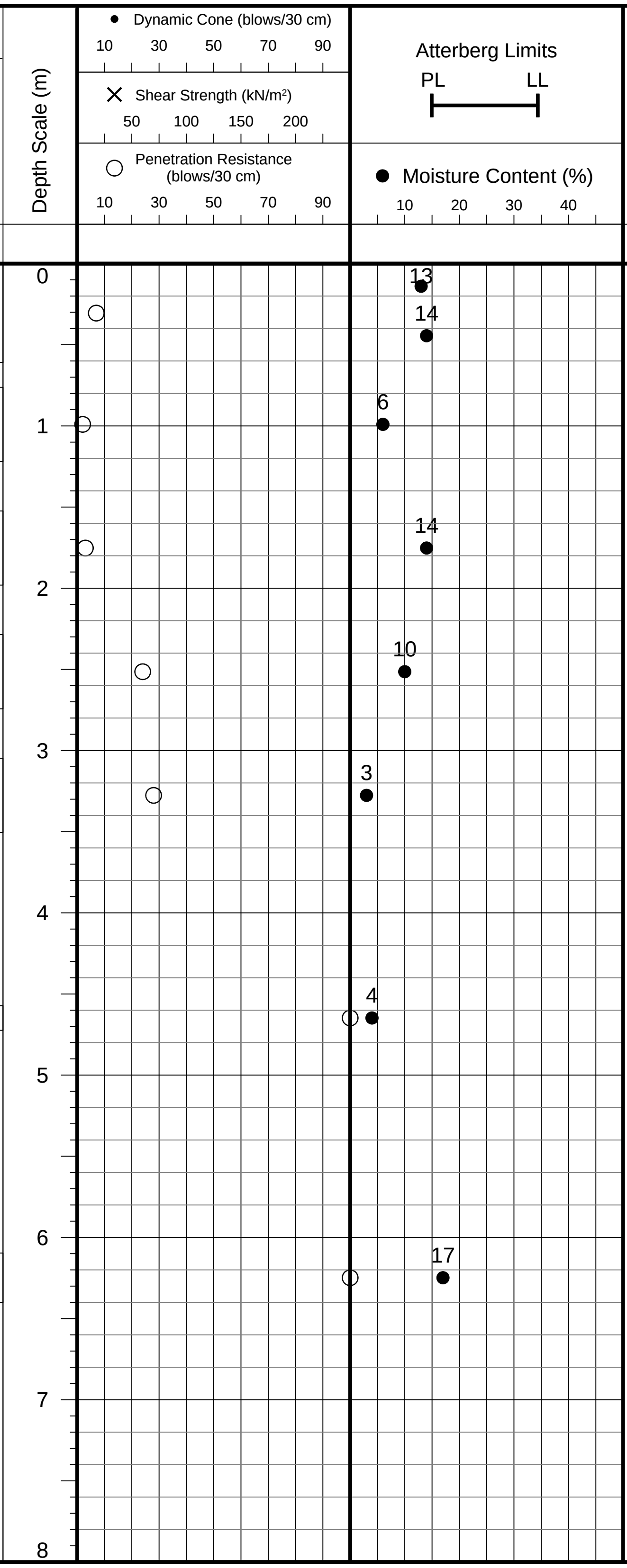
**PROJECT DESCRIPTION:** Proposed Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**DRILLING DATE:** September 23, 2020

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 469.6 | Ground Surface | | | |
| 0.0 | **28 cm TOPSOIL** | 1A | DO | 7 |
| | Brown, very loose to loose, weathered<br>**SAND**<br>fine to medium grained<br>a trace to some silt | 1B | | |
| | | 2 | DO | 2 |
| 468.1<br>1.5 | Brown, very loose to compact<br>**SILTY SAND/SILTY SAND TILL**<br>a trace of clay<br>a trace of gravel to gravelly<br>occ. sand seams and layers, cobbles and boulders<br>weathered | 3 | DO | 3 |
| | | 4 | DO | 24 |
| 466.6<br>3.0 | Brown, compact to very dense<br>**SAND**<br>fine to medium grained<br>a trace to some silt<br>a trace to some gravel | 5 | DO | 28 |
| | gravelly/<br>rock<br>fragments | 6 | DO | 50/15 |
| | silt and<br>clay layers | 7 | DO | 60/15 |
| 463.2<br>6.4 | **END OF BOREHOLE** | | | |



WATER LEVEL

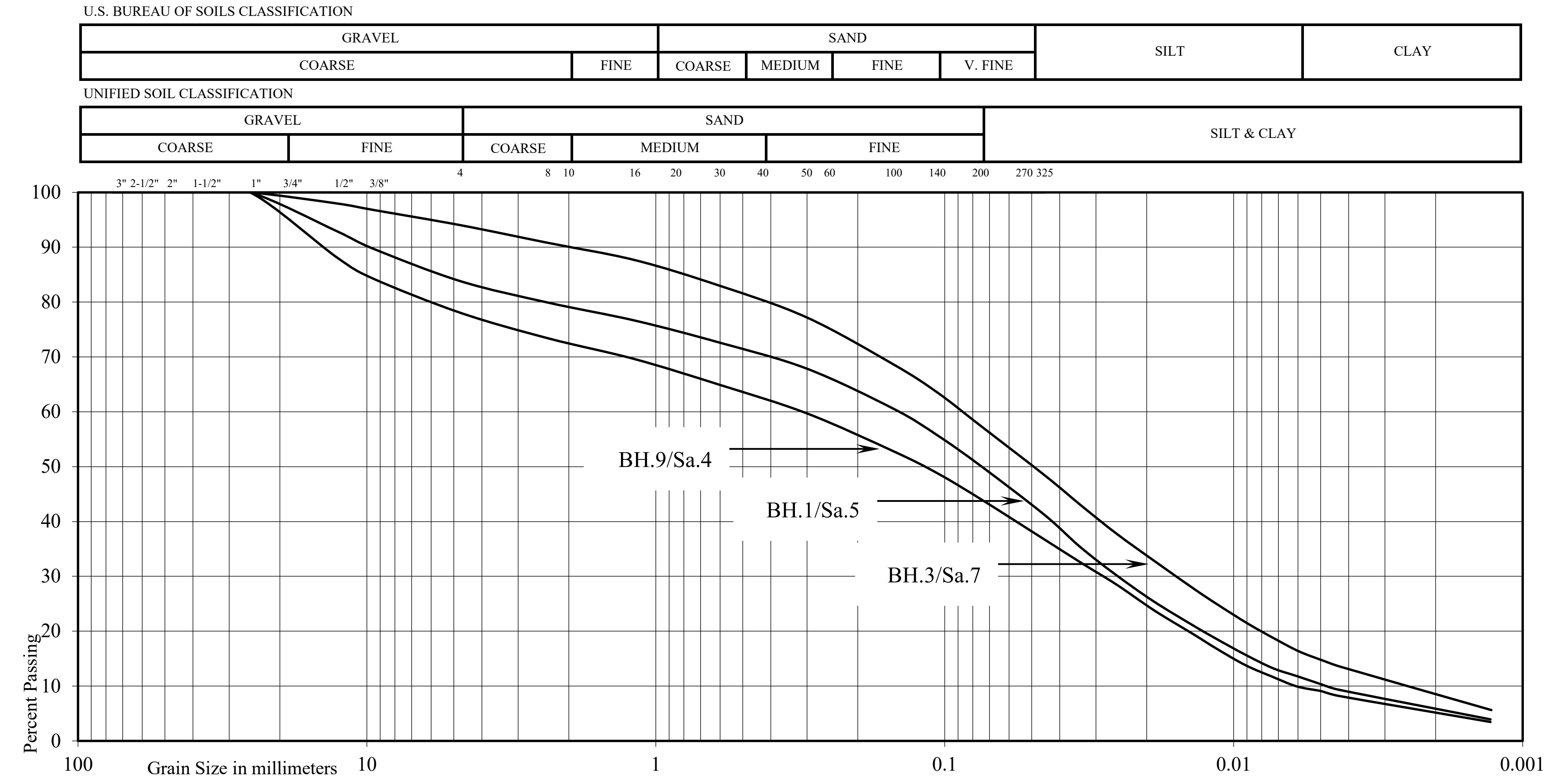
Dry and open upon completion of the field work

**Soil Engineers Ltd.**

**Soil Engineers Ltd.**

# GRAIN SIZE DISTRIBUTION

Reference No: 2009-S020



Project: Proposed Development

Location: 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

| | | | |
|---|---|---|---|
| Borehole No: | 1 | 3 | 9 |
| Sample No: | 5 | 7 | 4 |
| Depth (m): | 3.3 | 6.2 | 2.5 |
| Elevation (m): | 461.7 | 465.8 | 467.1 |

| BH./Sa. | 1/5 | 3/7 | 9/4 |
|---|---|---|---|
| Liquid Limit (%) = | - | - | - |
| Plastic Limit (%) = | - | - | - |
| Plasticity Index (%) = | - | - | - |
| Moisture Content (%) = | 9 | 11 | 10 |
| Estimated Permeability (cm./sec.) = | $10^{-6}$ | $10^{-6}$ | $10^{-5}$ |

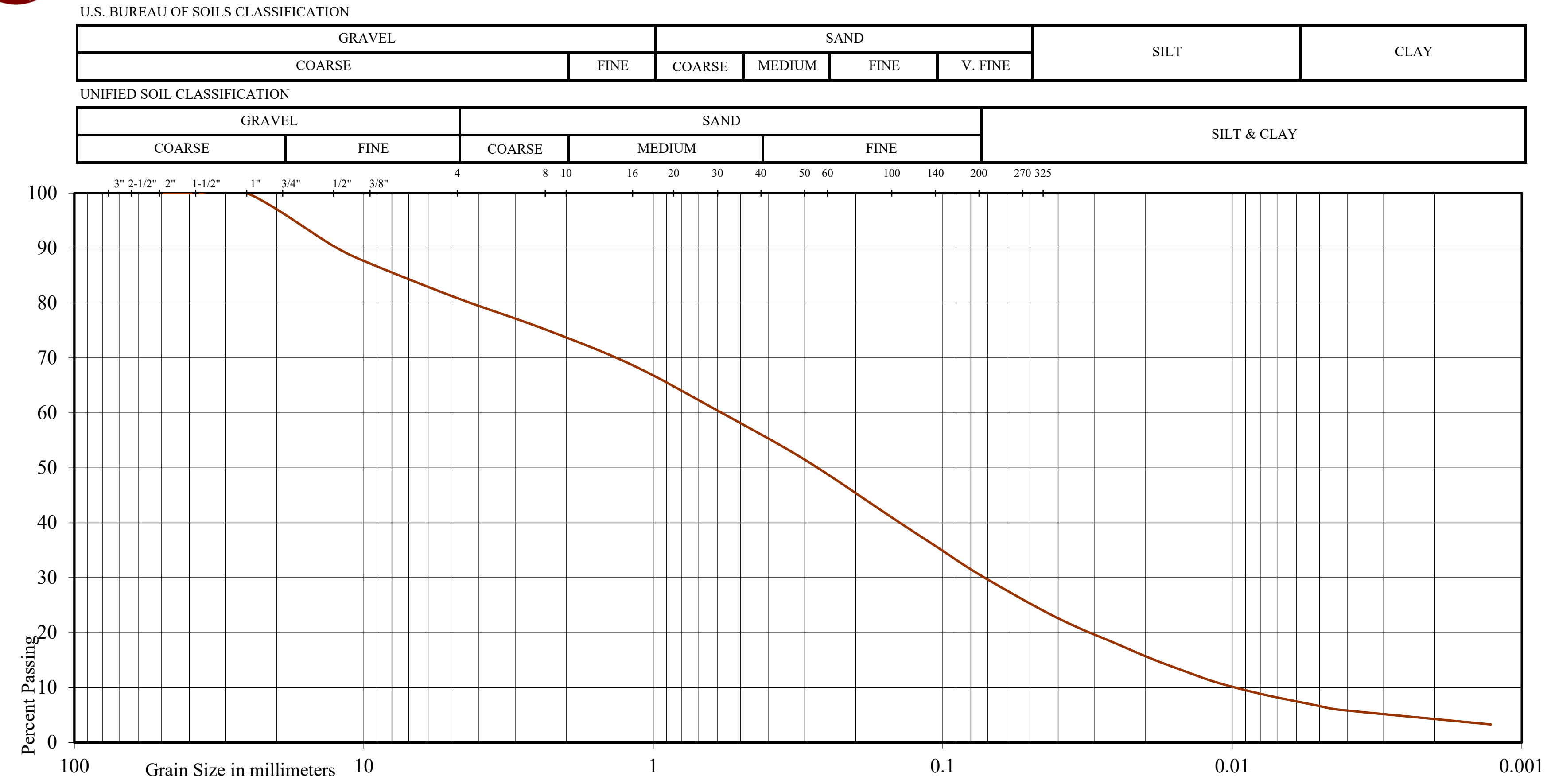
Classification of Sample [& Group Symbol]: SANDY SILT TILL, a trace to some gravel to gravelly, a trace of clay

Figure: 13

**Soil Engineers Ltd.**

# GRAIN SIZE DISTRIBUTION

Reference No: 2009-S020



Project: Proposed Development

Location: 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Borehole No: 12

Sample No: 3

Moisture Content (%) = 7

Depth (m): 1.8

Estimated Permeability

Elevation (m): 458.9

(cm./sec.) = $10^{-5}$

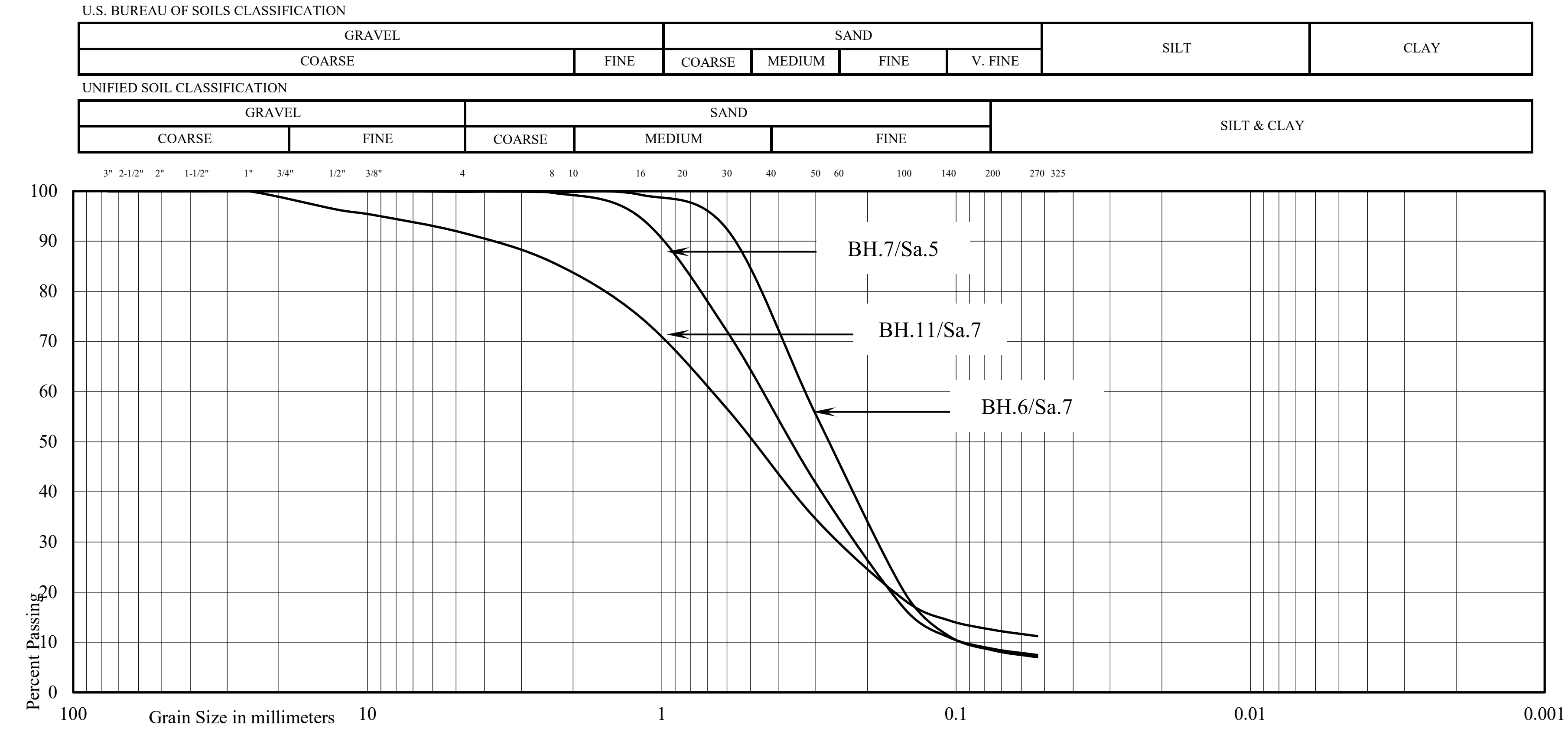
Classification of Sample [& Group Symbol]: SILTY SAND TILL, some gravel, a trace of clay

Figure: 14

**Soil Engineers Ltd.**

# GRAIN SIZE DISTRIBUTION

Reference No: 2009-S020



Project: Proposed Development

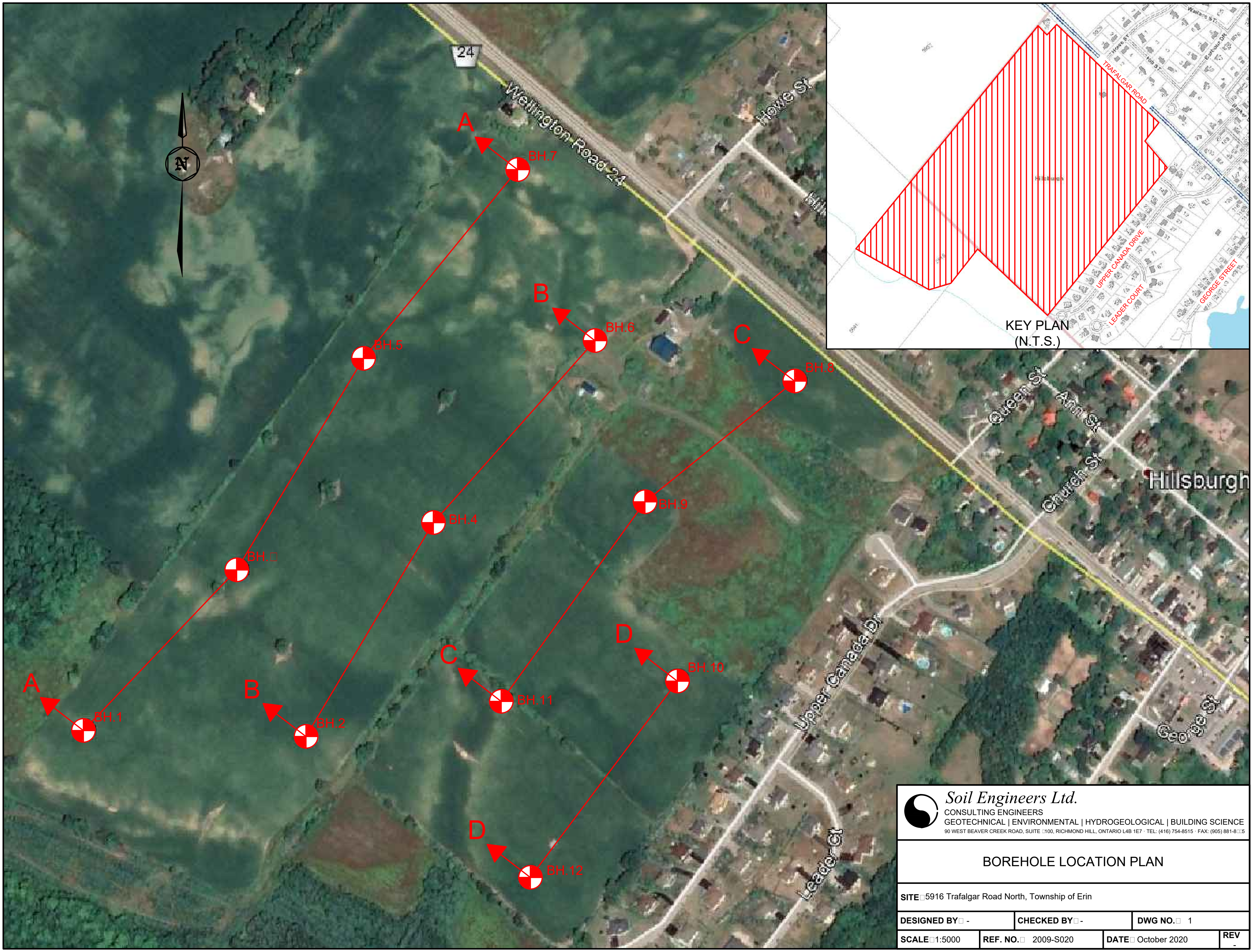
Location: 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

| | | | |
|---|---|---|---|
| Borehole No: | 6 | 7 | 11 |
| Sample No: | 7 | 5 | 7 |
| Depth (m): | 4.0 | 1.8 | 6.3 |
| Elevation (m): | 458.4 | 476.1 | 458.9 |

| BH./Sa. | 6/7 | 7/5 | 11/7 |
|---|---|---|---|
| Liquid Limit (%) = | - | - | - |
| Plastic Limit (%) = | - | - | - |
| Plasticity Index (%) = | - | - | - |
| Moisture Content (%) = | 4 | 3 | 4 |
| Estimated Permeability (cm./sec.) = | $10^{-2}$ | $10^{-2}$ | $10^{-3}$ |

Classification of Sample [& Group Symbol]: FINE TO MEDIUM SAND, a trace to some silt, traces of coarse sand and gravel

Figure: 15



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90 WEST BEAVER CREEK ROAD, SUITE □100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8□□5

# BOREHOLE LOCATION PLAN

**SITE□**5916 Trafalgar Road North, Township of Erin

**DESIGNED BY□** -
**CHECKED BY□** -
**DWG NO.□** 1
**SCALE□**1:5000
**REF. NO.□** 2009-S020
**DATE□** October 2020
**REV** -

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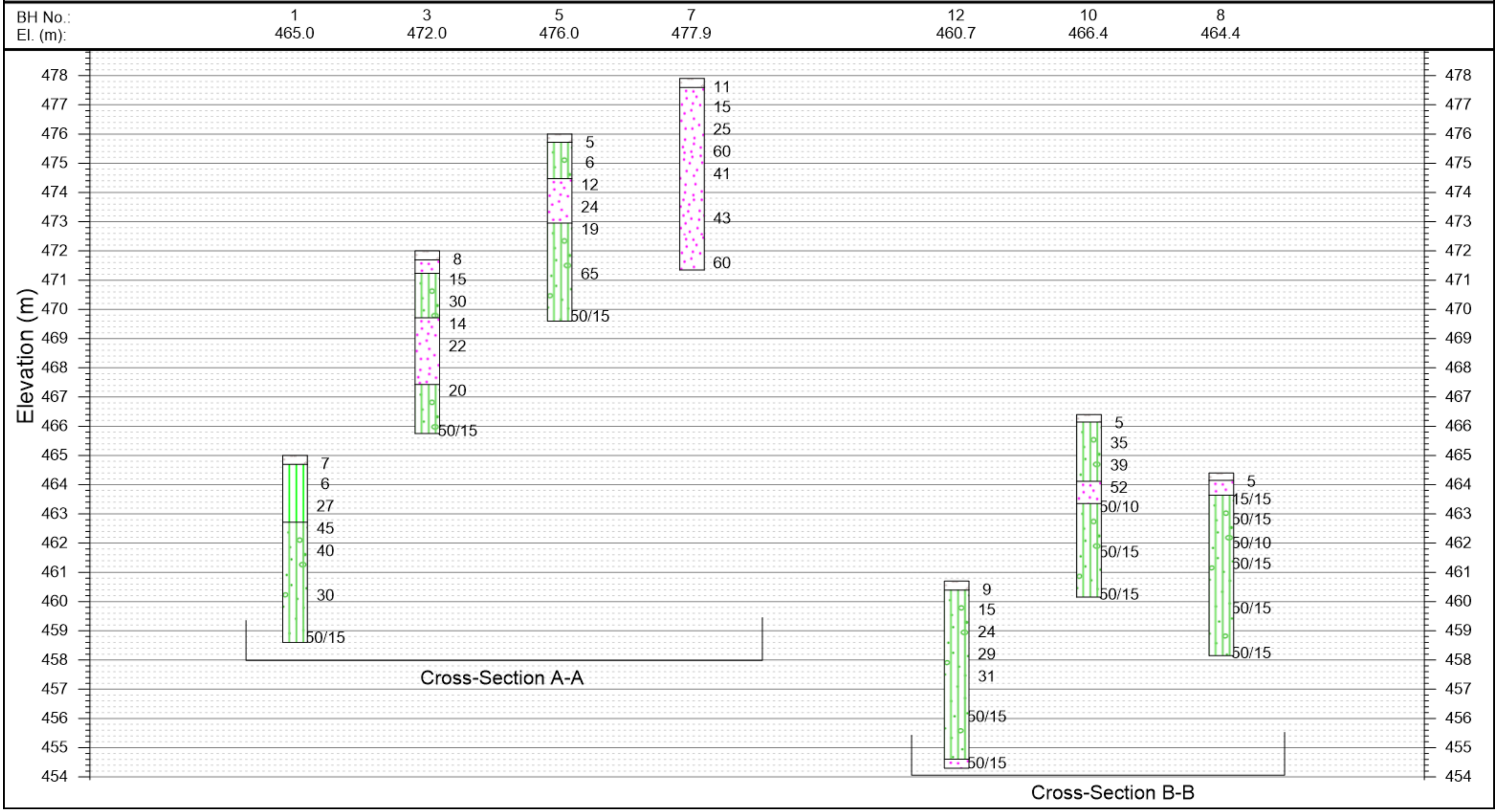
**SUBSURFACE PROFILE**
**DRAWING NO. 2**
**SCALE: AS SHOWN**

**JOB NO.:** 2009-S020
**REPORT DATE:** October 2020
**PROJECT DESCRIPTION:** Proposed Development

**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**LEGEND**

▤ TOPSOIL ▨ SAND ▥ SANDY SILT/SILTY SAND TILL ▥ SILT



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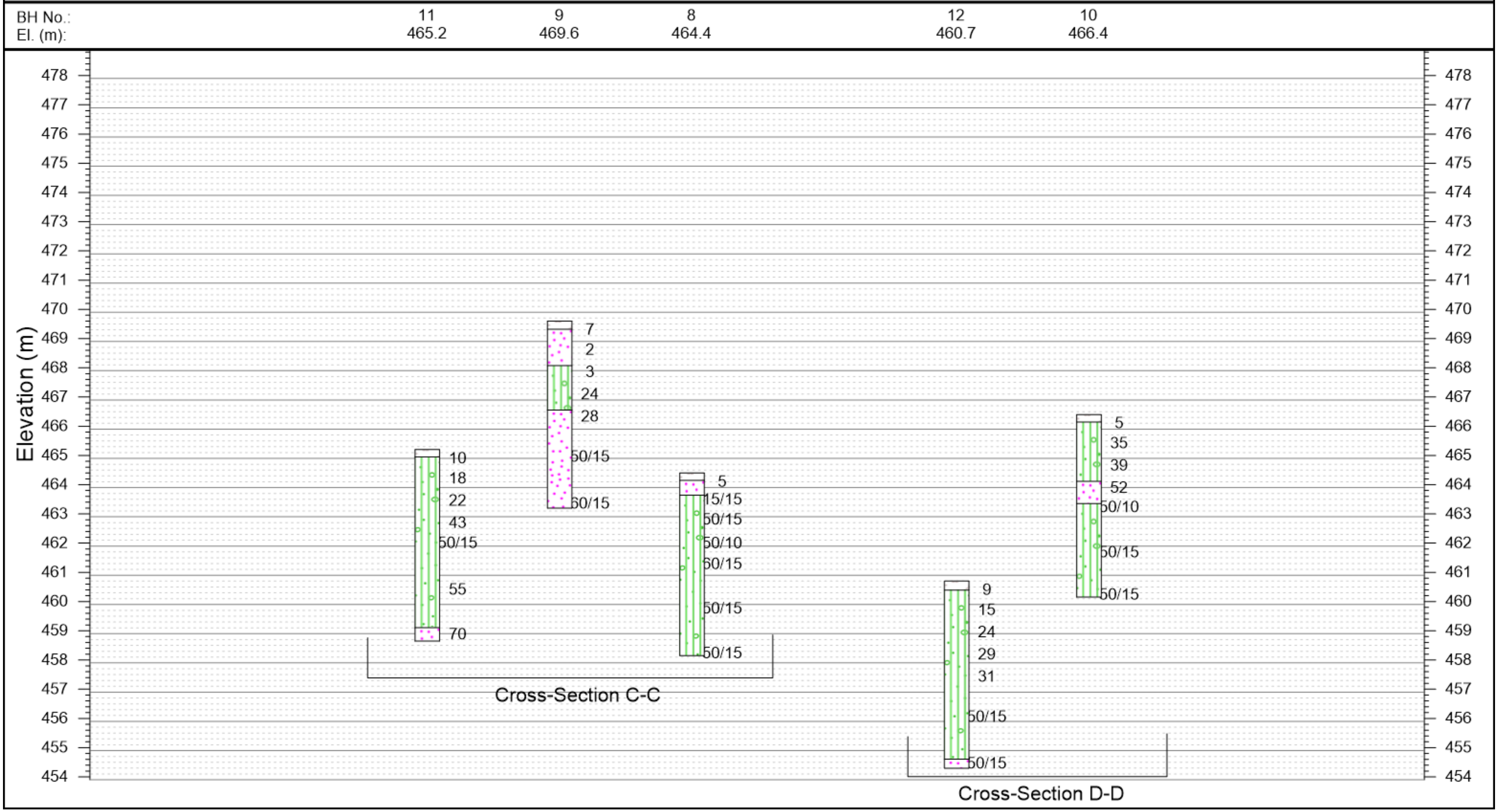
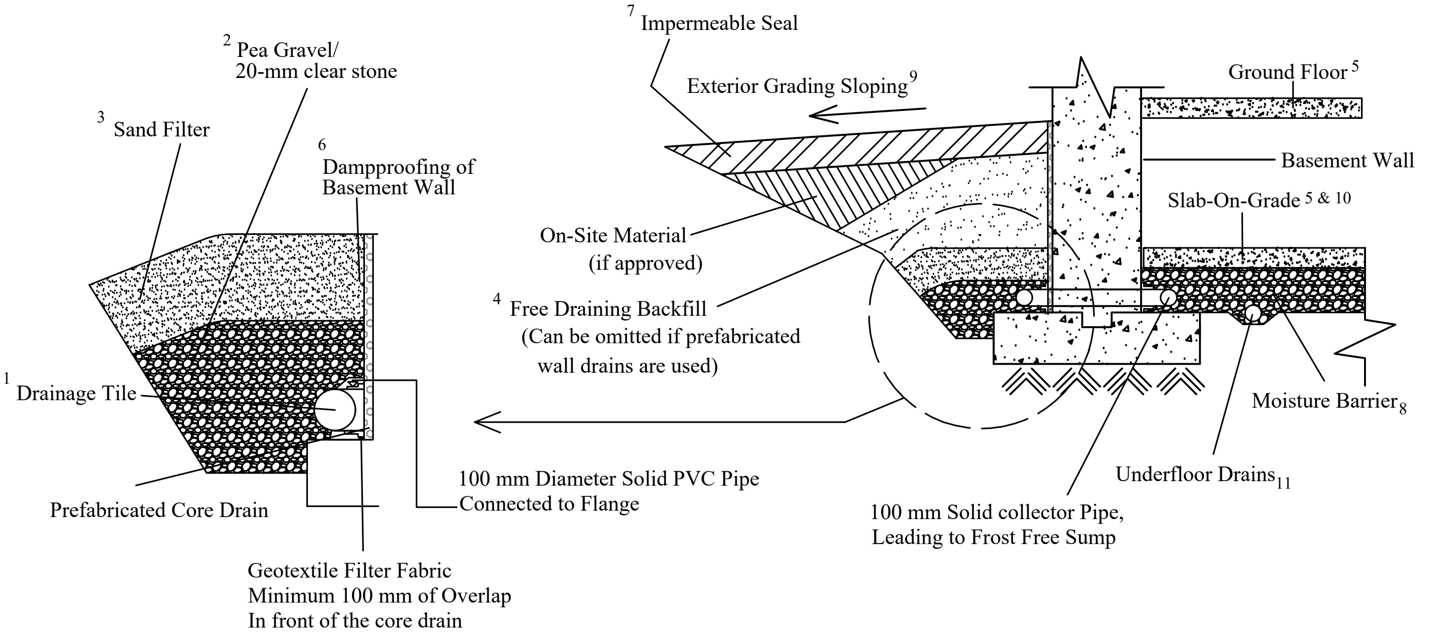
**SUBSURFACE PROFILE**
**DRAWING NO. 3**
**SCALE: AS SHOWN**

**JOB NO.:** 2009-S020
**REPORT DATE:** October 2020
**PROJECT DESCRIPTION:** Proposed Development
**PROJECT LOCATION:** 5916 Trafalgar Road North, Town of Erin (Hillsburgh)

**LEGEND**

▤ TOPSOIL ▨ SAND 🟩 SANDY SILT/SILTY SAND TILL





## NOTES:

1. **Drainage tile**: consists of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be at minimum of 150 mm (6") below underside of basement floor slab.

2. **Pea gravel**: at 150 mm (6") on the top and sides of drain. If drain is not placed on concrete footing, provide 100 mm (4") of pea gravel below drain. The pea gravel may be replaced by 20 mm clear stone provided that the drain is covered by a porous geotextile membrane of Terrafix 270R or equivalent.

3. **Filter material**: consists of C.S.A. fine concrete aggregate. A minimum of 300 mm (12") on the top and sides of gravel. This may be replaced by an approved porous geotextile membrane of Terrafix 270R or equivalent.

4. **Free-draining backfill**: OPSS Granular 'B' or equivalent, compacted to 95% to 98% (maximum) Standard Proctor dry density. Do not compact closer than 1.8 m (6') from wall with heavy equipment. This may be replaced by on-site material if prefabricated wall drains (Miradrain) extending from the finished grade to the bottom of the basement wall are used.

5. **Do not backfill** until the wall is supported by the basement floor slab and ground floor framing, or adquate bracing.

6. **Dampproofing** of the basement wall is required before backfilling

7. **Impermeable backfill seal** of compacted clay, clayey silt or equivalent. If the original soil in the vicinity is a free-draining sand, the seal may be omitted.

8. **Moisture barrier**: 20-mm clear stone or compacted OPSS Granular 'A', or equivalent. The thickness of this layer should be 150 mm (6") minimum.

9. **Exterior Grade**: slope away from basement wall on all the sides of the building.

10. **Slab-On-Grade** should not be structurally connected to walls or foundations.

11. **Underfloor drains*** should be placed in parallel rows at 6 to 8 m (20'-25') centre, on 100 mm (4") of pea gravel with 150 mm (6") of pea gravel on top and sides. The invert should be at least 300 mm (12") below the underside of the floor slab. The drains should be connected to positive sumps or outlets. Do not connect the underfloor drains to the perimeter drains.

*Underfloor drains can be deleted where not required.

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Details of Perimeter Drainage System

**SITE** 5916 Trafalgar Road North, Township of Erin
**DESIGNED BY** K.L. **CHECKED BY** B.S. **DWG NO.** 4
**SCALE** N.T.S. **REF. NO.** 2009-S020 **DATE** October 2020 **REV** -