Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

UPDATED REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
WEST HALF OF LOT 22, CONCESSION 1 (ALBION)
PART 1, PLAN 43R - 3575
TOWN OF CALEDON, ONTARIO

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File No. 11-13-3029
October 24, 2013
(Ref. File No. 01109, March 24, 2001)

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TABLE OF CONTENTS

1. INTRODUCTION 1

2. SITE AND PROJECT DESCRIPTION 2

3. FIELD PROCEDURE 2

4. SUBSURFACE CONDITIONS 3
4.1 Topsoil 4
4.2 Earth Fill/ Disturbed Native Soils 4
4.3 Native Soils 4
4.4 Ground Water 5

5. DISCUSSION AND RECOMMENDATIONS 7
5.1 Foundations 7
5.1.1 Foundations on Native Soils 8
5.1.2 Foundations on Engineered Fill 8
5.1.3 Placement of Footings and Floor Slab 10
5.2 Excavations and Ground Water Control 11
5.3 Lateral Earth Pressure 13
5.4 Backfill 14
5.5 Pipe Bedding 15
5.6 Basement Drainage 16
5.7 Pavement Design 17
5.8 Site Regrading Considerations 18

6. LIMITATION AND USE OF REPORT 19

APPENDIX
Abbreviations, Terminology and General Information
Engineered Fill Specifications
Borehole Logs 1 to 10 (Terraprobe 2001)
Sieve and Hydrometer Analysis (Terraprobe 2001)
Figure 1 - Site Location Plan (Terraprobe 2001)
Figure 2 - Borehole Location Plan (Terraprobe 2001)
Figure 2A - Updated Site Plan
Figure 2B - Proposed Townhouse Plan
Figure 2C - Proposed Single Family Dwelling Plan
Proposed Grading Plan (Townhouse Cluster)
Typical Foundation Wall Details for Houses on Engineered Fill
Basement Drainage Detail
Pavement Drainage Alternatives

1. INTRODUCTION

Terraprobe Inc. was retained by 2031818 Ontario Limited, to update a geotechnical investigation report for a property located on the east side of Airport Road, and south side of the existing residential development along Huntsmill Drive in Caledon East (Town of Caledon), Ontario (refer to Figure 1). The legal description of the property is Part of Lot 22, Concession 1 (Albion), Town of Caledon, Regional Municipality of Peel.

Terraprobe Inc. was retained by Valley Grove Investments Inc., to conduct a geotechnical investigation for the above noted property in 2001. The site at that time was been proposed to be developed as a residential subdivision to be serviced by municipal water and sewers, and by paved roads. Our investigation consisted of advancing a total of ten (10) exploratory boreholes across the site and provided geotechnical design recommendations for the proposed development (File No. 01109 dated March 23, 2001).

Subsequent to the above, the development scheme has been revised and consists of a cluster of townhouse blocks (Buildings 1 to 6), internal roadways and some parking areas, located within the south-middle portion of the property (on the west/south side of the creek, in the vicinity of our original Boreholes 3, 8, 9 and 10); and a single family home on the east/north side of the creek near the northeast corner of the property (in the vicinity of our original Boreholes 4 and 5). Access roads for the of townhouse cluster and the single family dwelling are proposed from McKee Drive from the south and north sides of the property, respectively (refer to enclosed Figures 2A, 2B and 2C). Some regrading and two small retaining walls are proposed to facilitate the development of the townhouse cluster (refer to the attached Proposed Grading Plan prepared by Masongsong Associates Engineering Limited, Project Number 03-141, dated April 2013, Drawing Number GR1). No grading plan was available for the single family dwelling at the time of writing this report. We understand that an updated geotechnical investigation report, based on the previously drilled boreholes, is required in support of the current development plan.

A visual inspection of the site was conducted on June 20, 2013 and it was noted that no noticeable development activities, including fill placement and cutting/regrading of the site, were carried out; and the site grade appeared to remain generally similar to the original grade existed at the time of our subsurface investigation.

This updated report encompasses the findings of the previous geotechnical investigation of the site conducted to determine the prevailing subsurface soil and shallow ground water conditions, and based on this information, provides pertinent updated geotechnical engineering recommendations/comments for the design of house foundations, basement drainage, excavation, backfill, installation of buried utilities, pipe bedding requirements, ground water control and pavement design.

2. SITE AND PROJECT DESCRIPTION

The approximate location of the subject property is shown on the enclosed site location plan (Figure 1). The property is located on the east side of Airport Road between the existing residential developments north of Old Church Road, in Caledon East (Town of Caledon), Ontario. The property consists of West Half of Lot 22, Part 1, Concession 1 (Albion), Town of Caledon within the Regional Municipality of Peel.

The subject property is roughly rectangular in shape. A creek meanders across the width of the property entering approximately at the north middle portion of the property and exiting close to the south east corner of the property. The valley lands associated with the creek are densely wooded with a variety of trees, grass and weeds etc. The site topography is generally gently rolling with some relatively flatter areas. The site locally exhibits a north-south or a north westerly to south easterly drainage pattern. The subject site is partially bounded by Airport Road to the west, while the lands to the immediate north, south and east generally comprise of existing residential developments.

As noted before, the original development concept was to develop the westerly portion of the property (located to the west side of the creek) as a residential subdivision comprising of about 75 lots containing detached and semi-detached houses. The revised development scheme consists of a cluster of townhouse blocks (Buildings 1 to 6), internal roadways and some parking areas, located within the south-middle portion of the property (on the west/south side of the creek); and a single family home on the east/north side of the creek near the northeast corner of the property. Access roads for the of townhouse cluster and the single family dwelling are proposed from McKee Drive from the south and north sides of the property, respectively. It is understood that the proposed townhouse development will be serviced by municipal water, storm and sanitary sewers and paved roads, however, the single family dwelling will be on site septic system.

3. FIELD PROCEDURE

The field investigation of the site was conducted on January 18, 19 and 22, 2001, and consisted of drilling and sampling a total of ten (10) exploratory boreholes (Figure 2). Boreholes 1 to 6 were advanced to a depth of about 8.1 m below existing grades, while, Boreholes 7 to 10 were advanced to a depth of about 5.0 m below existing grades. In addition, an additional shallow borehole (each about 3.0 m below existing grades) was also advanced within a couple of metres of each of the Boreholes 1 to 6. These boreholes (Boreholes 1A to 6A) were advanced without soil sampling, only to facilitate a piezometer installation. The boreholes were established in the field by Young & Young Surveying Inc., Project No. 01-B3970 at approximate locations suggested by Terraprobe Inc., further, the corresponding borehole surface elevations were also surveyed by Young & Young Surveying Inc.

The borings were made using a continuous flight power auger machine (Trackmount BOA 6M2) equipped with conventional soil sampling and testing tools. Both hollow stem and solid stem augers were utilized for drilling depending on the presence of the groundwater and amount of caving encountered in the boreholes. The drilling was conducted under the full time supervision of a member of our field engineering staff who logged the borings and examined the samples as they were obtained. The results of the boreholes are recorded in detail on the accompanying borehole logs.

Representative disturbed samples of the strata penetrated were obtained from the boreholes using a split-barrel sampler advanced by a 63.5 kg hammer dropping approximately 760 mm. The results of these Penetration Tests are reported as "N" values on the borehole logs at the corresponding depths.

Samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, colour and odour. The samples obtained were sealed in clean plastic containers and transferred to the Terraprobe laboratory where the samples were examined by a senior geotechnical engineer to verify the accuracy of the initial soil descriptions and to select appropriate samples for laboratory testing. Laboratory testing consisted of water content determination on all samples, while, sieve and hydrometer analyses were carried out on selected samples. The measured natural water contents for individual samples are plotted on the corresponding borehole logs at respective sample depths, while, the results of the sieve and hydrometer analyses are appended.

Water levels were monitored during and at the completion of each borehole. Standpipe type piezometers comprised of 12 mm I.D. PVC tubing were installed in selected boreholes in order to facilitate monitoring of shallow groundwater levels. The PVC tubing was saw slotted near its base and fitted with a bentonite clay seal as shown on the accompanying borehole logs. Protective caps were installed to protect the piezometer installations. Water levels in the standpipes were measured again on January 29, 2001 about one and a half weeks following the subsurface investigation. The results of the groundwater monitoring are summarized in a subsequent section.

4. SUBSURFACE CONDITIONS

The results of the individual boreholes are summarized below and recorded on the accompanying Borehole Logs. This summary is intended to correlate this data to assist in interpretation of the subsurface conditions at the site.

It should be noted that the soil conditions are confirmed at the borehole locations only and may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs and sections are based on a non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

In summary, the subsurface soil conditions encountered in the boreholes across the site consisted of a surficial topsoil layer underlain by a stratum of disturbed native soil zone which was in turn underlain by native soils which extended to the full depth of investigation at every borehole location.

4.1 Topsoil

A layer of topsoil was encountered at every borehole location. The estimated thickness of the topsoil layer varied from about 150 mm (Borehole 7) to about 500 mm (Boreholes 1 and 5). The topsoil was dark brown to black in colour and had a silt / sand matrix. The topsoil thicknesses presented here pertain to the estimated values at the respective borehole locations only and may vary between and beyond the boreholes. Further, the data presented in this report may not be sufficient for the purposes of estimating topsoil quantities across the site or for the associated stripping costs.

4.2 Earth Fill/Disturbed Native Soils

A stratum of disturbed native soils was encountered beneath the surficial topsoil layer at every borehole location. The thickness of this stratum varied across the site. The extent of the disturbed native soil stratum ranged from about 0.8 m below existing grades at Boreholes 3 and 9 to about 1.5 m at Boreholes 5 and 8, below existing grades. The soils encountered within this stratum predominantly consisted of sandy silt to silty sand or sand with trace to some silt and trace amounts of clay. Trace amounts of organics and rootlets were also noted within this stratum. In general, the composition of the soils encountered within this stratum was similar to that of the corresponding underlying native soils with the exception of sporadic presence of organics.

The Standard Penetration Test results (‘N’ Values) obtained within the fill stratum generally varied from 2 blows to 11 blows per 300 mm of penetration, averaging at about 6 blows per 300 mm of penetration indicating the soils within this stratum to be in a very loose to compact relative density (typically loose).

Measured moisture contents of the soil samples obtained from this stratum typically ranged between 6 percent and 33 percent by weight, indicating the soils to be in damp to very moist or wet condition.

4.3 Native Soils

Native soils were encountered underlying the surficial disturbed native soil zone at every borehole locations. The native soils encountered in the boreholes were generally alluvial deposits of cohesionless soils predominantly comprised of a silt or sand soil matrix with varying proportions of clay. The native alluvial soils can be characterized as brown silt to sandy silt or silty sand to sand with trace amounts of clay. Sand soils encountered in the boreholes were typically fine to medium grained in size. It is understood that there may be occasional and intermittent coarse sand and gravel layers embedded within the alluvial deposits as was noted in Borehole 3 at a depth of about 6.1 m below existing grades.

Silty sand till soils were encountered underlying the alluvial soil deposits in Boreholes 7, 9 and 10 at a depth of about 2.3 m, 1.5 m and 4.6 m below existing grades respectively. The till soils were typically brown to grey in colour and predominantly consisted of silty sand with some gravel and trace to some amounts of clay.

The Standard Penetration Test results (‘N’ Values) within the silt to silty sand alluvial soil deposits varied from 9 blows to 89 blows per 300 mm of penetration, averaging at about 31 blows per 300 mm of penetration indicating the soils within this stratum to be in a loose (surficially) to dense relative density (typically dense). A split spoon refusal (50 blows or more per 150 mm or less penetration) was noticed in Borehole 3, Sample 7 on sand and gravel layer.

Measured moisture contents for the samples obtained from the silt to silty sand alluvial soil deposits typically ranged between 17 percent and 28 percent by weight, indicating the soils to be typically in a wet condition. Measured moisture contents for the samples obtained from Boreholes 4, 5 and 6 up to depth of approximately 1.5 m or more (Borehole 4) below existing grades were found to be significantly lower (about 3 percent to 8 percent by weight) until the groundwater level was penetrated. This is likely due to the relatively higher elevations of these boreholes as well as presence of the upper free draining sand stratum.

The Standard Penetration Test results (‘N’ Values) within the till soils varied from about 43 blows to about 78 blows per 300 mm of penetration or split spoon refusal (50 blows or more per 150 mm or less penetration), averaging at about 59 blows per 300 mm of penetration indicating the till soils within this stratum to be in a dense to very dense relative density (typically very dense).

Measured moisture contents for the samples obtained from the glacial till soils typically ranged between 5 percent and 13 percent by weight, indicating the native till soils to be in a damp to moist condition.

4.4 Ground Water

The depth of ground water seepage in each of the boreholes was measured immediately following the drilling operation. Water level measurements were also taken on January 29, 2001 in the standpipe type PVC piezometers which were installed in selected boreholes at the time of drilling. The water levels measured at the time of drilling and during the subsequent visit are summarized as follows:

Borehole No.	Depth of Boring	Depth to Cave	Water level at the time of drilling	Water Level January 29, 2001
1	8.1 m BG	7.0 m BG	2.1 m BG	1.2 m BG
2	8.1 m BG	open	3.9 m BG	0.4 m BG
3	8.1 m BG	open	1.2 m BG	0.1 m BG
4	7.9 m BG	4.2 m BG	3.6 m BG	5.0 m BG
5	8.1 m BG	3.0 m BG	2.1 m BG	2.3 m BG
6	8.1 m BG	open	3.0 m BG	2.8 m BG
7	4.8 m BG	1.4 m BG	0.5 m BG	NP
8	5.0 m BG	open	dry	dry
9	4.7 m BG	open	dry	NP
10	4.7 m BG	2.4 m BG	dry	NP

BG = Below Grade
NP = Piezometer not Installed

It should be noted that the ground water levels indicated above may fluctuate seasonally depending on the amount of precipitation and surface runoff. Wet soils may be encountered to up to about 600 mm above the measured water level where there is capillary rise in fine cohesionless (silt/sand) soils.

5. DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use of the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards and guidelines of geotechnical engineering practice. The pertinent sections of Ontario Building Code may require additional considerations beyond the recommendations provided in this report, and must be followed. If there are any changes to the site development features or any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

5.1 Foundations

As noted previously, the new development plan consists of a cluster of townhouse buildings to the west side of the creek located generally in the middle-south portion the property (in the vicinity of Boreholes 3, 8, 9 and 10) and a single family home to the east side of the creek near the northeast corner of the property (in the vicinity of Boreholes 4 and 5). These boreholes encountered a surficial topsoil layer underlain by a stratum of disturbed native materials predominantly consisted of sandy silt to silty sand soils with trace amounts of clay and organics. Native silt to silty sand or sand soils were encountered in all of these boreholes underlying the surficial disturbed native zone which extended to the full depth of investigation except at Boreholes 9 where above soils were in turn underlain by silty sand till soils extending to the full depth of investigation.

Based on the subsurface investigation results it is understood that very moist to wet silt to silty sand soils are likely to be encountered to significants depths up to a minimum of 8.1 m at location of Borehole 3, while, these soils are expected to be underlain by silty sand till soils at a depth of about 1.5 m below existing grade at Borehole 9 location. As previously noted, till soils were found to be in a damp to moist condition.

The topsoil and disturbed native materials are considered to be unsuitable for the support of the foundations. The undisturbed native silt to silty sand soils or underlying silty sand till soils will be suitable for the support of the proposed house foundations. The borings encountered disturbed native materials extending to depths of about 0.8 m to 1.5 m below existing grades.

5.1.1 Foundations on Native Soils

It is anticipated that the proposed townhouses and the single family home would include basements. A net geotechnical reaction of 100 kPa (Serviceability Limit States, SLS), and a factored geotechnical resistance of 150 kPa at Ultimate Limit States, (ULS), may be used for the design of conventional strip footings supported on undisturbed silt to silty sand alluvial sand deposits, while a net nominal geotechnical reaction of 150 kPa (Serviceability Limit States, SLS), and a factored geotechnical resistance of 225 kPa at Ultimate Limit States, (ULS), may be used for the design of conventional strip footings supported on underlying undisturbed native till soils, placed at least 0.3 m into the competent undisturbed native strata.

The minimum foundation width to be used in conjunction with the above bearing pressure shall be 500 mm, and the minimum size of individual column footings shall be 1000 mm x 1000 mm. The footing sizes for housing and small buildings are stipulated in the Ontario Building Code (2006), Division B, Part 9, and must be followed.

5.1.2 Foundations on Engineered Fill

Although a final grading plan was not available at the time of preparation of this report, it is understood that construction of engineered fill may be required to raise the ambient grades at some of the low lying areas of the site.

The engineered fill refers to earth fill designed and constructed with the full-time inspection and testing, so as to support the building foundations without excessive settlement. Construction of engineered fill should only be conducted under the full-time engineering guidance and supervision.

Prior to the placement of the engineered fill, it is recommended that the topsoil and/or existing earth fill/disturbed native materials be stripped from beneath and beyond the proposed foundation envelopes (minimum of 2 m beyond), and that the subgrade be proof-rolled. Any soft or wet areas which deflect excessively during proof rolling, should be sub-excavated and replaced with suitably compacted clean earth fill in lifts of 150 mm or less. It should be noted that due to the presence of very moist to wet cohesionless soils (silt, sand), suitable subgrade stabilization measures may be required prior to the placement of engineered fill. Therefore, the subgrade must be evaluated by a qualified geotechnical engineer prior to the engineered fill placement to establish the requirement and to provide pertinent recommendations for the subgrade stabilization if required.

The engineered fill should consist of clean earth, free from any organic or deleterious matter. Some of the existing earth fill / disturbed native materials may be utilized as engineered fill provided the soils are not too wet for efficient compaction or do not contain excessive organic or topsoil materials. It must be noted that the transitional zone of the topsoil and the underlying earthfill / disturbed native materials (upper 0.3 m to 0.5 m of the earth fill/disturbed native stratum) typically contains relatively higher amounts of organic and topsoil inclusion and in-situ moisture content. Consequently, it would be prudent that the selection and sorting of the existing earthfill/disturbed native materials be supervised carefully on a full time basis to evaluate and allow reuse of only suitable existing earth fill/disturbed native materials as engineered fill, while, the remainder of the materials containing excessive amounts of organics could either be discarded or used for landscaping purposes. The native soils in general, can be utilized as engineered fill provided the soils are not too wet for efficient compaction and/or do not contain excessive organic inclusion. However, it should be noted that native soils excavated below the water table are likely be too wet to compact adequately. These soils may be left to dry or tilled with drier soils to reduce their water content to acceptable limits (±3 percent of optimum), otherwise these soils may be discarded and replaced with approved clean earthfill or granular materials which could be compacted to specified densities.

The engineered fill materials should be placed in lifts of 150 mm or less, and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). The engineered fill should extend for a distance of at least 2 m beyond the perimeter of the foundation envelopes as measured at the founding level, and should extend downwards from this point at a 1 to 1 (horizontal to vertical) slope, to the original ground. In addition, the fill should extend to an elevation of at least 0.6 m above the proposed founding level. This is to ensure that the foundations are placed on the engineered fill both in plan and elevation. The engineered fill must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate frost protection.

The placement and inspection of the engineered fill must be conducted under the full time supervision of a qualified geotechnical engineer. Provided the engineered fill is placed and compacted as indicated above, a maximum net geotechnical reaction of 150 kPa at Serviceability Limit States (S.L.S.) and a factored geotechnical resistance of 225kPa at Ultimate Limit States (U.L.S.) may be utilized for the design of conventional spread footing foundations supported on engineered fill, placed at least 0.3 m into the engineered fill strata. The proposed grading plans should be reviewed by Terraprobe to better assess the suitability and requirements for engineered fill.

In case of footings supported on engineered fill, the minimum width for the conventional spread strip footing must be 600 mm, and the minimum size of the individual column footing must be 1000 mm x 1000 mm, regardless of loading considerations.

It should be noted that for houses placed on engineered fill, nominal reinforcing steel is recommended in the foundation walls as well as in column foundations. The reinforcing steel should consist of two (2) continuous 15 M bars at the top of the foundation wall and two (2) continuous 15 M bars at the bottom (refer to the enclosed Figure - Typical Foundation Wall Details for Structures on Engineered Fill). A copy of "Engineered Fill Earthworks Specifications" is enclosed in the appendix section of this report for reference purposes. These specifications should be included in the earthworks contract.

5.1.3 Placement of Footings and Floor Slab

All foundations exposed to freezing temperatures must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation. However, it is anticipated that foundations placed on the competent native soils could result in deeper footings for the structures (i.e., greater than minimum depth required for frost protection).

It is also recommended that all excavated footing bases must be evaluated by a qualified geotechnical engineer to ensure that the founding soils exposed at the excavation base are consistent with the design bearing pressure intended by the geotechnical engineer.

It should be noted that due the presence of very moist to wet cohesionless soils (silt, sand), the excavated footing subgrade likely to become unstable due to disturbance by construction activities. Therefore, a layer of granular material or clear stone may be required to stabilize the exposed footing subgrades. Further, foundation subgrade which remain open for an extended period of time should be protected by a skim coat of lean concrete.

Prior to pouring concrete for the footings, the footing areas should be cleaned of all deleterious materials such as topsoil, fill, softened, disturbed or caved materials, as well as any standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

Concrete floor slabs should be placed on at least 150 mm of granular base (OPSS Granular "A" or 19 mm crusher run limestone) compacted to a minimum of 95 percent Standard Proctor Maximum Dry Density (SPMDD). Prior to the placement of the granular materials, the subgrade should be assessed by a geotechnical engineer or its representative. Any incompetent subgrade areas as identified must be subexcavated and backfilled with suitable compacted clean earth fill materials. Similarly, any soft or wet areas should also be subexcavated and be backfilled with suitably compacted clean earth fill. The granular fill base should be placed either on the undisturbed native subgrade or clean earth fill compacted to at least 95 percent SPMDD.

5.2 Excavations and Ground Water Control

The borehole data indicate that earthfill/disturbed native materials and native soils would be encountered in the excavations. Excavations must be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. These regulations designate four broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

a. is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b. has a low natural moisture content and a high degree of internal strength;
c. has no signs of water seepage; and
d. can be excavated only by mechanical equipment.

TYPE 2 SOIL

a. is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b. has a low to medium natural moisture content and a medium degree of internal strength; and
c. has a damp appearance after it is excavated.

TYPE 3 SOIL

a. is stiff to firm and compact to loose in consistency or is previously-excavated soil;
b. exhibits signs of surface cracking;
c. exhibits signs of water seepage;
d. if it is dry, may run easily into a well-defined conical pile; and
e. has a low degree of internal strength

TYPE 4 SOIL

a. is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b. runs easily or flows, unless it is completely supported before excavating procedures;
c. has almost no internal strength;
d. is wet or muddy; and
e. exerts substantial fluid pressure on its supporting system.

The earthfill/disturbed native materials; and native silt and sand soils encountered in the boreholes will be classified as Type 3 Soil above and Type 4 Soil below the prevailing groundwater level, while the undisturbed native silty sand till soils encountered at the site would be classified as Type 2 Soil above and Type 4 Soil below the prevailing groundwater level, under these regulations.

Where workmen must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates maximum slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Maximum Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

It should be noted that the native soils, especially the glacial till deposit may contain larger particles (cobbles and boulders) that are not specifically identified in the borehole logs. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples of the particles of this size. Provision should be made in excavation contracts to allocate risks associated with time spent and equipment utilized to remove or penetrate such obstructions when encountered.

Based on the borehole data and the piezometer readings, it is anticipated that there will be ground water seepage into the excavations. Further, deeper excavations required for the underground sanitary and storm sewers are likely to experience significant amount of ground water seepage. Any, water seepage into the shallow excavations can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation, however, it must be noted that deeper excavations extending to depths of greater than 0.3 m below the water table in silt and sand (cohesionless) soils, will likely require rigorous seepage control measures. For excavations which are extended to depths of greater than 0.3 m below the water table, it will be necessary to lower the ground water level below the excavation base prior to construction, and to maintain that level during the construction period. Ground water control by such methods as pumping from well points around the perimeter of the excavation, prior to construction, may be required depending upon the depth of excavation. Excavations carried below the water table in cohesionless soil (silt, sand, etc.) will experience loosening and sloughing of the base and sides, requiring slightly wider trenches, unless the ground water level is lowered first. A professional dewatering contractor should be consulted once the invert levels of the underground services are established to assess appropriate ground water control measures (if applicable). Dewatering of more than 50,000 litres/day would require a permit from the Ministry of Environment.

It is understood that the base of some of the manholes may be located below the water table. Therefore, it is recommended that the manholes be designed to resist uplift pressure from an assumed water level at the ground surface. The water level can temporarily rise to close to the ground surface during the times of heavy precipitation and spring melt. A nominal bearing capacity of 100 kPa is recommended for manhole foundation bases. Due to the likelihood of variable soil and ground water conditions across the site, it is recommended that the bearing capacity of the excavated base be confirmed by a qualified geotechnical engineer at the time of construction.

5.3 Lateral Earth Pressure

Walls or bracings subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$\mathbf{P = K [\gamma (h-h_w) + \gamma' h_w + q] + \gamma_w h_w}$$

where:

$\mathbf{P}$ = the horizontal pressure at depth, **h** (m)

$\mathbf{K}$ = the earth pressure coefficient,

$\mathbf{h_w}$ = the depth below the ground water level (m)

γ = the bulk unit weight of soil, (kN/m^3)

γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)

$\mathbf{q}$ = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, this equation can be simplified to:

$$\mathbf{P = K[\gamma h + q]}$$

This equation assumes that free-draining granular backfill is used and positive drainage is provided to ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure.

Resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact **(N)** and the frictional resistance of the soil **(tan ϕ)** expressed as **$R = N \tan \phi$**. This is an ultimate resistance value and does not contain a factor of safety.

Passive earth pressure resistance is generally not considered as a resisting force against sliding for conventional retaining structure design because a structure must deflect significantly to develop the full passive resistance.

The average values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follow:

Parameter	Definition	Units
ϕ	internal angle of friction	degrees
γ	bulk unit weight of soil	kN/ m^3
K_a	active earth pressure coefficient (Rankin)	dimensionless
K_o	at-rest earth pressure coefficient (Rankin)	dimensionless
K_p	passive earth pressure coefficient (Rankin)	dimensionless

Stratum/Parameter	ϕ	γ	K_a	K_o	K_p
Undisturbed Native Silt/Sandy Silt/Silty Sand	30	20.0	0.33	0.50	3.00
Undisturbed Native Silty Sand Till	32	21.5	0.30	0.47	3.25
Sandy Silt or Similar Fill	30	19.5	0.33	0.50	3.00
Compact Granular Fill	32	21.0	0.30	0.47	3.25

5.4 Backfill

As noted previously, the transitional zone of the topsoil and the underlying earthfill/disturbed native materials (upper 0.3 m to 0.5 m of the earthfill/disturbed native stratum) typically contain relatively higher amounts of organic and topsoil inclusion. Therefore, it is recommended that the selection and sorting of the existing earthfill/disturbed native materials must be supervised carefully on a full time basis to evaluate and allow reuse of only suitable existing earthfill/disturbed native materials as trench backfill or engineered fill. The earthfill/disturbed native materials which contain excessive amounts of topsoil and/or organic and/or exhibit a higher in-situ moisture content should not be reused as engineered fill, or backfill in settlement sensitive areas, such as trench backfill, beneath floor slabs and pavements. However, this material may be stockpiled and reused for landscaping purposes.

Further, it must be noted that native soils excavated below the water table are likely to be too wet to compact. Any soil materials with in-situ moisture content of more than 3 percent above the optimum moisture content could be put aside to dry, or could be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and be replaced with imported material which can be readily compacted. The glacial till and earthfill materials will be best compacted with a heavy sheepsfoot type roller.

It should be noted that the site soils are generally not free draining, and will be difficult to handle and compact should they become wetter as a result of inclement weather or seepage. Hence, it can be expected that earthworks will be difficult during the wet periods (i.e., spring and fall) of the year and may result in increased earthwork costs.

5.5 Pipe Bedding

The undisturbed native materials will be suitable for support of buried services on conventional well graded granular base material. Where disturbance of the trench base has occurred, such as due to ground water seepage, or construction traffic, the disturbed soils should be subexcavated and replaced with suitably compacted granular fill.

Granular bedding material should consist of a well graded, free draining soil, such as OPSS Granular “A” or 19 mm Crusher Run Limestone. These materials should be compacted to a minimum of 95 percent SPMDD.

A clear stone type bedding may be considered where sand or silt subgrades are encountered but only in conjunction with a suitable geotextile filter. Otherwise without proper filtering, there may be entry of fines from the native soils into the bedding. This loss of ground could result in loss of support to the pipes and possible future settlements. Where the trench base consists of clayey soils, a geotextile filter is not required. It should be noted that in case of an unstable subgrade, additional granular bedding thickness or other suitable subgrade stabilization measures may be required as deemed necessary based on the site assessment.

If the invert of the trench is below the water table and local drawdown of the groundwater level cannot be tolerated for environmental reasons then clay plugs should be installed within the granular bedding and the granular zones of backfill material to help prevent migration of the ground water along the relatively free draining bedding material and/or backfill material due to the “French Drain” effect.

Clay plugs should be placed in the trenches at 50 m intervals (or less) along the full length of the trench, where the invert of the trench is below the water table. The plug should be at least 1.0 m thick measured along the pipe, and should completely replace the granular bedding and relatively pervious (sand, granular) backfill. The clay plugs must be compacted to a minimum of 95 percent SPMDD. The clay plug material should have a coefficient of permeability less than 10^{-6} cm/s and must include a minimum of 15 percent clay (finer than 0.002 mm) and 30 percent silt sized (finer than 0.08 mm, i.e., passing No. 200 sieve) particles. The backfill material must not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.8 mm size (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots or topsoil.

Alternatively, concrete cut-off collars can be installed around the pipe barrel to achieve the same effect. Collars should not be placed closer than 1.0 m to a pipe joint and precautions should be taken to ensure that a minimum of 95 percent compaction is achieved around the collars. Watertight connections are required between the collar and the pipe wall. The trench backfilling operations should be carried out with materials that are similar to the materials that have been excavated. In particular, the sand zones must not be truncated by backfilling of the trench using lower permeability materials.

5.6 Basement Drainage

To assist in maintaining basements dry from seepage, it is recommended that exterior grades around the buildings be sloped away at a 2 percent gradient or more, for a distance of at least 1.2 m. As well, perimeter foundation drains should be provided, consisting of perforated pipe surrounded by a granular filter (minimum 150 mm thick), and freely outletting. The granular filter should consist of OPSS HL 8 Coarse Aggregate (refer to enclosed Figure - Basement Drainage Detail).

The basement wall must be provided with damp-proofing provisions in conformance to the Section 9.13.2 of the Ontario Building Code (2006). The basement wall backfill for a minimum lateral distance of 0.6 m out from the wall should consist of free-draining granular material (OPSS 1010 Granular 'B'), or provided with a suitable alternative drainage cellular media.

Apart from the above recommended perimeter drainage, the provision of a sub-floor drainage system installed beneath the basement floor is also recommended. The sub-floor drainage system may consist of perforated pipes located at a distance of about 3 m centre to centre (refer to the enclosed drawing - Basement Drainage Detail). The perimeter foundation drains and the sub-floor drains may be outlet to municipal sewer under gravity flow (if allowed), or to the exterior of the house under gravity provided adequate cross-fall is available to facilitate such drainage.

The size of the sump pit should be adequate to accommodate the water seepage. Further, the sub-floor drainage system should be adequately designed to prevent the possibility of back-flow.

A duplex pumping arrangement (main pump with a provision of a backup pump) on emergency backup power is recommended. The pumps should have sufficient capacity to accommodate a maximum peak flow of water of about 4 to 5 gallons per minute. This flow is not anticipated to be a sustained flow but could be achieved under certain conditions. The perimeter and sub-floor drain installation and outlet provisions must conform to the plumbing code requirements.

5.7 Pavement Design

The pavement subgrade in the proposed subdivision is expected to consist of native materials or clean earth fill compacted to a minimum of 98 percent SPMDD.

The earthfill/disturbed native materials encountered on the site may be utilized as subgrade provided they do not contain excessive organics and deleterious materials and their in-situ moisture content is within three (3) percent of its optimum moisture content. The pavement subgrade should be proof-rolled with a heavy rubber tire vehicle (such as a grader) and any loose, soft, wet or unstable areas should be sub-excavated, and then backfilled with clean earth materials placed in 150 mm lifts and compacted to a minimum of 95 percent SPMDD. The upper 1.2 m thick zone of the pavement subgrade backfill should be compacted to a minimum of 98 percent SPMDD.

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions and for the design traffic loadings. The following flexible pavement thickness is recommended on the above noted subgrade condition basis:

MATERIAL	COMPACTION REQUIREMENTS	MINOR LOCAL ROAD / FIRE ROUTE MINIMUM COMPONENT THICKNESS (mm)
Surface Course - HL3 Asphaltic Concrete (OPSS 1150 and pertinent Town Specifications)	as per OPSS 310	40
Binder Course - HL8 Asphaltic Concrete (OPSS 1150 and pertinent Town Specifications)	as per OPSS 310	65
Base Course: Granular “A” or 19 mm Crusher Run Limestone (OPSS 1010 and Pertinent Town Specifications)	100% Standard Proctor Maximum Dry Density	150
Subbase Course: Granular “B” or 50 mm Crusher Run Limestone (OPSS 1010 and Pertinent Town Specifications)	100% Standard Proctor Maximum Dry Density	300

The granular materials should be placed in lifts 150 mm thick or less, and compacted to a minimum of 100 percent SPMDD for granular base and granular sub-base. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS Forms 310, 501, 1010, 1101 and 1150 and pertinent Town specifications. Town and other applicable specifications should be referred for use of higher grades of asphalt cement (PGAC 64-28) for asphaltic concrete where applicable.

The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum grade of 2 percent) to provide effective drainage toward subgrade drains. Grading adjacent to the pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement. Continuous pavement subdrains should be provided along both sides of the roadway and drained into respective catchbasins to facilitate drainage of the subgrade and granular materials. The subdrain invert should be maintained at least 0.3 m below subgrade level (refer to the enclosed Figure - Pavement Drainage Alternatives).

The above pavement design thicknesses are considered adequate for the design traffic. However, if the pavement construction occurs in wet, winter or inclement weather; it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular sub-base, base or both. Traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.

It should be noted that in addition to the adherence to the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

5.8 Site Regrading Considerations

We understand that there will be some regrading (cut and fill) in some areas to facilitate the proposed development. It is understood that the proposed grading would be 3 horz. to 1 vert. or flatter; therefore, may be carried out safely and the re-graded areas (proposed grading, post-development condition) are considered to be stable.

As noted before, it is proposed to construct two small (about 0.9 m high) retaining walls near the northeast and southwest corners of the proposed townhouse development area (behind Buildings 3 and 4) to facilitate minor grade separation.

Boreholes 8 and 9 were located relatively close to the proposed retaining walls. These borehole encountered a surficial layer of topsoil underlain by a zone of weathered/disturbed soils extending to depths of about 0.8 to 1.5 m below grade. The weathered/disturbed soils were further underlain by competent native soils extending to the full depth of investigation (about 5.0 m below grade).

The details of the retaining wall design are not available at the time of preparation of this report, however it is understood that the proposed retaining wall would be designed by others. The topsoil and disturbed native materials are considered to be unsuitable for the support of the retaining wall foundations. The undisturbed native silt to sandy silt/sand soils or underlying silty sand till soils will be suitable for the support of the proposed retaining wall foundations. A net nominal geotechnical reaction of 100 kPa (Serviceability Limit States, SLS), and a factored geotechnical resistance of 150 kPa (Ultimate Limit States, ULS) are recommended for the design of retaining wall foundations supported on the underlying undisturbed native silt to sandy silt/sand soils or underlying silty sand till. Higher geotechnical resistance values may be available and can be analyzed based on the final design specific details, if required. All foundations should be designed to bear at least 0.3 m into the underlying undisturbed stratum. The wall must be provided with positive drainage.

It is recommended that the wall foundation base must be evaluated by a qualified geotechnical engineer to ensure that the founding soils exposed at the excavation base are consistent with the design bearing pressure intended by the geotechnical engineer. The wall footing subgrade should be cleaned of any softened, wet, loose, disturbed or caved materials, as well as any standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the foundation subgrade must be provided.

6. LIMITATIONS AND USE OF REPORT

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in strict accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions.

The discussion and recommendations are based on the factual data obtained from the investigation and are intended for use by the owner and its retained designers in the design phase of the project. Since the project is still in the design stage, all aspects of the project relative to the subsurface conditions cannot be anticipated. Terraprobe should review the design drawings and specifications prior to the construction of this work. If there are changes to the project scope and development features; the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant to the revised project. Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

The original investigation at this site was conceived and executed to provide information for the project design only. It may not be possible to drill a sufficient number of boreholes, or samples and report them in a way that would provide all the subsurface information that could have an effect on construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on this project should therefore, in this light, be directed to decide on their own investigations, as well as their own interpretations of the factual investigation results. They should be cognizant of the risks implicit in subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

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It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

Yours truly,

Terraprobe Inc.

LICENSED PROFESSIONAL ENGINEER
B. SINGH
10-25-2013
PROVINCE OF ONTARIO

M Talukdar

Madan Talukdar, B.A.Sc., P. Eng.
Associate

B. Singh , M.A.Sc., P. Eng.
Principal

APPENDICES

TERRAPROBE INC.

Terraprobe

ABBREVIATIONS, TERMINOLOGY, GENERAL INFORMATION

BOREHOLE LOGS

SAMPLING METHOD

SS	split spoon
ST	Shelby tube
AS	auger sample
WS	wash sample
RC	rock core
WH	weight of hammer
PH	pressure, hydraulic

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.).

SOIL DESCRIPTION - COHESIONLESS SOILS

Relative Density	'N' value
very loose	< 4
loose	4 - 10
compact	10 - 30
dense	30 - 50
very dense	> 50

SOIL DESCRIPTION - COHESIVE SOILS

Consistency	Undrained Shear Strength, kPa	'N' value
very soft	< 12	< 2
soft	12 - 25	2 - 4
firm	25 - 50	4 - 8
stiff	50 - 100	8 - 16
very stiff	100 - 200	16 - 32
hard	> 200	> 32

SOIL COMPOSITION

	% by weight
'trace' (e.g. trace silt)	< 10
'some' (e.g. some gravel)	10 - 20
adjective (e.g. sandy)	20 - 35
'and' (e.g. sand and gravel)	35 - 50

TESTS, SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
ϕ'	angle of internal friction
c'	cohesion shear strength
C_c	compression index

GENERAL INFORMATION, LIMITATIONS

The conclusions and recommendations provided in this report are based on the factual information obtained from the boreholes and/or test pits. Subsurface conditions between the test holes may vary.

The engineering interpretation and report recommendations are given only for the specific project detailed within, and only for the original client. Any third party decision, reliance, or use of this report is the sole and exclusive responsibility of such third party. The number and siting of boreholes and/or test pits may not be sufficient to determine all factors required for different purposes.

It is recommended Terraprobe be retained to review the project final design and to provide construction inspection and testing.

PART 1 GENERAL

1.01 Description

Engineered Fill refers to earth fill (earthworks) designed and constructed with engineering inspection and testing, so as to be capable of supporting structure foundations without excessive settlement. Poured concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

Preparation for Engineered Fill and Engineered Fill operations must only be conducted under full time inspection and testing by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

The work for the construction of Engineered Fill, is shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section includes the following:

a) Stripping of the topsoil layer from the ground surface below all areas to be covered with Engineered Fill,

b) Excavation of Test Holes into the subgrade to investigate the suitability of subsurface conditions for support of the Engineered Fill and determine if any prior existing fill materials are present,

c) Proof-rolling of the subgrade below areas to be covered with Engineered Fill, to detect the presence and extent of unstable ground conditions,

d) Excavation and removal of unstable subgrade materials or other approved stabilization measures, if required prior to the placement of Engineered Fill,

e) Surveying of ground elevations prior to placing Engineered Fill,

f) Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,

g) Surveying of ground elevations on completion of Engineered Fill placement,

h) Providing and maintaining survey lay out of areas to receive Engineered Fill, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.02 The Project Parties

A) The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of Engineered Fill.

B) The term Geotechnical Engineer shall refer to the individual or firm who will be carrying out the full time inspection and testing of the earthworks related to preparation and construction of Engineered Fill.

C) The term Design Civil Engineer shall refer to the individual or firm who will be carrying out the Site Grading Design (pre-grading), the determination of Design Foundation Grades for the structures on the site, and the choice of lots and site areas to receive Engineered Fill.

PART 2 MATERIALS

2.01 Definitions

A) Topsoil Layer is the surface layer of naturally organic soil typically found at the ground surface and commonly with thickness on the order of 100 to 300 mm thick.

B) Earth fill is soil material which has been placed by man-made effort and has not been deposited by nature over a long period of time.

C) Subgrade soil is the "in situ" (in place) natural or native soil beneath any earth fill and/or topsoil layer(s).

D) Engineered Fill soils must consist of clean earth materials (not excessively wet), free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials, placed in thin lifts not exceeding 150 mm in thickness. Cohesionless soils such as sand or gravel, are the easiest to handle and compact.

E) All values stated in metric units shall be considered as accurate.

PART 3 ENGINEERED FILL DESIGN

3.01 Design Foundation Pressure

A) Engineered Fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered Fill. The time period over which this settlement typically occurs, depends on the composition of the Engineered Fill as follows (after initial placement);

a) sand or gravel soil;	several days
b) silt soil;	several weeks
c) clay or clayey soil;	several months.

The placement of Engineered Fill might also result in post-construction settlement of the underlying natural soil.

The timing of foundation construction must take into account the post-construction settlement of the Engineered Fill and the foundation soil.

B) Unless otherwise stated, the Engineered Fill is to be placed over the entire lot area or site area.

C) The Engineered Fill is to extend up to at least 1 m above the highest level of required foundation support. Typically this can be within 1 m of the design final grades. Additional common fill can be placed over the Engineered Fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

D) An allowable design foundation pressure of 150 kPa is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.6 m for continuous strip footings, and minimum dimensions of 1 m for column footings.

E) At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.

F) Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for stiffening of basement foundation walls and for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.

G) At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,

  a) placement of footing concrete, and
  b) placement of foundation wall concrete.

PART 4 CONSTRUCTION

4.01 Survey Layout

A) The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.

B) At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed.

C) The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Geotechnical Engineer.

D) The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.

E) On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.02 Topsoil Stripping

A) The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.

B) Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have been suitably stripped.

4.03 Test Holes Into Subgrade

A) After topsoil has been stripped, the exposed subgrade must be investigated for the presence of old buried fill or deleterious material, which may be unsuitable for the support of Engineered Fill.

B) Exploratory test holes must be dug using a small backhoe, on a suitable pattern to obtain a representative indication of the entire site area.

C) The Geotechnical Engineer must observe the digging and backfilling of the test holes; must log the test hole stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test hole.

D) If the test holes discover any old buried fill or deleterious materials, it must be excavated and removed from the lot area down to undisturbed, stable native soil.

E) All test holes must be properly backfilled and compacted in thin lifts (max. 150mm thickness) to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Geotechnical Engineer must observe the backfilling and compaction of the test holes.

4.04 Subgrade Proof-rolling

A) Prior to placing any Engineered Fill, the exposed subgrade must be proof-rolled and the Geotechnical Engineer must observe the proof-rolling.

B) If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.05 Engineered Fill Placement

A) Engineered fill must not be placed without the approval of the Geotechnical Engineer. Prior to placing any Engineered Fill, the topsoil must be stripped, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.

B) Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability. Samples of the proposed fill material must be obtained by the Geotechnical Engineer and tested in the geotechnical laboratory for Standard Proctor Maximum Dry Density, prior to approval of the material for use as Engineered Fill. The Engineered Fill must consist of clean earth, free of organics and other deleterious material (wood, building debris, rubble, cobbles, boulders, and the like).

C) The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.

D) Field density tests must be taken by the Geotechnical Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.

E) Engineered fill must not be placed during the period of the year when cold weather occurs, i.e. when there are freezing ambient temperatures during the daytime and overnight.

BOREHOLE LOGS

TERRAPROBE INC.

Terraprobe

LOG OF BOREHOLE 1

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments

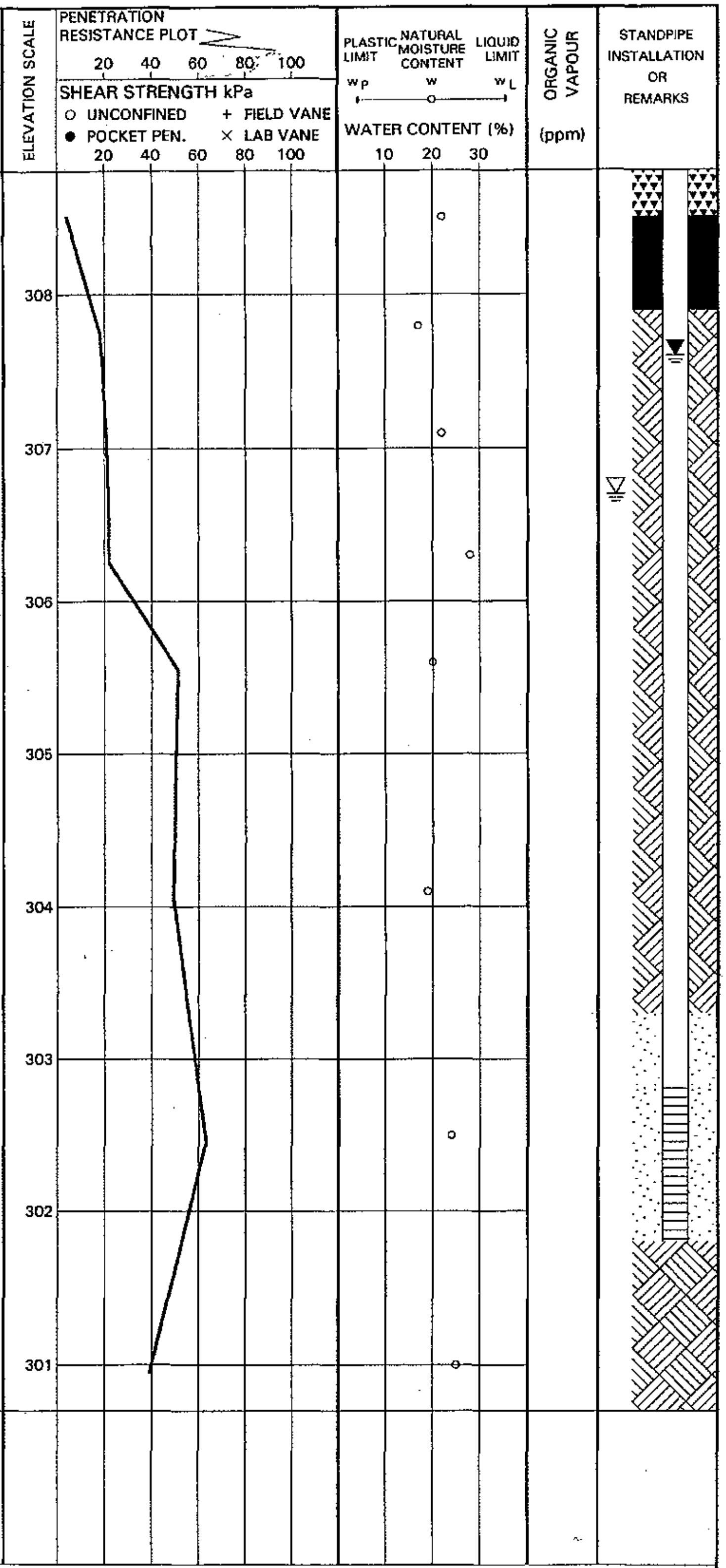
DATE: January 19, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
308.8	Ground Surface
0.0	**500mm Topsoil**
308.3 0.5	Sandy Silt to Silty Sand, trace clay & organics (DISTURBED NATIVE)
307.9 0.9	Compact to Dense Brown wet -- Silty Fine Sand -- locally very dense **SILT** trace to some clay & sand **TO** **SANDY SILT** trace to some clay -- grey -- locally very dense
300.7 8.1	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	4
2	SS	18
3	SS	21
4	SS	22
5	SS	51
6	SS	49
7	SS	63
8	SS	39



NOTES:
Borehole was caving at 7.0m and water level at 2.1m depth on completion of drilling. Water level in standpipe at 1.2m depth on January 29, 2001.

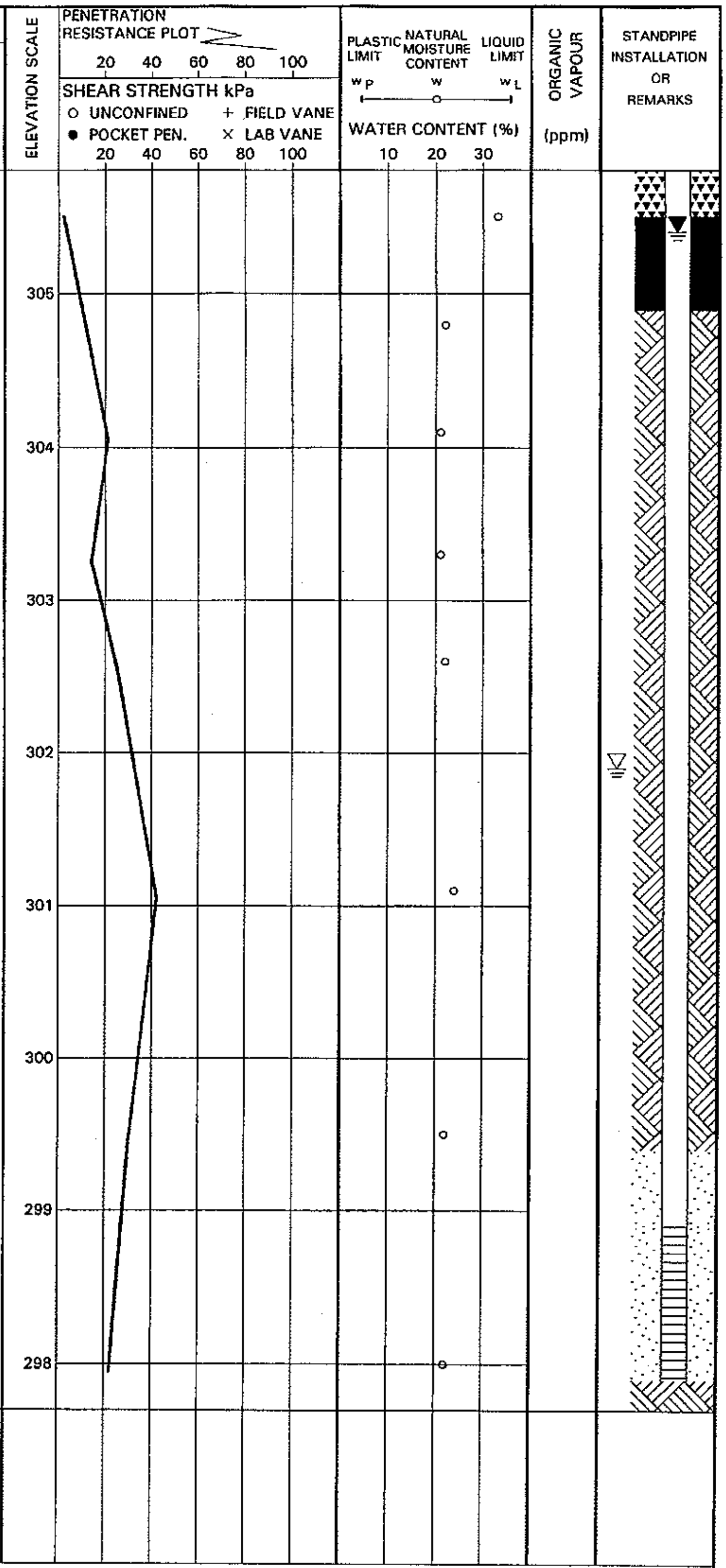
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 2

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 19, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES
305.8	Ground Surface			
0.0 305.4	**400mm Topsoil**	1	SS	2
0.4 304.9	Sandy Silt to Silty Sand, trace clay & organics (DISTURBED NATIVE)			
0.9	Compact to Dense Brown wet	2	SS	12
		3	SS	21
	-- grey	4	SS	14
	SILT trace to some clay & sand **TO** **SANDY SILT** trace to some clay	5	SS	25
299.7		6	SS	42
6.1 297.7	Compact Grey wet **SILTY SAND** trace clay **TO** **SAND** trace to some silt, trace clay	7	SS	30
		8	SS	22
8.1	End of Borehole			



NOTES:
Borehole was open and water level at 3.9m depth on completion of drilling. Water level in standpipe at 0.4m depth on January 29, 2001.

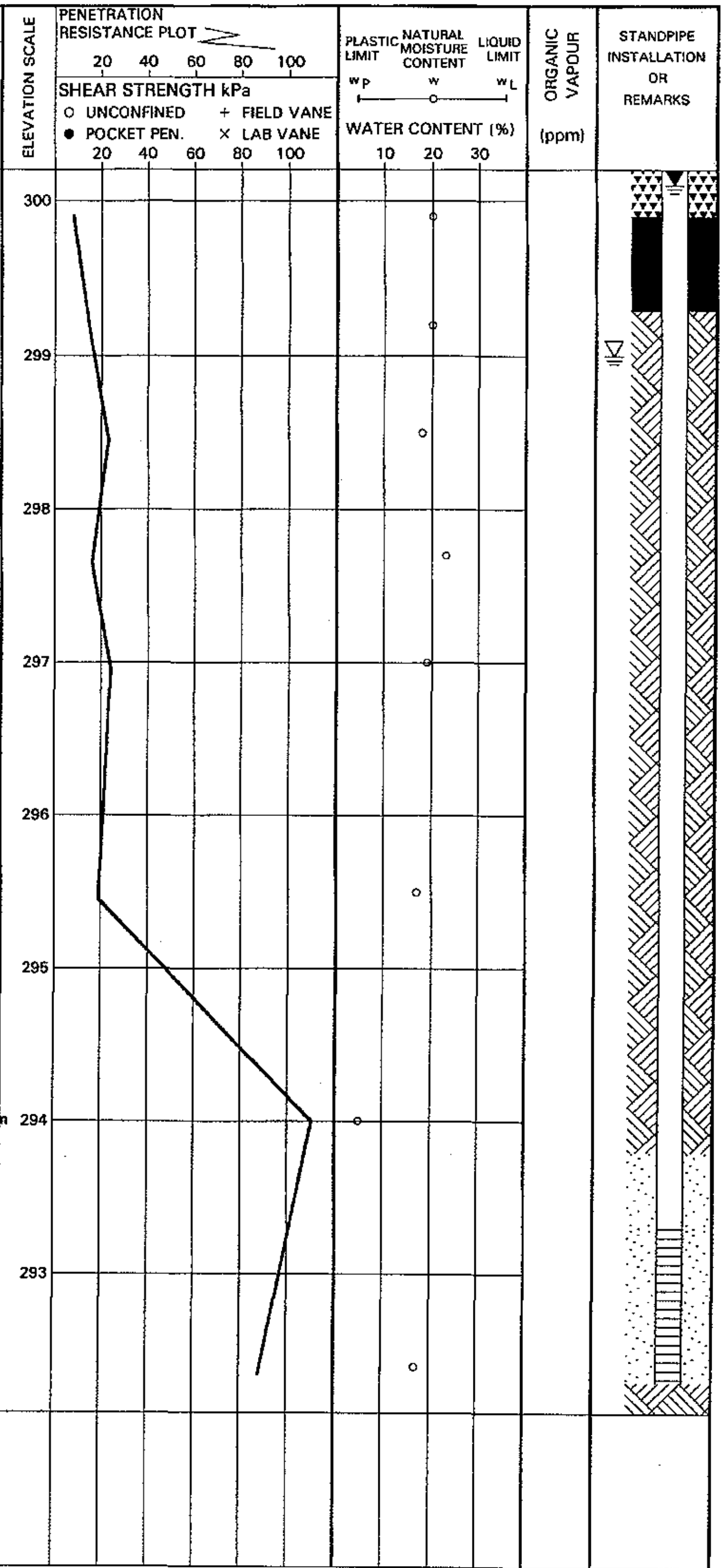
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 3

PROJECT: Proposed Residential Subdivision
DATE: January 19, 2001
LOCATION: Caledon East, Ontario
EQUIPMENT: Trackmount 6M2
CLIENT: Valley Grove Investments
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
300.2	Ground Surface			
0.0	**400mm Topsoil**	1	SS	8
299.8 0.4	Sandy Silt to Silty Sand, trace clay & organics (DISTURBED NATIVE)			
299.4 0.8	Compact Brown wet	2	SS	15
		3	SS	23
	-- grey	4	SS	16
	SILT trace to some clay & sand **TO** **SANDY SILT** trace to some clay	5	SS	24
		6	SS	19
294.1 6.1	-- coarse sand and gravel Dense to Very Dense Grey wet **SILTY SAND** trace clay **TO** **SAND** trace to some silt, trace clay	7	SS	50/15cm
		8	SS	88
292.1 8.1	End of Borehole			



NOTES:
Borehole was open and water level at 1.2m depth on completion of drilling. Water level in standpipe at 0.1m depth on January 29, 2001.

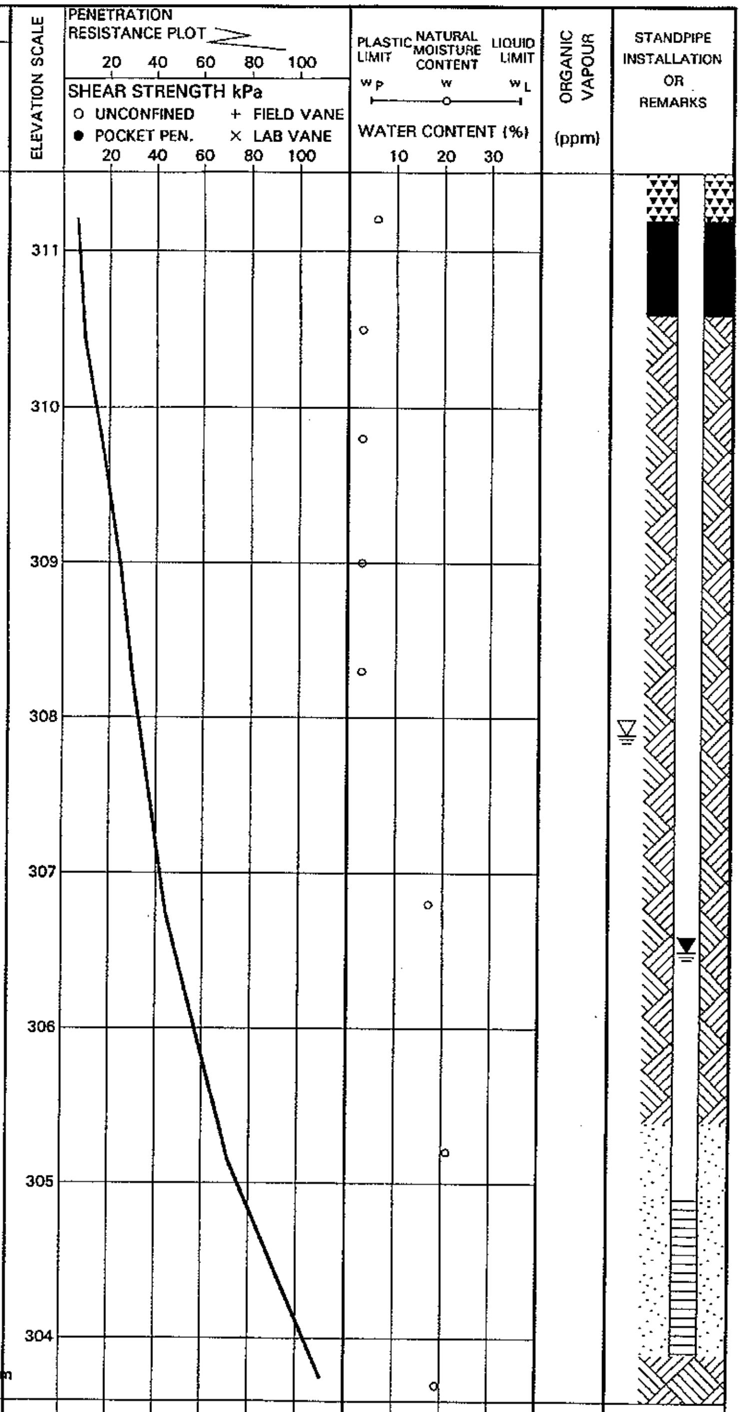
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 4

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 18, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
311.5	Ground Surface			
0.0	**300mm Topsoil**			
311.2 0.3	Loose Brown/Dark Brown moist Sand trace to some silt, trace clay and organics (DISTURBED NATIVE)	1	SS	6
		2	SS	9
310.4 1.1	Compact Brown damp **SAND** trace silt (Fine to Medium)	3	SS	17
		4	SS	25
		5	SS	30
306.9 4.6	Dense to Very Dense Brown wet **SILTY SAND** trace clay **TO** **SAND** trace to some silt, trace clay	6	SS	44
		7	SS	71
304.0 7.6	**SANDY SILT** trace clay	8	SS	50/10cm
303.6 7.9	End of Borehole			



NOTES:
Borehole was caving at 4.2m and water level at 3.6m depth on completion of drilling. Water level in standpipe at 5.0m depth on January 29, 2001.

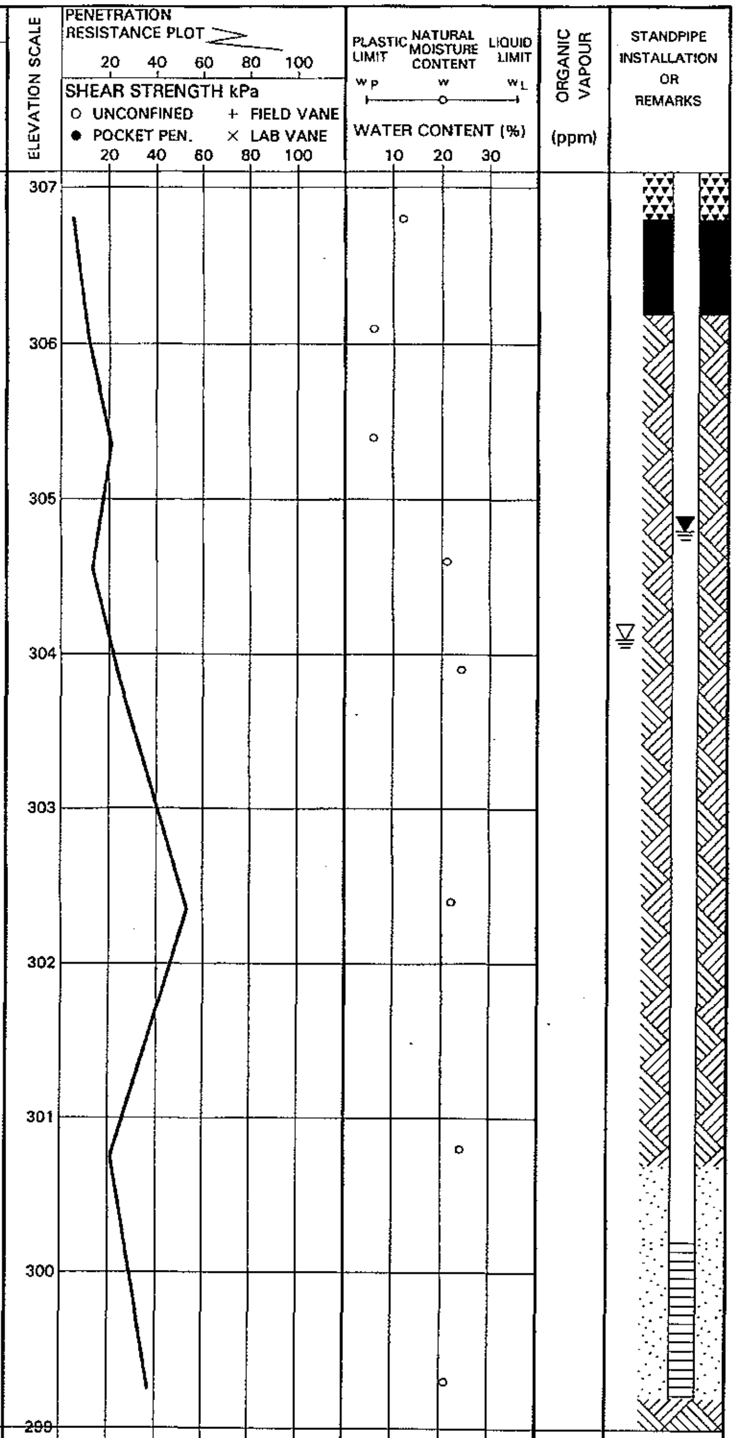
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 5

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 18, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES
307.1	Ground Surface			
0.0 306.6	500mm Topsoil	1	SS	5
0.5 305.6	Loose to Compact Brown to Dark Brown moist to very moist Sand trace to some silt, trace clay and organics (DISTURBED NATIVE)	2	SS	11
1.5 304.1	Compact Brown moist to wet **SAND** trace silt (Medium to Coarse)	3 4	SS SS	21 13
3.0	Compact to Dense Brown wet	5	SS	24
	-- locally very dense	6	SS	53
	SILT trace to some clay & sand **TO** **SANDY SILT** trace to some clay	7	SS	21
299.0	-- silty fine sand, wet	8	SS	37
8.1	End of Borehole			



NOTES:
Borehole was caving at 3.0m and water level at 2.1m depth on completion of drilling. Water level in standpipe at 2.3m depth on January 29, 2001.

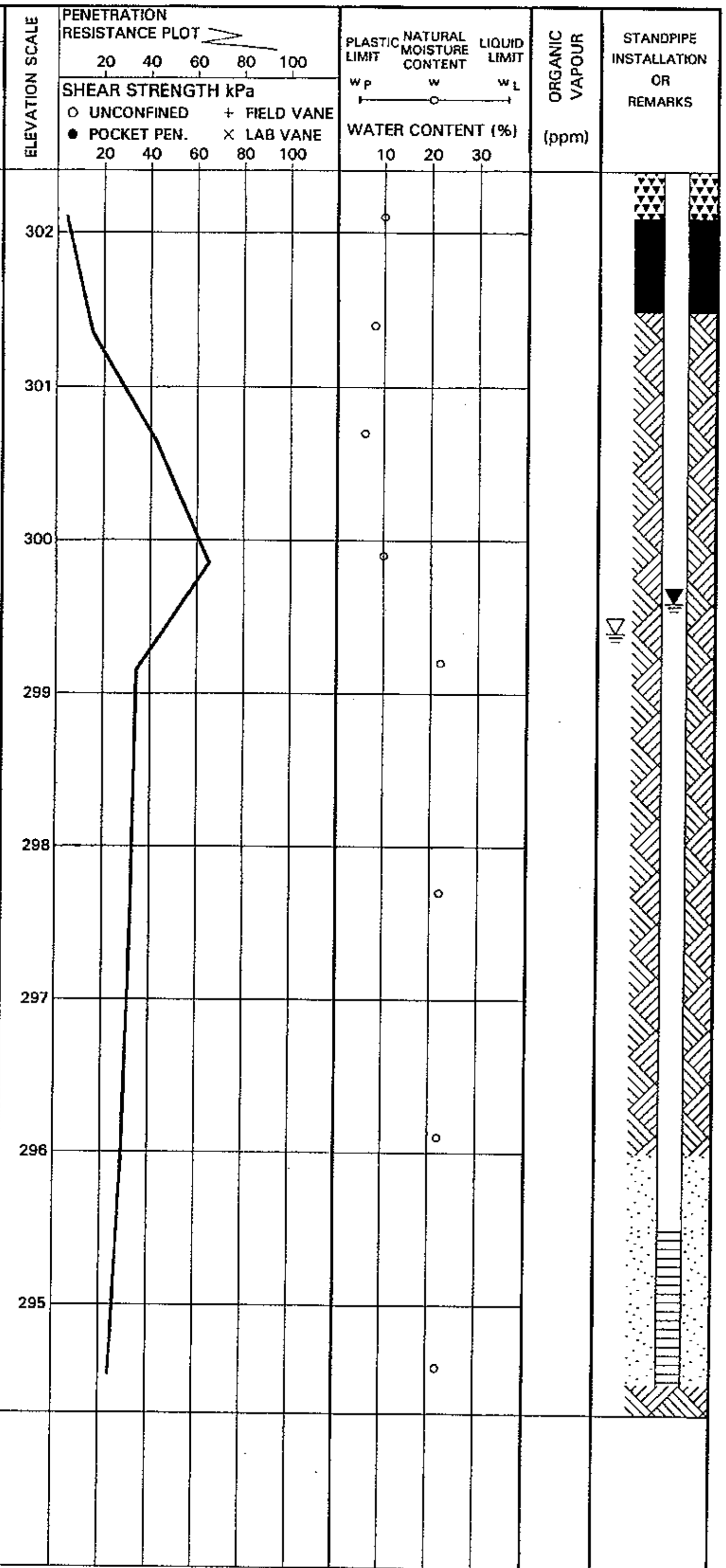
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 6

PROJECT: Proposed Residential Subdivision
DATE: January 18, 2001
LOCATION: Caledon East, Ontario
EQUIPMENT: Trackmount 6M2
CLIENT: Valley Grove Investments
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
302.4 0.0	Ground Surface 300mm Topsoil			
302.1 0.3	Loose moist Brown/Dark Brown Sand trace to some silt, trace clay and organics (DISTURBED NATIVE)	1	SS	4
301.5 0.9	Compact to Very Dense Brown moist **SAND** trace silt (Fine to Medium)	2	SS	15
		3	SS	42
		4	SS	65
299.4 3.0	Compact to Dense Brown wet **SILTY SAND** trace clay **TO** **SAND** trace to some silt, trace clay	5	SS	34
		6	SS	32
		7	SS	29
	– grey	8	SS	24
294.3 8.1	End of Borehole			



NOTES:
Borehole was open and water level at 3.0m depth on completion of drilling. Water level in standpipe at 2.8m depth on January 29, 2001.

Sheet 1 of 1

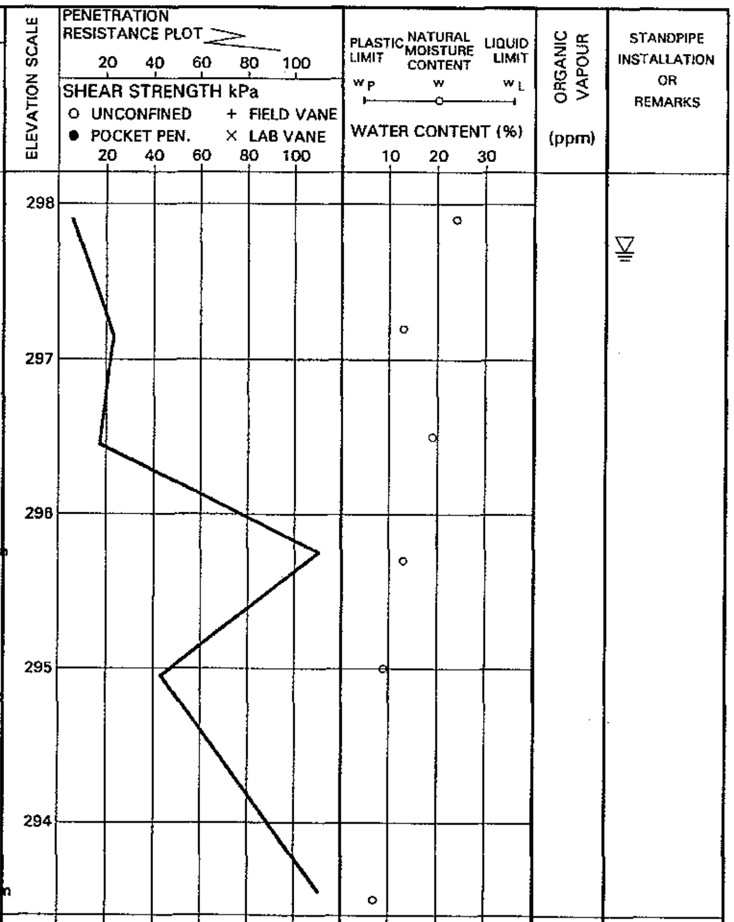
Terraprobe

LOG OF BOREHOLE 7

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 22, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

ELEV DEPTH	SOIL PROFILE DESCRIPTION
298.2	Ground Surface
298.0 0.0	**150mm Topsoil**
0.2	Loose wet Brown/Dark Brown Sand trace to some silt, trace clay and organics (DISTURBED NATIVE)
297.3 0.9	Compact wet Brown **SAND** trace silt (Fine to Medium)
295.9 2.3	Dense to Very Dense Brown/Grey moist **SILTY SAND** some gravel and clay **(TILL)**
293.4 4.8	End of Borehole

NUMBER	TYPE	"N" VALUES
1	SS	6
2	SS	23
3	SS	17
4	SS	50/8cm
5	SS	43
6	SS	50/10cm



NOTES:
Borehole was caving at 1.4m and water level at 0.5m depth on completion of drilling.

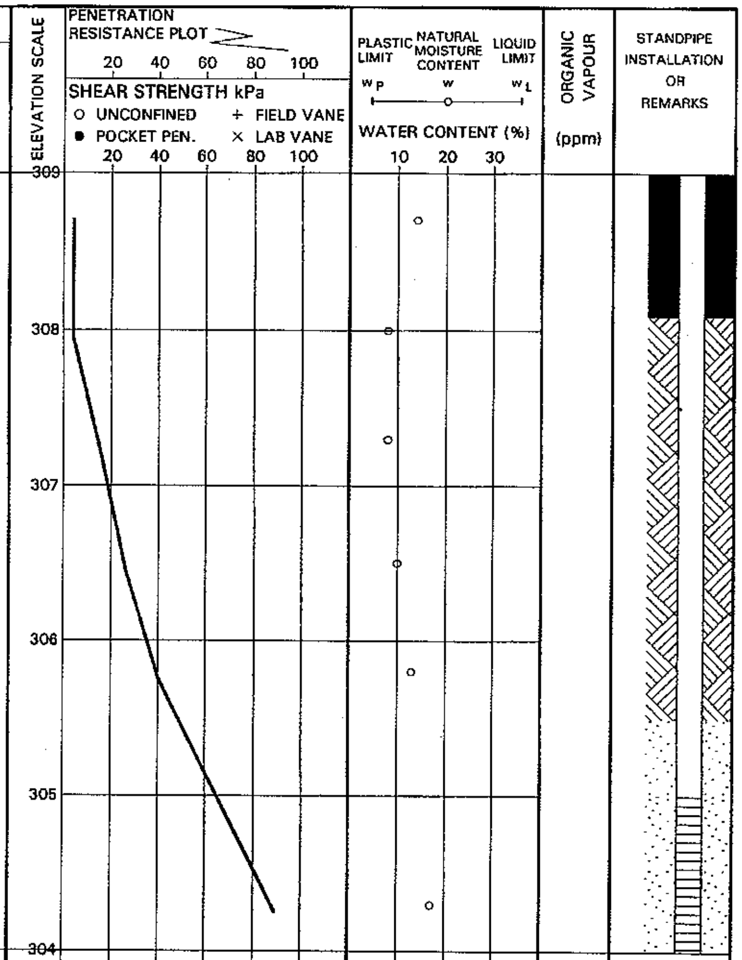
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 8

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 22, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
309.0	Ground Surface			
0.0 308.6	**350mm Topsoil**	1	SS.	4
0.4 307.5	Loose moist Brown/Dark Brown Sand trace to some silt, trace clay and organics (DISTURBED NATIVE)	2	SS	4
1.5	Compact to Dense Brown moist **SILT** trace to some clay & sand **TO** **SANDY SILT** trace to some clay	3	SS	15
		4	SS	26
		5	SS	40
304.0	– grey, locally very dense	6	SS	89
5.0	End of Borehole			



NOTES:
Borehole was open and dry on completion of drilling. Standpipe dry on January 29, 2001.

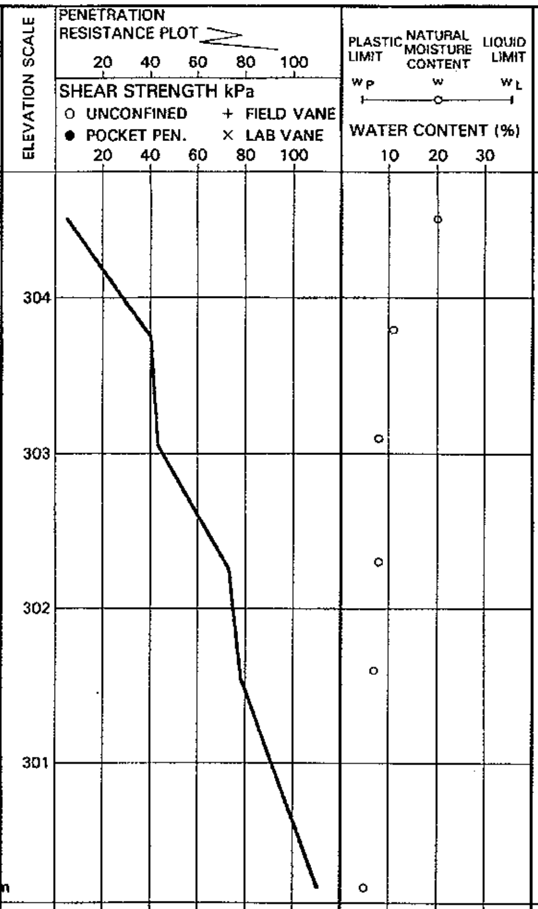
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 9

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 22, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE		SAMPLES			ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES		
304.8	Ground Surface					
0.0	350mm Topsoil	1	SS	5		
304.4 0.4	Sandy Silt to Silty Sand, trace clay & organics (DISTURBED NATIVE)					
304.0 0.8	Dense Brown very moist **SAND** trace silt (Medium to Coarse)	2	SS	40		
303.3 1.5	Dense to Very Dense Brown/Grey moist **SILTY SAND** some gravel and clay **(TILL)**	3	SS	43		
		4	SS	73		
		5	SS	78		
300.1		6	SS	50/13cm		
4.7	End of Borehole					



NOTES:
Borehole was open and dry on completion of drilling.

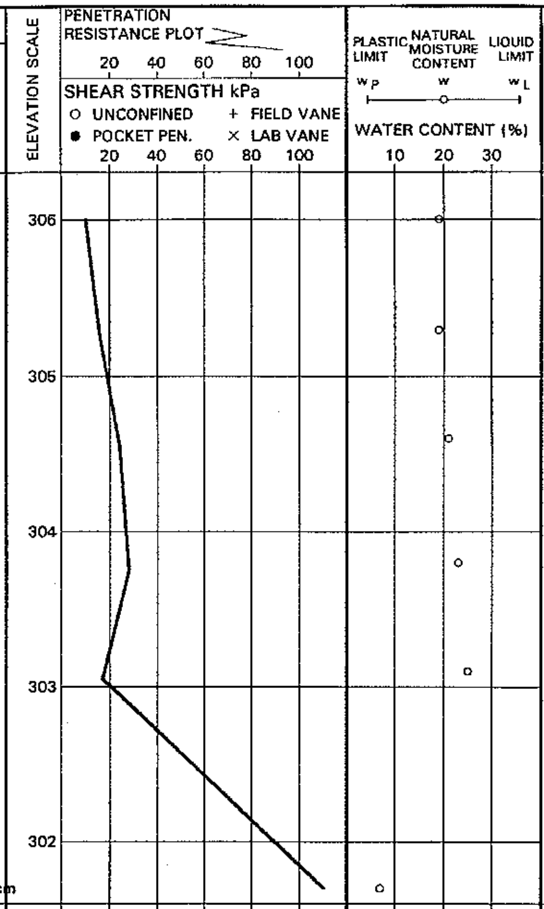
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 10

PROJECT: Proposed Residential Subdivision
LOCATION: Caledon East, Ontario
CLIENT: Valley Grove Investments
DATE: January 22, 2001
EQUIPMENT: Trackmount 6M2
ELEVATION DATUM: Geodetic
FILE: 01109

SOIL PROFILE			SAMPLES			ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		
306.3	Ground Surface						
0.0 306.0	**300mm Topsoil**		1	SS	10		
0.3	Compact wet Brown/Dark Brown Sandy Silt to Silty Sand, trace clay & organics (DISTURBED NATIVE)						
305.4 0.9	Compact Brown wet **SILTY SAND** trace clay **TO** **SAND** trace to some silt, trace clay		2	SS	16		
			3	SS	24		
			4	SS	28		
			5	SS	17		
301.8 4.6	**SILTY SAND TILL**		6	SS	50/15cm		
301.6 4.7	End of Borehole						



NOTES:
Borehole was caving at 2.4m depth and dry on completion of drilling.

LAB RESULTS

Terraprobe Limited

Terraprobe

SIEVE AND HYDROMETER ANALYSIS
REPORT FORM

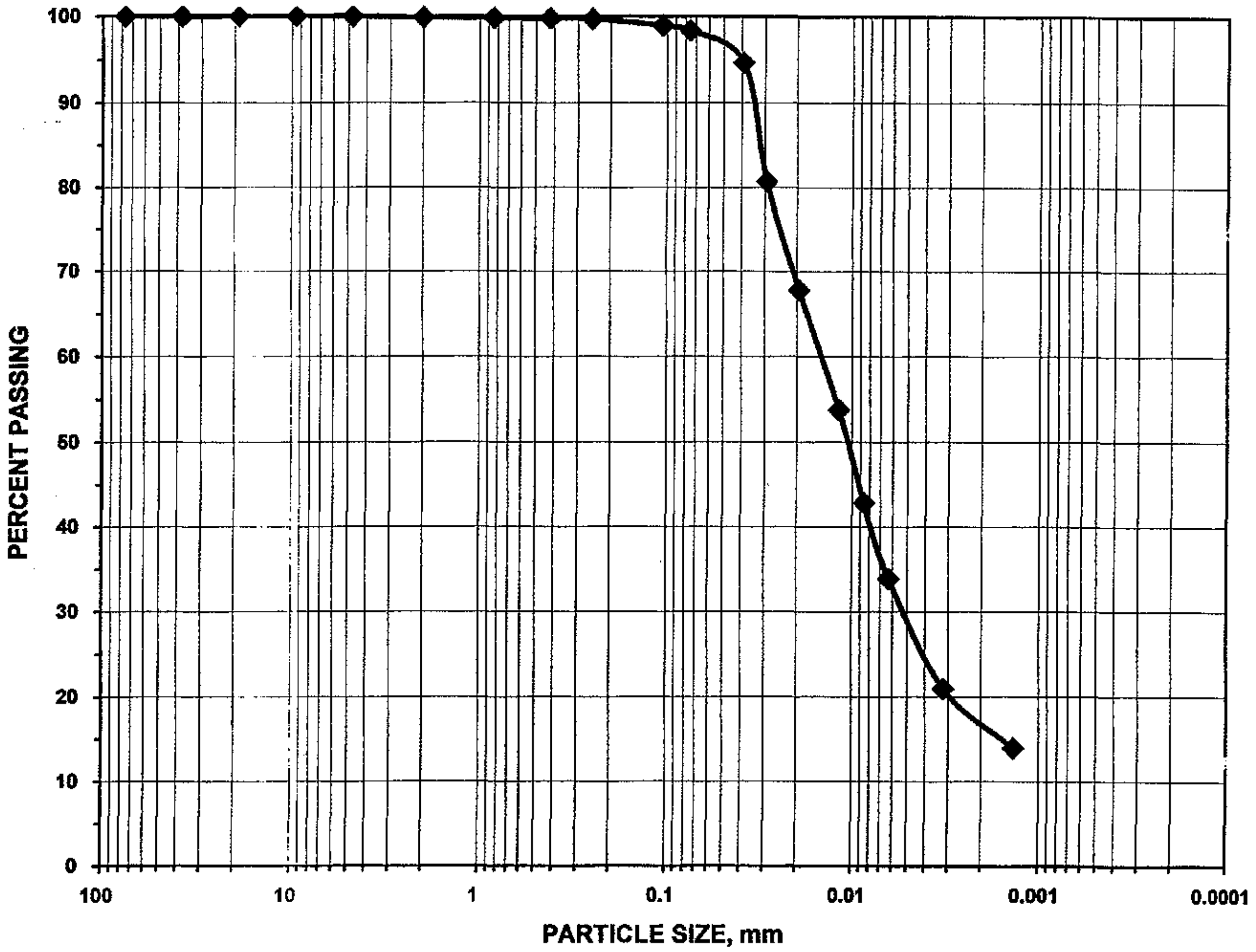
PROJECT : **Proposed Residential Subdivision**
LOCATION: **Caledon East, Ont.**
CLIENT : **Valley Grove Investments Ltd.**

FILE No.: **01109**
SAMPLE DATE: **Jan.19,2001**

BH No.: **1**
SA: **3**
SA DEPTH : **1.8 m**

SAMPLE DESCRIPTION: **SILT,some clay,trace sand**

GRAIN SIZE DISTRIBUTION



M.I.T. SYSTEM	COARSE MEDIUM FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT SIZE CLAY SIZE FINE GRAINED

UNIFIED SYSTEM	COARSE FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT OR CLAY SIZE FINE GRAINED

Terraprobe

SIEVE AND HYDROMETER ANALYSIS
REPORT FORM

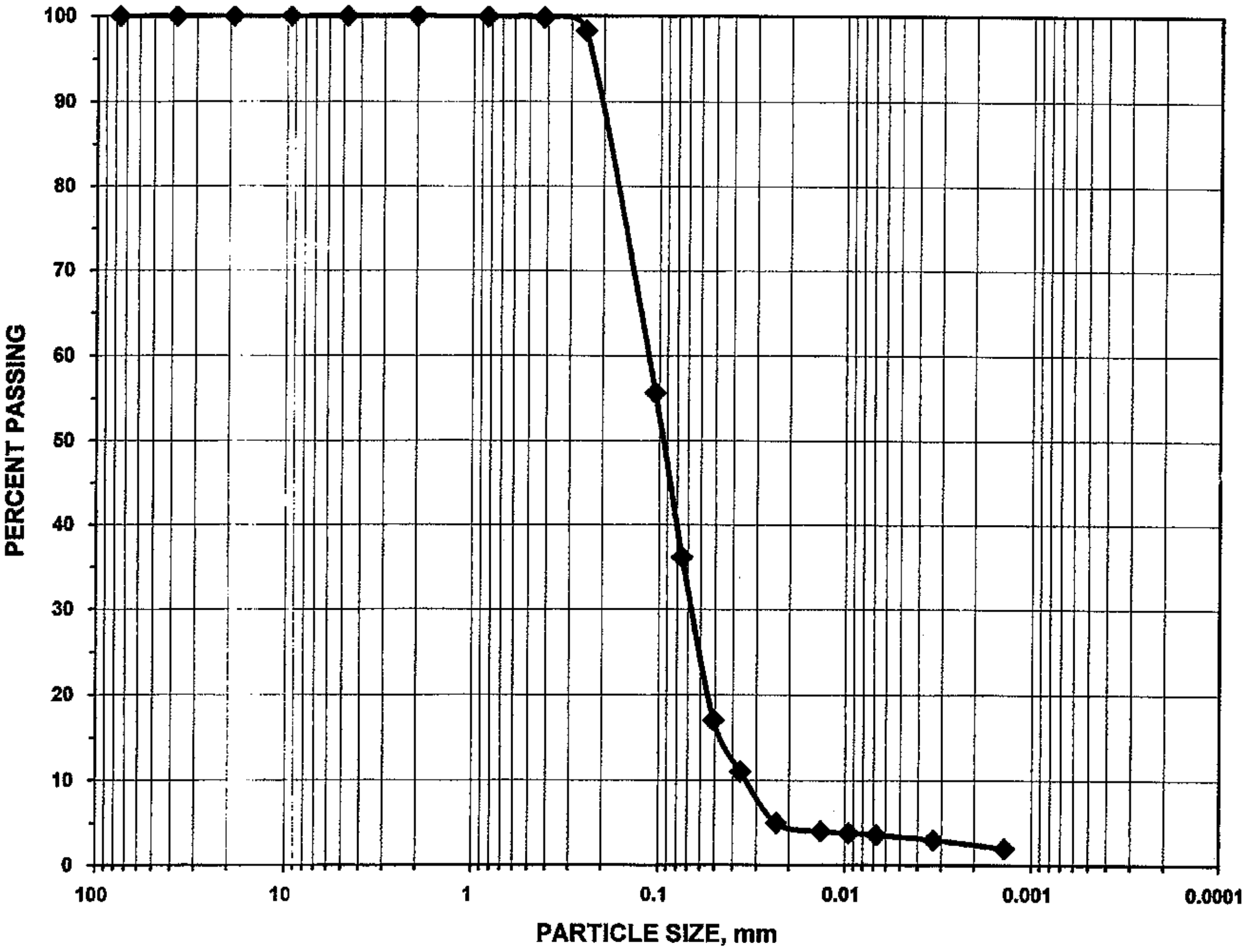
PROJECT : **Proposed Residential Subdivision**
LOCATION: **Caledon East, Ont.**
CLIENT : **Valley Grove Investments Ltd.**

FILE No.: **01109**
SAMPLE DATE: **Jan.19,2001**

BH No.: **2**
SA: **7**
SA DEPTH : **6.4 m**

SAMPLE DESCRIPTION: **SILTY SAND,trace clay**

GRAIN SIZE DISTRIBUTION



M.I.T. SYSTEM	COARSE MEDIUM FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT SIZE CLAY SIZE FINE GRAINED

UNIFIED SYSTEM	COARSE FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT OR CLAY SIZE FINE GRAINED

Terraprobe

SIEVE AND HYDROMETER ANALYSIS
REPORT FORM

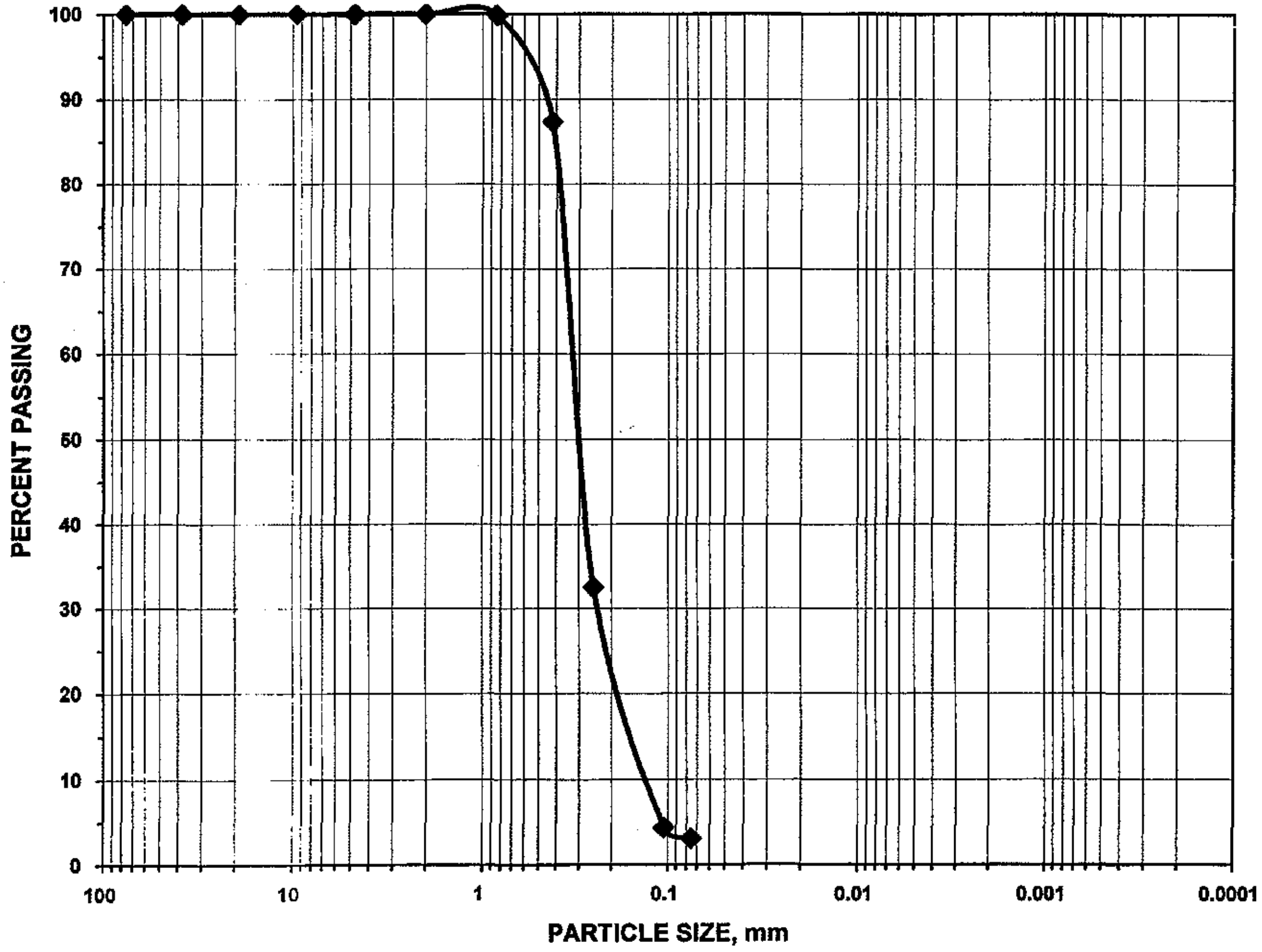
PROJECT : **Proposed Residential Subdivision**
LOCATION: **Caledon East, Ont.**
CLIENT : **Valley Grove Investments Ltd.**

FILE No.: **01109**
SAMPLE DATE: **Jan.18,2001**

BH No.: **4**
SA: **4**
SA DEPTH : **2.6 m**

SAMPLE DESCRIPTION: **SAND,trace silt**

GRAIN SIZE DISTRIBUTION



M.I.T. SYSTEM	COARSE MEDIUM FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT SIZE CLAY SIZE FINE GRAINED

UNIFIED SYSTEM	COARSE FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT OR CLAY SIZE FINE GRAINED

Terraprobe

SIEVE AND HYDROMETER ANALYSIS

REPORT FORM

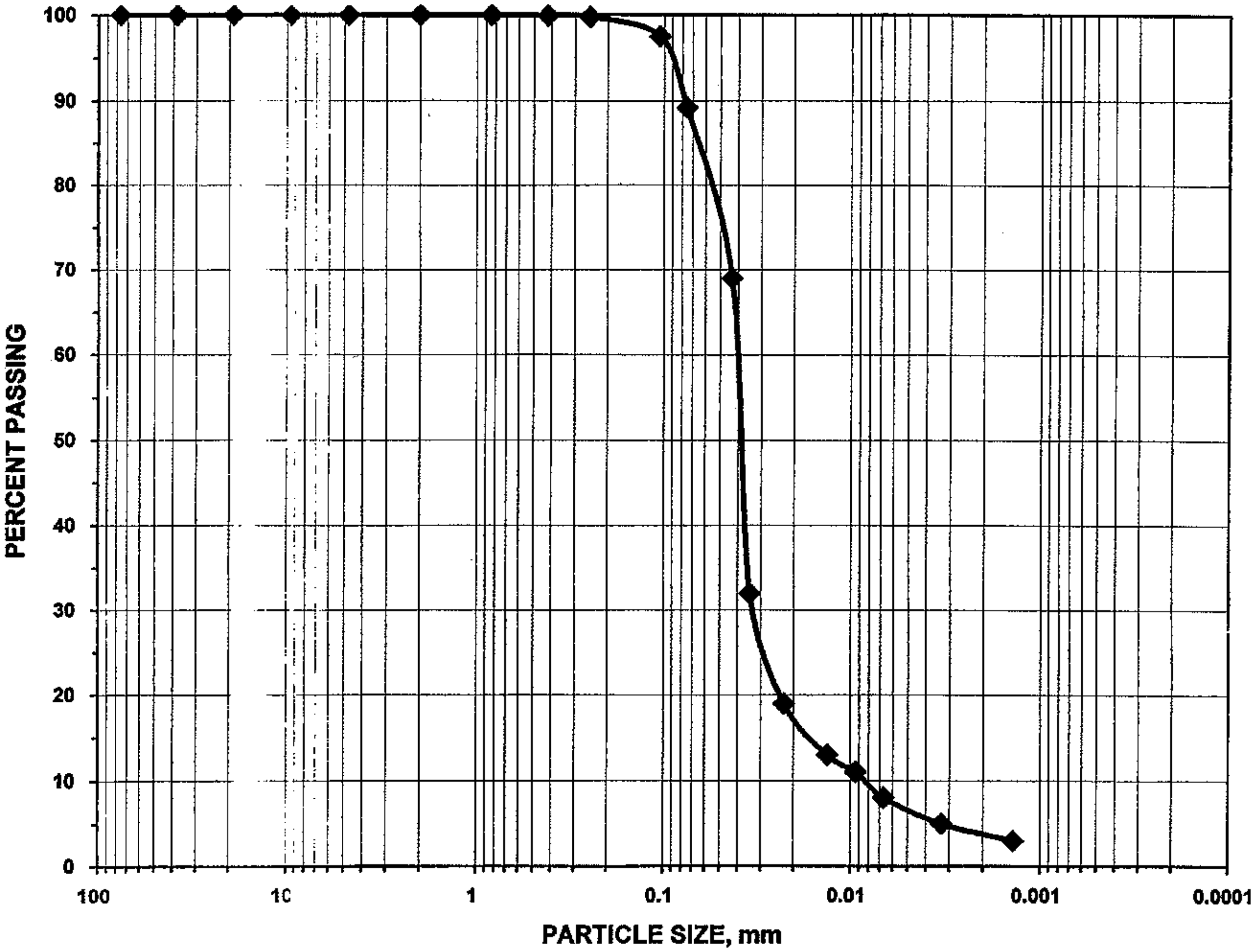
PROJECT : **Proposed Residential Subdivision**
LOCATION: **Caledon East, Ont.**
CLIENT : **Valley Grove Investments Ltd.**

FILE No.: **01109**
SAMPLE DATE: **Jan.22,2001**

BH No.: **8**
SA: **3**
SA DEPTH : **1.8 m**

SAMPLE DESCRIPTION: **SILT,some sand,trace clay**

GRAIN SIZE DISTRIBUTION



M.I.T. SYSTEM	COARSE MEDIUM FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT SIZE CLAY SIZE FINE GRAINED

UNIFIED SYSTEM	COARSE FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT OR CLAY SIZE FINE GRAINED

Terraprobe

SIEVE AND HYDROMETER ANALYSIS

REPORT FORM

PROJECT : Proposed **Residential Subdivision**
LOCATION: **Caledon East, Ont.**
CLIENT : **Valley Grove Investments Ltd.**

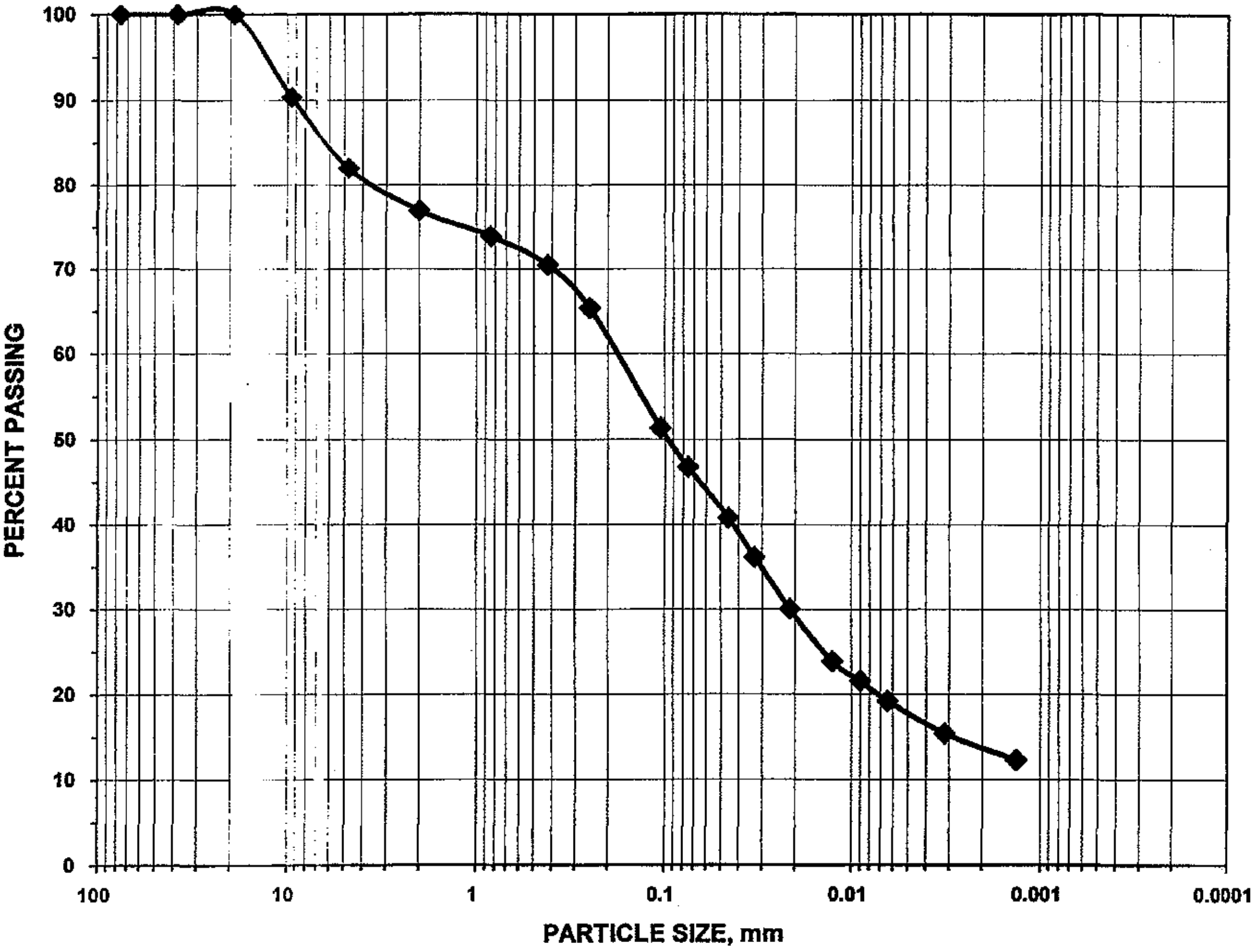
FILE No.: **01109**
SAMPLE DATE: **Jan.22,2001**

BH No.: **9**
SA: **5**

SAMPLE DESCRIPTION: **SILTY AND GRAVELLY SAND,some clay**

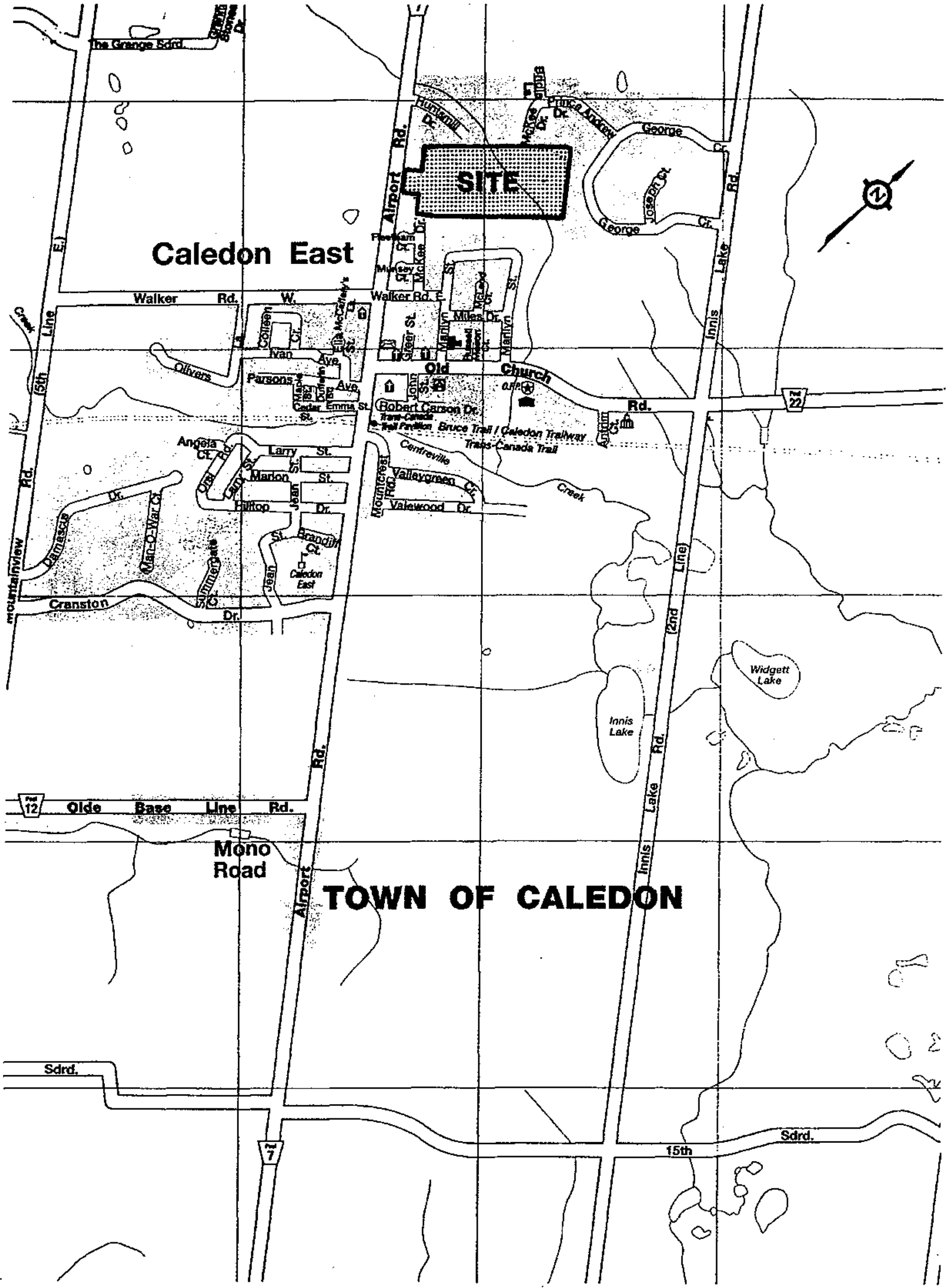
SA DEPTH : **3.4 m**

GRAIN SIZE DISTRIBUTION



M.I.T. SYSTEM	COARSE MEDIUM FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT SIZE	CLAY SIZE	FINE GRAINED

UNIFIED SYSTEM	COARSE FINE GRAVEL SIZE	COARSE MEDIUM FINE SAND SIZE	SILT OR CLAY SIZE FINE GRAINED

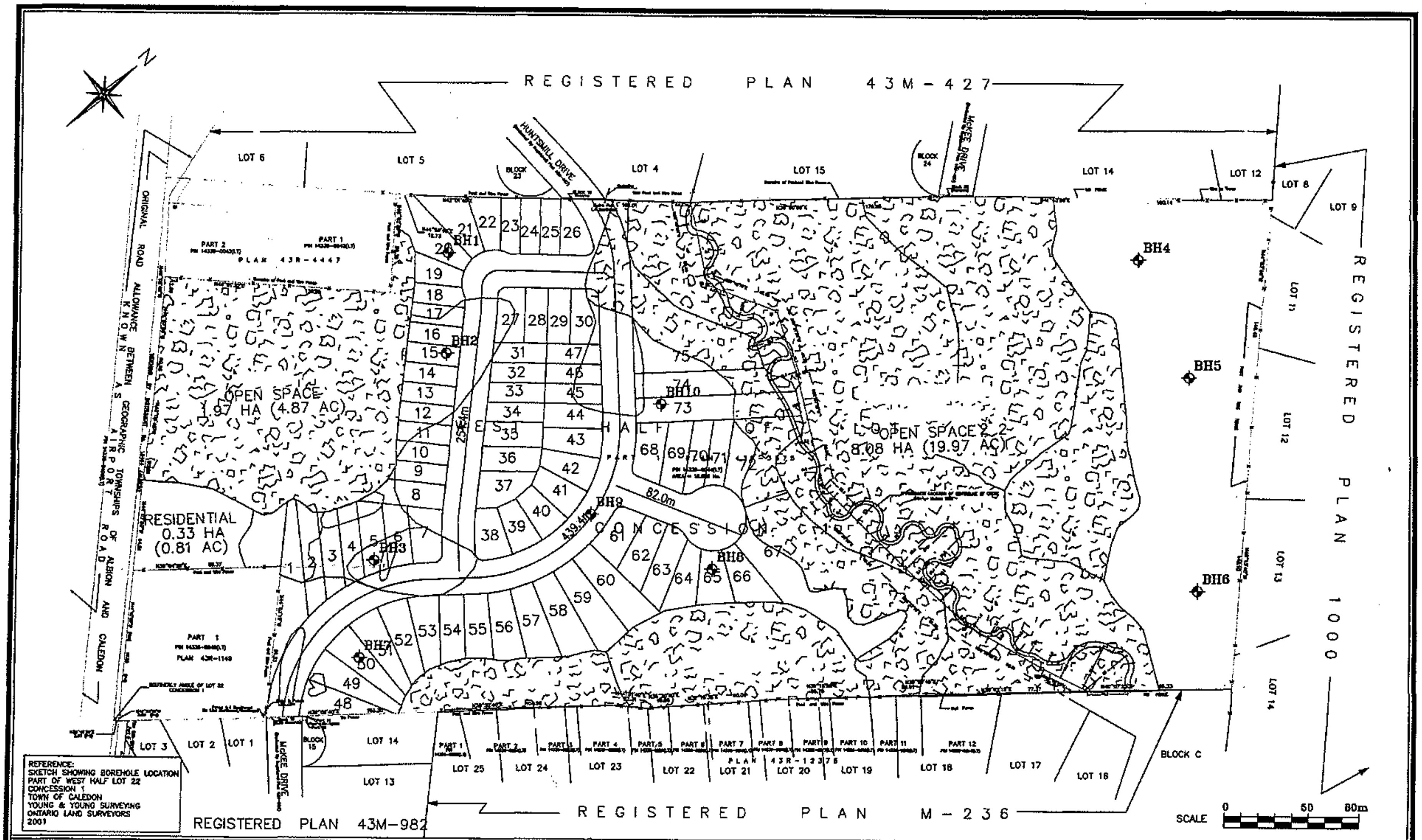


SITE LOCATION PLAN

TERRAPROBE

File No. 01109

FIGURE 1



BOREHOLE LOCATION PLAN

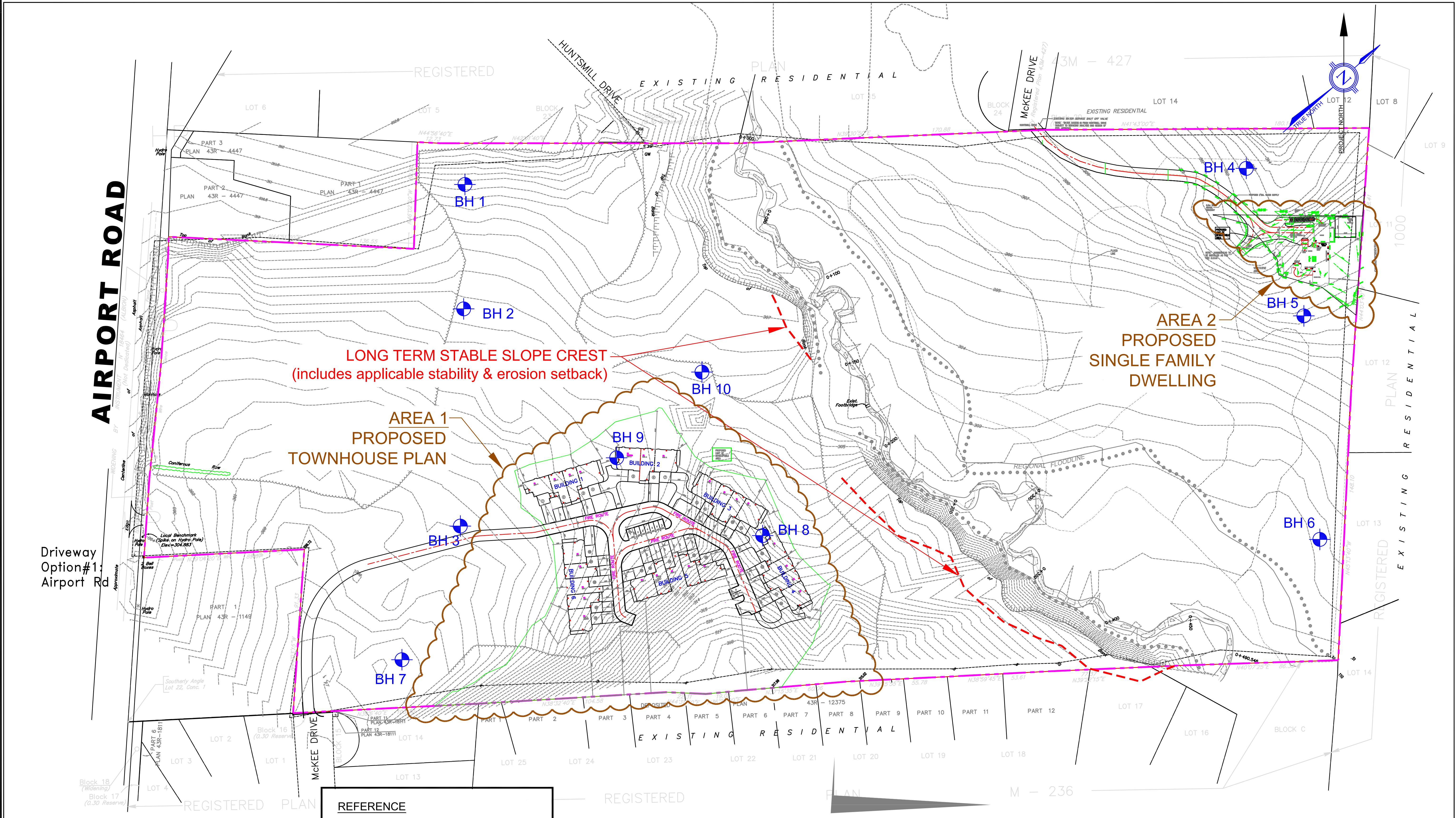
TERRAPROBE

File No. 01109

FIGURE 2

FIGURES

TERRAPROBE INC.



LEGEND

BH Borehole Location (Terraprobe 2001)

REFERENCE

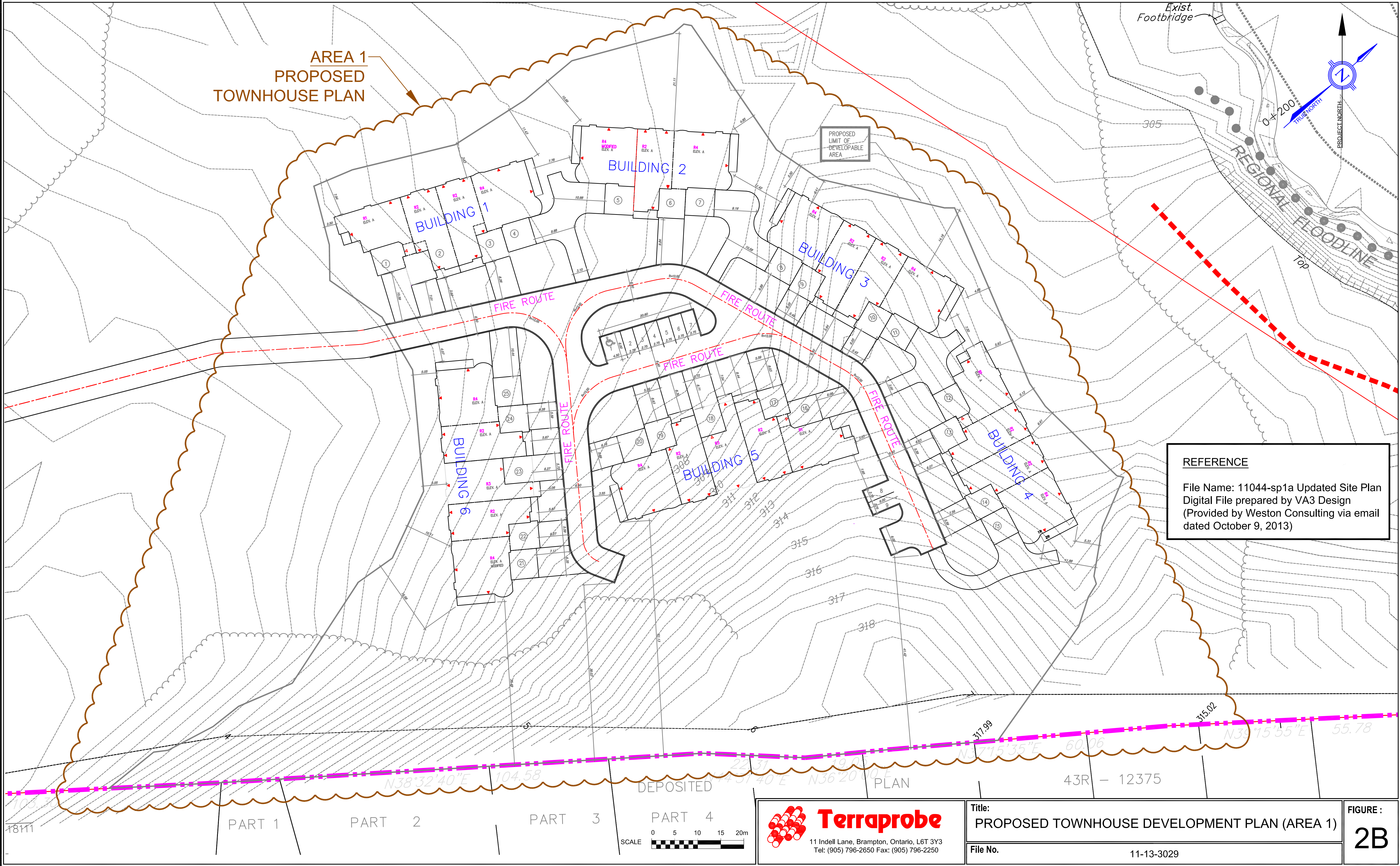
File Name: 11044-sp1a Updated Site Plan
Digital File prepared by VA3 Design
(Provided by Weston Consulting via email
dated October 9, 2013)

Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: UPDATED SITE PLAN

File No. 11-13-3029

FIGURE : 2A



REFERENCE

File Name: 11044-sp1a Updated Site Plan
Digital File prepared by VA3 Design
(Provided by Weston Consulting via email
dated October 9, 2013)

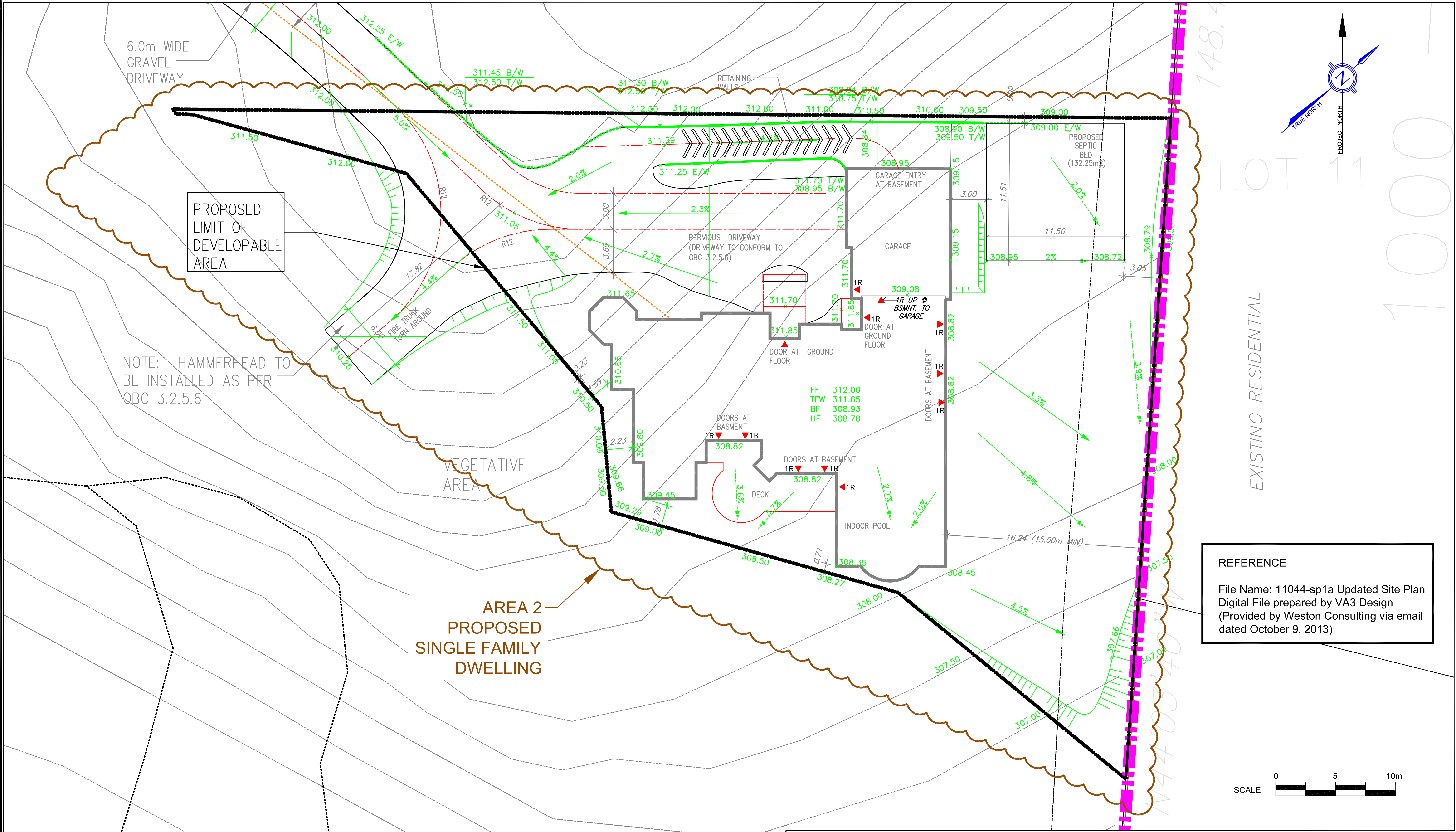
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:
PROPOSED TOWNHOUSE DEVELOPMENT PLAN (AREA 1)

File No. 11-13-3029

FIGURE :
2B

Z:\1-Project Files\11-Geo\2013\11-13-3029\A. Dwgs, Logs\AutoCAD\11-13-3029 FIG.dwg, SANDY



AREA 2
PROPOSED SINGLE FAMILY DWELLING

REFERENCE

File Name: 11044-sp1a Updated Site Plan
Digital File prepared by VA3 Design
(Provided by Weston Consulting via email
dated October 9, 2013)

Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:
PROPOSED SINGLE FAMILY DWELLING PLAN (AREA 2)

File No.
11-13-3029

FIGURE :
2C

Project:

PROPOSED TOWNHOUSE DEVELOPMENT
& SINGLE ESTATE LOT

Dwg.Title:

PROPOSED GRADING PLAN

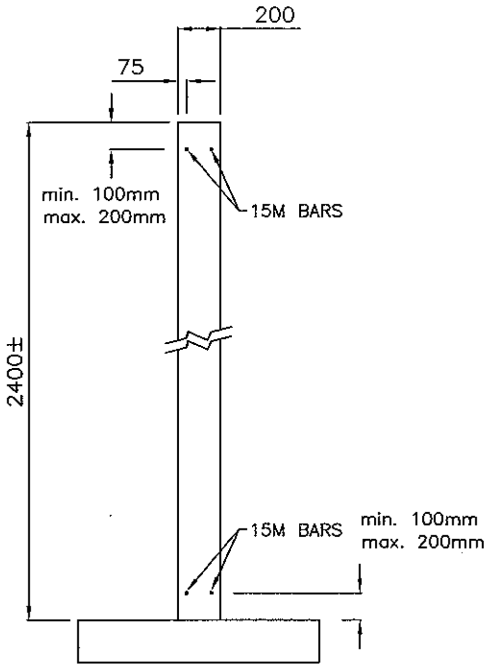
MASONGSONG ASSOCIATES ENGINEERING LIMITED
Consulting Engineers • Planners • Project Managers
7800 Kennedy Road • Suite 201 • Markham, Ontario • L3R 2C7
Tel:(905) 944-0162 • Fax:(905) 944-0165 • E-mail: maeng@maeng.ca

Scale: 1:1000

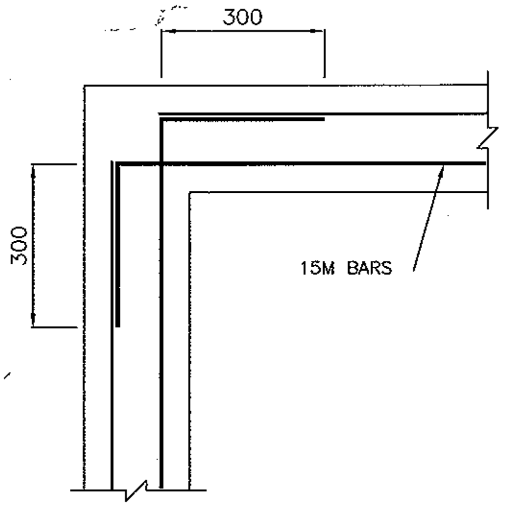
Date: APRIL 2013

Project Number: 03-141

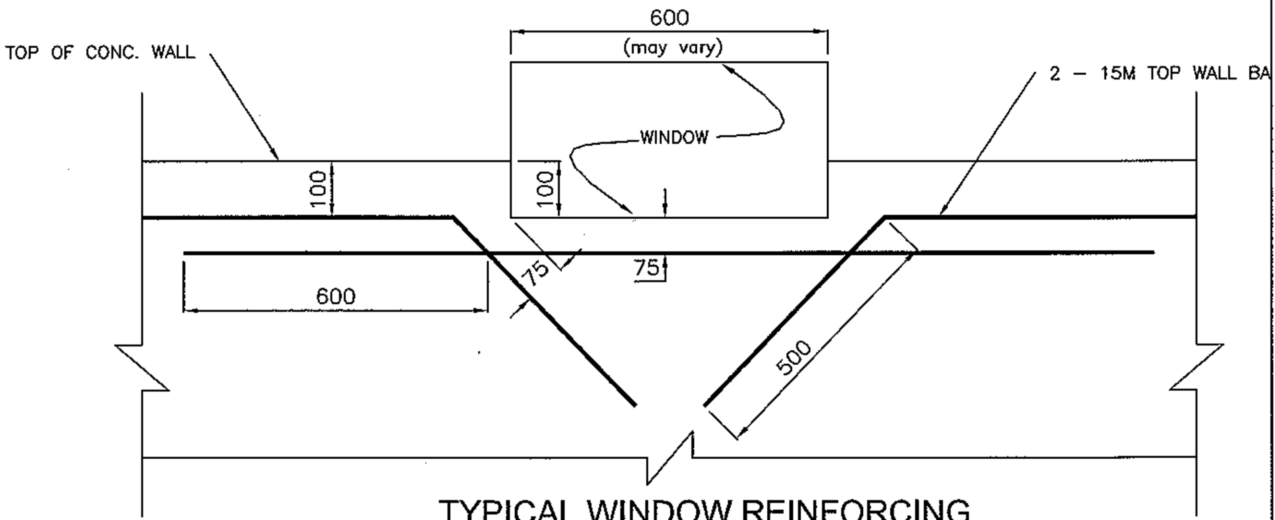
Drawing No. GR1



TYPICAL
REINFORCED WALL
NOT TO SCALE



TYPICAL SPLICING
AT CORNERS
NOT TO SCALE



TYPICAL WINDOW REINFORCING
NOT TO SCALE

NOTES:
1. Reinforcing steel C.S.A. G30.18–09 Grade 400
2. Concrete min. 28 day strength 20MPa (3000psi)
3. Base of all footing excavations to be inspected and approved prior to placing formwork.
4. All dimensions are in mm.

Terraprobe
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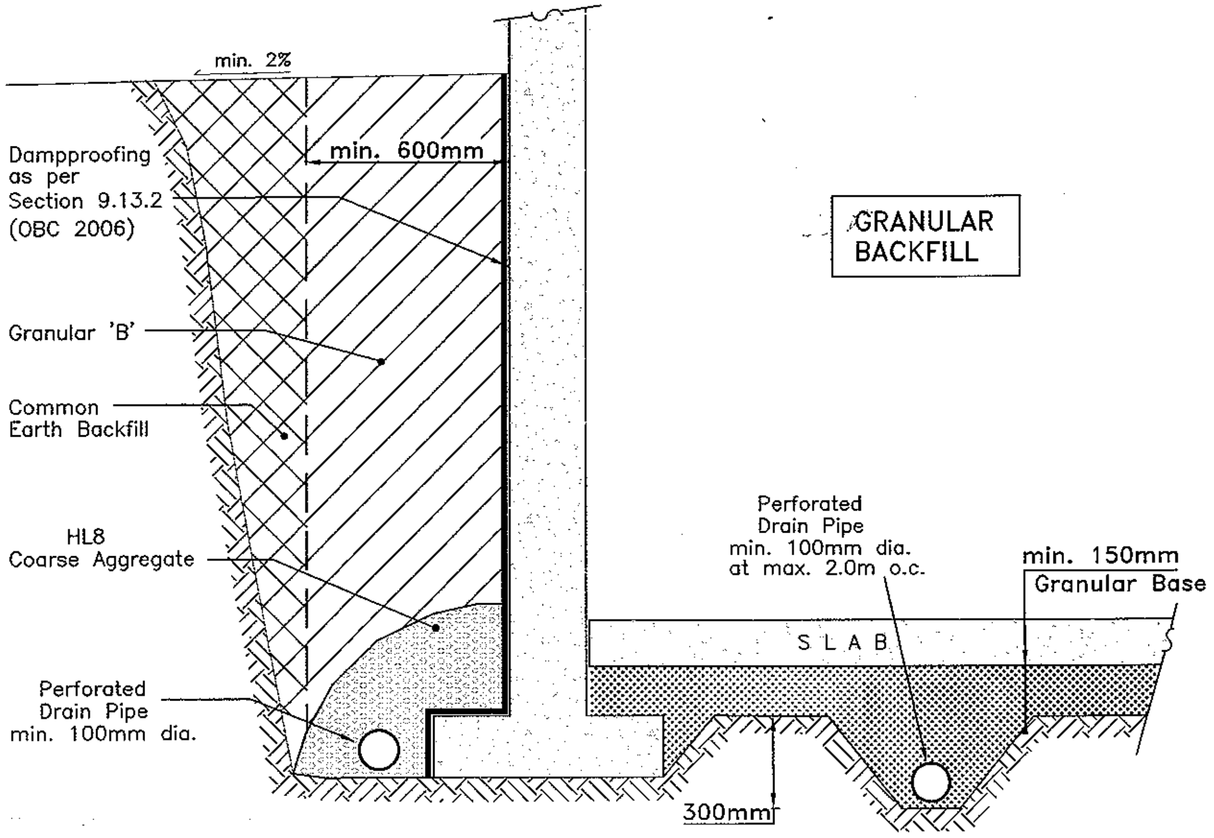
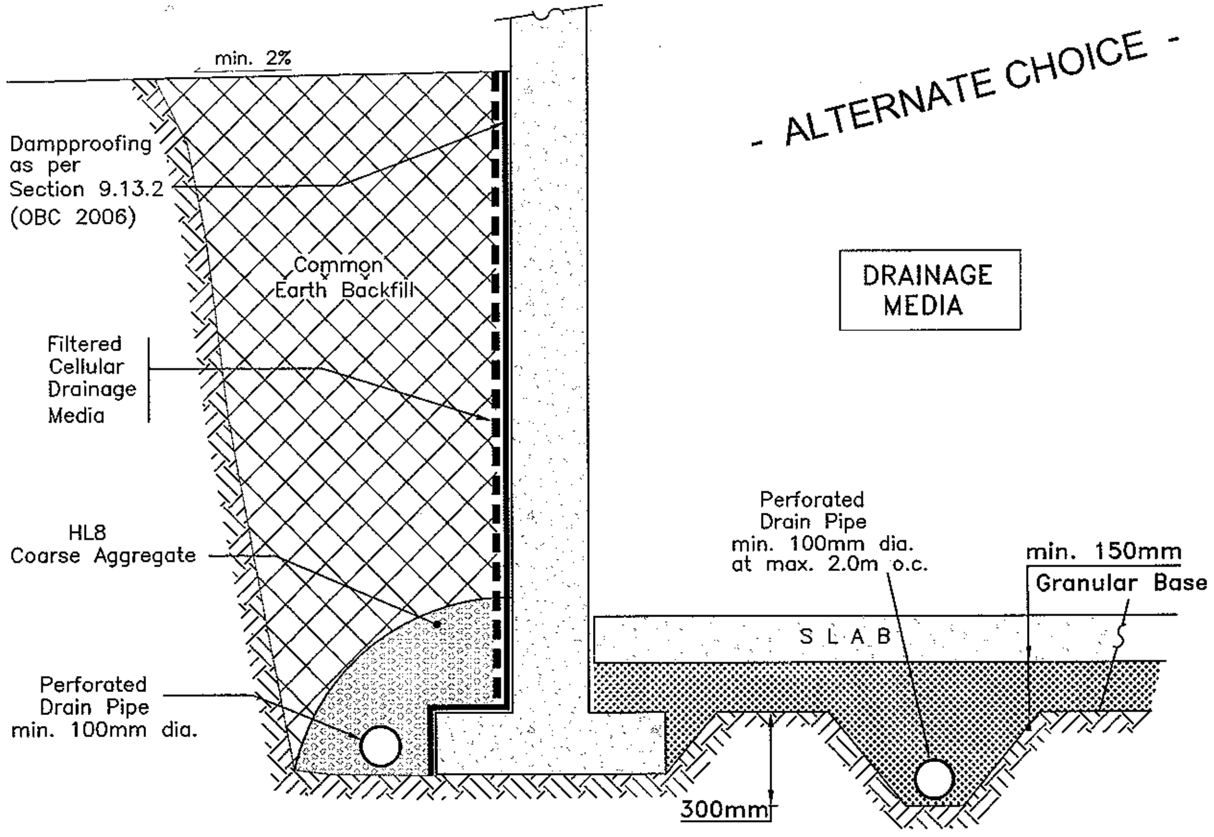
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

TYPICAL REINFORCED WALL DETAILS FOR
STRUCTURES ON ENGINEERED FILL





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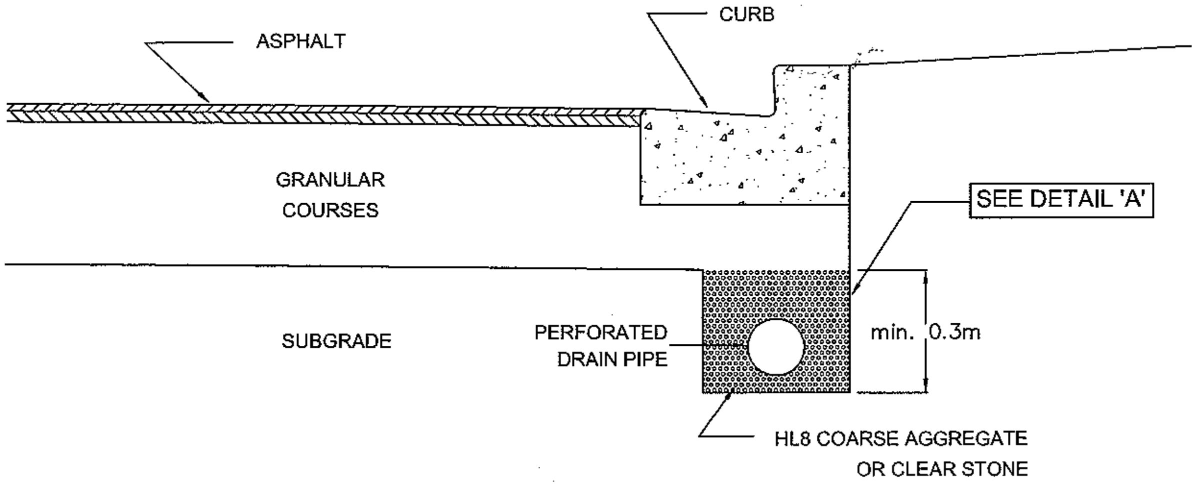
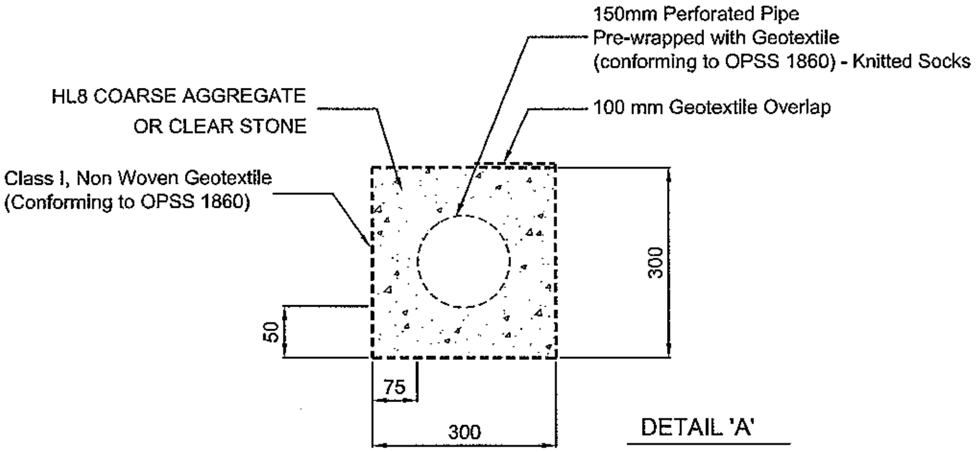
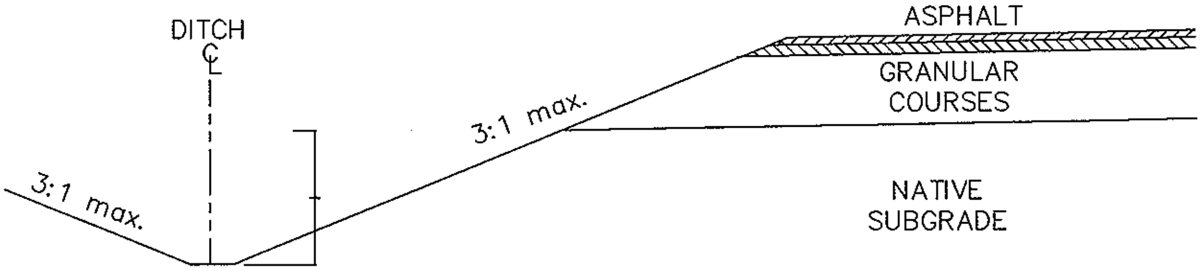
Tel: (905) 796-2650 Fax: (905) 796-2250

BASEMENT DRAINAGE DETAIL





DETAIL 'A'



NOT TO SCALE

Terraprobe

11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

PAVEMENT DRAINAGE ALTERNATIVES