

FOUNDATION INVESTIGATION REPORT
FOR
DOUGALL AVENUE UNDERPASS
G.W.P. 60-00-00, SITE 6-71
HIGHWAY 401
WINDSOR, ONTARIO

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FOUNDATION INVESTIGATION REPORT

for
Dougall Avenue Underpass
G.W.P. 60-00-00, Site 6-71
Highway 401
Windsor, Ontario

INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed underpass structure at Dougall Avenue and Highway 401 in Windsor, Ontario. The investigation was conducted for the Southwestern Region Structural Section of the Ontario Ministry of Transportation.

Highway 401 will pass under Dougall Avenue at approximate Station 12+770, Dougall Avenue chainage, in the Town of Tecumseh (Township of Sandwich South).

The report pertains to the proposed underpass structure and approaches within about 20 m of the abutments.

SITE DESCRIPTION

The site is situated at the intersection of the existing Highway 401 and Dougall Avenue. The proposed structure will carry Dougall Avenue traffic over Highway 401. At the location of the structure, Highway 401 runs in the southwest-northeast direction. Currently, Dougall Avenue passes under Highway 401.

The site is located in the south suburbs of the City of Windsor in Essex County (Southwestern Ontario). The surrounding lands are mainly level and used for a mix of residential, commercial and industrial purposes.

The area is part of the Essex Clay Plain physiographic sub-region. It is essentially a till plain smoothed by deposits of lacustrine clay which settled in the depressions while the knolls were being lowered by wave action. In general, the overburden in the sub-region consists of silty clays and/or clayey silts. The bedrock belonging to the Dundee Formation and anticipated at a depth of about 40 m is largely composed of Middle Devonian limestone, dolostone and shale.

INVESTIGATION PROCEDURES

The field work was carried out during the period January 28 to February 11, 2002 and comprised six boreholes advanced to depths of 9.6 to 44.3 m, as summarized in the following table, at the locations indicated on Drawing 1 (Appendix B).

Location	Borehole No.	Depth (m)		
		Auger	Rock Core ⁽¹⁾	Total
West Abutment, North Side	71-1	40.7	3.5	44.2
West Abutment, South Side	71-2	9.6	—	9.6
Pier, North Side	71-3	9.6	—	9.6
Pier, South Side	71-4	40.1	4.2	44.3
East Abutment, North Side	71-5	39.9	3.0	42.9
East Abutment, South Side	71-6	9.6	—	9.6

⁽¹⁾ NQ diamond rock coring equipment

In addition, three boreholes (No. 9 to 11) drilled to depths of 9.0 to 9.6 m for the concurrent Embankment Foundation Investigation were used to supplement the subsurface data at the approach locations.

The locations of and ground surface elevations at the boreholes were established in the field by Peto MacCallum Ltd. The following benchmark (BM) was used for vertical reference:

BM: Top of standard iron bar designated
SP-HCP 130.
Elevation 189.733 (geodetic)

The boreholes were advanced using continuous flight solid and hollow stem augers as well as mud rotary methods, powered by a track-mounted CME-75 Nodwell drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In situ vane shear and pocket penetrometer tests were also performed to further assess the shear strength of the cohesive soils.

The groundwater conditions in the boreholes were closely monitored during the course of the field work. Upon completion of drilling, two piezometers each consisting of 19 mm PVC pipe slotted over the bottom 900 mm were installed in boreholes 71-2 and 71-6 to monitor groundwater conditions. The annular space around the pipe was filled with filter sand or gravel and, after placing a bentonite seal, backfilled with auger cuttings to the ground surface (another bentonite seal was placed at the top of borehole 71-2) as illustrated on the respective borehole logs. The water level in the piezometers was measured on February 7 and 14, March 5 and 28, and May 6, 2002.

The deep boreholes were sealed with cement-bentonite grout upon completion of drilling and coring. The remaining boreholes without piezometers were backfilled with auger cuttings to the ground surface.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. A consolidation, unconfined uniaxial compression and consolidated undrained triaxial tests were performed to determine the compressibility and strength characteristics of the cohesive soils. Atterberg Limits tests and grain size distribution analyses were carried out on selected samples, their results being presented in Figures 1 and 2 (Appendix A) and on the Record of Borehole sheets (Appendix B).

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, boundary elevations, standard penetration and in situ vane shear/pocket penetrometer test results, groundwater observations, the results of laboratory grain size distribution analyses, Atterberg Limits tests and moisture content determinations. Samples submitted for laboratory testing are also shown on the borehole logs.

The borehole locations and stratigraphic profiles prepared from the borehole data are presented on Drawings 1 and 2.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised a surficial fill, topsoil and/or silty clay layer underlain by clay till overlying a discontinuous sand and gravel deposit. Limestone bedrock was contacted at depths of 39.9 to 40.7 m. The strata encountered are summarized below.

Fill

Surficial fill was present in boreholes 71-2 to 71-4 and 71-6. It typically consisted of firm to stiff silty clay and was 0.7 to 1.7 m thick. In borehole 71-3 put down near a maintenance hole, 2.9 m of very loose crushed limestone was encountered.

Topsoil

A 200 to 400 mm thick topsoil layer of stiff silty clay was revealed directly beneath the fill in boreholes 71-4 and 71-6 at respective depths of 1.7 and 0.7 m (elevation 189.8 and 190.9). Topsoil of 100 to 200 mm in thickness was present surficially in boreholes 71-5 and 9 to 11.

Silty Clay

A 2.1 m thick layer of stiff cohesive silty clay was identified surficially in borehole 71-1. The silty clay had moisture contents of 14 and 21%, showed a value of unconfined strength of 100 kPa in one pocket penetrometer test conducted.

Sandy Silty Clay Till

Cohesive sandy silty clay till was encountered in all boreholes at depths of 0.1 to 2.9 m (elevation 188.6 to 190.7). The consistency of this stratum was typically stiff to hard (N-values ranging from 8 to 61). The results of vane shear testing carried out in the unit at depths of 10.0 to 11.5 m indicate that the undisturbed and remoulded shear strength values ranged from 100 to 130 kPa and from 60 to 80 kPa respectively (soil sensitivity is about 1.7). A number of pocket penetrometer tests conducted within the unit at various depths gave the values of undrained strength varying broadly between 10 and 240 kPa, typically decreasing with depth from about 100 to 30 kPa (Values less than about 30 kPa were likely obtained from testing of disturbed/remoulded samples).

The moisture content of the clay till typically ranged from 13 to 20%, increasing locally to 23 and 34%. The results of the Atterberg Limits tests conducted on the clay till are presented in Figure 1, (Appendix A). The till plots as a clay of low plasticity with liquid limits of 26 to 32 and plastic limits of 12 to 16. The results of particle size distribution analyses are presented in Figure 2.

The results of one consolidation test performed on the clay till indicate a compression index C_c of 0.16 and recompression index C_s of 0.03. The unconfined uniaxial compression test gave a value of 158 kPa that corresponds to an estimated shear strength of about 80 kPa.

The clay till had a confirmed thickness of 33.9 to 39.8 m in boreholes 71-1, 71-4 and 71-5. The unit was not penetrated upon termination of the remaining boreholes at 9.0 to 9.6 m depth (elevation 180.9 to 182.0).

Sand and Gravel

Underlying the clay till in boreholes 71-1 and 71-4 at depths of 38.1 and 36.0 m (elevation 152.9 to 155.5) was a 2.6 to 4.1 m thick deposit of non-cohesive fine to coarse sand and gravel. The relative density ranged from compact to very dense with N-values of 25 and 62.

Bedrock

Limestone bedrock was contacted below the native clay till/sand and gravel at the following depths and elevations confirmed by rock coring:

Location	Depth to Rock (m)	Bedrock Elevation
West Abutment, North Side	40.7	150.3
Pier, South Side	40.1	151.4
East Abutment, North Side	39.9	150.6

Rock core description is provided in Table I (Appendix A). The measured core recovery varied between 80 and 95%. The RQD determined from the rock cores was in a range of 50 to 70%, indicating a fair quality rock. Complete loss of drill water circulation was experienced immediately following the start of coring in borehole 71-5. Voids of 75 and 100 mm in size were encountered at depths of 41.0 m (elevation 150.5) and 43.9 m (elevation 147.6) in borehole 71-4.

The unconfined compressive strength of the rock determined on two representative samples from borehole 71-1, corresponding to depths of 41.5 and 43.3 m (elevation 149.5 and 147.7) was 70 and 50 MPa, respectively.

Groundwater

No water was observed in the boreholes during the course of the field work, with the exception of perched water contained in the granular material encountered in borehole 71-3 drilled near a maintenance hole.

Upon completion of drilling, piezometers were installed in boreholes 71-2 and 71-6. Five sets of piezometer readings subsequently taken showed water levels to be at the following depths/elevations:

Date	Borehole 71-2		Borehole 71-6	
	Depth (m)	Elevation	Depth (m)	Elevation
February 7, 2002	6.0	185.4	8.6	183.1
February 14, 2002	3.6	187.8	7.3	184.4
March 5, 2002	1.4	190.0	2.5	189.2
March 28, 2002	1.1	190.3	2.3	189.4
May 6, 2002	0.9	190.5	2.2	189.5

CLOSURE

The field work was carried out under the supervision of Mr. M. Rapsey and direction of Mr. M.R. Anderson, M. Eng., P.Eng., Senior Foundation Engineer. The equipment was supplied by All-Terrain Drilling Limited.

The report was prepared by Mr. G.O. Degil, Ph.D., Senior Project Supervisor, and Mr. M.R. Anderson, M.Eng., P.Eng., Senior Foundation Engineer. It was reviewed by Mr. D.W. Kerr, M.Eng., P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, M.Eng., P.Eng., President, carried out an independent review of the report.

Yours very truly

Peto MacCallum Ltd.



A handwritten signature in black ink, appearing to read "M. R. Anderson".

Murray R. Anderson, M.Eng., P.Eng.
Senior Foundation Engineer



A handwritten signature in black ink, appearing to read "D. W. Kerr".

Dennis W. Kerr, M.Eng., P.Eng.
Chief Foundation Engineer



A handwritten signature in black ink, appearing to read "Brian R. Gray".

Brian R. Gray, M.Eng., P.Eng.
President

GD:lad

APPENDIX A

TABLE I	–	ROCK CORE DESCRIPTION
FIGURE 1	–	PLASTICITY CHART
FIGURE 2	–	PARTICLE SIZE DISTRIBUTION CHART

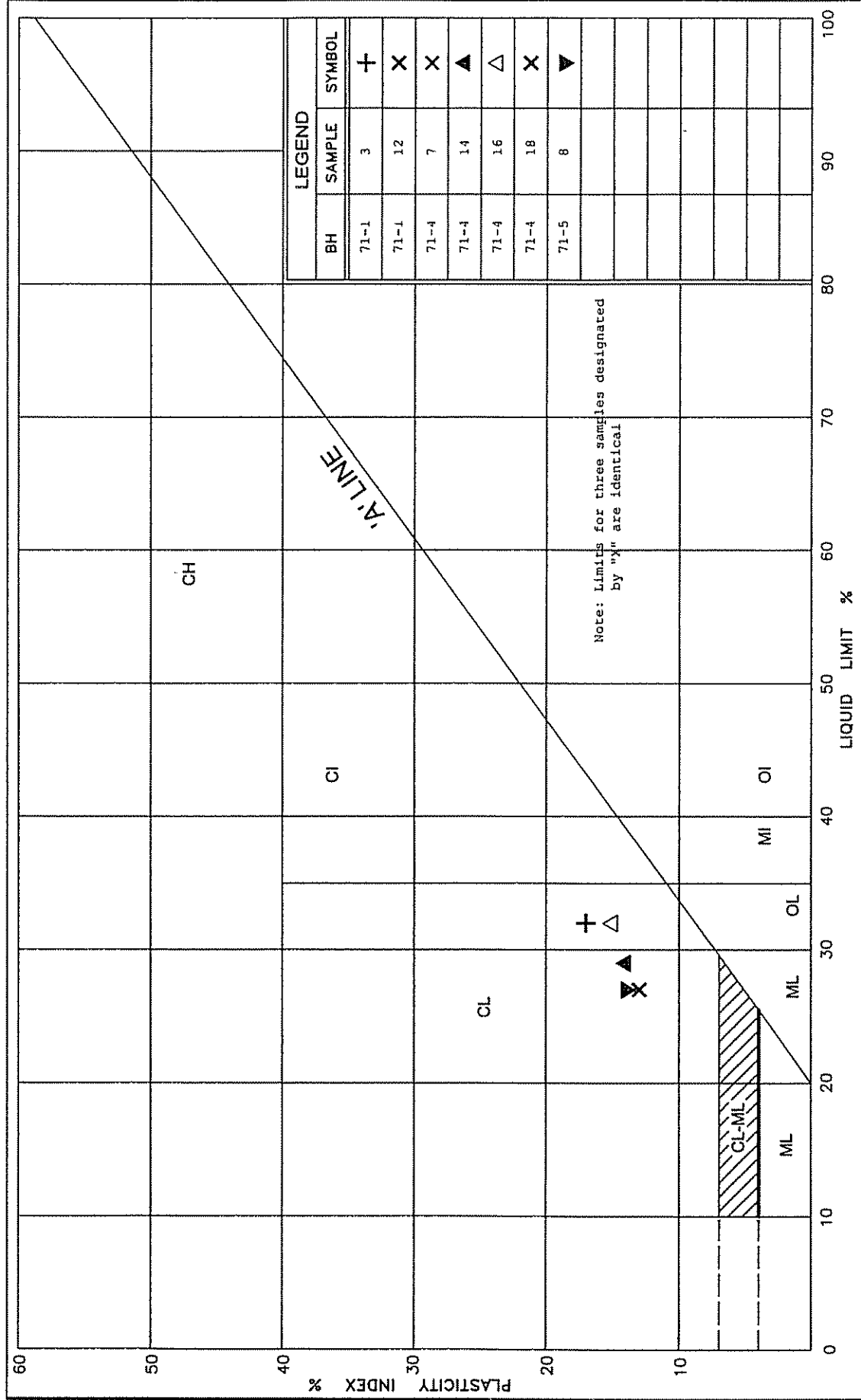
TABLE I

ROCK CORE DESCRIPTION
DOUGALL AVENUE UNDERPASS
G.W.P. 60-00-00, SITE 6-71
HIGHWAY 401
WINDSOR, ONTARIO

HOLE NO.	CORE RECOVERY			CORE DESCRIPTION	
	RUN NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)
71-1	21	40.70 – 41.10	0*	-	41.10 – 44.15
	22	41.10 – 43.10	80	70	
	23	43.10 – 44.15	90	50	
71-4	20	40.10 – 41.25	95	50	40.10 – 43.10
	21	41.25 – 44.30	95	55	
71-5	20	39.90 – 42.90	80	60	43.10 – 44.30
					39.90 – 42.90

*Sample lost due to mechanical problems

Originated: JFW
Compiled: GD
Checked: MRA



Ministry of Transportation
Ontario

FIG No 1

PLASTICITY CHART

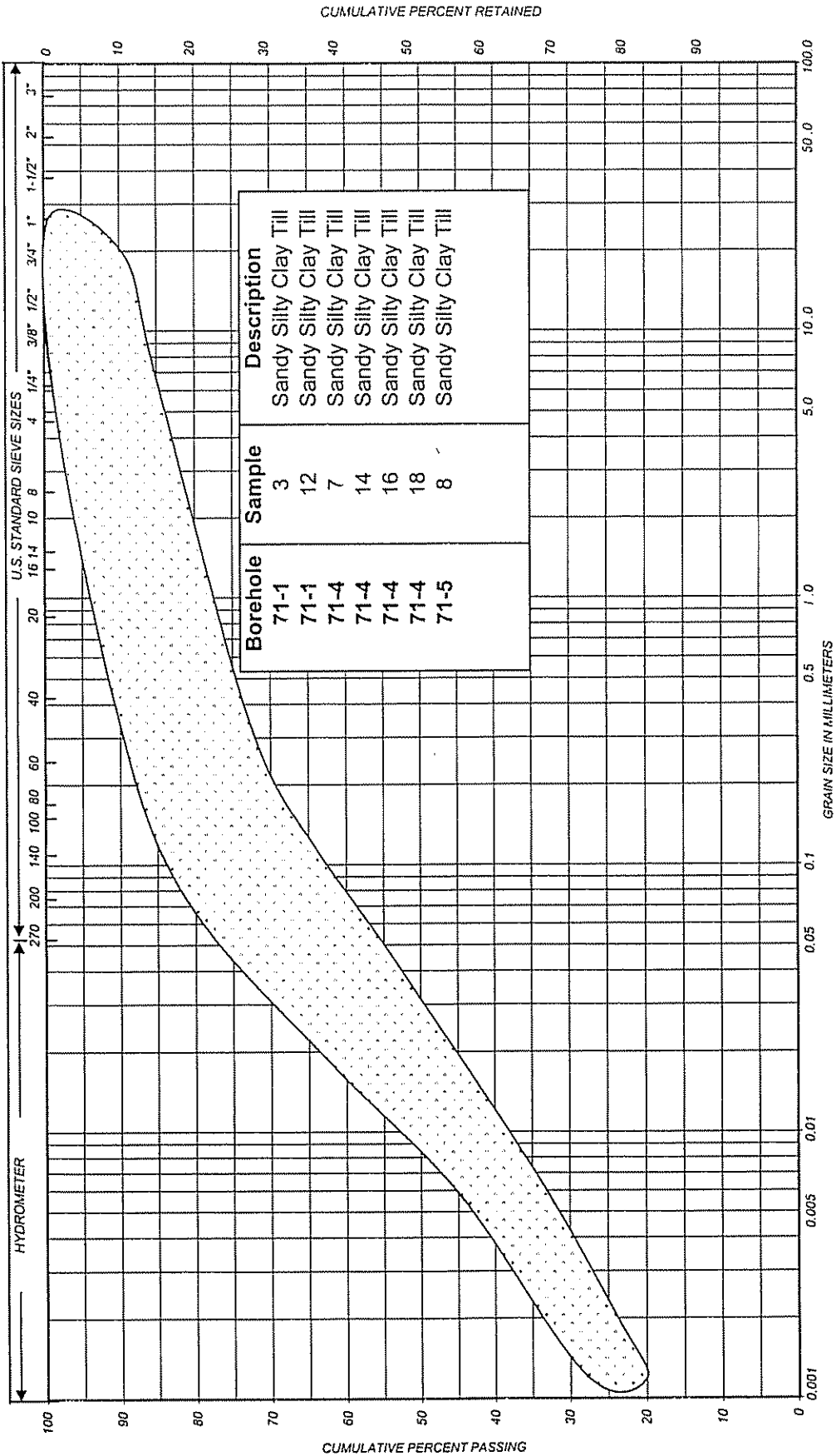
SANDY SILTY CLAY, trace to some gravel (CL)

HIGHWAY 401

G.W.P. 60-00-00, Site 6-71

PML REF 01TF072A
G.W.P 60-00-00
FIGURE 2

PARTICLE SIZE DISTRIBUTION CHART



CLAY		SILT & CLAY		GRAVEL		UNIFIED
CLAY	FINE	MEDIUM	SILT	FINE	COARSE	COBBLES
	VERY FINE	VERY FINE	VERY FINE	VERY FINE	VERY FINE	VERY FINE
CLAY		SILT		GRAVEL		U.S. BUREAU

REMARKS SANDY SILTY CLAY TILL

APPENDIX B

RECORD OF BOREHOLE SHEETS

DRAWINGS 1 AND 2

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 0.3 m INTO THE SUBSOIL. DRIVEN BY MEANS OF A 63.5 kg HAMMER FALLING FREELY A DISTANCE OF 0.76 m

DYNAMIC PENETRATION RESISTANCE: - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51 mm 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS. 0.3 m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:

<u>CONSISTENCY</u>	<u>'N' BLOWS/0.3 m</u>	<u>c kPa</u>	<u>DENSENESS</u>	<u>'N' BLOWS/0.3 m</u>
VERY SOFT	0 – 2	0 – 12	VERY LOOSE	0 – 4
SOFT	2 – 4	12 – 25	LOOSE	4 – 10
FIRM	4 – 8	25 – 50	COMPACT	10 – 30
STIFF	8 – 15	50 – 100	DENSE	30 – 50
VERY STIFF	15 – 30	100 – 200	VERY DENSE	> 50
HARD	> 30	> 200		
W.T.P.L. WETTER THAN PLASTIC LIMIT			D.T.P.L. DRIER THAN PLASTIC LIMIT	
A.P.L. ABOUT PLASTIC LIMIT				

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
P.H.	SAMPLE ADVANCED HYDRAULICALLY		
P.M.	SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

▲, Δ - UNDISTURBED AND REMOULDED SHEAR STRENGTH DETERMINED FROM IN SITU VANE TEST

■ - UNDRAINED SHEAR STRENGTH DETERMINED FROM POCKET PENETROMETER TEST

RECORD OF BOREHOLE No 71-1

1 of 4

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+725, o/s 9.5m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 28 to 30, 2002 CHECKED BY DWK

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								
191.00	Ground Level							20	40	60	80	100	20	40	60		GR SA SI CL		
0.00	Silty clay, trace of sand, with bluish grey fissures Stiff																		
	Brown		1	SS	8		190												
			2	SS	9		189												
188.90	Sandy silty clay, trace of gravel		3	SS	45		188										2 30 44 24		
2.10	(Till)		4	SS	48		187												
	Hard Brown		5	SS	23		186												
	Very Stiff to Stiff		6	SS	19		185												
	Grey		7	SS	10		184												
			8	SS	16		183												
			9	SS	13		182												
			10	SS	9		181												
				FV			180												
			11	SS	11		179												
							178												
							177												
	Cont'd		12	SS	14												4 30 37 29		

RECORD OF BOREHOLE No 71-1

2 of 4

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+725, o/s 9.5m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 28 to 30, 2002 CHECKED BY DWK

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L					
176.0																	
	Very Stiff to Stiff Grey		13	SS	13												
			14	SS	12												
			15	SS	9												
	some gravel Very Stiff to Hard		16	SS	22												
161.00	Cont'd																

RECORD OF BOREHOLE No 71-1

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METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+725, o/s 9.5m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 28 to 30, 2002 CHECKED BY DWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			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				w _p	w	w _L					
161.00			17	SS	35														
30.00	Sandy silty clay, some gravel Very Stiff to Hard Grey (Till)																		
			18	SS	61														
			19	SS	13														
152.90																			
38.10	Fine to coarse sand and gravel, some silt Very Dense Grey		20	SS	62														
150.30			21	RC	*													* Lost sample	
40.70	Bedrock Unweathered, strong limestone Grey to Light Grey		22	RC	REC 80%													RQD=70%	
			23	RC	REC 90%													RQD=50%	
146.85																			
44.15	End of Borehole																		
	Cont'd																		

RECORD OF BOREHOLE No 71-1

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METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE January 28 to 30, 2002 CHECKED BY DWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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	W _p	W	W _L			
	Borehole dry on completion of drilling ■ Penetrometer Test																	

RECORD OF BOREHOLE No 71-2

1 of 1

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+688, o/s 9.8m Rt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY MRA
DATUM Geodetic DATE February 05, 2002 CHECKED BY DWK

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 ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
191.38 0.00	Ground Level														
190.03 1.35	Silty clay, some sand Firm Brown (Fill)		1	SS	5										
	Sandy silty clay, trace of gravel (Till)		2	SS	11										
	Stiff to Hard Brown		3	SS	48										
			4	SS	67										
			5	SS	67										
			6	SS	30										
			7	SS	28										
			8	SS	16										
181.78 9.60	End of Borehole		9	SS	15										
<div>■ Penetrometer Test</div> <div>Piezometer Readings: Date Depth (m) Feb.07/02 6.00 Feb.14/02 3.55 Mar.05/02 1.40 Mar.28/02 1.05 May 06/02 0.85</div> <div>Borehole Backfill Legend: <div><div></div>Native Backfill</div><div><div></div>Bentonite Seal</div><div><div></div>Filter Sand</div></div>															

RECORD OF BOREHOLE No 71-3

1 of 1

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+782, o/s 6.0m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid and Hollow Stem Augers COMPILED BY MRA
DATUM Geodetic DATE February 11, 2002 CHECKED BY DWK

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									
191.47 0.00	Ground Level					▽*		20	40	60	80	100					
	Crushed limestone	[X]					191										* Low N value due to hydraulic disturbance
	Very Loose																
	Saturated (Fill)		1	SS	2*												
		[X]	2	SS	1*		190										
		[X]	3	SS	2*		189										
188.57 2.90	Sandy silty clay, trace of gravel, with oxidized stains	[S]	4	SS	44		188										
	Hard to Stiff		5	SS	26		187										
	Brown (Till)		6	SS	20		186										
	Grey						185										
			7	SS	17		184										
			8	SS	11		183										
							182										
			9	SS	13												
181.87 9.60	End of Borehole																
	▽ Groundwater level at surface																
	■ Penetrometer Test																

METRIC

+⁷, ×⁵: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

METRIC


(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 71-4

3 of 4

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+778, o/s 8.9m Rt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE February 05, 2002 CHECKED BY DWK

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					w _p	w	w _L		GR	SA	SI	CL	
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE	WATER CONTENT (%)									
161.46							20	40	60	80	100										
30.00	Sandy silty clay, some gravel Hard Grey (Till)		17	SS	30								○								
			18	SS	40								○	—						11 26 37 26	

RECORD OF BOREHOLE No 71-4

4 of 4

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE February 05, 2002 CHECKED BY DWK

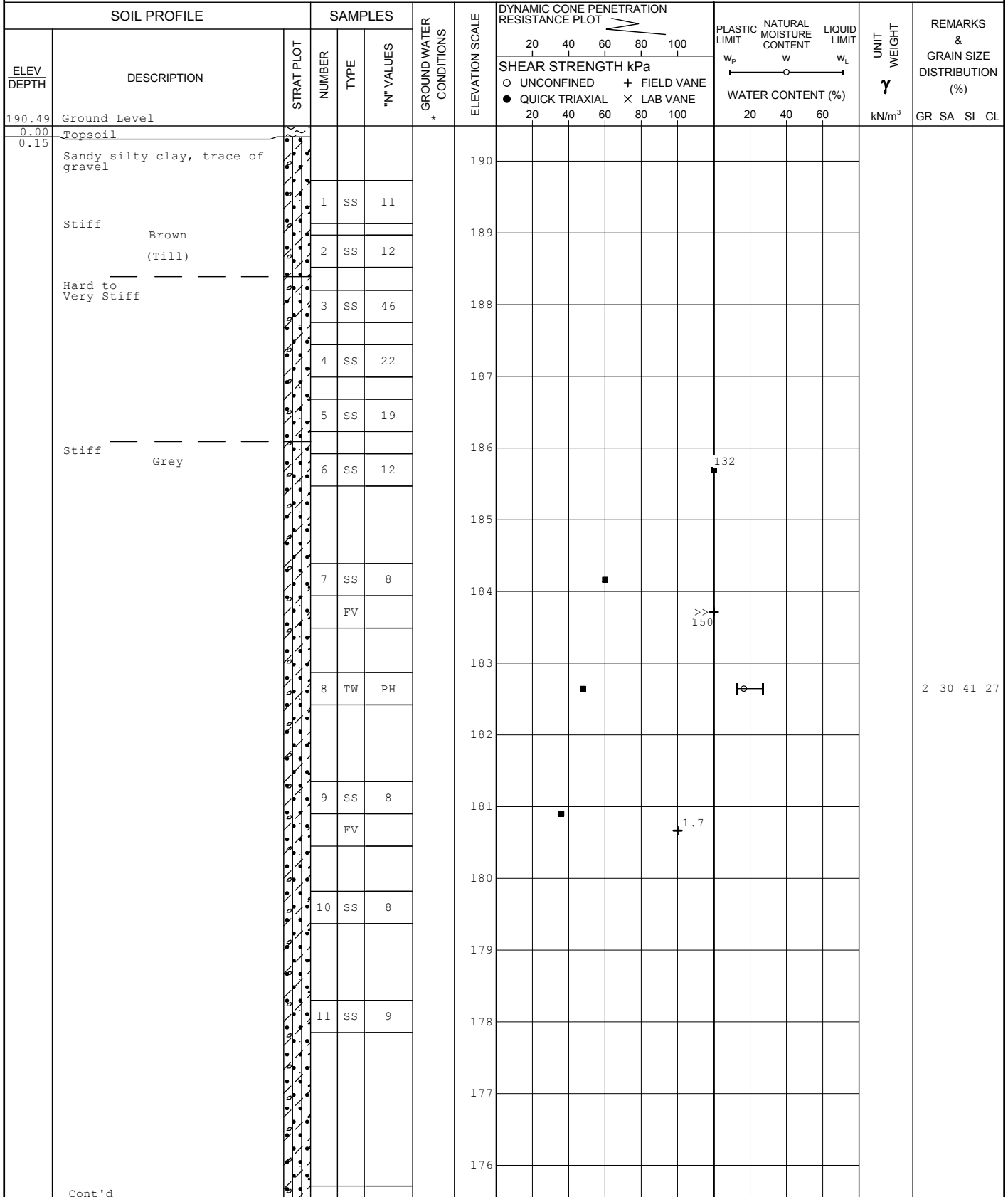
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	Borehole dry on completion of drilling ■ Penetrometer Test																

RECORD OF BOREHOLE No 71-5

1 of 3

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+850, o/s 6.3m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE February 7, 8 and 11, 2002 CHECKED BY DWK



RECORD OF BOREHOLE No 71-5

2 of 3

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp
Sta. 12+850, o/s 6.3m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE February 7, 8 and 11, 2002 CHECKED BY DWK

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 (%)					GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×					LAB VANE								
175.5			12	SS	11																				
Stiff to Very Stiff (Till)							175																		
							174																		
							173																		
			13	SS	15		172																		
							171																		
							170																		
			14	SS	15*		169																		
							168																		
							167																		
							166																		
							165																		
							164																		
							163																		
							162																		
							161																		
Hard																									
																			</						

* No
recovery

RECORD OF BOREHOLE No 71-5

3 of 3

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+850, o/s 6.3m Lt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE C.F.H.S.A., Mud Rotary & NQ Rock Coring COMPILED BY MRA
DATUM Geodetic DATE February 7, 8 and 11, 2002 CHECKED BY DWK

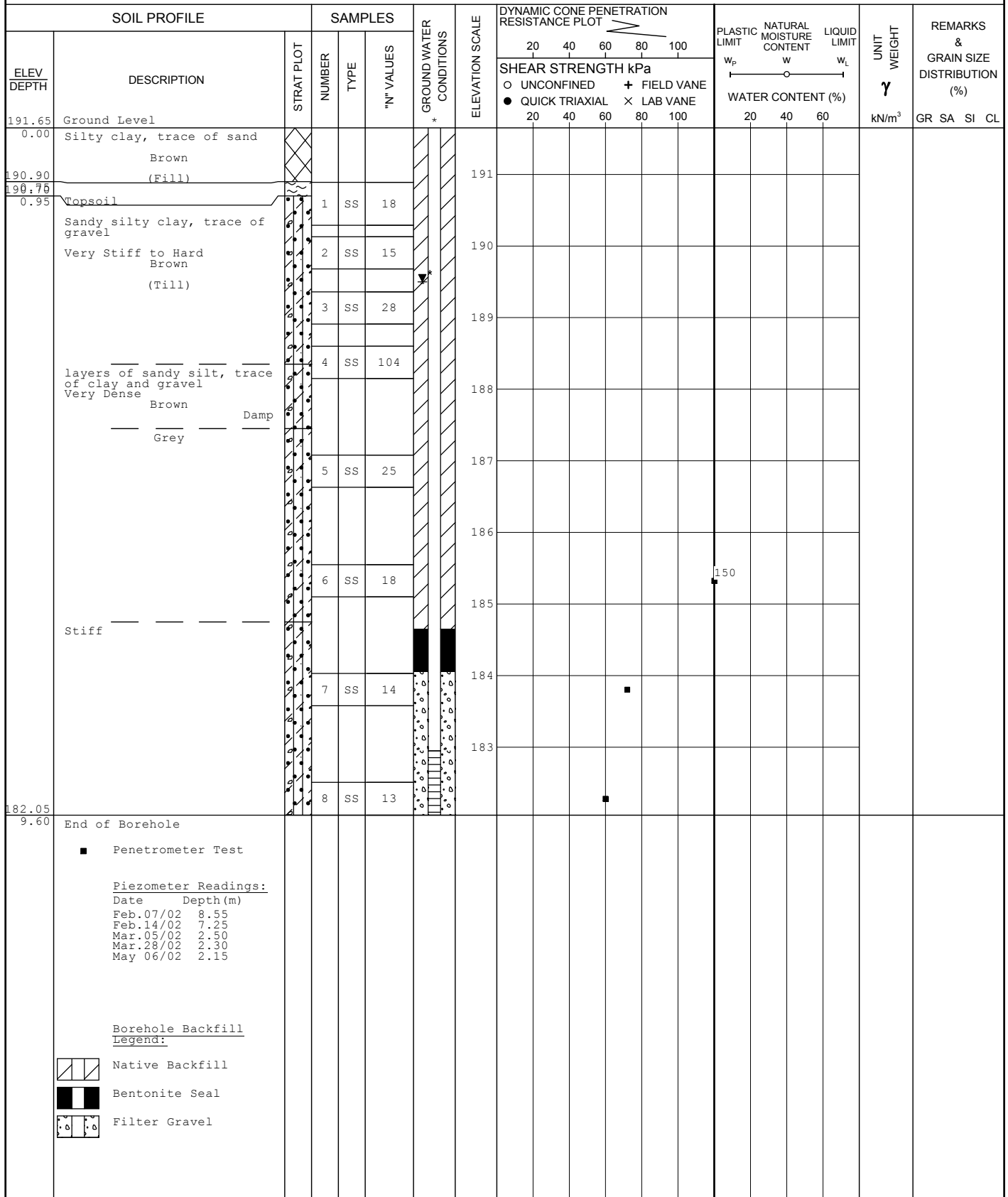
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE		w _p w w _L				
160.49			17	SS	30											
	(Till) 															

RECORD OF BOREHOLE No 71-6

1 of 1

METRIC

W.P. 64-00-02 LOCATION Dougall Parkway, N-E Ramp Sta. 12+845, o/s 8.8m Rt. of Lt. EP ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY MRA
DATUM Geodetic DATE February 05, 2002 CHECKED BY DWK



RECORD OF BOREHOLE No 9

1 of 1

METRIC

W.P. 64-00-00 LOCATION Dougall Parkway, EBL-N Leg Sta. 12+691, o/s 21.9m Lt. of CL ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY GD
DATUM Geodetic DATE February 01, 2002 CHECKED BY MRA

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									
190.48	Ground Level							20	40	60	80	100					
0.00	Topsoil, silty clay																
0.20	Dark Brown																
	Sandy silty clay, trace of gravel		1	SS	30		190										
	Hard Brown (Till)		2	SS	44		189										
			3	SS	40		188										
	Very Stiff Grey		4	SS	26		187										
			5	SS	29		186										
			6	SS	20		185										
			7	SS	19		184										
	Stiff		8	SS	12		183										
180.88			9	TW	PH		181										
9.60	End of Borehole																
	Borehole dry on completion of drilling																
	■ Penetrometer Test																

METRIC

20
15 — 5 (%) STRAIN AT FAILURE
10

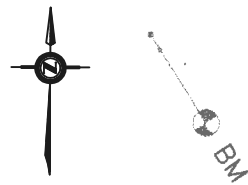
RECORD OF BOREHOLE No 11

1 of 1

METRIC

W.P. 64-00-00 LOCATION Dougall Parkway, EBL-N Leg Sta. 12+876, o/s 17.0m Rt. of CL ORIGINATED BY MR
DIST 31 HWY 401 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY GD
DATUM Geodetic DATE February 05, 2002 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L					
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE	WATER CONTENT (%)								
190.56	Ground Level						20	40	60	80	100						GR	SA	SI	CL
0.00	Topsoil, silty clay																			
0.10	Dark Brown																			
	Sandy silty clay, trace of gravel		1	SS	13									○						
	Stiff to Hard Brown (Till)		2	SS	34									○						
			3	SS	46									○						
	Very Stiff Grey		4	SS	26									○						
			5	SS	22									○						
			6	SS	17									○						



N 4678476.225
E 265889.519

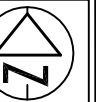
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No 2007-3043

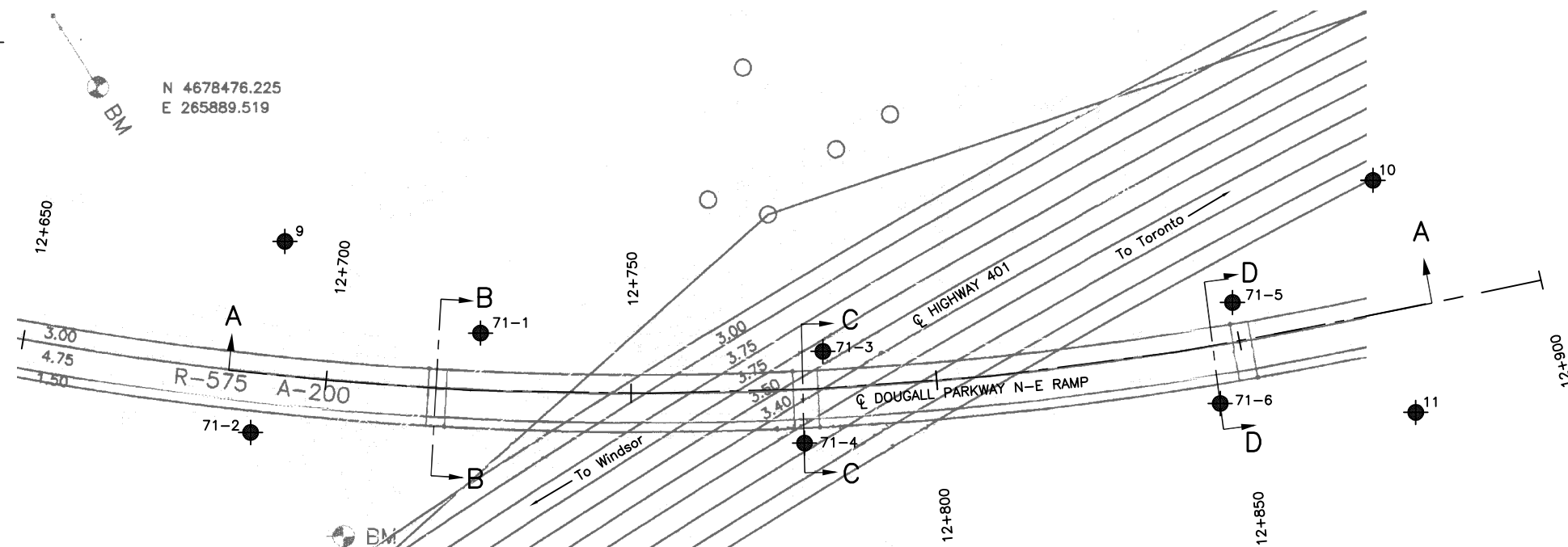
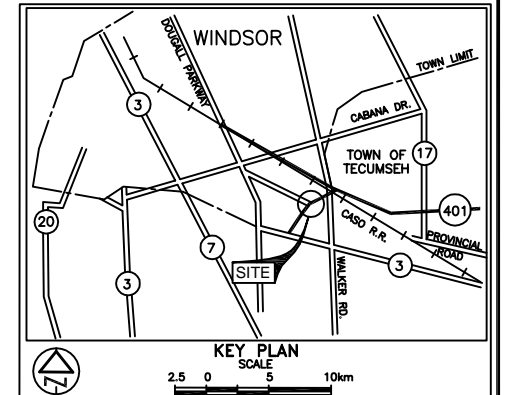
WP No 64-00-02

HIGHWAY 401
DOUGALL PARKWAY UNDERPASS
BOREHOLE LOCATIONS & SOIL STRATA



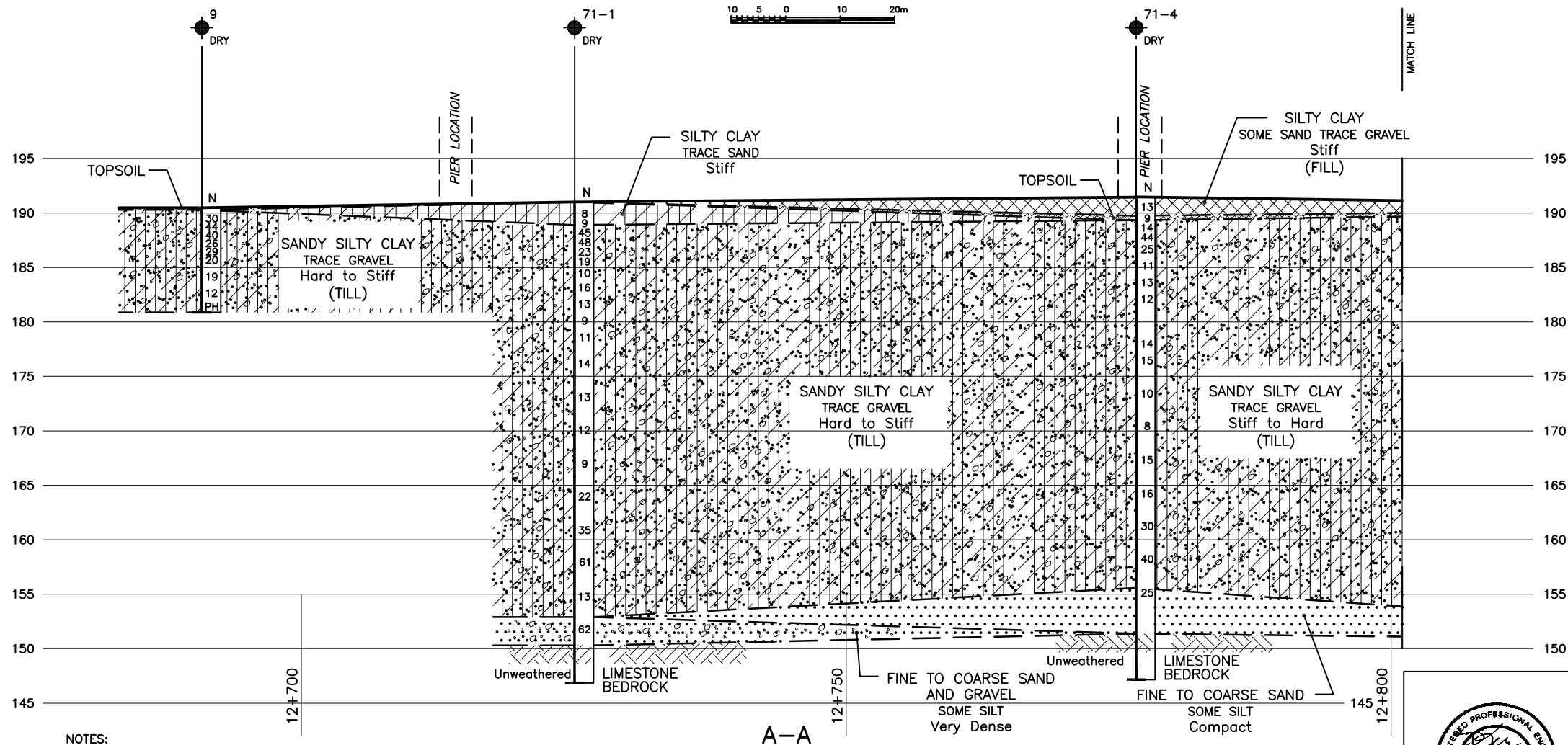
SHEET
432

PML Peto MacCallum Ltd.
CONSULTING ENGINEER



PLAN

SCALE



NOTES:

1. REFER TO DRAWING 2 FOR SECTION A-A CONTINUED, SECTIONS B-B, C-C, AND D-D.
2. SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

SECTION
A-A

SCALE



REF No Survey Plan 2001 Site # 6-71, entitled
Proposed Bridge Site at Tunnel Diversion and
Highway 401, Prepared by Planning and
Design Section, MTO.



LEGEND

- Borehole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- ▽ W L at time of investigation
Jan - Mar 2002
- ▽ Head
- ▽ ARTESIAN WATER
Encountered
- PIEZOMETER

BH No	ELEVATION	N-E RAMP STA.	o/s Lt. EP
71-1	191.00	12+725	9.5m Lt.
71-2	191.38	12+688	9.8m Rt.
71-3	191.47	12+782	6.0m Lt.
71-4	191.46	12+778	8.9m Rt.
71-5	190.49	12+850	6.3m Lt.
71-6	191.65	12+845	8.8m Rt.
9	190.48	12+691	21.9m Lt.
10	190.32	12+877	21.6m Lt.
11	190.56	12+876	17.0m Rt.

— NOTE —

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION
MAY 22/07	CN		CHANGED FOR CONTRACT DOCUMENTS AS PER EMAIL DATED APRIL 27, 2007, FROM DILLON CONSULTING LIMITED
FEB.15/07	CN		ADJUSTED BOREHOLES 71-2 AND 71-6 LOCATION AS PER MTO REQUEST

Geocres No. 40J2-48

HWY No 401	CHECKED MRA	DATE SEP 18, 2002	DIST 31
SUBM'D GD	APPROVED DWK	SITE 6-71	DWG 2
DRAWN MM/NA	CHECKED BRG		

METRIC

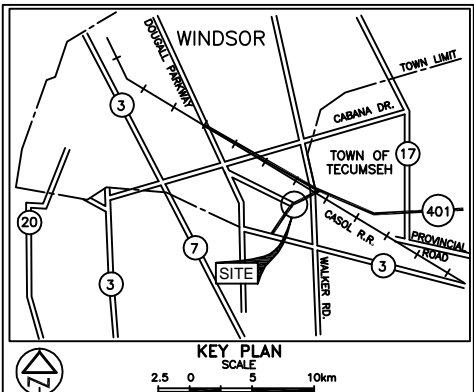
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No 2007-3043
WP No 64-00-02

HIGHWAY 401
DOUGALL PARKWAY UNDERPASS
SOIL STRATA

SHEET
433

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

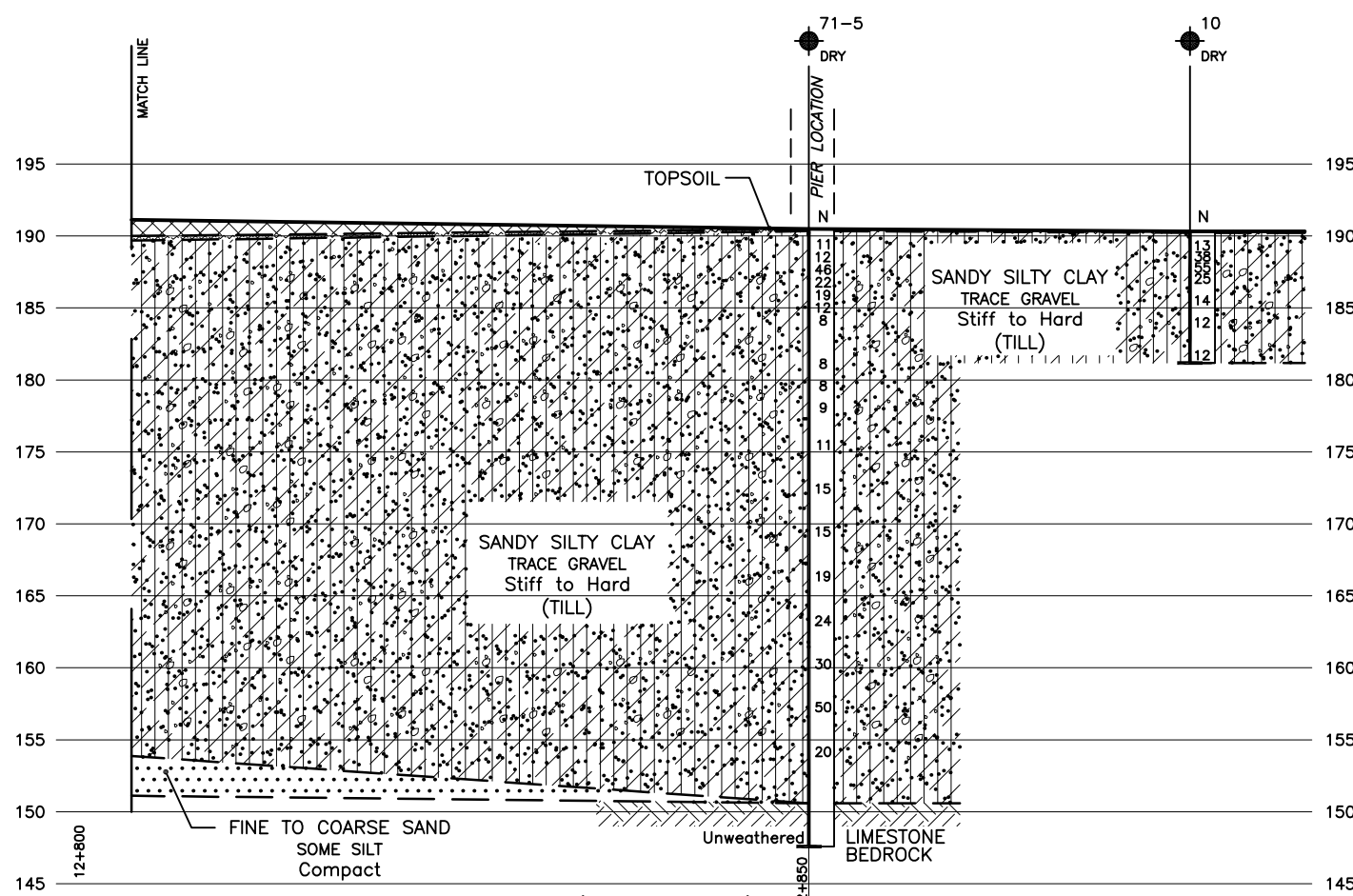


LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J / blow)		
CONE	Blows/0.3m (60° Cone, 475 J / blow)		
	W L at time of investigation Jan - Mar 2002		
	Head		
	ARTESIAN WATER Encountered		
	PIEZOMETER		

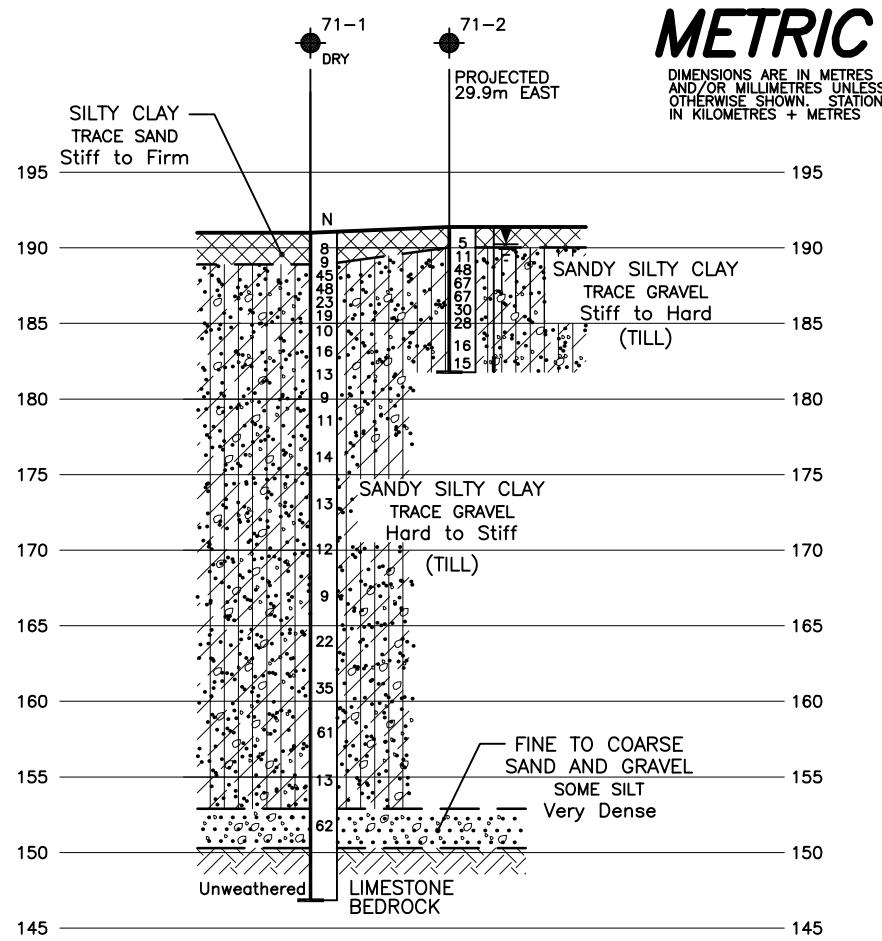
BH No	ELEVATION	HWY 401 STA.	o/s Lt EP
(Refer to drawing 2 for Stations and Offset)			

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

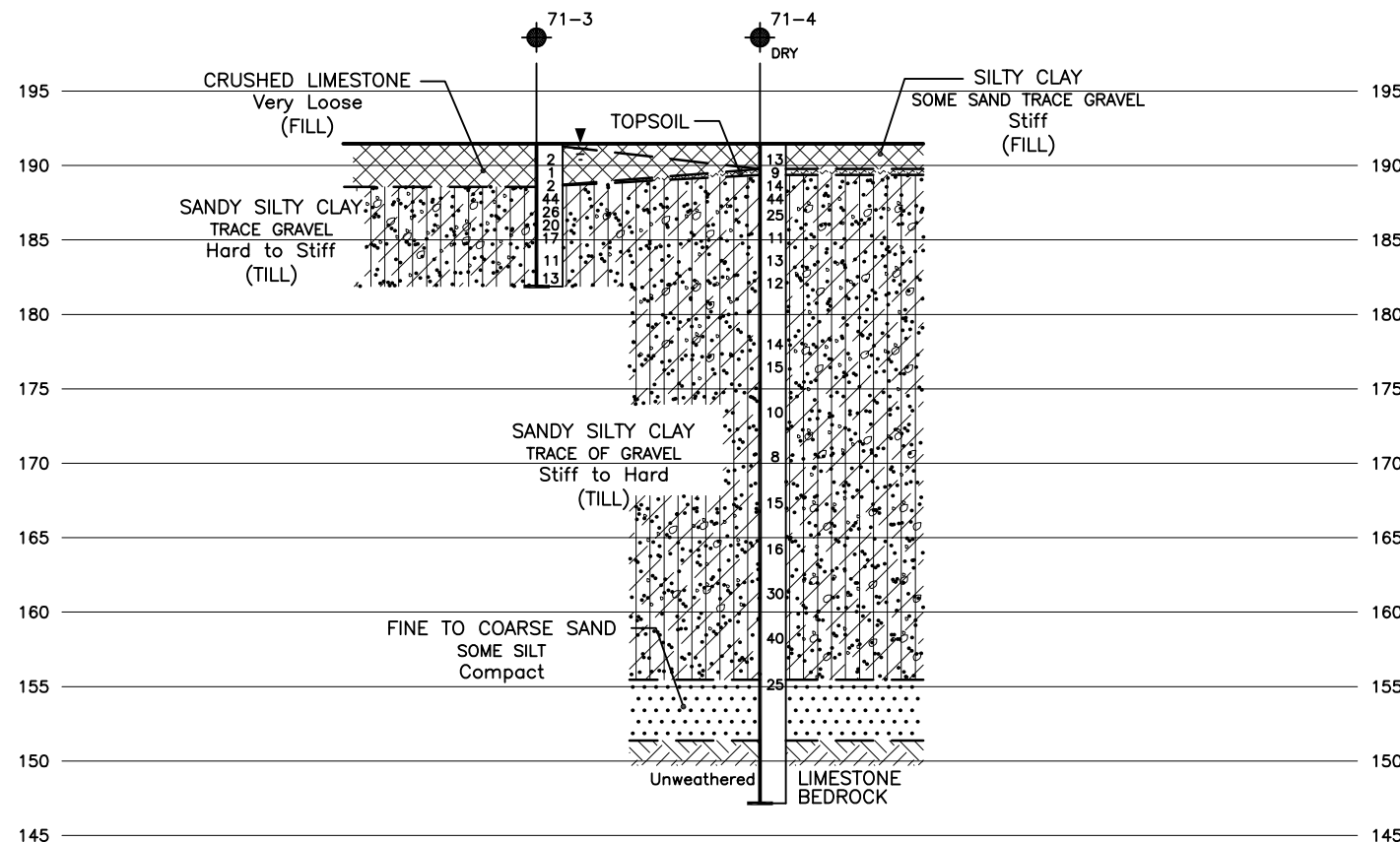
REVISIONS	DATE	BY	DESCRIPTION
MAY 22/07	CN		CHANGED FOR CONTRACT DOCUMENTS AS PER EMAIL DATED APRIL 27, 2007, FROM DILLON CONSULTING LIMITED
FEB.15/07	CN		ADJUSTED BOREHOLES 71-2 AND 71-6 LOCATION AS PER MTO REQUEST
DATE	BY		DESCRIPTION
Geocres No. 40J2-48			
HWY No	401	DIST	31
SUBM'D	GD	CHECKED	MRA
DATE	SEP 18, 2002	SITE	6-71
DRAWN	MM/NA	CHECKED	DWK
APPROVED	BRG	DWG	3



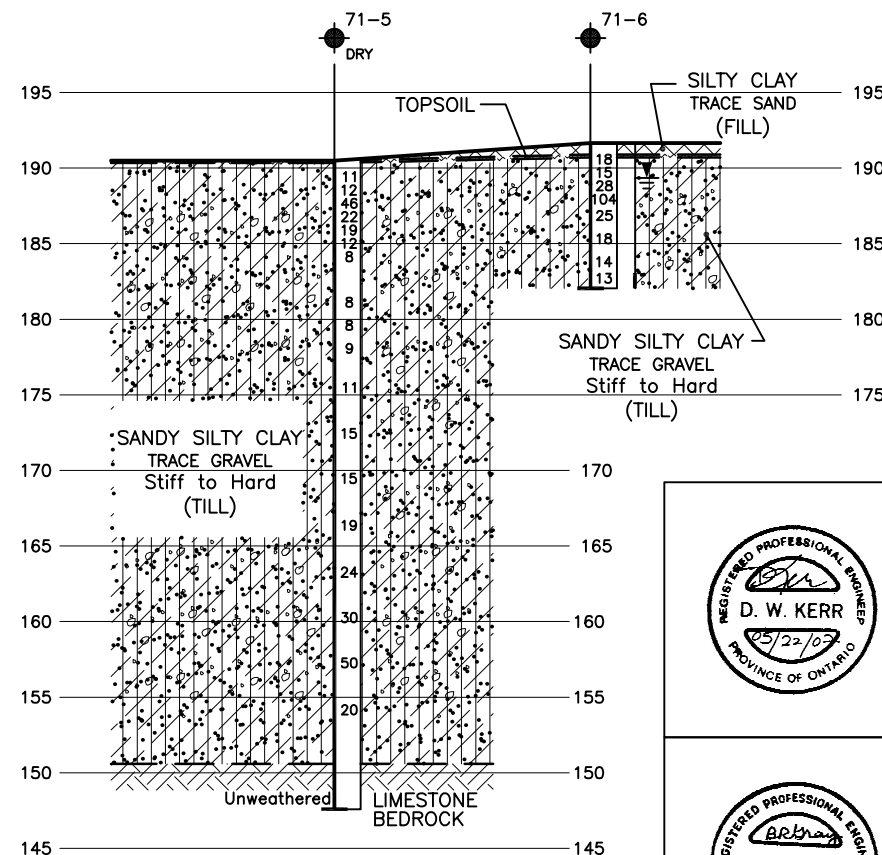
A-A (Continued)



B-B



C-C



D-D

NOTES:

- REFER TO DRAWING 1 FOR PLAN AND SECTION A-A.
- SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

SECTIONS
SCALE



REF No Survey Plan 2001 Site # 6-71, entitled Proposed Bridge Site at Tunnel Diversion and Highway 401, Prepared by Planning and Design Section, MTO.

