



Terraprobe

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

GEORES No:
30M12-320

**FOUNDATION INVESTIGATION REPORT
KENNEDY ROAD SANITARY SEWER INSTALLATION
HIGHWAY 410 EXTENSION – PHASE III
FROM 300 m EAST OF HEART LAKE ROAD TO HIGHWAY 10**

PREPARED FOR: Giffels Associates Ltd.
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**FOUNDATION INVESTIGATION REPORT
KENNEDY ROAD SANITARY SEWER INSTALLATION
HIGHWAY 410 EXTENSION – PHASE III
ONTARIO**

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted along the alignment of the sanitary sewer to be installed on both sides and below the proposed four-lane of Highway 410 in the Town of Caledon, Ontario.

Previous, investigations were carried out by Terraprobe Limited for the watermains and sewer installations on Kennedy Road and the deep cut and high fill areas of the Highway 410. The applicable factual data from these investigations were used to supplement the current field investigation.

The purpose of this investigation was to explore the subsurface conditions along the sanitary sewer alignment and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed using existing data and information obtained from this investigation.

Terraprobe conducted the investigation as a sub-consultant to Giffels Associates Ltd., for the Region of Peel.

The following documents are referenced in the preparation of this report:

- Terraprobe Limited, "Foundation Investigation & Design Report, Deep Cut and High Fill Areas, Highway 410 Extension – Phase III, From 300 m East of Heart Lake Road to Highway 10", Agreement No. 2005-A-000230, W.P. 105-00-00, dated May 31, 2007.
- Terraprobe Limited, "Foundation Investigation & Design Report, Kennedy Road Watermains and Sewer Installations, Highway 410 Extension – Phase III, From 300 m East of Heart Lake Road to Highway 10", Region of Peel, dated April 04, 2007.

2 SITE DESCRIPTION

The sanitary sewer alignment extends from Kennedy Road easterly and roughly parallel to and along the north side of the proposed highway to about Sta.23+591 where it crosses under the highway. The alignment then continues westerly and roughly parallel to and along the south side of the proposed highway to Kennedy Road.



The area is currently farmland and along the proposed alignment the ground surface is relatively flat falling to the east by about 3 m over a horizontal distance of 170 m.

The site is located in the physiographic region of Southern Ontario referred to as the Peel Plain whose topography slopes gradually and gently towards Lake Ontario. Etobicoke Creek and other rivers have cut deep valleys across the Peel Plain.

The Peel Plain is known to consist of generally clayey and silty soils that cover the central portion of the regions of York, Peel and Halton¹. There are exceptions to be noted in these major soil groups. Trains of sandy alluvium can be found at various places in the stream valleys. These overburden soils are underlain by the Georgian Bay Formation.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between June 28 and July 19, 2007 and consisted of drilling and sampling five boreholes to depths ranging from 9.2 m to 11.1 m. Boreholes T2 and T4 were previously drilled for the Kennedy Road watermain and sewer installations to depths ranging from 15.7 m to 17 m on November 10, 2006. Borehole 23+650 Rt. Of CL was previously drilled to a depth of 6.6 m on January 07, 2005 as part of the deep cut and high fill investigations. These previously drilled boreholes are also included in this report. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

The borehole locations were marked in the field by surveyors from Shiu Geomatics Limited who also provided Terraprobe with their coordinates and geodetic elevations. Utility clearances were obtained by Terraprobe prior to drilling.

The drilling, sampling and in-situ testing operations of this investigation were conducted with a track mounted B-57 Bombardier drill rig owned and operated by DBW Drilling Limited of Ajax, Ontario. Solid stem auger drilling techniques were used to advance the boreholes and samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen enclosed in sand were installed in selected boreholes to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are presented in Table 3.1.

¹ Chapman and Putnam, "The Physiography of South Ontario", 3rd Edition, 1984.



Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
KS2	8.3/254.3	Piezometer with 1.5 m slotted screen installed with filter sand to 5.8 m, bentonite seal from 5.8 m to 5.2 m, drill cuttings from 5.2 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
KS3	9.1/255.4	Piezometer with 1.5 m slotted screen installed with filter sand to 6.7 m, bentonite seal from 6.7 m to 5.5 m, drill cuttings from 5.5 m to 0.9 m and bentonite seal from 0.9 m to ground surface.
T2	15.2/249.3	Piezometer with 3 m slotted screen installed with filter sand to 12.2 m, bentonite seal from 12.2 m to 11.3 m, drill cuttings from 11.3 m to 0.9 m, and bentonite seal from 0.9 m to ground surface.
T4	16.1/250.3	Piezometer with 3 m slotted screen installed with filter sand to 12.2 m, bentonite seals from 12.2-10.4 m, 7.3-6.4 m and 0.6-ground surface, auger cuttings from 10.4-7.3 m and 6.4-0.6 m.

The drilling and sampling operations were supervised on a full time basis by a member of Terraprobe's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Terraprobe's Brampton laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis and Atterberg Limits tests. The results of this testing program are shown on the Record of Borehole sheets in Appendix A. The grain size distribution curves and plasticity charts are illustrated in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and Appendix C. Details of the encountered soil stratigraphy are presented in these appendices and on the "Borehole Locations and Soil Strata" drawing in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil and overburden soils consisting of clayey silt fill, clayey silt, clayey silt till and sand and silt till.



5.1 Topsoil

Topsoil ranging from 100 mm to 250 mm in thickness was encountered along the alignment. Topsoil thickness may vary between and beyond the boreholes.

5.2 Clayey Silt Fill

Fill consisting of a mixture of clayey silt, trace to some sand with trace gravel and trace organics was encountered at boreholes T2 and T4. The fill extends to depths ranging from 0.7 m to 1.1 m or to elevations ranging from Elev. 263.8 m to Elev. 265.3 m.

SPT 'N' values in the fill material ranged from 8 to 13 blows for 0.3 m penetration indicating a firm to stiff consistency. The moisture content of samples of the fill soils varies from 11% to 20% by weight.

5.3 Clayey Silt

Clayey silt was encountered in some of the boreholes extending to depths of 0.7 m below ground surface or to elevations ranging from Elev. 261.9 m to Elev. 263.1 m.

Standard Penetration tests in this deposit gave 'N' values ranging from 17 to 20 blows per 0.3 m penetration. Based on these results the deposit is considered to have a very stiff consistency. The moisture content of samples from this stratum ranged from 7% to 9% by weight.

5.4 Clayey Silt Till

Deposits of clayey silt till were encountered across the site. In the deeper boreholes (T2 and T4) the clayey silt till is divided into upper and lower units by a layer of sand and silt till.

Where the upper clayey silt till was fully penetrated the deposit extends to depths ranging from 6.9 m to 10.1 m below ground surface or to elevations of 253.6 m to 257.6 m.

The lower clayey silt till extends to borehole termination depths of 15.7 m (Elev. 248.8 m) and 17.0 m (Elev. 249.4 m) in boreholes T2 and T4 respectively.

The grain size distribution plots of tested samples from the upper till deposit are presented in Figures B1 and B2. These results show a grain size distribution consisting of 2-16% gravel, 19-44% sand, 34-53% silt and 10-26% clay size particles. Cobbles and boulders can also be expected to occur in till soils.

Samples from this deposit were also subjected to Atterberg Limits tests and the results are presented in Figure B3. The index values from these tests are summarized below:

Liquid Limit:	15-29%
Plastic Limit:	10-15%
Plasticity Index:	5-14%
Natural Moisture Content:	6-16%



These values are characteristic of clayey soils of low plasticity.

Standard Penetration tests in the till layers yielded 'N' values ranging from 9 to more than 100 blows per 0.3 m penetration. Based on these values the till is considered to have a stiff to a hard consistency. The moisture content of samples from these deposits ranged from 6% to 26% by weight.

5.5 Sand and Silt Till

The site is underlain by a deposit of sand and silt till. The till deposit was fully penetrated in boreholes T2 and T4 where it extends to depths of 11.5 m to 13 m below ground surface or to elevations ranging from 253.0 m to 253.4 m. Where this deposit was encountered in the remaining boreholes the sand and silt till extends to borehole termination depths ranging from 9.2 m to 11.1 m below ground surface or to elevations ranging from 252.6 m to 255.3 m and possibly beyond.

The results of grain size distribution tests conducted on samples obtained from this deposit are illustrated in Figure B4. These results show grain size distributions consisting of 6-9% gravel, 43-46% sand, 40% silt and 8% clay size particles. Cobbles and boulders can also be expected to occur in till soils.

Standard Penetration tests in the sand and silt till gave 'N' values of more than 100 blows per 0.3 m penetration. Based on these results the deposit is considered to have a very dense relative density. The moisture content of samples from this stratum ranged from 6% to 16% by weight.

5.6 Water Levels

Standpipe piezometers were installed in selected boreholes and water level readings were taken on separate visits made after the completion of drilling. The recorded water level measurements are presented in Table 5.2.

Table 5.2 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
KS2	July 06, 2007	5.9	256.7
	July 11, 2007	5.9	256.7
KS3	July 06, 2007	8.7	255.8
	July 11, 2007	8.1	256.4
T2	November 20, 2006	6.7	257.8
T4	November 20, 2006	10.5	255.9

Based on these observations, the local groundwater level generally ranges between 255.8 m and 257.8 m.

All groundwater observations are short term and the levels are expected to fluctuate seasonally and after severe weather events.



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APPENDICES

Terraprobe Limited



LIMITATIONS AND RISK

Procedures

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

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even 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 design parameters and 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 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 affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities.

Changes In Site And Scope

It must 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. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report

This report was prepared for the express use of the Region of Peel, Ministry of Transportation, its retained design consultants and Giffels Associates Ltd. 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. The Ministry of Transportation, its retained design consultants and Giffels Associates Ltd., are authorized users.

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0-12	12-25	25-50	50-100	100-200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0-5	5-10	10-30	30-50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0-25	25-50	50-75	75-90	90-100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50-300mm	0.3m-1m	1m-3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p)/I_p$	l	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(w_L - w)/I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

APPENDIX A

Record of Borehole Sheets

Terraprobe Limited



RECORD OF BOREHOLE No KS1

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,414.5N; 279,066.4E ORIGINATED BY SK
 DIST _____ HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 28.06.07 CHECKED BY JC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE								● QUICK TRIAXIAL		× LAB VANE
							20	40	60	80	100									
263.8	Ground Surface																			
263.7	100mm TOPSOIL																			
0.1	CLAYEY SILT some sand, trace gravel, occasional organic inclusions, very stiff, dark brown, damp		1	SS	17															
263.1			2	SS	28															
0.7	CLAYEY SILT sandy, trace to some gravel, occasional sandy silt seams and partings, very stiff to hard, brown, damp (GLACIAL TILL)		3	SS	40											6 28 46 20				
			4	SS	50															
			5	SS	41															
			6	SS	68															

ONTARIO MOT 1-07-2150 SEWER GPJ ONTARIO MOT GDT 31/08/07

RECORD OF BOREHOLE No KS2

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,477.8N; 279,168.8E ORIGINATED BY SK
 DIST _____ HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 28.06.07 CHECKED BY JC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		WATER CONTENT (%)			
							20 40 60 80 100		20 40 60 80 100	10 20 30			
							○ UNCONFINED + FIELD VANE						
							● QUICK TRIAXIAL × LAB VANE						
262.6	Ground Surface												
262.5	100mm TOPSOIL												
0.1	CLAYEY SILT some sand, trace gravel, very stiff, brown, damp		1	SS	20								
261.9													
0.7	CLAYEY SILT sandy, trace to some gravel, occasional sandy silt seams and partings, very stiff to hard, brown, damp to moist (GLACIAL TILL)		2	SS	15								
			3	SS	33								
			4	SS	58							12 34 38 16	
			5	SS	59								
			6	SS	100/ 13cm								
			7	SS	100/ 10cm								
255.5													
7.1	SAND AND SILT trace clay, trace gravel, very dense, brown, damp to moist (GLACIAL TILL)		8	SS	100/ 28cm								
253.4	End of Borehole		9	SS	100/ 14cm								
9.2													
	Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.5m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.06.07 5.9 256.7 July.11.07 5.9 256.7												

ONTARIO MOT 1-07-2150 SEWER GPJ ONTARIO MOT GDT 31/08/07

RECORD OF BOREHOLE No KS3

1 OF 1

METRIC

W.P. _____ LOCATION _____ Co-ords. 4,845,428.2N; 279,203.0E ORIGINATED BY SK
 DIST _____ HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 28.06.07 CHECKED BY JC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE
264.5 0.0	Ground Surface						20	40	60	80	100						
	weathered, occasional organic inclusions CLAYEY SILT sandy, trace to some gravel, very stiff to hard, brown, damp to moist (GLACIAL TILL)		1	SS	19												
			2	SS	25												
			3	SS	29												
			4	SS	44												
			5	SS	51												
			6	SS	48												
257.6 6.9	SAND AND SILT trace clay, trace gravel, very dense, brown, damp (GLACIAL TILL)																
			7	SS	100/ 13cm												
			8	SS	100/ 14cm												
255.3 9.2	End of Borehole																
	Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.5m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.06.07 8.7 255.8 July.11.07 8.1 256.4																

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No KS4

1 OF 1

METRIC

W.P. _____ LOCATION _____ Co-ords. 4 845,358.2N; 279,113.9E. _____ ORIGINATED BY SK
 DIST _____ HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers _____ COMPILED BY DB
 DATUM Geodetic DATE 19.07.07 _____ CHECKED BY JC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
264.4	Ground Surface						20	40	60	80	100	10	20	30	GR SA SI CL	
264.3 0.2	150mm TOPSOIL		1	SS	11											
	weathered, occasional organic inclusions		2	SS	24											
	CLAYEY SILT sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		3	SS	41											
	trace sand		4	SS	63											
			5	SS	38											
	grey		6	SS	19											
			7	SS	83											
257.3 7.1	SAND AND SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)		8	SS	100/ 28cm											
			9	SS	100/ 28cm											
253.4 11.0	End of Borehole Borehole was caving at 9.1m and unstabilized water level at 8.0m upon completion of drilling.		10	SS	100/ 25cm											

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No KS5

1 OF 1

METRIC

W.P. _____ LOCATION Co-ords. 4,845,398.9N; 279,151.1E. ORIGINATED BY SK
 DIST _____ HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 29.06.07 CHECKED BY JC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
263.7	Ground Surface							20 40 60 80 100							
263.5	200mm TOPSOIL							20 40 60 80 100							
0.2	weathered, occasional organic inclusions		1	SS	13		263								
	CLAYEY SILT some sand to sandy, trace gravel, very stiff to hard, brown, damp to moist		2	SS	23										
	(GLACIAL TILL)		3	SS	39		262								2 19 53 26
			4	SS	56		261								
			5	SS	69		260								
			6	SS	42		259								
			7	SS	45		258								
			8	SS	98		256								4 44 34 18
			9	SS	100/ 25cm		255								8 34 45 13
253.6	SAND AND SILT trace clay, trace gravel, very dense, grey, damp						254								
10.1	(GLACIAL TILL)		10	SS	100/ 23cm		253								
252.6	End of Borehole														
11.1	✱ Borehole was dry (unstabilized) and hole open to full depth upon completion of drilling														

ONTARIO MOT 1-07-2150 SEWER GPJ ONTARIO MOT GDT 31/08/07

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX B

Laboratory Test Results

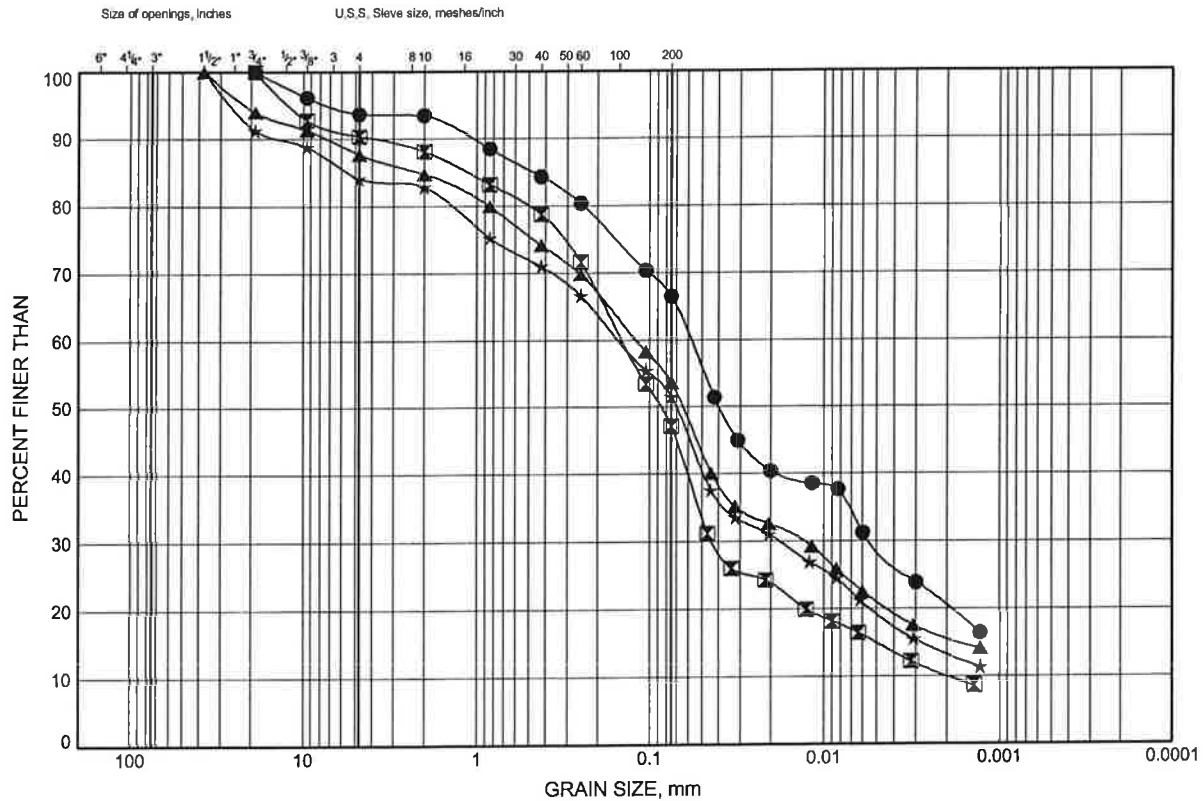
Terraprobe Limited



GRAIN SIZE DISTRIBUTION

FIGURE B1

CLAYEY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	KS1	1.8	262.7
⊠	KS1	6.2	258.3
▲	KS2	2.4	262.1
★	KS3	3.2	261.3

Date September 2007
Project

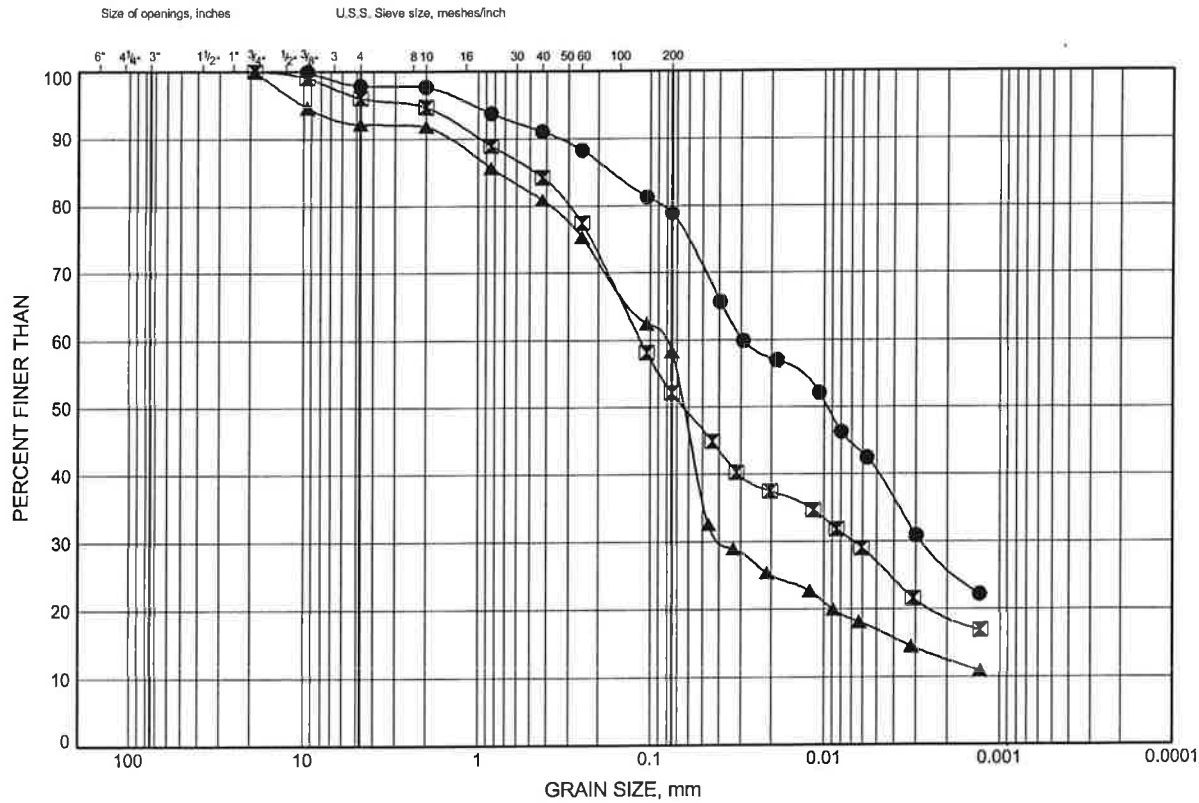


Prep'd GM
Chkd. RA

GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	KS5	1.7	262.0
⊠	KS5	7.7	256.0
▲	KS5	9.2	254.5

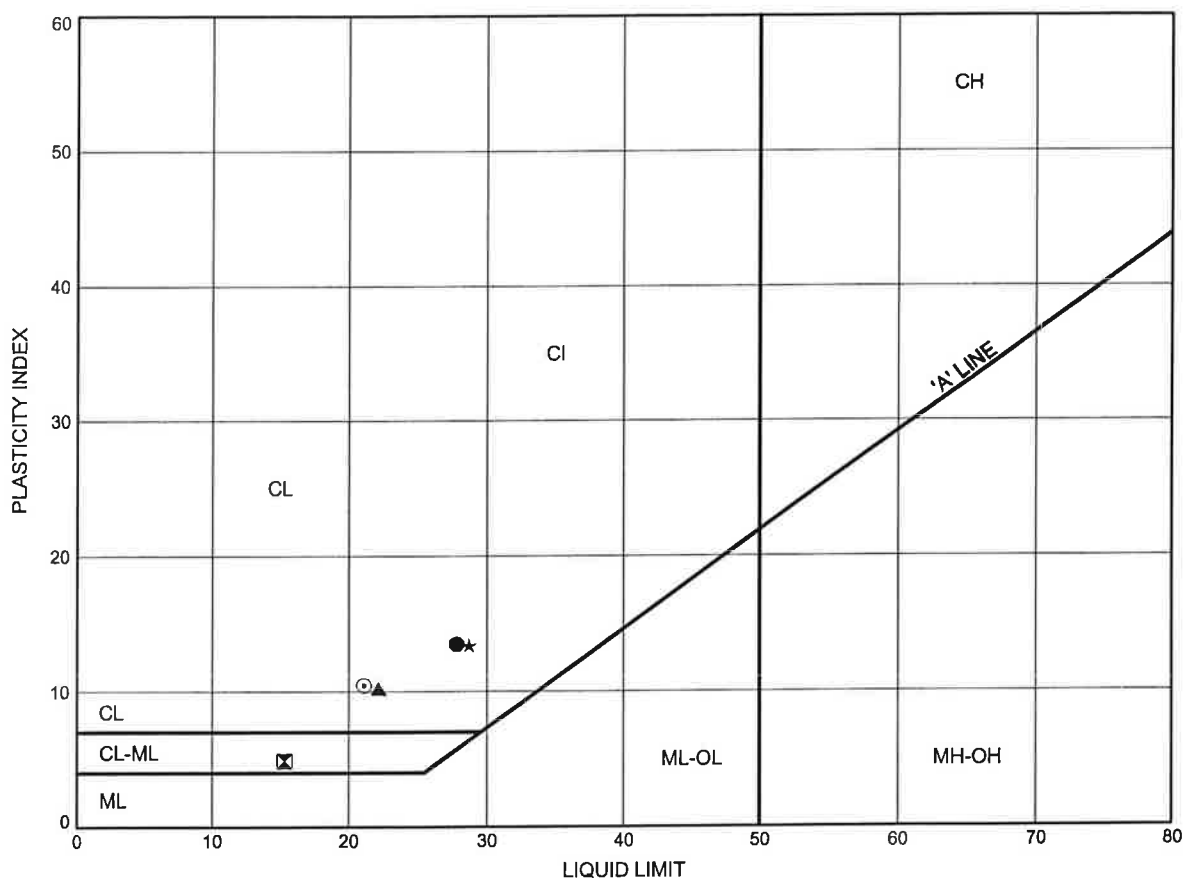
Date ..September 2007....
Project



Prep'dGM.....
Chkd.RA.....

FIGURE B3

CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	KS1	1.8	261.9
☒	KS1	6.2	257.5
▲	KS3	3.2	260.5
★	KS5	1.7	262.0
⊙	KS5	7.7	256.0

Date ..September 2007...

Project

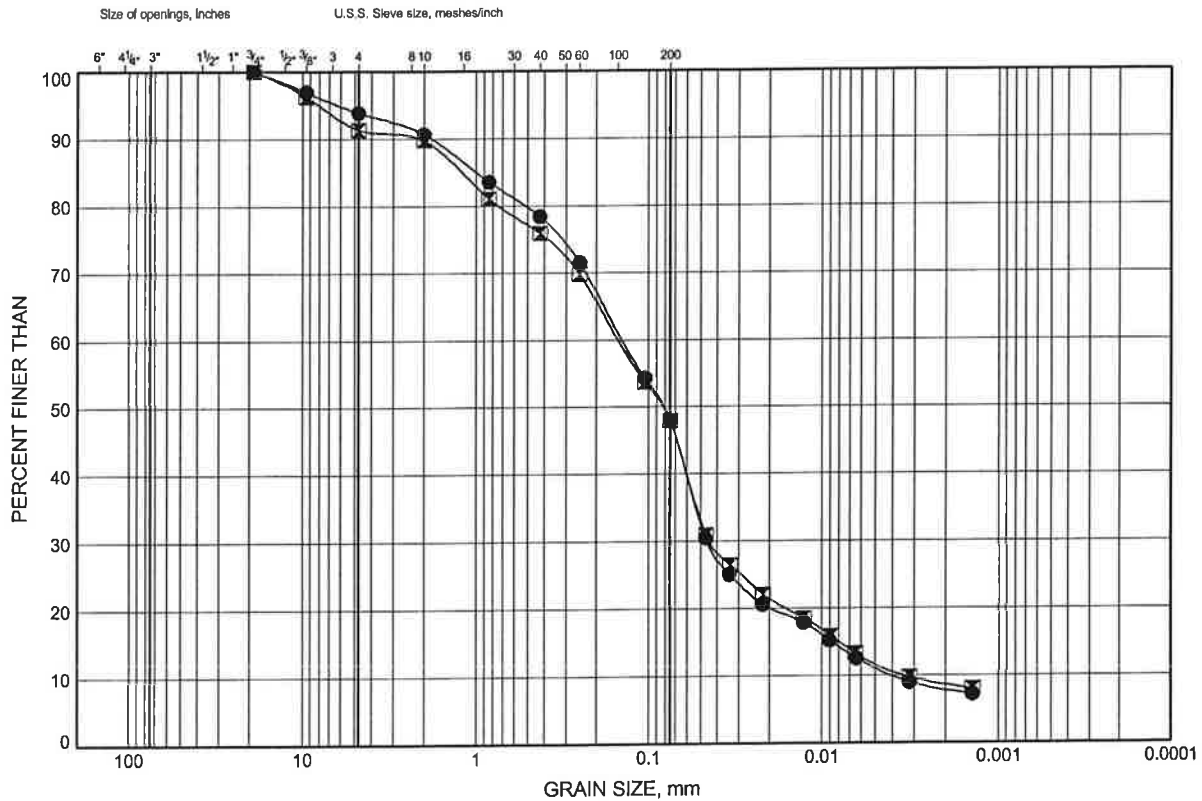


Prep'd GM
Chkd. RA

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND AND SILT TILL



APPENDIX C

Record of Boreholes (Previous Investigations)

Terraprobe Limited



RECORD OF BOREHOLE No T2

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,393.1 N; 279,008.1 E ORIGINATED BY A.Z.
 DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.
 DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE		
264.5	Ground Surface						20	40	60	80	100	10	20	30	GR SA SI CL			
264.3	250mm TOPSOIL, black																	
0.3	FILL - Clayey Silt, trace to some sand, trace gravel, with rootlets, firm to stiff, brown, damp to moist		1	SS	8													
263.8																		
0.7	CLAYEY SILT sandy, trace gravel, hard, brown, damp (GLACIAL TILL)		2	SS	54													
			3	SS	78													
			4	SS	75													
			5	SS	59													
	and sand, grey		6	SS	50/ 13cm													
257.5																		
7.0	SAND AND SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)		7	SS	130/ 8cm													
			8	SS	100/ 13cm													
			9	SS	100/ 13cm													
253.0																		
11.5	CLAYEY SILT trace to some sand, trace gravel, hard, grey, damp to moist (GLACIAL TILL)		10	SS	80/ 15cm													
			11	SS	110/ 8cm													

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T2

2 OF 2

METRIC

W.P. _____ LOCATION Co-ords 4,845,393.1 N; 279,008.1 E ORIGINATED BY A.Z.
 DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.
 DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100										
248.8	CLAYEY SILT trace to some sand, trace gravel, hard, grey, damp to moist (GLACIAL TILL)		12	SS	92											
15.7	End of Borehole															
	Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) 20/11/06 6.7 257.8															

+ 3, × 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No T4

1 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,316.0 N; 279,083.7 E ORIGINATED BY A.Z.
 DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.
 DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
266.4	Ground Surface							20 40 60 80 100						
266.0	200mm TOPSOIL, black		1	SS	13		266	○ UNCONFINED + FIELD VANE						
0.2	FILL - Clayey Silt, trace sand, trace gravel, trace organics, stiff, brown, moist							● QUICK TRIAXIAL × LAB VANE						
265.3			2	SS	46		265							
1.1	CLAYEY SILT some sand, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		3	SS	95		264							
			4	SS	92/ 28cm		263							
			5	SS	62/ 15cm		262							
			6	SS	87		261							
			7	SS	64		260							
			8	SS	50/ 15cm		259							
			9	SS	150/ 8cm		258							
256.3	SAND AND SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)		10	SS	110/ 10cm		257							
10.1			11	SS	110/ 13cm		256							
253.4	CLAYEY SILT sandy, trace gravel, hard, grey, damp to moist (GLACIAL TILL)						255							
13.0							254							
							253							
							252							

No Sample
Recovery

Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-06-1346 K SEWERS GPJ ONTARIO MOT GDT 30/11/06

RECORD OF BOREHOLE No T4

2 OF 2

METRIC

W.P. _____ LOCATION Co-ords. 4,845,316.0 N; 279,083.7 E. ORIGINATED BY A.Z.
 DIST _____ HWY Kennedy Road BOREHOLE TYPE Solid Stem Augers COMPILED BY D.B.
 DATUM Geodetic DATE 10.11.06 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	CLAYEY SILT sandy, trace gravel, hard, grey, damp to moist (GLACIAL TILL) (continued)		12	SS	100/ 15cm												
249.4 17.0	End of Borehole Piezometer Installation consists of 19mm diameter, schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) 20/11/06 10.5 255.9		13	SS	60/ 5cm												

RECORD OF BOREHOLE No 23+650 RT OF CL 1 OF 1 METRIC

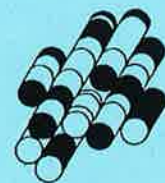
W.P. 105-00-00 LOCATION Coords: N:4845440.5 E:279123.2 (SITE 1) ORIGINATED BY MS
 DIST HWY 410 Phase III BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 07.01.05 CHECKED BY RA

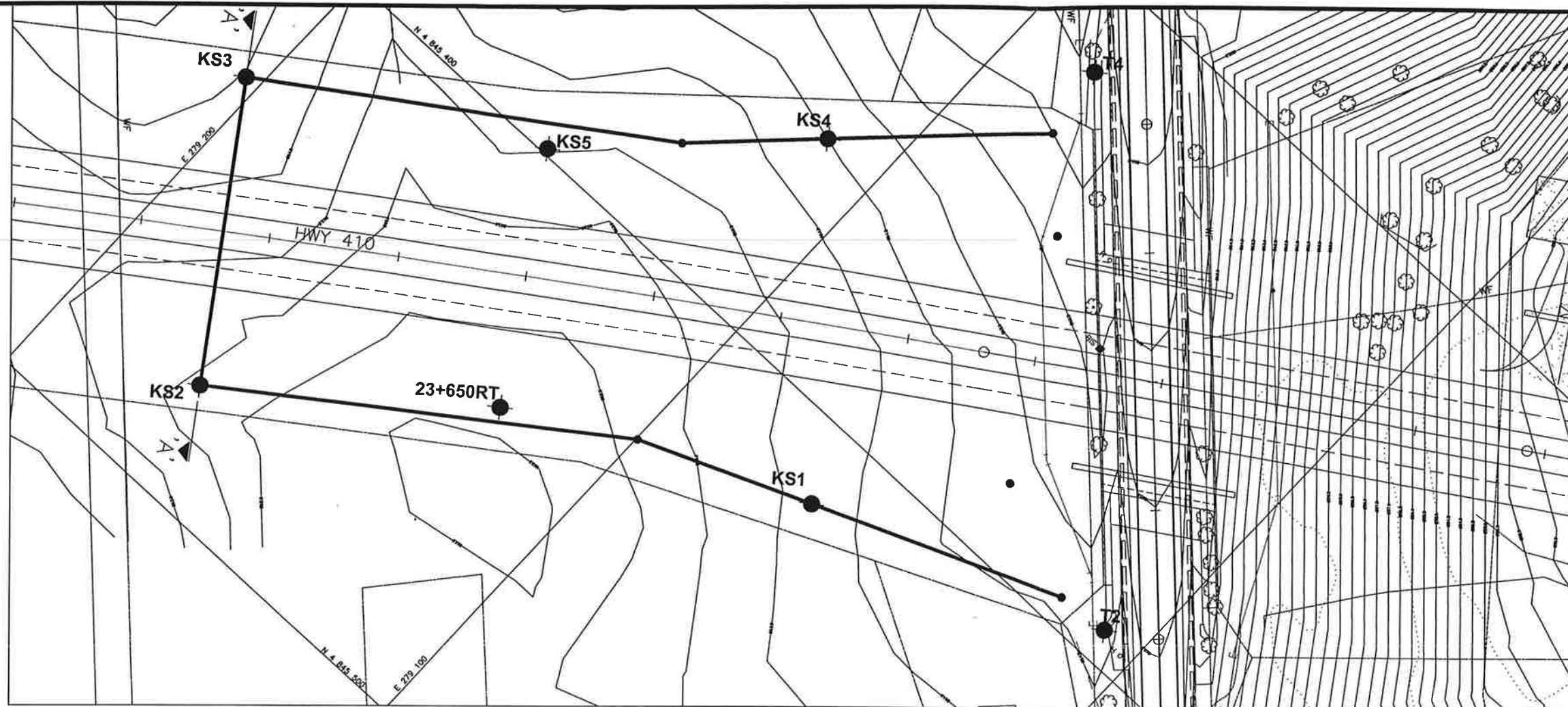
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
261.8	Ground Surface					*														
0.0	200mm TOPSOIL																			
0.2	weathered above 0.7m		1	SS	11															
	CLAYEY SILT - Sandy, trace gravel, occasional silty fine sand partings and pockets damp, brown (GLACIAL TILL)		2	SS	9															
			3	SS	10															
			4	SS	21															
	stiff to very stiff		5	SS	31															
	hard																			
			6	SS	43															
	grey below 5.6m																			
255.2			7	SS	37															
6.6	End of Borehole																			
	* Borehole was dry (not stabilized) and hole open to full depth on completion.																			

APPENDIX D

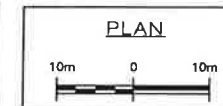
**Drawing titled
“Borehole Locations and Soil Strata”**

Terraprobe Limited





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN



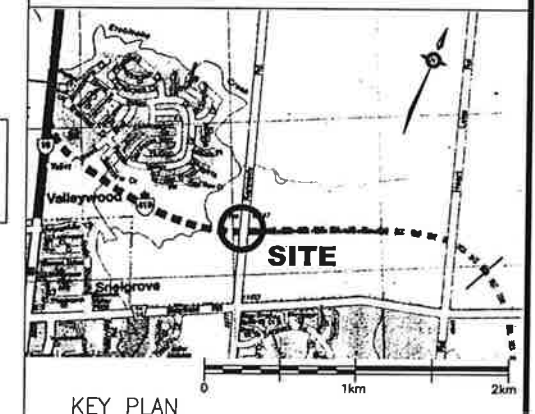
CONT No
WP No

HIGHWAY 410--PHASE III
Kennedy Road. Sanitary Sewer
Borehole Locations
and Soil Strata

SHEET
1 Of

Giffels
An Ingenium Group Company

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



KEY PLAN

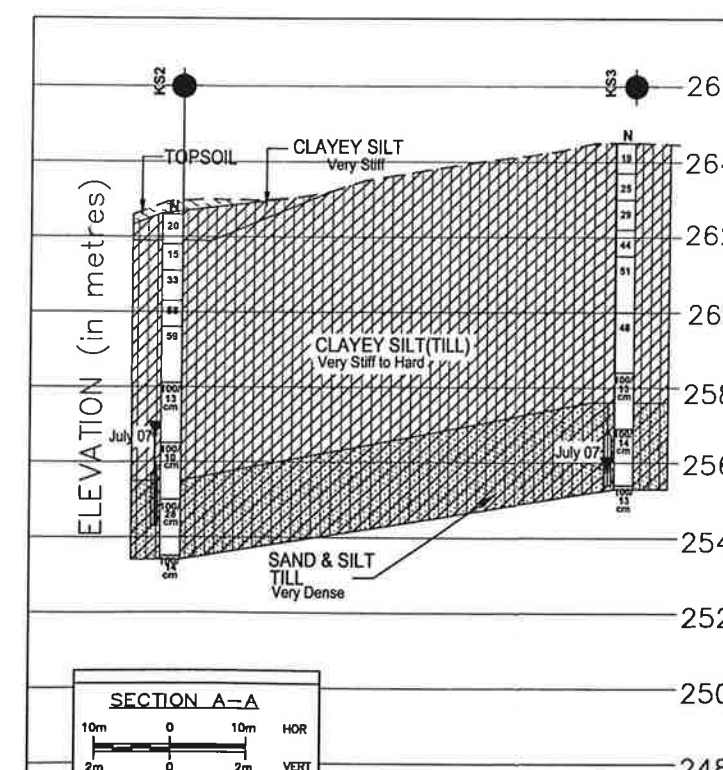
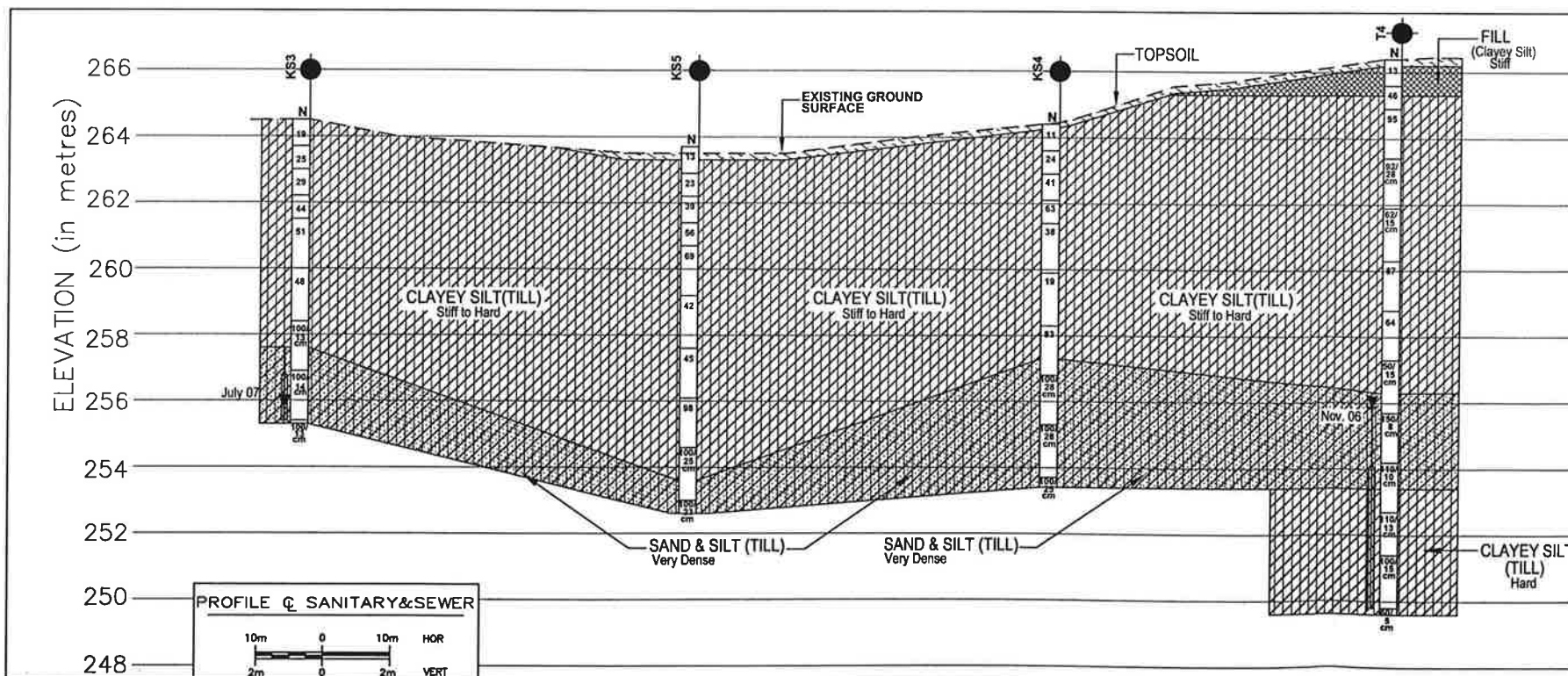
LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60" Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer 2005, 09
- Piezometer
- Rock Quality Designation
- Auger Refusal

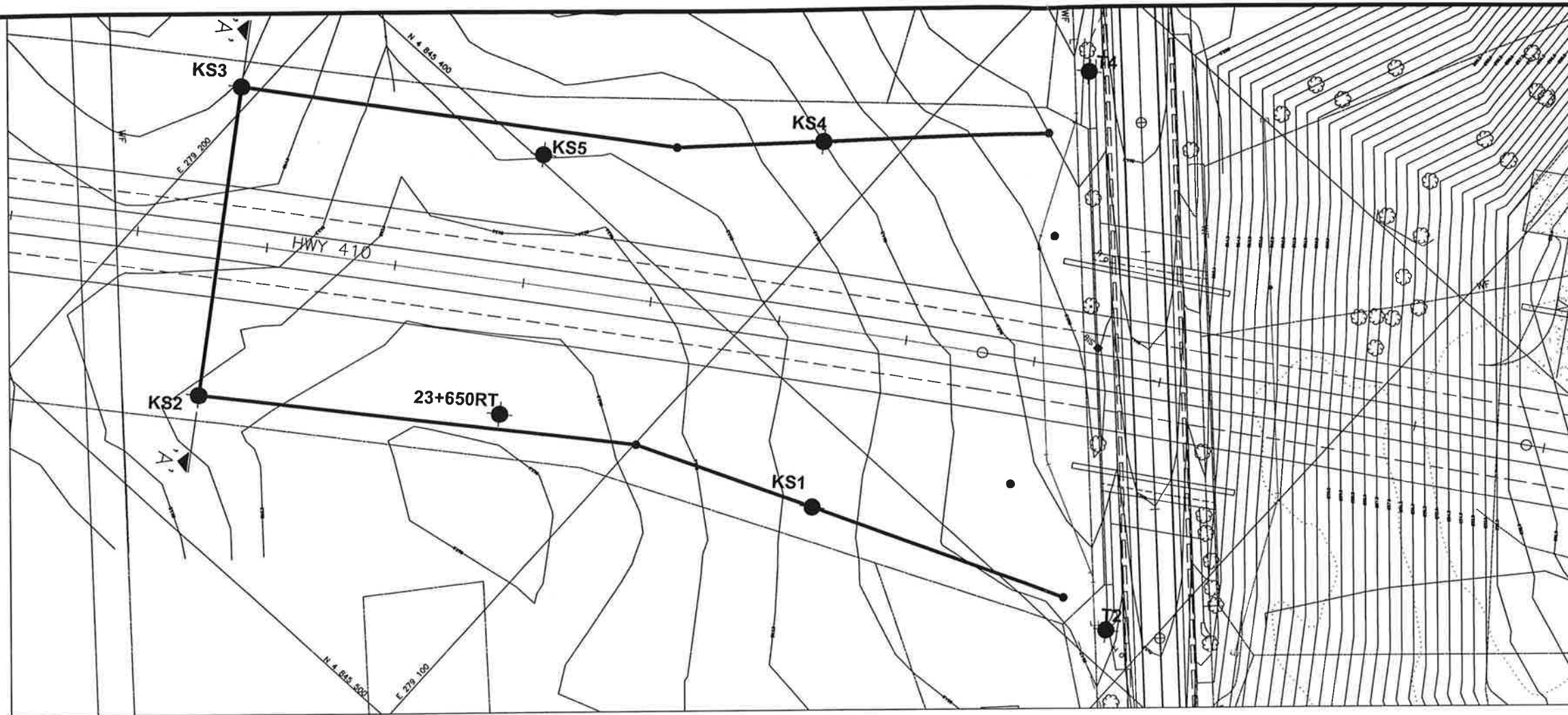
No	ELEVATION	COORDINATES	
		NORTHING	EASTING
T2	264.5	4845393.1	279008.1
KS1	263.8	4845414.5	279066.4
23+650RT	261.8	4845440.5	279123.2
KS2	262.6	4845477.8	279168.8
KS3	264.5	4845428.2	279203.0
KS4	264.4	4845358.2	279113.9
KS5	263.7	4845398.9	279151.1
T4	266.4	4845316.0	279083.7

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

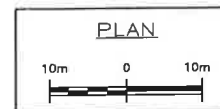
REVISIONS	DATE		BY		DESCRIPTION	
DESIGN	R.A.	CODE	CHBDC2000	LOAD	DATE	AUG.2007
DRAWN	R.Z.	CHK	R.A.	SITE:	STRUCT	DWG



DRAWING NOT TO BE SCALED
50mm ON ORIGINAL DRAWING



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

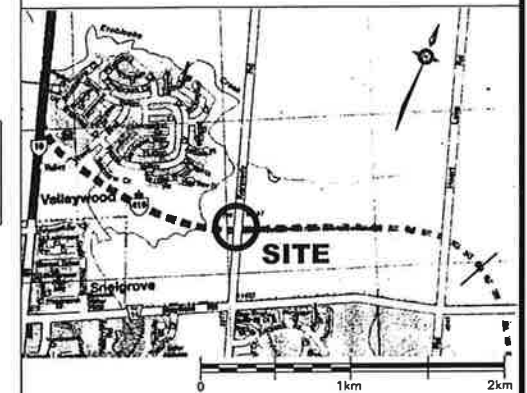


CONT No
WP No

HIGHWAY 410--PHASE III
Kennedy Road, Sanitary Sewer
Borehole Locations
and Soil Strata



SHEET
1 Of



KEY PLAN

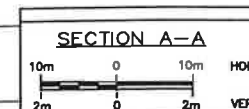
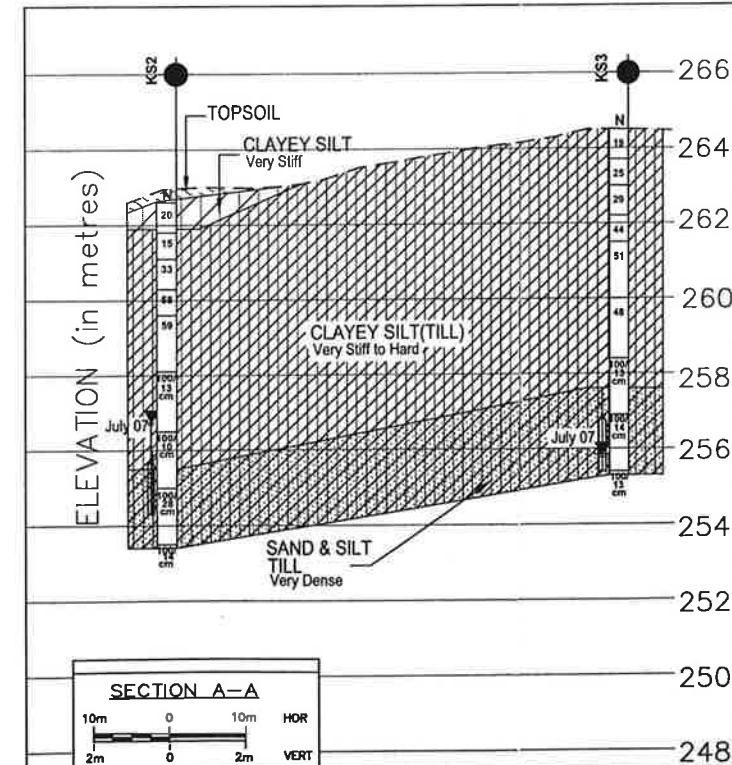
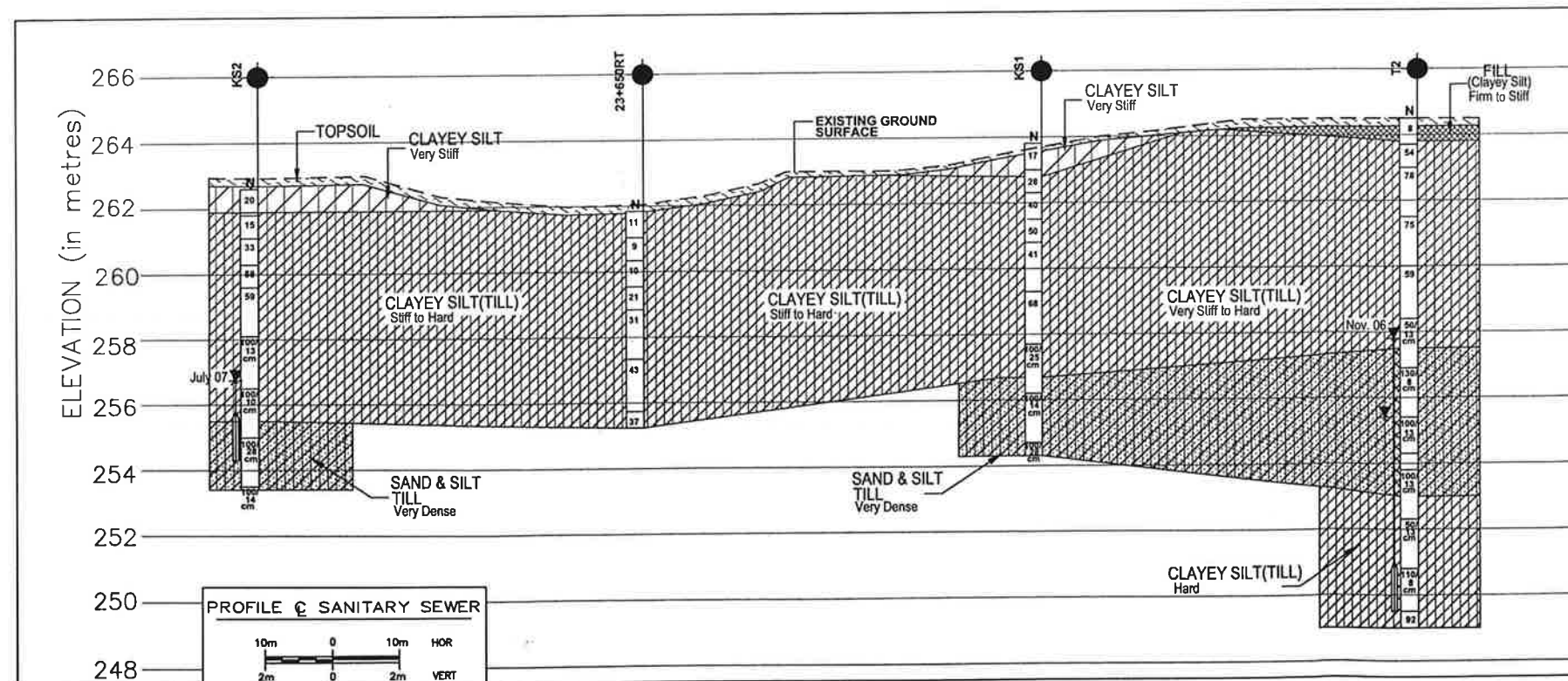
LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60' Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer
- Piezometer
- 90% Rock Quality Designation
- A/R Auger Refusal

No	ELEVATION	COORDINATES	
		NORTHING	EASTING
T2	264.5	4845393.1	279008.1
KS1	263.8	4845414.5	279066.4
23+650RT	261.8	4845440.5	279123.2
KS2	262.6	4845477.8	279168.8
KS3	264.5	4845428.2	279203.0
KS4	264.4	4845358.2	279113.9
KS5	263.7	4845398.9	279151.1
T4	266.4	4845316.0	279083.7

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

REVISIONS	DATE				DESCRIPTION	
	DATE	BY	DATE	DESCRIPTION	STRUCT	DWG
DESIGN	R.A	CODE	CHBDC2000	LOAD	DATE	AUG.2007
DRAWN	R.Z	CHK	R.A	SITE:	STRUCT	DWG



DRAWING NOT TO BE SCALED
50mm ON ORIGINAL DRAWING