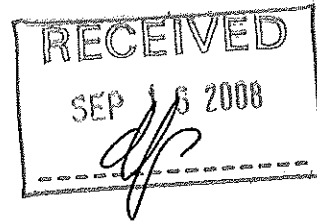


Terraprobe

**Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing**



**GEOTECHNICAL INVESTIGATION
PROPOSED ADDITION
203 QUEEN STREET, SOUTH
BOLTON, ONTARIO**

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1. INTRODUCTION

Terraprobe Limited was retained by Egan Funeral Home, Bolton c/o George Robb Architect to conduct a geotechnical investigation for the proposed addition to their existing funeral home, located at 203 Queen Street S, Bolton, Ontario. The site is located at the northeast corner of the intersection of Queen Street and Downey Drive. The general location of the property is presented on Figure 1.

This report encompasses the geotechnical investigation of the subject site to determine the prevailing subsurface soil and shallow ground water conditions, and based on this information, provides pertinent geotechnical engineering recommendations for the design of foundations, slab on grade, pavement design, earth pressure and earthquake design parameters. In addition, comments are also included on pertinent construction aspects relating to the geotechnical conditions including excavation, backfilling and shallow ground water conditions.

2. SITE AND PROJECT DESCRIPTION

The subject property is roughly rectangular in shape and fronts on Queen Street. It is our understanding that the site has had three phases of construction beginning in 1959 with the original funeral home and the attached residence. In 1972 a second floor apartment was added over the funeral home. In 1989 a two storey addition was added to the east side of the building, adding a chapel space, new garage and second storey offices and lounge area. Also additional parking and driveway areas were added towards the south, east and north side of the property.

The current work will remove the second floor apartment over the funeral home and add a pair of new visitation rooms, staircase, family room, elevator and extend the existing second floor over the garage to the north end of the existing building. It is also proposed to rehabilitate the existing parking and driveway areas. The development is serviced by municipal water and sewers.

3. FIELD PROCEDURE

The field investigation of the subject site was conducted on July 23, 2008, and consisted of drilling and sampling a total of seven (7) exploratory boreholes (Boreholes 1, 2, 5, 7, 9, 11 and 12) and advancing one test pit at the location of Borehole 12. The boreholes were located in the field by Terraprobe Limited at approximate locations shown on the enclosed Borehole Location Plan (Figure 2). The borehole surface elevations were estimated from the survey plan provided by George Rob Architects and are referenced to Geodetic Elevation. Four boreholes (7, 9, 11 and 12) were advanced within the general footprint of the proposed building addition, extending to depths ranging between 5.0 to 6.6 m below existing grade. Three boreholes (1, 2 and 5) were advanced in the pavement areas, extending to about 2.0 m below existing grade.

Five boreholes (1, 2, 5, 7 and 9) were advanced using a continuous flight power auger machine equipped with conventional soil sampling and testing tools. Two boreholes (11 and 12), which were located within the existing building footprint were advanced using portable equipment and continuous sampling was done with a conventional 50 mm diameter split barrel sampler. The drilling was observed by members 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.

One test pit was advanced by our field staff at the location of the borehole 12, after the completion of drilling. The test pit was made to get a general idea about the depth and geometry of the existing footings.

Samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, colour and odour. The samples obtained were then sealed in clean plastic containers and transferred to the Terraprobe laboratory where the samples were examined by a geotechnical engineer to verify the accuracy of the initial soil descriptions and to select appropriate samples for laboratory testing. Geotechnical laboratory testing consisted of water content determination on all samples, while sieve and hydrometer analysis was carried out on selected soil samples (Borehole 7, Sample 3 and Borehole 11, Sample 6). The measured natural water content of individual samples are plotted on the enclosed borehole logs at respective sampling depths, and the results of the sieve and hydrometer analysis are appended.

Ground water levels were recorded in open boreholes upon completion of drilling. The results of shallow ground water levels measured in the boreholes at the time of drilling are presented in a subsequent section of this report.

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 the 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 stratigraphic boundaries between various strata as shown on the borehole logs 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, three of the boreholes (Boreholes 5, 11 and 12) boreholes encountered a layer of earth fill at the ground surface. The earth fill materials were in general underlain by undisturbed native soil deposit

which extended to the full depth of investigation. A thin layer of topsoil was found sandwiched between the fill material and the native soils in Borehole 11. In the remaining boreholes native soils were encountered below the pavement structure and continued to the full depth of investigation.

4.1 Pavement Structure

Pavement structure was encountered at boreholes 1, 2, 5, 7 and 9. The thickness of the asphalt layer at these locations was found to be 50 mm (Boreholes 2, 5, 7 and 9) and 80 mm (Borehole 1). The thickness of granular base varied from 150 mm to 350 mm.

4.2 Topsoil

In general a distinct presence of topsoil layer was not evident except in Borehole 11, where a 200 mm thick topsoil layer was encountered just below the fill material. Apart from that only sporadic presence of topsoil staining in layers just below the pavement structure was observed in a few of the boreholes (Boreholes 7 and 9).

4.3 Earth Fill

Boreholes 5, 11 and 12 encountered earth fill materials below the slab structure. The fill material in general consisted of sand and gravel to sand and silt to clayey silt. The earth fill materials extended to a depth of about 0.6 m in Borehole 5, 1.8 m in borehole 12 and to about 2.3 m in borehole 11 below grade.

The Standard Penetration Test results ('N' Values) obtained from the earth fill materials generally varied from 1 blow to 9 blows per 300 mm of penetration, suggesting a loose relative density /stiff consistency.

Measured moisture contents of the earth fill samples typically ranged between 6 percent and 24 percent by weight, indicating a moist to wet condition.

4.4 Native Soils

Undisturbed native soils were encountered underlying the asphalt pavement structure (boreholes 1, 2, 5, 7, and 9) and earth fill material (boreholes 11 and 12) and extended to the full depth of investigation (depths of 2.0 to 6.6 m). The undisturbed native soil deposit predominantly consisted of Clayey Silt, trace amount of Gravel, except in Borehole 11, where a layer of silty clay was encountered at about 3.0 m below grade, which was further underlain by clayey silt which extended to the full depth of investigation.

The Standard Penetration Test results ('N' Values) obtained from the clayey silt deposit in all boreholes, but Borehole 11, generally varied from 15 blows to 73 blows per 300 mm of penetration, indicating a very stiff

to hard consistency. In Borehole 11 a blow count of about 7 blows per 300 mm of penetration was obtained in the clayey silt layer, indicating a firm consistency. The silty clay layer encountered in Borehole 11 (depth of 3 to 5.3 m), also presented a low blow count of 8 to 11 blows per 300 mm of penetration, thus indicating a stiff consistency.

4.5 Ground Water

Observation of presence or otherwise of ground water was made in the boreholes, immediately after the completion of drilling of each hole. All the boreholes were found dry on the completion of the drilling, indicating no presence of ground water table above the depth of investigation.

It should be noted that the above condition of water table prevailed just after the completion of drilling of the holes and the water table elevation may fluctuate seasonally depending on the amount of precipitation and surface runoff.

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 practice. If there are any changes to the site development features and/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

In the solo test pit, which was advanced at the location of the Borehole 12 after the completion of the drilling, the underside footing elevation of the existing footings was found to be about 252.40 m. The footing thickness was found to be about 200 mm and the projection of the footing from the formed concrete footing wall was found to be about 108 mm.

Two of the boreholes encountered earth fill and weathered/disturbed soil layer extending to a depth of about 1.8 m (Borehole 12) to as much as 2.3 m (Borehole 11) below grade. These materials were further underlain

by a native clayey silt deposit in Borehole 12 which extended to the full depth of investigation. In Borehole 11, The fill material was underlain by about 0.2 m thick layer of organic material. The organic layer was underlain by about 2.3 m thick layer of native silty clay which is further underlain by native clayey silt deposit which extended to the full depth of investigation. The above mentioned boreholes substantiate the findings of the previous soil investigation, of the presence of some past pond towards the east side of the property. Additional investigations would be required to identify the limits of that past pond, if required.

In other boreholes within the proposed building addition footprint (Boreholes 7 and 9), native clayey silt material was encountered just below the pavement structure and extended to the full depth of penetration.

The earth fill materials are considered to be unsuitable for the support of the proposed building foundations. All foundations must be supported on the underlying competent undisturbed native soil deposit. All footings must be designed to bear at least 0.3 m into the undisturbed native soil stratum.

It is understood that the proposed building addition would be a two storey structure on conventional spread footing foundations. The following table summarizes the recommended geotechnical resistance available at varying depths at the borehole locations.

Borehole No.	Minimum Depth Below Existing Grade	Geodetic Elevation	Net Geotechnical Resistance at S.L.S.	Factored Geotechnical Resistance at U.L.S.	Bearing Stratum
7	1.2 m	252.7 m	250 kPa	375 kPa	Clayey Silt
9	1.2 m	252.8 m	250 kPa	375 kPa	Clayey Silt
11	2.7 m	251.5 m	60 kPa	90 kPa	Clayey Silt/Silty Clay
12	2.6 m	251.6 m	250 kPa	375 kPa	Clayey Silt

The design underside of footing elevations must be determined based on the above data and the minimum frost cover requirement of 1.2 m for the foundation subgrade soils as applicable. The depths/elevations presented in the above table include the recommended 300 mm depth of embedment into the undisturbed native soil stratum.

The minimum width of the continuous strip footings must be 460 mm and the minimum size of isolated footings must be 800 mm x 800 mm regardless of loading considerations, in conjunction with the above recommended bearing pressures. The design bearing pressures as recommended allow for up to 25 mm of

total settlement. This settlement will occur as load is applied and is linear elastic and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

The provision of augured footings will need additional investigations to evaluate soils at lower depths and may be too costly for this type of construction.

5.1.1 Foundation Installation

It is 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.

All exterior foundations or foundations in unheated areas must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation.

Prior to pouring foundation concrete, the foundation subgrade 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 foundation subgrade and concrete must be provided.

It is noted that the native soils tend to weather rapidly and deteriorate on exposure to the atmosphere and/or surface water. Hence, foundation bases which remain open for an extended period of time should be protected by a skim coat of lean concrete.

5.2 Slab On Grade

Conventionally lightly loaded slab on grade may be placed on at least 150 mm of granular base (OPSS 1010 Granular "A" or 19 mm crusher run limestone) compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). The granular base may comprise 150 mm thick layer of 19 mm clearstone (OPSS 1004), vibrated to a dense state. The granular base thickness will have to be increased for moderately and heavily loaded slab. Recommendations for the granular base thickness and type of material for such slabs can be provided if required.

A layer of organic/topsoil material (0.2 m thick) was encountered just below the fill material in borehole 11 at a depth of 2.1 m. The thin topsoil layer should have been removed prior to the placement of 2 m of fill over the topsoil layer. If not removed, the topsoil layer could result in future minor settlement which could effect the slab. Removal of the topsoil layer could be very costly. Instead of removal of the topsoil layer, the granular base under the floor slab could be increased in thickness (to 300 mm) to protect against

damage from future minor settlement. The granular base must be placed on undisturbed native soils or clean earth fill compacted to at least 95 percent SPMDD. Prior to the placement of the granular base, the subgrade should be proof rolled. Any subgrade area containing excessive amounts of deleterious materials must be subexcavated. Similarly, any soft or wet subgrade areas which deflect excessively during proof roll should be subexcavated and backfilled with suitably compacted clean earth fill as noted above.

The following subgrade parameters are recommended:

$$K_s = 16 \text{ MN / cu.m}$$
$$\phi = 30^\circ$$

5.3 Pavement Design

5.3.1 Existing Pavement Structure

The borehole data shows that the existing pavement is made of relatively light structure, comprising in general 50 mm of asphaltic concrete surface over about 150 to 350 mm of granular base course aggregate. The existing pavement appears to have out lived its life. Frequent longitudinal cracks, transverse cracks and joint cracks and occasional alligator cracks are present at the surface. In general, the existing pavement thickness is inadequate and a new pavement should be more thick.

Borehole No.	Pavement Structure		Subgrade		
	Asphalt Thickness	Granular Thickness	Subgrade Soil Type	Subgrade "N" -Value (blows / 0.3 m)	Moisture Content (%)
BH 1	80 mm	200 mm	Very stiff to Hard Clayey Silt	16 to 22	15 to 22
BH 2	50 mm	150 mm	Stiff to Hard Clayey Silt	11 to 65	21 to 23
BH 5	50 mm	150 mm	Loose Sand with Silt and Clay to Hard Clayey Silt	11 to 55	15 to 25
BH 7	50 mm	250 mm	Stiff to Hard Clayey Silt	9 to 52	15 to 27
BH 9	50 mm	350 mm	Stiff to Hard Clayey Silt	15 to 50	8 to 28

A relatively loose layer of sandy material was encountered below the pavement structure in borehole 5.

5.3.2 Pavement Design Recommendations

The existing asphalt surface should be removed. The existing granular material should be removed and stacked in piles for re use. Any granular material contaminated with subgrade material should be separated and can be used for the preparation of the subgrade. Excess subgrade should be removed to accommodate additional thickness of granular material as per the recommendations noted below. Any visible areas of subgrade containing excessively moist or loose material should be removed and replaced with suitable material placed in 150 mm thick lifts and compacted to 98% percent SPMDD. Special attention should be given to areas around Borehole 5 as the presence of loose sandy material below the pavement structure was observed in this borehole.

The earth fill materials encountered on the site may be utilized for subgrade preparation provided they do not contain excessive amounts of organics and deleterious materials, as well as their in-situ moisture content is within 3 percent of the optimum moisture content. The pavement subgrade should be proof-rolled; and any loose, soft, wet or unstable areas should be sub-excavated, and backfilled with clean earth fill placed in 150 mm thick lifts and compacted to a minimum of 98 percent SPMDD. Local sub-excavation may be required in areas where incompetent (loose/firm) subgrade conditions and significant organic/topsoil inclusions are encountered during subgrade preparation. These areas must be sub-excavated and backfilled with clean and compacted earth fill as noted above. The entire pavement subgrade should be compacted to a minimum of 98 percent SPMDD prior to the granular sub-base placement.

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 pavement thickness design is provided on this basis.

Performance Asphaltic Concrete Pavement Structure			
Pavement Layer	Compaction Requirements	Car Parking Areas Minimum Component Thickness (Light Duty)	Driveway/Fire Route Minimum Component Thickness (Heavy Duty)
Surface Course Asphaltic Concrete HL3 (OPSS 1150) with PG asphalt cement (OPSS 1101)	as per OPSS 310	40 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150) with PG asphalt cement (OPSS 1101)	as per OPSS 310	50 mm	90 mm

Base Course: Granular 'A' or 19mm Crusher Run Limestone (OPSS 1010 and Pertinent City Specifications)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular 'B' or 50mm Crusher Run Limestone (OPSS 1010 and Pertinent City Specifications)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	450 mm

A minimal pavement design is also provided, which will provide an estimated service period of about 8 to 10 years before a complete rehabilitation is required. The cost of the minimal pavement design should be compared to the performance design which could be expected to last about twice as long before significant maintenance and rehabilitation.

Minimal Asphaltic Concrete Pavement Structure

Pavement Layer	Compaction Requirements	Car Parking Areas Minimum Component Thickness (Light Duty)	Driveway/Fire Route Minimum Component Thickness (Heavy Duty)
Surface Course Asphaltic Concrete HL3 (OPSS 1150) with PG asphalt cement (OPSS 1101)	as per OPSS 310	65 mm	40 mm
Base Course Asphaltic Concrete HL8 (OPSS 1150) with PG asphalt cement (OPSS 1101)	as per OPSS 310	N/A	70 mm
Base Course: Granular 'A' or 19mm Crusher Run Limestone (OPSS 1010 and Pertinent City Specifications)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Subbase Course: Granular 'B' or 50mm Crusher Run Limestone (OPSS 1010 and Pertinent City Specifications)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	200 mm	300 mm

The granular materials should be placed in lifts 150 mm thick or less and be compacted to a minimum of 100 percent and 98 percent SPMDD for granular base and granular sub-base, respectively. 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 City specifications.

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The pavement subgrade must be free of depressions and sloped (preferably at a minimum grade of two 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. Subdrains should be provided at all catchbasins within the

parking areas. Two lengths of subdrain (each minimum 3 m long) should be installed at each catchbasin (Figure 3).

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. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of the 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 strict adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during construction to confirm material quality, thickness and to ensure adequate compaction.

5.4 Excavations

The borehole data indicate that earth fill materials, and clayey silt 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, solid, only able to be penetrated by a small sharp object with difficulty;
- b. can only be excavated by mechanical equipment;
- c. shows no sign of visible cracks after excavation;
- d. exhibits a dry, shiny appearance after excavation; and
- e. possesses a low moisture content and a high degree of internal strength.

TYPE 2 SOIL

- a. cracks or crumbles;
- b. can be penetrated by small sharp objects easily;
- c. can be excavated by hand tools with moderate difficulty;
- d. exhibits signs of surface cracking;
- e. exhibits a damp appearance after excavation; and
- f. possesses a low to medium moisture content and a medium degree of internal strength.

TYPE 3 SOIL

- a. is loose, soft, sandy, or previously excavated;
- b. can be excavated with hand tools easily;
- c. will run easily into a well defined conical pile if dry;
- d. will flow or shift unless supported if wet; and
- e. possesses a low degree of internal strength.

TYPE 4 SOIL

- a. is wet or muddy;
- b. will run easily or flow unless completely supported immediately after excavation;
- c. exerts substantial fluid pressure upon its supporting system; and
- d. possesses almost no internal strength.

The earth fill and native soils encountered in the boreholes are classified as Type 3 Soil and Type 4 Soil respectively.

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.

Water seepage was not encountered in any of the Boreholes upon completion of drilling. However, there may be some ground water seepage into the excavation, likely emanate from the perched groundwater typically present within the earth fill materials and/or from the sand/silt lenses, seams and pockets generally present in the glacial till deposit. This seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation.

5.5 Earth Pressure Design Parameters

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

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

- where:
- P = the horizontal pressure at depth, h (m)
 - K = the earth pressure coefficient,
 - h_w = the depth below the ground water level (m)
 - γ = the bulk unit weight of soil, (kN/m³)
 - γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m³)
 - 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:

$$P = K[\gamma h + q]$$

This equation assumes that free-draining granular backfill is used and positive drainage is provided for the wall 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 φ**. 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 appropriate values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

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
Clayey to Sandy Silt or Similar Fill	30	19	0.35	0.5	3
Compact Granular Fill, Sand and Gravel	32	21	0.3	0.47	3.22
Clayey Silt	32	20	0.3	0.47	3.22

The values of the earth pressure coefficients noted above are for the horizontal backfill. The earth pressure coefficients for inclined backfill will vary based on the inclination of the retained ground surface.

5.6 Backfill

The native soils, and clean earth fill/disturbed native materials are considered suitable for backfilling purposes provided the in-situ moisture content of these soils is within 3 percent of their respective optimum moisture content. Any soil materials with 3 percent or higher in-situ moisture content than its optimum moisture content could be put aside to dry, or 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 borehole data indicate that in general, native soils should be suitable for backfilling. Clean earth fill materials may also be used for backfilling with selection and sorting. The selection and sorting of the earth fill materials must be conducted under the supervision of a qualified geotechnical engineer. The site soils will be best compacted with a heavy sheepsfoot type roller.

In settlement sensitive areas such as beneath floor slab and pavement, the backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less, and heavily compacted to a minimum of 95 percent SPMDD at a water content close to optimum. The upper 1.0 m of the slab and pavement subgrade fill should be compacted to a minimum of 98 percent SPMDD. It should be noted that soils encountered on the site are generally not free draining, therefore earthworks could be difficult to carry out in wet seasons such as spring and fall.

5.7 Earthquake Design Parameters

Ontario Building Code (2006) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code (2006). The classification is based on the determination of the average shear wave velocity in the top 30 meters of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated on the basis of rational analysis of undrained shear strength (s_u) or penetration resistance (N-values).

$$v_{s-avg} = \frac{\sum_{i=1}^n d_i}{\sum_{i=1}^n \frac{d_i}{v_{si}}}$$

$$S_{u-avg} = \frac{\sum_{i=1}^n d_i}{\sum_{i=1}^n \frac{d_i}{s_{ui}}}$$

$$N_{avg} = \frac{\sum_{i=1}^n d_i}{\sum_{i=1}^n \frac{d_i}{N_i}}$$

Shear wave
velocity

Undrained
shear strength

SPT – values

At this site, the stratigraphy consists of fill materials extending to a depth of about 2 to 3 m below grade underlain by undisturbed native soil deposit with penetration resistance ranging from about 35 blows to over 100 blows per 300 mm of penetration.

For seismic design purposes, the weighted Average Standard Penetration Resistance is taken as between 15 to 50 blows per 300 mm. On this basis, the site designation for seismic analysis is Class D, according to Table 4.1.8.4.A of the Ontario Building Code (2006). Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration and velocity based site coefficients.

Site Class	Values of F_a (acceleration-based site coefficient)				
	$S_a(0.2) \leq 0.25$	$S_a(0.2) = 0.50$	$S_a(0.2) = 0.75$	$S_a(0.2) = 1.00$	$S_a(0.2) \geq 1.25$
D	1.3	1.2	1.1	1.1	1

Site Class	Values of F_v (velocity-based site coefficient)				
	$S_a(1.0) \leq 0.1$	$S_a(1.0) = 0.2$	$S_a(1.0) = 0.3$	$S_a(1.0) = 0.4$	$S_a(1.0) \geq 0.5$
D	1.4	1.3	1.2	1.1	1.1

It should be noted that the above site designation is estimated on the basis of rational analysis of penetration resistance (N-values) with assumed N-values for the soil stratigraphy beyond the investigation depth. The seismic site designation should be reviewed once the foundation details of the building are finalized. Based on the design foundation elevations, an improved seismic site designation may be achieved. Alternatively, consideration should be given to conduct a site specific Multichannel Analysis of Surface Waves (MASW) to determine the average shear wave velocity in the top 30 meters of the site stratigraphy. The site specific shear wave analysis may result in an improved seismic site designation which may help reduce the cost implication for the structure designed on the basis of a Class D.

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 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 changes with respect to the contents of this report.

The investigation at this site was conceived and executed to provide information for project design. It may not be possible to drill a sufficient number of boreholes or sample 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.

This report was prepared for the express use of Egan Funeral Home c/o George Robb Architect and its retained design consultants. It is not for use by others. This report is copyright of Terraprobe Limited and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Limited and Egan Funeral Home c/o George Robb Architect who are the authorized users.

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 Limited

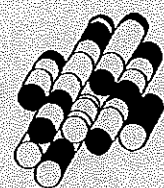


Bali Grewal, P. Eng.
Project Engineer

Mike Tanos, P. Eng.
Principal

APPENDIX

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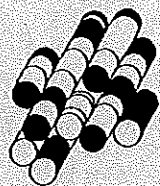


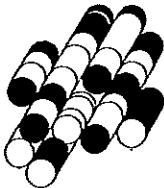
BOREHOLE LOGS

SAMPLING METHOD		PENETRATION RESISTANCE		
SS	split spoon	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.).		
ST	Shelby tube			
AS	auger sample			
WS	wash sample			
RC	rock core			
WH	weight of hammer	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.).		
PH	pressure, hydraulic			
SOIL DESCRIPTION - COHESIONLESS SOILS		SOIL DESCRIPTION - COHESIVE SOILS		
Relative Density	'N' value	Consistency	Undrained Shear Strength, kPa	'N' value
very loose	< 4	very soft	< 12	< 2
loose	4 - 10	soft	12 - 25	2 - 4
compact	10 - 30	firm	25 - 50	4 - 8
dense	30 - 50	stiff	50 - 100	8 - 15
very dense	> 50	very stiff	100 - 200	15 - 30
		hard	> 200	> 30
SOIL COMPOSITION		TESTS, SYMBOLS		
	% by weight	MH	mechanical sieve and hydrometer analysis	
'trace' (e.g. trace silt)	< 10	w, w _c	water content	
'some' (e.g. some gravel)	10 - 20	w _l	liquid limit	
adjective (e.g. sandy)	20 - 35	w _p	plastic limit	
'and' (e.g. sand and gravel)	35 - 50	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.				

BOREHOLE LOGS

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PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

EQUIPMENT: Bombardier

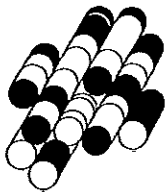
ELEVATION DATUM:

FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa		W P	W	W L		
253.9	Ground Surface						20	40	60	80	100		
253.8	80mm Asphalt												
0.1													
253.6	SAND AND GRAVEL		1	SS	20								
0.3	compact, grey, moist												
	CLAYEY SILT, trace gravel, very stiff, greyish, moist		2	SS	30	253							
	hard												
251.9			3	SS	59	252							
2.0	End of Borehole												

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

Sheet 1 of 1



PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

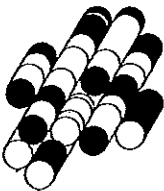
EQUIPMENT: Bombardier

ELEVATION DATUM:

FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa						
253.9	Ground Surface												
253.8	50mm Asphalt												
0.1													
253.7	ASPHALT WITH GRAVEL		1	SS	11								
0.2	CLAYEY SILT, trace gravel stiff, brown, moist ---- hard		2	SS	50								
			3	SS	65								
251.9													
2.0	End of Borehole												

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



PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

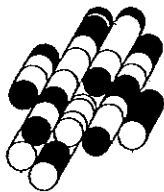
EQUIPMENT: Bombardier

ELEVATION DATUM:

FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					w _p	w	w _L		
							20	40	60	80	100					
253.9	Ground Surface															
253.8	50mm Asphalt															
0.1	ASPHALT AND GRAVEL															
253.7	FILL - Sand with Silt and Clay, loose, brown, moist		1	SS	11								10	20	30	
0.2																
253.1																
0.8	CLAYEY SILT trace gravel, hard, brown, moist		2	SS	39	253								20		
	----- very hard															
			3	SS	55									20		
251.9						252										
2.0	End of Borehole															

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



PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

EQUIPMENT: Bombardier

ELEVATION DATUM:

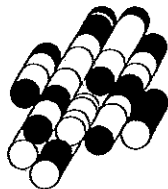
FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa		W P W W L				
							20 40 60 80 100	20 40 60 80 100	WATER CONTENT (%)				
							○ UNCONFINED + FIELD VANE						
							● POCKET PEN. x LAB VANE						
253.9	Ground Surface												
253.8	50mm Asphalt												
0.1													
253.6	ASPHALT, SAND AND GRAVEL		1	SS	9								
0.3	CLAYEY SILT												
	trace gravel, topsoil stains,												
	stiff, blackish grey, moist												

	hard brown		2	SS	21	253							
			3	SS	52	252							
			4	SS	46	251							
			5	SS	43	250							

	greyish		6	SS	57	249							
													</

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



PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

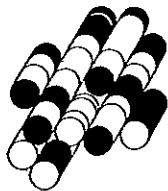
EQUIPMENT: Bombardier

ELEVATION DATUM:

FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	WATER CONTENT (%)	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa								
							○ UNCONFINED	+ FIELD VANE							
							● POCKET PEN.	x LAB VANE							
254.0	Ground Surface					20	40	60	80	100	10	20	30		
253.6	50mm Asphalt														
0.1	SAND WITH ASPHALT AND GRAVEL compact, brown, moist		1	SS	16										
253.4															
0.6	CLAYEY SILT trace gravel, trace topsoil, topsoil staining, stiff, greyish brown, moist		2	SS	15	253									
	trace gravel, very stiff, brown		3	SS	36	252									
	hard		4	SS	50	251									
	stiff, greyish brown		5	SS	16	250									
	very stiff		6	SS	28	249									
	hard		7	SS	49	248									
247.4	End of Borehole														
6.6															

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



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LOG OF BOREHOLE 11

PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

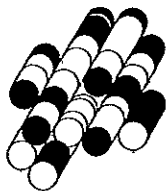
EQUIPMENT: Manual 70lb Hammer

ELEVATION DATUM:

FILE: 1-08-3182

SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa							
							○ UNCONFINED	+ FIELD VANE	● POCKET PEN.					
254.2	Ground Surface					20	40	60	80	100	WATER CONTENT (%)			
0.0						20	40	60	80	100	10	20	30	
	FILL - Sand and Gravel over Sandy Silt, loose, brown, moist		1	SS	9	254								
253.4														
0.8	FILL - Sand, some gravel, loose, brown, wet		2	SS	4	253								
253.0														
1.2	FILL - Clayey Silt, trace gravel, soft, brown, moist lumps of clay, damp		3	SS	5	253								
252.1														
2.1	TOPSOIL, rootlets, loose, black, damp					252								
251.9														
2.3	CLAYEY SILT, topsoil staining, stiff, blackish, moist		4	SS	11	251.5								
251.5														
2.7	CLAYEY SILT, laminated, stiff, grey, moist					251.2								
251.2														
3.0	SILTY CLAY stiff, grey, moist to wet		5	SS	11	251								
			6	SS	10	250								
			7	SS	8	249								
248.9														
5.3	CLAYEY SILT stiff, grey, very moist		8	SS	7									
248.1														
6.1	End of Borehole													

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



PROJECT: Egan Funeral Home

LOCATION: Bolton

CLIENT: Egan Funeral Home

DATE: July 23, 2008

EQUIPMENT: Manual 70lb Hammer

ELEVATION DATUM:

FILE: 1-08-3182

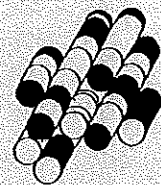
SOIL PROFILE			SAMPLES			ELEVATION SCALE	PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa																		
							20 40 60 80 100																		
254.2	Ground Surface						○ UNCONFINED + FIELD VANE					● POCKET PEN. x LAB VANE					WATER CONTENT (%)								
253.8	140mm Concrete Slab On Grade						20 40 60 80 100					10 20 30													
0.1	FILL - Sand, some silt, trace gravel, very loose, brown, moist		1	SS	2	254																			
			2	SS	1	253																			
252.7																									
1.5	FILL - Sand and Silt, trace gravel, loose, grey, very moist																								
252.4																									
1.8	CLAYEY SILT TO SILTY CLAY trace sand, firm, grey, moist		3	SS	5	252																			
251.9																									
2.3	CLAYEY SILT very stiff to hard, greyish brown, moist (GLACIAL TILL)		4	SS	15																				
			5	SS	41	251																			
			6	SS	23	250																			
	trace sand, trace gravel		7	SS	38																				
249.2																									
5.0	End of Borehole																								

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

Sheet 1 of 1

SIEVE AND HYDROMETER ANALYSIS

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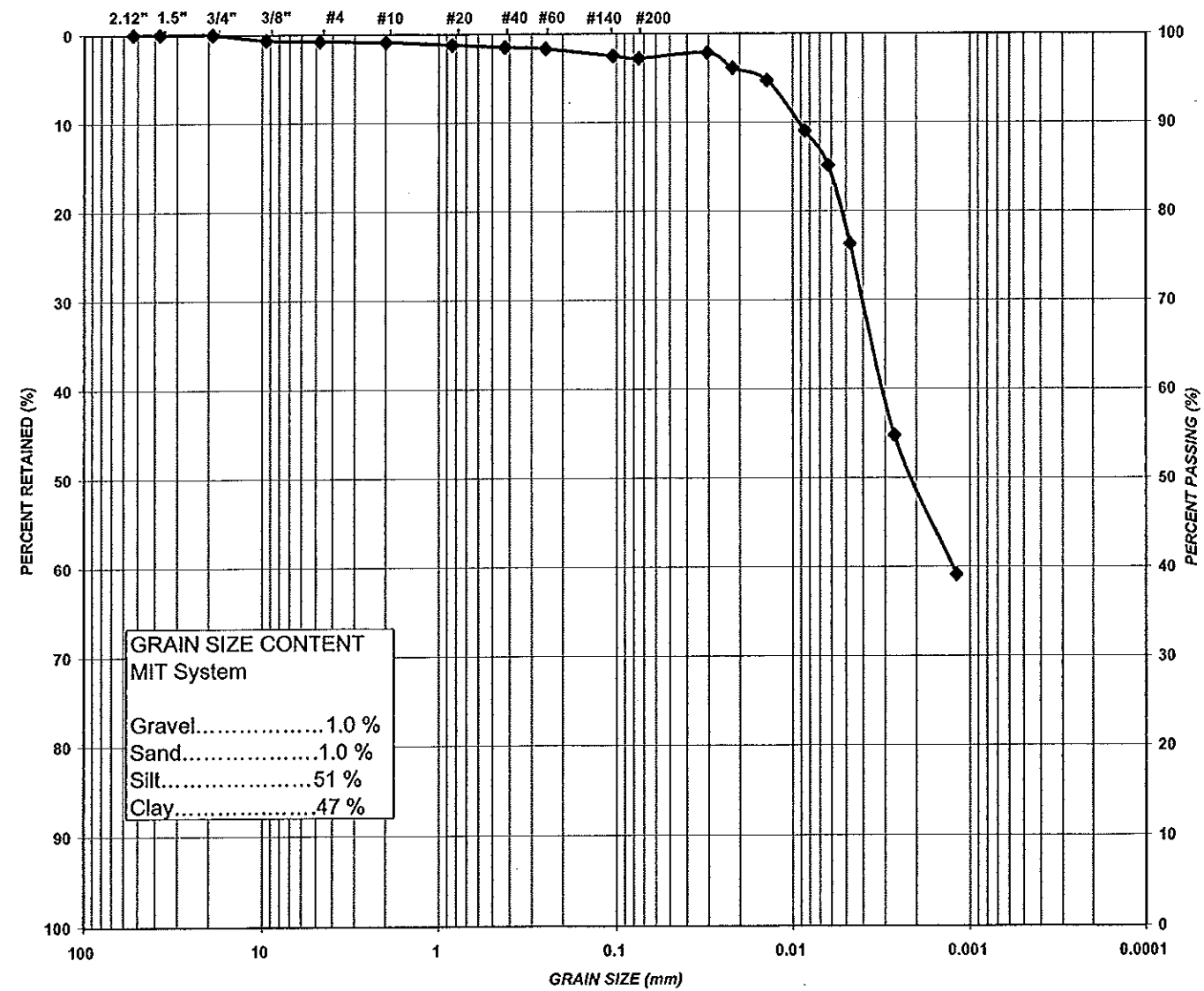




PROJECT: Egan Funeral Home
LOCATION: 203 Queen Street, Bolton, Ontario
CLIENT: Egan Funeral Home
BOREHOLE: 7
SAMPLE NUMBER: 3
SAMPLE DEPTH: 3.8 - 4.0 m
SAMPLE DESCRIPTION: CLAYEY SILT, trace sand, trace gravel

FILE NO.: 1-08-3182
LAB NO.: 1218B
SAMPLE DATE: July 23, 2008
SAMPLED BY: B.R. & H. B.

U.S. STANDARD SIEVE SIZES



MIT SYSTEM	GRAVEL		COARSE	MEDIUM	FINE	SILT	CLAY
			SAND				
UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY	
	GRAVEL		SAND				



Terraprobe

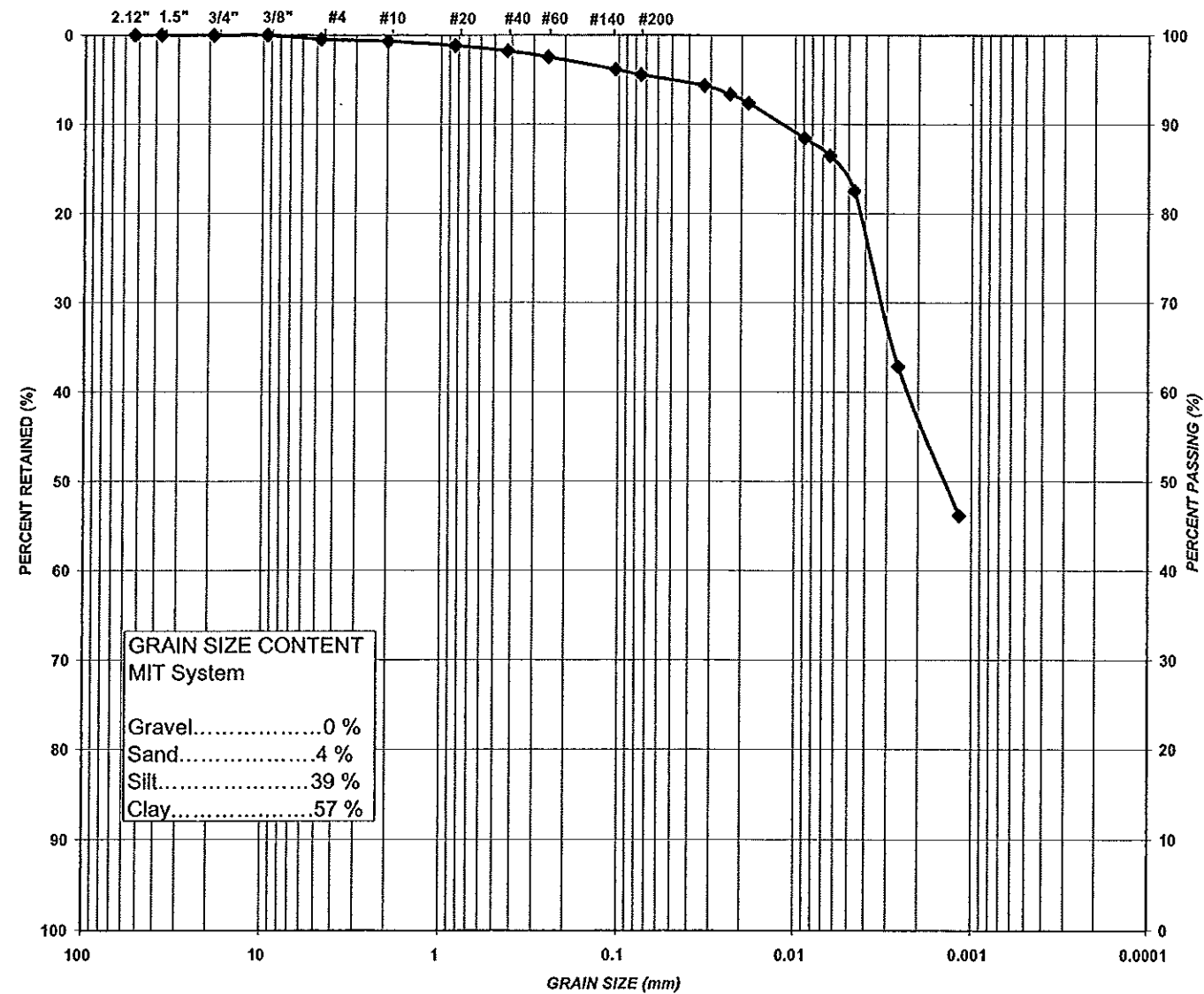
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: Egan Funeral Home
LOCATION: 203 Queen Street, Bolton, Ontario
CLIENT: Egan Funeral Home
BOREHOLE: 11
SAMPLE NUMBER: 6
SAMPLE DEPTH: 1.5 - 2.13 m
SAMPLE DESCRIPTION: SILTY CLAY, trace sand

FILE NO.: 1-08-3182
LAB NO.: 1218A
SAMPLE DATE: July 23, 2008
SAMPLED BY: B.R. & H. B.

GRAIN SIZE DISTRIBUTION

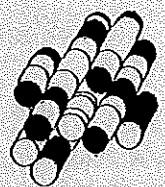
U.S. STANDARD SIEVE SIZES



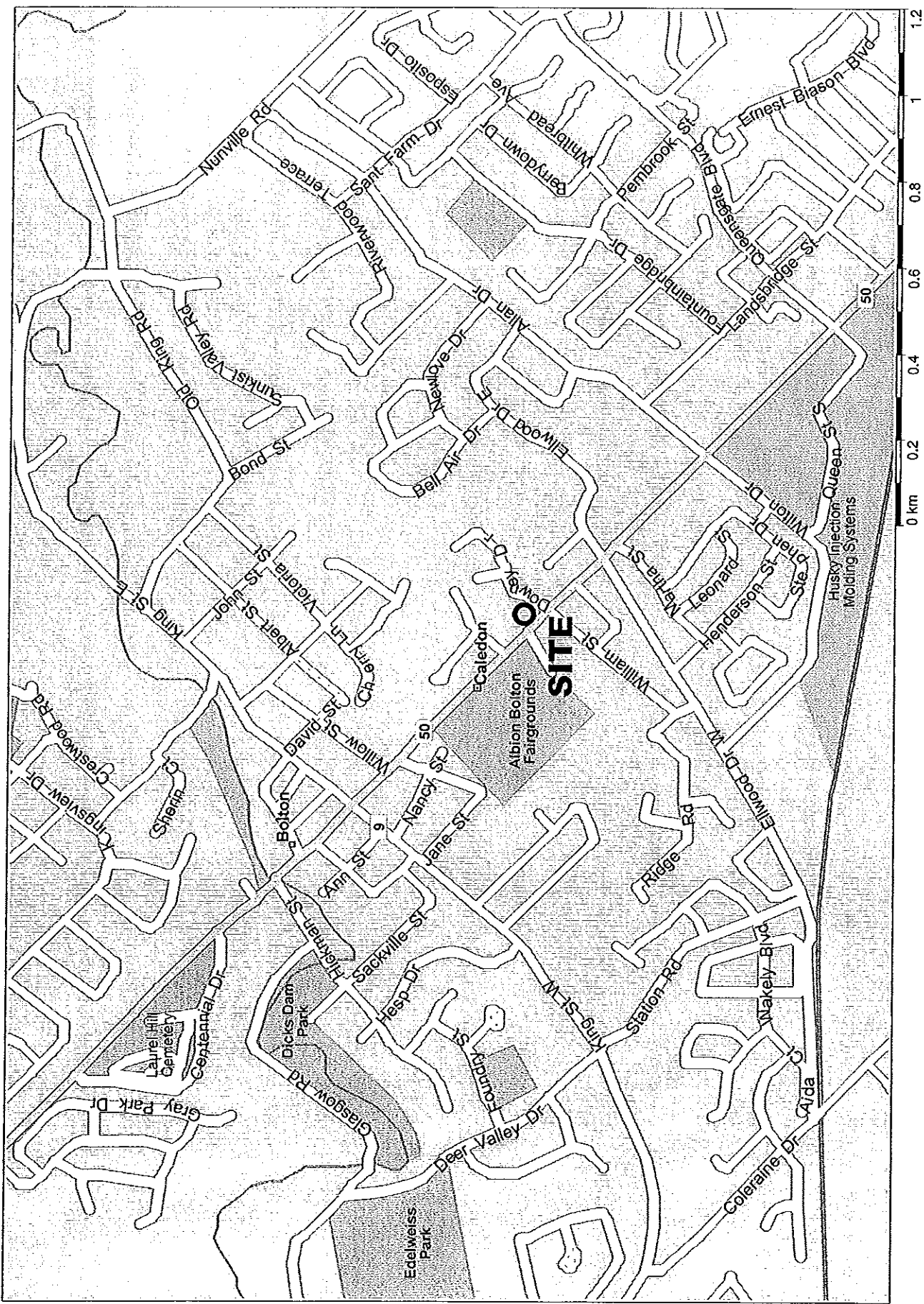
MIT SYSTEM	GRAVEL		COARSE	MEDIUM	FINE	SILT	CLAY
			SAND				
UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY	
	GRAVEL		SAND				

FIGURES

Terraprobe Limited



203 Queen Street South, Bolton, Ontario

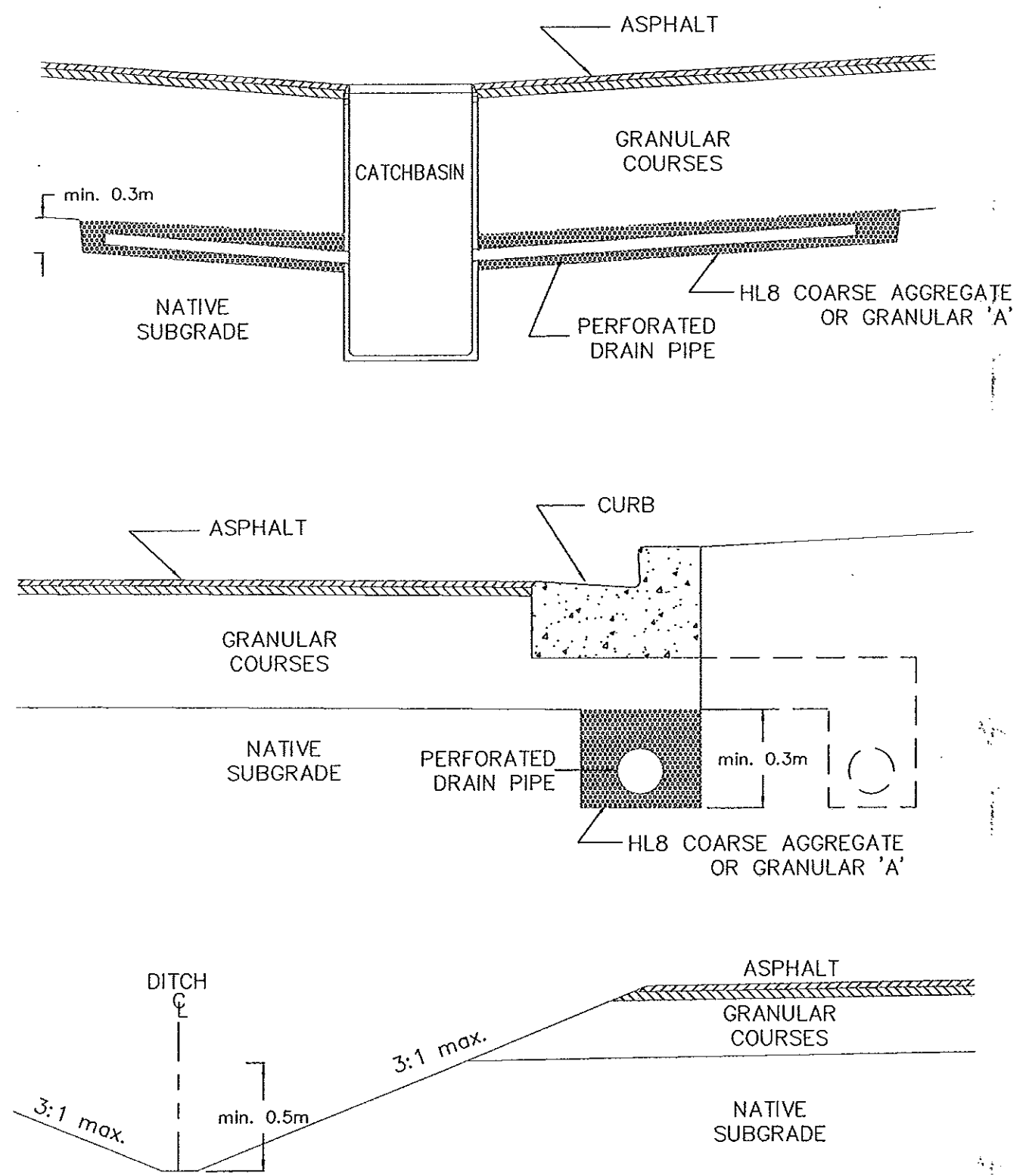


SITE LOCATION PLAN

TERRAPROBE

File No. 1-08-3182

FIGURE 1



PAVEMENT DRAINAGE ALTERNATIVES