GEOSPEC ENGINEERING LTD.
287 Tiffin Street, Unit 10, Barrie, Ontario L4N 7R8 TEL: (705) 722-4638 FAX: (705) 722-4958

CONFIDENTIAL

GEOTECHNICAL INVESTIGATION

27 & 31 BLAKE STREET
BARRIE, ONTARIO

PREPARED FOR:

Salter Pilon Architecture Inc.

151 Ferris Lane, Suite 400

Barrie, Ontario

L4M 6C1

Geospec Project N° 11-1660

August 12, 2011

Distribution: 1 – Client

EXECUTIVE SUMMARY

Further to authorization from Mr. G. Pilon on behalf of Salter Pilon Architecture Inc., **Geospec Engineering Ltd.** carried out a geotechnical investigation for a proposed three storey apartment building with basement, located at 27 & 31 Blake Street, Barrie, Ontario.

The fieldwork included the advancement of three drilled boreholes to a depth of 6.6 meters below the existing grade levels. The approximate borehole locations are identified on the Borehole Plan.

The boreholes generally encountered topsoil over an original deposit of sand & silt till or sandy silt. The condition of the original soil, within the depth of the investigation, varied from very loose to very dense being generally compact to dense. Furthermore, groundwater was encountered at depths varying between 2.2 to 2.7 meters below the existing grade levels. As a result, control of groundwater beyond standard filtered sump pits will only be a significant construction consideration in site development for excavations deeper than 2.5 meters.

Finally, based on the results of the investigation, we recommend that strip and spread footings founded at depths of 1.5 to 1.7 meters below the existing grade levels may be designed using a Soil Bearing Resistance of 200 kPa (SLS) when founded on original undisturbed soil.

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1.0 INTRODUCTION

Geospec Engineering Ltd. was retained by Mr. Gerry Pilon, on behalf of Salter Pilon Architecture Inc. to carry out a geotechnical investigation for a proposed three storey apartment building with basement located at 27 & 31 Blake Street, Barrie, Ontario. The approximate site location is identified on the Site Location Plan (Figure 1).

Figure 1: Site Location Plan

source: maps.simcoe.ca

27 & 31 Blake Street, Barrie

The purpose of the investigation was discussed with Mr. Pilon, between June 16 & 27, 2011. Based upon these communications, it was our understanding that a three storey apartment building with basement is proposed for the two lots. Furthermore, the two residences which currently exist on the property are to be demolished. This investigation was required in order to provide information to assist in the initial assessment of the shallow subsurface conditions and groundwater conditions. The boreholes were advanced as access permitted in the proposed building area.

This report briefly describes the fieldwork completed, subsurface conditions encountered and our general recommendations based on the information obtained.

2.0 FIELDWORK

In conjunction with our June 15th quotation, the investigation included the following:

- The advancement of three (3) boreholes drilled to a depth of 6.6 meters below the existing grade levels.
- The installation of three (3) 19 mm PVC standpipes in selected drilled boreholes.

Fieldwork was carried out, on July 30th, under the full time supervision of an experienced field supervisor registered in the Engineering Intern Training (EIT) program from the Professional Engineers of Ontario (PEO). A truck mounted drilling machine provided and operated by a specialist drilling contractor augured the boreholes. Finally, Standard Penetration Tests were carried out intermittently and discontinuous soil samples were recovered at regular intervals through the subsurface soil during the borehole advancement.

A Standard Penetration Test is a method of sampling soil, which has been standardized by the American Society for Testing and Materials ASTM D-1586. The test consists of driving a standard split-barrel sampler a distance of 45 cm into undisturbed soil, at the elevation to be tested, using a 63.5 kg driving mass falling free from a height of 76 cm, and totaling the number of blows to drive the sampler the last 30 cm.

All soil samples recovered were visually identified, classified and appropriately logged in the field. They were then individually bagged, labeled, and returned to our laboratory for a formal assessment by a geotechnical engineer in conjunction with routine laboratory analysis. The laboratory test program included moisture content determinations on all collected samples, as well as grain size analyses on selected samples.

Groundwater conditions were also observed in each borehole during and on completion of drilling. We reiterate that 19 mm PVC standpipes were installed in selected boreholes to facilitate groundwater measurements over an extended period of time. The resulting observations are detailed on the accompanying Borehole Logs (Enclosures N° 2 to 4).

The surface elevation at each borehole location was referenced to a Temporary Benchmark (TBM) with elevation assumed to be 100.0 meters. The TBM utilized was the base flange of the fire hydrant located across Blake Street from the site. The resulting elevation of each borehole is shown on the Borehole Plan (Enclosure N° 1) as well as in each borehole log respectively.

3.0 SUMMARIZED SUBSURFACE SOIL CONDITIONS

Briefly, site stratigraphy generally included a layer of topsoil over sand & silt till or sandy silt. Details of the subsurface conditions encountered in the boreholes are given on the Borehole Logs (Enclosures N°s 2 to 4). A summary of the subsurface conditions are provided in the following sections.

3.1 Surface Cover

At the surface of all borehole locations was a layer comprised of topsoil extending to an approximate depth of 50 centimetres below the existing grade levels. We do advise that the thickness of the topsoil as well as any fill can vary; therefore, allowances for possible variations across the area of the proposed development should be considered.

3.2 Sand & Silt Till

Extending below the topsoil described above, at Borehole N°s 1 & 3, to beyond the full depth investigated at these locations was a till deposit predominantly comprised of sand and silt with trace gravel to gravelly and occasional cobbles.

Standard Penetration Test results established that the Compactness Condition of the till deposit ranged from very loose to very dense (N value= 3 to >80 blows/30 cm), being generally dense. Moisture Content analysis established moistures ranging from 7 to 20%, indicative of a moist to wet deposit.

Frequently, a till deposit contains sand seams or pockets at variable depths as revealed in the final sample acquired from Borehole N° 3 (Enclosure N° 4) and Borehole N° 2. It is our considered opinion that soil encountered at Borehole N° 2, being sandy silt, is merely a large pocket of sandy silt within a local till deposit. These seams are outwash sediments deposited primarily as a result of glacial recession. Often, these veins store 'perched' water and may be seasonally saturated. Consequently, the till mass around the saturated normally cohesionless pockets or seams are also saturated or quasi-saturated.

Finally, gradation analysis of the till deposit (excluding cobbles & boulders) established a wide range of particle sizes, from fine-grained soil (particles smaller than 0.075 mm) to gravel (particles larger than 4.75 mm) of 40-54% sand, 34-38% silt and 8-26% gravel for the samples tested. The geotechnical characteristics normally associated with this type of deposit are provided in Table 1.

3.3 Sandy Silt

Encountered under the topsoil at Borehole N° 2, was a deposit of sandy silt with trace gravel. At Borehole N° 2, this deposit extended beyond the final borehole depth investigated.

Standard Penetration Test results established that the Compactness Condition of the deposit ranged from loose to very dense (N value= 9 to >80 blows/30 cm), responding to a direct proportionality with depth; while Moisture Content analysis established moistures ranging from 6 to 19%, indicative of a moist to wet deposit.

Finally, gradation analysis of the deposit (excluding cobbles & boulders) established a composition of approximately 70% silt, 26% sand and 4% gravel. The geotechnical characteristics normally associated with this type of deposit are provided in Table 1.

Table 1: Typical Soil Characteristics Associated with Site Soil

Soil Type	**Sand & Silt Till**	**Sandy Silt**
OHSA Soil Type	Type 1& 2	Type 2 & 3
	(Above/Below water)	(Above/Below water)
Soil Characteristic		
SPT Result (N-value)	3->80	9->80
Moisture Content (%)	7-20	6-19
Approximate Effective Size D_{10} (mm)	<0.01	<0.002
Soil Properties		
Consistency/Compactness Condition	Very Loose to Very Dense	Very Loose to Very Dense
Moisture State	Moist to Wet	Moist to Wet
Cohesiveness	Slightly cohesive	Cohesionless
Bulk Unit Weight (kg/m^3)		
Loose	1850-1950	1350-1400
Compact/Firm	1950-2050	1400-1450
Dense	2050-2200	1450-1500
Internal Friction Angle (°)		
Loose to compact	30-35	28-29
Compact	35-39	30-33
Dense	40-45	33-35
Lateral Earth Pressure Coefficient	39°	32°
(At Rest) K_o	0.37	0.47
(Active) K_a	0.23	0.31
(Passive) K_p	4.4	3.25
Susceptibility to Erosion	Moderate	High
Permeability (cm/sec)	$10^{-5} - 10^{-6}$	$<10^{-6}$
Drainage		
By Gravity	Poor	Poor
By Well Points	Success depends on silt content	Success depends on silt content
Capillarity	Moderate to High	High
Frost Susceptibility	Objectionable	High
Adfreezing Potential	Objectionable	High
Response to Compaction	Fair to poor	Poor to Fair

4.0 GROUNDWATER CONDITIONS

Groundwater conditions in the form of seepage or free water was noted during the drilling and sampling operations and measured on completion of each borehole. In addition, 19 mm diameter PVC (Polyvinyl Chloride) standpipes were installed in each borehole.

In order to reduce the effects of the intrusive drilling operation and in an effort to allow time for the groundwater to stabilize the water levels in all boreholes were measured in the installed standpipes on August 8th, 2011. The resulting water level measurements are presented in Table 2.

Table 2: Groundwater Measurements

Borehole N°	During Drilling		Standpipe – August 8th	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
1	Dry	-	2.2	96.2
2	3.6	93.2	2.5	94.3
3	4.4	92.8	2.7	94.5

We do advise that the shallow groundwater level will fluctuate seasonally, especially during periods of high precipitation and spring runoff.

We do advise that any excavation extended below the water table will require the installation of groundwater control systems. Based upon the subsurface information recovered, it is our considered opinion that a trench drainage system connected to filtered sump pumps should sufficiently control seepage in shallow temporary excavations of less than 2.5 meters.

5.0 GEOTECHNICAL CONSIDERATIONS

To reiterate, we have been advised that consideration is being given to the construction of a three-storey apartment building with basement in the area of the boreholes. Furthermore, due to the change in grade across the proposed building area, we understand consideration is being given to conventional strip and spread foundations set at depths in the order of 1.5-2.0 meters below the existing grade levels. We do advise that at the time of compilation of this geotechnical investigation, our office had not been advised of final development grades. Therefore, only general recommendations are provided and a review of the final project grading and profiles must be completed in order to ascertain whether the recommendations given are appropriate or require modification(s).

Nevertheless, based upon the subsurface conditions encountered at the boreholes, we offer the following preliminary geotechnical recommendations.

5.1 Site Stripping & Grading

Drainage available due to site topography in combination with the moist surface conditions across a majority of the site, suggest that difficulties stripping or grading with conventional equipment through standard cut and fill practices should not occur from a wet ground perspective. However, complications in construction during periods of unfavourable weather should always be anticipated.

We do advise that the samples recovered suggest that the existing native soil, comprised a significant percentage of silt, is not considered a favourable soil for reuse. Soil including greater than 8% silt is ***not*** considered optimum material since it would be difficult to compact to the specified degree without additional work effort. We advise that an imported granular fill has proven to be a better alternative. In our experience a well graded sand and gravel proves to be an effective material from a workable and overall performance point of view.

It is recommended that mass grading operations be completed during the dry summer months of the year in order to benefit from the potentially improved soil compaction characteristics. All material, free of organic matter or other deleterious inclusions, may be placed at or below Optimum Moisture Content and uniformly compacted in maximum 30 cm thick lifts to a degree of compaction required by design. We do stress that non-approved fill and organically included material are considered unsuitable for reuse in structurally sensitive areas. **Also all in place organically included material and fill must be removed from any structurally sensitive area.**

The addition of water during the compaction operations may be necessary to enable the maximum soil density to be achieved in the fill placed. Finally, any oversized cobbles or boulders (> 150 mm diameter) must be discarded in designated non-structural areas.

5.2 Foundation Recommendations

Based on the results of our investigation, we advise that the condition of the original undisturbed soil generally varied from compact to dense. As a result, it is our considered opinion that strip and spread footings may be incorporated into the development design.

Footing excavations extended to the minimum depths provided in Table 3 may be designed using the corresponding Soil Bearing Resistance (SLS) and Factored Bearing Resistance (ULS).

Table 3: Conventional Spread and Strip Footings Depths

Borehole N°	Approximate Depth (cm)	Approximate Elevation (m)*	Soil Bearing Resistance kPa (SLS)	Factored Bearing Resistance kPa (ULS)
1	150	96.9	200	300
2	150	95.3	200	300
3	170	95.5	200	300

*Based on site temporary bench mark (see Borehole Plan)

It must be noted that soil bearing resistance given is based on information obtained from the boreholes. Specific information with respect to soil conditions between boreholes is available during excavation of the foundations. Therefore, all excavated founding elevations must be inspected by a representative of **Geospec Engineering Ltd.** prior to forming and the placement of concrete, to ensure that the required bearing capacity is being complied with.

For the purpose of frost protection, all exterior footings and footings exposed to frost action should be covered by at least 122 cm of soil.

5.3 Slab on Grade Recommendations

For normal slab on grade construction, we recommend all organic matter, very loose soil and non-engineered fill be removed. The subgrade at the stripped grade level should then be proofrolled with a heavy smooth drum roller prior to placing any underfloor fill. Any soft areas encountered during proofrolling should be subexcavated and replaced with a well compacted and approved granular material. All fill must be uniformly compacted, in lifts not exceeding 15 cm in thickness, to at least 98% Standard Proctor Dry Density. Furthermore, at least 15 cm of Granular 'A' type material should be placed directly below the floor slab to act as a moisture barrier.

The floor slab should be founded above the finished exterior grade and all surface run-off water should be directed away from the building.

In order to prevent frost heave of the slab and adfreezing to foundation walls, it is recommended that the backfill under the slab and adjacent to the foundation walls consist of a non-frost susceptible granular material compacted to a minimum 95% Standard

Proctor Dry Density.

5.4 Underground Wall Recommendations

It is our understanding that the site development is to include a multi storey structure with a partially raised basement. In this regard, we offer the following remarks.

During the excavation of the basement or any underground opening deeper than 120 cm, the sides of the excavation must be sloped to a maximum 3:1 inclination for Type 4 soil and 1:1 for Type 3 soil. All excavations must be carried out in full compliance with the most recent guidelines of the Occupational Health and Safety Act.

At the time of the investigation, the groundwater levels encountered were below the proposed footing elevation; however, we advise that localized variations of the groundwater level may be encountered across the site during and post development. We therefore recommend that the exterior underground walls be water-proofed, perimeter weeping tiles be installed around the exterior footings as well as the inclusion of a system of under floor weeping tiles connected to a positive frost free outlet.

Underground walls should be designed to resist a lateral earth pressure as defined by the following expression:

$$P[kN/m] = K_o(\tfrac{1}{2}H_1^2\gamma + qH_1 + H_2(H_1\gamma + q) + \tfrac{1}{2}H_2^2\gamma') + \tfrac{1}{2}H_2^2\gamma_w$$

Where:

K_o	is the Coefficient of Lateral Earth Pressure at Rest ($K_o = 0.5$)
H_1	is the Height of the underground wall below the finished exterior grade and above the water level
H_2	is the Height of the underground wall below the water level
γ	is the Bulk Unit Weight of Soil ($\gamma = 20$ kN/m^3)
γ'	is the Effective Unit Weight of Soil below water ($\gamma' = 13.2$ kN/m^3)
γ_w	is the Bulk Unit Weight of Water ($\gamma_w = 9.81$ kN/m^3)
q	is the surcharge load (Minimum q = 20 kPa)

See Appendix A drawing for the drainage and backfilling requirements for the exterior subsurface walls with perimeter weepers.

6.0 STATEMENT OF LIMITATIONS

It is important to note that this investigation did not include soil sampling and analysis for environmental conditions. The statement of limitations, as enclosed in Appendix B, is an integral part of this report.

We trust the report has been completed within our present terms of reference; however, if you should have any questions, please do not hesitate to contact the undersigned.

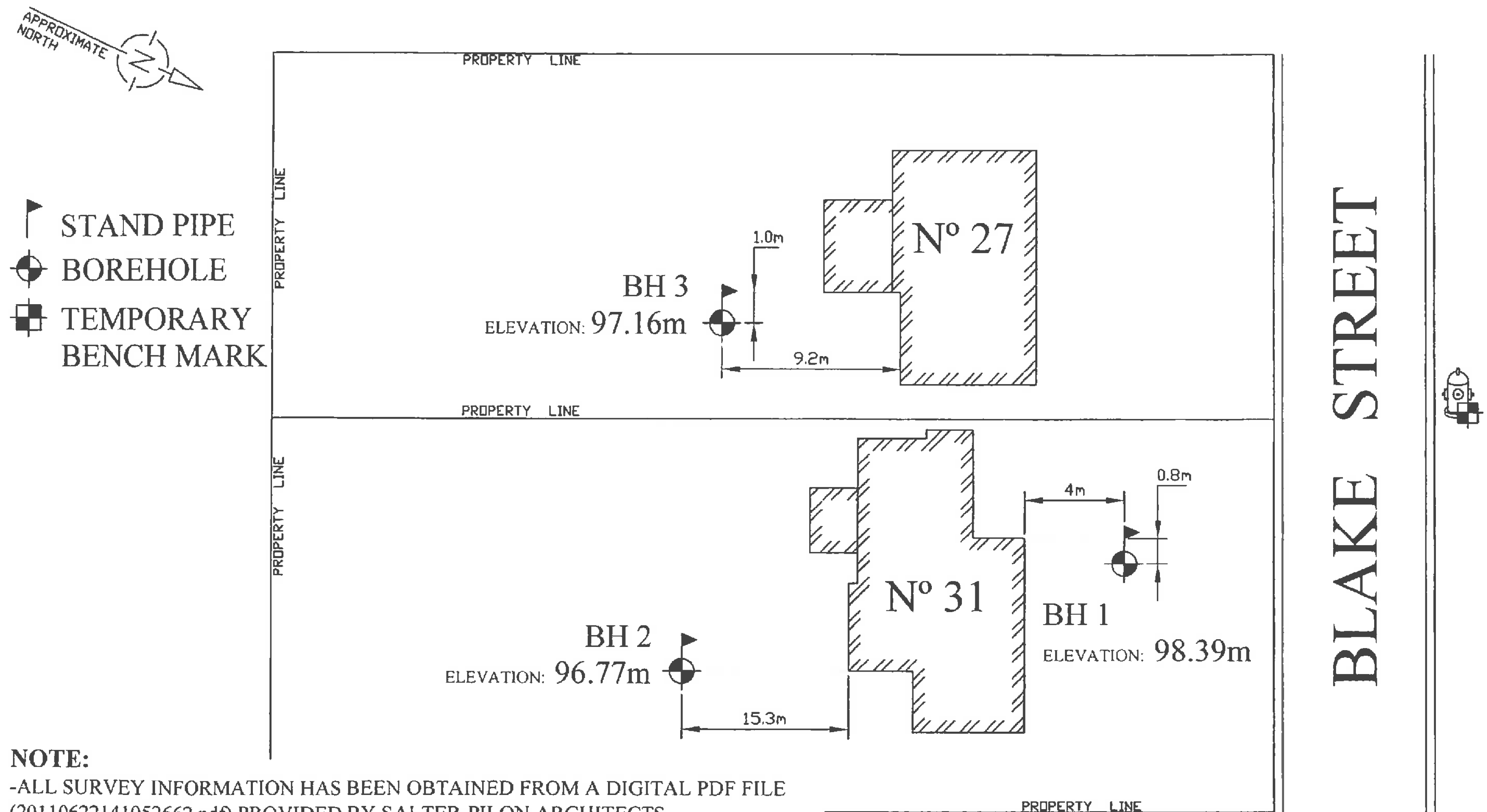
Reviewed by,

LICENSED PROFESSIONAL ENGINEER
M. K. MALCOLM
PROVINCE OF ONTARIO

Kent Malcolm, P. Eng.
Consulting Engineer

Enclosures

Borehole Plan
Borehole Logs
Grain Size Distribution Charts



NOTE:
-ALL SURVEY INFORMATION HAS BEEN OBTAINED FROM A DIGITAL PDF FILE (20110622141052662.pdf) PROVIDED BY SALTER-PILON ARCHITECTS.
-A TEMPORARY BENCH MARK WAS LOCATED AT THE BASE FLANGE OF THE SHOWN HYDRANT (LOCATION IS APPROXIMATE) WITH AN ESTIMATED ELEVATION OF 100.0m.

BOREHOLE PLAN

GEOSPEC ENGINEERING LTD.
287 Tiffin Street, Unit 10
Barrie, Ontario, L4N 7R8
TEL: (705) 722-4638
FAX: (705) 722-4958

CLIENT: Salter Pilon Architecture Inc.	PROJECT Nº: 11 - 1660	DATE: August 9 / 11	ENCL Nº: 1
PROJECT: 27 & 31 Blake Street, Barrie			SCALE: NOT TO SCALE

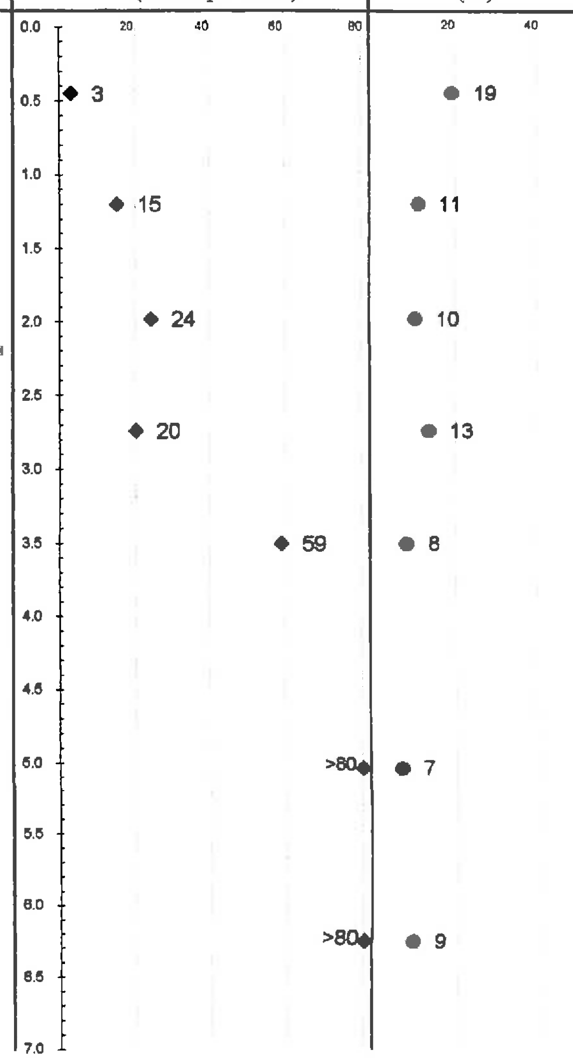
GEOSPEC ENGINEERING LTD.
287 Tiffin Street, Unit 10, Barrie, Ontario L4N 7R8
TEL: (705) 722-4638 FAX: (705) 722-4958

BOREHOLE LOG

CLIENT:	Salter Pilon Architecture Inc.	**DATE:**	August 05, 2011
		PROJECT N°:	11 - 1660
PROJECT:	27 & 31 Blake Street, Barrie	**BOREHOLE N°:**	1
		ENCLOSURE N°:	2
GROUND ELEVATION:	98.39 m	**BORING METHOD:**	Solid Stem Auger
BORING DATE:	July 30, 2011	**SAMPLING METHOD:**	Split Spoon
PAGE 1 **OF** 1			

ELEV (m)	SOIL DESCRIPTION (Unified Soil Classification System)	WATER (m)
	±50cm of **TOPSOIL** over **Sand & Silt Gravelly to trace Gravel TILL** Grey, Moist to Wet, Very Loose to Very Dense	
	Sand Layer	
	Gradation @ 1.2m ¬ Sand 40%, Silt 34%, Gravel 26%	
	Cobbles	
	Open & dry to 5.8m upon completion 19mm PVC standpipe installed to 6.1m Water level at 2.2m measured on August 8, 2011	
91.8	END OF BH	

N VALUE (Blows per 0.3m) | **WATER CONT** (%)



◆ Standard Penetration Test ▲Cone Penetration Test

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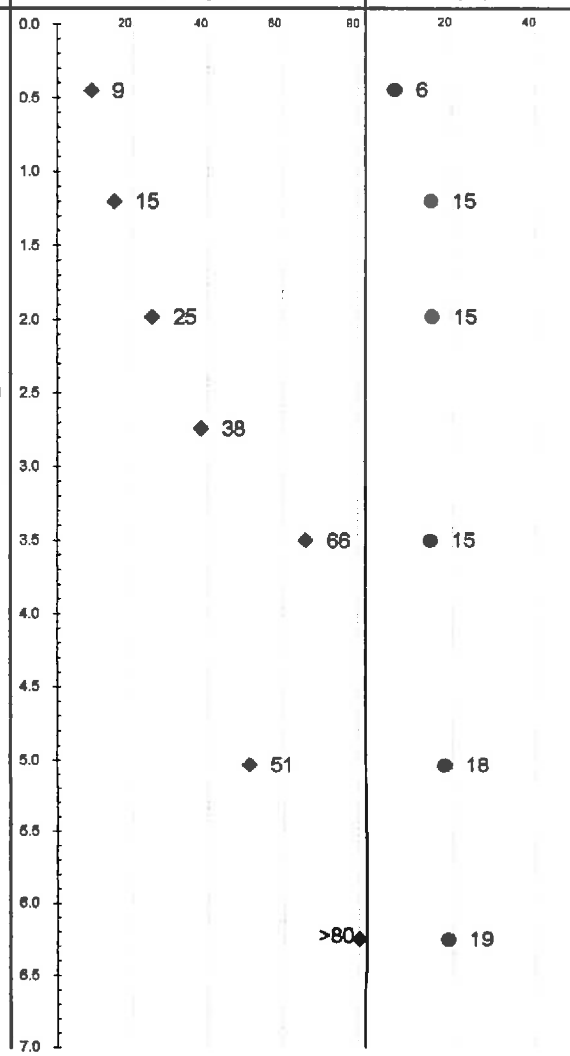
BOREHOLE LOG

CLIENT:	Salter Pilon Architecture Inc.	**DATE:**	August 05, 2011
		PROJECT N°:	11 - 1660
PROJECT:	27 & 31 Blake Street, Barrie	**BOREHOLE N°:**	2
		ENCLOSURE N°:	3
GROUND ELEVATION:	96.77 m	**BORING METHOD:**	Solid Stem Auger
BORING DATE:	July 30, 2011	**SAMPLING METHOD:**	Split Spoon
PAGE 1 **OF** 1			

ELEV (m)	SOIL DESCRIPTION (Unified Soil Classification System)	WATER (m)	N VALUE (Blows per 0.3m)	WATER CONT (%)
	±50cm of **TOPSOIL** over **Sandy Silt**, with trace Gravel Brown to Grey, Moist to Wet, Loose to Very Dense			
	Gradation @ 3.5m – Silt 70%, Sand 26%, Gravel 4%			
	Open to 4.6m, water at 3.6m from the surface upon completion 19mm PVC standpipe installed to 6.1m Water level at 2.5m measured on August 8, 2011			
90.2	END OF BH			



◆ Standard Penetration Test ▲Cone Penetration Test

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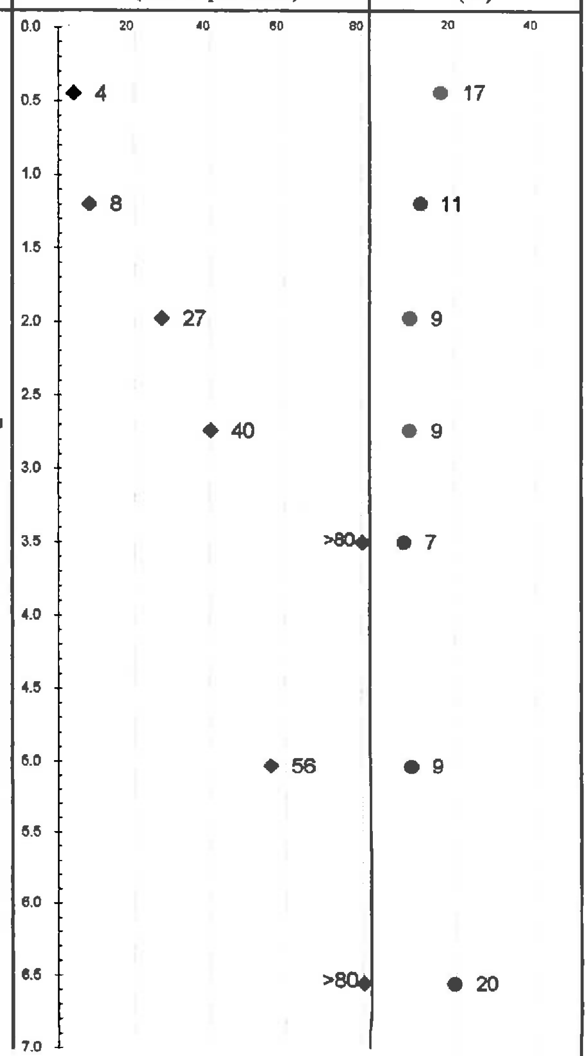
BOREHOLE LOG

CLIENT:	Salter Pilon Architecture Inc.	**DATE:**	August 05, 2011
		PROJECT N°:	11 - 1660
PROJECT:	27 & 31 Blake Street, Barrie	**BOREHOLE N°:**	3
		ENCLOSURE N°:	4
GROUND ELEVATION:	97.16 m	**BORING METHOD:**	Solid Stem Auger
BORING DATE:	July 30, 2011	**SAMPLING METHOD:**	Split Spoon
PAGE 1 **OF** 1			

ELEV (m)	SOIL DESCRIPTION (Unified Soil Classification System)	WATER (m)	N VALUE (Blows per 0.3m)	WATER CONT (%)
	±50cm of **TOPSOIL** over **Sand & Silt TILL**, with trace Gravel Grey, Moist to Wet, Very Loose to Very Dense Boulders Gradation @ 2.0m – Sand 54%, Silt 38%, Gravel 8% Cobbles Cobbles Open to 5.5m, water at 4.4m from the surface upon completion 19mm PVC standpipe installed to 6.1m Water level at 2.7m measured on August 8, 2011 Gradation @ 6.6m – Sand 96%, Silt 4%			
90.6	END OF BH			



◆ Standard Penetration Test ▲Cone Penetration Test

07/09

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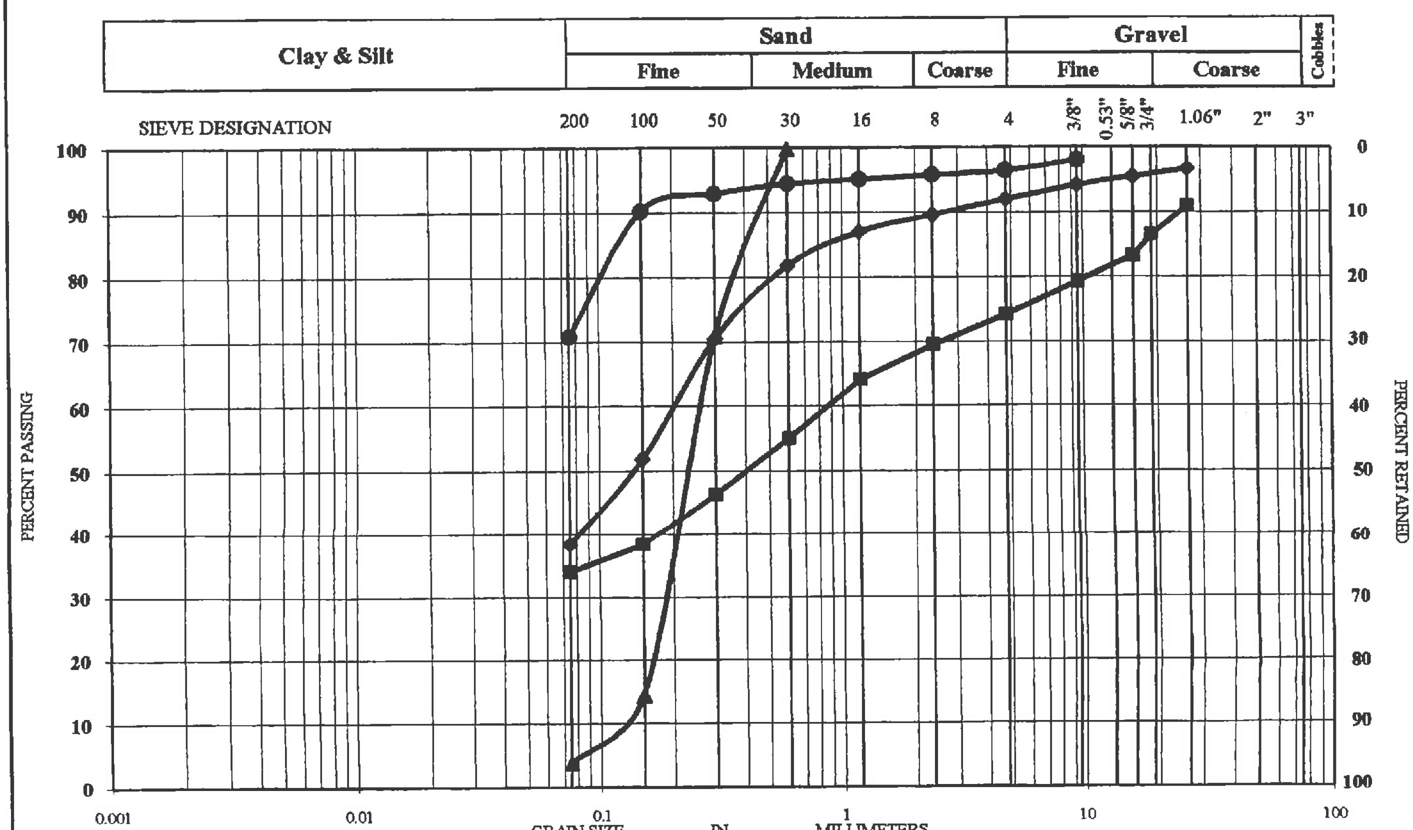
GRAIN SIZE DISTRIBUTION CHART

CLIENT:	Salter Pilon Architecture Inc.	**DATE:**	August 5, 2011
		ENCLOSURE N°:	5
PROJECT:	27 & 31 Blake Street, Barrie	**PROJECT N°:**	11 - 1660
LAB N° / TYPE:	84 / Native	**DATE SAMPLED:**	July 30, 2011
SAMPLED BY:	F.G.	**DATE RECEIVED:**	July 30, 2011
SAMPLED TYPE:	Split Spoon	**DATE TESTED:**	August 3, 2011
SAMPLED FROM:	BH 1 / 1.2 m Silty Gravelly Sand (Till)		BH 2 / 3.5 m Sandy Silt with trace Gravel
	BH 3 / 2.0 m Sand & Silt with trace Gravel (Till)		BH 3 / 6.6 m Sand with trace Silt

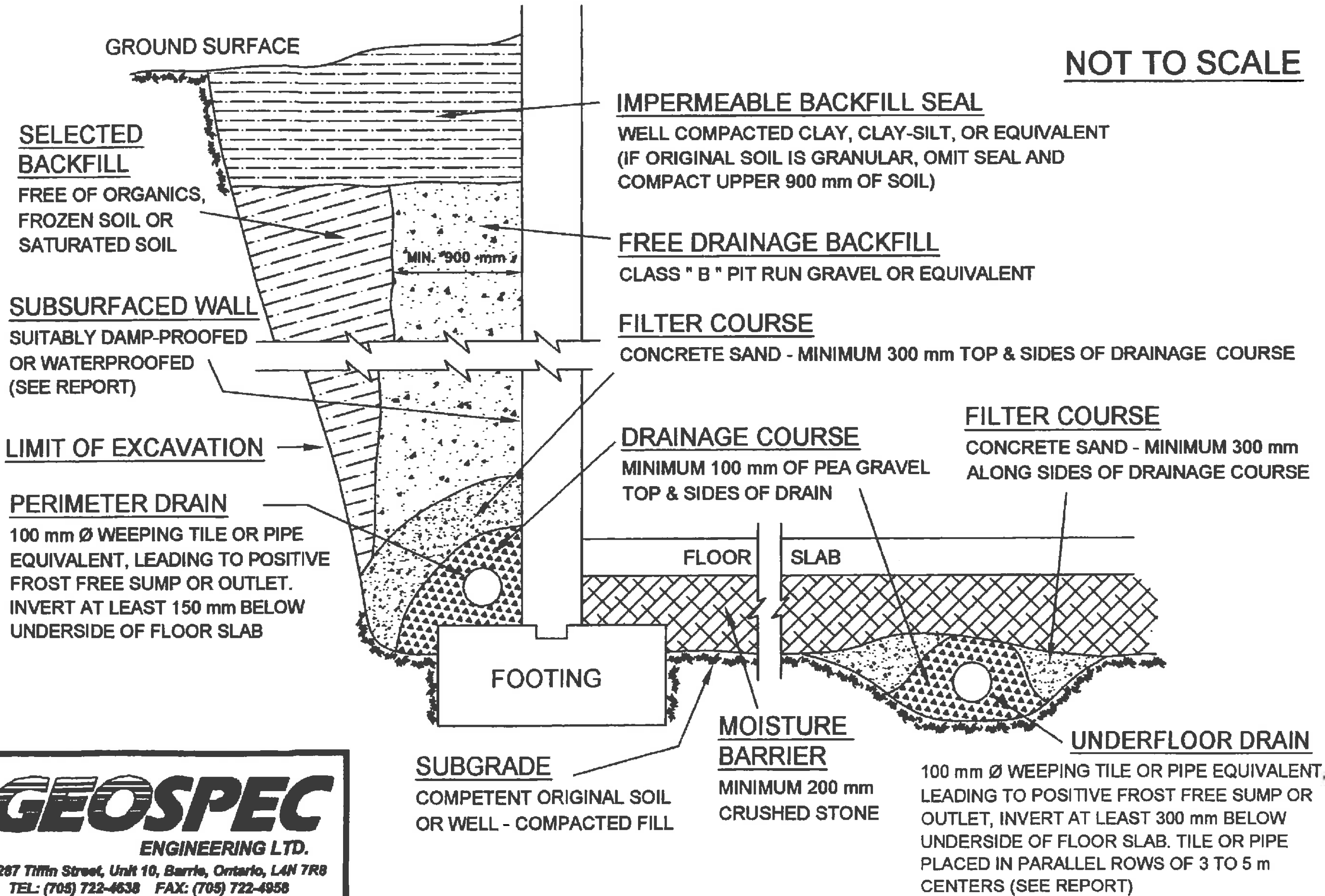
UNIFIED SOIL CLASSIFICATION SYSTEM *(ASTM D 2487)*



Appendix A

Underground Wall Recommendations

RECOMMENDED DRAINAGE AND BACKFILLING REQUIREMENTS FOR EXTERIOR SUBSURFACE WALLS WITH TILE DRAIN ABOVE FOOTING & UNDERFLOOR DRAINS FOR BASEMENT FLOOR LOCATED AT / OR **BELOW THE WATER TABLE**



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Appendix B

Statement of Limitations

STATEMENT OF LIMITATIONS

The conclusions and recommendations provided in this report are based on information determined at the borehole locations. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations. Conditions may vary from time to time and as such conditions may exist which could not be detected or anticipated at the time of subsurface investigation.

The design recommendations given in this report are applicable only to the project as described in the text and then only if constructed in accordance with the details of the alignment and elevations as stated in the report. If all details of the design were not provided to **Geospec Engineering Ltd.**, certain assumptions had to be made based on the information provided to us. If actual conditions vary from those assumed, modifications will be required.

We recommend, that **Geospec Engineering Ltd.** be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions that were made during our analysis. We further recommend that we be retained during the construction phase in order to confirm that the subsurface conditions throughout the site do not deviate significantly from those encountered in the boreholes. In instances where these limitations and recommendations are not followed, our responsibility is limited to accurately interpreting the information encountered at the boreholes.

The comments and recommendations given in this report on potential construction problems and possible methods are intended for the purpose of guidance only for the design engineer. The number of boreholes and parameters analysed may not be sufficient in order to determine all factors that may affect construction methods and cost. Therefore, the contractors bidding on this project or undertaking the construction shall make their own interpretation of the factual information presented and draw their own conclusions as to how subsurface conditions may affect their work.

Geospec Engineering Ltd. and its employees shall not be held liable for any special, indirect, incidental, consequential (including loss of profit), exemplary or punitive damages whatsoever arising out of or in connection with our services to the client or this agreement whether in contract, tort or other theories of law even if Geospec Engineering Ltd. has been advised of the possibility of those damages. The total cumulative liability of Geospec Engineering Ltd. arising from or relating to this project shall not exceed the total amount payable to Geospec Engineering Ltd. hereunder.

Except as set forth herein, **Geospec Engineering Ltd.** makes no warranties, express or implied, with respect to any services or deliverables provided hereunder, including, without limitation, any implied warranties of merchantability or fitness for a particular purpose. All such other warranties are hereby disclaimed.

GEOSPEC ENGINEERING LTD.
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October 21, 2013

Salter Pilon Architecture Inc.
151 Ferris Lane, Suite 400
Barrie, Ontario
L4M 6C1

Attn: Mr. G. Wilder (By email – gwilder@salterpilon.com)

Re: **Addendum to Geotechnical Investigation**
27-31 Blake Street, Barrie 13-1660

Dear Grant,

Further to your request, it is our understanding that additional geotechnical review is required to assist in the design for the installation of services and the pavement section for the proposed three storey residential development at the site referenced. In this regard, we offer the following comments and recommendations.

Service Installation

We anticipate that a majority of the service excavations for this development will be carried out by open cut in generally cohesionless soil. All excavations must be carried out in full compliance with the most recent guidelines of the Occupational Health and Safety Act and Ontario Provincial Standard Drawings, (OPSD 802.010, 802.030 & 802.031)

During the excavation of any underground opening deeper than 1.2 meters, the sides of the excavation must be sloped to a maximum 1:1 inclination based upon a Type 2 Soil for the till and 1:1 for a Type 3 Soil sandy silt or sand. Furthermore, for vertical cuts in excess of 1.2 m, temporary shoring (such as a structurally adequate, prefabricated box) will be required.

All services must be extended below any organically included material or fill. Consequently, the founding soils will likely be comprised of till or a sandy silt both of which were considered compact to very dense at anticipated service depths. As a result, the subgrade soil at the trench base will be suitable for the placement of service bedding provided the soil has been adequately surface compacted after excavation and does not become unstable during trenching operations. Finally, watermain bedding and cover must consist of a minimum 10 cm of uniform fine sand; while sewer bedding and cover must consist of a minimum of 15 cm to 30 cm of Granular A.

We do reiterate that the soil at this site included a significant percentage of fine-grained particles that are moisture sensitive and frost susceptible. To reiterate, soil with silt content greater than 8% is not considered an optimum material for reuse as backfill. Therefore, where service trenches follow the proposed driveway/parking area, particular attention must be given to the backfill placement in order to minimize settlement, which would have adverse effects on the pavement structure. It has been our experience that an imported well graded Granular B type backfill proves a reliable alternative backfill.

Pavement Construction

For normal pavement construction, we recommend that all fill and organically included matter be removed. Once the site has been adequately stripped, the exposed subgrade may be proofrolled and inspected, in order to detect any soft or saturated areas. Proofrolling is carried out prior to the placement of any subbase course fill materials. Questionable areas encountered during proofrolling must be removed and replaced with a select subgrade material. All subgrade fill must be uniformly compacted, in lifts not exceeding 30 cm in thickness, to at least 95% Standard Proctor Dry Density (SPDD).

Approved on site excavated soil may be used for subgrade backfilling purposes. The following minimum granular and pavement thickness will be satisfactory for pavement design over a stable subgrade:

Table 4: Pavement Section

Material	Designation	
	Light Duty (mm)	**Heavy Duty (mm)**
Surface Course Asphalt	50 HL-4	40 HL-4
Base Course Asphalt	--	50 HL-8
Granular A Base Course	150	150
Granular B Subbase Course	300	300

We stress that the tabulated values assume stable subgrade conditions. Several factors including weather conditions experienced during service installation and construction practices significantly affect subgrade stability. It is imperative that the subgrade be assessed by a representative of **Geospec Engineering Ltd.** prior to the placement of granular fill in order to ascertain whether modifications to the tabulated values are required.

We recommend that all base and subbase fill materials are compacted in 15 to 20 cm lifts to at least 98% Standard Proctor Dry Density and asphaltic concrete to 92% Maximum

Relative Density.

In order to establish the suitability of the paved area subgrade preparation and fill placement, it is recommended that a qualified soil technologist be present during the cut and fill operations.

It is also recommended that subgrade preparation and paving take place during the dry summer months of the year. Finally, to prevent unnecessary saturation of the subgrade soil, we recommend that all surface run-off water be directed away from the pavement to a positive frost-free outlet.

We thank you for the opportunity to provide you with our geotechnical services and look forward to working on this project. If you have any questions, or require clarification of any aspect of the above quotation, please do not hesitate to contact the undersigned.

Respectfully,
GEOSPEC ENGINEERING LTD.

K. Malcolm,
Consulting Engineer