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A REPORT TO
MARIANNEVILLE DEVELOPMENTS LIMITED

A SOIL INVESTIGATION FOR PROPOSED RESIDENTIAL SUBDIVISION ESTATES OF GLENWAY NEWMARKET

GLENWAY GOLF CLUB
DAVIS DRIVE WEST AND BATHURST STREET

TOWN OF NEWMARKET

Reference No. 1111-S053

MARCH 2012

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EXECUTIVE SUMMARY

Soil Engineers Ltd. was retained to carry out a Geotechnical Investigation for the Glenway Golf Club, at the southeast quadrant of Bathurst Street and Davis Drive West in the Town of Newmarket, for the proposed Estates of Glenway Newmarket Residential Subdivision 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 investigation has disclosed that beneath a veneer of topsoil, a pavement structure, or a layer of topsoil fill and earth fill, the site is underlain by strata of soft to hard, generally stiff silty clay; stiff to hard, generally very stiff silty clay till; and compact to very dense, generally very dense silty sand and sandy silt tills. The soft and firm soils are restricted to the weathered zone of the deposits which extends to depths ranging from 0.6 to 3.0± m below the prevailing ground surface.

Groundwater and/or cave-in levels were measured at depths ranging from 1.0 to 6.4 m below the prevailing ground surface (El. 275.6 to El. 267.3 m). Boreholes 9, 13, 17, 18, MW3 and MW12 remained dry upon completion of the field work. The groundwater encountered at shallow depths and in the brown zone of the soil stratigraphy is likely derived from infiltrated precipitation which renders perched groundwater at shallow depths. The groundwater regime of the site is expected to lie in the saturated grey soils, and the groundwater level will fluctuate with the seasons.

The yield of groundwater from the clay, clay till and silt till is expected to be small and limited and will generally be controllable by normal pumping from sumps. From the water-bearing silty sand till and the wet sand and silt seams and layers, the yield is expected to be moderate to appreciable but will generally be controllable with normal or vigorous pumping from sumps. However, in areas where seepage from water-bearing silty sand till is high, sheeting or a well-point dewatering system may need to be implemented to stabilize the excavations. The appropriate dewatering method can be further assessed by test pits and test pumping prior to the project construction.

The Geotechnical Investigation has revealed that the site is generally suitable for the construction of the proposed development. Maximum Allowable Soil Pressures (SLS) of 100 kPa, 150 kPa and 300 kPa and Factored Ultimate Soil Bearing Pressures (ULS) of 160 kPa, 250 kPa and 480 kPa, depending on depths and location, can be used for the design of normal spread and strip footings founded onto sound natural soils. In places where very dense sandy silt and silty sand tills occur at moderate depths, high foundation loads can be supported by normal spread and strip footings designed with a Maximum Allowable Soil Pressure (SLS) of 800 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 1400 kPa.

Excavation into the tills containing boulders may require extra effort and the use of a heavy-duty backhoe. Boulders larger than 15 cm in size are not suitable for structural backfill.

1.0 INTRODUCTION

In accordance with instructions from Mr. Peter Slama, P.Eng., Project Manager, of Cole Engineering Group Ltd., and written authorization dated October 31, 2011, from Ms. Joanne Barnett, Vice-President, of Marianneville Developments Limited, a soil investigation has been carried out at the Glenway Golf Club located at the southeast corner of Davis Drive West and Bathurst Street, in the Town of Newmarket, for a proposed Residential Subdivision.

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 site is situated on Schomberg clay plains, where drift has been partly eroded and filled, in places, with stratified lacustrine sand, silt, clay and reworked till.

The subject land is located in Glenway Golf Club at the southeast quadrant of Bathurst Street and Davis Drive West in the Town of Newmarket. The proposed residential component of the golf club redevelopment encompasses an approximate area of 36.3 ha (89.7 ac) and is located within an existing residential area. The ground surface is undulated and generally descends in a south and westerly direction.

It is understood that the site will be subdivided into residential lots, an apartment block, a commercial block and blocks reserved for neighbourhood parks. The proposed project will be provided with municipal water, sewer services, stormwater management ponds and roadways meeting urban standards.

3.0 FIELD WORK

The field work, consisting of 18 boreholes to depths ranging from 6.2 to 7.9 m and 12 monitoring wells to depths ranging from 6.2 to 11.0 m, was performed on December 12 to 19, 2011, at the locations shown on the Borehole and Monitoring Well Location Plan, Drawing No. 1. It should be noted that 6 of the 12 monitoring wells are nested wells.

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 elevation at each of the borehole locations was interpreted from the elevations indicated at each borehole location and/or interpolated from the contours shown on the Borehole and Monitoring Well Location Plan, Project No. L09-301, prepared and provided by Cole Engineering Group Ltd., the consulting engineers for the project.

4.0 SUBSURFACE CONDITIONS

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole and Monitoring Well Logs, comprising Figures 1 to 36, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile on Drawing Nos. 2, 3 and 4, and the engineering properties of the disclosed soils are discussed herein.

The investigation has disclosed that beneath a veneer of topsoil, a pavement structure, or a layer of topsoil fill and earth fill, the site is predominantly underlain by strata of silty clay, silty clay till, and sandy silt and silty sand tills.

4.1 **Pavement Structure** (Boreholes 1 and 2)

The existing pavement structure consists of 75 mm of asphaltic concrete overlying a layer of granular fill, 250 mm thick.

The determined water content values of the granular fill are 4% and 5%, indicating that the granular fill is in a moist condition.

Sample examination shows that the granular fill contains excess fines. This is likely due to the infiltration of fines through cracks in the pavement and/or the upfiltration of the fill subgrade under traffic loads; hence, it does not meet the Gradation Requirements of the OPS Specification for Granular ‘A’ or ‘B’. Nevertheless, the granular fill can be used for structural backfill and/or road subgrade stabilization.

4.2 **Topsoil** and **Topsoil Fill** (All Boreholes, except Boreholes 1 and 2)

The thickness of the revealed topsoil and topsoil fill ranges from 23 to 70 cm.

They are dark brown in colour, indicating the presence of appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil and topsoil fill are considered to be void of engineering value, but can be used for general landscaping purposes. A fertility analysis should be carried out to assess the suitability of the topsoil as a planting soil or sodding medium.

Due to their humus content, the topsoil and topsoil fill may produce volatile gases and will generate an offensive odour under anaerobic conditions. Therefore, they must not be buried within the building envelope, or deeper than 1.2 m below the exterior finished grade. This is to avoid an adverse impact on the environmental well-being of the project.

4.3 **Earth Fill** (Boreholes 1, 2, 3, 6, 7, 9, 11, 12, 14, MW1, MW2, MW5, MW6, MW8, MW9 and MW10)

The fill generally consists of silty clay till material; in places, it was found mixed with some sand, a trace of gravel and occasional topsoil inclusions. The fill extends to depths ranging from 0.8 to 3.0 m below the prevailing ground surface.

The original topsoil was detected beneath the earth fill at Boreholes 2, 3 and 9; topsoil may have been present at other borehole locations but was obscured by the augering process.

Sample examinations show that the fill is amorphous in structure. The water content was determined, and the results are plotted on the Borehole Logs; the values range from 7% to 28%, with a median of 16%, indicating that the fill is in a moist to wet, generally very moist condition.

The obtained ‘N’ values range from 5 to 45, with a median of 16 blows per 30 cm of penetration. This shows that the relative density of the fill is non-uniform and loose in places, and it has been partially self-consolidated. Due to the occurrence of gravel and other debris, some of the obtained ‘N’ values may have been exaggerated and may not represent the actual relative density of the fill.

Due to its unknown history, the non-uniform and in places loose density, and the presence of topsoil inclusions and other deleterious material, the fill is considered unsuitable for supporting structures. For structural use, the fill must be subexcavated, assessed, sorted free of any deleterious materials, aerated, and properly and uniformly compacted.

Grain size analyses were performed on 2 representative samples of the earth fill; the results are plotted on Figure 37.

As noted, the fill is amorphous in structure; it will ravel and is susceptible to sudden collapse in steep cuts, particularly if it is in wet condition. Where the earth fill is free of deleterious materials, its engineering properties are generally similar to the underlying silty clay and silty clay till discussed in the following sections.

One must be aware that the samples retrieved from boreholes 10 cm in diameter 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.

4.4 **Silty Clay** (Boreholes 1, 2, 3, 4, 5, 6, 8, 10, 14, 15, 16, 18, MW1, MW2, MW5, MW7, MW10, MW11 and MW12)

The deposit of silty clay was generally found in the upper zone of the revealed soil stratigraphy; it is also found laminated within the tills at various depths and locations. The deposit either extends to the maximum investigated depth or beds onto the silty clay till. It contains a trace of sand and is laminated with wet silt and occasional sand layers, showing the soil is a lacustrine deposit. The wet silt layers displayed dilatancy when shaken by hand.

The obtained 'N' values of the stratum range from 4 blows per 30 cm to 50 blows per 8 cm, with a median of 15 blows per 30 cm, indicating that the consistency of the clay is soft to hard, being generally stiff. The soft to firm silty clay is restricted to the weathered zone of the stratum which extends to depths ranging from 0.8 to 2.0± m; in 1 location, the weathered zone extends to a depth of 3.0 m below the prevailing ground surface.

The Atterberg Limits of 3 representative samples and the water content values of the samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	25%, 26% and 29%
Plastic Limit	15%, 16% and 17%
Natural Water Content	7% to 36% (median 22%)

The above results show that the clay is a cohesive material with low plasticity. The natural water content generally lies between its plastic and liquid limits, confirming the consistency of the clay as determined by the 'N' values.

Grain size analyses were performed on 3 representative samples; the results are plotted on Figure 38.

Accordingly, the soil engineering properties pertaining to the project are given below:

- High frost susceptibility and high soil-adfreezing potential.
- Low 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-frictional soil, its shear strength is derived from consistency and augmented by the internal friction of the silt. Its shear strength is moisture dependent. Due to the dilatancy of the wet silt layers, 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.
- A steep cut in the sound clay may collapse as the wet silt slowly sloughs. The firm clay will be stable in a cut at 1 vertical:1.5 or + horizontal; however, depending on the overburden load, the clay may fail from overstressing. In this case, the sides of cuts should be further flattened, and the excavated spoil should be removed from the sides of excavations to lessen the overburden load.
- A very poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3% or less.

- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm·cm.

4.5 **Silty Clay Till** (All Boreholes, except Boreholes 2, 3, 11, 12, 13, 18, MW6 and MW8)

The silty clay till was found throughout the site. It either extends to the maximum investigated depth or beds onto the sandy silt and silty sand tills. It consists of a random mixture of soils; the particle sizes range from clay to gravel, with the clay fraction exerting the dominant influence on the soil properties. Sample examinations show that the silty clay till contains some sand to being sandy, a trace of gravel, and occasional sand and silt seams and layers. The clay till is generally heterogeneous in structure, indicating that it is a glacial deposit which, in places, has been partially reworked by past glaciation.

Occasional hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the till mantle.

The surficial layers of the till mantle are weathered. The badly fissured till occurs at depths ranging from 0.8 to 1.2± m from the prevailing ground surface.

The obtained 'N' values range from 8 blows per 30 cm to 50 blows per 0 cm, with a median of 30 blows per 30 cm. This indicates that the consistency of the till is stiff to hard, being generally very stiff. The marginally stiff silty clay till is restricted to the weathered zone of the till stratum.

The Atterberg Limits of 2 representative samples and the natural water content values of all the samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	22% and 30%
Plastic Limit	15% and 18%
Natural Water Content	9% to 27% (median 15%)

The results indicate that the clay till is a cohesive material with low plasticity. The natural water content generally lies at or below its plastic limits, confirming the generally very stiff consistency of the till determined by the 'N' values.

Grain size analyses were performed on 2 representative samples of the silty clay till; the results are plotted on Figure 39.

Based on the laboratory and field findings, the engineering properties related to the project are given below:

- High frost susceptibility and low soil-adfreezing potential.
- Low 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

- Its shear strength is derived from consistency and is augmented by internal friction. The strength is, therefore, inversely dependent on the soil moisture and, to a lesser degree, directly dependent on the soil density.
- In excavations, the clay till will be stable with relatively steep slopes. However, prolonged exposure will allow infiltrating precipitation to saturate the soil fissures and the sand and silt layers in the till mantle; this may lead to slow localized sheet sloughing.
- A very poor material to support flexible pavement, with an estimated CBR value of 3% or less.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4000 ohm·cm.

4.6 **Sandy Silt Till and Silty Sand Till** (Boreholes 11 to 18, inclusive, MW1, MW3, MW5, MW6, MW7, MW8, MW10, MW11 and MW12)

The sandy silt and silty sand tills occur in the lower zone of the soil stratigraphy. The tills consist of a random mixture of particle sizes ranging from clay to gravel, with either the silt or sand being the dominant fraction. The soils are heterogeneous in structure, showing that they are glacial tills.

Sample examinations disclosed that the tills are moderately cemented and they display slight to some cohesion when remoulded, indicating that they contain variable amounts of clay. The samples slaked readily when placed in water and, when shaken, the wet samples displayed a low to moderate dilatancy. Occasional sand and silt seams and layers were found in the soil samples, and some of them were wet.

Occasional hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the strata.

The obtained 'N' values range from 13 blows per 30 cm to 50 blows per 0 cm of penetration, with a median of 50 blows per 13 cm. This shows that the relative density of the tills is compact to very dense, being generally very dense.

The natural water content values of the samples were determined; the results are plotted on the Borehole Logs. The values range from 5% to 16%, with a median of 10%, indicating that the tills are in a damp to wet, generally very moist condition.

Grain size analyses were performed on 2 representative samples of the silty sand till; the results are plotted on Figure 40.

Based on the above findings, the engineering properties of the soils are listed below:

- Moderate to low frost susceptibility and soil-adfreezing potential, depending on the silt content of the soils.
- Moderately low water erodibility.
- Low to relatively 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 density dependent.
- The soils will generally be stable in steep cuts; however, they will slough if they are wet or being under seepage condition, particularly in the zone where wet sand and silt layers are prevalent.
- Fair pavement-supportive materials, with an estimated CBR value of 10%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

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

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	7 to 28 (median 16)	14 and 17	12 to 22
Silty Clay	7 to 36 (median 22)	15 to 17	11 to 21
Silty Clay Till	9 to 27 (median 15)	14 and 18	12 to 22
Sandy Silt and Silty Sand Tills	5 to 16 (median 10)	10	6 to 15

The above values show that the earth fill and tills are generally suitable for a 95% or + Standard Proctor compaction. A portion of the earth fill and the majority of the weathered soils and silty clay are either too wet or are on the wet side of the optimum; these soils will require aeration or mixing with drier soils prior to structural compaction. Aeration can be effectively carried out by spreading the soils thinly on the ground in dry, warm weather conditions.

The earth fill must be sorted free of serious topsoil inclusions and other deleterious materials, if encountered, prior to its use as structural fill.

The in situ soils should be compacted using a heavy-duty, kneading-type roller. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment that will be used at the time of construction.

When compacting the very stiff to hard silty clay and silty clay till and the dense to very dense silty sand and sandy silt tills 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). 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 road subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness.

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 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.

The presence of boulders in the till will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in diameter 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

Groundwater seepage encountered during augering was recorded on the field logs. The groundwater and/or cave-in levels were measured upon completion of the boreholes, and the data are plotted on the Borehole Logs and listed 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)**	**Remarks**	**Depth (m)**	**El. (m)**
1	6.6	3.0	3.0	Some	3.7	269.3
2	6.6	3.5	4.5	Some	4.9	270.1
3	6.2	4.5	4.5	Some	4.0/5.8*	274.0/272.2*
4	6.6	4.5	-	-	1.8/1.8*	273.9/273.9*
5	6.6	3.0	-	-	3.4	269.0
6	6.6	5.5	4.5	Some	4.3/5.8*	265.9/264.4*
7	6.6	4.0	1.5	Some	1.0	268.2
8	6.6	2.3	2.3	Moderate	2.1/5.8*	265.3/261.6*
9	6.6	4.5	-	-	Dry	-
10	6.2	5.5	3.0	Some	4.9	267.3
11	6.2	6.2+	5.5	Some	5.5	268.1
12	6.2	6.2+	2.3	Moderate	2.1	271.5
13	6.2	6.2+	-	-	Dry	-
14	7.9	4.5	6.0	Appreciable	2.1/6.0*	271.5/267.6*
15	7.8	7.8+	2.3	Moderate	1.5	275.6

Table 2 - Groundwater Levels (cont'd)

	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)**	**Remarks**	**Depth (m)**	**El. (m)**
16	6.6	6.6+	4.5	Some	4.5	272.5
17	6.2	6.2+	-	-	Dry	-
18	6.2	6.2+	-	-	Dry	-
MW1	11.0	6.0	1.5	Some	4.9	272.1
MW2	6.4	6.4+	4.5	Moderate	1.8	275.2
MW3	6.6	2.3	-	-	Dry	-
MW4	11.1	6.0	3.0	Some	-**	-**
MW5	6.2	5.5	4.5	Some	3.7	269.3
MW6	6.4	5.8	2.5	Some	-**	-**
MW7	10.8	6.0	7.8	Some	-**	-**
MW8	10.8	10.8+	3.0	Some	6.4	267.6
MW9	6.6	6.6+	4.6	Some	3.7	269.3
MW10	10.8	6.0	4.6	Some	-**	-**
MW11	6.2	6.2+	4.6	Some	5.8	271.2
MW12	10.8	10.0	-	-	Dry	-

*Cave-in level (In wet sand and silt layers laminated in the clay and till mantles, the level generally represents the groundwater regime at the time of investigation.)

** The wells have been flushed-out after installation; therefore, no groundwater measurements were recorded at these locations.

As shown above, the groundwater and/or cave-in levels were measured at depths ranging from 1.0 to 6.4 m below the prevailing ground surface (El. 275.6 to El. 267.3 m). Boreholes 9, 13, 17, 18, MW3 and MW12 remained dry upon completion of the field work. The groundwater encountered at shallow depths and in the brown zone of the soil stratigraphy is likely derived from infiltrated precipitation trapped in the earth fill, in the fissures of the weathered soils, and in the sand and silt seams and layers in the soil mantle, which renders perched groundwater at shallow depths.

The colour of the revealed soils changes from brown to grey at depths ranging from 2.3 to 10.8+ m below the ground surface. This indicates that the upper zone of the stratigraphy has been oxidized. The groundwater is expected to lie in the saturated grey soils, and the groundwater level will fluctuate with the seasons.

The yield of groundwater from the clay, clay till and silt till, due to their low permeability, is expected to be small and limited and will generally be controllable by normal pumping from sumps. From the water-bearing silty sand till and the wet sand and silt seams and layers, the yield is expected to be moderate to appreciable but will generally be controllable with normal or vigorous pumping from sumps. However, in areas where seepage from water-bearing silty sand till is high, sheeting or a well-point dewatering system may need to be implemented to stabilize the excavations.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a veneer of topsoil, a pavement structure, or a layer of topsoil fill and earth fill, the site is underlain by strata of soft to hard, generally stiff silty clay; stiff to hard, generally very stiff silty clay till; and compact to very dense, generally very dense silty sand and sandy silt tills. The soft and firm soils are restricted to the weathered zone of the deposits.

The upper zone of the revealed stratigraphy is permeated with fissures due to weathering. The weathered zone generally extends to depths ranging from 0.6 to 3.0± m below the prevailing ground surface.

In places, the 'N' values in the silty clay and clay till decrease with depth where the soil colour changes from brown to grey, which indicates that the till has been partially reworked by past glaciation.

The groundwater and/or cave-in levels were measured at depths ranging from 1.0 to 6.4 m below the prevailing ground surface (El. 275.6 to El. 267.3 m). Boreholes 9, 13, 17, 18, MW3 and MW12 remained dry upon completion of the field work. The groundwater encountered at shallow depths and in the brown zone of the soil stratigraphy is likely derived from infiltrated precipitation trapped in the earth fill, in the fissures of the weathered soils, and in the sand and silt seams and layers in the soil mantle, which renders perched groundwater at shallow depths. The groundwater is expected to lie in the saturated grey soils, and the groundwater level will fluctuate with the seasons.

The yield of groundwater from the clay, clay till and silt till, due to their low permeability, is expected to be small and limited and will generally be controllable by normal pumping from sumps. From the water-bearing silty sand till and the wet sand and silt seams and layers, the yield is expected to be moderate to appreciable but will generally be controllable with normal or vigorous pumping from sumps. However, in areas where seepage from water-bearing silty sand till is high, sheeting or a well-point dewatering system may need to be implemented to stabilize the excavations.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil and topsoil fill are highly compressible and must be stripped as they are unsuitable for engineering applications. Due to their high humus content, they will generate volatile gases under anaerobic conditions. For the environmental as well as the geotechnical well-being of the future development, the topsoil should not be buried within the building envelope, or deeper than 1.2 m below the exterior finished grade.
2. The weathered soils are weak and will consolidate under surcharge loads. To upgrade the weathered soils to engineered status suitable for normal footing construction, they must be subexcavated, aerated and properly compacted.
3. The sound natural soils are suitable for normal spread and strip footing construction.
4. The silty clay is highly frost susceptible with high soil-adfreezing potential. Where this soil is used to backfill against the foundation walls, special measures must be incorporated into the building construction to prevent serious damage due to frost heave and soil adfreezing.
5. Cut and fill will likely be required for the site grading. It is generally more economical to place engineered fill for normal footing, sewer and road construction.

6. The firm clay will be stable in a cut at 1 vertical:1.5 or + horizontal; however, depending on the overburden load, the clay may fail from overstressing. In this case, the sides of cuts should be further flattened and the excavated spoil should be removed from the sides of excavations to lessen the overburden load.
7. Perimeter subdrains and dampproofing of the foundation walls will be required for basement construction. The subdrains should be shielded by a fabric filter to prevent blockage by silting.
8. Due to the presence of topsoil, topsoil fill, earth fill and weathered soils, and, in places, the decrease in 'N' values with depth, the footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, or by a building inspector who has geotechnical experience, to assess its suitability for bearing the designed foundations.
9. A Class 'B' bedding, consisting of compacted 20-mm Crusher-Run Limestone or equivalent, is recommended for the construction of the underground services.
10. Excavation into the clay or tills containing boulders may require extra effort and the use of a heavy-duty backhoe. Boulders larger than 15 cm in size are not suitable for structural backfill.

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 this 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, the footings should be placed below the topsoil and weathered soil onto the sound natural soils. The recommended soil pressures for use in the design of the normal spread and strip footings, together with the corresponding suitable founding levels, are presented in Table 3.

Table 3 - Founding Levels

	Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level					
	100 kPa (SLS) 160 kPa (ULS)		**150 kPa (SLS) 250 kPa (ULS)**		**300 kPa (SLS) 480 kPa (ULS)**	
Borehole No.	**Depth (m)**	**El. (m)**	**Depth (m)**	**El. (m)**	**Depth (m)**	**El. (m)**
1	-	-	2.5 or +	270.5 or -	-	-
2	2.5 or +	272.5 or -	4.5 or +	270.5 or -	-	-
3	-	-	3.2 or +	274.8 or -	4.5 or +	273.5 or -
4	-	-	1.0 or +	274.7 or -	3.2 or +	272.5 or -
5	1.2 or +	271.2 or -	2.5 or +	269.9 or -	-	-
6	2.5 or +	267.7 or -	4.5 or +	265.7 or -	-	-
7	-	-	1.6 or +	267.6 or -	2.5 or +*	266.7 or -
8	-	-	1.0 or +	266.4 or -	1.6 or +	265.8 or -
9	-	-	1.6 or +	266.2 or -	2.5 or +	265.3 or -
10	-	-	2.2 or +	270.0 or -	3.0 or +	269.2 or -
11	-	-	-	-	1.5 or +	272.1 or -
12	-	-	-	-	1.0 or +	272.6 or -
13	-	-	-	-	1.0 or +	277.4 or -
14	-	-	2.0 or +	271.6 or -	3.0 or +	270.6 or -

Table 3 - Founding Levels (cont'd)

Borehole No.	Maximum Allowable Soil Pressure (SLS) / Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level					
	100 kPa (SLS) 160 kPa (ULS)		150 kPa (SLS) 250 kPa (ULS)		300 kPa (SLS) 480 kPa (ULS)	
	Depth (m)	El. (m)	Depth (m)	El. (m)	Depth (m)	El. (m)
15	1.6 or +	275.5 or -	2.3 or +	274.8 or -	3.2 or +	273.9 or -
16	-	-	2.3 or +	274.7 or -	3.2 or +	273.8 or -
17	-	-	-	-	1.0 or +	281.8 or -
18	-	-	-	-	1.2 or +	283.9 or -

*Due to the decrease in 'N' values with depth, the 300 kPa (SLS) soil pressure must be linearly reduced to 150 kPa (SLS) from a depth of 5.0 m below the prevailing ground surface, and the size of the spread and strip footings should not be greater than 1.4 m and 0.8 m, respectively.

For high-load foundation, the structure should be located in the area delineated by Boreholes 10 to 18, inclusive (except Borehole 15), where very dense sandy silt and silty sand tills occur at shallow to moderate depths. These tills are capable of sustaining a Maximum Allowable Soil Pressure (SLS) of 800 kPa with a Factored Ultimate Soil Bearing Pressure (ULS) of 1400 kPa for the design of normal strip and spread foundations at moderate depths ranging from 2.0 to 7.0 m.

As noted, the subsurface conditions often vary between boreholes. Therefore, the recommendations given above must be further assessed during footing construction, to ensure that the foundation design is compatible with the subgrade conditions.

Where extended footings will be required, it may be more cost-effective to subexcavate to a size 30% larger than the designed footing width and fill with structural concrete up to the proposed 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. Stepped footings must be sloped at 7 vertical:10 horizontal.

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 are estimated to be 25 mm and 15 mm, respectively.

The footings exposed to weathering, and in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

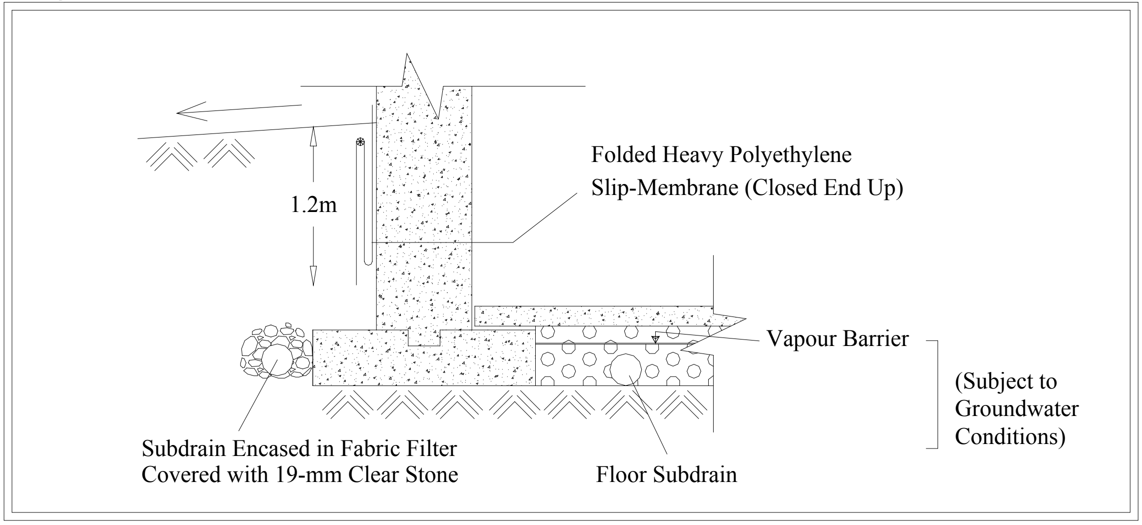
Due to the presence of topsoil, topsoil fill, earth fill and weathered soils, and the decrease of ‘N’ values with depth, the footing subgrade should be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, or by a building inspector who has geotechnical background, to ensure that the revealed conditions are compatible with the foundation design requirements.

The design of the foundations should meet the requirements specified in the Ontario Building Code 2006, and the structure should be designed to resist an earthquake force using Site Classification ‘C’ (very dense soil).

Perimeter subdrains and dampproofing of the foundation walls will be required for basement construction, particularly in areas where shallow groundwater was encountered. The subdrains should be encased in fabric filter to protect them against blockage by silting and they must be connected to a positive outlet.

As noted, the encountered silty clay is highly frost susceptible and has high soil-adfreezing potential. In order to alleviate the risk of frost damage, the foundation walls must be constructed of concrete and either backfilled with non-frost-susceptible pit-run granular, or shielded with a polyethylene slip-membrane. The recommended scheme is illustrated in Diagram 1.

Diagram 1 - Frost Protection Measures (Foundation)



The membrane will allow vertical movement of the heaving soil (due to frost) without imposing structural distress on the foundations. The external grading should be such that runoff is directed away from the foundation.

6.2 Engineered Fill

Where earth fill is required to raise the site, it is generally more economical to place engineered fill for normal footing, sewer and road construction.

The engineering requirements for a certifiable fill for road construction, municipal services, and footings designed with a 100 to 150 kPa Maximum Allowable Soil

Pressure (SLS) and a 160 to 250 kPa Factored Ultimate Soil Bearing Pressure (ULS), depending on location, 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 highly weathered soils must be subexcavated, aerated and properly compacted.
2. The in situ organic-free soils can 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 lot grade and/or road 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 by two 15-mm steel reinforcing bars in the footings and 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.
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.
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 footings 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 inspected the fill placement in order to document the locations of 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 engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the strip footings and the upper section of the foundation walls constructed on the engineered fill may require continuous reinforcement with steel bars, depending on the uniformity of the soils in the engineered fill and the

thickness of the engineered fill underlying the foundations. Should the footings and/or walls require reinforcement, the required number and size of reinforcing bars must be assessed by considering the uniformity as well as the thickness of the engineered fill beneath the foundations. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

6.3 **Underground Services**

The subgrade for the underground services should consist of natural soils or compacted organic-free earth fill. In areas where the subgrade consists of topsoil, fills or weathered soils, these materials should be subexcavated and replaced with properly compacted inorganic soils and/or bedding material compacted to at least 95% or + of its Standard Proctor compaction.

Where the sewers will be constructed using the open-cut method, the construction must be carried out in accordance with Ontario Regulation 213/91. In areas where a vertical cut is necessary, the use of a trench box is considered to be appropriate. In the design of the trench box and/or shoring structure, the recommended lateral earth pressure coefficients presented in Section 6.8 can be used.

A Class ‘B’ bedding is recommended for construction of the underground services. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting. In wet sand and silt seams and layers, the sewer joints should be leak-proof or wrapped with a waterproof membrane.

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

The subgrade soils are considered to have moderately high to moderately low corrosivity to ductile iron pipes and metal fittings, with an electrical resistivity ranging from 3500 to 5000 ohm·cm; therefore, the underground services should be protected against soil corrosion. For estimation purposes of the anode weight requirements, the electrical resistivity which has been given for each of the disclosed soils can be used. This, however, should be confirmed by testing the soils along the water main alignment at the time of sewer construction.

6.4 Backfilling in Trenches and Excavated Areas

The on-site inorganic soils are generally suitable for trench backfill. 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 material 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.

In normal sewer construction practice, the problem areas of road settlement largely occur adjacent to manholes, catch basins and services crossings. In areas which are inaccessible to a heavy compactor, 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 a period of at least 1 day.

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 soil have a water content on the dry side of the optimum, it would be impossible to wet the soil 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 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 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.

- 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, seepage collars should be provided.

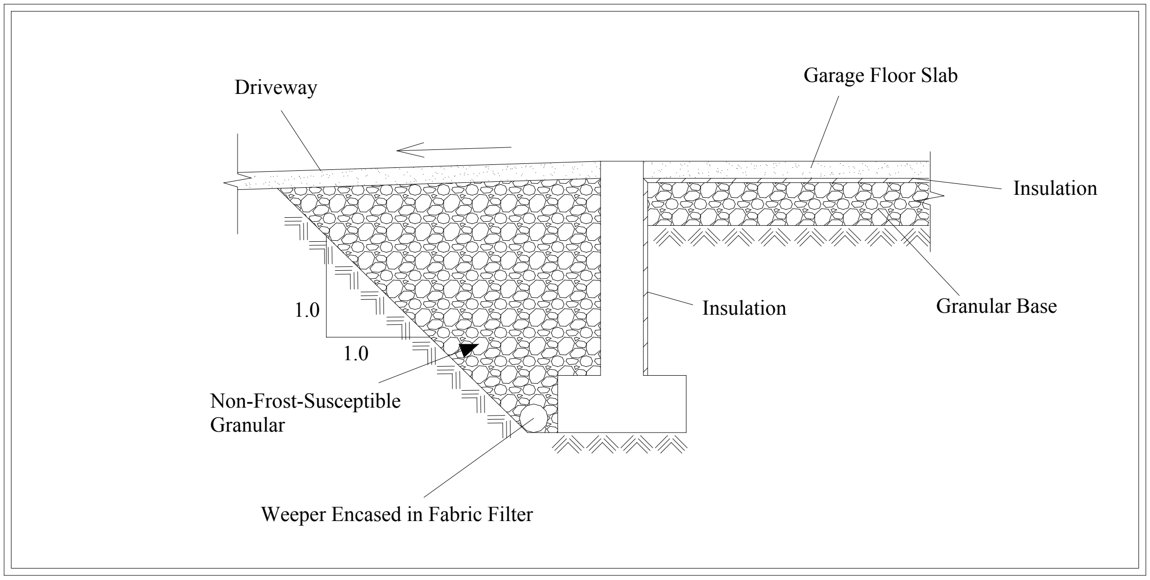
6.5 Slab-On-Grade, Garages, Driveways and Landscaping

As noted, most of the encountered soils are moderately to highly frost susceptible; therefore, the ground is expected to heave during cold weather.

The driveways at the entrances to the garages must be backfilled with non-frost-susceptible granular material, with a frost taper at a slope of 1 vertical:1 horizontal. The garage floor slab and interior garage foundation walls must be insulated with

50-mm Styrofoam, or equivalent. The recommended scheme is illustrated in Diagram 2.

Diagram 2 - Frost Protection Measures (Garage)



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 structure.

The subgrade for slab-on-grade must consist of sound natural soils or properly compacted inorganic engineered fill. It 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.

A Modulus of Subgrade Reaction of 30 MPa/m is recommended for the design of the floor slab.

In areas where ground movement due to frost heave cannot be tolerated, the slab-on-grade, sidewalks and interlocking stone pavement must be constructed on a free-draining granular base, 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, the slab-on-grade, sidewalks and interlocking stone pavement should be insulated with 50-mm Styrofoam, or equivalent.

6.6 Pavement Design

Based on the borehole findings, the recommended pavement design for local roads is presented 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	Granular ‘A’ or 20-mm Crusher-Run Limestone
Granular Sub-base	350	Granular ‘B’ or 50-mm Crusher-Run Limestone

In preparation of the subgrade, the surface should be proof-rolled. Any soft subgrade should be subexcavated, aerated and properly compacted, or replaced with uniformly compacted, organic-free earth fill or granular material.

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.

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

The road 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:

- If the road 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.
- Lot areas adjacent to the roads should be properly graded to prevent ponding of large amounts of water during interim construction period.
- If the roads are to be constructed during wet seasons and extensive soft subgrade occurs, the granular sub-base may require thickening. This can be assessed during construction.
- Curb subdrains will be required. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.

6.7 **Stormwater Management Ponds**

Based on the borehole findings, the in situ soils generally consist soft to hard, generally stiff silty clay; stiff to hard, generally very stiff silty clay till; and compact to very dense, generally very dense silty sand and sandy silt tills.

The silty clay, silty clay till and sandy silt till have low permeability, with an estimated coefficient of permeability of 10^{-6} to 10^{-7} cm/sec, and are considered suitable for the construction of the pond. Portions of the silty sand till are a moderately pervious material with an estimated coefficient of permeability of

10^{-5} cm/sec, and this will impact the storage capacity of the pond; therefore, where the bottom and sides of the pond below the wet perimeter consist of silty sand till, an impermeable geosynthetic clay liner or a compacted, 1.0 m thick, clay liner should be provided. The on-site silty clay and silty clay till can be used as a clay liner. The necessity to implement this measure can be further assessed when the final design of the pond become available and the locations have been determined.

The pond berms must be compacted to 95% or + of their maximum Standard Proctor dry density. The pond cut into the ground should be sloped to at least 1 vertical:3 or + and 4 or + horizontal for above and below the wet perimeter of the pond, respectively. All the exposed side slopes must be vegetated and/or sodded to prevent erosion.

The footings for all control structures for the stormwater management system must be placed onto the sound natural soils. They should be designed using the soil pressures and suitable founding levels presented in Table 3, and the footings must be placed below the frost depth of 1.2 m or below the anticipated scouring depth, whichever is deeper. Gabion mats must be placed at the upstream and downstream ends of the control structure to prevent bed scouring.

6.8 **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	**Loose**	**Compacted**
Earth Fill	20.5	1.20	0.98
Silty Clay	20.5	1.30	1.05
Silty Clay Till	22.0	1.30	1.05
Silty Sand and Sandy Silt Tills	22.5	1.30	1.03

Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Silty Clay and Silty Clay Till	0.45	0.50	2.50
Silty Sand and Sandy Silt Tills	0.35	0.40	3.0

Maximum Allowable Soil Pressures (SLS) For Thrust Block Design (kPa)	
Engineered Fill	75
Sound Natural Soils	100

6.9 Excavation

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

Excavations in excess of 1.2 m should be sloped at 1 vertical:at least 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, Earth Fill and firm Silty Clay	3

Excavations into the firm silty clay must be flattened to 1 vertical:
2 or + horizontal for stability; the excavation spoil should be placed away from the excavation at a distance equal to 3 times the height of the excavation to lessen the overburden load and reduce overstressing.

The groundwater yield is expected to be small and limited from the clay, clay till and silt till, and it will generally be controllable by normal pumping from sumps. From the water-bearing silty sand till and wet sand and silt seams and layers, the yield is expected to be moderate to appreciable but will generally be controllable with normal or vigorous pumping from sumps. However, in areas where seepage from water-bearing silty sand till is high, a sheeting structure or a well-point dewatering system may need to be implemented to stabilize the excavations. The sheeting structure should be driven to a depth below the bottom of the excavation equal to the height of water above the bed of the excavation, to restrict the inflow of groundwater so that it can be controlled by pumping from sumps. However, the appropriate dewatering method can be further assessed by test pits and test pumping prior to the project construction.

In order to provide a stable base for construction, the water level must be lowered to 0.5 m below the working base of the excavation.

Excavation into the very stiff to hard clay and clay till and dense to very dense silty sand and sandy silt tills containing boulders will require extra effort and the use of a heavy-duty, properly equipped backhoe.

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation prior to excavating. 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 no tests have been carried out to determine whether environmental contaminants are present in the soils. 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 Marianneville Developments Limited and for review by their designated consultants and government agencies. The material in it reflects the judgment of Basim Al-Ali, P.Eng., and Victor S. Chan, 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: 1111-S053

LOG OF BOREHOLE NO: 1

FIGURE NO: 1

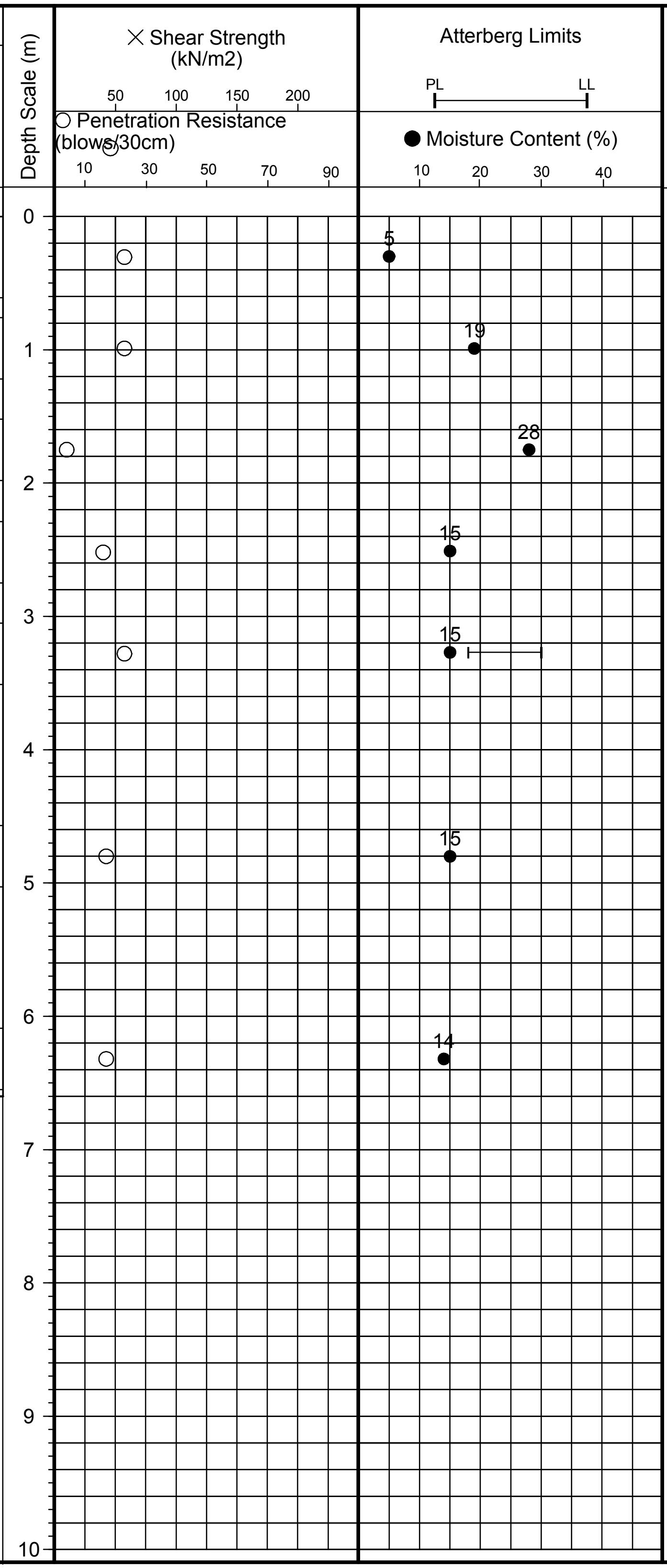
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
273.0	**75 mm ASPHALTIC CONCRETE** **250 mm GRANULAR, Fill**	1	DO	23
	Grey/brown **EARTH, Fill** sandy silt, some clay, a tr. of gravel	2	DO	23
1.5 271.5	Greyish-brown, soft, weathered **SILTY CLAY** a tr. of sand occ. sand and silt seams and layers	3	DO	4
2.3 270.7	Stiff to very stiff	4	DO	16
	SILTY CLAY, Till brown / grey	5	DO	23
	some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	6	DO	17
		7	DO	17
6.6 266.4	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 269.3 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 2

FIGURE NO: 2

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

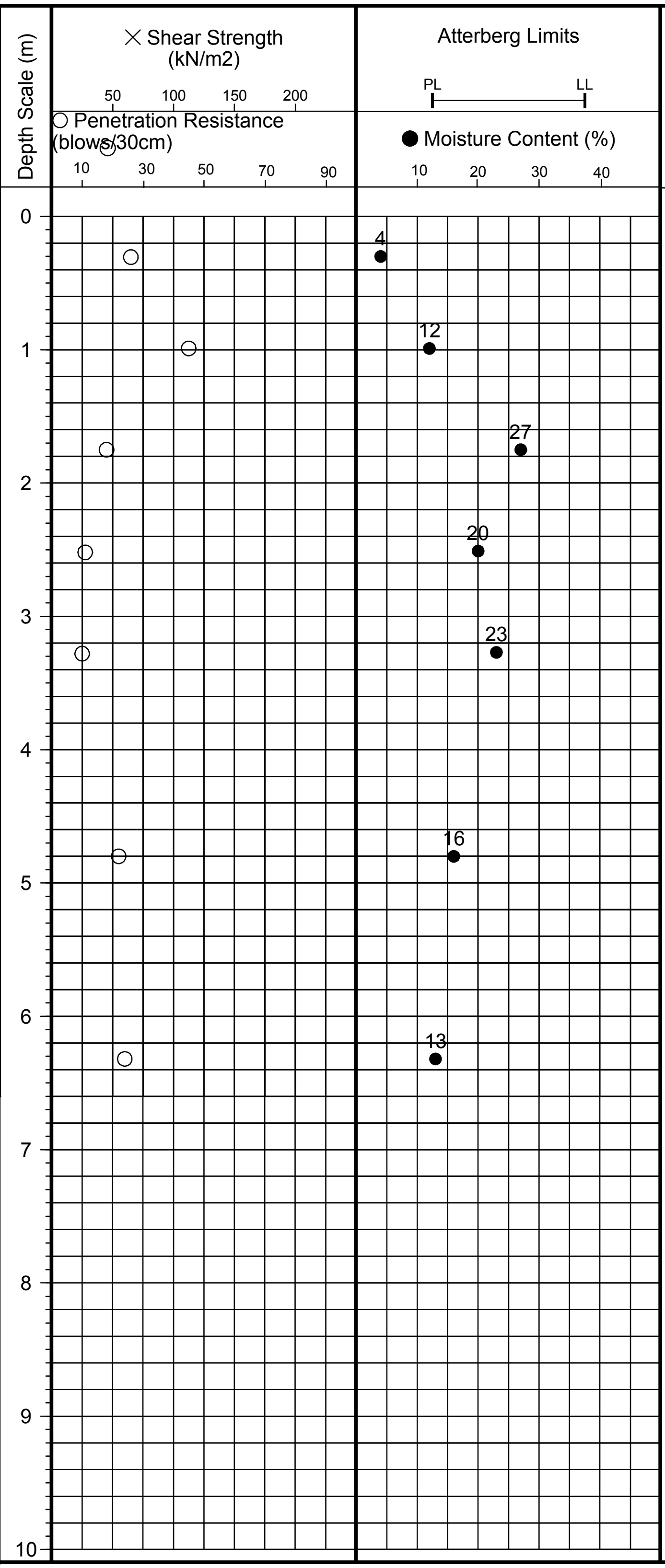
JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION
0.0	Ground Surface
275.0	**75 mm ASPHALTIC CONCRETE** **250 mm GRANULAR, Fill** Brown/grey **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl. topsoil layer
2.3 272.7	Stiff to very stiff **SILTY CLAY** a tr. of sand occ. sand and silt seams and layers brown grey
6.6 268.4	**END OF BOREHOLE**

SAMPLES			
Number	Type	N-Value	Moisture Content (%)
1	DO	26	4
2	DO	45	12
3	DO	18	27
4	DO	11	20
5	DO	10	23
6	DO	22	16
7	DO	24	13



WATER LEVEL

W.L. @ El. 270.1 m on completion ∇

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 3

FIGURE NO: 3

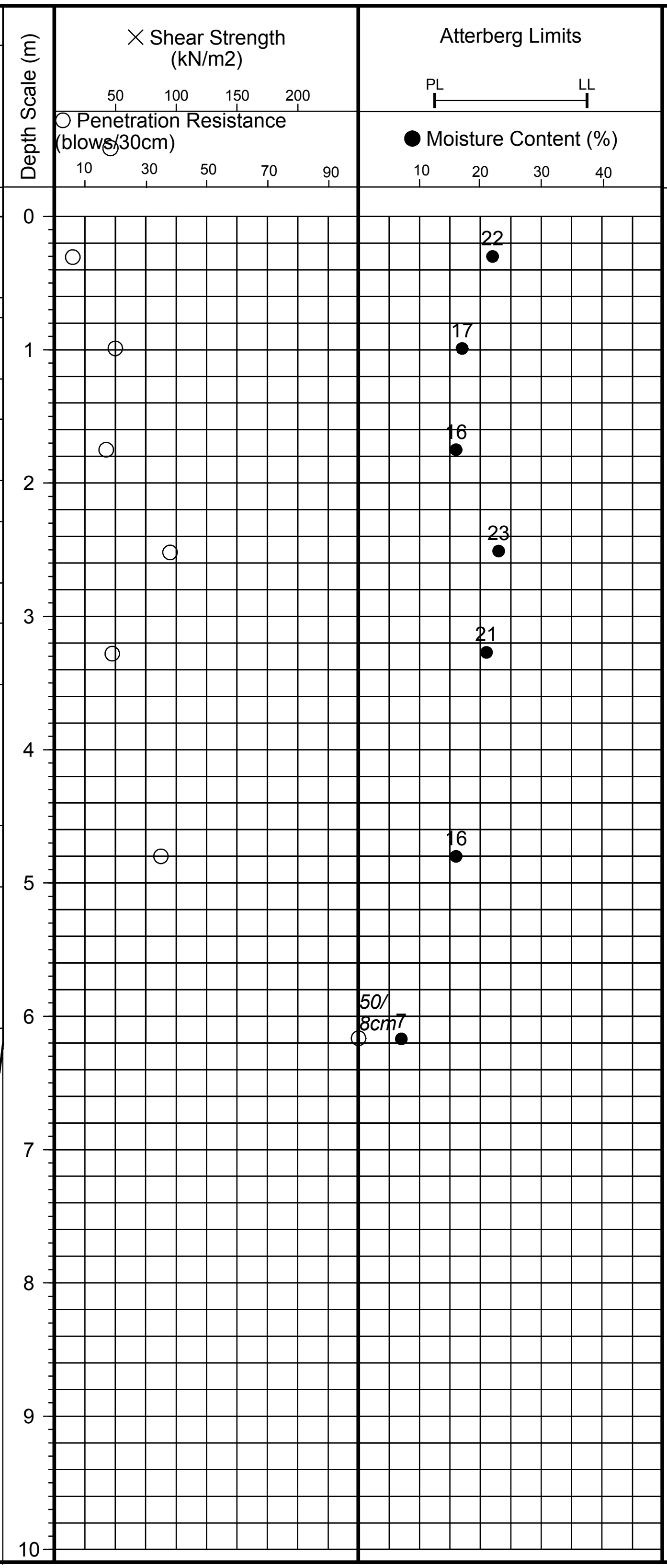
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 12, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
278.0	**50 cm TOPSOIL, Fill**	1	DO	6
	Brown/grey **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl.	2	DO	20
		3	DO	17
	topsoil layer	4	DO	38
3.0 275.0	Very stiff to hard **SILTY CLAY** a tr. of sand occ. sand and silt seams and layers	5	DO	19
	brown grey	6	DO	35
6.2 271.8	**END OF BOREHOLE**	7	DO	50/ 8



WATER LEVEL

W.L. @ El. 274.0 m on completion

Cave-in @ El. 272.2 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 4

FIGURE NO: 4

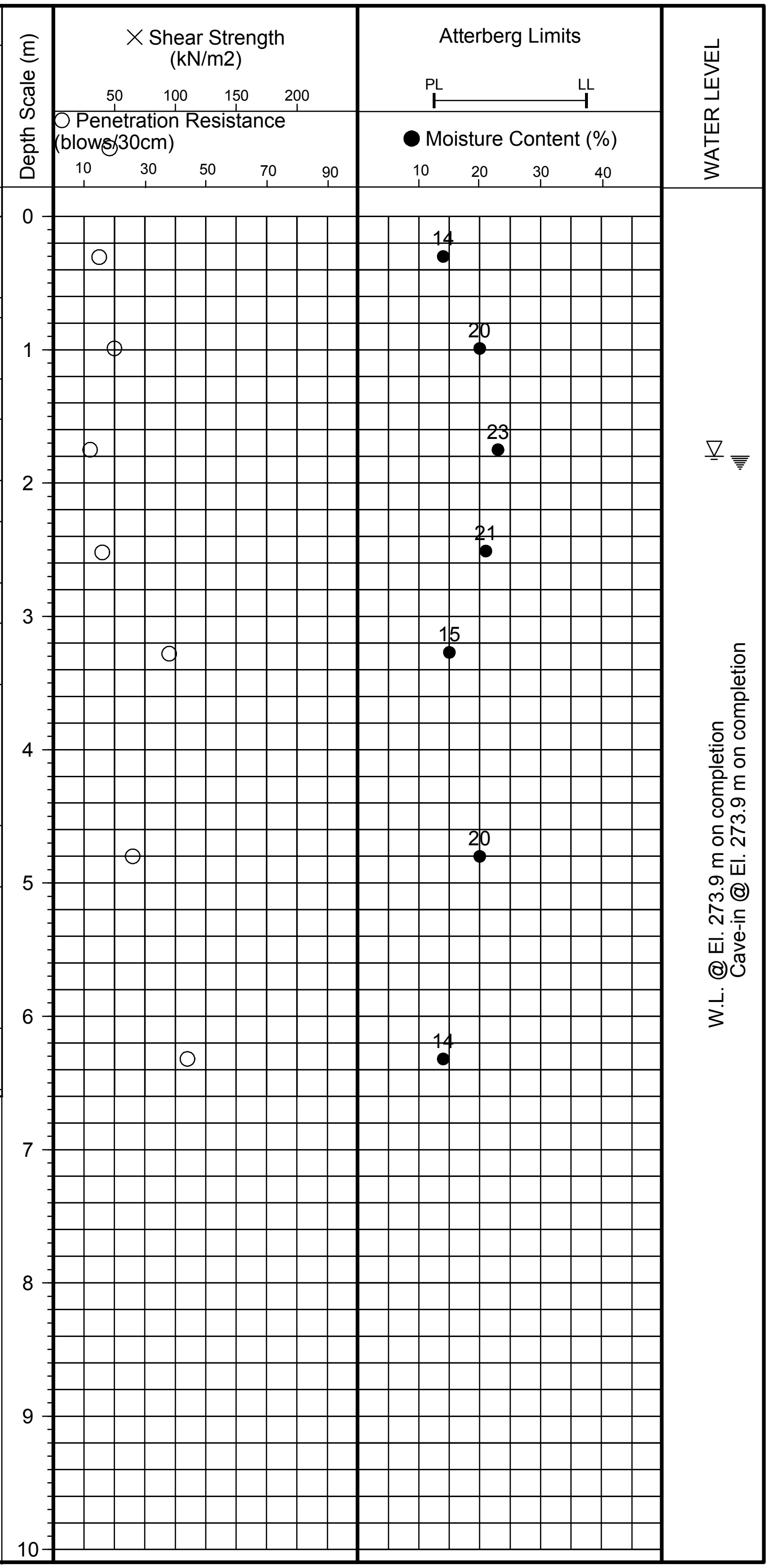
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 13, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
275.7	**60 cm TOPSOIL**	1	DO	15
	Brown, stiff to very stiff weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	2	DO	20
		3	DO	12
		4	DO	16
3.0 272.7	Very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders brown grey	5	DO	38
		6	DO	26
		7	DO	44
6.6 269.1	**END OF BOREHOLE**			



W.L. @ El. 273.9 m on completion
Cave-in @ El. 273.9 m on completion

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 5

FIGURE NO: 5

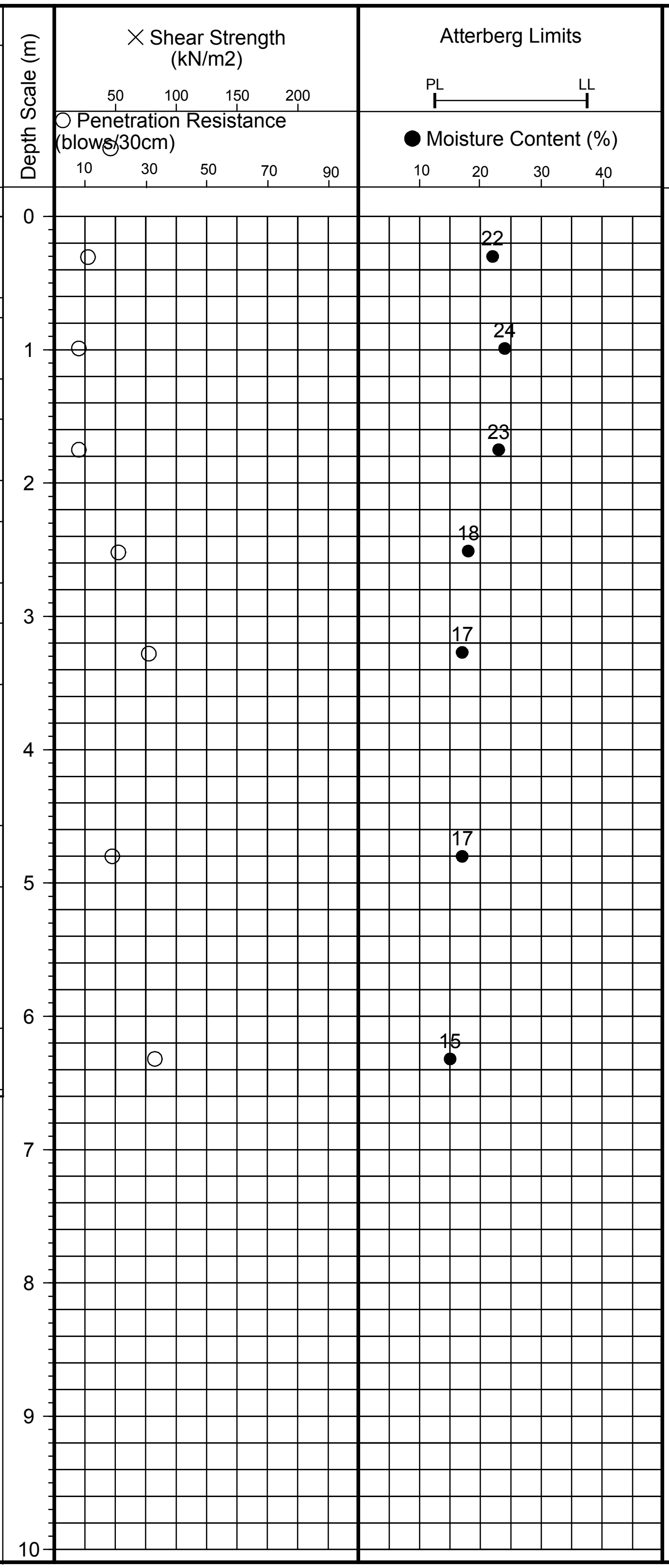
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 13, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0	Ground Surface			
272.4	**30 cm TOPSOIL**			
	Brown, stiff to very stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	1	DO	11
	weathered	2	DO	8
		3	DO	8
		4	DO	21
3.0 269.4	Grey, very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	31
		6	DO	19
		7	DO	33
6.6 265.8	**END OF BOREHOLE**			



WATER LEVEL

∇

W.L. @ El. 269.0 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 6

FIGURE NO: 6

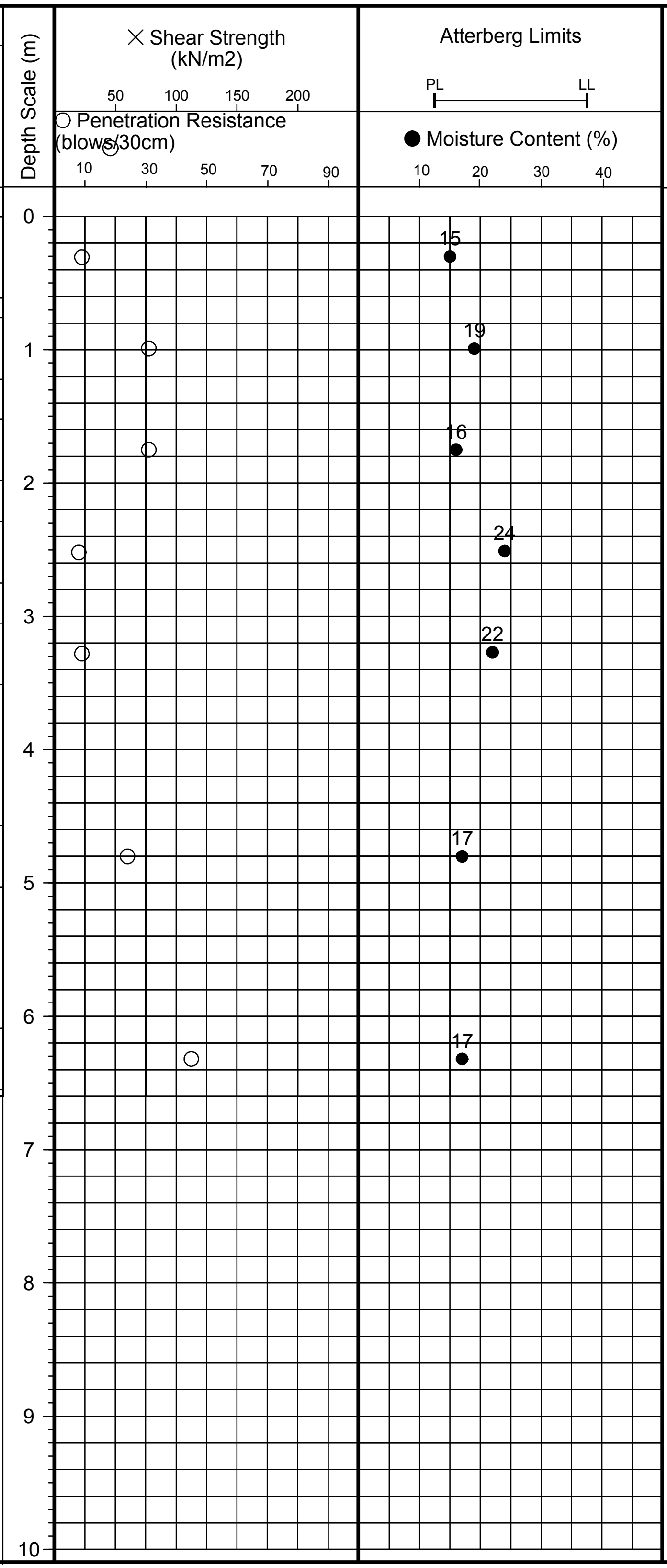
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 13, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
270.2	**30 cm TOPSOIL, Fill**	1	DO	9
	Brown/grey **EARTH, Fill** silty clay and silty sand, a tr. of gravel occ. topsoil incl.	2	DO	31
		3	DO	31
2.3 267.9	Brown, stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	4	DO	8
		5	DO	9
4.5 265.7	Very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders brown grey	6	DO	24
		7	DO	45
6.6 263.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 265.9 m on completion

Cave-in @ El. 264.4 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 7

FIGURE NO: 7

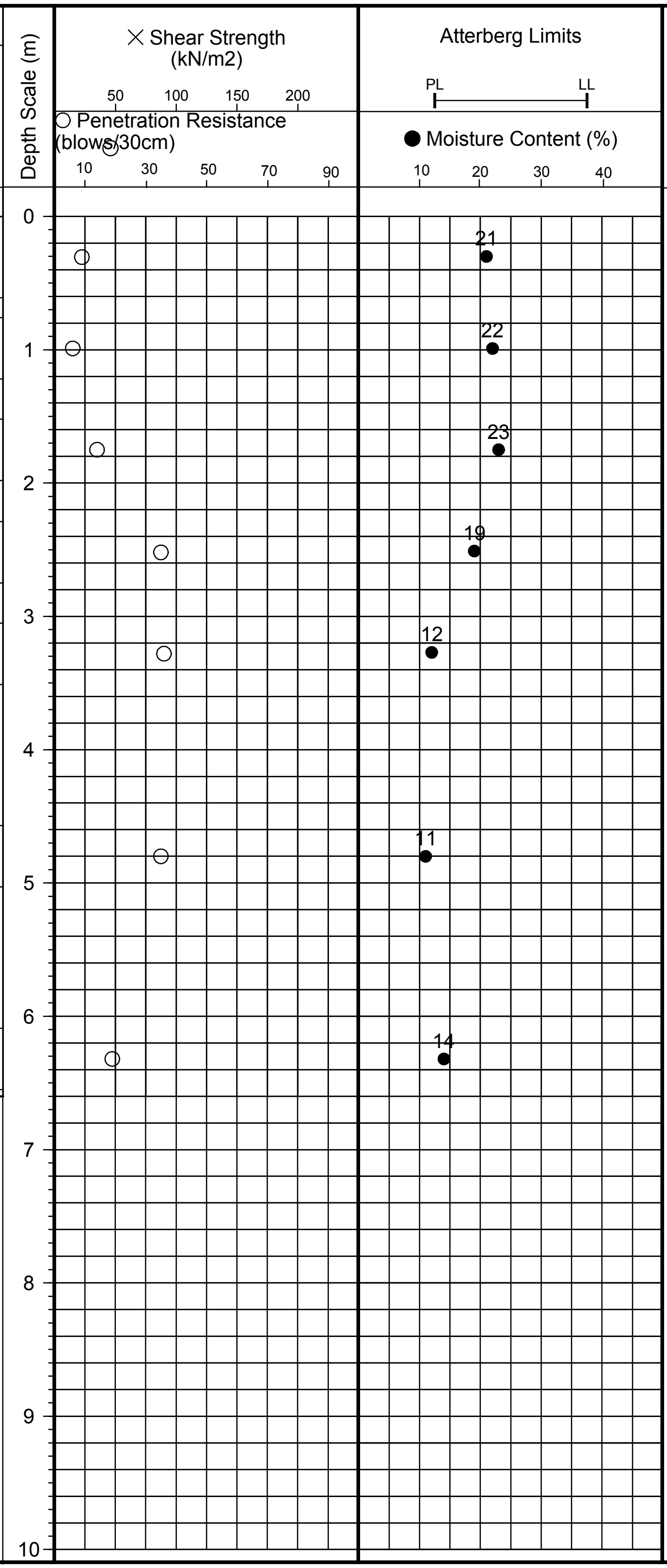
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 13, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
269.2	**36 cm TOPSOIL, Fill**	1	DO	9
	Brown/grey **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl.	2	DO	6
1.5 267.7	Stiff to hard	3	DO	14
	SILTY CLAY, Till	4	DO	35
	some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	36
	brown grey			
		6	DO	35
		7	DO	19
6.6 262.6	**END OF BOREHOLE**			



WATER LEVEL

∇

W.L. @ El. 268.2 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 8

FIGURE NO: 8

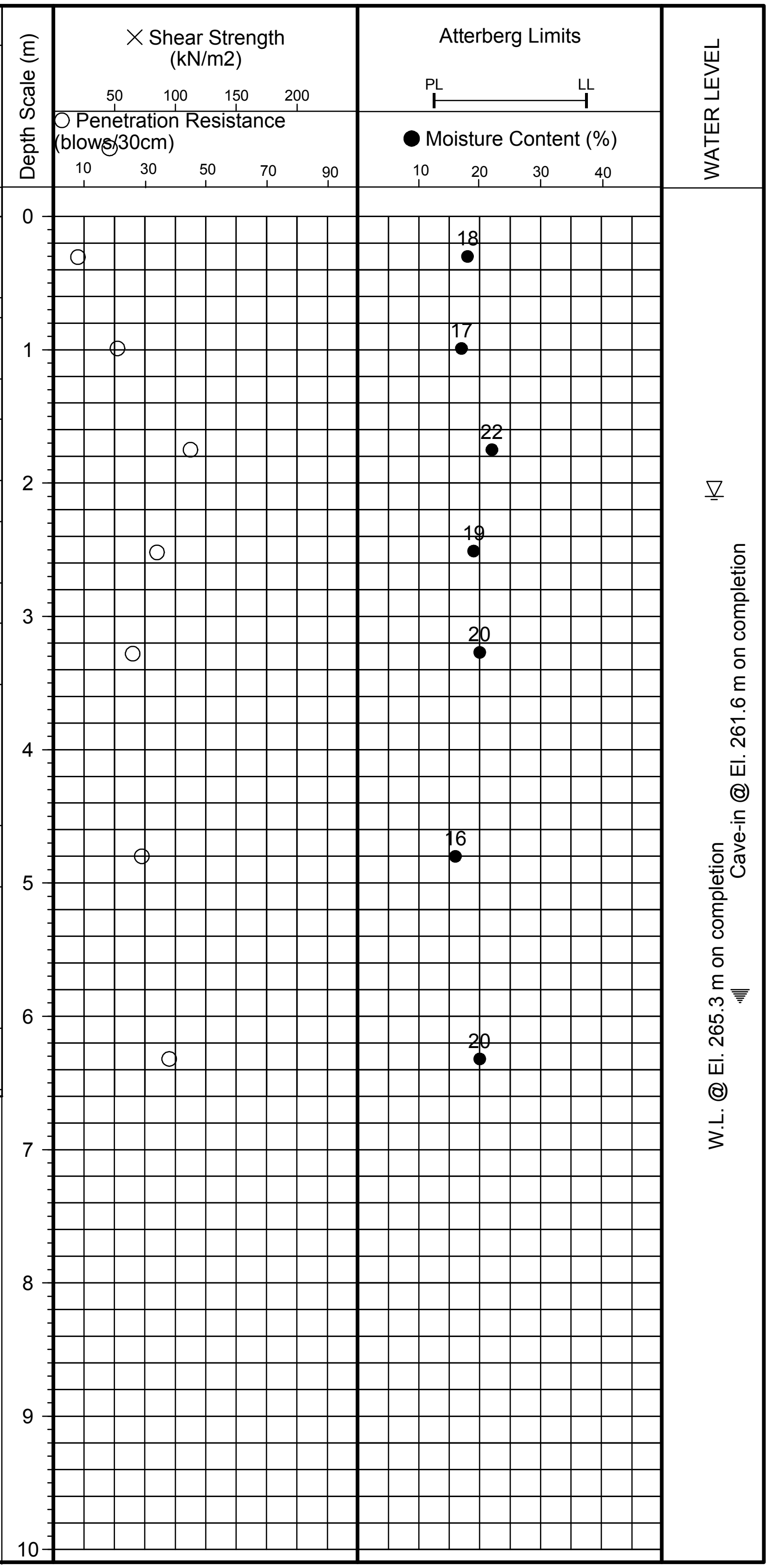
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 14, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
267.4	**28 cm TOPSOIL**			
	Brown/greyish-brown, firm to hard **SILTY CLAY** weathered a tr. to some sand occ. sand and silt seams and layers	1	DO	8
		2	DO	21
		3	DO	45
2.3 265.1	Grey, very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	4	DO	34
		5	DO	26
		6	DO	29
		7	DO	38
6.6 260.8	**END OF BOREHOLE**			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 9

FIGURE NO: 9

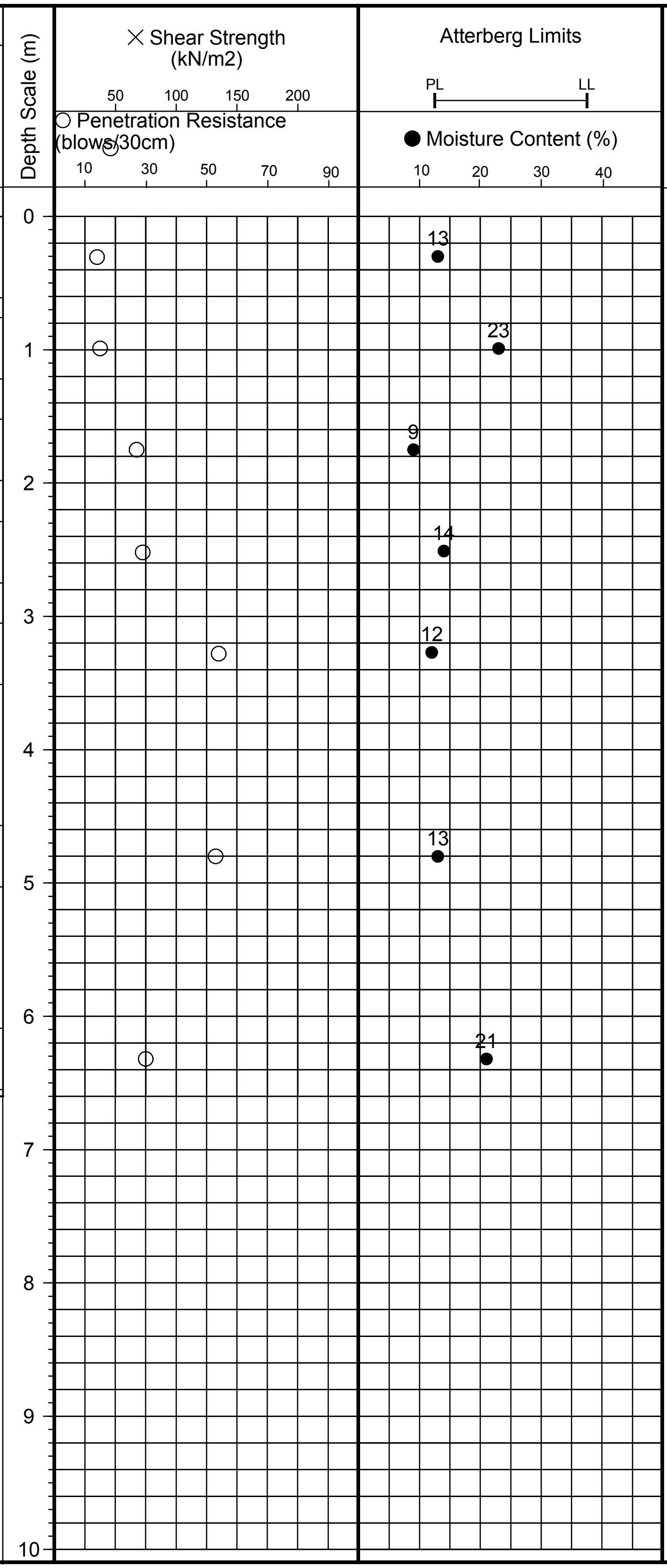
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 14, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
267.8	**30 cm TOPSOIL, Fill**			
	Brown **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl.	1	DO	14
	topsoil layer	2	DO	15
1.5 266.3	Very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	3	DO	27
		4	DO	29
		5	DO	54
	brown grey	6	DO	53
		7	DO	30
6.6 261.2	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 10

FIGURE NO: 10

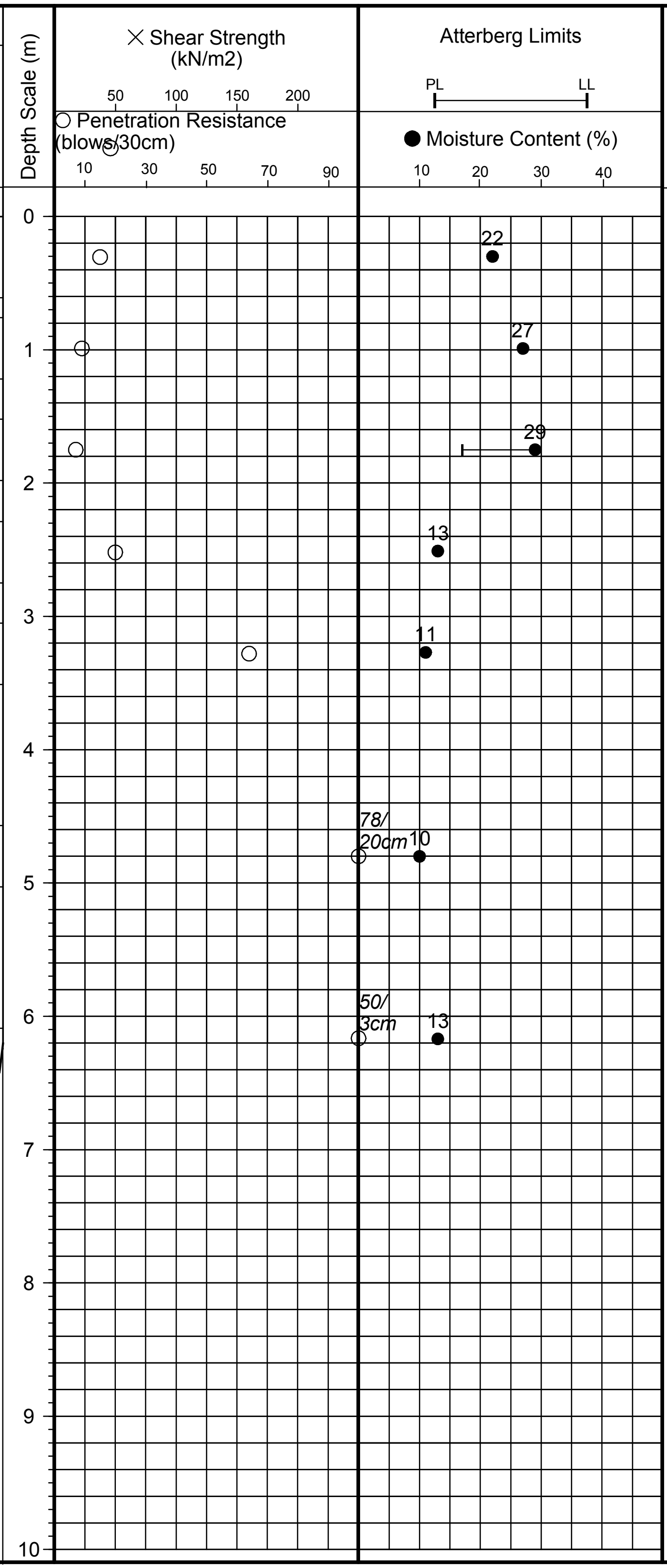
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 19, 2011

		SAMPLES		
Depth Elev. (m)	SOIL DESCRIPTION	Number	Type	N-Value
0.0	Ground Surface			
272.2	**51 cm TOPSOIL**	1	DO	15
	Brown, firm to stiff, weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	2	DO	9
		3	DO	7
2.0 270.2	Brown, very stiff **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers,	4	DO	20
3.0 269.2	Very dense **SILTY SAND, Till and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	5	DO	64
		6	DO	78/ 20
	brown grey			
		7	DO	50/ 3
6.2 266.0	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 267.3 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 11

FIGURE NO: 11

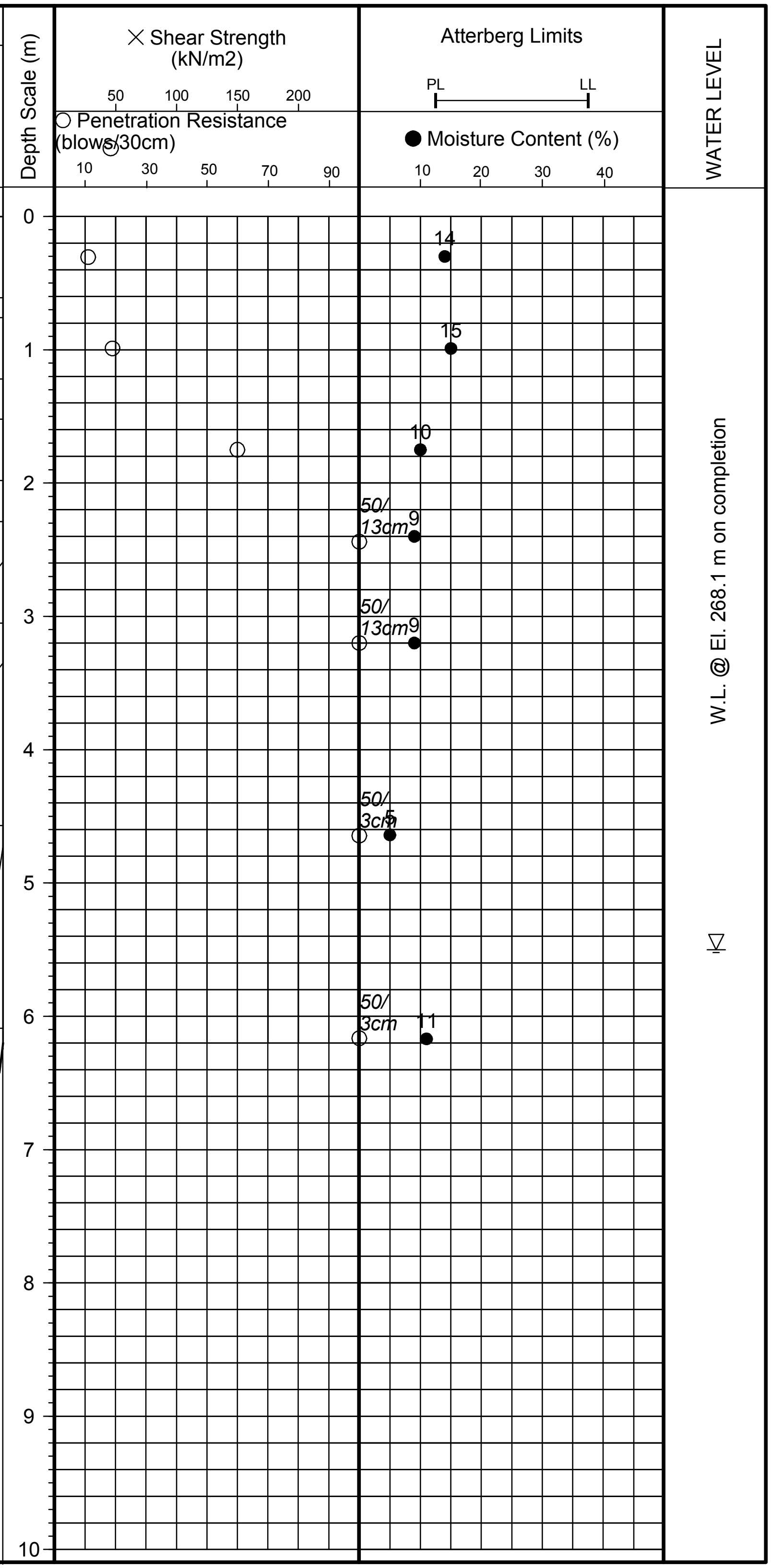
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0	Ground Surface			
273.6	**23 cm TOPSOIL, Fill**			
	Brown **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl.	1	DO	11
		2	DO	19
1.5 272.1	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	3	DO	60
		4	DO	50/ 13
		5	DO	50/ 13
		6	DO	50/ 3
6.2 267.4	**END OF BOREHOLE**	7	DO	50/ 3



JOB NO: 1111-S053

LOG OF BOREHOLE NO: 12

FIGURE NO: 12

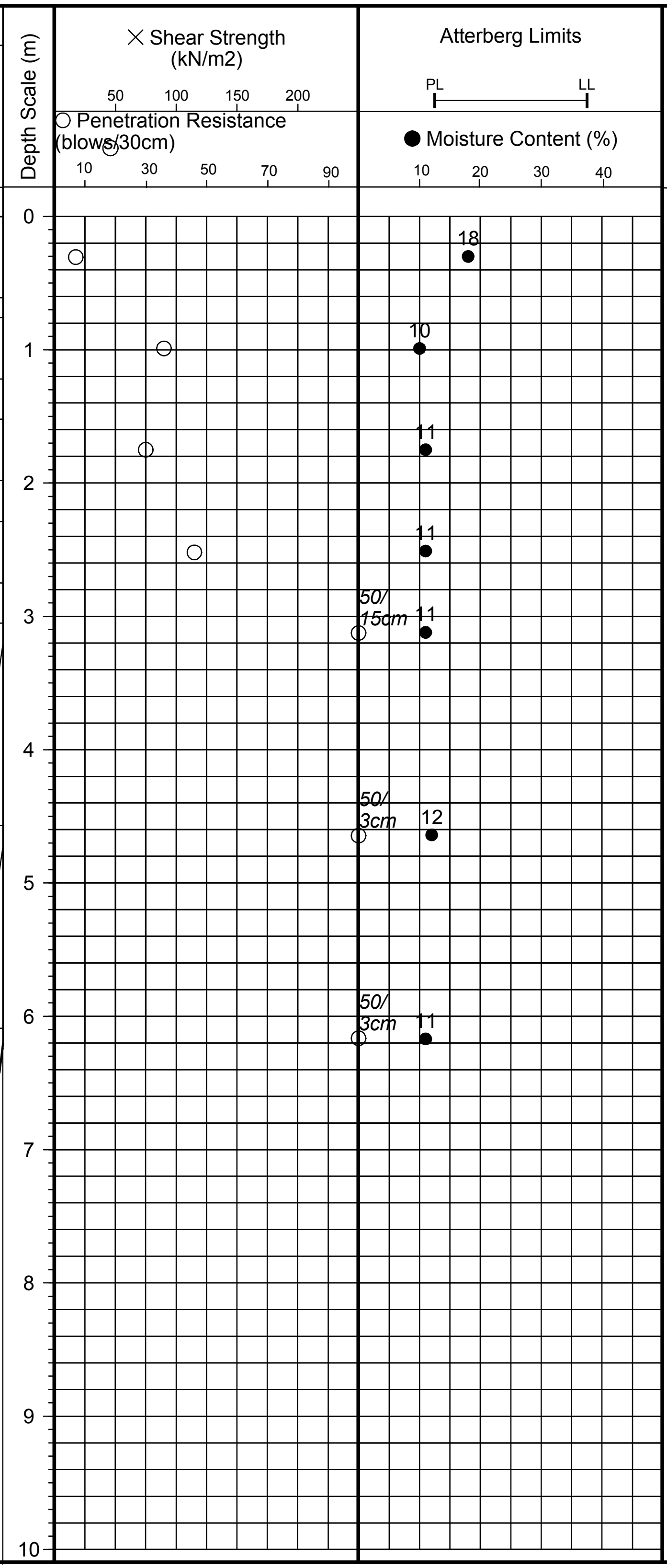
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 16, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0 273.6	Ground Surface **40 cm TOPSOIL, Fill**	1	DO	7
0.8 272.8	Brown **SILTY CLAY, Fill** some sand, a tr. of gravel occ. topsoil incl.	2	DO	36
	Brown, dense to very dense **SILTY SAND, Till** **and SANDY SILT, Till**	3	DO	30
	some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	4	DO	46
		5	DO	50/ 15
		6	DO	50/ 3
6.2 267.4	**END OF BOREHOLE**	7	DO	50/ 3



WATER LEVEL

∇

W.L. @ El. 271.5 m on completion

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 13

FIGURE NO: 13

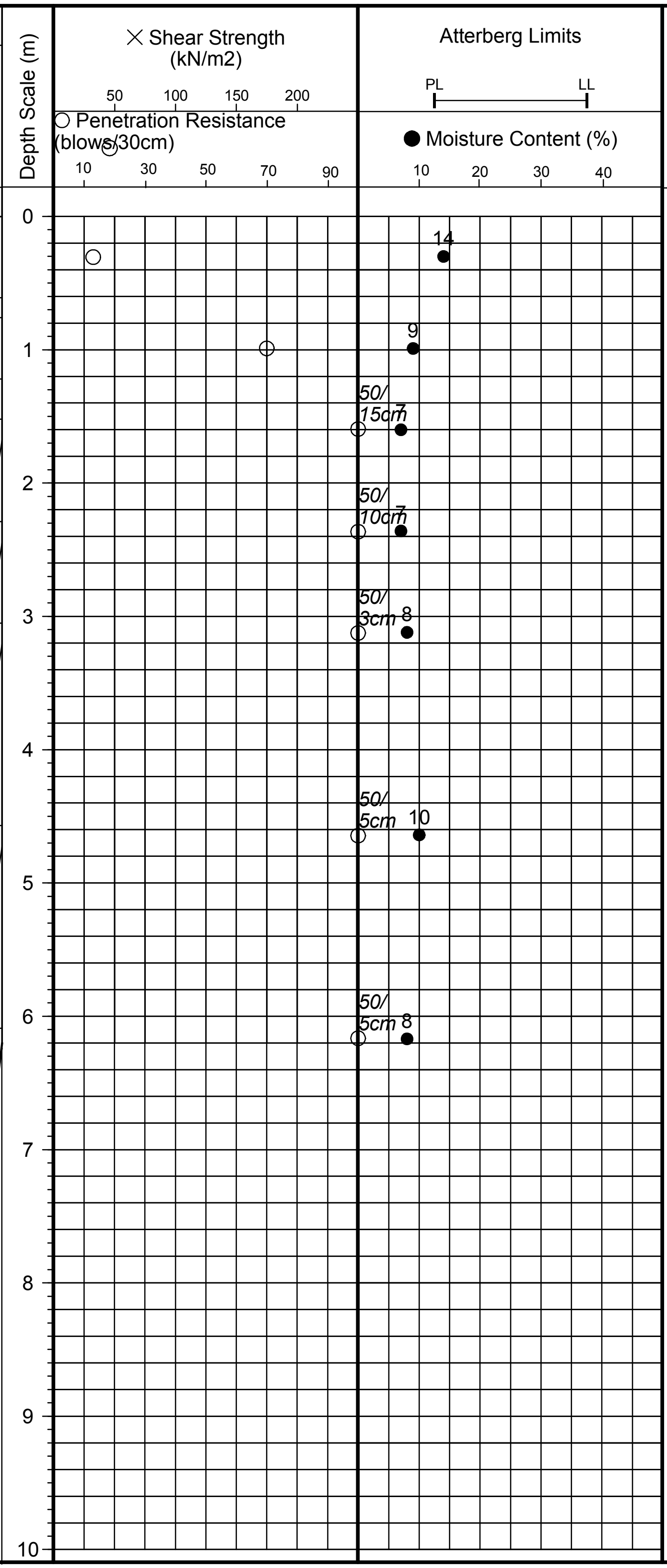
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 14, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0 278.4	Ground Surface **50 cm TOPSOIL**	1	DO	13
	Brown, compact to very dense weathered	2	DO	70
	SILTY SAND, Till **and SANDY SILT, Till**	3	DO	50/ 15
	some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	4	DO	50/ 10
		5	DO	50/ 3
		6	DO	50/ 5
6.2 272.2	**END OF BOREHOLE**	7	DO	50/ 5



WATER LEVEL

Dry on completion

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 14

FIGURE NO: 14

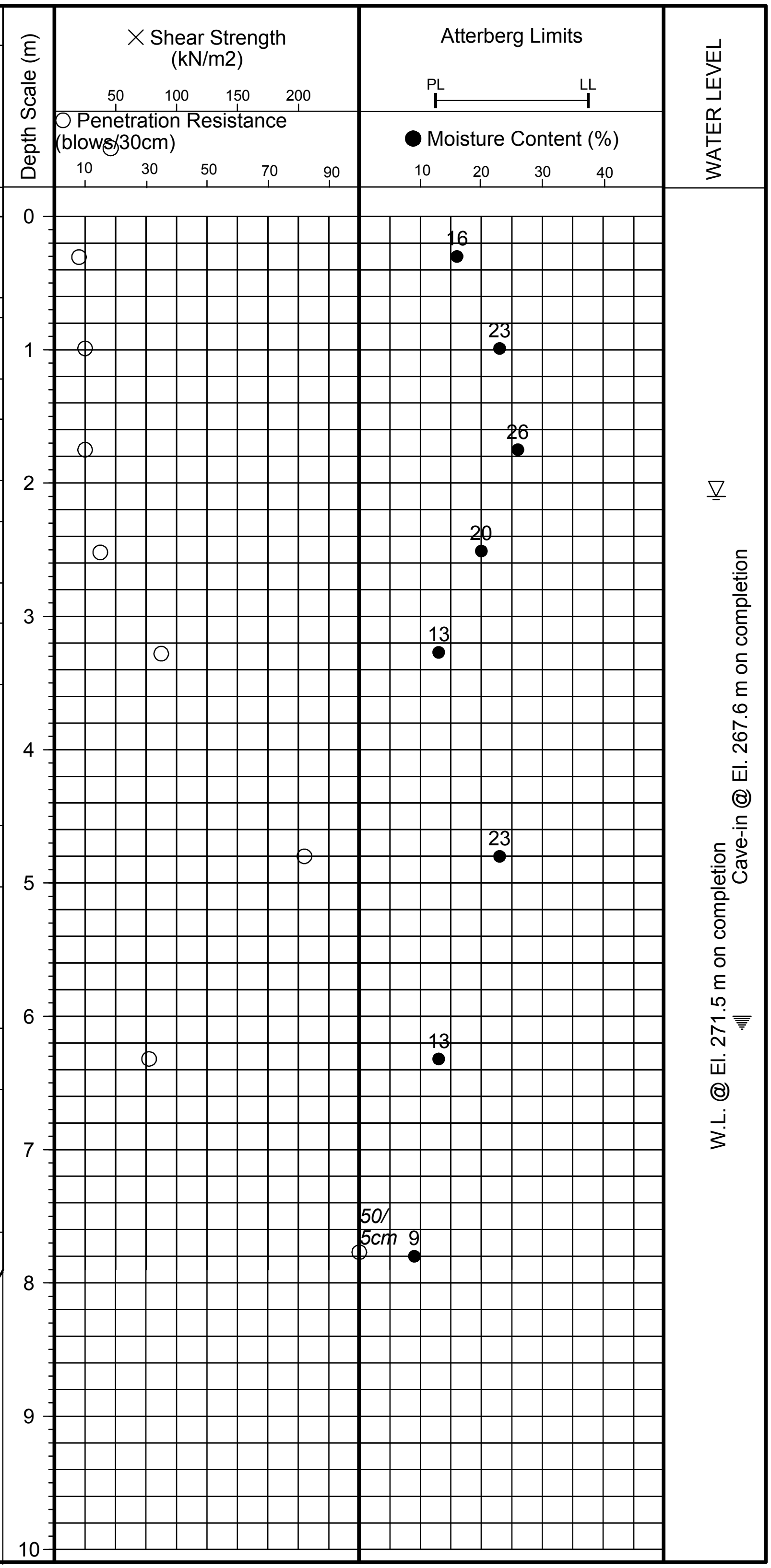
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 14, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
273.6	**30 cm TOPSOIL, Fill**			
	Brown **SILTY CLAY, Fill** some sand occ. topsoil incl.	1	DO	8
		2	DO	10
1.5 272.1	Brown, stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers weathered	3	DO	10
		4	DO	15
3.0 270.6	Hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders brown grey	5	DO	35
		6	DO	82
6.0 267.6	Grey, dense to very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	7	DO	31
		8	DO	50/ 5
7.9 265.7	**END OF BOREHOLE**			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 15

FIGURE NO: 15

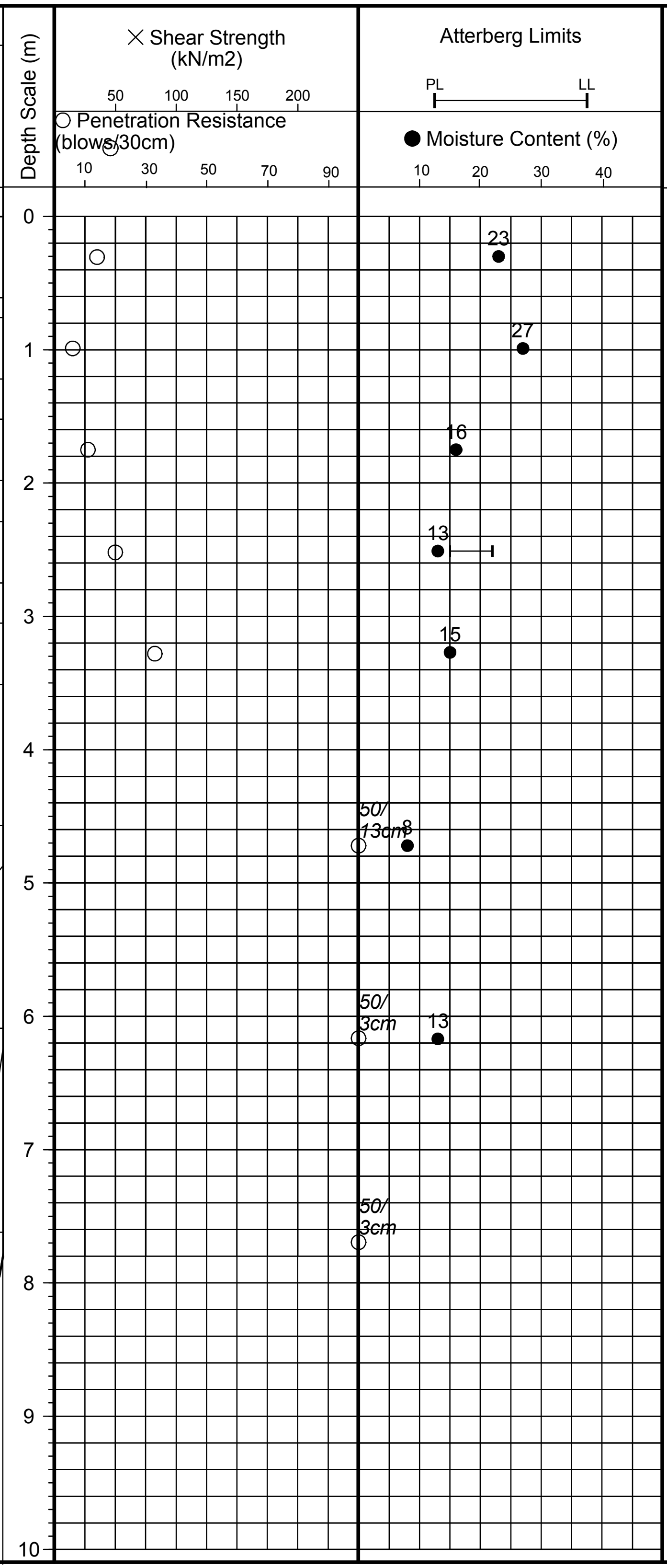
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.1	**70 cm TOPSOIL**	1	DO	14
	Brown, firm, weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	2	DO	6
1.5 275.6	Brown, stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	3	DO	11
		4	DO	20
		5	DO	33
4.5 272.6	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6	DO	50/ 13
6.0 271.1	Brown, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	7	DO	50/ 3
		8	DO	50/ 3
7.8 269.3	**END OF BOREHOLE**			



WATER LEVEL

∇

W.L. @ El. 275.6 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 16

FIGURE NO: 16

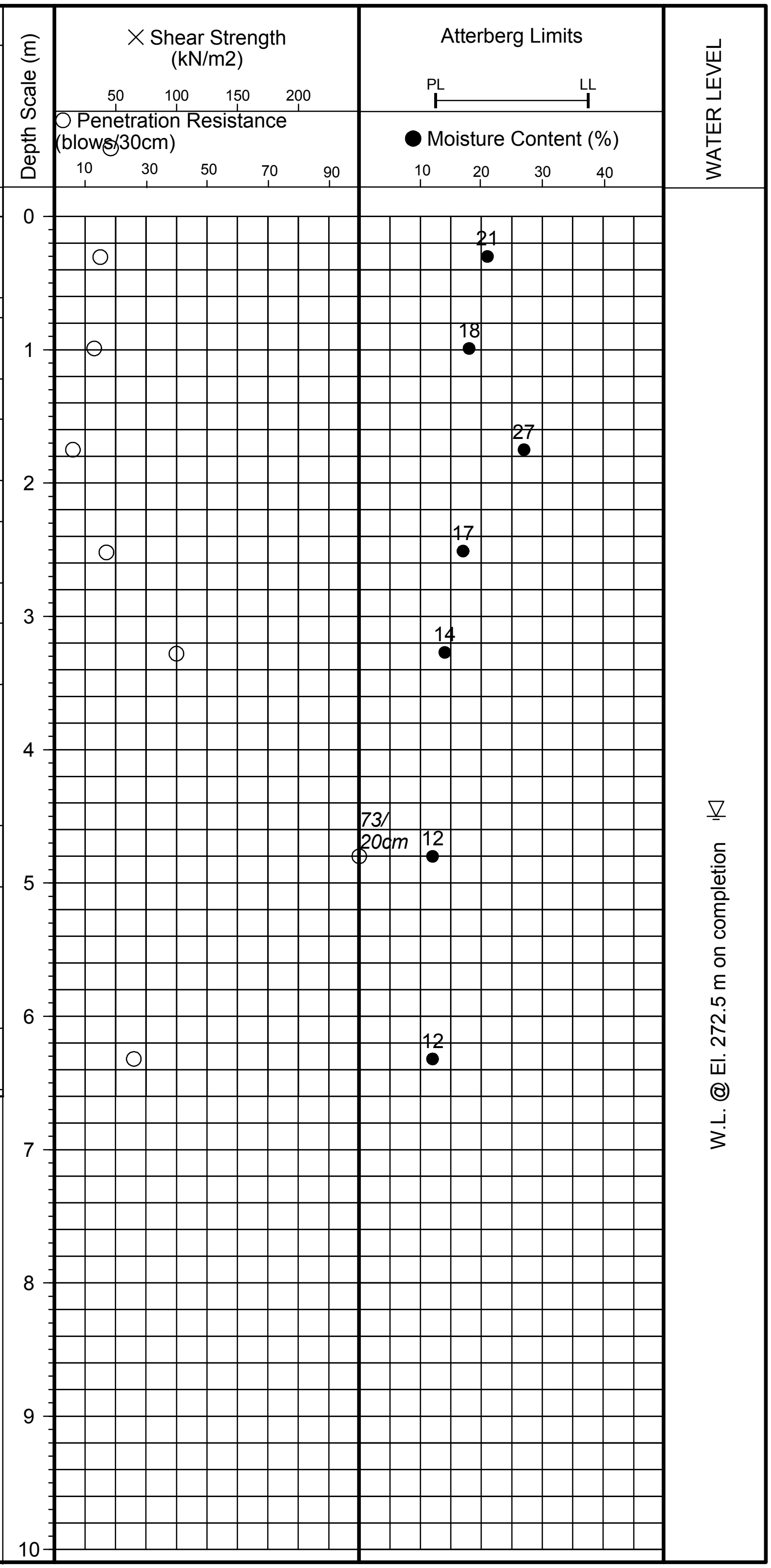
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.0	**33 cm TOPSOIL**			
	Brown, firm to stiff, weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	1	DO	15
		2	DO	13
		3	DO	6
2.3 274.7	Brown, very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	4	DO	17
		5	DO	40
4.5 272.5	Brown, compact to very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6	DO	73/ 20
		7	DO	26
6.6 270.4	**END OF BOREHOLE**			



JOB NO: 1111-S053

LOG OF BOREHOLE NO: 17

FIGURE NO: 17

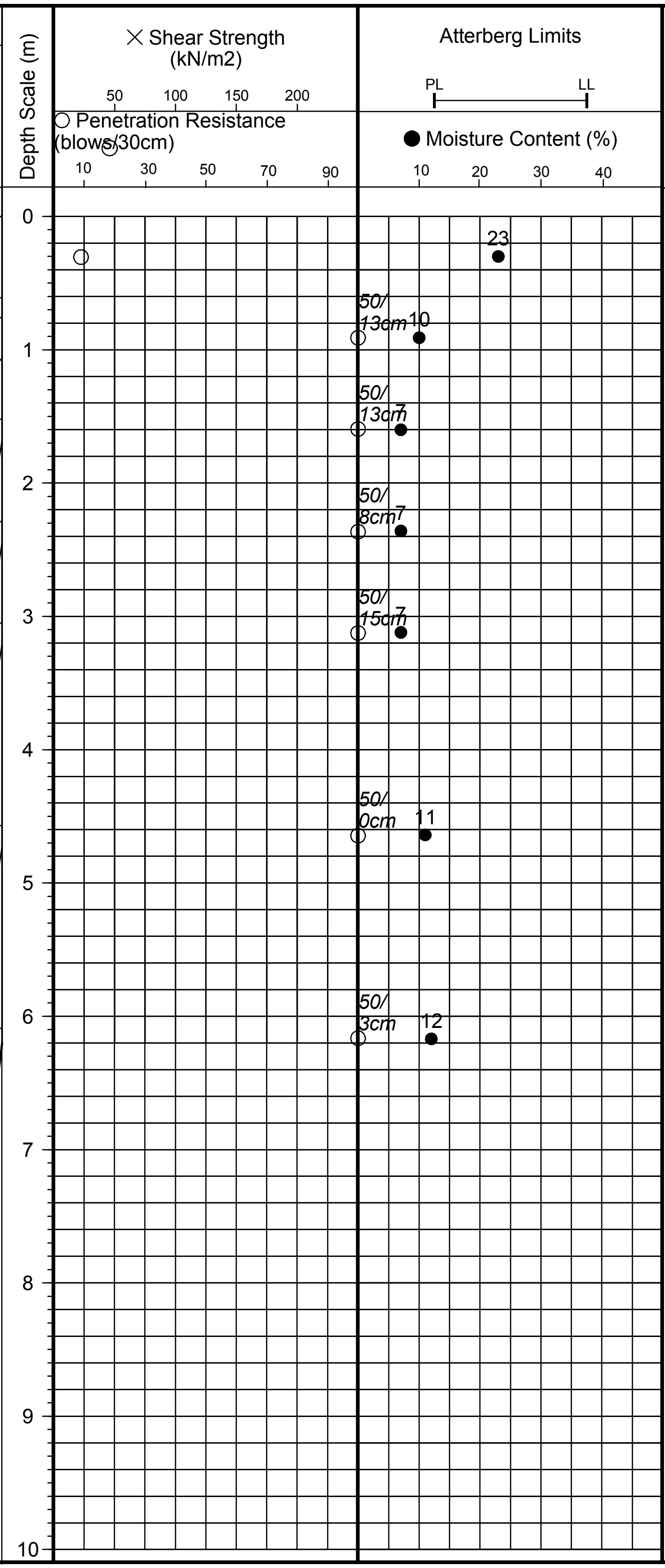
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
282.8	**30 cm TOPSOIL**			
	Brown, stiff, weathered **SILTY CLAY, Till** some sand, a tr. of gravel occ. sand and silt seams and layers	1	DO	9
0.8 282.0	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	2	DO	50/ 13
		3	DO	50/ 13
		4	DO	50/ 8
		5	DO	50/ 15
		6	DO	50/ 0
6.2 276.6	**END OF BOREHOLE**	7	DO	50/ 3



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: 18

FIGURE NO: 18

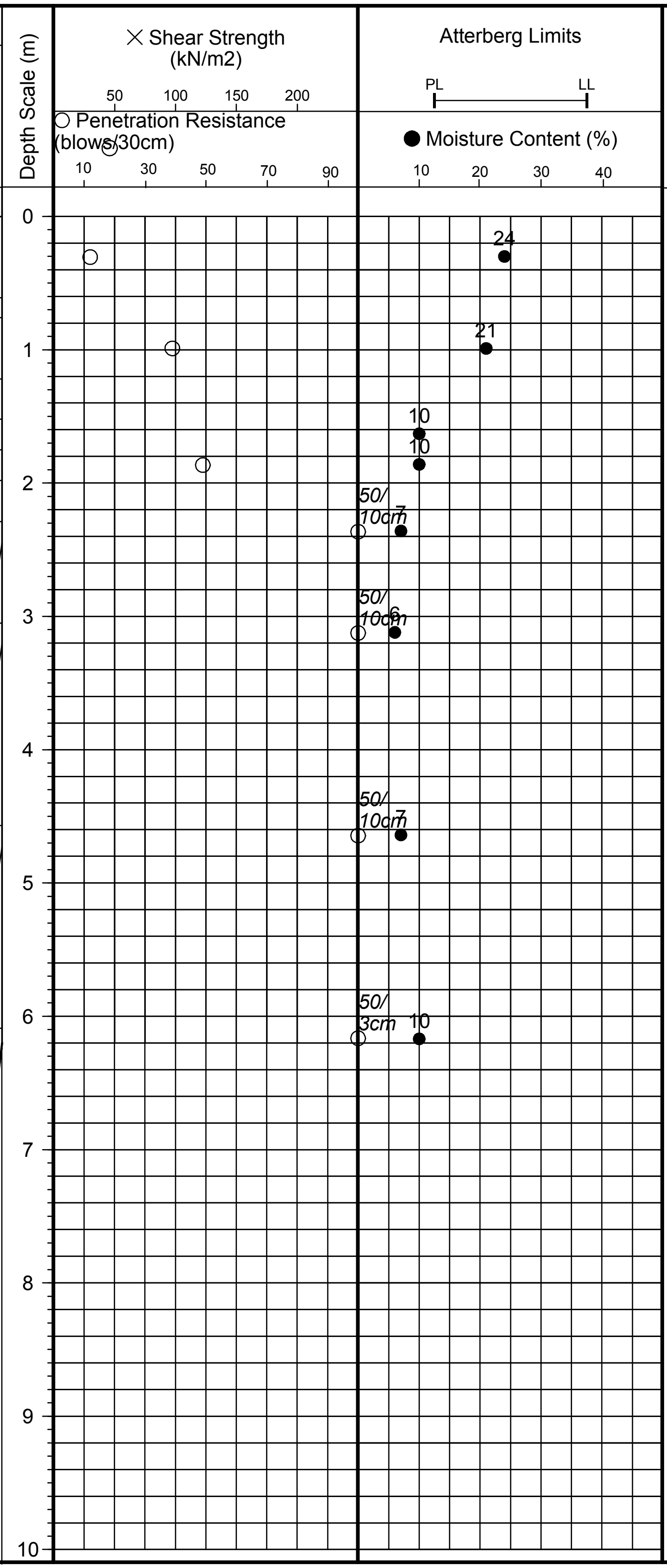
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 16, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
285.1	**30 cm TOPSOIL**			
	Brown, stiff to hard **SILTY CLAY** weathered a tr. to some sand occ. sand and silt seams and layers	1	DO	12
		2	DO	39
		3A	DO	-
1.8 283.3	Brown, dense to very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	3B	DO	49
		4	DO	50/ 10
		5	DO	50/ 10
		6	DO	50/ 10
6.2 278.9	**END OF BOREHOLE**	7	DO	50/ 3



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-1D

FIGURE NO: 19A

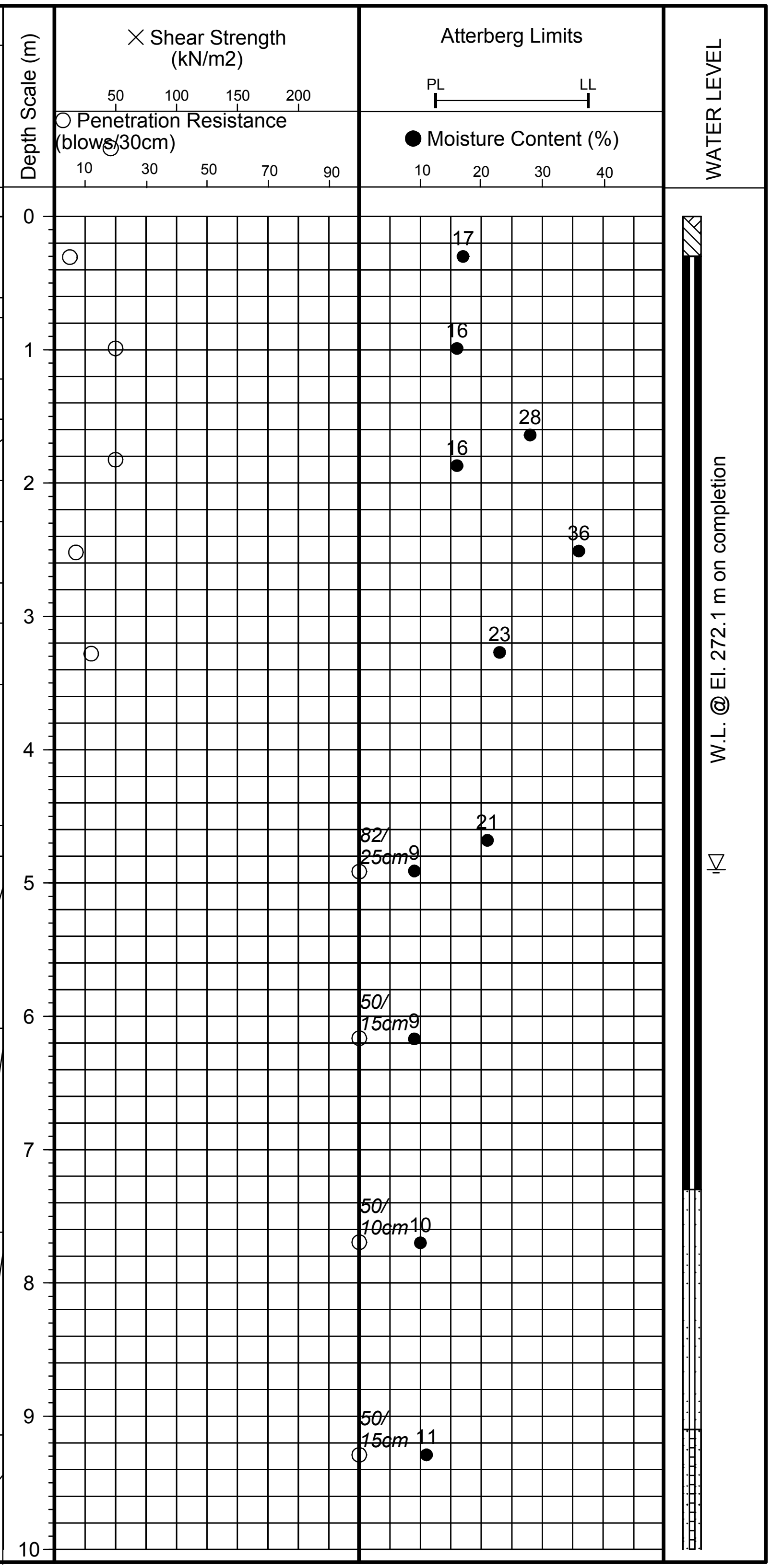
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 12, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.0	**30 cm TOPSOIL, Fill**	1	DO	5
	Grey **SILTY CLAY, Fill** some sand and occ. topsoil incl.	2	DO	20
	topsoil layer	3A	DO	-
1.8 275.2	Greyish-brown, firm to very stiff, weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	3B	DO	20
		4	DO	7
3.0 274.0	Brown, stiff **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	12
		6A	DO	-
4.8 272.2	Very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6B	DO	82/ 25
	brown grey	7	DO	50/ 15
		8	DO	50/ 10
		9	DO	50/ 15



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-1D

FIGURE NO: 19B

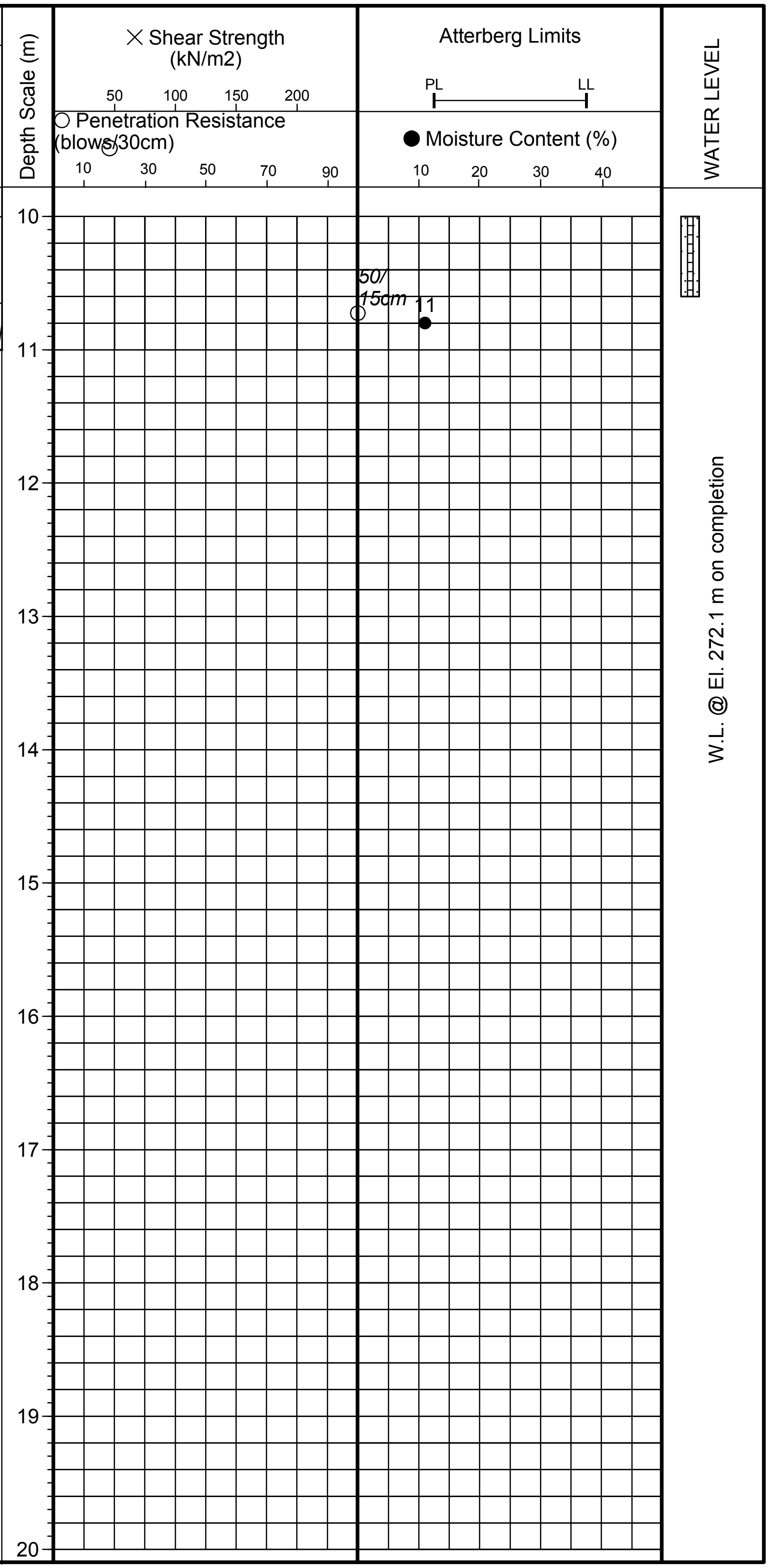
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 12, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
10.0 267.0	Grey, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel	10	DO	50/ 15
266.0	**END OF BOREHOLE** Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 7.3 to 10.6 m. Bentonite seal from 0.3 to 7.3 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



W.L. @ El. 272.1 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-1S

FIGURE NO: 20

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 12, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.0	**30 cm TOPSOIL, Fill**			
	Grey **SILTY CLAY, Fill** some sand and occ. topsoil incl. topsoil layer			
1.8 275.2	Greyish-brown, firm to very stiff, weathered **SILTY CLAY** tr. to some sand occ. sand and silt seams and layers			
3.0 274.0	Brown, stiff **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders			
4.8 272.2	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders			
6.0 271.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 1.8 to 6.0 m. Bentonite seal from 0.3 to 1.8 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

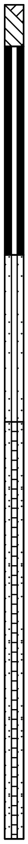
× Shear Strength (kN/m2): 50 100 150 200

○ Penetration Resistance (blows/30cm): 10 30 50 70 90

Atterberg Limits: PL LL

● Moisture Content (%): 10 20 30 40

WATER LEVEL



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-2S

FIGURE NO: 21

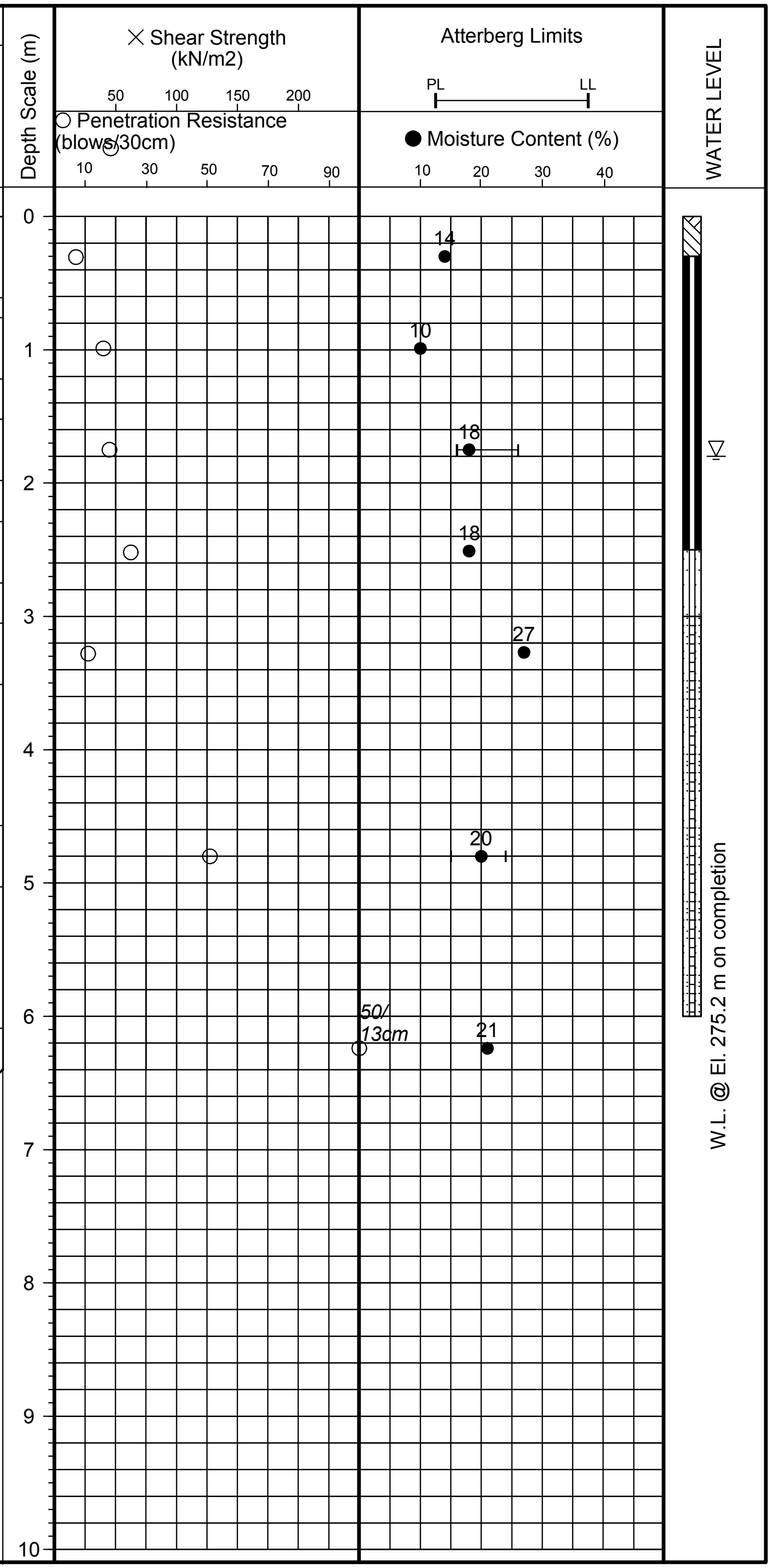
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 13, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.0	**45 cm TOPSOIL, Fill**	1	DO	7
	Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.	2	DO	16
1.5 275.5	Brown, stiff to very stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	3	DO	18
		4	DO	25
		5	DO	11
4.5 272.5	Brown, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	6	DO	51
		7	DO	50/ 13
6.4 270.6	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-3S

FIGURE NO: 22

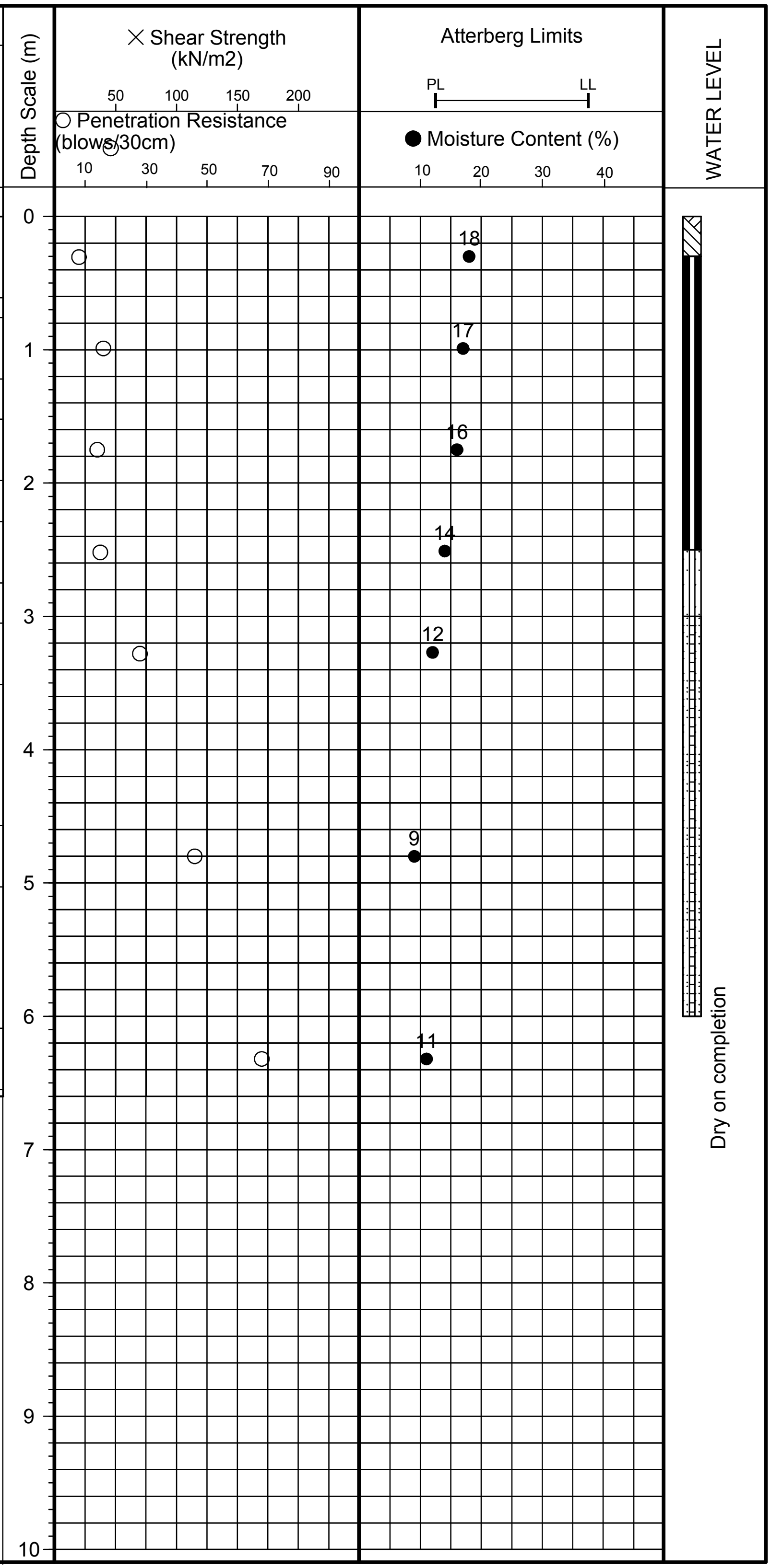
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 14, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 267.0	Ground Surface **45 cm TOPSOIL**	1	DO	8
	Stiff to very stiff weathered **SILTY CLAY, Till**	2	DO	16
		3	DO	14
	some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, brown cobbles and boulders grey	4	DO	15
		5	DO	28
4.5 262.5	Grey, dense to very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6	DO	46
		7	DO	68
6.6 260.4	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-4D

FIGURE NO: 23A

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

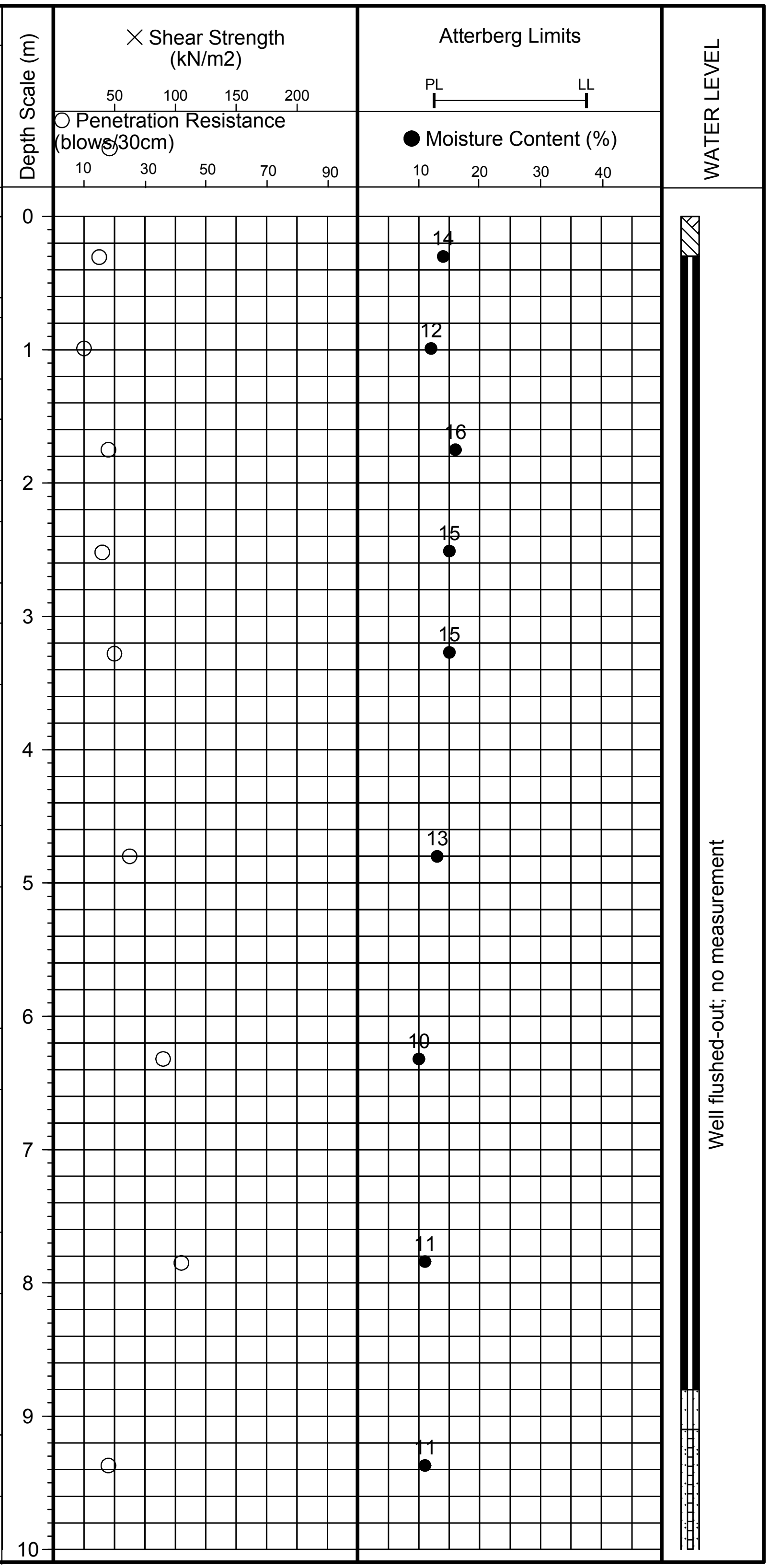
JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 19, 2011

Depth Elev. (m)	SOIL DESCRIPTION
0.0	Ground Surface
269.0	**45 cm TOPSOIL**
	Stiff to hard
	weathered
	SILTY CLAY, Till
	some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders
	brown grey

SAMPLES Number	Type	N-Value
1	DO	15
2	DO	10
3	DO	18
4	DO	16
5	DO	20
6	DO	25
7	DO	36
8	DO	42
9	DO	18



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-4D

FIGURE NO: 23B

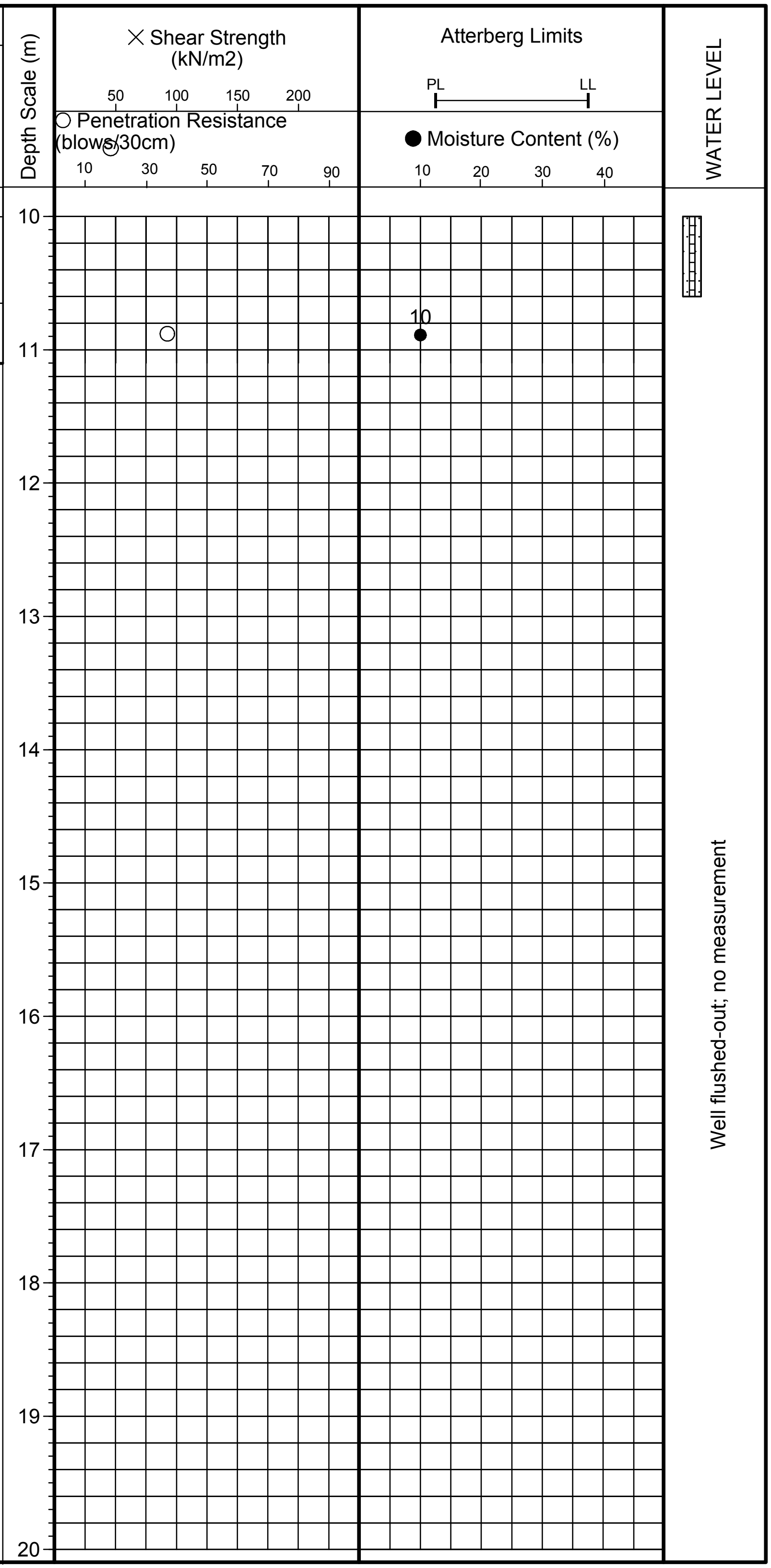
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 19, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
10.0				
259.0	Grey, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	10	DO	37
257.9	**END OF BOREHOLE** Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 8.8 to 10.6 m. Bentonite seal from 0.3 to 8.8 m. Concrete from 0.0 to 0.3. Provided with steel casing and lock.			



JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-4S

FIGURE NO: 24

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 19, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0	Ground Surface			
269.0	**45 cm TOPSOIL**			
	Brown, stiff to very stiff weathered **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders			
6.0 263.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

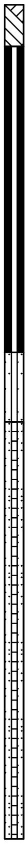
× Shear Strength (kN/m2): 50 100 150 200

○ Penetration Resistance (blows/30cm): 10 30 50 70 90

Atterberg Limits: PL LL

● Moisture Content (%): 10 20 30 40

WATER LEVEL



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-5S

FIGURE NO: 25

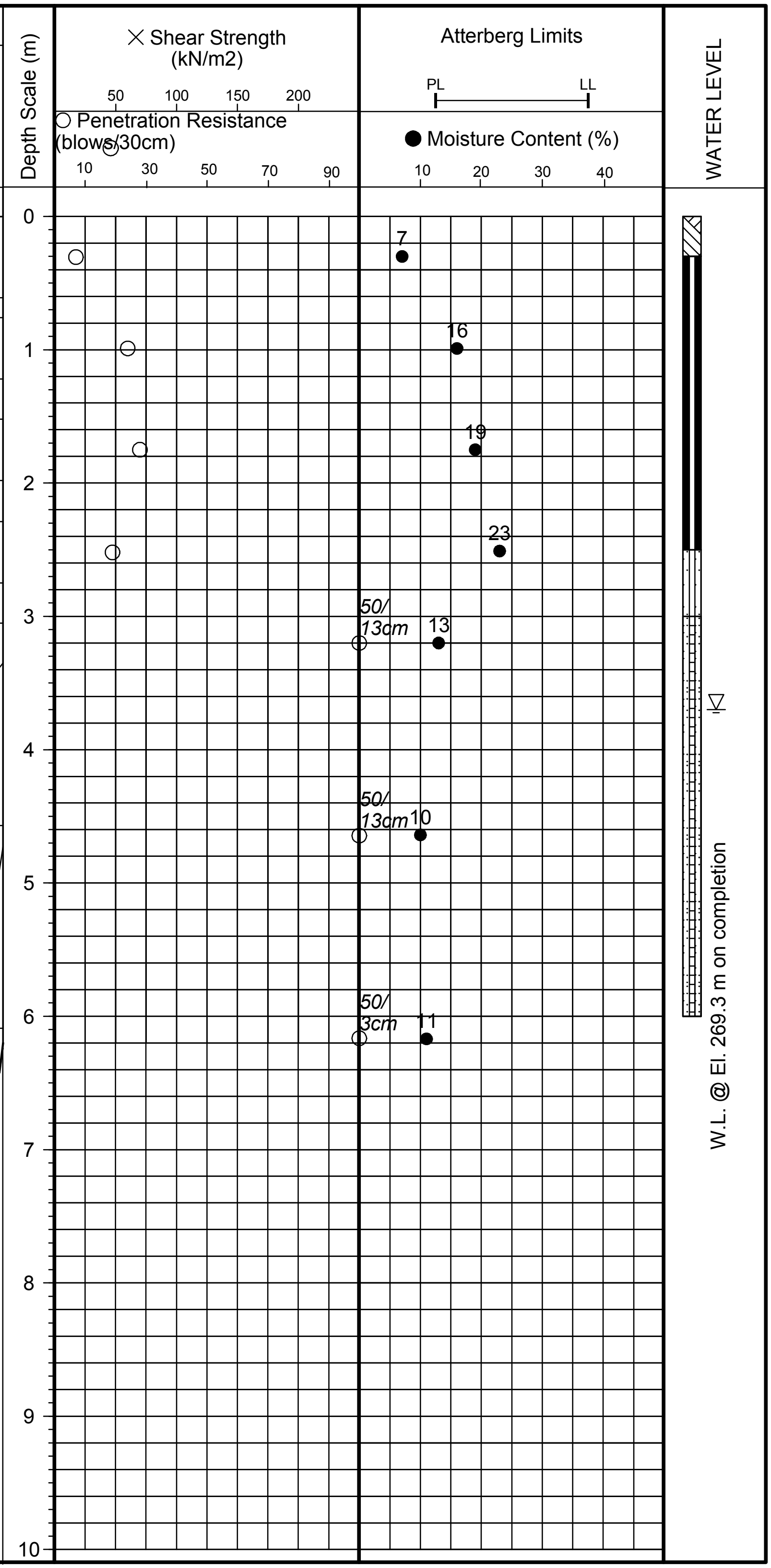
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 19, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
273.0	**60 cm TOPSOIL, Fill**	1	DO	7
0.8 272.2	Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.	2	DO	24
	Brown, very stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	3 4	DO DO	28 19
3.0 270.0	Brown, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	50/ 13
4.5 268.5	Very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders brown grey	6	DO	50/ 13
6.2 266.8	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.	7	DO	50/ 3



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-6S

FIGURE NO: 26

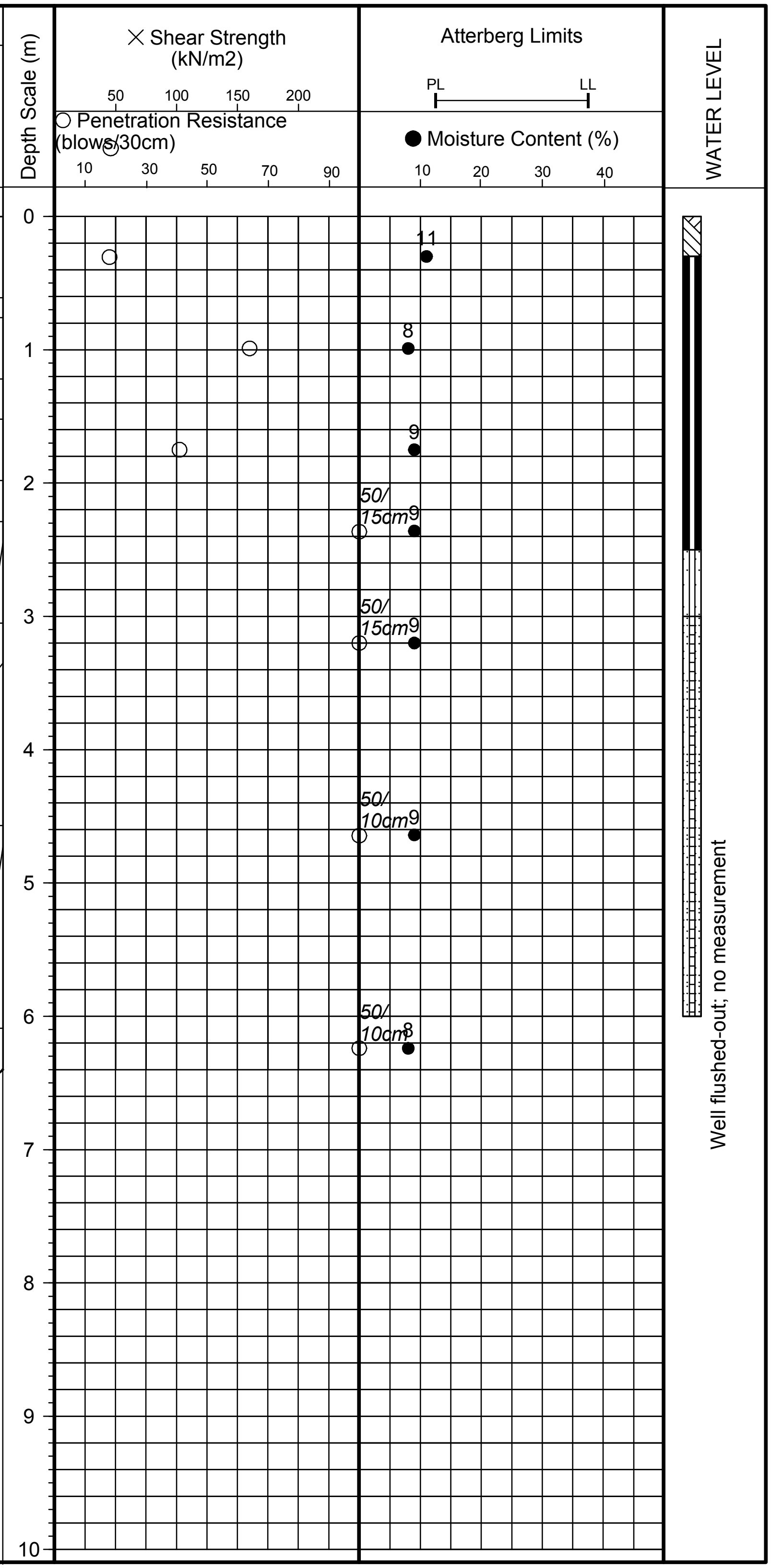
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 12, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
0.0	Ground Surface			
282.5	**30 cm TOPSOIL, Fill**	1	DO	18
	Brown			
0.8 281.7	**SILTY CLAY, Fill** some sand and occ. topsoil incl.	2	DO	64
	Dense to very dense			
	SILTY SAND, Till **and SANDY SILT, Till**	3	DO	41
	some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	4	DO	50/ 15
		5	DO	50/ 15
		6	DO	50/ 10
	brown grey			
6.4 276.1		7	DO	50/ 10
	END OF BOREHOLE Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-7D

FIGURE NO: 27A

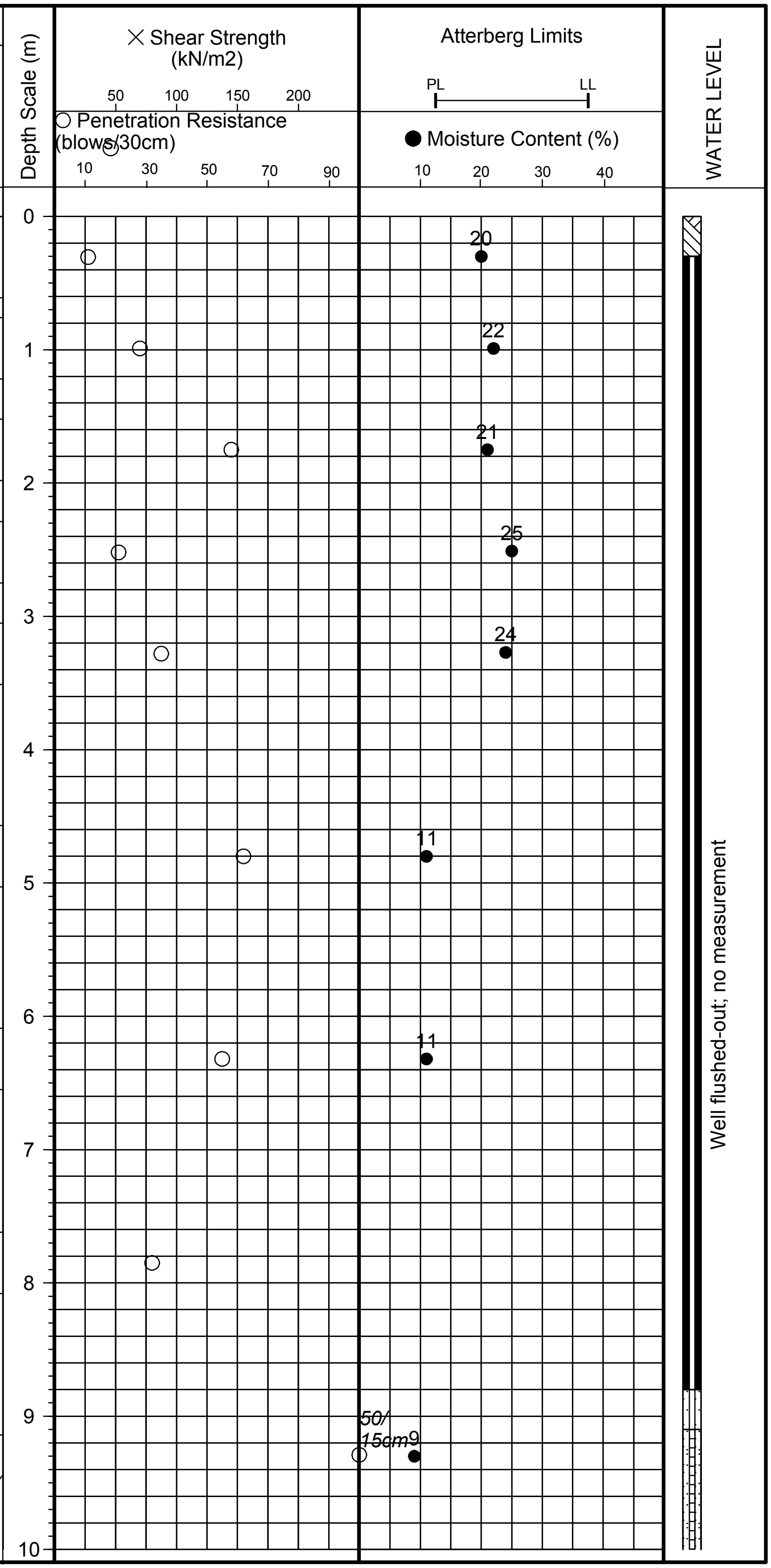
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
276.0	**30 cm TOPSOIL**			
	Brown, very stiff to hard weathered **SILTY CLAY** tr. to some sand occ. sand and silt seams and layers	1	DO	11
		2	DO	28
		3	DO	58
		4	DO	21
		5	DO	35
4.5 271.5	Hard **SILTY CLAY, Till** brown grey some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	6	DO	62
		7	DO	55
		8	DO	32
9.0 267.0	Grey, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	9	DO	50/ 15



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-7D

FIGURE NO: 27B

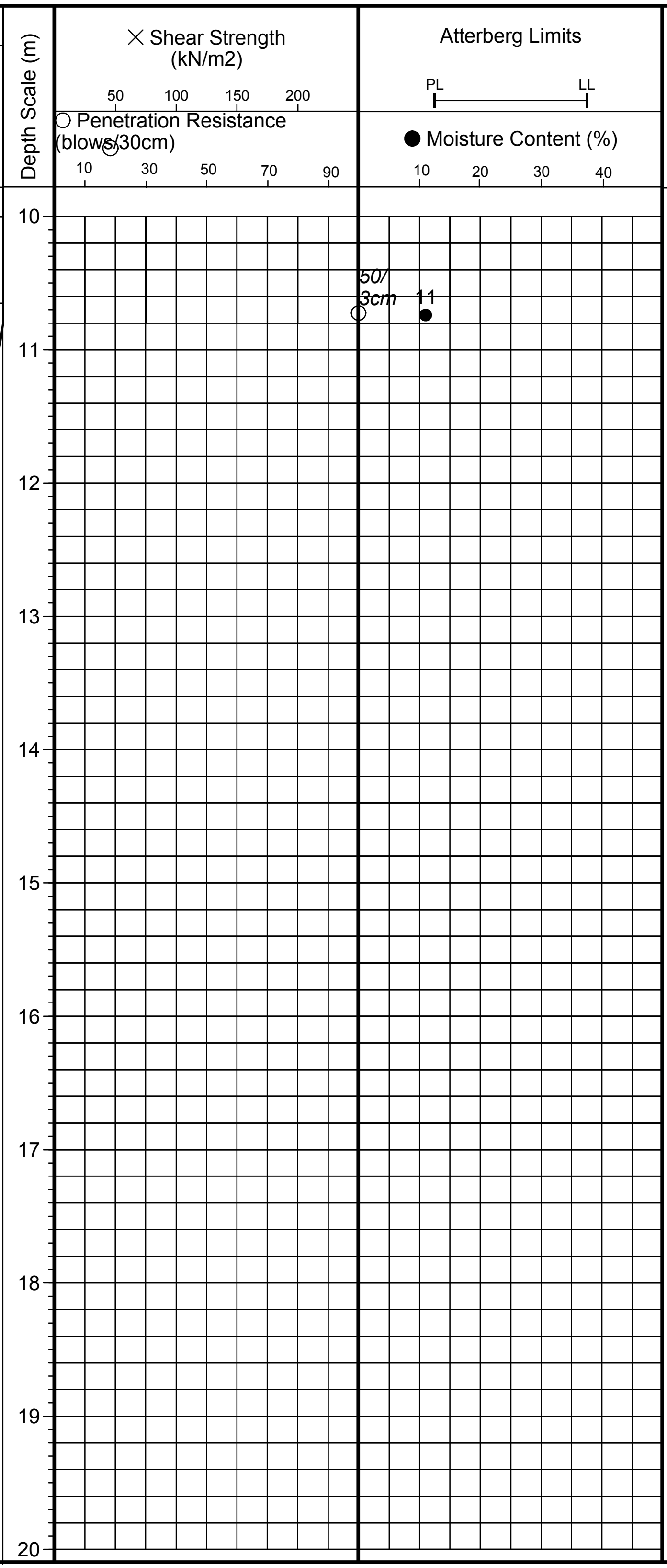
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
10.0					
266.0	Grey, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel	10	DO	50/3	Well flushed-out; no measurement
265.2	**END OF BOREHOLE** Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 8.8 to 10.6 m. Bentonite seal from 0.3 to 8.8 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.				



JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-7S

FIGURE NO: 28

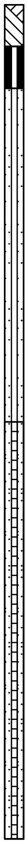
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	× Shear Strength (kN/m2) 50 100 150 200 ○ Penetration Resistance (blows/30cm) 10 30 50 70 90	Atterberg Limits PL LL ● Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface				0			
276.0	**30 cm TOPSOIL, Fill**							
	Brown, very stiff to hard weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers				1 2 3 4			
4.5 271.5	Brown, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders				5			
6.0 270.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 0.6 to 6.0 m. Bentonite seal from 0.3 to 0.6 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.				6 7 8 9 10			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-8D

FIGURE NO: 29A

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

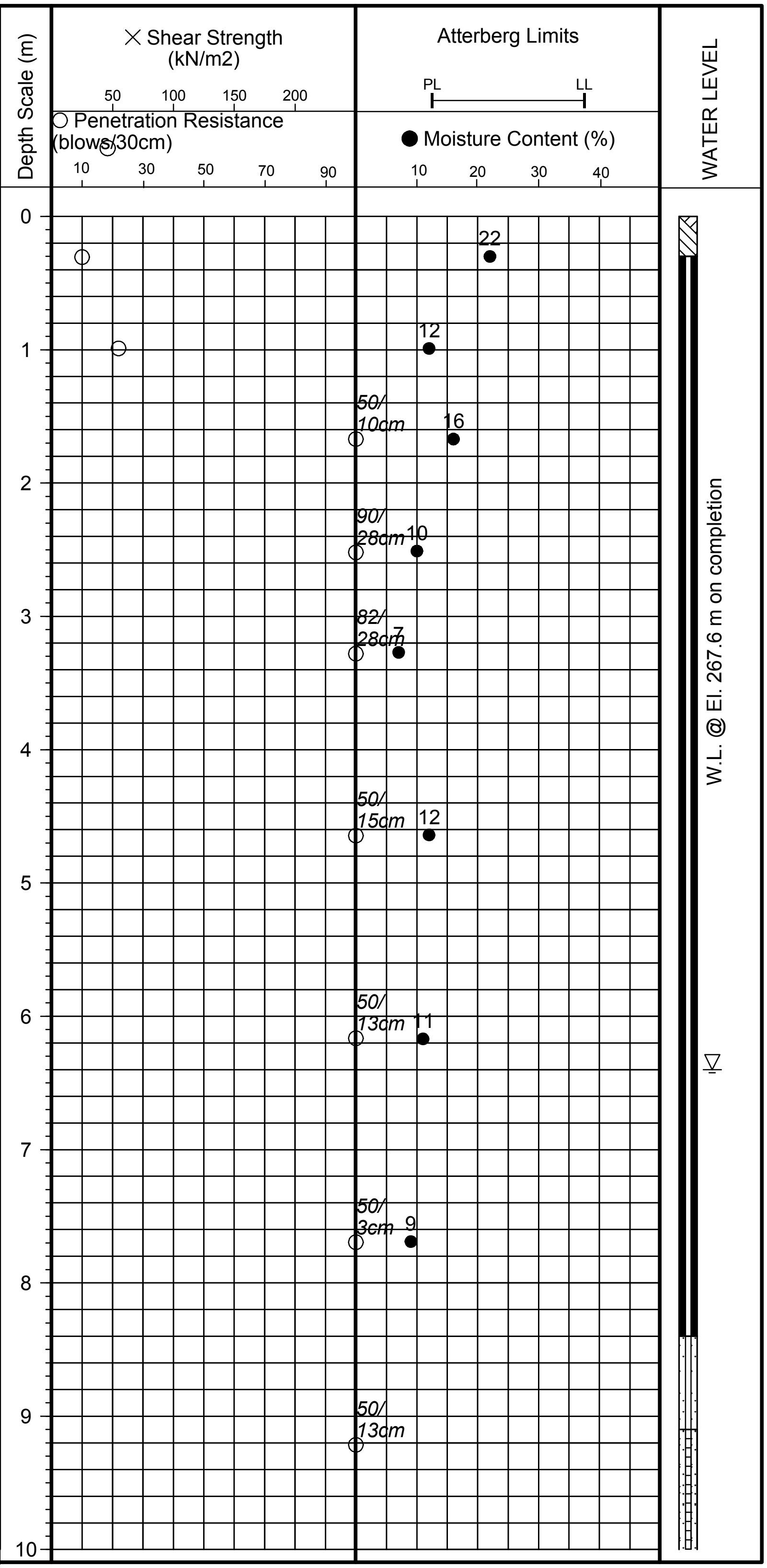
METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION
0.0	Ground Surface
274.0	**50 cm TOPSOIL, Fill**
	Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.
1.5 272.5	Brown, very dense **SILTY SAND, Till and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders

SAMPLES

Number	Type	N-Value
1	DO	10
2	DO	22
3	DO	50/ 10
4	DO	90/ 28
5	DO	82/ 28
6	DO	50/ 15
7	DO	50/ 13
8	DO	50/ 3
9	DO	50/ 13



JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-8D

FIGURE NO: 29B

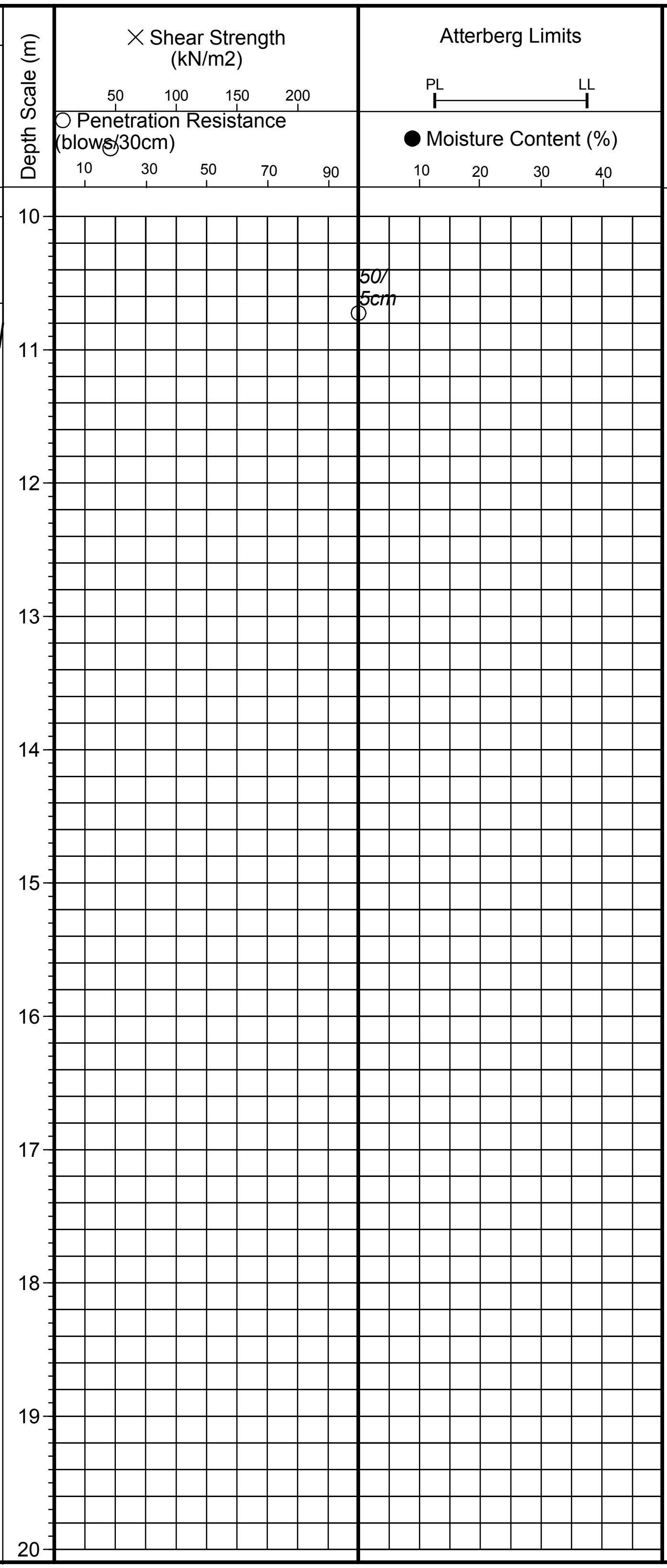
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
10.0				
	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel	10	DO	50/ 5
263.2	**END OF BOREHOLE** Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 8.4 to 10.6 m. Bentonite seal from 0.3 to 8.4 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



WATER LEVEL

W.L. @ El. 267.6 m on completion

Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-8S

FIGURE NO: 30

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0	Ground Surface			
274.0	**50 cm TOPSOIL, Fill**			
	Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.			
1.5 272.5	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders			
6.0 268.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

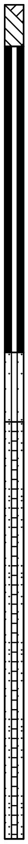
× Shear Strength (kN/m2): 50, 100, 150, 200

○ Penetration Resistance (blows/30cm): 10, 30, 50, 70, 90

Atterberg Limits: PL, LL

● Moisture Content (%): 10, 20, 30, 40

WATER LEVEL



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-9S

FIGURE NO: 31

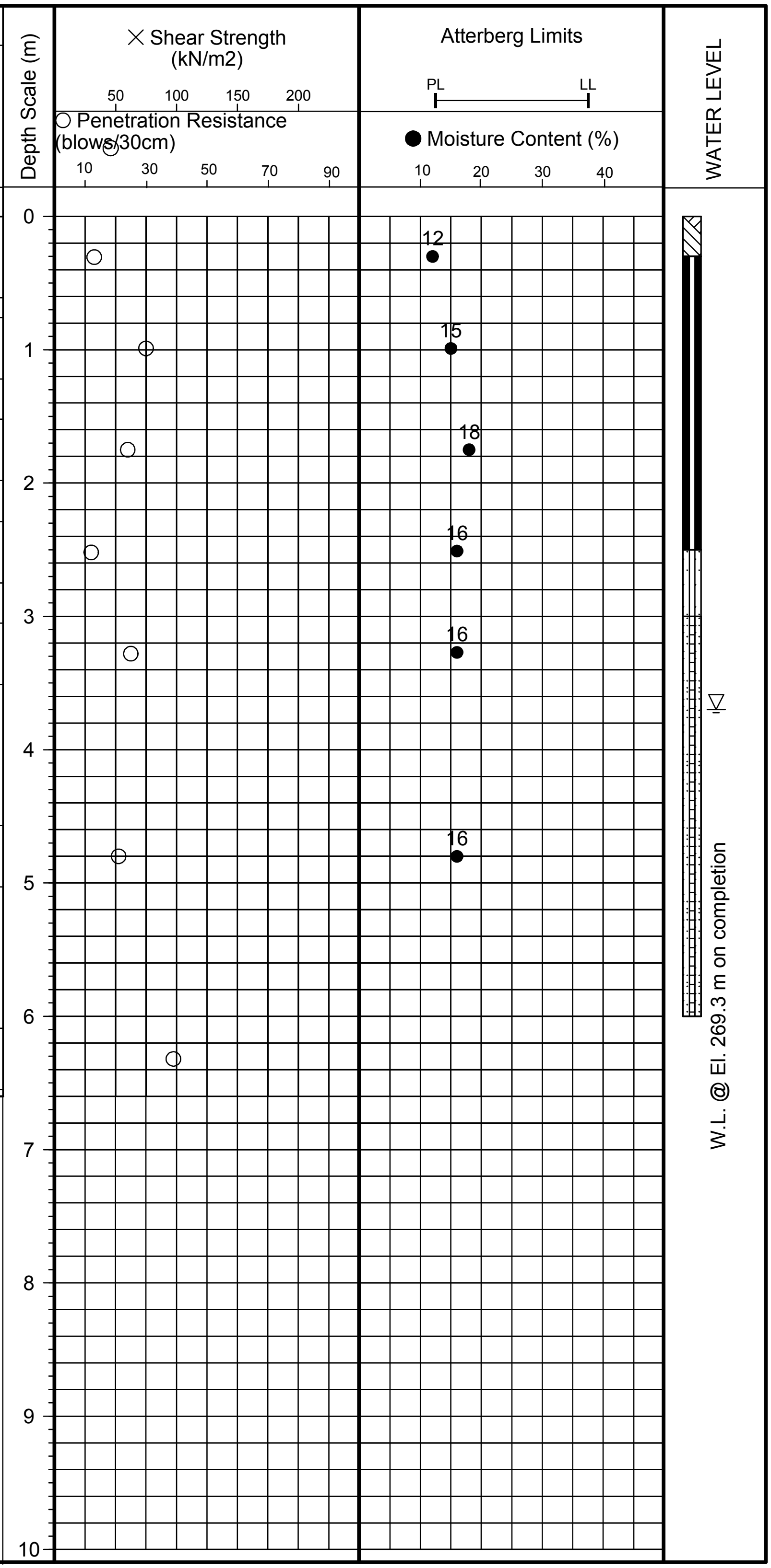
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 17, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
0.0	Ground Surface			
273.0	**25 cm TOPSOIL, Fill**			
	Brown **SILTY CLAY, Fill** some sand, traces of gravel and topsoil	1	DO	13
		2	DO	30
1.5 271.5	Brown, stiff to hard	3	DO	24
	SILTY CLAY, Till	4	DO	12
	some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	25
		6	DO	21
		7	DO	39
6.6 266.4	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-10D

FIGURE NO: 32A

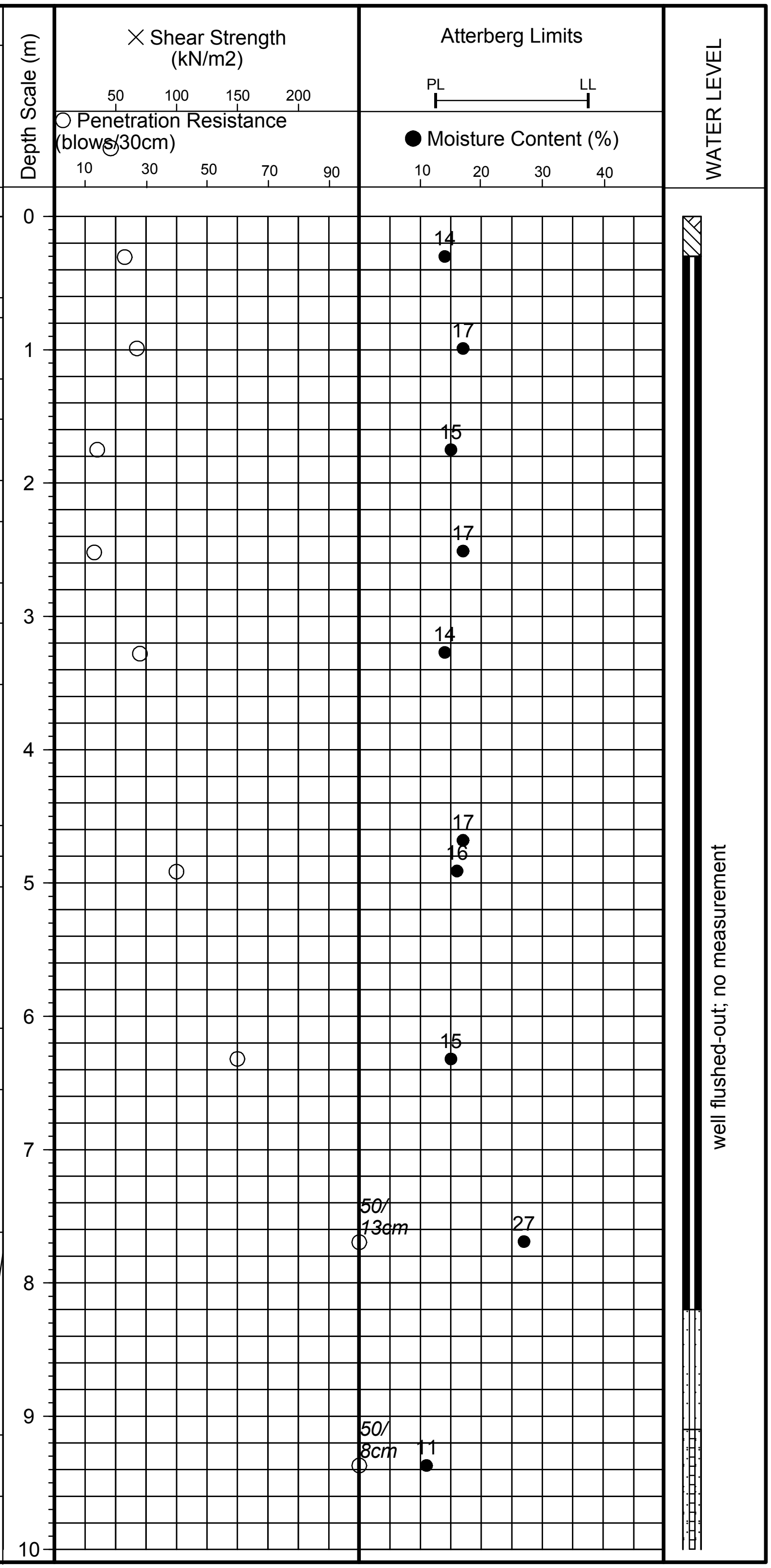
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 16, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
272.0	**15 cm TOPSOIL, Fill** Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.	1	DO	23
		2	DO	27
1.5 270.5	Brown, stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers	3	DO	14
		4	DO	13
3.0 269.0	Very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	5	DO	28
	sand layer	6A	DO	-
		6B	DO	40
	brown grey	7	DO	60
		8	DO	50/13
9.0 263.0	Grey, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	9	DO	50/8



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-10D

FIGURE NO: 32B

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

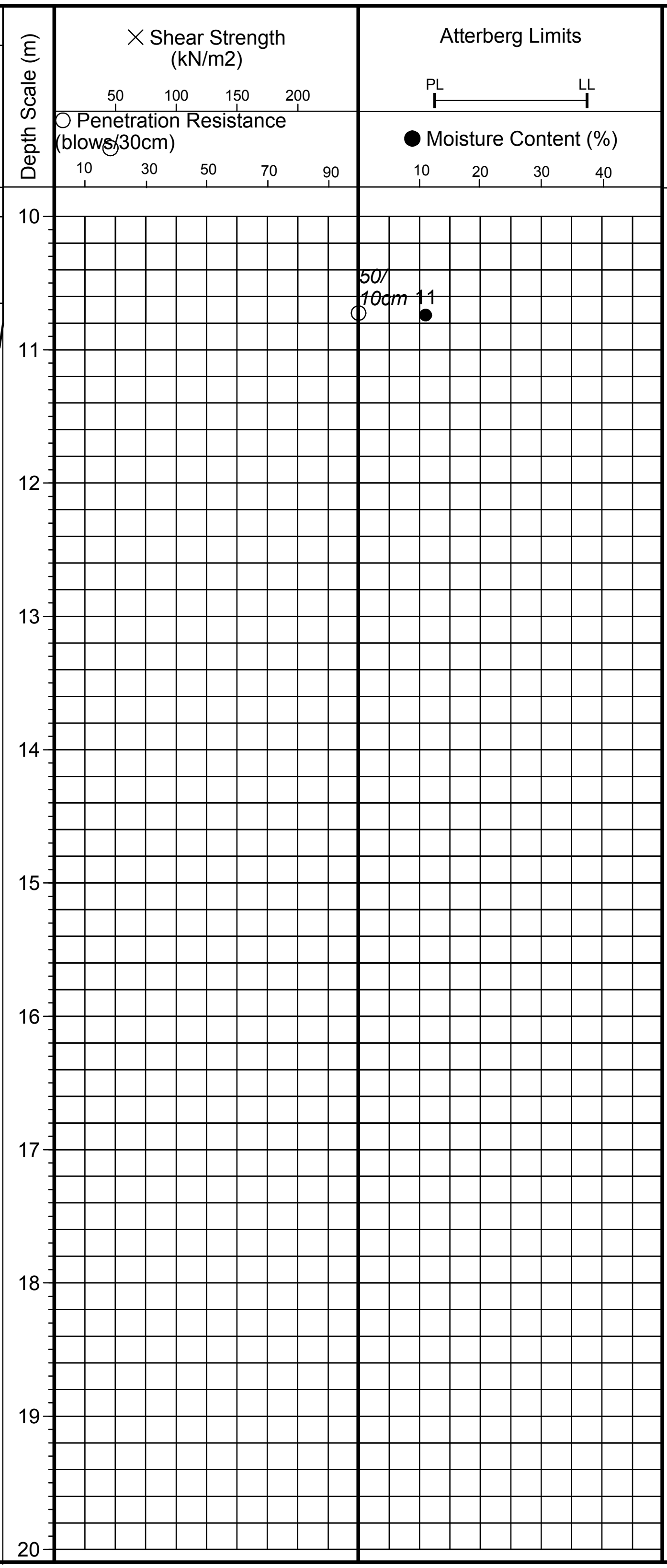
JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 16, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
10.0				
262.0	Grey, very dense **SILTY SAND, Till and SANDY SILT, Till** some clay, a tr. of gravel	10	DO	50/ 10
261.2	**END OF BOREHOLE**			

Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 8.2 to 10.6 m. Bentonite seal from 0.3 to 8.2 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.



WATER LEVEL

well flushed-out; no measurement

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-10S

FIGURE NO: 33

JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 16, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
0.0	Ground Surface			
272.0	**15 cm TOPSOIL, Fill** Brown **SILTY CLAY, Fill** some sand and occ. topsoil incl.			
1.5 270.5	Brown, stiff **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers			
3.0 269.0	Brown, very stiff to hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders sand layer			
6.0 266.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.4 to 6.0 m. Bentonite seal from 0.3 to 2.4 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

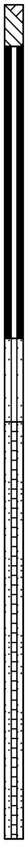
× Shear Strength (kN/m2): 50, 100, 150, 200

○ Penetration Resistance (blows/30cm): 10, 30, 50, 70, 90

Atterberg Limits: PL, LL

● Moisture Content (%): 10, 20, 30, 40

WATER LEVEL



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-11S

FIGURE NO: 34

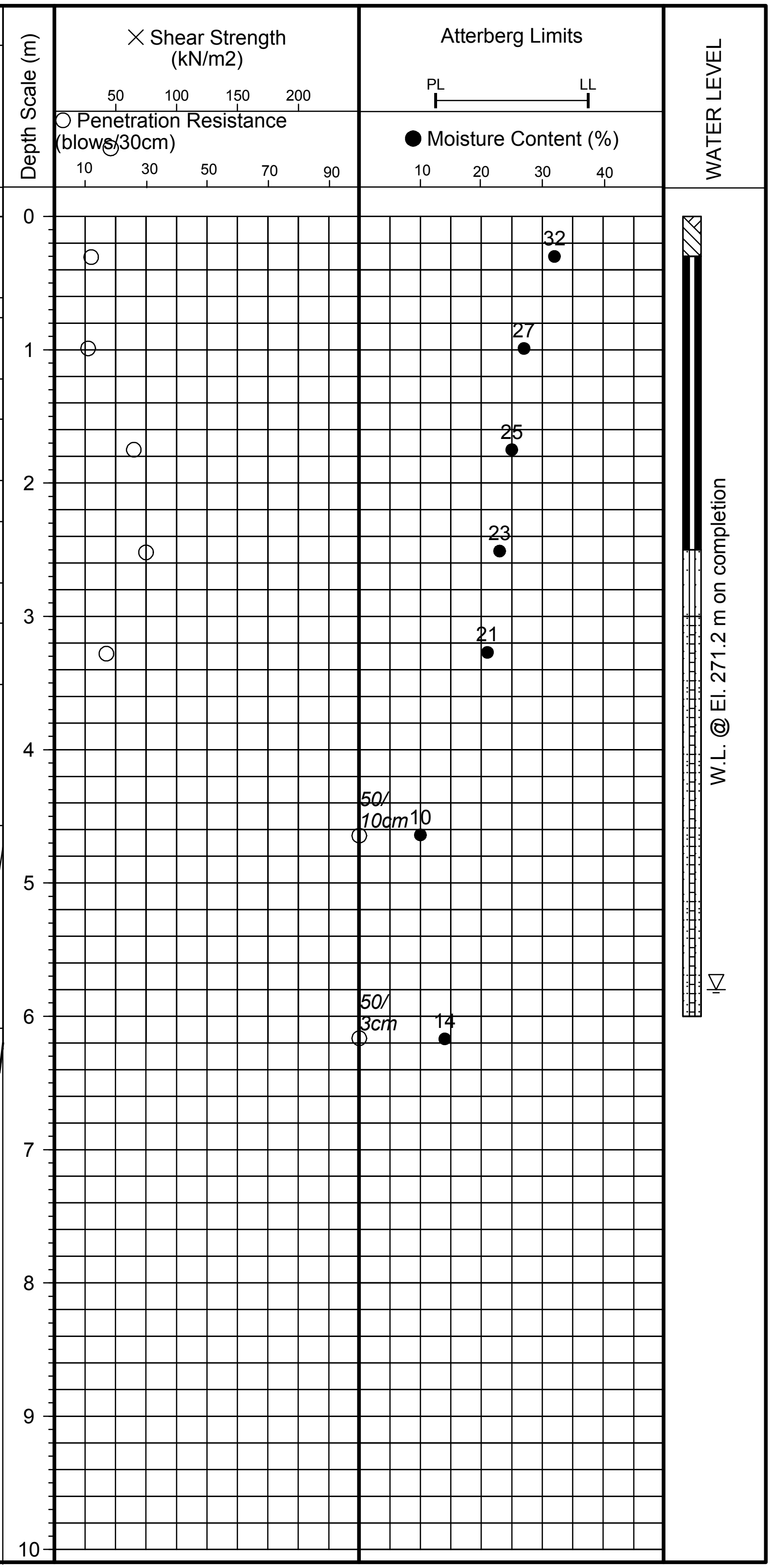
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 15, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
277.0	**51 cm TOPSOIL**	1	DO	12
	Brown, stiff to very stiff **SILTY CLAY** weathered tr. to some sand occ. sand and silt seams and layers	2	DO	11
		3	DO	26
2.3 274.7	Brown, very stiff **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	4	DO	30
		5	DO	17
4.5 272.5	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6	DO	50/10
		7	DO	50/3
6.2 270.8	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-12D

FIGURE NO: 35A

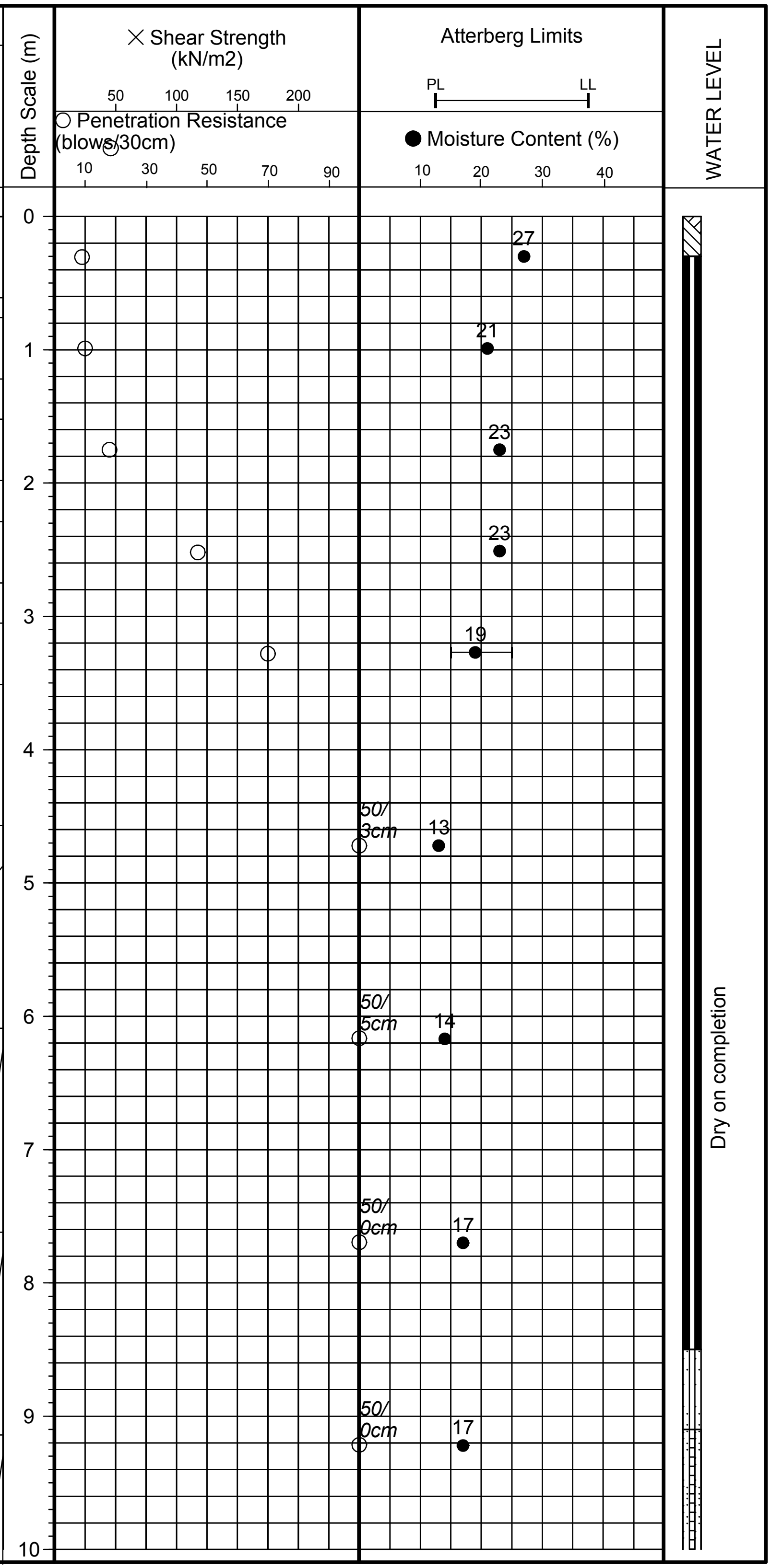
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 18, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
283.0	**60 cm TOPSOIL**	1	DO	9
	Brown, stiff to hard weathered **SILTY CLAY** tr. to some sand occ. sand and silt seams and layers	2	DO	10
		3	DO	18
		4	DO	47
		5	DO	70
4.5 278.5	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	6	DO	50/ 3
		7	AS	50/ 5
7.0 276.0	Brown, hard **SILTY CLAY, Till** some sand to sandy, a tr. of gravel occ. sand and silt seams and layers, cobbles and boulders	8	AS	50/ 0
		9	AS	50/ 0



JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-12D

FIGURE NO: 35B

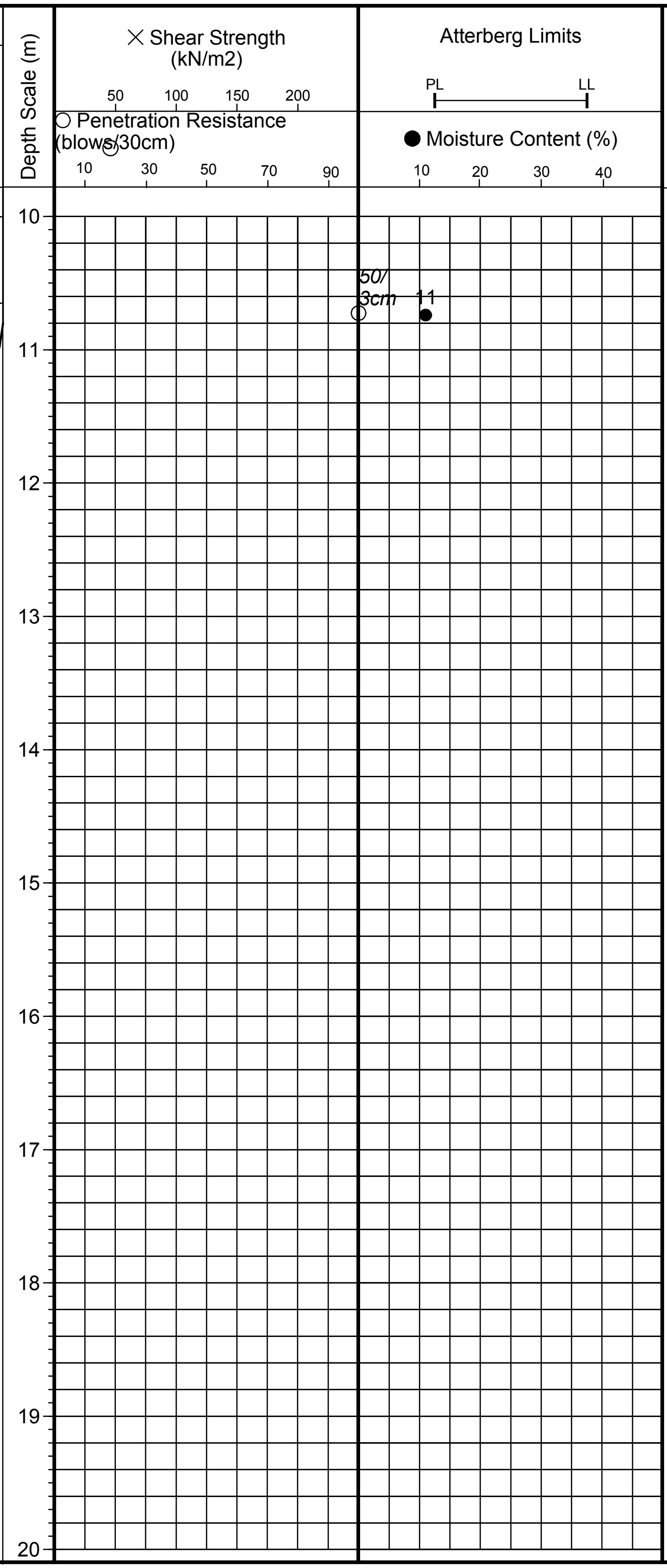
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 18, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
10.0					
273.0	Grey, very dense **SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders	10	AS	50/ 3	
272.2	**END OF BOREHOLE** Installed 50 mm standpipe to 10.6 m with 1.5 m screen. Sand backfill from 8.5 to 10.6 m. Bentonite seal from 0.3 to 8.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.				Dry on completion



Soil Engineers Ltd.

JOB NO: 1111-S053

LOG OF BOREHOLE NO: MW-12S

FIGURE NO: 36

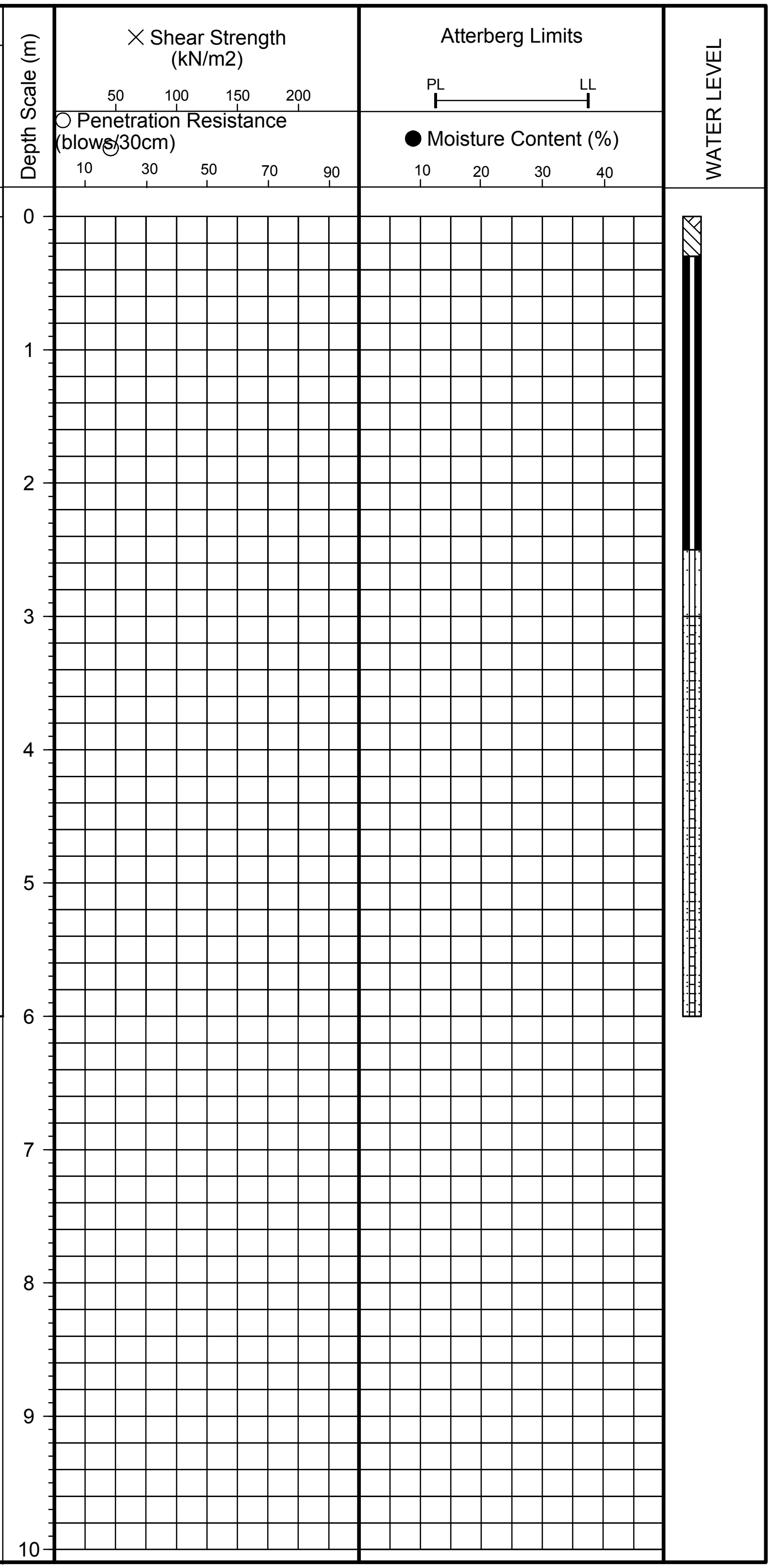
JOB DESCRIPTION: Proposed Residential Subdivision (Estates of Glenway Newmarket)

JOB LOCATION: Davis Drive West and Bathurst Street, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: December 18, 2011

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
283.0	**60 cm TOPSOIL**			
	Brown, stiff to hard weathered **SILTY CLAY** a tr. to some sand occ. sand and silt seams and layers			
4.5 278.5	Brown, very dense **SILTY SAND, Till** **and SANDY SILT, Till** some clay, a tr. of gravel occ. sand and silt seams and layers cobbles and boulders			
6.0 277.0	**END OF BOREHOLE** Installed 50 mm standpipe to 6.0 m with 3.0 m screen. Sand backfill from 2.5 to 6.0 m. Bentonite seal from 0.3 to 2.5 m. Concrete from 0.0 to 0.3 m. Provided with steel casing and lock.			



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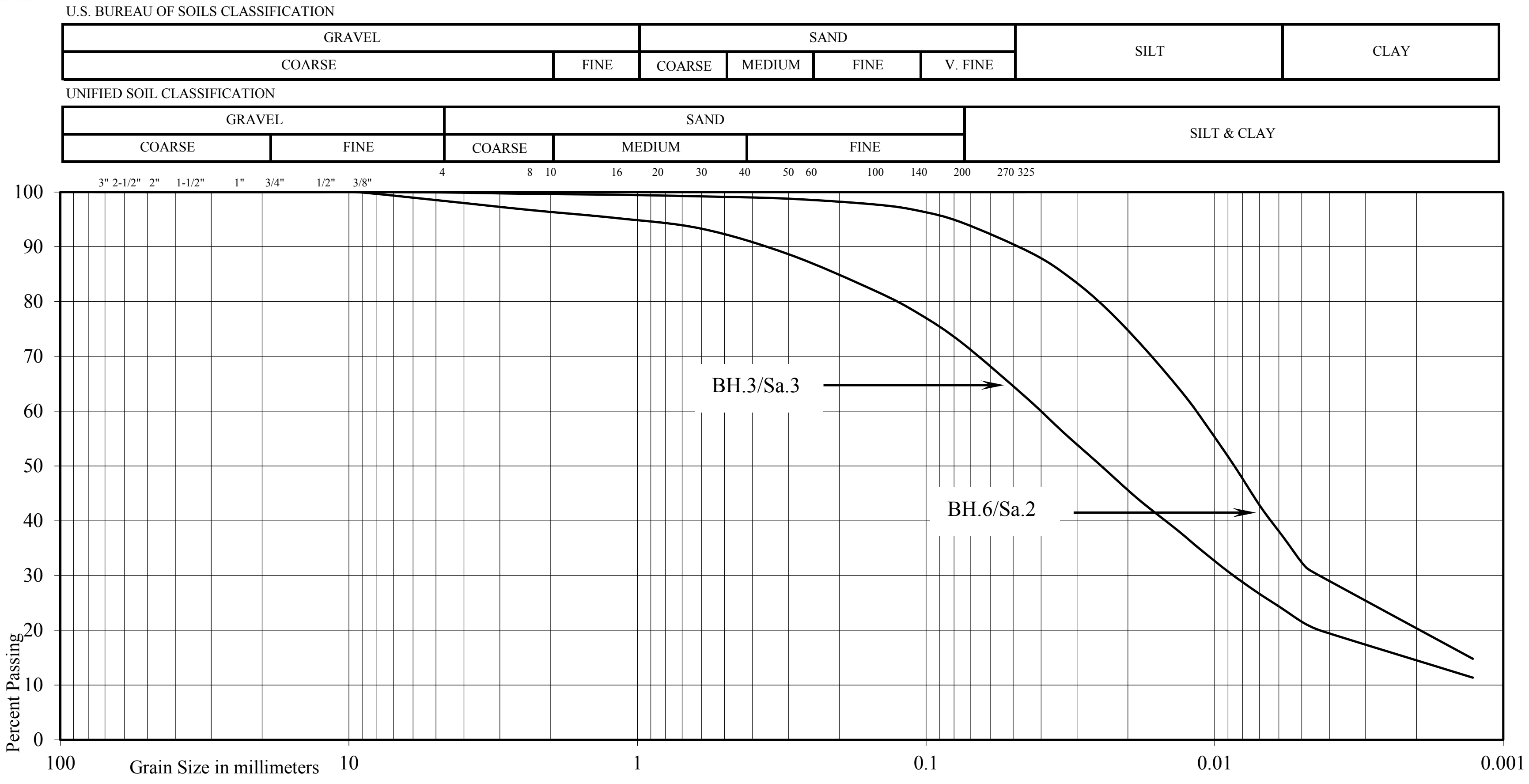
GRAIN SIZE DISTRIBUTION

Reference No: 1111-S053



Project: Proposed Residential Subdivision Estates of Glenway Newmarket

Location: Davis Drive West and Bathurst Street, Town of Newmarket

Borehole No:	3	6
Sample No:	3	2
Depth (m):	1.8	1.0
Elevation (m):	276.2	269.2

BH./Sa.	3/3	6/2
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	16	19
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

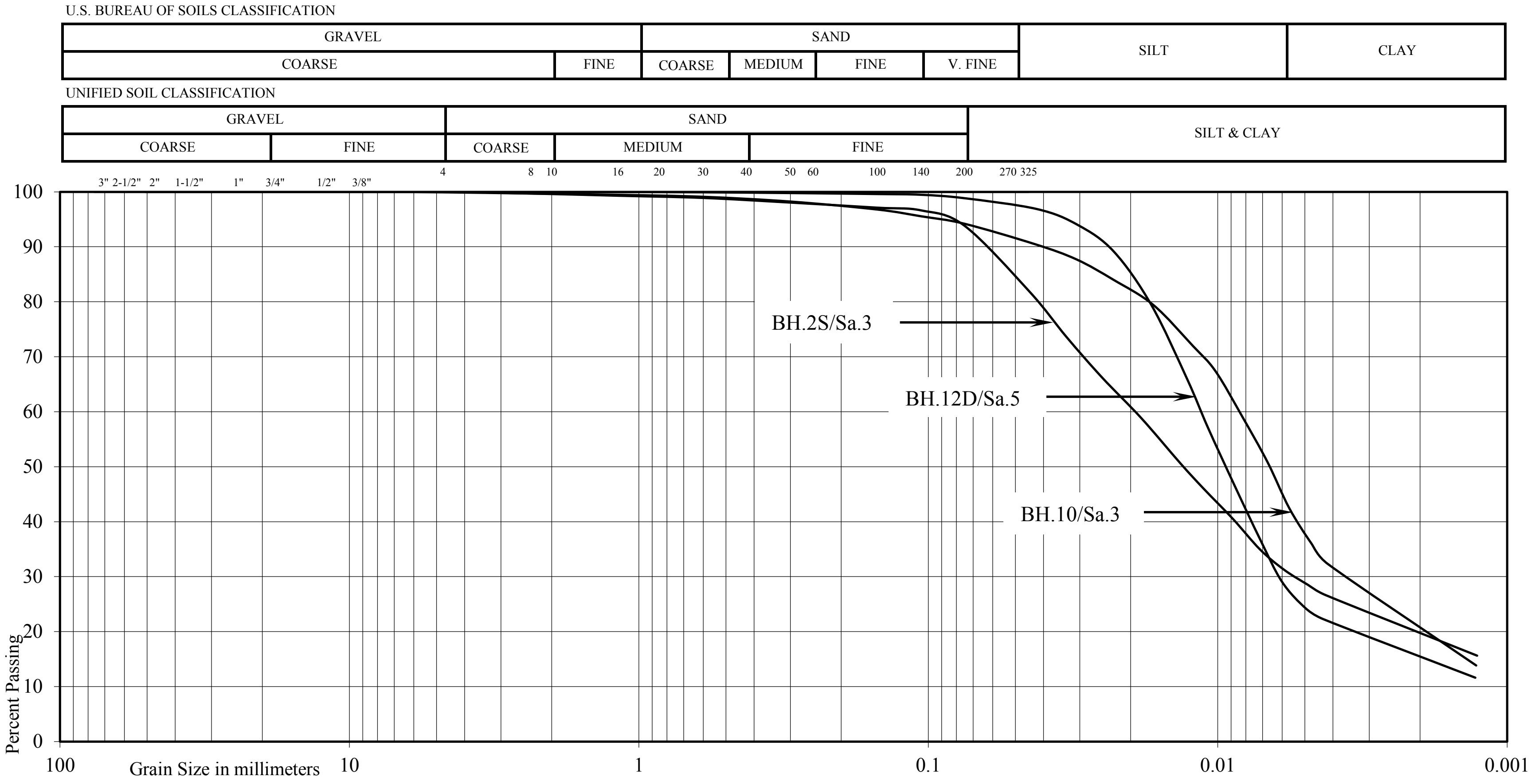
Classification of Sample [& Group Symbol]: SILTY CLAY, Fill
traces of gravel and sand

Figure: 37

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1111-S053



Project: Proposed Residential Subdivision Estates of Glenway Newmarket

Location: Davis Drive West and Bathurst Street, Town of Newmarket

Borehole No:	2S	10	12D
Sample No:	3	3	5
Depth (m):	1.8	1.8	3.3
Elevation (m):	275.2	270.4	279.7

BH./Sa.	2S/3	10/3	12D/5
Liquid Limit (%) =	26	29	25
Plastic Limit (%) =	16	17	15
Plasticity Index (%) =	10	12	10
Moisture Content (%) =	18	29	19
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

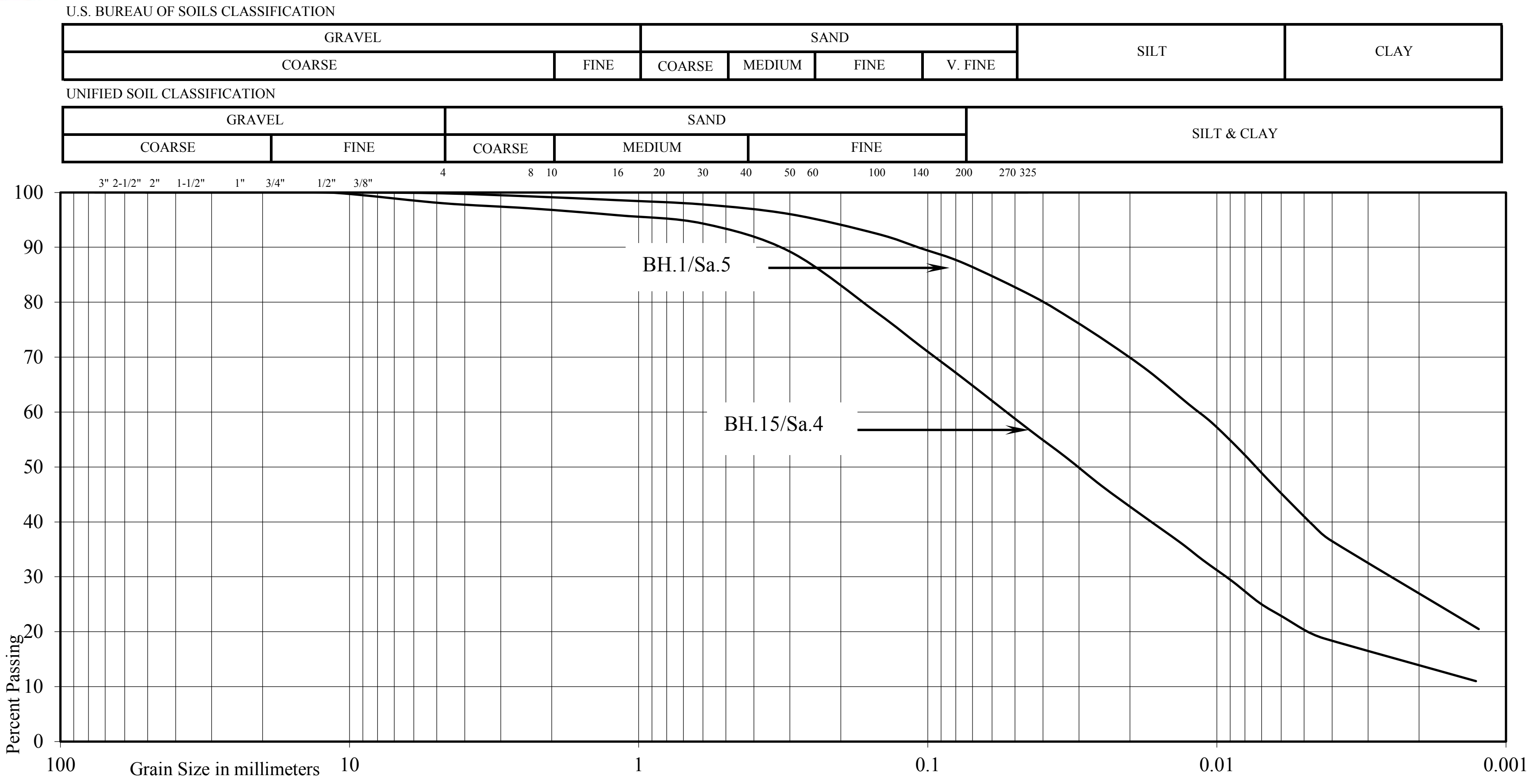
Classification of Sample [& Group Symbol]: SILTY CLAY
a trace of sand

Figure: 38

GRAIN SIZE DISTRIBUTION

Soil Engineers Ltd.

Reference No: 1111-S053



Project: Proposed Residential Subdivision Estates of Glenway Newmarket

Location: Davis Drive West and Bathurst Street, Town of Newmarket

Borehole No:	1	15
Sample No:	5	4
Depth (m):	3.3	2.5
Elevation (m):	269.7	274.6

BH./Sa.	1/5	15/4
Liquid Limit (%) =	30	22
Plastic Limit (%) =	18	15
Plasticity Index (%) =	12	7
Moisture Content (%) =	15	13
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

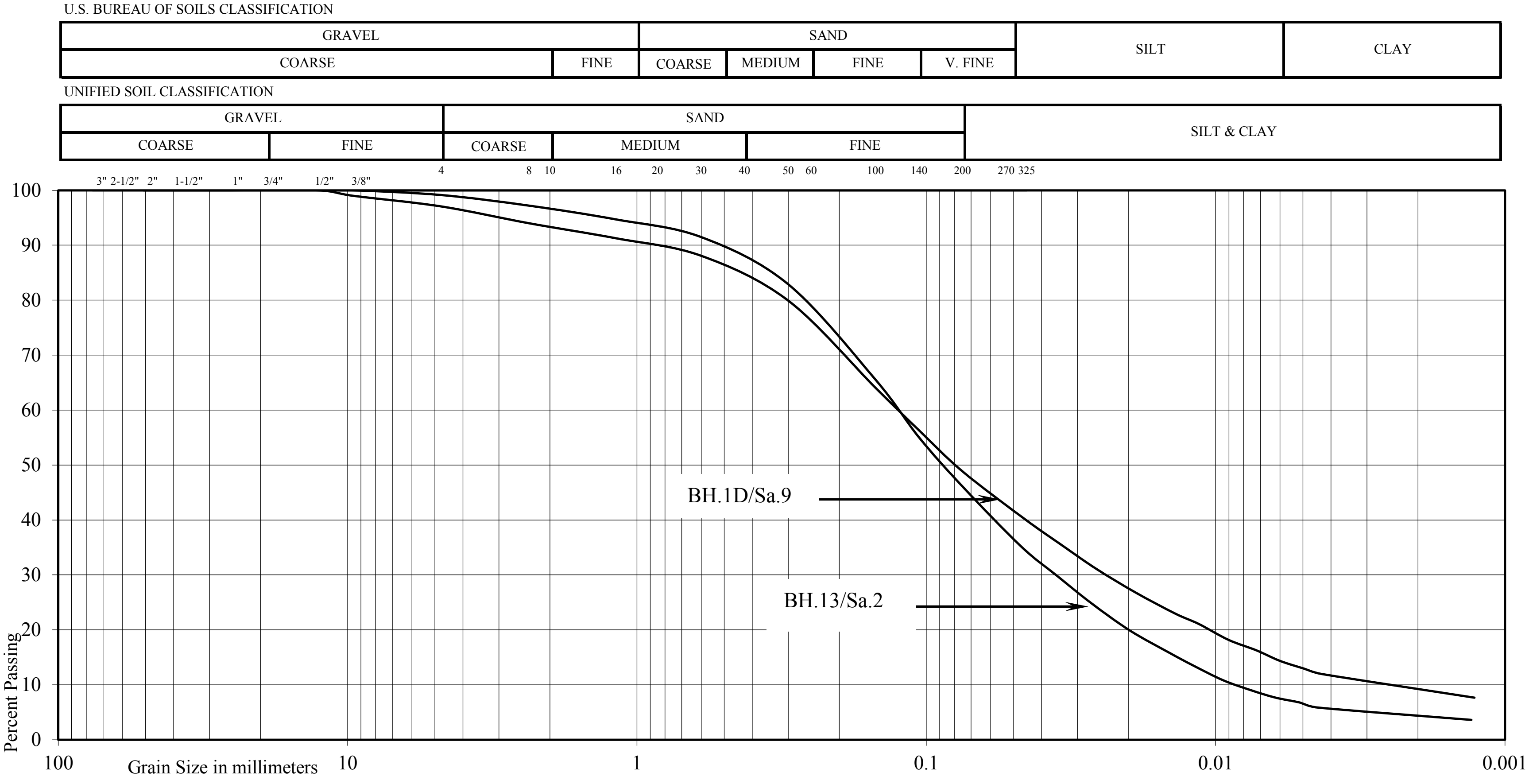
Classification of Sample [& Group Symbol]: SILTY CLAY, Till
some sand to sandy, a trace of gravel

Figure: 39

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1111-S053



Project: Proposed Residential Subdivision Estates of Glenway Newmarket

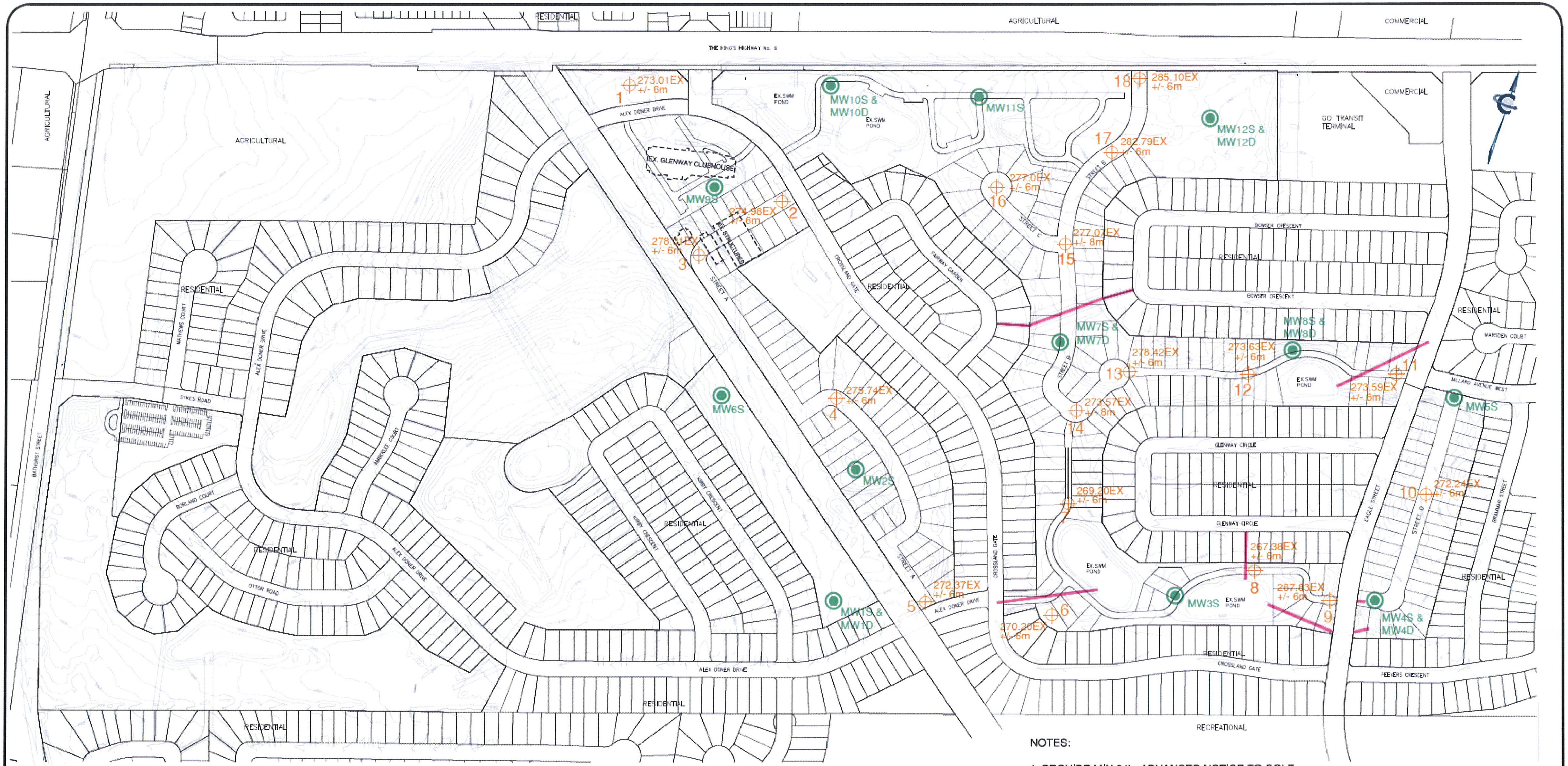
Location: Davis Drive West and Bathurst Street, Town of Newmarket

Borehole No:	1D	13
Sample No:	9	2
Depth (m):	9.3	1.0
Elevation (m):	267.7	277.4

BH./Sa.	1D/9	13/2
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	11	9
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-5}

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

Figure: 40



NOTES:

1. PROVIDE MIN 24hr ADVANCED NOTICE TO COLE ENGINEERING BEFORE ANY WORKS ON SITE

2. ALL REQUIRED PERMITS MUST BE OBTAINED BY THE CONTRACTOR

3. CONTRACTOR TO DETERMINE LOCATIONS OF ALL UNDERGROUND PIPES AND UTILITIES BEFORE DRILLING.

SOIL ENGINEERS LTD.

LEGEND

21⊕	PROPOSED BOREHOLE NUMBER/LOCATION
243.88EX	EXISTING GROUND ELEVATION
+/-6m	PROPOSED BOREHOLE DEPTH
● MW1S/D	BOREHOLE & MONITORING WELL UNDER HYDROGEOLOGICAL PROGRAM (SHALLOW/DEEP - 5/10m DEPTH)
▬	CAUTION - UNDERGROUND PIPES

BOREHOLE LOCATION PLAN

REF. NO.: 1111-S053
DATE: MARCH 2012
SCALE: 1:5000

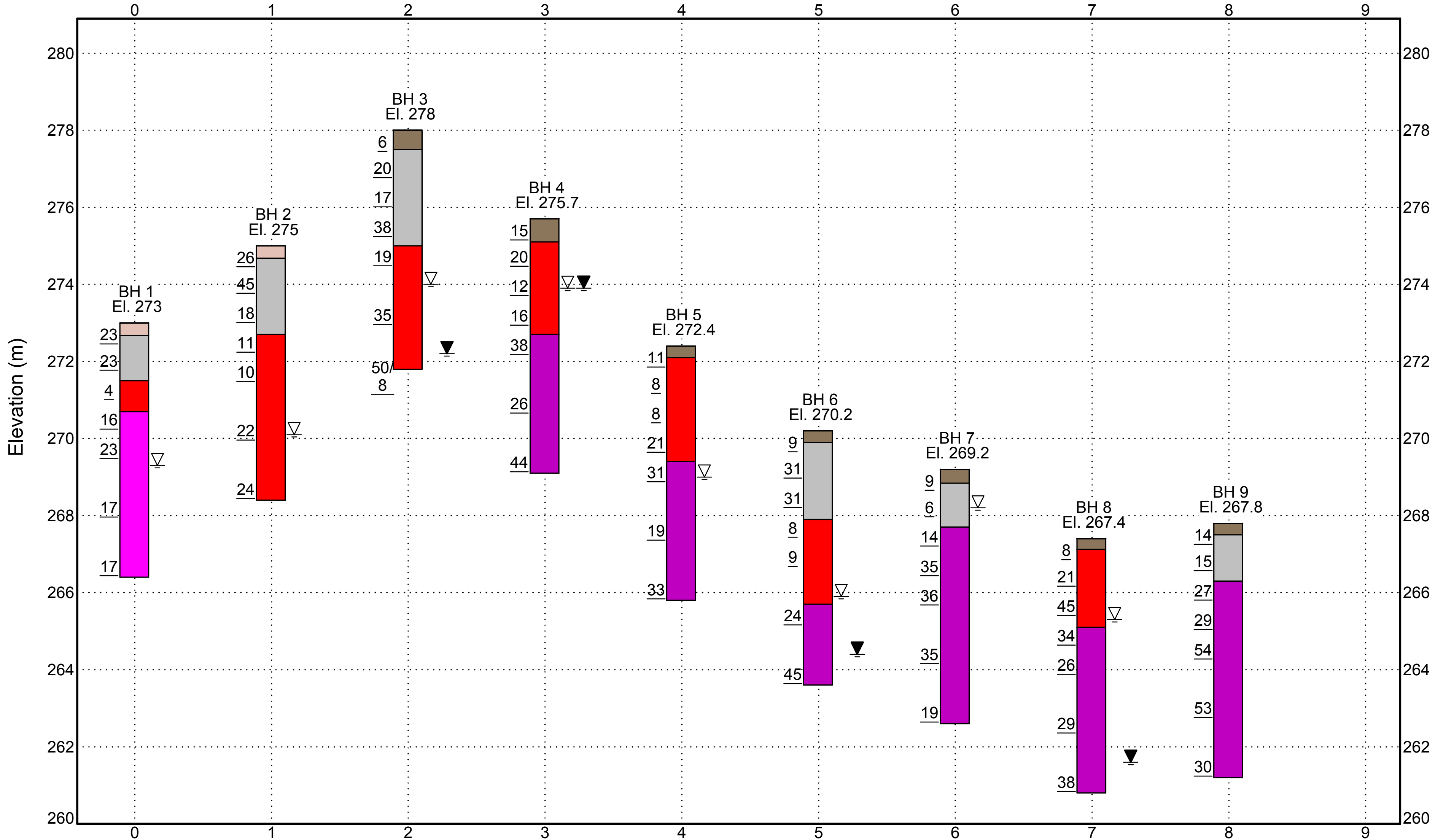
Soil Engineers Ltd.

Ref. No. 1111-S053

Drawing No. 2

LEGEND

- ● Topsoil / Topsoil Fill
- ● Sandy Silt Till / Silty Sand Till
- ● Silty Clay Till
- ● Earth Fill
- ● Silty Clay
- ● Pavement Structure
- ∇ Water Level
- ▼ Cave-in



SUBSURFACE PROFILE

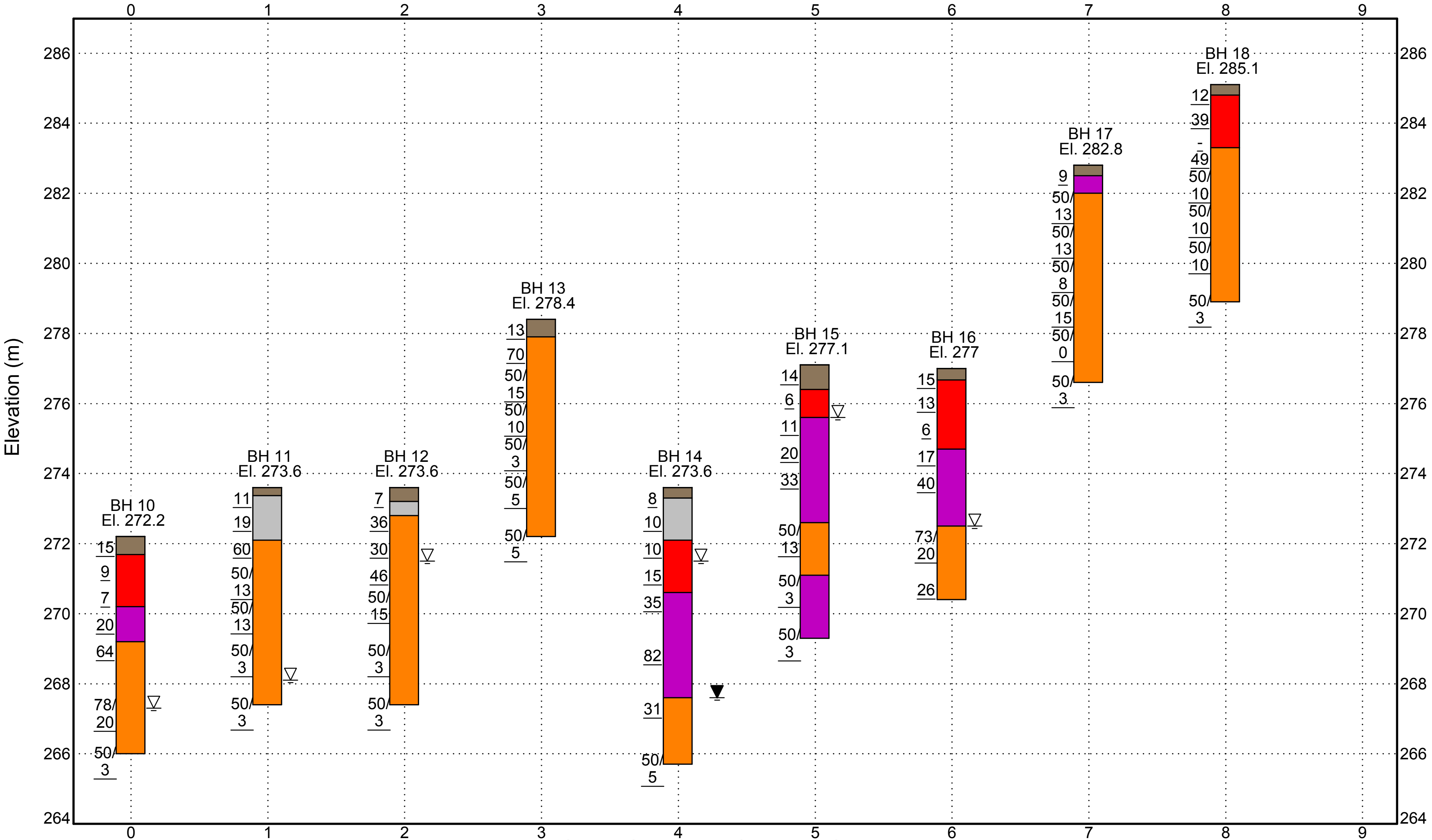
Soil Engineers Ltd.

Ref. No. 1111-S053

Drawing No. 3

LEGEND

- ● Topsoil / Topsoil Fill
- ● Sandy Silt Till / Silty Sand Till
- ● Silty Clay Till
- ● Earth Fill
- ▽ Water Level
- ● Silty Clay
- ● Pavement Structure
- ▼ Cave-in

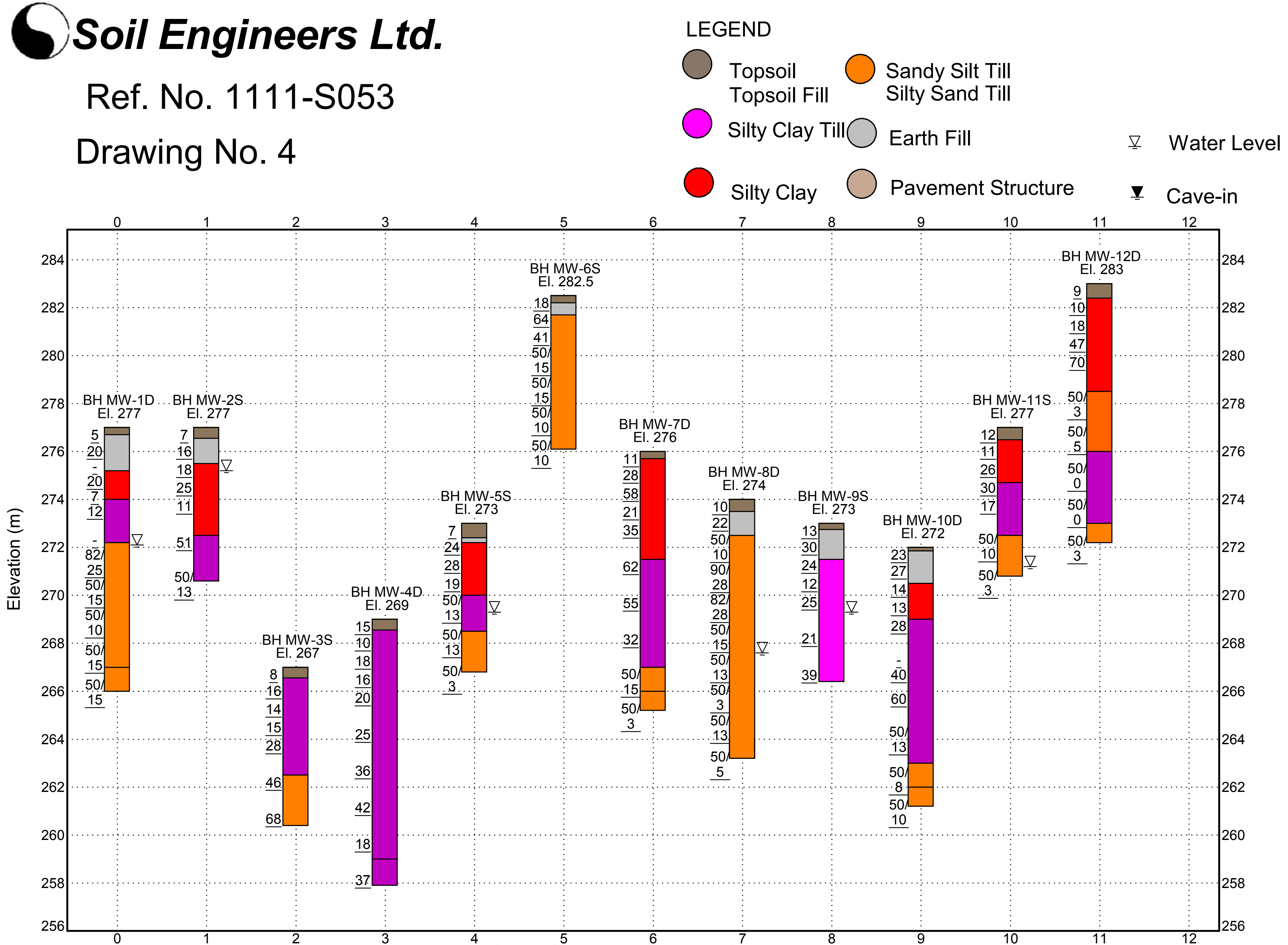


SUBSURFACE PROFILE

Soil Engineers Ltd.

Ref. No. 1111-S053

Drawing No. 4



SUBSURFACE PROFILE