GEOSPEC ENGINEERING LTD.
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CONFIDENTIAL

GEOTECHNICAL INVESTIGATION

ST. ANDREW'S VILLAGE
PENETANGUISHENE, ONTARIO

PREPARED FOR:

Dave Wright

c/o The Walter Fedy Partnership

546 Belmont Avenue West

Kitchener, Ontario

N2M 1N5

Geospec Project N° 05-1226

January 16, 2006

Distribution: 2 – Client

EXECUTIVE SUMMARY

Further to the authorization of Mr. Jon van Schubert of The Walter Fedy Partnership on behalf of Dave Wright, **Geospec Engineering Ltd.** carried out a subsurface investigation for the proposed residential subdivision development, St. Andrews Village, located in the Town of Penetanguishene, east of Fuller Avenue, south of Pinegrove Road and west of St. Andrew's Lake, Township of Tay.

The fieldwork included five boreholes situated within the proposed building development envelope. More specifically, the boreholes were drilled to depths between 6.5 and 11.1 meters below the existing grade levels. The approximate locations are identified on the Borehole Plan.

The boreholes generally encountered topsoil and peat that overlay sand, silt & sand and sand & silt till which extended beyond the final depths investigated. The density of the original soil within the depth of the investigation generally varied from compact to very dense.

Also based upon the results of the investigation, it is our considered opinion that conventional spread footings may be incorporated into the subdivision design. In this regard, footings founded on original sand & silt till extended to minimum depths varying between approximately 80 to 430 cm below the existing grade levels may be designed using an allowable bearing pressure of 100 kPa.

Finally, since a majority of the native soil removed from trench will include a significant percentage of fine-grained soil that will be at or above the Optimum Moisture Content for compaction some difficulties with the reinstatement of the trench with native soil is anticipated. As a result, either the original soil will require time to dry before reuse as backfill or consideration should be given to an imported Granular B type backfill in order to achieve an appropriate degree of compaction.

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1.0 INTRODUCTION

Geospec Engineering Ltd. was retained by Mr. Jon van Schubert of The Walter Fedy Partnership on behalf of Dave Wright to carry out a subsurface investigation for a proposed subdivision development, St. Andrews Village, located in the Town of Penetanguishene, east of Fuller Avenue, south of Pinegrove Road and west of St. Andrew's Lake, Township of Tay. The approximate site location is identified on the Site Location Plan (Figure 1)

Figure 1: Site Location Plan

Source: http://www.maps.discoverninnisfil.com

Site: St. Andrew's Village, Penetanguishene

The project and purpose of the investigation were discussed with Mr. van Schubert between December 1 and 6, 2005. The Subsurface Investigation was required in order to ascertain the shallow subsurface soil and groundwater conditions through boreholes and mechanical analysis of selected soil samples. The information was required to assist in the geotechnical development of the proposed subdivision as well as permit the hydrogeological monitoring by others of wells installed during the investigation.

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

2.0 FIELDWORK

As discussed, the field investigation included five boreholes; one drilled to a depth of 6.5 m, three to a depth of 8.1 m and one to a depth of 11.1 m below the existing grade levels and within the proposed subdivision development area. The approximate borehole locations are identified on the Borehole Plan (Enclosure N° 1).

Fieldwork was carried out under the full time supervision of an experienced field technologist from our office, on December 5, 2005. A track mounted drilling machine provided and operated by a specialist drilling contractor augured the boreholes. Standard Penetration Tests were carried out intermittently and discontinuous soil samples were recovered at intervals through the subsurface soil.

A Standard Penetration Test is a method of sampling soil, which has been standardized by ASTM D1586. 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 31 cm.

All soil samples recovered were visually classified and appropriately tested in the field. They were then individually bagged, labeled, and returned to our laboratory for a formal assessment.

The groundwater conditions were observed in the open borehole during and on completion of drilling. Observations are detailed on the accompanying Borehole Logs. In addition, 50 mm diameter monitoring wells were installed in each borehole, at the request of Azimuth Environmental, in order to permit the long term monitoring of groundwater levels. Each well was installed to the bottom of the borehole complete with a three-meter long Slot 10 screen, clear stone, sand cover, bentonite seal and concrete encased well cap.

3.0 SUMMARIZED SUBSURFACE SOIL CONDITIONS

The properties of the soil strata encountered at the boreholes are given in the appended Borehole Logs. Briefly, site stratigraphy included topsoil, peat, sand and silt & sand which overlay the original stratigraphy of sand & silt till that extended beyond the final depths investigated. A summary of the conditions encountered is detailed in the following sections.

3.1 Surface Cover

Topsoil and/or organically-included (Probable Fill) was encountered at the surface of each borehole and was measured to vary from 10 cm to 120 cm thick. The topsoil/organically-included material was dark brown to black in colour and highly

compressible. Due to the highly compressible nature of the topsoil, it is considered to be void of engineering considerations but may be suitable for landscaping purposes.

3.2 Peat

A layer of dark brown peat was encountered below the surface cover at Borehole N° 3. The peat extended to an approximate depth of two meters below the existing grade level. Moisture Content analysis established a moisture of over 100%, which is indicative of a deposit that is predominantly comprised of water and organic matter. Due to the highly compressible nature of the peat, it is considered to be void of engineering considerations but may be suitable for landscaping purposes.

3.3 Sand

Underlying the surface cover at Borehole N°s 4 & 5 and the peat layer at Borehole N° 3 was a layer of sand with trace to some gravel and silt. This layer extended to an approximate depth ranging between 0.4 and 2.9 metres below the existing grade levels. We do advise that the sand deposit may in fact simply be a layer within the massive till deposit.

Standard Penetration Test results established that the density of the sand layer varied from loose to compact. While Moisture Content analysis established moisture values in the order of 10%, which are indicative of moist sand.

3.4 Silt & Sand

A layer of silt & sand was found below the sand layer encountered at Borehole N° 3. This layer extended to an approximate depth of four meters below the existing grade levels. Furthermore, based on gradation analyses (Enclosure N° 7), the deposit consisted of silt (50%), sand (47%) and gravel (3%).

Standard Penetration Test results established that the density of the silt & sand layer was very loose. Moisture Content analysis established a moisture value of 34%, which is indicative of a wet deposit

The geotechnical characteristics normally associated with a silt & sand deposit are as follows:

- Low to moderate permeability depending on the silt content estimated to range from 10^{-4} to 10^{-6} cm/sec.
- Very high capillarity
- High to moderate, depending on silt content, frost susceptibility and adfreezing potential

- Non-cohesive, when excavated steeply the sidewalls of the excavation will remain stable for a limited extended period of time if the soil is maintained in a moist state. In a saturated state, the soil will flow.
- Poor to fair, depending on silt content, compaction characteristics will require additional effort and time to dry or will become unstable

3.5 Sand & Silt Till

Extending below the layers described above was a deposit of sand & silt till that extended beyond the final depths investigated. Standard Penetration Test results established that the density of the silt & sand till varied from loose to very dense. Moisture Content analysis established moistures ranging from 5 to 12%, which are indicative of a moist to wet deposit.

Based on our experience in the area, the till consists of a wide range of particle sizes from fine-grained soil to boulders. However, since the soil samples were obtained from boreholes, using the standard split-spoon sampler, the samples do not include cobbles or boulders. As a result, the particle size distribution curves represent only the material characteristics of the predominant part of the till (clay, silt, sand, gravel). Based on gradation analyses, the till (excluding cobbles & boulders) consists predominantly of sand (71-79%), silt (17-23%) and gravel (4-6%).

Frequently, a till deposit contains sand & silt seams and pockets at variable depths. These seams are outwash sediments deposited primarily as a result of glacial recession. Often, these granular veins 'store' perched water and may be saturated. Consequently, the till mass around the saturated cohesionless pockets and veins is also saturated or quasi-saturated.

The geotechnical characteristics normally associated with the sand & silt till deposit at this site are as follows:

- Low permeability depending on the silt content generally below 10^{-5} cm/sec.
- High to moderate, depending on silt content, frost susceptibility and adfreezing potential
- Exhibits practical cohesion, when excavated steeply the sidewalls of the excavation will remain stable for a limited period of time if the soil is maintained in a moist state. In a saturated state, the soil will slough.
- Moderately water erodable depending on sand content
- Poor to fair, depending on silt content, compaction characteristics will require additional effort and time to dry or will become unstable

4.0 GROUNDWATER CONDITIONS

Although moist to wet conditions were encountered at or near the surface, free flowing groundwater was not encountered in this investigation. Consequently, we do not anticipate difficulties with groundwater in shallow excavations. We do advise that any excavation extended below the ground surface has the potential to encounter water bearing layers or seams that will require the installation of groundwater control systems. Regardless, it is our opinion that a filtered sump pump should adequately control any seepage encountered in shallow excavations.

We do reiterate that 50 mm diameter monitoring wells were installed in each borehole, at the request of Azimuth Environmental, in order to permit the long term monitoring of groundwater levels and the completion of an independent hydrogeological study.

Finally, the groundwater level is anticipated to fluctuate seasonally.

5.0 GEOTECHNICAL CONSIDERATIONS

We have been advised that consideration is being given to the construction of a residential subdivision development in the area of the boreholes. Based upon the subsurface conditions encountered at the boreholes, we offer the following recommendations.

5.1 Site Stripping & Regrading

Due to the relatively dense nature of the site we do not anticipate difficulties stripping or regrading with conventional equipment through standard cut and fill practices.

Samples recovered suggest that the excavated inorganic soil will be comprised of sand and silt that will be at or above the Optimum Moisture Content for compaction. We do advise that soil predominantly comprised of silt is *not* considered favourable for reuse since it would be very difficult to compact to the specified degree unless it was dried considerably and will become unstable when wet. An imported granular fill would prove to be a better alternative. Regardless, it is recommended that mass grading operations take place during the dry summer months of the year in order to benefit from the potentially improved soil compaction characteristics.

All subgrade fill, free of organic matter or other deleterious inclusions, may be placed at or below Optimum Moisture Content and uniformly compacted in thin lifts to at least 95% of the Maximum Standard Proctor Dry Density. Any oversized cobbles or boulders (> 150 mm diameter) and/or logs should be stockpiled or discarded in designated non-structural areas.

5.2 Foundation Recommendations

Based on the results of our investigation, we advise that the density of the original undisturbed soil within conventional founding depth was predominantly compact to very dense. As a result, it is our considered opinion that conventional spread and strip footings may be incorporated into the building designs when founded on the original undisturbed sand & silt till. More specifically, the SPT results recorded at the boreholes indicate an allowable bearing pressure of 100 kPa may be utilized for design purposes at the approximate depths, below the existing grade levels, specified in the following Table 1.

Table 1: Conventional Spread and Strip Footings Depths

Footings Depths for 100 kPa Bearing Pressure		
Borehole N°	**Approximate Depth (cm)**	**Elevation (m)**
1	120	225.1
2	80	225.6
3	430	221.1
4	80	228.5
5	100	224.6

Attention is drawn to the fact that suitable bearing is not available at Borehole N° 3 until a depth of 4.3 meters below grade. Moreover, bearing is found below moist to wet layers of peat, silt & sand on a very dense deposit of till. It is also noted that Borehole N° 3 was the borehole situated closest to the existing lake.

Furthermore, bearing pressure 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.** or a qualified footing foundation inspector 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 Service Installation

We anticipate that a majority of the service excavations for this development will be carried out by open cut (in cohesionless soil). All excavations must be carried out in full compliance with the most recent guidelines of the Occupational Health and Safety Act.

The soil at this site includes loose to very dense sand & silt till as well as moist to wet, very loose sand & silt that will flow and exert substantial fluid pressure upon supporting systems if not adequately dewatered. The till is best defined by OSHA as Type 2 soil while the sand & silt is best defined as a Type 4 soil below the groundwater and Type 3 above. As a result, the highest numbered soil Type shall govern the trench excavation and excavation slope geometry.

We do advise that since the density of the original undisturbed soil varied from loose to very dense, being generally compact the undisturbed subgrade soil at the trench base will be suitable for the placement of service bedding.

We also advise that the some of the soil at this site includes a significant percentage of fine-grained silt that is both moisture sensitive and frost susceptible. Silt is <u>not</u> considered an optimum material for reuse as backfill. Therefore, where service trenches follow the proposed roadway, particular attention must be given to the backfill placement in order to minimize settlement, which would have adverse effects on the pavement structure. A well-graded OPSS Granular B type backfill material would prove to be a simple alternative where predominantly silty soil is encountered.

5.4 Road Construction

For normal road construction, all organic material and existing fill must be removed. Once any unsuitable material has been removed, the exposed subgrade must be inspected and proofrolled, in order to detect any soft, loose or saturated areas. Proofrolling is carried out after the service trenches have been appropriately backfilled but prior to the placement of any subgrade or subbase course fill materials. Questionable areas encountered during proofrolling must be removed and replaced with a select subgrade material that is uniformly compacted, in lifts not exceeding 15 cm in thickness, to at least 95% of the Standard Proctor Dry Density.

The minimum granular and pavement thickness provided in Table 2 are considered satisfactory for pavement design over a <u>stable</u> subgrade. We strongly advise that any instability observed at the top of subgrade would require modification to the road sections provided and would likely require the subexcavation and replacement of subgrade material.

Table 2: Pavement Section

Pavement Section		
Material	Designation	
	Local Residential (mm)	Residential Collector (mm)
HL3 Top Course Asphalt	40	40
HL4 or HL8 Base Course Asphalt	50	80
Granular A Base Course	150	150
Granular B Subbase Course	300	300

We recommend that all base and subbase fill materials be compacted in 15 cm lifts to at least 98% Standard Proctor Dry Density and asphaltic concrete to 97% Marshall Density. In addition, in order to establish the suitability of the road preparation and fill placement, it is recommended that a qualified soil technologist be present during the cut and fill operations

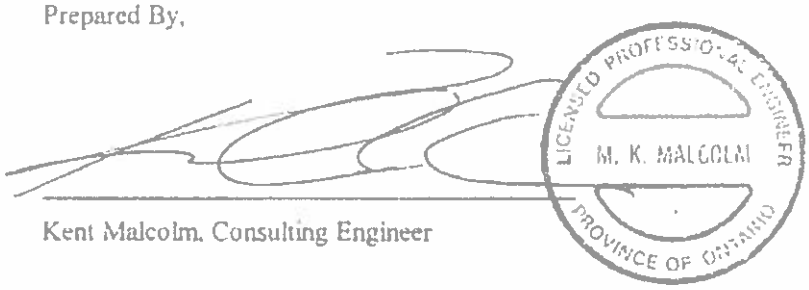
Furthermore, it is recommended that subgrade preparation and paving take place during the dry summer months of the year to prevent saturation of the subgrade soil. Finally, due to the absence of groundwater in a majority of the boreholes and the sandy nature of a majority of the site, we do not anticipate the need for longitudinal subdrains. Regardless, the subgrade must be reviewed prior to the placement of subbase material in order to ascertain whether modification of this recommendation is required

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 A, 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.

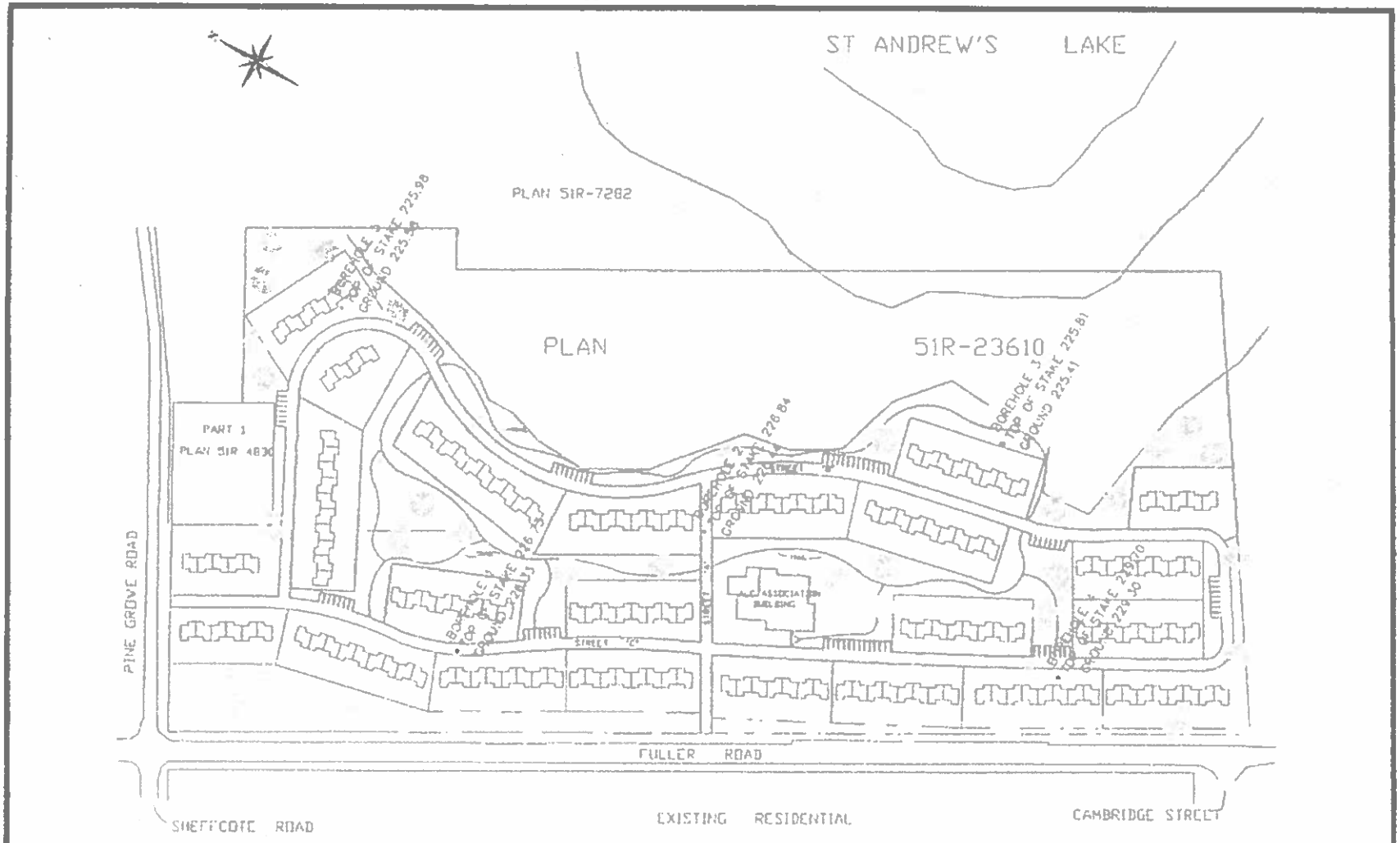
Prepared By,



Kent Malcolm, Consulting Engineer

Enclosures

Borehole Plan
Borehole Logs
Grain Size Distribution Charts



BOREHOLE PLAN

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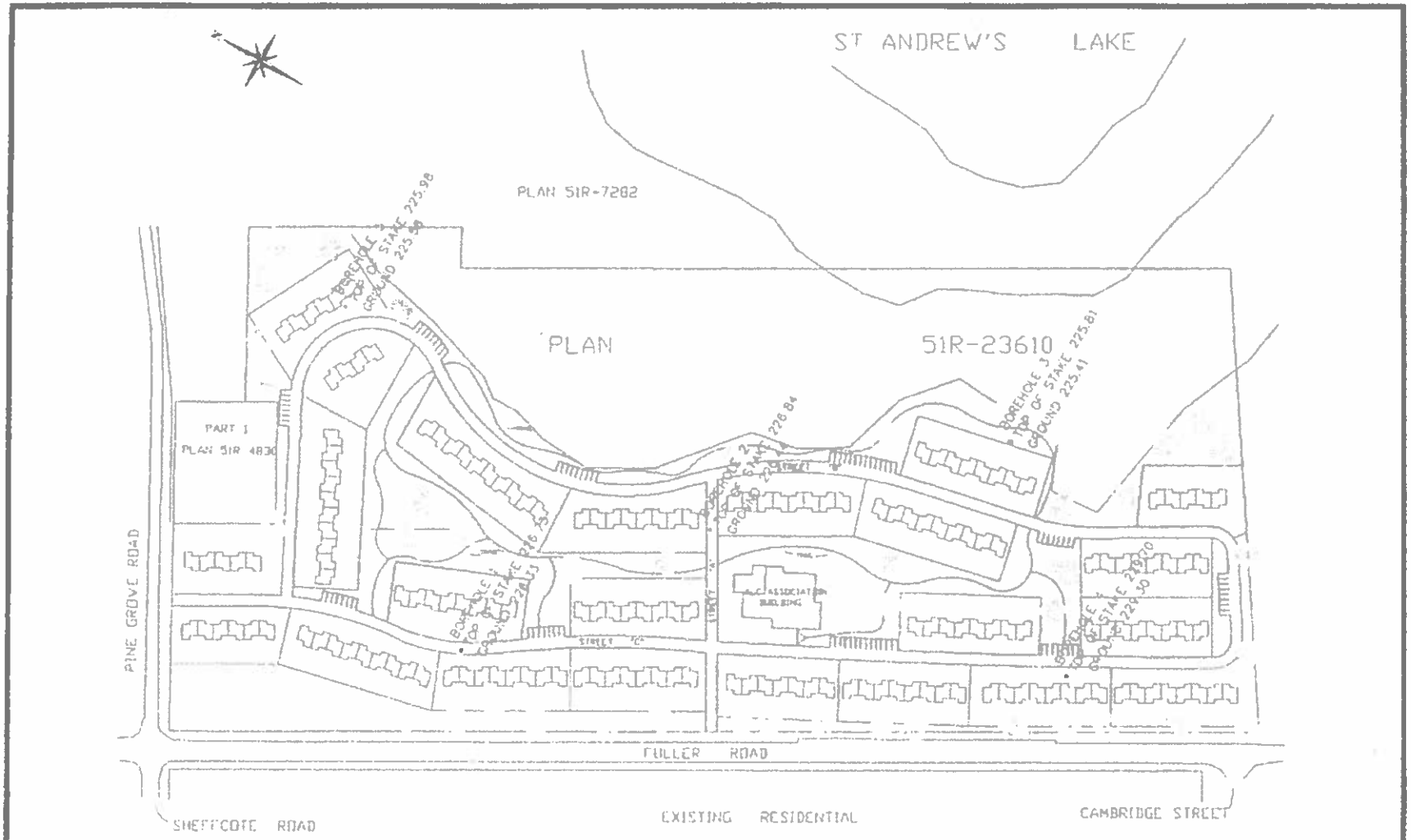
CLIENT: Dave Wright c/o The Walter Fedy Group	PROJECT #: 05-1226	ENCLOSURE #: 1
PROJECT: St. Andrew's Village, Penetanguishene	DATE: January 16, 2006	SCALE: NTS



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BOREHOLE LOG

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**BOREHOLE N°:**	1
PROJECT NAME:	St. Andrew's Village, Penetanguishene	**BORING DATE:**	December 5, 2005
PROJECT N°:	05-1226	**SAMPLING METHOD:**	Split Spoon
GROUND ELEVATION:	226.33 m	**BORING METHOD:**	Standard Auger

Elevation (m)	Soil Description (Unified Soil Classification System)	Water Level (m)	Depth (m)	N' Value per 0.3 m	N' Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 10 20 30
226.33	20 cm **Topsoil** over		0.4	6		
			0.8			
			1.2	10		
			1.6			
			2.0	63		
			2.4			
			2.8	50		
			3.2			
	Sand & Silt Till with trace to some gravel Brown, moist, compact to very dense		3.6	46		
			4.0			
			4.4			
	Gradation @ 3.5 m *Sand 73%* *Gravel 17%* *Silt 10%*		4.8	33		
			5.2			
			5.6			
			6.0			
	Gradation @ 6.5 m *Sand 71%* *Silt 23%* *Gravel 6%*		6.4	>99		
			6.8			
			7.2			
			7.6			
			8.0	>99		
			8.4			
			8.8			
			9.2			
			9.6	>99		
			10.0			
215.2			10.4			
	END OF BOREHOLE Dry and open to 9.9 m		10.8	>99		
			11.2			
			11.6			
			12.0			
	* 50 mm diameter monitoring well installed to bottom of borehole complete with 3.0 m screen & 100 mm well cap.		12.4			
			12.8			
			13.2			
			13.6			
			14.0			
			14.4			
			14.8			
			15.2			
			15.6			
			16.0			

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BOREHOLE LOG

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**BOREHOLE N°:**	2
PROJECT NAME:	St. Andrew's Village, Penetanguishene	**BORING DATE:**	December 5, 2005
PROJECT N°:	05-1226	**SAMPLING METHOD:**	Split Spoon
GROUND ELEVATION:	226.44 m	**BORING METHOD:**	Standard Auger

Elevation (m)	Soil Description (Unified Soil Classification System)	Water Level (m)	Depth (m)	N° Value per 0.3 m	N° Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 10 20 30
226.44						
226.3	15 cm **Topsoil**			8	●	○
	Sand & Silt Till with some gravel Brown, moist, compact to very dense			23		
	Gradation @ 2.0 m *Sand 73%* *Silt 23%* *Gravel 4%*		2.0	14		
				26		
			4.0	43		
				>99		
			6.0	>99		
218.3			8.0	>99		
	END OF BOREHOLE Dry and open to 7.5 m					
	* 50 mm diameter monitoring well installed to bottom of borehole complete with 3.0 m screen & 100 mm well cap		10.0			
			12.0			
			14.0			
			16.0			

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BOREHOLE LOG

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**BOREHOLE N°:**	3
PROJECT NAME:	St. Andrew's Village, Penetanguishene	**BORING DATE:**	December 5, 2005
PROJECT N°:	05-1226	**SAMPLING METHOD:**	Split Spoon
GROUND ELEVATION:	225.41 m	**BORING METHOD:**	Standard Auger

Elevation (m)	Soil Description (Unified Soil Classification System)	Water Level (m)	Depth (m)	N' Value per 0.3 m	N' Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 10 20 30
225.41						
224.2	**Topsoil/Organically-Included** (Probable Fill) Dark brown, wet		1.2	10		
223.5	**Peat** - dark brown, wet					
222.5	**Sand** - brown, moist, loose		2.0	4		
				5		
221.1	**Silt & Sand** with trace gravel Grey, wet, very loose *Gradation @ 3.5 m Silt - 50%, Sand - 47%, Gravel - 3%*		4.0	2		
	Sand & Silt Till Grey, very moist to wet, very dense		6.0	>99		
217.3			8.0	>99		
	END OF BOREHOLE Dry and open to 7.5 m * 50 mm diameter monitoring well installed to bottom of borehole complete with 3.0 m screen & 100 mm well cap		10.0 12.0 14.0 16.0			

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BOREHOLE LOG

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**BOREHOLE N°:**	4
PROJECT NAME:	St. Andrew's Village, Penetanguishene	**BORING DATE:**	December 5, 2005
PROJECT N°:	05-1226	**SAMPLING METHOD:**	Split Spoon
GROUND ELEVATION:	229.30 m	**BORING METHOD:**	Standard Auger

Elevation (m)	Soil Description (Unified Soil Classification System)	Water Level (m)	Depth (m)	N° Value per 0.3 m	N° Value (Blows/0.3 m)	Water Content (%)
229.30					20 40 60 80	10 20 30
228.9	10 cm **Topsoil** over **Sand** - tan, moist, compact		0.4	8		
	Sand & Silt Till Brown to grey, moist, very dense		1.2	49		
			2.0	62		
			2.8	>99		
			3.6	>99		
			4.0			
			4.8	71		
			6.0			
			6.8	>99		
221.2			8.0	>99		
	END OF BOREHOLE Dry and open to 7.5 m * 50 mm diameter monitoring well installed to bottom of borehole complete with 3.0 m screen & 100 mm well cap		9.6			
			10.0			
			10.8			
			12.0			
			12.8			
			13.6			
			14.0			
			15.2			
			16.0			

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BOREHOLE LOG

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**BOREHOLE N°:**	5
PROJECT NAME:	St. Andrew's Village, Penetanguishene	**BORING DATE:**	December 5, 2005
PROJECT N°:	05-1226	**SAMPLING METHOD:**	Split Spoon
GROUND ELEVATION:	225.58 m	**BORING METHOD:**	Standard Auger

Elevation (m)	Soil Description (Unified Soil Classification System)	Water Level (m)	Depth (m)	N° Value per 0.3 m	N° Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 10 20 30
225.58						
	10 cm **Topsoil** over **Sand** with trace to some silt Rust, moist, compact		1.0	11		
224.4				13		
	Sand & Silt Till with some silt and trace gravel Brown, moist to wet, loose to very dense		2.0	10		
	Gradation @ 2.7 m *Sand 79%* *Silt 17%* *Gravel 4%*		3.0	7		
			4.0	25		
			5.0	>99		
219.1			6.0			
	END OF BOREHOLE Dry and open * 50 mm diameter monitoring well installed to bottom of borehole complete with 3.0 m screen & 100 mm well cap		7.0 8.0	>99		

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GRAIN SIZE DISTRIBUTION CHART

CLIENT:	Dave Wright c/o The Walter Fedy Partnership	**DATE:** **ENCLOSURE N°:**	December 29, 2005 7
PROJECT:	St. Andrew's Village, Penetanguishene	**PROJECT N°:**	05-1226
SAMPLE N°:	3 11/Native	**DATE SAMPLED:**	December 5, 2005
SAMPLE TYPE:	Split Spoon	**DATE RECEIVED:**	December 5, 2005
SAMPLED BY:	PB	**DATE TESTED:**	December 9, 2005
SAMPLED FROM:			

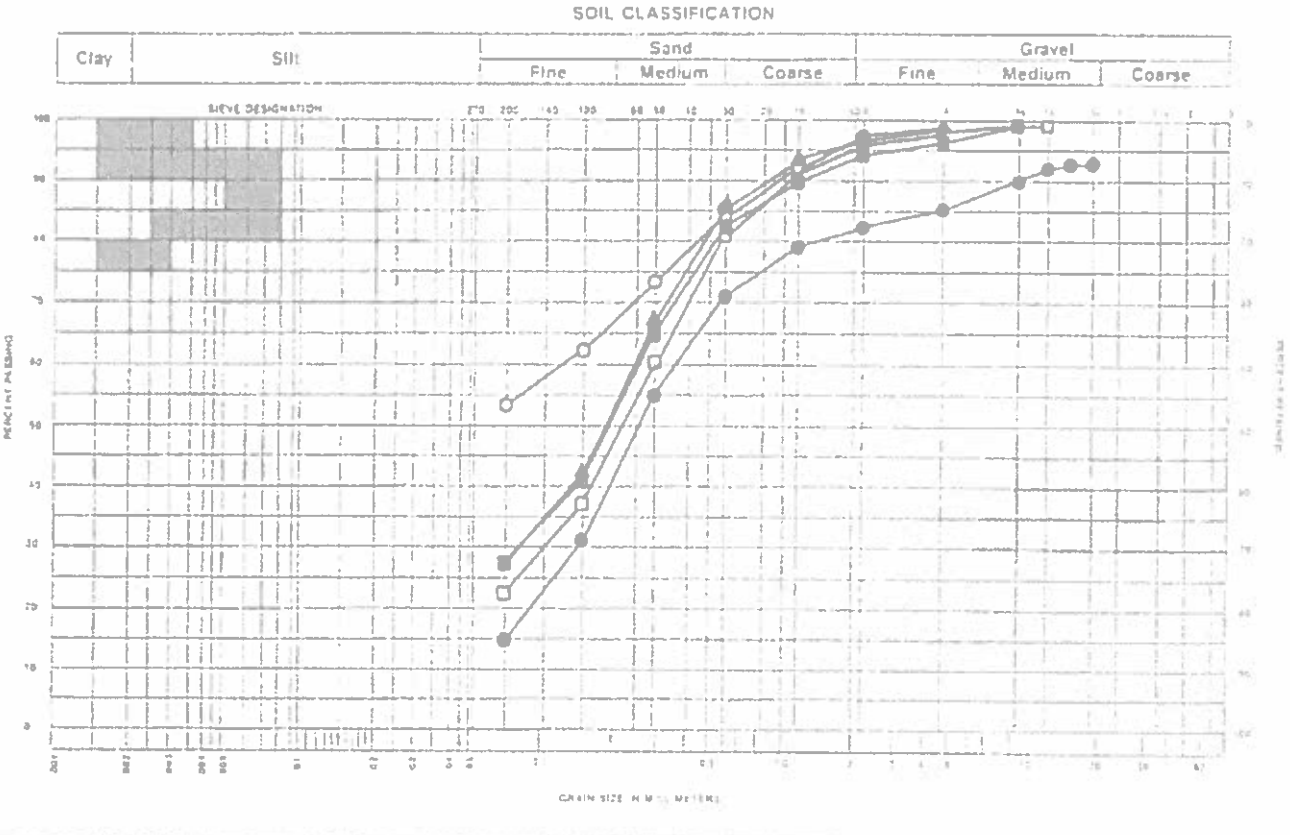
BH 1/3.5 m — Sand with some gravel and silt

BH 1/6.5 m — Silty Sand with trace gravel

BH 2/2.0 m — Silty Sand with trace gravel

BH 3/3.5 m — Silt & Sand with trace gravel

BH 5/2.7 m — Sand with some silt and trace gravel



Appendix A

Statement of Limitations

STATEMENT OF LIMITATIONS

The conclusions and recommendations provided in this report, with respect to subsurface conditions, 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. Furthermore, 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 described in the text and then only if constructed substantially in accordance with the details of the alignment and elevations stated in the report. Since all details of the design may not be known to **Geospec Engineering Ltd.**, certain assumptions had to be made. The actual conditions may, however, vary from those assumed; in which case, changes and modifications may be required to our recommendations.

We recommend, therefore, 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 which were made in our analysis. We recommend also that we be retained during construction 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 are not followed, **Geospec Engineering Ltd.** 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 only for the guidance of the design engineer. The number of boreholes and parameters analysed may not be sufficient to determine all the factors that may affect construction methods and cost. Therefore, the contractors bidding on this project or undertaking the construction must make their own interpretation of the factual information presented and draw conclusions as to how the subsurface conditions may affect their work, with the knowledge, that specific locations were investigated.