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A REPORT TO
HEN & CHICKENS BREWING CO. LTD.

A SOIL INVESTIGATION FOR PROPOSED INDUSTRIAL DEVELOPMENT

MOUNTAIN ROAD

TOWN OF COLLINGWOOD

Reference No. 1205-S095

JULY 2012

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1.0 INTRODUCTION

In accordance with a written authorization dated May 16, 2012, from Mr. Garnet Pratt Siddall of Hen & Chickens Brewing Co. Ltd., a soil investigation was carried out at the parcel of land east of 200 Mountain Road in the Town of Collingwood, for a proposed Industrial Development.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of the proposed project.

The findings and resulting geotechnical recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Collingwood is situated on the Simcoe Lowlands bordering the Niagara Escarpment where lacustrine sand, silt and clay deposits, outwash sands and glacial till have bedded onto undulated Black River and Trenton Group of bedrock.

The site is located east of the development at 200 Mountain Road, which is situated east of Tenth Line on the south side of Mountain Road in the Town of Collingwood. The subject property was primarily tree-covered with boulders found throughout the site. The site slopes down heading northeast.

Neighbouring properties generally consisted of wooded areas. An industrial building was located to the west. Commercial buildings were located further to the east. Golf courses were located further north and west of the property in addition to a vacant parcel of land further west.

It is understood that the proposed project consists of an industrial development which is to be the site of a brewery. It is to be provided with municipal services, and paved on-grade parking areas and access roadways meeting the municipal standards.

3.0 **FIELD WORK**

The field work, consisting of 9 boreholes to depths ranging from 2.5 to 6.6 m, was performed during the period from June 20 to 22, 2012, at the locations shown on the Borehole Location Plan, Drawing No. 1.

The holes 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 granular 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 field work was supervised and the findings recorded by a Geotechnical Technician.

The geodetic elevation at each borehole location was determined using the Global Navigation Satellite System. The elevations are shown on the Borehole Logs.

4.0 SUBSURFACE CONDITIONS

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 9, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

This investigation has disclosed that beneath a layer of topsoil, or a layer of sand and gravel topping at 1 location, the site is underlain by strata of sandy silt till, silty sand till, silt, sandy silt, and silty clay at various depths and locations.

4.1 **Topsoil** (All Boreholes, except Borehole 4)

The revealed topsoil layer ranges from approximately 20 to 36 cm in thickness. It is dark brown in colour, indicating that it contains appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil is considered to be void of engineering value. Due to its humus content, the topsoil will generate an offensive odour and may produce volatile gases under anaerobic conditions. Therefore, the topsoil must not be buried within any building envelopes 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.

Since the topsoil is considered void of engineering value, it can only be used for general landscaping and landscape contouring purposes. A fertility analysis should be carried out to determine the suitability of the topsoil for general planting material.

4.2 **Sandy Silt Till** and **Silty Sand Till** (All Boreholes)

The sandy silt till and/or silty sand till were encountered beneath the topsoil at all boreholes except Boreholes 4, 5, 7 and 9 where they were encountered at depths of 1.4± m and 2.1± m below the prevailing ground surface. In Borehole 4, the silty sand till was overlain with a layer of sand and gravel determined to be approximately 30 cm thick. They were also encountered at various depths within the lower stratigraphy at Boreholes 2 and 6. The tills extend to the maximum investigated depth at all boreholes except Boreholes 7 and 8. The tills consist of a random mixture of particle sizes ranging from clay to gravel, with either the sand or silt fraction exerting the dominant influence on the soils' properties. Occasional wet sand and silt seams and layers, cobbles and boulders were detected within the tills. In places, the tills contain clay layers and rock fragments; topsoil and root inclusions occurred in the uppermost layer of the tills. The tills are heterogeneous in structure, showing the tills are glacial deposits. The upper layer of the tills has generally been weathered, indicating that fissures have permeated these layers.

Hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the tills.

Sample examinations disclosed that the tills, in places, displayed cohesion when remoulded indicating that they contain variable amounts of clay. The samples showed dilatancy when wetted and shaken by hand.

The obtained 'N' values range from 10 blows per 30 cm of penetration to 50 per 0 cm, with a median of 50 per 15 cm, indicating that the relative density of the sandy silt till and silty sand till is loose to very dense, being generally very dense. The loose silty sand till is restricted to the badly weathered zone.

The natural water content values of the samples were determined and the results are plotted on the Borehole Logs; the values range from 4% to 16%, with a median of 7%, indicating the tills are in a damp to very moist, generally damp condition.

Grain size analyses were performed on 2 representative samples each of the sandy silt till and silty sand till; the results are plotted on Figures 10 and 11, respectively.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and moderate water erodibility.
- Medium to low permeability, with an estimated coefficient of permeability of 10^{-5} to 10^{-6} cm/sec, 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

- Frictional soils, their shear strength is primarily derived from internal friction, and is augmented by cementation. Therefore, their strength is primarily soil density dependent.
- In steep cuts, they will be stable; however, under prolonged exposure, localized sheet collapse will occur.
- Fair pavement-supportive materials, with an estimated California Bearing Ratio (CBR) value of 8% to 10%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5500 ohm·cm.

4.3 **Silt** (Boreholes 2, 5, 6, 7 and 9)

The silt deposits were encountered beneath the topsoil layer at Borehole 5, interstratified within the sandy silt till at Boreholes 2 and 6, and beneath the silty clay at Boreholes 7 and 9. It was also located beneath the sandy silt at Borehole 7 and it extends to the maximum investigated depth at that borehole. The silt contains traces to some clay and sand, and a trace of gravel, in places, with occasional wet sand and clay seams and layers, cobbles and boulders at various locations. The laminated structure shows that the silt is a glaciolacustrine deposit.

The obtained 'N' values range from 20 per 30 cm to 50 per 15 cm, with a median of 32 per 30 cm, indicating that the relative density of the silt is compact to very dense, being generally dense. In places, the upper layer of the silt has been weathered.

The natural water content values of the silt were determined, and the results are plotted on the Borehole Logs; the values range from 10% to 20%, with a median of 16%, indicating that the silt is in a moist to wet, generally very moist condition. The samples showed dilatancy when wetted and shaken by hand, indicating that the shear strength of the wet silt is susceptible to impact disturbance.

Grain size analyses were performed on 3 representative samples of the silt; the results are plotted on Figure 12.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.

- High water erodibility; it is susceptible to migration through small openings under seepage pressure.
- A soil of high capillarity and water retention capacity.
- Medium to low permeability, with an estimated coefficient of permeability of 10^{-5} to 10^{-6} cm/sec, 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

- A frictional soil, its shear strength is derived from internal friction; therefore, its shear strength is density dependent. Due to its dilatancy, the strength of the wet silt is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- When excavated, the moist silt will be stable in relatively steep cuts, while the very moist to wet silt will slough and run slowly with seepage bleeding from the cut face. It will boil under a piezometric head of 0.4 m.
- A 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.

4.4 <u>Sandy Silt</u> (Boreholes 7 and 8)

The sandy silt was encountered beneath the silty sand till at depths of 2.1± m and 4.0± m below the prevailing ground surface at Boreholes 8 and 7, respectively; it extends to the maximum investigated depth at Borehole 8. The sandy silt contains a trace of clay with occasional wet sand and silt seams and layers, cobbles and boulders. The sorted structure indicates that the sandy silt is a glaciolacustrine deposit.

The obtained 'N' values are 50 per 15 cm and 50 per 8 cm, indicating that the relative density of the sandy silt is very dense.

The natural water content values of the samples were determined, and the results are plotted on the Borehole Logs; the values are 12%, 13% and 16%, indicating that the sandy silt is in a moist to very moist, generally very moist condition. The samples showed dilatancy when wetted and shaken, indicating that the shear strength of the sandy silt, in a wet state, is susceptible to impact disturbance.

A grain size analysis was performed on 1 representative sample of the sandy silt; the result is plotted on Figure 13.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.
- High water erodibility; it will migrate through small openings under low to moderate seepage pressure.
- A soil of high capillarity and water retention capacity.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-4} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.07
2% - 6%	0.12
6% +	0.18

- A frictional soil, its shear strength is density dependent. Due to its dilatancy, the strength of the wet silt is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction in shear strength.

- When excavated, the moist silt will be stable in relatively steep cuts, while the wet silt will slough, run slowly with seepage bleeding from the cut face, and boil under a piezometric head of 0.4 m.
- A poor pavement-supportive material, with an estimated CBR value of 5%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 6000 ohm·cm.

4.5 **Silty Clay** (Boreholes 7 and 9)

The silty clay was encountered beneath the topsoil at both boreholes it was encountered in, extending to a depth of 0.7± m below the prevailing ground surface. The silty clay contains a trace of sand with occasional silt seams and layers. The laminated structure shows that the silty clay is a glaciolacustrine deposit. The silty clay has been weathered, indicating that fissures have permeated the clay.

The obtained 'N' values are 4 and 6 per 30 cm, indicating that the consistency of the silty clay is soft to firm.

The Atterberg Limits of 1 representative sample and the water content values of the silty clay were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	25%
Plastic Limit	15%
Natural Water Content	16% and 21%

The above results show that the silty clay is a cohesive material with low plasticity. The natural water content generally lies between its plastic and liquid limits.

A grain size analysis was performed on 1 representative sample of the silty clay; the result is plotted on Figure 14.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.
- The laminated silt layers are high in water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive soil, its shear strength is derived from consistency and augmented by the internal friction of the silt. Its shear strength is moisture dependent and, due to the dilatancy of the silt, the overall shear strength of the silty clay is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- The soft to firm clay will consolidate under area surcharge loads. In steep excavations to depths of 2.0 to 3.0 m, the sides may fail and the bottom may heave due to overstressing.
- In steep cuts, the weathered clay will slough readily and a cut face in the sound clay may collapse as the wet silt slowly sloughs.
- A very poor pavement-supportive material, with an estimated CBR value of 3% or less.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm·cm.

4.6 Interpretation of Refusal to Augering

Refusal to augering was encountered at Borehole 9 at a depth of 2.5 m below the prevailing ground surface. It is inferred that boulders or bedrock most likely occur at this level. This can be verified by test pits prior to and/or at the time of the project construction.

4.7 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

		Water Content (%) for Standard Proctor Compaction	
Soil Type	**Determined Natural Water Content (%)**	**100% (optimum)**	**Range for 95% or +**
Sandy Silt Till and Silty Sand Till	4 to 16 (median 7)	10, 11 and 12	6 to 16
Silt	10 to 20 (median 16)	13	8 to 17
Sandy Silt	12, 13 and 16	12	8 to 16
Silty Clay	16 and 21	15	11 to 20

Based on the above findings, the majority of the in situ soils are suitable for a 95% or + Standard Proctor compaction. However, portions of the sandy silt till and silty sand till are too dry and will require wetting prior to structural compaction.

In addition, portions of the silt and silty clay are too wet and will require aeration or mixing with drier soils prior to structural compaction. Aeration can be achieved by spreading the soils thinly on the ground in the dry, warm weather.

The tills and clay should be compacted using a heavy-weight, kneading-type roller. The silts can be compacted by a smooth roller with or without vibration, depending on the water content of the soils being compacted. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

When compacting the cemented, dense to very dense sandy silt till and silty sand 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 must be limited to 20 cm or less (before compaction). It is difficult to monitor the lifts of backfill placed in deep trenches; therefore, it is preferable that the compaction of backfill at depths over 1.0 m below the subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness. Wetting of the sound tills will be necessary to achieve this requirement.

One should be aware that with considerable effort, a 90%± Standard Proctor compaction of the wet silt and sandy 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 months of rest, the density of the compacted mantle has increased to over 95% of its maximum Standard Proctor dry density.

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 underground services and slab-on-grade 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 adequate subgrade strength for the project construction.

The presence of boulders in the soils will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in size is mixed with the material, it must either be sorted or must not be used for structural backfill and/or construction of engineered fill.

5.0 GROUNDWATER CONDITIONS

The boreholes were checked for the presence of groundwater and the occurrence of cave-in upon completion. The data was plotted on the Borehole Logs and summarize in Table 2.

Table 2 - Groundwater Levels

	Borehole	**Soil Colour Changes Brown to Grey**	**Seepage Encountered During Augering**		**Measured Groundwater/ Cave-In* Level On Completion**	
BH No.	**Depth (m)**	**Depth (m)**	**Depth (m)**	**Amount**	**Depth (m)**	**El. (m)**
1	3.2	1.0	-	-	Dry	-
2	3.2	1.3	1.6	Moderate	Dry	-
3	6.4	1.3	-	-	4.3*	183.9*
4	6.1	0.9	-	-	Dry	-
5	6.1	2.1	-	-	Dry	-
6	6.1	1.4	-	-	Dry	-
7	6.6	1.4			5.5*	183.4*
8	3.4	1.4	3.1	Some	2.7*	185.8*
9	2.5	1.4	0.9	Moderate	Dry	-

*Cave-in level (In wet silts, the level generally represents the groundwater regime at the borehole location.)

As shown above, cave-in occurred at Boreholes 3, 7 and 8 at depths ranging from 2.7± to 5.5± m below the prevailing ground surface. The rest of the boreholes remained dry upon completion of the field work. In addition, relatively high water content values in the soils, in places, indicate that infiltrated precipitation and groundwater seepage are being held in the voids of the soils by capillary action. The soil colour changes from brown to grey at depths ranging from 0.9± to 2.1± m from the prevailing ground surface. The brown colour indicates that the soils have oxidized. The groundwater will fluctuate with the seasons.

If encountered, the groundwater yield from the silty clay, due to its low permeability, will be small and limited, while the yield from the sandy silt till and silty sand till will be slight to some; if encountered, the yield from the silts is expected to be moderate to appreciable and likely persistent.

6.0 DISCUSSION AND RECOMMENDATIONS

This investigation has disclosed that beneath a layer of topsoil, or a surficial layer of sand and gravel topping at 1 location, the site is underlain by strata of loose to very dense, generally very dense sandy silt till and silty sand till, compact to very dense, generally dense silt, very dense sandy silt and soft to firm silty clay at various depths and locations. The soils within the top 0.5± to 0.8± m below the prevailing ground surface have generally been weathered.

An Environmental Subsurface Investigation was conducted at the subject property and its neighbouring parcel of land. Although 'N' values for the boreholes drilled to install the monitoring wells were not obtained, it is our understanding that from the field work conducted, the soils were found to be hard and very dense. Furthermore, a soil investigation was conducted previously on a neighbouring property and its information, presented under separate cover, Reference No. 1110-S118, dated December 2011, indicates that the neighbouring areas consist of hard and very dense soils.

Cave-in occurred at Boreholes 3, 7 and 8 at depths ranging from 2.7± to 5.5± m below the prevailing ground surface. Furthermore, relatively high water content values in the soils, in places, indicate that infiltrated precipitation and groundwater seepage are being held in the voids of the soils by capillary action. The soil colour changes from brown to grey at depths ranging from 0.9± to 2.1± m from the prevailing ground surface. The groundwater will fluctuate with the seasons.

If encountered, the yield of groundwater from the silty clay, due to its low permeability, will be small and limited, while the yield from the sandy silt till and silty sand till will be slight to some; if encountered, the yield from the silts is expected to be moderate to appreciable and likely persistent.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil and weathered soils are unsuitable for engineering applications and must be removed. They should be replaced with properly compacted inorganic fill. Due to its humus content, the topsoil will generate volatile gases under anaerobic conditions. For the environmental well-being as well as the geotechnical well-being of the future development, it should not be buried within any building envelopes or deeper than 1.2 m below the exterior finished grade. A fertility analysis should be carried out to confirm the suitability of the topsoil for use as a general planting material.
2. The sound natural soils are suitable for normal spread and strip footing construction. Due to the presence of topsoil and weathered soils, the footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the design of the foundation.
3. For slab-on-grade construction, the slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.
4. Cut and fill may be required for the site grading and it is generally economical to place engineered fill for normal footing, sewer and pavement construction.
5. A Class 'B' bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. Where water-bearing silts are present, the pipe joints must be leak-proof, or the joints should be wrapped with a waterproof membrane. Where extensive dewatering is required, a Class 'A' bedding may be required.
6. Excavation should be carried out in accordance with Ontario Regulation 213/91.

7. Most of the soils contain occasional boulders. Boulders over 15 cm in size must not be used for structural backfill and/or construction of engineered fill. Excavation into the dense to very dense soils containing boulders will require extra effort and the use of a heavy-duty backhoe.
8. If rock excavation is required, this can be achieved by using a backhoe equipped with a rock-ripper or pneumatic hammering in the weathered zone of the bedrock. Excavation into the sound rock will likely require blasting to break up the sound rock mass. A consultant who specializes in rock blasting must be consulted.
9. In the vicinity of Borehole 9, a test pit can be performed to verify the occurrence of boulders and/or bedrock at a depth of 2.5± m from the prevailing ground surface.

The recommendations appropriate for the project described in Section 2.0 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 to determine whether the following recommendations require revision.

6.1 **Foundations**

Based on the borehole findings, it is recommended that the normal spread and strip footings for the proposed project be placed below the topsoil and weathered soils onto the sound natural native soils or engineered fill. As a general guide, the recommended soil pressures for use in the design of the footings, together with the corresponding suitable founding levels, are presented in Table 3.

Table 3 - Founding Levels

	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Suitable Founding Level			
	250 kPa (SLS) 450 kPa (ULS)		**500 kPa (SLS) 800 kPa (ULS)**	
BH No.	**Depth (m)**	**El. (m)**	**Depth (m)**	**El. (m)**
1	0.7 or +	186.7 or -	1.0 or +	186.4 or -
2	2.0 or +	186.6 or -	2.6 or +	186.0 or -
3	0.6 or +	187.6 or -	1.0 or +	187.2 or -
4	0.7 or +	187.6 or -	1.6 or +	186.7 or -
5	0.8 or +	187.4 or -	1.7 or +	186.5 or -
6	0.7 or +	188.0 or -	1.7 or +	187.0 or -
7	1.0 or +	187.9 or -	2.5 or +	186.4 or -
8	0.8 or +	187.7 or -	1.4 or +	187.1 or -
9	1.0 or +	188.0 or -	1.7 or +	187.3 or -

Where extended footings or stepped footings are required, it may be more cost effective to subexcavate to a size 30% larger than the designed footing width and fill with lean concrete up to the normal footing elevation immediately after the suitable founding soil is exposed. In order to allow a minor amount of side sloughing of the incidental in situ material on the approved subgrade, the sequence of footing excavation, subgrade inspection and concreting must be carried out simultaneously. The stepped footings must be sloped at 7 vertical:10 horizontal.

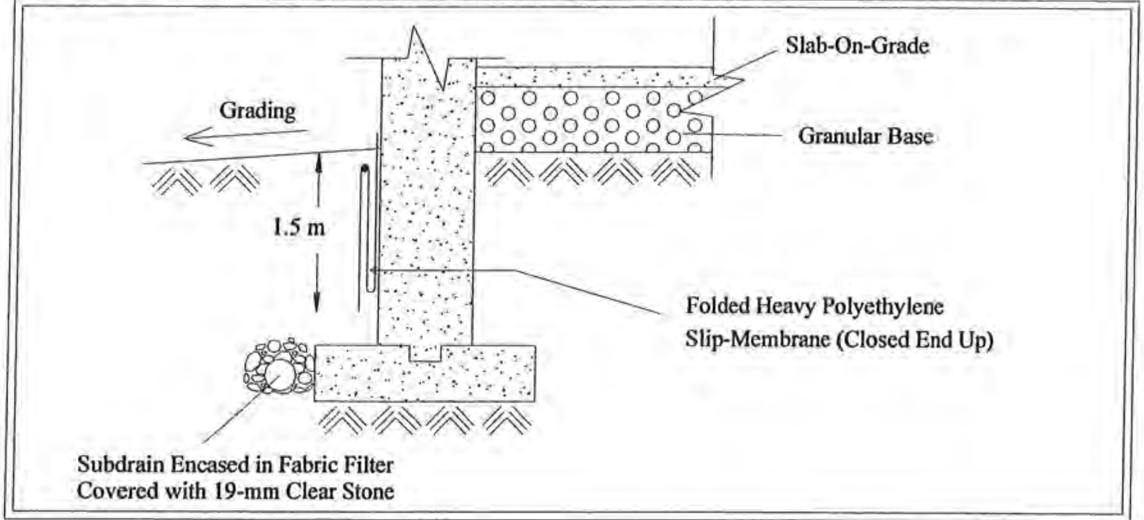
It should be noted that if groundwater seepage is encountered in the footing excavations or where normal foundations are founded on wet silts, the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification.

The recommended soil pressures (SLS) incorporate a safety factor of 3 against shear failure of the underlying soils. The total and differential settlements of the footings on the soil are estimated to be 25 mm and 15 mm, respectively.

The foundations exposed to weathering or in unheated areas should have at least 1.5 m of earth cover for protection against frost action or must be properly insulated.

The in situ soils are high in frost heave and soil-adfreezing potential. Therefore, the foundation walls must be properly shielded with a polyethylene slip-membrane extending below the frost depth or properly insulated. The slip membrane will allow vertical movement of the heaving soil (due to frost) without imposing structural distress on the foundation. The recommended scheme is presented in Diagram 1.

Diagram 1 - Frost Protection Measures (Foundation)



The footings must meet the requirements specified in the Ontario Building Code 2006. As a guide, the structure should be designed to resist an earthquake force using Site Classification 'C' (very dense soil and soft rock).

Due to the presence of topsoil and weathered soils, the footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to assess its suitability for bearing the designed foundations.

The exterior grading adjacent to the building must be designed to slope away from the building to prevent any water ponding close to the building envelope.

6.2 Engineered Fill

In areas where earth fill is required to raise the site, or where extended footings are necessary, it is generally more economical to place engineered fill for normal footing, underground services and pavement construction. The engineering requirements for a certifiable fill for pavement construction, municipal services, slab-on-grade, and footings designed with a Maximum Allowable Soil Pressure (SLS) of 150 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 250 kPa are presented below:

1. All of the topsoil and organics must be removed, and the subgrade must be inspected and proof-rolled prior to any fill placement. The badly weathered soils should be subexcavated, sorted free of any topsoil inclusions and deleterious materials, aerated and properly compacted.
2. Inorganic soils must be used, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of their maximum Standard Proctor dry density up to the proposed finished grade and/or slab-on-grade subgrade. The soil moisture must be properly controlled on the wet side of 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 imported fill is to be used, the hauler is responsible for its environmental quality and must provide a document to certify that the material is free of hazardous contaminants.
4. 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.
5. The engineered fill must extend over the entire graded area; the engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors. Foundations partially on engineered fill must be reinforced and designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15± mm) between the natural soils and engineered fill.
6. 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.
7. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground or a bank.
8. Where the fill is to be placed on a bank steeper than 1 vertical:3 horizontal, the face of the bank must be flattened to 3 + so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
10. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations 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.

11. 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 the excavation and/or to inspect 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.
12. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the foundations must be properly reinforced and designed by the structural engineer for the project. The total and differential settlements of 25 mm and 15 mm, respectively, should be considered in the design of the foundations founded on engineered fill. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

6.3 Slab-On-Grade

The subgrade for slab-on grade construction must consist of sound natural soils or properly compacted inorganic earth fill. In preparation of the subgrade, the topsoil and any deleterious material detected must be removed.

The subgrade should be inspected and assessed by proof-rolling prior to slab-on-grade construction. Where weathered soils or soft subgrade is detected, it should be subexcavated, sorted free of topsoil inclusions and any deleterious materials, aerated and uniformly compacted to 98% or + of its maximum Standard Proctor dry density.

Any new material for raising the grade should consist of organic-free soil compacted to at least 98% of its maximum Standard Proctor dry density.

The slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.

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.

A Modulus of Subgrade Reaction of 30 MPa/m can be used for the design of the floor slab founded on engineered fill and sound natural soils.

If the subgrade has been loosened due to construction traffic, it must be proof-rolled before placement of the granular base.

Where groundwater seepage is encountered during slab-on-grade construction or the subgrade is found to be wet, floor subdrains should be provided and connected to a positive outlet. The subdrains should be encased in a fabric filter to protect them against blockage by silting. The necessity of implementing these measures should be further assessed by a geotechnical engineer during construction.

Insulation consisting of 60-mm Styrofoam, or equivalent, should be provided beneath the floor slab in non-heated areas for protection against frost heave. The slab at the entrance doors should be insulated with 60-mm Styrofoam, or its thermal equivalent, extending 3.0 m internally. This measure is to prevent cold drafts in the winter months from inducing frost action on the subgrade and thereby causing damage to the floor slab.

6.4 Underground Services

The subgrade for the underground services should consist of sound natural soils or properly compacted organic-free earth fill. Where topsoil and badly weathered soils are encountered, these materials should be subexcavated and replaced with bedding material compacted to at least 95% or + of its Standard Proctor compaction.

A Class 'B' bedding is recommended for the underground services construction. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent. In areas where more extensive dewatering is required, a Class 'A' bedding may be required.

Where water-bearing silts are present, the pipes should be connected by leak-proof joints or the joints should be wrapped with a waterproof membrane to prevent subgrade upfiltration through the joints.

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

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

Since the silty clay has moderately high corrosivity to buried metal, the water main should be protected against soil corrosion. In determining the mode of protection, an electrical resistivity of 3500 ohm·cm should be used. This, however, should be confirmed by testing the soil along the water main alignment at the time of sewer construction.

6.5 Backfilling in Trenches and Excavated Areas

The on-site inorganic soils are generally suitable for trench backfill. However, the soils should be sorted free of topsoil or any deleterious materials prior to the backfilling.

The backfill in the trenches should be compacted to at least 95% of its maximum Standard Proctor dry density. In the zone within 1.0 m below the road subgrade, the materials should be compacted with the water content 2% to 3% drier than the optimum, and the compaction should be increased to at least 98% of the respective maximum Standard Proctor dry density. This is to provide the required stiffness for pavement construction. In the lower zone, the compaction should be carried out on the wet side of the optimum; this allows a wider latitude of lift thickness. Wetting of the dry soils will be necessary to achieve this requirement. Backfill below any slab-on-grade which is sensitive to settlement must be compacted to at least 98% of its maximum Standard Proctor dry density.

In normal construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, imported sand backfill should be used. Unless compaction of the backfill is carefully performed, the interface of the native soils and the sand backfill will have to be flooded for several days.

The narrow trenches for services crossings should be cut at 1 vertical:
2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

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

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, 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 flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the underground services construction is carried out during the 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 and the slab-on-grade construction.
- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1 vertical: 1.5+ 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% of the maximum Standard Proctor dry density, 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. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, 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 sand fill mantle, anti-seepage collars should be provided.

6.6 Perimeter Walls at Truck Loading Dock

The perimeter walls at the loading area must be designed to sustain the lateral earth pressure calculated using the soil parameters given in Section 6.9. Any surcharge loads adjacent to the walls must also be considered in the design of the perimeter walls. The backfill against the wall must consist of free-draining granular fill. The loading dock must be provided with subdrains connected to a positive outlet to relieve possible groundwater seepage.

A concrete apron is recommended at the truck loading area and ramp. The apron should be designed using the Modulus of Subgrade Reaction given for the design of the slab-on-grade, and it should be insulated with 60-mm Styrofoam, or equivalent, on a compacted granular base 300 mm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent.

6.7 **Pavement Design**

Based on the borehole findings, the recommended pavement design based on the borehole findings is given in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	150	20-mm Crusher-Run Limestone or equivalent
Granular Sub-base		50-mm Crusher-Run Limestone or equivalent
Parking	300	
Access Roads	400	

In preparation of the subgrade, the topsoil should be stripped. Prior to placement of the granular bases, the subgrade surface should be proof-rolled. Any badly weathered soils and soft subgrade, organics and deleterious materials should be subexcavated and replaced by properly compacted, organic-free earth fill or granular materials. Earth fill/engineered fill used to raise the grade for the pavement construction should be organic-free and compacted to 95% or + of its maximum Standard Proctor dry density.

All the granular bases should be compacted to their maximum Standard Proctor dry density.

In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% of its maximum Standard Proctor dry density, with the water content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered adequate.

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 pavement design:

- If the pavement construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Areas adjacent to the pavement should be properly graded to prevent ponding of large amounts of water during the interim construction period.
- Curb subdrains will be required. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.
- If the pavement is to be constructed during wet seasons and extensively soft subgrade occurs, the granular sub-base should be thickened in order to compensate for the inadequate strength of the subgrade. This can be assessed during construction.

Along the perimeter where surface runoff may drain onto the pavement, a swale or an intercept subdrain system should be installed to prevent infiltrating precipitation from seeping into the granular bases (since this may inflict frost damage on the pavement). In the pavement areas, subdrains consisting of filter-wrapped weepers should be connected to the catch basins and storm manholes in the paved areas. The subdrains should be backfilled with free-draining granular material and encased with fabric filter.

6.8 Sidewalks, Interlocking Stone Pavement and Landscaping

Due to the high frost susceptibility of the underlying soils, heaving of the pavement is expected to occur during the cold weather.

Interlocking stone pavement, sidewalks and landscaping structures in areas which are sensitive to frost-induced ground movement, such as entrances, must be constructed on a free-draining, non-frost-susceptible granular material such as Granular 'B'. It must extend to at least 1.5 m below the sidewalk, slab or pavement surface and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins. Alternatively, the landscaping structures, sidewalks and interlocking stone pavement should be properly insulated with 60-mm Styrofoam, or equivalent.

6.9 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor

	Unit Weight (kN/m^3)		Estimated Bulk Factor	
	Bulk	**Submerged**	**Loose**	**Compacted**
Sandy Silt Till and Silty Sand Till	22.5	12.5	1.33	1.05
Silt	21.0	10.5	1.20	1.00
Sandy Silt	20.5	10.5	1.20	1.00
Silty Clay	20.5	11.5	1.30	1.00

Lateral Earth Pressure Coefficients

	Active K_a	At Rest K_0	Passive K_p
Sandy Silt Till, Silty Sand Till and Sandy Silt	0.33	0.43	3.00
Silt and Silty Clay	0.40	0.50	2.50

Table 5 - Soil Parameters (Cont'd)

Coefficient of Friction	
Between Concrete and Granular Base	0.60
Between Concrete and Sound Natural Soils	0.40
Maximum Allowable Soil Pressure (SLS) **For Thrust Block Design**	
Sound Natural Soils	100 kPa

6.10 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91.

Excavations should be sloped at 1 vertical:1 horizontal for stability.

For excavation purposes, the types of soils are classified in Table 6.

Table 6 - Classification of Soils for Excavation

Material	Type
Sound natural Soils	2
Weathered Soils and dewatered Silts	3
Water-bearing Silts	4

If encountered, the groundwater yield from the silty clay, due to its low permeability, will be small and limited, while the yield from the sandy silt till and silty sand till will be slight to some. The yield from these soils can be controllable by normal pumping from sumps. If encountered, the yield from the silts is expected to be moderate to appreciable and likely persistent. Deep excavations into the water-bearing silts will need to be stabilized by vigorous pumping from closely-spaced sumps and/or the use of a well-point dewatering system; alternatively, sheeting of the excavation will be required to control the groundwater. The appropriate dewatering method should be further assessed by test pits and/or test pumping prior to the project construction.

Most of the soils contain occasional boulders. Extra effort and the use of a properly equipped backhoe will be required for excavation. If rock excavation is required, this can be achieved by using a backhoe equipped with a rock-ripper or pneumatic hammering in the weathered zone of the bedrock. Excavation into the sound rock will likely require blasting to break up the sound rock mass. A consultant who specializes in rock blasting must be consulted. Boulders larger than 15 cm in size are not suitable for structural backfill and/or construction of engineered fill.

Prospective contractors must assess the in situ subsurface conditions prior to excavation by performing test cuts to at least 0.5 m below the intended bottom of excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.

7.0 LIMITATIONS OF REPORT

It should be noted that an Environmental Subsurface Investigation was carried out and the results were presented under separate cover, Reference No. 1203-E032, dated April 18, 2012. Therefore, this report deals only with a study of the geotechnical aspects of the proposed project.

This report was prepared by Soil Engineers Ltd. for the account of Hen & Chickens Brewing Co. Ltd., and for review by their designated consultants and government agencies. The material in it reflects the judgement of Mumta Mistry, B.A.Sc., and Daniel Man, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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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:

1. SAMPLE TYPES

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

2. PENETRATION RESISTANCE/'N'

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 'O'

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

3. SOIL DESCRIPTION

a) 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

b) 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

c) 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
1 lb. = 0.453 kg
1 inch = 25.4 mm
1 ksf = 47.88 kN/m^2

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 1

FIGURE NO: 1

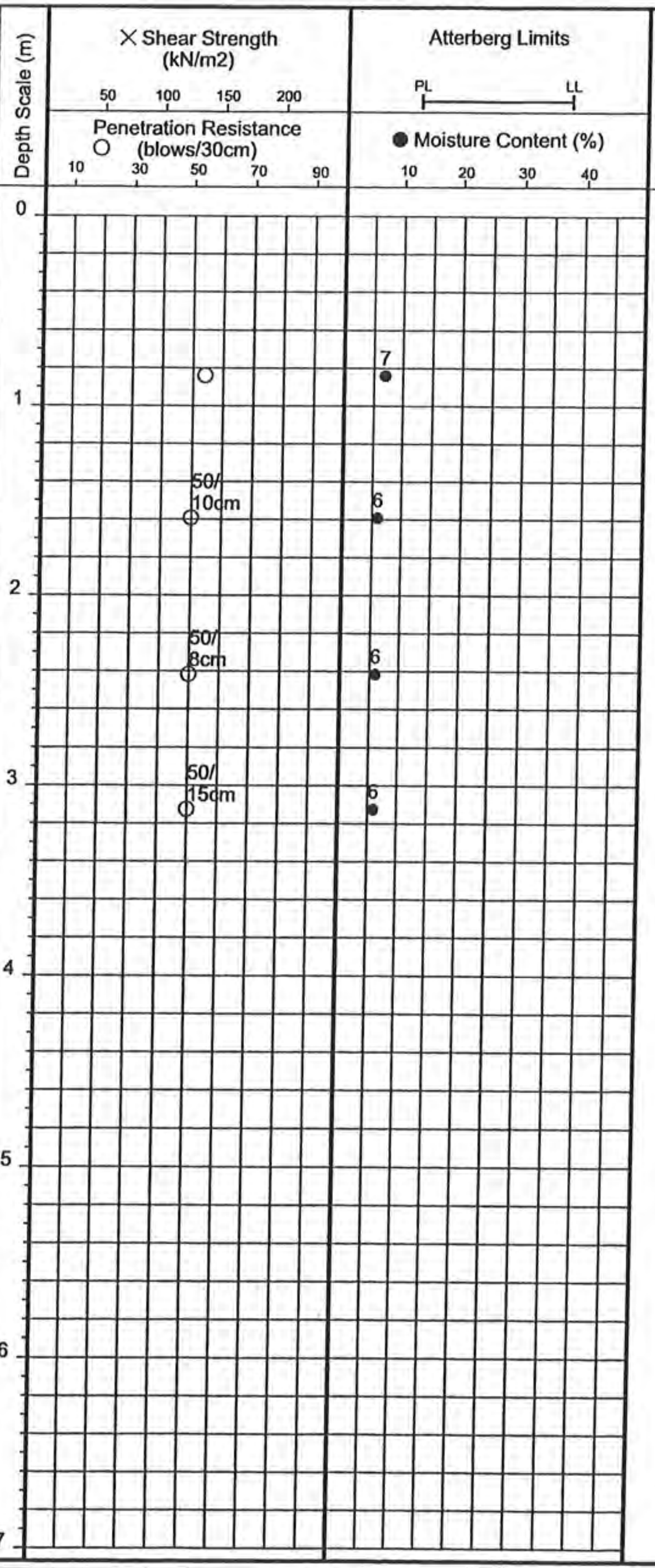
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 22, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 187.4	Ground Surface **36 cm TOPSOIL** occ. cobbles and boulders			
	Very dense **SILTY SAND, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders weathered brown grey	1	DO	54
1.3 186.1	Grey, very dense **SANDY SILT, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	2 3 4	DO DO DO	50/10 50/8 50/15
3.2 184.2	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 2

FIGURE NO: 2

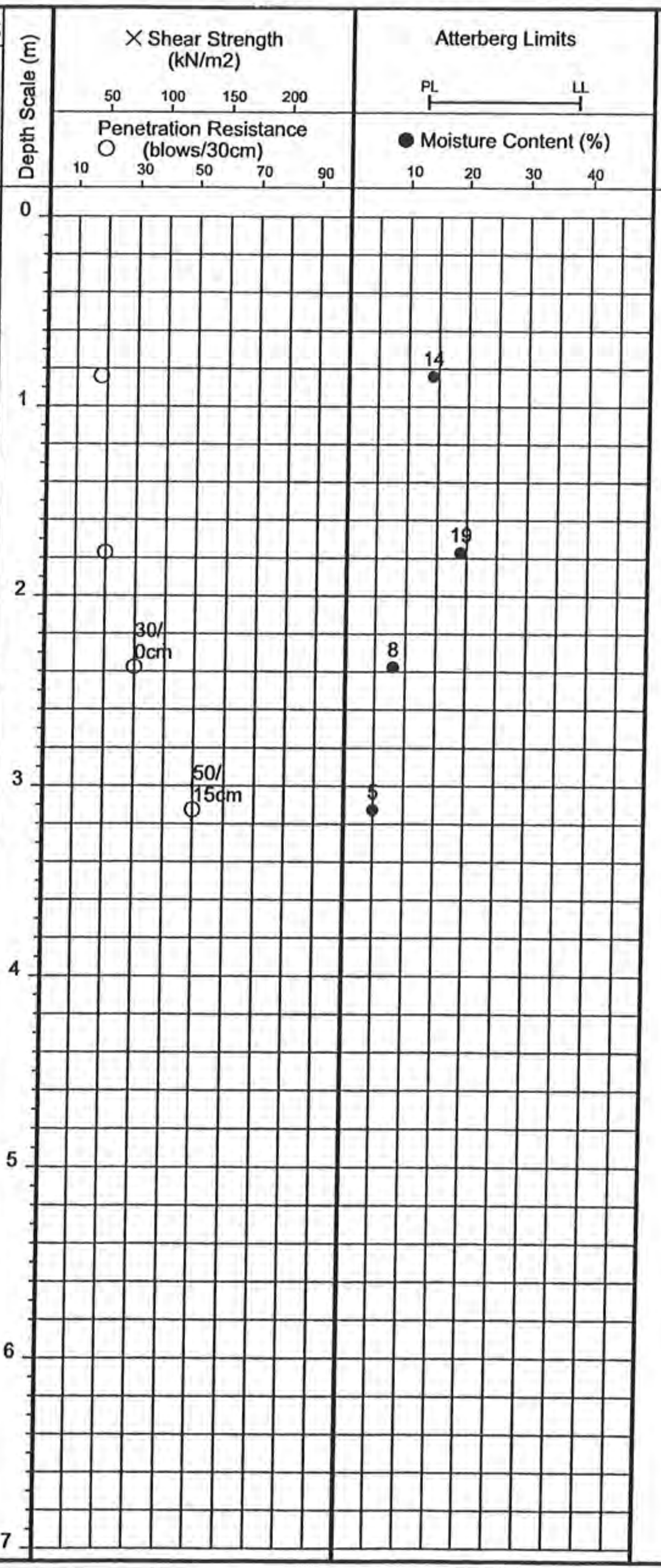
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 20, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
188.6	**30 cm TOPSOIL** occ. gravel, cobbles and boulders			
	Brown, compact **SANDY SILT, Till** some clay, a trace of gravel occ. wet clay, sand and silt seams and layers, cobbles and boulders weathered silt/clay layers	1	DO	18
1.3 187.3	Grey, compact **SILT** some clay	2	DO	20
2.1 186.5	Grey, very dense **SANDY SILT, Till** silty clay till layer	3	DO	30/ 0
	some clay, a trace of gravel occ. wet silty clay till, sand and silt seams and layers, cobbles and boulders with rock fragments rock fragments	4	DO	50/ 15
3.2 185.4	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 3

FIGURE NO: 3

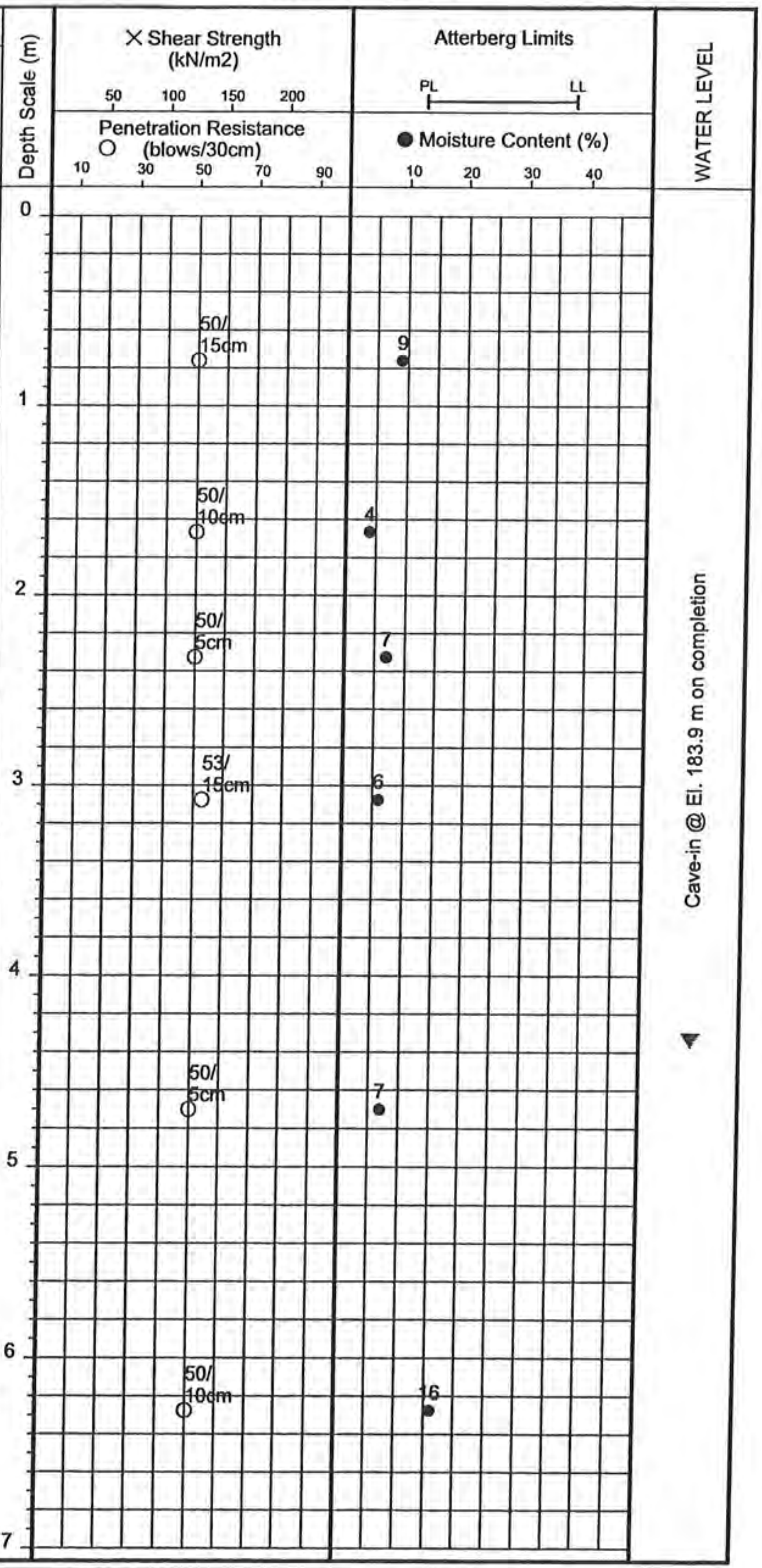
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 22, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0 188.2	Ground Surface **36 cm TOPSOIL** occ. cobbles and boulders			
	Brown, very dense weathered silt layers **SANDY SILT, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders with rock fragments	1	DO	50/15
1.3 186.9	Grey, very dense **SILTY SAND, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	2	DO	50/10
2.1 186.1	Grey, very dense	3	DO	50/5
	rock fragments **SANDY SILT, Till**	4	DO	53/15
	traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders with rock fragments silt layers	5	DO	50/5
5.5 182.7	Grey, very dense **SILTY SAND, Till and** **SANDY SILT, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders sand/silt layers	6	DO	50/10
6.4 181.8	**END OF BOREHOLE**			



Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 4

FIGURE NO: 4

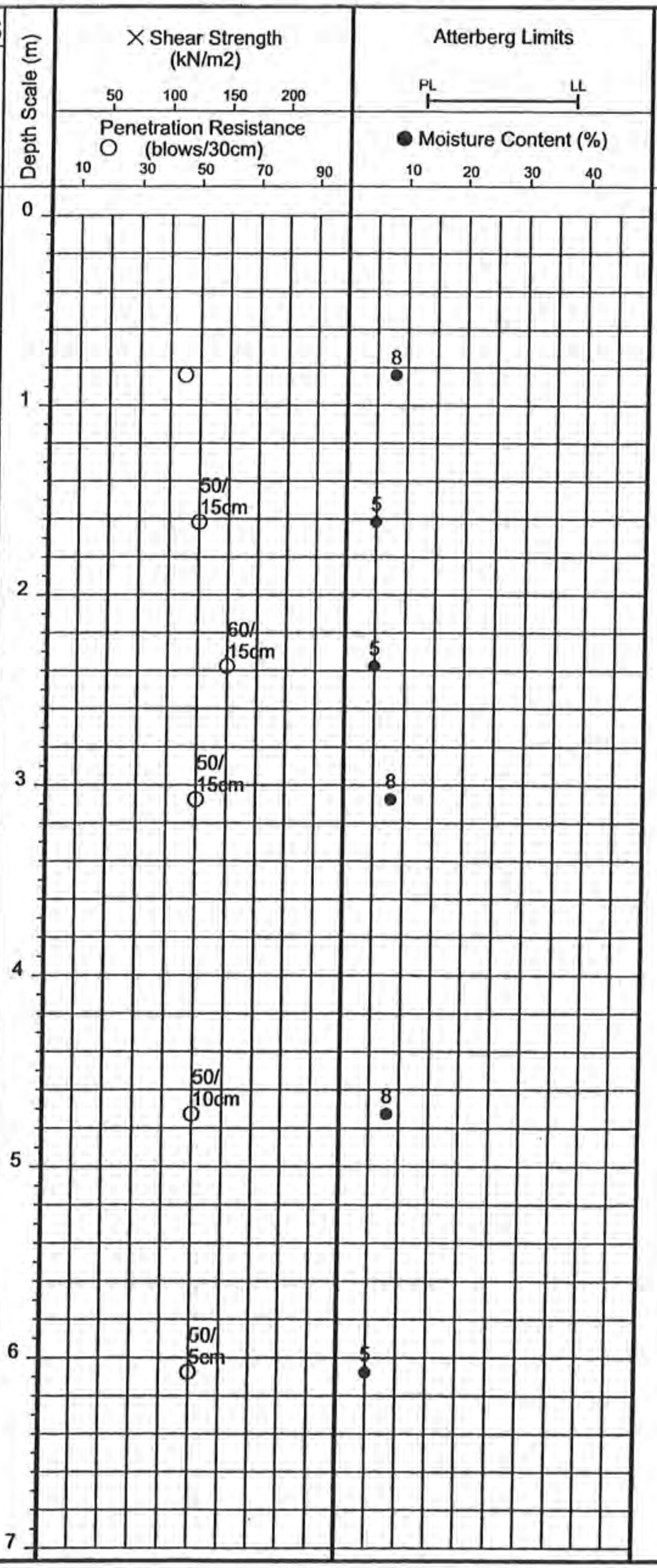
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 22, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0 188.3	Ground Surface **30 cm SAND AND GRAVEL** occ. cobbles and boulders			
	Dense **SILTY SAND, Till** — weathered traces of clay and gravel — brown / grey occ. wet sand and silt seams and layers, cobbles and boulders with topsoil and root inclusions	1	DO	45
1.3 187.0	Grey, very dense	2	DO	50/15
		3	DO	60/15
	SANDY SILT, Till — silt layers	4	DO	50/15
	traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	50/10
6.1 182.2	**END OF BOREHOLE**	6	DO	50/5



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 5

FIGURE NO: 5

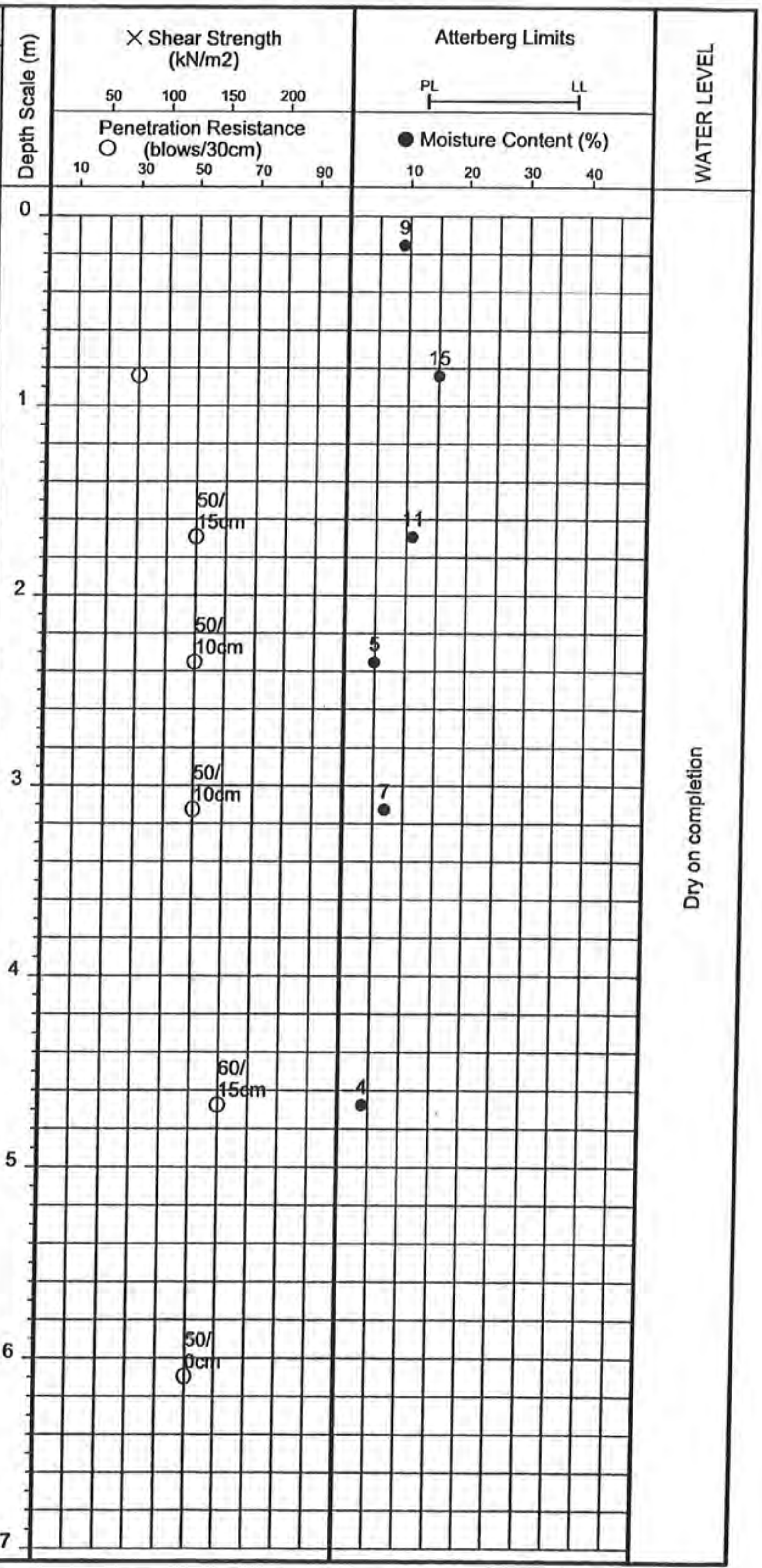
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 21, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 188.2	Ground Surface **36 cm TOPSOIL** occ. gravel, cobbles and boulders	1	AS	-
	Brown, dense to very dense weathered **SILT** a trace to some sand traces of clay and gravel occ. cobbles and boulders	2	DO	30
		3	DO	50/ 15
2.1 186.1	Grey, very dense	4	DO	50/ 10
	silt layers **SANDY SILT, Till**	5	DO	50/ 10
	rock fragments traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders with rock fragments	6	DO	60/ 15
6.1 182.1	**END OF BOREHOLE**	7	DO	50/ 0



Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 6

FIGURE NO: 6

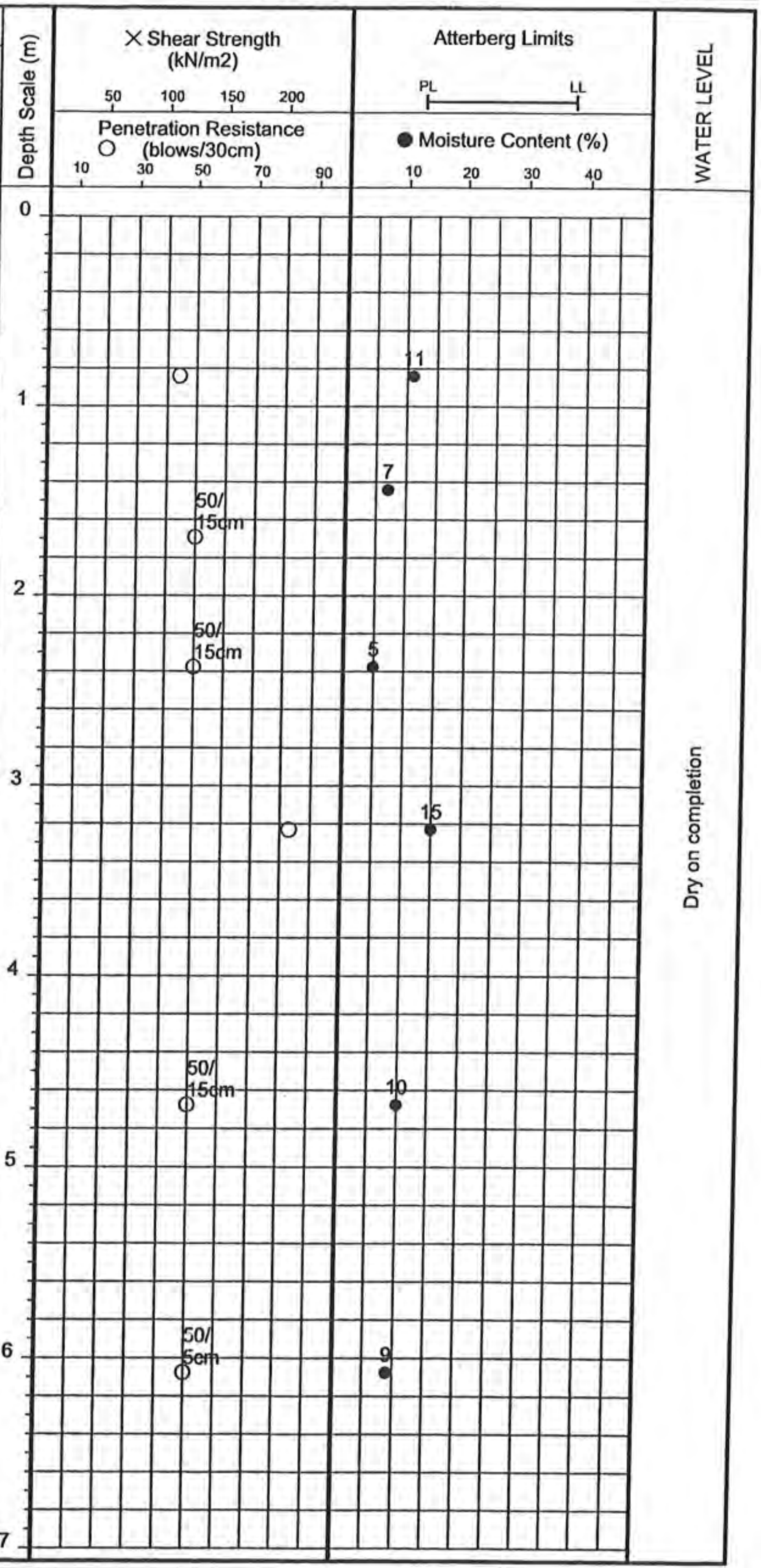
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 21, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
0.0 188.7	Ground Surface **36 cm TOPSOIL** occ. cobbles and boulders			
	Dense to very dense weathered sand layers	1	DO	44
	brown grey **SANDY SILT, Till**	2	DO	50/15
		3	DO	50/15
	traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders silt layers	4	DO	83
4.0 184.7	Grey, very dense **SILT** a trace to some sand traces of clay and gravel occ. cobbles and boulders	5	DO	50/15
5.5 183.2	Grey, very dense **SANDY SILT, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders			
6.1 182.6	**END OF BOREHOLE**	6	DO	50/5



Dry on completion

Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 7

FIGURE NO: 7

JOB DESCRIPTION: Proposed Industrial Development

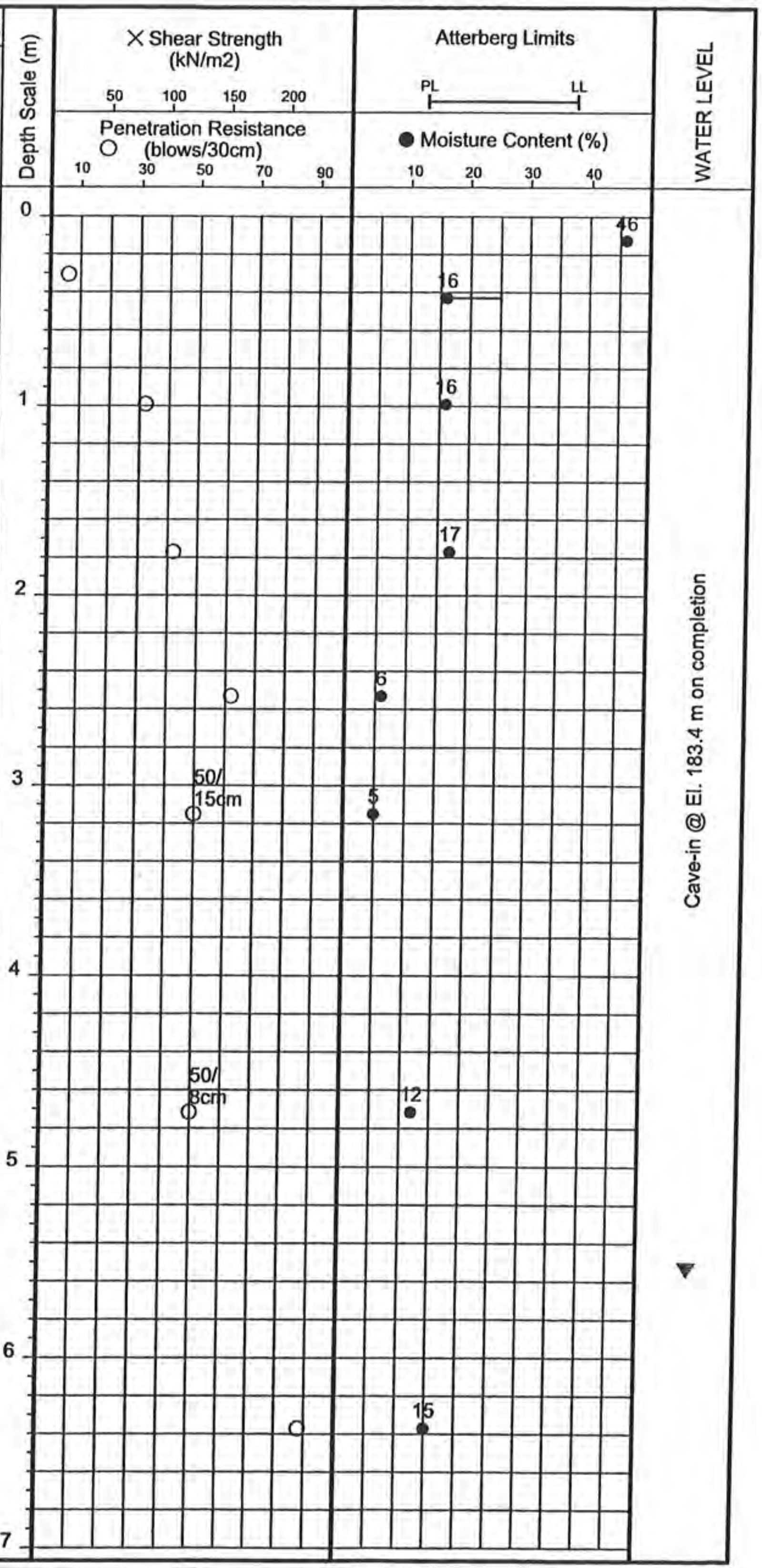
JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 20, 2012

Depth Elev. (m)	SOIL DESCRIPTION
0.0 188.9	Ground Surface **25 cm TOPSOIL**
	Brown, firm, weathered **SILTY CLAY** a trace of sand occ. silt seams and layers
0.7 188.2	Dense **SILT** a trace to some clay a trace of sand occ. wet sand and clay seams and layers sand/clay layers brown / grey
2.1 186.8	Grey, very dense **SILTY SAND, Till** a trace to some gravel a trace of clay occ. wet sand and silt seams and layers, cobbles and boulders
4.0 184.9	Grey, very dense **SANDY SILT** a trace of clay occ. wet silt seams and layers, cobbles and boulders
5.5 183.4	Grey, very dense **SILT** a trace to some sand traces of clay and gravel
6.6 182.3	**END OF BOREHOLE**

SAMPLES			
Number	Type	N-Value	Moisture Content (%)
1A			46
1B	DO	6	16
2	DO	32	16
3	DO	42	17
4	DO	62	6
5	DO	50/15	5
6	DO	50/8	12
7	DO	88	15



Cave-in @ El. 183.4 m on completion

Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 8

FIGURE NO: 8

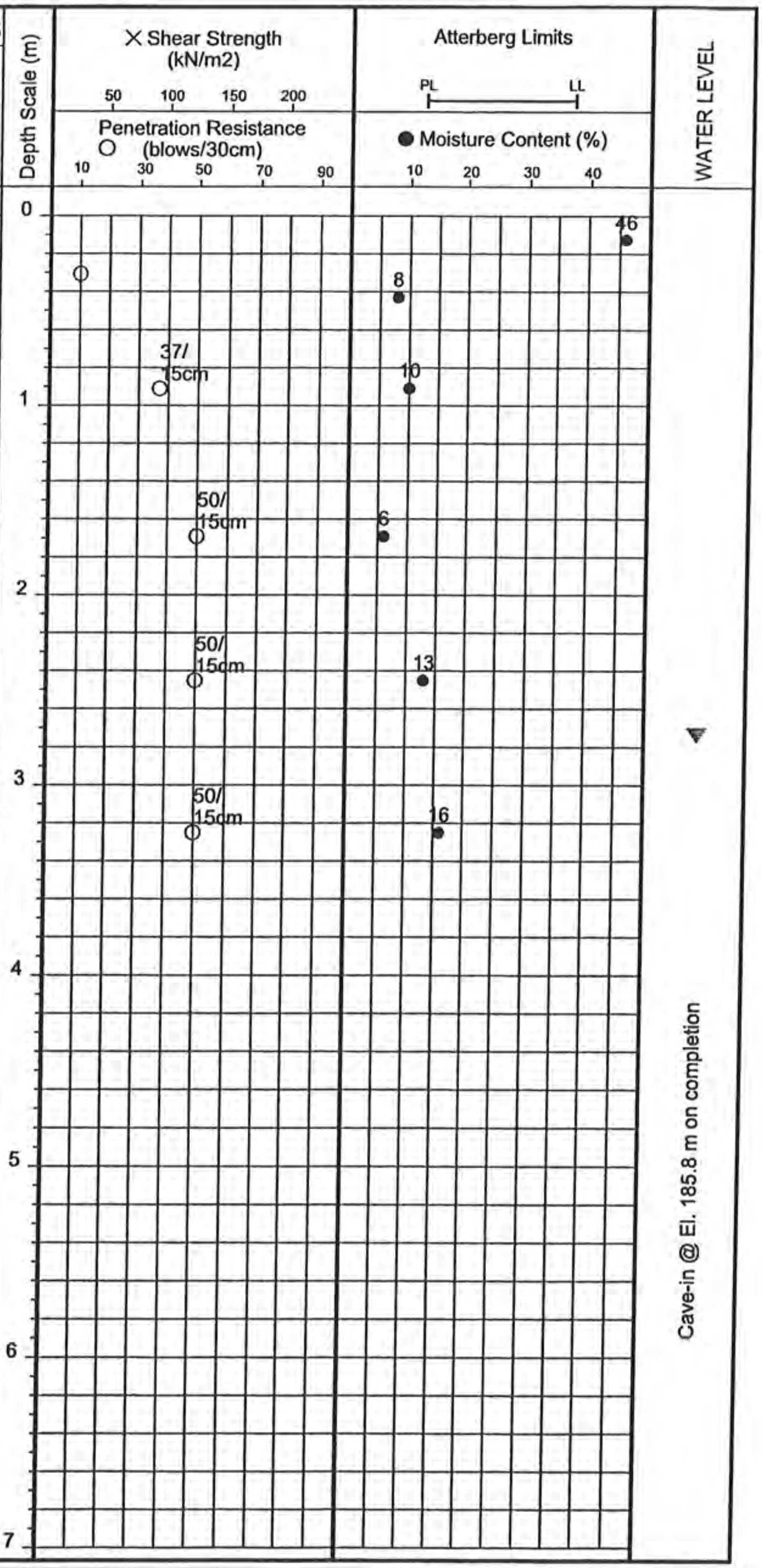
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 20, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 188.5	Ground Surface **25 cm TOPSOIL**	1A	DO	10
	Loose to very dense weathered **SILTY SAND, Till** a trace to some clay a trace of gravel brown grey occ. wet clay, sand and silt seams and layers, cobbles and boulders with rock fragments	1B		
		2	DO	37/ 15
		3	DO	50/ 15
2.1 186.4	Grey, very dense **SANDY SILT** a trace of clay occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	50/ 15
		5	DO	50/ 15
3.4 185.1	**END OF BOREHOLE**			



Cave-in @ El. 185.8 m on completion

Soil Engineers Ltd.

JOB NO: 1205-S095

LOG OF BOREHOLE NO: 9

FIGURE NO: 9

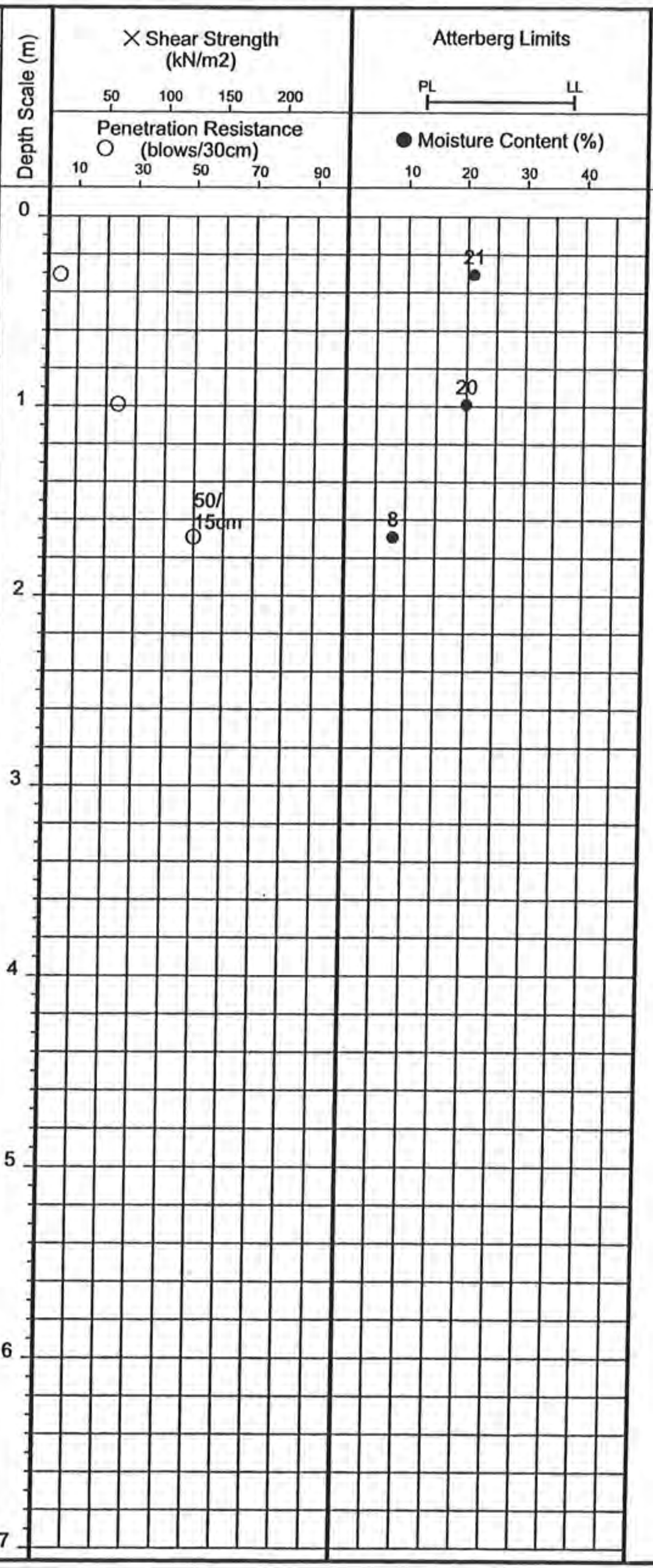
JOB DESCRIPTION: Proposed Industrial Development

JOB LOCATION: Mountain Road, Town of Collingwood

METHOD OF BORING: Flight-Auger

DATE: June 20, 2012

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
0.0	Ground Surface				
189.0	**20 cm TOPSOIL**				
	Brown, soft, weathered **SILTY CLAY** a trace of sand	1	DO	4	
0.7 188.3	Brown, compact **SILT** some fine sand, a trace of clay occ. wet sand and clay seams and layers weathered sand/clay layers	2	DO	24	
1.4 187.6	Grey, very dense **SANDY SILT, Till** traces of clay and gravel occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	50/ 15	
2.5 186.5	**END OF BOREHOLE** Auger Refusal at a depth of 2.5 m				Dry on completion



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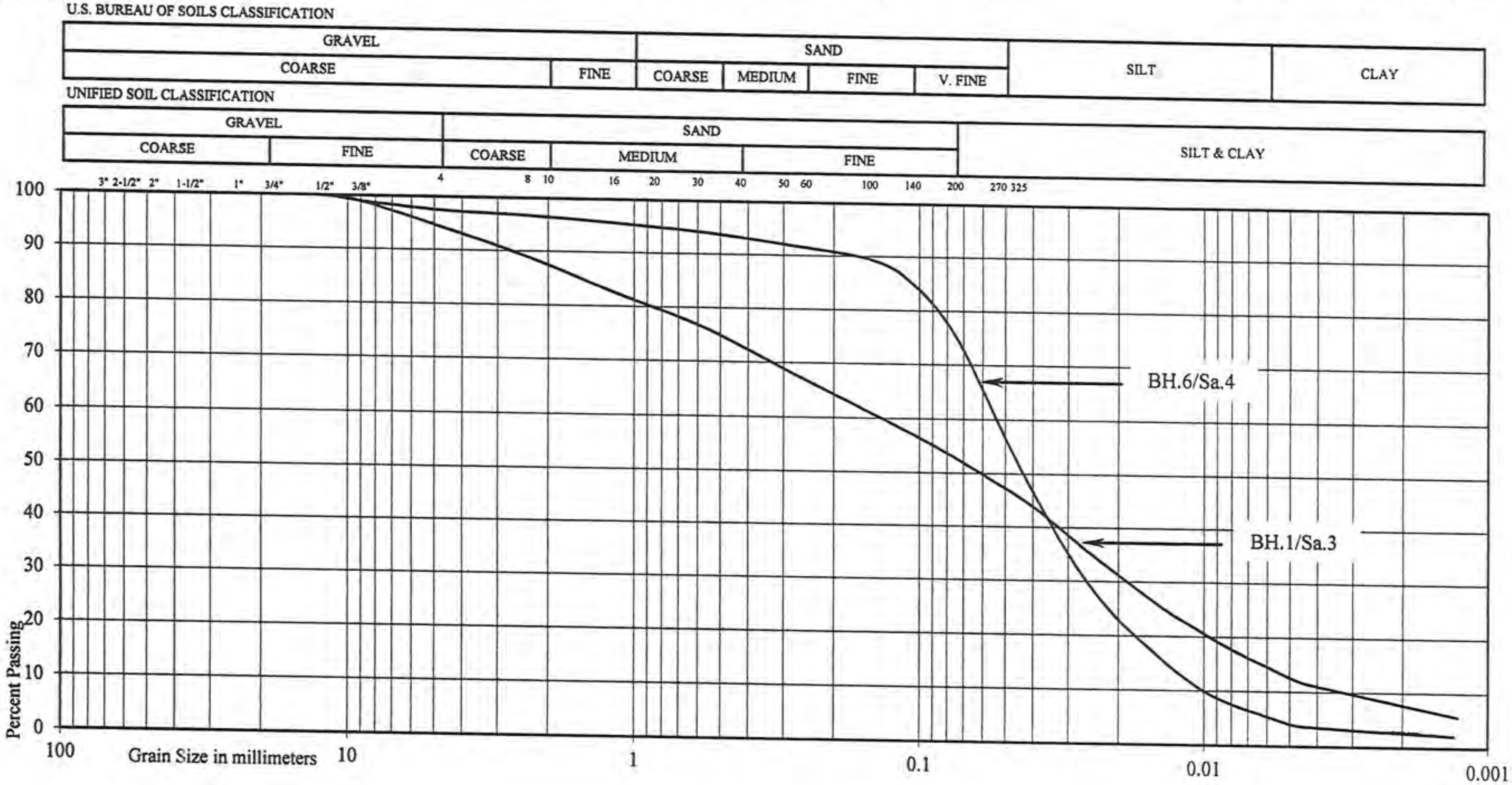
GRAIN SIZE DISTRIBUTION

Reference No: 1205-S095



Project: Proposed Industrial Development

Location: Mountain Road, Town of Collingwood

Borehole No:	1	6
Sample No:	3	4
Depth (m):	2.4	3.2
Elevation (m):	185.0	185.5

BH./Sa.	1/3	6/4
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	6	15
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-5}

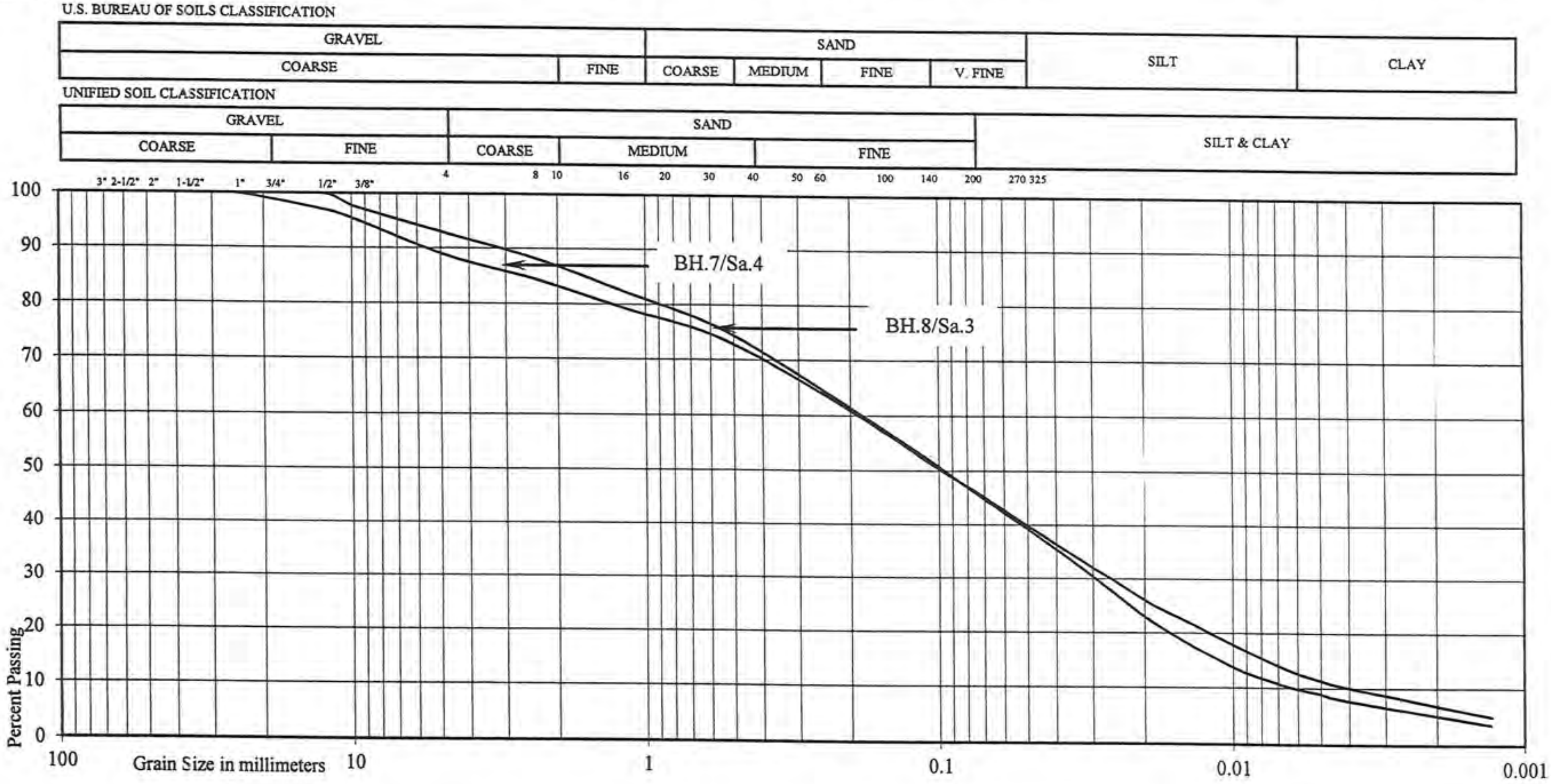
Classification of Sample [& Group Symbol]: SANDY SILT, Till
traces of clay and gravel

Figure: 10

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1205-S095



Project: Proposed Industrial Development

Location: Mountain Road, Town of Collingwood

Borehole No:	7	8
Sample No:	4	3
Depth (m):	2.5	1.7
Elevation (m):	186.4	186.8

BH./Sa.	7/4	8/3
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	6	6
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-5}

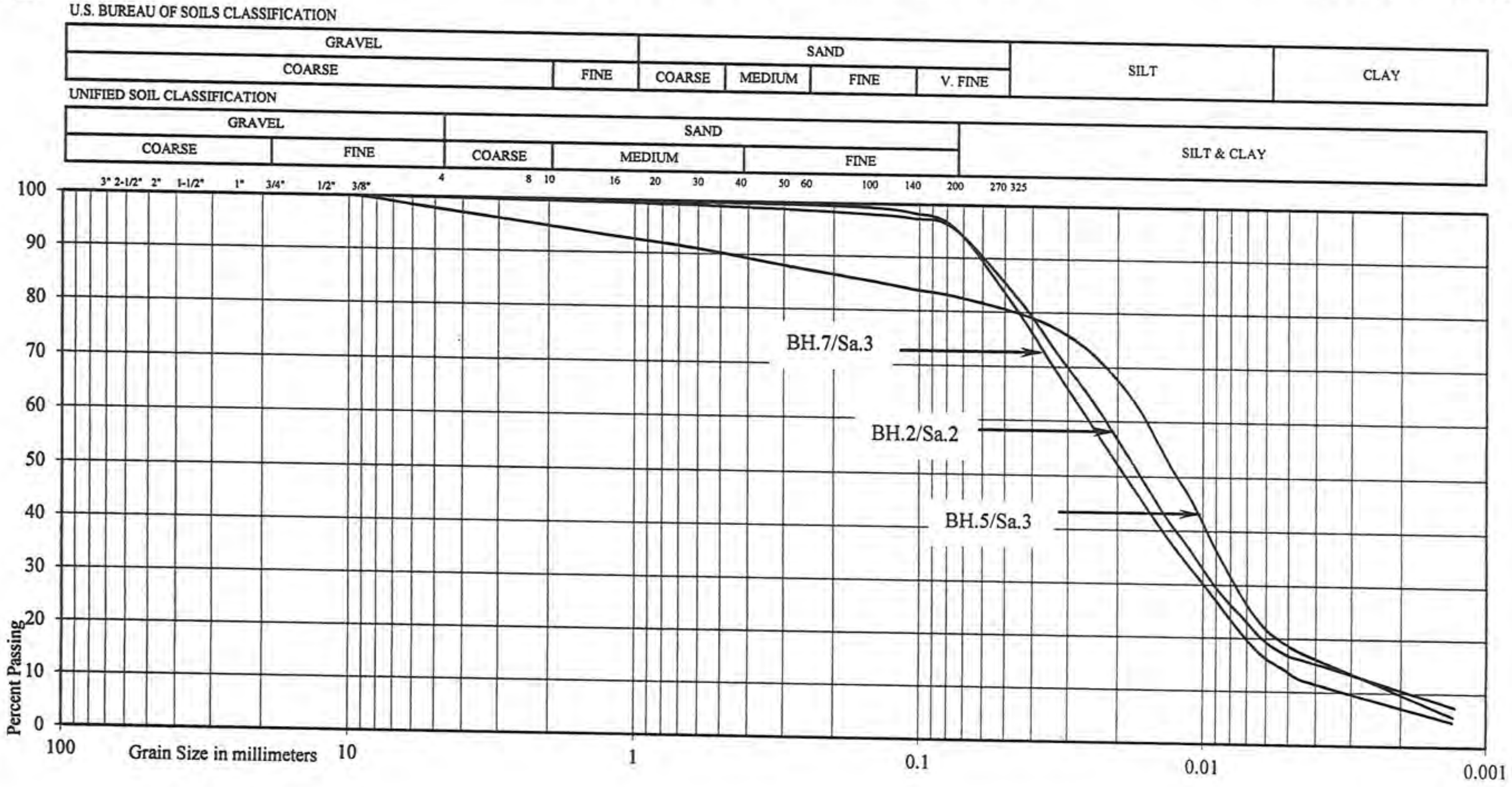
Classification of Sample [& Group Symbol]: SILTY SAND, Till
a trace to some gravel, a trace of clay

Figure: 11

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1205-S095



Project: Proposed Industrial Development

Location: Mountain Road, Town of Collingwood

Borehole No:	2	5	7
Sample No:	2	3	3
Depth (m):	1.8	1.7	1.8
Elevation (m):	186.8	186.5	187.1

BH./Sa.	2/2	5/3	7/3
Liquid Limit (%) =	-	-	-
Plastic Limit (%) =	-	-	-
Plasticity Index (%) =	-	-	-
Moisture Content (%) =	19	11	17
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-6}	10^{-5}

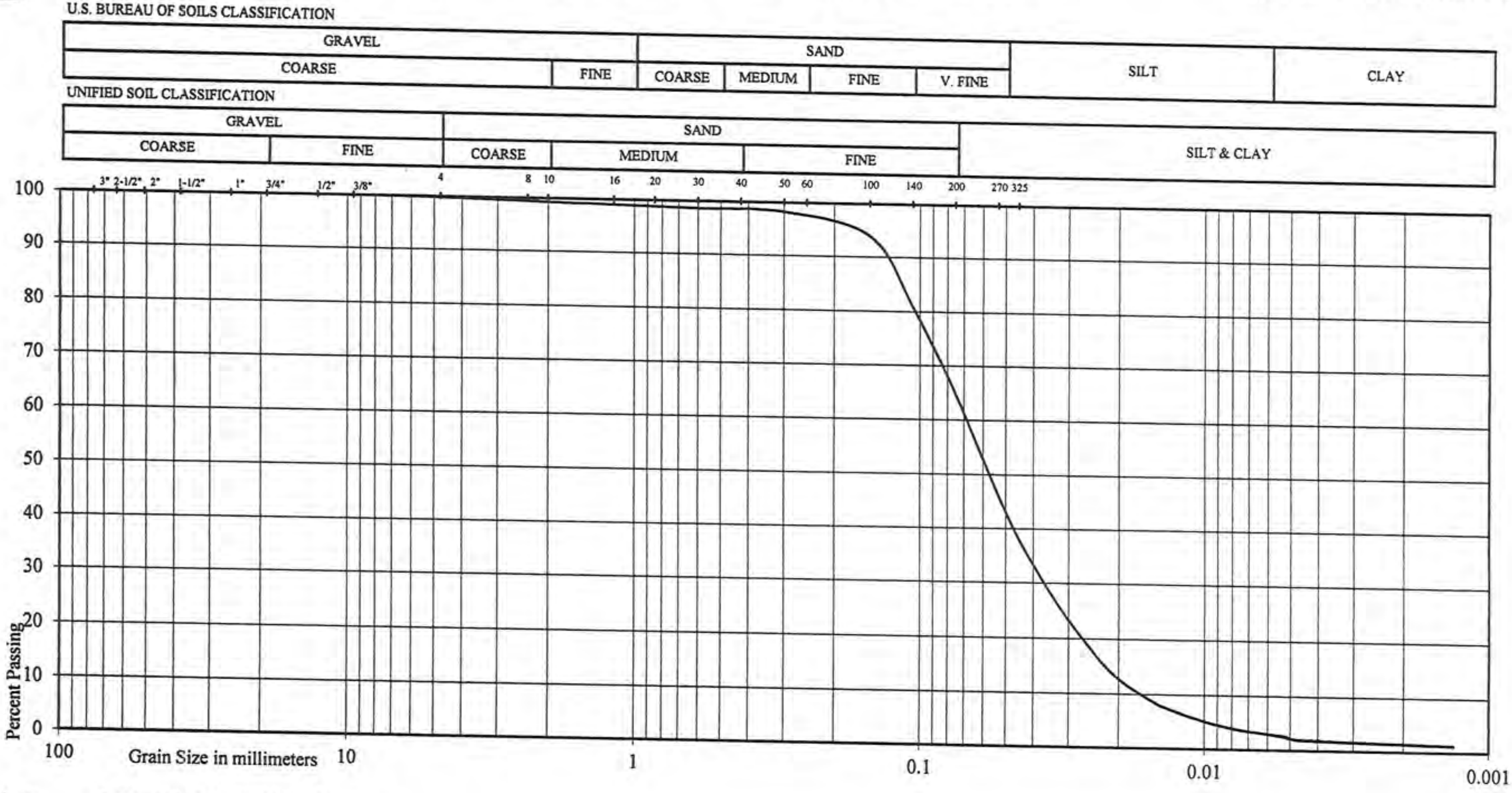
Classification of Sample [& Group Symbol]: SILT

traces to some sand and clay, a trace of gravel

Figure: 12

Soil Engineers Ltd. GRAIN SIZE DISTRIBUTION

Reference No: 1205-S095



Project: Proposed Industrial Development

Location: Mountain Road, Town of Collingwood

Borehole No: 8

Sample No: 5

Depth (m): 3.3

Elevation (m): 185.2

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 16

Estimated Permeability (cm./sec.) = 10^{-4}

Classification of Sample [& Group Symbol]: SANDY SILT

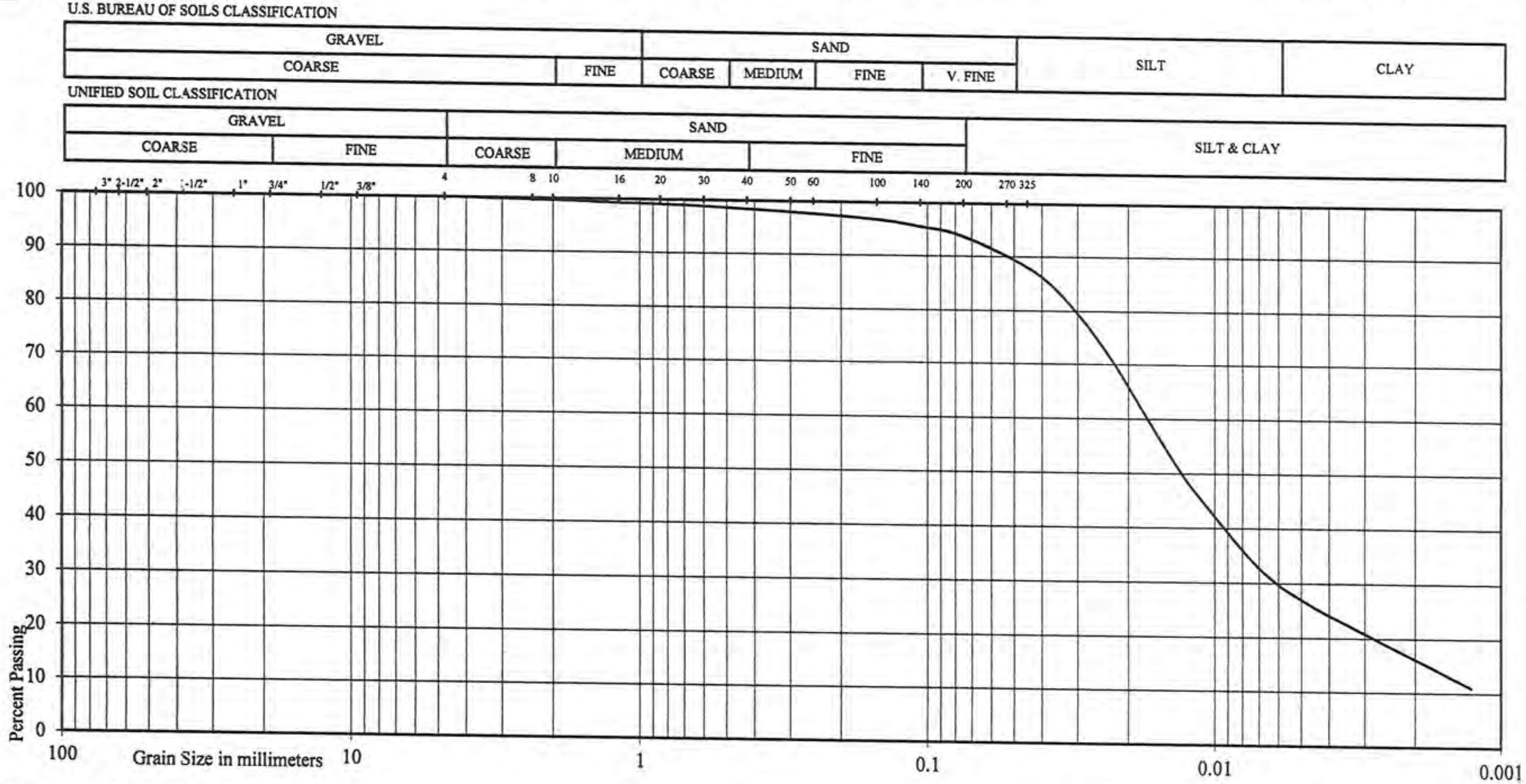
a trace of clay

Figure: 13

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1205-S095



Project: Proposed Industrial Development

Location: Mountain Road, Town of Collingwood

Borehole No: 7

Sample No: 1B

Depth (m): 0.4

Elevation (m): 188.5

Liquid Limit (%) = 25

Plastic Limit (%) = 15

Plasticity Index (%) = 10

Moisture Content (%) = 16

Estimated Permeability (cm./sec.) = 10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY
a trace of sand

Figure: 14

BOREHOLE LOCATION PLAN

Reference No.:	1205-S095
Date:	July 2012
Drawing No.:	1
Scale:	1:1000 ±

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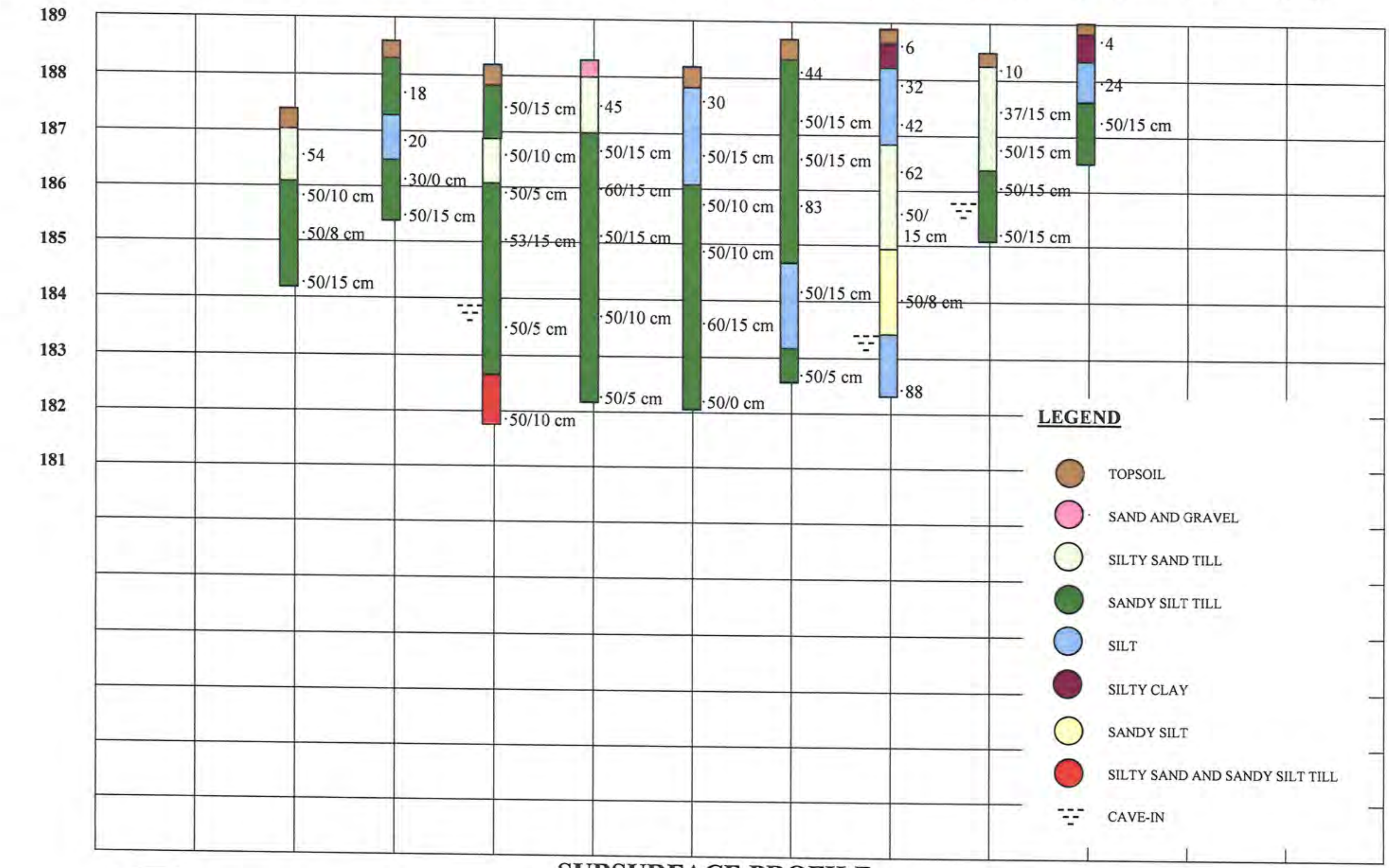
BH. No.		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		
Topsoil (cm)		**36**	**30**	**36**	**-**	**36**	**36**	**25**	**25**	**20**		
Elevation (m)		**187.4**	**188.6**	**188.2**	**188.3**	**188.2**	**188.7**	**188.9**	**188.5**	**189.0**		
El. (m)	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'	'W' 'N'



SUBSURFACE PROFILE

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Scale: ***Horiz.:*** *N.T.S.*
Vert.: *1:100*

Ref. No.: *1205-S095*
Drawing No. *2*