Appendix B
Geotechnical Investigations

Appendix B includes the following:

Figure B1 - Compilation of Geotechnical Sampling Locations from 1954 to 2014

ITEM B1. In Depth Geotechnical Inc.- IN-Situ Flat Plate Dilatometer Testing, Randle Reef Project, Hamilton, Ontario, February 16, 2014.

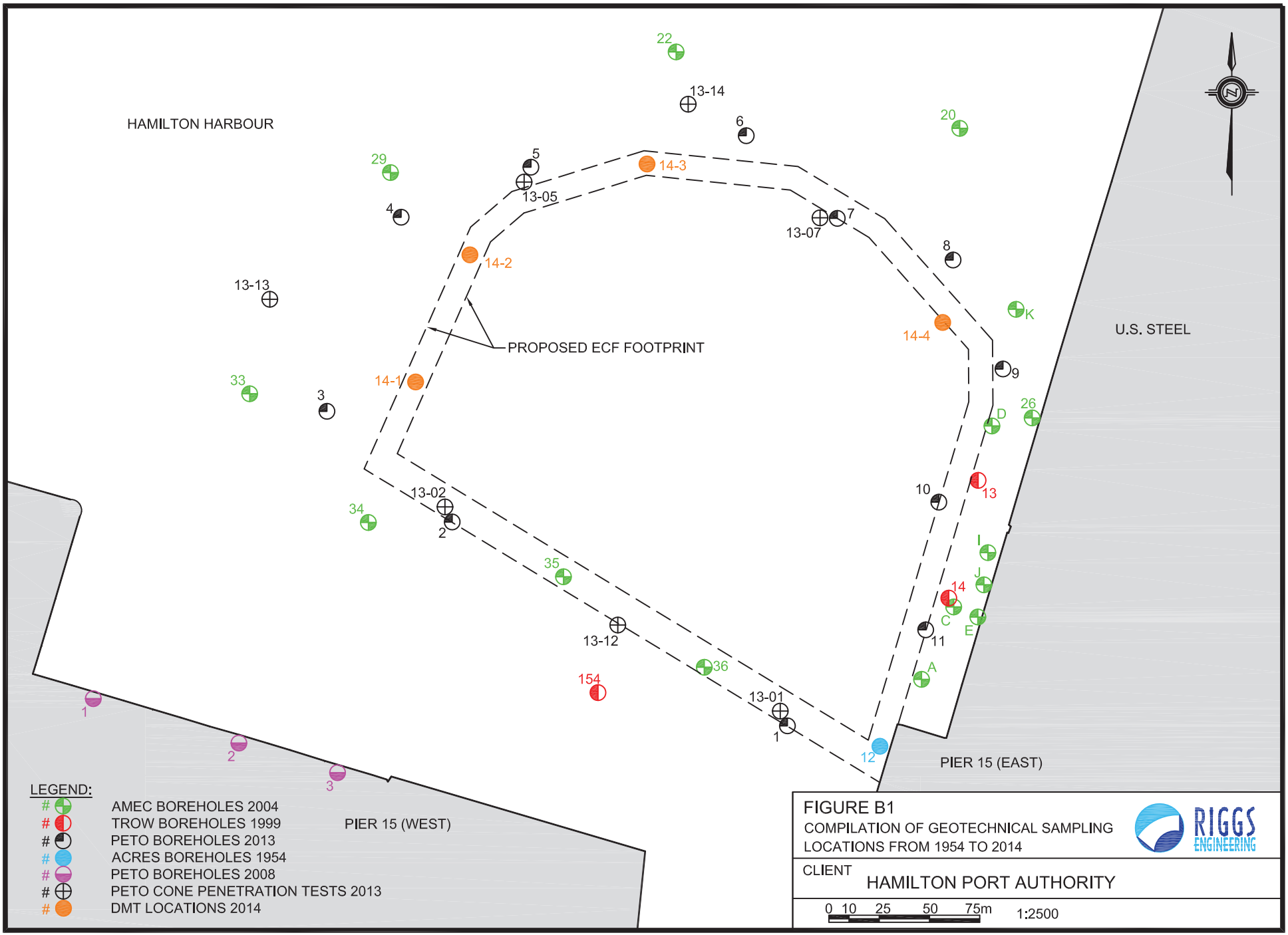
ITEM B2. Peto MacCallum Ltd. - Geotenchinal Investigation, Contaminated Sediment Remediation Project, Randle Reef, Hamilton Harbour, Hamilton, Ontario, January 2014.

ITEM B3. Excerpts from: Peto MacCallum Ltd. - Geotechnical Investgation, Pier 1 Rehabilitation, Hillyard Street, Hamilton, Ontario, July 2008.

ITEM B4. Excerpts from: Amec Earth & Environmental - Randle Reef Sediment Remediation Project, Hamilton, Ontario, RS-2 Phase 1 Geotechnical Investigation Report, March 2004.

ITEM B5. Excerpts from: Trow Consulting Engineers Ltd. - Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour Pier 16, Hamilton, Ontario, August 1999.

ITEM B6. Excerpts part plan drawing from : H.G. Arces & Company Ltd. Consulting Engineers - International Harvester Company of Canada Ltd., Hamilton, Ontario, Waterfront Construction, dated May 12, 1954.


HAMILTON HARBOUR
U.S. STEEL
PIER 15 (EAST)
PIER 15 (WEST)
PROPOSED ECF FOOTPRINT
22
13-14
6
20
29
5
14-3
13-05
4
7
13-07
8
14-2
13-13
K
14-4
33
14-1
3
9
26
D
13-02
10
13
34
2
35
I
J
14
C
E
13-12
11
36
A
154
13-01
1
12
1
2
3
LEGEND:
AMEC BOREHOLES 2004
TROW BOREHOLES 1999
PETO BOREHOLES 2013
ACRES BOREHOLES 1954
PETO BOREHOLES 2008
PETO CONE PENETRATION TESTS 2013
DMT LOCATIONS 2014
FIGURE B1
COMPILATION OF GEOTECHNICAL SAMPLING LOCATIONS FROM 1954 TO 2014
RIGGS ENGINEERING
CLIENT
HAMILTON PORT AUTHORITY
0 10 25 50 75m
1:2500

Appendix B
Geotechnical Investigations

ITEM B1

In Depth Geotechnical Inc.- IN-Situ Flat Plate Dilatometer Testing, Randle Reef Project, Hamilton, Ontario, December 12, 2014.

Project No. IDG 140195

In-Situ Flat Plate Dilatometer Testing
Randle Reef Project
Hamilton, Ontario
Revised on February 16, 2015

Prepared for:
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1. Introduction

In-Depth Geotechnical Inc. was retained by Peto MacCallum Ltd. (PML) to conduct in-situ Flat Plate Dilatometer testing in relation to their Randle Reef Project, located in Burlington Bay Basin, in Hamilton, Ontario.

The purpose of the in-situ dilatometer (DMT) testing was to further investigate the subsoil conditions of the site in order to provide soil parameters necessary for foundation analyses and design. Specifically, this additional in-situ testing was aimed at confirming undrained shear strength and deformation properties of the encountered silty clay materials present in the upper layer of the investigated site. DMT was conducted at three sounding locations as designated by PML site representative.

It is understood that the site's subsurface conditions have been previously investigated and soil types, layering, and site variability have already been identified.

The present report present factual data from in-situ testing results as well as interpreted soil parameters derived from DMT data.

2. Field Testing Procedures

In-situ dilatometer testing procedures were performed in general accordance with ASTM D6635-01 (2007), "Standard Test Method for Performing Flat Plate Dilatometer", and as suggested by the Dilatometer Manufacturer (GPE Inc., of Gainesville, Florida, USA).

The investigated area is located off-shore. In-situ testing was completed on November 26, 2014. At this time the water elevation at this location of the Burlington Bay was recorded at 74.49 m, IGLD (provided by the Canadian Hydrographic Services, in Burlington, Ontario).

The DMT blade was pushed into the silty clay deposits using a truck-mounted CME75 drill-rig, with an 8-ton push capacity. The push rig was set on a barge and secured over the sounding locations by the barge's two legs (spud barge). No significant drift movements occurred at sounding locations during in-situ testing procedures. The average depth of water to the top of present mudline (soft sediments), at sounding locations, varied approximately from 11.0 to 11.5 m.

In order to control buckling of the push-rods, we had installed HW casing from the work platform (at Elevation 76.1 m IGLD) to the approximate bottom of the soft sediments. The total length of casing was 12.31 m (40.4 feet). DMT testing was attempted immediately below bottom of the HW casing.

DMT test equipment, including dilatometer blade, tubing, and control unit were checked and calibrated at the start and at the end of each sounding, as recommended by the Manufacturer.

The soundings were advanced down into the stiff silt layer at about 13 m below the sediments or mudline. No sampling was completed within the investigated layers.

Testing procedures consist of advancing the dilatometer blade into the undisturbed soil and inflating the diaphragm (or stainless steel membrane) to two specific stages, namely the *lift-off stage* and the *1.1 mm deformation* stage. The pressure readings associated with these two stages are known as the A and B readings, respectively. There is a deflation stage also, with a corresponding pressure reading defined as the C reading. These readings, once corrected for blade calibration parameters (membrane inertia), provide a set of three test parameters, namely p_0, p_1, and p_2. The push and test process is repeated every at 0.20 m depth intervals. The rate of penetration is adjusted to 200 mm in 10 seconds.

3. In-situ Dilatometer Test Parameters

As mentioned in the previous Section, the soil testing stages consist of recording three pressures, A, B, and C, measured during diaphragm inflation while no axial force is applied to the rods. These values, once corrected for membrane/diaphragm stiffness (calibration constants), are used to derive the basic dilatometer pressure parameters p_0, p_1, and p_2. These corrected pressures are then utilized, as indicated in Table 1 below, to determine basic dilatometer test parameters, namely

1. Soil Index number I_D. This index is an indicator of the type mechanical behavior of soil rather than a description of soil gradation.

2. Horizontal Stress Index K_D. This index is related to the in-situ total horizontal stresses.

3. Dilatometer Modulus E_D and Constrained (Odoemeter) Modulus M_{DMT}. These two moduli express the elastic behavior of the soil in contact with the dilatometer diaphragm, and are both related to the elastic Young's Modulus and the bulk modulus k, respectively, acting in the horizontal plane. And

4. Pore Water Pressure u_0. This pressure indicates the amount of excess pore pressure generated during the dilatometer test sequence. This value is useful to assess the drainage capacity of the tested soil.

SYMBOL	DESCRIPTION	BASIC DMT REDUCTION FORMULAE	
p_0	Corrected First Reading	$p_0 = 1.05\ (A - Z_M + \Delta A) - 0.05\ (B - Z_M - \Delta B)$	Z_M = Gage reading when vented to atm. If ΔA & ΔB are measured with the same gage used for current readings A & B, set $Z_M = 0$ (Z_M is compensated)
p_1	Corrected Second Reading	$p_1 = B - Z_M - \Delta B$	
I_D	Material Index	$I_D = (p_1 - p_0) / (p_0 - u_0)$	u_0 = pre-insertion pore pressure
K_D	Horizontal Stress Index	$K_D = (p_0 - u_0) / \sigma'_{vo}$	σ'_{vo} = pre-insertion overburden stress
E_D	Dilatometer Modulus	$E_D = 34.7\ (p_1 - p_0)$	E_D is NOT a Young's modulus E. E_D should be used only AFTER combining it with K_D (Stress History). First obtain $M_{DMT} = R_M E_D$, then e.g. $E \approx 0.8\ M_{DMT}$
K_0	Coeff. Earth Pressure in Situ	$K_{0,DMT} = (K_D / 1.5)^{0.47} - 0.6$	for $I_D < 1.2$
OCR	Overconsolidation Ratio	$OCR_{DMT} = (0.5\ K_D)^{1.56}$	for $I_D < 1.2$
c_u	Undrained Shear Strength	$c_{u,DMT} = 0.22\ \sigma'_{vo}\ (0.5\ K_D)^{1.25}$	for $I_D < 1.2$
Φ	Friction Angle	$\Phi_{safe,DMT} = 28° + 14.6°\ \log K_D - 2.1°\ \log^2 K_D$	for $I_D > 1.8$
c_h	Coefficient of Consolidation	$c_{h,DMTA} \approx 7\ cm^2 / t_{flex}$	t_{flex} from A-log t DMT-A decay curve
k_h	Coefficient of Permeability	$k_h = c_h\ \gamma_w / M_h$ ($M_h \approx K_0\ M_{DMT}$)	
γ	Unit Weight and Description	(see chart in Fig. 16)	
M	Vertical Drained Constrained Modulus	$M_{DMT} = R_M\ E_D$ if $I_D \le 0.6$ $R_M = 0.14 + 2.36 \log K_D$ if $I_D \ge 3$ $R_M = 0.5 + 2 \log K_D$ if $0.6 < I_D < 3$ $R_M = R_{M,0} + (2.5 - R_{M,0}) \log K_D$ with $R_{M,0} = 0.14 + 0.15\ (I_D - 0.6)$ if $K_D > 10$ $R_M = 0.32 + 2.18 \log K_D$ if $R_M < 0.85$ set $R_M = 0.85$	
u_0	Equilibrium Pore Pressure	$u_0 = p_2 = C - Z_M + \Delta A$	In free-draining soils

Table 1. Basic DMT reduction formulae

The dilatometer basic parameters are shown both in tabular format (Summary Table Nos. 1 to 3) as well in graphic format (Figure Nos. 1 to 3) in Appendix One.

Further guidelines to infer soil properties from DMT test data can be found in the following references:

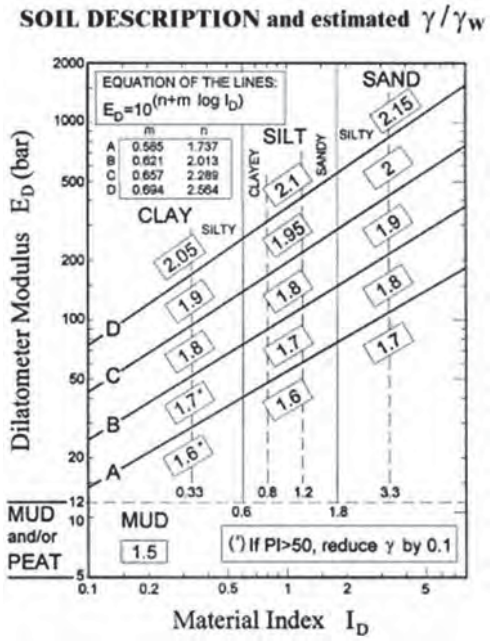
- ASTM D6635-01 (2007) Standard Test Method for Performing the Flat Plate Dilatometer;
- "Guidelines for using the CPT, CPTU, and Marchetti DMT for Geotechnical Design, Vol. III – DMT test method and data reduction". Also presented as Report FHWA-PA-87-024 + 84-24. USA, DOT, Federal Highway Administration; and
- "The Flat Dilatometer Test (DMT) in Soil Investigations". International Society for Soil Mechanics and Geotechnical Engineering". (Report of the ISSMGE, Technical Committee 16 on Ground Property Characterization from IN-Situ Testing, 2001. Bali, Indonesia.

4. Data Interpretation

Based on DMT test parameters listed in the previous section, basic material properties are inferred. These are described in the following subsections.

4.1 Bulk Unit Weight γ_B:

Bulk unit weights can be inferred from E_D and I_D parameters using the following published chart:



This chart only provides estimates of bulk unit weights, and care should be exercised when using these estimates, as they may not compare well with unit weight values measured in laboratory determination. The inferred values of bulk unit weight are listed in tabulated format in Appendix A.

4.2 Young's Modulus *E'*:

Values of the Constrained Modulus M_{DMT} inferred from dilatometer testing correspond to large strain moduli, i.e., axial strains in the 0.05 to 0.01 range (~10^{-2}). With these M_{DMT} values and using a Poisson's Ratio ν of 0.33 it is possible to infer estimates of Young's modulus. These *E'* values may be required, for instance, to estimate settlements associated with elastic deformations under structural loading.

From elasticity theory, and for isotropic and liner elastic materials, the effective elastic modulus is calculated as:

$$E' = \frac{(1+\nu)\,(1-2\nu)\,M_{DMT}}{(1-\nu)}$$

The calculated values of *E'* are presented in the tabulated data, in Appendix One.

In terms of the constraint moduli M_{DMT}, inferred values for this site varied between 9 to 15 MPa. M_{DMT} variation can be observed in in the profiles shown in Figure No. 1.

4.3 At-rest Lateral Earth Pressure Coefficient k_0:

The at-rest horizontal earth pressure coefficient k_0 for clays and silts may be inferred (Marchetti, 1980) from K_D values using the following expression:

$$k_0 = (K_D / 1.5)^{0.47} - 0.6$$

Based on this correlation, values of k_0 for this Site were in excess of 1.7. However, care should be exercised in using these *ko* values, as the in-situ stress history for the site is not clearly known.

Corresponding Effective Horizontal Stresses at the site were noted to vary in a linearly increasing trend with depth, as shown in Figure No. 3, in Appendix One.

4.4 Undrained Shear Strengths c_u:

For the case of soils with some amount of cohesion, the undrained shear strength c_u can be inferred from DMT parameters using then following expression:

$$c_u = 0.22\ \sigma'_{v0}\ (0.5\ K_D)^{1.25}$$

This expression may be used in soils with a Material Index I_D typically less than 1.2. Interpreted values of I_D for the silt and clay deposit were typically less than 0.3, and the inferred values of undrained strengths for the encountered upper clay deposit were noted within the 62 to 108 kPa range, as shown in the Summary Table Nos. 1 to 3 and in Figure No. 2 included in Appendix One.

4.5 Friction Angles ϕ':

For frictional materials, such as soils identified by a Material Index I_D over 1.8, the angle of internal friction can be inferred with the following expression:

$$\phi_{DMT} = 28^o + 14.6^o \log K_D + 2.1^o \log^2 K_D$$

No significant sand layer had been identified by DMT testing at the sounding locations and for the investigated depths.

5. Closure

The subsoils data presented in this report is based on in-situ dilatometer testing procedures.

We trust that the present in-situ DMT testing report fulfill your present requirements. The data presented here can be subjected to further analysis.

It is noted that DMT test-specific methods of analyses have been developed to assist in the determination of settlements, bearing capacities, and other geotechnical-related analyses. These methods have been found to be adequate to provide cost-effective solutions based on advanced testing and analytical techniques. Shall you require further assistance with DMT test data interpretation and related geotechnical evaluations, please feel free to contact the undersigned.

Sincerely,

In-Depth Geotechnical Inc.

Gabriel Sedran, P.Eng., Ph.D.
President

Appendix One

DMT Test Results - Tables and Graphic Data

Dilatometer Sounding No. DMT14-01

In-Depth Geotechnical Inc.

Test date: November 26, 2014
Client: Riggs Engineering
Location: Randle Reef, Burlington Bay, Hamilton, Ontario

surface elevation (approx. mudline)	65.99	m
ground water elevation (IGLD)	74.49	m
Initial testing depth	1.60	m
Δ A	15	kPa
Δ B	35	kPa

Field Data					DMT parameters										Inferred Soil Properties					
							Pore Water Pressure	Hydrostatic Pore Water Pressure	Effective Horizontal Stresses	Material Index	Pore Pressure Index	Horizontal Stress Index	Dilatometer Modulus	Constrained Modulus	Unit Weight	Stress Ratio	Sand	Clay	Effective Young's Modulus	Soil Description
Depth	Elevation	A	B	C	p_0	p_1	$p_2 = u_w$	u_0	σ'_H	I_D	U_D	K_D	E_D	M_{DTM}	γ	$k_{0,DMT}$	Sand ϕ	Clay c_u	E'	
(m)	(m)	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]				[MPa]	[MPa]	[kN/m^3]		[degree]	[kPa]	[MPa]	
1.6	64.4	460	577	258	472	542	273	99	12	0.19	0.47	32.4	2.4	8.8	16.7	3.60		82	5.9	CLAY
1.8	64.2	458	605	313	468	570	328	101	13	0.28	0.62	28.5	3.5	12.3	16.7	3.40		78	8.3	CLAY
2.0	64.0	408	508	355	421	473	370	103	14	0.17	0.84	22.3	1.8	5.9	15.7	3.00		64	4.0	CLAY
2.2	63.8	420	533	355	432	498	370	105	15	0.20	0.81	21.2	2.3	7.4	16.7	2.90		65	5.0	CLAY
2.4	63.6	431	542	350	443	507	365	107	17	0.19	0.77	20.0	2.2	7.0	16.7	2.80		66	4.7	CLAY
2.6	63.4	444	561	355	456	526	370	109	18	0.20	0.75	19.1	2.4	7.6	16.7	2.70		67	5.1	CLAY
2.8	63.2	490	620	408	501	585	423	111	20	0.22	0.80	20.0	2.9	9.2	16.7	2.80		76	6.2	CLAY
3.0	63.0	486	614	403	497	579	418	113	21	0.21	0.79	18.4	2.8	8.7	16.7	2.60		74	5.9	CLAY
3.2	62.8	479	599	398	490	564	413	115	22	0.20	0.79	16.9	2.6	7.6	16.7	2.50		70	5.1	CLAY
3.4	62.6	478	632	377	488	597	392	117	24	0.29	0.74	15.7	3.8	11.1	16.7	2.40		68	7.5	CLAY
3.6	62.4	476	585	398	488	550	413	119	25	0.17	0.80	14.7	2.1	6.2	16.7	2.30		67	4.2	CLAY
3.8	62.2	515	658	403	525	623	418	121	26	0.24	0.74	15.3	3.4	9.8	16.7	2.40		74	6.6	CLAY
4.0	62.0	533	649	438	545	614	453	123	28	0.16	0.78	15.2	2.4	7.0	16.7	2.40		77	4.7	CLAY
4.2	61.8	529	653	438	540	618	453	125	29	0.19	0.79	14.3	2.7	7.6	16.7	2.30		75	5.1	CLAY
4.4	61.6	532	639	438	544	604	453	127	31	0.14	0.78	13.7	2.1	5.8	16.7	2.20		74	3.9	CLAY
4.6	61.4	528	638	440	540	603	455	129	32	0.15	0.79	12.9	2.2	6.0	16.7	2.10		72	4.0	CLAY
4.8	61.2	528	636	442	540	601	457	131	33	0.15	0.80	12.3	2.1	5.7	16.7	2.10		71	3.8	CLAY
5.0	61.0	530	648	433	542	613	448	132	35	0.17	0.77	11.8	2.5	6.6	16.7	2.00		70	4.5	CLAY
5.2	60.8	528	620	460	541	585	475	134	36	0.11	0.84	11.3	1.5	4.0	16.7	2.00		69	2.7	CLAY
5.4	60.6	525	618	465	538	583	480	136	37	0.11	0.86	10.7	1.6	4.0	16.7	1.90		67	2.7	CLAY
5.6	60.4	540	640	463	553	605	478	138	39	0.13	0.82	10.7	1.8	4.7	16.7	1.90		69	3.2	CLAY
5.8	60.2	634	798	488	643	763	503	140	40	0.24	0.72	12.5	4.2	11.3	16.7	2.10		88	7.6	CLAY
6.0	60.0	640	801	530	649	766	545	142	42	0.23	0.79	12.2	4.0	10.9	16.7	2.10		88	7.4	CLAY
6.2	59.8	628	756	515	639	721	530	144	43	0.17	0.78	11.5	2.8	7.5	16.7	2.00		84	5.1	CLAY
6.4	59.6	641	792	524	651	757	539	146	44	0.21	0.78	11.4	3.7	9.7	16.7	2.00		86	6.5	CLAY
6.6	59.4	653	793	540	663	758	555	148	46	0.18	0.79	11.3	3.3	8.6	16.7	2.00		87	5.8	CLAY
6.8	59.2	660	803	562	670	768	577	150	47	0.19	0.82	11.1	3.4	8.8	16.7	2.00		88	5.9	CLAY
7.0	59.0	680	831	568	690	796	583	152	48	0.20	0.80	11.1	3.7	9.6	16.7	2.00		91	6.5	CLAY
7.2	58.8	680	840	573	689	805	588	154	50	0.22	0.81	10.8	4.0	10.3	17.7	1.90		90	7.0	CLAY
7.4	58.6	681	818	584	692	783	599	156	51	0.17	0.83	10.4	3.2	8.1	16.7	1.90		89	5.5	CLAY
7.6	58.4	690	838	380	700	803	395	158	53	0.19	0.44	10.3	3.6	9.0	16.7	1.90		90	6.1	CLAY
7.8	58.2	704	842	600	715	807	615	160	54	0.17	0.82	10.3	3.2	8.1	16.7	1.90		92	5.5	CLAY
8.0	58.0	715	850	620	726	815	635	162	55	0.16	0.84	10.2	3.1	7.8	16.7	1.90		93	5.3	CLAY
8.2	57.8	730	880	626	740	845	641	164	57	0.18	0.83	10.1	3.6	9.2	17.7	1.90		95	6.2	CLAY
8.4	57.6	748	886	640	759	851	655	166	58	0.16	0.82	10.2	3.2	8.1	16.7	1.90		98	5.5	CLAY
8.6	57.4	758	912	660	768	877	675	168	60	0.18	0.85	10.0	3.8	9.5	17.7	1.80		99	6.4	CLAY
8.8	57.2	772	916	664	782	881	679	170	61	0.16	0.83	10.0	3.4	8.6	17.7	1.80		101	5.8	CLAY
9.0	57.0	808	948	690	818	913	705	172	63	0.15	0.83	10.3	3.3	8.3	17.7	1.90		107	5.6	CLAY
9.2	56.8	806	956	675	816	921	690	174	64	0.16	0.80	10.0	3.6	9.1	17.7	1.80		106	6.1	CLAY
9.4	56.6	760	930	603	769	895	618	176	66	0.21	0.75	9.0	4.4	10.5	17.7	1.70		95	7.1	CLAY
9.6	56.4	780	1020	633	785	985	648	178	68	0.33	0.77	9.0	6.9	16.6	17.7	1.70		97	11.2	CLAY
9.8	56.2	768	996	605	774	961	620	180	69	0.31	0.74	8.6	6.5	15.2	17.7	1.70		94	10.3	CLAY
10.0	56.0	776	1019	580	781	984	595	182	71	0.34	0.69	8.5	7.0	16.4	17.7	1.70		95	11.1	SILTY CLAY
10.2	55.8	820	1156	584	821	1121	599	183	72	0.47	0.65	8.8	10.4	24.7	17.7	1.70		102	16.7	SILTY CLAY
10.4	55.6	822	1126	540	824	1091	555	185	74	0.42	0.58	8.6	9.3	21.8	17.7	1.70		101	14.7	SILTY CLAY
10.6	55.4	690	930	480	695	895	495	187	75	0.39	0.61	6.7	6.9	14.5	17.7	1.40		76	9.8	SILTY CLAY
10.8	55.2	950	1180	630	956	1145	645	189	77	0.25	0.59	10.0	6.6	16.4	17.7	1.80		126	11.1	CLAY
11.0	55.0	880	1150	715	884	1115	730	191	79	0.33	0.78	8.8	8.0	19.0	17.7	1.70		110	12.8	SILTY CLAY
11.2	54.8	890	1120	722	896	1085	737	193	80	0.27	0.77	8.8	6.6	15.5	17.7	1.70		112	10.5	CLAY

Summary Table No.1

surface elevation (approx. mudline)	65.57	m
ground water elevation (IGLD)	74.07	m
Initial testing depth	1.40	m
Δ A	15	kPa
Δ B	35	kPa

Dilatometer Sounding No. DMT14-02

Test date: November 26, 2014
Client: Riggs Engineering
Location: Randle Reef, Burlington Bay, Hamilton, Ontario

In-Depth Geotechnical Inc.

Field Data					DMT parameters										Inferred Soil Properties					
							Pore Water Pressure	Hydrostatic Pore Water Pressure	Effective Horizontal Stresses	Material Index	Pore Pressure Index	Horizontal Stress Index	Dilatometer Modulus	Constrained Modulus	Unit Weight	Stress Ratio	Sand	Clay	Effective Young's Modulus	Soil Description
Depth	Elevation	A	B	C	p_0	p_1	$p_2 = u_w$	u_0	σ'_H	I_D	U_D	K_D	E_D	M_{DTM}	γ	$k_{0,DMT}$	Sand ϕ	Clay c_u	E'	
(m)	(m)	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]				[MPa]	[MPa]	[kN/m^3]		[degree]	[kPa]	[MPa]	
1.4	64.2	290	410	180	302	375	195	97	10	0.36	0.48	20.3	2.6	8.1	15.7	2.80		40	5.5	SILTY CLAY
1.6	64.0	490	665	176	499	630	191	99	11	0.33	0.23	35.5	4.6	16.9	16.7	3.80		90	11.4	CLAY
1.8	63.8	465	620	220	475	585	235	101	13	0.30	0.36	29.6	3.8	13.5	16.7	3.50		81	9.1	CLAY
2.0	63.6	320	380	190	335	345	205	103	14	0.05	0.44	16.5	0.4	1.1	13.7	2.50		43	0.7	MUD AND/OR PEAT
2.2	63.4	260	350	110	273	315	125	105	15	0.25	0.12	11.4	1.5	3.8	15.7	2.00		29	2.6	CLAY
2.4	63.2	190	309	83	202	274	98	107	16	0.77	-0.09	5.9	2.5	5.0	15.7	1.30		14	3.4	CLAYEY SILT
2.6	63.0	290	450	180	300	415	195	109	17	0.61	0.45	11.1	4.0	10.4	15.7	2.00		32	7.0	CLAYEY SILT
2.8	62.8	408	540	308	419	505	323	111	18	0.28	0.69	16.8	3.0	8.9	16.7	2.50		58	6.0	CLAY
3.0	62.6	442	552	325	454	517	340	113	20	0.18	0.67	17.3	2.2	6.6	16.7	2.60		64	4.5	CLAY
3.2	62.4	490	610	418	502	575	433	115	21	0.19	0.82	18.4	2.6	7.8	16.7	2.60		74	5.3	CLAY
3.4	62.2	575	689	438	587	654	453	117	22	0.14	0.72	21.0	2.3	7.5	16.7	2.90		93	5.1	CLAY
3.6	62.0	554	678	457	565	643	472	119	24	0.17	0.79	18.8	2.7	8.3	16.7	2.70		86	5.6	CLAY
3.8	61.8	550	672	461	561	637	476	121	25	0.17	0.81	17.5	2.6	7.9	16.7	2.60		83	5.3	CLAY
4.0	61.6	520	708	482	528	673	497	123	27	0.36	0.92	15.3	5.0	14.6	16.7	2.40		74	9.9	SILTY CLAY
4.2	61.4	576	708	484	587	673	499	125	28	0.19	0.81	16.6	3.0	8.9	16.7	2.50		86	6.0	CLAY
4.4	61.2	610	748	503	621	713	518	127	29	0.19	0.79	16.9	3.2	9.6	16.7	2.50		93	6.5	CLAY
4.6	61.0	612	749	514	623	714	529	129	31	0.18	0.81	16.1	3.2	9.4	16.7	2.50		92	6.3	CLAY
4.8	60.8	613	752	514	624	717	529	131	32	0.19	0.81	15.4	3.2	9.4	16.7	2.40		90	6.3	CLAY
5.0	60.6	630	766	522	641	731	537	132	33	0.18	0.80	15.2	3.1	9.1	16.7	2.40		93	6.1	CLAY
5.2	60.4	638	780	538	648	745	553	134	35	0.19	0.82	14.8	3.4	9.6	16.7	2.30		93	6.5	CLAY
5.4	60.2	636	779	524	646	744	539	136	36	0.19	0.79	14.1	3.4	9.6	16.7	2.30		91	6.5	CLAY
5.6	60.0	639	786	538	649	751	553	138	38	0.20	0.81	13.6	3.5	9.9	16.7	2.20		91	6.7	CLAY
5.8	59.8	644	782	538	655	747	553	140	39	0.18	0.80	13.2	3.2	8.9	16.7	2.20		91	6.0	CLAY
6.0	59.6	640	786	540	650	751	555	142	40	0.20	0.81	12.6	3.5	9.5	16.7	2.10		89	6.4	CLAY
6.2	59.4	651	782	552	662	747	567	144	42	0.16	0.82	12.4	3.0	8.0	16.7	2.10		90	5.4	CLAY
6.4	59.2	683	804	587	694	769	602	146	43	0.14	0.83	12.7	2.6	7.1	16.7	2.10		96	4.8	CLAY
6.6	59.0	703	853	589	713	818	604	148	44	0.19	0.81	12.7	3.6	9.9	17.7	2.10		99	6.7	CLAY
6.8	58.8	701	836	596	712	801	611	150	46	0.16	0.82	12.2	3.1	8.3	16.7	2.10		97	5.6	CLAY
7.0	58.6	687	811	583	698	776	598	152	47	0.14	0.82	11.5	2.7	7.1	16.7	2.00		93	4.8	CLAY
7.2	58.4	689	815	601	700	780	616	154	49	0.15	0.85	11.2	2.8	7.2	16.7	2.00		92	4.9	CLAY
7.4	58.2	696	833	589	707	798	604	156	50	0.17	0.81	11.0	3.2	8.2	16.7	1.90		93	5.5	CLAY
7.6	58.0	712	855	607	722	820	622	158	51	0.17	0.82	11.0	3.4	8.8	16.7	1.90		95	5.9	CLAY
7.8	57.8	713	858	606	723	823	621	160	53	0.18	0.82	10.7	3.5	8.9	16.7	1.90		94	6.0	CLAY
8.0	57.6	713	858	596	723	823	611	162	54	0.18	0.80	10.4	3.5	8.8	16.7	1.90		93	5.9	CLAY
8.2	57.4	726	851	618	737	816	633	164	56	0.14	0.82	10.3	2.7	6.9	16.7	1.90		95	4.7	CLAY
8.4	57.2	738	863	608	749	828	623	166	57	0.13	0.78	10.2	2.7	6.9	16.7	1.90		97	4.7	CLAY
8.6	57.0	744	885	624	754	850	639	168	58	0.16	0.80	10.1	3.3	8.3	16.7	1.80		97	5.6	CLAY
8.8	56.8	748	896	626	758	861	641	170	60	0.17	0.80	9.9	3.6	8.9	17.7	1.80		96	6.0	CLAY
9.0	56.6	753	920	631	762	885	646	172	61	0.21	0.80	9.6	4.3	10.5	17.7	1.80		96	7.1	CLAY
9.2	56.4	755	896	623	765	861	638	174	63	0.16	0.79	9.4	3.3	8.1	16.7	1.80		96	5.5	CLAY
9.4	56.2	768	912	652	778	877	667	176	64	0.16	0.82	9.4	3.4	8.3	17.7	1.80		98	5.6	CLAY
9.6	56.0	781	943	662	790	908	677	178	66	0.19	0.82	9.3	4.1	9.9	17.7	1.80		99	6.7	CLAY
9.8	55.8	809	968	670	819	933	685	180	67	0.18	0.79	9.5	4.0	9.7	17.7	1.80		104	6.5	CLAY
10.0	55.6	823	989	690	832	954	705	182	69	0.19	0.80	9.4	4.2	10.3	17.7	1.80		106	7.0	CLAY
10.2	55.4	833	1008	694	842	973	709	183	70	0.20	0.80	9.3	4.6	11.1	17.7	1.80		106	7.5	CLAY
10.4	55.2	779	885	657	791	850	672	185	72	0.10	0.80	8.4	2.0	4.7	16.7	1.60		95	3.2	CLAY
10.6	55.0	340	556	189	347	521	204	187	73	1.09	0.10	2.2	6.0	5.9	16.7	0.59		18	4.0	SILT
10.8	54.8	627	940	320	629	905	335	189	75	0.63	0.33	5.9	9.6	18.7	17.7	1.30		63	12.6	CLAYEY SILT
11.0	54.6	880	1268	510	878	1233	525	191	76	0.52	0.49	9.0	12.3	29.4	17.7	1.70		110	19.8	SILTY CLAY
11.2	54.4	992	1287	687	995	1252	702	193	78	0.32	0.63	10.3	8.9	22.6	17.7	1.90		133	15.3	CLAY
11.4	54.2	1050	1550	636	1043	1515	651	195	80	0.56	0.54	10.7	16.4	42.0	18.6	1.90		142	28.3	SILTY CLAY
11.6	54.0	1120	1660	680	1111	1625	695	197	81	0.56	0.54	11.2	17.9	46.6	18.6	2.00		155	31.5	SILTY CLAY
11.8	53.8	1130	1672	703	1120	1637	718	199	83	0.56	0.56	11.1	17.9	46.6	18.6	2.00		156	31.5	SILTY CLAY

Summary Table No. 2

surface elevation (approx. mudline)	66.20	m
ground water elevation (IGLD)	74.49	m
Initial testing depth	1.80	m
Δ A	15	kPa
Δ B	35	kPa

Dilatometer Sounding No. DMT14-03

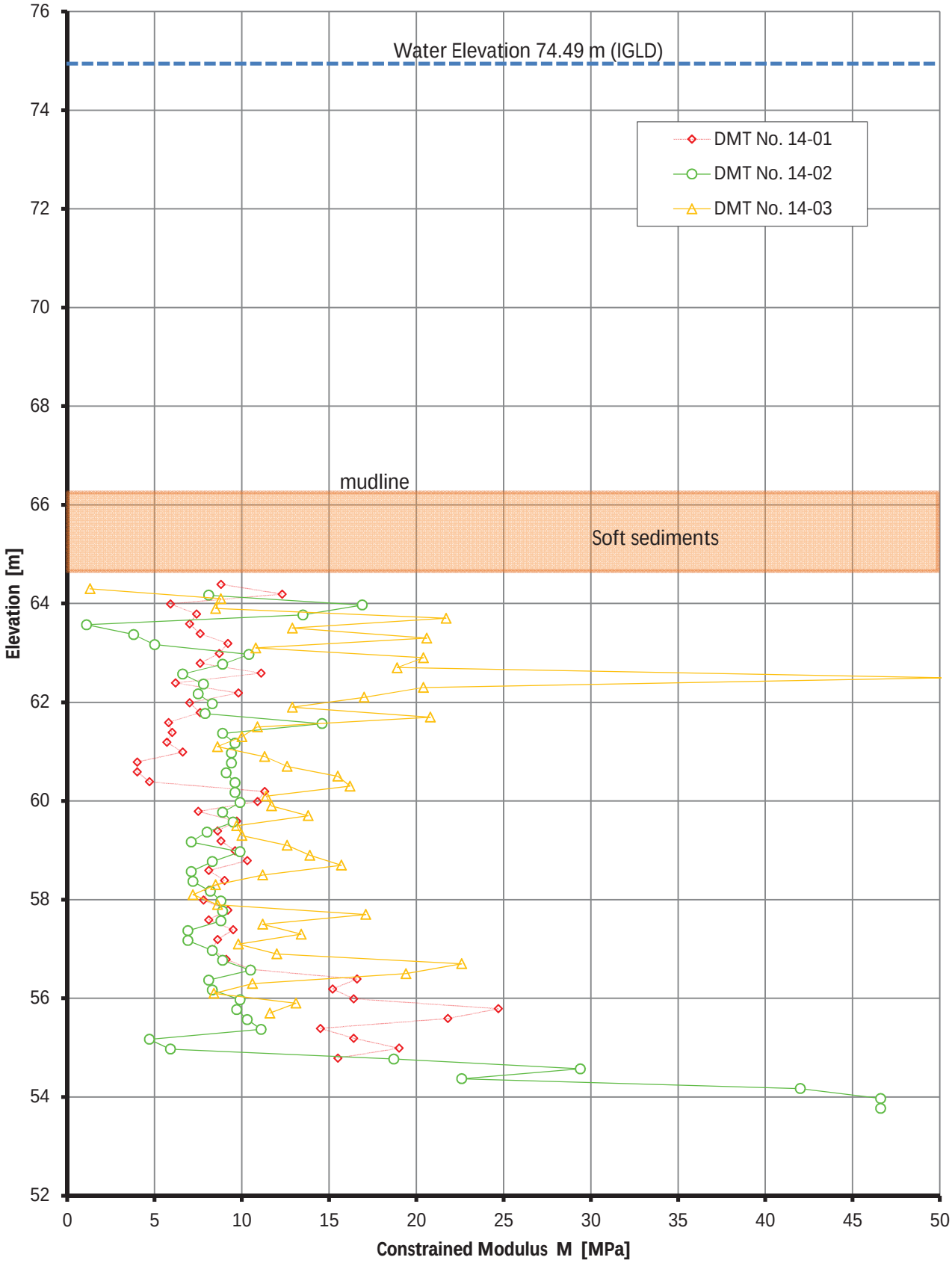
Test date: November 26, 2014
Client: Riggs Engineering
Location: Randle Reef, Burlington Bay, Hamilton, Ontario

In-Depth Geotechnical Inc.

Field Data					DMT parameters										Inferred Soil Properties					
							Pore Water Pressure	Hydrostatic Pore Water Pressure	Effective Horizontal Stresses	Material Index	Pore Pressure Index	Horizontal Stress Index	Dilatometer Modulus	Constrained Modulus	Unit Weight	Stress Ratio	Sand	Clay	Effective Young's Modulus	Soil Description
Depth	Elevation	A	B	C	p_0	p_1	$p_2 = u_w$	u_0	σ'_H	I_D	U_D	K_D	E_D	M_{DTM}	γ	$k_{0,DMT}$	ϕ	c_u	E'	
(m)	(m)	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]				[MPa]	[MPa]	[kN/m^3]		[degree]	[kPa]	[MPa]	
1.8	64.3	120	201	66	133	166	81	101	13	1.00		2.5	1.1	1.3	14.7	0.67		4	0.9	MUD
2.0	64.1	390	515	320	401	480	335	103	14	0.26	0.78	21.4	2.7	8.8	16.7	2.90		59	5.9	CLAY
2.2	63.9	401	525	330	412	490	345	105	15	0.25	0.78	20.1	2.7	8.5	16.7	2.80		60	5.7	CLAY
2.4	63.7	418	660	299	423	625	314	107	17	0.64	0.66	19.0	7.0	21.7	16.7	2.70		61	14.6	CLAYEY SILT
2.6	63.5	476	637	358	485	602	373	109	18	0.31	0.70	20.9	4.0	12.9	16.7	2.80		74	8.7	CLAY
2.8	63.3	541	764	380	547	729	395	111	19	0.42	0.65	22.5	6.3	20.6	17.7	3.00		88	13.9	SILTY CLAY
3.0	63.1	552	694	423	562	659	438	113	21	0.21	0.72	21.4	3.4	10.8	16.7	2.90		89	7.3	CLAY
3.2	62.9	561	788	434	567	753	449	115	22	0.41	0.74	20.2	6.4	20.4	17.7	2.80		89	13.8	SILTY CLAY
3.4	62.7	558	776	440	565	741	455	117	24	0.39	0.75	18.7	6.1	18.9	17.7	2.70		86	12.8	SILTY CLAY
3.6	62.5	802	1255	350	797	1220	365	119	25	0.62	0.36	26.6	14.7	50.3	19.1	3.30		142	33.9	CLAYEY SILT
3.8	62.3	687	912	497	693	877	512	121	27	0.32	0.68	20.9	6.4	20.4	17.7	2.80		113	13.8	CLAY
4.0	62.1	689	887	526	697	852	541	123	29	0.27	0.73	19.8	5.4	17.0	17.7	2.80		112	11.5	CLAY
4.2	61.9	675	840	533	684	805	548	125	31	0.22	0.76	18.3	4.2	12.9	17.7	2.60		107	8.7	CLAY
4.4	61.7	720	955	566	726	920	581	127	32	0.32	0.76	18.7	6.7	20.8	17.7	2.70		115	14.0	CLAY
4.6	61.5	680	830	561	690	795	576	129	34	0.19	0.80	16.7	3.6	10.9	17.7	2.50		105	7.4	CLAY
4.8	61.3	665	809	560	675	774	575	131	35	0.18	0.82	15.5	3.4	10.0	16.7	2.40		100	6.7	CLAY
5.0	61.1	661	793	566	672	758	581	132	37	0.16	0.83	14.7	3.0	8.6	16.7	2.30		98	5.8	CLAY
5.2	60.9	708	865	588	718	830	603	134	38	0.19	0.80	15.4	3.9	11.3	17.7	2.40		107	7.6	CLAY
5.4	60.7	730	899	592	739	864	607	136	40	0.21	0.78	15.2	4.3	12.6	17.7	2.40		110	8.5	CLAY
5.6	60.5	744	942	580	752	907	595	138	41	0.25	0.74	14.9	5.4	15.5	17.7	2.30		111	10.5	CLAY
5.8	60.3	776	980	604	783	945	619	140	43	0.25	0.74	15.1	5.6	16.2	17.7	2.40		117	10.9	CLAY
6.0	60.1	768	928	630	777	893	645	142	44	0.18	0.79	14.4	4.0	11.4	17.7	2.30		114	7.7	CLAY
6.2	59.9	756	921	641	765	886	656	144	46	0.19	0.82	13.6	4.2	11.7	17.7	2.20		110	7.9	CLAY
6.4	59.7	808	992	648	816	957	663	146	47	0.21	0.77	14.1	4.9	13.8	17.7	2.30		120	9.3	CLAY
6.6	59.5	863	1006	668	873	971	683	148	49	0.13	0.74	14.8	3.4	9.7	17.7	2.30		132	6.5	CLAY
6.8	59.3	818	967	693	828	932	708	150	51	0.15	0.82	13.4	3.6	10.0	17.7	2.20		120	6.7	CLAY
7.0	59.1	845	1019	712	854	984	727	152	52	0.19	0.82	13.5	4.5	12.6	17.7	2.20		124	8.5	CLAY
7.2	58.9	904	1089	739	912	1054	754	154	54	0.19	0.79	14.1	4.9	13.9	17.7	2.30		136	9.4	CLAY
7.4	58.7	887	1092	743	894	1057	758	156	55	0.22	0.82	13.4	5.6	15.7	17.7	2.20		131	10.6	CLAY
7.6	58.5	853	1017	756	862	982	771	158	57	0.17	0.87	12.4	4.2	11.2	17.7	2.10		122	7.6	CLAY
7.8	58.3	839	977	732	850	942	747	160	58	0.13	0.85	11.8	3.2	8.5	17.7	2.00		118	5.7	CLAY
8.0	58.1	853	978	742	864	943	757	162	60	0.11	0.85	11.7	2.7	7.2	17.7	2.00		120	4.9	CLAY
8.2	57.9	876	1015	743	887	980	758	164	62	0.13	0.82	11.8	3.2	8.6	17.7	2.00		124	5.8	CLAY
8.4	57.7	813	1048	687	819	1013	702	166	63	0.30	0.82	10.4	6.7	17.1	17.7	1.90		108	11.5	CLAY
8.6	57.5	830	1001	755	839	966	770	168	65	0.19	0.90	10.4	4.4	11.2	17.7	1.90		111	7.6	CLAY
8.8	57.3	834	1030	693	842	995	708	170	66	0.23	0.80	10.1	5.3	13.4	17.7	1.90		111	9.0	CLAY
9.0	57.1	794	955	698	803	920	713	172	68	0.18	0.86	9.3	4.0	9.8	17.7	1.80		102	6.6	CLAY
9.2	56.9	814	999	676	822	964	691	174	69	0.22	0.80	9.4	4.9	12.0	17.7	1.80		105	8.1	CLAY
9.4	56.7	935	1226	633	938	1191	648	176	71	0.33	0.62	10.7	8.8	22.6	17.7	1.90		128	15.3	SILTY CLAY
9.6	56.5	866	1133	640	870	1098	655	178	72	0.33	0.69	9.6	7.9	19.4	17.7	1.80		113	13.1	CLAY
9.8	56.3	750	930	603	758	895	618	180	74	0.24	0.76	7.8	4.7	10.6	17.7	1.60		90	7.2	CLAY
10.0	56.1	710	867	661	720	832	676	182	76	0.21	0.92	7.1	3.9	8.4	17.7	1.50		81	5.7	CLAY
10.2	55.9	730	946	626	737	911	641	183	77	0.32	0.83	7.2	6.0	13.1	17.7	1.50		84	8.8	CLAY
10.4	55.7	860	1045	720	868	1010	735	185	79	0.21	0.81	8.7	4.9	11.6	17.7	1.70		108	7.8	CLAY

Summary Table No. 3

Constrained Modulus M_{DMT}



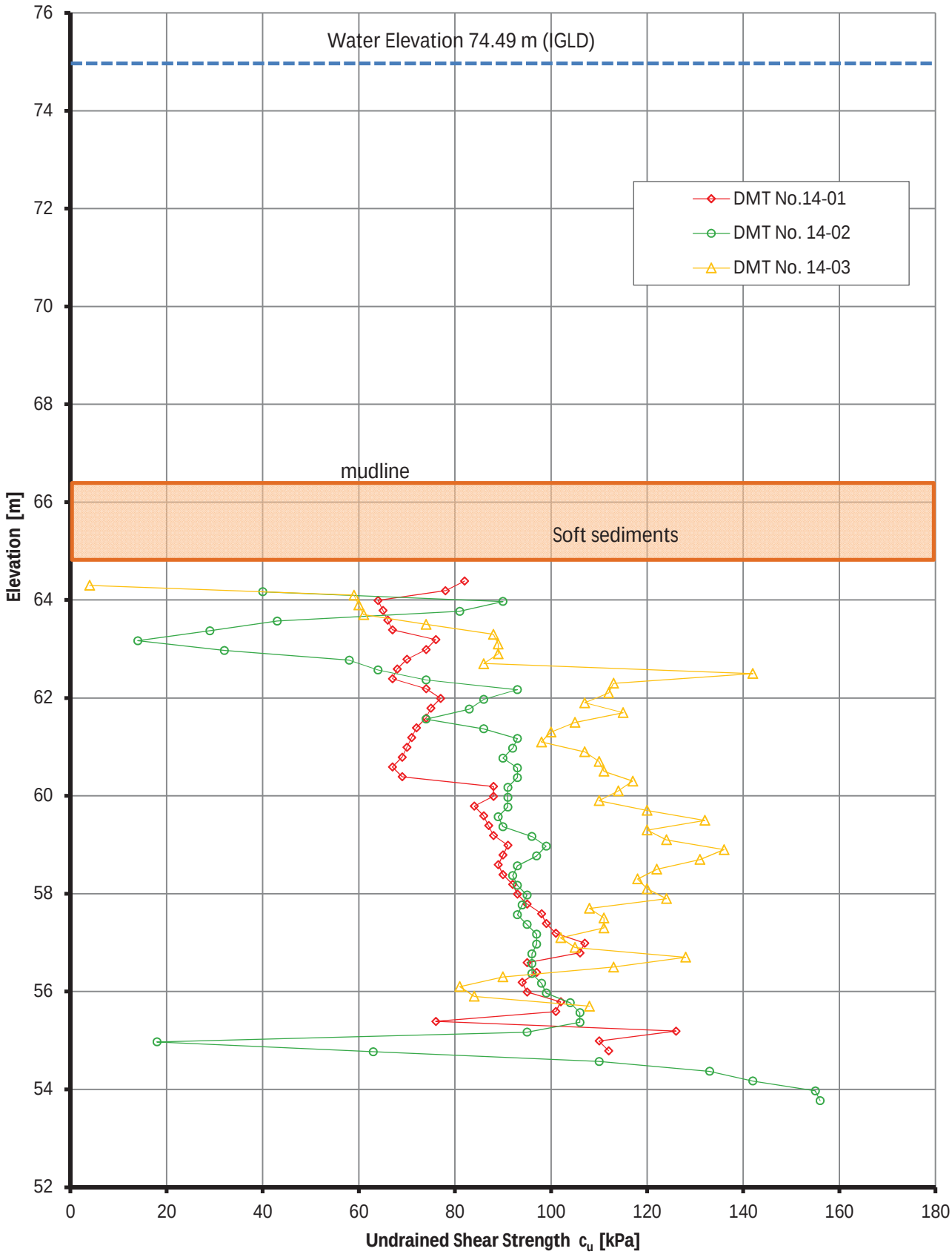
Client: Riggs Engineering

Project: Randle Reef, Burlington Bay, Hamilton, Ontario

In-Depth Geotechnical Inc.

Figure 1

Undrained Shear Strength c_u

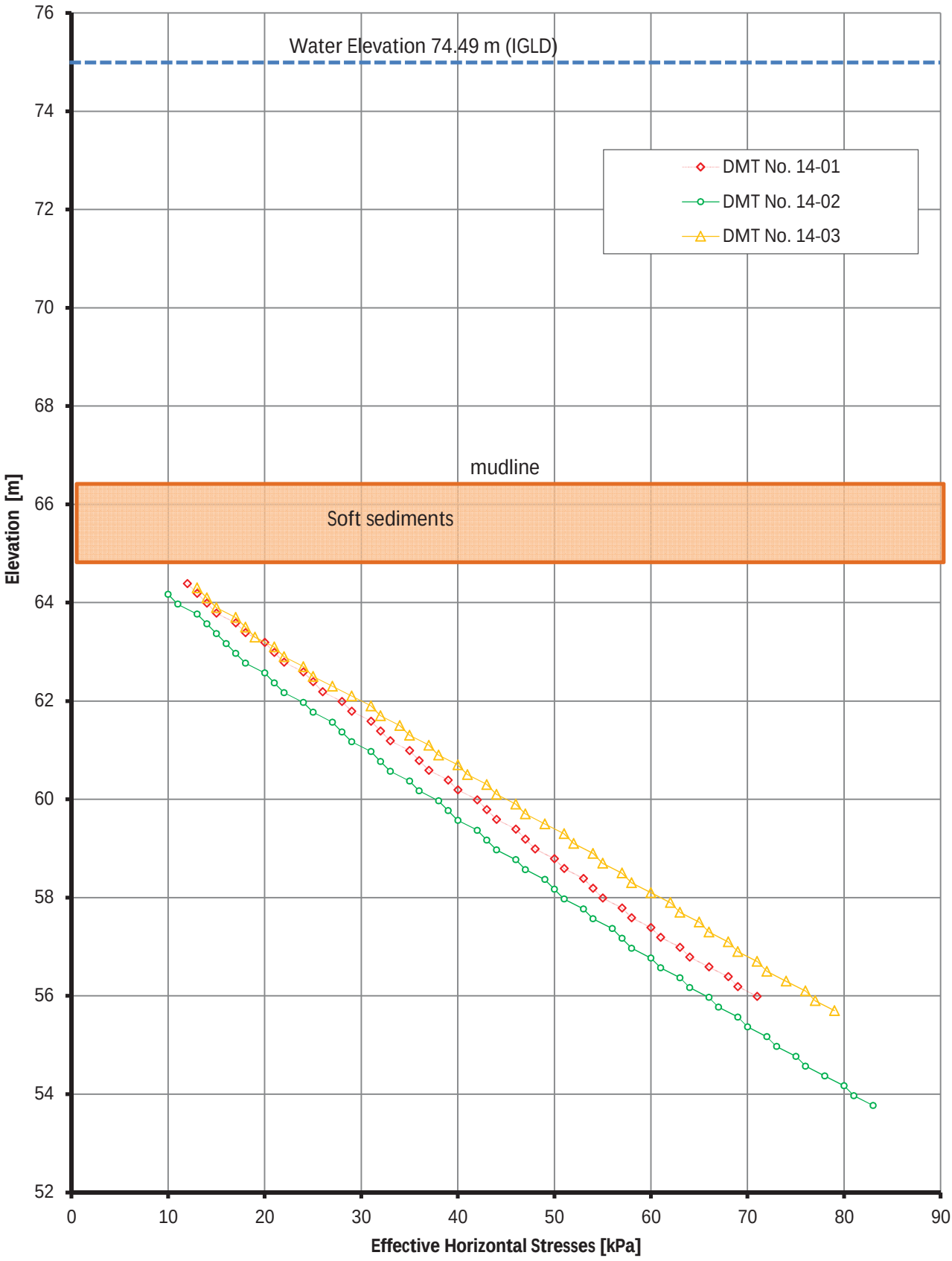


Client: Riggs Engineering

Project: Randle Reef, Burlington Bay, Hamilton, Ontario

In-Depth Geotechnical Inc.

Figure 2



Client: Riggs Engineering

Project: Randle Reef, Burlington Bay, Hamilton, Ontario

Figure 3

In-Depth Geotechnical Inc.

Appendix B
Geotechnical Investigations

ITEM B2

Peto MacCallum Ltd. - Geotenchinal Investigation, Contaminated Sediment Remediation Project, Randle Reef, Hamilton Harbour, Hamilton, Ontario, January 2014.

Appendix B
Geotechnical Investigations

ITEM B2

Peto MacCallum Ltd. - Geotenchinal Investigation, Contaminated Sediment Remediation Project, Randle Reef, Hamilton Harbour, Hamilton, Ontario, January 2014.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

GEOTECHNICAL INVESTIGATION
CONTAMINATED SEDIMENT REMEDIATION PROJECT
RANDLE REEF, HAMILTON HARBOUR
HAMILTON, ONTARIO

for

RIGGS ENGINEERING LTD.

PETO MacCALLUM LTD.
45 BURFORD ROAD
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Email: hamilton@petomaccallum.com

Distribution:
4 cc: Riggs Engineering Ltd.
1 cc: PML Hamilton

PML Ref.: 13HF033
Report: 1
January 2014

Peto MacCallum Ltd.
CONSULTING ENGINEERS

January 23, 2014

PML Ref.: 13HF033
Report: 1

Mr. Brian Riggs, P.Eng.
Riggs Engineering Ltd.
1240 Commissioners Road West
Suite 205
London, Ontario
N6K 1C7

Dear Mr. Riggs

Geotechnical Investigation
Contaminated Sediment Remediation Project
Randle Reef, Hamilton Harbour
Hamilton, Ontario

Peto MacCallum Ltd. (PML) is pleased to present the results of the geotechnical investigation recently completed for this project. Authorization to proceed with this assignment was provided by Mr. Brian Riggs in an email dated August 19, 2013.

It is understood that the Randle Reef remediation project is to consist of in situ containment of the areas with the highest contaminant concentrations, within an engineered containment facility (ECF). The containment facility is to be located north of Piers 14 and 15 and west of Pier 16 (U.S. Steel) in Hamilton, Ontario.

Current conceptual design calls for an ECF having an approximate area of 18.6 acres (7.5 hectares) with a proposed mixed end use of marine terminal operations, light industrial use and/or naturalized areas. The design of the ECF calls for the installation of a double sheet pile wall system where the outer wall will serve as a structural wall anchored by the inner sheet pile wall which will also act as an impermeable barrier to contamination migration.

A previous geotechnical investigation was completed by AMEC Earth and Environmental. The report, titled “Randle Reef Sediment Remediation Project; Hamilton, Ontario; RS-2 Phase 1 Geotechnical Investigation Report” dated March 2004 is referenced herein as “AMEC (2004)”.

ARCADIS BBL completed supplemental design reports as follows:

- Randle Reef Sediment Remediation Report, Basis of Design Report, ARCADIS Ref.: 34305-009, May 2006.
- Task 2.1.1 – Geotechnical Design Analysis, Randle Reef Sediment Remediation Project, ARCADIS Ref.: 34305.017, August 2007.

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- Amendment to Geotechnical Basis of Design, Undrained Shear Strength for Earth Pressures, Randle Reef Sediment Remediation Project, Hamilton, Ontario ARCADIS Ref.: B0034305.0000.00017, August 2010.

- Updated Global Stability Evaluation of Port Facility Wall, Randle Reef Sediment Remediation Project, ARCADIS Ref.: B0034305.0000.230NB, March 2011.

The purpose of the current geotechnical investigation was to supplement the information from the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports with additional boreholes and laboratory testing data to provide further coverage of the engineered containment facility.

The field work consisted of 11 boreholes (BH 1 to 11) and seven cone penetration tests (CPT 1, 2, 5, 7 and 12 to 14).

The subsurface stratigraphy revealed in the boreholes typically comprised sediment over silt, underlain by clay overlying clay till, over silt till grading to silt till/shale complex. It is noted that the silt layer ranged in thickness from 0.7 to 1.9 m in Boreholes 4 and 6 to 8 and from 5.0 to 9.0 m in Boreholes 1, 5, and 9 to 11.

The scope of work for this project did not include geotechnical sampling, testing or classification of the sediment.

Supplemental sampling and testing of the clay and clay till strata to assess the strength and compressibility characteristics was required. A summary of all samples tested and type of tests conducted is provided as Table A1, in Appendix A. Further discussion of laboratory testing of selected samples is detailed in Section 4.2. Reference is made to Table A2 for a complete list of laboratory results of index testing.

The scope of work for this study did not include the observation, recording or assessment of the environmental conditions of the soil, bedrock and groundwater on the property.

We trust the information presented in the attached report will be sufficient for your present purposes. If you have any questions, please do not hesitate to contact our office.

Sincerely

Peto MacCallum Ltd.

Matthew D. St Denis, P.Eng.
Senior Engineer, Geotechnical Services

KF:lad

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1. INTRODUCTION

1.1 Authorization

Authorization to proceed with this assignment was provided by Mr. Brian Riggs in an email dated August 19, 2013. Services were provided in accordance with PML's proposal dated August 29, 2013, PML Ref.: FQH3544A.

1.2 Background

The Randle Reef Sediment Remediation Project is part of a multi-partnered project headed by Environment Canada to develop and implement a Hamilton Harbour Remedial Action Plan (RAP). The RAP is a detailed strategy to clean up the Harbour, which would result in the "delisting" of the Harbour as an Area of Concern identified in the Great Lakes Water Quality Agreement between Canada and the United States.

The Hamilton Harbour RAP identified Randle Reef as a high priority area for remedial action. The purpose of the Randle Reef Sediment Remediation Project is to remediate areas of sediment with high levels of contamination in order to reduce exposure of organisms (aquatic and terrestrial) to the contamination.

The proposed remediation methodology is to construct an engineered containment facility (ECF) for in situ containment of the areas with the highest contaminant concentrations and storage of dredged contaminated sediments.

Current conceptual design calls for an ECF having an approximate area of 18.6 acres (7.5 hectares) with a proposed mixed end use of marine terminal operations, light industrial use and/or naturalized areas.

2. SITE AND PROJECT DESCRIPTION

2.1 Site Description

The Randle Reef Contaminated Sediment Remediation Project area is located north of Piers 14 and 15 and west of Pier 16 (U.S. Steel, formerly Stelco) in Hamilton Harbour, located in Hamilton, Ontario.

Hamilton Harbour is located on the west end of Lake Ontario connected to the lake by a single ship canal across a sandbar which embays it.

Randle Reef is an area of higher lake bed elevation located on the south side of Hamilton Harbour. Bathymetry indicates the depth of water in the area of Randle Reef is generally 3.0 to 5.0 m. The area outside the reef was dredged for commercial boat access and the depth of water is generally 5.0 to 9.0 m.

2.1.1 Physiographic and Geologic Setting

The project area is situated adjacent to the physiographic region known as the Iroquois Plain. The Iroquois Plain was formed in the late Pleistocene times by a body of water known as Lake Iroquois, which emptied eastward at Rome, New York. (Chapman and Putnam, 1984). Lake Iroquois was characterized by higher water levels than the present day Lake Ontario, caused by an ice sheet blocking the present day St. Lawrence River valley. When the St. Lawrence valley became free of ice, the water level dropped to a level much lower than the present Lake Ontario levels (Karrow, 1959).

Based on Quaternary Geology Map M2509 and Pleistocene Geology Map M2033, the land area adjacent to the site is “recent” stream deposits of gravel, sand, silt and clay.

According to Paleozoic Geology Map 2334, the area is underlain by red shale bedrock of the Queenston Formation.

2.2 Project Description

The containment facility is to be located north of Piers 14 and 15 and west of Pier 16 (U.S. Steel, formerly Stelco) in Hamilton Harbour, located in Hamilton, Ontario. The ECF footprint is designed as a peninsula bound on the northwest by Randle Reef, forming a boat slip on the east for U.S. Steel and with land access via Hamilton Port Authority property located on Pier 15. The footprint of the ECF is shown on Drawing 1, appended.

Current conceptual design calls for an ECF having an approximate area of 18.6 acres (7.5 hectares) with a proposed mixed end use of marine terminal operations, light industrial use and/or naturalized areas.

The design of the ECF calls for the installation of a double sheet pile wall system where the outer wall will serve as a structural wall anchored by the inner sheet pile wall which will also act as an impermeable barrier to contamination migration.

3. SCOPE OF WORK

The comments and recommendations provided in this report are based on the site conditions at the time of the investigation and are applicable only to the proposed project as described in the report. Any changes in the project, including finishing grades and layout, will require review by PML to assess the validity of the report and may require modified recommendations, additional investigation and/or analysis.

3.1 Geotechnical

A previous geotechnical investigation was completed by AMEC Earth and Environmental and was provided for review. The report, titled “Randle Reef Sediment Remediation Project; Hamilton, Ontario; RS-2 Phase 1 Geotechnical Investigation Report” dated March 2004 is referenced herein as “AMEC (2004)”.

The previous geotechnical investigation was carried out from October 6 to October 29, 2003 and included the advancement of 16 boreholes, two flat plate dilatometer tests and seven slag delineation boreholes (AMEC, 2004).

ARCADIS BBL completed supplemental design reports as follows:

- Randle Reef Sediment Remediation Report, Basis of Design Report, ARCADIS Ref.: 34305-009, May 2006.
- Task 2.1.1 – Geotechnical Design Analysis, Randle Reef Sediment Remediation Project, ARCADIS Ref.: 34305.017, August 2007.
- Amendment to Geotechnical Basis of Design, Undrained Shear Strength for Earth Pressures, Randle Reef Sediment Remediation Project, Hamilton, Ontario ARCADIS Ref.: B0034305.0000.00017, August 2010.
- Updated Global Stability Evaluation of Port Facility Wall, Randle Reef Sediment Remediation Project, ARCADIS Ref.: B0034305.0000.230NB, March 2011.

The purpose of the current geotechnical investigation was to supplement the information from the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports with additional boreholes and laboratory testing data to provide further coverage of the engineered containment facility.

Supplemental sampling and testing of the clay and clay till strata to assess the strength and compressibility characteristics was required. It is noted that the clay stratum is referred to as “upper silty clay” in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports and the clay till stratum is referred to as “lower clayey silt” and “lower silty clay” in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports, respectively.

A limited scope sampling of the sediment was conducted for future geotechnical analysis. Laboratory testing of the sediment was not part of the scope of work for this stage of the project.

3.2 Geoenvironmental

The scope of work for this study did not include the observation, recording or assessment of the environmental conditions of the soil, bedrock and groundwater.

4. INVESTIGATION PROCEDURES

4.1 Field Work

4.1.1 Overview

The field work was carried out from September 3 to 27, 2013 and consisted of 11 boreholes (BH 1 to 11) drilled to 26.2 to 33.4 m termination depths. In addition, seven cone penetration tests (CPT 1, 2, 5, 7 and 12 to 14) were advanced on September 17 to 19, 2013 to depths of 19.5 to 21.1 m. The borehole and cone penetration tests locations are shown on Drawing 1, appended.

The borehole and cone penetration test location co-ordinates were provided in Universal Transverse Mercator format by Riggs Engineering and established in the field by PML using Trimble GPS survey equipment.

The borehole elevations are the top of the barge platform and are referenced to the lake water level elevation. The lake water elevation was obtained from The Canadian Hydrographic Service water level gauging station located in Burlington, Ontario. The elevations are referenced to the International Great Lakes Datum 1985.

The boreholes and cone penetration tests were advanced by a truck-mounted CME-75 drill rig, supplied and operated by Elite Drilling Services. The drill rig was mounted on a spud barge and directed using a tug boat supplied and operated by Dean Construction Company Ltd. All work was completed under the full time supervision of a member of PML's engineering staff.

4.1.2 Borehole Sampling

The boreholes were advanced using wash boring and tri-coning inside NW size casing. Representative samples of the overburden were recovered at frequent depth intervals using a conventional split-spoon sampler. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In situ vane, pocket penetrometer and torvane tests were conducted on cohesive soils to determine in situ shear strength. Relatively undisturbed thin walled Shelby tube samples were obtained of cohesive soils for laboratory strength and compressibility testing.

All of the recovered samples were returned to our laboratory for detailed visual examination and classification. A summary of all samples tested and type of tests conducted is provided as Table A1, in Appendix A. Further discussion of laboratory testing of selected samples is detailed in Section 4.2.

Upon completion of drilling, all boreholes were fully grouted with Quik-Grout® mixed to the manufacturers specifications and emplaced using tremie methodology.

4.1.3 Cone Penetration Testing

Cone penetration tests were advanced using direct push of an integrated electronic piezocone manufactured, supplied and operated by ConeTec. Reference is made to the appended ConeTec Field Report, dated September 23, 2013, in Appendix B, for further information regarding the field equipment and procedures relating to the cone penetration testing.

4.2 Laboratory Testing

Laboratory testing was completed on selected samples to determine index properties and soil classification (moisture content, organic content, grain size, Atterberg Limits and specific gravity), settlement properties (consolidation) and strength parameters (unconfined uniaxial compression, undrained triaxial and consolidated undrained triaxial). A summary of all samples tested and type of tests conducted is provided as Table A1, appended.

4.2.1 Index Properties and Soil Classification

4.2.1.1 Moisture Content

Moisture content determinations were completed on retrieved samples and are shown on the appended Borehole Logs.

4.2.1.2 Organic Content

Organic content testing was completed on the following four samples:

TABLE 4-1

ORGANIC CONTENT TESTING SAMPLES

Sample	Depth (m)	Soil Type
BH1 SS9	14.2 – 14.65	Silt
BH9 SS9	17.2 – 17.65	Silt
BH10 SS8	15.4 – 15.85	Silt
BH11 SS8	16.5 – 16.95	Silt

The results of the organic content testing are shown on Table 5-1 and the appended Borehole Logs and are discussed in Section 5.2.

4.2.1.3 Grain Size, Atterberg Limits, Specific Gravity

Grain size, Atterberg Limit and specific gravity testing was completed on twenty-two samples as shown on Table A1, appended. The results of the grain size and Atterberg limits tests are shown on the appended Borehole Logs and on Figures A1 to A4 and A5 to A8, respectively, and on Table A2, in Appendix A.

4.2.2 Unconfined Uniaxial Compression

Unconfined uniaxial compression testing was completed on seventeen samples as shown on Table A1, appended. The results of the unconfined uniaxial compression testing are shown on the appended Borehole Logs and Table A3 and discussed in Sections 5.3 and 5.4.

4.2.3 Undrained Triaxial

Undrained triaxial testing was completed on the following five samples:

TABLE 4-2

UNDRAINED TRIAXIAL TESTING SAMPLES

Sample	Depth (m)	Soil Type
BH2 TW4	13.4 –13.85	Clay
BH3 TW10	18.0 – 18.45	Clay
BH4 TW4	13.4 – 13.85	Clay
BH6 TW4	13.4 – 13.85	Clay
BH6 TW12	19.5 – 19.95	Clay Till

The results of the unconfined undrained triaxial testing are shown on Table A4, appended, and discussed in Section 5.3 and 5.4.

Consolidated undrained triaxial testing was completed on the following four samples:

TABLE 4-3

CONSOLIDATED UNDRAINED TRIAXIAL TESTING SAMPLES

Sample	Depth (m)	Soil Type
BH3 TW2	11.9 – 12.35	Clay
BH4 TW12	19.5 – 19.95	Clay
BH5 TW7	14.9 – 15.35	Clay
BH8 TW5	14.9 – 15.35	Clay

The results are shown in Table 5-3 and on Figures A9 to A12, in Appendix A.

4.2.4 Consolidation Testing

One dimensional consolidation testing was completed on a total of seven samples. The testing included one loading cycle on four samples and two loading cycles on three samples. A summary of the testing is summarized in the following tables:

TABLE 4-4

CONSOLIDATION TESTING (ONE CYCLE) SAMPLES

Sample	Depth (m)	Soil Type
BH3 TW4	13.4 – 13.85	Clay
BH4 TW6	14.9 – 15.35	Clay
BH6 TW10	18.0 – 18.45	Clay
BH10 TW10	18.0 – 18.45	Silt

The results of the one cycle consolidation testing are shown on Figures A13 to A16 in Appendix A.

TABLE 4-5

CONSOLIDATION TESTING (TWO CYCLE) SAMPLES

Sample	Depth (m)	Soil Type
BH2 TW6	14.9 – 15.35	Clay
BH5 TW9	16.5 – 16.95	Clay
BH7 TW4	13.4 – 13.85	Clay

The results of the two cycle consolidation testing are shown on Figures A17 to A19, in Appendix A.

The results of all of the consolidation tests are summarized in Table 5-4.

5. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test N values, in situ vane, pocket penetrometer and torvane shear tests, laboratory moisture and organic content determinations, unconfined uniaxial compression, undrained triaxial and unconsolidated undrained triaxial test results, specific gravity, unit weight, Atterberg Limits tests and grain size analyses.

Reference is made to the appended ConeTec Field Report, dated September 23, 2013, in Appendix B, for results of the cone penetration testing.

Reference is made to Table A2 for a complete list of laboratory results of index testing.

The subsurface stratigraphy revealed in the boreholes by AMEC (2004) typically comprised "slag and heterogeneous fill along existing docks over a layer of organics and recent soft sediments over shallow silt deposits overlying silty clay to clayey silt (Upper Silty Clay) underlain by clayey silt (Lower Clayey Silt) over clayey silt till overlying assumed shale bedrock" (AMEC, 2004, pg. 22).

The subsurface stratigraphy revealed in the boreholes during this investigation typically comprised sediment over silt, underlain by clay overlying clay till, over silt till grading to silt till/shale complex. It is noted that the silt layer ranged in thickness from 0.7 to 1.9 m in Boreholes 4 and 6 to 8 and from 5.0 to 9.0 m in Boreholes 1, 5, and 9 to 11.

The subsurface stratigraphies revealed in the AMEC investigation and during this investigation are generally consistent. It is noted that the clay stratum is referred to as "upper silty clay" in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports and the clay till stratum is referred to as "lower clayey silt" and "lower silty clay" in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports, respectively. It is also noted that slag was not contacted during the course of this investigation. In addition, the thicker silt layer contacted in Boreholes 1, 5, and 9 to 11 was not revealed in the AMEC report.

5.1 Sediment

The 0.1 to 2.9 m thick sediment layer was contacted at depths of 7.0 to 10.7 m (elevation 65.5 to 69.3) and extended to depths ranging from 8.2 to 11.6 m (elevation 64.5 to 68.1). The scope of work for this project did not include geotechnical sampling, testing or classification of the sediment.

5.2 Silt

Silt was contacted below the sediment in Boreholes 1 and 4 to 11. The silt layer ranged in thickness from 0.7 to 1.9 m in Boreholes 4 and 6 to 8 and from 5.0 to 9.0 m in Boreholes 1, 5 and 9 to 11. The silt layer was penetrated at depths of 11.8 to 20.2 m (elevation 55.9 to 64.4). The condition of the silt was very loose/soft to compact/stiff. The silt was interspersed with layers of sandy or clayey composition and layers with varying levels of organic content. It is noted that the upper portion (0.2 to 1.1 m) of the silt often had possible coal tar related staining and odour.

5.2.1 Index Properties

The results of eight grain size tests (Figure A1, Table A2) indicate that the silt stratum comprises 0 to 3% gravel, 4 to 37% sand, 44 to 81% silt and 4 to 38% clay.

The results of eight Atterberg limits tests determined five of the samples to be non-plastic. The liquid limit, plastic limit and plasticity index values were 19 and 25, 15 and 15 and 4 and 10, in Samples BH5 SS3 and BH9 SS12B, respectively (Figure A5, Table A2). The Atterberg limits test results indicate low plasticity clay.

In Sample BH10 TW10, the plastic limit, liquid limit and plasticity index values were 70, 42 and 28, respectively (Figure A5, Table A2). The Atterberg limits test results indicates organic silt.

Moisture content of the silt generally ranged from 19 to 25%. Organic silt layer moisture contents ranged from 44 to 242%.

5.2.2 Organic Content

The results of the laboratory testing of the organic content of the silt are summarized in the following table:

TABLE 5-1

ORGANIC CONTENT PERCENT

Sample	Depth (m)	Organic Content (%)
BH1 SS9	14.2 – 14.65	14
BH9 SS9	17.2 – 17.65	9
BH10 SS8	15.4 – 15.85	8
BH11 SS8	16.5 – 16.95	22

5.2.3 Undrained Shear Strength

One sample (BH10 TW10) of the clayey silt was submitted for unconfined uniaxial compression testing. Based on the results of the test, the clayey silt has a shear strength of 19 kPa, indicating a soft consistency.

5.3 Clay

A silty clay stratum was contacted below the sediment in Boreholes 2 and 3 and below the silt in Boreholes 1 and 4 to 8 at depths of 11.3 to 16.0 m (elevation 60.3 to 65.0). The clay stratum was not contacted in Boreholes 9 to 11. In general, the clay was 5.4 to 9.6 m thick; locally, in Borehole 1, the clay layer was 1.9 m thick. The silty clay was penetrated at depths of 17.9 to 21.0 m (elevation 55.3 to 58.4). It is noted that the silt and clay layer thicknesses are inversely correlated.

Often, the upper portions of the clay had thin partings of silt and the lower portions had sand seams and/or a greater percentage of sand content.

5.3.1 Index Properties

The results of nine grain size tests (Figure A3, Table A2) indicate that the clay stratum comprises 0 to 2% gravel, 1 to 8% sand, 44 to 70% silt and 29 to 54% clay.

The results of nine Atterberg limits tests determined the liquid limit, plastic limit and plasticity index values ranged from 27 to 36, 16 to 20 and 11 to 16, respectively (Figure A6, Table A2). The Atterberg limits test results indicate low plasticity clay.

Moisture content of the clay generally ranged from 17 to 32%, indicating the moisture content of the clay was about plastic limit (APL) to wetter than plastic limit (WTPL).

5.3.2 Undrained Shear Strength

The following table summarizes the measured undrained shear strengths of the silty clay:

TABLE 5-2

SUMMARY OF UNDRAINED SHEAR STRENGTHS

		Undrained Shear Strength Range (kPa)		
Test	**No. of Tests**	Minimum	Maximum	Average
Field Vane	23	57	215	105
Torvane[1]	39	6	35	15
Pocket Penetrometer[1]	28	25	100	40
Unconfined Uniaxial Compression	17	9	261	60
Undrained Triaxial	4	20	97	45
CPT[2]	350	22	110	65

Notes:

1. Torvane and Pocket Penetrometer tests performed on disturbed samples.
2. CPT conducted with near continuous readings at 50 mm intervals.

Based on the data, the consistency of the silty clay stratum is considered to be firm, with an undrained shear strength of about 30 kPa. It is noted that the shear strength values had no discernible pattern. It is likely that silt partings and/or sand seams within the clay caused variance in shear strength values.

5.3.3 Effective Stress Shear Strength

Consolidated undrained triaxial compression tests were conducted on four samples of the silty clay. The test results are provided on Figures A9 to A12.

The geotechnical parameters indicated by the test results are summarized:

TABLE 5-3

CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Sample	Depth (m)	Soil Type	c' (kPa)	$\varnothing'_{cs}$ (degrees)
BH3 TW2	11.9 – 12.35	Clay	0	32
BH4 TW12	19.5 – 19.95	Clay	0	33
BH5 TW7	14.9 – 15.35	Clay	0	29
BH8 TW5	14.9 – 15.35	Clay	0	29

5.3.4 Consolidation

The results of the consolidation tests are shown on Figure A13 to A19 and are summarized in the table below.

TABLE 5-4

SUMMARY OF CONSOLIDATION TEST RESULTS

Sample	Depth (m)	Natural Moisture Content (%)	Initial Void Ratio	Estimated Effective Overburden Pressure (kPa)	Estimated Preconsolidation Pressure (kPa)	Overconsolidation Ratio (OCR)	Compression Index, C_c	Recompression Index, C_r	Coefficient of Consolidation, C_v (m^2/day)
BH3 TW4	13.4 – 13.85	34	0.93	25	225	9.0	0.68	0.04	0.039 – 0.053
BH4 TW6	14.9 – 15.35	27	0.73	47	275	5.9	0.20	0.02	0.024 – 0.054
BH6 TW10	18.0 – 18.45	23	0.66	75	325	4.3	0.36	0.03	0.043 – 0.062
BH10 TW10	18.0 – 18.45	46	1.29	74	175	2.4	0.44	0.05	0.021 – 0.049
BH2 TW6	14.9 – 15.35	22	0.60	46	300	6.5	0.20	0.02	0.030 – 0.075
BH5 TW9	16.5 – 16.95	29	0.78	74	425	5.7	0.46	0.05	0.034 – 0.065
BH7 TW4	13.4 – 13.85	29	0.76	25	425	17.0	0.43	0.03	0.034 – 0.075

It is noted that CPT correlations of the OCR were generally in the range of 2 to 10.

5.3.5 Permeability

A summary of the coefficient of permeability values calculated from the consolidation test results are as follows:

TABLE 5-5

COEFFICIENT OF PERMEABILITY

		Coefficient of Permeability, k (cm/s)	
Sample	**Depth (m)**	**Range of Values**	**Average**
BH3 TW4	13.4 – 13.85	$5.9x10^{-7} – 9.3x10^{-8}$	$2.4x10^{-7}$
BH4 TW6	14.9 – 15.35	$3.3x10^{-7} – 9.8x10^{-8}$	$2.0x10^{-7}$
BH6 TW10	18.0 – 18.45	$7.2x10^{-7} – 6.1x10^{-8}$	$2.4x10^{-7}$
BH10 TW10	18.0 – 18.45	$3.9x10^{-7} – 7.9x10^{-8}$	$1.8x10^{-7}$
BH2 TW6	14.9 – 15.35	$2.9x10^{-7} – 6.4x10^{-8}$	$1.4x10^{-7}$
BH5 TW9	16.5 – 16.95	$4.1x10^{-7} – 5.4x10^{-8}$	$2.0x10^{-7}$
BH7 TW4	13.4 – 13.85	$7.6x10^{-7} – 8.1x10^{-8}$	$3.0x10^{-7}$

In general, the coefficient of vertical permeability for the clay deposit can be taken as 1×10^{-7} to 3×10^{-7}.

5.4 Clay Till

A 4.3 to 7.9 m thick very stiff to hard silty clay till layer was encountered beneath the clay. The clay till was contacted at depths ranging from 17.9 to 21.0 m (elevation 55.3 to 58.4) and penetrated at depths of 25.3 to 25.8 m (elevation 50.3 to 51.0). Borehole 6 was terminated in this stratum at a depth of 26.2 m (elevation 50.0), upon practical refusal to advance on a probable

boulder. It is noted that the clay till contained occasional shale fragments. The presence of cobbles, boulders and sand and gravel layers within the clay till deposit was inferred from tricone grinding, wash samples and CPT dissipation test results.

5.4.1 Index Properties

The results of three grain size tests (Figure A3, Table A2) indicate that the clay till stratum comprises 2 to 8% gravel, 6 to 11% sand, 53 to 56% silt and 31 to 33% clay.

The results of three Atterberg limits tests determined the liquid limit, plastic limit and plasticity index values ranged from 27 to 29, 16 to 17 and 11 to 12, respectively (Figure A7, Table A2). The Atterberg limits test results indicates low plasticity clay.

Moisture content of the clay till generally ranged from 11 to 25% and was determined to be drier than plastic limit to WTPL.

5.4.2 Undrained Shear Strength

Samples BH1 TW14 and BH6 TW12 were submitted for unconfined uniaxial compression testing and undrained triaxial, respectively. Based on the results of the tests, the shear strength of the silty clay till was 90 to 99 kPa, indicating a stiff to very stiff consistency. It is noted that the shear strength values generally increased with depth.

5.5 Silt Till

A 4.7 to 7.3 m thick silt till stratum was contacted below the clay till at depths of 25.3 to 25.8 m (elevation 50.3 to 51.0) and extended to 30.0 to 32.6 m (elevation 43.6 to 46.2). This material extended to the borehole termination depths of 30.6, 31.9 and 32.0 m, (elevation 45.7, 44.4 and 44.1) in Boreholes 1, 3 and 10, respectively. SPT N values generally ranging from 100 blows over 100 mm to 100 blows over 250 mm were noted within this material, indicating a very dense/hard density. The silt till was typically clayey in the upper potion, becoming sandier with depth.

The results of grain size analysis of Sample BH4 SS16 (2% gravel, 8% sand, 55% silt and 35% clay) indicate a clayey composition. The plastic limit, liquid limit and plasticity index values were 29%, 16% and 13%, respectively. The results of Atterberg and grain size analysis on Sample BH8 SS15 indicate a non–plastic sandy composition (25% gravel, 25% sand, 45% silt and 5% clay).

The grain size and Atterberg results are shown on Figures A4 and A8, appended.

5.6 Silt Till/Shale Complex

Silt till/shale complex was contacted below the silt till deposit at depths ranging from 30.0 to 32.6 m (elevation 43.6 to 46.2). This material generally consisted of silt till with variable amounts of sand, gravel, and shale fragments and represents the transition between the overlying till deposits and the underlying weathered shale bedrock. Boreholes 2, 4, 5, 7 to 9 and 11 were terminated within this material at 30.4 to 33.4 m depth (elevation 42.8 to 45.8).

SPT N values measured within the till/shale complex were typically 100 blows per 50 mm of penetration, suggesting that this material is very dense.

6. ENGINEERING DISCUSSION AND RECOMMENDATIONS

It is understood that the Randle Reef remediation project is to consist of in situ containment of the areas with the highest contaminant concentrations, within an engineered containment facility. The containment facility is to be located north of Piers 14 and 15 and west of Pier 16 (U.S. Steel) in Hamilton, Ontario.

Current conceptual design calls for an ECF having an approximate area of 18.6 acres (7.5 hectares) with a proposed mixed end use of marine terminal operations, light industrial use and/or naturalized areas.

The design of the ECF calls for the installation of a double sheet pile wall system where the outer wall will serve as a structural wall anchored by the inner sheet pile wall which will also act as an impermeable barrier to contamination migration.

The purpose of the current geotechnical investigation was to supplement the information from the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports with additional boreholes and laboratory testing data to provide further coverage of the engineered containment facility.

The subsurface stratigraphy revealed in the boreholes by AMEC typically comprised “slag and heterogeneous fill along existing docks over a layer of organics and recent soft sediments over shallow silt deposits overlying silty clay to clayey silt (Upper Silty Clay) underlain by clayey silt (Lower Clayey Silt) over clayey silt till overlying assumed shale bedrock” (AMEC, 2004, pg. 22).

The subsurface stratigraphy revealed in the boreholes during this investigation typically comprised sediment over silt, underlain by clay overlying clay till, over silt till grading to silt till/shale complex. It is noted that the silt layer ranged in thickness from 0.7 to 1.9 m in Boreholes 4 and 6 to 8 and from 5.0 to 9.0 m in Boreholes 1, 5, and 9 to 11.

It is noted that the clay stratum is referred to as “upper silty clay” in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports and the clay till stratum is referred to as “lower clayey silt” and “lower silty clay” in the AMEC (2004) and ARCADIS (2006, 2007, 2010, 2011) reports, respectively. It is also noted that slag was not contacted during the course of this investigation. In addition, the thicker silt layer contacted in Boreholes 1, 5, and 9 to 11 was not revealed in the AMEC report.

Other than the exceptions noted above, the subsurface stratigraphies revealed in the AMEC investigation and during this investigation are generally consistent.

We trust the information presented in this report is sufficient for your present purposes. If you have any questions, please do not hesitate to contact our office.

Sincerely

Peto MacCallum Ltd.

Karel Furbacher, BEng.
Project Supervisor

Matthew D. St Denis, P.Eng.
Senior Engineer, Geotechnical Services

Brian R. Gray, MEng, P.Eng.
Principal Consultant

KF:lad

References

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M2605; Quaternary Geology, Hamilton, Southern Ontario; Ministry of Natural Resources; 1983; Scale: 1:50 000.

M2336; Paleozoic Geology, Hamilton, Southern Ontario; Ontario Division of Mines, 1975; Scale: 1:50 000.

M2033; Pleistocene Geology of the Hamilton Area, Southern Ontario; Ontario Department of Mines, 1962; Scale: 1:63,360.

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:

CONSISTENCY	N (blows/0.3 m)	c (kPa)	DENSENESS	N (blows/0.3 m)
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		

WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample		

PH	Sample Advanced Hydraulically
PM	Sample Advanced Manually

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

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LOG OF BOREHOLE NO. 1

METRIC

17T 0594696E
4791663N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 4 & 5, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Barge					
	BARGE					
74.9 / 1.4	WATER					
69.3 / 7.0	SEDIMENT					
68.1 / 8.2	SILT: Very loose to loose, grey sandy organic silt, trace clay and gravel, saturated; with occasional shell fragments		1	SS	2	
			2	SS	2	
66.8 / 9.5	with trace sand and clay; with inclusions of shell fragments, occasional peat, rootlets and decayed wood and plant matter		3	SS	2	
66.1 / 10.2	becoming brown, some sand; with black staining		4	SS	3	
65.3 / 11.0	becoming greenish grey, some sand and clay, occasional shell fragments and organics		5	SS	2	
			6	SS	3	
63.8 / 12.5	with numerous shell fragments, peat and decayed wood fragments		7	SS	5	
			8	SS	3	
62.3 / 14.0	becoming some clay to clayey		9	SS	4	
61.3	Cont'd					

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

ELEVATION SCALE: 76 75 74 73 72 71 70 69 68 67 66 65 64 63 62

	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
○		
63		Non Plastic 1 28 67 4 G_s = 2.669
107		
71		
82		Non Plastic 1 12 73 14 G_s = 2.400
145		
144		
200	Org. 14%	

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:11:52 PM

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 1

METRIC

17T 0594696E
4791663N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 4 & 5, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
61.3 / 15.0	SILT: Very loose, grey silt, some clay to clayey, saturated; occasional organics		10	SS	5
			11A	SS	
60.3 / 16.0	CLAY: Soft to firm, grey silty clay, trace sand, low plastic, WTPL		11B	SS	1
			12	TW	PH
			13	SS	4
				FV	
58.4 / 17.9	CLAY TILL: Very stiff, grey silty clay till, trace to some sand, trace gravel, low plastic, WTPL; occasional shale fragments		14	TW	PH
			15	SS	18
			16	SS	25
			17	SS	29
50.5 / 25.8	SILT TILL: Very dense, reddish brown sandy silt till, trace clay and gravel, damp, with layers of grey clayey silt; occasional shale fragments		18	SS	99/250mm
48.2 / 28.1	becoming grey silt till, some sand, trace gravel, damp		19	SS	90/275mm
46.3	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT kN/m³: 154, 69, 20.5

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
High field vane value likely due to silt seams
Qu

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 1

METRIC

17T 0594696E
4791663N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 4 & 5, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (O Qu, O Q, ⊕ Qcu, + FIELD VANE; ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST ×/●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.3							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Hard, reddish brown and grey mottled clayey silt till, some sand to sandy, trace to some gravel, DTPL, with 25 mm silt layer midspoon		20	SS	99/250mm	46	>>▲	○		
45.7										
30.6	BOREHOLE TERMINATED AT 30.6 m									Upon completion, borehole fully grouted

31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:11:52 PM

+7 Number refers to sensitivity

20
15 ○ 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

METRIC

17T 0594533E
4791761N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 5 & 6, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Barge						
	BARGE						
74.9 / 1.4	WATER						
66.5 / 9.8	SEDIMENT						
65.0 / 11.3	CLAY: Very soft to soft, grey silty clay, trace sand, low plastic, WTPL		1	SS	1		
			2	TW	PH	18.9	Qu Poor recovery due to silt seams
			3	SS	4		
				FV			
62.9 / 13.4	becoming firm to stiff, trace gravel		4	TW	PH	20.3	Q 2 6 50 42 G_s = 2.745
			5	SS	13		
				FV			
61.3	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

ELEVATION SCALE: 76 75 74 73 72 71 70 69 68 67 66 65 64 63 62

1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

METRIC

17T 0594533E
4791761N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 5 & 6, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.3 / 15.0	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL	6	TW	PH	20.8	Qu, C; G_s = 2.769
		7	SS	15		
			FV			
		8	SS	18		1 6 50 43; G_s = 2.736
		9	SS	11		
57.4 / 18.9	with some sand	10	SS	11		
55.8 / 20.5	CLAY TILL: Hard, grey silty clay till, trace to some sand, trace gravel, low plastic, DTPL to WTPL; occasional shale fragments	11	SS	39		
		12	SS	32		
50.5 / 25.8	SILT TILL: Hard, grey clayey silt till, some sand, trace gravel, slightly plastic, DTPL, with layers of grey silt; occasional shale fragments	13	SS	61		
48.2 / 28.1	with inclusions of shale fragments					
46.3	Cont'd					

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

ELEVATION SCALE: 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:11:57 PM

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

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LOG OF BOREHOLE NO. 2

METRIC

17T 0594533E
4791761N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 5 & 6, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

SOIL PROFILE			SAMPLES				SHEAR STRENGTH kPa			
ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	○ Qu ◘ Q ⊕ Qcu + FIELD VANE; ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION ×; STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.3							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Hard, grey clayey silt till, some sand, trace gravel, slightly plastic, DTPL; inclusions of shale fragments		14	SS	84/275mm	46	>>	○		
31.0						45				
44.4										
32.0 31.9	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp					44				
33.0 42.9			15	SS	100/175mm	43	>>	○		
33.4	BOREHOLE TERMINATED AT 33.4 m									Upon completion, borehole fully grouted
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

17T 0594470E
4791817N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 9 & 10, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Barge						
	BARGE						
74.9 / 1.4	WATER						
65.7 / 10.6	SEDIMENT						
64.9 / 11.4	CLAY: Very soft to soft, grey silty clay, trace sand, low plastic, WTPL		1	SS	2		
			2	TW	PH	19.4	Qcu
			3	SS	4		
				FV			
62.9 / 13.4	becoming firm, trace gravel, with partings of silt		4	TW	PH	19.0	Qu, C G_s = 2.745
			5	SS	5		
				FV			
61.3	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:02 PM

+7 Number refers to sensitivity
15 (20 / 10) 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

17T 0594470E
4791817N

2 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 9 & 10, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.3 / 15.0	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL		6	TW	PH		No recovery
			7	SS	5		
				FV			
			8	TW	PH		No recovery
			9	SS	13		
				FV			
58.3 / 18.0	with some sand		10	TW	PH	20.3	Qu 1 8 49 42 G_s = 2.769
			11	SS	13		
				FV			
			12	TW	PH		No recovery
			13	SS	10		
				FV			Attempted vane shear at 20.4 m. Unable to turn vane
55.3 / 21.0	CLAY TILL: Hard, greyish brown silty clay till, trace sand and gravel, low plastic, WTPL; occasional shale fragments		14	SS	25		
			15	SS	28		8 6 53 33 G_s = 2.742
50.5 / 25.8	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL, with layers of grey silt; occasional shale fragments		16	SS	47		
48.2 / 28.1	with reddish brown silt lenses		17	SS	98/225mm		
46.3	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

ELEVATION SCALE: 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47

DEPTH SCALE: 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

17T 0594470E
4791817N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 9 & 10, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH kPa / DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		○ Qu ◘ Q ⊕ Qcu + FIELD VANE ▲/△ POCKET PENETROMETER/TORVANE; 50 100 150 200; DYNAMIC CONE PENETRATION ×; STANDARD PENETRATION TEST ●; 20 40 60 80	w_P w w_L; 10 20 30 40		GR SA SI CL
46.3										
30.0	SILT TILL: Very dense, reddish brown sandy silt till, some gravel, trace clay, damp; occasional shale fragments		18	SS	50/125mm	46	>>			
31.0						45				
44.4			19	SS	100/100mm		>>	○		
31.9	BOREHOLE TERMINATED AT 31.9 m									Upon completion, borehole fully grouted

32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:03 PM

+7 Number refers to sensitivity

20
15 ○ 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 4

METRIC

17T 0594504E
4791913N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 10 & 11, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Barge						
	BARGE						
74.9 / 1.4	WATER						
66.7 / 9.6	SEDIMENT						
64.9 / 11.4	SILT: Loose brown silt, some sand, trace clay, saturated; with black staining		1A	SS	9		
11.6			1B	SS			
11.9	becoming, clayey, trace sand, WTPL		2	SS	24		
63.8 / 12.5	becoming grey and brown mottled, with partings of silt		3	SS	24		
	CLAY: Very stiff, brownish grey to grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		4	TW	PH	20.4	Qu, Q
			5	SS	28		
61.3	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

ELEVATION SCALE: 76 75 74 73 72 71 70 69 68 67 66 65 64 63 62

1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 4

METRIC

17T 0594504E
4791913N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 10 & 11, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.3 / 15.0	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL		6	TW	PH	19.2	Qu, C 0 2 50 48 G_s = 2.757
			7	SS	5		
				FV			
			8	TW	PH		No recovery
			9	SS	9		
				FV			
			10	TW	PH	19.9	
			11	SS	7		
				FV			
			12	TW	PH	19.3	Qcu
			13	SS	9		
				FV			Attempted vane shear at 20.4 m. Unable to turn vane
55.3 / 21.0	CLAY TILL: Hard, grey silty clay till, some sand, trace gravel, low plastic, DTPL to WTPL; occasional shale fragments		14	SS	56		
			15	SS	94/300mm		
51.0 / 25.3	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL, with layers of grey silt; occasional shale fragments		16	SS	41		2 8 55 35 G_s = 2.739
49.7 / 26.6	becoming reddish brown		17	SS	53		
46.3	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:08 PM

+7 Number refers to sensitivity
15 (20 / 10) 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 4

METRIC

17T 0594504E
4791913N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 10 & 11, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH kPa / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		○ Qu ◘ Q ⊕ Qcu + FIELD VANE; ▲/△ POCKET PENETROMETER/TORVANE (50 100 150 200); DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST × ● (20 40 60 80); PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) (10 20 30 40)	kN/m³	GR SA SI CL
46.3									
30.0	SILT TILL: Very dense, reddish brown sandy silt till, some gravel, trace clay, damp; occasional shale fragments		18	SS	100/100mm	46	>> ● ○		
45.3									
31.0	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp					45			
44.4			19	SS	100/0mm and bouncing		>> ●		
32.0 31.9	BOREHOLE TERMINATED AT 31.9 m								Upon completion, borehole fully grouted
33.0									
34.0									
35.0									
36.0									
37.0									
38.0									
39.0									
40.0									
41.0									
42.0									
43.0									
44.0									
45.0									

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 5

METRIC

17T 0594570E
4791937N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 16, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	NUMBER	TYPE	"N" VALUES
76.2	Barge			
	BARGE			
74.8 / 1.4	WATER			
67.5 / 8.7	SEDIMENT			
8.8	SILT: Compact, brown fine sandy silt, saturated, with pockets of sand; with black staining	1	SS	21
		2A	SS	
66.3 / 9.9	becoming stiff, greyish brown, some clay to clayey, trace sand, WTPL, with layers of sand and silt	2B	SS	12
		3	SS	18
		4	SS	18
64.5 / 11.7	becoming brown	5	SS	14
62.7 / 13.5	becoming grey and brown mottled, with partings of silt	6A	SS	
		6B	SS	14
13.8	CLAY: Firm, grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt	6C	SS	
			FV	
61.2	Cont'd			

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

0 4 81 15
G_s = 2.733

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 5

METRIC

17T 0594570E
4791937N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 16, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.2 / 15.0	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		7	TW	PH	19.1	Qcu
			8	SS	8		
				FV			
			9	TW	PH	19.4	Qu, C 0 4 47 49 G_s = 2.768
			10	SS	8		
				FV			
			11	TW	PH	21.7	Qu
			12	SS	11		
				FV			
			13	TW	PH		No recovery
			14	SS	16		
55.3 / 20.9	CLAY TILL: Hard, grey silty clay till, some sand, trace gravel, low plastic, DTPL to APL; occasional shale fragments		15	SS	32		
			16	SS	36		
50.9 / 25.3	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL, with layers of grey silt; occasional shale fragments		17	SS	74/300mm		
48.1 / 28.1	becoming very dense, reddish brown sandy silt till, some gravel, trace clay, damp, with layer of grey to reddish brown silt; occasional shale fragments		18	SS	98/225mm		
46.2	Cont'd						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

+7 Number refers to sensitivity
15 (20 / 10) 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 5

METRIC

17T 0594570E
4791937N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 16, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (O Qu, O Q, ⊕ Qcu, + FIELD VANE; ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.2 30.0 45.8 30.4	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp		19	SS	100/50mm	46	>>	○		Upon completion, borehole fully grouted
	BOREHOLE TERMINATED AT 30.4 m									

31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:15 PM

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 6

METRIC

17T 0594681E
4791955N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 11 & 12, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
76.2	Barge					76
	BARGE					
1.0						75
74.8 1.4	WATER					
2.0						74
3.0						73
4.0						72
5.0						71
6.0						70
7.0						69
8.0						68
9.0						67
10.0 66.0 10.2	SEDIMENT					66
65.4 10.8 11.0	SILT: Compact, black sandy silt, saturated; with oily sheen		1A 1B	SS SS	 14	65
64.6 11.6	becoming brown, some sand; with black staining					
12.0	becoming sandy, grey, saturated, with layers of sand and clay		2	SS	25	64
63.7 12.5	CLAY: Very stiff, grey to greyish brown silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		3	SS	17	63
13.0			4	TW	PH	
14.0			5	SS	17	62
				FV		
15.0 61.2	Cont'd					

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

0 1 70 29
G_s = 2.738

21.4 Qu, Q

+7 Number refers to sensitivity
20 / 15 5 (%) STRAIN AT FAILURE / 10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 6

METRIC

17T 0594681E
4791955N

2 of 2

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 11 & 12, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
61.2 / 15.0	CLAY: Very stiff to hard, grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		6	TW	PH		No recovery
			7	SS	26		
			8	TW	PH	20.0	Qu
			9	SS	32		
			10	TW	PH	19.9	Qu, C 0 2 44 54 G_s = 2.727
			11	SS	13		
56.8 / 19.4				FV			Attempted vane shear at 18.9 m. Unable to turn vane
	CLAY TILL: Hard, grey silty clay till, some sand, trace gravel, low plastic, WTPL; occasional shale fragments		12	TW	PH	20.9	Qu, Q
			13	SS	32		
			14	SS	20		
			15	SS	65		
			16	WS			
50.0 / 26.2	BOREHOLE TERMINATED UPON PRACTICAL REFUSAL TO ADVANCE ON PROBABLE BOULDER AT 26.2 m						Upon completion, borehole fully grouted

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

ELEVATION SCALE: 61, 60, 59, 58, 57, 56, 55, 54, 53, 52, 51, 50

16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

+7 Number refers to sensitivity

20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 7

METRIC

17T 0594725E
4791912N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 13, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES
76.2	Barge				
	BARGE				
74.8 / 1.4	WATER				
65.5 / 10.7	SEDIMENT				
65.1 / 11.1	SILT: Compact, black sandy silt, saturated; with oily sheen		1A	SS	5
64.6 / 11.6	becoming brown, some sand; with black staining		1B	SS	
11.8	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		2	SS	7
			3	SS	7
			4	TW	PH
			5	SS	5
				FV	
61.2	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

19.6 Qu, C
G_s = 2.761

+7 Number refers to sensitivity
15 — 20 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 7

METRIC

17T 0594725E
4791912N

PROJECT Randle Reef Contaminated Sediment Remediation
PML PROJECT NO. 13HF033
LOCATION Hamilton Harbour, Hamilton
BORING DATE September 13, 2013
ENGINEER M. D. St. Denis
BORING METHOD NW Wash Boring
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
61.2						61
15.0	CLAY: Firm to stiff, grey silty clay, trace sand and gravel, low plastic, WTPL		6	TW	PH	
			7	SS	7	
				FV		
16.0						60
			8	TW	PH	
17.0			9	SS	8	59
				FV		
18.0						58
			10	TW	PH	
			11	SS	7	
19.0				FV		57
			12	TW	PH	
20.0			13	SS	6	
55.8						56
20.4	CLAY TILL: Very stiff, grey silty clay till, some sand, trace gravel, low plastic, WTPL; occasional shale fragments			FV		
21.0			14	SS	27	55
22.0						54
23.0						53
24.0						52
			15	SS	28	
25.0						51
50.9						
25.3	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments					
26.0						50
27.0						49
			16	SS	23	
28.0						48
47.2						
29.0	becoming very dense, reddish brown sandy silt till, some gravel, trace clay, damp; occasional shale fragments					47
46.2	Cont'd					
30.0						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	No recovery
	No recovery
19.5	Qu 1 2 54 43 G_s = 2.722
	No recovery
	2 11 54 33 G_s = 2.752

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:24 PM

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 7

METRIC

17T 0594725E
4791912N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 13, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ Qu ◘ Q ⊕ Qcu + FIELD VANE ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST ×/●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.2							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Very dense, reddish brown sandy silt till, some gravel, trace clay, damp; occasional shale fragments		17	SS	100/100mm	46	>●	○		
31.0						45				
32.0						44				
43.6										
32.6	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp									
33.0			18	SS	100/0mm	43	>●			
42.8										
33.4	BOREHOLE TERMINATED AT 33.4 m				and bouncing					Upon completion, borehole fully grouted
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

METRIC

17T 0594779E
4791893N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 19 & 20, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
76.2	Barge					76
	BARGE					
1.0						
74.8						75
1.4	WATER					
2.0						74
3.0						73
4.0						72
5.0						71
6.0						70
7.0						69
8.0						68
9.0						67
10.0						66
65.8						
10.4	SEDIMENT					
11.0						65
65.1						
11.1	SILT: Loose, black and brown mottled silt, saturated, with pockets of grey clay, occasional decayed wood fragment		1A	SS	5	
64.6						
11.6	becoming greenish grey clayey silt, trace sand, WTPL; with black staining		2A	SS		
64.1			2B	SS	18	
12.0			2C	SS		64
12.1						
12.2	becoming brown, with bluish grey fissures and iron staining		3A	SS	39	
63.2						
13.0	brown silt, trace to some sand, damp, with iron staining		3B	SS		
13.0	CLAY: Firm, grey silty clay, trace sand and gravel, low plastic, WTPL, with partings of silt		4	SS	6	63
14.0				FV		
14.0						62
61.2	Cont'd					
15.0						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

51

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

METRIC

17T 0594779E
4791893N

2 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 19 & 20, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
61.2 / 15.0	CLAY: Firm, grey silty clay, trace sand and gravel, low plastic, WTPL, with 25 to 50 mm sand seams		5	TW	PH
			6	SS	6
				FV	
			7	TW	PH
			8	SS	13
				FV	
			9	TW	PH
57.7 / 18.5	CLAY TILL: Very stiff, grey silty clay till, some sand, trace gravel, low plastic, WTPL; occasional shale fragments		10	SS	23
			11	SS	28
			12	SS	47
			13	SS	28
50.9 / 25.3	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments		14	SS	36
47.2 / 29.0	becoming very dense, reddish brown sandy silt till, some gravel, trace clay, damp; inclusions of shale fragments				
46.2	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT kN/m³: 20.0

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
Qcu	0	4	53	43

$G_s = 2.752$

No recovery

No recovery

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:29 PM

+7 Number refers to sensitivity

20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

METRIC

17T 0594779E
4791893N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 19 & 20, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ Qu ◘ Q ⊕ Qcu + FIELD VANE ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST ●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.2							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Very dense, reddish brown silt till, some sand and gravel, trace clay, damp; occasional shale fragments		15	SS	100/200mm	46				Non Plastic 25 25 45 5 G_s = 2.689
31.0						45				
32.0			16	SS	100/125mm	44				
43.6										
32.6	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy gravely silt till/shale complex, some clay, damp									
33.0										
42.8			17	SS	100/25mm and bouncing	43				
33.4	BOREHOLE TERMINATED AT 33.4 m									Upon completion, borehole fully grouted
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 9

METRIC

17T 0594804E
4791838N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 23, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
76.2	Barge					76
	BARGE					
74.8 / 1.4	WATER					75
						74
						73
						72
						71
						70
						69
						68
						67
						66
65.5 / 10.7	SEDIMENT		1A	SS	1	65
65.0 / 11.2	SILT: Very loose, brown silt, trace sand, saturated; with occasional shell fragments and rootlets, with black staining		1B 1C	SS SS		
64.5 / 11.7	becoming greyish brown		2	SS	1	64
63.7 / 12.5	becoming brown, some sand, trace clay		3	SS	3	
62.9 / 13.3	with trace sand, partings of sand and silt		4	SS	2	63
			5	SS	2	62
61.2	Cont'd					

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

73
92
54
72

Non Plastic
0 13 80 7
G_s = 2.627

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:34 PM

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 9

METRIC

17T 0594804E
4791838N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 23, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES
61.2 / 15.0	SILT: Very loose, grey silt, some clay to clayey, trace sand, saturated		6A	SS	2
			6B	SS	
60.7 / 15.5	with occasional to numerous shell fragments, decayed wood and plant matter and peat		7	SS	3
			8	SS	2
59.1 / 17.1	becoming greenish grey, with 5 to 10 mm grey silty clay seams		9	SS	1
58.4 / 17.8	becoming grey, black and brown mottled, with inclusions of peat		10	SS	2
57.6 / 18.6	becoming grey clayey silt, some sand, trace gravel, WTPL, occasional to numerous shell fragments, occasional decayed wood fragment and peat		11	SS	0*
56.5 / 19.7	becoming grey sandy silt, some clay, trace gravel, saturated, occasional shell fragments		12A	SS	0*
			12B	SS	
56.0 / 20.2	CLAY TILL: Very stiff, grey silty clay till, trace to some sand, trace gravel, low plastic, WTPL; occasional shale fragments		13	SS	32
			14	SS	22
			15	SS	28
50.4 / 25.8	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments		16	SS	82
46.2	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

* Weight of rods

* Weight of rods
3 37 44 16
G_s = 2.722

Org. 9%

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:34 PM

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 9

METRIC

17T 0594804E
4791838N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 23, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ Qu ◘ Q ⊕ Qcu + FIELD VANE ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST ● ×)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.2							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Hard, grey clayey silt till,									
45.8	trace sand and gravel, slightly plastic,		17A	SS		46				
30.4	DTPL; occasional shale fragments		17B	SS	100/150mm					
	becoming very dense, reddish brown sandy silt till, some gravel, trace clay, damp; inclusions of shale fragments					45				
31.0										
32.0			18	SS	100/175mm	44				
43.6										
32.6	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp									
33.0										
42.8			19	SS	100/100mm	43				
33.4	BOREHOLE TERMINATED AT 33.4 m									Upon completion, borehole fully grouted
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 10

METRIC

17T 0594773E
4791772N

1 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 25 & 26, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
76.1	Barge				
	BARGE				
74.7 / 1.4	WATER				
67.0 / 9.1	SEDIMENT		1	SS	0
			2	SS	0
64.5 / 11.6	SILT: Very loose, black, brown and grey mottled silt, trace sand and clay, saturated; with occasional shell fragments		3	SS	2
63.6 / 12.5	becoming brown, trace to some sand and clay, with occasional black banding		4	SS	2
			5	SS	3
61.9 / 14.2	becoming grey, some clay, trace sand		6	SS	2
61.1	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Non Plastic
0 4 81 15
G_s = 2.590

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:39 PM

+7 Number refers to sensitivity
20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 10

METRIC

17T 0594773E
4791772N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 25 & 26, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES
61.1 / 15.0	SILT: Very loose, grey silt, some clay to clayey, trace sand, saturated		7	TW	
			8	SS	1
			9	SS	3
				FV	
58.4 / 17.7	becoming greenish grey, with grey silty clay seams		10	TW	PH
57.6 / 18.5	becoming grey and black mottled, with occasional peat and decayed wood fragments		11	SS	5
				FV	
56.7 / 19.4	becoming grey, clayey, some sand, trace gravel, WTPL		12A	SS	10
56.4 / 19.7	becoming sandy, some clay, trace gravel, saturated, occasional shell fragments		12B	SS	
55.9 / 20.2	CLAY TILL: Very stiff, grey silty clay till, trace to some sand, trace gravel, low plastic, DTPL to WTPL		13A	SS	44
			13B	SS	
			14A	SS	46
			14B	SS	
50.3 / 25.8	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments		15	SS	38
46.1	Cont'd				

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
101	Org. 8%
98	
70	
16.6	Qu, C 0 7 55 38 G_s = 2.682

+7 Number refers to sensitivity
20 / 15 ○ 5 (%) STRAIN AT FAILURE / 10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 10

METRIC

17T 0594773E
4791772N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 25 & 26, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (O Qu, O Q, ⊕ Qcu, + FIELD VANE; ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.1							50 100 150 200 / 20 40 60 80	10 20 30 40		
30.0	SILT TILL: Very dense, reddish brown sandy silt till, some gravel, trace clay, damp; occasional shale fragments		16	SS	83/275mm	46	>>	○		
31.0						45				
44.1			17	SS	100/225mm		>>	○		
32.0	BOREHOLE TERMINATED AT 32.0 m									Upon completion, borehole fully grouted
33.0										
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 11

METRIC

17T 0594766E
4791709N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 24 & 25, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
76.2	Barge					76
	BARGE					
1.0						
74.8						75
1.4	WATER					
2.0						74
3.0						73
4.0						72
5.0						71
6.0						70
7.0						69
8.0						68
67.7						
8.5	SEDIMENT					67
9.0						
10.0						66
11.0						65
64.8						
11.4	SILT: Very loose, brown silt, trace sand, saturated; with black staining and black inclusions		1	SS	1	
12.0			2	SS	1	64
63.7						
12.5	becoming loose, black, brown and reddish brown mottled, some clay		3	SS	5	
13.0						63
62.9						
13.3	with trace to some clay		4	SS	5	
14.0						62
			5	SS	4	
61.2	Cont'd					
15.0						

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 11

METRIC

17T 0594766E
4791709N

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 24 & 25, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	NUMBER	TYPE	"N" VALUES
61.2 / 15.0	SILT: Loose, black, brown, grey and reddish brown mottled silt, trace to some clay, trace sand, saturated	6	SS	4
60.7 / 15.5	with layers of brown to black peat, decayed plant matter	7	SS	5
		8	SS	7
59.1 / 17.1	becoming greenish brown, inclusions of decayed wood and plant matter, occasional peat	9	SS	7
58.4 / 17.8	becoming grey, clayey, some sand, trace gravel, WTPL, occasional to numerous shell fragments, occasional decayed wood fragment and peat	10	SS	5
57.3 / 18.9	becoming sandy, some clay, trace gravel, saturated, occasional shell fragments	11A	SS	8
		11B	SS	
56.8 / 19.4	CLAY TILL: Very stiff, brown silty clay till, trace to some sand, trace gravel, low plastic, WTPL; occasional shale fragments	12	SS	46
56.0 / 20.2	becoming grey, APL, occasional cobble and boulder	13	SS	38
		14	SS	17
50.9 / 25.3	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments	15	SS	100/125mm
		16	SS	70
46.2	Cont'd			

SHEAR STRENGTH kPa
○ Qu ◘ Q ⊕ Qcu + FIELD VANE
▲/△ POCKET PENETROMETER/TORVANE
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Org. 22%

2 11 56 31
G_s = 2.720

PML - BH LOG GEO/ENV WITH MWS 13HF033 BOREHOLE LOGS 2013-09-10 KF.GPJ ON_MOT.GDT 1/29/2014 3:12:44 PM

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 11

METRIC

17T 0594766E
4791709N

3 of 3

PROJECT Randle Reef Contaminated Sediment Remediation
LOCATION Hamilton Harbour, Hamilton
BORING METHOD NW Wash Boring
BORING DATE September 24 & 25, 2013
PML PROJECT NO. 13HF033
ENGINEER M. D. St. Denis
TECHNICIAN K. Furbacher

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ Qu ◘ Q ⊕ Qcu + FIELD VANE ▲/△ POCKET PENETROMETER/TORVANE; DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST ● ×)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
46.2										
30.0	SILT TILL: Hard, grey clayey silt till, trace sand and gravel, slightly plastic, DTPL; occasional shale fragments					46				
45.8			17	SS	99/250mm					
30.4	becoming very dense, reddish brown sandy silt till, some gravel, trace clay, damp; inclusions of shale fragments					45				
31.0										
32.0			18	SS	100/150mm	44				
43.6										
32.6	SILT TILL/SHALE COMPLEX: Very dense, reddish brown sandy silt till/shale complex, some clay, trace gravel, damp									
33.0						43				
42.8			19	SS	100/100mm					
33.4	BOREHOLE TERMINATED AT 33.4 m									Upon completion, borehole fully grouted
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0										
41.0										
42.0										
43.0										
44.0										
45.0										

+7 Number refers to sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

HAMILTON HARBOUR

BH 14
EL. 76.2

BH 6
EL. 76.2

BH 5
EL. 76.2

BH 4
EL. 76.3

BH 7
EL. 76.2

BH 8
EL. 76.2

BH 13
EL. 76.3

BH 9
EL. 76.2

BH 3
EL. 76.3

BH 10
EL. 76.1

BH 2
EL. 76.3

PROPOSED ECF FOOTPRINT

BH 12
EL. 76.3

BH 11
EL. 76.2

BH 1
EL. 76.3

U.S. STEEL
(PIER 16)

PIER 15

LEGEND:

BH 11 EL. 74.8 PML B

BH 14 EL. 74.8 PML C

BH 7 EL. 74.8 PML B (BH/C

REFERENCE:

PLAN PRODUCED FR
SUPPLEMENTARY GE
ENGINEERING, DATE

NOTES:

1. THE LAKE WATER
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RIG
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PIER 15/16

Appendix A

Results of Laboratory Testing

Table A1 – Summary of Laboratory Testing Program

Table A2 – Summary of Index Properties

Table A3 – Unconfined Compression Test Results

Table A4 – Undrained Triaxial Test Results

Figures A1 to A4 – Grain Size Analyses

Figures A5 to A8 – Atterberg Limits

Figures A9 to A12 – Unconsolidated Undrained Triaxial Test Results

Figure A13 to A16 – Consolidation Test Results (One Cycle)

Figure A17 to A19 – Consolidation Test Results (Two Cycle)

TABLE A1

SUMMARY OF LABORATORY TEST PROGRAM

					Laboratory Test								
Borehole No.	**Sample Type**	**Sample No.**	**Depth (m)**	**Soil Type**	**Grain Size**	**Atterberg Limits**	**Specific Gravity**	**Organic Content**	**Consolidation (One Loading Cycle)**	**Consolidation (Two Loading Cycles)**	**Unconfined Uniaxial Compression**	**Undrained Triaxial**	**Consolidated Undrained Triaxial**
1	SS	2	8.8 – 9.25	Silt	✓	✓	✓						
	SS	5	11.1 – 11.55	Silt	✓	✓	✓						
	SS	9	14.2 – 14.65	Silt				✓					
	TW	14	18.0 – 18.45	Clay Till							✓		
2	TW	2	11.9 – 12.35	Clay							✓		
	TW	4	13.4 –13.85	Clay	✓	✓	✓					✓	
	TW	6	14.9 – 15.35	Clay						✓	✓		
	SS	8	16.5 – 16.95	Clay Till	✓	✓	✓						
3	TW	2	11.9 – 12.35	Clay									✓
	TW	4	13.4 – 13.85	Clay					✓		✓		
	TW	10	18.0 – 18.45	Clay	✓	✓	✓				✓	✓	
	SS	15	24.1 – 24.55	Clay Till	✓	✓	✓						
4	TW	4	13.4 – 13.85	Clay							✓	✓	
	TW	6	14.9 – 15.35	Clay	✓	✓	✓		✓		✓		
	TW	10	18.0 – 18.45	Clay							✓		
	TW	12	19.5 – 19.95	Clay									✓
	SS	16	25.6 – 26.05	Silt Till	✓	✓	✓						

TABLE A1

SUMMARY OF LABORATORY TEST PROGRAM

					Laboratory Test								
Borehole No.	**Sample Type**	**Sample No.**	**Depth (m)**	**Soil Type**	**Grain Size**	**Atterberg Limits**	**Specific Gravity**	**Organic Content**	**Consolidation (One Loading Cycle)**	**Consolidation (Two Loading Cycles)**	**Unconfined Uniaxial Compression**	**Undrained Triaxial**	**Consolidated Undrained Triaxial**
5	SS	3	10.4 – 10.85	Silt	✓	✓	✓						
	TW	7	14.9 – 15.35	Clay									✓
	TW	9	16.5 – 16.95	Clay	✓	✓	✓			✓	✓		
	TW	11	18.0 – 18.45	Clay							✓		
6	SS	3	12.6 – 13.05	Clay	✓	✓	✓						
	TW	4	13.4 – 13.85	Clay							✓	✓	
	TW	8	16.5 – 16.95	Clay							✓		
	TW	10	18.0 – 18.45	Clay	✓	✓	✓		✓		✓		
	TW	12	19.5 – 19.95	Clay Till							✓	✓	
7	TW	4	13.4 – 13.85	Clay						✓	✓		
	TW	10	18.0 – 18.45	Clay	✓	✓	✓				✓		
	SS	15	24.1 – 24.55	Clay Till	✓	✓	✓						
8	TW	5	14.9 – 15.35	Clay	✓	✓	✓						✓
	SS	15	30.2 – 30.65	Silt Till	✓	✓	✓						
9	SS	3	12.6 – 13.05	Silt	✓	✓	✓						
	SS	9	17.2 – 17.65	Silt				✓					
	SS	12B	19.65 – 19.95	Silt	✓	✓	✓						

TABLE A1

SUMMARY OF LABORATORY TEST PROGRAM

					Laboratory Test								
Borehole No.	**Sample Type**	**Sample No.**	**Depth (m)**	**Soil Type**	**Grain Size**	**Atterberg Limits**	**Specific Gravity**	**Organic Content**	**Consolidation (One Loading Cycle)**	**Consolidation (Two Loading Cycles)**	**Unconfined Uniaxial Compression**	**Undrained Triaxial**	**Consolidated Undrained Triaxial**
10	SS	6	14.5 – 14.95	Silt	✓	✓	✓						
	SS	8	15.4 – 15.85	Silt				✓					
	TW	10	18.0 – 18.45	Silt	✓	✓	✓		✓		✓		
11	SS	3	12.6 – 13.05	Silt	✓	✓	✓						
	SS	8	16.5 – 16.95	Silt				✓					
	SS	13	21.0 – 21.45	Clay Till	✓	✓	✓						
Total No. of Tests					22	22	22	4	4	3	17	5	4

TABLE A2
SUMMARY OF INDEX PROPERTIES

					Laboratory Test							
					Grain Size				Atterberg			Moisture Content (%)
Soil Unit	Borehole No.	Sample Type	Sample No.	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit	Plastic Limit	Plasticity Index	
Silt	1	SS	2	8.8 – 9.25	1	28	67	4	NP	NP	NP	63
	1	SS	5	11.1 – 11.55	1	12	73	14	NP	NP	NP	82
	5	SS	3	10.4 – 10.85	0	4	81	15	19	15	4	24
	9	SS	3	12.6 – 13.05	0	13	80	7	NP	NP	NP	54
	9	SS	12B	19.65 – 19.95	3	37	44	16	25	15	10	27
	10	SS	6	14.5 – 14.95	0	4	81	15	NP	NP	NP	96
	10	TW	10	18.0 – 18.45	0	7	55	38	70	42	28	42
	11	SS	3	12.6 – 13.05	0	6	81	13	NP	NP	NP	61
Clay	2	TW	4	13.4 –13.85	2	6	50	42	30	18	12	18
	2	SS	8	16.5 – 16.95	1	6	50	43	31	17	14	22
	3	TW	10	18.0 – 18.45	1	8	49	42	30	17	13	17
	4	TW	6	14.9 – 15.35	0	2	50	48	32	19	13	19
	5	TW	9	16.5 – 16.95	0	4	47	49	35	19	16	19
	6	SS	3	12.6 – 13.05	0	1	70	29	27	16	11	18
	6	TW	10	18.0 – 18.45	0	2	44	54	36	20	16	20
	7	TW	10	18.0 – 18.45	1	2	54	43	33	19	14	19
	8	TW	5	14.9 – 15.35	0	4	53	43	34	19	15	19
Clay Till	3	SS	15	24.1 – 24.55	8	6	53	33	29	17	12	20
	7	SS	15	24.1 – 24.55	2	11	54	33	28	16	12	18
	11	SS	13	21.0 – 21.45	2	11	56	31	27	16	11	16
Silt Till	4	SS	16	25.6 – 26.05	2	8	55	35	29	16	13	16
	8	SS	15	30.2 – 30.65	25	25	45	5	NP	NP	NP	9

TABLE A3

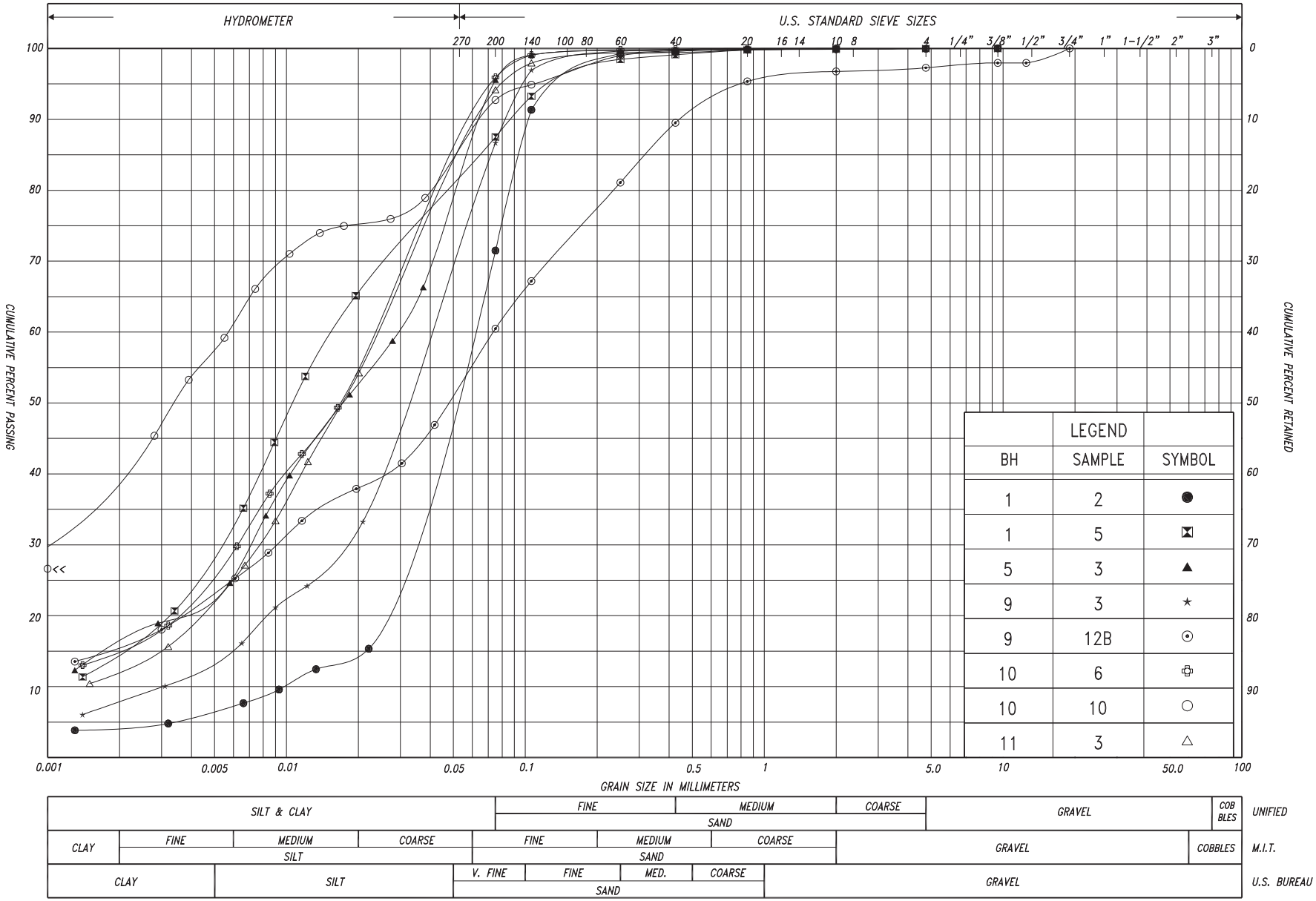
UNCONFINED COMPRESSION TEST RESULTS

Sample	Depth (m)	Soil Type	Undrained Shear Strength (kPa)
BH1 TW14	18.0 – 18.45	Clay Till	90.3
BH2 TW2	11.9 – 12.35	Clay	8.8
BH2 TW6	14.9 – 15.35	Clay	37.6
BH3 TW4	13.4 – 13.85	Clay	23.8
BH3 TW10	18.0 – 18.45	Clay	34.4
BH4 TW4	13.4 – 13.85	Clay	76.3
BH4 TW6	14.9 – 15.35	Clay	14.3
BH4 TW10	18.0 – 18.45	Clay	27.8
BH5 TW9	16.5 – 16.95	Clay	261.0
BH5 TW11	18.0 – 18.45	Clay	66.7
BH6 TW4	13.4 – 13.85	Clay	101.4
BH6 TW8	16.5 – 16.95	Clay	36.1
BH6 TW10	18.0 – 18.45	Clay	75.1
BH6 TW12	19.5 – 19.95	Clay Till	88.5
BH7 TW4	13.4 – 13.85	Clay	59.0
BH7 TW10	18.0 – 18.45	Clay	31.2
BH10 TW10	18.0 – 18.45	Silt	18.8

TABLE A4

UNDRAINED TRIAXIAL TEST RESULTS

Sample	Depth (m)	Soil Type	Undrained Shear Strength (kPa)
BH2 TW4	13.4 – 13.85	Clay	19.8
BH3 TW10	18.0 – 18.45	Clay	22.0
BH4 TW4	13.4 – 13.85	Clay	46.8
BH6 TW4	13.4 – 13.85	Clay	96.9
BH6 TW12	19.5 – 19.95	Clay Till	98.6



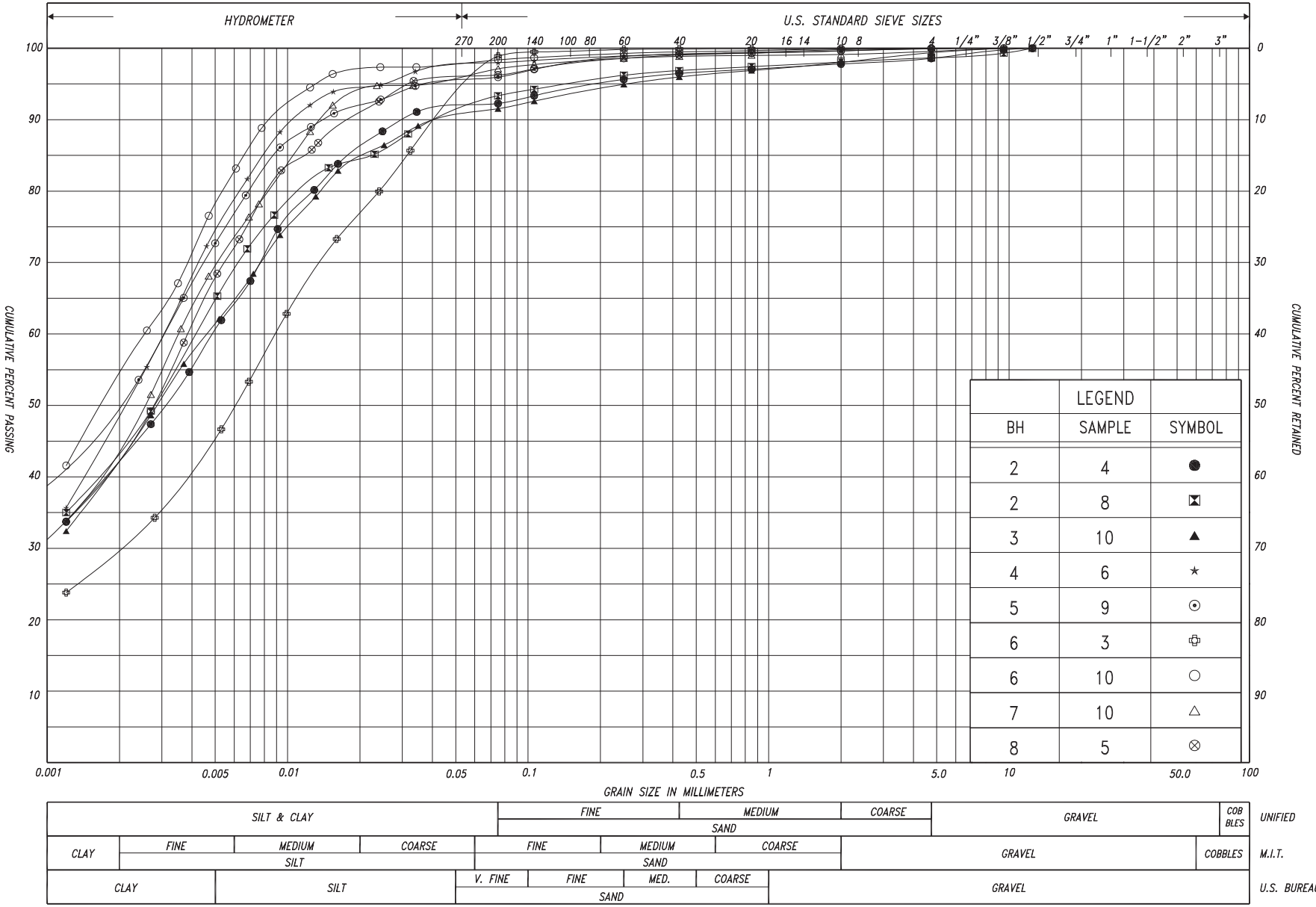
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILT

FIG No. A1

PROJECT No. 13HF033



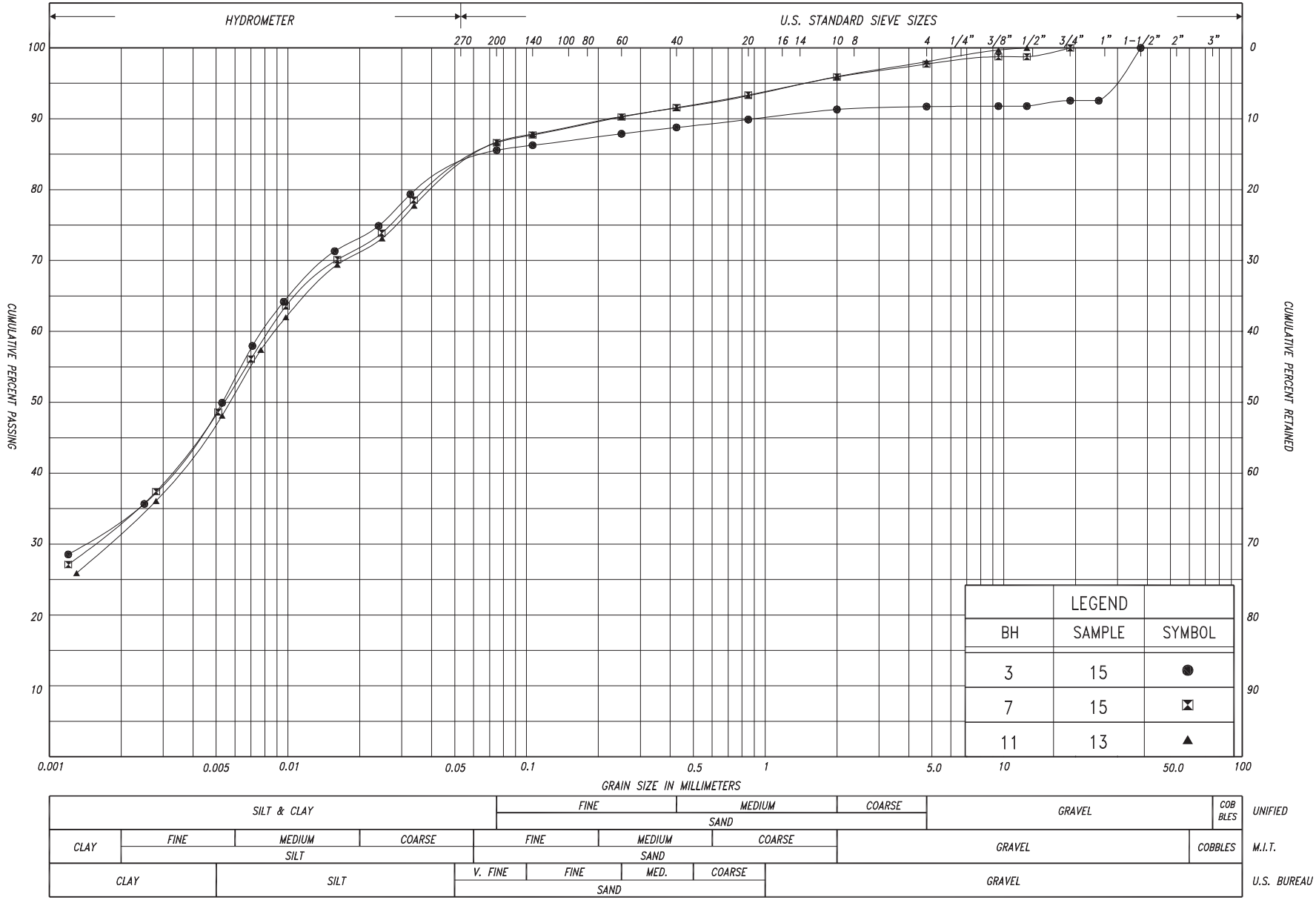
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAY

FIG No. A2

PROJECT No. 13HF033



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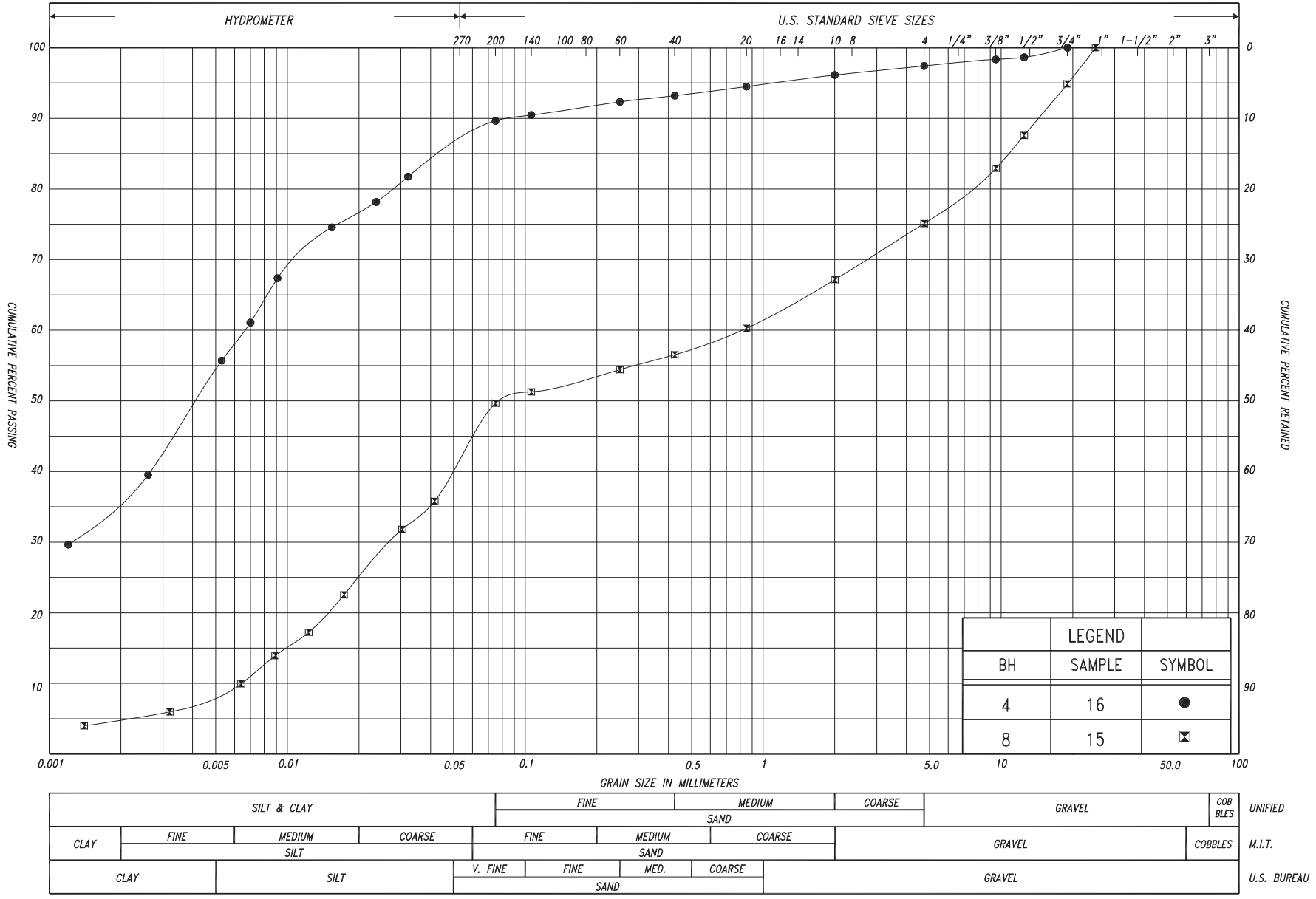
GRAIN SIZE DISTRIBUTION

CLAY TILL

FIG No. A3

PROJECT No. 13HF033



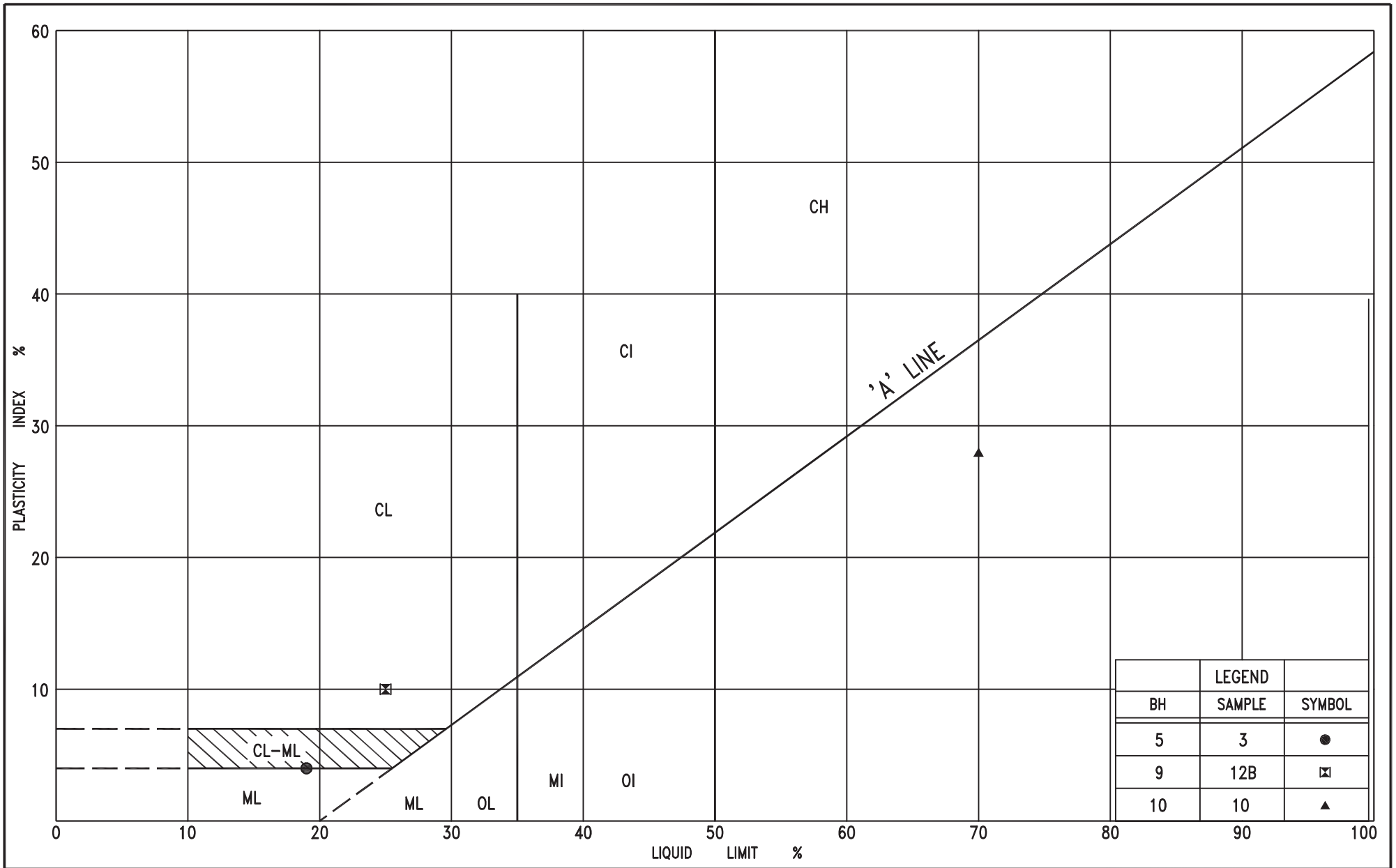
Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILT TILL

FIG No. A4

PROJECT No. 13HF033



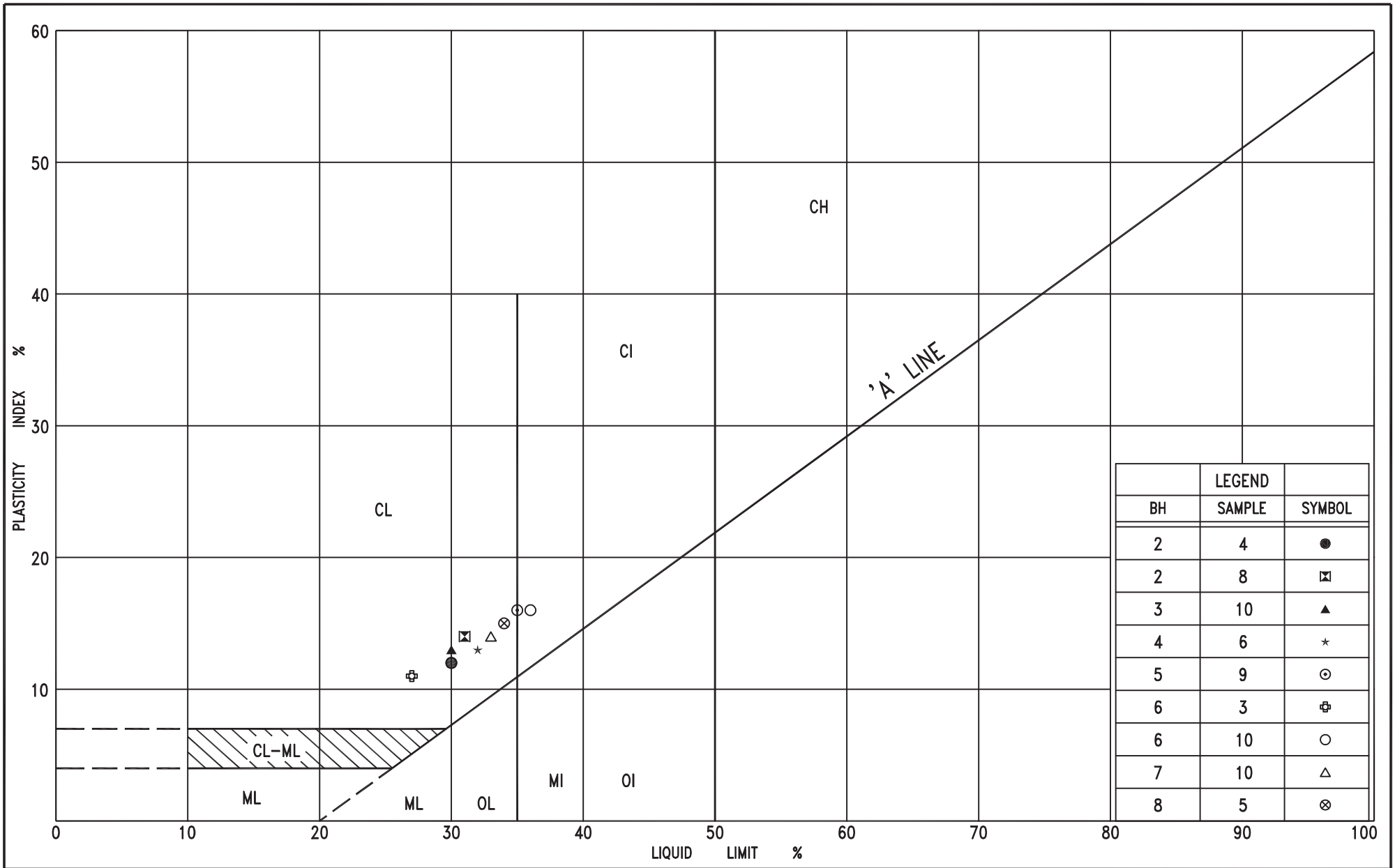
Peto MacCallum Ltd.
CONSULTING ENGINEERS

PLASTICITY CHART

SILT

FIG No. A5

PROJECT No. 13HF033



	LEGEND	
BH	SAMPLE	SYMBOL
2	4	●
2	8	⊠
3	10	▲
4	6	★
5	9	⊙
6	3	⊕
6	10	○
7	10	△
8	5	⊗

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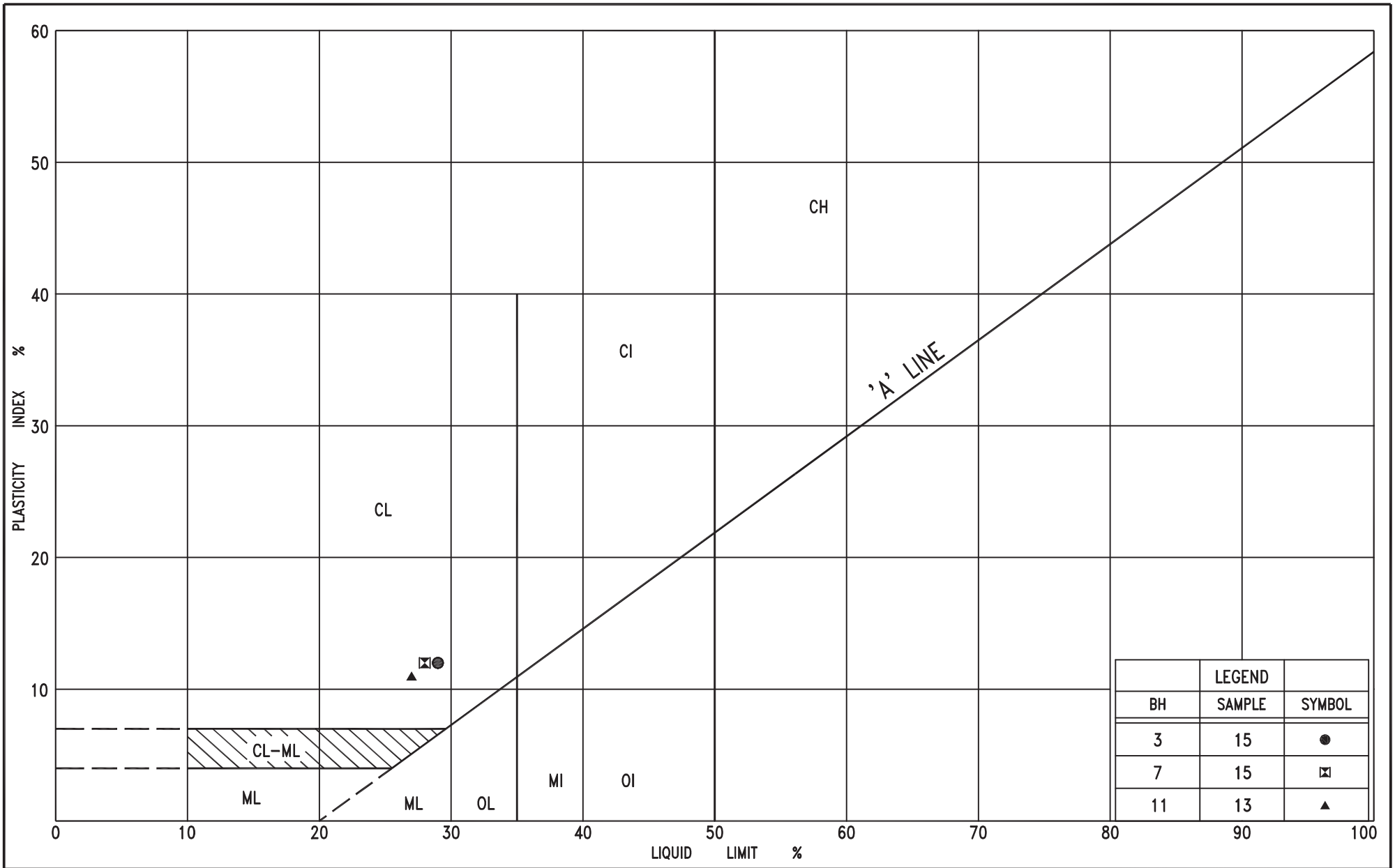
PLASTICITY CHART

CLAY

FIG No. A6

PROJECT No. 13HF033



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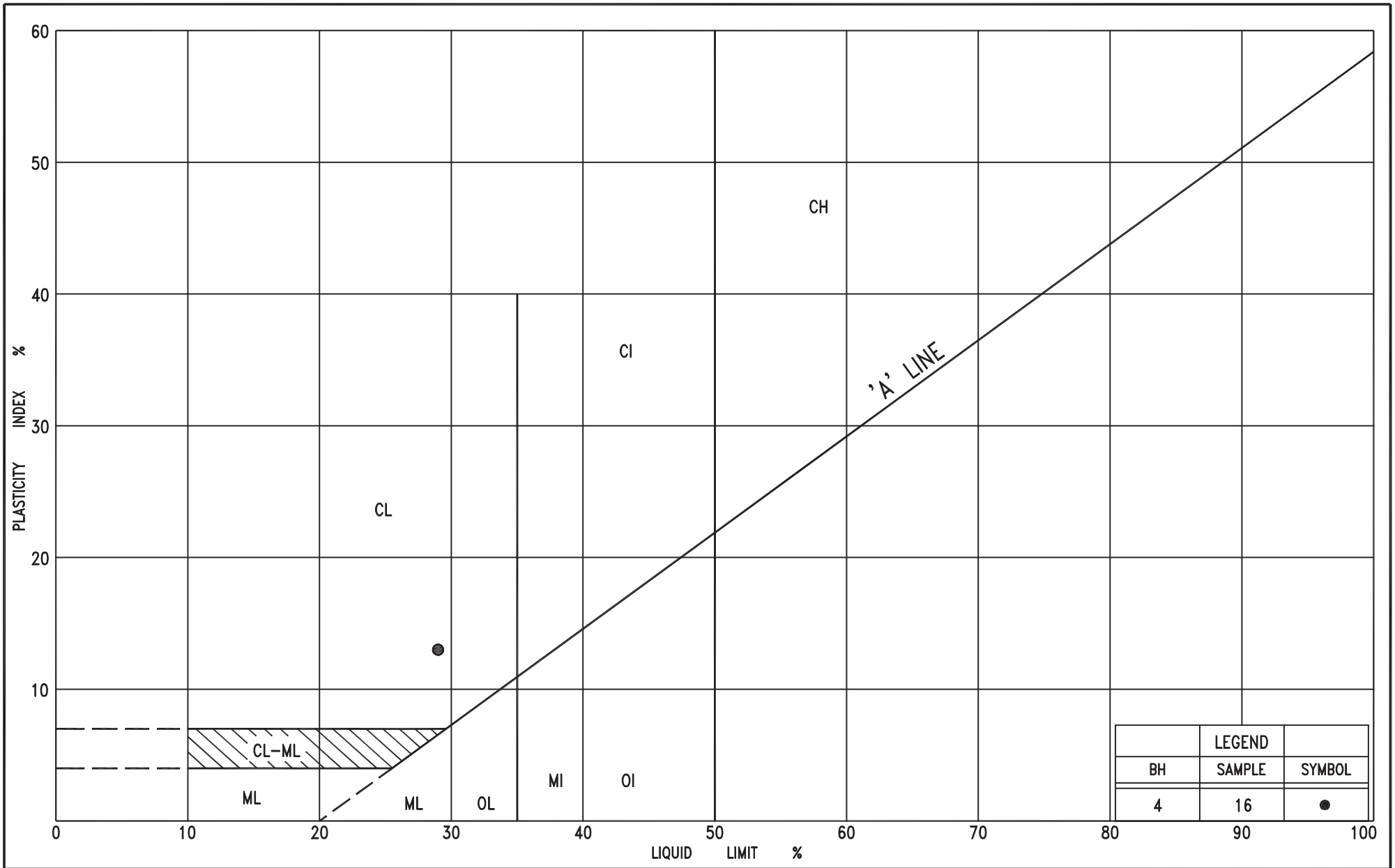
CONSULTING ENGINEERS

PLASTICITY CHART

CLAY TILL

FIG No. A7

PROJECT No. 13HF033



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PLASTICITY CHART

SILT TILL

FIG No. A8

PROJECT No. 13HF033

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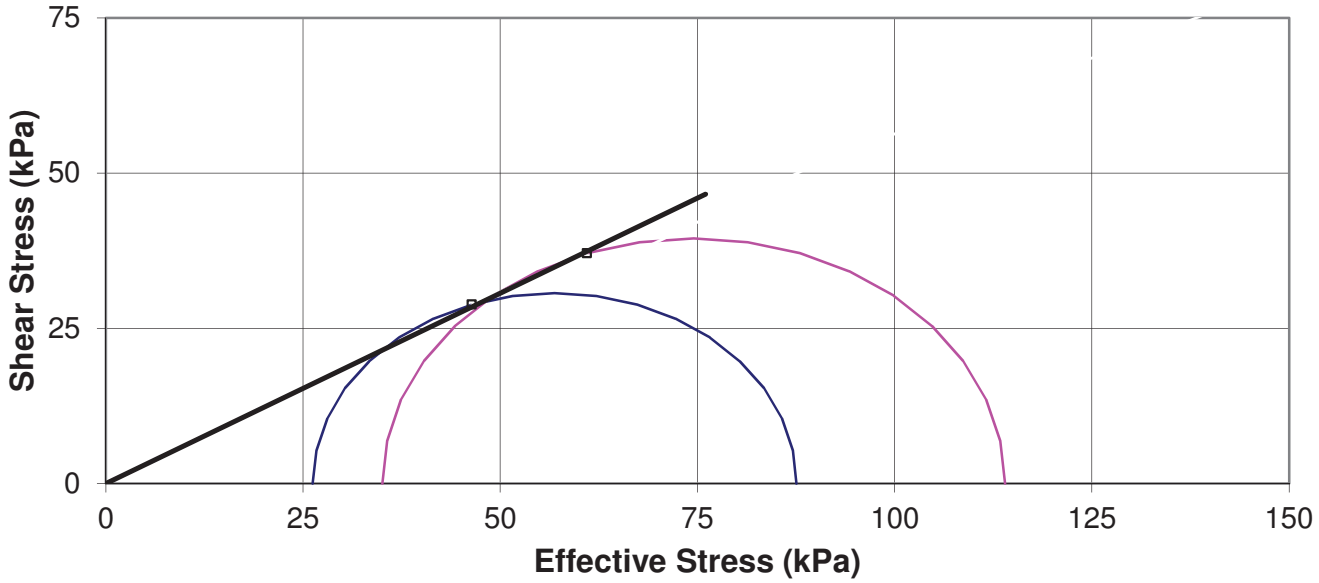
CONSULTING ENGINEERS

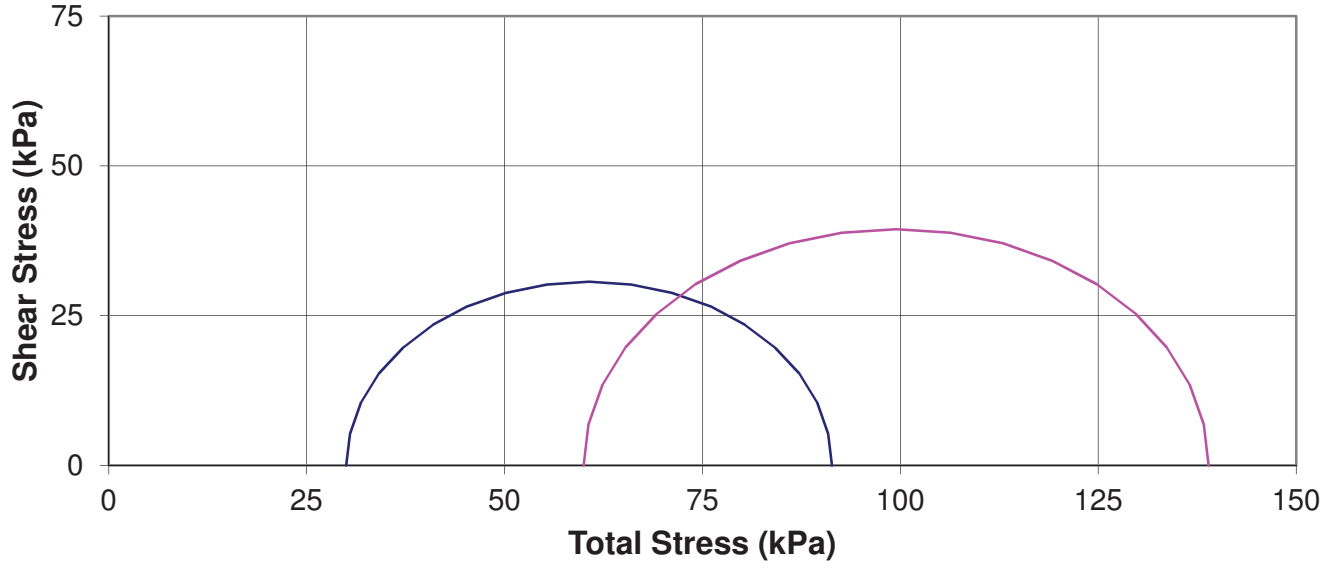
CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	3	*FIGURE*	A9
SAMPLE	2		
DEPTH	11.9 – 12.35 m		

Consolidated Undrained Triaxial - Effective Stress



Consolidated Undrained Triaxial - Total Stress

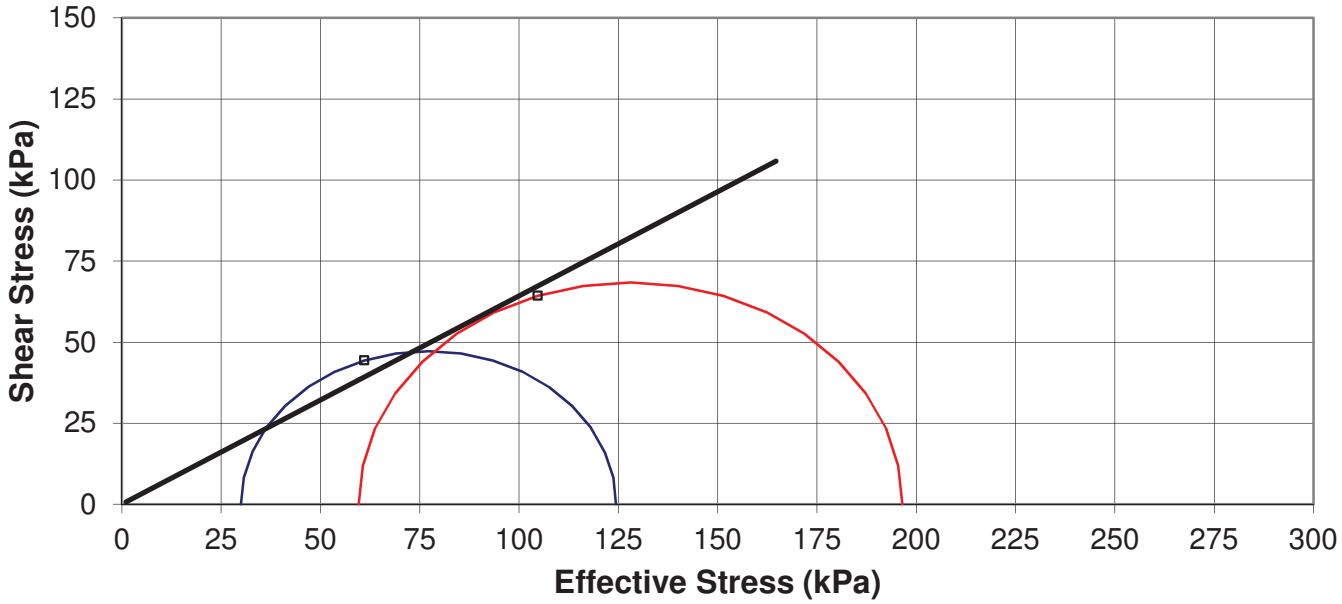


Peto MacCallum Ltd.
CONSULTING ENGINEERS

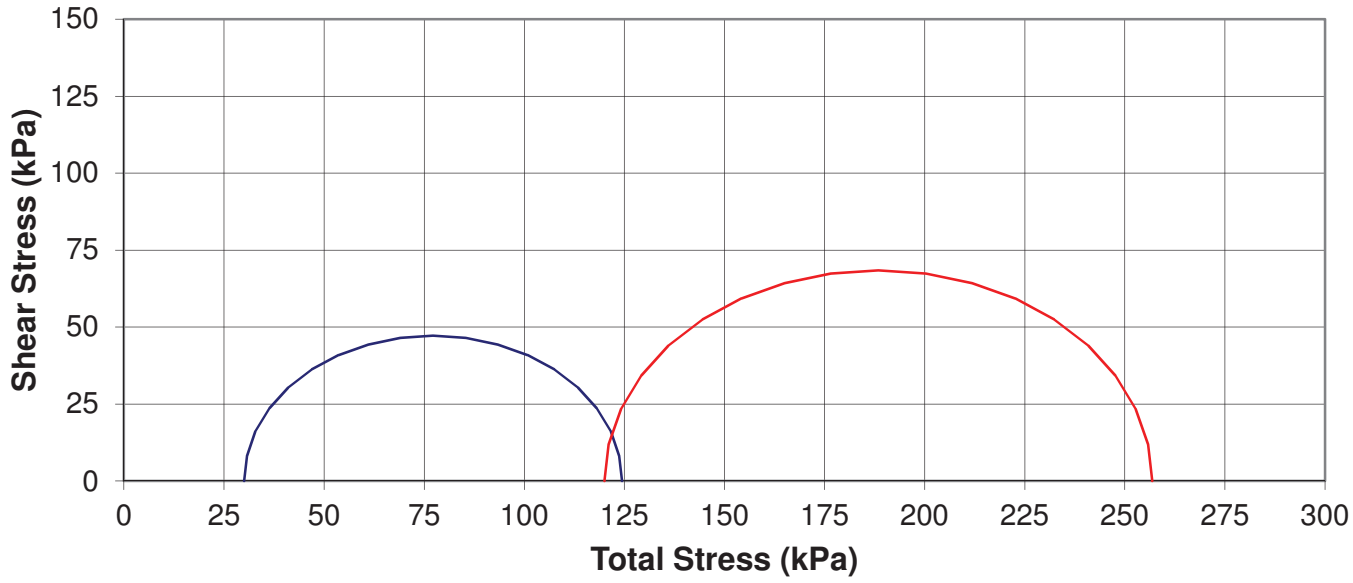
CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	4	*FIGURE*	A10
SAMPLE	12		
DEPTH	19.5 – 19.95 m		

Consolidated Undrained Triaxial - Effective Stress



Consolidated Undrained Triaxial - Total Stress



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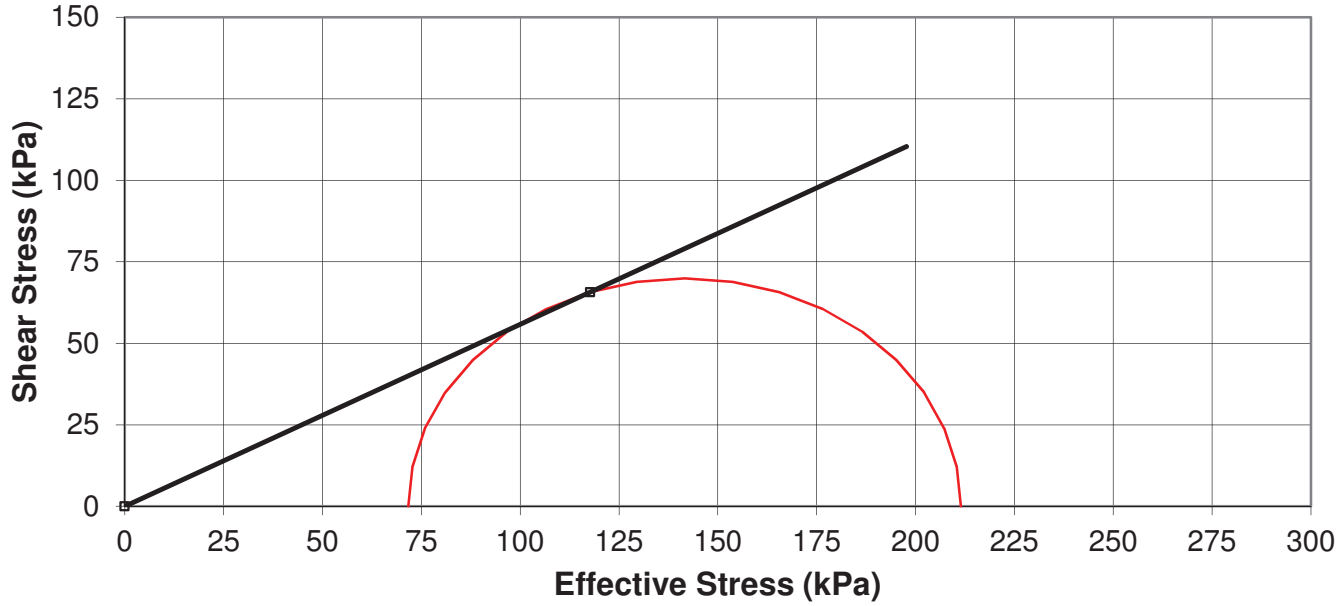
CONSULTING ENGINEERS

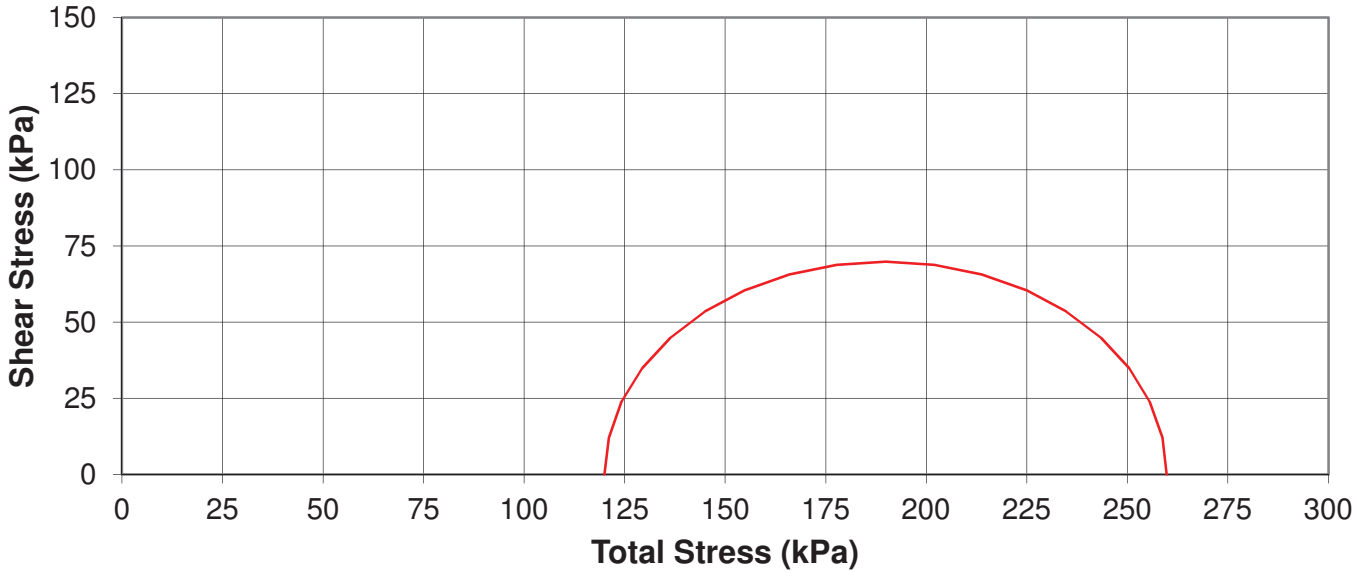
CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	5	*FIGURE*	A11
SAMPLE	7		
DEPTH	14.9 – 15.35 m		

Consolidated Undrained Triaxial - Effective Stress



Consolidated Undrained Triaxial - Total Stress



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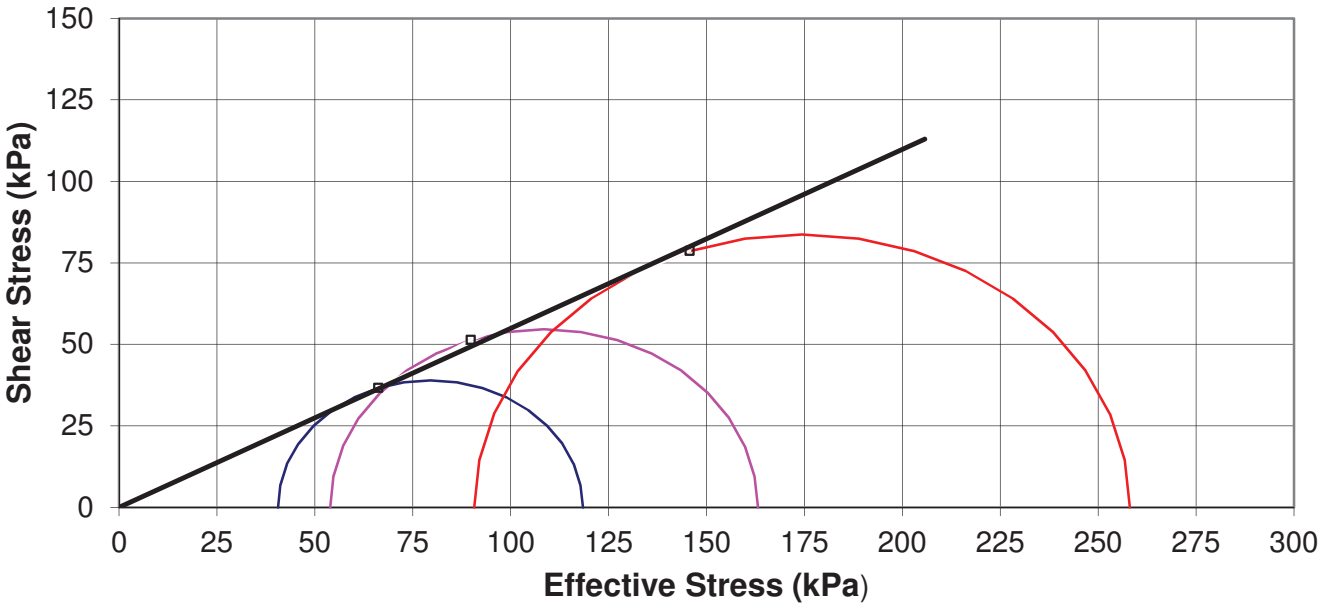
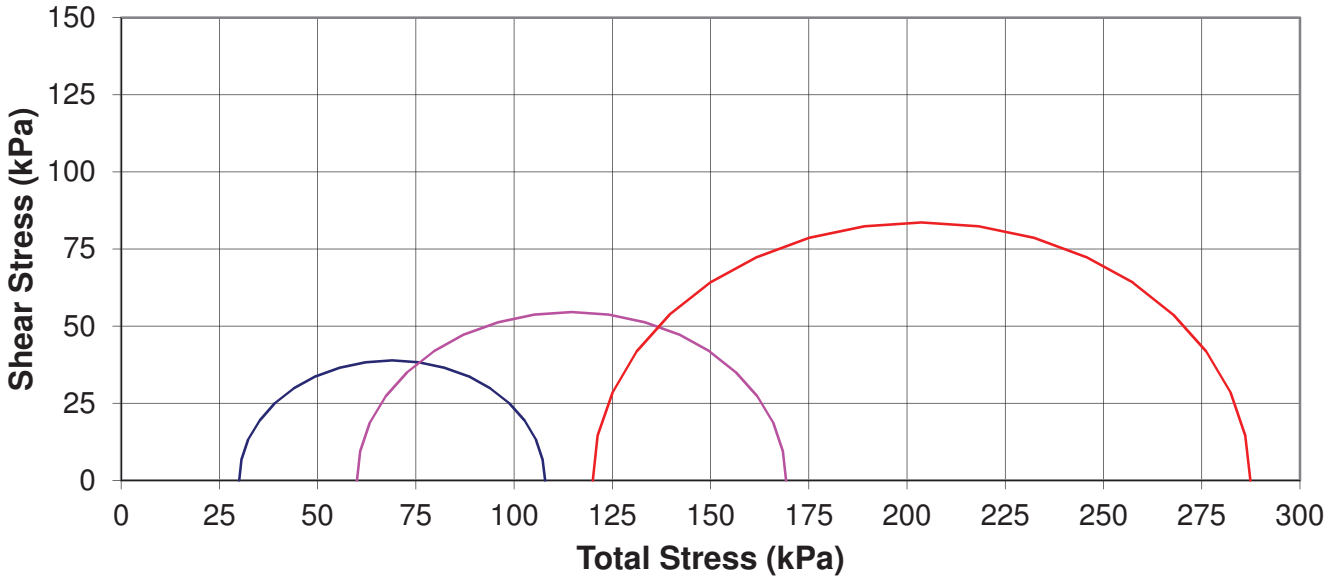
CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	8	*FIGURE*	A12
SAMPLE	5		
DEPTH	14.9 – 15.35 m		

Consolidated Undrained Triaxial - Effective Stress



Consolidated Undrained Triaxial - Total Stress



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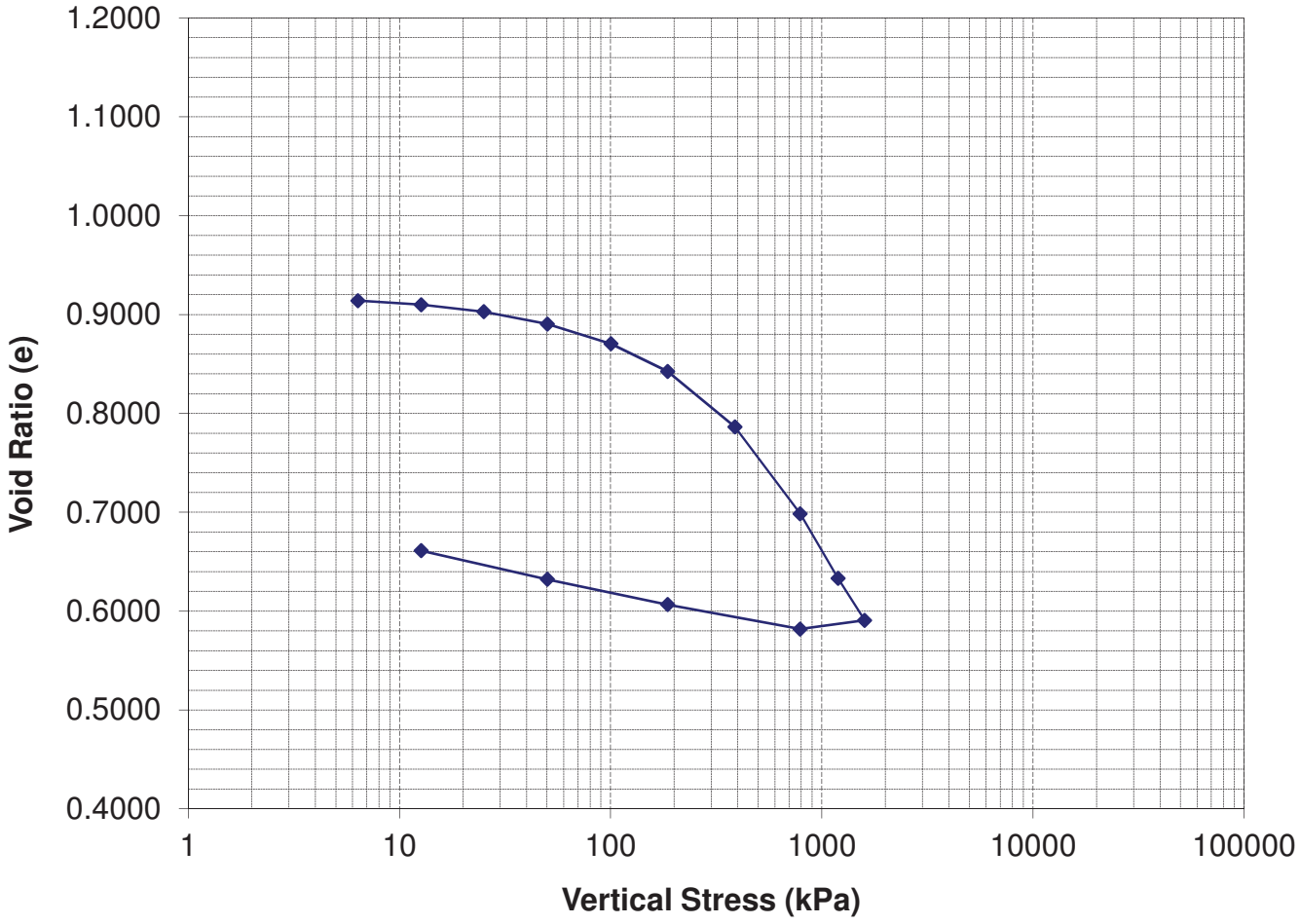
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	3	*FIGURE*	A13
SAMPLE	4		
DEPTH	13.4 - 13.85 m		

Void Ratio vs. Log of Vertical Stress



SOIL TYPE: SILTY CLAY, trace sand and gravel		
e_o = 0.93	P'_c = 225 kPa	W_L = 30
w_o = 34%	C_c = 0.68	W_p = 17
γ = 19.0 kN/m^3	C_r = 0.04	PI = 13

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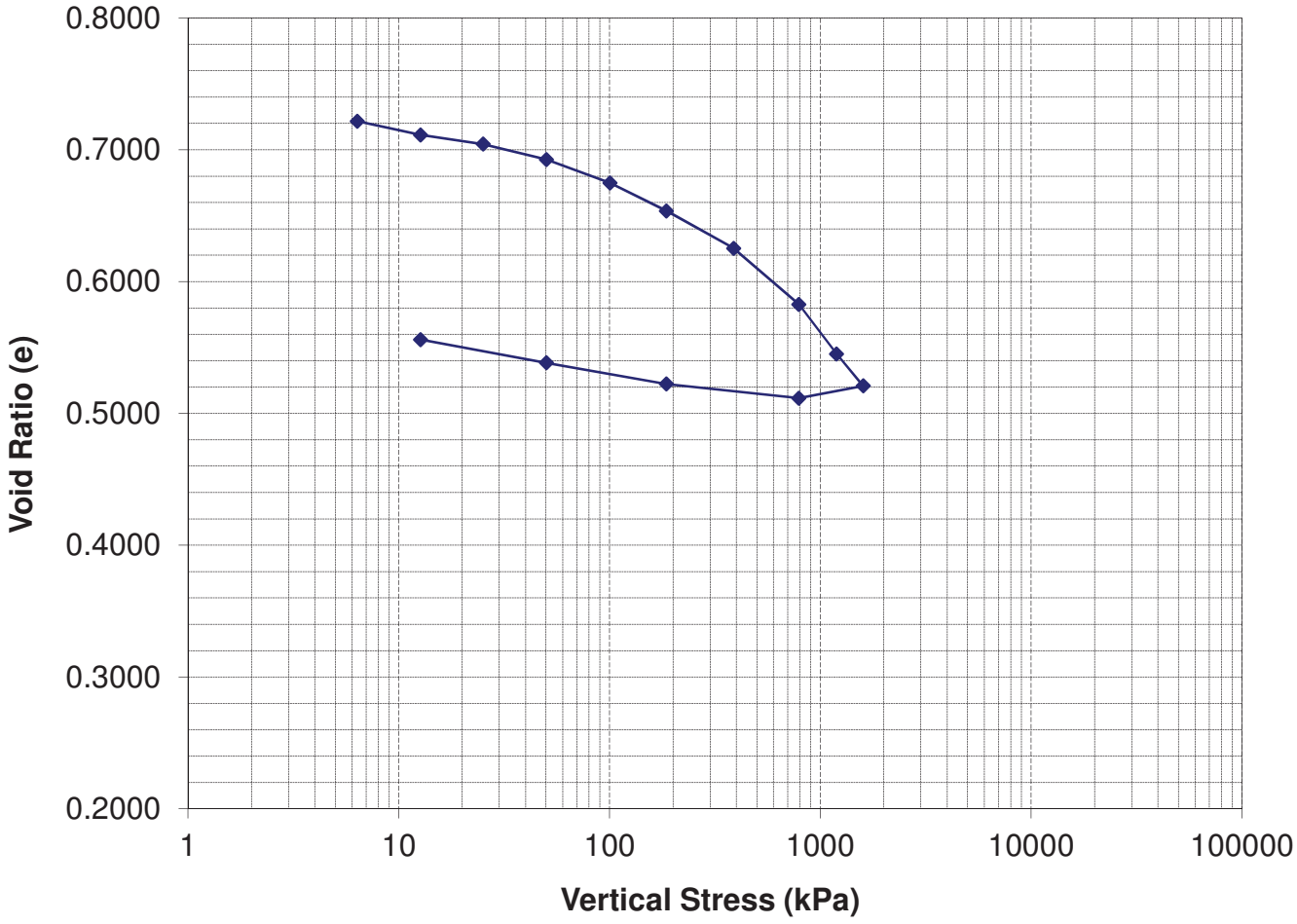
CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project.	*REPORT*	1
BOREHOLE	4	*FIGURE*	A14
SAMPLE	6		
DEPTH	14.9 – 15.35 m		

Void Ratio vs. Log of Vertical Stress



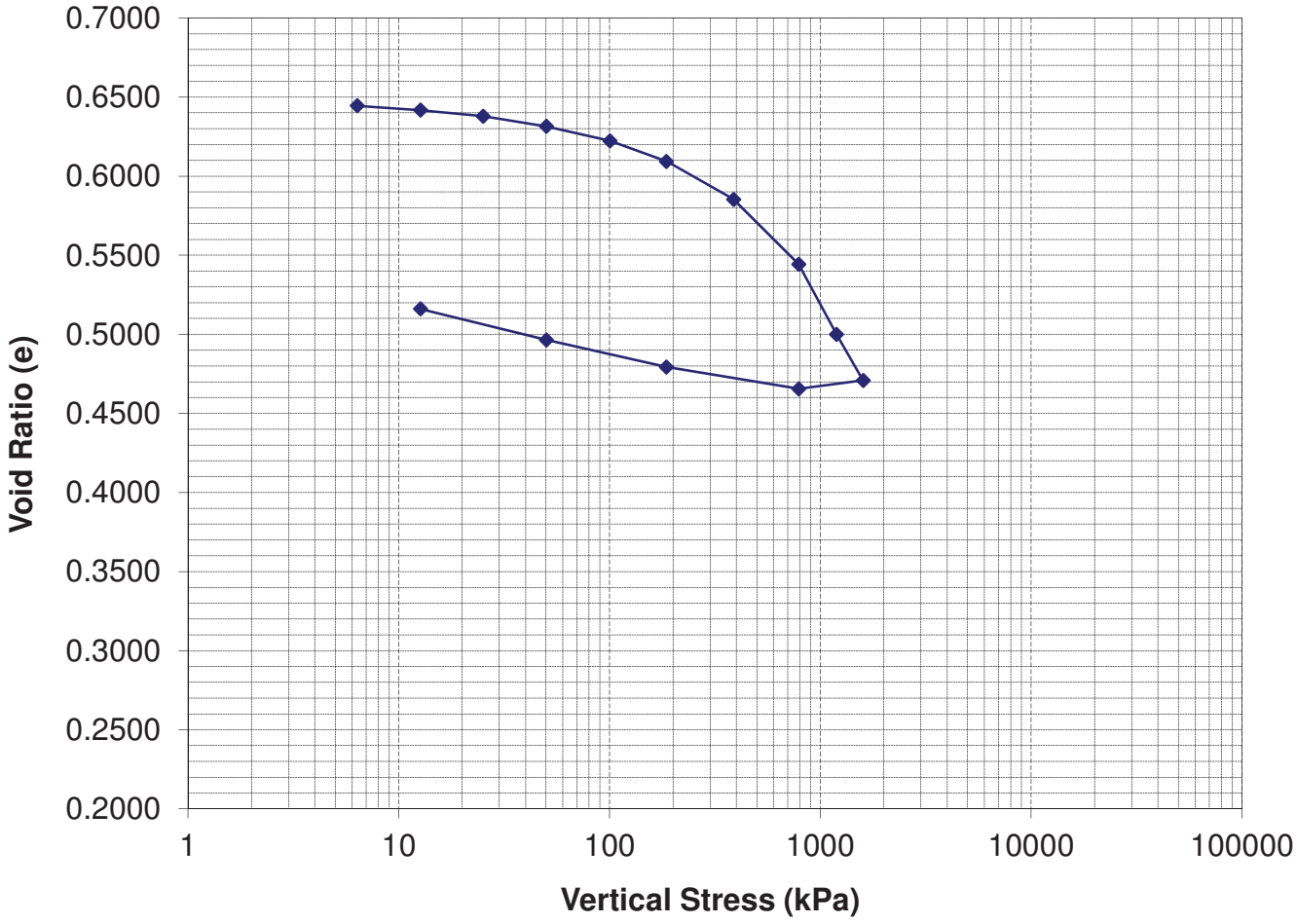
SOIL TYPE: SILTY CLAY, trace sand and gravel		
e_o = 0.73	P'_c = 275 kPa	W_L = 32
w_o = 27%	C_c = 0.20	W_p = 19
γ = 19.2 kN/m^3	C_r = 0.02	PI = 13

Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	6	*FIGURE*	A15
SAMPLE	10		
DEPTH	18.0 – 18.45 m		

Void Ratio vs. Log of Vertical Stress



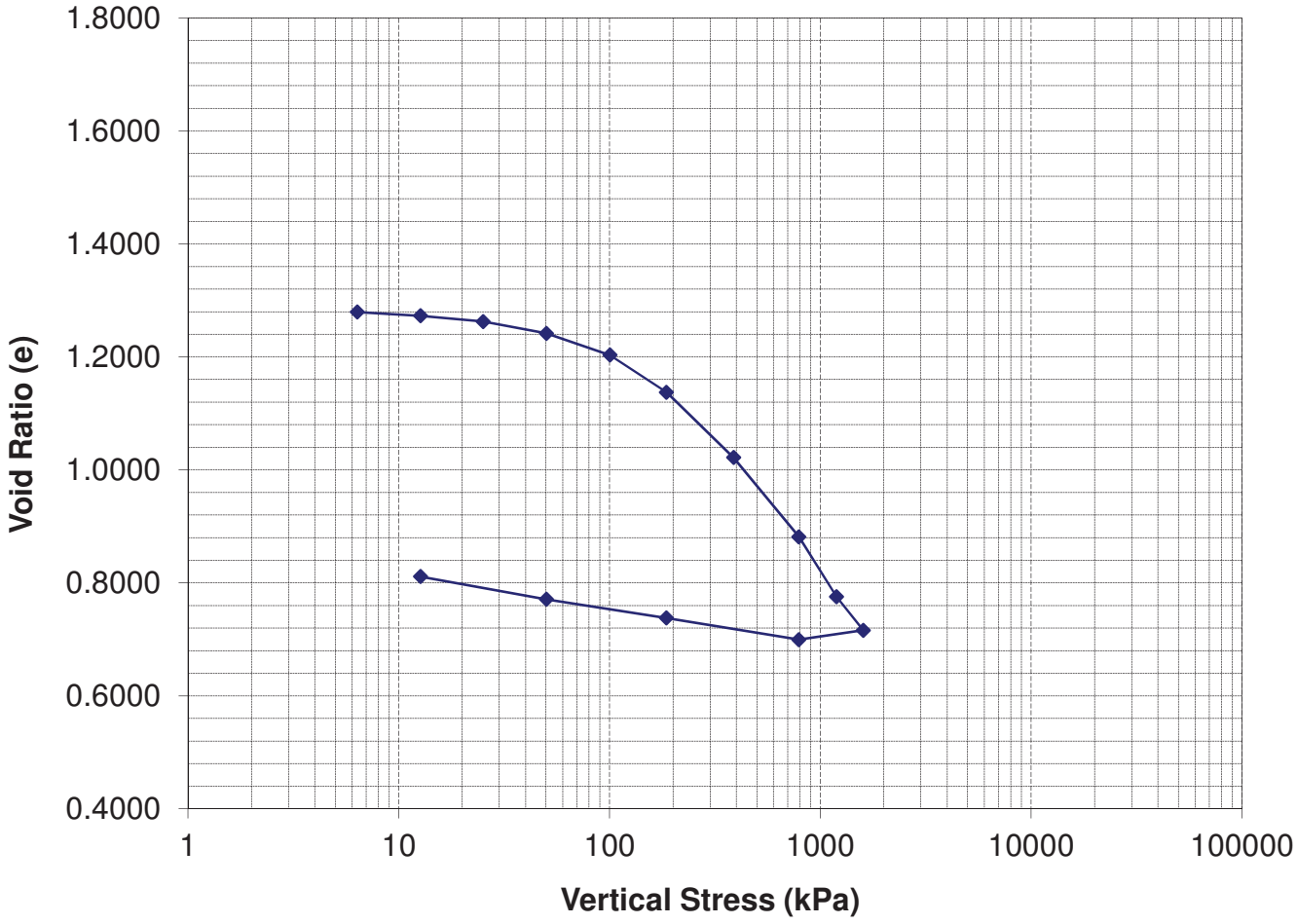
SOIL TYPE: SILTY CLAY, trace sand and gravel		
e_o = 0.66	P'_c = 325 kPa	W_L = 36
w_o = 23%	C_c = 0.36	W_p = 20
γ = 19.9 kN/m^3	C_r = 0.03	PI = 16

Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reed Sediment Remediation Project	*REPORT*	1
BOREHOLE	10	*FIGURE*	A16
SAMPLE	10		
DEPTH	18.0 – 18.45 m		

Void Ratio vs. Log of Vertical Stress



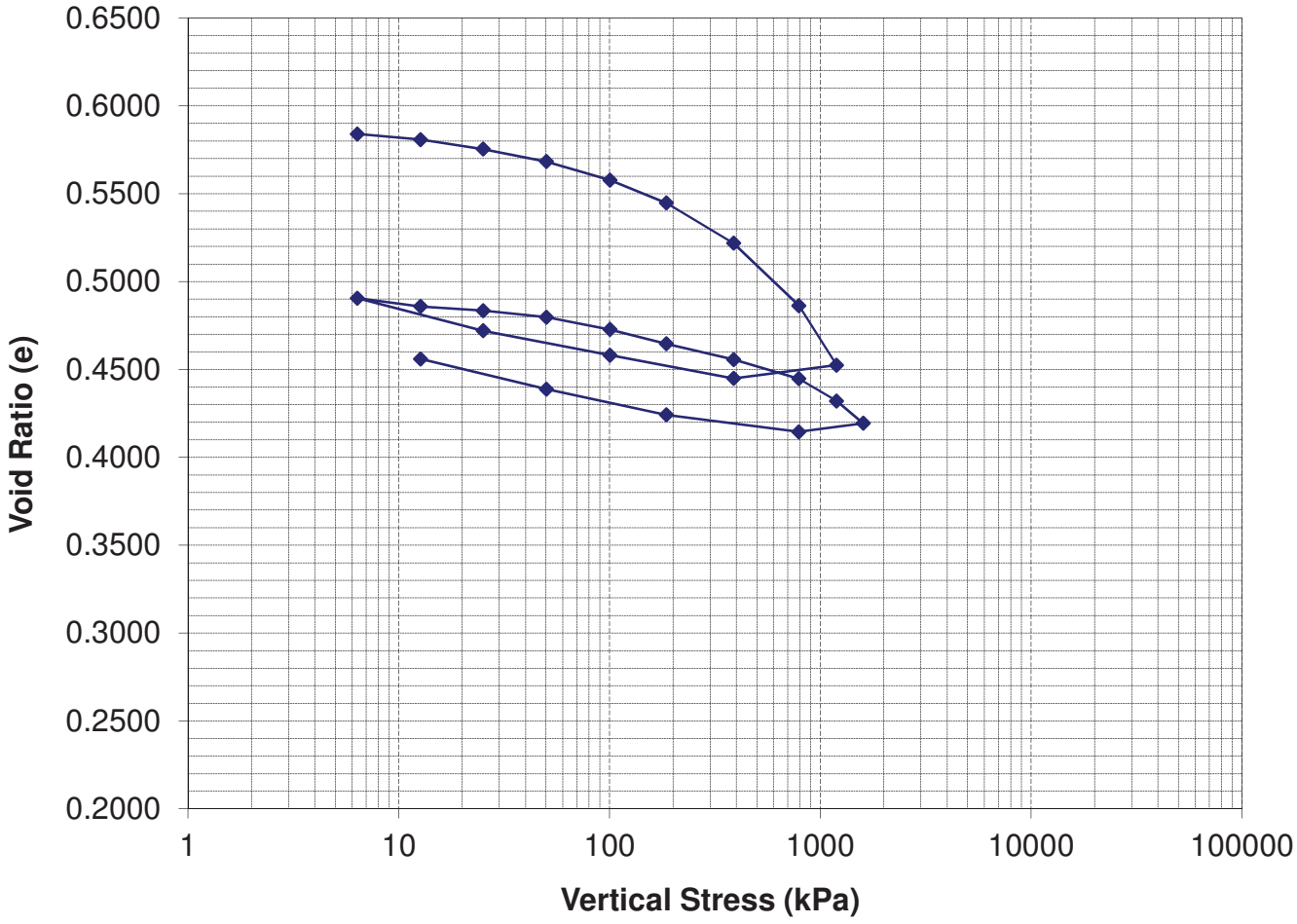
SOIL TYPE: SILT, some clay, trace sand		
e_o = 1.29	P'_c = 175 kPa	W_L = 70
w_o = 46%	C_c = 0.44	W_p = 42
γ = 16.6 kN/m^3	C_r = 0.05	PI = 28

Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	2	*FIGURE*	A17
SAMPLE	6		
DEPTH	14.9 – 15.35 m		

Void Ratio vs. Log of Vertical Stress



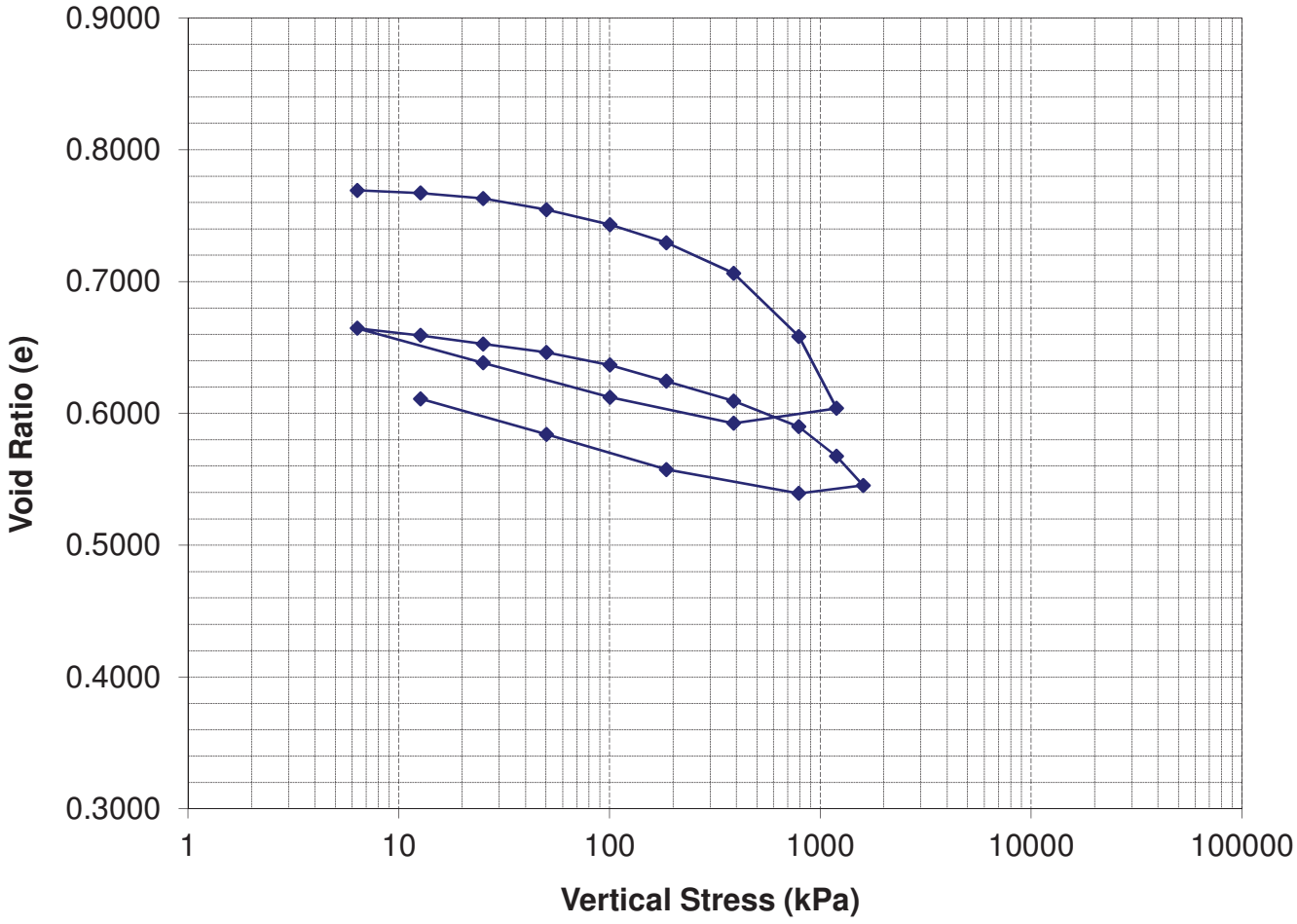
SILTY CLAY, trace sand and gravel		
e_o = 0.60	P'_c = 300 kPa	W_L = 31
w_o = 22%	C_c = 0.20	W_p = 17
γ = 20.8 kN/m^3	C_r = 0.02	PI = 14

Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Sediment Remediation Project	*REPORT*	1
BOREHOLE	5	*FIGURE*	A18
SAMPLE	9		
DEPTH	16.5 – 16.95 m		

Void Ratio vs. Log of Vertical Stress



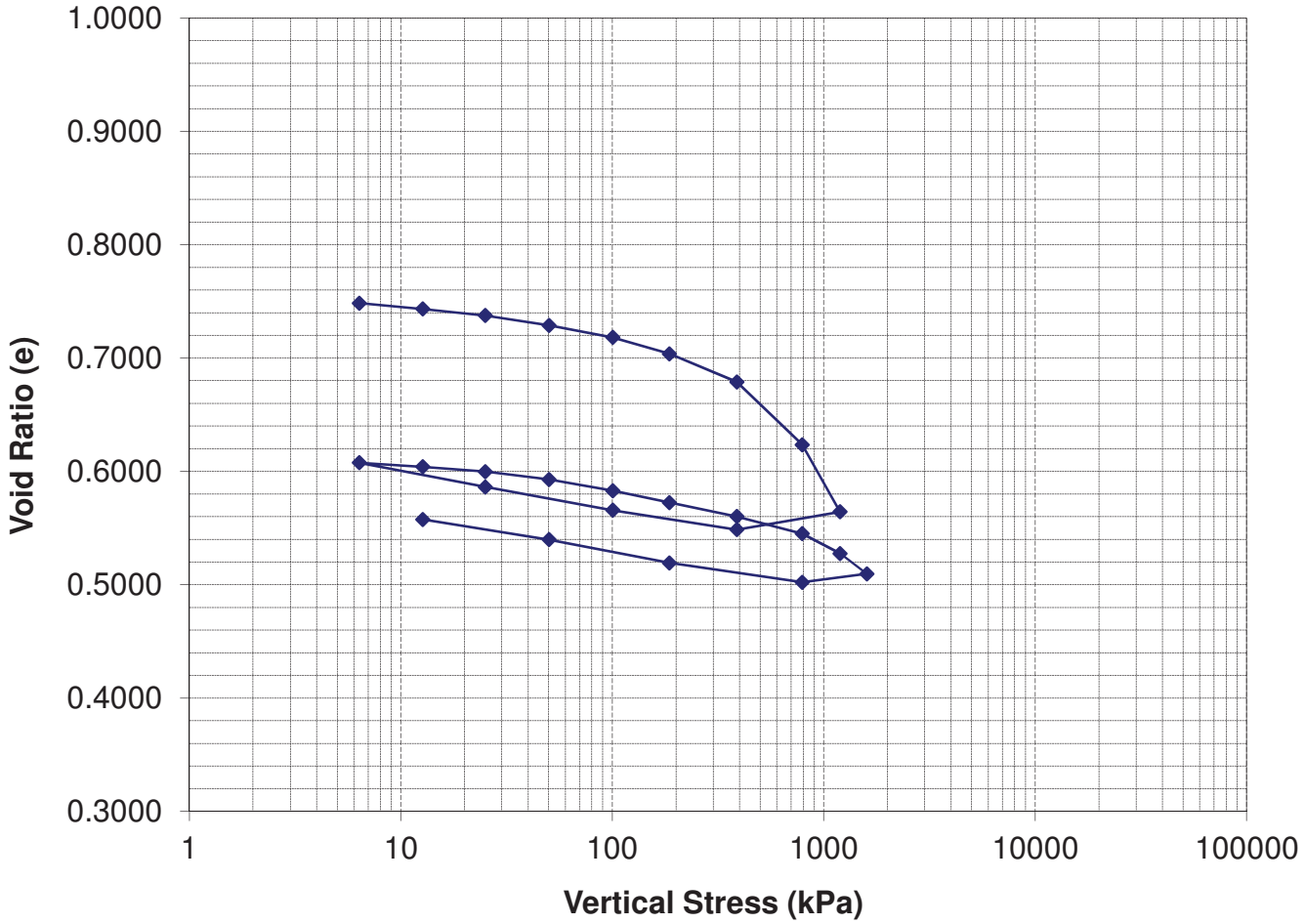
SILTY CLAY, trace sand and gravel		
e_o = 0.78	P'_c = 425 kPa	W_L = 35
w_o = 29%	C_c = 0.46	W_p = 19
γ = 19.4 kN/m^3	C_r = 0.05	PI = 16

Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONSOLIDATION TEST RESULTS

CLIENT	Riggs Engineering Ltd.	*PML REF*	13HF033
PROJECT	Randle Reef Cont.Sediment Remediation Project	*REPORT*	1
BOREHOLE	7	*FIGURE*	A19
SAMPLE	4		
DEPTH	13.4 – 13.85 m		

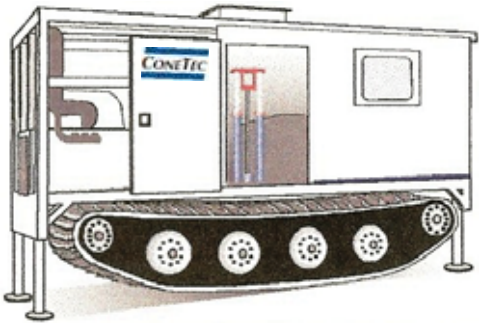
Void Ratio vs. Log of Vertical Stress



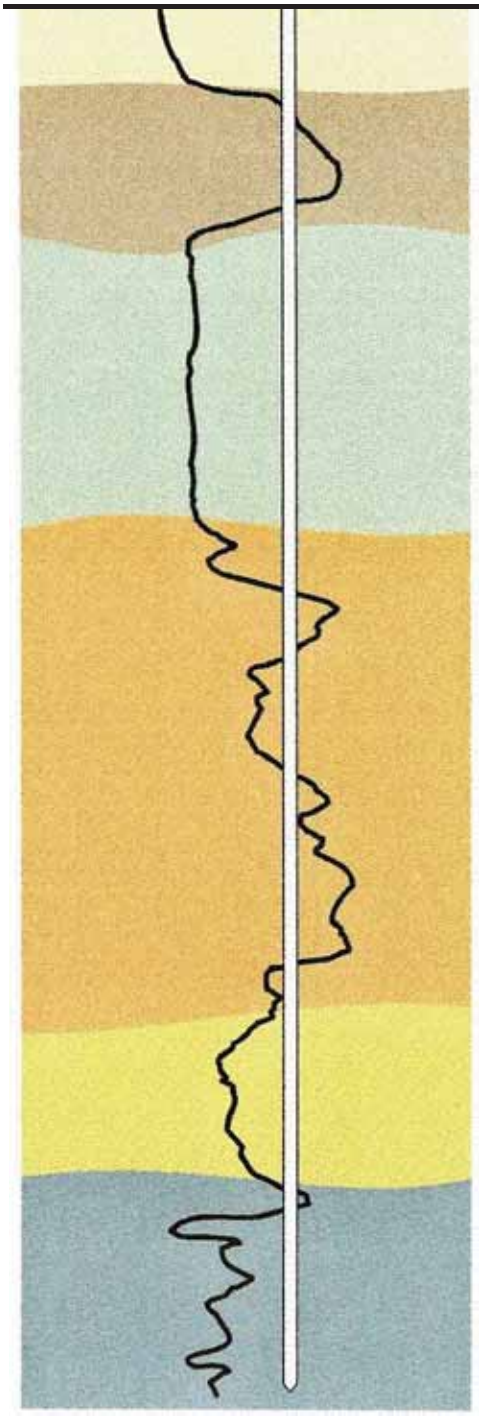
SILTY CLAY, trace sand and gravel		
e_o = 0.76	P'_c = 425 kPa	W_L = 33
w_o = 29%	C_c = 0.43	W_p = 19
γ = 19.6 kN/m^3	C_r = 0.03	PI = 14

Appendix B

ConeTec Field Report



Geotechnical and Environmental In Situ Testing Contractors



ConeTec Field Report

Presentation of In Situ Test Results for:

Randle Reef
Hamilton, Ontario

Presented to:	Peto-MacCallum Ltd.
Date:	September 23rd, 2013
Presented by:	ConeTec Investigations Limited 9033 Leslie Street, Unit 15 Richmond Hill, ON L4B 4K3 (905) 886-2663

PRESENTATION OF IN SITU TESTING PROGRAM RESULTS

Randle Reef
Hamilton, Ontario

September 17th, 2013 through September 19th, 2013

Prepared for:

Peto-MacCallum Ltd.
Hamilton, Ontario

Prepared by:
ConeTec Inc.
West Berlin, NJ

September 23rd, 2013

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1.0 INTRODUCTION

This report presents the results of a piezocone penetrometer testing (CPTU) program carried out at the Randle Reef Site located in Hamilton, Ontario. The work was performed under subcontract to Peto-MacCallum Ltd. of Hamilton, Ontario. The CPTU program took place on September 17th, 2013 through September 19th, 2013.

A total of seven soundings were completed at seven different sounding locations. The CPT testing was performed to evaluate insitu geotechnical criteria of the soils.

CPT sounding locations were selected and numbered under the direction and supervision of Peto-MacCallum personnel (Mr. Matthew St. Denis).

2.0 FIELD EQUIPMENT AND PROCEDURES

2.1 CONE PENETRATION TESTING

The cone penetrometer tests were carried out using an integrated electronic piezocone manufactured by ConeTec in Vancouver, Canada. The piezocone used was a compression model cone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80. The piezocone dimensions and the operating procedure were in accordance with ASTM Standard D-5778-12. A diagram of the cone penetrometer used for this project is shown as Figure 1.

Pore pressure filter elements, made of porous plastic, were saturated under a vacuum using silicone as the saturating fluid. The pore pressure element was six millimeters thick and was located immediately behind the tip (the u_2 location) for all soundings.

The cone was advanced using a CME 75 drill rig mounted on a spud barge. The following data were recorded onto magnetic media every five centimeters (approximately every two inches) as the cone was advanced into the ground:

- Tip Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u_t)

Before each sounding a complete set of analog baseline readings are taken with a multi-meter and compared with the digitized value on the computer screen. This provides a check on the analog to digital conversion board.

Evaluation of the analog baselines is key to consistent readings. The baseline data should be stable and should not wander excessively during the course of a sounding. Baseline data can be used to apply corrections to the cone data where necessary. For this project, the baseline shift from sounding to sounding was small, typically less than 0.1% of full scale, and no data corrections were applied.

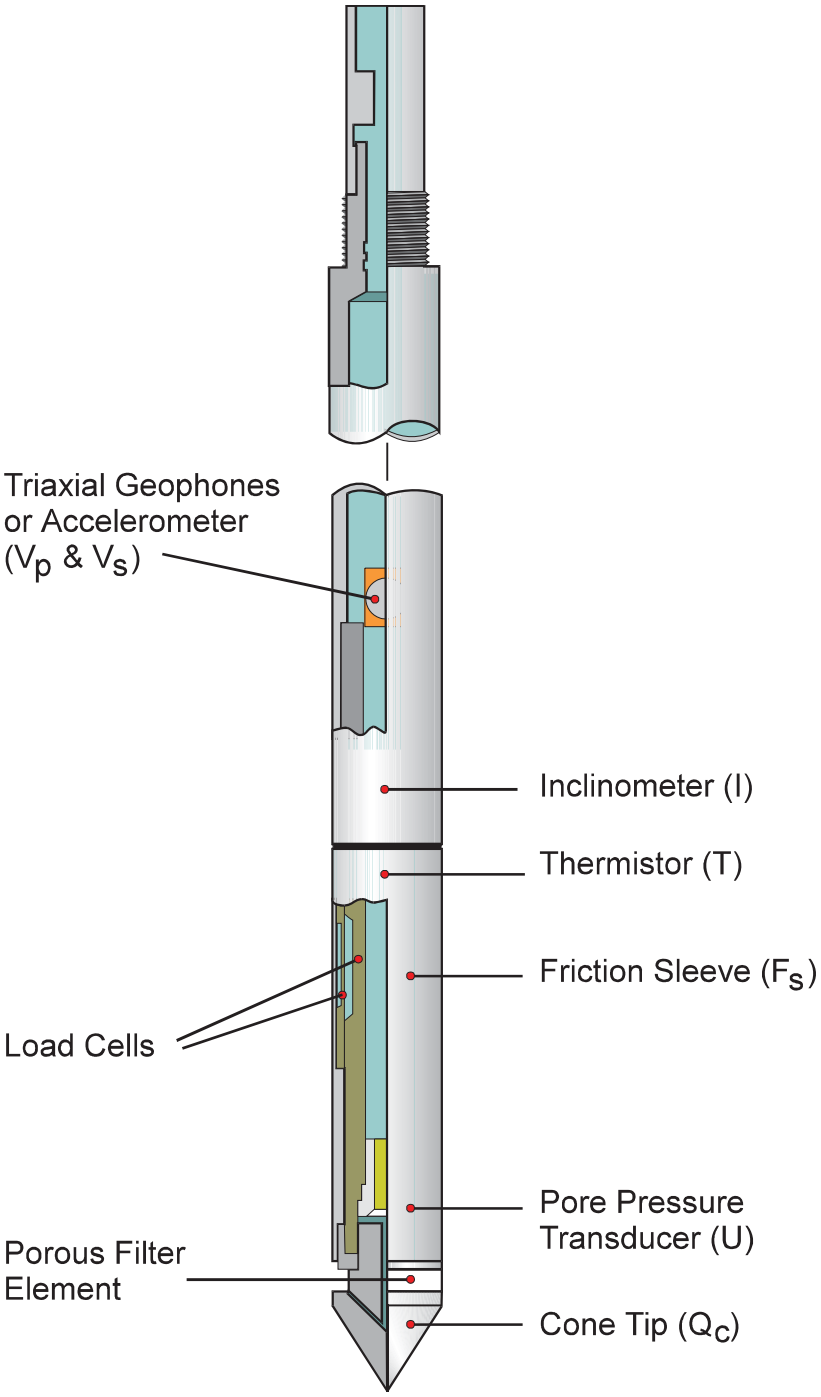


FIGURE 1 - TYPICAL CONE PENETROMETER

2.2 PORE PRESSURE DISSIPATION TESTS

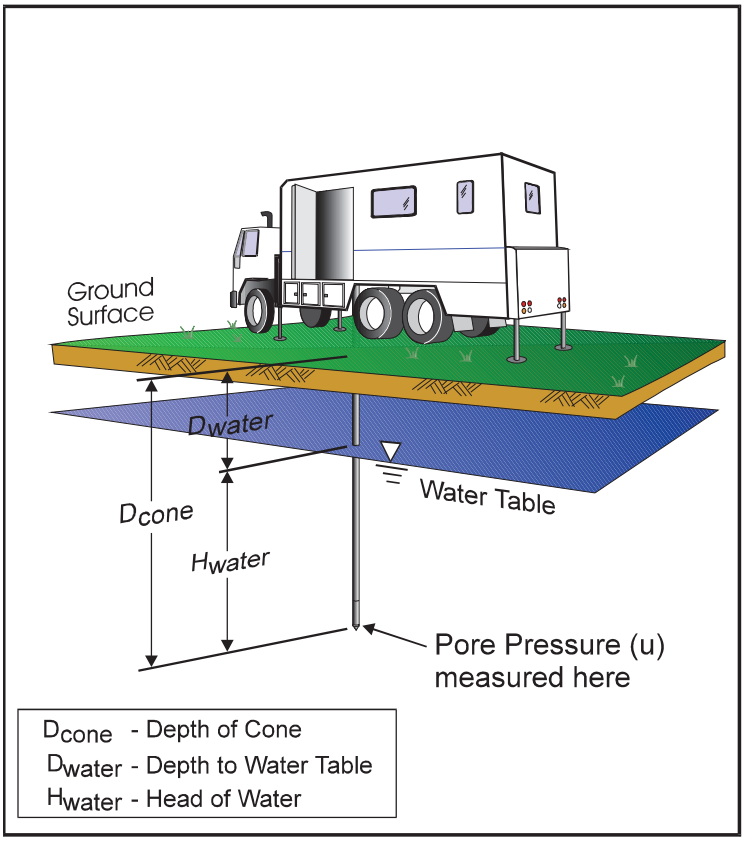
When cone penetration is stopped, the piezocone essentially becomes a piezometer. While stopped, pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file (.ppd). Dissipation data can then be plotted onto a dissipation curve consisting of pore water pressure (u) verses time (t). The shapes of dissipation curves are very useful in evaluating soil type, drainage and in situ static water level.

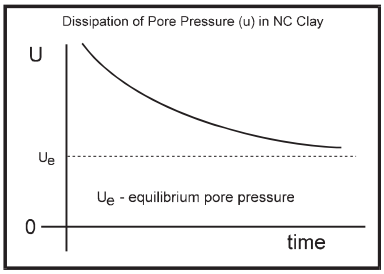
A flat curve that stabilizes quickly (i.e. less than 30 seconds) is typical of a free draining sand. In this case, the final measured pore water pressure is the static in situ water pressure.

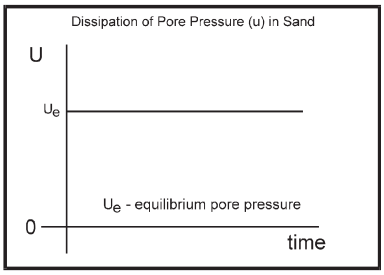
Soils that generate excess dynamic pore water pressure during penetration will dissipate this excess pressure when penetration stops. The shape of the dissipation curve and the time of dissipation can be used to estimate C_h, the coefficient of consolidation that can in turn be used to calculate K_h, the horizontal permeability.

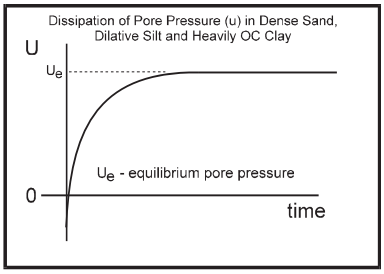
Figure 2 shows some idealized shapes of various pore water pressure dissipation curves. The reader is referred Robertson et. al., 1990 to reference dissipation test data analytical techniques.

Estimation of Ground Water Table from CPT Dissipation Tests









Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors: 1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

FIGURE 2 - TYPICAL DISSIPATION TESTS

3.0 CONE PENETRATION TEST DATA AND INTERPRETATION

3.1 ANALYSIS OF PIEZOCONE DATA - GENERAL

A total of seven CPT soundings, involving 146.0 meters of testing, were completed.

The interpretation of cone data is based on the relationship between cone bearing, qc, sleeve friction, fs, and penetration pore water pressure, u. The friction ratio, Rf , (sleeve friction divided by cone bearing) is a calculated parameter which is used to infer soil behavior type. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

The interpretation of soils encountered on this project was carried out using correlations developed by Robertson et al., 1992. It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. Occasionally soils will fall within different soil categories on the classification charts. In these situations, experience and judgment and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type. Computer tabulations of the interpreted soil types along with certain other geotechnical parameters for each cone hole is presented in Appendix B.

Each of the parameters measured in the sounding is discussed briefly below. A detailed explanation of CPTU testing and interpretation of the results can be found in Robertson, 1989.

TIP RESISTANCE (q_c): The resistance to penetration, measured at the cone tip, provides an accurate profile of subsurface strata. The recorded tip resistance is a composite of the penetration resistance of the soils located five to ten cone diameters (7 to 14 inches) in front of and behind the tip. The actual resistance "sensed" by the tip depends on the soil properties and on the relative stiffness of the layers encountered. Tip resistance is often corrected for pore pressure effects when testing in soft saturated cohesive soils.

For this project the correction was made and the tip resistance shown, q_t is the corrected tip resistance.

The correction used is: $q_t = q_c + (1\text{-}a)u$

Where:
- q_t = corrected tip resistance
- q_c = measured tip resistance
- a = net area ratio for cone (0.80 for this project)
- u = dynamic pore water pressure measured behind tip

SLEEVE FRICTION (f_s) The resistance recorded on the friction sleeve, is a measure of the remolded strength of the soil. Values of sleeve friction in very soft soils (such as peat) may fluctuate due to the measured force being small relative to the capacity of the measuring load cell.

FRICTION RATIO (R_f) The ratio of sleeve friction to tip resistance expressed as a percentage, is an indicator of soil type. Cohesive soils generally have friction ratios that are greater than two, while sands and non-plastic silts have friction ratios that are lower than two.

PORE PRESSURE (u*)* Dynamic pore water pressure is measured during penetration. (dynamic pore water pressure data can be found in the .cor, and .xls files. Static pore water pressure is measured when cone penetration is stopped (static pore water pressure data can be found in the .ppd files). The measured dynamic pore water pressure changes with the location of the porous filter and negative readings are possible when the filter is located behind the tip.

It is important to note that the CPT classifies soil by physical behavior, not by grain size; therefore, the CPT classification should be verified against samples obtained from a conventional drilling program. While the CPT soil classification may not always be accurate in terms of the actual label it applies to a particular soil, it is very accurate in grouping soils with similar mechanical properties.

Table 1 presents a summary of CPT soundings, including sounding depths, UTM coordinates and number of Vs tests performed. Table 1 can be found in Appendix A.
Table 2 presents a summary of the dissipation testing, including test depths, estimated phreatic surface, T_{50} and C_h values. Table 2 can be found in Appendix C.

3.2 CONE PLOTS

The data from each sounding was plotted using the computer program SCREENzW. The plots are included in Appendix A. SCREENzW was developed by ConeTec Inc. and it incorporates soil behavior type (SBT) classification as part of the plot. The soil classification is based on the classification chart reproduced chart in Appendix B.

3.3 PORE PRESSURE DISSIPATION TEST RESULTS

Pore water pressure dissipation data are collected and automatically recorded during pauses in penetration. The pore water pressure data is recorded at five second intervals. Numerous pore water pressure dissipation tests were performed on this project. Those plots can be found in Appendix C.

3.4 CPT DATA PROCESSING

The electronic data files were processed using the program SCREENzW. SCREENzW is a program developed by ConeTec to calculate common engineering parameters from CPT data. The processed data file summery sheet is attached in Appendix B. The files (IFI.xls) are included in the electronic data package. The calculations used are summarized in the table at the front of the Appendix. Each calculation is derived according to the referenced article.

For this project, the piezometric surface used was determined from the pore water pressure dissipation tests and the dynamic pore water pressure responses recorded during the CPT. The exact depth used can be found in the headers of the ifi.xls files.

3.5 ELECTRONIC DATA FILES

Along with the report, all of the project data can be downloaded from ConeTec's "ConeTec Data Services" (CDS) website (www.conetecdataservices.com) using a secure, project-specific user name and password. These electronic files contain all important project information including tabular data (.xls and ASCII formats), GPS coordinates of approximate sounding locations, dynamic and static pore water pressure and some basic interpretation files in Microsoft™ Excel format (.xls). Information regarding the digital file formats of the electronic files is included in Appendix D.

5.0 REFERENCES

Robertson, P.K., 1989, “Soil Classification using the Cone Penetration Test”, Canadian Geotechnical Journal, vol. 27, pages 151-158.

Robertson, P.K., Sully, J., Woeller, D.G., Lunne, T., Powell, J.M., and Gillespie, D.J., 1992, “Estimating Coefficient of Consolidation from Piezocone Tests”, Canadian Geotechnical Journal, vol. 29, pages 539-550.

Appendix A

Project: Randle Reef - Hamilton, Ontario
Date: 09/17/13 to 09/19/13

TABLE 1 Summary of CPT Soundings

unding	File Name	Date	Cone	Assumed Phreatic Surface (m)	Final Depth (m)	Northing UTM Zone 17	Easting UTM Zone 17
3-01	13-05017_CP01	9/18/2013	322:T1500F15U500	0.000	20.60	4791652	594700
3-02	13-05017_CP02	9/17/2013	322:T1500F15U500	0.000	22.95	4791763	594535
3-05	13-05017_CP05	9/17/2013	322:T1500F15U500	0.000	20.45	4791937	594573
3-07	13-05017_CP07	9/18/2013	322:T1500F15U500	0.000	20.85	4791915	594720
3-12	13-05017_CP12	9/18/2013	322:T1500F15U500	0.000	21.10	4791705	594623
3-13	13-05017_CP13	9/19/2013	322:T1500F15U500	0.000	20.55	4791874	594441
3-14	13-05017_CP14	9/19/2013	322:T1500F15U500	0.000	19.50	4791970	594651
	7				146.00		

ydrostatic water table is assumed for the interpretation tables and based on pore pressure dissipations.

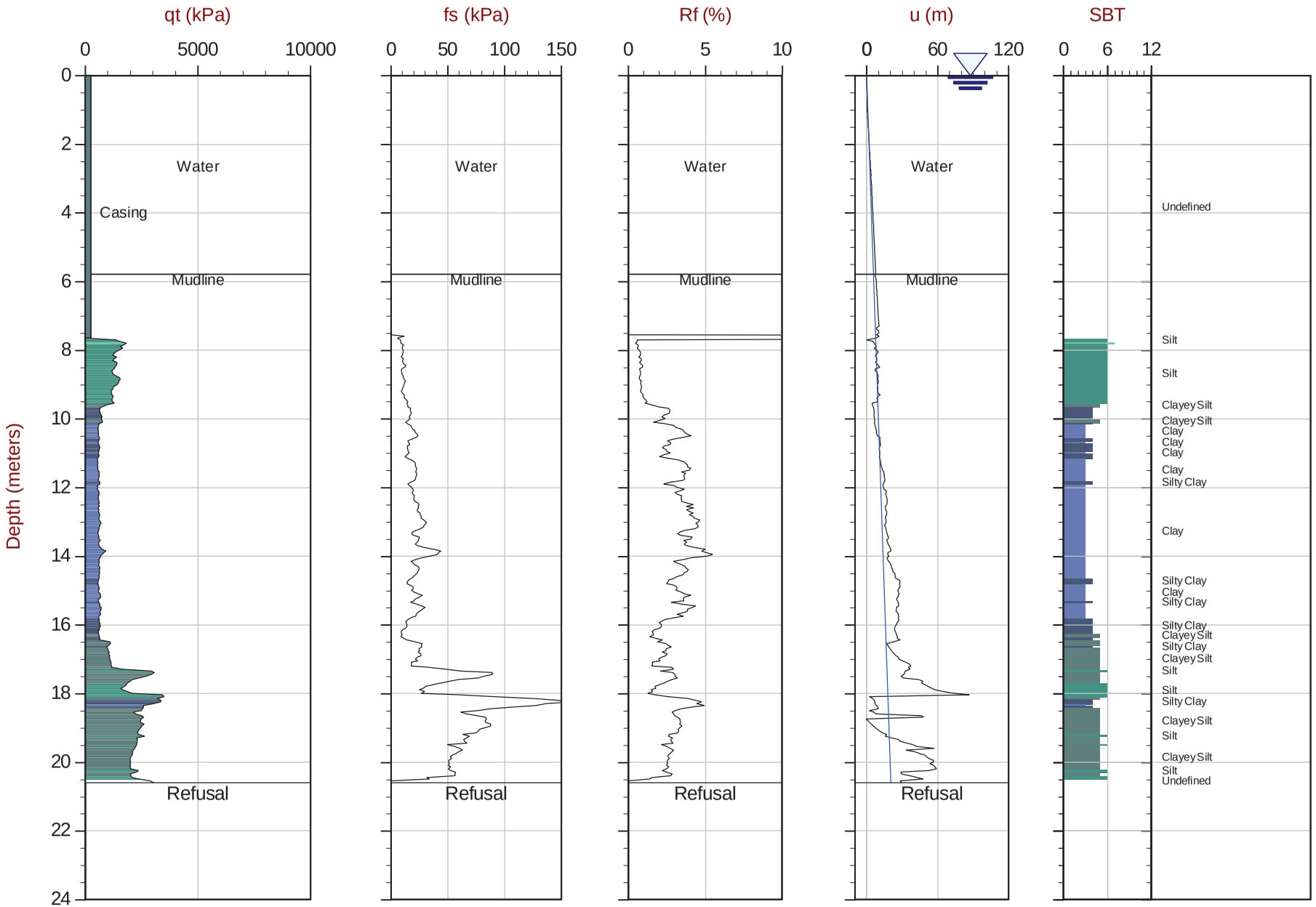
Non-Normalized CPT Plots

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:18:13 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP01.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791652 E: 594700

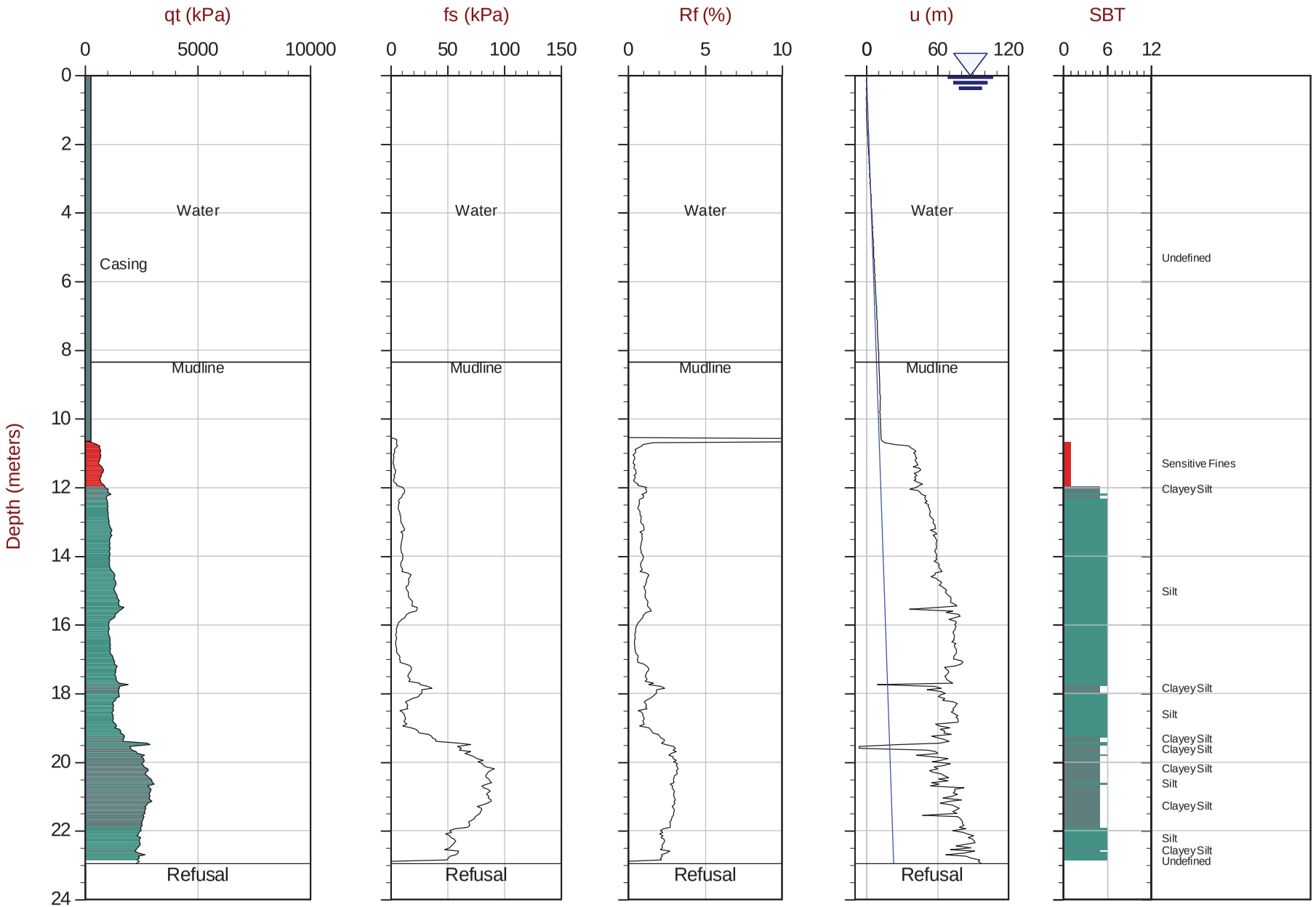
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:17:13 16:20
Site: Hamilton, ON

Sounding: CPT13-02
Cone: 322:T1500F15U500



Max Depth: 22.950 m / 75.29 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP02.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791763 E: 594535

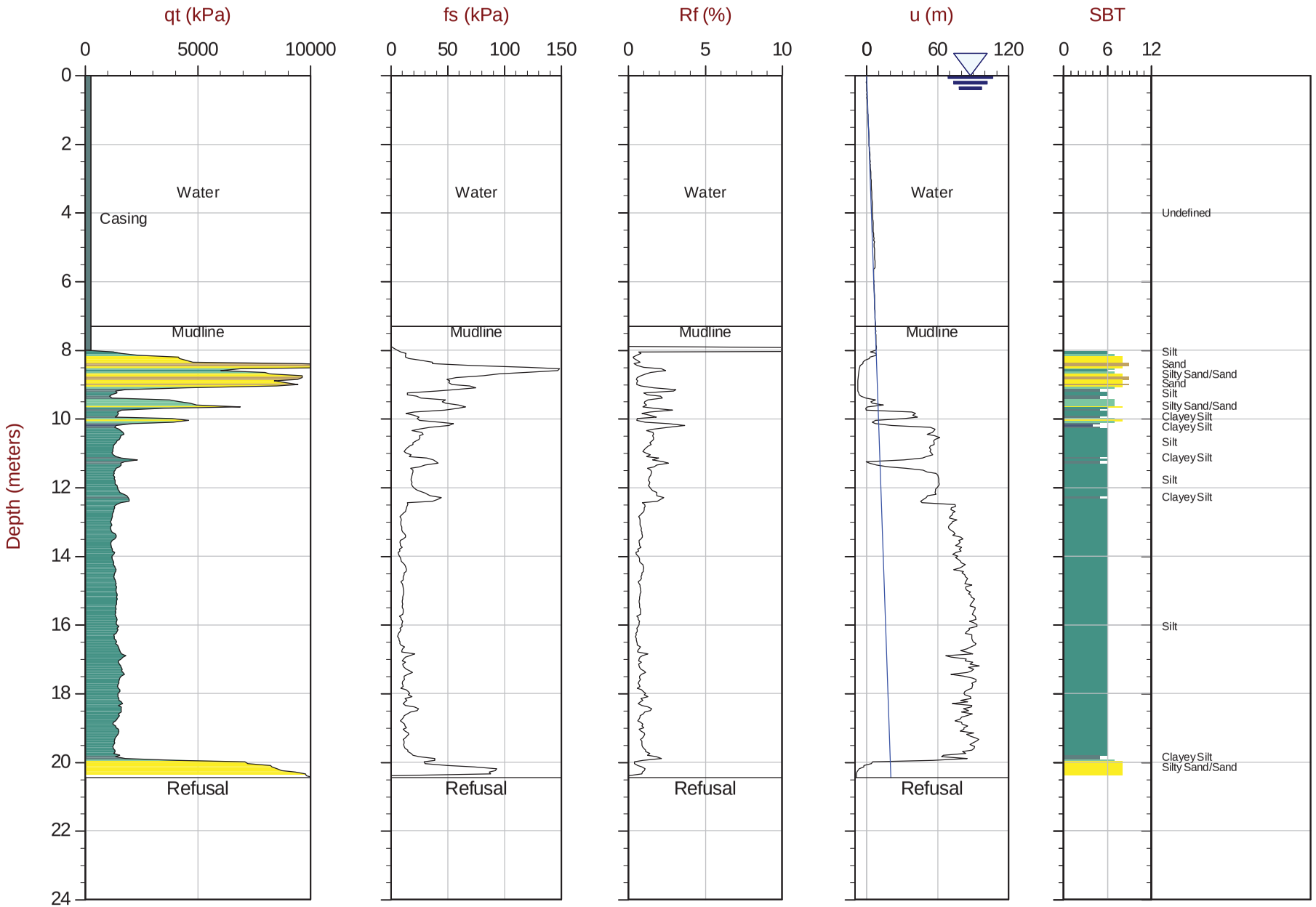
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:17:13 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500



Max Depth: 20.450 m / 67.09 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP05.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791937 E: 594573

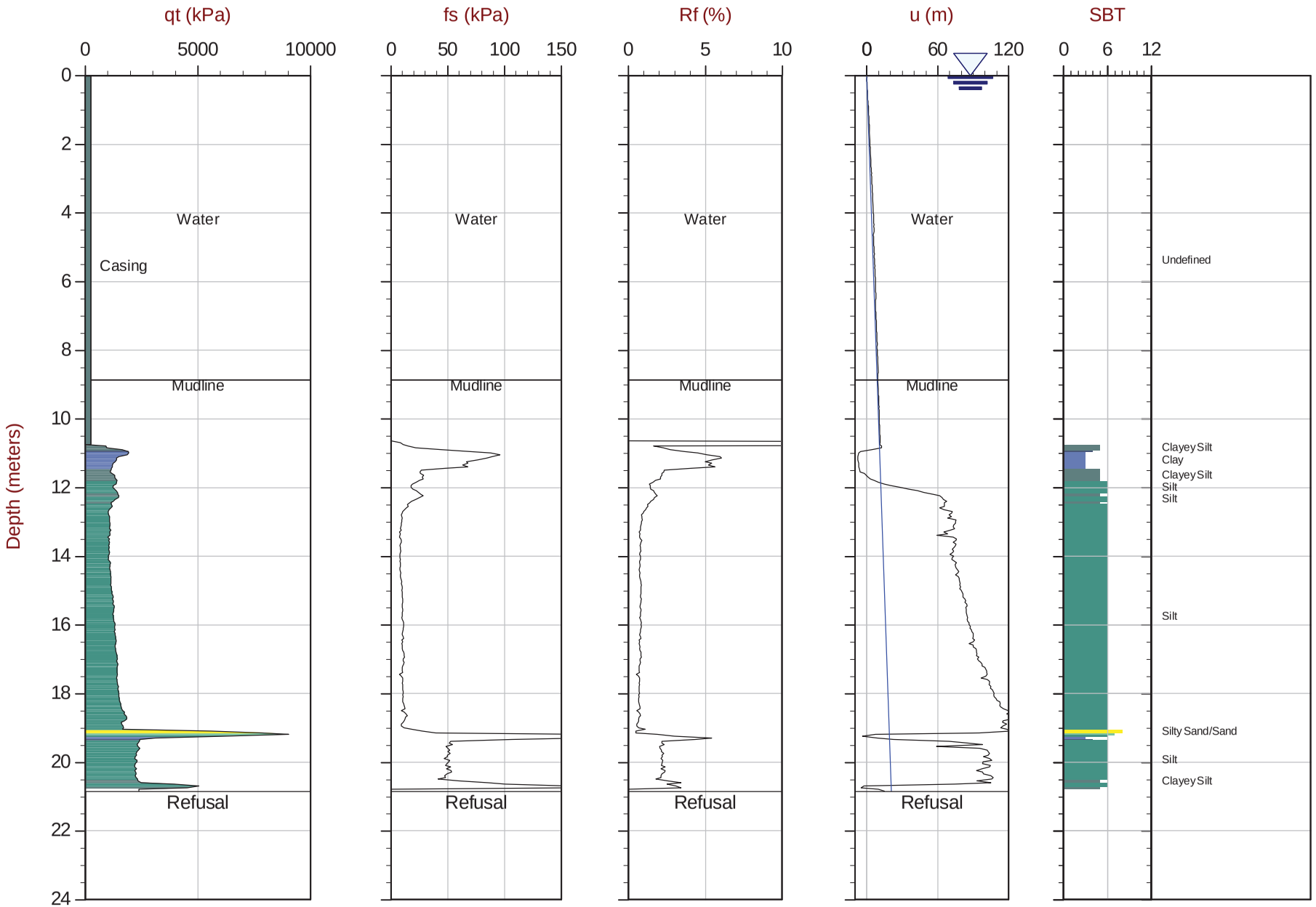
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:18:13 12:04
Site: Hamilton, ON

Sounding: CPT13-07
Cone: 322:T1500F15U500



Max Depth: 20.850 m / 68.40 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP07.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791915 E: 594720

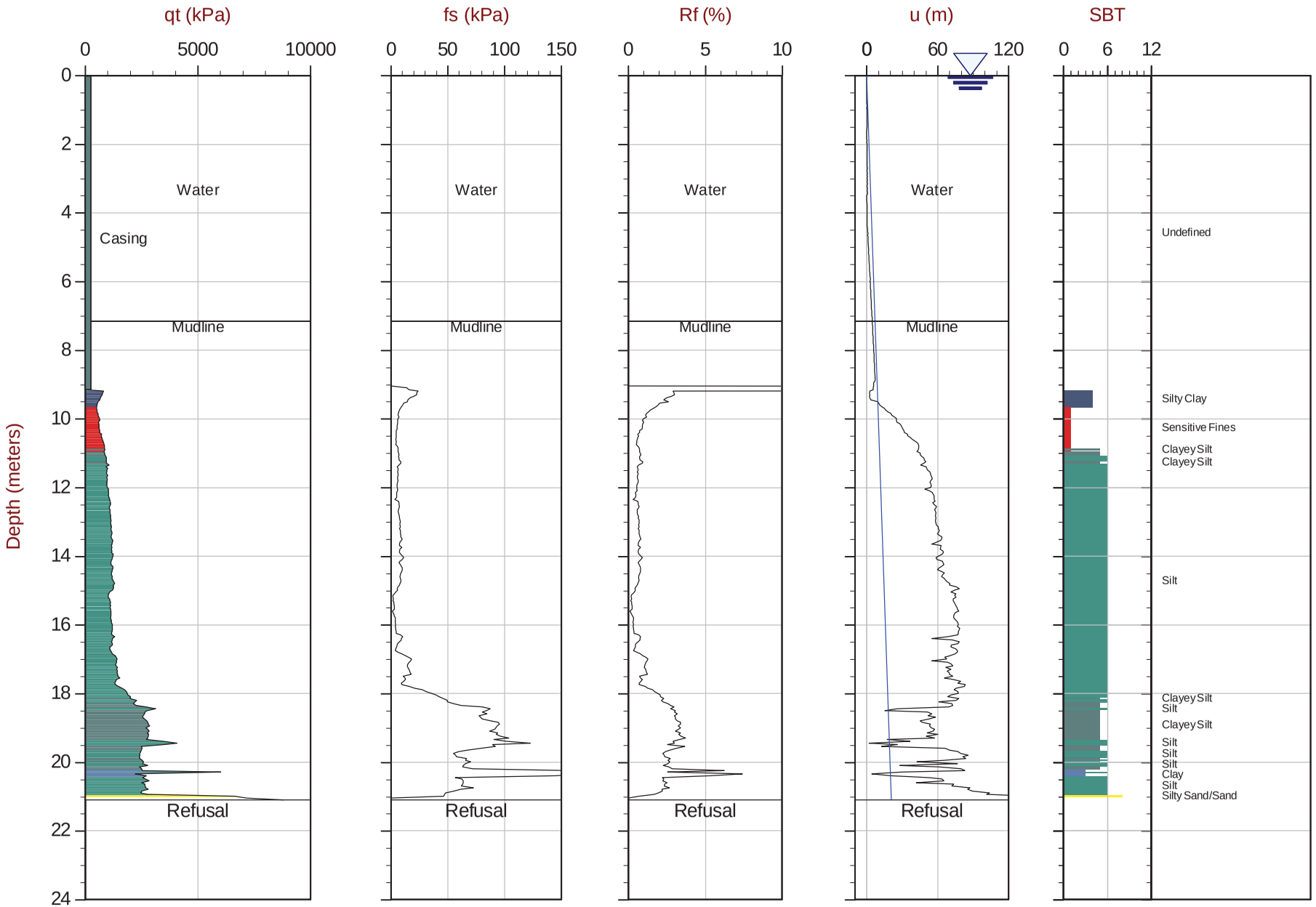
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:18:13 14:56
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500



Max Depth: 21.100 m / 69.22 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP12.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791705 E: 594623

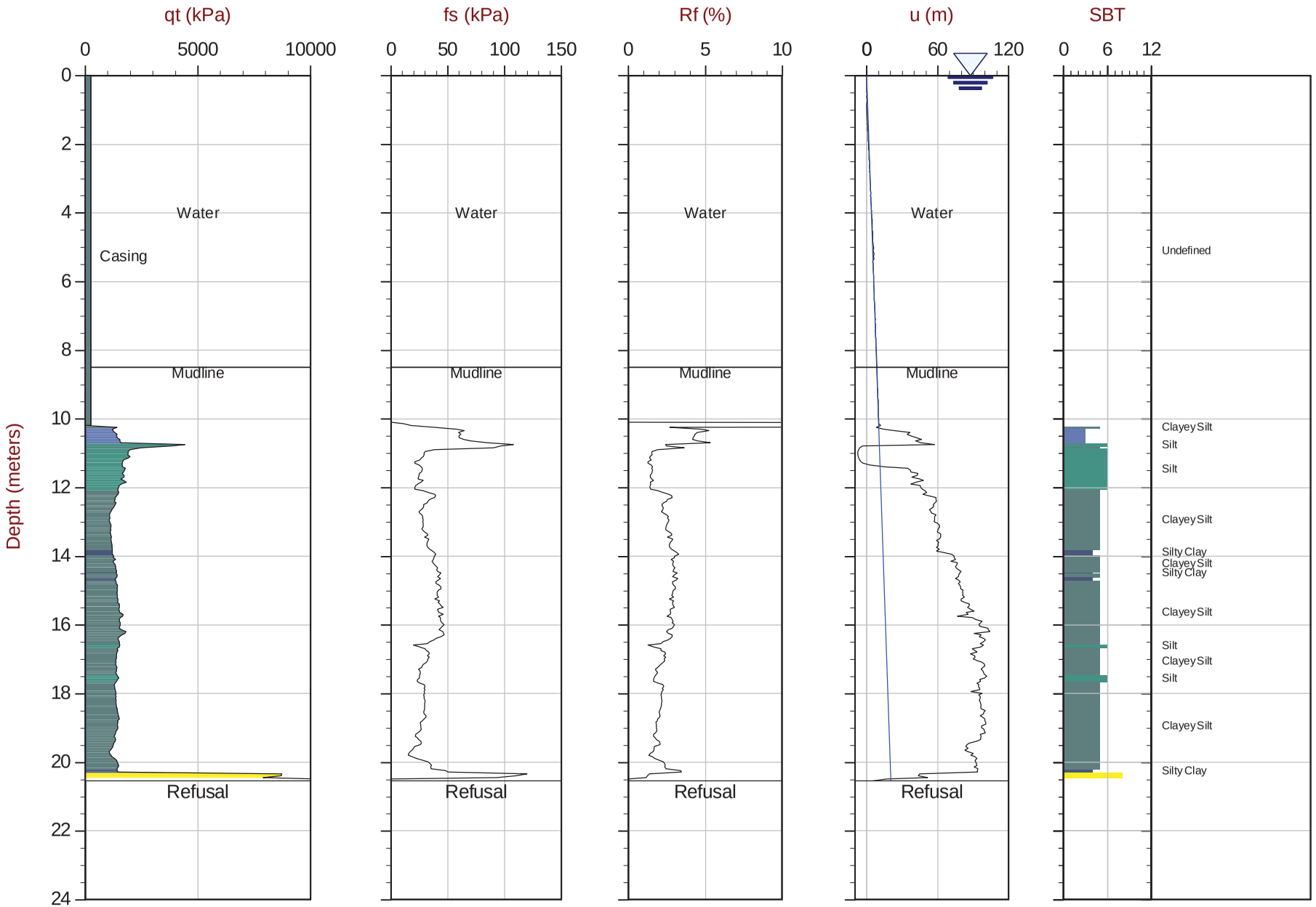
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:19:13 08:29
Site: Hamilton, ON

Sounding: CPT13-13
Cone: 322:T1500F15U500



Max Depth: 20.550 m / 67.42 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP13.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791874 E: 594441

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
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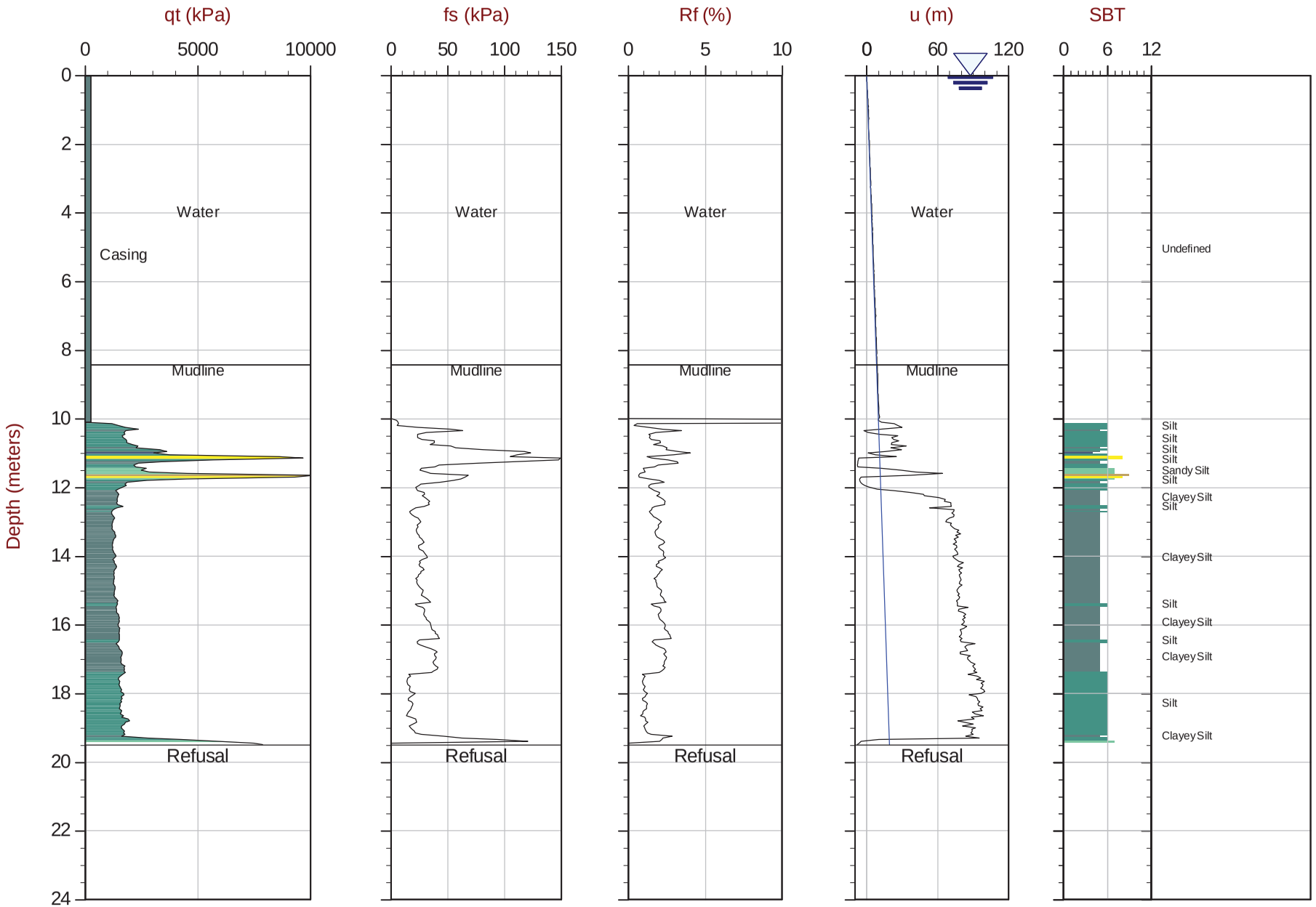
Site: Hamilton, ON

Sounding: CPT13-14
Cone: 322:T1500F15U500



Max Depth: 19.500 m / 63.98 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP14.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791970 E: 594651

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

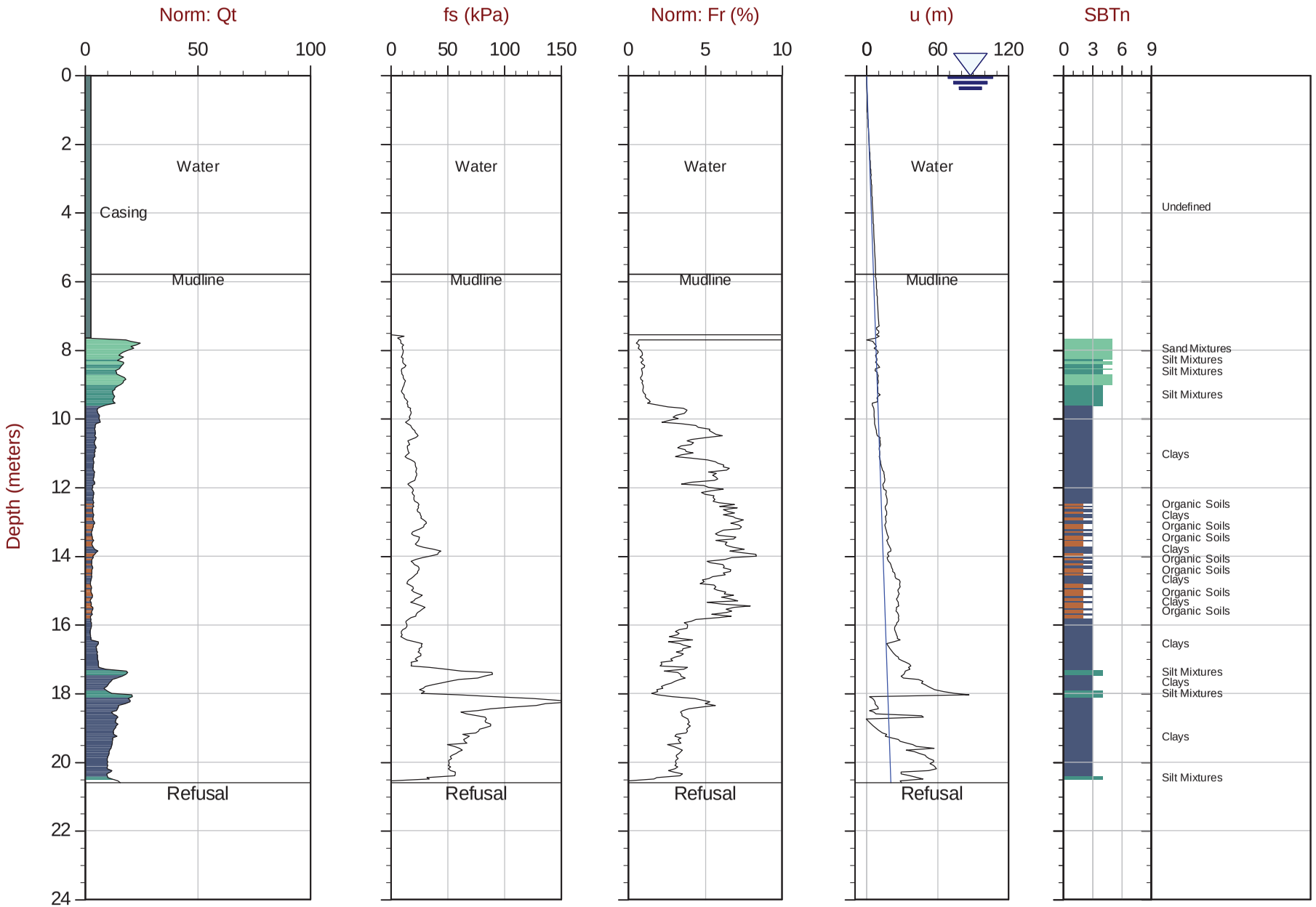
Normalized CPT Plots

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:18:13 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500



Max Depth: 20.600 m / 67.58 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP01.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791652 E: 594700

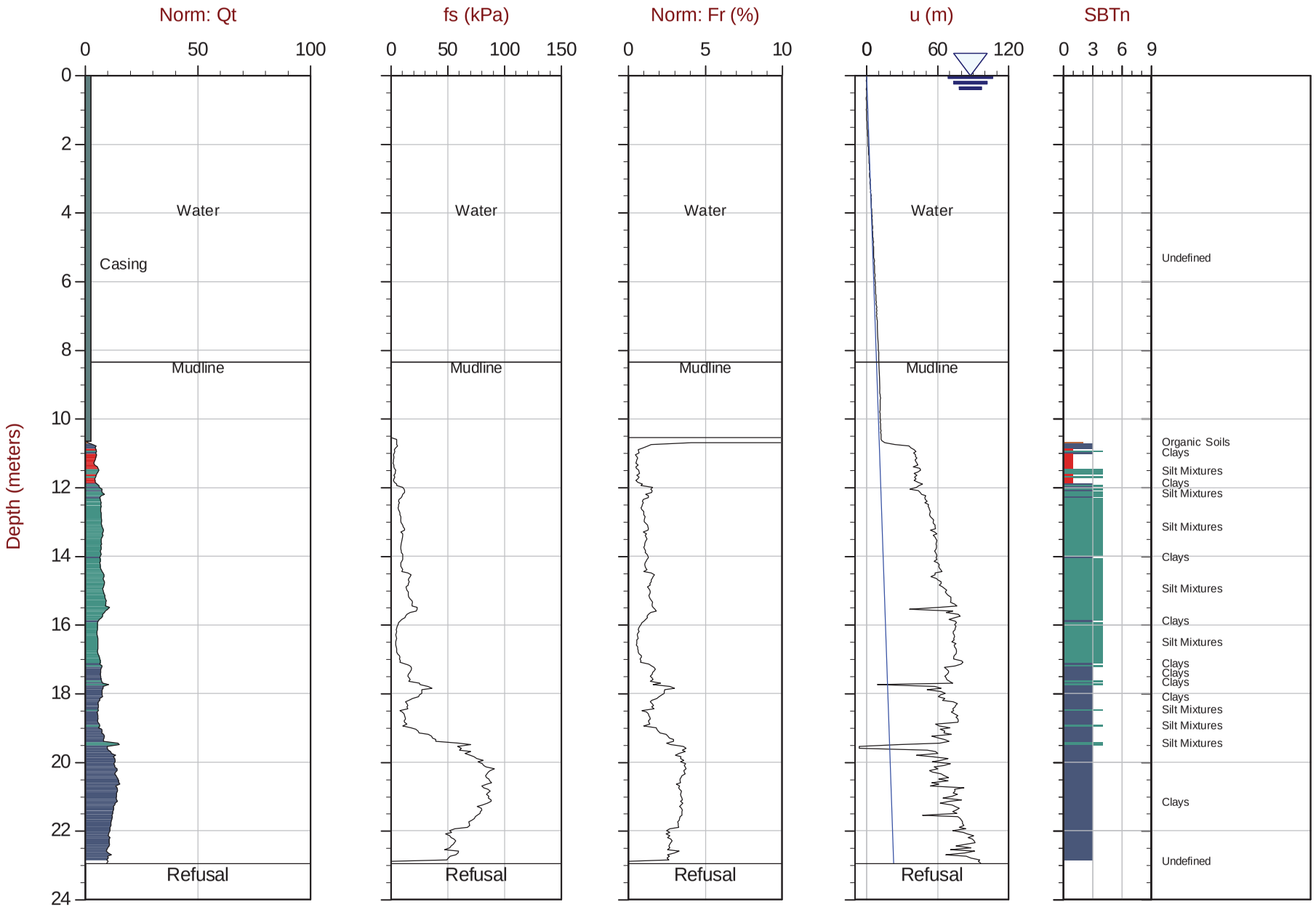
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:17:13 16:20
Site: Hamilton, ON

Sounding: CPT13-02
Cone: 322:T1500F15U500



Max Depth: 22.950 m / 75.29 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP02.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791763 E: 594535

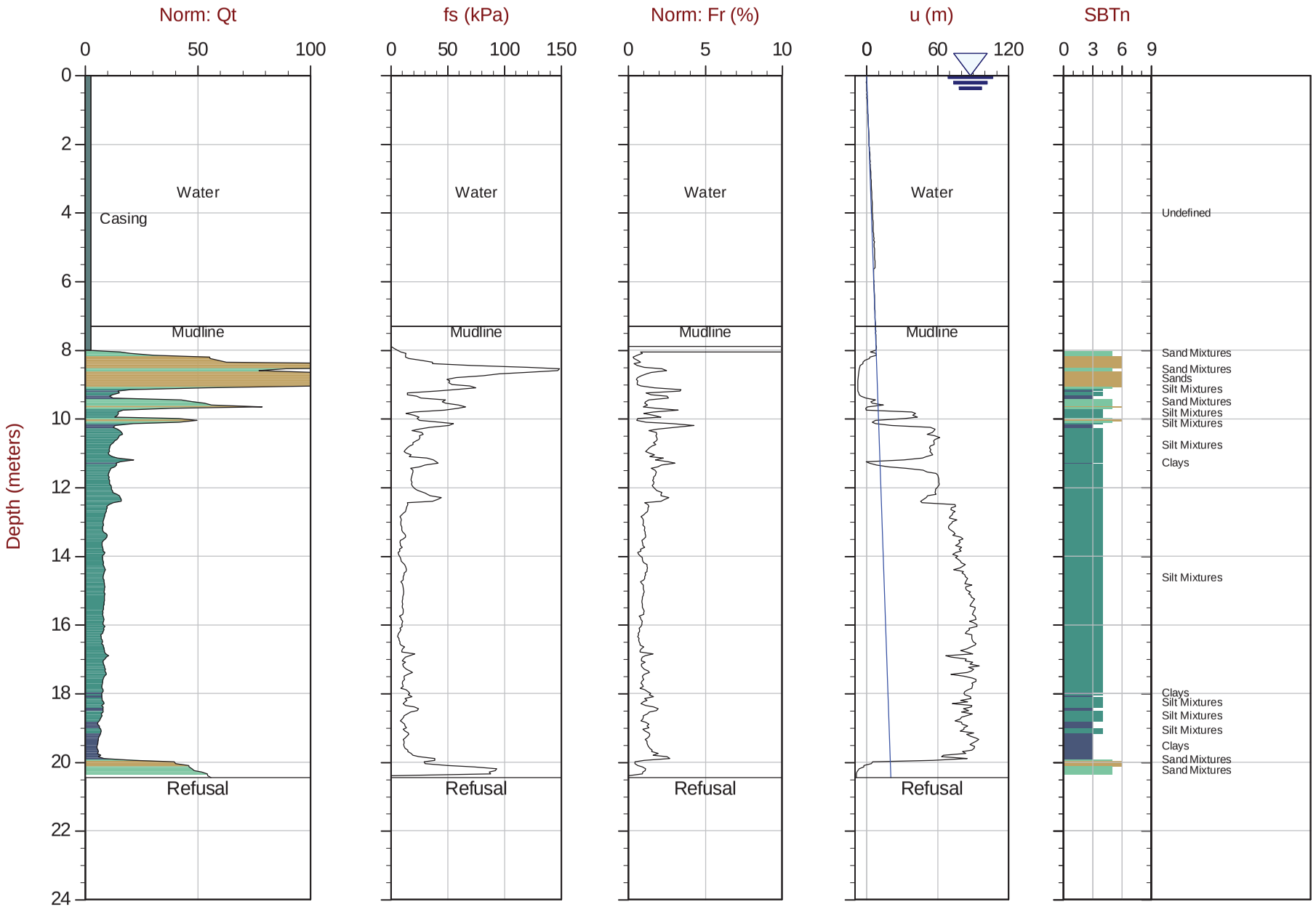
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:17:13 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500



Max Depth: 20.450 m / 67.09 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP05.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791937 E: 594573

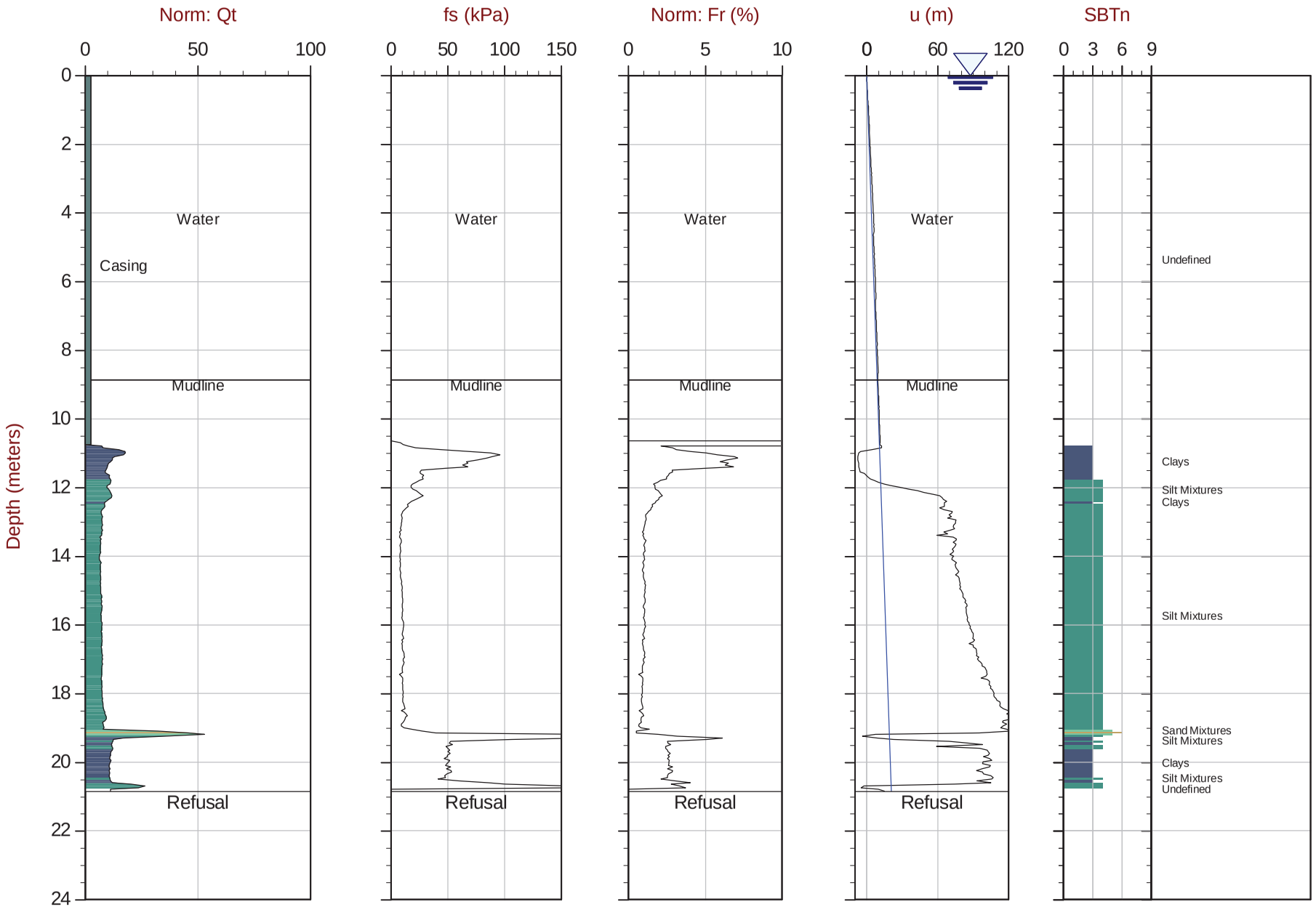
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:18:13 12:04
Site: Hamilton, ON

Sounding: CPT13-07
Cone: 322:T1500F15U500



Max Depth: 20.850 m / 68.40 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP07.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791915 E: 594720

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
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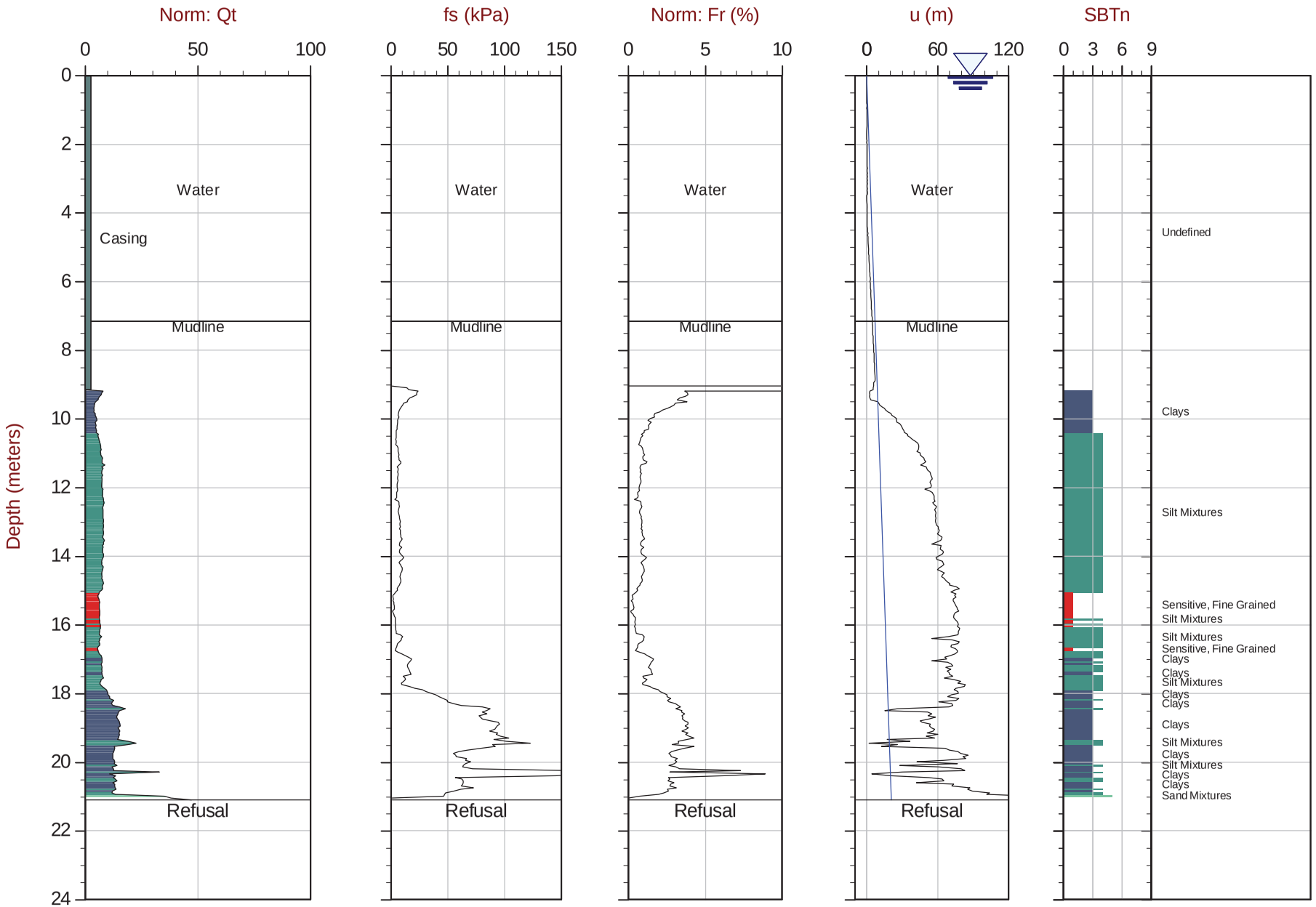
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500



Max Depth: 21.100 m / 69.22 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP12.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791705 E: 594623

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

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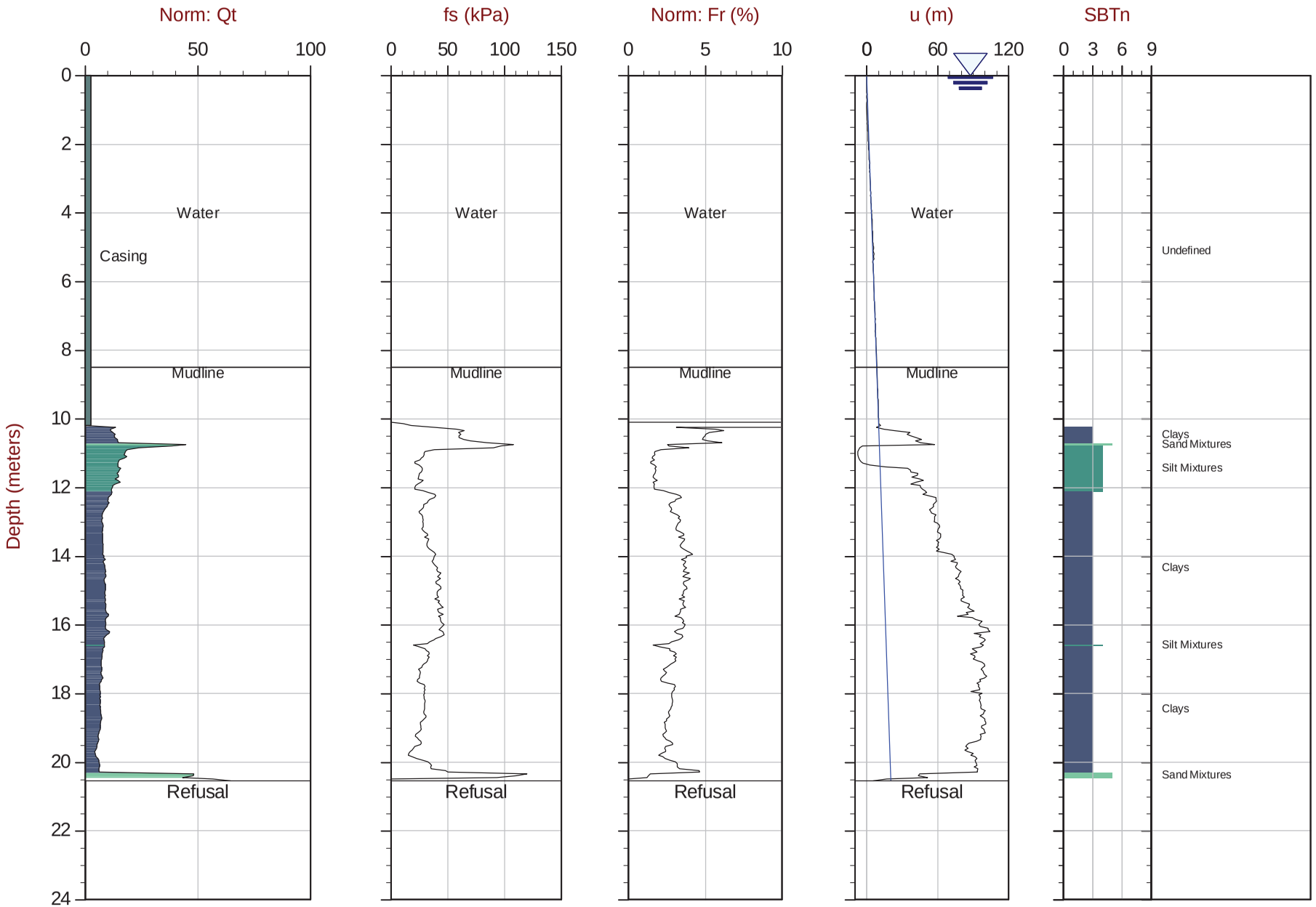
Date: 09:19:13 08:29
Site: Hamilton, ON

Sounding: CPT13-13
Cone: 322:T1500F15U500



Max Depth: 20.550 m / 67.42 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP13.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791874 E: 594441

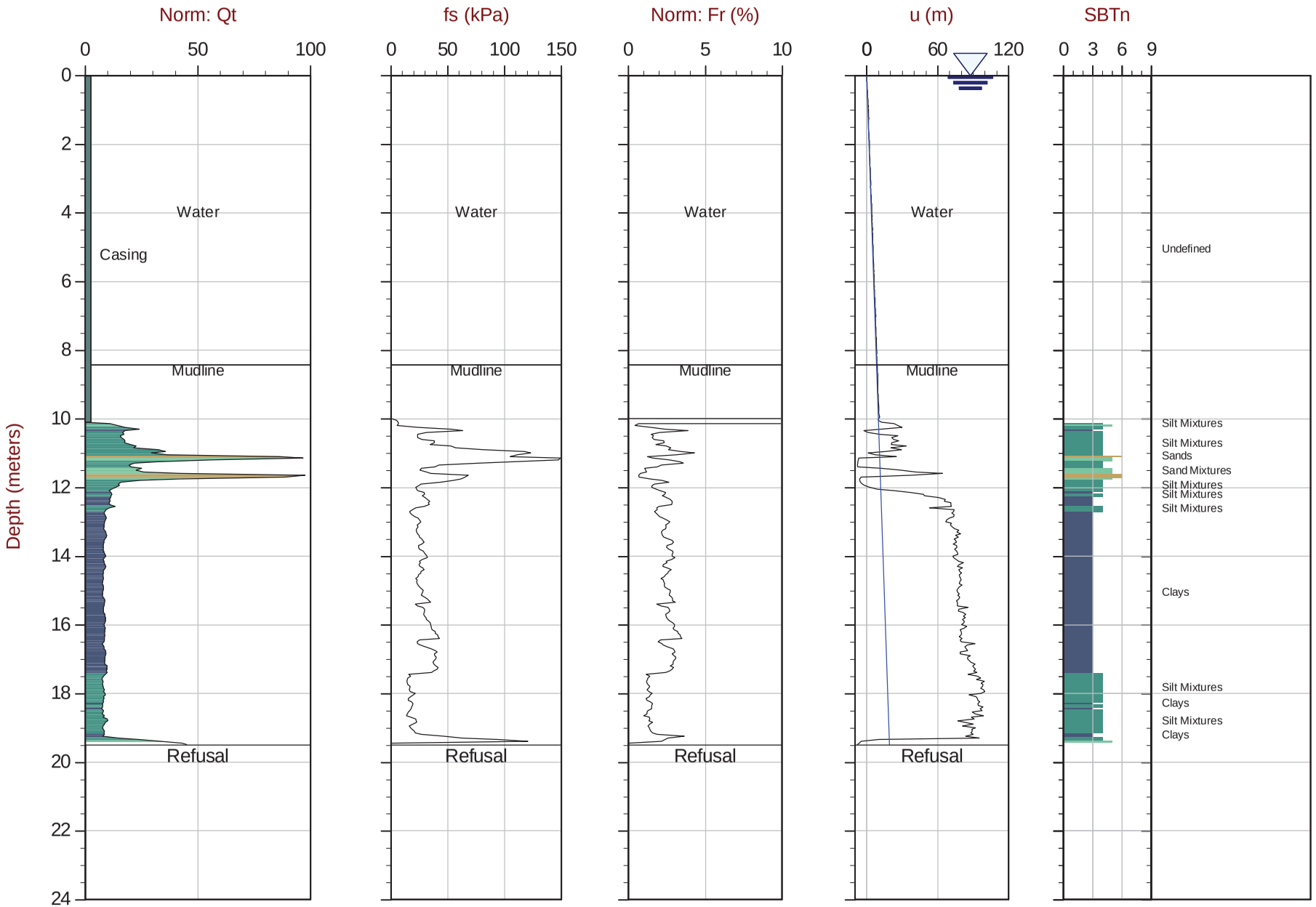
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09:19:13 10:59
Site: Hamilton, ON

Sounding: CPT13-14
Cone: 322:T1500F15U500



Max Depth: 19.500 m / 63.98 ft
Depth Inc: 0.050 m / 0.164 ft

File: 13-05017_CP14.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4791970 E: 594651

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Appendix B

CONETEC INTERPRETATION METHODS

A Detailed Description of the Methods Used in ConeTec's CPT Interpretation and Plotting Software

Revision SZW-Rev 05A
April 8, 2011

Prepared by Jim Greig

CONETEC

ConeTec Interpretations as of April 8, 2011

ConeTec's interpretation routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the program and does not assume liability for any use of the results in any design or review. Representative hand calculations should be made for any parameter that is critical for design purposes. The end user of the interpreted output should also be fully aware of the techniques and the limitations of any method used in this program. The purpose of this document is to inform the user as to which methods were used and what the appropriate papers and/or publications are for further reference.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (e.g. 0.20m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction, f_s, are not required.

The tip correction is: $q_t = q_c + (1-a) \cdot u_2$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weights that have been assigned to the Soil Behavior Type zones, from a user defined unit weight profile or by using a single value throughout the profile.

Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). For over water projects the effects of the column of water have been taken into account as has the appropriate unit weight of water. How this is done depends on where the instruments were zeroed (i.e. on deck or at mud line).

Details regarding the interpretation methods for all of the interpreted parameters are provided in Table 1. The appropriate references cited in Table 1 are listed in Table 2. Where methods are based on charts or techniques that are too complex to describe in this summary the user should refer to the cited material.

The Soil Behavior Type classification charts (normalized and non-normalized) shown in Figures 1 and 2 are based on the charts developed by Dr. Robertson and Dr. Campanella at the University of British Columbia. These charts appear in many publications, most notably: Robertson, Campanella, Gillespie and Greig (1986); Robertson (1990) and Lunne, Robertson and Powell (1997). The Bq classification charts shown in Figures 3a and 3b are based on those described in Robertson (1990) and Lunne, Robertson and Powell (1997). The Jefferies and Davies SBT chart shown in Figure 3c is based on that discussed in Jefferies and Davies, 1993.

Where the results of a calculation/interpretation are declared *'invalid'* the value will be represented by the text strings "-9999" or "-9999.0". In some cases the value 0 will be used. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g. drilled out section or data gap).

2. Where the interpretation method is inappropriate, for example, drained parameters in an undrained material (and vice versa).

3. Where interpretation input values are beyond the range of the referenced charts or specified limitations of the interpretation method.

4. Where pre-requisite or intermediate interpretation calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the interpreted parameters listed in Table 1 may be included in the output files delivered with this report.

The output files are provided in Microsoft Excel XLS format. The ConeTec software has several options for output depending on the number or types of interpreted parameters desired. Each output file will be named using the original COR file basename followed by a three or four letter indicator of the interpretation set selected (e.g. BSC, TBL, NLI or IFI) and possibly followed by an operator selected suffix identifying the characteristics of the particular interpretation run.

Table 1
CPT Interpretation Methods

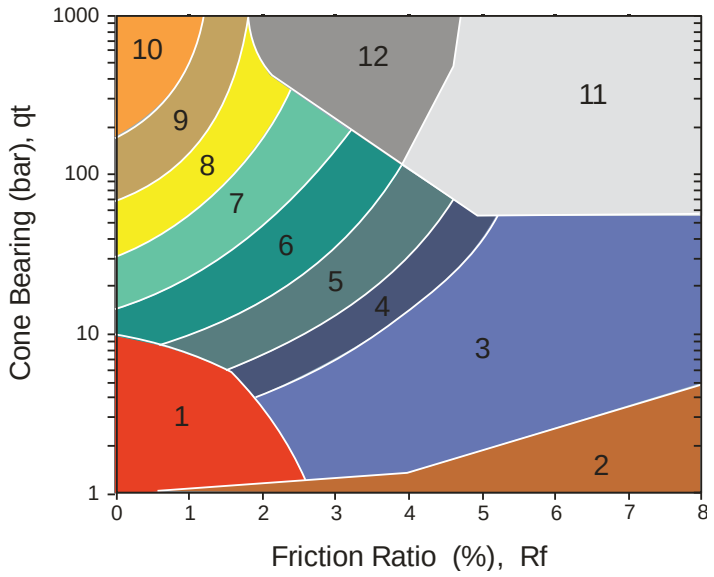
Interpreted Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where interpretations are done at each point then Mid Layer Depth = Recorded Depth)*	*Depth (Layer Top) + Depth (Layer Bottom) / 2.0*	
Elevation	Elevation of Mid Layer based on sounding collar elevation supplied by client	Elevation = Collar Elevation - Depth	
Avgqc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when interpretations are done at each point*	
Avgqt	Averaged corrected tip (q_t) where: $q_t = q_c + (1-a) \bullet u$	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when interpretations are done at each point*	
Avgfs	Averaged sleeve friction (f_s)	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when interpretations are done at each point*	
AvgRf	Averaged friction ratio (Rf) where friction ratio is defined as: $Rf = 100\% \bullet \frac{fs}{qt}$	$AvgRf = 100\% \bullet \frac{Avgfs}{Avgqt}$ *n=1 when interpretations are done at each point*	
Avgu	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when interpretations are done at each point*	
AvgRes	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} RESISTIVITY_i$ *n=1 when interpretations are done at each point*	
AvgUVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when interpretations are done at each point*	
AvgTemp	Averaged Temperature (this data is not always available since it is a specialized test)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} TEMPERATURE_i$ *n=1 when interpretations are done at each point*	

Interpreted Parameter	Description	Equation	Ref
AvgGamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} GAMMA_i$ *n=1 when interpretations are done at each point*	
SBT	Soil Behavior Type as defined by Robertson and Campanella	See Figure 1	2, 5
U.Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) user supplied unit weight profile	See references	5
T. Stress σ_v	Total vertical overburden stress at Mid Layer Depth. *A layer is defined as the averaging interval specified by the user. For data interpreted at each point the Mid Layer Depth is the same as the recorded depth.*	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness	
E. Stress σ_v'	Effective vertical overburden stress at Mid Layer Depth	*Estress = Tstress - u_{eq}*	
Ueq	Equilibrium pore pressure determined from one of the following user selectable options: 1) hydrostatic from water table depth 2) user supplied profile	For hydrostatic option: $u_{eq} = \gamma_w \cdot (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is unit weight of water D is the current depth D_{wt} is the depth to the water table	
Cn	SPT N_{60} overburden correction factor	*$Cn=(\sigma_v')^{-0.5}$* where *σ_v' is in tsf* *$0.5 < C_n < 2.0$*	
N_{60}	SPT N value at 60% energy calculated from qt/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	4, 5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure	*$(N_1)_{60} = Cn \cdot N_{60}$*	4
$N_{60}I_c$	SPT N_{60} values based on the Ic parameter	(qt/pa)/ N_{60} = 8.5 (1 – Ic/4.6)	5
$(N_1)_{60}$Ic	SPT N_{60} value corrected for overburden pressure (using N_{60} $I_{c)}$. User has 2 options.	*1) $(N_1)_{60}Ic = Cn \cdot (N_{60}\, Ic)$* 2) q_{c1n}/ *$(N_1)_{60}Ic$* = 8.5 (1 – Ic/4.6)	4 5
$(N_1)_{60cs}$Ic	Clean sand equivalent SPT $(N_1)_{60}$Ic. User has 3 options.	1) $(N_1)_{60cs}Ic = \alpha + \beta((N_1)_{60}Ic)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}Ic)$ 3) q_{c1ncs})/ $(N_1)_{60cs}$Ic = 8.5 (1 – Ic/4.6) FC ≤ 5%: α = 0, β=1.0 FC ≥ 35% α = 5.0, β=1.2 5% < FC < 35% $\alpha = \exp[1.76 - (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
Su	Undrained shear strength based on q_t Su factor N_{kt} is user selectable	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
Su	Undrained shear strength based on pore pressure Su factor $N_{\Delta u}$ is user selectable	$Su = \frac{u_2 - u_{eq}}{N_{\Delta u}}$	1, 5
k	Coefficient of permeability (assigned to each SBT zone)		5

Interpreted Parameter	Description	Equation	Ref
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ *where:* $\Delta u = u - u_{eq}$ *and u = dynamic pore pressure* *u_{eq} = equilibrium pore pressure*	1, 5
Q_t	Normalized q_t for Soil Behavior Type classification as defined by Robertson, 1990	$Qt = \frac{qt - \sigma_v}{\sigma'_v}$	2, 5
F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson, 1990	$Fr = 100\% \cdot \frac{fs}{qt - \sigma_v}$	2, 5
Net qt	Net tip resistance	$qt - \sigma_v$	
qe	Effective tip resistance	$qt - u_2$	
qeNorm	Normalized effective tip resistance	$\frac{qt - u_2}{\sigma'_v}$	
SBTn	Normalized Soil Behavior Type as defined by Robertson and Campanella	See Figure 2	2, 5
SBT-BQ	Non-normalized Soil Behavior type based on the Bq parameter	See Figure 3	2, 5
SBT-BQn	Normalized Soil Behavior based on the Bq parameter	See Figure 3	2, 5
SBT-JandD	Soil Behaviour Type as defined by Jeffries and Davies	See Figure 3	7
SBT-BQn	Normalized Soil Behavior base on the Bq parameter	See Figure 3	2, 5
I_c	Soil index for estimating grain characteristics	*$Ic = [(3.47 - \log_{10}Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$* *Where:* $Q = \left(\frac{qt - \sigma_v}{P_{a2}}\right)\left(\frac{P_a}{\sigma'_v}\right)^n$ *And Fr is in percent* *P_a = atmospheric pressure* *P_{a2} = atmospheric pressure* *n varies from 0.5 to 1.0 and is selected in an iterative manner based on the resulting I_c*	3, 8
FC	Apparent fines content (%)	*$FC = 1.75(Ic^{3.25}) - 3.7$* *FC=100 for Ic > 3.5* *FC=0 for Ic < 1.26* *FC = 5% if 1.64 < Ic < 2.6 AND F_r<0.5*	3
Ic Zone	This parameter is the Soil Behavior Type zone based on the Ic parameter (valid for zones 2 through 7 on SBTn chart)	Ic < 1.31 Zone = 7 1.31 < Ic < 2.05 Zone = 6 2.05 < Ic < 2.60 Zone = 5 2.60 < Ic < 2.95 Zone = 4 2.95 < Ic < 3.60 Zone = 3 Ic > 3.60 Zone = 2	3
PHI ϕ	Friction Angle determined from one of the following user selectable options: a) Campanella and Robertson b) Durgunoglu and Mitchel c) Janbu d) Kulhawy and Mayne	See reference	5 5 5 11

Interpreted Parameter	Description	Equation	Ref
Dr	Relative Density determined from one of the following user selectable options: a) Ticino Sand b) Hokksund Sand c) Schmertmann 1976 d) Jamiolkowski - All Sands	See reference	5
OCR	Over Consolidation Ratio	a) Based on Schmertmann's method involving a plot of S_u/σ_v' /($S_u/\sigma_v')_{NC}$ and OCR where the Su/p' ratio for NC clay is user selectable	9
State Parameter	The state parameter is used to describe whether a soil is contractive (SP is positive) or dilative (SP is negative) at large strains based on the work by Been and Jefferies	See reference	8, 6, 5
Es/qt	Intermediate parameter for calculating Young's Modulus, E, in sands. It is the Y axis of the reference chart.	Based on Figure 5.59 in the reference	5
Young's Modulus E	Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the Es/qt chart.	Mean normal stress is evaluated from: $\sigma_m' = \frac{1}{3}(\sigma_v' + \sigma_h' + \sigma_h')$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress and $\sigma_h = K_o \cdot \sigma_v'$ with Ko assumed to be 0.5	5
q_{c1}	q_t normalized for overburden stress used for seismic analysis	$q_{c1} = q_t \cdot (Pa/\sigma_v')^{0.5}$ where: Pa = atm. Pressure q_t is in MPa	3
q_{c1n}	q_{c1} in dimensionless form used for seismic analysis	$q_{c1n} = (q_{c1} / Pa)(Pa/\sigma_v')^n$ where: Pa = atm. Pressure and n ranges from 0.5 to 0.75 based on Ic.	3
K_{SPT}	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) \cdot (FC - 5))$	10
K_{CPT}	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$ $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference)	10
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \cdot K_{cpt}$	3
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833 [(q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93 [(q_{c1ncs}/1000]^3 + 0.08$	10

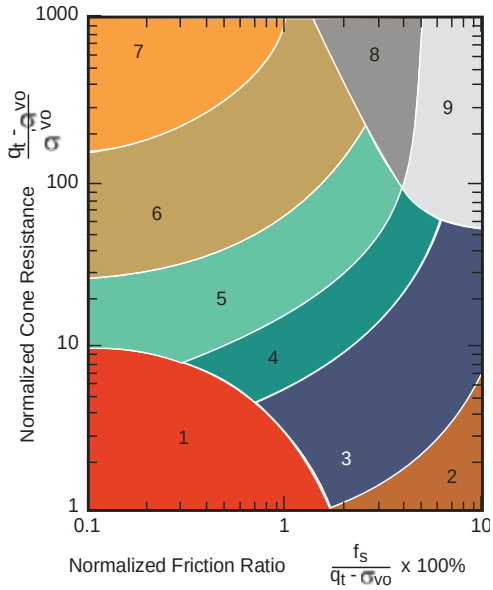
Interpreted Parameter	Description	Equation	Ref
CSR	Cyclic Stress Ratio	$CSR = (\tau_{av}/\sigma_v') = 0.65\ (a_{max} / g)\ (\sigma_v/ \sigma_v')\ r_d$ $r_d = 1.0 – 0.00765\ z$ $z \leq 9.15m$ $r_d = 1.174 – 0.0267\ z$ $9.15 < z \leq 23m$ $r_d = 0.744 – 0.008\ z$ $23 < z \leq 30m$ $r_d = 0.50$ $z > 30m$	10
MSF	Magnitude Scaling Factor	See Reference	10
FofS	Factor of Safety against Liquefaction	$FS = (CRR_{7.5} / CSR)\ MSF$	10
Liquefaction Status	Statement indicating possible liquefaction	Takes into account FofS and limitations based on I_c and q_{c1ncs}.	10
Cont/Dilat Tip	Contractive / Dilative qc1 Boundary based on $(N_1)_{60}$	$(\sigma_v')_{boundary} = 9.58 \times 10^{-4}\ [(N_1)_{60}]^{4.79}$ qc1 is calculated from specified qt(MPa)/N ratio	13
Cq	Normalizing Factor	$Cq = 1.8 / (0.8 + ((\sigma_v'/Pa))$	12
qc1 (Cq)	Normalized tip resistance based on Cq	$q_{c1} = C_q * q_t$ (some papers use q_c)	12
Su(Liq)/s'v	Liquefied Shear Strength Ratio	$\frac{Su(Liq)}{\sigma_v'} = 0.03 + 0.0143(q_{c1})$	13



Zone	qt / N	Soil Behavior Type
1	2	sensitive fine grained
2	1	organic material
3	1	clay
4	1.5	silty clay to clay
5	2	clayey silt to silty clay
6	2.5	sandy silt to clayey silt
7	3	silty sand to sandy silt
8	4	sand to silty sand
9	5	sand
10	6	gravelly sand to sand
11	1	very stiff fine grained *
12	2	sand to clayey sand *

* overconsolidated or cemented

Figure 1 Non-Normalized Behavior Type Classification Chart



Zone	Normalized Soil Behavior Type
1	sensitive fine grained
2	organic material
3	clay to silty clay
4	clayey silt to silty clay
5	silty sand to sandy silt
6	clean sands to silty sands
7	gravelly sand to sand
8	very stiff sand to clayey sand
9	very stiff fine grained

Figure 2 Normalized Behavior Type Classification Chart

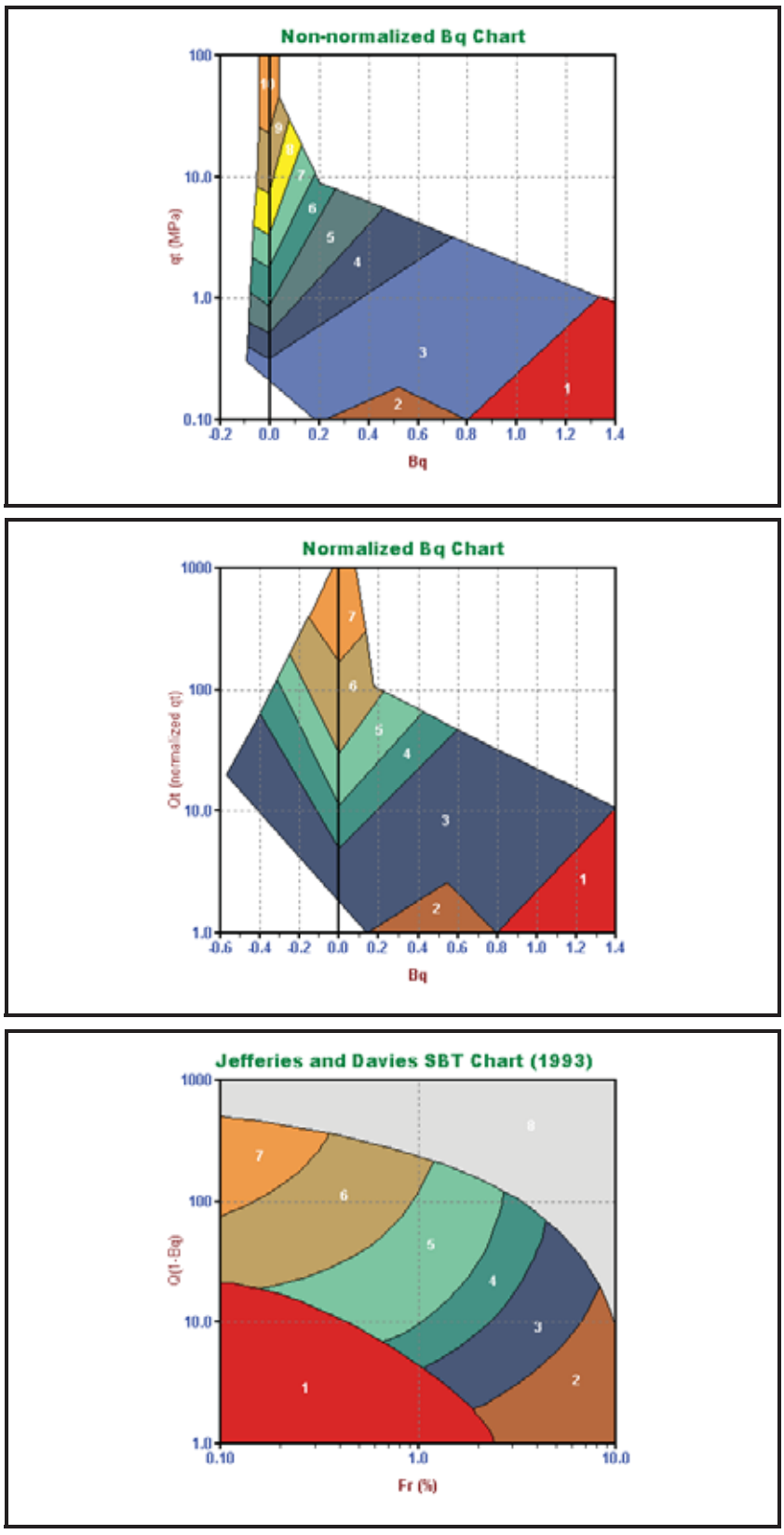


Figure 3 – Alternate Soil Behaviour Type Charts

Table 2 References

No.	References
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10	Proceedings of theNCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt LakeCity, 1996. Chaired by Leslie Youd. 11
11	Kulhawy, F.H. and Mayne, P.W. ,1990, “Manual on Estimating Soil Properties for Foundation Design, *Report No. EL-6800”*, Electric Power Research Institute, Palo Alto, CA, August 1990, 306 p.
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Appendix C

Job Number 13-05017
Client Peto-MacCallum Ltd.
Project Randle Reef
Date Sep 17, 2013 to Sep 19, 2013

Table 2 Dissipation Trace Summary

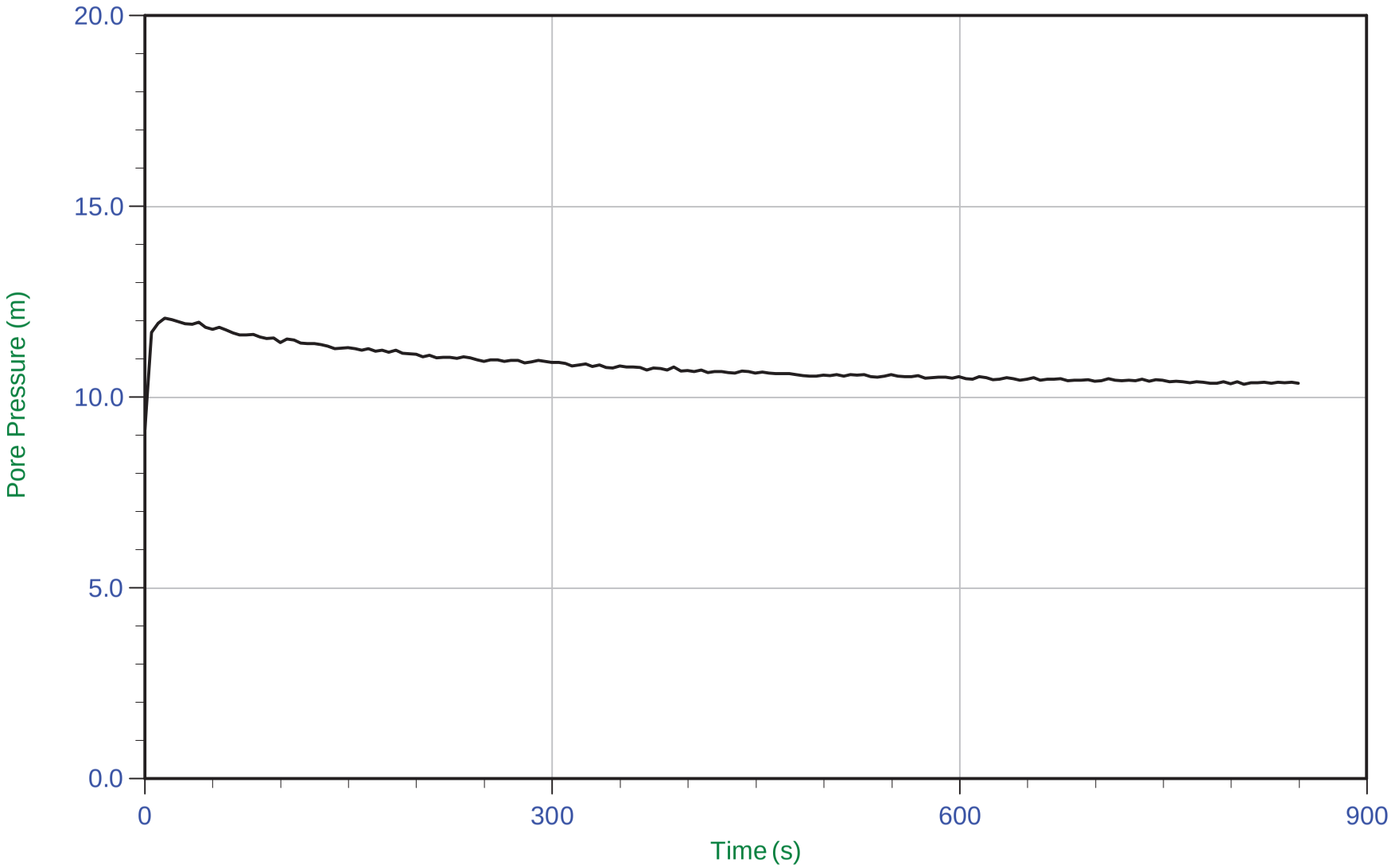
Sounding ID	Duration s	Depth m	Ueq m	Calc. Phrea. Surface m	Est. Phrea. Surface m	T at U50 s	T50 s	Ch cm^2/min
CPT13-01	850.0	9.000	9.00		0.00	536.7	521.7	1.35
CPT13-01	900.0	14.000	14.00		0.00	769.4	699.4	1.00
CPT13-01	585.0	18.600						
CPT13-01	400.0	20.600						
CPT13-02	370.0	12.000	12.00		0.00			
CPT13-02	280.0	19.000	19.00		0.00			
CPT13-02	220.0	22.950	22.95		0.00			
CPT13-05	70.0	8.350	8.35		0.00			
CPT13-05	250.0	12.500	12.50		0.00			
CPT13-05	630.0	20.050	20.05		0.00			
CPT13-05	220.0	20.450	20.45		0.00			
CPT13-07	920.0	19.150	19.15		0.00	121.5	116.5	6.03
CPT13-07	300.0	20.850	20.85		0.00			
CPT13-12	200.0	12.000	12.00		0.00			
CPT13-12	530.0	18.500	18.50		0.00			
CPT13-12	230.0	20.700	20.70		0.00			
CPT13-12	800.0	21.100	21.10		0.00	545.2	545.2	1.29
CPT13-13	130.0	11.400						
CPT13-13	150.0	20.550	20.55		0.00			
CPT13-14	300.0	11.150	11.15		0.00			
CPT13-14	730.0	11.400	11.40		0.00			
CPT13-14	1000.0	19.500	19.50		0.00	764.8	659.8	1.06

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP01.PPD
Depth: 9.000 m / 29.527 ft
Duration: 850.0 s

U Min: 9.2 m
U Max: 12.1 m

WT: 0.000 m / 0.000 ft
Ueq: 9.0 m
U(50): 10.54 m

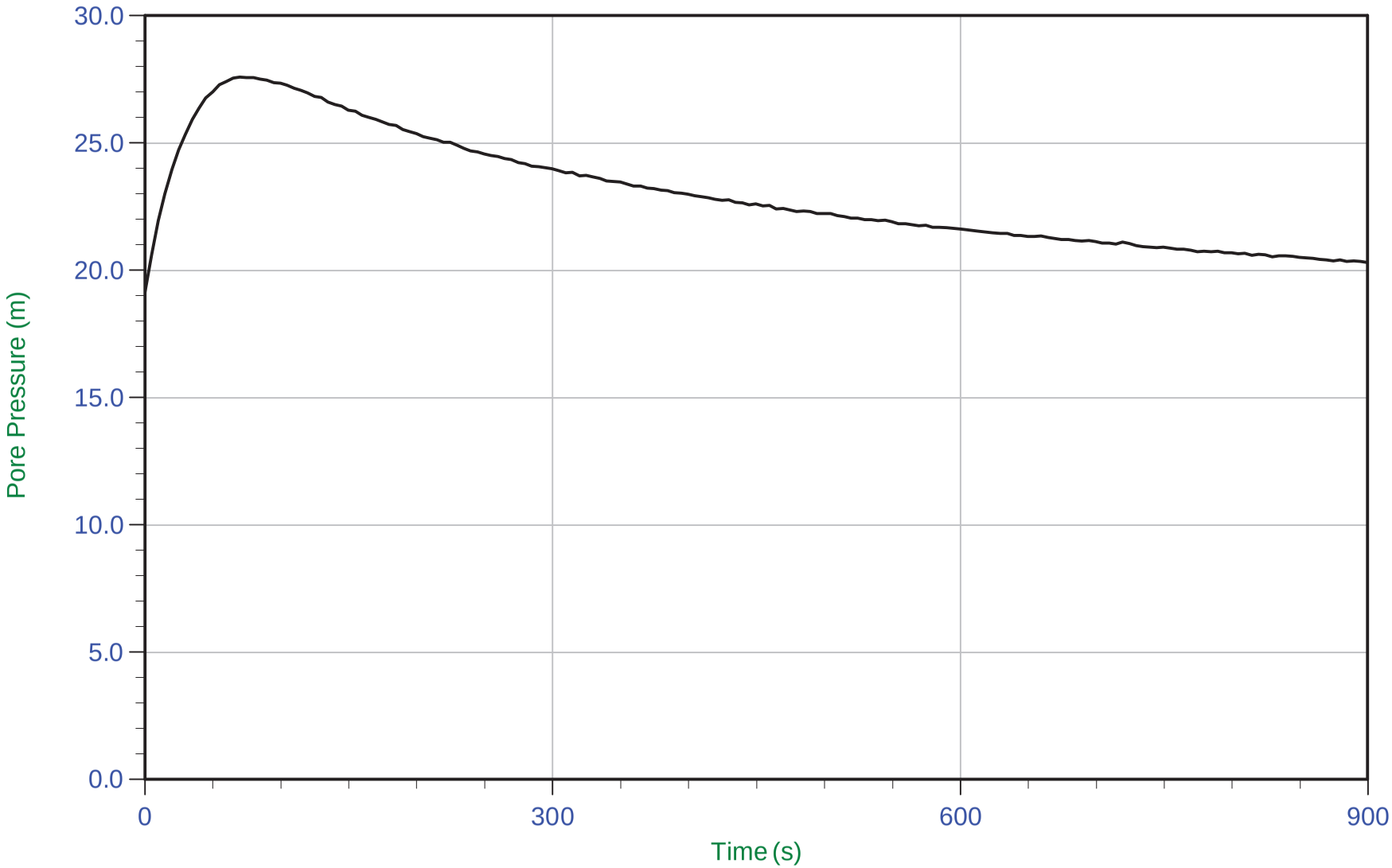
T(50): 521.7 s
Ir: 100
Ch: 1.3 sq cm/min

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP01.PPD
Depth: 14.000 m / 45.931 ft
Duration: 900.0 s

U Min: 19.1 m
U Max: 27.6 m

WT: 0.000 m / 0.000 ft
Ueq: 14.0 m
U(50): 20.79 m

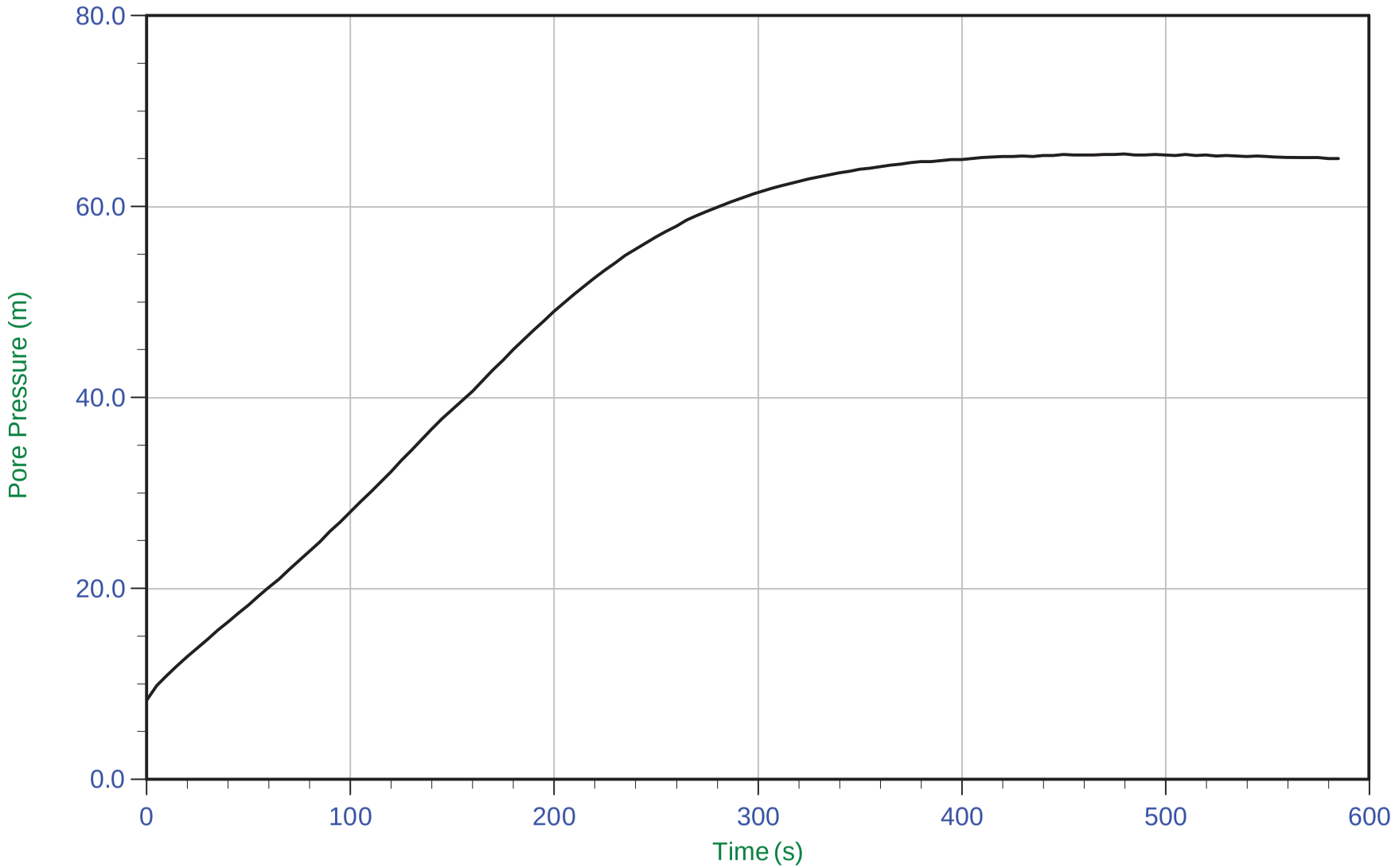
T(50): 699.4 s
Ir: 100
Ch: 1.0 sq cm/min

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP01.PPD
Depth: 18.600 m / 61.023 ft
Duration: 585.0 s

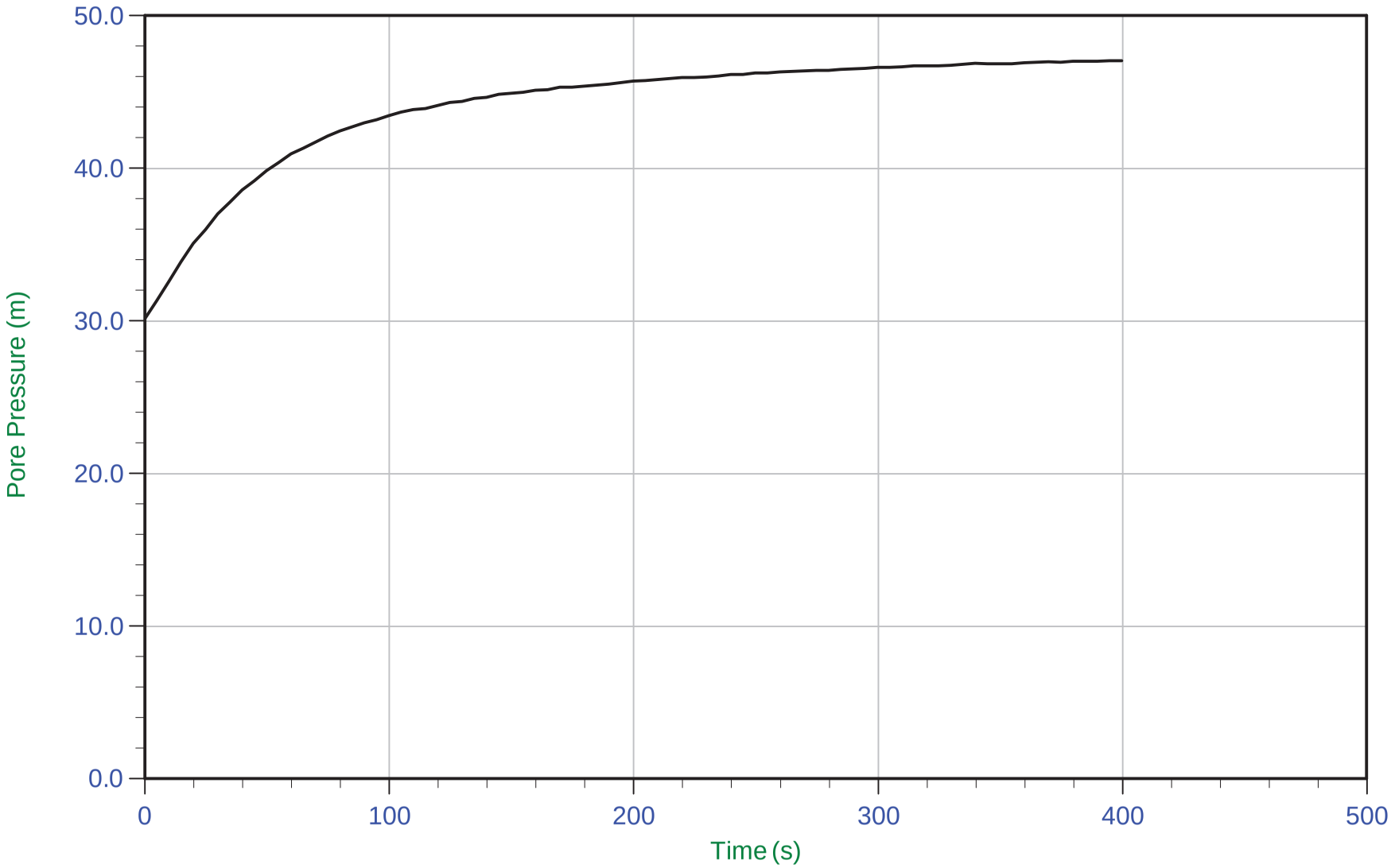
U Min: 8.3 m
U Max: 65.5 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 08:39
Site: Hamilton, ON

Sounding: CPT13-01
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP01.PPD
Depth: 20.600 m / 67.584 ft
Duration: 400.0 s

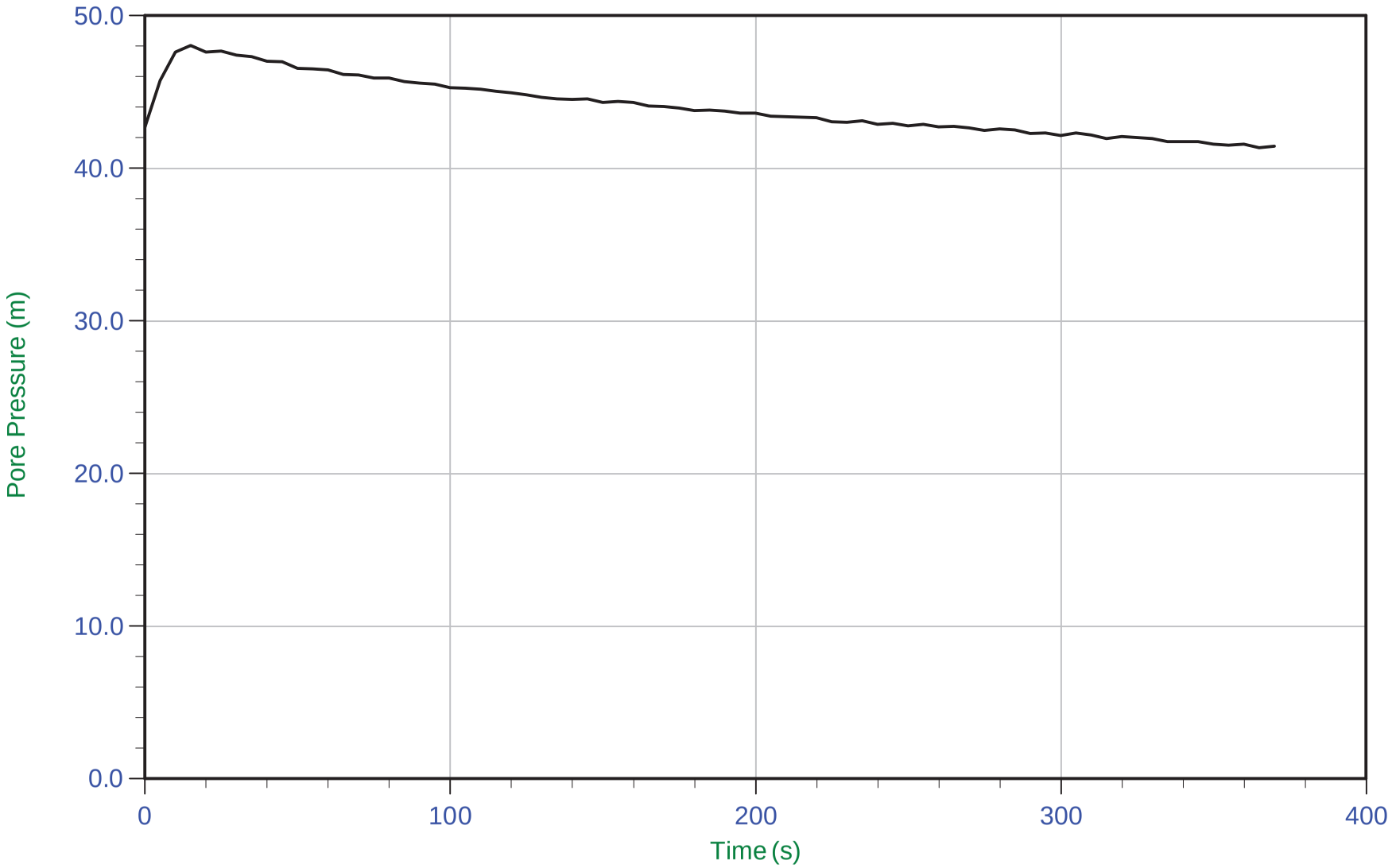
U Min: 30.2 m
U Max: 47.1 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 16:20
Site: Hamilton, ON

Sounding: CPT13-02
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP02.PPD
Depth: 12.000 m / 39.370 ft
Duration: 370.0 s

U Min: 41.4 m
U Max: 48.0 m

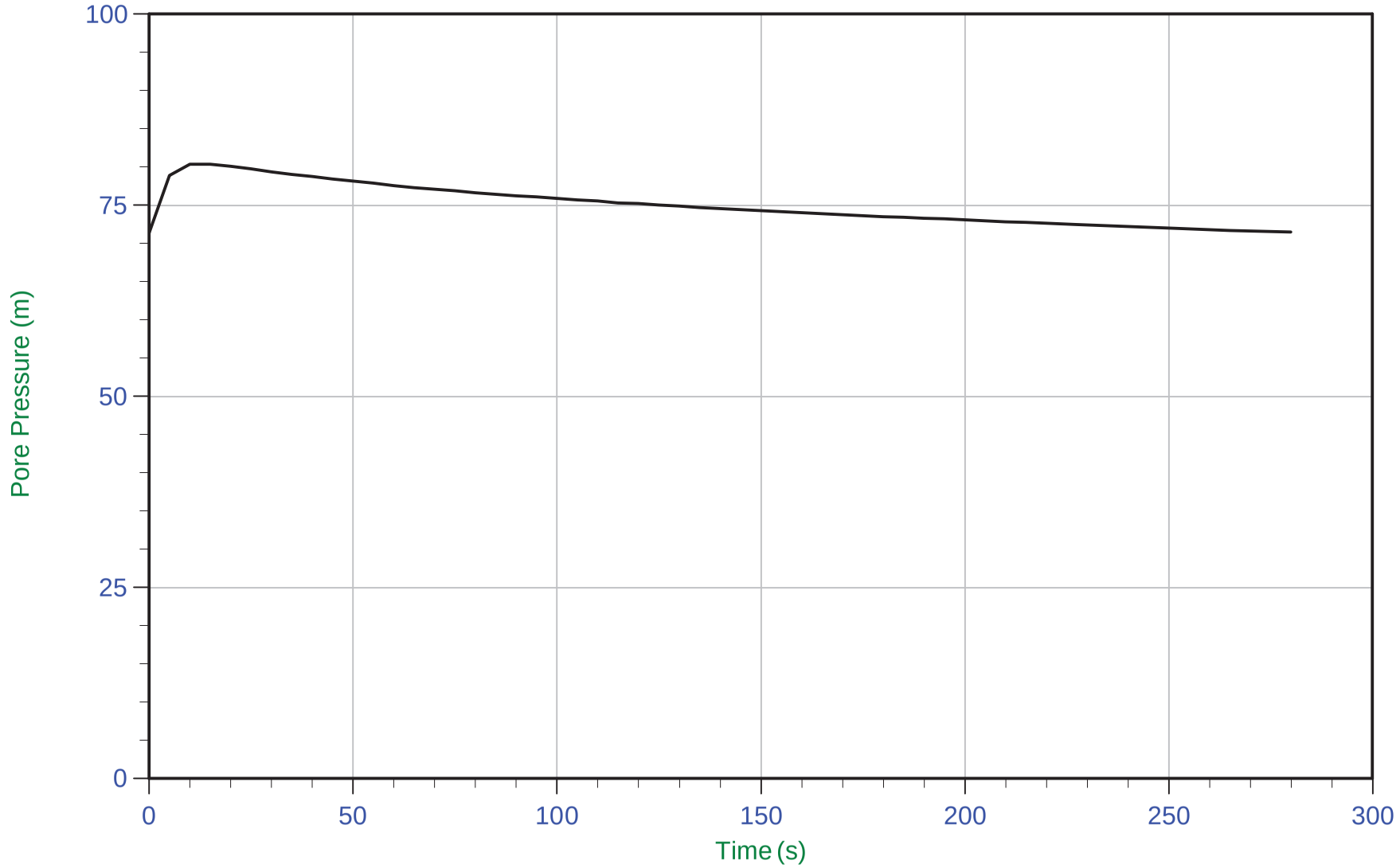
WT: 0.000 m / 0.000 ft
Ueq: 12.0 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 16:20
Site: Hamilton, ON

Sounding: CPT13-02
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP02.PPD
Depth: 19.000 m / 62.335 ft
Duration: 280.0 s

U Min: 71.4 m
U Max: 80.4 m

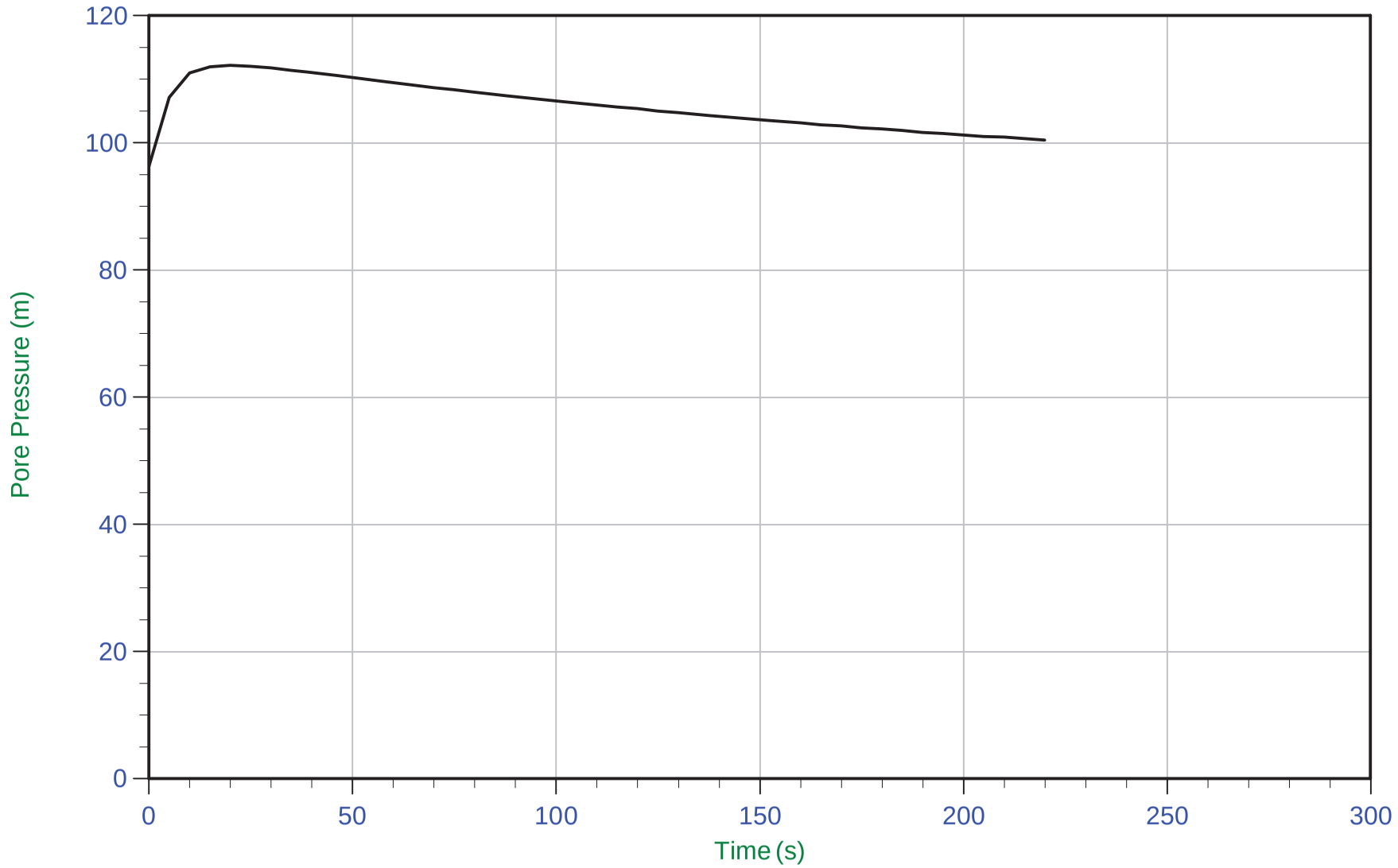
WT: 0.000 m / 0.000 ft
Ueq: 19.0 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 16:20
Site: Hamilton, ON

Sounding: CPT13-02
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP02.PPD
Depth: 22.950 m / 75.294 ft
Duration: 220.0 s

U Min: 96.2 m
U Max: 112.2 m

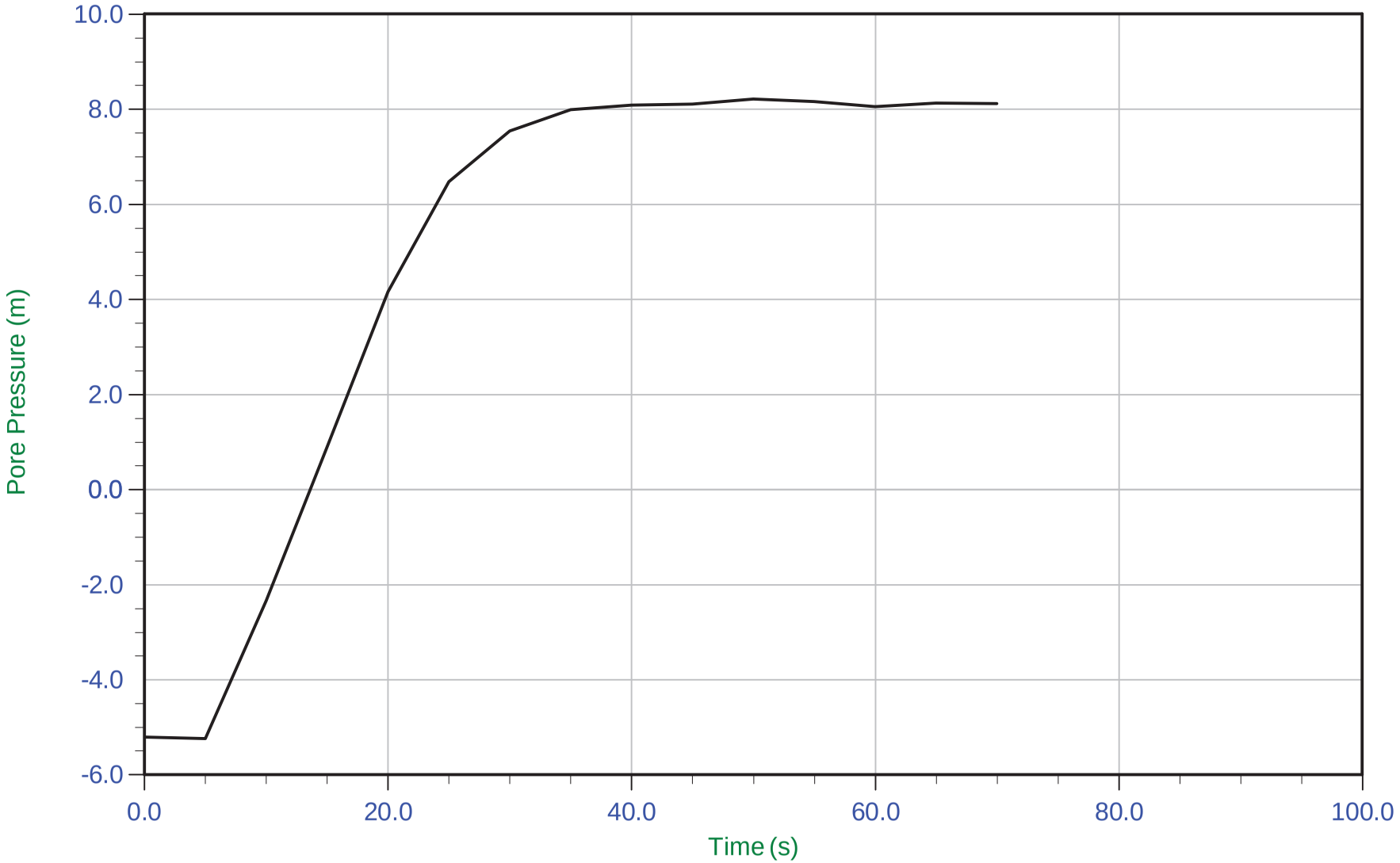
WT: 0.000 m / 0.000 ft
Ueq: 22.9 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP05.PPD
Depth: 8.350 m / 27.395 ft
Duration: 70.0 s

U Min: -5.2 m
U Max: 8.2 m

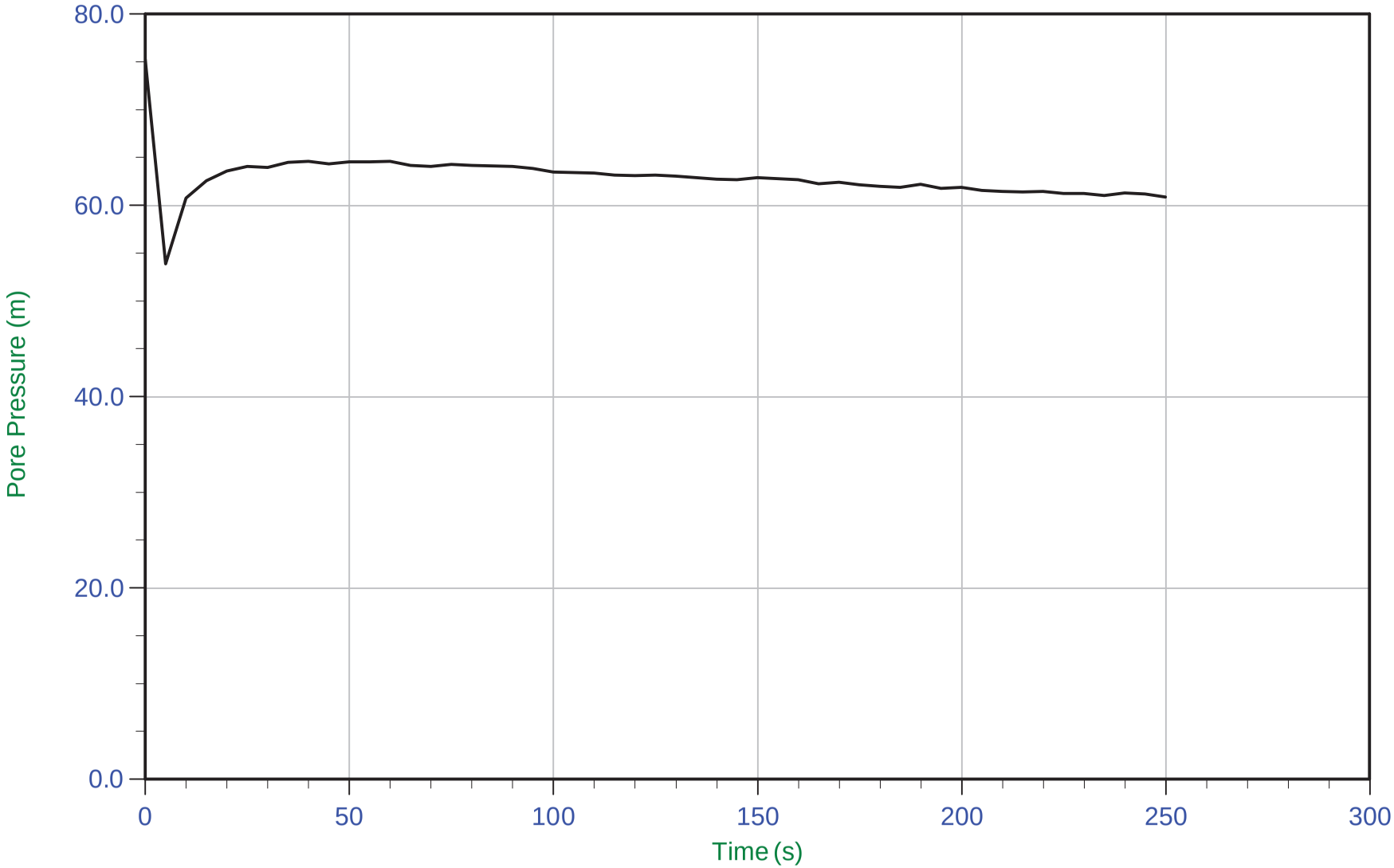
WT: 0.000 m / 0.000 ft
Ueq: 8.3 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP05.PPD
Depth: 12.500 m / 41.010 ft
Duration: 250.0 s

U Min: 53.9 m
U Max: 75.3 m

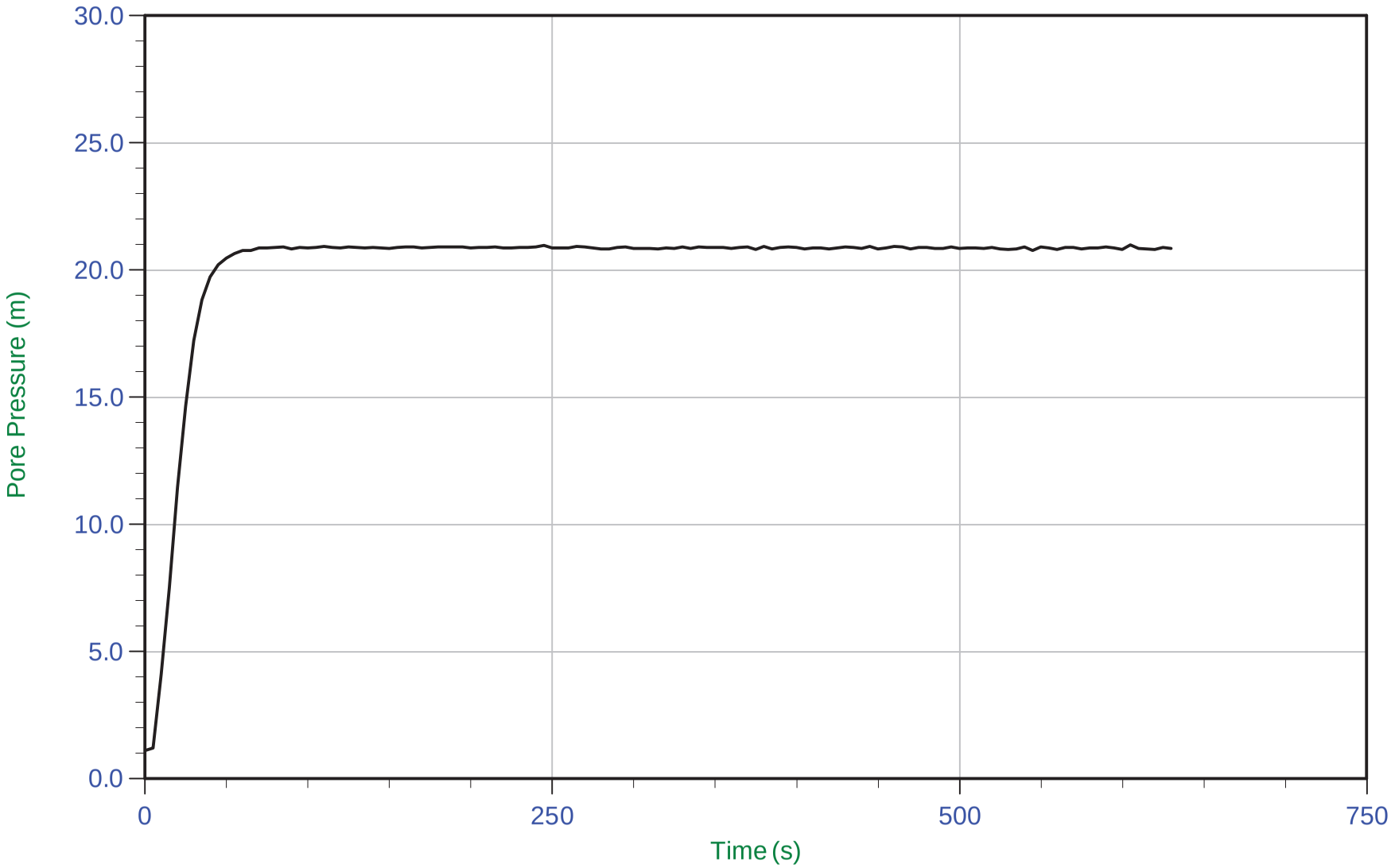
WT: 0.000 m / 0.000 ft
Ueq: 12.5 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP05.PPD
Depth: 20.050 m / 65.780 ft
Duration: 630.0 s

U Min: 1.1 m
U Max: 21.0 m

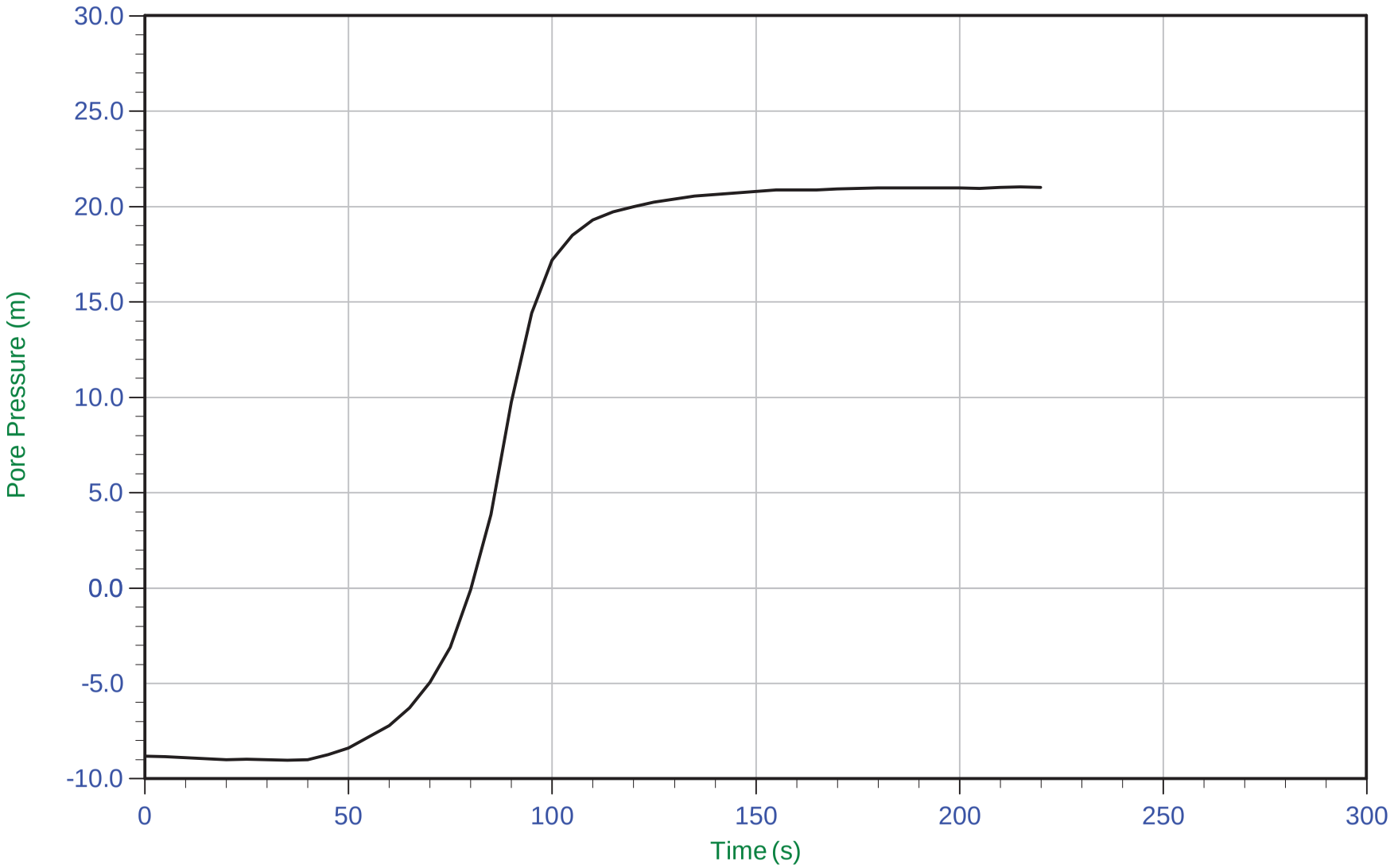
WT: 0.000 m / 0.000 ft
Ueq: 20.1 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/17/2013 12:56
Site: Hamilton, ON

Sounding: CPT13-05
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP05.PPD
Depth: 20.450 m / 67.092 ft
Duration: 220.0 s

U Min: -9.0 m
U Max: 21.0 m

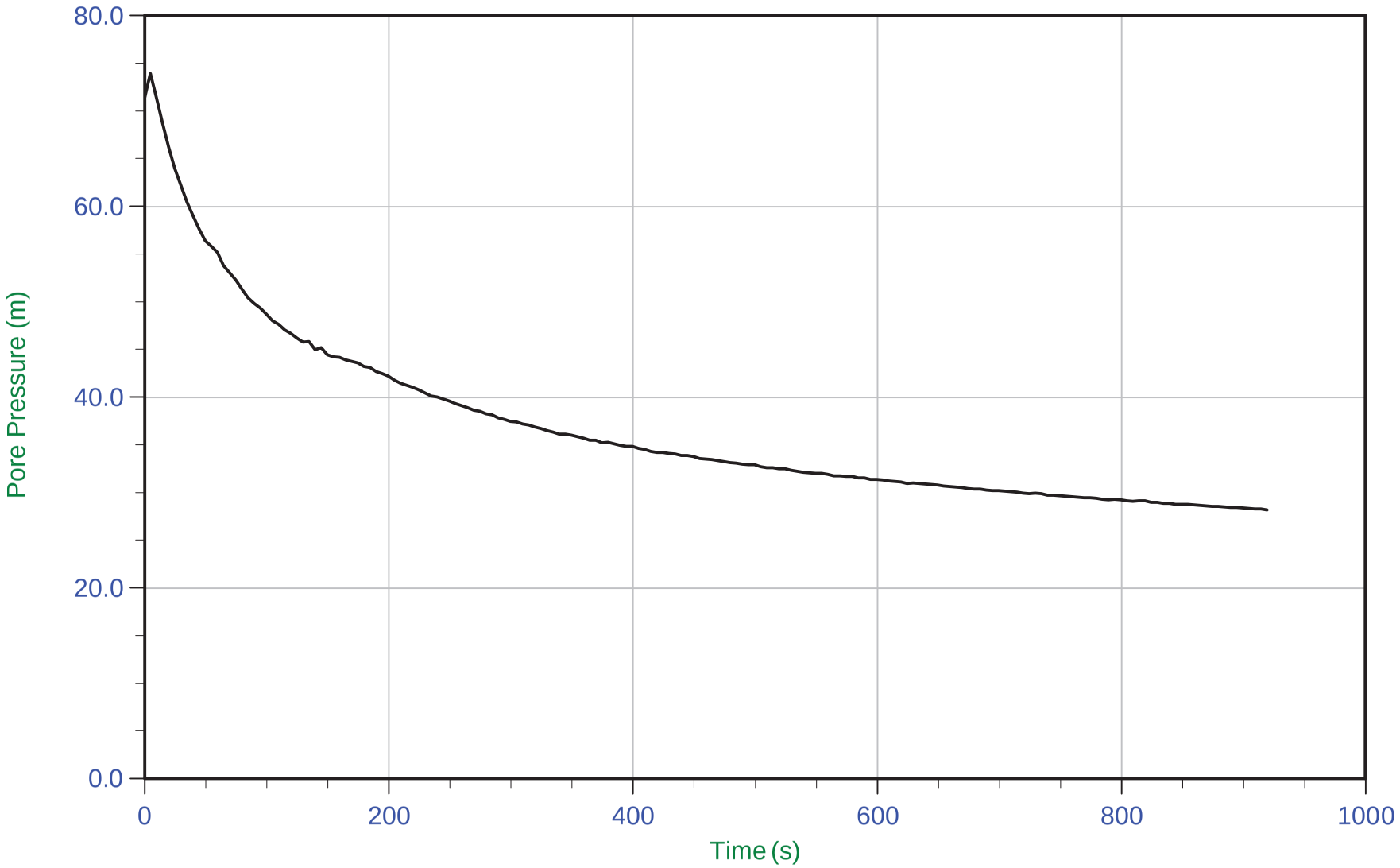
WT: 0.000 m / 0.000 ft
Ueq: 20.4 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 12:04
Site: Hamilton, ON

Sounding: CPT13-07
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP07.PPD
Depth: 19.150 m / 62.827 ft
Duration: 920.0 s

U Min: 28.2 m
U Max: 73.9 m

WT: 0.000 m / 0.000 ft
Ueq: 19.1 m
U(50): 46.54 m

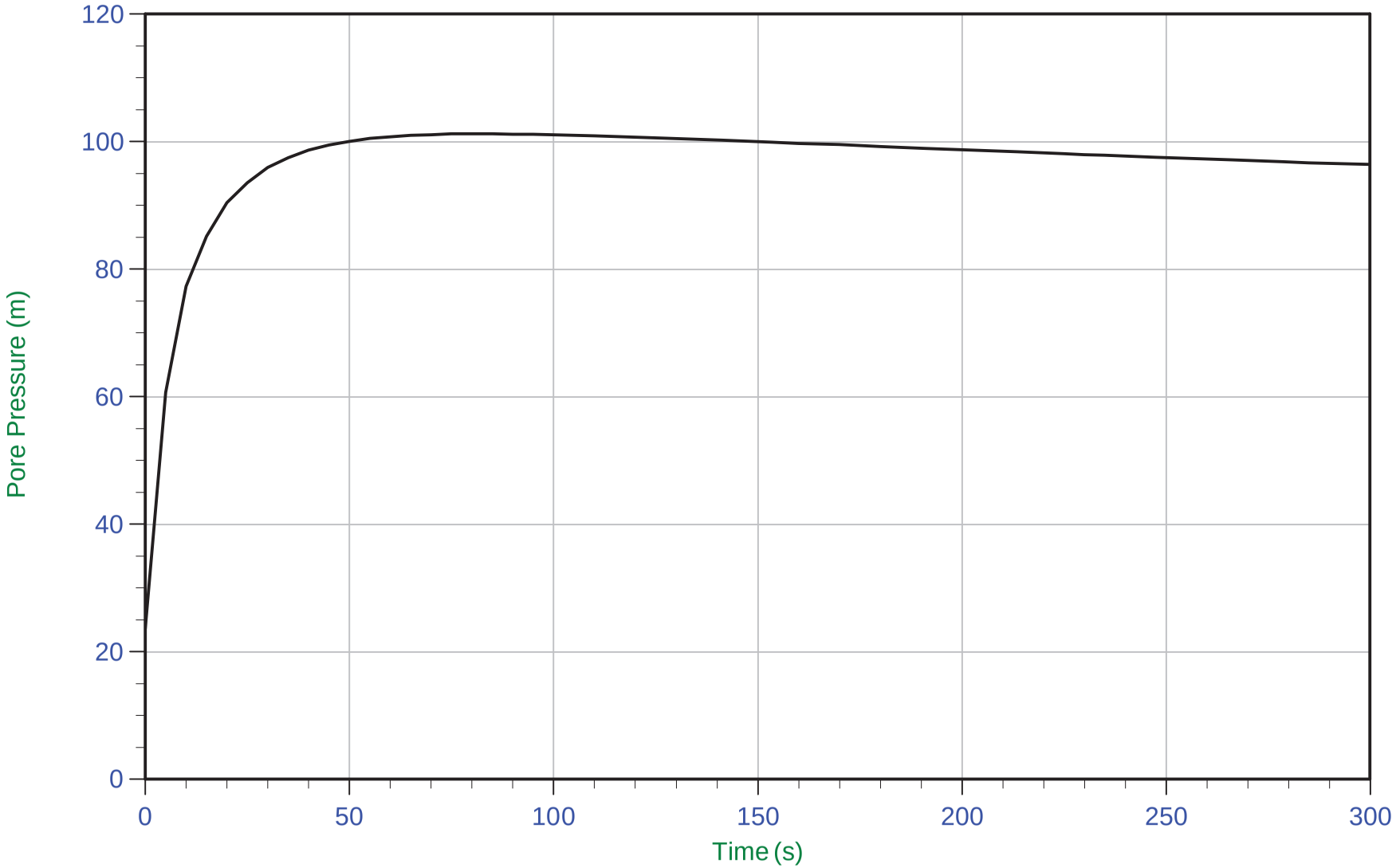
T(50): 116.5 s
Ir: 100
Ch: 6.0 sq cm/min

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 12:04
Site: Hamilton, ON

Sounding: CPT13-07
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP07.PPD
Depth: 20.850 m / 68.405 ft
Duration: 300.0 s

U Min: 23.6 m
U Max: 101.2 m

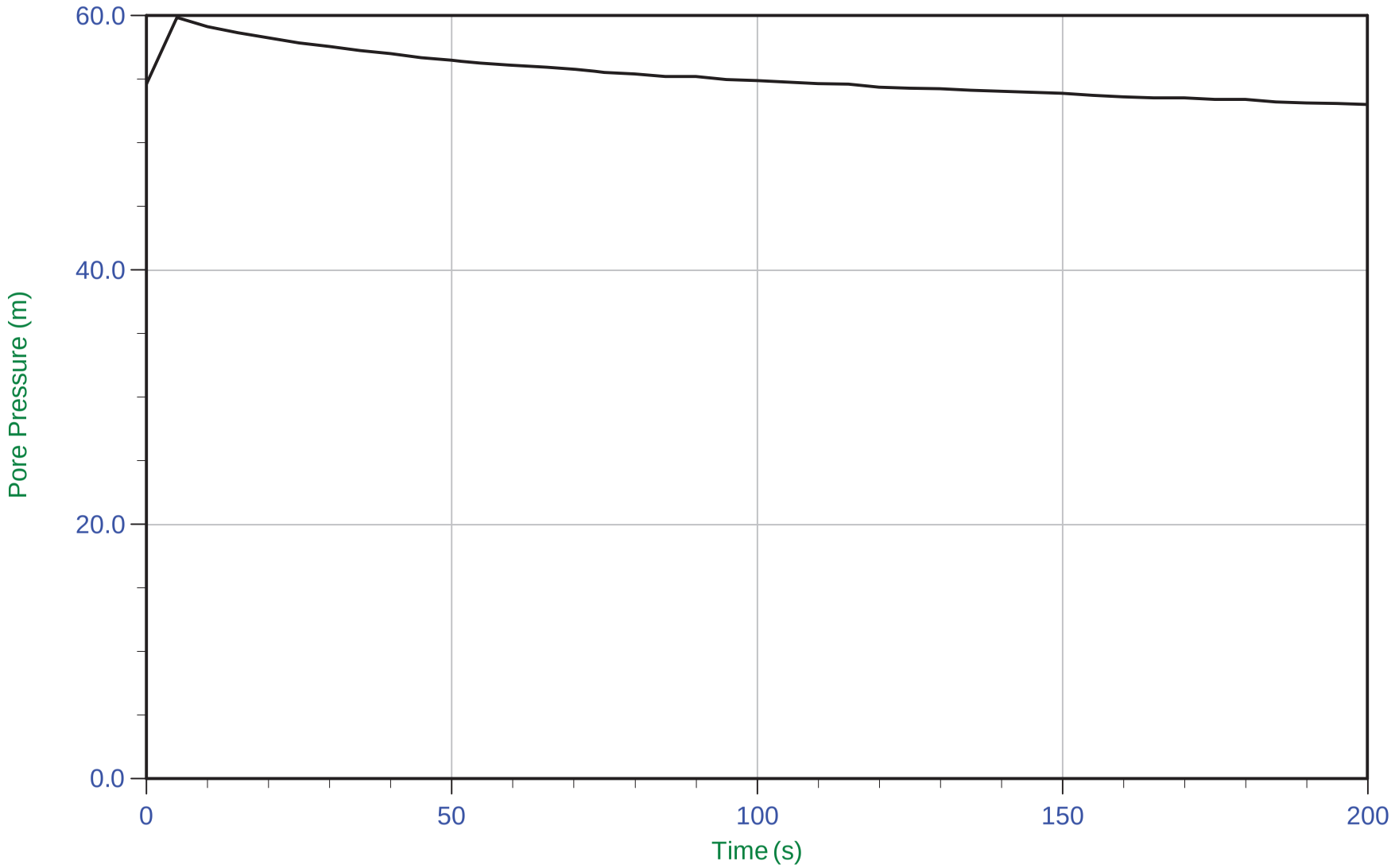
WT: 0.000 m / 0.000 ft
Ueq: 20.9 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 14:56
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP12.PPD
Depth: 12.000 m / 39.370 ft
Duration: 200.0 s

U Min: 53.0 m
U Max: 59.9 m

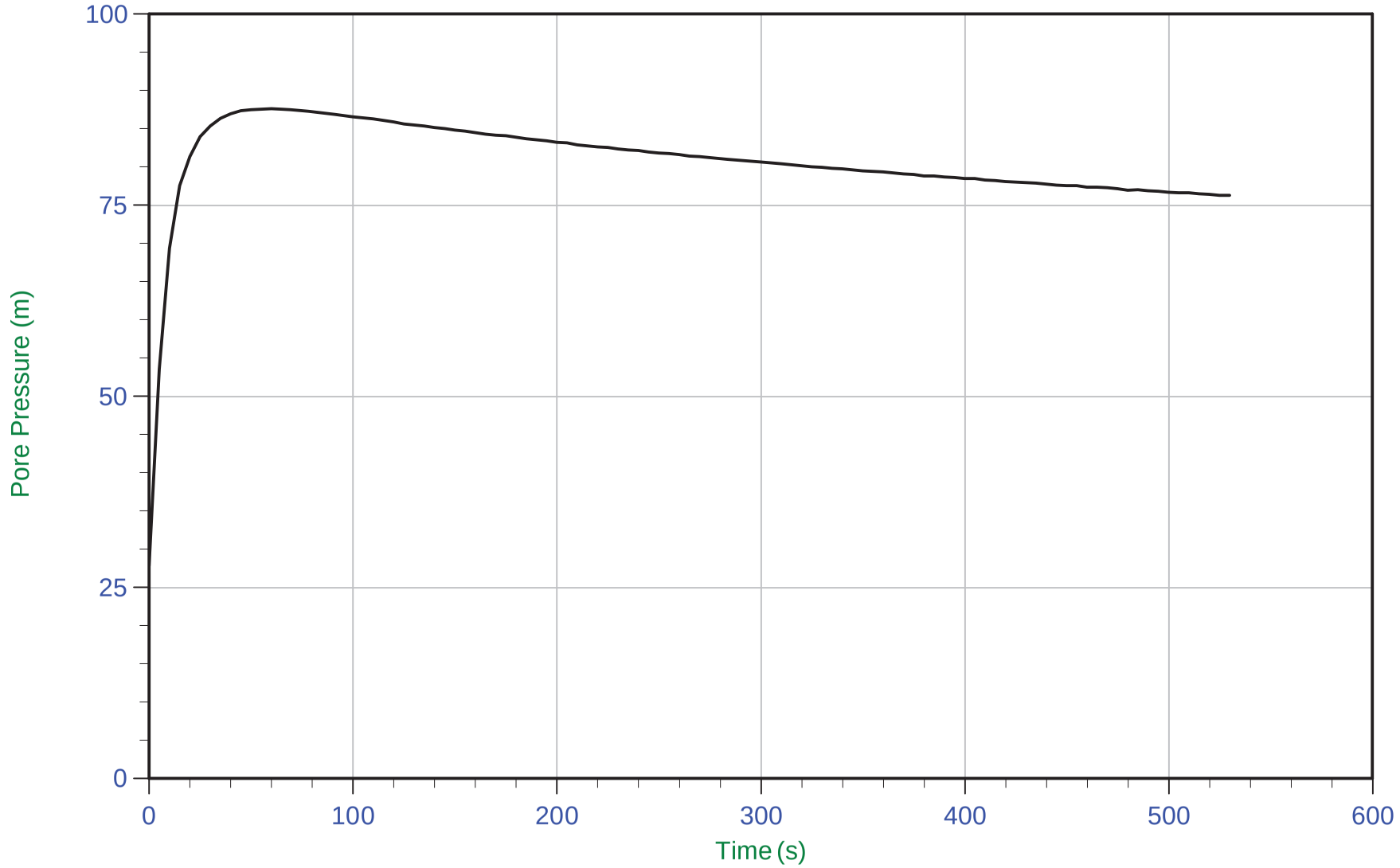
WT: 0.000 m / 0.000 ft
Ueq: 12.0 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 14:56
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP12.PPD
Depth: 18.500 m / 60.695 ft
Duration: 530.0 s

U Min: 27.8 m
U Max: 87.6 m

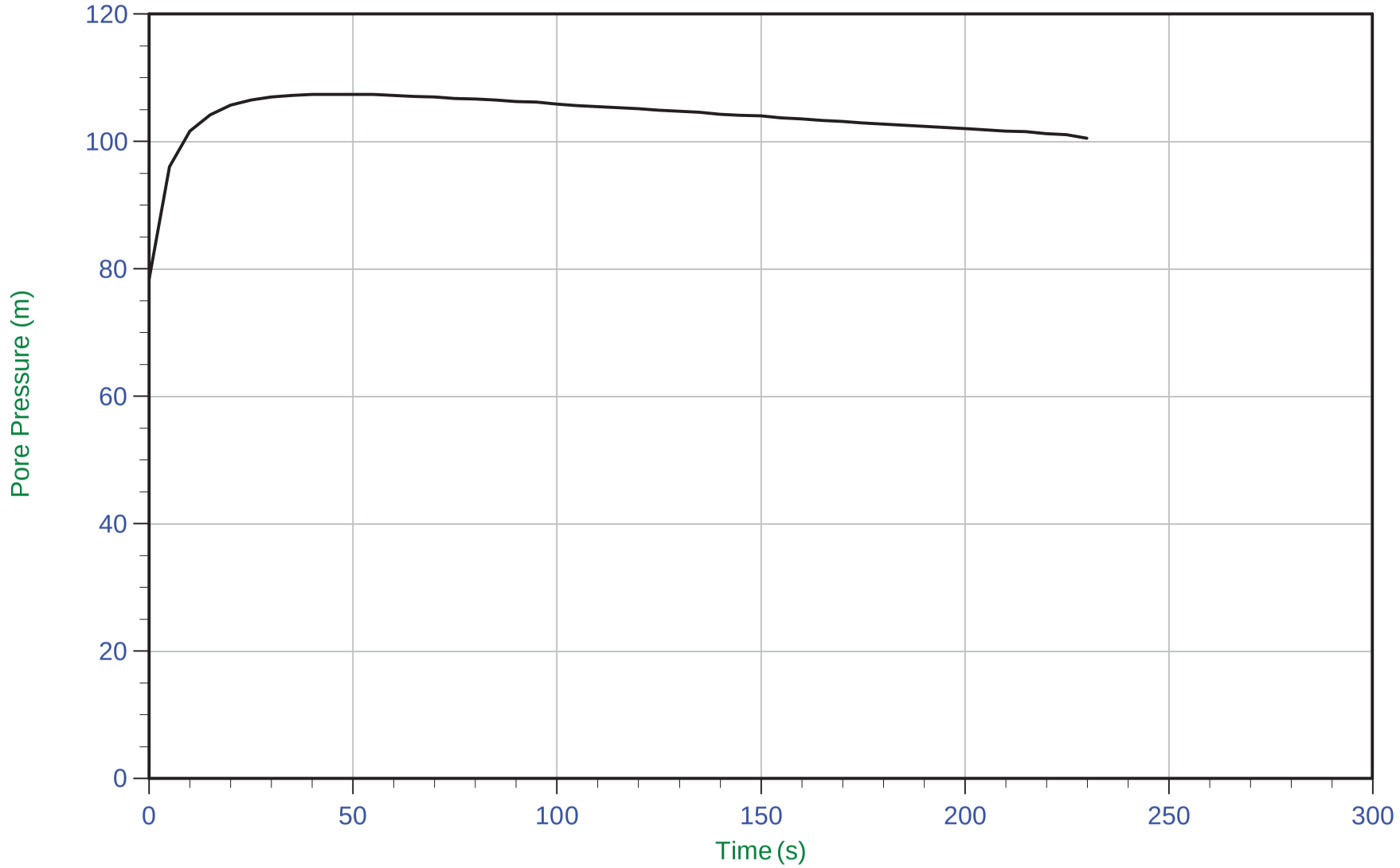
WT: 0.000 m / 0.000 ft
Ueq: 18.5 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 14:56
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP12.PPD
Depth: 20.700 m / 67.913 ft
Duration: 230.0 s

U Min: 78.3 m
U Max: 107.4 m

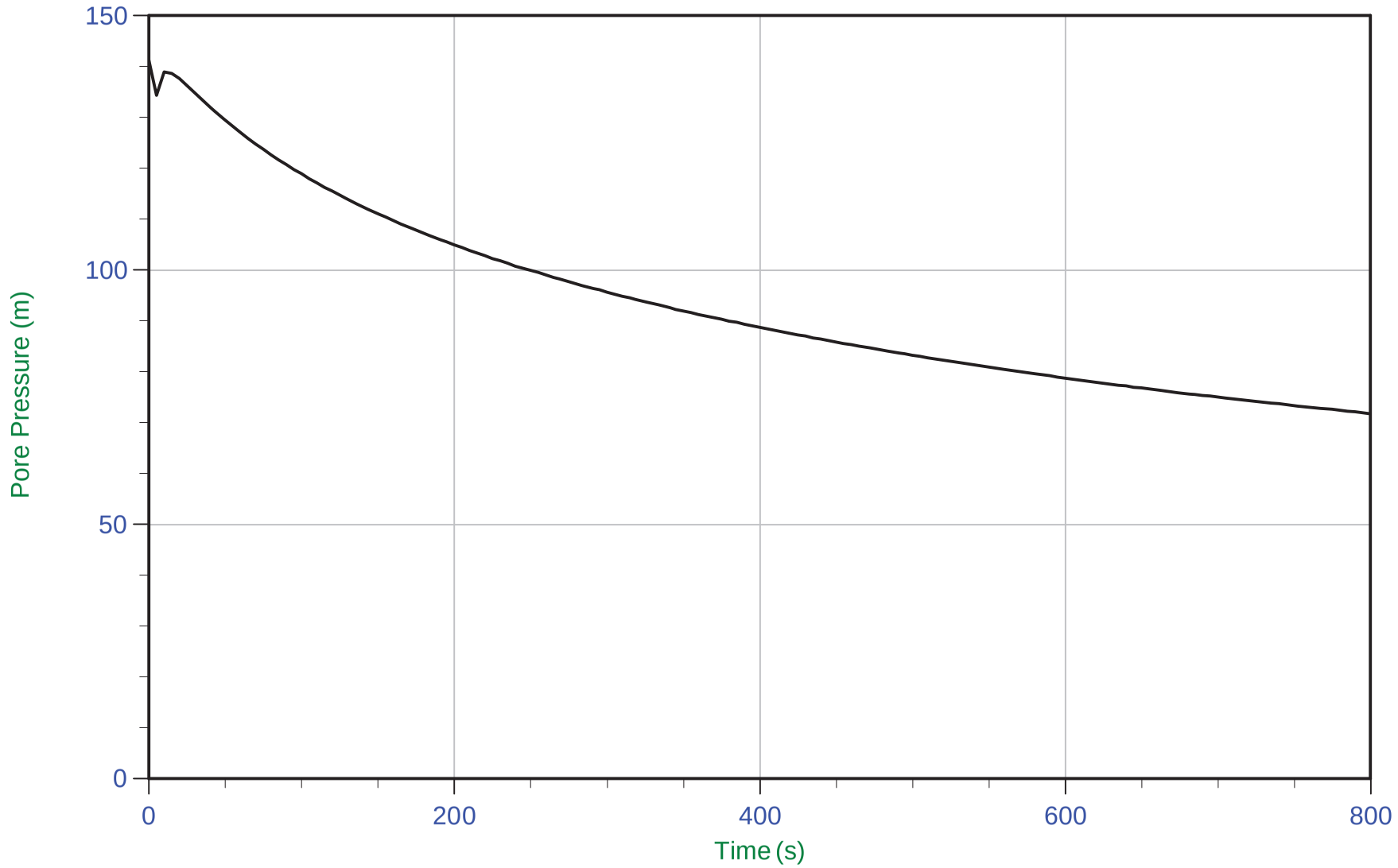
WT: 0.000 m / 0.000 ft
Ueq: 20.7 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/18/2013 14:56
Site: Hamilton, ON

Sounding: CPT13-12
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP12.PPD
Depth: 21.100 m / 69.225 ft
Duration: 800.0 s

U Min: 71.8 m
U Max: 141.2 m

WT: 0.000 m / 0.000 ft
Ueq: 21.1 m
U(50): 81.15 m

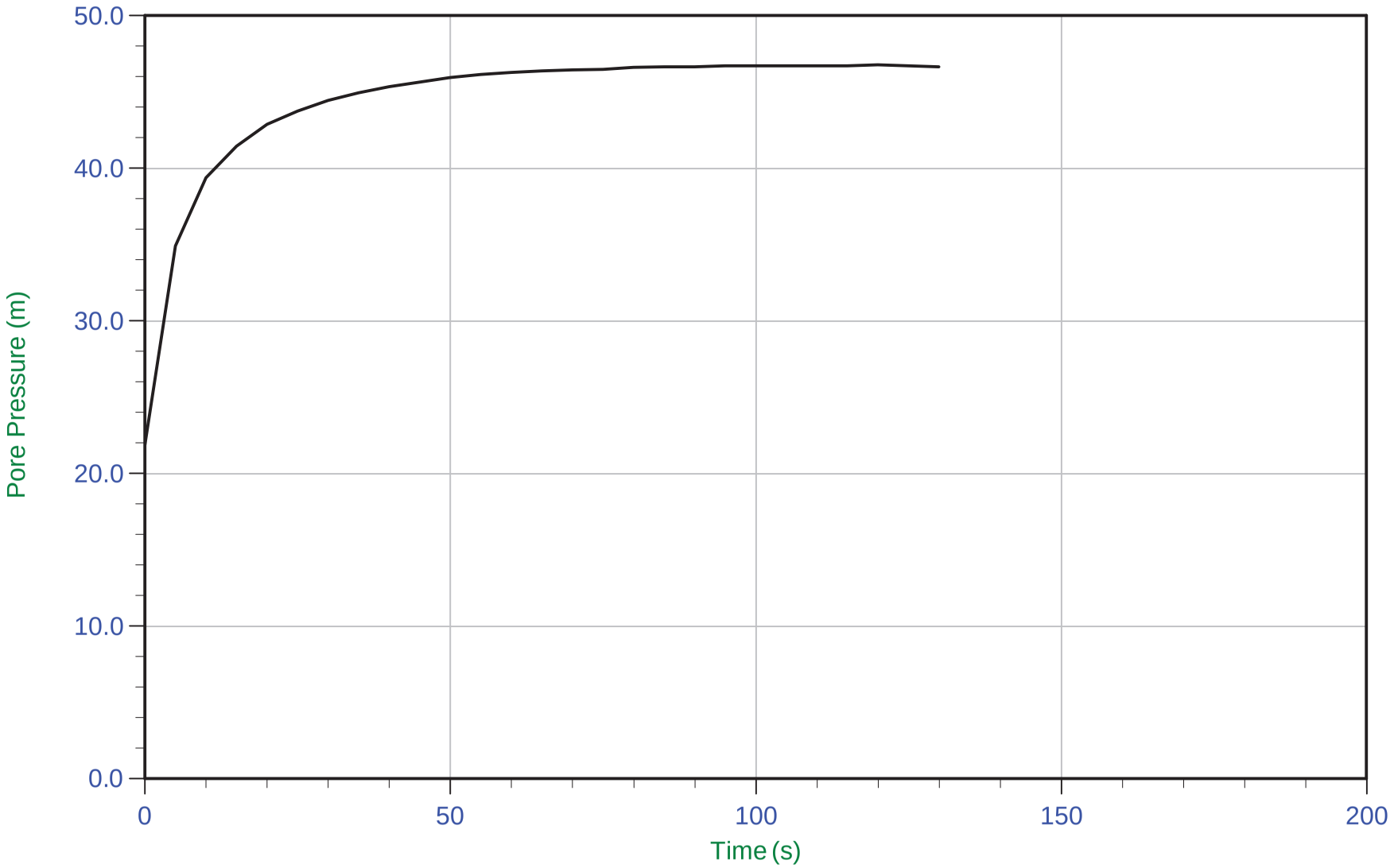
T(50): 545.2 s
Ir: 100
Ch: 1.3 sq cm/min

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/19/2013 08:29
Site: Hamilton, ON

Sounding: CPT13-13
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP13.PPD
Depth: 11.400 m / 37.401 ft
Duration: 130.0 s

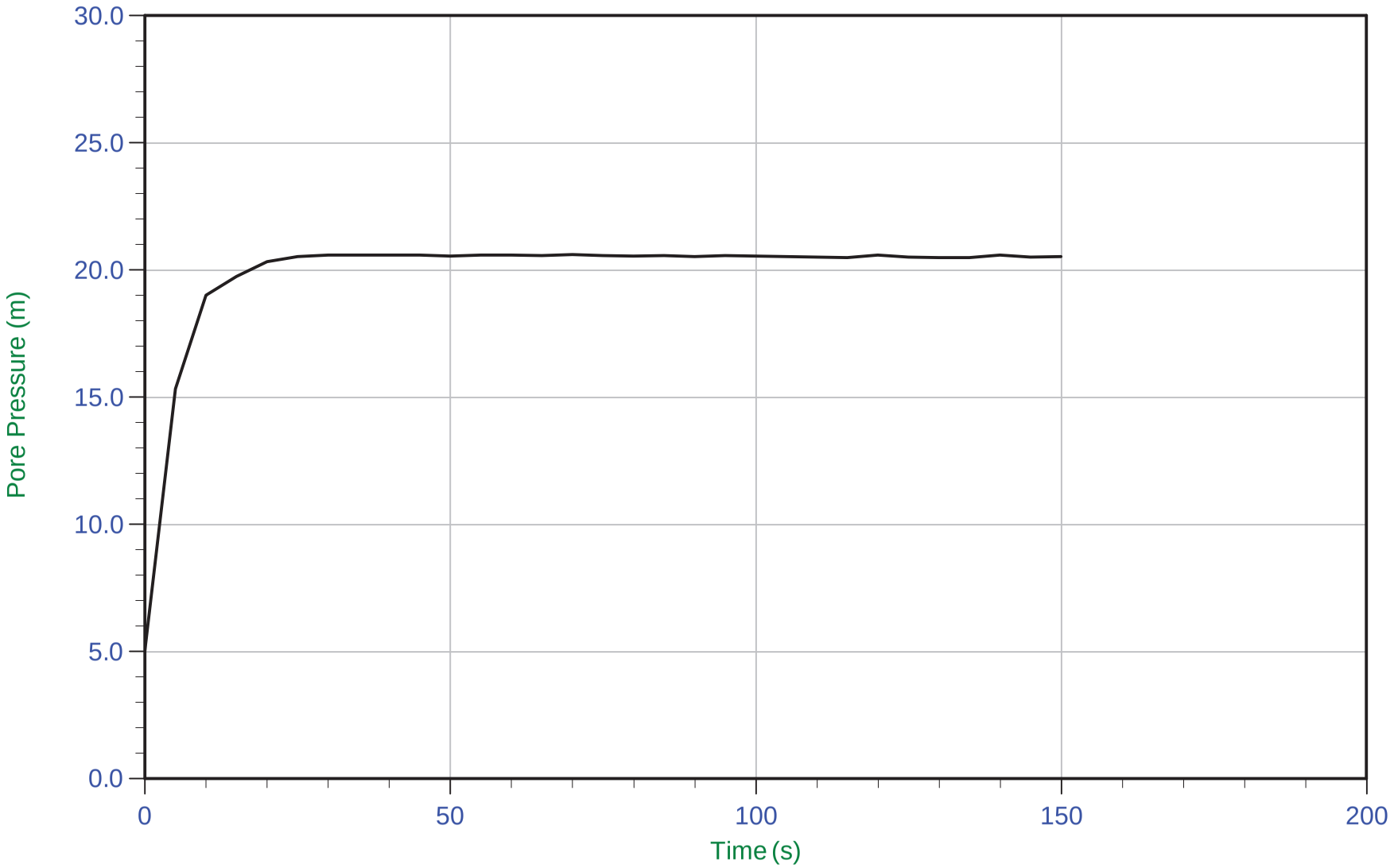
U Min: 21.9 m
U Max: 46.8 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/19/2013 08:29
Site: Hamilton, ON

Sounding: CPT13-13
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP13.PPD
Depth: 20.550 m / 67.420 ft
Duration: 150.0 s

U Min: 5.0 m
U Max: 20.6 m

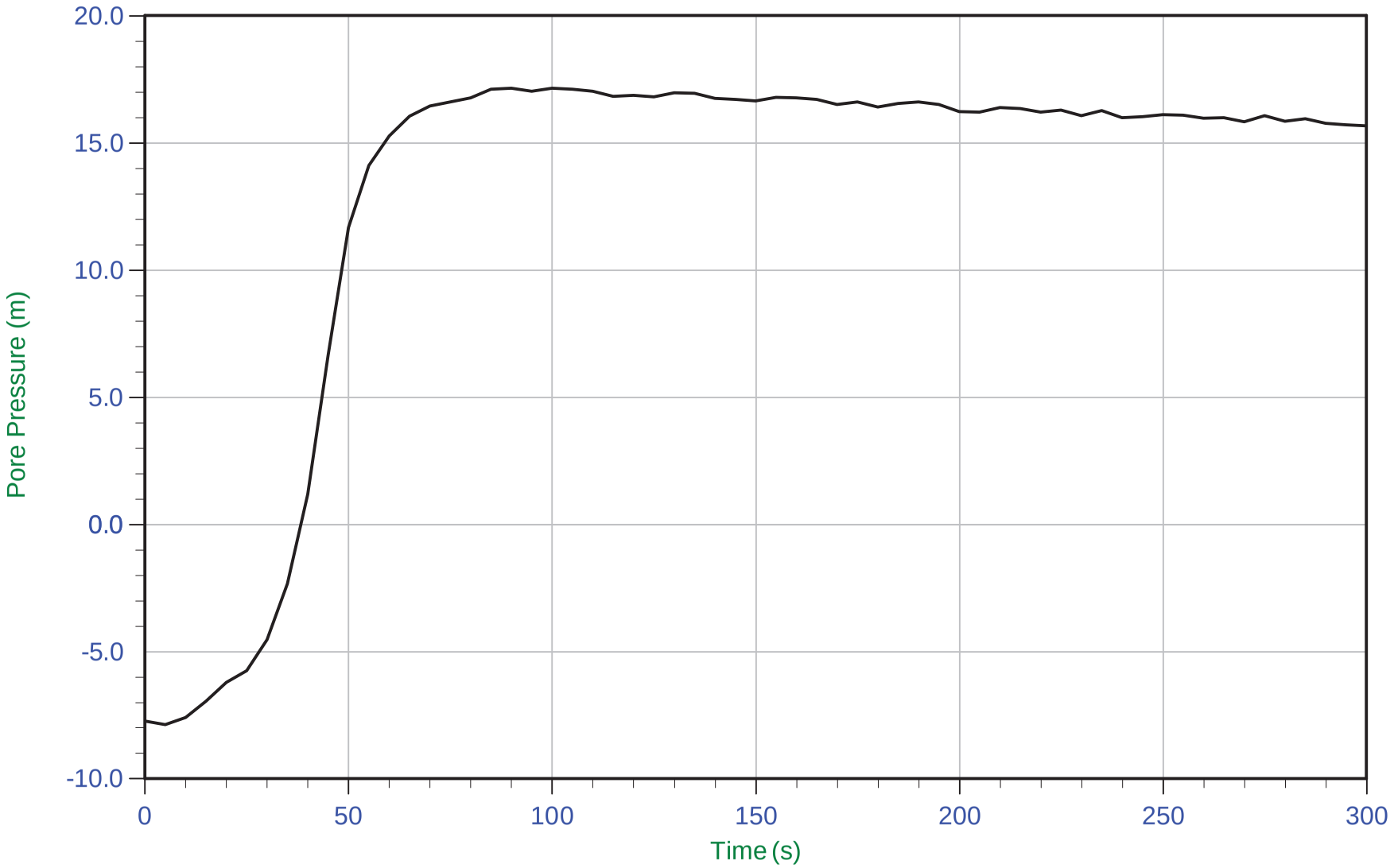
WT: 0.000 m / 0.000 ft
Ueq: 20.6 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/19/2013 10:59
Site: Hamilton, ON

Sounding: CPT13-14
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP14.PPD
Depth: 11.150 m / 36.581 ft
Duration: 300.0 s

U Min: -7.9 m
U Max: 17.2 m

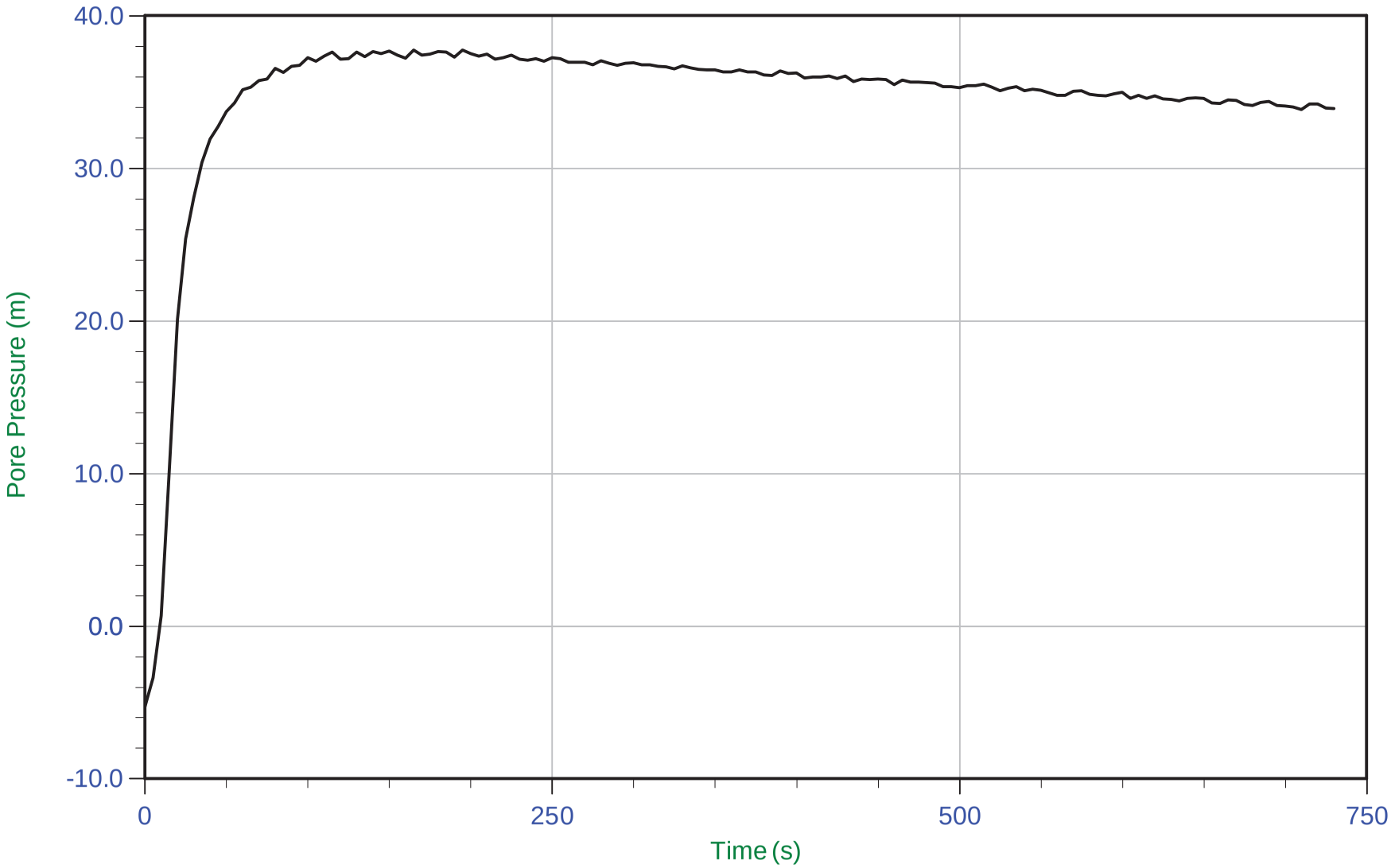
WT: 0.000 m / 0.000 ft
Ueq: 11.2 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/19/2013 10:59
Site: Hamilton, ON

Sounding: CPT13-14
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP14.PPD
Depth: 11.400 m / 37.401 ft
Duration: 730.0 s

U Min: -5.3 m
U Max: 37.7 m

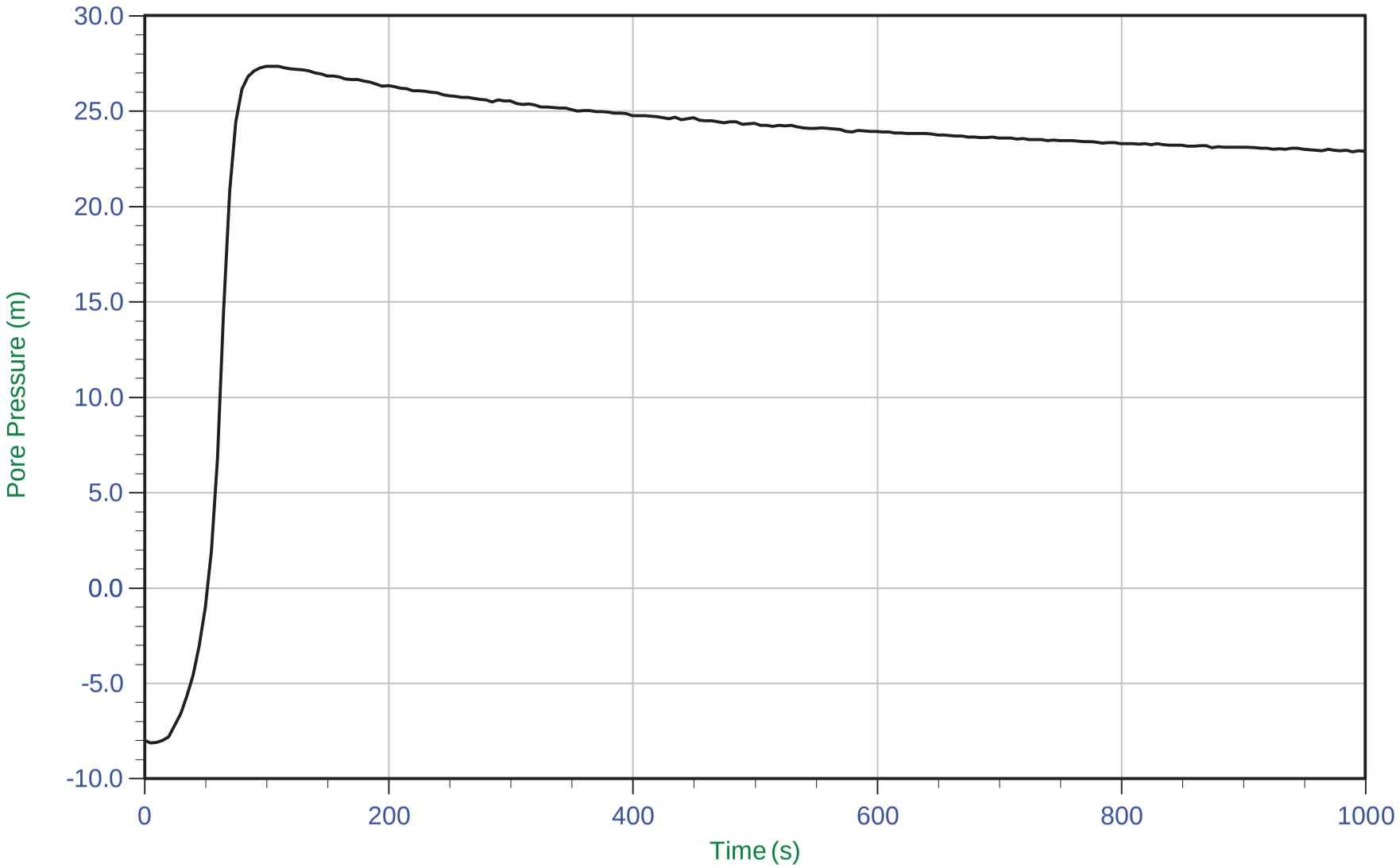
WT: 0.000 m / 0.000 ft
Ueq: 11.4 m

CONETEC

Peto-MacCallum Ltd.

Job No: 13-05017
Date: 09/19/2013 10:59
Site: Hamilton, ON

Sounding: CPT13-14
Cone: 322:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 13-05017_CP14.PPD
Depth: 19.500 m / 63.976 ft
Duration: 1000.0 s

U Min: -8.1 m
U Max: 27.3 m

WT: 0.000 m / 0.000 ft
Ueq: 19.5 m
U(50): 23.42 m

T(50): 659.8 s
Ir: 100
Ch: 1.1 sq cm/min

Appendix D

Electronic Data Files

The released data contains the following folders:

1. CPT Data - .cor files in ASCII format, and or .xls files.
2. Pore Pressure Dissipation Data - .ppd files in Excel format
3. CPT Plots - .pdf files
4. Data Interpretation - .xls files contain common engineering values

ConeTec Digital File Formats

CPT Data Files (COR Extension)

ConeTec data files are stored in ASCII text files that are readable by almost any text editor. ConeTec CPT data files are named such that the first 3 characters contain the job number, the next two characters are CP followed by two characters indicating the sounding number. The last 8th character position is reserved for the letters a, b, c, d etc to uniquely identify multiple soundings at the same location. The CPT sounding file has the extension COR, and pore pressure dissipation files have the extension PPD or PPF. As an example, for job number 06-127 the first sounding will have file names 127CP01.COR and 127CP01.PPD.

The sounding (COR) file consists of the following components:

1. Two lines of header information
2. Data records
3. End of data marker
4. Units information

Header Lines

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records contain 4 or more columns of data in floating point format. A comma (and spaces) separates each data item:

Column 1: Sounding Depth (meters)
Column 2: Tip (q_c) data uncorrected for pore pressure effects. Recorded in units selected by the operator.
Column 3: Sleeve (f_s) data. Recorded in units selected by the operator
Column 4: Dynamic pore pressure readings. Recorded in units selected by the operator
Column 5: Empty, Resistivity, UVIF or Gamma data

End of Data Marker

After the last line of data there will be a line containing ASCII 26 (CTL-Z) and a newline (carriage return/ line feed) character. This is used to mark the end of data.

Units Information

The last section of the file contains information about the units that were selected for the sounding. A separator bar makes up the first line. The second line contains the type of units used for depth, q_c, f_s and u. The third line contains the conversion values required for ConeTec's software to convert the recorded data to an internal set of base units (bar for q_c, bar for f_s and meters for u).

CPT Dissipation Files (PPx Extension)

CPT Dissipation files have the same naming convention as the CPT sounding files and have the extension PPD, PPF or PPM. PPF (PPM and PPD) files consist of the following components:

1. Two lines of header information
2. Data records

Header Lines (same as COR file):

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records immediately follow the header lines. Each data record can occupy several lines in the file and is a complete record of a dissipation test at a particular depth. Each data record starts with a line containing two values separated by spaces; the first value being an index number (not currently used by the Software) and the second being the dissipation test depth in meters. Following this line are the dissipation pore pressure values stored at 5 second intervals with a maximum of 12 entries per line. The last line of the dissipation record may not contain a full 12 entries. The data record is terminated with an ASCII 30 character (appears as a triangle in some editors).

This sequence is repeated for every dissipation test in the sounding. No marker is used to indicate end of file. Units information is not stored in this file. Users need to check the CPT file for the units that were used.

CPT Basic Interpretations (TBL Extension)

ConeTec's basic CPT interpretation output files are generally delivered in text files with a TBL extension. The root file name is the same as the COR files. A number of calculated geotechnical parameters are presented in these files. The files are stored as ASCII text files that can be viewed using any text editor such as Notepad or Wordpad. The files do not contain any page formatting. These files are not distributed if the enhanced interpretation files are provided.

CPT Enhanced Interpretations (IFI, IFP, XLS Extension)

ConeTec's enhanced CPT interpretation output files are delivered in several formats, each file type containing the exact same information but formatted slightly differently. The files typically have any of the following file extensions:

1. IFI — an importable TAB delimited ASCII text file containing approximately 47 data columns of geotechnical interpretations. The file is designed for easy import to Excel. A companion document describes the techniques used for the interpretations (usually reproduced at the beginning of the Interpretation Appendix). Text editors can be used to view the file contents, however, they may remove the tabs or replace the tabs with spaces upon saving the file destroying the feature that makes them easy to import into Excel.

   Because Excel imports the data as text and the sheet is protected two steps may be necessary to modify the data or use the values in certain Excel functions:

   a) Under Tools (Excel 2000) Select the Protection Option and then Unprotect the sheet
   b) Select the entire sheet, copy and then use Paste Special to paste as values to a second sheet.

   Future versions of our interpretation routine will address these inconveniences.

2. IFP — a printable ASCII text file containing the same 47 columns of geotechnical interpretations as the IFI file. This file type has been formatted as a multi-page document with up to 132 characters per line and up to 68 lines per page. Each page has been separated into multiple sections to accommodate all the data fields. Each physical page has a header section and a page/section number. The file is designed for direct printing to laser printers set into compressed font mode. This output is typically provided in the Interpretation Appendix.

   An abbreviated set of interpretations (containing 36 columns of output) may be generated instead. These files usually have the extensions NLI and NLP. XLS files can be generated from these as well.

3. XLS — an Excel format file that has been generated directly from the corresponding IFI file. IFI and IFP files are not distributed if the XLS files are generated. The XLS files may have been generated from abbreviated NLI interpretation files.

In each case root file name is the same as the COR files.

CPT Interpretations (Excel Format)

ConeTec's latest software (September 2007) outputs CPT interpretations directly to Excel format (XLS extension) without creating intermediate ASCII files. Because of the desires of various clients, there are several different configurations of output parameters in ConeTec's interpretation files. Since the Excel format file must have the XLS extension a suffix is used after the basename of the source CPT data file (COR) to identify the format of the file. The configurations still follow the formats described above and use the same extensions but now as suffixes. To allow for various runs (e.g. using a different water table, or user supplied equilibrium profile, or different methods for a particular parameter) of the same data an additional suffix may be specified by the engineer post processing the data to identify each particular run. This suffix will follow the one used to identify the format of the file.

For example:

If the selected format is ConeTec's TBL configuration and each run is identified by a run number. The resultant files generated for 278CP01.COR would be:

78CP01-TBL-RUN01.XLS
78CP01-TBL-RUN02.XLS
78CP01-TBL-RUN03.XLS

CPT Data in Excel Format

ConeTec can now provide the equivalent of the ASCII COR files in Excel Format. These files will have the same basename as the COR files and an XLS extension.

Pore Pressure Dissipation Data in Excel Format

ConeTec can now provide the equivalent of the ASCII PPD format files in Excel format. These files will contain each dissipation trace that exceeds a minimum duration (selected by the engineer during post-processing) in a particular Excel spreadsheet column. The first column (Column A) will contain the time in seconds and the second column (Column B) will contain the time in minutes. Subsequent columns will contain dissipation trace data. The time columns will extend to the longest trace of the data set.

Detailed header information is provided at the top of the spreadsheet. The test depth in meters and feet, the number of points in the trace and the particular units are identified at the top of each trace column.

The Excel format file names will have the same basename as the original PPD format file followed by the suffix -PPD and then followed by a second suffix that the engineer doing the post processing can specify. Because the engineer can select various types of units for the dissipation data output (which can be different from the units used in the original recording) the secondary suffix is often used to identify the units in the XLS file, however, the original recorded units and the output units are clearly identified within the XLS spreadsheet file.

Appendix B
Geotechnical Investigations

ITEM B3
Excerpts from: Peto MacCallum Ltd. - Geotechnical Investgation, Pier 1 Rehabilitation, Hillyard Street, Hamilton, Ontario, July 2008.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

GEOTECHNICAL INVESTIGATION
PIER 15 REHABILITATION
HILLYARD STREET
HAMILTON, ONTARIO

for

HAMILTON PORT AUTHORITY

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Distribution:
4 cc: Hamilton Port Authority
1 cc: PML Hamilton
1 cc: PML Toronto

PML Ref.: 08HF025
Report: 2
July 2008

Peto MacCallum Ltd.
CONSULTING ENGINEERS

July 24, 2008

PML Ref.: 08HF028
Report: 2

Mr. Bill Fitzgerald, P.Eng.
Hamilton Port Authority
605 James Street North
Hamilton, Ontario
L8L 1K1

Dear Mr. FItzgerald

Geotechnical Investigation
Pier 15 Rehabilitation
Hillyard Street
Hamilton, Ontario

Peto MacCallum Ltd. (PML) is pleased to present the results of the geotechnical investigation recently completed in connection with the above noted project. Our services were provided in accordance with our proposal dated April 18, 2008. Authorization to proceed with this assignment was provided by Mr. Bill Fitzgerald of the Hamilton Port Authority (HPA) by signing our Engineered Services Agreement dated April 23, 2008.

It is understood that reconstruction of an approximately 185 m long section on the west end of Pier 15 is planned. The planned dredge depth is 12.6 m from the top of the pier.

The purpose of this study was to assess the subsurface soil and groundwater conditions along the section of Pier 15 to be reconstructed by advancing three widely spaced boreholes to approximately 32 m depth, conduct field and laboratory tests to characterize the geotechnical properties of the soil and provide geotechnical parameters for design of the new sheet pile wall.

The purpose of the environmental screening component was to check the environmental quality of the soil at selected borehole locations to the anticipated depth of excavation, to provide recommendations for handling, disposal and/or off site reuse options for excess material generated during the proposed construction.

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BARRIE, BRAMPTON, HAMILTON, KITCHENER, TORONTO

It should be noted that ground water sampling and testing was not part of the Terms of Reference for this assignment and the environmental sampling and testing was conducted as a limited screening program. Soil or ground water impairment that has not been identified by the screening program may exist at the site. It should also be noted that the environmental screening component is an indicator of environmental quality only, since with the exception of metals and inorganics, the samples exceeded their holding times.

Investigation Procedures

The fieldwork was carried out on April 24, 25 and 28, 2008 and consisted of three boreholes advanced to depths varying from 31.0 to 32.5 m. The borehole locations are shown on Drawing 1.

The locations of and ground surface elevations at the boreholes were established in the field by PML. The following benchmark (BM) data, provided by the HPA, was used for vertical reference:

BM: Aluminium disk, southeast corner of intersection of Evans McKeil Way and Lane to Simore Transport, Pier 15.
Elevation: 78.61 m (IGLD 1985)

The boreholes were advanced using continuous flight hollow stem augers, powered by a truck-mounted CME-75 drillrig, 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 tests were conducted within the clayey soils and penetrometer tests on recovered soil samples. Relatively thin walled Shelby tube samples of the clayey soil were also obtained.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification, routine moisture content determinations, Atterberg Limits tests and grain size analyses. A consolidation test, three triaxial compressive strength tests and a specific gravity test were also conducted on thin walled Shelby tube samples.

Summarized Subsurface Conditions

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test N values, in situ vane shear strength tests, penetrometer tests conducted on the recovered samples, laboratory moisture content determinations, Atterberg Limits tests and Grain Size analyses.

The subsurface stratigraphy revealed in the boreholes typically comprised a heterogeneous fill overlying silt, silty clay, silty clay till, sand and silt till and clayey silt. A detailed description of the various stratigraphic units is provided in the following paragraphs.

Fill

The fill ranged in thickness from 3.2 to 3.4 m and consisted of a surficial 300 mm layer of sand and gravel, underlain by silt and silty clay fill penetrated at depths varying from 3.2 to 3.4 m (elevation 74.6 to 74.9). Concrete approximately 130 mm in thickness was encountered below the sand and gravel fill in Borehole 3. A 100 mm thick layer of slag fill was contacted underlying the sand and gravel fill in Borehole 2. Standard Penetration test (SPT) N values in the fill varied from 4 to 17, decreasing with depth.

Silt

Below the fill, silt was contacted at 5.8 to 7.0 m depth (elevation 70.8 to 72.4). The silt was very loose to compact in relative density with SPT N values in the silt varying from 2 to 16. Layers of grey silty clay and clayey silt were observed within the silt. The moisture content varies from 19 to 26%.

Silty Clay

A 3.0 to 5.9 m thick layer of silty clay was encountered below the silt to 10.0 to 11.7 m depth (elevation 66.5 to 67.8). The silty clay was soft to stiff in consistency. SPT N values varied from 2 to 10. Vane shear tests conducted within the silty clay indicated undrained shear strengths varying from 36 to 86 kPa; typically about 50 kPa in Boreholes 1 and 2 and 36 to 45 kPa in Borehole 3. Penetrometer tests indicated undrained shear strengths varying from 13 to 24 kPa. A value of 96 kPa was measured in Borehole 3, this value is considered to be unrepresentative of the deposit due to the presence of silt layers. Moisture content tests varied from 23% to 29%.

Results of two grain size analyses conducted on representative samples of the silty clay stratum indicated a sand fraction of 6 and 8%, a silt fraction of 51 and 43% and a clay fraction of 41 and 51%, respectively.

Three Atterberg Limits tests conducted on representative samples from the silty clay stratum indicated a Liquid Limit varying from 29% to 33%, a Plastic Limit varying from 16% to 18% and a Plasticity Index varying from 13 to 15%. Based on the Atterberg Limits, the soil is considered to be a low plasticity clay having a CL designation. Specific gravity tests conducted on the silty clay indicated a specific gravity of 2.74.

A consolidation test was conducted on a relatively undisturbed thin walled Shelby tube sample recovered at a depth of approximately 7.6 m from Borehole 2 (Sample No 9) in order to estimate the stress history of the silty clay stratum. Results of the consolidation test are shown on Figure 1 and are summarized in the table below.

Borehole/Sample	Depth (m)	Natural Moisture Content	Initial Void Ratio	Effective Overburden Pressure (kPa)	Preconsolidation Pressure (kPa)
Borehole 2 Sample 9	7.6 – 8.1	28%	0.7251	94	250 - 350

The index properties of the tested sample are as follows:

Borehole/Sample	Depth (m)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
Borehole 2 Sample 9	7.6 – 8.1	33%	16%	17%	0.71

This preconsolidation pressure indicated by the laboratory test is reasonably consistent with values measured by consolidation tests conducted for other projects in the Hamilton Harbour.

The undrained shear strength/overburden pressure (s_u/p_0) with depth plot (Figure 2) indicates the s_u/p_0 ratio varies from 0.39 to 0.71. For a normally consolidated clay with a PI of 15 (typical), the s_u/p_0 ratio would be 0.16 based on the empirical correlation

$$s_u/p_0 = 0.11+0.0037 \times PI$$

The s_u/p_0 ratio from field tests also indicate the silty clay is overconsolidated.

Consolidated undrained triaxial compression tests were conducted on three representative samples of the silty clay (Borehole 1 - Sample 11, Borehole 3 - Sample 10 and Borehole 3 - Sample 11). The test results are provided on Figures 3, 4 and 5 respectively.

The geotechnical parameters indicated by the test results are summarized:

BH No./ Sample No.	Depth (m)	Soil Type	C'	Ø
1 / 11	12.2 - 12.6	Silty clay till	32 kPa	14.0
3 / 10	7.6 - 8.1	Silty clay	32 kPa	5.0
3 / 11	9.1 - 9.6	Silty clay	2 kPa	7.0*

*Based on first two stress levels; stress level increased substantially for third stress level to assess the response at a higher stress, however it is not shown on Figure 5.

The shape of the Mohr Circles and the resultant geotechnical parameters are not consistent with our experience in the area. It appears that the test results may not be representative due to the presence of silt/sand lenses in the deposit and/or sample disturbance. The geotechnical parameters indicated by Figures 3, 4 and 5 suggest an undrained response.

Silty Clay Till

Underlying the silty clay, a relatively extensive deposit of silty clay till was contacted to depths of 28.0 to 29.2 m (elevation 48.8 to 49.8). The silty clay was typically firm, becoming stiff to very stiff in consistency with depth. SPT N values in the silty clay varied from 3 to 25. Vane shear tests conducted within the silty clays indicated undrained shear strengths varying from 48 to 89 kPa while penetrometer tests on the recovered samples indicated undrained shear strengths varying from 13 to 106 kPa. The moisture content varied from 21% to 31%. In general the SPT N values and shear strength increased with depth, while moisture contents decreased with depth.

Results of two grain size analyses conducted on representative samples of the silty clay till indicated a sand fraction of 5 and 6%, a silt fraction of 40 and 44% and a clay fraction of 50 and 55%, respectively.

Two Atterberg limits tests conducted on representative samples from the silty clay till indicated Liquid Limits of 33% and 34%, a Plastic Limit of 17 and a Plasticity Index of 16 and 17, respectively. Based on results of Atterberg Limits test, the soil is considered to be a low plasticity clay having a CL designation.

Silt and Sand Till

Very dense sand and silt till was contacted below the silty clay to 30.5 to 31.5 m depth (elevation 46.5 to 47.3). SPT N values of more than 50 blows per 150 mm were recorded in the sand and silt till. Moisture content varied from 7 to 10%.

Clayey Silt Till/Silt Till

Underlying the sand and silt till, clayey silt till/silt till was contacted in all the boreholes to the borehole termination depth of 31.0 to 32.5 m (elevation 45.5 to 46.8). SPT N values of 85 to 138 were recorded in this stratum. Moisture content varied from 14 to 18%.

Groundwater was not detected in the boreholes at the time of drilling. The lake water level was at elevation 75.2 m (IGLD 1985).

TABLE I

Summary of Samples Submitted for Chemical Testing

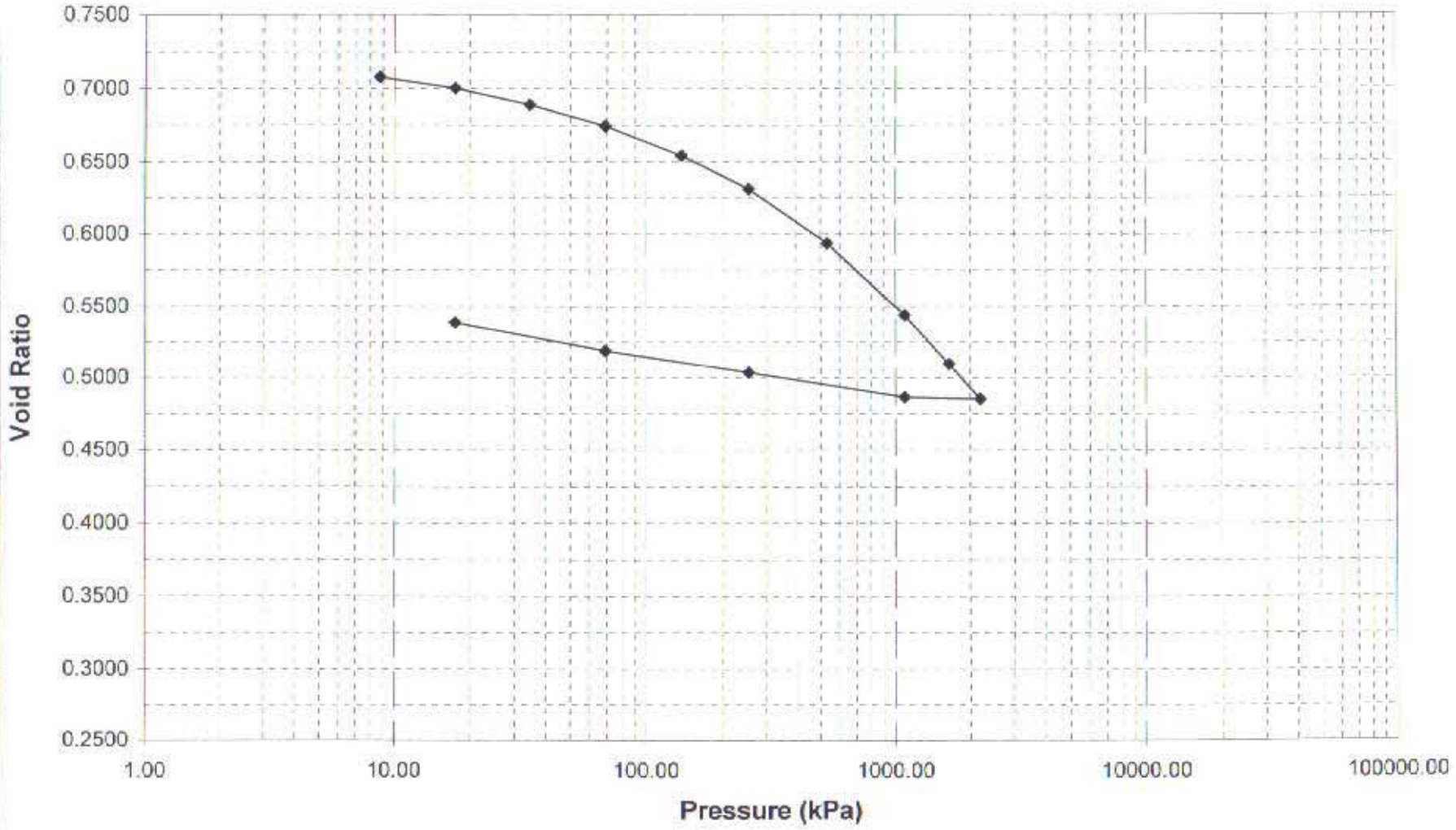
Location	Sample ID	Approx. Depth (m)	Description	Type of Chemical Analysis
Borehole 1	BH1 SS2	1.5 – 2.1	Brown, clayey silt fill with silt lenses	O. Reg. 153/04 metals and inorganic parameters PAHs PCBs
Borehole 1	BH1 SS3	2.3 –2.7	Grey silty clay fill with silt lenses	O. Reg. 153/04 metals and inorganic parameters PHC Fractions F1 - F4 VOCs
Borehole 2	BH2 SS3	2.3 – 2.7	Brown silty clay fill, trace sand, mottled grey with lenses of silt	O. Reg. 153/04 metals and inorganic parameters
Borehole 2	BH2 SS4	3.1 – 3.7	Black to brown silt with 80 mm layer of grey silty clay	O. Reg. 153/04 metals and inorganic parameters
Borehole 3	BH3 SS3	2.3 – 2.7	Grey silty clay fill, trace sand with thin layers of brown silt	O. Reg. 153/04 metals and inorganic parameters PAHs PCBs
Borehole 3	BH3 SS5	3.8 – 4.4	Dark brown to brown silt, some fine sand	O. Reg. 153/04 metals and inorganic parameters PHC Fractions F1 - F4 VOCs

Note:
PAH – Polycyclic Aromatic Hydrocarbons
PHC – Petroleum Hydrocarbon
VOCs – Volatile Organic Compounds

Hamilton Port Authority
Pier 15 Rehabilitation
PML Ref.: 08HF025

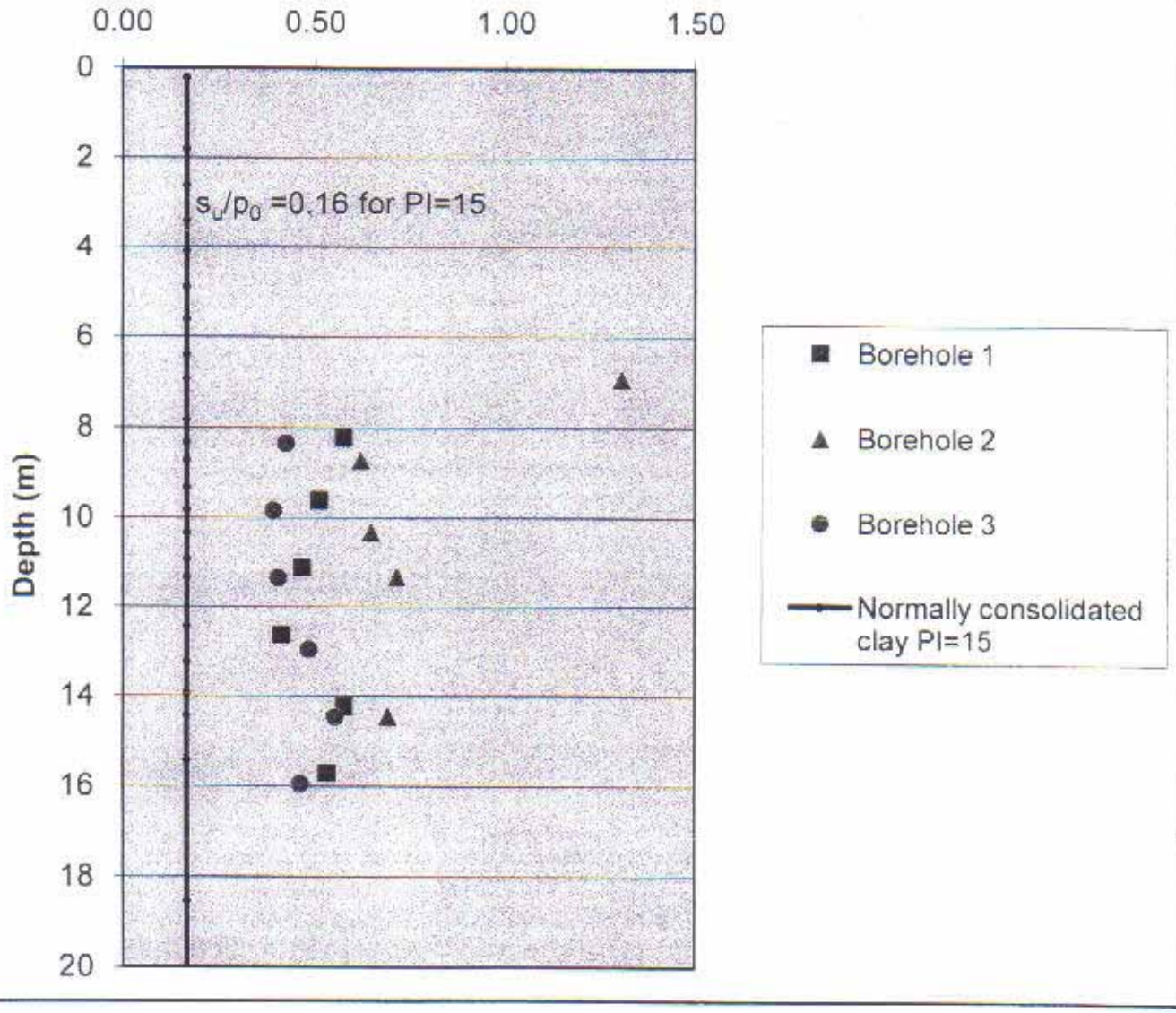
Figure 1
Consolidation Test Results
Void Ratio versus Log of Pressure

Borehole 2, Sample 9
Sample Depth: 7.6 - 8.1 m
Silty Clay



Hamilton Port Authority
Pier 15 Rehabilitation
PML Ref.: 08HF025

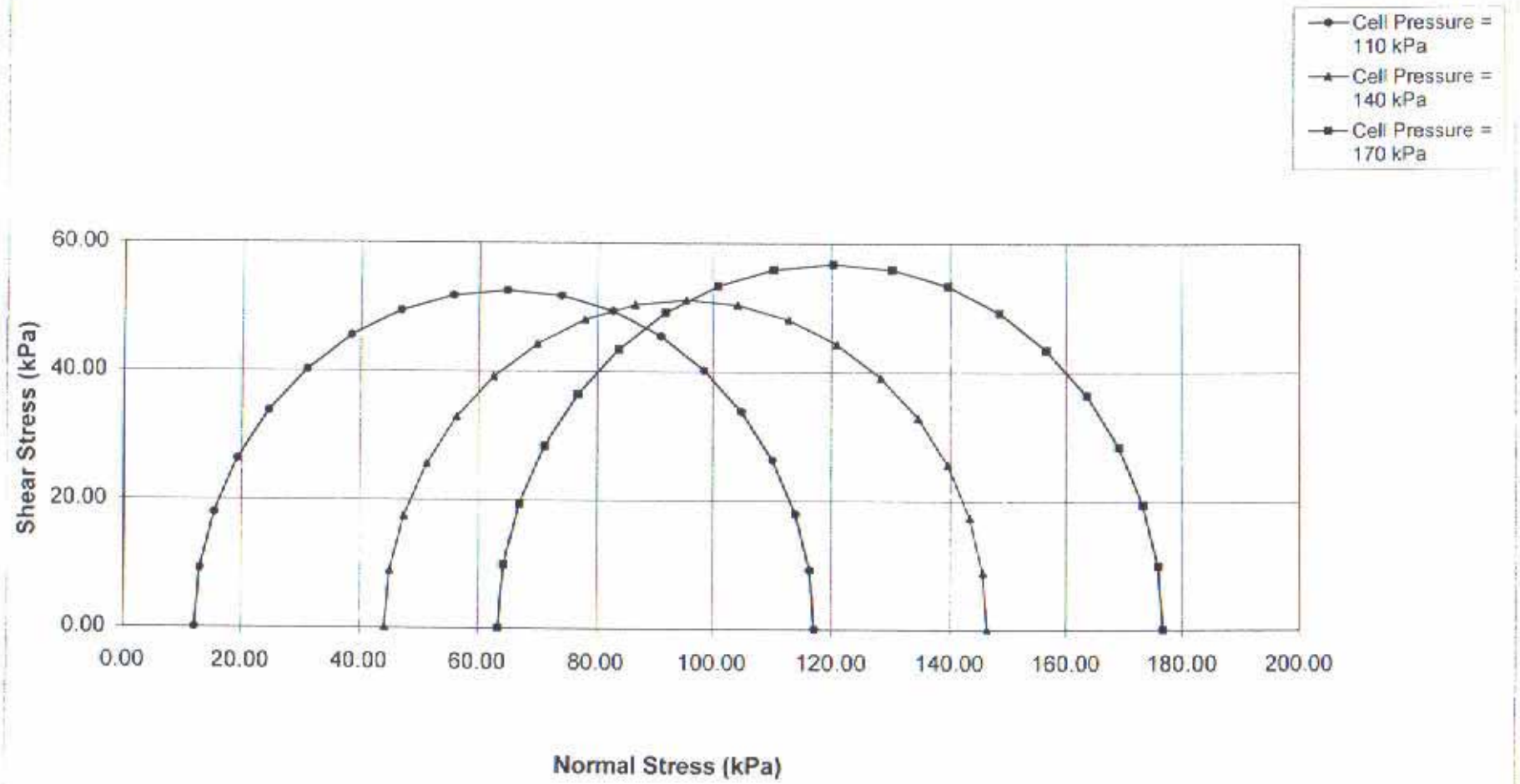
Figure 2
Shear Strength / Effective Overburden Pressure versus Depth



Hamilton Port Authority
Pier 15 Rehabilitation
PML Ref : 08HF025

Figure 3. Triaxial Test Results

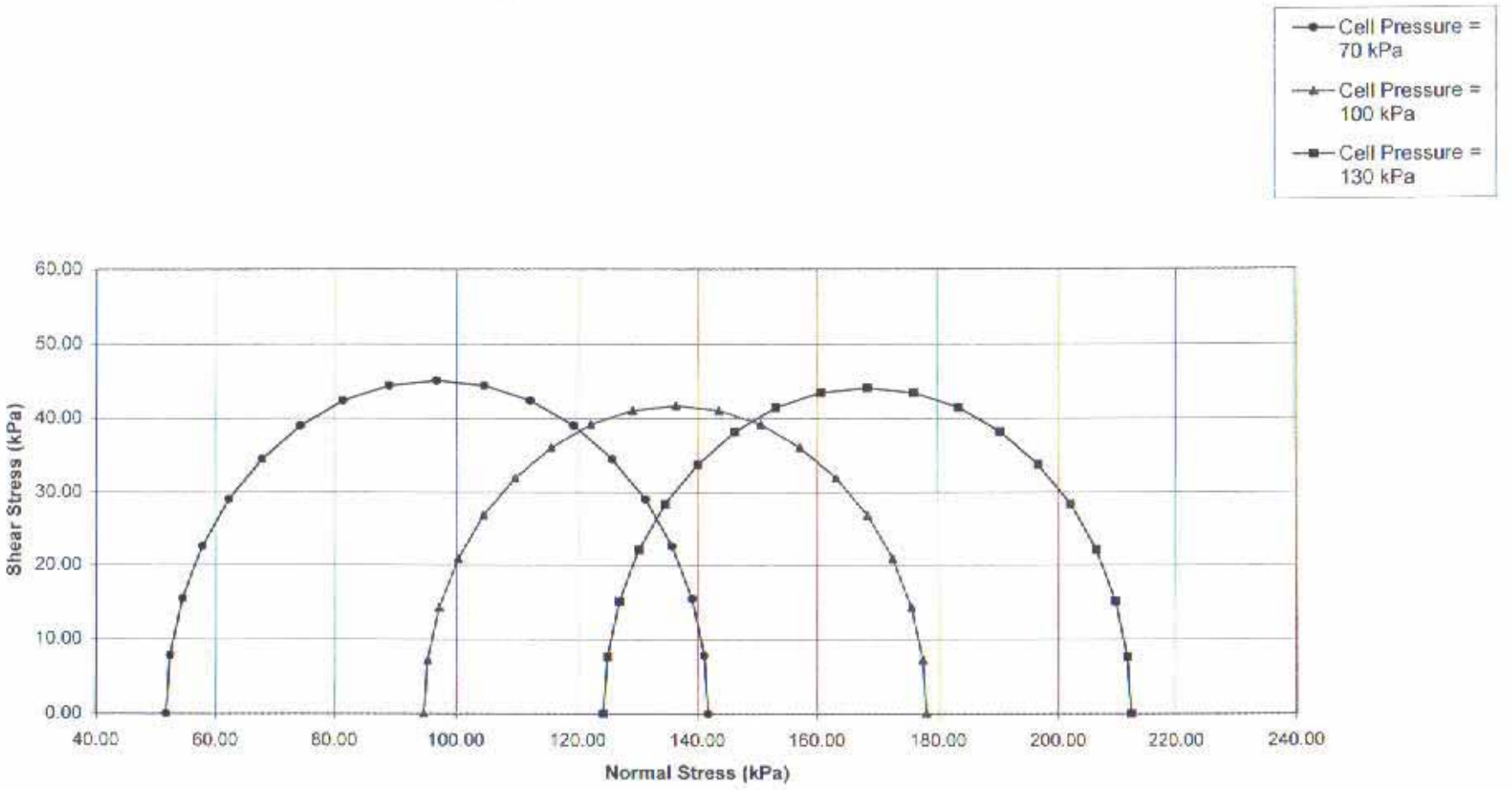
Borehole 1, Sample 11
Sample Depth 12.2 - 12.6 m
Silty Clay



Hamilton Port Authority
Pier 15 Rehabilitation
PML Ref.: 08HF025

Figure 4. Triaxial Test Results

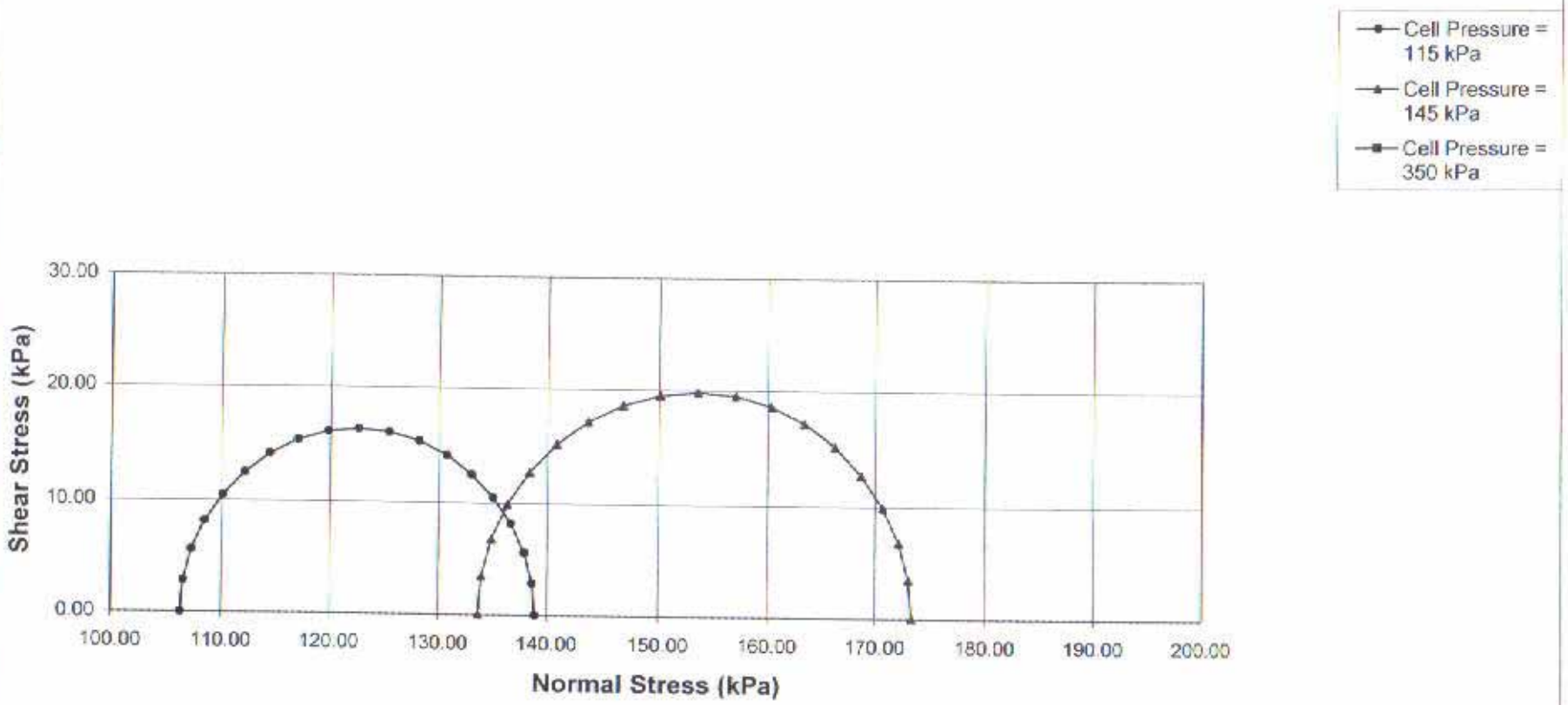
Borehole 3, Sample 10
Sample Depth: 7.6 - 8.1 m
Silty Clay



Hamilton Port Authority
Pier 15 Rehabilitation
PML Ref.: 08HF025

Figure 5. Triaxial Test Results

Borehole 3, Sample 11
Sample Depth: 9.1 - 9.6 m
Silty Clay



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:

CONSISTENCY	N (blows/0.3 m)	c (kPa)	DENSENESS	N (blows/0.3 m)
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		

WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample		

- PH Sample Advanced Hydraulically
- PM Sample Advanced Manually

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

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LOG OF BOREHOLE NO. 1

METRIC

1 of 2

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS
BORING DATE April 24, 2008
OUR PROJECT NO. 08HF025
ENGINEER H. Gharegrat
TECHNICIAN M. Rapsey

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	ELEVATION SCALE
77.8 / 0.0	**Ground Surface**					77
77.5 / 0.3	SAND AND GRAVEL FILL: Granular 'A' crushed limestone					
	SILT FILL: Compact, brown silt with inclusions of brown clayey silt, damp		1	SS	13	
1.0						
76.4 / 1.4	becoming clayey silt fill with silt lenses		2*	SS	10	76
2.0						
75.6 / 2.2	SILTY CLAY FILL: Soft, grey silty clay fill with silt lenses, medium plastic, W.T.P.L.		3*	SS	3	
3.0						75
74.6 / 3.2	SILT: Loose to compact, brown silt with layers of brown clayey silt, non-plastic, wet		4	SS	6	
4.0			5	SS	15	74
5.0			6	SS	13	73
6.0			7	SS	15	72
7.0						71
70.8 / 7.0	SILTY CLAY: Firm, grey silty clay with occasional thin lenses of silt, medium plastic, W.T.P.L.		8	SS	3	70
				FV		
8.0						
9.0			9	TW		69
				FV		
67.8 / 10.0	SILTY CLAY TILL: Firm to stiff, grey silty clay till, trace sand, medium plastic, W.T.P.L.					68
			10	TW		
11.0				FV		67
12.0			11	TW		66
				FV		
13.0						65
14.0			12	SS	5	64
				FV		
15.0						63
16.0			13	SS	6	
				FV		62
17.0	Cont'd					61

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲ POCKET PENETROMETER
50 100 150 200
DYNAMIC CONE PENETRATION
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kg/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Borehole Elevation referenced to IGLD 1985

Groundwater was not observed in borehole at time of drilling.
* Sample submitted for chemical testing
* Sample submitted for chemical testing
Lake water elevation was 75.2 (IGLD 1985) at time of drilling.

0 6 43 51

Consolidated drained triaxial test conducted on thin walled tube sample recovered at 12.2 m depth.

0 6 44 50

+ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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LOG OF BOREHOLE NO. 1

METRIC

2 of 2

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS
BORING DATE April 24, 2008
OUR PROJECT NO. 08HF025
ENGINEER H. Gharegrat
TECHNICIAN M. Rapsey

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES
62.9					
			14	SS	5
57.8 / 20.0	becoming stiff				
			15	SS	13
50.0 / 21.8	becoming very stiff				
			16	SS	25
			17	SS	19
49.8 / 28.0	SILT AND SAND TILL: Very dense, reddish brown silt and sand, some gravel, trace clay				
47.3 / 30.5	SILT: Very dense, grey silt, trace clay and sand, non to slightly plastic		18	SS	102
46.8 / 31.0	BOREHOLE TERMINATED AT 31.0 m				

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲ POCKET PENETROMETER
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

ELEVATION SCALE: 60 59 58 57 56 55 54 53 52 51 50 49 48 47

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kg/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0

PML- BH LOG GEO 08HF025 BOREHOLE LOGS 2008-04-28 DD.GPJ DN_MOT.GDT 7/22/2008 9:27:36 AM

Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

METRIC

1 of 2

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS
BORING DATE April 25, 2008
OUR PROJECT NO. 08HF025
ENGINEER H. Gharegrat
TECHNICIAN M. Rapsey

ELEV DEPTH in meters	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ▲ POCKET PENETROMETER; DYNAMIC CONE PENETRATION ×, STANDARD PENETRATION TEST ●)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kg/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.0 / 0.0	**Ground Surface**									
0.3 / 77.7 / 0.6	SAND AND GRAVEL FILL: Granular 'A' crushed limestone SLAG FILL: Black, fine slag									
1.0	SILTY CLAY FILL: Stiff to soft, brown silty clay fill, trace sand, mottled grey with lenses of silt, low plastic, W.T.P.L.		1	SS	12	77				Borehole Elevation referenced to IGLD 1985
2.0			2	SS	5	76				Groundwater was not observed in borehole at time of drilling.
3.0			3*	SS	3	75				* Sample submitted for chemical testing Lake water elevation was 75.2 (IGLD 1985) at time of drilling.
74.6 / 3.4	SILT: Very loose, black to brown silt with 80 mm layer of grey silty clay		4*	SS	3					* Sample submitted for chemical testing
4.0 / 73.9 / 4.1	becoming compact, brown silt, trace clay, oxidized stains, non plastic, wet		5	SS	2	74				
5.0			6	SS	15	73				
72.7 / 5.3	becoming brownish grey		7	SS	16					
6.0 / 72.0 / 6.0	SILTY CLAY: Firm to stiff, grey silty clay, trace sand with thin lenses of silt, medium plastic, W.T.P.L.		8	SS	5	72				One dimensional consolidation test conducted on thin walled tube sample recovered at 7.6 m depth.
7.0				FV		71	+ +			
8.0			9	TW		70				0 8 51 41
			10	SS	2					
9.0				FV		69	+ +			
			11	TW						Consolidated drained triaxial test conducted on thin walled tube sample recovered at 9.1 m depth.
10.0			12	SS	4	68				
67.4 / 10.6				FV			+ +			
11.0	SILTY CLAY TILL: Stiff, grey silty clay till, trace sand, low to medium plastic, W.T.P.L.		13	TW		67				
				FV			++			
12.0						66				
			14	TW						
13.0						65				0 5 40 55
			15	SS	3					
14.0			16	SS	7	64				
				FV			++			
15.0						63				
			17	SS	5					
16.0						62				
17.0	Cont'd									

PML-BH LOG GEO 08HF025 BOREHOLE LOGS 2008-04-25.DD.GPJ ON_MOT.GDT 7/22/2008 9:28:03 AM

+ × Numbers refer to Sensitivity

20 / 15 / 10 — 5 (%) STRAIN AT FAILURE

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

METRIC

2 of 2

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS
BORING DATE April 25, 2008
OUR PROJECT NO. 08HF025
ENGINEER H. Gharegrat
TECHNICIAN M. Rapsey

ELEV DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES
63.0					
			19	SS	6
58.0 / 20.0	becoming very stiff with occasional particles of red shale				
			19	SS	26
			20	SS	14
			21	SS	18
48.8 / 29.2	SILT AND SAND TILL: Very dense, grey fine to coarse sand and silt till, gravelly, damp				
			22	SS	99/150mm
46.6 / 31.5	CLAYEY SILT TILL: Hard, grey clayey silt till, trace sand, slightly plastic. D.T.P.L.				
			23	SS	138
45.5 / 32.5	BOREHOLE TERMINATED AT 32.5 m				

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲ POCKET PENETROMETER
60 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

ELEVATION SCALE: 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT γ kg/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0

PML - BH LOG GEO 08HF025 BOREHOLE LOGS 2008-04-25 CO.GPJ ON_MOT.GDT 7/22/2008 9:28:04 AM

+ , × : Numbers refer to Sensitivity

15 10 5 (%) STRAIN AT FAILURE

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

1 of 2

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS
BORING DATE April 28, 2008
OUR PROJECT NO. 08HF025
ENGINEER H. Charegrat
TECHNICIAN M. Rapsey

ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES
79.2	**Ground Surface**				
78.9 / 0.2	SAND AND GRAVEL FILL: Brown granular 'A' crushed limestone				
	CONCRETE: 130 mm thick concrete				
	SILTY CLAY FILL: Very stiff to firm, grey silty clay fill, trace sand with thin layers of brown silt, medium plastic, W.T.P.L.		1	SS	17
			2	SS	10
			3*	SS	4
74.9 / 3.3	SILT: Loose, dark brown to brown silt, some fine sand, saturated		4	SS	4
			5*	SS	5
73.2 / 5.0	becoming compact, trace clay		6	SS	7
			7	SS	15
72.4 / 5.8	SILTY CLAY Stiff to soft, grey silty clay, trace sand with occasional thin lenses of silt, medium plastic, W.T.P.L.		8	SS	10
			9	SS	8
			10	TW	
				FV	
			11	TW	
				FV	
			12	TW	
				FV	
66.5 / 11.7	SILTY CLAY TILL: Soft to stiff, grey silty clay till, trace sand, low to medium plastic, W.T.P.L.		13	SS	2
				FV	
			14	SS	4
				FV	
			15	SS	4
				FV	
	Cont'd				

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
▲ POCKET PENETROMETER
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)

UNIT WEIGHT γ kg/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Borehole Elevation referenced to IGLD 1985

Groundwater was not observed in borehole at time of drilling.

* Sample submitted for chemical testing
Lake water elevation was 75.2 (IGLD 1985) at time of drilling.

* Sample submitted for chemical testing

Consolidated drained triaxial test conducted on thin walled tube sample recovered at 7.6 m depth.

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

METRIC

PROJECT Pier 15 Rehabilitation
LOCATION Hillyard Street, Hamilton
BORING METHOD CONTINUOUS FLIGHT HOLLOW STEM AUGERS

2 of 2
BORING DATE April 28, 2008

OUR PROJECT NO. 08HF025
ENGINEER H. Gharegrat
TECHNICIAN M. Rapsey

SOIL PROFILE			SAMPLES				SHEAR STRENGTH kPa			
ELEV / DEPTH in meters	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	○ UNCONFINED + FIELD VANE ▲ POCKET PENETROMETER	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kg/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
53.2 / 61.0 / 17.2	becoming firm					61	50 100 150 200		WATER CONTENT (%) 10 20 30 40			
18.0			16	SS	7	60	DYNAMIC CONE PENETRATION ✕ STANDARD PENETRATION TEST ● 20 40 60 80					
19.0						59						
58.2 / 20.0	becoming very stiff											
20.0						58						
21.0						57						
			17	SS	21							
22.0						56						
55.1 / 23.1	with some sand, trace gravel, low plastic											
23.0						55						
24.0						54						
			18	SS	24							
25.0						53						
26.0						52						
27.0						51						
			19	SS	23							
28.0						50						
49.7 / 28.5	SILT AND SAND TILL: Very dense, grey silt and sand till, some gravel, non to slightly plastic, D.T.P.L.											
29.0						49						
30.0						48						
31.0			20	SS	100/175mm							
46.7 / 31.5	SILTY CLAY: Hard, grey silty clay, trace sand, slightly to low plastic, D.T.P.L.					47						
32.0			21	SS	85	46						
45.7 / 32.5	BOREHOLE TERMINATED AT 32.5 m.											
33.0												
34.0												

PML BH LOG GEO 08HF025 BOREHOLE LOGS 2008-04-28 CO.GPJ ON_MOT.GDT 7/22/2008 9:28:23 AM

+ , ×: Numbers refer to Sensitivity

20
15 ○ 5 (%) STRAIN AT FAILURE
10

BURLINGTON BAY

BH1
EL. 77.8

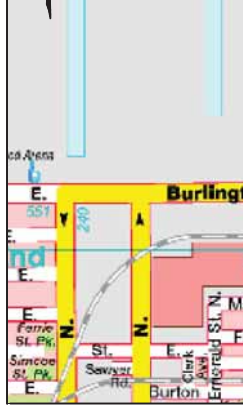
BH2
EL. 78.0

BH3
EL. 78.2

SKID JIM

EVANS McKEIL WAY

MG DISPOSAL



LEGEND:

BH3 PML BORE

BENCHMAR

REFERENCE:
PLAN PRODUCED
BY THE CLIENT
2008.

BENCHMARK:
ALUMINIUM DISK
INTERSECTION OF
LANE TO SIMORE
ELEVATION: 78.5

NOTE:
THE INFERRED S
THE REPORT IS
THESE BOREHOLE
GEOLOGICAL EVID
STRATIGRAPHY BE
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HAMILT
PIER
H
BORE

Appendix A

AGAT Laboratories

Certificates of Analysis

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L4Z 1Y2

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CLIENT NAME: PETO MACCALLUM LIMITED
45 BURFORD ROAD
HAMILTON, ON L8E3C5

ATTENTION TO: Danika Durish

PROJECT NO: 08HF025

AGAT WORK ORDER: 08T276249

SOIL ANALYSIS REVIEWED BY: Jacky Takeuchi, BScH (Chem Eng), BSc (Bio), C.Chem, Laboratory Manager

TRACE ORGANICS REVIEWED BY: Irina Romanova, BSc, Organic Lab Supervisor

DATE REPORTED: Jun 13, 2008

PAGES (INCLUDING COVER): 14

Should you require any information regarding this analysis please contact your client services representative at (905) 712 5100, or at 1-800-856-6261

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Member of: Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Standards Council of Canada (SCC) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.caeal.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested

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Certificate of Analysis

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

O. Reg. 153 Metals & Inorganics in Soil - Table 1

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS2 984066	BH1 SS3 984067	BH2 SS3 984069	BH2 SS4 984077	BH3 SS3 984079	BH3 SS5 984080
Antimony	µg/g	1.0	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	17	0.3	2.5	2.3	2.5	2.7	2.9	2.8
Barium	µg/g	210	0.2	49.8	73.9	53.2	42.7	105	21.6
Beryllium	µg/g	1.2	0.2	0.4	0.5	0.4	0.4	0.6	0.3
Boron (Hot Water Extractable)	µg/g		0.10	0.27	0.22	0.21	0.29	0.31	0.51
Cadmium	µg/g	1.0	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	µg/g	71	0.3	11.4	13.3	11.1	10.8	17.2	7.5
Cobalt	µg/g	21	0.2	8.2	7.6	7.6	7.2	8.8	4.6
Copper	µg/g	85	0.2	18.1	18.0	17.4	18.5	19.3	15.9
Lead	µg/g	120	0.3	7.6	8.3	7.4	9.2	10.5	6.7
Molybdenum	µg/g	2.5	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Nickel	µg/g	43	0.3	15.6	15.9	14.9	13.5	18.8	9.5
Selenium	µg/g	1.9	0.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.42	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	2.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vanadium	µg/g	91	0.2	15.6	18.2	15.4	15.5	23.3	12.6
Zinc	µg/g	160	0.2	40.1	39.3	38.0	44.1	49.1	27.7
Chromium, Hexavalent	µg/g	2.5	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Cyanide, Free	µg/g	0.12	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Mercury	µg/g	0.23	0.011	0.011	0.016	0.015	0.032	0.021	0.011
Electrical Conductivity (2:1)	mS/cm	0.57	0.002	**0.671**	**0.883**	**0.842**	**0.666**	**0.835**	0.197
Sodium Adsorption Ratio (2:1)	N/A	2.4	N/A	**2.62**	**9.06**	**2.44**	0.713	0.790	1.58
pH (2:1)	N/A		N/A	8.18	9.19	8.06	8.03	7.96	8.57
Chloride (2:1)	µg/g	330	0.20	100	141	256	107	45.5	44.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1(All)

Certified By: Jordy Tokeveli

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AGAT WORK ORDER: 08T276249
PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

O. Reg 153 - Volatile Organic Compounds in Soil

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS3 984067	BH3 SS5 984080
Chloromethane	µg/g		0.002	<0.002	<0.002
Vinyl Chloride	µg/g	0.003	0.002	<0.002	<0.002
Bromomethane	µg/g	0.003	0.002	<0.002	<0.002
Chloroethane	µg/g		0.005	<0.005	<0.005
Trichlorofluoromethane	µg/g		0.004	<0.004	<0.004
Acetone	µg/g		0.130	<0.130	<0.130
1,1-Dichloroethylene	µg/g	0.002	0.002	<0.002	<0.002
Methylene Chloride	µg/g	0.003	0.002	<0.002	<0.002
TRANS-1,2-Dichloroethylene	µg/g	0.003	0.003	<0.003	<0.003
Methyl tert-butyl Ether	µg/g		0.004	<0.004	<0.004
1,1-Dichloroethane	µg/g	0.002	0.002	<0.002	<0.002
Methyl Ethyl Ketone	µg/g		0.044	<0.044	<0.044
CIS 1,2-Dichloroethylene	µg/g		0.002	<0.002	<0.002
Chloroform	µg/g	0.006	0.002	<0.002	<0.002
1,2- Dichloroethane	µg/g	0.002	0.002	<0.002	<0.002
1,1,1-Trichloroethane	µg/g	0.009	0.002	<0.002	<0.002
Carbon Tetrachloride	µg/g	0.002	0.002	<0.002	<0.002
Benzene	µg/g	0.002	0.002	<0.002	<0.002
1,2-Dichloropropane	µg/g	0.002	0.002	<0.002	<0.002
Trichloroethylene	µg/g	0.004	0.004	<0.004	<0.004
Bromodichloromethane	µg/g		0.003	<0.003	<0.003
CIS-1,3-Dichloropropene	µg/g		0.002	<0.002	<0.002
Methyl Isobutyl Ketone	µg/g		0.041	<0.041	<0.041
TRANS-1,3-Dichloropropene	µg/g		0.003	<0.003	<0.003
1,1,2-Trichloroethane	µg/g	0.002	0.002	<0.002	<0.002
Toluene	µg/g	0.002	0.002	<0.002	<0.002
2-Hexanone	µg/g		0.470	<0.470	<0.470
Dibromochloromethane	µg/g	0.003	0.003	<0.003	<0.003
Ethylene Dibromide	µg/g	0.004	0.002	<0.002	<0.002
Tetrachloroethene	µg/g	0.002	0.002	<0.002	<0.002
1,1,1,2-Tetrachloroethane	µg/g		0.002	<0.002	<0.002

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AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

O. Reg 153 - Volatile Organic Compounds in Soil

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS3 984067	BH3 SS5 984080
Chlorobenzene	ug/g	0.002	0.002	<0.002	<0.002
Ethylbenzene	ug/g	0.002	0.002	<0.002	<0.002
m & p-Xylene	ug/g		0.002	<0.002	<0.002
Bromoform	ug/g	0.002	0.002	<0.002	<0.002
Styrene	ug/g	0.002	0.002	<0.002	<0.002
1,1,2,2-Tetrachloroethane	ug/g	0.004	0.004	<0.004	<0.004
o-Xylene	ug/g		0.002	<0.002	<0.002
1,3-Dichlorobenzene	ug/g	0.002	0.002	<0.002	<0.002
1,4-Dichlorobenzene	ug/g	0.002	0.002	<0.002	<0.002
1,2-Dichlorobenzene	ug/g	0.002	0.002	<0.002	<0.002
1,2,4-Trichlorobenzene	ug/g		0.007	<0.007	<0.007
Xylenes (Total)	ug/g	0.002	0.002	<0.002	<0.002
1,3-Dichloropropene (Cis + Trans)	ug/g	0.003	0.002	<0.002	<0.002

Comments: RDL - Reported Detection Limit. G / S - Guideline / Standard: Refers to T1(All)

984067
Toluene-d8 Surrogate Recovery: 90%
4-Bromofluorobenzene Surrogate Recovery: 85%
Results are based on the dry weight of the soil.
Percent Moisture = 15.5%.
Results relate only to the items tested.

984080
Toluene-d8 Surrogate Recovery: 93%
4-Bromofluorobenzene Surrogate Recovery: 87%
Results are based on the dry weight of the soil.
Percent Moisture = 20.5%.
Results relate only to the items tested.

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AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS3 984067	BH3 SS5 984080
C6 - C10 (F1)	µg/g		5	<5	<5
C6 - C10 (F1 minus BTEX)	µg/g		5	<5	<5
C>10 - C16 (F2)	µg/g		10	<10	<10
C>16 - C34 (F3)	µg/g		50	<50	50
C>34 - C50 (F4)	µg/g		50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g		50	NA	NA
Moisture Content	%		0.1	15.5	20.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

984067-984080 Results are based on sample dry weight.
The C6-C10 fraction is calculated using toluene response factor.
The C10 - C16, C16 - C34 and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
Total C6 - C50 results are corrected for BTEX and PAH contributions (when is available).
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified without the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.

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AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

O. Reg. 153 PAHs in Soil

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS2 984066	BH3 SS3 984079
Naphthalene	µg/g	0.09	0.03	<0.03	<0.03
Acenaphthylene	µg/g	0.08	0.02	<0.02	<0.02
Acenaphthene	µg/g	0.07	0.03	<0.03	<0.03
Fluorene	µg/g	0.12	0.02	<0.02	<0.02
Phenanthrene	µg/g	0.69	0.02	<0.02	<0.02
Anthracene	µg/g	0.16	0.02	<0.02	<0.02
Fluoranthene	µg/g	1.1	0.02	<0.02	<0.02
Pyrene	µg/g	1.0	0.02	<0.02	<0.02
Benzo(a)anthracene	µg/g	0.74	0.02	<0.02	<0.02
Chrysene	µg/g	0.69	0.02	<0.02	<0.02
Benzo(b)fluoranthene	µg/g	0.47	0.02	<0.02	<0.02
Benzo(k)fluoranthene	µg/g	0.48	0.02	<0.02	<0.02
Benzo(a)pyrene	µg/g	0.49	0.02	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	µg/g	0.38	0.02	<0.02	<0.02
Dibenzo(a,h)anthracene	µg/g	0.15	0.02	<0.02	<0.02
Benzo(g,h,i)perylene	µg/g	0.68	0.02	<0.02	<0.02

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1(All)

984066 Results are based on the dry weight of the soil.
Surrogate Recovery of Chrysene-d12: 73%.
Percent moisture:15.6 %.
Results relate only to the items tested.

984079 Results are based on the dry weight of the soil.
Surrogate Recovery of Chrysene-d12: 75%.
Percent moisture: 18.7%.
Results relate only to the items tested.

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AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Danika Durish

PCBs [soil]

DATE SAMPLED: Apr 24, 2008 | **DATE RECEIVED: Jun 05, 2008** | **DATE REPORTED: Jun 13, 2008** | **SAMPLE TYPE: Soil**

	Unit	G / S	RDL	BH1 SS2 984066	BH3 SS3 984079
PCBs	µg/g	0.3	0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T1(All)

984066 Results are based on the dry weight of soil extracted.
Decachlorobiphenyl surrogate recovery: 130 %.

984079 Results are based on the dry weight of soil extracted.
Decachlorobiphenyl surrogate recovery: 100 %.

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Quality Assurance

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

Soil Analysis

RPT Date: Jun 13, 2008			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153 Metals & Inorganics in Soil - Table 1															
Antimony (µg/g)	0	984066	< 0.8	< 0.8	0.0%	< 0.8	104%	90%	110%	101%	90%	110%	100%	70%	130%
Arsenic (µg/g)	0	984066	2.5	2.6	0.0%	< 0.3	95%	90%	110%	99%	90%	110%	96%	70%	130%
Barium (µg/g)	0	984066	49.8	49.9	0.2%	< 0.2	106%	90%	110%	100%	90%	110%	101%	70%	130%
Beryllium (µg/g)	0	984066	0.44	0.45	2.2%	< 0.2	95%	90%	110%	104%	90%	110%	101%	70%	130%
Boron (Hot Water Extractable) (µg/g)	1	984079	0.31	0.32	3.2%	< 0.10	95%	90%	110%	98%	90%	110%	94%	80%	120%
Cadmium (µg/g)	0	984066	< 0.2	< 0.2	0.0%	< 0.2	99%	90%	110%	96%	90%	110%	104%	70%	130%
Chromium (µg/g)	0	984066	11.4	11.3	0.9%	< 0.3	83%	80%	120%	101%	90%	110%	92%	70%	130%
Cobalt (µg/g)	0	984066	8.2	8.3	1.2%	< 0.2	100%	90%	110%	95%	90%	110%	85%	70%	130%
Copper (µg/g)	0	984066	18.1	18.2	0.6%	< 0.2	101%	90%	110%	99%	90%	110%	89%	70%	130%
Lead (µg/g)	0	984066	7.8	7.9	1.3%	< 0.3	105%	90%	110%	104%	90%	110%	96%	70%	130%
Molybdenum (µg/g)	0	984066	< 0.3	< 0.3	0.0%	< 0.3	96%	90%	110%	95%	90%	110%	106%	70%	130%
Nickel (µg/g)	0	984066	15.6	15.5	0.6%	< 0.3	100%	90%	110%	100%	90%	110%	90%	70%	130%
Selenium (µg/g)	0	984066	0.43	0.49	13.0%	< 0.4	94%	90%	110%	100%	90%	110%	100%	70%	130%
Silver (µg/g)	0	984066	< 0.2	< 0.2	0.0%	< 0.2	100%	90%	110%	96%	90%	110%	94%	70%	130%
Thallium (µg/g)	0	984066	< 0.2	< 0.2	0.0%	< 0.2	114%	80%	120%	103%	90%	110%	100%	70%	130%
Vanadium (µg/g)	0	984066	16.6	16.4	1.2%	< 0.2	88%	80%	120%	94%	90%	110%	86%	70%	130%
Zinc (µg/g)	0	984066	40.1	38.0	5.4%	< 0.2	110%	90%	110%	92%	90%	110%	94%	70%	130%
Chromium, Hexavalent (µg/g)	1	984079	< 0.40	< 0.40	0.0%	< 0.40	97%	80%	120%	98%	80%	120%	99%	80%	120%
Cyanide, Free (µg/g)	1	984079	< 0.08	< 0.08	0.0%	< 0.08	92%	90%	110%	99%	90%	110%	94%	80%	120%
Mercury (µg/g)	1	984066	0.011	0.011	0.0%	< 0.011	101%	90%	110%	105%	90%	120%	110%	70%	130%
Electrical Conductivity (2:1) (mS/cm)	1	984066	0.671	0.672	0.1%	< 0.002	99%	90%	110%						
Sodium Adsorption Ratio (2:1) (N/A)	1	984066	2.63	2.60	1.1%	N/A									
pH (2:1) (N/A)	1	984066	8.18	8.20	0.2%	N/A	98%	90%	110%						
Chloride (2:1) (µg/g)	1	984066	100	98.7	1.3%	< 0.20	94%	80%	120%	90%	80%	120%	113%	80%	120%

Certified By: Jacky Takewski

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Quality Assurance

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

Trace Organics Analysis

RPT Date: Jun 13, 2008			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) In Soil															
C6 - C10 (F1) (µg/g)	1		< 5	< 5	0.0%	< 5	123%	60%	140%	116%	60%	140%	85%	60%	140%
C>10 - C16 (F2) (µg/g)	1		< 10	< 10	0.0%	< 10	96%	60%	140%	87%	60%	140%	119%	50%	140%
C>16 - C34 (F3) (µg/g)	1		< 50	< 50	0.0%	< 50	100%	60%	140%	99%	60%	140%	119%	60%	140%
C>34 - C50 (F4) (µg/g)	1		< 50	< 50	0.0%	< 50	101%	60%	140%	97%	60%	140%	106%	60%	140%
O. Reg. 153 PAHs in Soil															
Naphthalene (µg/g)	1		0.17	0.17	0.0%	< 0.03	115%	60%	140%	77%	60%	140%		60%	140%
Acenaphthylene (µg/g)	1		< 0.02	< 0.02	0.0%	< 0.02	115%	60%	140%	81%	60%	140%		60%	140%
Acenaphthene (µg/g)	1		< 0.03	< 0.03	0.0%	< 0.03	115%	60%	140%	83%	60%	140%		60%	140%
Fluorene (µg/g)	1		0.02	0.02	0.0%	< 0.02	113%	60%	140%	86%	60%	140%		60%	140%
Phenanthrene (µg/g)	1		0.33	0.33	0.0%	< 0.02	109%	60%	140%	99%	60%	140%		60%	140%
Anthracene (µg/g)	1		0.05	0.05	0.0%	< 0.02	110%	60%	140%	102%	60%	140%		60%	140%
Fluoranthene (µg/g)	1		0.30	0.30	0.0%	< 0.02	115%	60%	140%	123%	60%	140%		60%	140%
Pyrene (µg/g)	1		0.26	0.27	3.8%	< 0.02	114%	60%	140%	117%	60%	140%		60%	140%
Benzo(a)anthracene (µg/g)	1		0.13	0.13	0.0%	< 0.02	112%	60%	140%	92%	60%	140%		60%	140%
Chrysene (µg/g)	1		0.16	0.16	0.0%	< 0.02	113%	60%	140%	82%	60%	140%		60%	140%
Benzo(b)fluoranthene (µg/g)	1		0.22	0.21	4.7%	< 0.02	113%	60%	140%	70%	60%	140%		60%	140%
Benzo(k)fluoranthene (µg/g)	1		0.07	0.07	0.0%	< 0.02	119%	60%	140%	82%	60%	140%		60%	140%
Benzo(a)pyrene (µg/g)	1		0.14	0.13	7.4%	< 0.02	115%	60%	140%	85%	60%	140%		60%	140%
Indeno(1,2,3-cd)pyrene (µg/g)	1		0.11	0.10	9.5%	< 0.02	78%	60%	140%	74%	60%	140%		60%	140%
Dibenzo(a,h)anthracene (µg/g)	1		0.02	0.02	0.0%	< 0.02	114%	60%	140%	76%	60%	140%		60%	140%
Benzo(g,h,i)perylene (µg/g)	1		0.13	0.11	16.7%	< 0.02	112%	60%	140%	79%	60%	140%		60%	140%
O. Reg 153 - Volatile Organic Compounds in Soil															
Chloromethane (µg/g)	1		< 0.010	< 0.010	0.0%	< 0.002		60%	140%	114%	60%	140%		60%	140%
Vinyl Chloride (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.002		60%	140%	116%	60%	140%		60%	140%
Bromomethane (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.002		60%	140%	91%	60%	140%		60%	140%
Chloroethane (µg/g)	1		< 0.010	< 0.010	0.0%	< 0.005		60%	140%	107%	60%	140%		60%	140%
Trichlorofluoromethane (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.004		60%	140%	101%	60%	140%		60%	140%
Acetone (µg/g)	1		< 0.074	< 0.074	0.0%	< 0.130	106%	60%	140%	111%	60%	140%		60%	140%
1,1-Dichloroethylene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	106%	60%	140%	105%	60%	140%		60%	140%
Methylene Chloride (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.002	104%	60%	140%	104%	60%	140%		60%	140%
TRANS-1,2-Dichloroethylene (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.003	104%	60%	140%	99%	60%	140%		60%	140%
Methyl tert-butyl Ether (µg/g)	1		< 0.005	< 0.005	0.0%	< 0.004	103%	60%	140%	89%	60%	140%		60%	140%
1,1-Dichloroethane (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	105%	60%	140%	104%	60%	140%		60%	140%

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Quality Assurance

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

Trace Organics Analysis (Continued)

RPT Date: Jun 13, 2008			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Methyl Ethyl Ketone (µg/g)	1		< 0.044	< 0.044	0.0%	< 0.044	100%	60%	140%	102%	60%	140%		60%	140%
CIS 1,2-Dichloroethylene (µg/g)	1		< 0.006	< 0.006	0.0%	< 0.002	103%	60%	140%	94%	60%	140%		60%	140%
Chloroform (µg/g)	1		< 0.006	< 0.006	0.0%	< 0.002	101%	60%	140%	106%	60%	140%		60%	140%
1,2- Dichloroethane (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	101%	60%	140%	106%	60%	140%		60%	140%
1,1,1-Trichloroethane (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.002	102%	60%	140%	103%	60%	140%		60%	140%
Carbon Tetrachloride (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	111%	60%	140%	102%	60%	140%		60%	140%
Benzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	111%	60%	140%	102%	60%	140%		60%	140%
1,2-Dichloropropane (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	103%	60%	140%	99%	60%	140%		60%	140%
Trichloroethylene (µg/g)	1		< 0.004	< 0.004	0.0%	< 0.004	101%	60%	140%	107%	60%	140%		60%	140%
Bromodichloromethane (µg/g)	1		< 0.004	< 0.004	0.0%	< 0.003	104%	60%	140%	100%	60%	140%		60%	140%
CIS-1,3-Dichloropropene (µg/g)	1		< 0.004	< 0.004	0.0%	< 0.002	104%	60%	140%	100%	60%	140%		60%	140%
Methyl Isobutyl Ketone (µg/g)	1		< 0.016	< 0.016	0.0%	< 0.041	104%	60%	140%	99%	60%	140%		60%	140%
TRANS-1,3-Dichloropropene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.003	100%	60%	140%	99%	60%	140%		50%	150%
1,1,2-Trichloroethane (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	106%	60%	140%	100%	60%	140%		60%	140%
Toluene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	104%	60%	140%	94%	60%	140%		60%	140%
2-Hexanone (µg/g)	1		< 0.021	< 0.021	0.0%	< 0.470	111%	60%	140%	103%	60%	140%		60%	140%
Dibromochloromethane (µg/g)	1		< 0.003	< 0.003	0.0%	< 0.003	110%	60%	140%	103%	60%	140%		60%	140%
Ethylene Dibromide (µg/g)	1		< 0.004	< 0.004	0.0%	< 0.002	89%	60%	140%	96%	60%	140%		60%	140%
1,1,1,2-Tetrachloroethane (µg/g)	1		< 0.004	< 0.004	0.0%	< 0.002		60%	140%	94%	60%	140%		60%	140%
Chlorobenzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	95%	60%	140%	102%	60%	140%		60%	140%
Ethylbenzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	105%	60%	140%	93%	60%	140%		60%	140%
m & p-Xylene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	96%	60%	140%	95%	60%	140%		60%	140%
Bromoform (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	108%	60%	140%	88%	60%	140%		60%	140%
Styrene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	102%	60%	140%	96%	60%	140%		60%	140%
1,1,2,2- Tetrachloroethane (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.004		60%	140%	104%	60%	140%		60%	140%
o-Xylene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	90%	60%	140%	95%	60%	140%		60%	140%
1,3-Dichlorobenzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	95%	60%	140%	102%	60%	140%		60%	140%
1,4-Dichlorobenzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	100%	60%	140%	102%	60%	140%		60%	140%
1,2-Dichlorobenzene (µg/g)	1		< 0.002	< 0.002	0.0%	< 0.002	93%	60%	140%	90%	60%	140%		60%	140%
1,2,4-Trichlorobenzene (µg/g)	1		< 0.007	< 0.007	0.0%	< 0.007	98%	60%	140%	95%	60%	140%		60%	140%
PCBs [soil]															
PCBs (µg/g)	1	986903	< 0.05	< 0.05	0.0%	< 0.05	101%	60%	140%	96%	60%	140%		60%	140%

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Quality Assurance

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

Trace Organics Analysis (Continued)

RPT Date: Jun 13, 2008			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Certified By:

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Method Summary

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Arsenic	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Barium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Beryllium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Boron (Hot Water Extractable)	MET 1004	EPA SW 846 6010; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Chromium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Cobalt	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Copper	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Lead	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Molybdenum	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Nickel	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Selenium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Silver	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Thallium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Vanadium	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Zinc	MET 1003	EPA SW-846 3050B & 6020	ICP-MS
Chromium, Hexavalent	INOR 1029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide, Free	INOR 1052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET 1001	EPA SW 846 7471A, 245.5	CVAAS
Electrical Conductivity (2:1)	INOR 1036	McKeague 4.12 & SM 2510 B	EC METER
Sodium Adsorption Ratio (2:1)	INOR 1007	McKeague 4.12 & 3.26 & EPA SW-846 6010B	ICP/OES
pH (2:1)	INOR 1031	McKeague 4.12 & SM 4500-H+ B	pH METER
Chloride (2:1)	INOR 1005	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH

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Method Summary

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Chloromethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Vinyl Chloride	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromomethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Chloroethane	Vol-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Trichlorofluoromethane	Vol-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Acetone	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1-Dichloroethylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methylene Chloride	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
TRANS-1,2-Dichloroethylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl tert-butyl Ether	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1-Dichloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl Ethyl Ketone	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
CIS 1,2-Dichloroethylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Chloroform	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2- Dichloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,1-Trichloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Carbon Tetrachloride	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Benzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2-Dichloropropane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Trichloroethylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromodichloromethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
CIS-1,3-Dichloropropene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Methyl Isobutyl Ketone	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
TRANS-1,3-Dichloropropene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,2-Trichloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Toluene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
2-Hexanone	Vol-5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Dibromochloromethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Ethylene Dibromide	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Tetrachloroethene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,1,2-Tetrachloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Chlorobenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Ethylbenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
m & p-Xylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Bromoform	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Styrene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,1,2,2- Tetrachloroethane	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
o-Xylene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,3-Dichlorobenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,4-Dichlorobenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2-Dichlorobenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,2,4-Trichlorobenzene	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
Xylenes (Total)	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
1,3-Dichloropropene (Cis + Trans)	VOL 5002	EPA SW-846 5035 & 8260	(P&T)GC/MS
C6 - C10 (F1)	VOL - 5009	CCME Tier 1 Method	GC / FID
C6 - C10 (F1 minus BTEX)	VOL - 5009	CCME Tier 1 Method	GC / FID
C>10 - C16 (F2)	VOL - 5012	CCME Tier 1 Method	GC / FID
C>16 - C34 (F3)	VOL - 5012	CCME Tier 1 Method	GC / FID
C>34 - C50 (F4)	VOL - 5012	CCME Tier 1 Method	GC / FID

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Method Summary

CLIENT NAME: PETO MACCALLUM LIMITED

AGAT WORK ORDER: 08T276249

PROJECT NO: 08HF025

ATTENTION TO: Danika Durish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Gravimetric Heavy Hydrocarbons	VOL - 5012	CCME Tier 1 Method	GRAVIMETRIC ANALYSIS
Moisture Content	VOL - 5009	CCME Tier 1 Method	GRAVIMETRIC
Naphthalene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Acenaphthylene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Acenaphthene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Fluorene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Phenanthrene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Anthracene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Fluoranthene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Pyrene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Benzo(a)anthracene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Chrysene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Benzo(b)fluoranthene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Benzo(k)fluoranthene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Benzo(a)pyrene	TO 0500	EPA SW-846 3540 & 8270	GC/MS
Indeno(1,2,3-cd)pyrene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Dibenzo(a,h)anthracene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
Benzo(g,h,i)perylene	Org 5506	EPA SW-846 3540 & 8270	GC/MS
PCBs	ORG 5009	EPA SW-846 3550 & 8081	GC/ECD

Results relate only to the items tested

CHAIN OF CUSTODY RECORD

BIL C COOLER

AGAT Laboratories Limited
5623 McAdam Road
Mississauga, Ontario L4Z 1N9
http://webearth.agatlabs.com

Phone: 905-501-9998
Fax: 905-501-0589
Toll free: 800-856-6261
www.agatlabs.com

LABORATORY USE ONLY
Arrival Condition: ☐ Good ☐ Poor (complete "notes")
Arrival Temperature: 8.3
AGAT Job Number: 081276249
Notes:

Client Information
Company: Peto MacCallum Ltd.
Contact: Danika Durish
Address: 45 Burford Road
Hamilton, ON L8E 3C6
Phone: 905-561-2231 Fax: 905-561-6366
PO #:
Client Project #: 08HF025
AGAT Quotation #:

Report Information - reports to be sent to:
1. Name: Danika Durish
Email: ddurish@petomaccallum.com
2. Name: Melissa King
Email: mking@petomaccallum.com
3. Name:
Email:
Notes (i.e. billing, sub-sampling requirements etc.)

Report Format
☐ Single Sample per page
☒ Multiple Samples per page
☐ Results by Fax

Turnaround Time (TAT) Required*
Regular TAT:
☒ 5 to 7 Working Days
Rush TAT: (please provide prior notification)
Rush Surcharges Apply
☐ 3 to 5 days
☐ 48 to 72 Hours
☐ 24 to 48 hours
OR
DATE REQUIRED (Rush surcharges may apply):

Regulatory Guideline Required
☒ Reg 153 Table 1 (Indicate one)
☐ Ind/Comm ☐ Res/Park ☐ Ag ☐ Med/Fine ☒ Coarse
☐ Sewer Use Region (Indicate one) ☐ Sanitary ☐ Storm
☐ PWQO ☐ Reg 558 ☐ CCME ☐ Other (indicate)
all other

Is this a drinking water sample (potable water intended for human consumption)?
☐ Yes ☒ No
If "Yes" please use the Drinking Water Chain of Custody Record

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments: Site/ Sample Information	Metals and Inorganics	Metals Scan (not reg'd for)	CCME Fractions 1 to 4	VOCs	PAHs	PCBs	TCLP Metals/Inorganics	TCLP	Storm Sewer Use	Sanitary Sewer Use
BH1 SS2	Apr 24/08	8-5	SOIL	1		X		X	X	X	X				
BH1 SS3	↓			2		X		X	X						
BH2 SS3	Apr 25/08			2		X									
BH2 SS4	↓			1		X									
BH3 SS3	Apr 28/08			2		X				X	X				
BH3 SS5	↓	↓	↓	2		X		X	X						

TOTAL # OF CONTAINERS

*Samples received after 2:00 PM will be logged in for the next business day. TAT is exclusive of weekends and statutory holidays

Samples Relinquished By (print name & sign)	Date/Time	Samples Received By (print name & sign)	Date/Time
Danika Durish	June 5'08	Greg Sayles	June 5/08 1:35
	Date/Time		Date/Time

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

PAGE 1 of 1
NO: 61684

Appendix B
Geotechnical Investigations

ITEM B4
Excerpts from: Amec Earth & Environmental - Randle Reef Sediment Remediation Project, Hamilton, Ontario, RS-2 Phase 1 Geotechnical Investigation Report, March 2004.

RANDLE REEF SEDIMENT REMEDIATION PROJECT
HAMILTON, ONTARIO

RS-2 PHASE 1 GEOTECHNICAL INVESTIGATION REPORT

Submitted to:

AMEC E&C Services, a division of AMEC Americas Limited
Hamilton Port Authority
Environment Canada
Ministry of Environment of Ontario

Submitted by:

AMEC Earth & Environmental
A division of AMEC Americas Limited
505 Woodward Avenue, Unit 1
Hamilton, Ontario
L8H 6N6

March 2004
TC035071

4.0 FIELDWORK AND LABORATORY TESTING

The fieldwork for the investigation program outlined in Section 3.4.2 was carried out from October 6 to October 29, 2003, during which time 16 boreholes (numbered, 20, 22, 26, 28, 29, 31 to 36, 38, 39, and 41 to 43) and 3 monitoring wells (numbered, 40 MW, 40A MW, and 43A MW) were put down. The fieldwork also included two flat plate dilatometer test (DMT) profiles performed beside the locations of Boreholes 33 and 36. On encountering a thick deposit of slag fill, an additional investigation program to delineate the slag deposit was also executed. The slag delineation investigation carried out between December 16 and 23, 2003 involved 7 boreholes (numbered, A, C, D, E, I, J and K).

The land boreholes (Boreholes 38 and 43) were put down using a truck-mounted CME 75 drilling rig, supplied by Elite Drilling. The boreholes were advanced by driving 95 mm (inside diameter) hollow-stem augers. All excess soils from the land-based boreholes were removed from site for appropriate disposal as directed by AMEC environmental staff.

The water boreholes (all remaining boreholes) were put down using the same equipment mounted on a 500-ton spudding drill platform, supplied by McKeil Marine Limited. The barge was modified by the construction of a platform off the rear of the barge to allow the drilling crew to safely access the drill head and controls. The drilling platform was moved between borehole locations using a harbour tugboat, also supplied by McKeil Marine Limited.

Casing Setup: After setup at the borehole location, the depth from the drilling platform to the lake water surface was measured. NX–sized casing was lowered into the water and was allowed to settle under its own weight. Generally, the depth to which the casing settled provided “a reasonably good indication” of the interface between the soft, recent sediments and the underlying native soils. The casing was then hydraulically pushed an additional 0.15 m, to set the casing.

These boreholes were advanced by wash boring and tri-coning, with wash water from the drilling operations being discharged directly into the harbour. The casing was advanced when necessary to prevent caving. As well, Quick-Gel® was added where required to keep boreholes from caving across the deep saturated sand and gravel seams. Quick-Gel® is a finely ground bentonite that when mixed with fresh water, forms a low-solids drilling fluid. The product is ANSI/NSF Standard 60 certified. Upon completion, these boreholes were backfilled using Quik-Grout®, as per new Ontario Regulation 903 dated August 2003. The grout was applied through the water by a tremie process. The Quik-Grout® is ANSI/NSF Standard 60 certified, and was mixed to the manufacturer’s specifications.

Prior to commencement of the drilling program, the site specific Health & Safety Plan, developed in the RS-1 stage, was reviewed and implemented. In addition to the standard safety equipment worn by the drill crew and field staff, Tyvek suits, Nitrile gloves, respirators and safety glasses were issued. PID readings were taken in the work area and at the borehole casing to ensure the field staff were not exposed to adverse air conditions.

The borehole locations developed in the proposal stage were translated into UTM (Universal Transverse Mercator) coordinates, based on 1983 North American Datum (NAD 83). A global positioning survey (“GPS”) unit was used to locate the borehole coordinates in the field, as close as possible to the proposed coordinates. The survey was carried out using a Lowrance GlobalMap 100 with DGPS beacon receiver. The GPS unit was deployed until a

minimum of 3 satellites was accounted for and the unit gave a "position acquired" signal. Following that, the DPGS signal was acquired, which, according to the Unit Manual, placed the borehole within 1 to 3 meters of the intended location. No daily calibration of the GPS unit was carried out. Subsequent comparison of borehole locations to actual coordinates indicates the GPS readings were out by 4 metres in one direction.

The elevations of the water boreholes were determined using data from the Lake Ontario Real-Time Water Level Gauging Station located in Burlington, Ontario. The elevations are referred to International Great Lakes Datum (IGLD) 1985. The elevations of the land boreholes were surveyed relative to lake level.

The location coordinates and elevations of the land boreholes were subsequently surveyed by Russell Technical Services Inc., as part of the total station survey of the project site.

All of the above-described fieldwork was directly supervised in the field by experienced AMEC geotechnical personnel, under the direction of the project engineer.

4.1 Geotechnical Sample Collection and Testing

Sampling and testing was performed using standard split spoons, Shelby tubes, NX-size casing, and side sampling equipment. A brief description of each type of equipment follows.

- Split Spoon: Split spoon sampling was carried out to recover samples in both cohesive and non-cohesive soil strata. Where necessary (in soft or loose soils), the split spoon sampler was equipped with a spring trap to reduce sample loss during retrieval of the equipment. The Standard Penetration Tests (SPT) were carried out in conjunction with the split spoon sampling, in accordance with ASTM D1586. The resulting standard penetration resistance 'N-values' provide a measure of the resistance of the soil to penetration of the sampler (or the state of relative density).

- Shelby Tube: Thin-walled Shelby tubes were used to recover relatively undisturbed soil samples (suitable for quantitative laboratory tests of engineering properties, such as strength, compressibility, permeability and unit weight) of cohesive soil strata.

Prior to starting the geotechnical sampling, two Shelby tube samples of the soft surficial deposits (i.e., the recent sediments and/or the silt layers) were taken at each borehole location for environmental testing. Geotechnical sampling and testing started immediately after the environmental sampling.

In the deep boreholes (i.e., Boreholes 26, 33 to 36, 39, 41 and 42, located around the perimeter of the proposed ECF and terminated on encountering practical refusal to further penetration), the typical sampling schedule was to sample at 1.5 m intervals to a depth of 17 m. Below that depth, the sampling interval was increased to every 3 m, until practical refusal to sampling was encountered. Refusal was defined as 100 blows for 30 cm penetration with the split spoon sampler. Shelby tube samples were taken within the relatively softer cohesive deposits in between split spoon sampling (generally between 11 and 15 m depth below lake water level). The sampling depths were generally staggered between boreholes, so that the interval between samples in one borehole would be sampled in an adjacent borehole.

The remaining deep boreholes (Boreholes 20, 22, and 29, which were not driven to refusal) within the anticipated berm areas were typically sampled every 1.5 m, and terminated at 12.5 to 27 m depths where Standard Penetration test results were greater than 15 blows for 30 cm penetration. Shelby Tube samples and field vanes were taken at about the 12 m depth.

The shallow boreholes inside the perimeter of the proposed ECF (i.e., Boreholes 28, 31 and 32) were sampled every 1.5 m, and terminated when the borehole had been advanced a minimum of 3 m into native soils.

Slag Delineation

Sampling and testing was performed in the slag delineation boreholes using a standard split spoon. Sampling was carried at 1.5 metres intervals through the slag fill. The boreholes were terminated approximately 3 metres into the deposit underlying the slag fill.

Preliminary identification of the split spoon samples was carried out upon retrieval from the borehole. The samples were then sealed in individual containers, and returned to an AMEC laboratory for detailed examination and testing.

4.2 Geotechnical Down Hole Testing

The down hole geotechnical testing included: standard penetration tests (SPT), conventional field vane tests (in between soil sampling) to determine in-situ undrained shear strength, and three flat plate dilatometer (DMT) probes. One in-situ consolidation test was also performed at the location of the softest soil layer using the DMT.

Standard Penetration Tests: Described earlier in Section 4.1.

Conventional Field Vane: Field vane tests (using a standard MTO vane) were carried out in the relatively soft clay deposit to determine the in-situ undrained shear strength. The vane was pushed into the soil to the desired depth, and the test carried out to determine in-situ as well as remoulded shear strengths. The ratio of the two strengths provides a measure of the soil sensitivity.

Flat Plate Dilatometer (DMT): This test is initiated by forcing the steel, flat plate, dilatometer blade, with its sharp cutting edge into the soil, stopping at 0.2 meter increments of vertical penetration and performing a test. Each test consists of applying pressure to the back of a flat, circular, metallic membrane, which causes its expansion into the surrounding soil. Correlation of the resulting pressures, expansion and the time that this expansion takes allows estimation of the soil's in-situ stratigraphy, stress, strength, compressibility, and pore-water pressure.

4.3 Environmental Sample Collection

The sediment sampling procedures used at the site are designed to maintain the integrity of the sample for laboratory analysis. Although the technologist completing these procedures

wore Nitrile gloves, the Nitrile does not contact the sediment sample. The cleaning procedure is described below.

- Loose dirt was removed from the sampling equipment using a brush.
- The sampling equipment was washed with a brush in a dilute mix of potable water and Alconox soap.
- The sampling equipment was rinsed with distilled water.
- The sampling equipment was rinsed with methanol and allowed to air dry.

4.3.1 Collection of Environmental Samples at Geotechnical Borehole Locations

As part of the geotechnical fieldwork, samples of surface deposits (recent sediments and/or the shallow silt deposits) were collected for environmental assessment purposes (Boreholes 20, 22, 26, 28, 29, 31 to 36, 38, 39, and 41 to 43). The proscribed sampling schedule was to collect a Shelby tube straddling the interface between the recent, soft sediment and the underlying native soil. A second Shelby tube sample was taken immediately below the first, so that the potential downward migration of any contaminants could be assessed.

Where required, the upper recent, soft sediment was washed from the casing to a point where it was judged that the first Shelby tube interval would straddle the interface. After collection of the first Shelby tube within the casing, the borehole was washed out to the depth of the end of the Shelby tube sample. The second Shelby tube was then pushed into the underlying soil.

Samples for environmental assessment were also collected outside the borehole casing. After setting the borehole casing, an NX-sized length of casing was pushed into the recent, soft sediments next to the borehole casing. In the event of poor or no recovery, alternative sampling procedures were carried out using a side sampler or the split spoon. Stainless steel spring traps were used in the split spoon sampler as required.

<u>NX-size Casing Sampler</u>

NX sized casing was used to obtain bulk samples of the recent, soft sediment, from the ground adjacent the main borehole locations. The sampler was approximately 1 metre in length with a sharpened tip. In most cases, this technique allowed a relatively large sample of the entire stratum of sediment to be sampled. The base of the casing was pushed into the underlying clay and sheared, so that the clay would act as a plug to prevent the loss of the sediment during retrieval.

<u>Side Sampler</u>

Recovering samples of the saturated soft recent sediments was occasionally impossible with open-ended core samplers (e.g. Shelby tube, or split spoon, with or without a spring trap). A

side sampler is a hollow tube similar in size to a split spoon but with a solid base to contain the sample during retrieval. The sampler is driven through the soil and rotated which allows a soil sample to be collected through a raised side port. Although the sample is disturbed during collection, it allows a bulk sample to be taken where no recovery can be obtained with conventional core samplers. Where required, the side sampler was used both inside and outside the borehole casing.

4.3.2 Collection of Environmental Samples at Other Locations

The sediment sampling program consisted of 28 cores collected manually by divers. These sediment sampling locations have been referred to as 'Sediment Sampling Holes', and are indicated on Figure 3-2 as BH-1 to 18, 20, 21, 23 to 25, 29, 30, and 44 to 46.

A Wildco sampler was used by divers in the sediment sampling holes. The Wildco sampler consists of a 1.5 m long stainless steel core tube equipped with a T-handle. A polycarbonate sample collection tube was inserted into the sampling device and driven into the soft sediments by hand. Prior to submerging the sampling device beneath the water, the ends of the Wildco sampler were sealed with plugs. As the sampler was positioned into place on the lakebed, the plugs were removed for sample collection. Upon retrieval, the ends of the sampler were again plugged and the sample brought to the surface. At the surface, the polycarbonate sample collection tube was removed from the sampler, sealed at each end and labelled. Diver notes pertaining to sediment depth were recorded at this time. Sample collection tubes were stored vertically in the field (on the barge) and kept on ice until they were delivered to AMEC's Hamilton laboratory.

The sediment thickness was measured on retrieving the sample to the barge (without correction for any changes that may have occurred during sampling). The sample tubes were stored vertically while they were prepared for freezing and transportation to the laboratory. The sample lengths were measured again prior to freezing. The changes noticed between the two measurements were: 8 samples showed no change, 13 samples showed a 2 to 10% increase and 5 samples showed a 2 to 7% reduction.

In the laboratory, each core sample was divided into two to three segments (referred to as sub-samples) and subjected to testing, or archived for future reference. Each core was visually assessed and logged to determine soil type, visual evidence of contamination and an estimate of sediment thickness

4.4 Sample Containment and Preservation

The NX-size casing samples taken outside the borehole casing through the recent sediments, were extruded in the field and divided into separate, sealed containers for environmental assessment as well geotechnical testing to be carried out by Hart Crowser. The samples were transported back to an AMEC laboratory, after which the environmental portions of the recent sediment samples and the geotechnical sediment samples were refrigerated.

All environmental Shelby tube samples were sealed on-site (with plastic sheets at tube ends) for transport back to AMEC's Hamilton laboratory. Generally, the soft sediments from the

first (uppermost) Shelby tube were examined and the top and bottom portion of these samples used for environmental analysis. These samples were refrigerated and submitted to AMEC's Analytical Chemistry Laboratory in Mississauga. Sediment samples remaining within the tubes were placed in individual bags for geotechnical examination. The second Shelby tube (typically containing lower part of the sediment and the underlying soil deposit) from each borehole was opened, and the bottom 15 cm extruded and submitted for environmental assessment. The Shelby tube was then sealed with wax and preserved for subsequent geotechnical testing. Shelby tube samples obtained from the underlying silty clay stratum for detailed geotechnical laboratory testing (e.g., consolidation, triaxial testing) were immediately sealed with wax upon arrival in the Hamilton laboratory.

Preliminary identification of the split spoon samples was carried out upon retrieval from the borehole. The samples were then identified in the field and sealed in individual labelled containers. These samples were subsequently subjected to detailed examination in the laboratory.

4.5 Geotechnical Laboratory Testing

This section presents the results of the laboratory testing, which was carried out on selected representative soil samples. Interpretation of test results vis-à-vis the geotechnical design of the ECF components is presented in Section 6 of this report.

Routine laboratory testing (e.g., natural moisture content, grain size distribution and Atterberg limits) was carried out in the AMEC geotechnical laboratories in St. Catharines and Hamilton. More sophisticated testing (e.g., triaxial shear and one-dimensional consolidation) was carried out by the AMEC Scarborough laboratory. The minimum qualifications for each laboratory is certification according to the Canadian Council for Independent Laboratories (CCIL) as well as MTO approval by participation in a yearly Soils and Aggregates Correlation Program.

Table 4.1 on the following page summarizes the samples tested and type of tests carried out on each sample.

Index or Classification Tests: Grain size distribution curves (based on mechanical sieve and/or hydrometer analyses) are presented on Figures B-1 to B-8 in Appendix B. The natural moisture content, liquid limit, plastic limit and the plasticity index values are presented on the individual borehole logs. The results of the Atterberg limits tests are also plotted on the plasticity chart on Figures B-9A and B-9B in Appendix B.

Consolidation Testing: An important consideration for ECF design is the estimated settlement resulting from compression under future loading of the silty clay soils within and surrounding the ECF. One-dimensional consolidation (oedometer) testing was carried out to obtain consolidation characteristics for the upper silty clay stratum (the relatively softer deposit) that will permit estimating compression of the stratum. The tests were carried out on the following Shelby tube samples:

Table 4.1 Laboratory Test Program on Recovered Soil Samples

BH	Location	Sample Type	Depth (m)	Soil Type	Laboratory Tests					Notes
					Gradation	Atterberg Limits	Consolidation	Triaxial – c', phi'	Triaxial – (U-U)	
20	Berm	SS5	11.9-12.3	Silty Clay	X	X				
20		SH6	13.4-13.55	Silty Clay	X	X		X		
22	Berm	SS5&6	7-8.6	Silt	X	X				
22		SH8	11.4-11.55	Silty Clay	X	X	X		X	
22		SS9	13-13.4	Silty Clay	X	X				
29	Berm	SS3,4,5	5.5-8.5	Silt	X	X				
29		SH8	12.8-13.15	Silty Clay	X	X			X	
29		SS9	14.5-14.9	Silty Clay	X	X				
29		SS13	22.1-22.5	Clayey Silt Till	X	X				
32	ECF	SS6	14.5-14.9	Silty Clay	X	X				
33	Dock	SH4	13.15-13.4	Silty Clay	X	X	X		X	
34	Dock	SS3	10.2-10.6	Silty Clay	X	X				
34		SH4	11.6-12	Silty Clay	X	X		X		
35	Dock	SS7	11.6-11.10	Silty Clay	X	X				
35		SH8	13-13.2	Silty Clay	X	X		X		
35		SS12	26.7-27.1	Silt Till	X	X				
36	Dock	SH6	13-13.4	Silty Clay	X	X		X	X	DMT Consolidation Test
36		SS11	20.4-20.8	Clayey Silt	X	X				
38	Dock (Land)	SS2	3-3.4	Alluvium	X	X				
38		SS5	7.6-8.2	Silty Clay	X	X				
38		SH8	12.2-12.4	Silty Clay	X	X			X	
39	Dock	SH4	10.8-11.2	Silty Clay	X	X	X		X	
42	Dock	SH1	8.1 – 8.5	Silt	X	X				
42		SH4	11.4-11.6	Silty Clay	X	X	X		X	
43	Dock (Land)	SS10	15.2-15.6	Silty Clay	X	X				
43		SH11	18.25-18.6	Silty Clay	X	X			X	

Sample	Location	Description of Soil	Depth of Sample below IGLD
BH 22 – Sa8	Berm Area	Silty Clay	11.4 to 11.5 m
BH 33 – Sa4	Berthing Area	Silty Clay	13.2 to 13.4 m
BH 39 – Sa4	Berthing Area	Silty Clay	10.8 to 11.2 m
BH 42 – Sa4	Berthing Area	Silty Clay	11.4 to 11.6 m

The test results are shown on Figures B-10 to B-13 (each with three sheets, A: Test Data, B: ‘v versus e and c_v, and C: Strain energy data).

Undrained Shear Strength

Triaxial “Quick” tests were carried out to determine undrained shear strength of the cohesive soils. Selected representative samples were subjected to confining cell pressures corresponding to approximately 50% of the effective in-situ vertical stress (existing overburden pressure) and then sheared at a strain rate of 0.5% per minute.

Sample	Location	Description of Soil	Depth of Sample below IGLD
BH 22 – Sa8	Berm Area	Upper Silty Clay	11.4 to 11.5 m
BH 29 – Sa8	Berm Area	Upper Silty Clay	12.8 to 13.2 m
BH 33 – Sa4	Dock Area	Upper Silty Clay	13.2 to 13.4 m
BH 38 – Sa8	Dock (Land)	Upper Silty Clay	12.2 to 12.4 m
BH 39 – Sa4	Berthing Area	Upper Silty Clay	10.8 to 11.2 m
BH 42 – Sa4	Berthing Area	Upper Silty Clay	11.4 to 11.6 m
BH 43 - Sa11	Dock (Land)	Upper Silty Clay	18.3 to 18.6 m

The test results for the above seven samples are summarized on Figures B-14 and B-15 in Appendix B.

Triaxial Testing to Obtain Effective Stress Strength Parameters

Isotropically Consolidated Undrained (CIU) Triaxial compression shear tests with pore pressure measurement were carried out to determine the effective shear strength parameters of the cohesive soils. Each test involved testing three specimens of the soil sample obtained from the same Shelby tube sample. The specimens were saturated by backpressure application (together with a small effective confining cell pressure), then consolidated under effective cell pressures of 30, 60 and 120 kPa, and finally sheared in compression (in undrained condition with pore pressure response measurement).

Sample	Location	Description of Soil	Depth of Sample below IGLD
BH 20 – Sa6	Berm Area	Silty Clay	13.4 to 13.6 m
BH 34 – Sa4	Berthing Area	Silty Clay	11.6 to 12.1 m
BH 35 – Sa8	Berthing Area	Silty Clay	16.0 to 16.4 m
BH 36 – Sa6	Berthing Area	Silty Clay	13.0 to 13.4 m

The test results for the above four samples are shown on Figures B-16 to B-19 in Appendix B. Each figure is a set of four sub-figures as follows: (A) Test Data, (B) Stress-Strain curves, (C) Stress Paths, and (D) Mohr’s envelopes.

APPENDIX A – BOREHOLE LOGS AND SOIL STRATIGRAPHIC PROFILES

General Borehole Log Notes

Borehole Logs

Boreholes 20, 22, 26, 28, 29, 31 to 36, 38, 39 and 41 to 43.
Monitoring Well Holes 40 (MW), 40A (MW) and 43A (MW).
Slag Delineation Boreholes A, C, D, E, I, J and K.

Stratigraphic Profiles

Figure A-1 Profile Location Plan
Figure A-2 Inferred Stratigraphic Profile A-A along Secondary ECF Wall
Figure A-3 Inferred Stratigraphic Profile B-B along Primary ECF Wall
Figure A-4 Inferred Stratigraphic Profile C-C along West and North Perimeter of ECF
Figure A-5 Inferred Stratigraphic Profile D-D along East Perimeter of ECF
Figure A-6 Inferred Stratigraphic Profile E-E along East Perimeter of ECF
Figure A-7 Slag Delineation Borehole Location Plan

GENERAL BOREHOLE LOG NOTES

DEFINITIONS OF PENETRATION RESISTANCE

Standard penetration resistance, SPT 'N'-value: -- The number of blows required to advance a standard split spoon sampler 30 cm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 70 cm (ASTM D1586).

Dynamic cone penetration resistance, DCPT: -- The number of blows required to advance a 50 mm, 60 degree cone, fitted to the end of drill rods, 30 cm into the subsoil, the driving energy being 475 Joules per blow.

SAMPLE TYPE ABBREVIATIONS USED IN BOREHOLE LOGS

S.S.	Split spoon	T.W.	Thinwall open	R.C.	Rock core
A.S.	Auger sample	T.P.	Thinwall piston	W.S.	Washed sample
P.H.	Sample pushed hydraulically			P.M.	Sample pushed manually

SOIL TEST SYMBOLS USED IN BOREHOLE LOGS

☐ Standard penetration resistance	▼ Laboratory vane	○ Unconfined
■ Dynamic penetration resistance	▲ Field vane	● Undrained triaxial
	✕ Penetrometer	**S** Sensitivity

CONVENTIONAL SOIL DESCRIPTIONS

The terms used to describe size variation in a soil mass, and the corresponding percentage by weight, are as follows: "and" implies >35%, "adjectives (such as silty, sandy, etc)" imply 20-35%, "some" represents 10-20%, and "trace" indicates 1-10%, respectively.

COHESIVE SOILS		GRANULAR SOILS (SANDS, ETC.)	
Consistency	Shear Strength, kPa	Compactness	SPT 'N'-Value
Very Soft	0 - 12	Very Loose	0 - 4
Soft	12 – 25	Loose	4 - 10
Firm	25 – 50	Compact	10 - 30
Stiff	50 -100	Dense	30 - 50
Very Stiff	100 -200	Very Dense	>50
Hard	> 200		

ABBREVIATIONS FOR MOISTURE CONDITIONS

sdtpl - slightly drier than the plastic limit.
dtpl - drier than the plastic limit.
apl - about the plastic limit.
swtpl - slightly wetter than the plastic limit.
wtpl - wetter than the plastic limit.
mwtpl - much wetter than the plastic limit.

NOTE

The soil conditions, profiles, comments, conclusions and recommendations found in this report are based upon the samples recovered during the fieldwork. Soils are heterogeneous materials and, consequently, variations (possibly extreme) may be encountered at site locations away from boreholes. During construction, competent, qualified inspection personnel should verify that no significant variations exist from the conditions described in this report.

RECORD OF BOREHOLE No 20

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791958N 594784E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6									20 40 60 80 100	10 20 30	
0.0	**WATER**										
65.9											
8.7	Black **SOFT SEDIMENT (Recent)**		1	SIDE							
65.2											
9.4	Brown to grey-brown **SILT**, marbled with recent sediment near top, frequent thin clay seams at depth, saturated/wtpl, very stiff/compact.		2	SH							
			3	SH							
			4	SS		17					
63.2											
11.4	Grey **SILTY CLAY**, occasional silt and sand laminae, wtpl, firm to stiff.		5	SS		8					**Gs/Hyd LL/PI**
			6	SH	100						**'C-U'**
				VANE					S=2.0		

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RECORD OF BOREHOLE No 20

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791958N 594784E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES					
			7	SS		5					
			8	SS		4					
			9	SS		4					
			10	SS		9					
53.3 21.3	Grey to grey-brown **CLAYEY SILT TILL**, wtpl to apl, hard.										
			11	SS		35					
51.4 23.2	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 22

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791996N 594643E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 16.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6 / 0.0	**WATER**										
70.5 / 4.1	**SOFT SEDIMENT (Recent)**, with zebra mussels.		1	SH							
70.2 / 4.4	3 cm brown Organic **ALLUVIUM** over Grey, red-brown and brown **SILT**, some black staining in upper 0.4 m(±), layer of brown Organic **PEAT** and **ALLUVIUM** from 4.6 to 4.8 m(±), occasional grey clay seam and thin organic layers, wet to saturated, loose to compact.		2	SH							
			3	SH							
			4	SS		4					
			5	SS		16					**Gs/Hyd LL/PI**
			6	SS		13					**Gs/Hyd LL/PI**
65.2 / 9.4	Grey to grey-brown **SILTY CLAY**, wtpl, occasional siltier zones, traces of sand at depth, firm.		7	SS		5					
			8	SH							**Cons**
				VANE					S=2.1		
			9	SS		2					**Gs/Hyd LL/PI**
			10	SS		3					

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RECORD OF BOREHOLE No 22

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791996N 594643E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 16.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
55.3 / 19.3	Grey **SILTY CLAY** to **CLAYEY SILT**, weakly laminated, occasional medium to coarse Sand layer, occasional small cobble below 21.0 m, wtpl, stiff.		11	SS		4		16			
			12	SS		6		17			
								18			
								19			
			13	SS		14		20			
52.3 / 22.3	Grey-brown **CLAYEY SILT TILL**, occasional small cobbles, apl, hard.							21			Good wash return
								22			
								23			
			14	SS		30		24			
49.2 / 25.4	**SAND & GRAVEL**, saturated.							25			Quick-Gel added to displace sand & gravel.
48.3 / 26.3	Reddish-brown and grey/green **SILT TILL** to **SHALE** at 26.8 m(±), very dense.		15	SS		100/13cm		26			
47.5 / 27.1	Borehole Terminated.							27			Borehole backfilled completely with Grout.

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST
SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE
20 40 60 80 100
WATER CONTENT (%)
10 20 30

RECORD OF BOREHOLE No 26

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791814N 594805E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 29.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE		
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**										
65.8											
8.9	**SOFT SEDIMENT (Recent)**, mixed with **SLAG Fill** and **Zebra Mussels**										Sampling outside casing: Nx casing pushed to 9.9 m.
64.9											
9.8	Grey to black **SLAG**, minor recent sediment and shells in upper 0.4 m(±), little sample recovery, trace coal tar below 17.0 m(±), saturated, compact.		1	SS	15	10					
			2	SS	5	30					
			3	SS	5	8					
			4	SS	5	7					
			5	SS	5	9					
			6	SS	5	19					

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RECORD OF BOREHOLE No 26

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791814N 594805E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 29.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
53.1								16			
			7	SS	5	11					
								17			
			8	SS	5	15					
								18			
			9	SS	5	23					
								19			
			10	SS	10	17					
								20			
21.6	Grey **SILTY CLAY**, traces of sand and gravel, wtpl, very stiff.							21			Good wash return.
			11	SS	5	25					
			12	SS	70	19		22			
								23			
49.3								24			
25.4	Brown, Grey and Reddish-brown **SILT TILL** to **CLAYEY SILT TILL**, apl/moist to wet, hard/very dense.		13	SS	10	69		25			
								26			
								27			
46.3			14	SS	60	50/3cm		28			
28.4	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 28

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791871N 594597E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 27.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6									20 40 60 80 100	10 20 30	
0.0	**WATER**								○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✥ LAB VANE		
65.5								1			
9.1	**SOFT SEDIMENT (Recent)**							2			
64.8			1	SH		N/R		3			Sampling outside casing: Nx sampler pushed to 9.5 m - no recovery. Split Spoon driven from 9.5 to 10.0 m(±).
9.8	Brown saturated **SILT**, occasional black Recent Sediment seams, loose.		2	SH				4			
64.2								5			
10.4	Grey **SILTY CLAY**, occasional silt seams, wtpl, firm.		3	SS	100	8		6			No recovery from SH 1. Side Sampler used to obtain sample.
62.1			4	SS	100	3		7			
12.5	Borehole Terminated.							8			Borehole backfilled completely with Grout.
								9			
								10			
								11			
								12			

RECORD OF BOREHOLE No 29

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791936N 594501E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 20.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6											
0.0	**WATER**										
70.9											
70.8	**SOFT SEDIMENT (Recent)**		1	SH						46.1	Sampling outside casing: Nx sampler driven twice to 4.1 m - no recovery. Split Spoon driven from 3.7 to 4.0 m(±).
3.8	Brown to reddish-brown **SILT**, wet to saturated, 10 cm thick black recent sediment layer at 4.1 m(±), trace clay increasing with depth, dense to compact (apl and very stiff near base of deposit).		2	SH				4			
			3	SS	45	30		5			**Gs/Hyd LL/PI**
			4	SS	40	22		7			**Gs/Hyd LL/PI**
			5	SS	45	18		8			**Gs/Hyd LL/PI**
64.8								9			
9.8	Grey to grey-brown **SILTY CLAY** to **CLAYEY SILT** trace of sand & gravel, occasional silt/sand seam, becoming siltier below 17.5 m(±), wtpl, firm to stiff.		6	SS	50	14		10			
			7	SS	100	14		11			
	(harder zone at 13.2 m, vane not attempted)		8	SH				12			
			9	SS	70	7		13			
								14			

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RECORD OF BOREHOLE No 29

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791936N 594501E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 20.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✥ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
				VANE					S=1.9		
			10	SS	100	7		16			
			11	SS	100	9		17			
			12	SS	100	6		18			
54.5								19			
20.1	Grey-brown **CLAYEY SILT TILL**, cobbles from 21.8 to 22.1 m(±), wtpl to sdtpl, hard.							20			
								21			
								22			
52.0			13	SS	15	45					**Gs/Hyd LL/PI**
22.6	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 31

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791830N 594534E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 24.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6									20 40 60 80 100	10 20 30	
0.0	**WATER**										
65.6								1			
9.0	**SOFT SEDIMENT (Recent)**							2			
64.8								3			
9.8	Brown **SILT**, minor staining, saturated.		1	SH				4			
64.5								5			
10.1	Grey **SILTY CLAY**, wtpl, firm.		2	SH				6			
								7			
			3	SS	100	5		8			
								9			
								10			
								11			
								12			
61.2			4	SS	100	4		13			
13.4	Borehole Terminated.										

Sampling outside casing: Nx sampler pushed to 10.0 m. Duplicate sample taken.

Bottom 65 cm of SH 1 saved as bag sample.

Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 32

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791783N 594619E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 24.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6 0.0	**WATER**							0			
66.2 8.4	Brown **ORGANIC ALLUVIUM** Black **SOFT SEDIMENT (Recent)**, some shells, silt layers. Brown **ORGANICS**, saturated, very loose.		1	SH		N/R		9			Sampling outside casing: Nx sampler pushed to 10.2 m.
			2	SH				10		242.7	
			3	SH				11			
			4	SS	40	1/46cm		12			
	(wood in split spoon #5)		5	SS	20	2		13			
60.6 14.0	Brown to Grey **SILTY CLAY**, fissured, apl to wtpl, very stiff to firm.		6	SS	55	18		14			**Gs/Hyd** **LL/PI**

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RECORD OF BOREHOLE No 32

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791783N 594619E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 24.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100 20 40 60 80 100	10 20 30	
58.1			7	SS	100	8		16			
16.5	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 33

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791826N 594431E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 10.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**										
65.7											
9.0 / 65.4	**SOFT SEDIMENT (Recent)**										
9.3	Grey **SILTY CLAY** to **CLAYEY SILT**, trace to some sand, trace of gravel below 18.0 m (±), wtpl, firm to stiff.		1	SH				10			
			2	SS		2					
			3	SS		3		12			
				VANE							
			4	SH				13			**Gs/Hyd LL/Pl Cons**
			5	SS		6					

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RECORD OF BOREHOLE No 33

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791826N 594431E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 10.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
56.8								16			
			6	SS		9					
17.9	Grey, laminated **SILTY CLAY**, traces of sand & gravel, augers grinding occasionally below 21.6 m(±), wtpl, very stiff.							17			
								18			
								19			
			7	SS		17					SS 8 - Driving Stone.
								20			
								21			
								22			
			8	SS		29					
50.9								23			
23.8	**SAND & GRAVEL**, saturated.										Quick-Gel added to prevent water loss through sand & gravel layer.
50.2								24			
24.5	Grey **CLAYEY SILT**, traces of sand & gravel, wtpl.										
49.2								25			
49.1	Reddish-brown **SILT TILL**, wet to saturated, very dense.		9	SS		138					
25.8	Reddish-brown **SAND & GRAVEL**, saturated, very dense.										Borehole backfilled completely with Grout.
	Borehole Terminated.										

RECORD OF BOREHOLE No 34

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791762N 594490E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 21.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**								○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✥ LAB VANE		
66.5								1			
8.2	**SOFT SEDIMENT (Recent)**							2			
65.3								3			
9.4	Grey **SILTY CLAY** to **CLAYEY SILT**, trace of sand & gravel, wtpl, stiff to firm.		1	SH				4			Sampling outside casing: Three Nx samplers pushed to 9.7 m(±).
			2	SH				5			
			3	SS		4		6			
								7			
			4	SH				8			
								9			
				VANE				10		57.1	**Gs/Hyd LL/PI**
								11			**'C-U'**
								12	S=1.7		
								13			
			5	SS	100	9		14			
			6	SS	100	12					

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RECORD OF BOREHOLE No 34

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791762N 594490E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 21.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
55.8								16			
			7	SS	100	10		17			
			8	SS	100	6		18			
18.9	Grey-brown **CLAYEY SILT**, traces of sand & gravel, some till-like zones, cobbles below 24.6 m(±), sdtpl to apl, hard.							19			harder augering.
			9	SS	100	44		20			
								21			
								22			
			10	SS	100	33		23			Good wash return.
49.8								24			
24.9	Reddish-brown **SAND & GRAVEL**, cobbles at 26.8 m±, saturated, dense.							25			
								26			
			11	SS	20	33					Quick-Gel added to keep Hole open across sand & gravel layer.
47.5								27			
27.2	Grey **CLAYEY SILT TILL**, damp, very dense.										
			12	SS	100	124		28			
46.5											
28.2	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 35

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791735N 594587E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 14.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**										
66.8								1			
7.9	**SOFT SEDIMENT (Recent)**		1	SIDE				2			
64.9			2	SIDE				3			
9.8	Grey **SILTY CLAY**, trace of sand and gravel, swtpl to wtpl, firm.		3	SH				4			
			4	SH				5			
			5	SS		7		6			
	(last 0.3 m of SH 6 hard to push (silt layers) - no vane attempted)		6	SH				7			
			7	SS		6		8			
								9			
								10		48.9	
								11			
								12			
								13			
								14			
											Gs/Hyd LL/PI

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RECORD OF BOREHOLE No 35

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791735N 594587E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 14.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
				VANE					S=2.2		
			8	SH				16			**'C-U'**
57.1								17			
17.6	Grey **SILTY CLAY**, weakly laminated, occasional weathered shale piece, becoming siltier, cobble at 21 m, wtpl to swtpl, very stiff.							18			harder augering
			9	SS		22		19			
								20			
								21			
			10	SS		22		22			
								23			
								24			Good wash return to 25 m. Quick-Gel added to displace sand & gravel 25.5 to 26.1m(±).
49.2			11	SS		43		25			
25.5	Reddish-brown **SAND & GRAVEL**, saturated.										
48.6								26			
26.1	Reddish-brown **SILT TILL**, minor cohesion, moist, very dense.										**Gs/Hyd LL/PI**
47.6			12	SS		98		27			
27.1	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 36

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791690N 594657E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 21.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	OBSERVATIONS & REMARKS
74.6									
0.0	**WATER**								
69.0									
5.6	**SOFT SEDIMENT (Recent)**, with Silt layers.								Sampling outside casing: Nx sampler driven to 6.7m.
67.7									
6.9	Grey **SILTY CLAY**, traces of sand & gravel at depth, wtpl to apl, firm to stiff.		1	SH					
			2	SH					
			3	SS	80	6			
			4	SS	100	5			
				VANE					
			5	SS	100	5			
			6	SH					**'C-U'**
			7	SS	100	13			
			8	SS	100	8			

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE

20 40 60 80 100

S=2.0

WATER CONTENT (%)

10 20 30

Continued Next Page

RECORD OF BOREHOLE No 36

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791690N 594657E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 21.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
55.5								16			
			9	SS	35	13					Good wash return.
								17			
			10	SS	100	10					
								18			
19.1	Grey-brown **CLAYEY SILT**, traces of sand & gravel, cobbles below 25 m, wtpl to apl, very stiff.							19			Good wash return.
								20			
			11	SS	30	23					**Gs/Hyd LL/PI**
								21			
								22			
								23			
			12	SS	100	20					
								24			
								25			
								26			
48.1											
26.5	**SILT, SAND & GRAVEL**, some cobbles, saturated, very dense.		13	SS	20	70		27			Hole caving at 26.5 m. Quick-Gel added to displace sand & gravel.
46.3											
28.3	Possibly **Queenston SHALE**, very dense.							28			Borehole backfilled completely with Grout.
45.0								29			
			14	SS	0	100/8cm					
29.6	Borehole Terminated.										

RECORD OF BOREHOLE No 38

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791574N 594604E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 6.10.03 CHECKED BY pmc

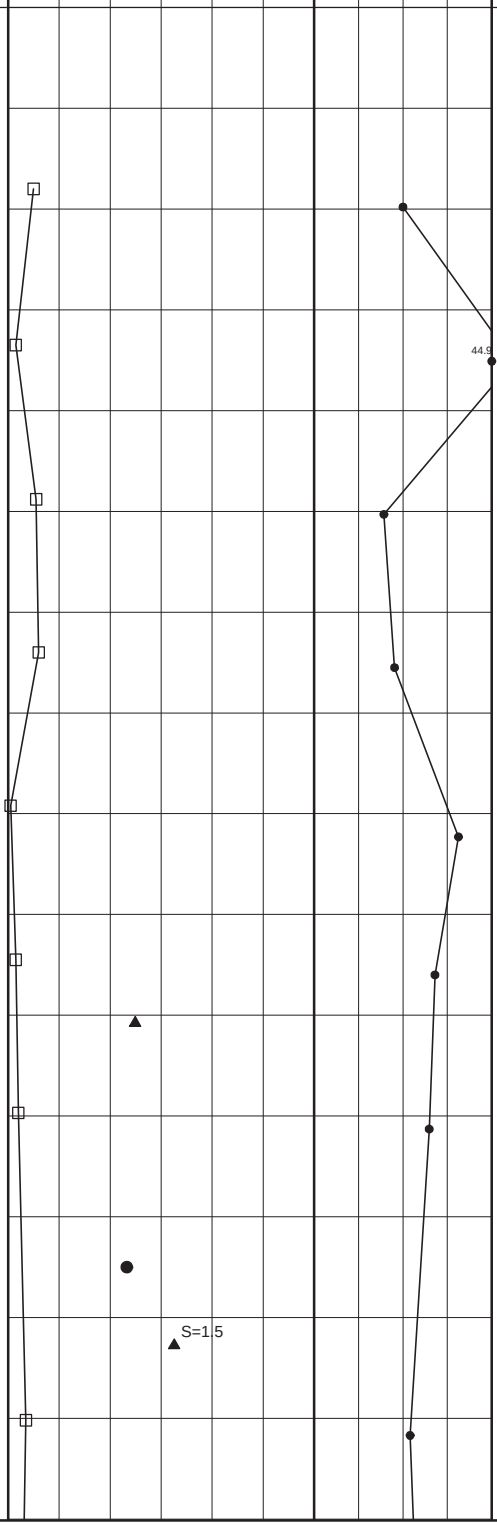
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES
76.5 0.0	**FILL** - Grey and Black Granular (silt, sand & gravel).					
74.8 1.7	**ALLUVIUM**- Black to brown Silt, some sand, few silty clay zones, trace of organics, augers grinding from 2.9 to 3.1 m(±), wet, very loose.		1	SS		10
			2	SS		3
71.9 4.6	Brown to grey **SILTY CLAY** to **CLAYEY SILT** occasional thin silt seams, becoming siltier below 15.0 m(±), traces of sand & gravel, wtpl, stiff to firm.		3	SS		11
			4	SS		12
			5	SS		1
			6	SS		3
				VANE		
			7	SS		4
			8	SH		
				VANE		
			9	SS		7

GROUND WATER CONDITIONS

DEPTH (m)

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE



WATER CONTENT (%)

OBSERVATIONS & REMARKS

Gs/Hyd LL/Pl

Gs/Hyd LL/Pl

Continued Next Page

RECORD OF BOREHOLE No 38

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791574N 594604E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 6.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
			10	SS		6		16			
			11	SS		11		17, 18, 19, 20			
56.0 / 20.5	Grey **SILTY CLAY**, weakly laminated, traces of sand & gravel, occasional reddish-brown Silt Till layers, wtpl, very stiff.		12	SS		21		21, 22, 23, 24			harder augering
51.5			13	SS		21					Bearing gone in carriage. Deeper augering not possible. Dynamic Penetration testing carried out. Refusal depth correlates with Acres 1954 Borehole #'s 10 and 11.
25.0			14	DT		18		25			
			15	DT		28					
			16	DT		44		26			
			17	DT		52					
			18	DT		60					
			19	DT		74					
49.4			20	DT		88		27			
27.1	Borehole Terminated.										Upon Completion: Borehole dry & open. Borehole backfilled with Quick Grout.

STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST
SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE
20 40 60 80 100

WATER CONTENT (%)
10 20 30

RECORD OF BOREHOLE No 39

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791666N 594513E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 27.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUES
74.6 / 0.0	**WATER**				
66.8 / 7.8	Black **SOFT SEDIMENT (Recent)**	1	SS		1
66.1 / 8.5	Grey **SILT**, layered with **Soft Recent Sediment** saturated, very loose.	2	SH		
65.2 / 9.4	Grey **SILTY CLAY**, occasional weathered shale pieces below 17.0 m(±), wtpl, firm to stiff.	3	SH		
			VANE		
		4	SH		
		5	SS	100	9
		6	SS	100	5

STRAT PLOT

GROUND WATER CONDITIONS

DEPTH (m)

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE

20 40 60 80 100

S=2.3

WATER CONTENT (%)

10 20 30

OBSERVATIONS & REMARKS

Sampling outside casing: Nx sampler pushed to 8.7 m.

Cons.

Continued Next Page

RECORD OF BOREHOLE No 39

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791666N 594513E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 27.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	"N" VALUES	DEPTH (m)	OBSERVATIONS & REMARKS
55.3							
19.3	**SAND & GRAVEL**, cobbles, saturated.	7	SS	100	6	16	
54.6							
20.0	Grey **CLAYEY SILT TILL**, cobbles below 25.8 m(±), wtpl to apl, hard to stiff.	8	SS	100	10	17	
						18	
						19	
		9	SS	100	45	20	Hole caving at 19.8 m. Casing advanced to 23.6 m(±).
						21	
						22	
						23	
		10	SS	75	14	24	
48.8						25	
25.8	**SAND & GRAVEL**, saturated.						Quick-Gel added to disperse sand & gravel 25.8 to 26.7m(±).
47.9						26	
26.7	Reddish-brown to green-grey **SILT TILL**, possible **SHALE**, damp, very dense	11	SS	10	100/28cm		
47.5						27	
27.1	Borehole Terminated.						Borehole backfilled completely with Grout.

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE

WATER CONTENT (%)

RECORD OF BOREHOLE No 41

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791702N 594452E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 28.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7 0.0	**WATER**										
66.6 8.1	Black **SOFT SEDIMENT (Recent)**										
66.2 8.5	Grey **SILTY CLAY**, wtpl, firm.		1	SH							Sampling outside casing: Nx sampler pushed to 8.8 m.
			2	SH							
			3	SS	100	2					
			4	SH		N/R					
				VANE					S=2.0		
			5	SS	100	5					
			6	SS	100	4					

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RECORD OF BOREHOLE No 41

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791702N 594452E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 28.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
56.9 / 17.8	Grey **SILTY CLAY**, traces of sand & gravel, wtpl, very stiff.		7	SS	100	4		16			
			8	SS	90	15		19			
			9	SS	20	28		22			
			10	SS	10	22		25			Quick-Gel used to clear cave through sand & gravel 25.1 to 27.2m(±).
47.9 / 26.8	Brown to Red-brown **CLAYEY SILT TILL** to **SILT TILL**, damp, very dense.		11	SS	65	153		27			
46.7 / 28.0	Borehole Terminated.							28			Borehole backfilled completely with Grout.

STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE; 20 40 60 80 100

WATER CONTENT (%): 10 20 30

RECORD OF BOREHOLE No 42

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791741N 594395E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 29.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.6									20 40 60 80 100	10 20 30	
0.0	**WATER**										
67.0								1			
7.6	**Black Oily Film** over Brown **SILT**, occasional clay seam, wood and organics in top 0.5 m(±), saturated.		1	SH				2			Sampling outside casing: Nx sampler pushed to 8.2 m.
65.4			2	SH				3			
9.2	Grey **SILTY CLAY**, traces of sand & gravel, wtpl, firm to stiff.		3	SS	70	12		4			
			4	SH				5			**'C-U'**
				VANE				6	S=1.9		
			5	SS	100	7		7			
			6	SS	100	10		8			
								9			
								10			
								11			
								12			
								13			
								14			

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RECORD OF BOREHOLE No 42

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791741N 594395E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 29.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
56.8 / 17.8	Grey **CLAYEY SILT**, traces of sand & gravel, wtpl, very stiff to hard.		7	SS	100	8		16			
			8	SS	5	23		19			SS 8 - Driving Stone
			9	SS	100	30		22			
50.8 / 23.8	Grey **CLAYEY SILT TILL**, cobbles from 25.7 to 26.2 m and 27.8 to 28.0 m, wtpl, very stiff.		10	SS	15	28		25			
48.1 / 26.5	Reddish-brown **SILT TILL**, wet, very dense.		11	SS	80	147		28			Reddish-brown wash water at 26.5 m.
45.9 / 28.7	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No 43

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791758N 594322E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
77.0							
0.0	**FILL** - 15 cm black **Sand** over grey **Slag**, moist to saturated, loose to compact.						
			1	SS		25	
			2	SS		6	
			3	SS		7	
			4	SS		19	
	Black **ALLUVIUM**and **SLAG**, occasional clayey zones, more frequent below 9.5 m(±), saturated, compact.						
			5	SS		8	
			6	SS		12	
			7	SS		13	
			8	SS		16	
	Black **SILT**, some slag, coal tar odour, saturated, compact.						
			9	SS		12	
62.3							
14.7	Grey **SILTY CLAY**, traces						

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE

20 40 60 80 100

WATER CONTENT (%)

10 20 30

58.5
44.1
51.3

OBSERVATIONS & REMARKS

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RECORD OF BOREHOLE No 43

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791758N 594322E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✥ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
	of sand & gravel, wtpl, firm.										
			10	SS		5					**Gs/Hyd LL/PI**
				VANE				16	S=1.9		
								17			
								18			
			11	SH							
				VANE				19	S=2.0		
56.7								20			
20.3	Grey **SILTY CLAY**, traces of sand & gravel, occasional silt seam, scattered weathered shale pieces, becoming harder (augers grinding occasionally) below 23.2 m(±), cobble at 26.8 m(±), wtpl to apl, very stiff to hard.		12	SS		17		21			
								22			
								23			
			13	SS		24		24			
								25			
								26			
			14	SS		32		27			
48.8								28			
28.2	Grey **SAND** & **GRAVEL**, numerous cobbles, saturated, very dense.										Sand & Gravel flowing into hole. Quick Grout added to keep Borehole open.
48.0			15	SS		104					
29.0	Reddish-brown **SILT TILL**, wet to moist, very dense.							29			

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RECORD OF BOREHOLE No 43

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791758N 594322E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100	10 20 30	
46.6			16	SS		70/8cm					
30.4	Borehole Terminated.										Borehole backfilled with Grout.

RECORD OF BOREHOLE No 40 (MW)

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791600N 594520E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✥ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
77.0									20 40 60 80 100	10 20 30	
0.0 76.1	$^{3}/_{4}$" grey **GRANULAR**										
0.9 75.3	Black **SAND**.							1			
1.7 74.9	Brown **CLAY**.							2			
2.1 71.4	Grey/brown SILT, some organic zones, saturated.							3 4 5			
5.6	Grey **SILTY CLAY**, wtpl.							6 7 8 9 10 11 12 13 14			Borehole Upon Completion: Dry and open.

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RECORD OF BOREHOLE No 40 (MW)

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791600N 594520E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100	10 20 30	
61.8											
15.2	Borehole Terminated.										

RECORD OF BOREHOLE No 40A (MW)

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791598N 594522E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 8.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100	10 20 30	
77.0											
0.0	**GRANULAR FILL**							1			
75.3											
1.7	**CLAY** with black to brown **SILT**, saturated							2			
72.4								3			
4.6	Borehole Terminated							4			

RECORD OF BOREHOLE No 43A (MW)

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791758N 594322E ORIGINATED BY rse

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 7.10.03 CHECKED BY pmc

SOIL PROFILE			SAMPLES								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
77.0									20 40 60 80 100	10 20 30	
77.0 0.0	Black **SAND**										
0.2	Black granular **SLAG**							1			
								2			
								3			
72.3								4			
4.7	Borehole Terminated										

RECORD OF BOREHOLE No A

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791684N 594765E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 16.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**										
67.3								1			
7.4	Black, **SOFT SEDIMENT (Recent)**, loose to compact.		1	SS	100	10					
67.0								2			
7.7	Black to grey **SLAG**, compact.										
63.8			2	SS	50	14		3			
11.0	Black, **SOFT SEDIMENT (Recent)**, trace to some slag, poor recovery, very loose.		3	SS	28	2		4			
62.2								5			
12.5	Grey to grey-brown **SILTY CLAY** to **CLAYEY SILT** layered, some slag to 13.5 m(±), pebbles, wtpl, stiff to very stiff.		4	SS	83	10		6			
								7			
			5	SS	100	12		8			
								9			
								10			
								11			
								12			
								13			
								14			

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RECORD OF BOREHOLE No A

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791684N 594765E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 16.12.04 CHECKED BY nve

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100 / 20 40 60 80 100	10 20 30	
58.1			6	SS	100	17		16			
16.6	Borehole Terminated										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No C

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791720N 594781E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	RECOVERY (%)	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7									20 40 60 80 100	10 20 30	
0.0	**WATER**										
66.6											
8.1	Black, **SOFT SEDIMENT (Recent)** very loose.		1	SS	100	0				117.5	
65.0											
9.7	Grey **CLAY SEDIMENT** very soft to soft, leaves and twigs at 15.9 m(±), mwtpl.		2	SS	100	0				89.5	
			3	SS	100	2				97.7	
			4	SS	100	1				99.3	

Continued Next Page

RECORD OF BOREHOLE No C

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791720N 594781E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.12.04 CHECKED BY nve

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100; ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE; 20 40 60 80 100	10 20 30	
58.9			5	SS	100	0				164.6	
15.9	Borehole Terminated										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No D

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791810N 594800E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 23.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.8									20 40 60 80 100	10 20 30	
0.0	**WATER**										
65.6											
9.3	Black, soft **SEDIMENT (Recent)**, some slag, loose.										
64.5			1	SS	31	7					
10.3	Grey **SLAG**, little recovery, some black, soft sediment, compact to very loose.										
			2	SS	34	15					
			3	SS	0	2					
			4	SS	11	0					
59.8											

Continued Next Page

RECORD OF BOREHOLE No D

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791810N 594800E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 23.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) (○ UNCONFINED, ● QUICK TRIAXIAL, ▲ FIELD VANE, ✤ LAB VANE)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
15.0	Brown to grey **ORGANIC SILT TO CLAYEY SILT** very soft.										
			5	SS	100	0		16		111.3	
57.4			6	SS	100	2		17		51.8	
17.5	Borehole Terminated										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No E

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791715N 594793E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7											
0.0	**WATER**										
66.3											
8.4 / 65.9	Black, **SOFT SEDIMENT (Recent)**, very loose.		1	SS	44	0					
8.8 / 64.3	Brown **SILT**, black stain, organics.										
10.4	**SLAG**, some **SOFT SEDIMENT (Recent)** to 10.8 m(±), compact.		2	SS	72	13					
			3	SS	33	20					
61.4 / 13.3	Brown **SILT**, some organics, clayey silt layers, pebbles, wtpl, very loose to compact.		4	SS	100	8					

STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST
SHEAR STRENGTH (kPa): ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE
WATER CONTENT (%)

Continued Next Page

RECORD OF BOREHOLE No E

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791715N 594793E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 17.12.04 CHECKED BY nve

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100	10 20 30	
			5	SS	100	2		16		173.9	
57.3			6	SS	100	14		17			
17.4	Borehole Terminated										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No I

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791747N 594798E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 18.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES
74.7 / 0.0	**WATER**					
66.6 / 8.1	Grey **SLAG**, little recovery, saturated, loose to compact.		1	SS	17	5
			2	SS	6	4
			3	SS	11	14
			4	SS	6	11
59.8						

GROUND WATER CONDITIONS

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14

STANDARD PENETRATION TEST
DYNAMIC PENETRATION TEST

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE

20 40 60 80 100

WATER CONTENT (%)

10 20 30

OBSERVATIONS & REMARKS

Continued Next Page

RECORD OF BOREHOLE No I

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791747N 594798E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 18.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
14.9	**SLAG** some **SOFT SEDIMENT (Recent)** loose to dense.										
			5	SS	17	27		16			
			6	SS	6	12		17			
			7	SS	6	6		18			
			8	SS	22	16		19			
			9	SS	6	34		20			
52.3								21			
22.4	Grey **SILTY CLAY** to **CLAYEY SILT**, weakly laminated, occasional medium to coarse Sand layer, occasional small cobble below 21.0 m(±), wtpl, stiff to hard.							22			
			10	SS	61	11		23			
			11	SS	11	26		24			
			12	SS	11	40		25			
48.2								26			
26.5	Borehole Terminated.										Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No J

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791731N 594796E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 18.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY (%)	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa)	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.7											
0.0	**WATER**										
66.6											
8.1	Black, **SOFT SEDIMENT (Recent)**, some slag, compact to very loose.		1	SS	39	20					
			2	SS	67	2					
62.7											
12.0	Grey **SLAG**, some **SOFT SEDIMENT (Recent)** layers, compact.		3	SS	3	12					
			4	SS	56	12					

STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST
SHEAR STRENGTH (kPa): 20 40 60 80 100
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE
WATER CONTENT (%): 10 20 30

Continued Next Page

RECORD OF BOREHOLE No J

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791731N 594796E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 18.12.04 CHECKED BY nve

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	"N" VALUES			20 40 60 80 100 20 40 60 80 100	10 20 30	
58.7			5	SS	39	15					
16.0	Borehole Terminated							16			Borehole backfilled completely with Grout.

RECORD OF BOREHOLE No K

PROJECT Randle Reef Sediment Remediation Project LOCATION 4791868N 594812E ORIGINATED BY kho

CLIENT Hamilton Port Authority COMPILED BY jdo

JOB NO. TC035071 DATE 23.12.04 CHECKED BY nve

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (%)	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST / DYNAMIC PENETRATION TEST; SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✥ LAB VANE	WATER CONTENT (%)	OBSERVATIONS & REMARKS
74.8 / 0.0	**WATER**										
65.3 / 9.4	Brown, **SOFT SEDIMENT (Recent)** loose, silty, organics, very loose.										
63.5 / 11.3	Reddish brown to grey **CLAYEY SILT**, layered, reddish silt seams, some pebbles, trace shale, wtpl, soft to stiff.		1	SS	94	2					
			2	SS	100	9					
			3	SS	100	15					Borehole backfilled completely with Grout.
60.4 / 14.4	Borehole Terminated										

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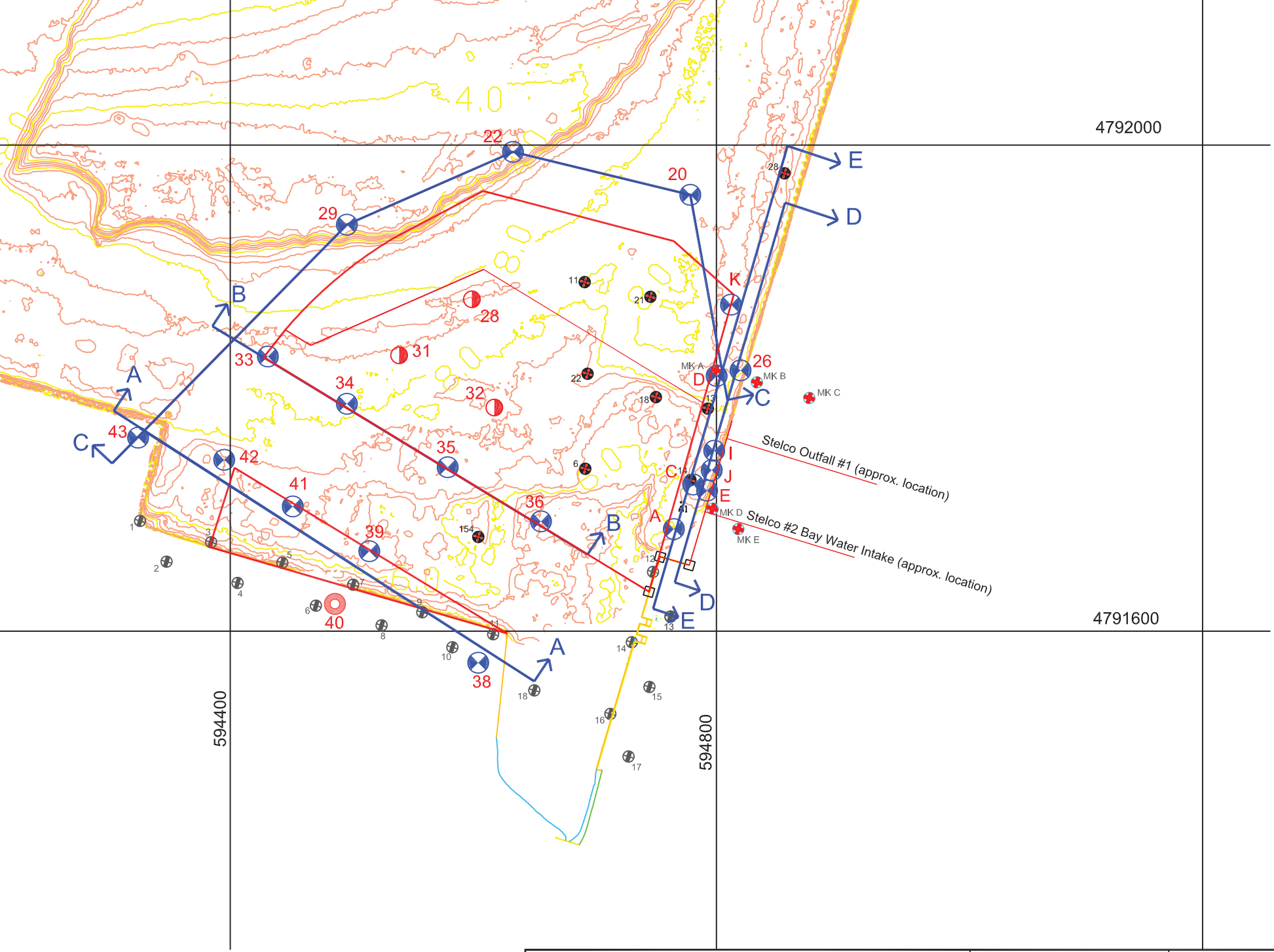

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GEOTE

1999 TROW	
BH #	NORTHING
6	4791733.6
11	4791887.2
13	4791783.1
14	4791724.3
18	4791792.3
21	4791875.1
22	4791811.8
28	4791976.7
154	4791677.5

AMEC DEEP AND SH	
BH #	NORTHING
20	4791958
22	4791996
26	+/- 4791814
28	4791871
29	4791936
31	4791830
32	4791873
33	4791826
34	4791762
35	4791735
36	4791690
38	4791574
39	4791666
41	4791702
42	4791741
43	4791758
A	4791684
C	4791720
D	4791810
E	4791715
I	4791747
J	4791731
K	4791868

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Date: February 2004

Approximate Scale: 1 : 4000

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Hamilton Port Authority
Randle Reef Sediment Remediation Project

Drawn by:

Approved by:

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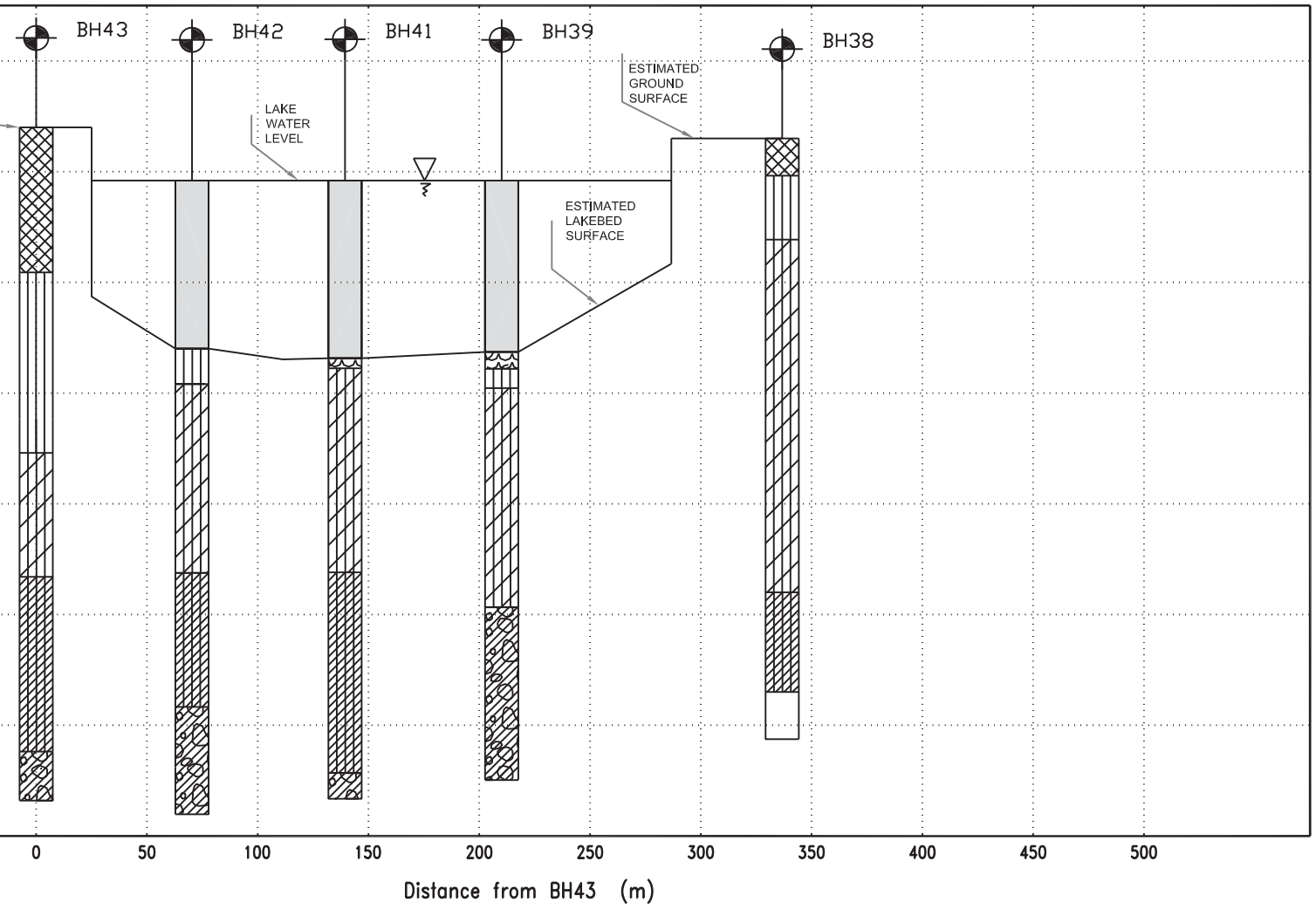

Legend/Stratigraphy

- Water
- Fill (Slag and/or Misc.)
- Recent (Soft) Sediment
- Silt Deposits
- Upper Firm Silty Clay
- Lower Very Stiff to Hard Clayey Silt
- Clay/Silt Till Including Sand and Gravel
- Shale Bedrock

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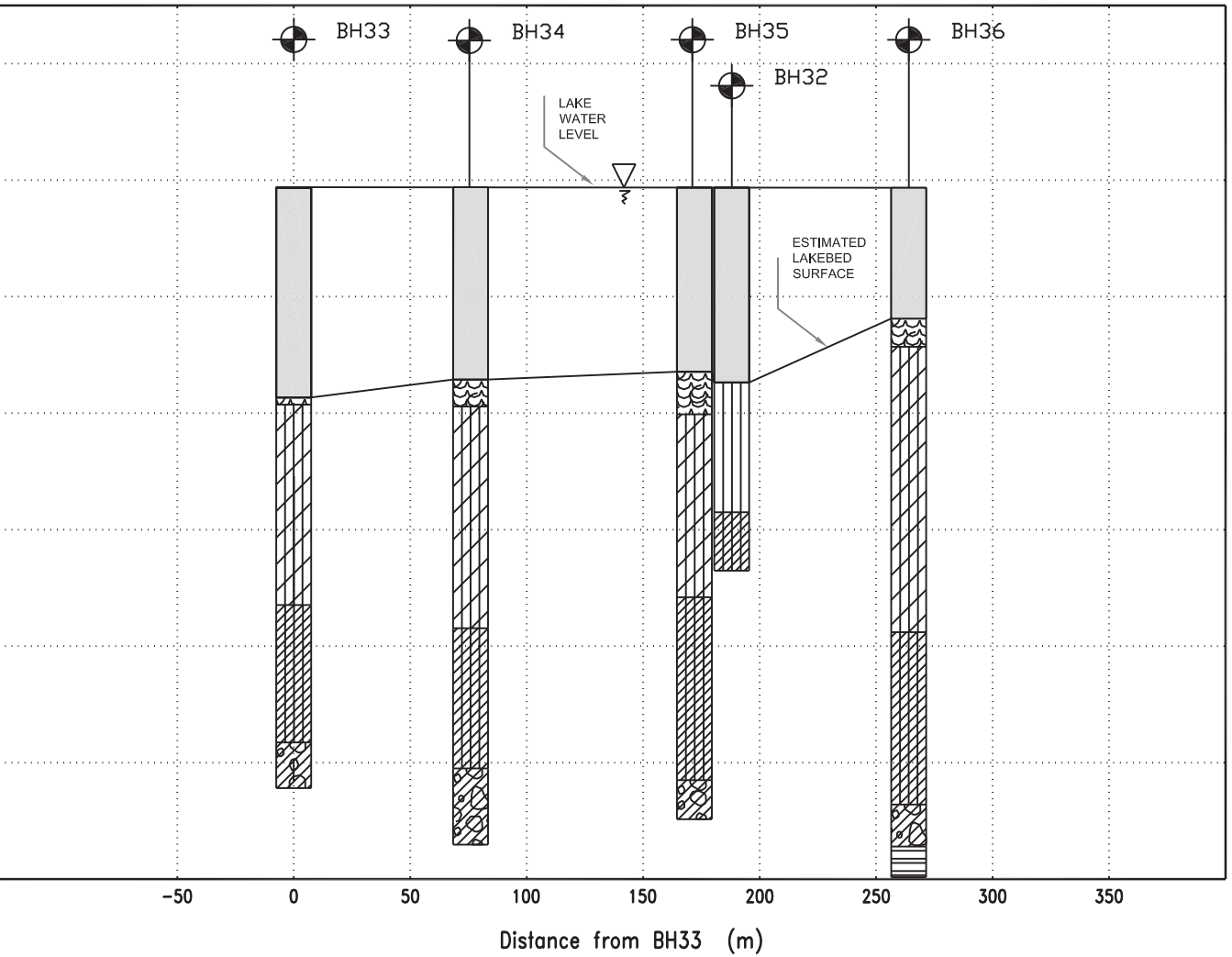
amec Earth & Environmental	Date: February 2004	Scale: 1 : 300 V 1 : 3000 H



Legend/Stratigraphy

- Water
- Fill (Slag and/or Misc.)
- Recent (Soft) Sediment
- Silt Deposits
- Upper Firm Silty Clay
- Lower Very Stiff to Hard Clayey Silt
- Clay/Silt Till Including Sand and Gravel
- Shale Bedrock

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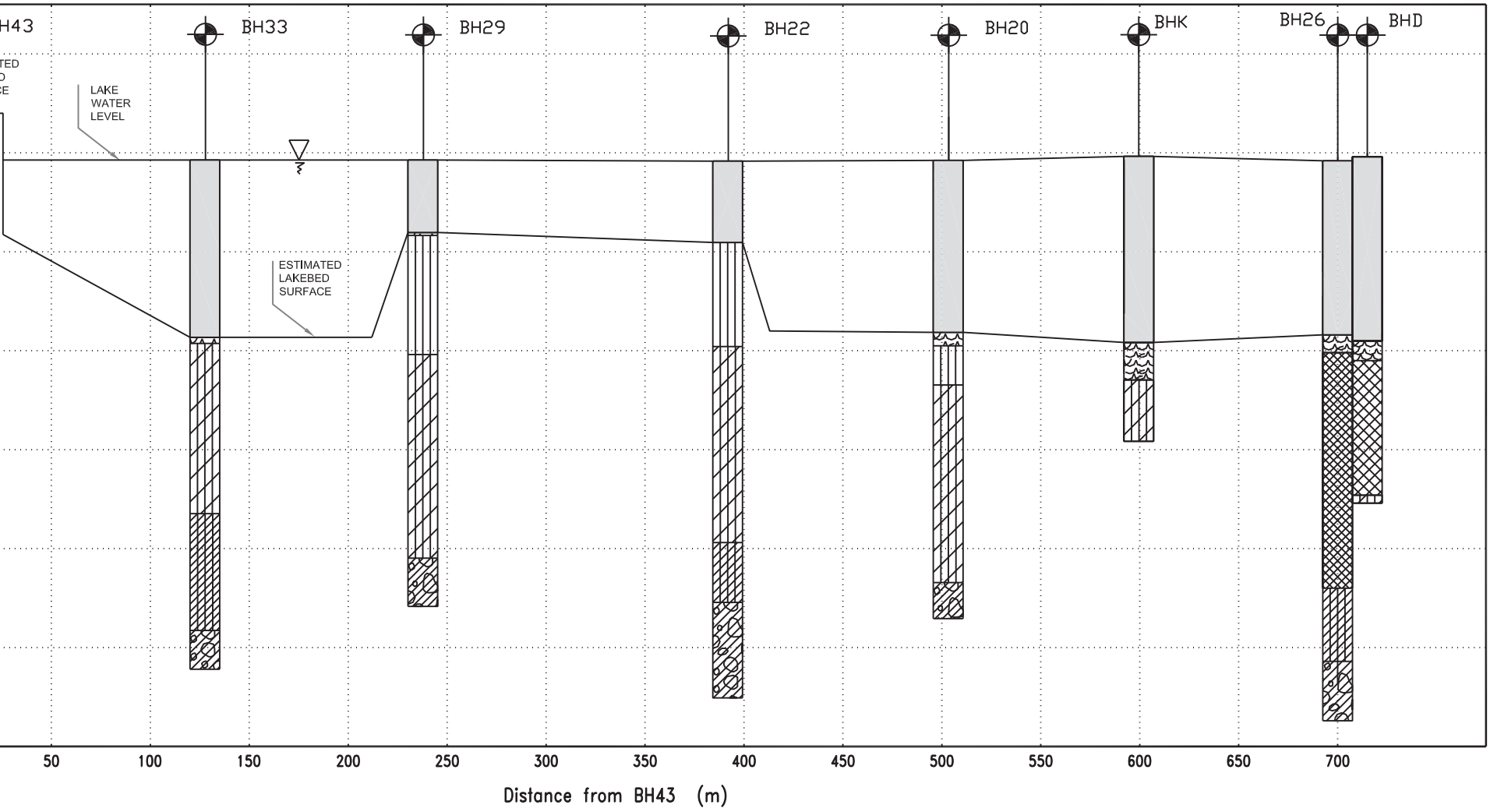
amec Earth & Environmental	Date: February 2004	Scale: 1 : 300 V 1 : 3000 H



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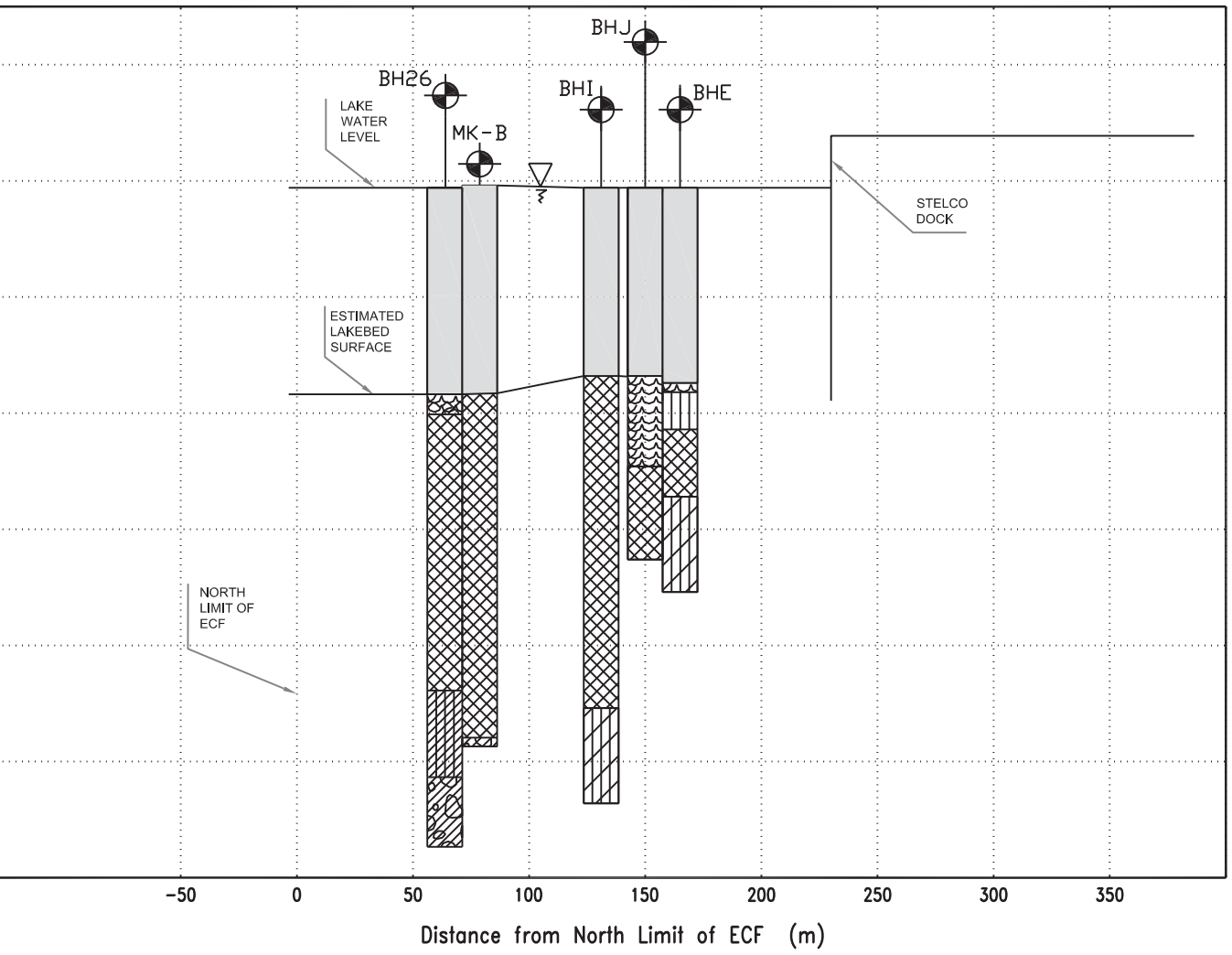

Legend/Stratigraphy

- Water
- Fill (Slag and/or Misc.)
- Recent (Soft) Sediment
- Silt Deposits
- Upper Firm Silty Clay
- Lower Very Stiff to Hard Clayey Silt
- Clay/Silt Till Including Sand and Gravel
- Shale Bedrock

NOTES:

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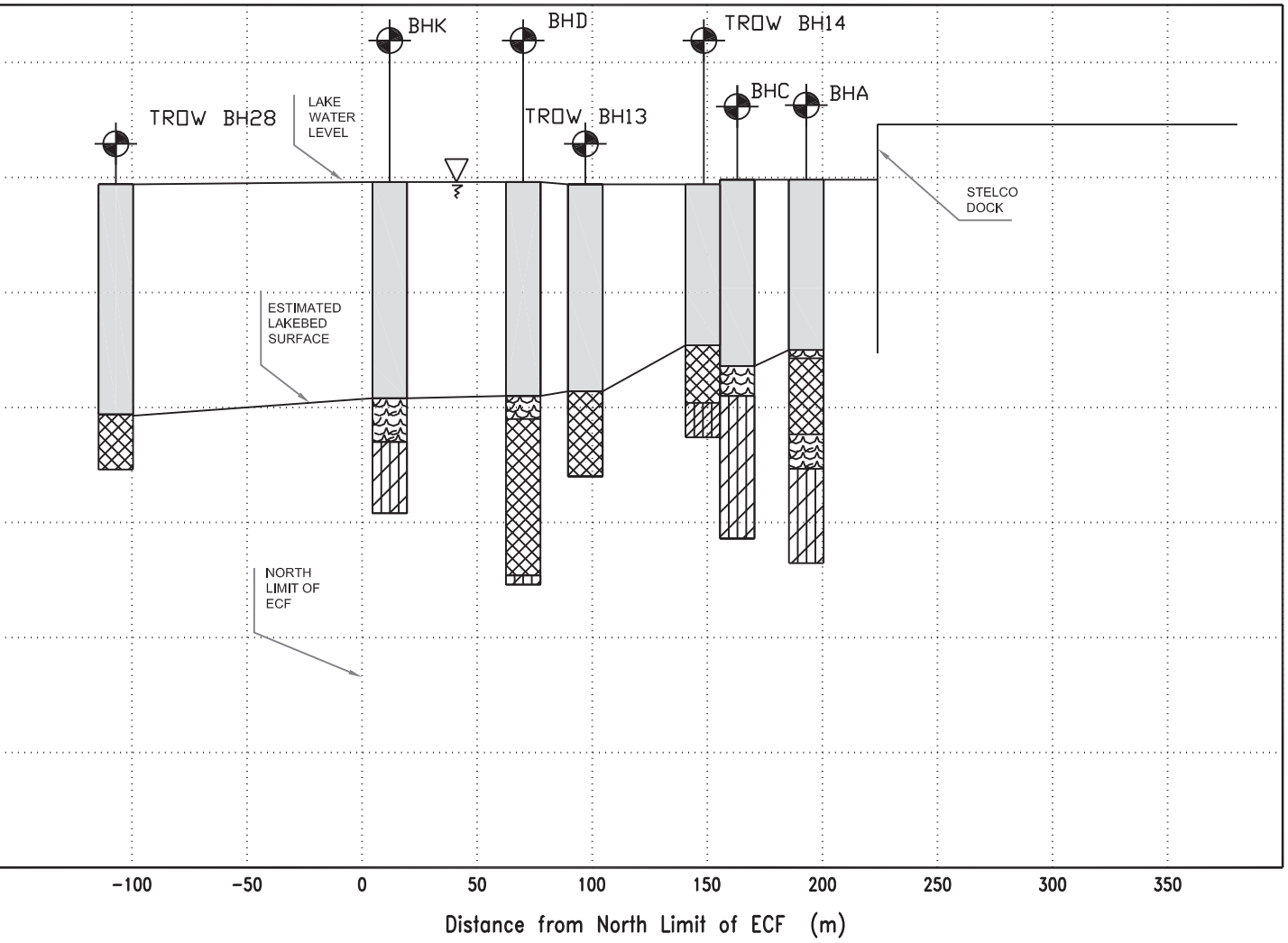

Legend/Stratigraphy

- Water
- Fill (Slag and/or Misc.)
- Recent (Soft) Sediment
- Silt Deposits
- Upper Firm Silty Clay
- Lower Very Stiff to Hard Clayey Silt
- Clay/Silt Till Including Sand and Gravel
- Shale Bedrock

NOTES:

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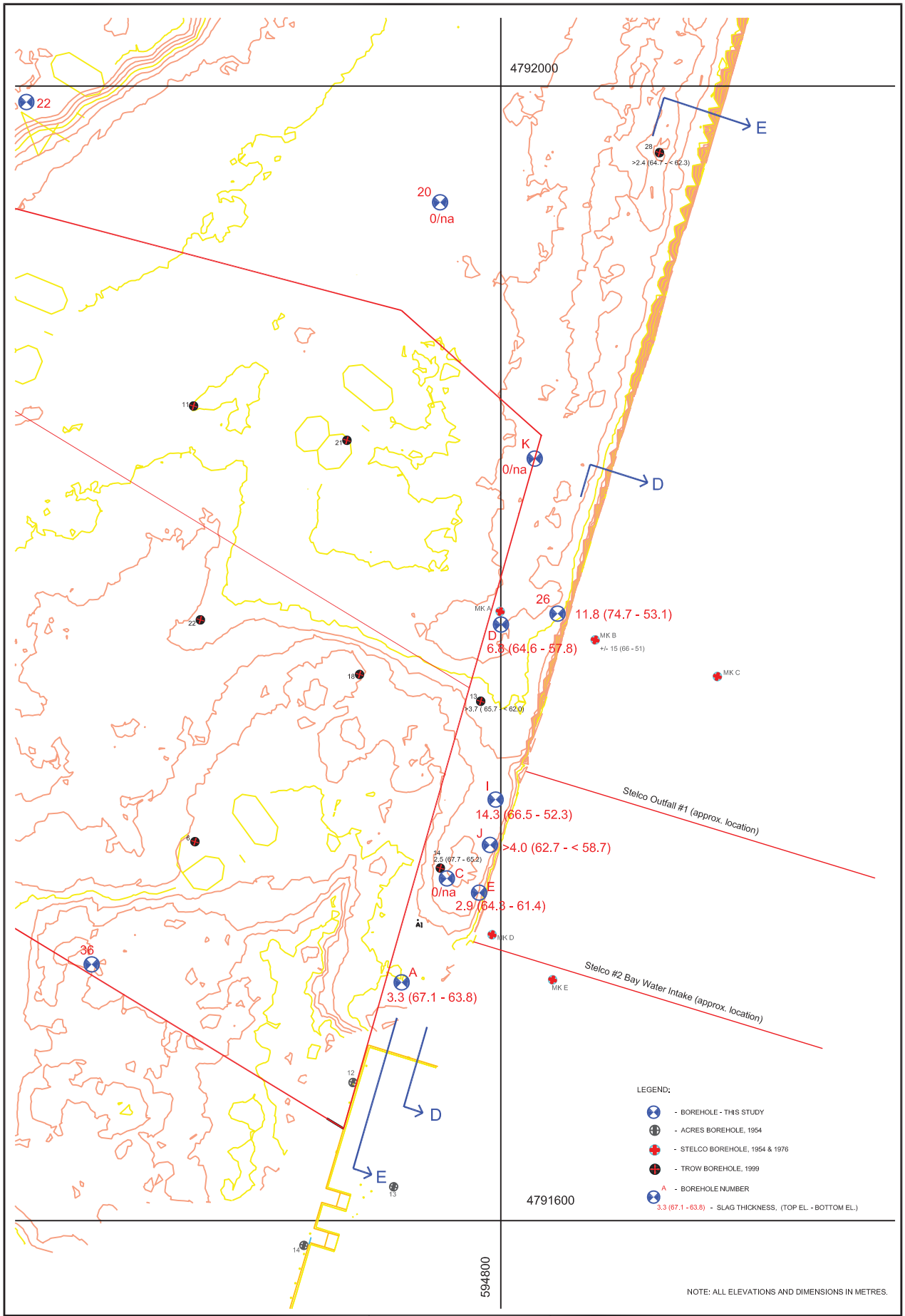


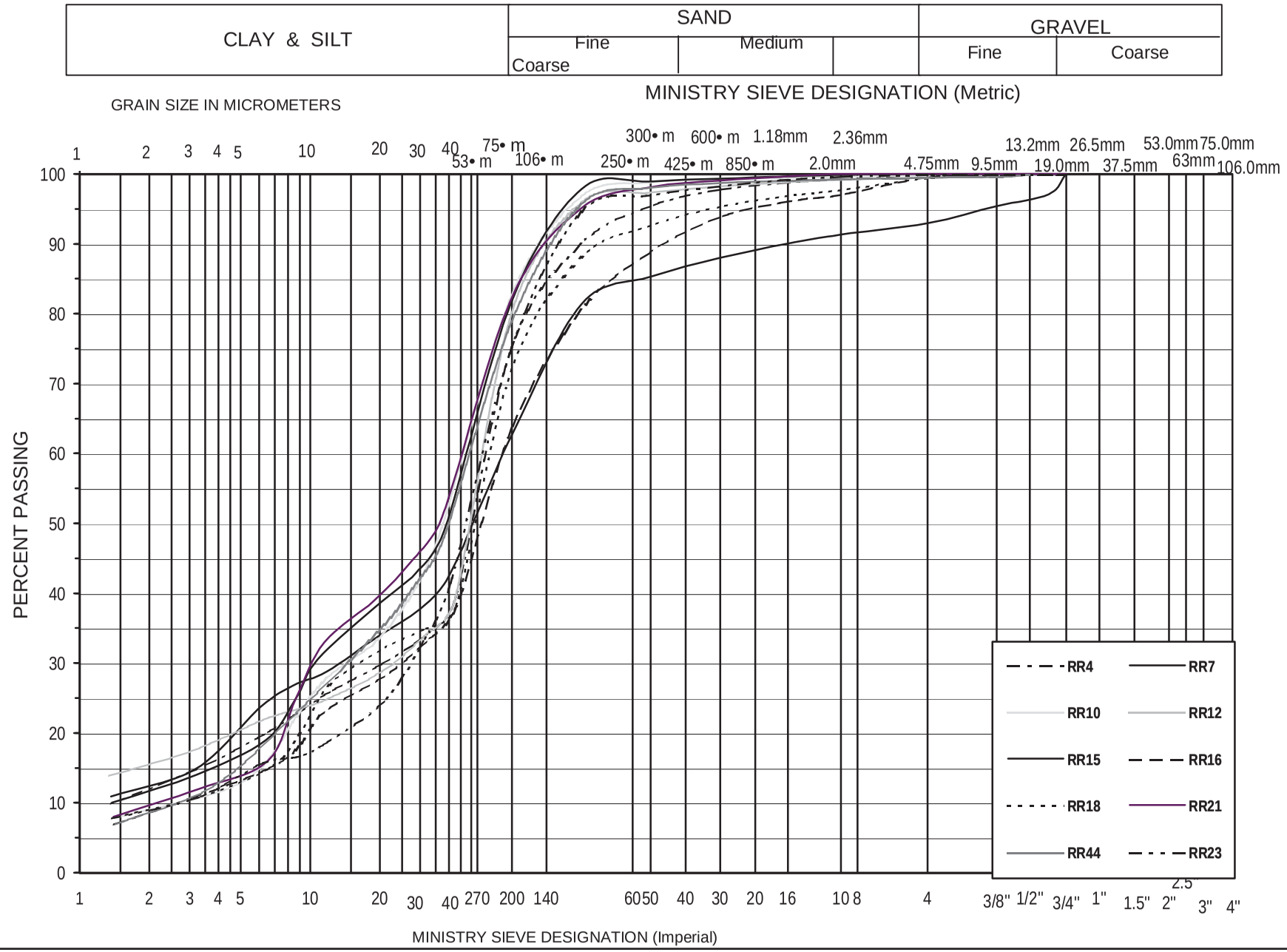
amec Earth & Environmental	Date: February 2004	Approximate Scale: 1 : 1250	Project No.: TC035071
Hamilton Port Authority Randle Reef Sediment Remediation Project RS 2 Phase 1 Geotechnical Investigation	Drawn by: PN/KH	Approved by: IS/JD/NV	Figure A-7 Slag Delineation Borehole Location Plan

APPENDIX B – FIGURES : LABORATORY TEST RESULTS

APPENDIX B FIGURES – LABORATORY TEST RESULTS

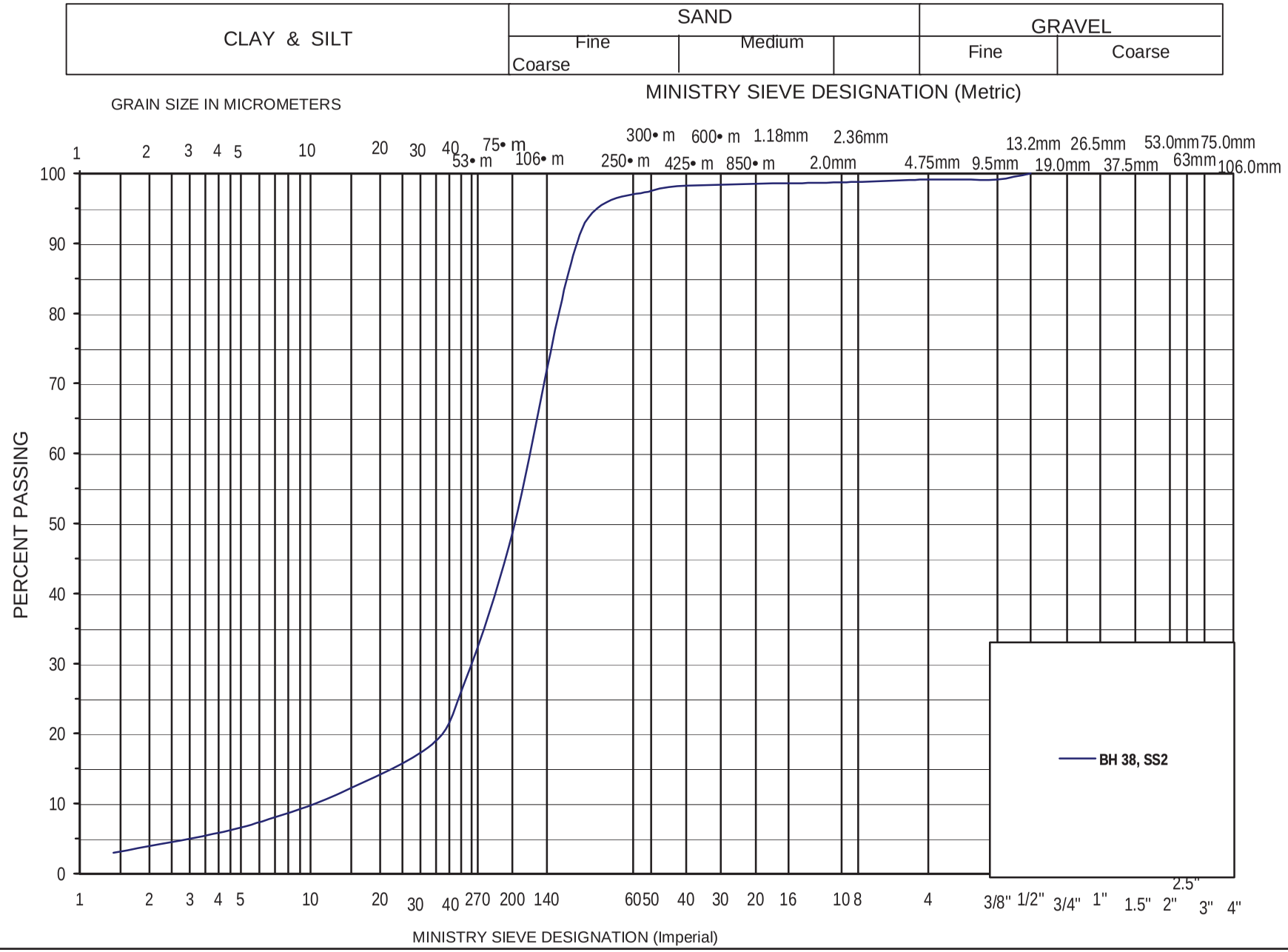
Figure B-1	Gradation Curves: Recent Sediment (Boreholes RR4, RR7, RR10, RR12, RR15, RR16, RR18, RR21, RR23, RR44)
Figure B-2	Gradation Curve: Alluvium Stratum (BH38-Sa2)
Figure B-3	Gradation Curves: Silt Stratum (BH22-Sa5/6, BH29-Sa3/4/5, BH4-Sa1)
Figure B-4	Gradation Curves: Upper Silty Clay Stratum (BH20-Sa5, BH20-Sa6, BH22-Sa8, BH22-Sa9, BH29-Sa8, BH29-Sa9)
Figure B-5	Gradation Curves: Upper Silty Clay Stratum (BH32-Sa6, BH33-Sa4, BH34-Sa3. BH34-Sa4, BH35-Sa7, BH35-Sa8)
Figure B-6	Gradation Curves: Upper Silty Clay Stratum (BH36-6, BH38-Sa5, BH38-Sa8, BH39-Sa4, BH42-Sa4, BH43-Sa10)
Figure B-7	Gradation Curves: Lower Clayey Silt Stratum (BH36-Sa11)
Figure B-8	Gradation Curves: Silt Till Stratum (BH29-Sa13, BH35-Sa12)
Figure B-9A	Plasticity Chart: Upper Silty Clay Stratum (Split Spoon Samples)
Figure B-9B	Plasticity Chart: Upper Silty Clay Stratum (Shelby Tube Samples)
Figure B-10A	One Dimensional Consolidation Test – BH22-Sa8: Test Data
Figure B-10B	One Dimensional Consolidation Test – BH22-Sa8: σ'_v versus e and c_v
Figure B-10C	One Dimensional Consolidation Test – BH22-Sa8: Strain Energy Data
Figure B-11A	One Dimensional Consolidation Test – BH33-Sa4: Test Data
Figure B-11B	One Dimensional Consolidation Test – BH33-Sa4: σ'_v versus e and c_v
Figure B-11C	One Dimensional Consolidation Test – BH33-Sa4: Strain Energy Data
Figure B-12A	One Dimensional Consolidation Test – BH39-Sa4: Test Data
Figure B-12B	One Dimensional Consolidation Test – BH39-Sa4: σ'_v versus e and c_v
Figure B-12A	One Dimensional Consolidation Test – BH39-Sa4: Strain Energy Data
Figure B-13A	One Dimensional Consolidation Test – BH42-Sa4: Test Data
Figure B-13B	One Dimensional Consolidation Test – BH42-Sa4: σ'_v versus e and c_v
Figure B-13C	One Dimensional Consolidation Test – BH42-Sa4: Strain Energy Data
Figure B-14	Triaxial Quick Shear Tests – BH22-Sa8, BH29-8, BH33-Sa4, BH38-Sa8
Figure B-15	Triaxial Quick Shear Tests – BH39-Sa4, BH42-Sa4, BH43-Sa11
Figure B-16A	Triaxial CU Compression Shear Test – BH20-Sa6: Test Data
Figure B-16B	Triaxial CU Compression Shear Test – BH20-Sa6: Stress Strain Curves
Figure B-16C	Triaxial CU Compression Shear Test – BH20-Sa6: Stress Paths
Figure B-16D	Triaxial CU Compression Shear Test – BH20-Sa6: Mohr's Envelopes
Figure B-17A	Triaxial CU Compression Shear Test – BH34-Sa4: Test Data
Figure B-17B	Triaxial CU Compression Shear Test – BH34-Sa4: Stress Strain Curves
Figure B-17C	Triaxial CU Compression Shear Test – BH34-Sa4: Stress Paths
Figure B-17D	Triaxial CU Compression Shear Test – BH34-Sa4: Mohr's Envelopes
Figure B-18A	Triaxial CU Compression Shear Test – BH35-Sa8: Test Data
Figure B-18B	Triaxial CU Compression Shear Test – BH35-Sa8: Stress Strain Curves
Figure B-18C	Triaxial CU Compression Shear Test – BH35-Sa8: Stress Paths
Figure B-18D	Triaxial CU Compression Shear Test – BH35-Sa8: Mohr's Envelopes
Figure B-19A	Triaxial CU Compression Shear Test – BH36-Sa6: Test Data
Figure B-19B	Triaxial CU Compression Shear Test – BH36-Sa6: Stress Strain Curves
Figure B-19C	Triaxial CU Compression Shear Test – BH36-Sa6: Stress Paths
Figure B-19D	Triaxial CU Compression Shear Test – BH36-Sa6: Mohr's Envelopes

UNIFIED SOIL CLASSIFICATION SYSTEM



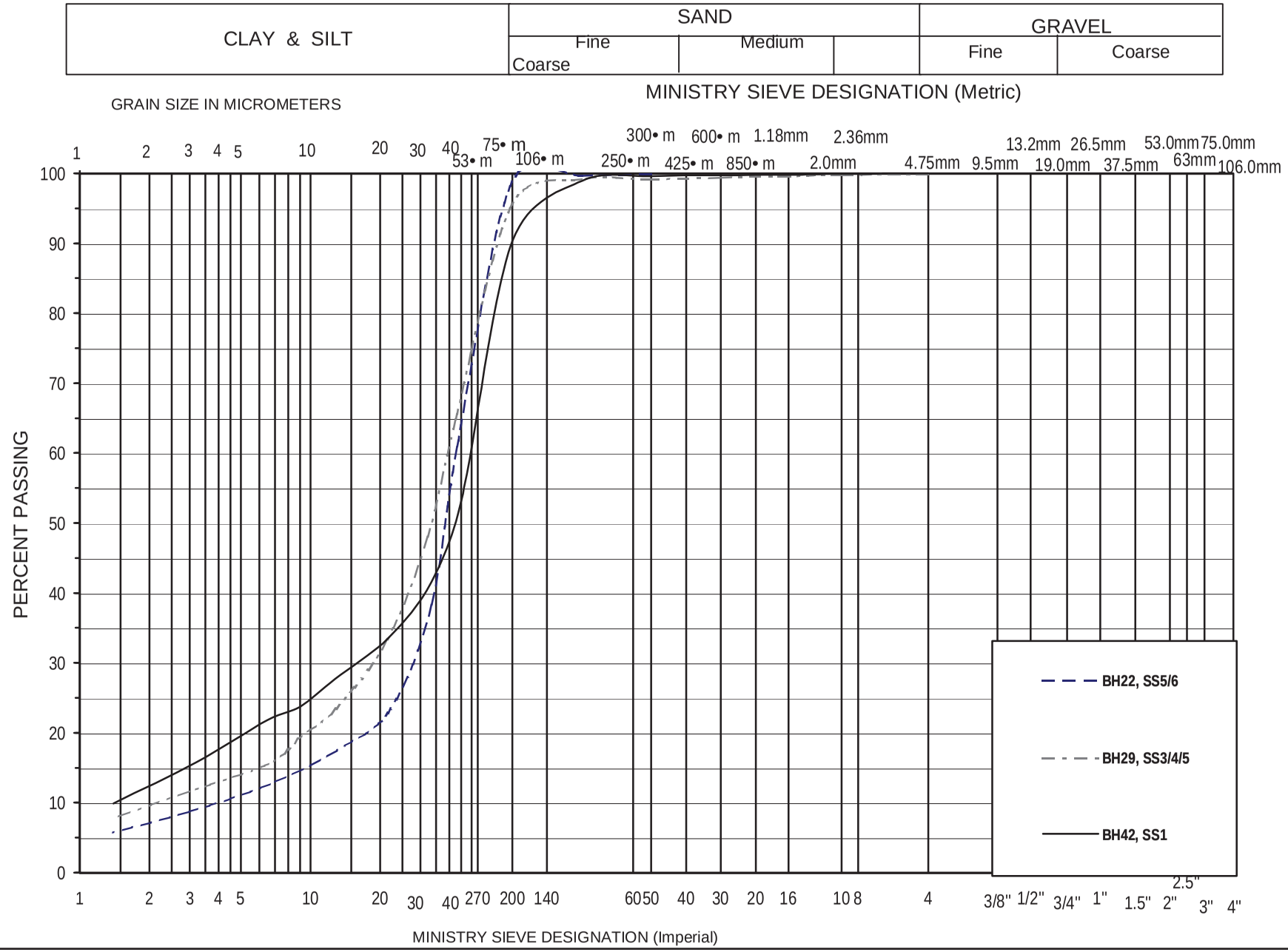
	GRAIN SIZE DISTRIBUTION RECENT SEDIMENT	**FIGURE B-1**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	05-Feb-04

UNIFIED SOIL CLASSIFICATION SYSTEM



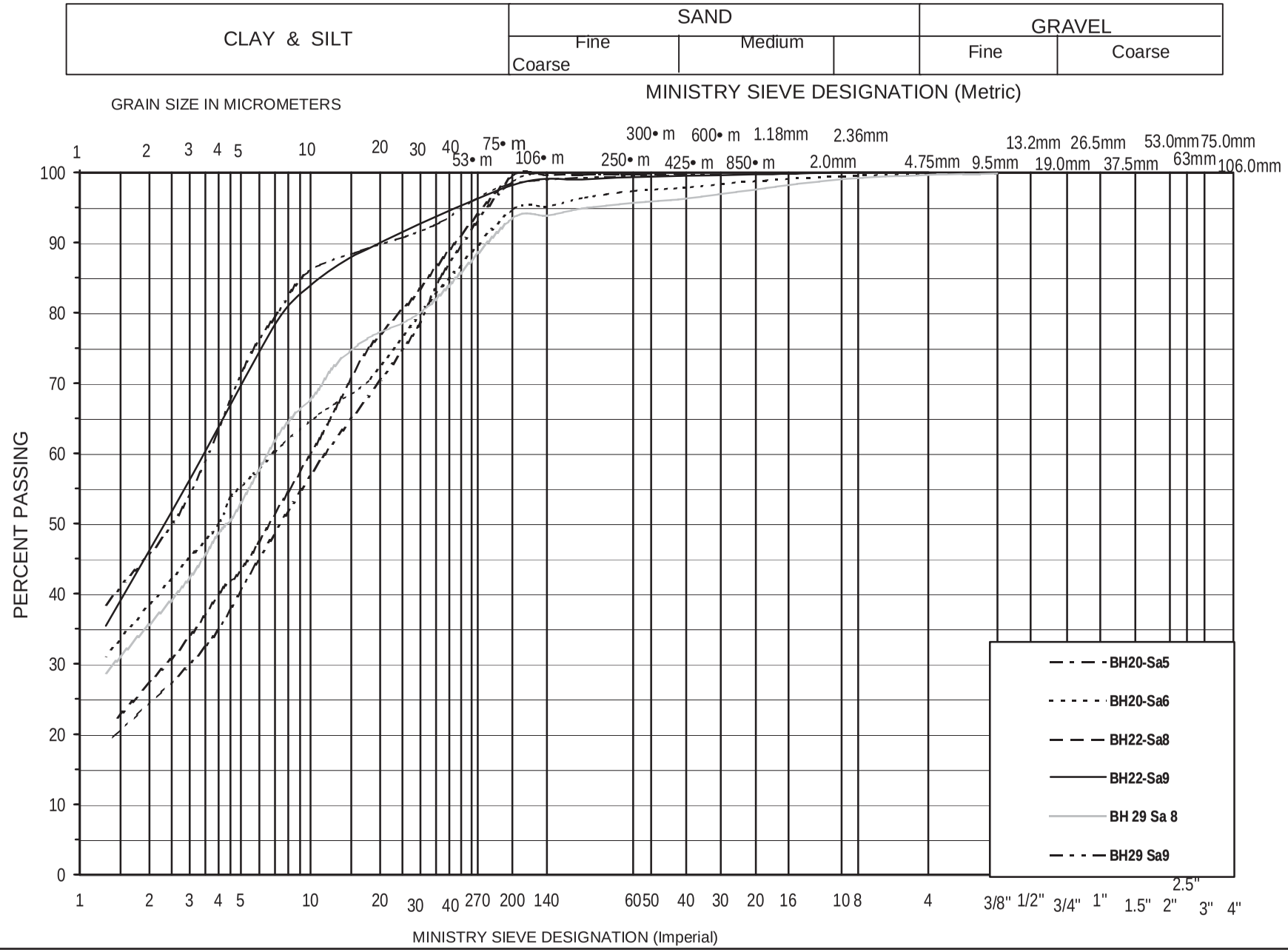
	GRAIN SIZE DISTRIBUTION	**FIGURE B-2**	
	ALLUVIUM (Grey - Black Silt Deposit)	Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03

UNIFIED SOIL CLASSIFICATION SYSTEM

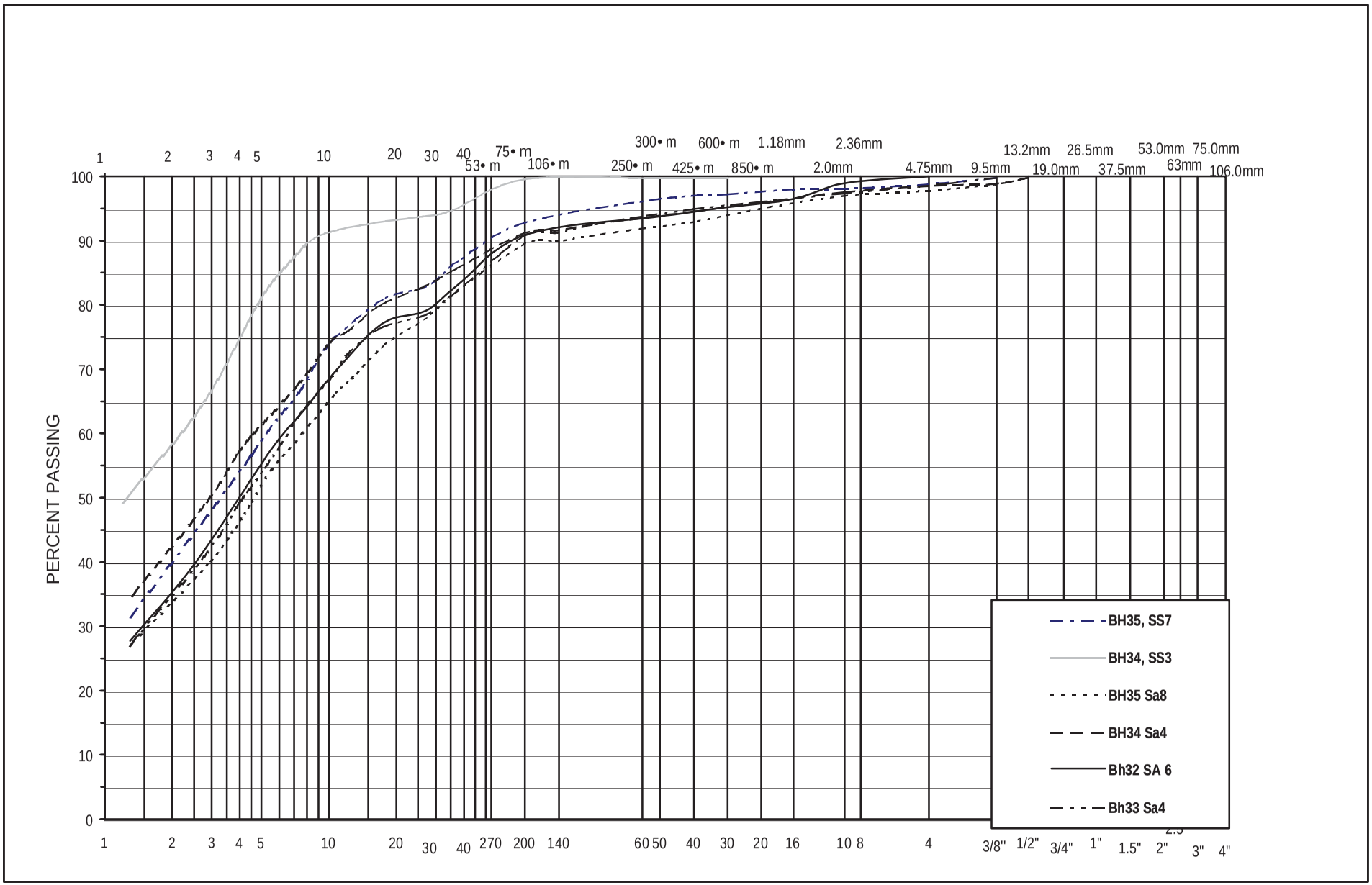


	GRAIN SIZE DISTRIBUTION BROWN SILT STRATUM	**FIGURE B-3**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03

UNIFIED SOIL CLASSIFICATION SYSTEM



	GRAIN SIZE DISTRIBUTION UPPER SILTY CLAY STRATUM	**FIGURE B-4**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03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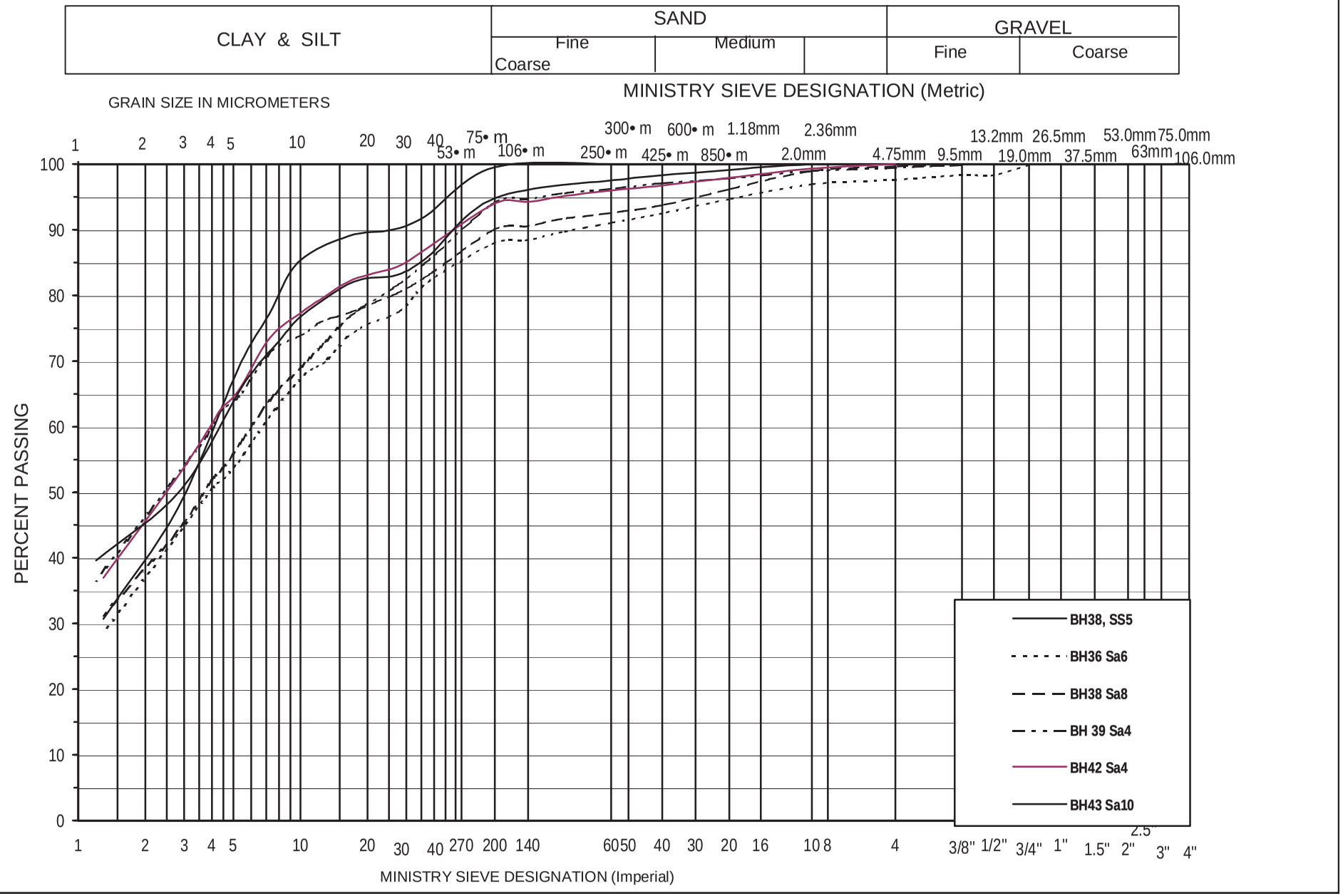
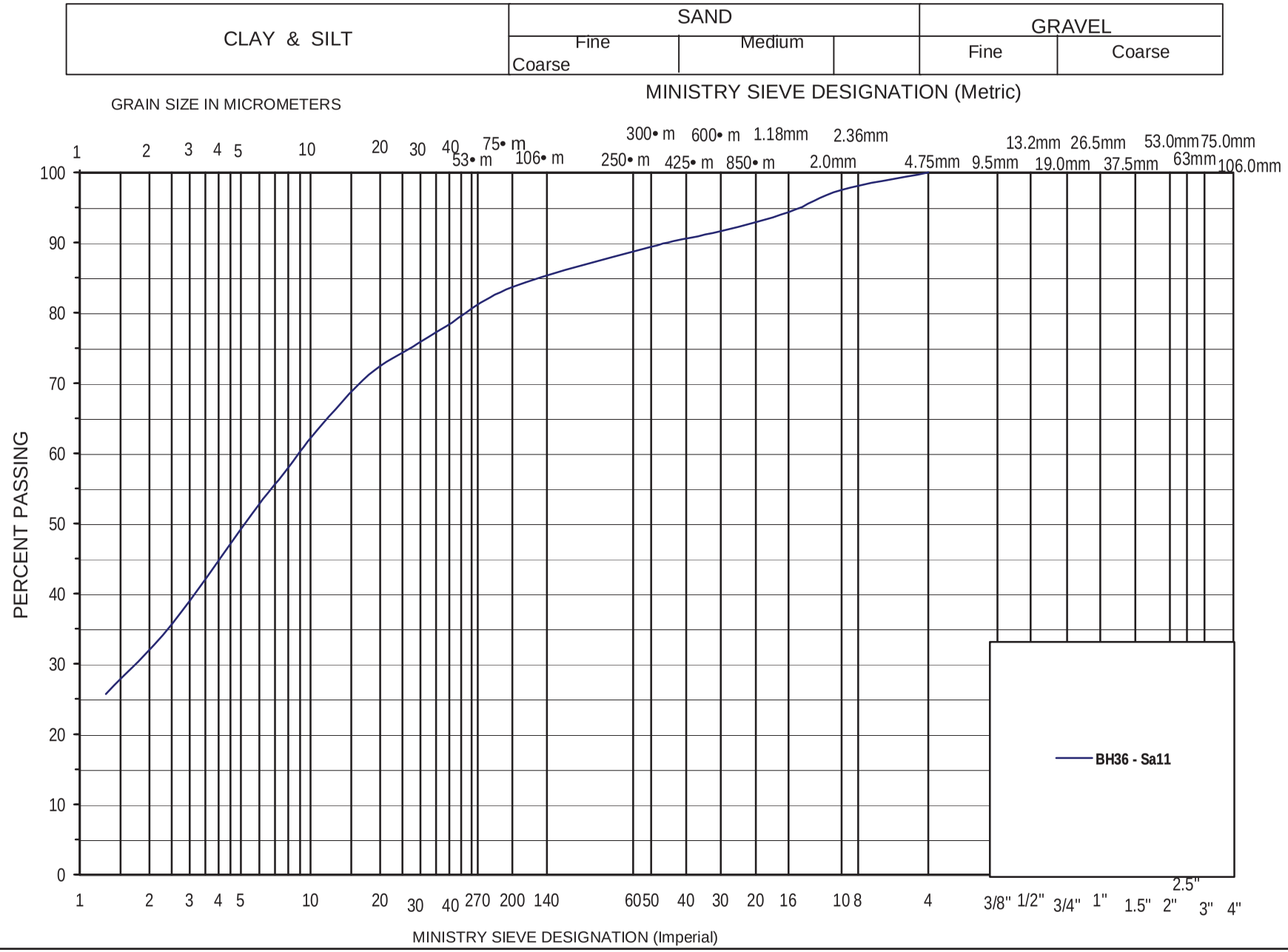
53• m
106• m
300• m
250• m
600• m
425• m
1.18mm
850• m
2.36mm
2.0mm
4.75mm
9.5mm
13.2mm
19.0mm
26.5mm
37.5mm
53.0mm
63mm
75.0mm
106.0mm
270
200
140
60
50
40
30
20
16
10
8
4
3/8"
1/2"
3/4"
1"
1.5"
2"
3"
4"
BH35, SS7
BH34, SS3
BH35 Sa8
BH34 Sa4
Bh32 SA 6
Bh33 Sa4

UNIFIED SOIL CLASSIFICATION SYSTEM



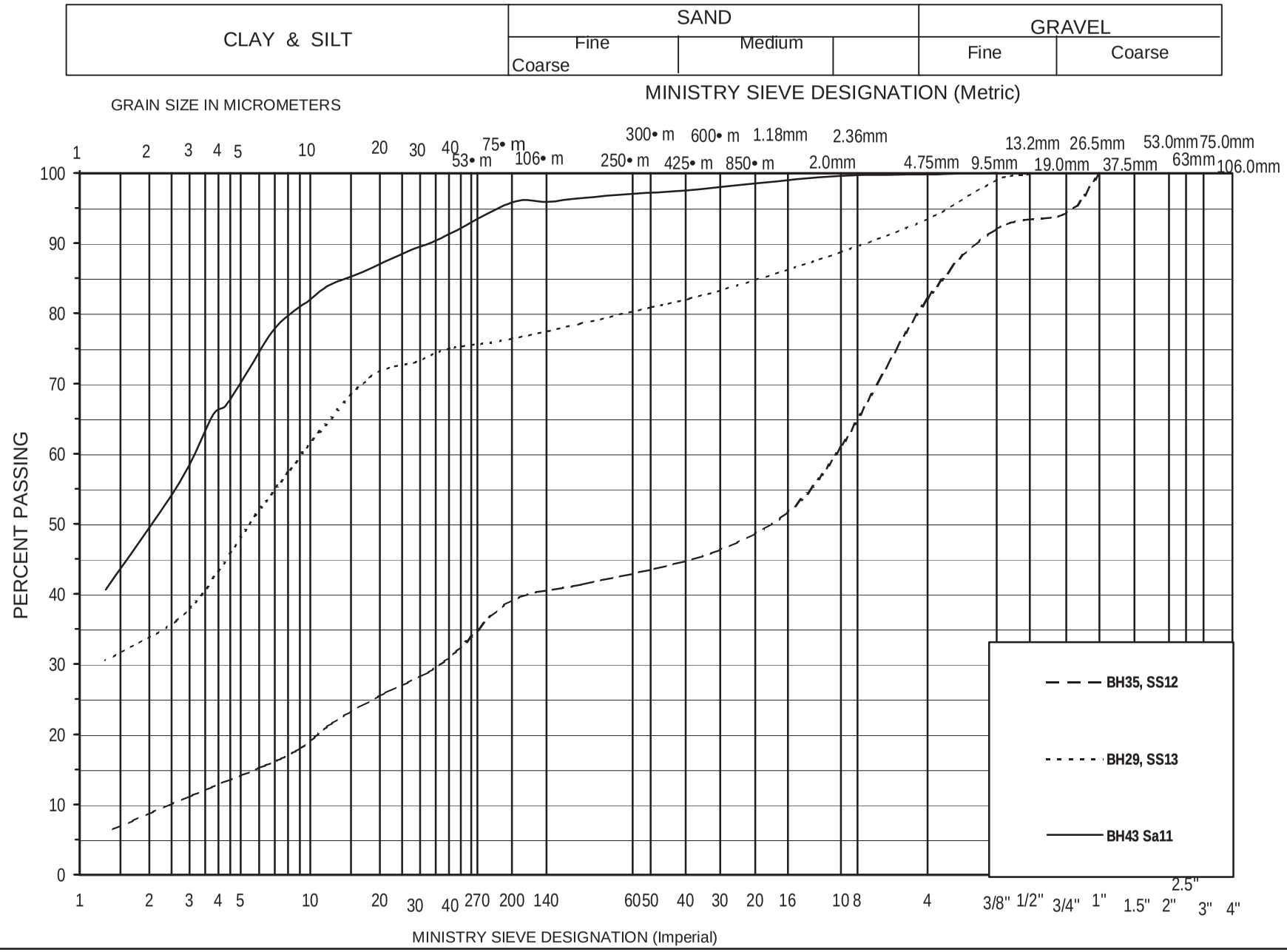
	GRAIN SIZE DISTRIBUTION UPPER SILTY CLAY STRATUM	**FIGURE B-6**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03

UNIFIED SOIL CLASSIFICATION SYSTEM

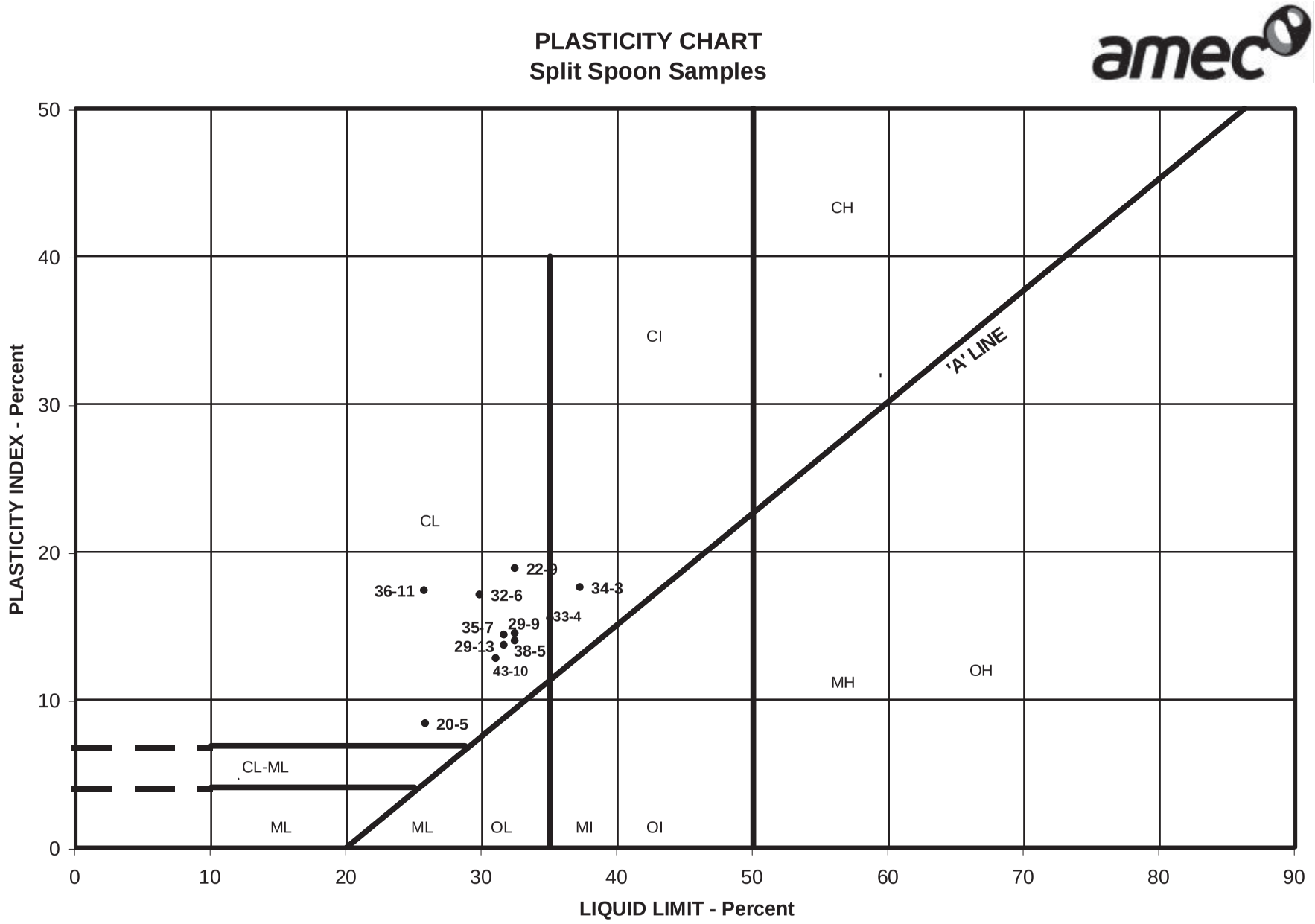


	GRAIN SIZE DISTRIBUTION LOWER CLAYEY SILT STRATUM	**FIGURE B-7**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03

UNIFIED SOIL CLASSIFICATION SYSTEM

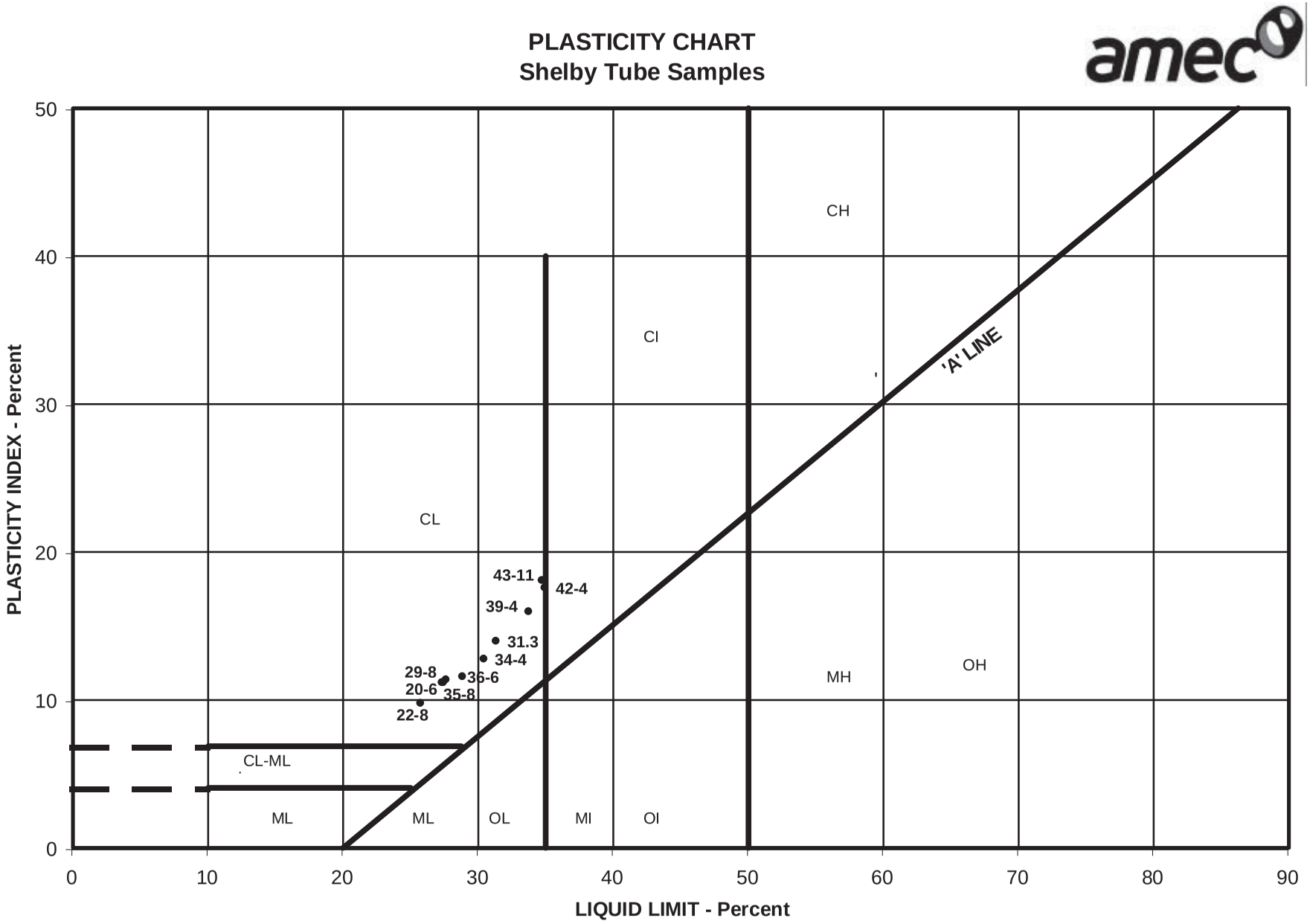


	GRAIN SIZE DISTRIBUTION SILT TILL STRATUM	**FIGURE B-8**	
		Prepared: GR	TC 030571
	RANDLE REEF SEDIMENT REMEDIATION PROJECT	Checked: JD	01-Dec-03



Project Number: TC035071
Project Name: Randle Reef Sediment Remediation Project

FIGURE B-9A



Project Number: TC035071
Project Name: Randle Reef Sediment Remediation Project

FIGURE B-9B

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH22-Sa8** **Depth(m):** 11.4

Test Data

Ring # :	A	**Ring Height (in) =**	0.753	**Wt of dry filter paper (g)**	0.64
Wet soil + Ring Wt (g)			199.61	**Wt of ring (g)**	76.61
Wet soil + Wet Paper + Ring (g)			198.31	**Wet Paper (g)**	1.72
Dry Soil + Dry Paper + Ring (g)			176.51	**Ring Dia (in)**	2.485
Initial moisture Content (%)			23.92	**Final moisture Content (%)**	20.87
Area of Ring (in^2)			4.85	**Initial Volume (in^3)**	3.6521
Initial Bulk Density (kg/m^3)			2055	**Initial Dry Density (kg/m^3)**	1659
Specific Gravity of Soil			2.72	**Eqiv. Thick. of solids (mm)**	11.663
Final Bulk Density (kg/m^3)			2131	**Final Dry Density (kg/m^3)**	1719
Initiall gauge reading for Load 1			0.2455	**Gauge reading for last Loading**	0.2010
Initial Voids Ratio			0.640	**Final Void Ratio**	0.543
Initial Degree of Saturation (%)			100.0	**Final Degree of Saturation (%)**	100.0

Trial #	1	2	3	4	5	6	7
Load (kpa)	0	20	30	45	70	100	150
Load (tsf)	0	0.208	0.312	0.468	0.728	1.04	1.56
Gauge Reading (in)	0.2455	0.2346	0.2318	0.2284	0.2253	0.2215	0.2165
(H-Hs) mm	7.464	7.185	7.116	7.029	6.951	6.854	6.727
Voids ratio	0.640	0.616	0.610	0.603	0.596	0.588	0.577
t90 (min)		0.64	3.61	1.96	4.00	4.00	2.10
Cv (ft^2/day)		1.851	0.322	0.588	0.286	0.283	0.532
k' (tsf)		14.304	28.320	33.674	62.222	59.776	75.816
Mv (ft^2 / ton)		0.0699	0.0353	0.0297	0.0161	0.0167	0.0132

Trial #	8	9	10	11	12	13	14
Load (kpa)	220	330	450	600	900	330	100
Load (tsf)	2.288	3.432	4.68	6.24	9.36	3.432	1.040
Gauge Reading (in)	0.2116	0.2047	0.1988	0.1921	0.1823	0.1864	0.1907
(H-Hs) mm	6.601	6.426	6.277	6.106	5.857	5.961	6.072
Voids ratio	0.566	0.551	0.538	0.524	0.502	0.511	0.521
t90 (min)	2.25	1.56	2.56	4.00	1.96		
Cv (ft^2/day)	0.491	0.695	0.417	0.262	0.522		
k' (tsf)	106.479	119.216	151.925	163.234	222.714		
Mv (ft^2 / ton)	0.0094	0.0084	0.0066	0.0061	0.0045		

Trial #	15	16
Load (kpa)	45	10
Load (tsf)	0.468	0.104
Gauge Reading (in)	0.1940	0.2010
(H-Hs) mm	6.154	6.333
Voids ratio	0.528	0.543
t90 (min)		
Cv (ft^2/day)		
k' (tsf)		
Mv (ft^2 / ton)		

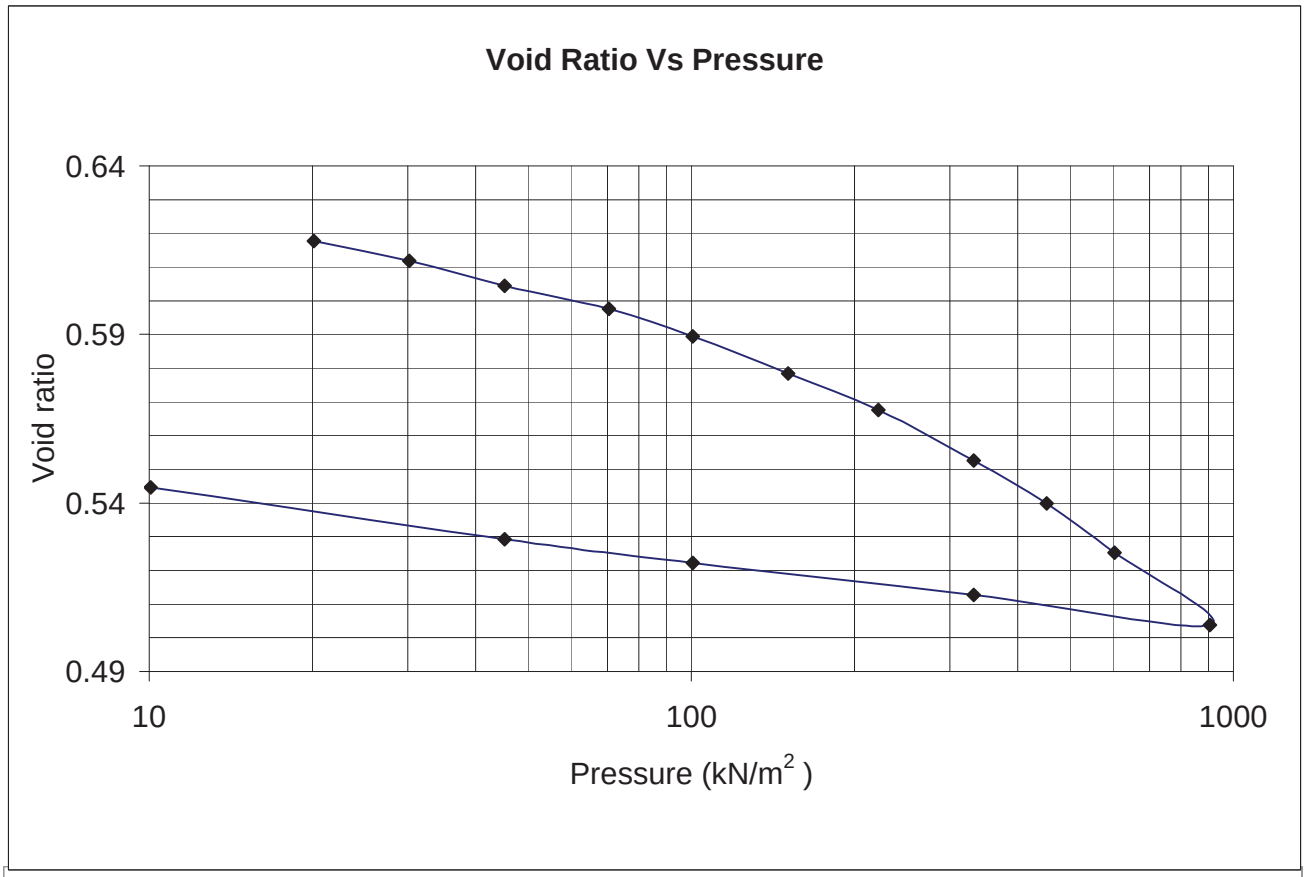
Figure B-10A

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH22-Sa8** **Depth(m):** 11.4

s'_v versus e and c_v



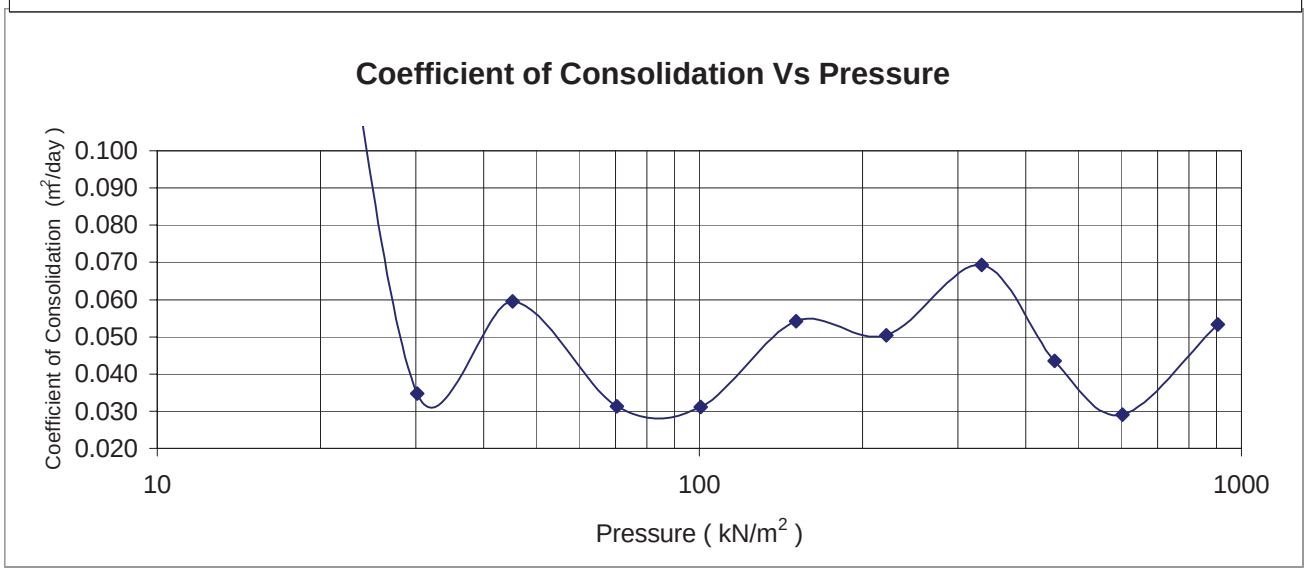


Figure B-10B

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH22-Sa8** **Depth(m):** 11.4

Strain Energy Data

Presssure (tsf)	c_v (ft^2/day)	Presssure (kN/m^2)	c_v (m^2/day)	Void ratio
0.2080	1.851	20	0.1720	0.616
0.3120	0.322	30	0.0299	0.610
0.4680	0.588	45	0.0547	0.603
0.7280	0.286	70	0.0266	0.596
1.0400	0.283	100	0.0263	0.588
1.5600	0.532	150	0.0494	0.577
2.2880	0.491	220	0.0456	0.566
3.4320	0.695	330	0.0645	0.551
4.6800	0.417	450	0.0387	0.538
6.2400	0.262	600	0.0243	0.524
9.3600	0.522	900	0.0485	0.502
3.4320		330		0.511
1.0400		100		0.521
0.4680		45		0.528
0.1040		10		0.543

Presssure (KN/m^2)	Height mm	Total Work (KJ/m^3)
0.0	19.126	0.000
20.0	18.848	0.145
30.0	18.779	0.237
45.0	18.692	0.411
70.0	18.614	0.651
100.0	18.517	1.095
150.0	18.390	1.952
220.0	18.264	3.217
330.0	18.089	5.856
450.0	17.940	9.060
600.0	17.769	14.077
900.0	17.520	24.584
330.0	17.624	20.928
100.0	17.734	19.580
45.0	17.817	19.243
10.0	17.996	18.966

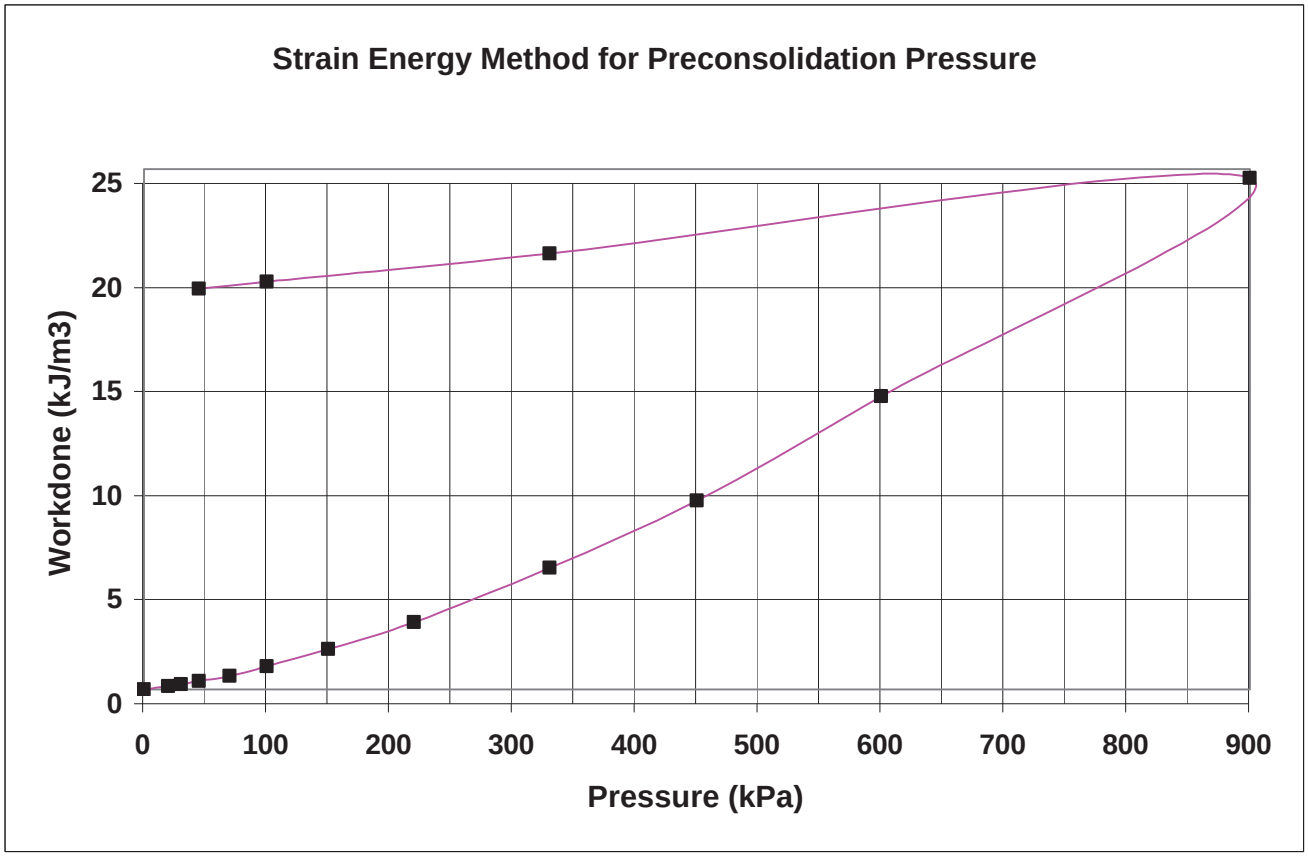


Figure B-10C

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH33-Sa4** **Depth(m):** 13.1

Test Data

Ring # :	A	Ring Height (in) =	0.753	Wt of dry filter paper (g)	0.65
Wet soil + Ring Wt (g)			195.99	Wt of ring (g)	76.61
Wet soil + Wet Paper + Ring (g)			193.51	Wet Paper (g)	1.74
Dry Soil + Dry Paper + Ring (g)			169.85	Ring Dia (in)	2.485
Initial moisture Content (%)			28.93	Final moisture Content (%)	24.38
Area of Ring (in^2)			4.85	Initial Volume (in^3)	3.6521
Initial Bulk Density (kg/m^3)			1995	Initial Dry Density (kg/m^3)	1547
Specific Gravity of Soil			2.70	Eqiv. Thick. of solids (mm)	10.959
Final Bulk Density (kg/m^3)			2095	Final Dry Density (kg/m^3)	1625
Initiall gauge reading for Load 1			0.2537	Gauge reading for last Loading	0.1923
Initial Voids Ratio			0.745	Final Void Ratio	0.603
Initial Degree of Saturation (%)			100.0	Final Degree of Saturation (%)	100.0

Trial #	1	2	3	4	5	6	7
Load (kpa)	0	20	30	45	70	100	150
Load (tsf)	0	0.208	0.312	0.468	0.728	1.04	1.56
Gauge Reading (in)	0.2537	0.2455	0.2426	0.2394	0.2345	0.2299	0.2235
(H-Hs) mm	8.167	7.958	7.885	7.803	7.678	7.563	7.399
Voids ratio	0.745	0.726	0.720	0.712	0.701	0.690	0.675
t90 (min)		4.00	5.76	3.24	5.76	4.20	3.42
Cv (ft^2/day)		0.297	0.203	0.359	0.199	0.270	0.326
k' (tsf)		19.042	27.178	35.888	38.800	50.592	58.790
Mv (ft^2 / ton)		0.0525	0.0368	0.0279	0.0258	0.0198	0.0170

Trial #	8	9	10	11	12	13	14
Load (kpa)	220	330	450	600	220	100	45
Load (tsf)	2.288	3.432	4.68	6.24	2.288	1.040	0.468
Gauge Reading (in)	0.2152	0.1993	0.1860	0.1740	0.1778	0.1807	0.1848
(H-Hs) mm	7.189	6.784	6.446	6.141	6.238	6.312	6.415
Voids ratio	0.656	0.619	0.588	0.560	0.569	0.576	0.585
t90 (min)	4.00	4.41	7.56	5.29			
Cv (ft^2/day)	0.274	0.240	0.134	0.185			
k' (tsf)	63.779	51.168	65.548	89.083			
Mv (ft^2 / ton)	0.0157	0.0195	0.0153	0.0112			

Trial #	15
Load (kpa)	10
Load (tsf)	0.104
Gauge Reading (in)	0.1923
(H-Hs) mm	6.608
Voids ratio	0.603
t90 (min)	
Cv (ft^2/day)	
k' (tsf)	
Mv (ft^2 / ton)	

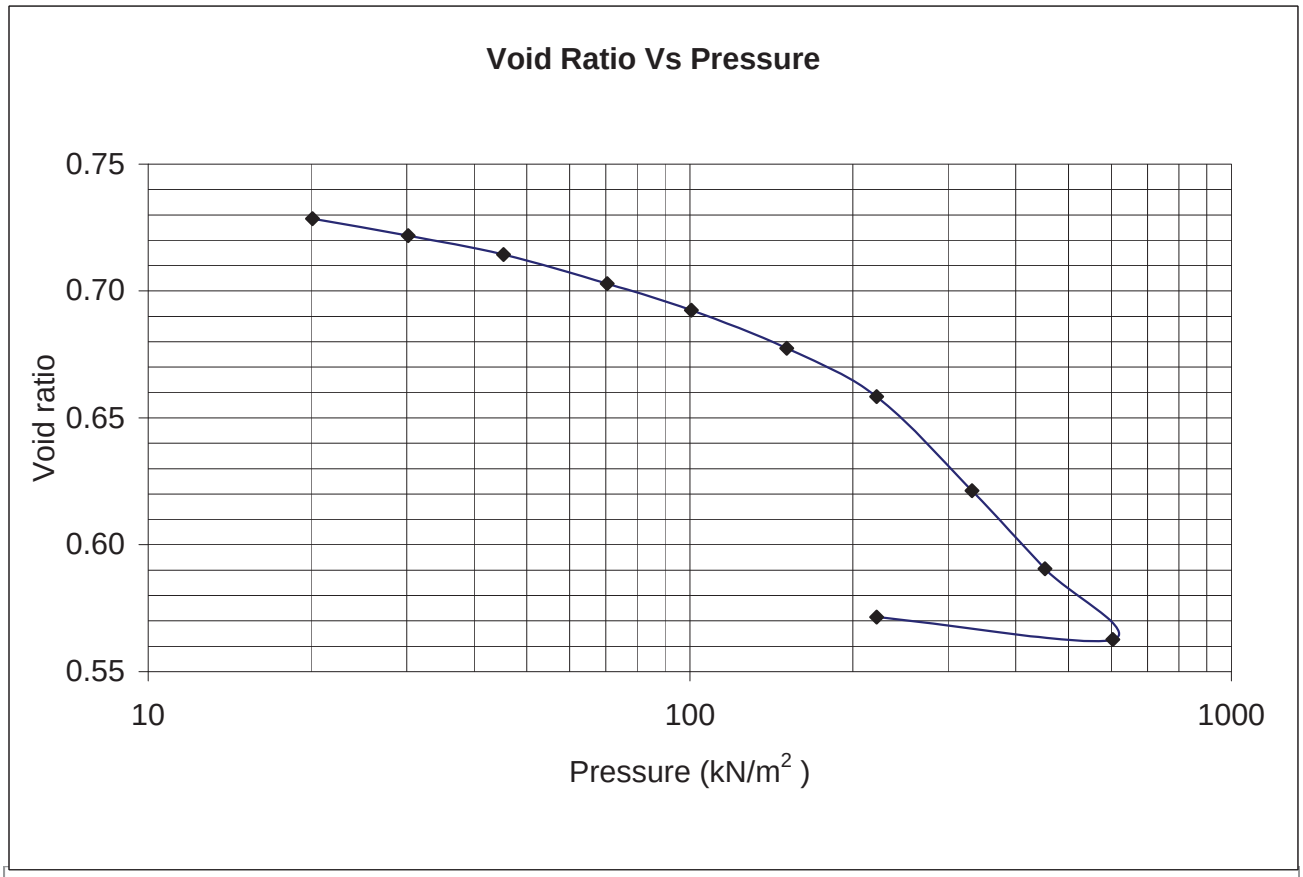
Figure B-11A

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH33-Sa4** **Depth(m):** 13.1

s'_v versus e and c_v



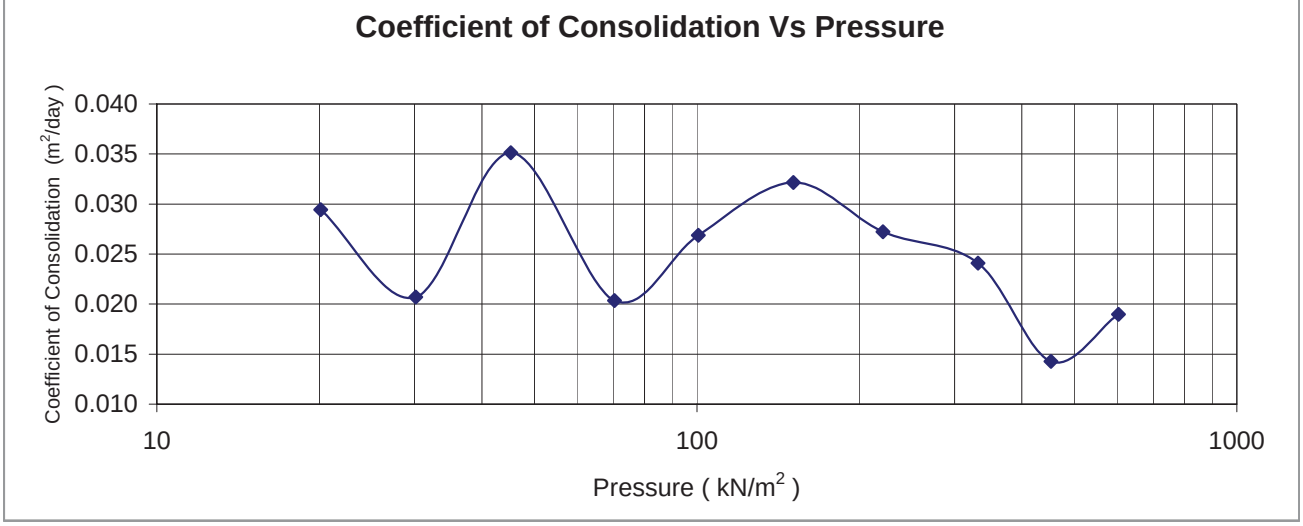


Figure B-11B

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH33-Sa4** **Depth(m):** 13.1

Strain Energy Data

Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio
0.2080	0.297	20	0.0276	0.726
0.3120	0.203	30	0.0189	0.720
0.4680	0.359	45	0.0333	0.712
0.7280	0.199	70	0.0185	0.701
1.0400	0.270	100	0.0251	0.690
1.5600	0.326	150	0.0303	0.675
2.2880	0.274	220	0.0254	0.656
3.4320	0.240	330	0.0223	0.619
4.6800	0.134	450	0.0125	0.588
6.2400	0.185	600	0.0172	0.560
2.2880		220		0.569
1.0400		100		0.576
0.4680		45		0.585
0.1040		10		0.603

Presssure (KN/m^2)	Height mm	Total Work (KJ/m^3)
0.0	19.126	0.000
20.0	18.917	0.109
30.0	18.845	0.205
45.0	18.763	0.368
70.0	18.637	0.753
100.0	18.522	1.277
150.0	18.358	2.383
220.0	18.149	4.495
330.0	17.743	10.643
450.0	17.405	18.068
600.0	17.101	27.262
220.0	17.197	24.948
100.0	17.271	24.257
45.0	17.375	23.822
10.0	17.567	23.518

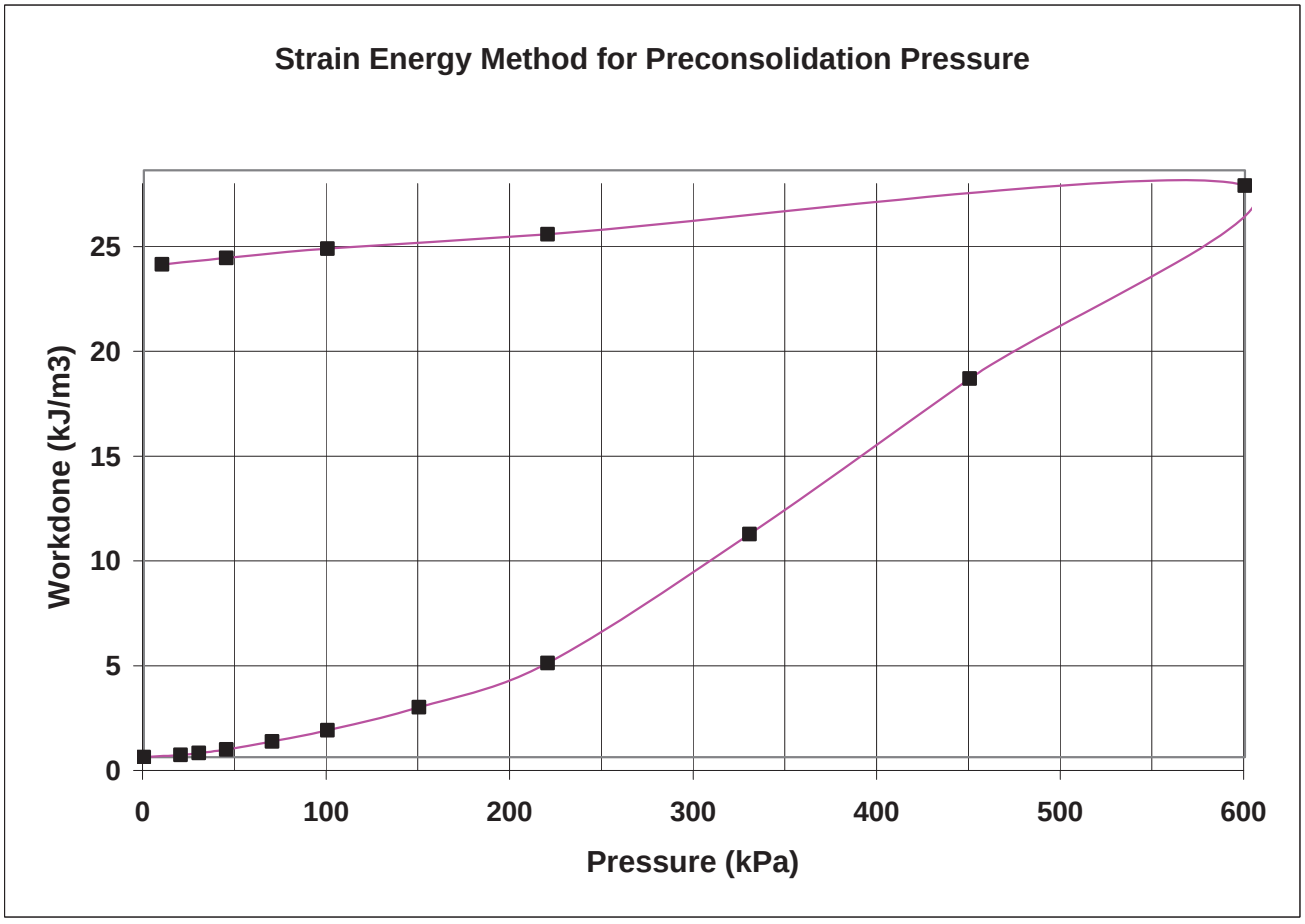


Figure B-11C

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH39-Sa4** **Depth(m):** 10.8

Test Data

Ring # :	B	Ring Height (in) =	0.753	Wt of dry filter paper (g)	0.71
Wet soil + Ring Wt (g)			196.12	Wt of ring (g)	76.57
Wet soil + Wet Paper + Ring (g)			195.78	Wet Paper (g)	1.86
Dry Soil + Dry Paper + Ring (g)			171.09	Ring Dia (in)	2.485
Initial moisture Content (%)			27.44	Final moisture Content (%)	25.093
Area of Ring (in^2)			4.85	Initial Volume (in^3)	3.6521
Initial Bulk Density (kg/m^3)			1998	Initial Dry Density (kg/m^3)	1568
Specific Gravity of Soil			2.72	Eqiv. Thick. of solids (mm)	11.022
Final Bulk Density (kg/m^3)			2126	Final Dry Density (kg/m^3)	1668
Initiall gauge reading for Load 1			0.2599	Gauge reading for last Loading	0.2015
Initial Voids Ratio			0.735	Final Void Ratio	0.601
Initial Degree of Saturation (%)			100.0	Final Degree of Saturation (%)	100.0

Trial #	1	2	3	4	5	6	7
Load (kpa)	0	20	30	45	70	100	150
Load (tsf)	0	0.208	0.312	0.468	0.728	1.04	1.56
Gauge Reading (in)	0.2599	0.2561	0.25415	0.2515	0.2479	0.2446	0.2400
(H-Hs) mm	8.104	8.007	7.958	7.891	7.799	7.715	7.598
Voids ratio	0.735	0.726	0.722	0.716	0.708	0.700	0.689
t90 (min)		4.00	4.62	5.06	4.84	4.00	3.24
Cv (ft^2/day)		0.299	0.257	0.233	0.242	0.290	0.354
k' (tsf)		41.217	39.957	43.989	53.777	69.531	83.845
Mv (ft^2 / ton)		0.0243	0.0250	0.0227	0.0186	0.0144	0.0119

Trial #	8	9	10	11	12	13	14
Load (kpa)	220	330	450	600	220	100	45
Load (tsf)	2.288	3.432	4.68	6.24	2.288	1.04	0.468
Gauge Reading (in)	0.2338	0.2216	0.2049	0.1908	0.1967	0.2015	0.2081
(H-Hs) mm	7.440	7.130	6.707	6.348	6.497	6.621	6.789
Voids ratio	0.675	0.647	0.608	0.576	0.589	0.601	0.616
t90 (min)	3.24	6.76	13.32	12.96			
Cv (ft^2/day)	0.349	0.163	0.079	0.078			
k' (tsf)	85.391	68.157	53.567	76.953			
Mv (ft^2 / ton)	0.0117	0.0147	0.0187	0.0130			

Trial #	8
Load (kpa)	10
Load (tsf)	0.104
Gauge Reading (in)	0.2193
(H-Hs) mm	7.073
Voids ratio	0.642
t90 (min)	
Cv (ft^2/day)	
k' (tsf)	
Mv (ft^2 / ton)	

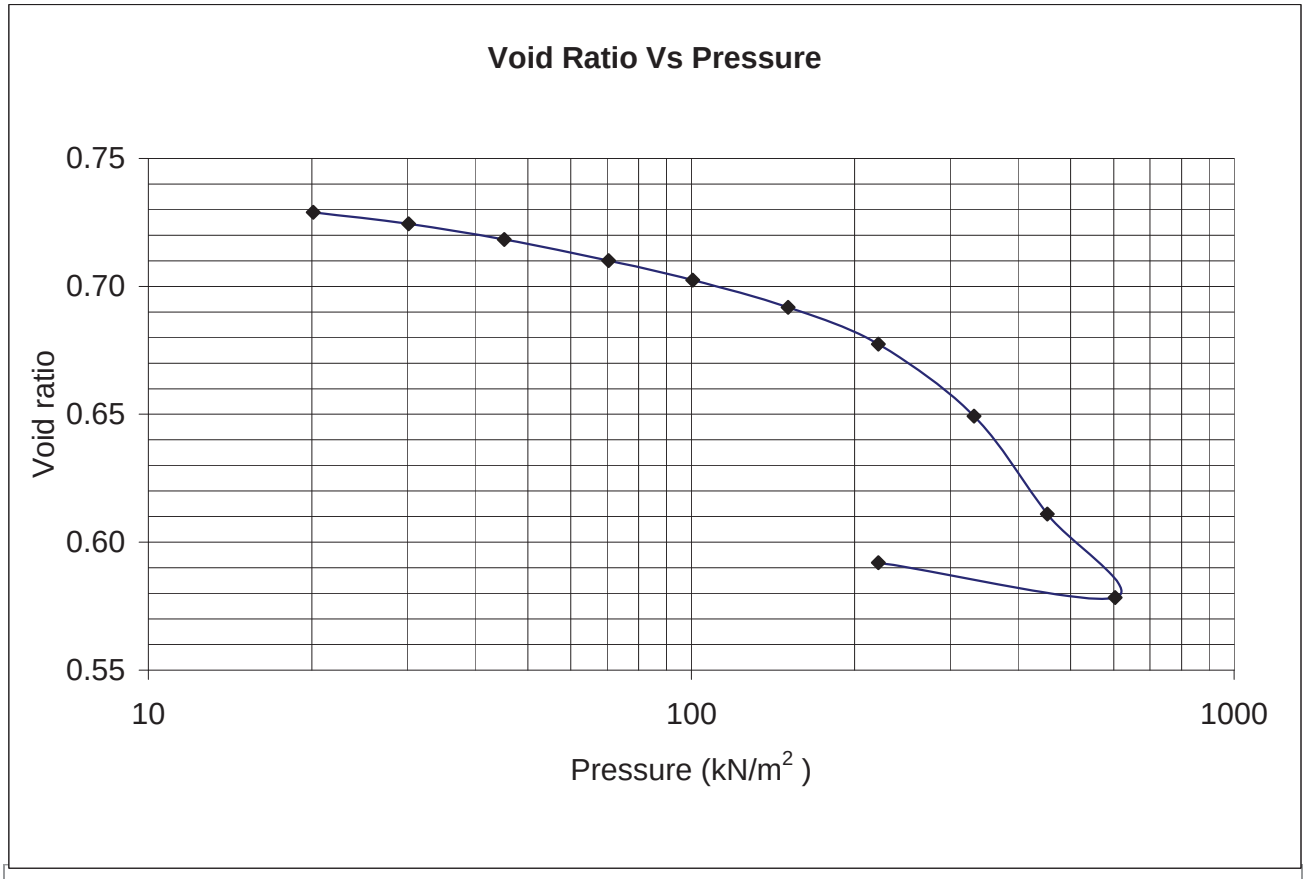
Figure B-12A

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH39-Sa4** **Depth(m):** 10.8

s'_v versus e and c_v



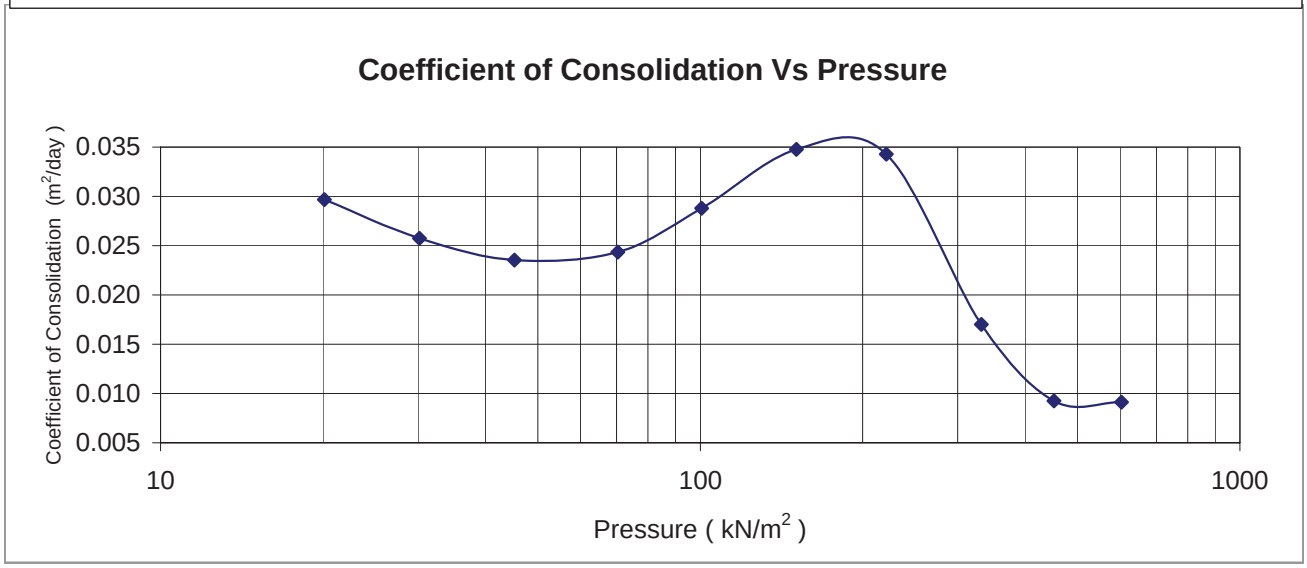


Figure B-12B

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 12 November 2003 **BH39-Sa4** **Depth(m):** 10.8

Strain Energy Data

Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio
0.2080	0.299	20	0.0278	0.726
0.3120	0.257	30	0.0239	0.722
0.4680	0.233	45	0.0216	0.716
0.7280	0.242	70	0.0225	0.708
1.0400	0.290	100	0.0269	0.700
1.5600	0.354	150	0.0329	0.689
2.2880	0.349	220	0.0324	0.675
3.4320	0.163	330	0.0151	0.647
4.6800	0.079	450	0.0074	0.608
6.2400	0.078	600	0.0073	0.576
2.2880		220		0.589
1.0400		100		0.601
0.4680		45		0.616
0.1040		10		0.642

Presssure (KN/m^2)	Height mm	Total Work (KJ/m^3)
0.0	19.126	0.000
20.0	19.030	0.050
30.0	18.980	0.116
45.0	18.913	0.249
70.0	18.821	0.527
100.0	18.737	0.908
150.0	18.621	1.683
220.0	18.462	3.260
330.0	18.152	7.876
450.0	17.729	16.962
600.0	17.370	27.605
220.0	17.520	24.068
100.0	17.643	22.937
45.0	17.811	22.248
10.0	18.095	21.810

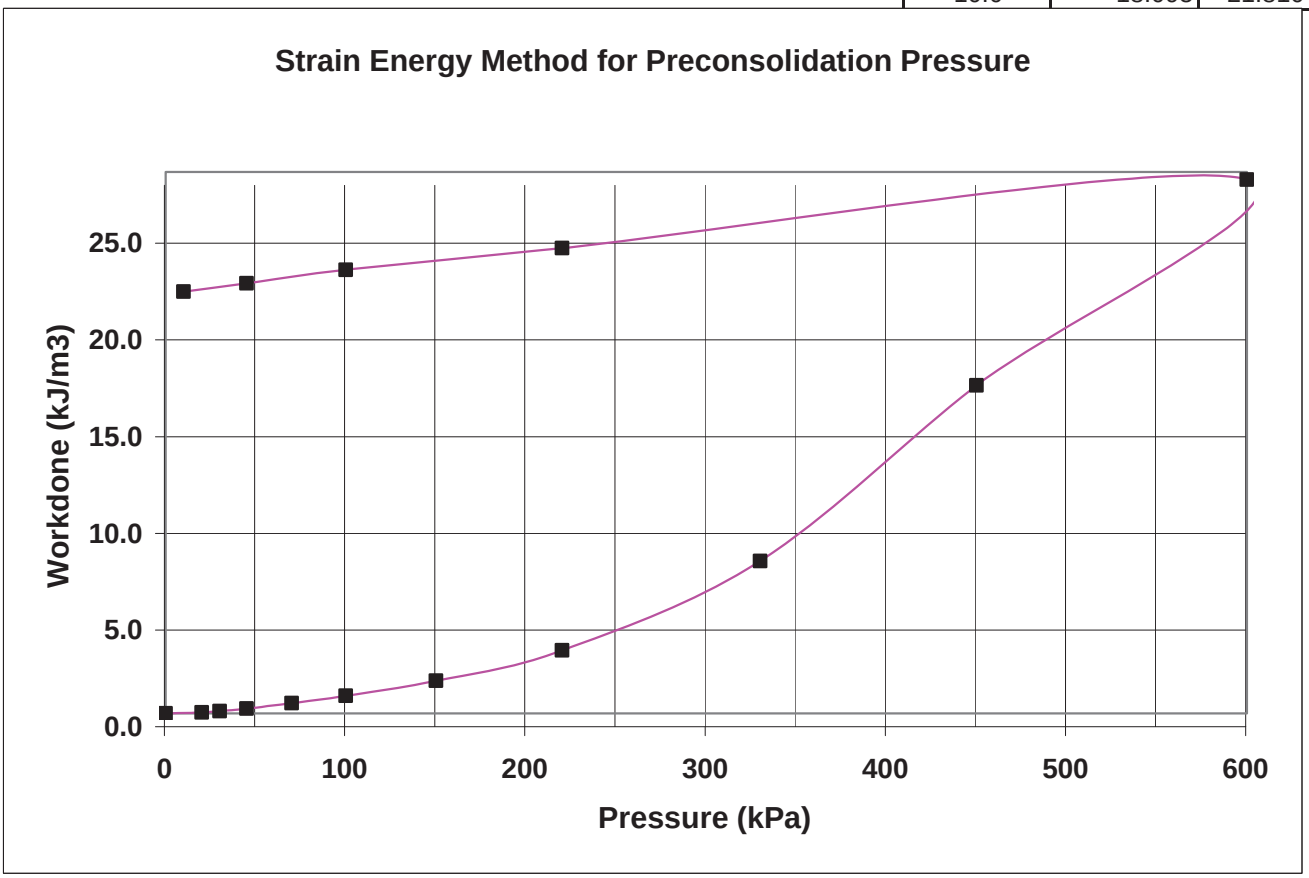


Figure B-12C

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH42-Sa4** **Depth(m):** 11.4

Test Data

Ring # :	B	**Ring Height (in) =**	0.753	**Wt of dry filter paper (g)**	0.63
Wet soil + Ring Wt (g)			196.65	**Wt of ring (g)**	76.61
Wet soil + Wet Paper + Ring (g)			194.36	**Wet Paper (g)**	1.70
Dry Soil + Dry Paper + Ring (g)			170.98	**Ring Dia (in)**	2.485
Initial moisture Content (%)			28.06	**Final moisture Content (%)**	23.80
Area of Ring (in^2)			4.85	**Initial Volume (in^3)**	3.6521
Initial Bulk Density (kg/m^3)			2006	**Initial Dry Density (kg/m^3)**	1566
Specific Gravity of Soil			2.72	**Eqiv. Thick. of solids (mm)**	11.014
Final Bulk Density (kg/m^3)			2117	**Final Dry Density (kg/m^3)**	1653
Initiall gauge reading for Load 1			0.2436	**Gauge reading for last Loading**	0.1803
Initial Voids Ratio			0.737	**Final Void Ratio**	0.591
Initial Degree of Saturation (%)			100.0	**Final Degree of Saturation (%)**	100.0

Trial #	1	2	3	4	5	6	7
Load (kpa)	0	20	30	45	70	100	150
Load (tsf)	0	0.208	0.312	0.468	0.728	1.04	1.56
Gauge Reading (in)	0.2436	0.2324	0.2287	0.2246	0.2167	0.2126	0.2051
(H-Hs) mm	8.112	7.828	7.734	7.629	7.430	7.325	7.133
Voids ratio	0.737	0.711	0.702	0.693	0.675	0.665	0.648
t90 (min)		16.00	23.04	14.44	12.96	6.25	10.56
Cv (ft^2/day)		0.074	0.050	0.080	0.087	0.178	0.104
k' (tsf)		14.016	20.851	27.746	24.310	55.256	49.565
Mv (ft^2 / ton)		0.0713	0.0480	0.0360	0.0411	0.0181	0.0202

Trial #	8	9	10	11	12	13	14
Load (kpa)	220	330	450	600	900	300	100
Load (tsf)	2.288	3.432	4.68	6.24	9.36	3.120	1.040
Gauge Reading (in)	0.1957	0.1831	0.1725	0.1608	0.1447	0.1515	0.1600
(H-Hs) mm	6.895	6.575	6.306	6.008	5.600	5.773	5.989
Voids ratio	0.626	0.597	0.573	0.546	0.508	0.524	0.544
t90 (min)	10.89	9.00	11.56	6.76	6.76		
Cv (ft^2/day)	0.098	0.115	0.087	0.143	0.137		
k' (tsf)	55.479	64.016	81.529	90.917	130.074		
Mv (ft^2 / ton)	0.0180	0.0156	0.0123	0.0110	0.0077		

Trial #	15	16
Load (kpa)	45	10
Load (tsf)	0.468	0.104
Gauge Reading (in)	0.1669	0.1803
(H-Hs) mm	6.163	6.504
Voids ratio	0.560	0.591
t90 (min)		
Cv (ft^2/day)		
k' (tsf)		
Mv (ft^2 / ton)		

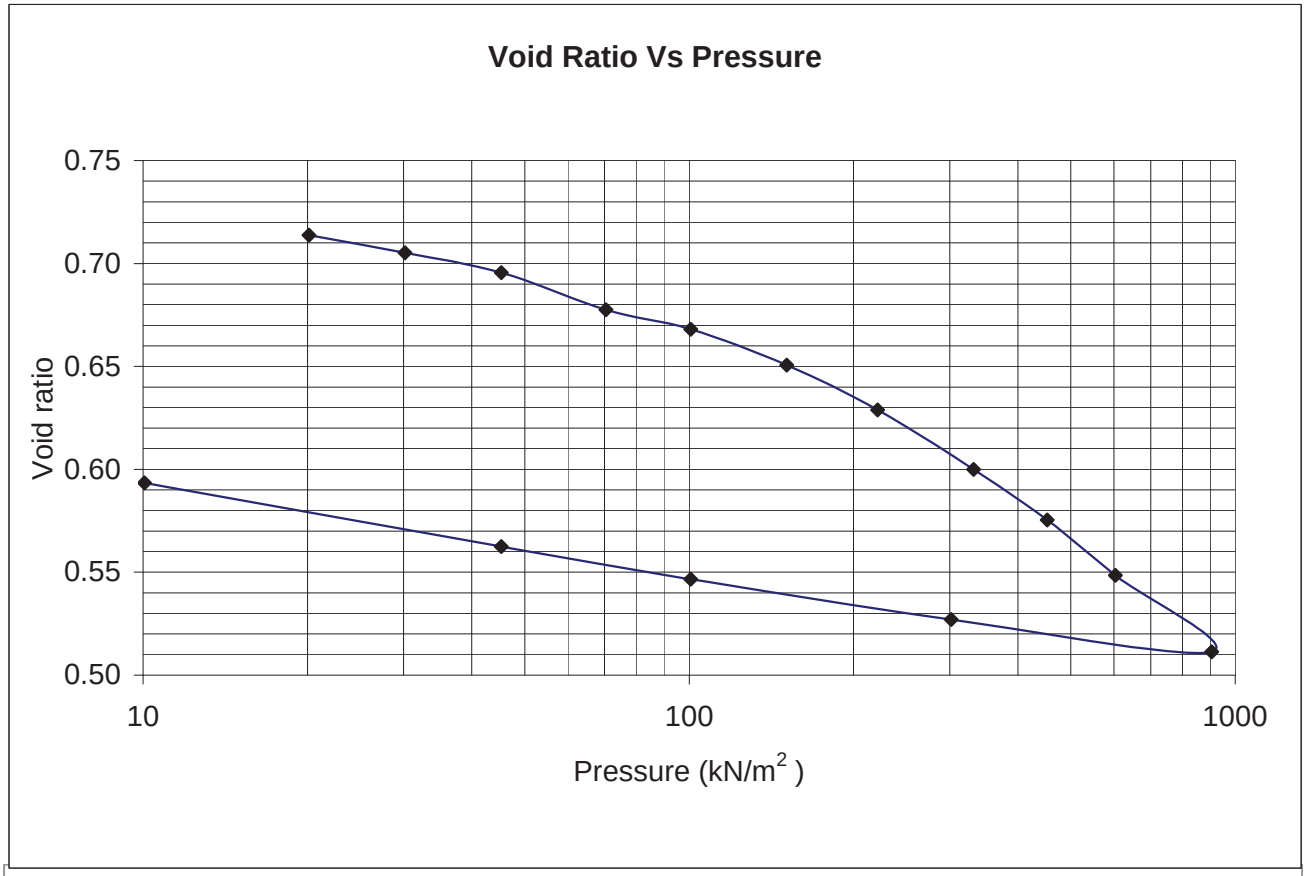
Figure B-13A

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH42-Sa4** **Depth(m):** 11.4

s'_v versus e and c_v



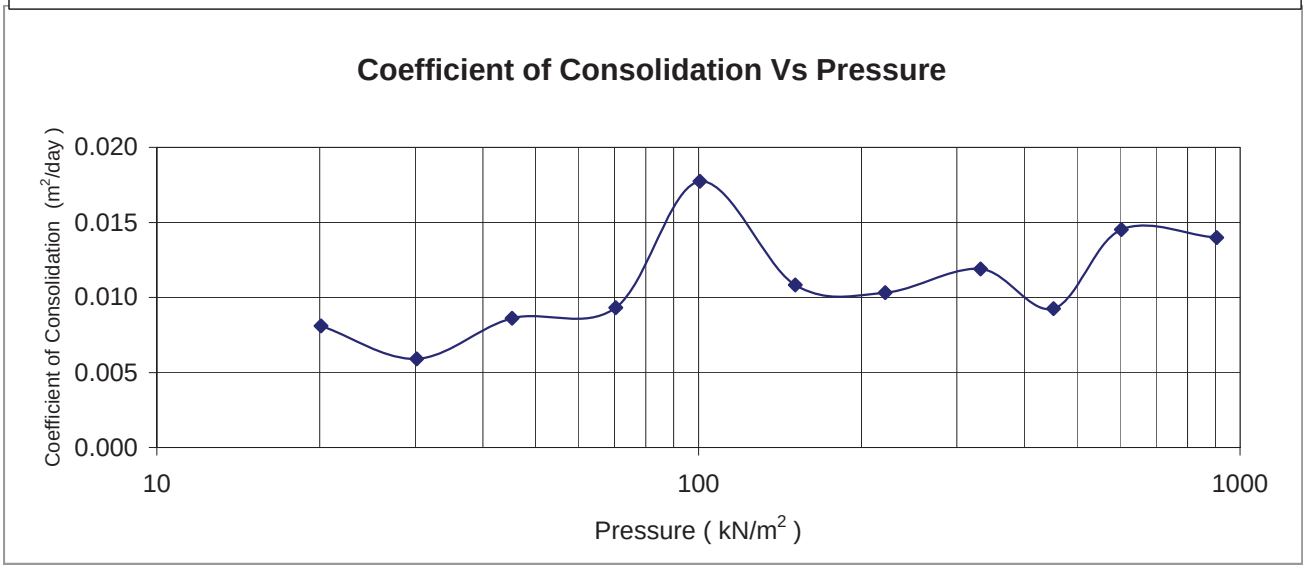


Figure B-13B

ONE DIMENSIONAL CONSOLIDATION TEST

Project: Randle Reef Remediation **Job#:** TC035071

Date: 20 November 2003 **BH42-Sa4** **Depth(m):** 11.4

Strain Energy Data

Presssure (tsf)	Cv (ft^2/day)	Presssure (kN/m^2)	Cv (m^2/day)	Void ratio
0.2080	0.074	20	0.0069	0.711
0.3120	0.050	30	0.0047	0.702
0.4680	0.080	45	0.0074	0.693
0.7280	0.087	70	0.0081	0.675
1.0400	0.178	100	0.0165	0.665
1.5600	0.104	150	0.0096	0.648
2.2880	0.098	220	0.0091	0.626
3.4320	0.115	330	0.0107	0.597
4.6800	0.087	450	0.0080	0.573
6.2400	0.143	600	0.0133	0.546
9.3600	0.137	900	0.0128	0.508
3.1200		300		0.524
1.0400		100		0.544
0.4680		45		0.560
0.1040		10		0.591

Presssure (KN/m^2)	Height mm	Total Work (KJ/m^3)
0.0	19.126	0.000
20.0	18.842	0.148
30.0	18.748	0.273
45.0	18.643	0.484
70.0	18.444	1.099
100.0	18.339	1.579
150.0	18.147	2.890
220.0	17.909	5.318
330.0	17.589	10.232
450.0	17.320	16.202
600.0	17.022	25.210
900.0	16.614	43.200
300.0	16.787	36.962
100.0	17.003	34.390
45.0	17.177	33.648
10.0	17.518	33.102

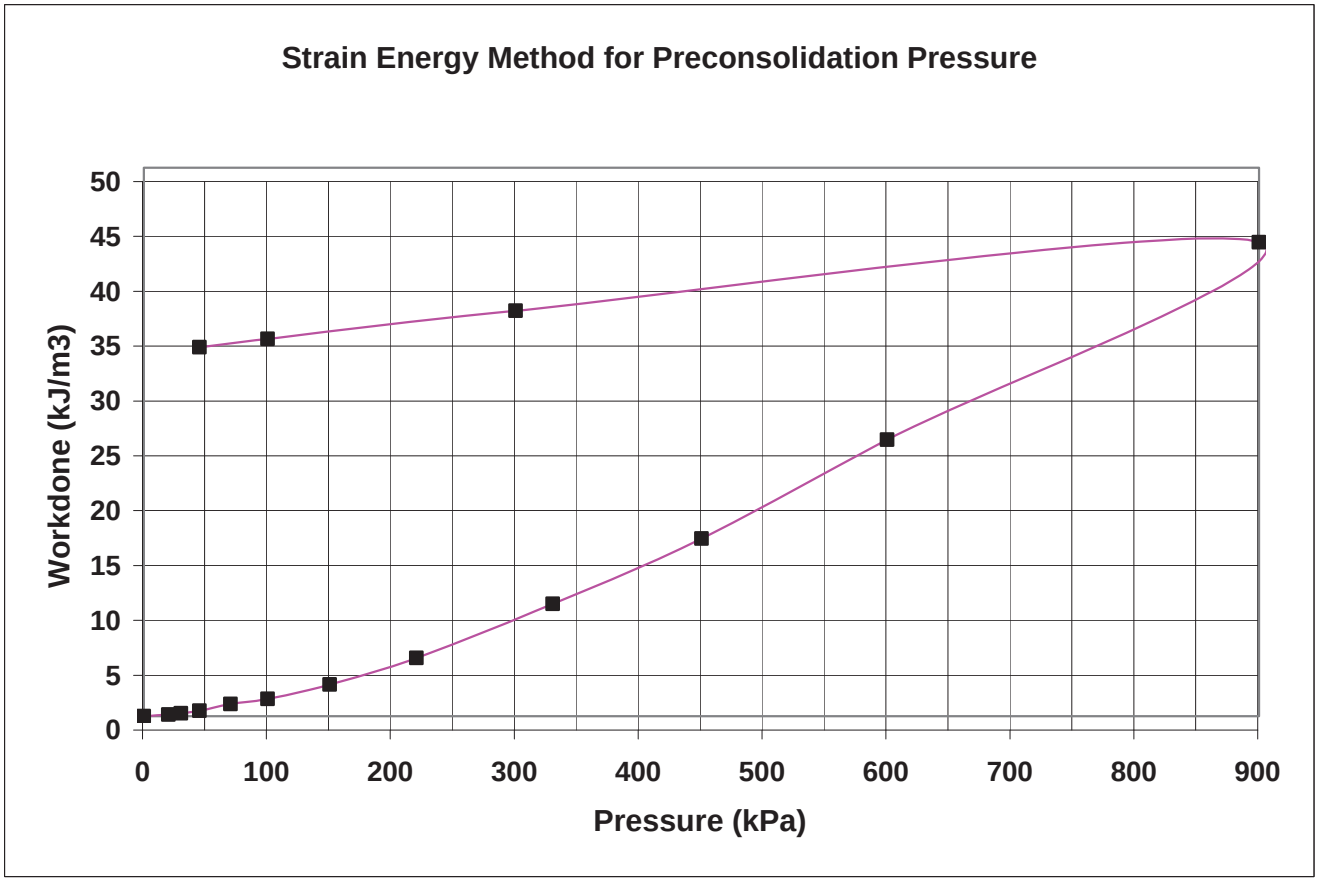


Figure B-13C

Triaxial Quick Shear Test – BH22-Sa8, BH29-Sa8, BH33-Sa4, BH38-Sa8

Project: Randle Reef Remediation **Job#:** TC035071

BH#	22	29	33	38
Sa#	8	8	4	8
Height (mm)	136.2	140.7	140.9	140.8
Diameter (mm)	69.7	69.4	69.4	69.4
Weight (g)	1060.3	1123.1	1095.8	1108.9
Unit Weight (kN/m3)	20.0	20.7	20.2	20.4
Natural Moisture Content (%)	24.0	21.0	25.0	22.0
s 3 (kPa)	37	50	22	80
Shear rate (mm / min)	0.7	0.7	0.7	0.7
Maximum Deviator Stress (kPa)	89.1	199.2	64.2	93.1
Shear Strength (kPa)	44.6	99.6	32.1	46.6
Strain (%)	14.4	14.1	13.4	14.1

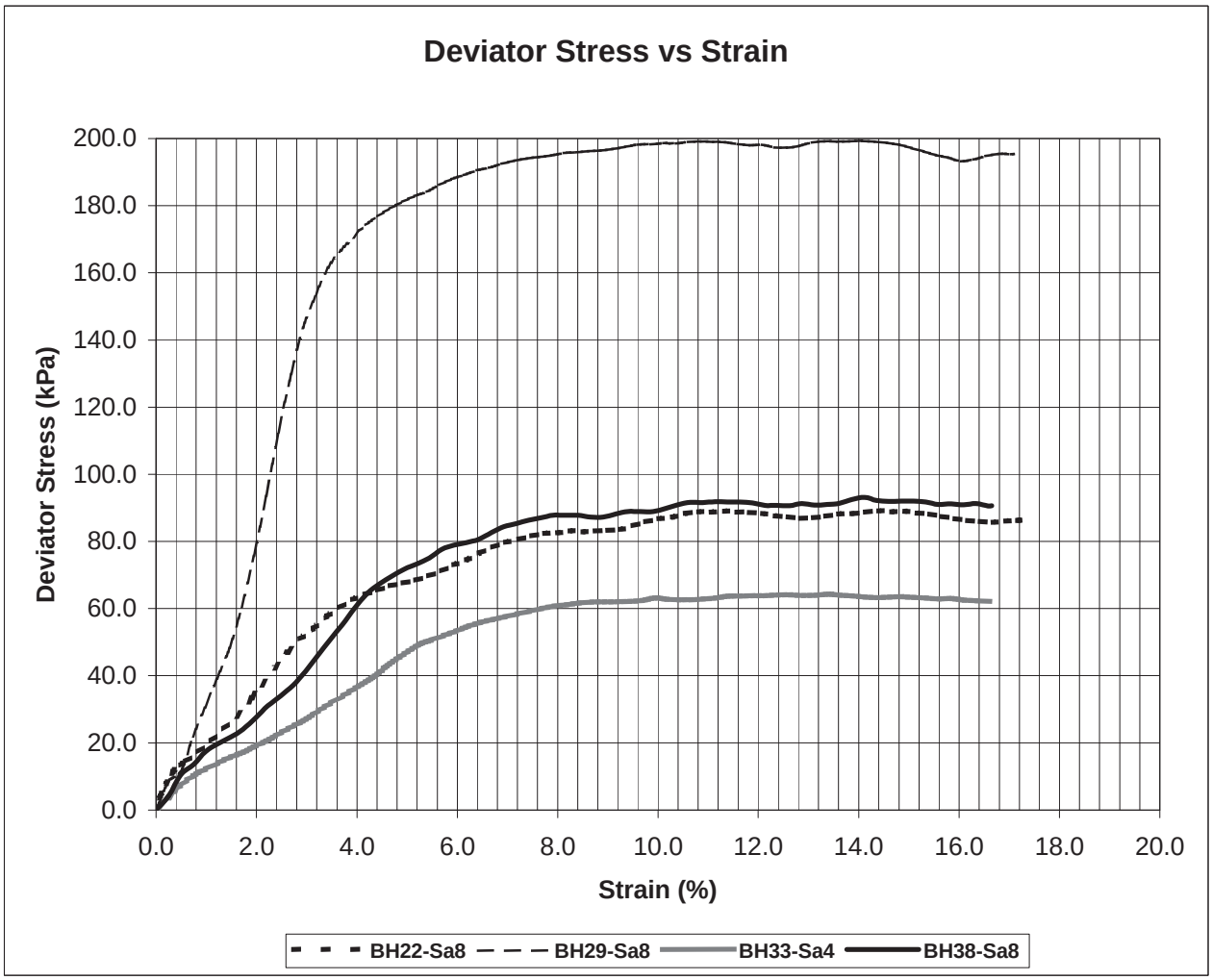


Figure B-14

Triaxial Quick Shear Test – BH39-Sa4, BH42-Sa4, BH43-Sa11

Project: Randle Reef Remediation **Job#:** TC035071

BH#	39	42	43
Sa#	4	4	11
Height (mm)	137.9	139.8	139.0
Diameter (mm)	69.5	69.6	69.5
Weight (g)	1049.9	1068.5	1075.1
Unit Weight (kN/m3)	19.7	19.7	20.0
Natural Moisture Content (%)	28.0	26.0	26.0
s 3 (kPa)	15	20	110
Shear rate (mm / min)	0.7	0.7	0.7
Maximum Deviator Stress (kPa)	80.1	73.7	159.8
Shear Strength (kPa)	40.0	36.8	79.9
Strain (%)	10.9	16.8	3.8

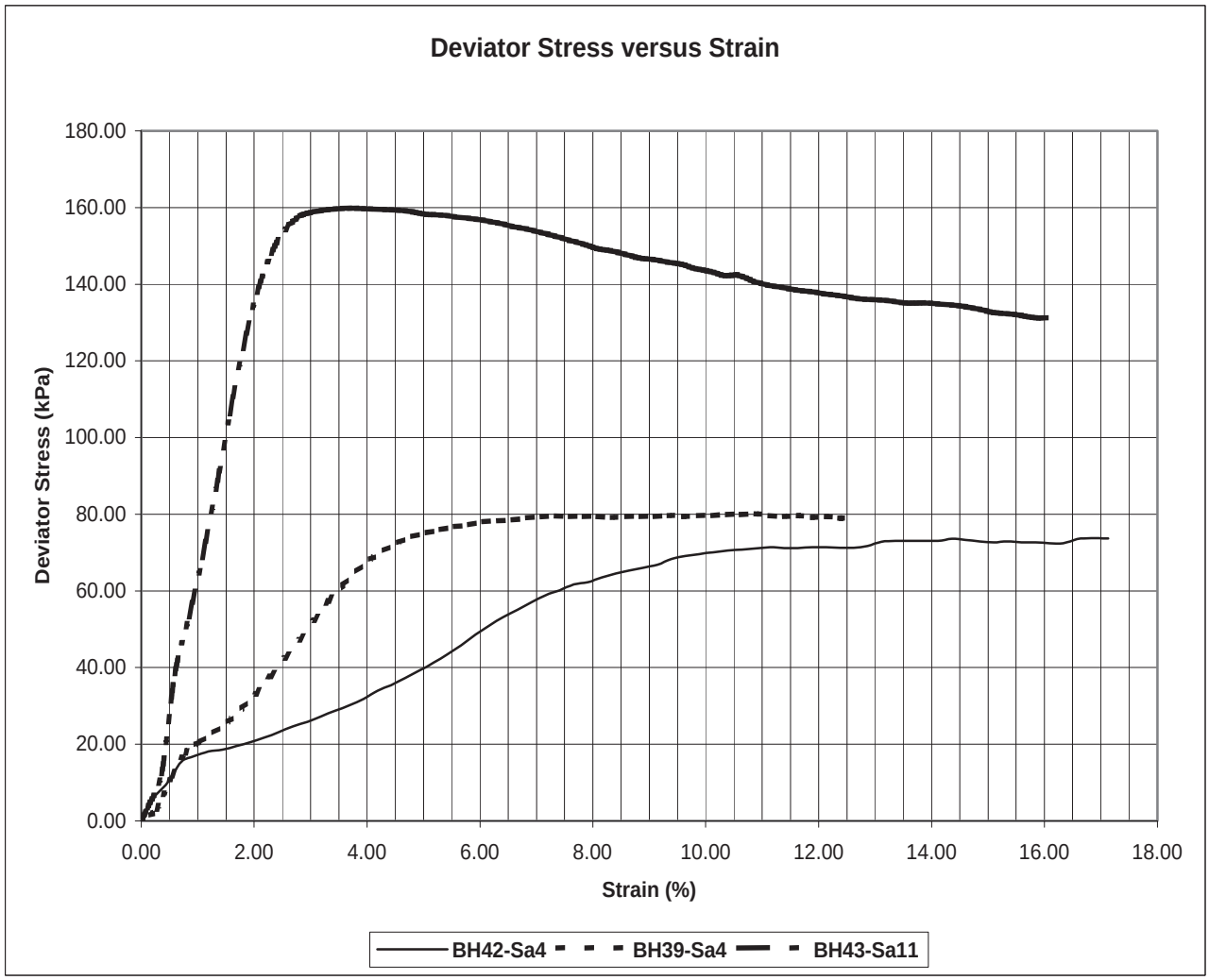


Figure B-15

Figure B-16A

Triaxial CU Compression Shear Test – BH20-Sa6 – Test Data

Consolidated Undrained

Sample details

Sketch showing specimen location in original Sample

Depth 13.4 m
Description: Grey Silty Clay

	Specimen 1	Specimen 2	Specimen 3
Type	Grey Clay	Grey Clay	Grey Clay
Height H_0 (mm)	125.2	132.72	132.22
Diameter D_0 (mm)	69.63	69.75	69.72
Weight W_0 (gr)	967.49	1031.71	1035.63
Bulk Density ρ (Mg/m3)	2.03	2.03	2.05
Particle Density ρ_s	2.7 (assumed)	2.65 (assumed)	2.7 (assumed)

Initial Conditions

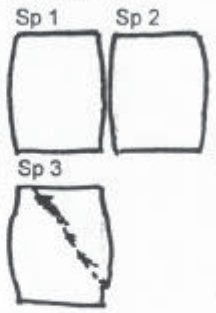
	Specimen 1	Specimen 2	Specimen 3
Cell Pressure σ_3 (kPa)	290.00	300.00	361.00
Pore Pressure u (kPa)	260.40	240.30	241.00
Machine Speed d_r(mm/min)	0.06	0.06	0.06
No. of Membranes	0	1	1
Total Thickness (mm)	0.2	0.2	0.2
Strain Channel	18	18	18
Load Channel	17	17	17
Pore P. Channel	19	23	19
Volume Channel	20	20	20
Moisture Content w_0%	26	26	26
Dry Density ρ_{d0} (Mg/m3)	1.61	1.61	1.63
Voids Ratio e_0	0.68	0.64	0.66
Deg of Saturation S_0%	100.00	100.00	100.00
Final B Value	0.99	0.99	1.00

Final Conditions

	Specimen 1	Specimen 2	Specimen 3
Moisture Content w_f%	25	24	22
Dry Density ρ_d (Mg/m3)	1.64	1.66	1.70
Voids Ratio e_f	0.65	0.59	0.59
Deg of Saturation S_f%	100.00	100.00	100.00
Failure Criteria	Mx Dev Stress	Mx Dev Stress	Mx Dev Stress
Axial Strain ε_f%	14.8	11.8	7.7
Corr Dev Stress $(\sigma_1 - \sigma_3)f$ (kPa)	96.9	115.1	145.9
Minor Stress σ'_{3f} (kPa)	47.0	52.3	67.5
Major Stress σ'_{1f} (kPa)	143.9	167.4	213.4
Stress Ratio $(\sigma'_1/\sigma'_3)_f$	3.1	3.2	3.2

Notes:

Failure Sketch



Surface Inclination

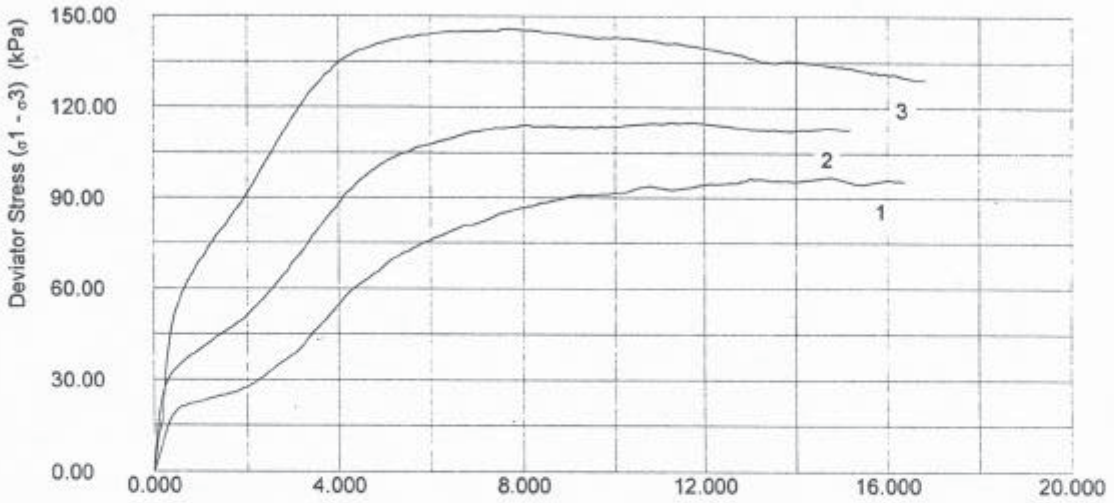
AMEC Earth & Environmental Limited

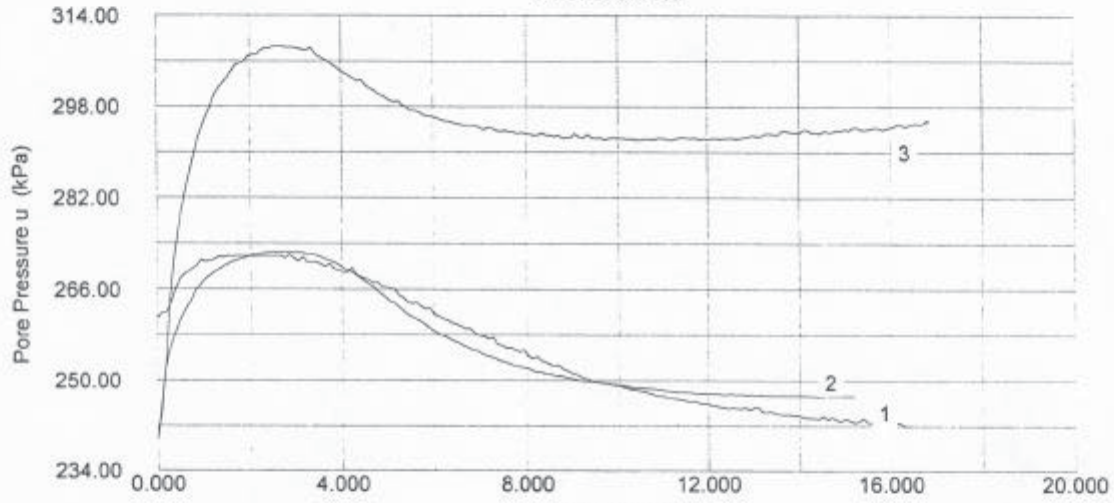
Test Method : BS1377 : Part 8 : 1990 : 8/9* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/24/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	20
Operator: SB	*Checked:* CB	*Approved:*	

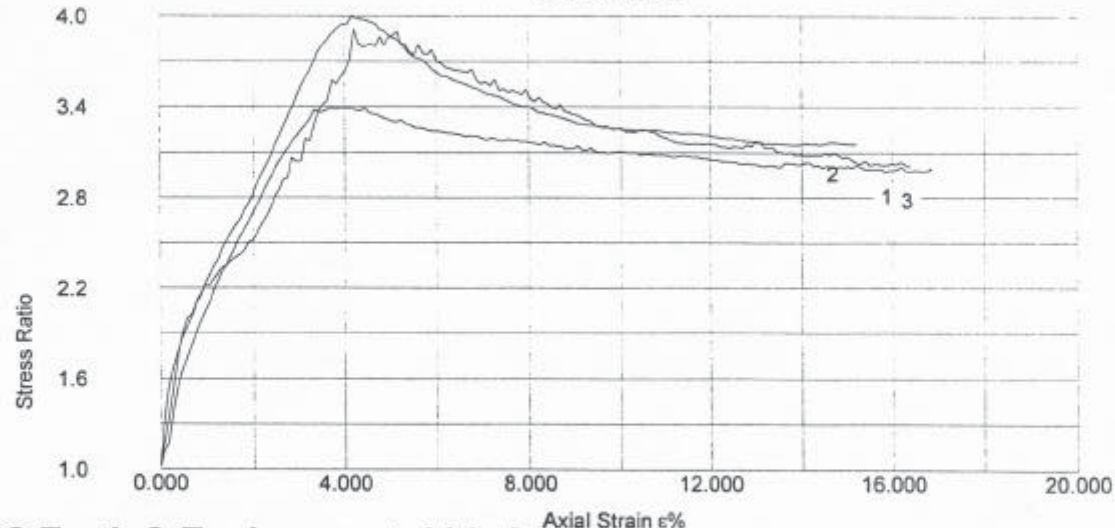
Figure B-16B

Triaxial CU Compression Shear Test – BH20-Sa6 – Stress Strain Curves

Consolidated Undrained







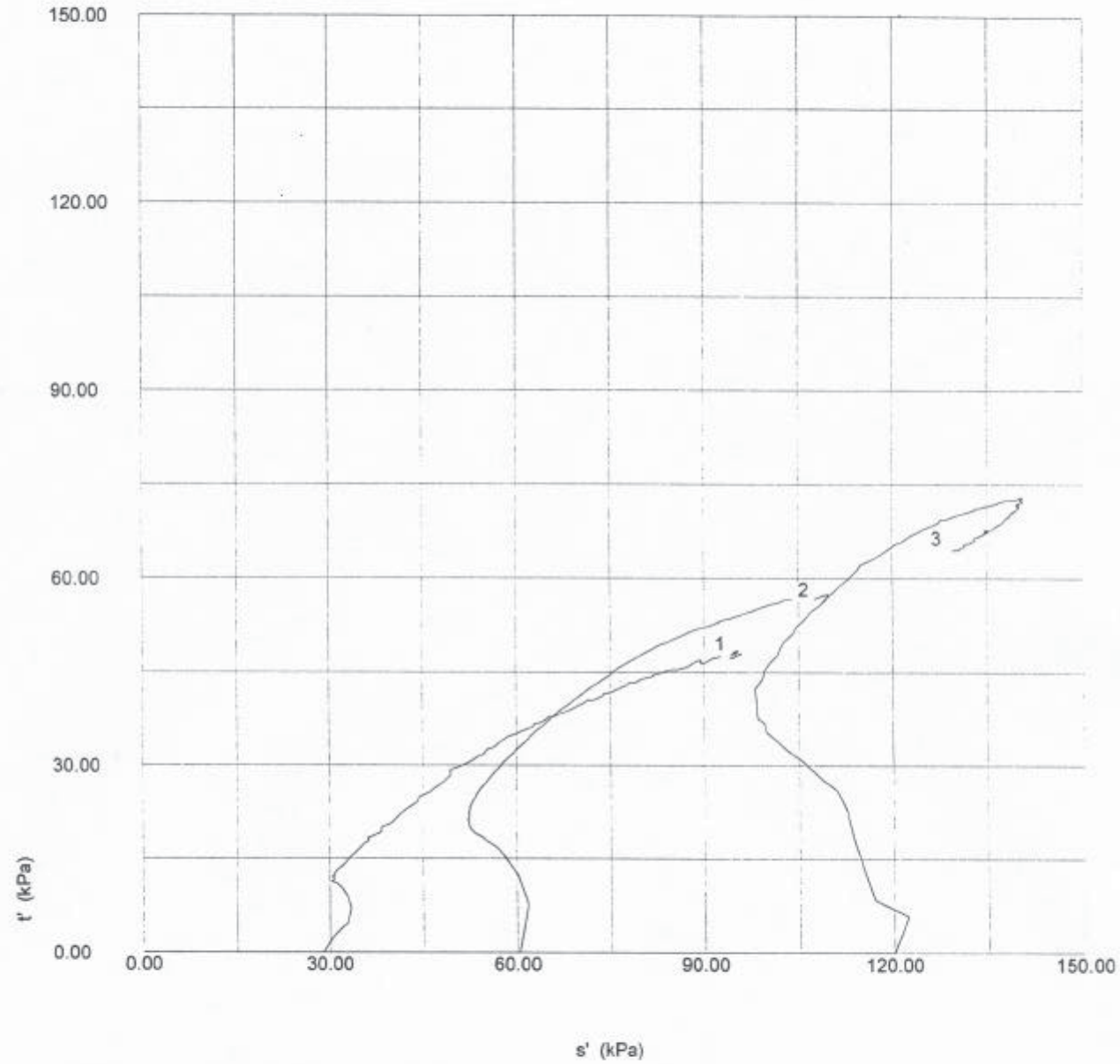
AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/24/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	20
Operator: SA	Checked: SB		Approved:

Figure B-16C

Triaxial CU Compression Shear Test – BH20-Sa6 – Stress Paths

Consolidated Undrained



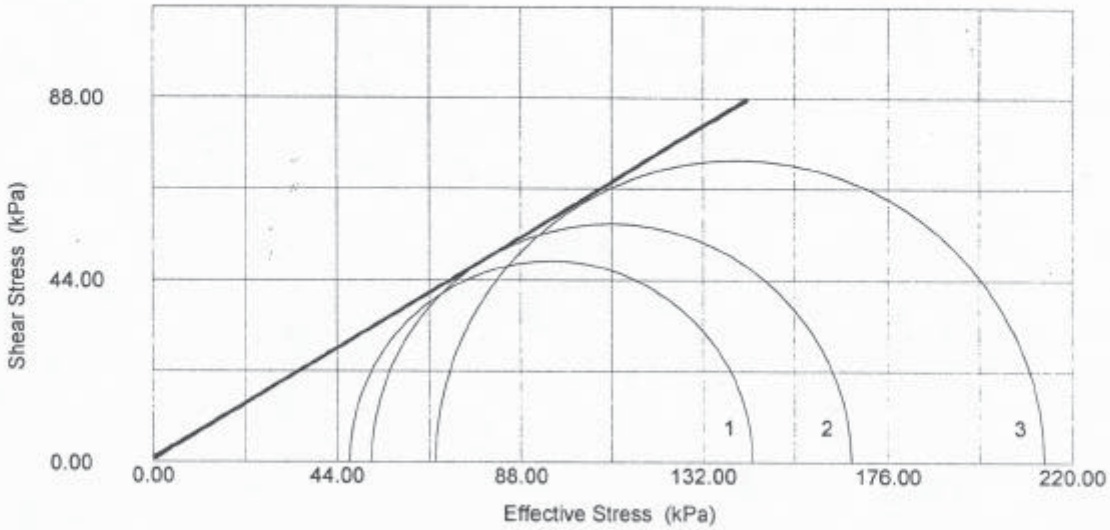
AMEC Earth & Environmental Limited

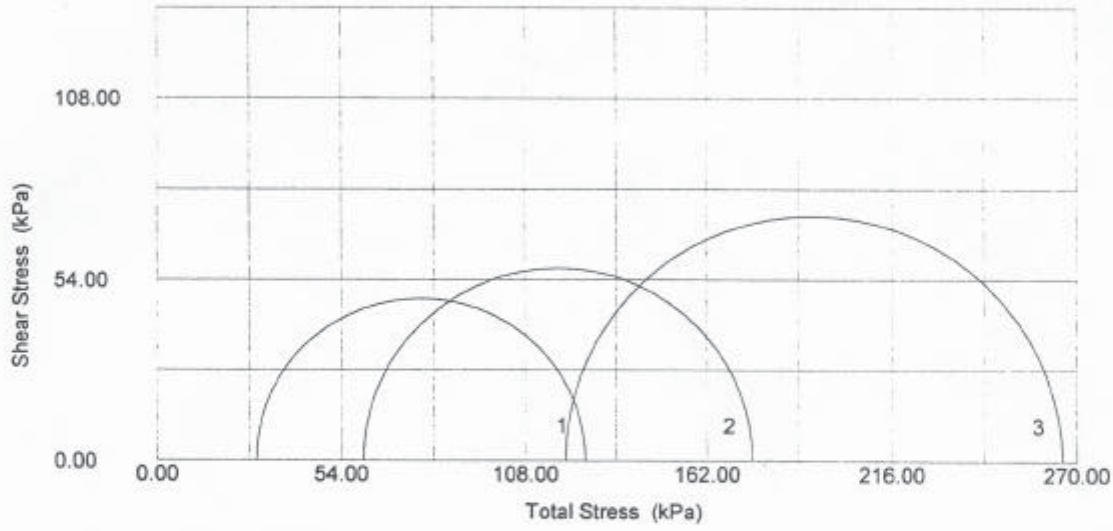
Test Method : BS1377 : Part 8 : 1990 : 8~~8~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/24/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	20
Operator: SB	Checked: SB		Approved:

Figure B-16D

Triaxial CU Compression Shear Test – BH20-Sa6 – Mohr's Envelopes

Consolidated Undrained





AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/9* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/24/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	20
Operator: SB	Checked: SB	Approved:	

Figure B-17A

Triaxial CU Compression Shear Test – BH34-Sa4 – Test Data

Consolidated Undrained

Sample details

Sketch showing specimen location in original Sample

Depth 11.6 m
Description: Grey Silty Clay

	Specimen 1	Specimen 2	Specimen 3
Type	Shelby Tube	Shelby Tube	Shelby Tube(39/4)
Height H_0 (mm)	133.35	133.55	131.7
Diameter D_0 (mm)	69.47	69.47	69.2
Weight W_0 (gr)	1052.61	1034.7	998.47
Bulk Density ρ (Mg/m3)	2.08	2.04	2.02
Particle Density ρ_s	2.7 (assumed)	2.7 (assumed)	2.7 (assumed)

Initial Conditions

	Specimen 1	Specimen 2	Specimen 3
Cell Pressure σ_3 (kPa)	250.00	410.00	275.00
Pore Pressure u (kPa)	190.60	290.00	245.40
Machine Speed d_r(mm/min)	0.06	0.06	0.06
No. of Membranes	1	1	1
Total Thickness (mm)	0.2	0.2	0.2
Strain Channel	18	18	18
Load Channel	17	17	17
Pore P. Channel	23	23	23
Volume Channel			
Moisture Content w_0%	22	22	25
Dry Density ρ_{d0} (Mg/m3)	1.71	1.67	1.62
Voids Ratio e_0	0.58	0.62	0.67
Deg of Saturation S_0%	100.00	98.13	99.41
Final B Value	0.98	0.99	0.98

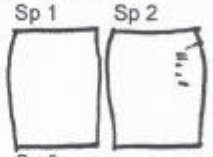
Final Conditions

	Specimen 1	Specimen 2	Specimen 3
Moisture Content w_f%	22	23	25
Dry Density ρ_d (Mg/m3)	1.74	1.70	1.66
Voids Ratio e_f	0.56	0.59	0.63
Deg of Saturation S_f%	100.00	100.00	100.00
Failure Criteria	Mx Dev Stress	Mx Dev Stress	Mx Dev Stress
Axial Strain ε_f%	11.6	3.1	15.7
Corr Dev Stress $(\sigma_1 - \sigma_3)f$ (kPa)	93.2	126.7	56.2
Minor Stress σ'_{3f} (kPa)	44.5	59.9	23.3
Major Stress σ'_{1f} (kPa)	137.7	186.6	79.5
Stress Ratio $(\sigma'_1/\sigma'_3)_f$	3.1	3.1	3.4

Notes:

Failure Sketch

Sp 1 Sp 2



Sp 3

Surface Inclination

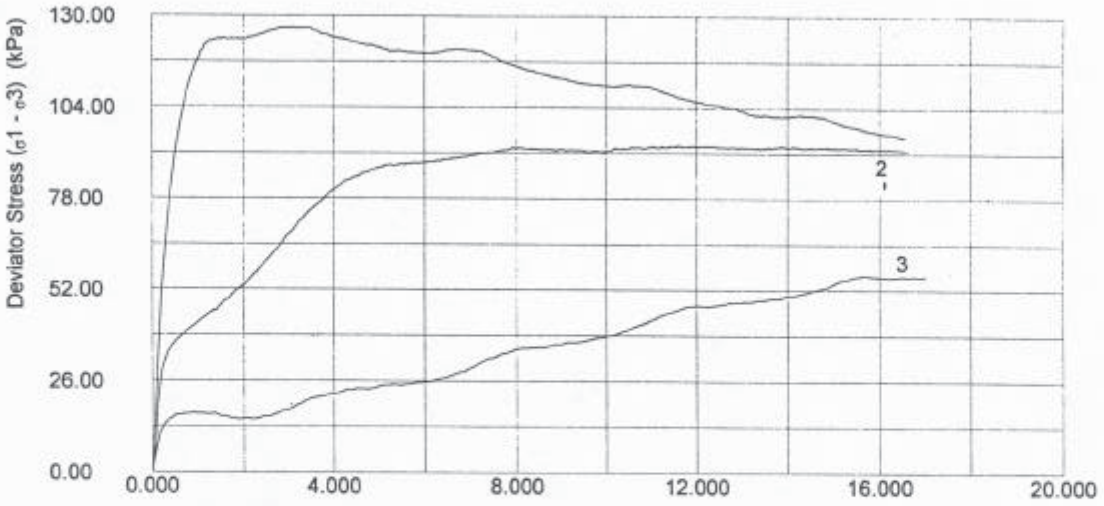
AMEC Earth & Environmental Limited

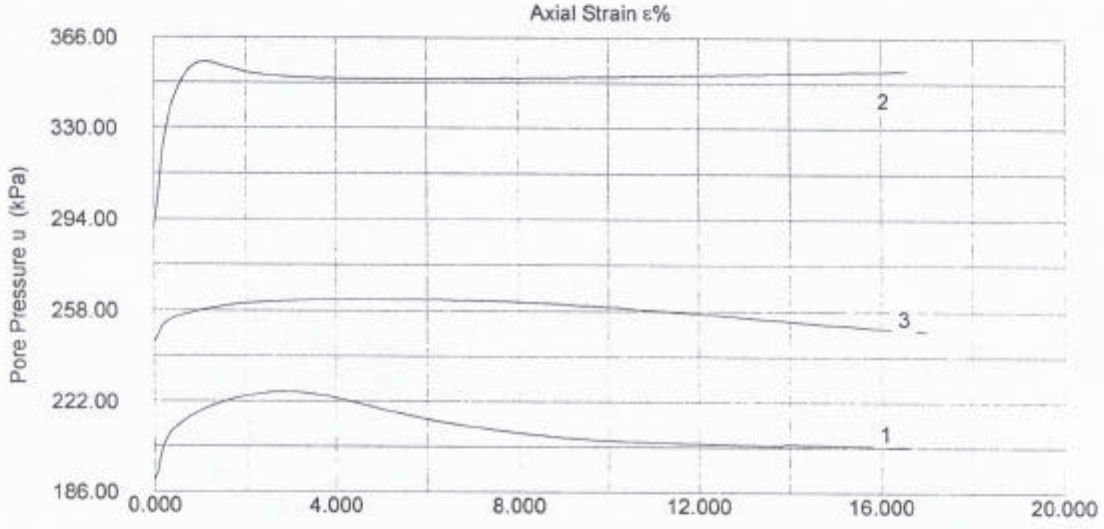
Test Method : BS1377 : Part 8 : 1990 : 8/ (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/14/2003
Site Reference:	TC035071	Sample:	SH4
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	34
Operator: SC/SB	Checked: SB	Approved:	

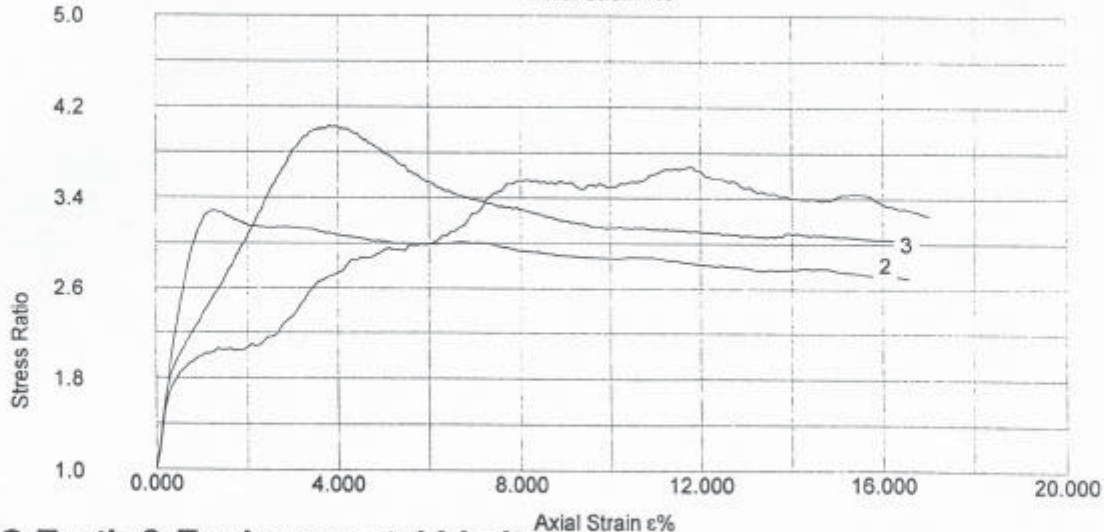
Figure B-17B

Triaxial CU Compression Shear Test – BH34-Sa4 – Stress Strain Curves

Consolidated Undrained







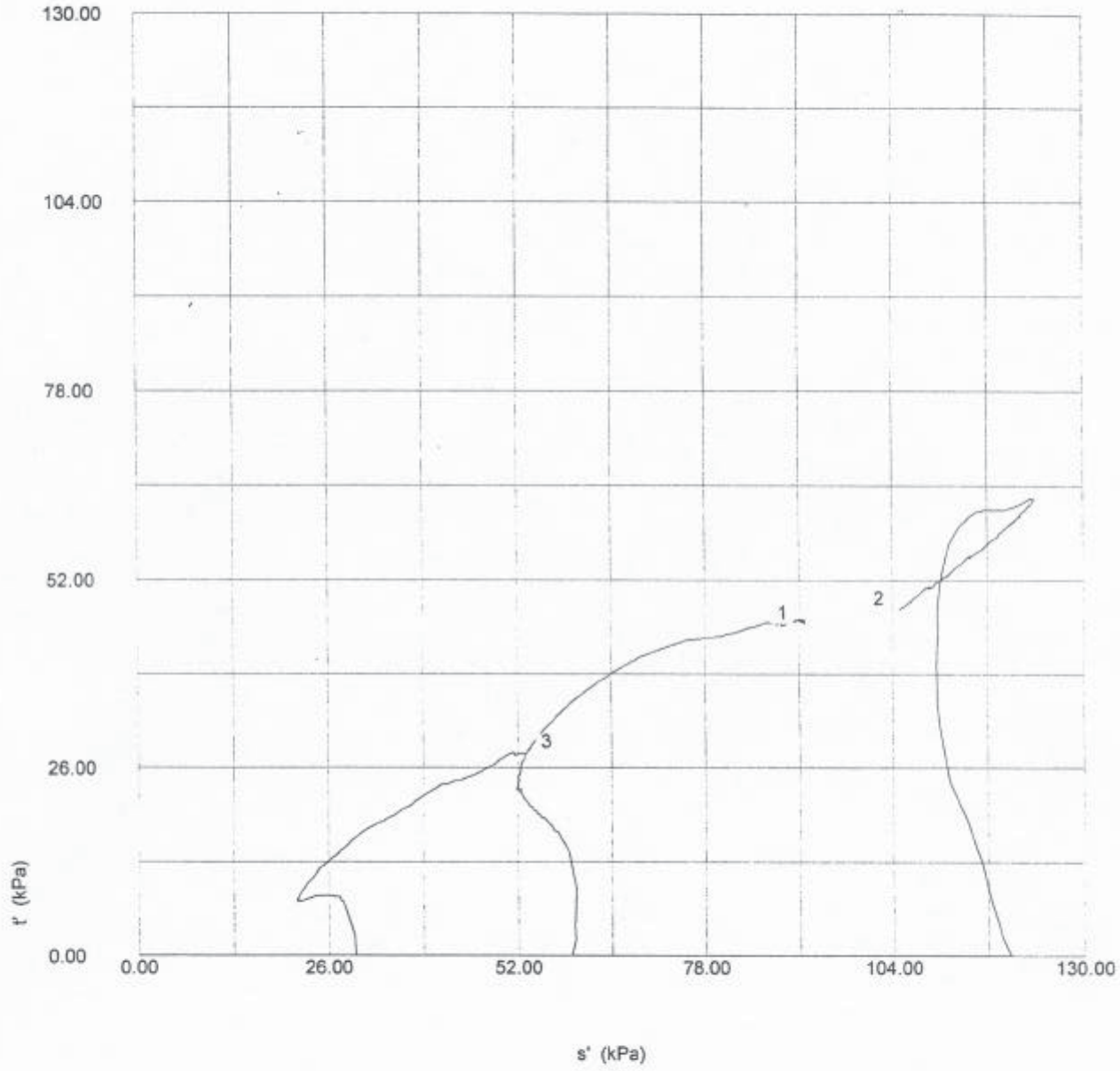
AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/9* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/14/2003
Site Reference:	TC035071	Sample:	SH4
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	34
Operator: SC/SB	Checked: SD	Approved:	

Figure B-17C

Triaxial CU Compression Shear Test – BH34-Sa4 – Stress Paths

Consolidated Undrained



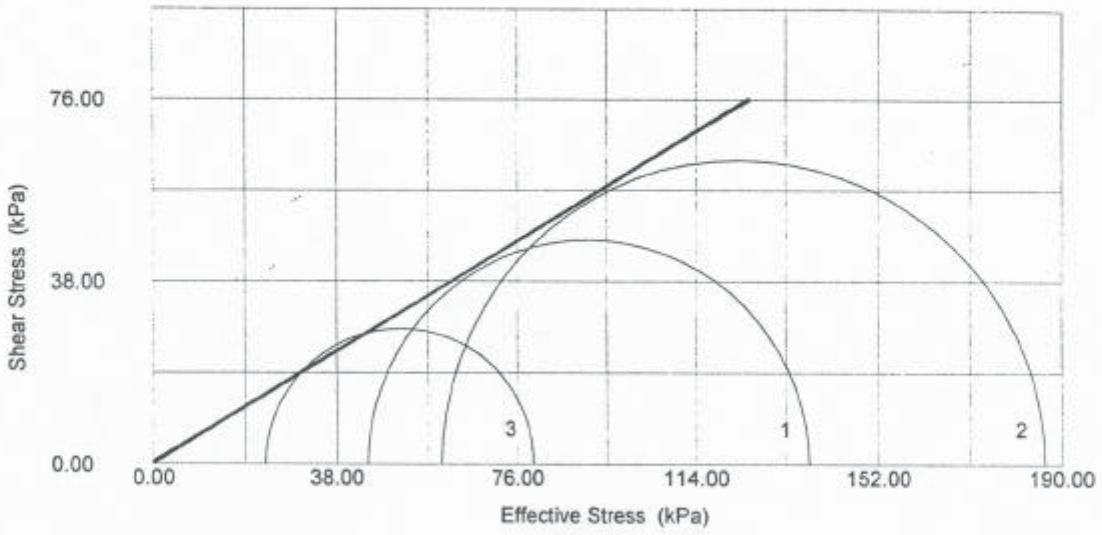
AMEC Earth & Environmental Limited

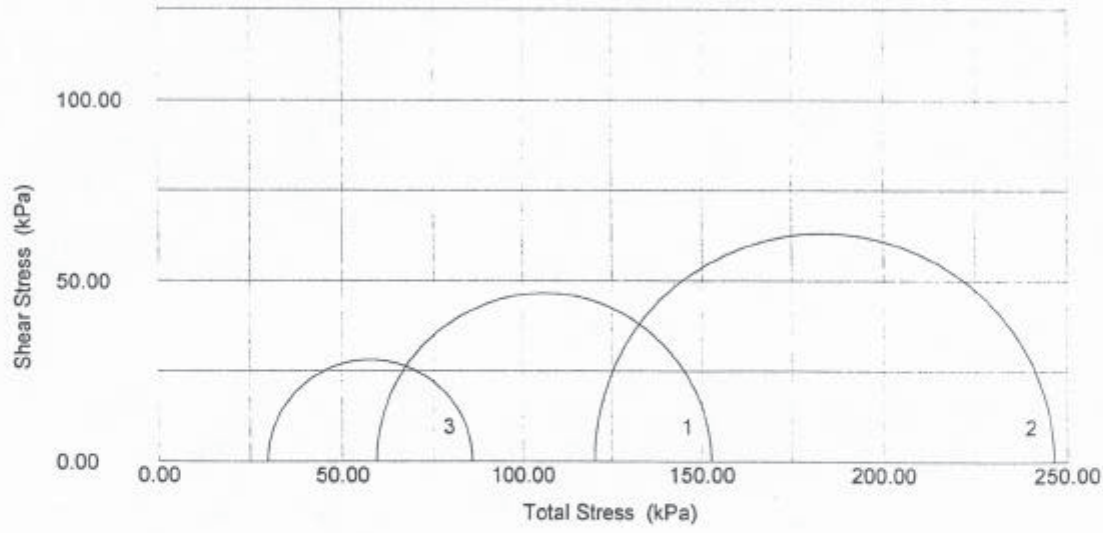
amec	Test Method : BS1377 : Part 8 : 1990 : 8/~~β~~* (* delete as appropriate)	Test name	CU (SS, MS)
		Date of Test:	11/14/2003
	Site Reference: TC035071	Sample:	SH4
	Jobfile: C:\WINCLISP\RANDLE.JOB	Borehole:	34
	Operator: Sa / ~~SA~~	Checked: ~~SA~~	Approved:

Figure B-17D

Triaxial CU Compression Shear Test – BH34-Sa4 – Mohr's Envelopes

Consolidated Undrained





AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/9* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/14/2003
Site Reference:	TC035071	Sample:	SH4
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	34
Operator: SC/SB	Checked: SB	Approved:	

Figure B-18A

Triaxial CU Compression Shear Test – BH35-Sa8 – Test Data

Consolidated Undrained

Sample details

Sketch showing specimen location in original Sample

Depth 16.0 m
Description: Grey Silty Clay

	Specimen 1	Specimen 2	Specimen 3
Type	Shelby Tube	Shelby Tube	Shelby Tube
Height H_0 (mm)	127.7	135.29	137.16
Diameter D_0 (mm)	69.4	69.09	69.09
Weight W_0 (gr)	981.33	1073.89	1102.35
Bulk Density ρ (Mg/m3)	2.03	2.12	2.14
Particle Density ρ_s	2.7 (assumed)	2.7 (assumed)	2.7 (assumed)

Initial Conditions

	Specimen 1	Specimen 2	Specimen 3
Cell Pressure σ_3 (kPa)	320.00	299.00	360.00
Pore Pressure u (kPa)	288.00	239.00	239.40
Machine Speed d_r(mm/min)	0.06	0.06	0.04
No. of Membranes	1	1	1
Total Thickness (mm)	0.2	0.2	0.2
Strain Channel	18	18	18
Load Channel	17	17	17
Pore P. Channel	19	23	19
Volume Channel	20	24	20
Moisture Content w_0%	24	23	20
Dry Density ρ_{d0} (Mg/m3)	1.64	1.72	1.78
Voids Ratio e_0	0.65	0.57	0.51
Deg of Saturation S_0%	100.00	100.00	100.00
Final B Value	0.98	0.98	0.98

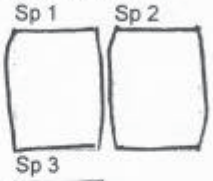
Final Conditions

	Specimen 1	Specimen 2	Specimen 3
Moisture Content w_f%	24	22	19
Dry Density ρ_d (Mg/m3)	1.65	1.75	1.84
Voids Ratio e_f	0.64	0.54	0.47
Deg of Saturation S_f%	100.00	100.00	100.00
Failure Criteria	Mx Dev Stress	Mx Dev Stress	Mx Dev Stress
Axial Strain ε_f%	15.9	15.1	15.6
Corr Dev Stress $(\sigma_1 - \sigma_3)f$ (kPa)	87.7	124.5	174.1
Minor Stress σ'_{3f} (kPa)	41.8	52.3	77.2
Major Stress σ'_{1f} (kPa)	129.5	176.8	251.3
Stress Ratio $(\sigma'_1/\sigma'_3)_f$	3.1	3.4	3.3

Notes:

Failure Sketch

Sp 1 Sp 2



Sp 3

Surface Inclination

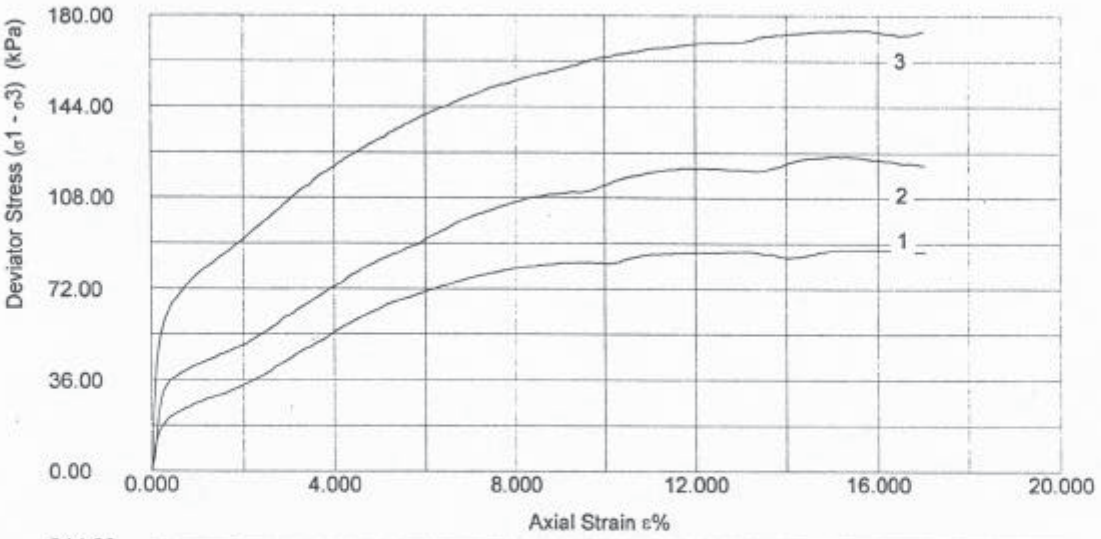
AMEC Earth & Environmental Limited

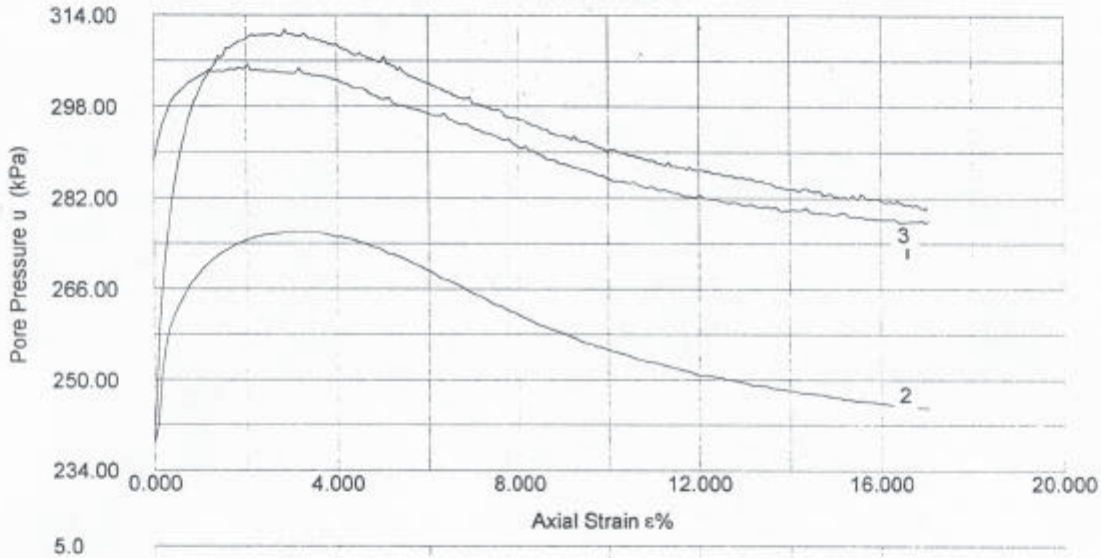
Test Method : BS1377 : Part 8 : 1990 : 8/9* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/28/2003
Site Reference:	TC035071	Sample:	SH8
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	35
Operator: SB	*Checked:* SB	*Approved:*	

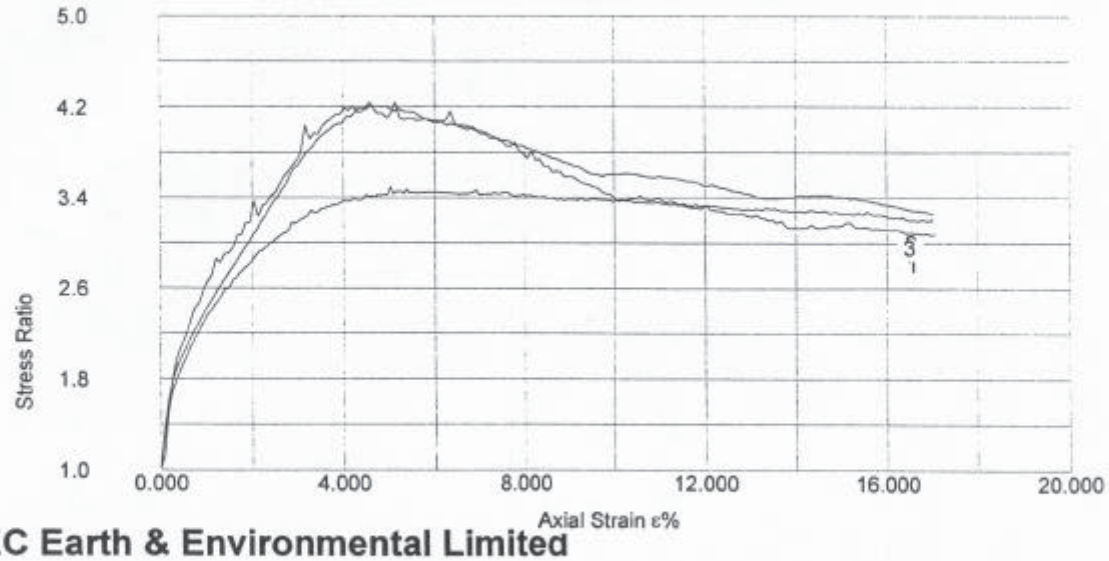
Figure B-18B

Triaxial CU Compression Shear Test – BH35-Sa8 – Stress Strain Curves

Consolidated Undrained







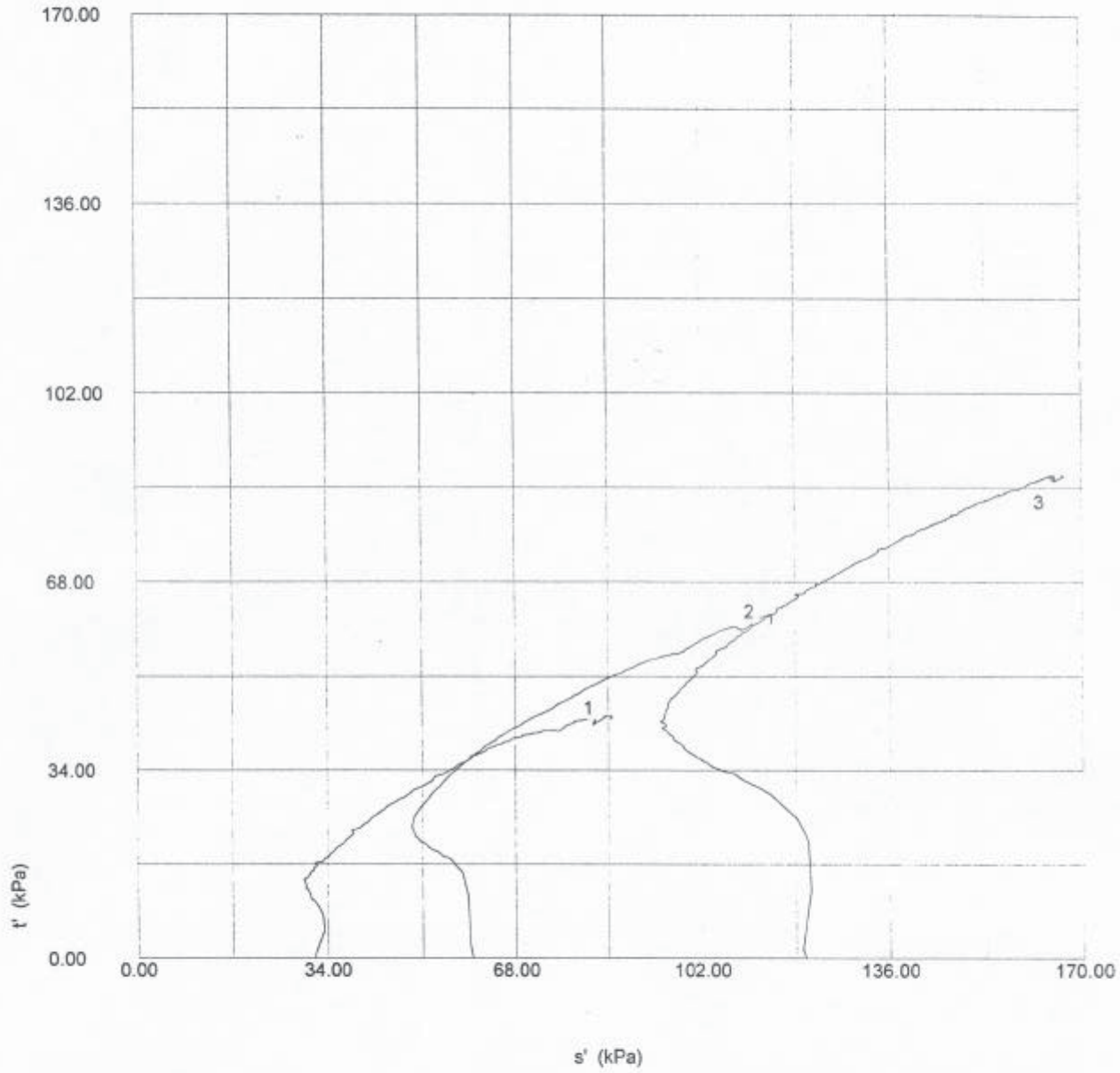
AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8~~6~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/28/2003
Site Reference:	TC035071	Sample:	SH8
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	35
Operator: SB	Checked: SB	Approved:	

Figure B-18C

Triaxial CU Compression Shear Test – BH35-Sa8 – Stress Paths

Consolidated Undrained



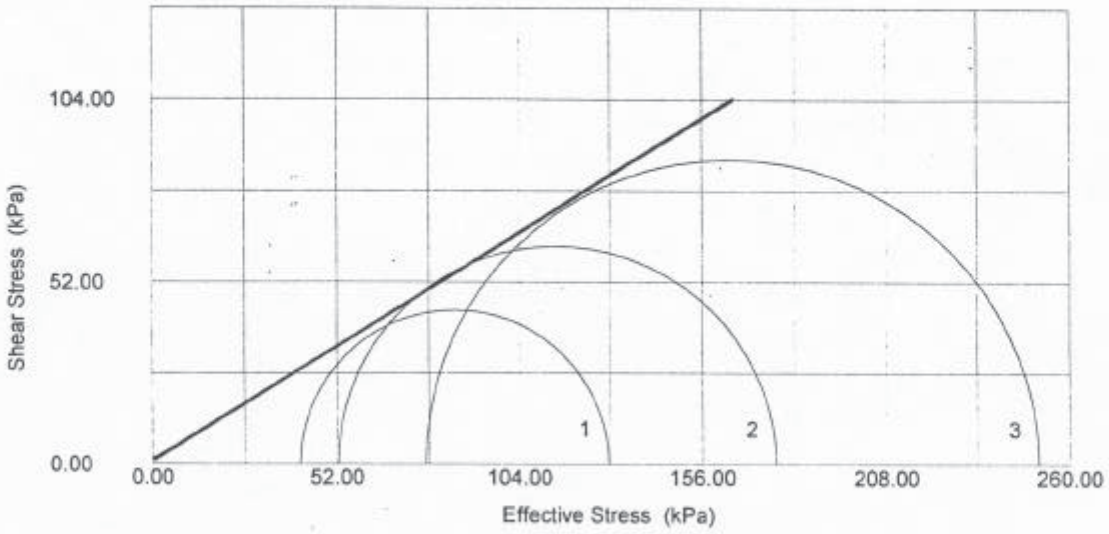
AMEC Earth & Environmental Limited

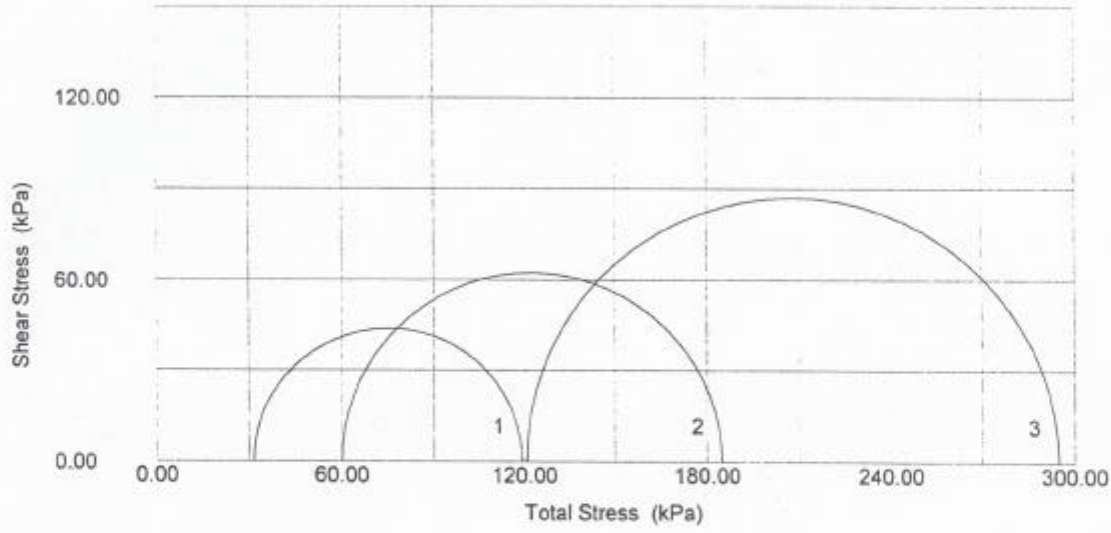
Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/28/2008
Site Reference:	TC035071	Sample:	SH8
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	35
Operator: SB	Checked: SA	Approved:	

Figure B-18D

Triaxial CU Compression Shear Test – BH35-Sa8 – Mohr's Envelopes

Consolidated Undrained





AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/28/2003
Site Reference:	TC035071	Sample:	SH8
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	35
Operator: SM	Checked: SA	Approved:	

Triaxial CU Compression Shear Test – BH36-Sa6 – Test Data

Consolidated Undrained

Sample details

Sketch showing specimen location in original Sample

Depth 11.3 m
Description: Grey Silty Clay trace gravel

	Specimen 1	Specimen 2	Specimen 3
Type	Shelby Tube	Shelby Tube	Shelby Tube
Height H_0 (mm)	132.82	132.68	134.8
Diameter D_0 (mm)	69.62	69.6569	69.8
Weight W_0 (gr)	1058.77	1062.28	1072.38
Bulk Density ρ (Mg/m3)	2.09	2.10	2.08
Particle Density ρ_s	2.7 (assumed)	2.7 (assumed)	2.7 (assumed)

Initial Conditions

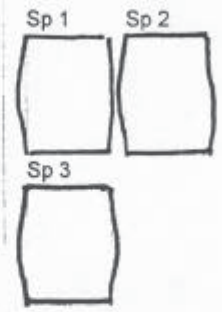
	Specimen 1	Specimen 2	Specimen 3
Cell Pressure σ_3 (kPa)	220.00	300.00	360.00
Pore Pressure u (kPa)	190.40	240.00	240.00
Machine Speed d_r(mm/min)	0.04	0.05	0.05
No. of Membranes	1	1	1
Total Thickness (mm)	0.2	0.2	0.2
Strain Channel	18	18	18
Load Channel	17	17	17
Pore P. Channel	23	19	23
Volume Channel		20	
Moisture Content w_0%	22	22	23
Dry Density ρ_{d0} (Mg/m3)	1.72	1.72	1.69
Voids Ratio e_0	0.57	0.57	0.59
Deg of Saturation S_0%	100.00	100.00	100.00
Final B Value	1.00	1.00	0.99

Final Conditions

	Specimen 1	Specimen 2	Specimen 3
Moisture Content w_f%	21	21	27
Dry Density ρ_d (Mg/m3)	1.74	1.77	1.67
Voids Ratio e_f	0.55	0.53	0.62
Deg of Saturation S_f%	100.00	100.00	100.00
Failure Criteria	Mx Dev Stress	Mx Dev Stress	Mx Dev Stress
Axial Strain ε_f%	15.3	10.6	7.7
Corr Dev Stress $(\sigma_1 - \sigma_3)f$ (kPa)	96.2	127.0	148.3
Minor Stress σ'_{3f} (kPa)	43.1	60.0	71.0
Major Stress σ'_{1f} (kPa)	139.3	187.0	219.3
Stress Ratio $(\sigma'_1/\sigma_3)_f$	3.2	3.1	3.1

Notes:

Failure Sketch



Surface Inclination

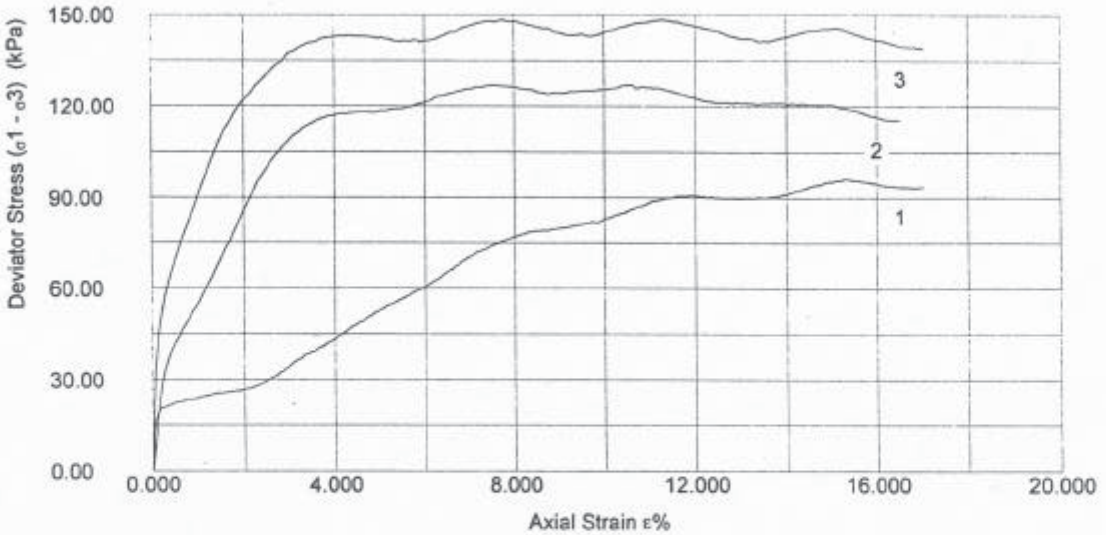
AMEC Earth & Environmental Limited

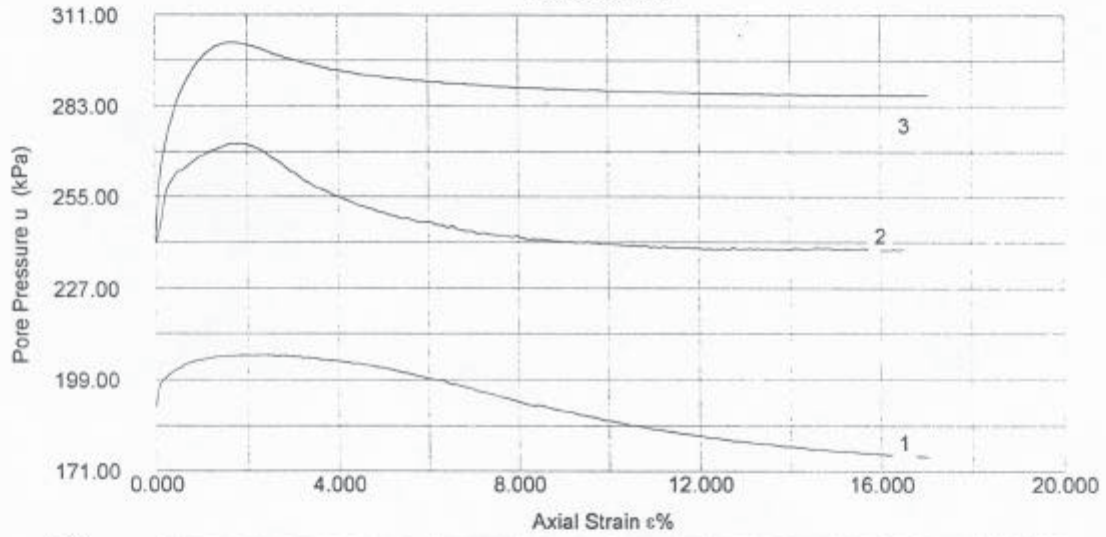
Test Method : BS1377 : Part 8 : 1990 : 8/~~8~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/20/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	36
Operator: SB	*Checked:* SB		*Approved:*

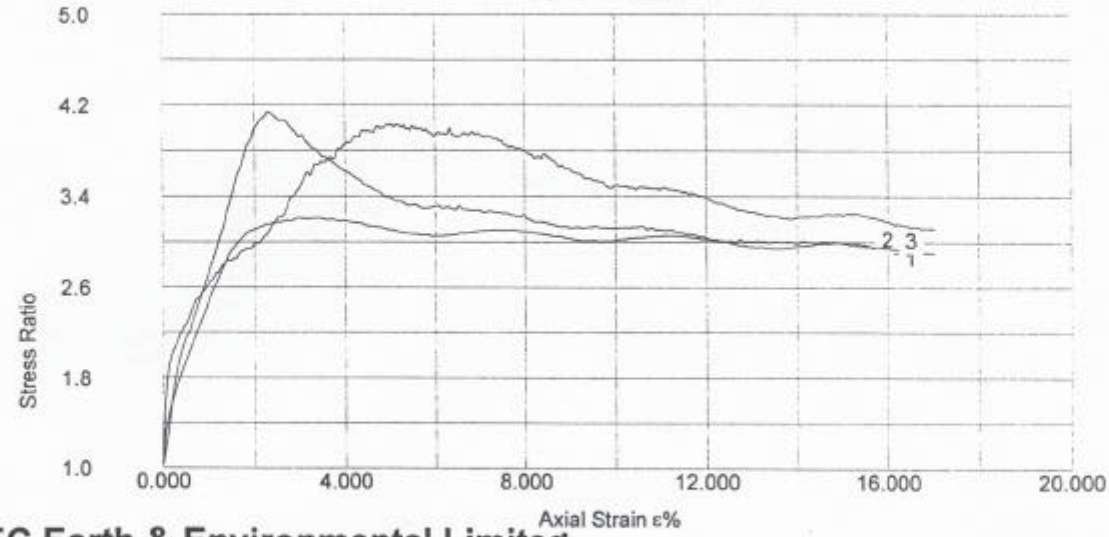
Figure B-19B

Triaxial CU Compression Shear Test – BH36-Sa6 – Stress Strain Curves

Consolidated Undrained







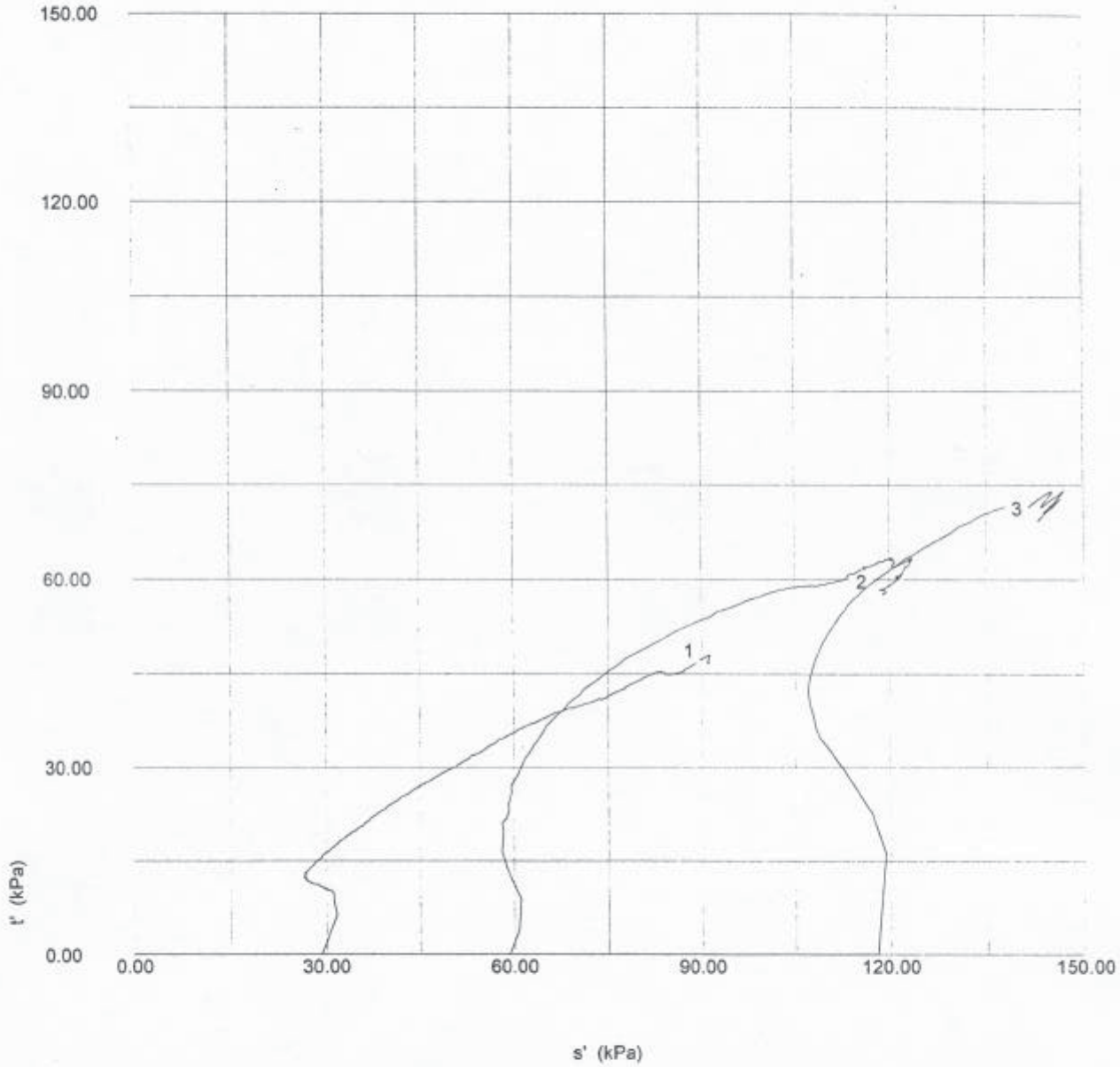
AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/20/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	36
Operator: SB	*Checked:* SB		*Approved:*

Figure B-19C

Triaxial CU Compression Shear Test – BH36-Sa6 – Stress Paths

Consolidated Undrained



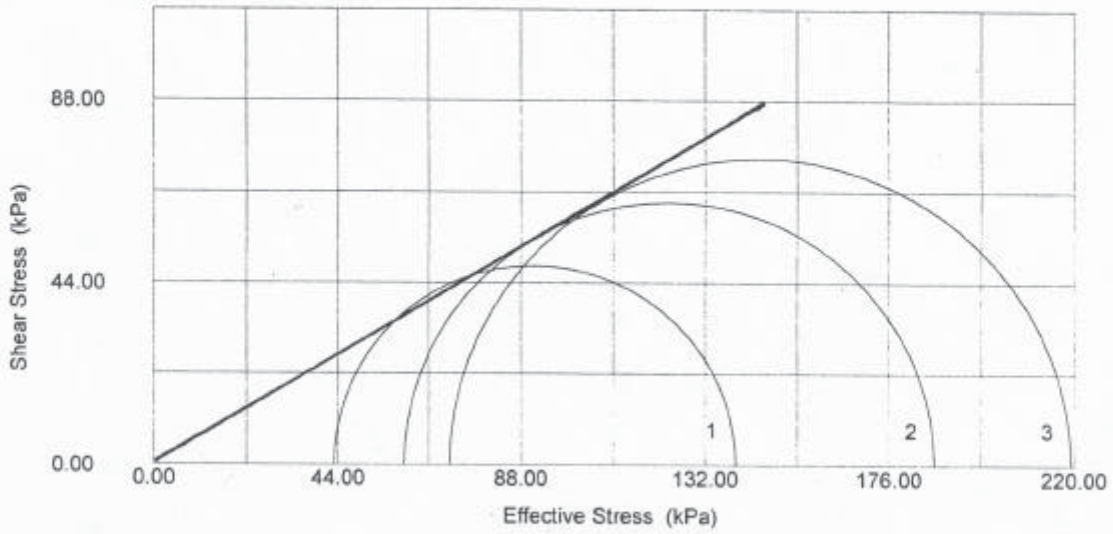
AMEC Earth & Environmental Limited

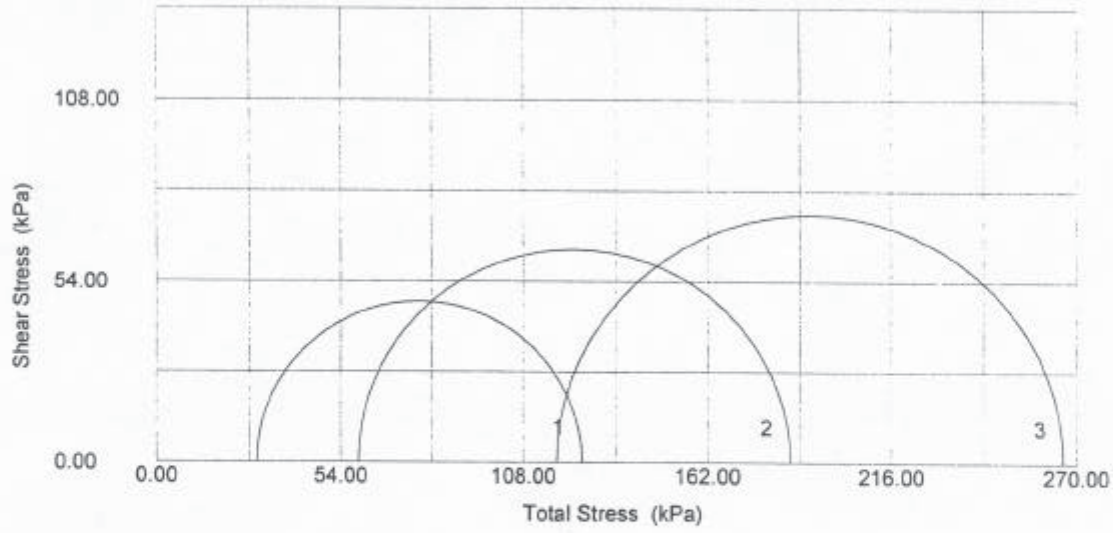
Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/20/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	36
Operator: SB	Checked: SB	Approved:	

Figure B-19D

Triaxial CU Compression Shear Test – BH36-Sa6 – Mohr's Envelopes

Consolidated Undrained





AMEC Earth & Environmental Limited

Test Method : BS1377 : Part 8 : 1990 : 8/~~9~~* (* delete as appropriate)		Test name	CU (SS, MS)
		Date of Test:	11/20/2003
Site Reference:	TC035071	Sample:	SH6
Jobfile:	C:\WINCLISP\RANDLE.JOB	Borehole:	36
Operator: SB	Checked: SA	Approved:	

APPENDIX C – FLAT PLATE DILATOMETER TEST (DMT) RESULTS

DMT-1 Results Near Borehole 33

Project: TC035071 Randle Reef

DMT #33

Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6 m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.24
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62 m
U -	Pore Pressure	kPa	q -	PC - PO	kPa		
Id -	Material Index		CU -	Undrained Cohesion	kPa		
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg		

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
64.0	3.0	3.8	16.8	11.6	103.8	0.4	16.5	2.7	8.0	2.5	26.9	35.6		Silty Clay	Firm
63.8	3.6	4.5	16.9	13.0	105.8	0.3	19.0	3.0	9.5	2.7	33.6	47.8		Silty Clay	Firm
63.6	3.8	4.6	16.9	14.4	107.7	0.3	18.4	2.7	8.3	2.7	32.0	50.9		Clay	Stiff
63.4	4.0	4.8	16.9	15.8	109.7	0.3	17.9	2.7	8.2	2.6	30.5	53.9		Clay	Stiff
63.2	4.2	5.0	16.9	17.2	111.6	0.2	17.5	2.7	8.2	2.6	29.4	56.9		Clay	Stiff
63.0	4.4	5.4	17.0	18.7	113.6	0.3	17.0	3.4	10.3	2.5	28.2	59.6		Silty Clay	Stiff
62.8	4.7	5.6	17.0	20.1	115.6	0.2	17.2	3.0	9.2	2.5	28.6	65.0		Clay	Stiff
62.6	4.7	5.6	17.0	21.5	117.5	0.2	15.9	3.0	9.0	2.4	25.5	63.5		Clay	Stiff
62.4	4.8	5.6	16.9	23.0	119.5	0.2	15.3	2.7	7.8	2.4	23.9	64.4		Clay	Stiff
62.2	4.9	5.6	16.8	24.4	121.4	0.2	14.8	2.3	6.6	2.3	22.6	65.3		Clay	Stiff
62.0	5.2	6.0	16.9	25.8	123.4	0.2	15.0	2.7	7.7	2.4	23.2	70.5		Clay	Stiff
61.8	5.3	6.1	16.9	27.2	125.4	0.2	14.5	2.7	7.7	2.3	22.0	71.3		Clay	Stiff
61.6	5.1	5.6	16.7	28.6	127.3	0.1	13.1	1.6	4.3	2.2	18.8	66.0		Clay	Stiff
61.4	5.1	5.5	16.6	29.9	129.3	0.1	12.5	1.2	3.3	2.1	17.4	64.9		Clay	Stiff
61.2	5.0	5.4	16.6	31.3	131.3	0.1	11.6	1.2	3.2	2.0	15.4	61.6		Clay	Stiff
61.0	5.4	6.4	17.1	32.7	133.2	0.2	12.1	3.4	9.1	2.1	16.6	68.3		Clay	Stiff
60.8	5.5	6.2	16.8	34.1	135.2	0.2	11.9	2.3	6.1	2.0	16.1	69.6		Clay	Stiff
60.6	6.0	7.0	17.1	35.6	137.1	0.2	12.7	3.4	9.3	2.1	17.8	78.7		Clay	Stiff
60.4	6.4	7.3	17.0	37.1	139.1	0.2	13.2	3.0	8.4	2.2	19.0	86.1		Clay	Stiff
60.2	6.5	7.6	17.2	38.5	141.1	0.2	12.9	3.7	10.3	2.1	18.2	86.8		Clay	Stiff
60.0	6.9	8.1	17.3	40.0	143.0	0.2	13.3	4.1	11.5	2.2	19.2	94.0		Clay	Stiff
59.8	7.2	8.6	17.5	41.6	145.0	0.2	13.4	4.8	13.6	2.2	19.5	99.0		Clay	Stiff
59.6	7.0	8.4	17.4	43.1	147.0	0.3	12.5	4.8	13.2	2.1	17.4	93.4		Clay	Stiff
59.4	6.8	7.9	17.2	44.6	148.9	0.2	11.6	3.7	9.9	2.0	15.5	88.3		Clay	Stiff
59.2	6.8	7.9	17.2	46.0	150.9	0.2	11.2	3.7	9.8	2.0	14.7	87.1		Clay	Stiff
59.0	6.6	7.6	17.1	47.5	152.8	0.2	10.4	3.4	8.6	1.9	13.1	82.1		Clay	Stiff
58.8	6.6	7.5	17.0	48.9	154.8	0.2	10.1	3.0	7.6	1.8	12.4	81.1		Clay	Stiff
58.6	6.3	7.1	16.9	50.4	156.8	0.2	9.2	2.7	6.4	1.7	10.7	74.3		Clay	Stiff

Project: TC035071 Randle Reef

DMT-1 Results Near Borehole 33

DMT #33
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.24	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
58.4	6.9	8.4	17.5	51.9	158.7	0.3	9.9	5.2	13.0	1.8	12.2	84.6		Clay	Stiff
58.2	7.0	8.6	17.6	53.5	160.7	0.3	9.8	5.6	13.8	1.8	11.9	85.5		Silty Clay	Stiff
58.0	6.9	8.4	17.5	55.0	162.6	0.3	9.3	5.2	12.6	1.8	11.0	82.6		Clay	Stiff
57.8	6.9	8.4	17.5	56.5	164.6	0.3	9.0	5.2	12.4	1.7	10.5	81.6		Clay	Stiff
57.6	7.3	9.1	17.7	58.1	166.6	0.3	9.4	6.3	15.3	1.8	11.1	88.2		Silty Clay	Stiff
57.4	7.3	9.1	17.7	59.7	168.5	0.3	9.1	6.3	15.1	1.7	10.6	87.3		Silty Clay	Stiff
57.2	7.5	9.4	17.8	61.3	170.5	0.3	9.1	6.7	16.0	1.7	10.7	90.1		Silty Clay	Stiff
57.0	7.6	9.3	17.7	62.9	172.5	0.3	9.1	5.9	14.2	1.7	10.5	91.3		Clay	Stiff
56.8	7.7	9.6	17.8	64.5	174.4	0.3	8.9	6.7	15.9	1.7	10.3	92.1		Silty Clay	Stiff
56.6	8.0	9.9	17.8	66.1	176.4	0.3	9.1	6.7	16.0	1.7	10.7	97.1		Silty Clay	Stiff
56.4	7.4	8.3	17.1	67.5	178.3	0.2	8.1	3.0	6.9	1.6	8.9	85.4		Clay	Stiff
56.2	7.1	7.5	16.6	68.9	180.3	0.1	7.5	1.2	2.7	1.5	7.9	79.4		Clay	Stiff
56.0	8.2	11.6	18.6	70.6	182.3	0.5	8.8	11.8	27.8	1.7	10.1	98.8		Silty Clay	Stiff
55.8	6.9	9.6	18.1	72.3	184.2	0.5	6.8	9.2	19.4	1.4	6.8	73.9		Silty Clay	Stiff
55.6	7.5	10.1	18.1	74.0	186.2	0.5	7.5	8.8	19.4	1.5	7.8	84.3		Silty Clay	Stiff
55.4	7.8	10.6	18.3	75.6	188.2	0.5	7.6	9.6	21.3	1.5	8.1	88.9		Silty Clay	Stiff
55.2	8.4	11.3	18.4	77.4	190.1	0.4	8.2	9.9	22.8	1.6	9.0	99.3		Silty Clay	Stiff
55.0	9.2	12.9	18.9	79.2	192.1	0.5	8.9	12.8	30.6	1.7	10.3	113.1		Silty Clay	Very Stiff
54.8	10.1	14.1	19.1	81.0	194.0	0.5	9.8	13.9	34.5	1.8	11.9	129.6		Silty Clay	Very Stiff
54.6	10.0	14.6	19.4	83.0	196.0	0.6	9.5	15.8	38.5	1.8	11.4	128.0		Silty Clay	Very Stiff
54.4	10.0	14.6	19.4	84.9	198.0	0.6	9.3	15.8	38.1	1.8	10.9	126.8		Silty Clay	Very Stiff
54.2	10.0	15.1	19.6	86.8	199.9	0.6	9.0	17.6	42.0	1.7	10.5	125.3		Clayey Silt	Very Stiff
54.0	9.5	14.1	19.3	88.7	201.9	0.6	8.3	15.8	36.3	1.6	9.1	115.0		Clayey Silt	Very Stiff
53.8	10.0	15.1	19.6	90.7	203.9	0.6	8.6	17.6	41.2	1.7	9.7	123.1		Clayey Silt	Very Stiff
53.6	10.0	14.6	19.3	92.6	205.8	0.6	8.4	15.8	36.6	1.6	9.4	122.6		Silty Clay	Very Stiff
53.4	10.2	14.6	19.3	94.5	207.8	0.5	8.4	15.0	34.9	1.7	9.4	125.6		Silty Clay	Very Stiff
53.2	9.6	13.6	19.0	96.3	209.7	0.5	7.6	13.9	30.8	1.5	8.0	111.6		Silty Clay	Very Stiff
53.0	10.0	14.6	19.3	98.2	211.7	0.6	7.9	15.8	35.5	1.6	8.5	119.6		Silty Clay	Very Stiff
52.8	10.0	14.3	19.2	100.1	213.7	0.5	7.7	14.7	32.7	1.6	8.2	118.9		Silty Clay	Very Stiff
52.6	9.6	13.1	18.8	101.9	215.6	0.5	7.1	12.1	26.0	1.5	7.2	109.3		Silty Clay	Very Stiff
52.4	9.1	12.8	18.8	103.7	217.6	0.5	6.5	12.8	26.4	1.4	6.3	99.2		Silty Clay	Stiff
52.2	8.8	11.6	18.3	105.4	219.5	0.4	6.1	9.6	19.1	1.3	5.7	93.8		Silty Clay	Stiff
52.0	9.4	11.9	18.2	107.1	221.5	0.3	6.6	8.5	17.5	1.4	6.4	104.1		Silty Clay	Very Stiff
51.8	9.3	14.6	19.5	109.0	223.5	0.8	6.3	18.3	37.2	1.4	6.0	101.0		Clayey Silt	Very Stiff
51.6	9.1	14.1	19.3	110.9	225.4	0.7	6.0	17.2	34.2	1.3	5.6	96.9		Clayey Silt	Stiff
51.4	9.7	13.8	19.1	112.8	227.4	0.6	6.4	14.3	29.2	1.4	6.1	105.7		Silty Clay	Very Stiff
51.2	9.8	14.1	19.2	114.6	229.4	0.6	6.4	14.7	30.0	1.4	6.2	108.4		Silty Clay	Very Stiff
51.0	9.5	14.6	19.4	116.6	231.3	0.7	6.0	17.6	34.8	1.3	5.6	101.6		Clayey Silt	Very Stiff
50.8	10.5	15.1	19.4	118.5	233.3	0.6	6.8	15.8	33.0	1.4	6.7	119.2		Silty Clay	Very Stiff
50.6	10.5	15.1	19.4	120.4	235.2	0.6	6.6	15.8	32.7	1.4	6.5	118.4		Silty Clay	Very Stiff
50.4	10.6	14.4	19.0	122.2	237.2	0.5	6.5	13.2	27.3	1.4	6.3	118.2		Silty Clay	Very Stiff
50.2	7.9	11.6	18.6	124.0	239.2	0.7	4.3	12.8	21.0	1.0	3.3	71.0		Clayey Silt	Stiff
50.0	9.7	22.1	21.0	126.2	241.1	1.7	5.6	43.0	83.9	1.3	9.0		29	Sandy Silt	Dense
49.8	9.3	12.6	18.6	128.0	243.1	0.5	5.2	11.4	20.9	1.2	4.5	93.4		Silty Clay	Stiff
49.6	9.4	12.3	18.4	129.7	245.1	0.4	5.2	9.9	18.2	1.2	4.5	94.8		Silty Clay	Stiff
49.4	9.1	12.1	18.5	131.4	247.0	0.5	4.9	10.3	18.2	1.1	4.1	89.0		Silty Clay	Stiff
49.2	9.1	11.6	18.2	133.1	249.0	0.4	4.9	8.5	14.9	1.1	4.0	88.7		Silty Clay	Stiff
49.0	9.6	12.6	18.5	134.8	250.9	0.4	5.1	10.3	18.7	1.2	4.3	96.2		Silty Clay	Stiff
48.8	9.5	12.3	18.4	136.6	252.9	0.4	5.0	9.6	17.1	1.2	4.2	94.0		Silty Clay	Stiff
48.6	9.5	12.3	18.4	138.3	254.9	0.4	4.9	9.6	16.9	1.1	4.1	93.4		Silty Clay	Stiff
48.4	9.2	11.8	18.2	140.0	256.8	0.4	4.6	8.8	15.1	1.1	3.7	87.9		Silty Clay	Stiff
48.2	9.4	11.9	18.2	141.6	258.8	0.4	4.7	8.5	14.6	1.1	3.8	90.7		Silty Clay	Stiff
48.0	9.3	11.6	18.1	143.3	260.7	0.3	4.6	7.7	13.2	1.1	3.6	88.6		Silty Clay	Stiff
47.8	9.1	11.4	18.0	144.9	262.7	0.3	4.4	7.7	12.8	1.1	3.4	84.7		Silty Clay	Stiff
47.6	8.3	10.6	18.0	146.6	264.7	0.4	3.8	7.7	11.6	0.9	2.7	71.3		Silty Clay	Stiff
47.4	10.1	12.3	18.0	148.2	266.6	0.3	4.9	7.4	13.1	1.1	4.1	100.3		Clay	Very Stiff
47.2	9.3	11.6	18.1	149.9	268.6	0.3	4.3	7.7	12.7	1.0	3.3	86.3		Silty Clay	Stiff
47.0	9.2	11.6	18.1	151.5	270.6	0.4	4.2	8.1	13.0	1.0	3.2	84.0		Silty Clay	Stiff
46.8	9.2	11.6	18.1	153.2	272.5	0.4	4.1	8.1	12.9	1.0	3.1	83.5		Silty Clay	Stiff
46.6	9.3	11.6	18.0	154.8	274.5	0.3	4.1	7.7	12.4	1.0	3.1	84.6		Silty Clay	Stiff

DMT-1 Results Near Borehole 33

Project: TC035071 Randle Reef

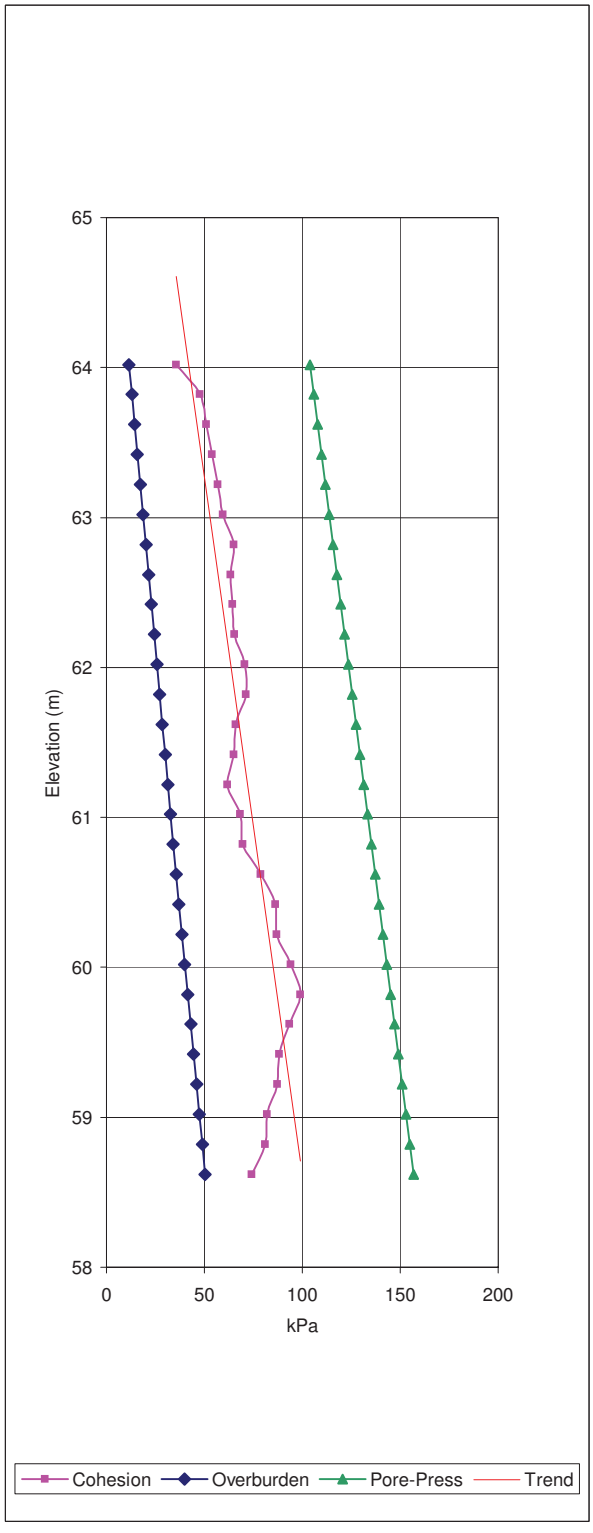
DMT #33

Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.24	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
46.4	9.6	12.1	18.2	156.5	276.4	0.4	4.3	8.5	13.8	1.0	3.3	88.8		Silty Clay	Stiff
46.2	9.8	12.8	18.5	158.2	278.4	0.4	4.3	10.3	16.9	1.0	3.3	91.1		Silty Clay	Stiff
46.0	10.6	13.3	18.4	160.0	280.4	0.3	4.8	9.2	16.0	1.1	3.9	104.0		Silty Clay	Very Stiff
45.8	10.6	13.6	18.6	161.7	282.3	0.4	4.7	10.3	17.7	1.1	3.8	103.1		Silty Clay	Very Stiff
45.6	9.8	12.4	18.3	163.4	284.3	0.4	4.2	8.8	14.1	1.0	3.1	89.7		Silty Clay	Stiff
45.4	9.8	12.6	18.4	165.1	286.3	0.4	4.1	9.6	15.2	1.0	3.1	89.0		Silty Clay	Stiff
45.2	9.1	11.6	18.1	166.8	288.2	0.4	3.6	8.5	12.4	0.9	2.5	77.6		Silty Clay	Stiff
45.0	10.1	12.9	18.4	168.5	290.2	0.4	4.2	9.6	15.3	1.0	3.1	92.7		Silty Clay	Stiff
44.8	10.1	12.8	18.3	170.2	292.1	0.4	4.1	9.2	14.6	1.0	3.1	92.2		Silty Clay	Stiff
44.6	10.1	12.8	18.3	171.9	294.1	0.4	4.1	9.2	14.5	1.0	3.0	91.7		Silty Clay	Stiff
44.4	10.6	13.3	18.4	173.6	296.1	0.3	4.3	9.2	15.0	1.0	3.3	99.2		Silty Clay	Stiff
44.2	10.1	13.1	18.5	175.4	298.0	0.4	4.0	10.3	15.9	1.0	2.9	90.4		Silty Clay	Stiff
44.0	10.6	13.4	18.4	177.1	300.0	0.4	4.2	9.6	15.4	1.0	3.2	98.0		Silty Clay	Stiff
43.8	10.1	12.9	18.4	178.8	302.0	0.4	3.9	9.6	14.6	1.0	2.8	89.5		Silty Clay	Stiff
43.6	10.6	13.1	18.3	180.5	303.9	0.3	4.1	8.5	13.4	1.0	3.1	97.1		Silty Clay	Stiff
43.4	10.6	13.3	18.4	182.2	305.9	0.4	4.0	9.2	14.5	1.0	3.0	96.4		Silty Clay	Stiff

DMT -1 Results Near Borehole 33



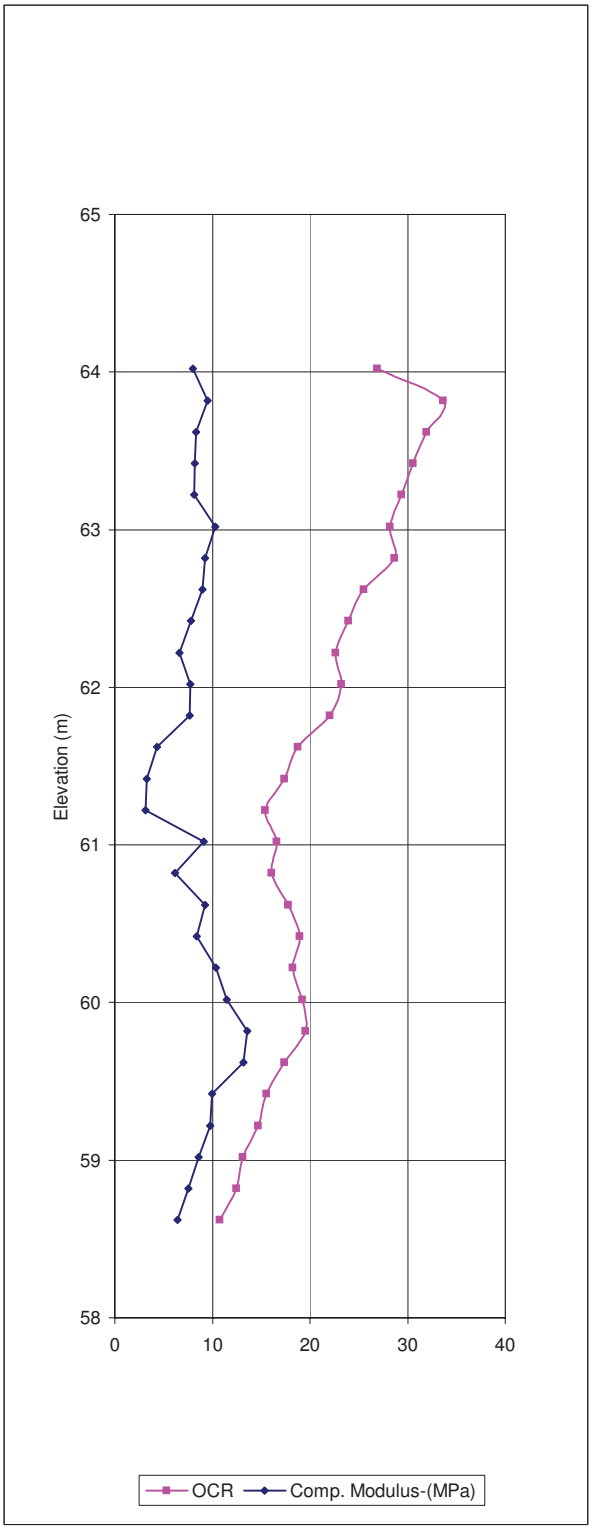


Figure C - 1B

DMT-2 Results Near Borehole 33

Project: TC035071 Randle Reef

DMT #33A
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6 m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.23
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.6 m
U -	Pore Pressure	kPa	q -	PC - PO	kPa		
Id -	Material Index		CU -	Undrained Cohesion	kPa		
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg		

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
65.4	1.0	1.0	16.2	4.0	90.1	0.0	2.3	0.0	0.0	0.6	1.2	1.0		Clay	Very Soft
65.2	1.0	1.0	16.2	5.3	92.0	0.0	1.3	0.0	0.0	0.3	0.5	0.7		Clay	Very Soft
65.0	1.0	1.3	17.2	6.8	94.0	4.2	0.9	0.9	0.3	0.2	0.4		29	Sand	Loose
64.8	1.2	1.4	16.3	8.0	95.9	0.6	3.0	0.5	0.6	0.8	1.9	2.9		Silty Clay	Very Soft
64.6	1.2	1.3	16.2	9.3	97.9	0.2	2.4	0.1	0.2	0.7	1.3	2.6		Clay	Very Soft
64.4	1.5	1.7	16.3	10.6	99.9	0.3	4.7	0.5	0.9	1.1	3.7	6.7		Clay	Very Soft
64.2	2.0	2.5	16.5	12.0	101.8	0.5	7.9	1.6	3.6	1.6	8.6	14.8		Silty Clay	Soft
64.0	2.7	3.7	16.9	13.4	103.8	0.6	11.9	3.4	9.2	2.0	16.2	27.4		Clayey Silt	Firm
63.8	2.3	3.3	16.8	14.8	105.8	0.8	8.0	3.4	7.8	1.6	8.7	18.4		Silty Sand	Soft
63.6	2.9	3.6	16.7	16.2	107.7	0.4	10.9	2.3	6.0	1.9	14.1	29.7		Silty Clay	Firm
63.4	3.1	4.0	16.9	17.6	109.7	0.4	11.0	3.1	7.9	2.0	14.3	32.6		Silty Clay	Firm
63.2	3.2	4.1	16.9	19.0	111.6	0.4	10.6	3.1	7.8	1.9	13.5	33.6		Silty Clay	Firm
63.0	3.3	4.2	16.9	20.4	113.6	0.4	10.2	3.1	7.7	1.9	12.8	34.6		Silty Clay	Firm
62.8	3.3	4.1	16.8	21.8	115.6	0.4	9.5	2.7	6.6	1.8	11.4	33.7		Silty Clay	Firm
62.6	3.4	4.1	16.8	23.2	117.5	0.3	9.3	2.3	5.6	1.8	11.0	34.9		Silty Clay	Firm
62.4	3.4	4.1	16.8	24.6	119.5	0.3	8.7	2.3	5.5	1.7	9.9	34.0		Silty Clay	Firm
62.2	3.4	4.0	16.7	26.0	121.4	0.3	8.2	2.0	4.5	1.6	9.0	33.2		Clay	Firm
62.0	3.6	4.3	16.8	27.4	123.4	0.3	8.4	2.3	5.4	1.6	9.4	36.1		Clay	Firm
61.8	3.7	4.4	16.8	28.8	125.4	0.3	8.3	2.3	5.4	1.6	9.1	37.2		Clay	Firm
61.6	3.7	4.4	16.8	30.2	127.3	0.3	7.8	2.3	5.2	1.6	8.4	36.4		Clay	Firm
61.4	3.4	4.2	16.8	31.6	129.3	0.4	6.4	2.7	5.5	1.4	6.2	30.0		Silty Clay	Firm
61.2	4.2	4.9	16.8	33.0	131.3	0.2	8.5	2.3	5.4	1.7	9.6	44.3		Clay	Firm
61.0	4.7	5.6	17.0	34.4	133.2	0.3	9.5	3.1	7.5	1.8	11.4	53.0		Clay	Stiff
60.8	5.2	6.2	17.1	35.9	135.2	0.3	10.4	3.4	8.7	1.9	13.1	62.0		Clay	Stiff
60.6	5.8	6.9	17.2	37.3	137.1	0.2	11.5	3.8	10.0	2.0	15.3	73.2		Clay	Stiff
60.4	6.1	7.2	17.2	38.8	139.1	0.2	11.8	3.8	10.1	2.0	15.9	78.3		Clay	Stiff
60.2	6.3	7.7	17.4	40.3	141.1	0.3	11.7	4.9	13.0	2.0	15.8	81.1		Clay	Stiff
60.0	6.4	7.9	17.5	41.9	143.0	0.3	11.5	5.2	13.8	2.0	15.3	81.9		Silty Clay	Stiff
59.8	6.5	7.9	17.4	43.4	145.0	0.3	11.3	4.9	12.8	2.0	14.8	82.9		Clay	Stiff
59.6	6.7	7.9	17.3	44.9	147.0	0.2	11.3	4.1	10.9	2.0	14.9	86.1		Clay	Stiff
59.4	6.9	8.1	17.3	46.4	148.9	0.2	11.3	4.1	10.9	2.0	15.0	89.2		Clay	Stiff
59.2	6.3	7.7	17.4	47.9	150.9	0.3	9.7	4.9	12.0	1.8	11.7	75.6		Clay	Stiff
59.0	6.9	8.6	17.6	49.5	152.8	0.3	10.5	6.0	15.2	1.9	13.3	86.4		Silty Clay	Stiff
58.8	7.6	10.1	18.1	51.1	154.8	0.4	11.6	8.5	22.6	2.0	15.5	101.1		Silty Clay	Very Stiff
58.6	8.3	10.6	18.1	52.8	156.8	0.3	12.5	7.8	21.2	2.1	17.4	114.8		Silty Clay	Very Stiff
58.4	8.5	10.9	18.1	54.4	158.7	0.3	12.4	8.1	22.2	2.1	17.3	117.6		Silty Clay	Very Stiff
58.2	8.1	10.6	18.2	56.1	160.7	0.4	11.3	8.5	22.4	2.0	14.9	107.8		Silty Clay	Very Stiff
58.0	8.3	9.6	17.4	57.6	162.6	0.2	11.2	4.5	11.8	2.0	14.8	109.8		Clay	Very Stiff
57.8	9.1	11.1	17.9	59.3	164.6	0.3	12.4	6.7	18.2	2.1	17.1	126.9		Clay	Very Stiff
57.6	8.4	9.4	17.2	60.7	166.6	0.1	10.8	3.4	8.8	1.9	13.9	109.9		Clay	Very Stiff
57.4	8.7	9.6	17.1	62.2	168.5	0.1	11.0	3.1	7.9	2.0	14.3	115.1		Clay	Very Stiff
57.2	8.6	9.6	17.2	63.7	170.5	0.1	10.5	3.4	8.7	1.9	13.4	111.9		Clay	Very Stiff
57.0	8.5	9.4	17.1	65.1	172.5	0.1	10.1	3.1	7.7	1.9	12.6	109.0		Clay	Very Stiff
56.8	9.0	10.4	17.5	66.7	174.4	0.2	10.6	4.9	12.5	1.9	13.4	117.6		Clay	Very Stiff
56.6	8.5	9.2	16.9	68.1	176.4	0.1	9.7	2.3	5.7	1.8	11.7	107.1		Clay	Very Stiff
56.4	7.8	8.8	17.2	69.5	178.3	0.2	8.4	3.4	7.9	1.6	9.4	92.2		Clay	Stiff
56.2	8.3	9.6	17.4	71.1	180.3	0.2	8.9	4.5	10.7	1.7	10.2	100.7		Clay	Very Stiff
56.0	8.4	9.6	17.3	72.6	182.3	0.2	8.8	4.1	9.8	1.7	10.1	101.8		Clay	Very Stiff
55.8	8.6	9.8	17.3	74.1	184.2	0.2	8.9	4.1	9.9	1.7	10.2	104.8		Clay	Very Stiff
55.6	8.6	9.6	17.2	75.6	186.2	0.1	8.7	3.4	8.1	1.7	9.9	104.1		Clay	Very Stiff

Figure C-2A

DMT-2 Results Near Borehole 33

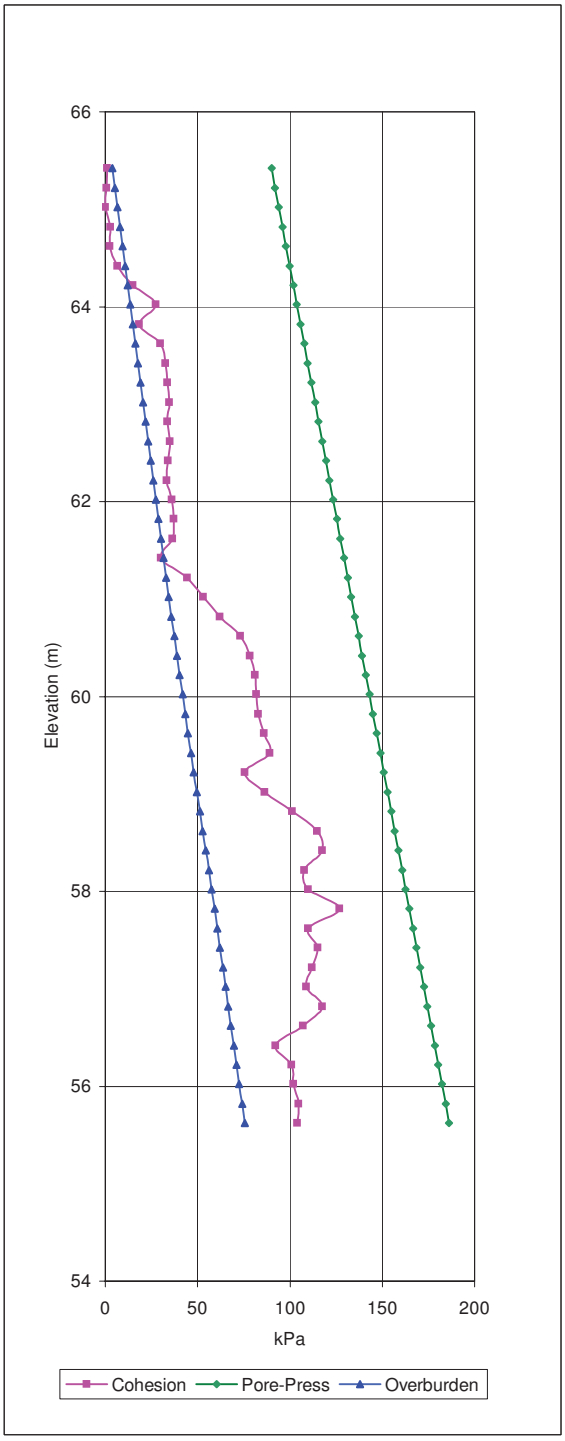
Project: TC035071 Randle Reef

DMT #33A
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.23	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.6	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
55.4	9.5	14.1	19.3	77.5	188.2	0.6	9.6	15.8	38.9	1.8	11.6	121.5		Silty Clay	Very Stiff
55.2	10.0	15.1	19.6	79.4	190.1	0.6	10.0	17.6	43.9	1.8	12.2	129.9		Clayey Silt	Very Stiff
55.0	10.0	14.6	19.4	81.3	192.1	0.6	9.7	15.8	39.0	1.8	11.8	129.2		Silty Clay	Very Stiff
54.8	10.2	14.6	19.3	83.2	194.0	0.5	9.7	15.1	37.2	1.8	11.8	132.2		Silty Clay	Very Stiff
54.6	9.5	13.6	19.1	85.1	196.0	0.5	8.7	14.0	32.9	1.7	9.9	117.6		Silty Clay	Very Stiff
54.4	10.0	14.6	19.4	87.0	198.0	0.6	9.0	15.8	37.8	1.7	10.5	125.9		Silty Clay	Very Stiff
54.2	10.0	14.3	19.2	88.9	199.9	0.5	8.8	14.7	34.9	1.7	10.1	125.1		Silty Clay	Very Stiff
54.0	9.6	13.1	18.8	90.7	201.9	0.5	8.1	12.2	27.8	1.6	8.9	115.0		Silty Clay	Very Stiff
53.8	9.1	12.8	18.9	92.5	203.9	0.5	7.4	12.9	28.2	1.5	7.7	104.5		Silty Clay	Very Stiff
53.6	8.8	11.6	18.4	94.2	205.8	0.4	7.0	9.6	20.5	1.5	7.0	98.9		Silty Clay	Stiff
53.4	9.4	11.9	18.2	95.9	207.8	0.3	7.5	8.5	18.7	1.5	7.8	109.5		Silty Clay	Very Stiff
53.2	9.3	14.6	19.5	97.8	209.7	0.7	7.2	18.3	39.6	1.5	7.3	106.2		Clayey Silt	Very Stiff
53.0	9.1	14.1	19.3	99.7	211.7	0.7	6.8	17.2	36.4	1.4	6.8	101.9		Clayey Silt	Very Stiff
52.8	9.6	13.8	19.1	101.6	213.7	0.6	7.2	14.3	31.0	1.5	7.4	110.9		Silty Clay	Very Stiff
52.6	9.8	14.1	19.2	103.4	215.6	0.6	7.2	14.7	31.9	1.5	7.4	113.7		Silty Clay	Very Stiff
52.4	9.5	14.6	19.4	105.4	217.6	0.7	6.8	17.6	37.0	1.4	6.7	106.6		Clayey Silt	Very Stiff
52.2	10.5	15.1	19.4	107.3	219.5	0.5	7.6	15.8	35.0	1.5	8.0	124.7		Silty Clay	Very Stiff
52.0	10.5	15.1	19.4	109.2	221.5	0.6	7.4	15.8	34.6	1.5	7.7	123.7		Silty Clay	Very Stiff
51.8	10.6	14.4	19.1	111.1	223.5	0.5	7.3	13.2	28.8	1.5	7.6	123.5		Silty Clay	Very Stiff
51.6	7.9	11.6	18.6	112.8	225.4	0.7	4.8	12.9	22.6	1.1	4.0	74.8		Clayey Silt	Stiff
51.4	9.7	22.1	21.0	115.1	227.4	1.7	6.3	43.1	88.4	1.4	10.6		29	Sandy Silt	Dense
51.2	9.3	12.6	18.7	116.8	229.4	0.5	5.8	11.4	22.2	1.3	5.3	97.8		Silty Clay	Stiff
51.0	9.4	12.3	18.5	118.6	231.3	0.4	5.8	10.0	19.4	1.3	5.3	99.2		Silty Clay	Stiff
50.8	9.1	12.1	18.5	120.3	233.3	0.4	5.5	10.3	19.4	1.2	4.8	93.2		Silty Clay	Stiff
50.6	9.1	11.6	18.2	122.0	235.2	0.4	5.4	8.5	15.9	1.2	4.7	92.9		Silty Clay	Stiff
50.4	9.6	12.6	18.5	123.7	237.2	0.4	5.7	10.3	19.9	1.3	5.1	100.5		Silty Clay	Very Stiff
50.2	9.5	12.3	18.4	125.4	239.2	0.4	5.5	9.6	18.2	1.2	4.9	98.3		Silty Clay	Stiff
50.0	9.5	12.3	18.4	127.2	241.1	0.4	5.4	9.6	18.0	1.2	4.8	97.6		Silty Clay	Stiff
49.8	9.2	11.8	18.3	128.8	243.1	0.4	5.1	8.9	16.1	1.2	4.3	91.9		Silty Clay	Stiff
49.6	9.4	11.9	18.2	130.5	245.1	0.4	5.2	8.5	15.6	1.2	4.4	94.8		Silty Clay	Stiff
49.4	9.3	11.6	18.1	132.2	247.0	0.3	5.1	7.8	14.0	1.2	4.2	92.6		Silty Clay	Stiff
49.2	9.1	11.4	18.1	133.8	249.0	0.3	4.8	7.8	13.7	1.1	4.0	88.6		Silty Clay	Stiff
49.0	8.3	10.6	18.0	135.5	250.9	0.4	4.2	7.8	12.5	1.0	3.2	74.8		Silty Clay	Stiff
48.8	10.1	12.3	18.1	137.1	252.9	0.3	5.4	7.4	13.9	1.2	4.7	104.5		Clay	Very Stiff
48.6	9.3	11.6	18.1	138.8	254.9	0.3	4.8	7.8	13.5	1.1	3.9	90.1		Silty Clay	Stiff
48.4	9.2	11.6	18.1	140.4	256.8	0.4	4.6	8.1	13.9	1.1	3.7	87.8		Silty Clay	Stiff
48.2	9.2	11.6	18.1	142.1	258.8	0.4	4.5	8.1	13.8	1.1	3.6	87.2		Silty Clay	Stiff
48.0	9.3	11.6	18.1	143.7	260.7	0.3	4.6	7.8	13.2	1.1	3.6	88.4		Silty Clay	Stiff
47.8	9.6	12.1	18.2	145.4	262.7	0.4	4.7	8.5	14.7	1.1	3.8	92.6		Silty Clay	Stiff
47.6	9.8	12.8	18.5	147.2	264.7	0.4	4.7	10.3	17.9	1.1	3.8	94.9		Silty Clay	Stiff
47.4	10.6	13.3	18.4	148.9	266.6	0.3	5.2	9.2	16.9	1.2	4.4	108.1		Silty Clay	Very Stiff
47.2	10.6	13.6	18.6	150.6	268.6	0.4	5.1	10.3	18.7	1.2	4.3	107.2		Silty Clay	Very Stiff
47.0	9.8	12.4	18.3	152.3	270.6	0.4	4.5	8.9	15.0	1.1	3.6	93.4		Silty Clay	Stiff
46.8	9.8	12.6	18.4	154.0	272.5	0.4	4.5	9.6	16.1	1.1	3.5	92.7		Silty Clay	Stiff
46.6	9.1	11.6	18.2	155.7	274.5	0.4	4.0	8.5	13.2	1.0	2.9	81.0		Silty Clay	Stiff
46.4	10.1	12.9	18.4	157.4	276.4	0.4	4.5	9.6	16.2	1.1	3.6	96.5		Silty Clay	Stiff
46.2	10.1	12.8	18.4	159.1	278.4	0.4	4.5	9.2	15.5	1.1	3.5	95.9		Silty Clay	Stiff
46.0	10.1	12.8	18.4	160.8	280.4	0.4	4.4	9.2	15.4	1.1	3.4	95.4		Silty Clay	Stiff
45.8	10.6	13.3	18.4	162.6	282.3	0.3	4.7	9.2	15.9	1.1	3.7	103.0		Silty Clay	Very Stiff
45.6	10.1	13.1	18.5	164.3	284.3	0.4	4.3	10.3	16.9	1.0	3.3	94.0		Silty Clay	Stiff
45.4	10.6	13.4	18.5	166.0	286.3	0.4	4.5	9.6	16.2	1.1	3.6	101.8		Silty Clay	Very Stiff
45.2	10.1	12.9	18.4	167.8	288.2	0.4	4.2	9.6	15.4	1.0	3.2	93.0		Silty Clay	Stiff
45.0	10.6	13.1	18.3	169.4	290.2	0.3	4.4	8.5	14.2	1.1	3.5	100.8		Silty Clay	Very Stiff
44.8	10.6	13.3	18.4	171.2	292.1	0.3	4.4	9.2	15.3	1.1	3.4	100.1		Silty Clay	Very Stiff

DMT - 2 Results Near Borehole 33



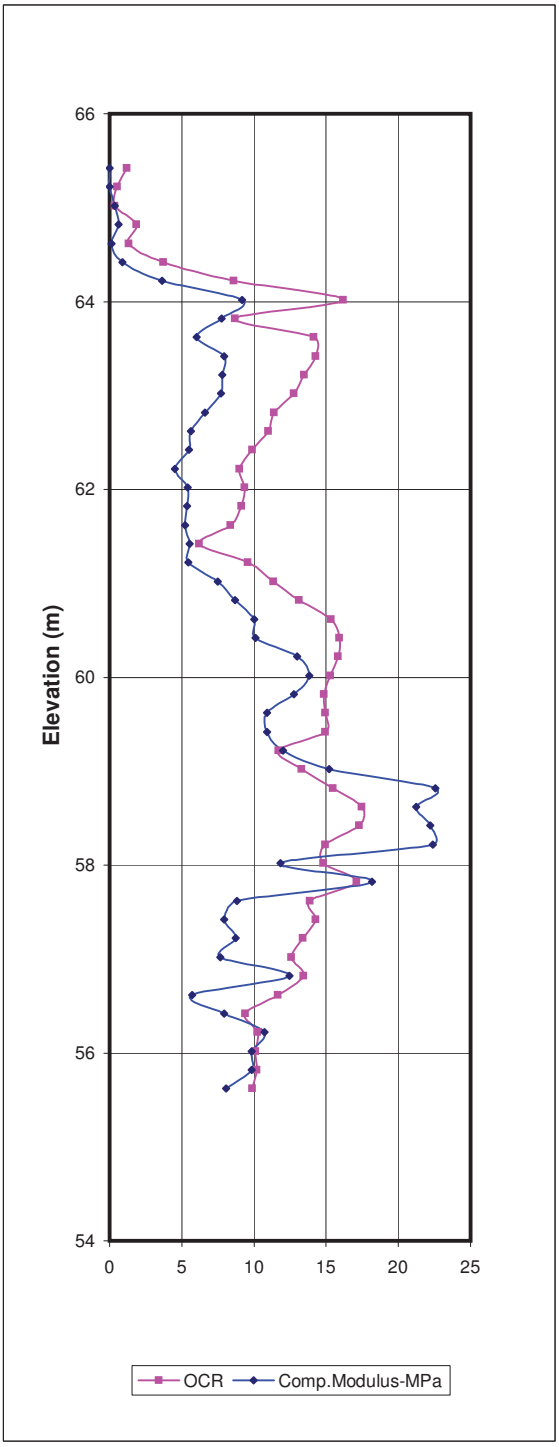


Figure C - 2B

DMT Results Near Borehole 36

Project: TC035071 Randle Reef

DMT #36
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.22	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
67.8	1.2	1.5	16.4	11.3	66.7	0.5	4.6	0.9	1.5	1.1	3.6	7.0		Silty Clay	Very Soft
67.6	1.9	2.6	16.7	12.7	68.7	0.6	9.2	2.4	5.7	1.7	10.8	18.8		Silty Clay	Soft
67.4	2.4	3.2	16.8	14.1	70.6	0.5	11.6	2.7	7.2	2.0	15.5	27.8		Silty Clay	Firm
67.2	2.5	3.4	16.8	15.5	72.6	0.5	11.0	3.1	8.0	2.0	14.3	28.7		Silty Clay	Firm
67.0	2.8	3.6	16.8	16.9	74.6	0.4	11.7	2.7	7.3	2.0	15.8	34.0		Silty Clay	Firm
66.8	3.0	3.7	16.8	18.3	76.5	0.3	11.8	2.4	6.3	2.0	16.0	37.2		Silty Clay	Firm
66.6	3.2	4.1	16.9	19.7	78.5	0.4	11.8	3.1	8.3	2.0	16.0	40.0		Silty Clay	Firm
66.4	3.3	4.2	16.9	21.1	80.4	0.4	11.4	3.1	8.1	2.0	15.1	41.0		Silty Clay	Firm
66.2	3.4	4.2	16.9	22.5	82.4	0.3	11.1	2.7	7.1	2.0	14.4	42.1		Silty Clay	Firm
66.0	3.5	4.4	16.9	24.0	84.4	0.3	10.7	3.1	7.9	1.9	13.7	43.0		Silty Clay	Firm
65.8	3.5	4.3	16.9	25.4	86.3	0.3	10.1	2.7	6.8	1.8	12.4	42.1		Silty Clay	Firm
65.6	3.6	4.4	16.9	26.8	88.3	0.3	9.8	2.7	6.8	1.8	12.0	43.1		Clay	Firm
65.4	3.5	4.4	16.9	28.2	90.3	0.3	8.9	3.1	7.4	1.7	10.3	40.1		Silty Clay	Firm
65.2	3.8	4.6	16.9	29.6	92.2	0.3	9.4	2.7	6.7	1.8	11.2	45.2		Clay	Firm
65.0	3.9	4.9	17.0	31.1	94.2	0.3	9.2	3.5	8.3	1.7	10.8	46.0		Silty Clay	Firm
64.8	4.1	5.1	17.0	32.5	96.1	0.3	9.3	3.5	8.4	1.8	11.0	49.1		Silty Clay	Firm
64.6	4.4	5.3	17.0	34.0	98.1	0.3	9.8	3.1	7.7	1.8	11.9	54.2		Clay	Stiff
64.4	4.6	5.6	17.1	35.4	100.1	0.3	9.8	3.5	8.6	1.8	12.0	57.1		Clay	Stiff
64.2	4.7	5.9	17.2	36.9	102.0	0.3	9.6	4.2	10.3	1.8	11.6	57.9		Silty Clay	Stiff
64.0	5.0	6.1	17.2	38.4	104.0	0.3	10.0	3.8	9.5	1.8	12.3	63.1		Clay	Stiff
63.8	5.3	6.5	17.2	39.9	105.9	0.3	10.3	4.2	10.6	1.9	12.9	68.0		Clay	Stiff
63.6	5.6	6.9	17.3	41.4	107.9	0.3	10.6	4.5	11.6	1.9	13.4	73.0		Clay	Stiff
63.4	5.8	7.0	17.3	42.8	109.9	0.3	10.6	4.2	10.7	1.9	13.5	76.1		Clay	Stiff
63.2	6.0	7.3	17.4	44.4	111.8	0.3	10.7	4.5	11.7	1.9	13.6	79.0		Clay	Stiff
63.0	6.2	7.4	17.3	45.9	113.8	0.2	10.7	4.2	10.8	1.9	13.7	82.1		Clay	Stiff
62.8	6.3	7.6	17.4	47.4	115.8	0.3	10.5	4.5	11.6	1.9	13.3	83.0		Clay	Stiff
62.6	6.4	7.6	17.3	48.9	117.7	0.2	10.4	4.2	10.6	1.9	13.0	84.1		Clay	Stiff
62.4	6.6	7.7	17.2	50.3	119.7	0.2	10.4	3.8	9.7	1.9	13.1	87.2		Clay	Stiff
62.2	6.9	8.4	17.5	51.9	121.6	0.3	10.6	5.3	13.5	1.9	13.5	91.8		Clay	Stiff
62.0	6.9	8.6	17.6	53.4	123.6	0.3	10.4	5.6	14.3	1.9	13.2	92.7		Clay	Stiff
61.8	6.9	8.4	17.5	55.0	125.6	0.3	9.9	5.3	13.2	1.8	12.2	89.7		Clay	Stiff
61.6	6.9	8.4	17.5	56.5	127.5	0.3	9.6	5.3	13.0	1.8	11.6	88.7		Clay	Stiff
61.4	7.2	9.1	17.8	58.1	129.5	0.3	10.0	6.4	15.9	1.8	12.3	95.4		Silty Clay	Stiff
61.2	7.2	9.1	17.8	59.7	131.5	0.3	9.7	6.4	15.7	1.8	11.7	94.3		Silty Clay	Stiff
61.0	7.4	9.4	17.8	61.3	133.4	0.3	9.7	6.7	16.6	1.8	11.8	97.2		Silty Clay	Stiff
60.8	7.5	9.3	17.7	62.9	135.4	0.3	9.6	6.0	14.8	1.8	11.6	98.4		Clay	Stiff
60.6	7.6	9.6	17.8	64.5	137.3	0.3	9.5	6.7	16.5	1.8	11.3	99.2		Silty Clay	Stiff
60.4	7.9	9.9	17.9	66.1	139.3	0.3	9.7	6.7	16.6	1.8	11.7	104.1		Clay	Very Stiff
60.2	7.4	8.3	17.1	67.6	141.3	0.1	8.6	3.1	7.3	1.7	9.8	92.3		Clay	Stiff
60.0	7.1	7.5	16.6	68.9	143.2	0.1	8.0	1.3	2.9	1.6	8.7	86.2		Clay	Stiff

Figure C-3A

Project: TC035071 Randle Reef

DMT Results Near Borehole 36

DMT #36
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.22	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
59.8	8.2	11.6	18.7	70.7	145.2	0.5	9.3	11.8	28.6	1.8	10.9	105.8		Silty Clay	Very Stiff
59.6	6.9	9.6	18.2	72.4	147.2	0.5	7.3	9.3	20.2	1.5	7.6	80.5		Silty Clay	Stiff
59.4	7.5	10.1	18.2	74.0	149.1	0.4	7.9	8.9	20.2	1.6	8.6	91.1		Silty Clay	Stiff
59.2	7.8	10.6	18.3	75.7	151.1	0.4	8.1	9.6	22.0	1.6	8.9	95.7		Silty Clay	Stiff
59.0	8.4	11.3	18.4	77.5	153.0	0.4	8.6	10.0	23.5	1.7	9.8	106.2		Silty Clay	Very Stiff
58.8	9.2	12.9	18.9	79.3	155.0	0.5	9.4	12.9	31.4	1.8	11.1	120.1		Silty Clay	Very Stiff
58.6	10.0	14.1	19.2	81.2	157.0	0.5	10.2	14.0	35.3	1.9	12.7	136.7		Silty Clay	Very Stiff
58.4	10.0	14.6	19.4	83.1	158.9	0.5	9.9	15.8	39.4	1.8	12.1	135.0		Silty Clay	Very Stiff
58.2	10.0	14.6	19.4	85.0	160.9	0.5	9.7	15.8	39.0	1.8	11.7	133.9		Silty Clay	Very Stiff
58.0	10.0	15.1	19.6	87.0	162.8	0.6	9.4	17.6	43.0	1.8	11.2	132.2		Clayey Silt	Very Stiff
57.8	9.5	14.1	19.3	88.9	164.8	0.6	8.6	15.8	37.2	1.7	9.8	121.8		Silty Clay	Very Stiff
57.6	10.0	15.1	19.6	90.9	166.8	0.6	8.9	17.6	42.1	1.7	10.4	130.0		Clayey Silt	Very Stiff
57.4	10.0	14.6	19.4	92.8	168.7	0.5	8.8	15.8	37.4	1.7	10.0	129.4		Silty Clay	Very Stiff
57.2	10.2	14.6	19.3	94.7	170.7	0.5	8.8	15.1	35.7	1.7	10.1	132.5		Silty Clay	Very Stiff
57.0	9.5	13.6	19.1	96.5	172.7	0.5	7.9	14.0	31.6	1.6	8.5	118.3		Silty Clay	Very Stiff
56.8	10.0	14.6	19.4	98.5	174.6	0.6	8.2	15.8	36.3	1.6	9.0	126.4		Silty Clay	Very Stiff
56.6	10.0	14.3	19.3	100.4	176.6	0.5	8.0	14.7	33.5	1.6	8.8	125.7		Silty Clay	Very Stiff
56.4	9.6	13.1	18.9	102.2	178.5	0.5	7.4	12.2	26.8	1.5	7.7	115.9		Silty Clay	Very Stiff
56.2	9.1	12.8	18.9	104.0	180.5	0.5	6.8	12.9	27.2	1.4	6.7	105.6		Silty Clay	Very Stiff
56.0	8.8	11.6	18.4	105.7	182.5	0.4	6.4	9.6	19.7	1.4	6.2	100.2		Silty Clay	Very Stiff
55.8	9.4	11.9	18.3	107.4	184.4	0.3	6.9	8.5	18.1	1.4	6.9	110.6		Silty Clay	Very Stiff
55.6	9.3	14.6	19.5	109.3	186.4	0.7	6.6	18.4	38.2	1.4	6.5	107.4		Clayey Silt	Very Stiff
55.4	9.1	14.1	19.4	111.2	188.4	0.7	6.3	17.3	35.1	1.4	6.0	103.2		Clayey Silt	Very Stiff
55.2	9.6	13.8	19.1	113.1	190.3	0.5	6.7	14.4	30.0	1.4	6.5	112.1		Silty Clay	Very Stiff
55.0	9.8	14.1	19.2	115.0	192.3	0.5	6.7	14.7	30.8	1.4	6.6	114.8		Silty Clay	Very Stiff
54.8	9.5	14.6	19.5	116.9	194.2	0.7	6.3	17.6	35.8	1.4	6.0	107.9		Clayey Silt	Very Stiff
54.6	10.5	15.1	19.4	118.9	196.2	0.5	7.0	15.8	33.8	1.5	7.1	125.7		Silty Clay	Very Stiff
54.4	10.5	15.1	19.4	120.8	198.2	0.5	6.9	15.8	33.5	1.4	6.9	124.8		Silty Clay	Very Stiff
54.2	10.5	14.4	19.1	122.6	200.1	0.4	6.8	13.3	27.9	1.4	6.7	124.6		Silty Clay	Very Stiff
54.0	7.9	11.6	18.7	124.4	202.1	0.6	4.6	12.9	21.9	1.1	3.6	76.8		Clayey Silt	Stiff
53.8	9.7	22.1	21.1	126.7	204.0	1.6	5.9	43.1	85.7	1.3	8.9		29	Sandy Silt	Dense
53.6	9.3	12.6	18.7	128.5	206.0	0.5	5.5	11.5	21.6	1.2	4.8	99.5		Silty Clay	Stiff
53.4	9.4	12.3	18.5	130.2	208.0	0.4	5.5	10.0	18.8	1.2	4.8	100.9		Silty Clay	Very Stiff
53.2	9.1	12.1	18.5	131.9	209.9	0.4	5.2	10.4	18.9	1.2	4.4	94.9		Silty Clay	Stiff
53.0	9.1	11.6	18.2	133.6	211.9	0.4	5.1	8.5	15.5	1.2	4.3	94.7		Silty Clay	Stiff
52.8	9.6	12.6	18.6	135.4	213.9	0.4	5.4	10.4	19.3	1.2	4.7	102.2		Silty Clay	Very Stiff
52.6	9.5	12.3	18.4	137.1	215.8	0.4	5.2	9.6	17.7	1.2	4.5	100.0		Silty Clay	Stiff
52.4	9.5	12.3	18.4	138.8	217.8	0.4	5.1	9.6	17.5	1.2	4.4	99.3		Silty Clay	Stiff
52.2	9.2	11.8	18.3	140.5	219.7	0.4	4.9	8.9	15.7	1.1	4.0	93.8		Silty Clay	Stiff
52.0	9.4	11.9	18.2	142.2	221.7	0.3	4.9	8.5	15.2	1.1	4.1	96.6		Silty Clay	Stiff
51.8	9.3	11.6	18.1	143.8	223.7	0.3	4.8	7.8	13.7	1.1	3.9	94.5		Silty Clay	Stiff
51.6	9.1	11.4	18.1	145.5	225.6	0.3	4.6	7.8	13.3	1.1	3.7	90.5		Silty Clay	Stiff
51.4	8.3	10.6	18.0	147.1	227.6	0.4	4.0	7.8	12.2	1.0	2.9	76.9		Silty Clay	Stiff
51.2	10.1	12.3	18.1	148.8	229.6	0.3	5.1	7.5	13.5	1.2	4.3	106.2		Clay	Very Stiff
51.0	9.3	11.6	18.1	150.4	231.5	0.3	4.5	7.8	13.2	1.1	3.6	92.1		Silty Clay	Stiff
50.8	9.2	11.6	18.1	152.1	233.5	0.3	4.4	8.2	13.6	1.1	3.4	89.8		Silty Clay	Stiff
50.6	9.2	11.6	18.1	153.8	235.4	0.3	4.3	8.2	13.5	1.0	3.4	89.2		Silty Clay	Stiff
50.4	9.3	11.6	18.1	155.4	237.4	0.3	4.4	7.8	12.9	1.0	3.4	90.4		Silty Clay	Stiff
50.2	9.6	12.1	18.2	157.1	239.4	0.3	4.5	8.5	14.3	1.1	3.5	94.6		Silty Clay	Stiff
50.0	9.8	12.8	18.5	158.9	241.3	0.4	4.5	10.4	17.5	1.1	3.6	96.9		Silty Clay	Stiff
49.8	10.6	13.3	18.4	160.6	243.3	0.3	5.0	9.3	16.5	1.2	4.1	109.9		Silty Clay	Very Stiff
49.6	10.6	13.6	18.6	162.3	245.3	0.4	4.9	10.4	18.3	1.1	4.0	109.0		Silty Clay	Very Stiff
49.4	9.8	12.4	18.3	164.0	247.2	0.4	4.4	8.9	14.7	1.1	3.4	95.4		Silty Clay	Stiff
49.2	9.8	12.6	18.4	165.8	249.2	0.4	4.3	9.6	15.7	1.0	3.3	94.7		Silty Clay	Stiff
49.0	9.1	11.6	18.2	167.4	251.1	0.4	3.8	8.5	13.0	1.0	2.8	83.1		Silty Clay	Stiff
48.8	10.1	12.9	18.4	169.2	253.1	0.4	4.4	9.6	15.9	1.1	3.4	98.5		Silty Clay	Stiff
48.6	10.1	12.8	18.4	170.9	255.1	0.4	4.3	9.3	15.2	1.0	3.3	98.0		Silty Clay	Stiff
48.4	10.1	12.8	18.4	172.6	257.0	0.4	4.2	9.3	15.1	1.0	3.2	97.4		Silty Clay	Stiff
48.2	10.6	13.3	18.4	174.3	259.0	0.3	4.5	9.3	15.5	1.1	3.5	105.0		Silty Clay	Very Stiff
48.0	10.1	13.1	18.6	176.1	260.9	0.4	4.1	10.4	16.5	1.0	3.1	96.0		Silty Clay	Stiff

DMT Results Near Borehole 36

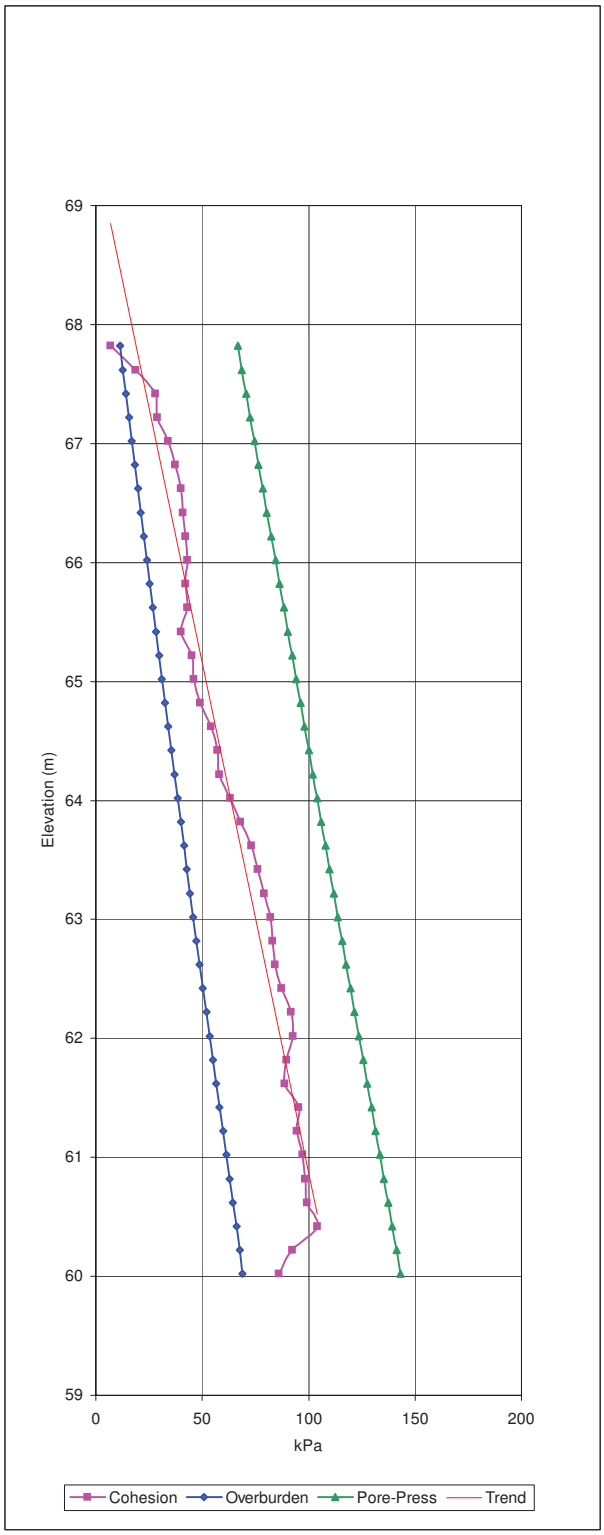
Project: TC035071 Randle Reef

DMT #36
Enclosure: 0

Z -	Elevation	m	Ed -	Dilatometer Modulus	MPa	GW El.	74.6	m
A' -	Corrected A Reading	kg/cm2	M -	Constrained (Oedometer) Modulus	MPa	Delta A	0.22	
B' -	Corrected B Reading	kg/cm2	KO -	Coefficient of Earth Pressure		Delta B	0.43	
G -	Bulk Unit Weight	kN/m3	OCR -	Overconsolidation Ratio		Zero Gauge Reading	0.00	
PO -	Effective Overburden Pressure	kPa	PC -	Preconsolidation Pressure	kPa	Elevation	74.62	m
U -	Pore Pressure	kPa	q -	PC - PO	kPa			
Id -	Material Index		CU -	Undrained Cohesion	kPa			
Kd -	Horizontal Stress Index		Phi -	Friction Angle	Deg			

Z	A'	B'	G	PO	U	Id	Kd	Ed	M	KO	OCR	CU	Phi	Description	
47.8	10.6	13.4	18.5	177.8	262.9	0.4	4.4	9.6	15.9	1.1	3.4	103.7		Silty Clay	Very Stiff
47.6	10.1	12.9	18.4	179.5	264.9	0.4	4.0	9.6	15.1	1.0	3.0	95.1		Silty Clay	Stiff
47.4	10.6	13.1	18.3	181.2	266.8	0.3	4.3	8.5	13.9	1.0	3.3	102.8		Silty Clay	Very Stiff
47.2	10.6	13.3	18.4	182.9	268.8	0.3	4.2	9.3	15.0	1.0	3.2	102.1		Silty Clay	Very Stiff

DMT Results Near Borehole 36



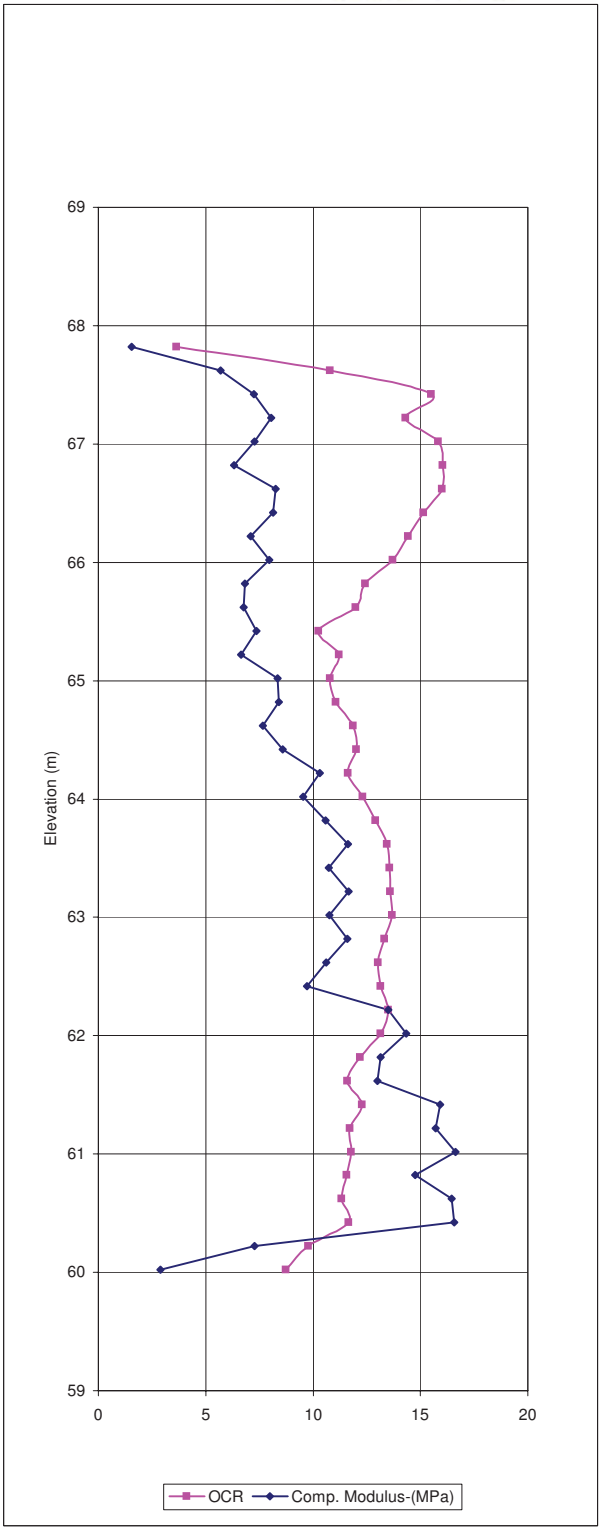


Figure C- 3B

APPENDIX D – RESULTS OF LABORATORY TESTS ON SEDIMENT SAMPLES

MEMORANDUM

DATE: February 18, 2004

TO: Ivan Severinsky, AMEC E&E Services Limited

FROM: Carsten Becker, P.E. and Garry E. Horvitz, P.E., Hart Crowser, Inc.

RE: **Randle Reef Sediment Remediation Project**
Consolidation Test Results
7979-01

This memorandum presents the results of geotechnical laboratory testing performed in January/February 2004 at Hart Crowser's laboratory in Seattle to estimate the consolidation behavior of dredged sediments sampled at the Randle Reef site.

INTRODUCTION

An Engineered Containment Facility (ECF) is proposed for the disposal of contaminated sediments at the Randle Reef site. The contaminated sediments will be dredged in areas surrounding the ECF. The test results presented herein will be used to model the consolidation settlement of the dredged material placed within the ECF using the computer model PSDDF (developed by the U.S. Army Corps of Engineers). At this time, it has not been determined whether the sediments will be dredged hydraulically or mechanically. The consolidation behavior of hydraulically dredged material is different than the behavior of mechanically dredged material. This difference in behavior demands the use of two sets of tests to simulate the corresponding conditions. The following tests were conducted:

- Index property tests and analyses including Atterberg limits, specific gravity, grain size, and organic content.

- One oedometer consolidation test on a remolded, composite sample at the as-received moisture content. This test represents the behavior of mechanically dredged sediment.
- One self-weight settlement test using a composite sample. The self-weight settlement test simulates the consolidation behavior of hydraulically dredged sediment at an early stage following deposition when the settled sediment is at its highest void ratio.

1910 Fairview Avenue East
Seattle, Washington 98102-3699
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- One oedometer consolidation test on the settled sediment from the self-weight settlement test. This test represents the behavior of hydraulically dredged sediment at higher stresses starting at a void ratio near the void ratio at the end of the self-weight settlement test.

The test results are summarized in the following section. Additional laboratory test results are presented in Attachment A to this memorandum. Test procedures are outlined at the end of this memorandum.

SUMMARY OF TEST RESULTS

The testing was performed on composite samples from the Randle Reef site. The sediment samples along with water from the site were sampled and provided to Hart Crowser by AMEC. Material from the following samples were combined to make up composite sample material for the various tests that were performed: RR-2, RR-4, RR-10, RR-12, RR-14, RR-20, RR-22, RR-23, RR-24, RR-25, RR-29, RR-30, RR-39, RR-44, and RR-46. The sampling procedures and locations are presented in AMEC's Environmental Studies Report dated December 2003.

Sediment Characterization

Index tests were performed to characterize the composite sediment sample material. Based on these tests, the composite material is characterized as sandy to very sandy SILT (ML) containing 30 percent sand with an organic matter content of 6 percent. The material is slightly plastic (PI = 8) and its initial moisture content is significantly higher than its liquid limit (w_n = 106 percent, LL = 42), which is typical for very soft, surficial sediments. The sediment solids have a specific gravity of 2.68.

Oedometer Test Results

As outlined above, two oedometer tests were conducted to simulate the two basic dredging conditions. The oedometer test results are summarized in Table 1. The test results plotted in terms of void ratio and coefficient of consolidation versus effective stress are presented on Figures 4 and 5.

Table 1 - Summary of Oedometer Consolidation Test Results

	"Mechanically Dredged"	"Hydraulically Dredged"
Initial Bulk Unit Weight in kN/m^3 (pcf)[1)]	15.7 (100)	14.1 (90)
Initial Dry Unit Weight in kN/m^3 (pcf)[1)]	7.5 (48)	6.6 (42)
Initial Moisture Content in Percent[1)]	106	113
Initial Void Ratio[1)]	2.45	2.98
Compression Index	0.43	0.42
Recompression Index	0.01	0.03
Secondary Compression Index	0.037	----

Note: [1)]Condition at beginning of test.

Self-Weight Settlement Test Results

A self-weight settlement test was conducted to obtain the initial void ratio at the time when the interface between supernatant and settled solids first develops and the hydraulically dredged sediment is at nearly zero effective stress. The average void ratio and corresponding average effective stress was also calculated at the end of the test after no further change in effective stress and void ratio is detected and the sediment is in an equilibrium state. The test results are summarized in Table 2, and the test data are presented in Attachment A.

Table 2 - Summary of Self-Weight Settlement Test Results

	"Hydraulically Dredged"
Initial Solids Content in Percent[1) 2)]	12.5
Initial Slurry Concentration in g/L[1)]	136
Average Void Ratio at Formation of Solids Interface	11.8
Average Void Ratio at Equilibrium	3.2
Average Effective Stress at Equilibrium in kPa (psf)	0.59 (12.4)

Notes: [1)]Condition at beginning of test.
[2)]Weight of solids as a percentage of the total weight

TEST PROCEDURES

The test procedures for the index, oedometer consolidation, and self-weight settlement tests on the composite samples from Randle Reef are outlined below.

Sediment Classification

A composite sediment sample was classified in a relatively controlled laboratory environment. The classification was based on laboratory tests such as Atterberg limits determination and grain size analyses and was made in general accordance with the Unified Soil Classification (USC) System, ASTM D 2487, as presented on Figure 1.

Moisture Content Determinations

Moisture contents were determined in general accordance with ASTM D 2216. Moisture contents were conducted for samples subjected to consolidation testing and are reported along with the consolidation test results.

Atterberg Limits

We determined Atterberg limits for the composite sample material. The liquid limit and plastic limit were determined in general accordance with ASTM D 4318. The results of the Atterberg limits analyses and the plasticity characteristics are summarized in the Liquid and Plastic Limits Test Report, Figure 2. This relates the plasticity index (liquid limit minus the plastic limit) to the liquid limit. The results of the Atterberg limits tests are also shown on the consolidation test figures.

Specific Gravity

Hart Crowser's laboratory determined specific gravity for one composite sample. Specific gravity is a measure of the density of the sediment solids, and is expressed as a multiple of the density of water. Specific gravity was determined in general accordance with ASTM 854-91. The test data are presented in Attachment A.

Grain Size Analysis

Grain size distribution was analyzed on a composite sample in general accordance with ASTM D 422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method. The results of the tests are presented as a curve on Figure 3 plotting percent finer by weight versus grain size.

Organic Content

Organic content of the composite sample material was determined in general accordance with ASTM D 2974 - Method C. The moisture content of the sample was determined using Method A. The test data are presented in Attachment A.

Self-Weight Settlement Test

The self-weight settlement test is described as part of the settling column test procedure, which can be obtained via the World Wide Web on the U.S. Army Engineer Waterways Experiment Station web page (http://www.wes.army.mil). The self-weight settlement test simulates the consolidation behavior of hydraulically dredged material shortly after sediment deposition and the formation of an interface that develops between the water and the settled solids.

Before initiation of the test, a slurry was mixed using on-site water and composite sample material. Deionized as well as on-site water was added to achieve the required slurry volume for the test. The appropriate slurry concentration for the test was estimated based on the grain size distribution of the material. After thoroughly mixing the slurry in a drum, a 6-foot-high, 8-inch-diameter column was filled rapidly while compressed air was introduced at the bottom of the column to keep the solids in suspension until the start of the test. The test was then initiated by turning off the compressed air and the start time was recorded. After a solids interface developed, the interface height was recorded as a function of time. The test was carried out for 15 days. The equilibrium condition at which the column height no longer continued to change was reached a few days before the test was terminated.

The objective of the test is to obtain the initial void ratio at the time when the interface first occurs and the sediment is at nearly zero effective stress. The average void ratio and corresponding average effective stress is also calculated at the end of the test after no further change in effective stress and void ratio is detected, and the sediment is in an equilibrium state.

Consolidation Test

The one-dimensional consolidation test provides data for estimating the magnitude and time rate of settlement. The test was performed using the oedometer method described in U.S. Army Corps of Engineers (1987). In this method, a remolded sample of the material to be dredged is placed in the oedometer ring with porous stones placed on the top and bottom of the sample to allow drainage. Vertical loads were then applied incrementally to the sample in such a way that the sample was allowed to consolidate under each load increment. Measurements were made of the compression of the sample as a function of time under each load increment. Rebound was measured during the unloading phase. In general, each load was left in-place until the completion of 100 percent primary consolidation, as computed using Taylor's square root of time method. The next load increment was applied soon after attaining 100 percent primary consolidation. For a selected test, a load was left in-place for as long as 26 hours to record secondary consolidation characteristics.

Two oedometer tests were conducted, one for each method of dredging. A test to represent the behavior of mechanically dredged material was conducted at the *in situ* moisture content (i.e., the moisture content at which the material arrived at our laboratory, which should be close to the moisture content at the time of sampling). The results on the "mechanically dredged material" are shown on Figure 4. A second oedometer test was performed on the remolded, settled material from the self-weight settlement test. This test

represents the behavior of hydraulically dredged material at stresses higher than simulated in the self-weight settlement test. The results on the "hydraulically dredged material" are shown on Figure 5. The test results are plotted in terms of void ratio and coefficient of consolidation versus effective stress.

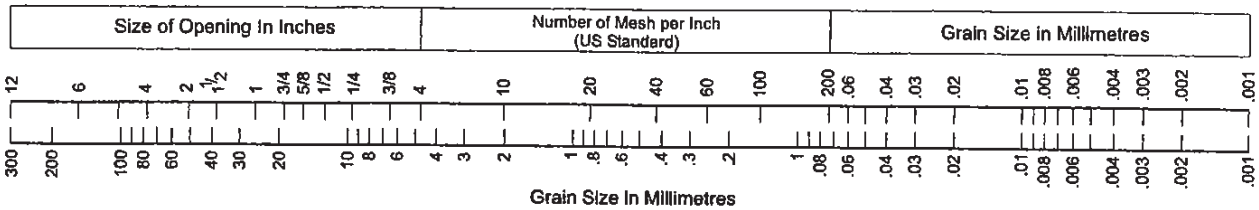
REFERENCES

U.S. Army Corps of Engineers 1987. Confined Disposal of Dredged Material, Engineer Manual EM 1110-2-5027.

Attachments:
Figure 1 - Unified Soil Classification (USC) System
Figure 2 - Liquid and Plastic Limit Test Report
Figure 3 - Particle Size Distribution Report
Figures 4 and 5 - Consolidation Test Results
Attachment A - Other Laboratory Test Results

F:\docs\jobs\797901\Consolidation Results Memo.doc

Unified Soil Classification (USC) System
Soil Grain Size



COBBLES	GRAVEL	SAND	SILT and CLAY
Coarse-Grained Soils			Fine-Grained Soils

Coarse-Grained Soils

G W	G P	G M	G C	S W	S P	S M	S C
Clean GRAVEL <5% fines	*	GRAVEL with >12% fines		Clean SAND <5% fines	*	SAND with >12% fines	
GRAVEL >50% coarse fraction larger than No. 4				SAND >50% coarse fraction smaller than No. 4			
Coarse-Grained Soils >50% larger than No. 200 sieve							

G W and S W $\left(\frac{D_{60}}{D_{10}}\right)$ >4 for G W >6 for S W & $1 \leq \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right) \leq 3$

G P and S P Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M Atterberg limits below A line with PI <4

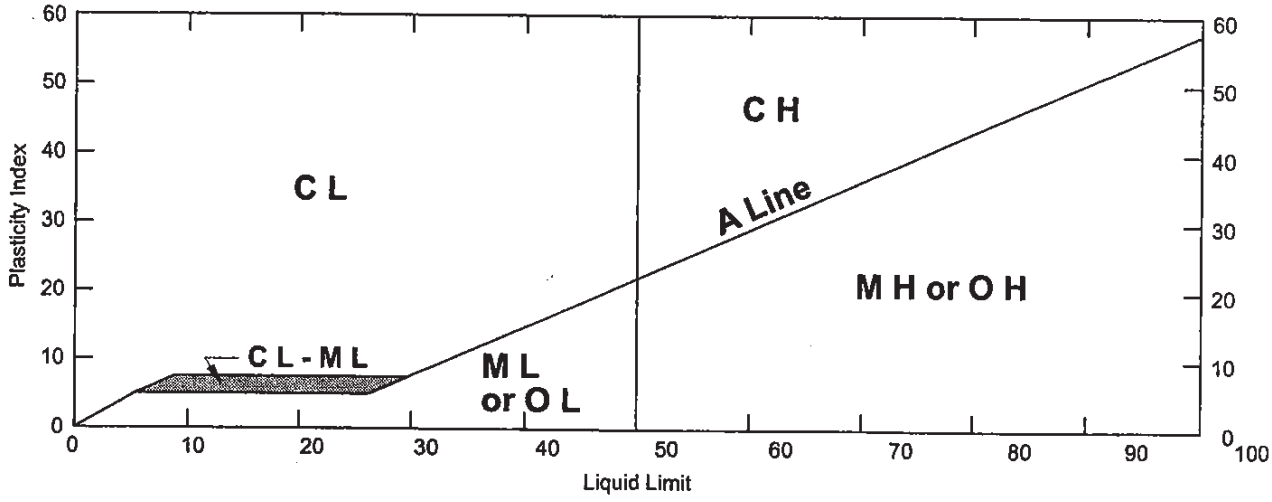
G C and S C Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases requiring use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particles diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

Fine-Grained Soils

M L	C L	O L	M H	C H	O H	Pt
SILT	CLAY	Organic	SILT	CLAY	Organic	Highly Organic Soils
Soils with Liquid Limit <50%			Soils with Liquid Limit >50%			
Fine-Grained Soils >50% smaller than No. 200 sieve						



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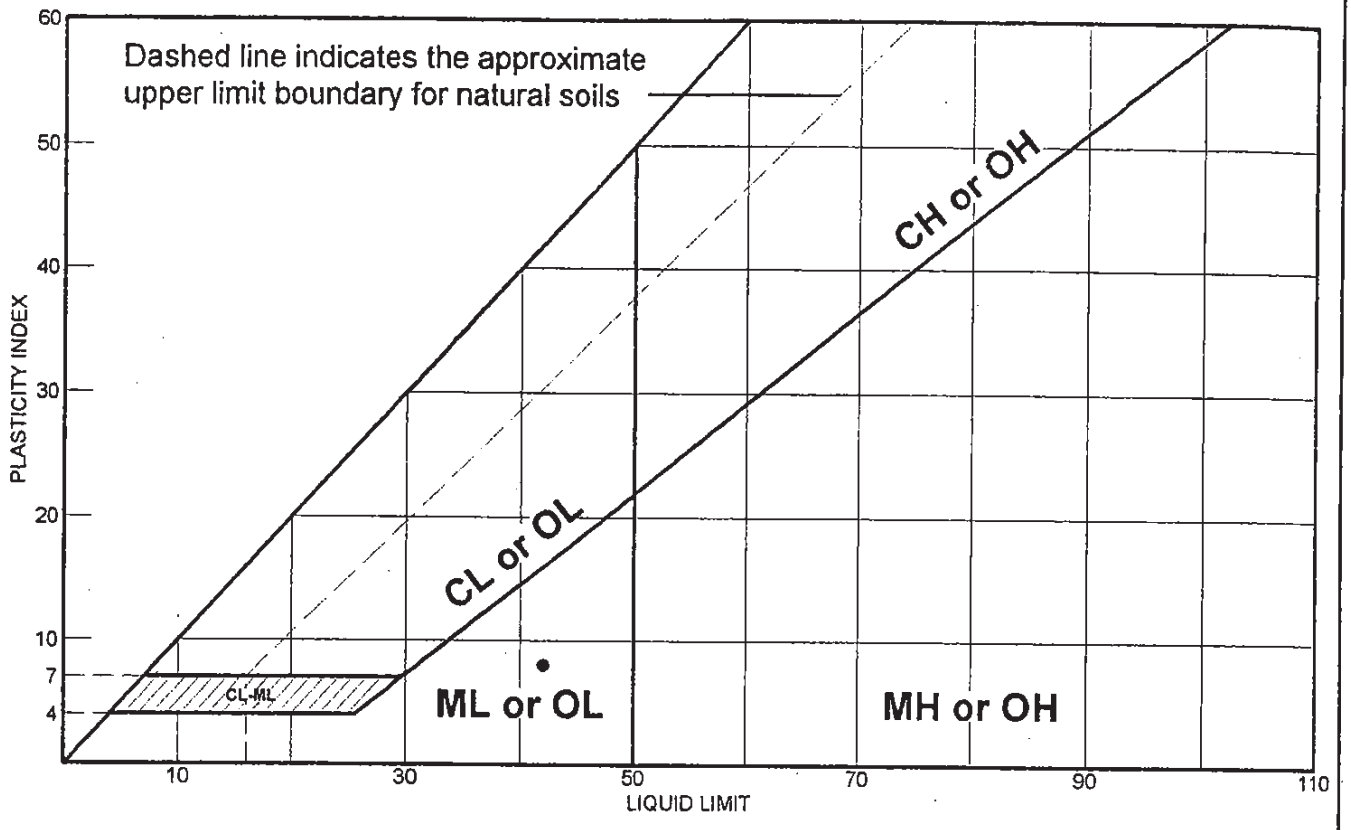
7979-01 2/04
Figure 1

Grain Size (B-1).cdr

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description	LL	PL	PI	-200	USCS
● Source: Sample No.: Composite Clayey, very sandy SILT	42	34	8	67.1	ML

Remarks:
●

Project: Randle Reef Geotechnical Lab Testing

Client: AMEC

Location: Hamilton, Ontario, Canada

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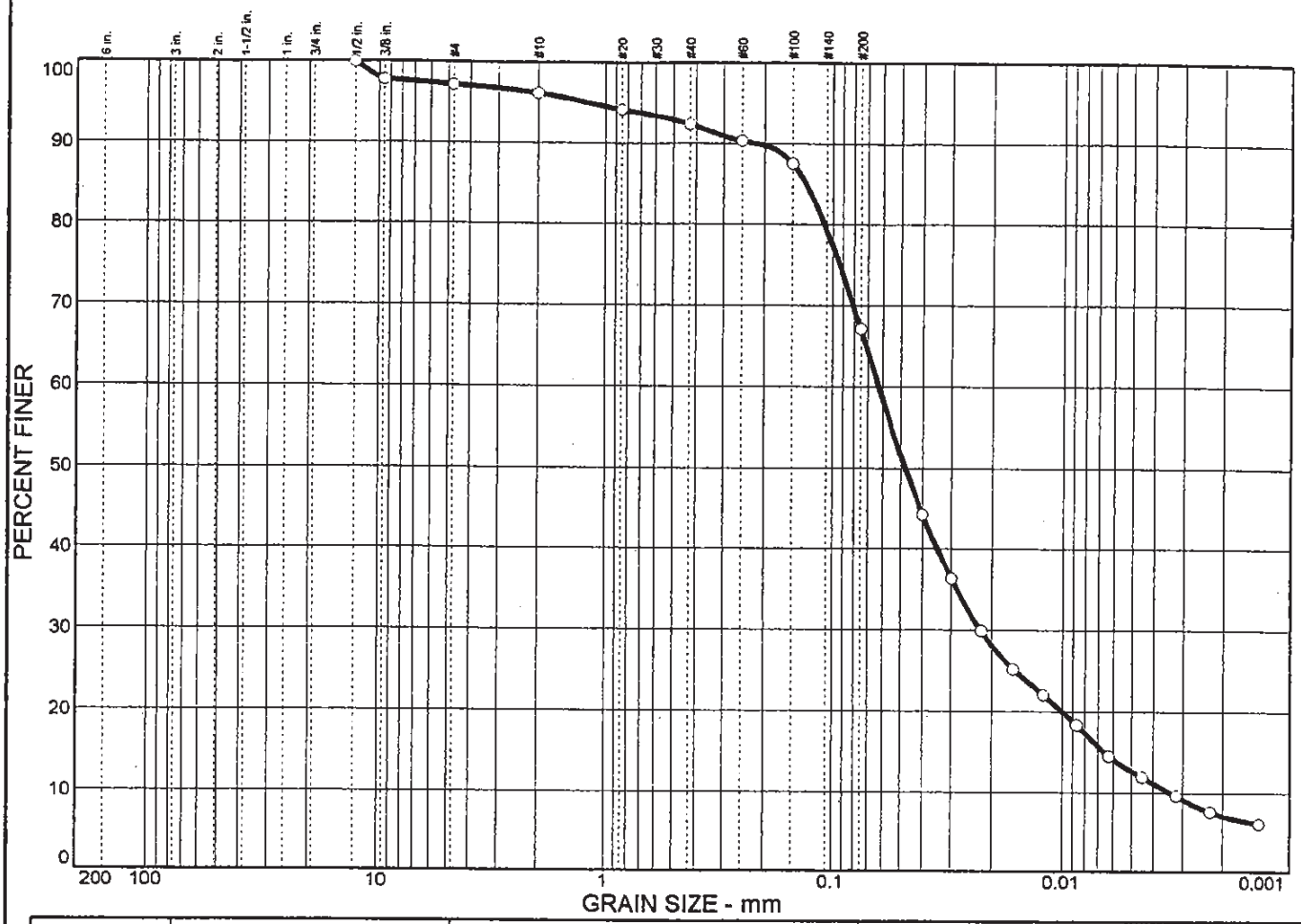
797901 2/13/2004

Figure No. 2

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	2.8	30.1	54.4	12.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	42	8	0.132	0.0624	0.0478	0.0223	0.0066	0.0034	2.34	18.35

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○ Clayey, very sandy SILT	ML	106%

Remarks:

○

Project: Randle Reef Geotechnical Lab Testing

Client: AMEC

○ **Source:** **Sample No.:** Composite

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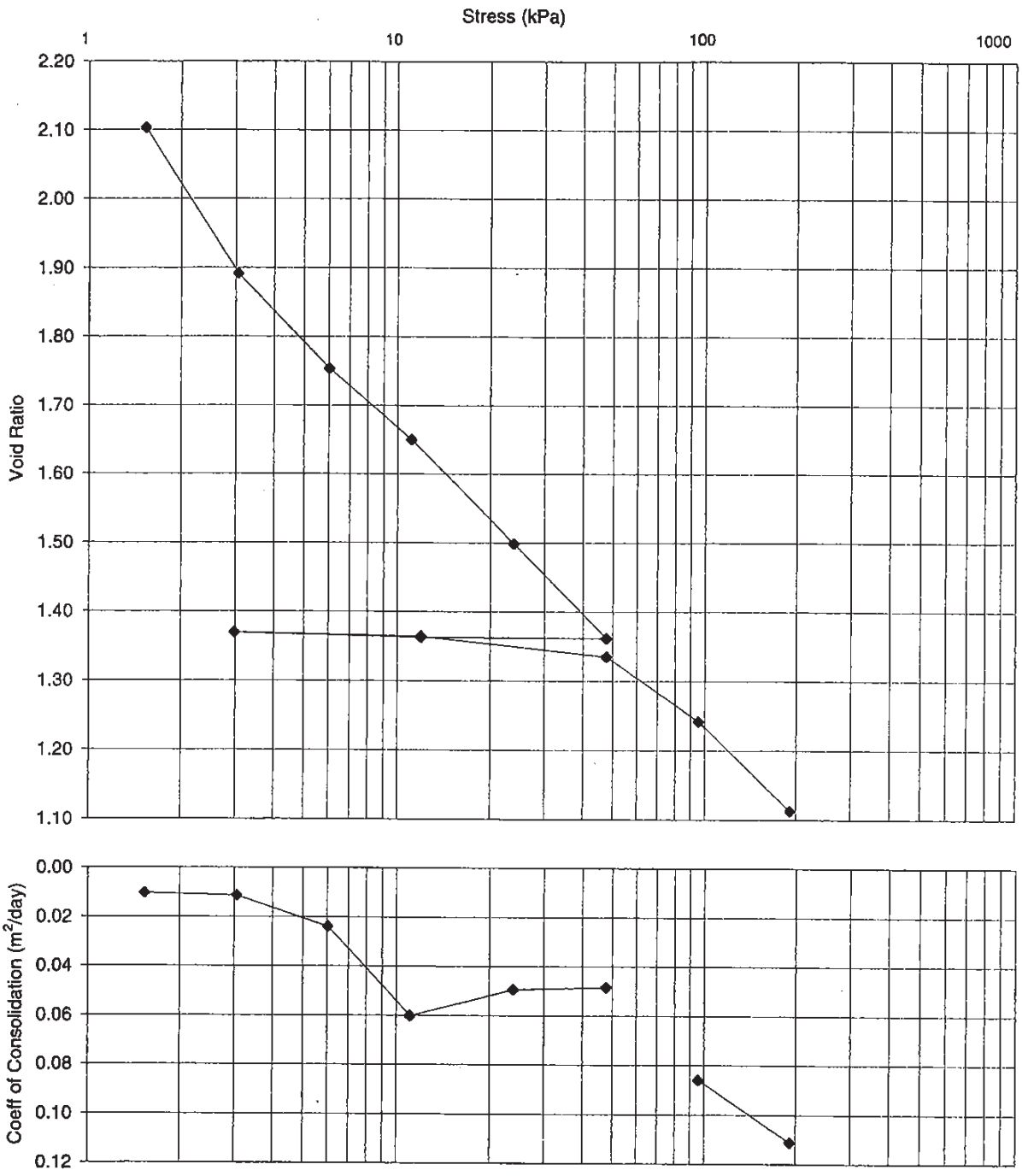
797901 2/13/2004

Figure No. 3

CONSOLIDATION TEST RESULTS



Expl. No.	Sample No.	Depth (ft)	W.C. %		Atterberg Limit			Wet Wt (pcf)	USCS	Description
			Before	After	LL	PL	PI			
AMEC	Comp.	-	106%	39%	42	34	8	15.7 KN/m^3	ML	Clayey, very sandy SILT

Remarks: Test to simulate behavior of "mechanically dredged material".

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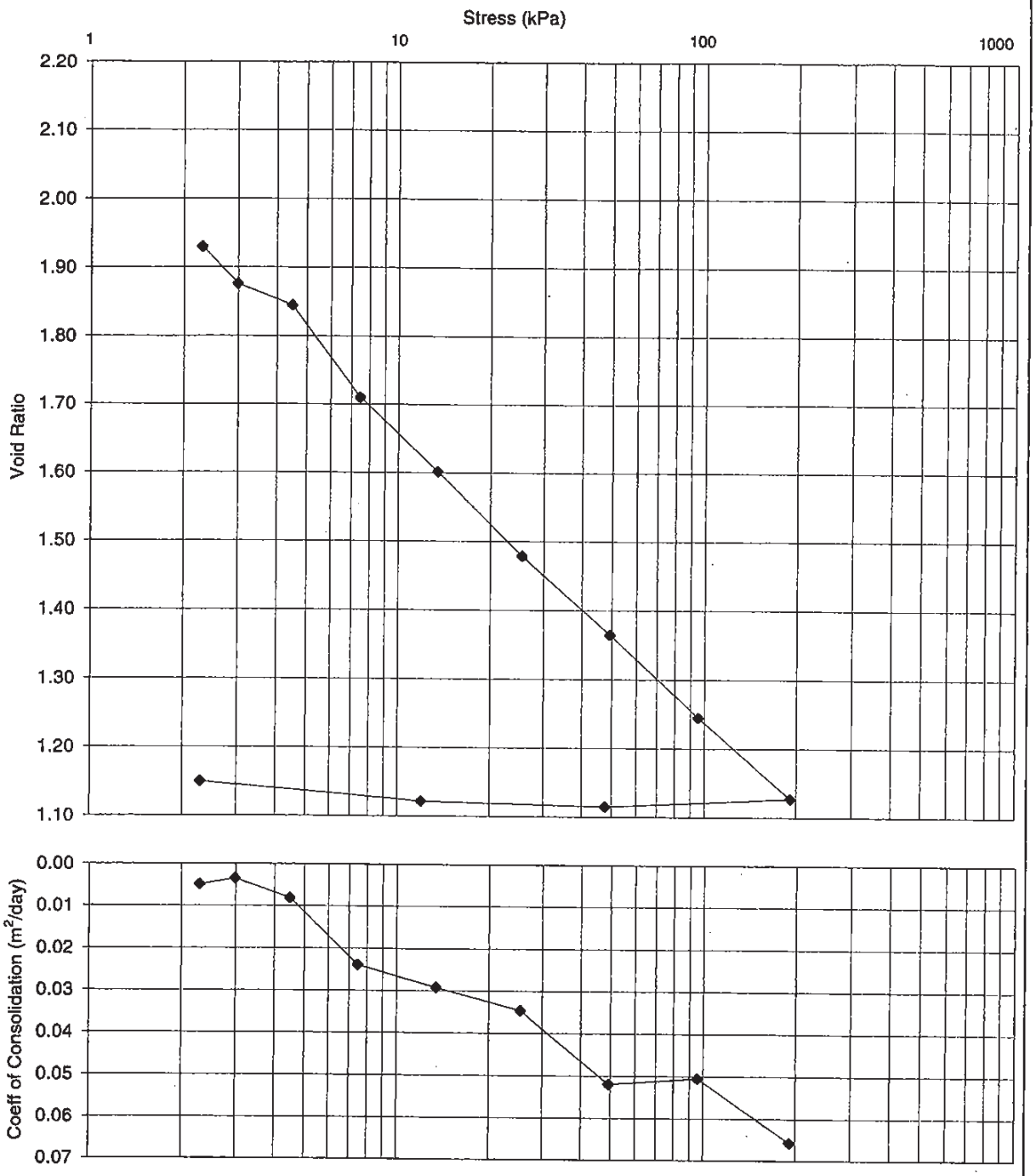
J-7979-01 1/13/2004

Figure 4

CONSOLIDATION TEST RESULTS



Expl. No.	Sample No.	Depth (ft)	W.C. %		Atterberg Limit			Wet Wt (pcf)	USCS	Description
			Before	After	LL	PL	PI			
AMEC	Comp.	-	113%	39%	42	34	8	14.1 KN/m^3	ML	Clayey, very sandy SILT

Remarks: Test to simulate behavior of "hydraulically dredged material". Test was conducted on material from the self-weight settlement test column.

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J-7979-01 2/5/2004

Figure 5

ATTACHMENT A
OTHER LABORATORY TEST RESULTS

Randle Reef - Self-Weight Settlement Test Data - Composite Sediment Sample

Date and Time	Measured Soil Water Interface Height from Base in Feet	Height of Top of Water Column in Feet	Water/Zone Settling Interface Height in Feet
1/20/2004 10:37	4.950	4.950	
1/20/2004 11:37	3.020	4.930	
1/20/2004 12:37	2.260	4.930	
1/20/2004 13:37	1.820	4.920	
1/20/2004 14:37	1.660	4.920	
1/20/2004 15:37	1.590	4.920	
1/20/2004 16:37	1.550	4.920	
1/21/2004 6:14	1.230	4.910	
1/21/2004 17:21	1.150	4.910	
1/22/2004 6:23	1.100	4.910	
1/22/2004 15:32	1.065	4.910	
1/23/2004 8:25	1.035	4.910	
1/23/2004 14:05	1.030	4.910	4.790
1/26/2004 8:40	1.000	4.900	
1/28/2004 8:03	0.990	4.910	4.460
1/30/2004 8:34	0.995	4.910	4.210
2/2/2004 7:20	0.995	4.910	3.850
2/4/2004 10:40	0.995	4.910	0.995

Other Data:
Diameter of Column - 8.00 inches
Initial dry weight of sediment - 6250 grams
Initial weight of water - 43755 grams
Specific gravity of sediment - 2.68
Solids retained in water at end of test - 0.7 mg/L
Add base measuring point correction to height readings to get actual height
Distance of base measuring point from actual bottom of column - 0.012 feet

Specific Gravity

Date: 2/3/2004

Job Name: Randle Reef Geotechnical Testing

Job No: 7979-01

Boring Number	----	----	----	----	----	----	
Sample ID	Composite						
Depth (feet)	----						
Flask Number	B-2						
Tx (Centigrade)	21.1						
Tare ID	SA-27						
Tare Wt	377.29						
Wo + Tare	525.75						
Wo (gm)	148.46						
Wa (gm)	661.83						
Wo + Wa	810.29						-
Wb (gm)	754.92						-
Wo + Wa - Wb	55.37						
K	0.99977						-
Gs	2.68						-

Gs = Wo /(Wo+Wa-Wb) * K

Gs = Specific gravity of soil
Tx = Temperature of contents of Volumetric Flask when Wb was determined
Wo = Weight of oven dry sample
Wa = Weight of Volumetric Flask filled with water at Tx
Wb = Weight of Volumetric Flask filled with water and soil at Tx
K = Correction coefficient for density of water at Tx

Tested By: GWK

Organic Content

Job Name: Randle Reef

Job No: 797901

Sample Number	Geotech					
Boring Number	Composite					
Depth						
Tare ID	V					
Tare Wt	162.04					
Dry + Tare	200.69					
Dry + Tare, After Ashing	198.51					
% Organic Content	6 %	-	-	-	-	-

Tst By: GWK

Chk By: GWK

APPENDIX E – REPORT LIMITATIONS

REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.

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 stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AMEC Earth & Environmental Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix B
Geotechnical Investigations

ITEM B5
Excerpts from: Trow Consulting Engineers Ltd. - Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour Pier 16, Hamilton, Ontario, August 1999.

Trow

Geotechnical Sampling of Sediment Dredging of Hamilton Harbour Pier 16 Hamilton, Ontario

Prepared for:

Mr. J. Shaw
Chief, Great Lakes 2000 Clean-up Fund
867 Lakeshore Road
Burlington, Ontario
L7R 4A6

Trow Consulting Engineers Ltd.

428 Millen Road
Stoney Creek, Ontario L8E 3N9
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HAGE-0053319-A
August 10, 1999

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Summary Table of Sampling Parameters ..... Appendix A

1. Introduction

Trow Consulting Engineers Ltd. (Trow) was retained by the Great Lakes 2000 Clean-up Fund to conduct geotechnical sampling of sediment west of Pier 16 within the Hamilton Harbour for the purpose of assessing dredging operations in Hamilton, Ontario (Drawing No. 1). Authorization to proceed with the investigation was provided by Mr. John Shaw Chief of the Great Lakes 2000 Clean-up Fund.

The project will involve the dredging of an area immediately adjacent to Pier 16 on the west side and north of the mouth of the former Sherman Inlet. This area is also known as The Randel Reef. It is understood that the proposed area to be dredged was previously sampled and analytical testing was conducted by others. The previously sampled boreholes met refusal at depths of up to 2.1 m within or on an unknown material. The purpose of this investigation was to determine the geotechnical engineering properties of the unknown materials where refusal was met during the initial sampling program.

2. Terms of Reference

The geotechnical investigation was undertaken to:

a) establish the sediment and/or soil conditions at the site based on drilling eight (8) boreholes (each to 4 m (13 ft.) depth below harbour bottom) at locations specified by the Client, and

b) provide geotechnical engineering recommendations regarding dredging operations.

The following modifications to the terms of reference were made:

a) Nine (9) boreholes were drilled instead of eight (8). The boreholes extended to depths of 2.4 (~7' 10") to 4.9 (~16' 1") m below harbour bottom.

b) Based on subsequent discussions with the Client, geotechnical engineering recommendations regarding dredging operations are not required at this time. The report should be factual in nature.

c) The laboratory testing program was to consist of natural moisture content tests on all recovered soil and sediment samples. In addition, grain size analysis, Atterberg Limits and unit weights on selected soil samples was proposed.

   Based on subsequent meetings and correspondences with the Client, it was determined that additional laboratory testing was not required at this time and hence, grain size analysis, Atterberg Limit and unit weights were eliminated from the program. The samples will be retained for up to 3 months from the date of sample collection in Trow's laboratory. The samples will be discarded beyond this time period unless a longer retention time is requested by the Client.

   Environmental testing was not conducted as part of this sampling program, hence, this report does not reflect the environmental conditions at the site.

3. Investigation Program

3.1 Fieldwork

The fieldwork for this investigation was carried out from April 19 to 26, 1999. In accordance with the terms of reference (TOR), and subsequent modifications, nine (9) boreholes were located within the area to be investigated. The borehole locations are shown on Drawing No. 2. The boreholes were advanced by N-casing using equipment owned and operated by a specialized drilling subcontractor, under the full-time monitoring by Trow Consulting Engineers Ltd.

As requested, nine (9) boreholes were drilled at the proposed borehole locations shown on Drawing No. 2. Each borehole was advanced to depths ranging from 2.4 (~7' 10") to 4.9 (~16' 1") m below the harbour bottom, Elevation 61.3 to 65.0 m. The boreholes were advanced by means of a drill rig adapted for soil sampling mounted on the front of a spud barge.

The fieldwork was monitored by a member of Trow's engineering staff who directed the drilling and sampling operations, and documented the stratigraphy encountered at the boreholes.

Soil samples were retrieved on a continuous basis by using the split spoon sampler driven in accordance with the standard penetration test procedures. The undrained shear strength of the cohesive soils was measured using a field vane and pocket penetrometer. Poor sample recovery during the early stages of the fieldwork indicated other sampling equipment such as thin walled tubes (shelby tubes), piston samplers and side samplers were necessary to obtain sufficient sample recovery.

The borehole locations were established in the field by Trow Consulting Engineers Ltd. utilizing a Global Positioning System unit (GPS) supplied by the Canada Centre For Inland Waters (CCIW), Technical Operations Division. Antennae and receivers for the GPS unit were mounted on the top of the drill rig mast. Final borehole position co-ordinates (northing and eastings) were recorded once the spuds from the barge were set in the lake bottom and locations ranged from 0.2 to 5.7 m out of proposed layout centres. Final positions of each borehole are recorded on each borehole log.

The borehole elevations were determined from lake level elevations (on the days the fieldwork was conducted) provided by CCIW.

4. Summarized Subsurface Soil Conditions

Details of the fieldwork including soil descriptions, inferred stratigraphy, sampling methods, standard penetration 'N' values, shear strengths, and sampling method in the boreholes during and following completion of drilling are given on the Log of Borehole sheets, (Drawing Nos. 3 to 11). A summary of the borehole information is also presented in tabular form in Appendix A.

It must be noted that the boundaries of soil indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purposes of geotechnical assessment and should not be interpreted as exact planes of geological change. It should be noted that the "Notes on Sample Description", preceding the borehole logs, forms an integral part of the report and should be read in conjunction with it.

A brief description of the soils stratigraphy encountered at the borehole locations is summarized, in order of depth, in the following sections.

4.1 Water

The depth of water at each borehole location was determined by CCIW - Technical Operations Division prior to drilling. The lake level elevations were in the order of Elevation 74.7 m. The depth of water varied from approximately 6.0 to 11.0 m below the mean water level of the lake. At the borehole locations, the harbour bottom was contacted at Elevation 63.7 to 68.7 m.

4.2 Fill

A layer of fill was encountered at the surface of each borehole (ie. the harbour bottom) and ranges from approximately 0.8 to 3.4 m depth below harbour bottom, Elevation 62.5 to 66.5 m. The fill was not penetrated in Borehole Nos. 28 and 13. In general, the fill consists of a heterogeneous mixture of sandy silt to silt sediment, dark grey to black in colour with some fragments of coal tar, slag and trace organics (wood, rootlets). Numerous fragments of suspected slag were encountered in the fill within Borehole Nos. 28 and 13. The fill had significant coal tar (hydrocarbon) stains and odours. The compactness condition of the cohesionless portion of the fill based on SPT results of Borehole Nos. 28 and 13 is very loose to compact. The consistency of the cohesive portion based on shear strength measurements (from field vane tests) of 20 to greater than 115 kPa is soft to very stiff. The moisture content of the fill is 13 to 292 percent.

Sandy Silt to Silty Sand

A layer of sandy silt to silty sand was encountered beneath the fill in Borehole Nos. 11 and 18 and extended to 1.8 and 4.3 m depth below harbour bottom, Elevation 63.9 and 63.4 m. This layer was also encountered in Borehole No. 21 below the clay at 2.2 m depth below harbour bottom, Elevation 61.5 m. In general, this layer is described as a grey to brown sandy silt to silty sand with trace gravel, trace organics (shells, rootlets in Borehole No. 18) with no coal tar (hydrocarbons) stains or odours. Based on SPT N values from Borehole Nos. 11 and 18, the compactness condition of the sandy silt to silty sand is loose to dense and the natural moisture content ranges from 16 to 29 percent.

Clay

Beneath the fill in Borehole Nos. 154, 6, 22 and 21 and beneath a layer of sandy silt to silty sand in Borehole No. 11 exists a grey clay layer. The clay was penetrated in Borehole No. 21 at 2.2 m depth below harbour bottom, Elevation 61.5 m. In general, the clay is described as grey with trace silt and sand having no stains or odours and becoming till-like with trace to some sand and gravel in Boreholes No. 22 and 21. The undrained shear strength of the clay, based on field vane and pocket penetrometer tests was up to 115 kPa which indicates a very soft to very stiff consistency. The sensitivity of the clay was 1.0 to 9.2 indicating a low to highly sensitive clay. The natural moisture content of the clay ranges from 23 to 37 percent.

Organic Silt

Beneath the layer of fill within Borehole No. 14 and beneath a layer of silty sand within Borehole No. 18, a layer of organic silt was encountered at depths of 2.5 and 4.3 m below harbour bottom, Elevation 63.4 and 65.2 m. Both boreholes terminated within this layer. In general, this layer is described as a greeenish grey to grey organic silt with trace to some sand and gravel, trace organics (wood, rootlets). The silt has a spongy texture with organic stains, slight coal tar (hydrocarbon) stains and odours. Based on field vane tests from Borehole No. 14, the measured shear strength of the organic silt is 70 to 110 kPa indicating a consistency of stiff to very stiff. The natural moisture content of the silt is 69 to 87 percent.

5. Environmental Considerations

The disposal of any excess material is regulated by the current provincial government environmental regulations. If any of the excess material is disposed of off-site, the material should be tested so that the disposal of such material will be carried out in compliance with the environmental guidelines. Ontario Regulation 347 (O.Reg. 347) would apply. Trow will composite and retain the excess samples collected during this investigation and submit composite samples for O.Reg. 347 testing (leachate chemistry) to assess disposal options.

We trust this information is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

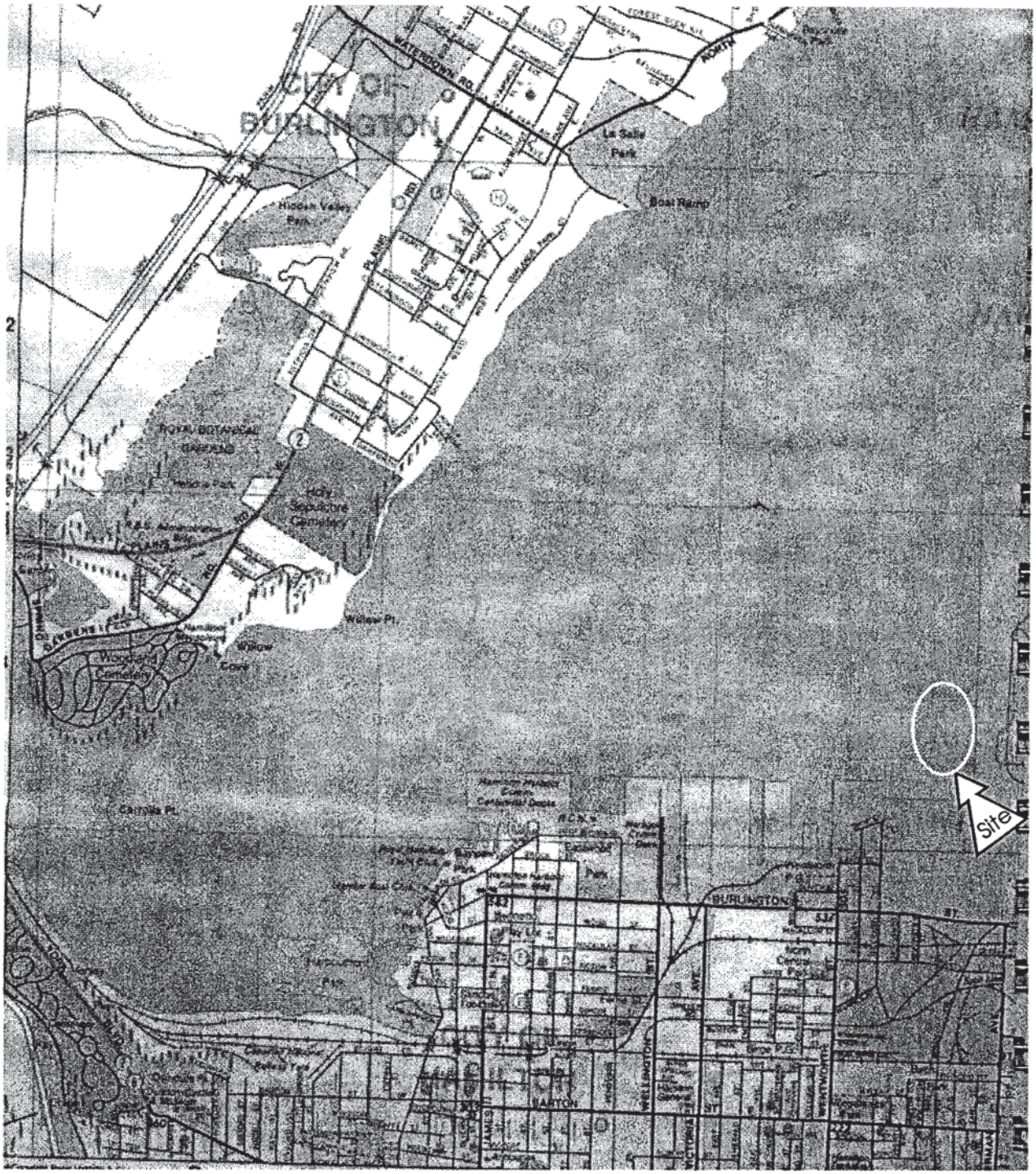
Yours very truly,

Trow Consulting Engineers Ltd.

Todd Barlow, P.Eng.
Field Engineer
Geotechnical Services Group

S. M. Potyondy, P.Eng.
Head, Geotechnical Services Group

Drawings:

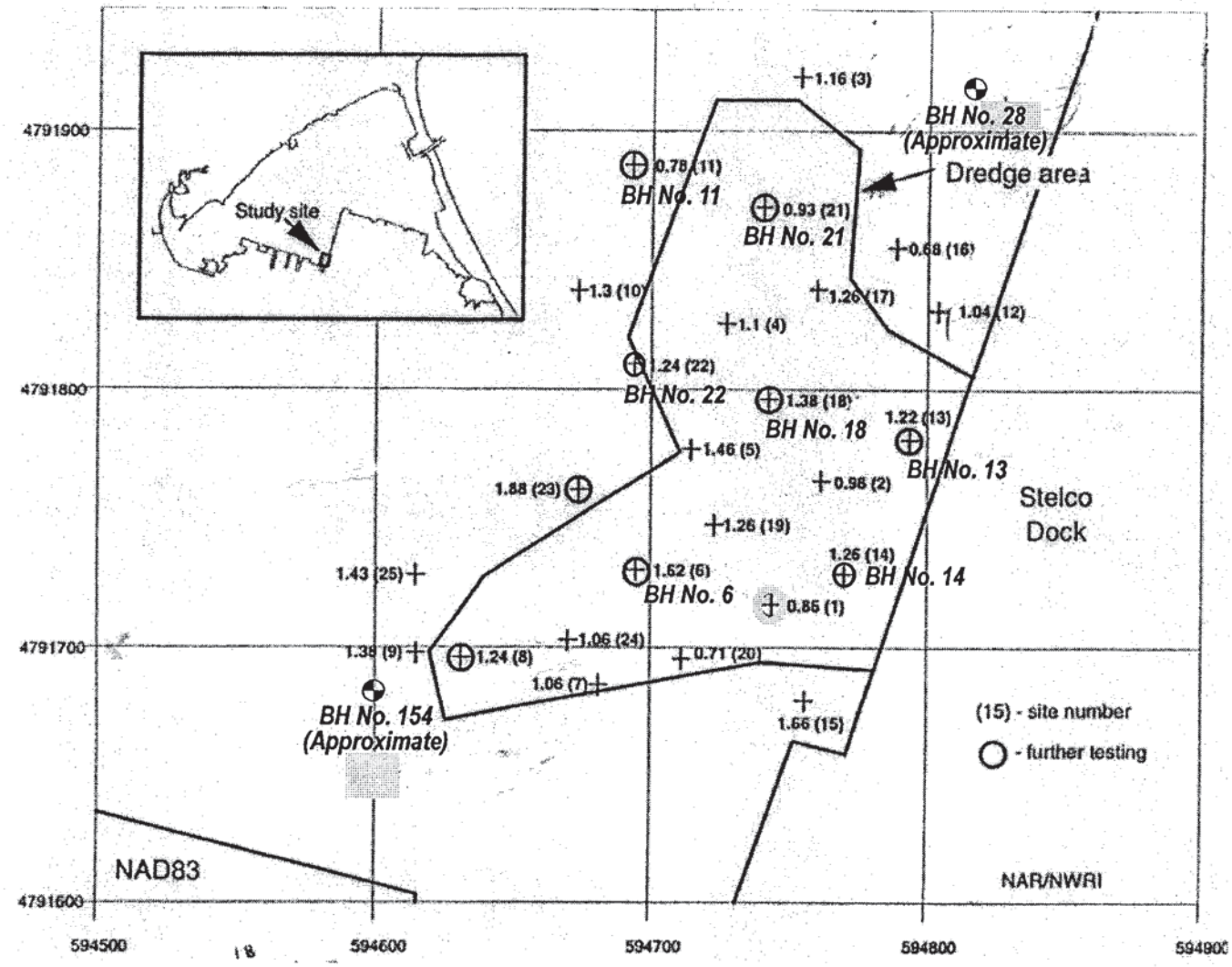


Geotechnical Sampling of Sediment
Derdging of Hamilton Harbour, Pier 16,
Hamilton, Ontario
HAGE-0053319-A/E

Location Plan

Drawing No. 1
August, 1999

TROW CONSULTING ENGINEERS LTD.



Note:

Site Plan Modified as supplied to Trow by CCIW via the Great Lakes 2000 Clean-Up Fund.

LEGEND

- Borehole Location Corresponding to CCIW Site No.

* All Dimensions are Approximate as Shown.

Notes:

1) Boundaries and soil types have been established only at Borehole locations.
Between Boreholes they are assumed and may be subject to considerable error.
2) Soil Samples will be retained in storage for 3 months and then destroyed unless the client advises otherwise.
3) Topsoil quantities should not be established from the information provided at the Borehole locations.
4) Borehole elevations should not be used to design building(s), or floor slab(s), or parking lot(s) grades.

Geotechnical Sampling of Sediment
Dredging of Hamilton Harbour, Pier 16,
Hamilton, Ontario
HAEN-0053319-A/E

Site Plan

Drawing No. 2
August, 1999
N.T.S.

TROW CONSULTING ENGINEERS LTD.

NOTES ON SAMPLE DESCRIPTIONS

Trow

1. All sample descriptions included in this report follow the Canadian Foundation Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Trow also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60 200

EQUIVALENT GRAIN DIAMETER IN MILLIMTERES

CLAY (Plastic) to	FINE	MEDIUM	COARSE	FINE	COARSE	
SILT (Non Plastic)	SAND			GRAVEL		

UNIFIED SOIL CLASSIFICATION

2. **Fill:** Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstructions such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. **Till:** The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

LOG OF BOREHOLE 28

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 3
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 856.0 m
N 4 791 976.7 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa) 20 40 60 80 / 100 200	Natural Moisture Content % Dry Weight 10 20 30	Sample
	74.66	Approximate Depth of Water = 10.0 m (as reported by CCIW - Tech Ops.)						
	~64.7 ~(10.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, numerous fragments of slag, trace fragments of coal tar, (sand to cobble size), coal tar (hydrocarbon) stains and odours, very loose to compact, wet.	10	32	6	o	X = 130%	
		- limited sample recovery due to suspected presence of slag throughout, based on drilling and sampling observations in the field.	11	34 36	8	o	X	
				38	23	o	X	
		- heterogenous mixture of silty sand to clayey silt, dark brown to black, with oxidized and coal tar stains and odours and numerous fragments of slag from 11.7 to 12.4 m depth.	12	40	2	o	X	
	~62.3 ~(12.4)	*BOREHOLE TERMINATED*						
			13	42				
				44				
			14	46				

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 2.4 m below the Lake bottom or at 12.4 m depth from top of water level in lake on April 19, 1999.
2. Borehole advanced by means of wash-boring techniques (where applicable).

LOG OF BOREHOLE 13

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 4
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 792.9 m
N 4 791 783.1 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.66	Approximate Depth of Water = 9.0 m (as reported by CCIW - Tech Ops.)		28				
	~65.7 ~(9.0)	FILL: Sandy Silt to Clayey Silt Sediment and coal tar sludge, black, numerous fragments of slag, trace fragments of coal tar, (sand to cobble size), coal tar (hydrocarbon) stains and odours, loose to compact, stiff to very stiff, wet.	9	30	-		*Benthos Sample Retrieved from CCIW - Tech Ops. from 0 to 0.3 m depth below lake bottom or approx. 9.0 to 9.3 m depth from top of water level in lake* X = 68%	
		- limited sample recovery due to suspected presence of slag throughout, based on drilling and sampling observations in the field.	10	32	23	o	X = 73%	
		-mixed with trace to some organics (wood) and organic silt from 9.6 to 11.4 m depth.		34		+ > 115 kPa		
					15	o + s = 2.2	X = 58%	
			11	36	5	o + s = 9.2	X = 51%	
		-heterogenous mixture of silty sand, dark brown to black, with coal tar stains and odours and numerous fragments of slag from 11.4 to 12.7 m depth.		38	13	o	X = 59%	
			12	40	8	o	X = No sample for Moisture Content Retained - Large Fragment of Slag	
	~62.0 ~(12.7)	*BOREHOLE TERMINATED*		42				
			13					
				44				

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 3.7 m below the Lake bottom or 12.7 m depth from top of water level in lake on April 19 and 20, 1999.
2. Borehole advanced by means of wash-boring techniques (where applicable).

LOG OF BOREHOLE 14

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 5
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 778.6 m
N 4 791 724.3 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.66	Approximate Depth of Water = 7.0 m (as reported by CCIW - Tech Ops.)						
	~67.7 ~(7.0)	FILL: Sandy Silt to Clayey Silt Sediment and coal tar sludge, black, trace fragments of slag, and coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, firm to stiff, wet.	7	22				
				24	-			
			8	26	-			
		-heavy coal tar sludge (thick) from 7.6 to 9.5 m depth below lake bottom.		28	-	$+_s$ = 2.5		
			9	30	-	$+_s$ = 9.4		
						$+_s$ = 3.0		
	~65.2 ~(9.5)	ORGANIC CLAYEY SILT: Greenish-grey to grey, trace to some sand, trace gravel, trace organics (wood, rootlets), spongy texture, organic stains, slight coal tar odour, stiff to very stiff, moist to wet.	10	32	5	$+_s$ = 3.1		
						$+_s$ = 1.8		
				34	pushed spoon	$+_s$ = 1.5		
	~64.0 ~(10.7)	- soil type from 10.7 to 11.0 m depth assumed to be organic clayey silt.	11	36		$+_s$ = 1.7		
	~63.7 ~(11.0)	*BOREHOLE TERMINATED*				$+_s$ = 1.9		

Benthos Sample Retrieved from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottomor approx. 7.0 to 7.6 m depth from top of water level in lake.

X = No Sample for Moisture Content Retained

X = 90%
X = 63.5%
X = 56%
X = 98%
X = 69%

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 4.0 m below the Lake bottom or 11.0 depth from top of water level in lake on April 20 and 21, 1999
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).
3. Vane Profile Hole conducted approximately 0.3 m to the south of existing hole.

LOG OF BOREHOLE 154

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 6
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 604.1 m
N 4 791 677.5 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.66	Approximate Depth of Water = 6.0 m (as reported by CCIW - Tech Ops.)						
	~68.7 ~(6.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, wet.	6	20	-		*Benthos Sample Retrived from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottom or approx. 6.0 to 6.6 m depth from top of water level in lake.* X = 135%	
				22				
			7		-		X = 129%	
		-heavy coal tar sludge (thick) from 6.6 to 8.2 m depth.		24				
					-		X = 123%	
			8	26				
	~66.5 ~(8.2)	CLAY: Grey, trace silt and sand, no stains or odours, firm, moist to wet.			-		X	
				28				
					-	$+_s$ = 1.5	X	
			9	30				
					-	$+_s$ = 1.5	X	
	~65.0 ~(9.7)	*BOREHOLE TERMINATED*		32				
			10					
				34				

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 3.7 m below the Lake bottom or 9.7 m from top of water level in lake on April 22, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).

LOG OF BOREHOLE 6

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 7
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 692.1 m
N 4 791 733.6 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.67	Approximate Depth of Water = 7.0 m (as reported by CCIW - Tech Ops.)		22			*Benthos Sample Retrived from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottom o approx. 7.0 to 7.6 m depth from top of water level in lake.*	
	~67.7 ~(7.0)	FILL: Sandy Silt to Clayey Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, soft to firm, wet.	7	24	-		X = No Sample for Moisture Content Retained	
			8	26	-		X = 129%	
						$+_s$ = 1.0		
				28	-	$+_s$ = 1.2	X = 88%	
						$+_s$ = 1.6		
			9	30	-	$+_s$ = 9.2	X = 156%	
						$+_s$ = 9.2		
		-becoming coal tar sludge mixed with dark grey to grey clay from 9.4 to 10.2 m depth.		32	-	$+_s$ = 0.8	X = 135%	
			10			$+_s$ = 3.2		
	~64.5 ~(10.2)	CLAY: Grey, trace silt and sand, no stains or odours, stiff, moist to wet.		34	-	$+_s$ = 1.6	X	
						$+_s$ = 1.7		
			11	36	-	$+_s$ = 1.6	X	
						$+_s$ = 1.3		
	~63.1 ~(11.6)	*BOREHOLE TERMINATED*		38		$+_s$ = 1.3		

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 4.3 m below the Lake bottom or 11.6 m depth from top of water level in lake on April 22 and 23, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).
3. Vane Profile Hole conducted approximately 0.3 m south of the existing hole.

LOG OF BOREHOLE 18

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 8
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 750.1 m
N 4 791 792.3 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.67	Approximate Depth of Water = 7.0 m (as reported by CCIW - Tech Ops.)		22			*Benthos Sample Retrieved from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottom or approx. 7.0 to 7.6 m depth from top of water level in lake.*	
	~67.7 ~(7.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, wet.	7	24	-			
			8	26	-		X = 88%	
	~66.5 ~(8.2)	FILL: Sand mixed with coal tar sludge, black, trace fragments of coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, wet.		28	-		X = 227%	
			9	30	-		X = 292%	
				32	-		X = 85%	
		-becoming thicker coal tar sludge from 9.9 to 10.4 m depth.	10					
	~64.3 ~(10.4)	SILTY SAND: Grey to brown, trace gravel, trace organics (shells, rootlets), no stains or odours, loose, moist to wet.		34	-		X	
			11	36	4	O	X	
	~63.4 ~(11.3)	ORGANIC SILT: Grey, trace sand and gravel, spongy texture, no stains or odours, wet.		38	-		X = 87%	
	~62.8 ~(11.9)	BOREHOLE TERMINATED	12					

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 4.9 m below the Lake bottom or 11.9 m depth from top pf water level in lake on April 23, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).

LOG OF BOREHOLE 11

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 9
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 691.6 m
N 4 791 887.2 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.67	Approximate Depth of Water = 9.0 m (as reported by CCIW - Tech Ops.)		28				
	~65.7 ~(9.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), coal tar (hydrocarbon) stains and odours, wet.	9	30	-		X = 128%	
	~64.9 ~(9.8)	SANDY SILT to SILTY SAND: Brown, no stains or odours, dilatent, compact to dense, moist to wet.	10	32	39	○	X	
		-increasing silt content from 10.4 to 10.8 m depth.		34	16	○	X	
	~63.9 ~(10.8)	CLAY: Grey, trace to some silt and sand, no stains or odours, stiff, moist.	11	36	-	$+_s$=1.6	X	
	~63.3 ~(11.4)	*BOREHOLE TERMINATED*		38				
			12	40				
				42				
			13					
				44				
			14					

Benthos Sample Retrieved by CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottom or approx. 9.0 to 9.6 m depth from top of water level in lake.

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 2.4 m below the Lake bottomor 11.4 m from top of water level in lake on April 26, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).

LOG OF BOREHOLE 22

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 10
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 694.0 m
N 4 791 811.8 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.67	Approximate Depth of Water = 9.0 m (as reported by CCIW - Tech Ops.)	9	28 30			*Benthos Sample Retrieved from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottomor approx. 9.0 to 9.6 m depth from top of water level in lake.*	
	~65.7 ~(9.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), trace organics (wood pieces), coal tar (hydrocarbon) stains and odours, wet.	10	32 34			X = 102% X = 183% X = 119%	
	~63.9 ~(10.8)	CLAY: Grey, trace to some silt and sand, trace gravel (Till-Like), no stains or odours, stiff to very stiff, wet.	11 12	36 38		+s = 2.8 ▲ +>115 kPa ▲	X X	
	~62.6 ~(12.1)	*BOREHOLE TERMINATED*	13 14	40 42 44				

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 3.1 m below the Lake bottom or 12.1 m depth from top of water level in lake on April 26, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).

LOG OF BOREHOLE 21

Trow

Piston Sample
Side Sampler
SPT(N) Value
Dynamic Cone Test
Shelby or BenthosTube
Field Vane Test
Natural Moisture
Plastic and Liquid Limit
Penetrometer

Project: Geotechnical Sampling of Sediment, Dredging of Hamilton Harbour, Pier 16, Hamilton, Ontario

Dwg. No: 11
Project No: HAGE0053319-A
Ground Elevation : N/A
Supervised By: T.B.

Borehole Location : E 594 745.7 m
N 4 791 875.1 m

Water Level	Elev. Scale (m)	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value / Shear Strength (kPa)	Natural Moisture Content % Dry Weight	Sample
	74.67	Approximate Depth of Water = 11.0 m (as reported by CCIW - Tech Ops.)					*Benthos Sample Retrieved from CCIW - Tech Ops. from 0 to 0.6 m depth below lake bottom or approx. 11.0 to 11.6 m depth from top of water level in lake*	
	~63.7 ~(11.0)	FILL: Sandy Silt to Silt Sediment and coal tar sludge, black, trace fragments of coal tar (sand size), coal tar (hydrocarbon) stains and odours, wet.	11	36	-		X = 167%	
				38				
			12		-		X = 46%	
	~62.5 ~(12.2)	CLAY: Grey, trace to some silt and sand, trace gravel (Till-Like), no stains or odours, very stiff, moist to wet.		40				
					-	+ >115 kPa	X	
				42		▲		
			13					
	~61.5 ~(13.2)	SILTY SAND: Brown, trace gravel, no stains or odours, moist to wet.			-	+ s = 3.6	X	
	~61.3 ~(13.4)	*BOREHOLE TERMINATED*		44				
			14	46				
				48				
			15					
				50				
				52				
			16					

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced using N-Casing to a termination depth of 2.4 m below the Lake bottom or 13.4 m depth from top of water level in lake on April 26, 1999.
2. Borehole advanced by means of tricone and wash-boring techniques (where applicable).

Appendix A:

Summary Table of Sampling Parameters

Table No. 1
Summary of Sampling Parameters

Borehole No. (Site No.)	Sample No. *	Sampler Type	Shear Strength (kPa)	SPT N-Value	% Moisture Content
28	1	Split Spoon	--	6	130.0
28	2	Split Spoon	--	8	20.0
28	3	Split Spoon	--	23	14.1
28	4	Split Spoon	--	2	23.4
13	1	Side Sampler	--	--	68.0
13	2	Split Spoon	>115	23	73.0
13	3	Side Sampler	50	15	58.0
13	4	Side Sampler	78	5	51.0
13	5	Side Sampler	--	13	59.0
13	6	Side Sampler	--	8	--
14	1	Piston Sampler	--	--	--
14	2	Piston Sampler	--	--	90.0
14	3	Side Sampler	23	--	63.5
14	4	Side Sampler	65	--	56.0
14	5	Side Sampler	65	5	98.0
14	6	Split Spoon	78	push	69.0
154	1	Side Sampler	--	--	135.0
154	2	Side Sampler	--	--	129.0
154	3	Side Sampler	--	--	123.0
154	4	Shelby Tube	--	--	38.0
154	5	Shelby Tube	41	--	26.1
154	6	Shelby Tube	46	--	28.9
6	1	Benthos Tube	--	--	--
6	2	Side Sampler	--	--	129.0
6	3	Side Sampler	14	--	88.0
6	4	Side Sampler	9	--	156.0
6	5	Side Sampler	9	--	135.0
6	6	Shelby Tube	55	--	27.0
6	7	Shelby Tube	65	--	28.0

Table No. 1 (cont'd)
Summary of Sampling Parameters

Borehole No. (Site No.)	Sample No. *	Sampler Type	Shear Strength (kPa)	SPT N-Value	% Moisture Content
18	1	Benthos Tube	--	--	--
18	2	Side Sampler	--	--	88.0
18	3	Side Sampler	--	--	227.0
18	4	Side Sampler	--	--	292.0
18	5	Side Sampler	--	--	85.0
18	6	Shelby Tube	--	--	26.4
18	7	Split Spoon	--	4	29.3
18	8	Shelby Tube	--	--	87.0
11	1	Benthos Tube	--	--	128.0
11	2	Split Spoon	--	39	17.6
11	3	Split Spoon	--	16	18.3
11	4	Shelby Tube	83	--	23.4
22	1	Benthos Tube	--	--	102.0
22	2	Side Sampler	--	--	183.0
22	3	Side Sampler	--	--	119.0
22	4	Shelby Tube	97	--	36.0
22	5	Shelby Tube	>115	--	36.0
21	1	Benthos Tube	--	--	167.0
21	2	Side Sampler	--	--	46.0
21	3	Shelby Tube	>115	--	21.0
21	4	Shelby Tube	115	--	27.7

* Samples attempted at 0.6 m (2 ft.) depth intervals, therefore Sample No. 1 = 0' to 2', Sample No. 2 = 2' to 4', Sample No. 3 = 4' to 6' .....etc.

Appendix B
Geotechnical Investigations

ITEM B6
Excerpts part plan drawing from : H.G. Arces & Company Ltd. Consulting Engineers - International Harvester Company of Canada Ltd., Hamilton, Ontario, Waterfront Construction, dated May 12, 1954.

12

EL. 2500'

EL. 246.9'

0.0

WATER

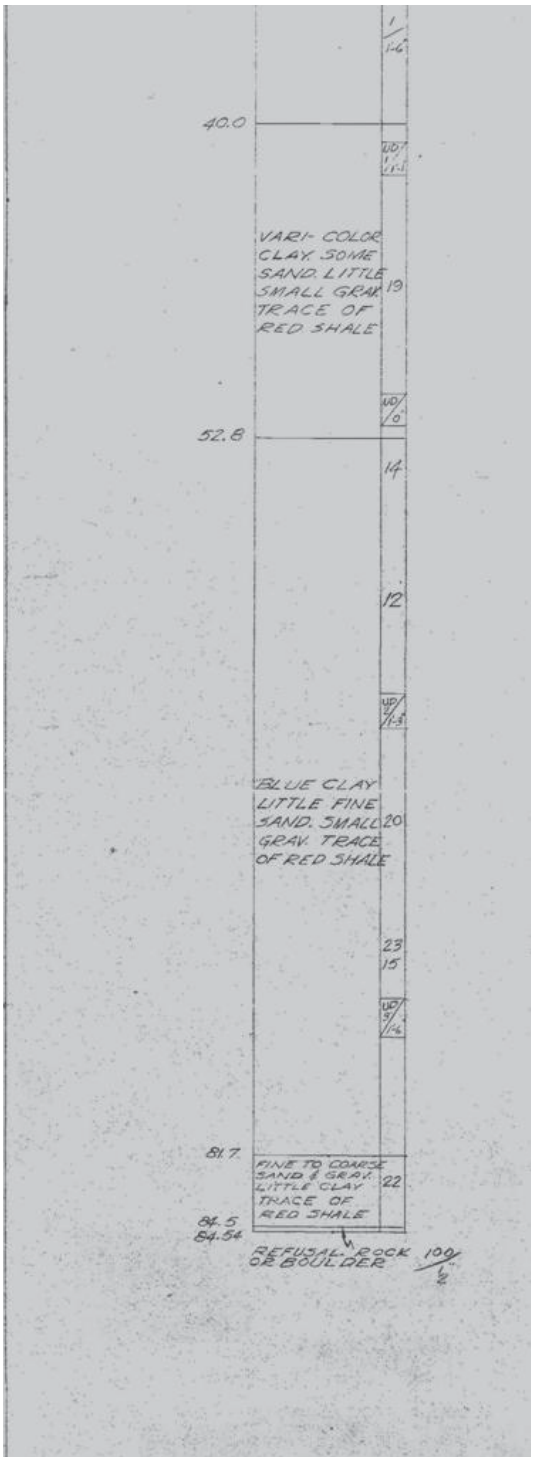
23.0

VERY SOFT VARI-COLOR SILTY MARL

1/2-2

1/1-6

40.0

UD/1/1-1

VARI-COLOR CLAY SOME SAND. LITTLE SMALL GRAV. TRACE OF RED SHALE