

Geocres No.
31L-74

Ministry of Transportation

Northern Region
North Bay, Ontario

Powassan Patrol Yard
Geocres No. 31L-74

Foundation Investigation Report Sand/Salt Storage Structure

FINAL

January 30, 2001



Acres International
Oakville, Ontario, Canada

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Part 1 Foundation Investigations

1 Introduction

Acres International (Acres) was retained by the Ministry of Transportation Ontario (MTO) to undertake foundation investigations and testing, and preparation of geotechnical reports for Highway (Hwy) 510 swamp and Hwy 607A swamp and three sand/salt storage structures located in the Northern Region. The work was authorized by MTO Agreement PO5005A000167 dated June 2000. The Terms of Reference also included the evaluation of potential impact of the storage of deicing salts on the quality of shallow water in the ground at the site.

This report presents the results of foundation investigations at one of the proposed sand/salt storage structures located at the MTO Patrol Yard in Powassan, Northern Ontario.

2 Site Description

The Powassan Patrol Yard is located adjacent to Hwy 11 about 35 km south of North Bay and about 1 km north of the intersection of Hwy 534 and Hwy 64 as shown in Figure 1.

The site of the storage structure is situated in an MTO operating maintenance patrol yard. It is fully fenced and accessed from Hwy 11. The yard contains 2 existing 30-m dia sand/salt structures, a 5-bay garage, 1 storage shed and 1 large single bay garage, Figure 1. Access roads to these facilities are all paved with asphalt.

The new sand/salt structure is proposed to be located directly north of the existing sand/salt structures. The Powassan Yard is situated on a fill sloping from the east to west with a maximum height of 3.5 m above original ground at the east end of the yard. Stockpiles of sand exist east of the proposed new storage dome.

3 Investigation Procedures

3.1 Field Investigations

The site investigations were carried out on August 2, 2000. A total of four boreholes, numbered BH-1 to BH-4, were drilled at the locations shown in Figure 1. The boreholes were advanced to depths ranging from 6.7 to 14.3 m using a truck-mounted continuous flight hollow-stem augering equipment owned and operated by Boart Longyear Inc. (Boart) of Maple, Ontario. Soil samples were obtained at approximately 0.75- and 1.5-m intervals using a split-spoon sampler in conjunction with Standard Penetration Test (SPT), performed in accordance with ASTM D1586 Designation. SPT 'N' values were recorded and used to provide an estimate of the relative denseness of the cohesionless soils and consistency of cohesive soils.

A representative of Acres was present throughout the drilling period to monitor and inspect drilling and sampling operations. All soil samples were identified and described in the field, and subsequently transported to Acres Geotechnical Laboratory in Niagara Falls for further detailed examination and laboratory testing.

A summary of borehole data is given in Table 1. Detailed information on the boreholes is presented in the Record of Boreholes in Appendix A.

As per MTO guidelines and OHBDC standards, soil samples were classified according to Unified Soil Classification Systems. The clay content reported as per MTO format in Record of Boreholes forms is based on grain size less than 0.002 mm.

At the request of the MTO Northern Region, Acres' staff collected a water sample from the Powassan Patrol Yard for chemical analysis. This was done to obtain a preliminary evaluation of the potential impact on groundwater quality as a result of the use and/or storage of de-icing salts at the site. It had been planned that such a sample would be taken from a standpipe piezometer installed in a borehole, however, significant groundwater was not encountered during drilling. Consequently, the water sample was taken from an existing drilled well on site, which was reported to extend into bedrock to a depth of about 30 m or more.

3.2 Field Survey

Survey of location and ground surface elevation of the boreholes was carried out by Acres. The elevation was referenced to an MTO monument located in the north west corner of the 5 bay garage and office building situated in the north west section of the site with a known elevation of 265.79 m.

3.3 Laboratory Testing

Two samples of the overburden obtained from the boreholes were tested for grain size distribution in accordance with applicable ASTM standards.

Testing was carried out at Acres Geotechnical Laboratory in Niagara Falls and the results are shown in Figure 3, and also included in the Record of Boreholes in Appendix A.

Chemical analyses of the groundwater sample collected from the site well was carried out to assess the potential impact of storage of deicing salt at the site. Testing was carried out by Maxxam Analytics Inc. of Mississauga, Ontario, and the results are included in Appendix B.

4 Subsurface Conditions

The stratigraphy encountered at the site, as shown in Figure 2, comprised granular fill, overlying silty fine sand to sandy silt (SP - SM) followed by uniform fine to medium sand (SP).

Details of the various soils encountered at the borehole locations, together with the summary of SPT 'N' and the results of laboratory test results, are given in the Record of Boreholes in Appendix A. It should be noted that the soil boundaries indicated in the Record of Boreholes are inferred from non-continuous sampling and observations during drilling.

A brief description of the soils encountered at the site in the order of depth is given below.

4.1 Fill

A thin layer of fill was encountered in all four boreholes. The fill comprised a well graded clean grayish brown sand with gravel (SW), generally dry. The STP 'N' measured in Borehole BH-1 was 15 indicating the material to be generally compact. The fill thickness varied from 0.1 to 0.6 m.

4.2 Silty Fine Sand to Sand and Silt (SP - SM)

A deposit of light brown silty fine sand to sand and silt (SP - SM) was encountered in all the four boreholes. The material is generally moist to wet and contains thin seams of silt. The thickness varies from 1 to 5 m. The SPT 'N' ranged between 8 and 15 indicating loose to compact material.

4.3 Fine to Medium Sand (SP)

Clean sand (SP) was encountered below the silty fine sand to sand & silt (SP - SM) below el 262.4 to 265 m. This deposit is dry to moist and generally compact to very dense with SPT 'N' ranging between 14 and 73.

5 Groundwater Conditions

No groundwater was encountered during drilling. Based on the moist to wet condition of samples from the silty sand to sand and silt (SP - SM) from the upper few metres of the boreholes, minor perched water may be present within local zones.

A groundwater sample collected from the on-site water well was chemically analyzed to evaluate the potential impact of groundwater quality as a result of storage of de-icing salt at the site. The results of chemical analyses are included in Appendix B. The test results indicate no evidence of impact by de-icing salts. This is evidenced by the extremely low chloride concentration (5 mg/L) and sodium concentration (14 mg/L), which are typical of fresh water within a granitic environment.

Since the samples were taken from the water supply well completed in bedrock rather than from a shallow piezometer completed within the overburden, the results from this sample do not conclusively conclude that there is absolutely no impact on the quality of shallow perched groundwater. However, the very low

dissolved salt concentration from the closest available water well does suggest that there is not a significant problem at the site. It would, however, be appropriate to resample this well in future for comparison with the present results.

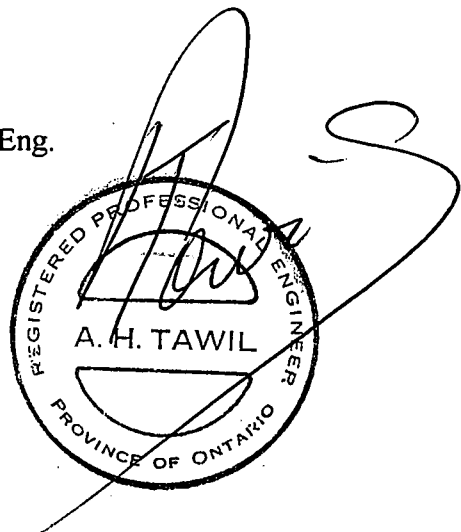
Design and Construction

Information in this report is intended to provide general characterization of ground conditions. Variations in the subsurface should be expected and provided for in detailed engineering and construction practices. Supervision of excavations and backfill should be performed and approved by experienced geotechnical engineers familiar with the requirements of design.

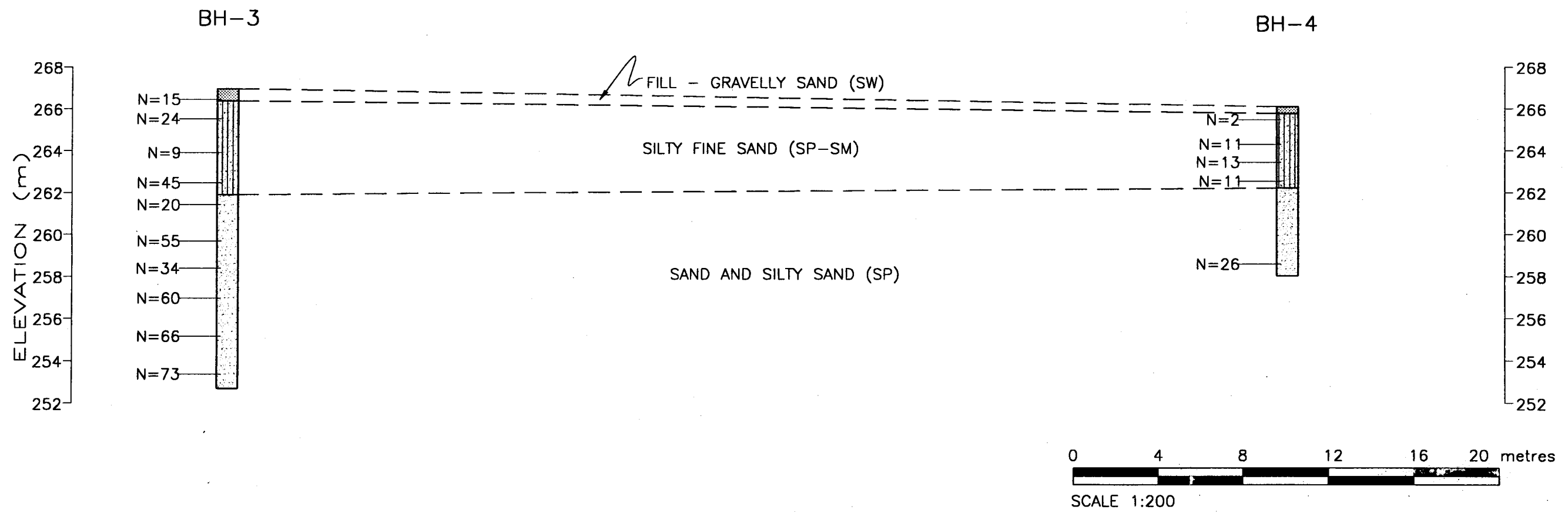
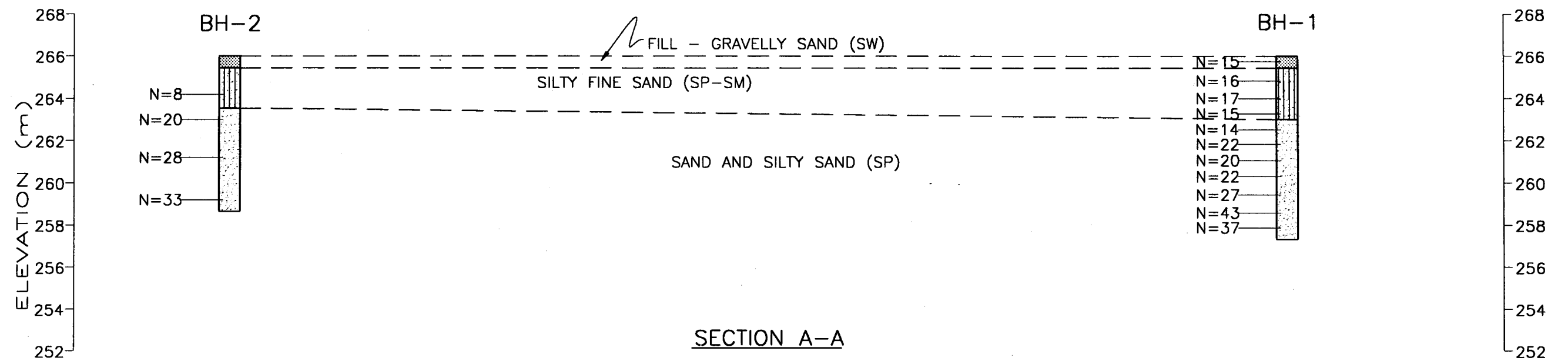
I. R. Fleming, P.Eng.



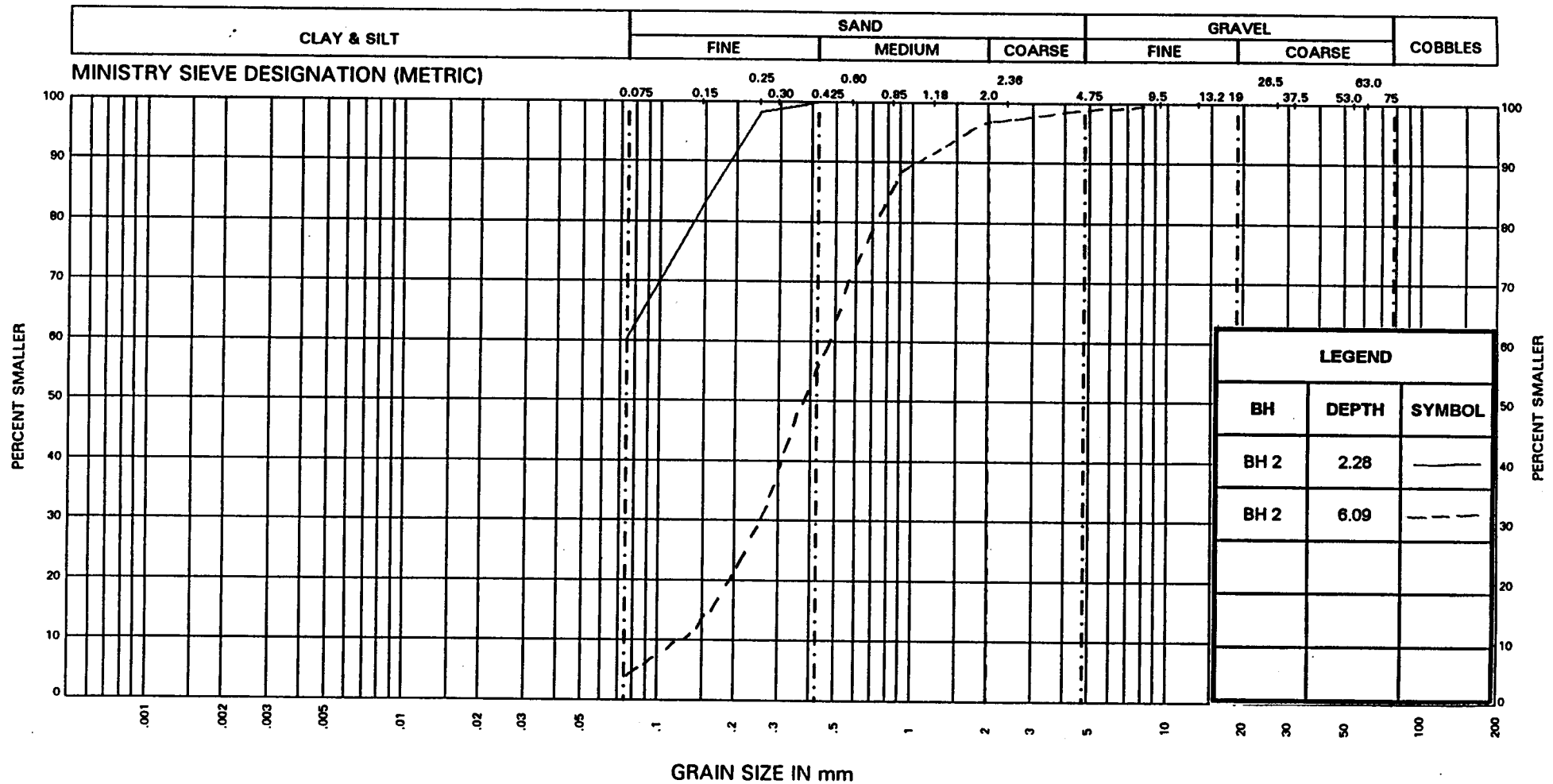
A. H. Tawil, P.Eng.



Figures



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

GRAIN SIZE DISTRIBUTION SILTY SAND (ML) AND SAND

FIGURE 3

W.P 3 SAND/SALT STRUCTURES

POWASSAN PATROL YARD

Tables

Table 1

Summary of Borehole Data

Borehole	Ground Surface Elevation (m)	Bottom of Borehole (m)	
		Depth (m)	Elevation (m)
BH-1	266.07	8.23	257.84
BH-2	266.26	6.70	259.56
BH-3	267.71	14.32	253.34
BH-4	266.22	7.00	259.22

Appendix A

Record of Boreholes

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			SHEAR STRENGTH (kPa)		WATER CONTENT(%)				
								✕ FIELD VANE ◆ POCKET PEN.	● LAB VANE ○ CONE PENETRATION	W _P	W _N	W _L		
266.07 0.00	Fill, gravelly sand, brown, compact and moist.		1	SS	15								No freestanding water in borehole at end of drilling	
265.47 60			Silty sand (SM), grayish brown, loose to compact, moist to wet.	2	SS	16								
				3	SS	17								
				4	SS	15								
263.02 3.05	Sand,(SP), reddish brown, compact, moist.		5	SS	14									
			6	SS	22									
			7	SS	20									
260.89 5.18	Silty sand (SM), grayish brown, compact to dense, moist.		8	SS	22									
			9	SS	27									
			10	SS	43									
			11	SS	37									
257.84 8.23							END OF BOREHOLE							

METRIC

ORIGINATED BY RS
COMPILED BY RS
CHECKED BY IF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT KN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			SHEAR STRENGTH (kPa)		WATER CONTENT(%)						
DEPTH								FIELD VANE	LAB VANE	POCKET PEN.	CONE PENETRATION	W _P			W _N	W _L
266.26																
0.00	Fill, gravelly sand, brown, compact and moist.													Wet condition of soil from 1.52 to 2.28m possibly perched water.		
265.96 .3																
264.14	Silty sand (SM), grayish brown, loose to compact, moist to wet.		2	SS	8									No freestanding water in borehole at end of drilling.		
264.14 2.12	Sand,(SP), reddish brown, compact, moist.		3	SS	20											
			4	SS	28											
			5	SS	33											
259.56 6.70																
							END OF BOREHOLE									

RECORD OF BOREHOLE No 3

METRIC

W P 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY R.S
 DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.S
 DATUM Geodetic DATE Sept 20 2000 CHECKED BY LF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20 40 60 80 100	20 40 60 80 100			
267.71												
0.00 267.41 .30	Fill, gravelly sand, brown, compact and moist.		1	SS	15		267.0					Wet condition of soil from 1.52 to 3.65m possibly perched water.
266.79 .92	Silty sand with trace of clay(SM-ML), grayish brown, loose to compact, moist.		2	SS	24		266.0					
	Silty sand (SM), grayish brown, loose to compact, moist to wet.		3	SS	9		265.0					
			4	SS	45		264.0					
			5	SS	20		263.0					
261.01 6.70	Sand,(SP), reddish brown, compact, moist.		6	SS	55		262.0					No freestanding water in borehole at the end of drilling
			7	SS	34		261.0					
			8	SS	60		260.0					
			9	SS	66		259.0					
							258.0					
							257.0					
							256.0					
							255.0					

RECORD OF BOREHOLE No 3

METRIC

W P 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY B.S
 DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY B.S
 DATUM Geodetic DATE Sept 20 2000 CHECKED BY L.E

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT KN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			SHEAR STRENGTH (kPa)		WATER CONTENT(%)				
								* FIELD VANE * POCKET PEN.	* LAB VANE O CONE PENETRATION	W _P W _N W _L				
253.39 14.32			10	SS	73		254.0							
END OF BOREHOLE														

METRIC

ORIGINATED BY R.S
COMPILED BY R.S
CHECKED BY LF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT			UNIT WEIGHT KN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH (kPa)							WATER CONTENT(%)
266.22															
266.14 .08	Fill, gravelly sand, brown, compact and moist.		1	SS	2									Wet condition of soil from 2.13 to 3.65m possibly perched water.	
	Silty sand with trace of clay (SM-ML), grayish brown, loose to compact, moist.														
			2	SS	11										
			3	SS	13										
263.33 2.89	Silty sand (SM) with occasional cobble or boulder. Grayish brown, loose to compact, moist to wet.		4	SS	11								"N" values not reliable, pushing something but still recovering small samples. Samples 5 to 8.		
			5	SS											
			6	SS											
			7	SS											
			8	SS											
259.22 7.0	Sand,(SP), reddish brown, compact, moist.												No freestanding water in borehole at end of drilling		
			9	SS	26										
257.99 8.23															
							END OF BOREHOLE								

Appendix B

Chemical Test Results



Acres & Associates
525-21 Four Seasons Pl
Etobicoke, ON
M9B 6J8

Attention: Louise Pearce

Report Date: 2000/10/06

Your Project #: MTO WELL 005A32

ANALYTICAL REPORT

MAXXAM JOB #: A018512

Received: 2000/09/20, 13:21

Sample Matrix: LIQUID

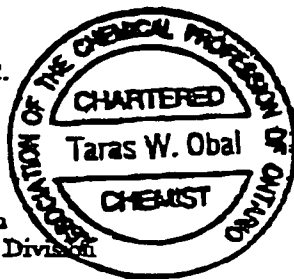
Samples Received: 3

<u>Analytes</u>	<u>Number of Tests</u>	<u>Date Extracted</u>	<u>Date Analyzed</u>	<u>Laboratory Method</u>	<u>Method Analytical Method</u>
ALKALINITY	3	N/A	2000/09/28	APHA 2320 B	TITRATION
ANIONS	3	N/A	2000/09/29	EPA 300.0	Ion Chromatography
AQUA-PAK - CALCULATION (mg/L)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (mg/L)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (%)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (umho/cm)	3	N/A	2000/10/04		
COLOUR	3	N/A	2000/10/02	APHA 2120	COLOURIMETRIC
CONDUCTIVITY	3	N/A	2000/09/21	APHA 2510	CONDUCTIVITY METER
GRAPHITE FURNACE METALS	3	2000/10/03	2000/10/03		GRAPHITE FURNACE
ICP METALS (SELECTED)	3	2000/10/02	2000/10/02	EPA 6010	ICP
SOLUBLE ICP METALS (SELECTED)	3	2000/09/22	2000/09/22	EPA 6010	ICP
AMMONIA-N	3	N/A	2000/09/28	APHA 4500	COLOURIMETRIC
NITRITE-N - COLOUR	3	N/A	2000/09/28	APHA 4500	COLOURIMETRIC
pH	3	N/A	2000/09/21	APHA 4500H	PH METER
ORTHOPHOSPHATE-P	3	N/A	2000/09/21	APHA 4500 PE	COLOURIMETRIC
TOC	3	N/A	2000/09/27	EPA 9060	UV/PEROX/FID
TURBIDITY	3	N/A	2000/09/21	APHA 2130	TURBIDITY METER

MAXXAM ANALYTICS INC.

T. W. Obal

TERRY OBAL, Ph.D., C. Chem
General Manager, Environment Division



Total pages: 1



REPORT DATE: 2000/10/06

PROJECT #: MTO WELL 005A32
MAXXAM JOB #: A018512

RESULTS OF CHEMICAL ANALYSES OF LIQUID

Maxxam ID		448189		448191		448192		
CDC Number		107967		107967		107987		
Sampling Date		2000/09/19		2000/09/19		2000/09/19		
Parameter	Units	BRITT	MDL	FIELD	POWASSAN	MDL	SPIKED BLANK %REC	
Alkalinity (Total as CaCO ₃)	mg/L	197	1	202	110	1	N/A	
Nitrate (N)	mg/L	<1	1	0.2	<0.1	0.1	N/A	
bromide (Br-)	mg/L	<0.35	0.35	<0.35	<0.35	0.35	N/A	
Fluoride (F-)	mg/L	2	1	1.3	1.6	0.1	N/A	
Chloride (Cl)	mg/L	13500	0.15	626	4.97	0.15	N/A	
Sulfates (SO ₄)	mg/L	191	0.5	82.6	11.3	0.5	N/A	
Hardness (CaCO ₃)	mg/L	1020	1	609	95.1	1	N/A	
Carbonate (CaCO ₃)	mg/L	<1	1	<1	<1	1	N/A	
Bicarbonate (CaCO ₃)	mg/L	197	0.05	202	109	0.05	N/A	
Calculated TDS	mg/L	21800	1	1280	135	1	N/A	
Cation Sum	mg/L	350	N/A	23.2	2.55	N/A	N/A	
Anion Sum	mg/L	388	N/A	23.0	2.58	N/A	N/A	
% Difference	%	5.25	N/A	0.454	0.507	N/A	N/A	
Ion Ratio	N/A	0.800	N/A	1.01	0.990	N/A	N/A	
Saturation pH @ 4C	N/A	6.90	N/A	7.20	8.19	N/A	N/A	
Langelier Index @ 4C	N/A	0.158	N/A	0.0770	-0.457	N/A	N/A	
Calculated Conductivity	umho/cm	48600	N/A	2770	251	N/A	N/A	
Colour	TCU	83.7	1	12.1	3	1	99	
Conductivity	umho/cm	31800	0.01	2570	260	0.01	N/A	
Lead (Pb)	mg/L	<0.002	0.002	<0.002	<0.002	0.002	103	
Aluminum (Al)	mg/L	36.7	0.025	0.062	<0.025	0.025	101	
Copper (Cu)	mg/L	0.108	0.003	<0.003	<0.003	0.003	123	
Iron (Fe)	mg/L	42.1	0.005	0.300	0.012	0.005	108	
Manganese (Mn)	mg/L	2.36	0.001	0.512	0.014	0.001	102	
Zinc (Zn)	mg/L	1.14	0.003	0.035	0.031	0.003	105	
Magnesium (Mg)	mg/L	32.7	0.003	43.5	8.61	0.003	N/A	
Potassium (K)	mg/L	27.9	1	8	<1	1	N/A	
Silicon (Si)	mg/L	6.40	0.015	3.26	5.45	0.015	N/A	
Sodium (Na)	mg/L	7550	0.6	247	13.8	0.68	N/A	
Calcium (Ca)	mg/L	353	0.04	172	24.9	0.04	N/A	
Ammonia-N	mg/L	1.93	0.05	0.53	<0.05	0.05	N/A	
Nitrite (N)	mg/L	<0.1	0.1	<0.1	<0.1	0.1	101	
pH	pH	7.98	0.01	7.28	7.73	0.01	N/A	
orthophosphate (P)	mg/L	0.010	0.005	0.012	0.009	0.005	N/A	
Total Organic Carbon	mg/L	14.9	0.1	5.2	0.4	0.1	94	
Turbidity	NTU	1060	0.1	5.5	0.2	0.1	N/A	

N/A = Not Applicable

MDL = METHOD DETECTION LIMIT



REPORT DATE: 2000/10/08

PROJECT #: MTO WELL 005A32

MAXXAM JOB #: A018512

RESULTS OF CHEMICAL ANALYSES OF LIQUID

Maxxam ID					
COC Number					
Sampling Date					

Parameter	Units	METHOD BLANK	MDL	MATRIX SPIKE %REC	QC %REC
Alkalinity (Total as CaCO ₃)	mg/L	<1	1	N/A	103
Nitrate (N)	mg/L	<0.1	0.1	94	98
bromide (Br ⁻)	mg/L	<0.35	0.35	98	98
Fluoride (F ⁻)	mg/L	<0.1	0.1	95	99
Chloride (Cl ⁻)	mg/L	<0.15	0.15	99	99
Sulfates (SO ₄ ²⁻)	mg/L	<0.5	0.5	100	102
Hardness (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Carbonate (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Bicarbonate (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Calculated TDS	mg/L	N/A	N/A	N/A	N/A
Cation Sum	me/L	N/A	N/A	N/A	N/A
Anion Sum	me/L	N/A	N/A	N/A	N/A
% Difference	%	N/A	N/A	N/A	N/A
Ion Ratio	N/A	N/A	N/A	N/A	N/A
Saturation pH @ 4C	N/A	N/A	N/A	N/A	N/A
Langelier Index @ 4C	N/A	N/A	N/A	N/A	N/A
Calculated Conductivity	umho/cm	N/A	N/A	N/A	N/A
Colour	TCU	<1	1	98	101
Conductivity	umho/cm	1.80	0.01	N/A	100
Lead (Pb)	mg/L	<0.002	0.002	99	110
Aluminum (Al)	mg/L	<0.025	0.025	109	99
Copper (Cu)	mg/L	<0.003	0.003	110	98
Iron (Fe)	mg/L	<0.005	0.005	117	102
Manganese (Mn)	mg/L	<0.001	0.001	111	99
Zinc (Zn)	mg/L	0.003	0.003	114	98
Magnesium (Mg)	mg/L	<0.003	0.003	N/A	102
Potassium (K)	mg/L	<1	1	N/A	103
Silicon (Si)	mg/L	<0.015	0.015	N/A	98
Sodium (Na)	mg/L	<0.08	0.08	N/A	99
Calcium (Ca)	mg/L	<0.04	0.04	N/A	100
Ammonia-N	mg/L	<0.05	0.05	100	102
Nitrite (N)	mg/L	<0.1	0.1	100	102
pH	pH	N/A	N/A	N/A	100
Orthophosphate (P)	mg/L	<0.005	0.005	102	104
Total Organic Carbon	mg/L	<0.1	0.1	89	100
Turbidity	NTU	N/A	N/A	N/A	103

N/A = Not Applicable

MDL = METHOD DETECTION LIMIT

QC = QC Standard

Ministry of Transportation

Northern Region
North Bay, Ontario

Powassan Patrol Yard
Geocres No. 31L-74

Foundation Investigation and Design Report Sand/Salt Storage Structure

FINAL

January 30, 2001



Acres International
Oakville, Ontario, Canada

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1	Summary of Borehole Data

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No.	Title
1	Location of Boreholes
2	Soil Stratigraphy
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Part 1 Foundation Investigations

1 Introduction

Acres International (Acres) was retained by the Ministry of Transportation Ontario (MTO) to undertake foundation investigations and testing, and preparation of geotechnical reports for Highway (Hwy) 510 swamp and Hwy 607A swamp and three sand/salt storage structures located in the Northern Region. The work was authorized by MTO Agreement PO5005A000167 dated June 2000. The Terms of Reference also included the evaluation of potential impact of the storage of deicing salts on the quality of shallow water in the ground at the site.

This report presents the results of foundation investigations at one of the proposed sand/salt storage structures located at the MTO Patrol Yard in Powassan, Northern Ontario.

2 Site Description

The Powassan Patrol Yard is located adjacent to Hwy 11 about 35 km south of North Bay and about 1 km north of the intersection of Hwy 534 and Hwy 64 as shown in Figure 1.

The site of the storage structure is situated in an MTO operating maintenance patrol yard. It is fully fenced and accessed from Hwy 11. The yard contains 2 existing 30-m dia sand/salt structures, a 5-bay garage, 1 storage shed and 1 large single bay garage, Figure 1. Access roads to these facilities are all paved with asphalt.

The new sand/salt structure is proposed to be located directly north of the existing sand/salt structures. The Powassan Yard is situated on a fill sloping from the east to west with a maximum height of 3.5 m above original ground at the east end of the yard. Stockpiles of sand exist east of the proposed new storage dome.

3 Investigation Procedures

3.1 Field Investigations

The site investigations were carried out on August 2, 2000. A total of four boreholes, numbered BH-1 to BH-4, were drilled at the locations shown in Figure 1. The boreholes were advanced to depths ranging from 6.7 to 14.3 m using a truck-mounted continuous flight hollow-stem augering equipment owned and operated by Boart Longyear Inc. (Boart) of Maple, Ontario. Soil samples were obtained at approximately 0.75- and 1.5-m intervals using a split-spoon sampler in conjunction with Standard Penetration Test (SPT), performed in accordance with ASTM D1586 Designation. SPT 'N' values were recorded and used to provide an estimate of the relative denseness of the cohesionless soils and consistency of cohesive soils.

A representative of Acres was present throughout the drilling period to monitor and inspect drilling and sampling operations. All soil samples were identified and described in the field, and subsequently transported to Acres Geotechnical Laboratory in Niagara Falls for further detailed examination and laboratory testing.

A summary of borehole data is given in Table 1. Detailed information on the boreholes is presented in the Record of Boreholes in Appendix A.

As per MTO guidelines and OHBDC standards, soil samples were classified according to Unified Soil Classification Systems. The clay content reported as per MTO format in Record of Boreholes forms is based on grain size less than 0.002 mm.

At the request of the MTO Northern Region, Acres' staff collected a water sample from the Powassan Patrol Yard for chemical analysis. This was done to obtain a preliminary evaluation of the potential impact on groundwater quality as a result of the use and/or storage of de-icing salts at the site. It had been planned that such a sample would be taken from a standpipe piezometer installed in a borehole, however, significant groundwater was not encountered during drilling. Consequently, the water sample was taken from an existing drilled well on site, which was reported to extend into bedrock to a depth of about 30 m or more.

3.2 Field Survey

Survey of location and ground surface elevation of the boreholes was carried out by Acres. The elevation was referenced to an MTO monument located in the north west corner of the 5 bay garage and office building situated in the north west section of the site with a known elevation of 265.79 m.

3.3 Laboratory Testing

Two samples of the overburden obtained from the boreholes were tested for grain size distribution in accordance with applicable ASTM standards.

Testing was carried out at Acres Geotechnical Laboratory in Niagara Falls and the results are shown in Figure 3, and also included in the Record of Boreholes in Appendix A.

Chemical analyses of the groundwater sample collected from the site well was carried out to assess the potential impact of storage of deicing salt at the site. Testing was carried out by Maxxam Analytics Inc. of Mississauga, Ontario, and the results are included in Appendix B.

4 Subsurface Conditions

The stratigraphy encountered at the site, as shown in Figure 2, comprised granular fill, overlying silty fine sand to sandy silt (SP - SM) followed by uniform fine to medium sand (SP).

Details of the various soils encountered at the borehole locations, together with the summary of SPT 'N' and the results of laboratory test results, are given in the Record of Boreholes in Appendix A. It should be noted that the soil boundaries indicated in the Record of Boreholes are inferred from non-continuous sampling and observations during drilling.

A brief description of the soils encountered at the site in the order of depth is given below.

4.1 Fill

A thin layer of fill was encountered in all four boreholes. The fill comprised a well graded clean grayish brown sand with gravel (SW), generally dry. The STP 'N' measured in Borehole BH-1 was 15 indicating the material to be generally compact. The fill thickness varied from 0.1 to 0.6 m.

4.2 Silty Fine Sand to Sand and Silt (SP - SM)

A deposit of light brown silty fine sand to sand and silt (SP - SM) was encountered in all the four boreholes. The material is generally moist to wet and contains thin seams of silt. The thickness varies from 1 to 5 m. The SPT 'N' ranged between 8 and 15 indicating loose to compact material.

4.3 Fine to Medium Sand (SP)

Clean sand (SP) was encountered below the silty fine sand to sand & silt (SP - SM) below el 262.4 to 265 m. This deposit is dry to moist and generally compact to very dense with SPT 'N' ranging between 14 and 73.

5 Groundwater Conditions

No groundwater was encountered during drilling. Based on the moist to wet condition of samples from the silty sand to sand and silt (SP - SM) from the upper few metres of the boreholes, minor perched water may be present within local zones.

A groundwater sample collected from the on-site water well was chemically analyzed to evaluate the potential impact of groundwater quality as a result of storage of de-icing salt at the site. The results of chemical analyses are included in Appendix B. The test results indicate no evidence of impact by de-icing salts. This is evidenced by the extremely low chloride concentration (5 mg/L) and sodium concentration (14 mg/L), which are typical of fresh water within a granitic environment.

Since the samples were taken from the water supply well completed in bedrock rather than from a shallow piezometer completed within the overburden, the results from this sample do not conclusively conclude that there is absolutely no impact on the quality of shallow perched groundwater. However, the very low

dissolved salt concentration from the closest available water well does suggest that there is not a significant problem at the site. It would, however, be appropriate to resample this well in future for comparison with the present results.

Part 2 Foundation Design

6 Engineering Discussion and Recommendations

6.1 General

The following sections contain a summary of the site geotechnical conditions and provide guidelines for the design and construction of the proposed sand/salt storage structure and stockpiles. Specifically, recommendations and/or comments are given regarding foundation type, bearing pressure, groundwater conditions and construction aspects.

6.2 Summary of Geotechnical Site Conditions

The subsurface soil at the site essentially consisted of the following soil types in the order of increasing depth:

The subsurface materials at the site consist of the following soil types in the order of increasing depth.

- fill, well graded clean sand with gravel (SW), compact about 0.1 to 0.6 m thick
- silty sand to sand and silt (SP - SM) moist, loose to compact, 1 to 5 m thick
- uniform fine to medium sand (SP), dry, compact to very dense.

The groundwater at the site is estimated to be at a depth greater than 10 to 15 m. The ground surface elevation across the site varies from el 266 to 268 m and the drainage is mainly towards the south and west ends.

The depth of frost penetration is estimated at about 2 m. Therefore, foundations should be placed at a minimum depth of 2.0 m below finished grade to provide protection against frost action.

6.3 Sand/Salt Storage Structure

The MTO Terms of Reference offer no specific dimensions or required floor elevation of the proposed storage structure at the Powassan Patrol Yard. Based

on the examination of the topography shown in Figure 1 and details of site conditions, the following recommendations and comments are provided for consideration in the design of the proposed storage structure at the Powassan Patrol Yard:

- maximum size of the storage structure which can be accommodated at the proposed site is about 30 m
- considering drainage, the floor elevation of the proposed storage structure should be higher than the surrounding finished ground surface. The area around the storage structure must be graded away from the structure at a minimum slope of 2% within at least 5 m of the structure.
- the foundation preparation to consist of the following:
 - first stage excavation down to foundation level.
 - proof roll the foundation material at the excavation grade to achieve a compaction of at least 98% of the Standard Proctor Maximum Dry Density (SPMDD) as obtained from the Standard Proctor Compaction Tests.
 - any soft or unsuitable material at the excavation grade to be removed and replaced with Granular 'A' material and compacted to 98% SPMDD
 - if slab on grade is considered, provide a minimum 300 mm bedding layer of Granular 'A' for the support of floor slab inside the storage structure.
 - spread fill materials in continuous layers not exceeding 150 mm before compaction and compact to 98% SPMDD for granular fill.
- during excavation within the original soils encountered on site, there may be perched water that may seep out. It is expected that such seepage will be minimal and can be controlled using conventional construction techniques such as pumping from sumps or perimeter ditches. The side slopes of shallow excavations for footings should be constructed at a maximum gradient of 1H:1V beginning at the excavation base.
- perimeter drains around the paved areas and around access ways, parking lot and loading areas are recommended.

- a circular ring stip footing founded below frost penetration depth of 2 m below finished ground level is considered suitable for the support of the proposed storage structure
- for the purpose of design based on the Ontario Bridge Design Code, the following bearing capacities can be used for a strip ring footing
 - factored bearing resistance at ULS = 200 kPa
 - bearing resistance at SLS = 140 kPa.

The above bearing pressures may be used for a strip ring footing founded within the original soils encountered at the Powassan Yard site or founded within a compacted granular pad comprising Granular "A" compacted to a minimum 98% SPMDD.

6.4 Foundations for Sand/Salt Stockpiles

The exact location of the sand/salt stockpiles is not known. Assuming locations in the proximity of the storage structure, it is expected that organics at the surface or close to the surface within 0.6 to 0.7 m. It is preferable to strip the entire organics within the footprint of the sand/salt stockpile and backfill with compacted Granular 'B', Type I to the required grade. The material at subgrade level should be proof-rolled to achieve a compaction of at least 98% of the maximum dry density as obtained from SPMDD. Considering a functional design life of 10 to 15 years, the following pavement structure is recommended under the sand/salt stockpiles:

Pavement Layer	Compaction Requirements	Thickness
Asphaltic concrete	97% Marshall density	40 mm OPSS HL-4 surface course 50 mm OPSS HL-4 binder course
Granular 'A'	98% SPMDD	150 mm
Granular 'B', Type I	98% SPMDD	350 mm

Subdrains should be provided to intercept excess moisture and to prevent subgrade softening. The finished pavement surface should be free of depressions. Given the

free draining nature of the foundation soils, the safe height of stockpiles on the site will exceed the maximum practical height for storage.

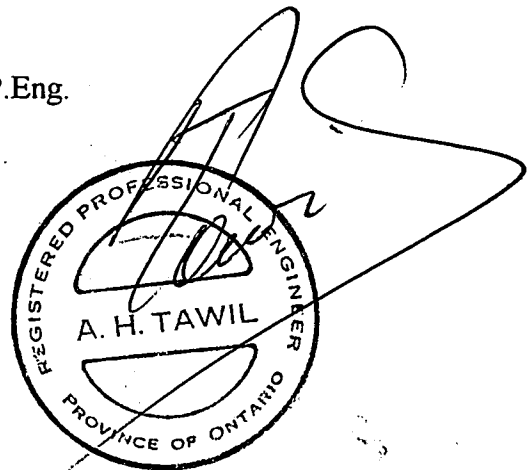
Design and Construction

Information in this report is intended to provide general characterization of ground conditions. Variations in the subsurface should be expected and provided for in detailed engineering and construction practices. Supervision of excavations and backfill should be performed and approved by experienced geotechnical engineers familiar with the requirements of design.

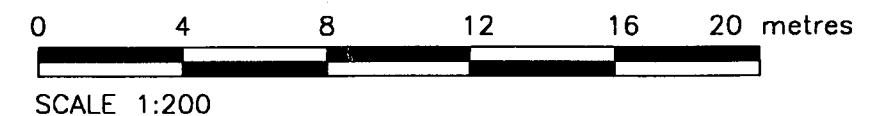
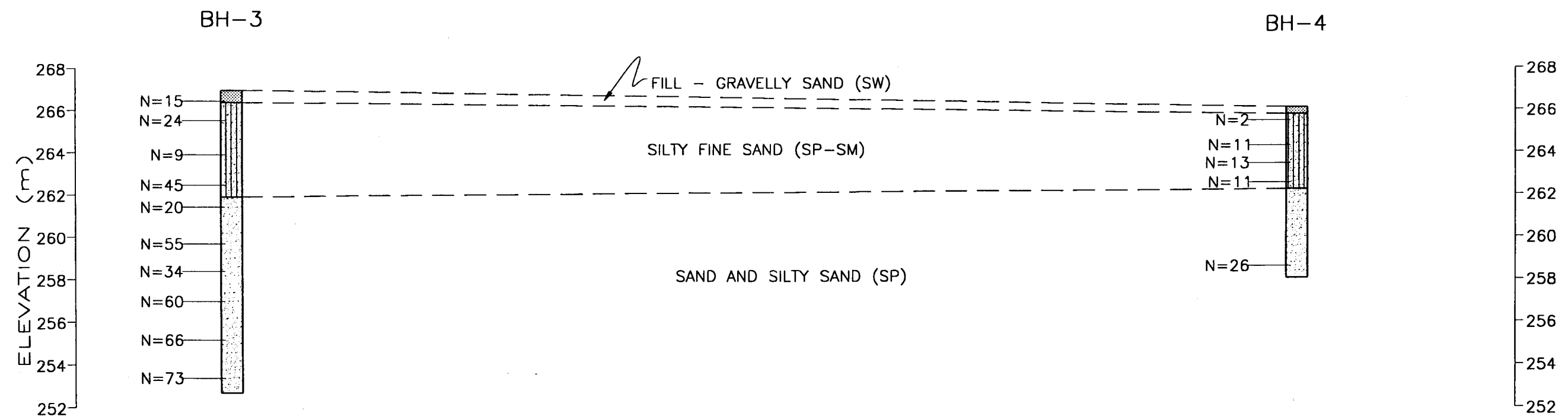
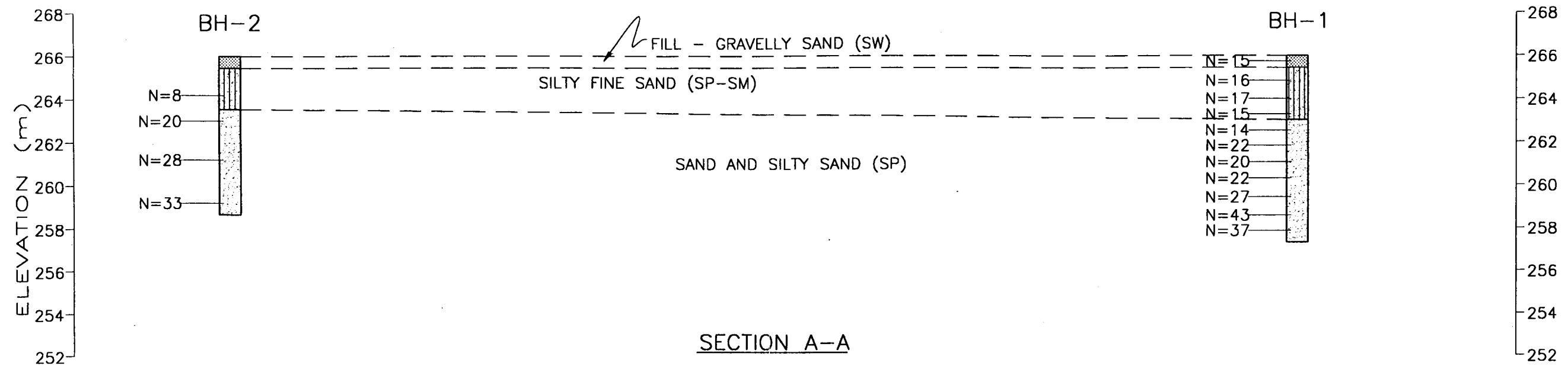
I. R. Fleming, P.Eng.



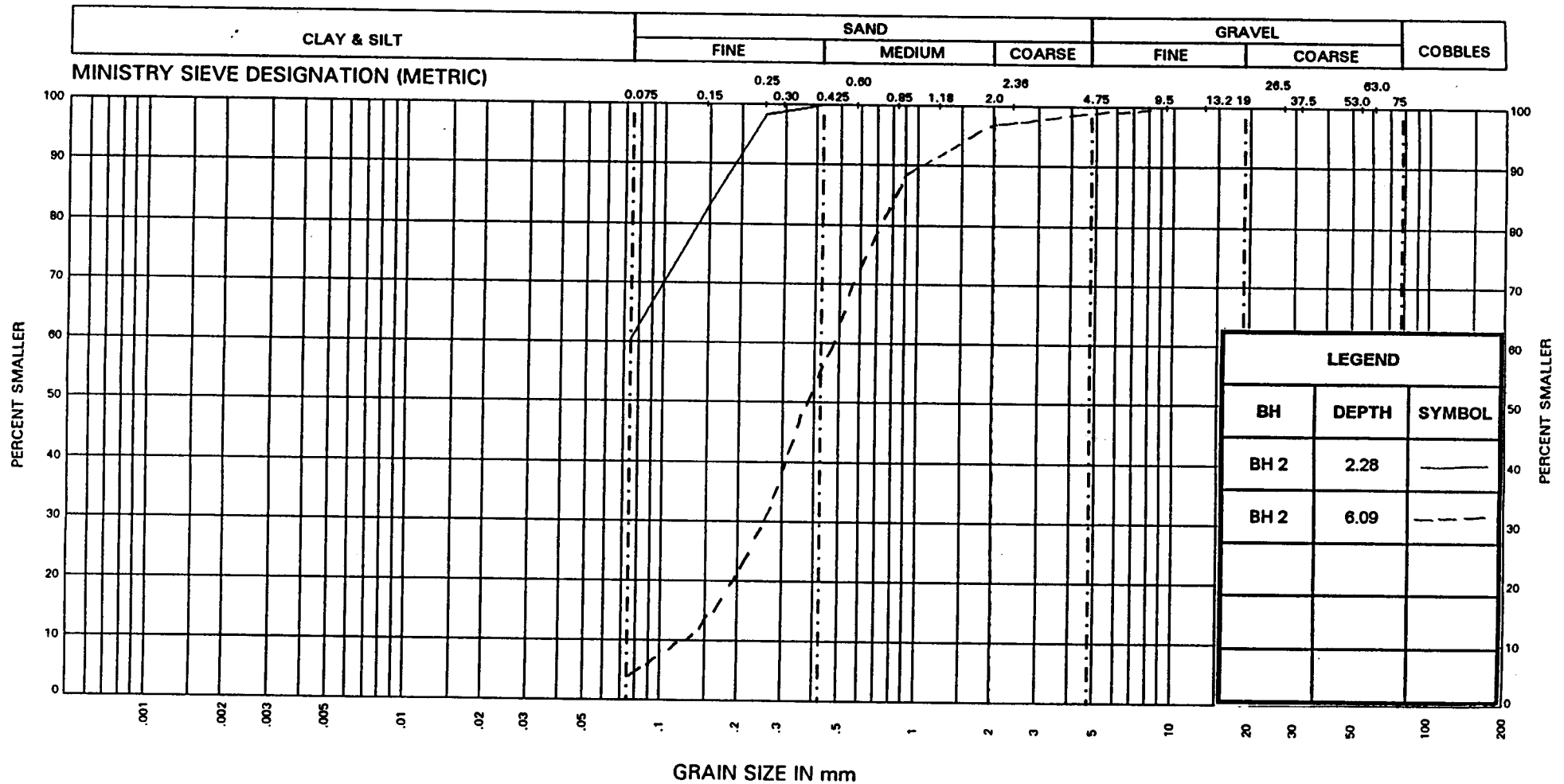
A. H. Tawil, P.Eng.



Figures



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

GRAIN SIZE DISTRIBUTION SILTY SAND (ML) AND SAND

FIGURE 3

W.P 3 SAND/SALT STRUCTURES

POWASSAN PATROL YARD

Tables

Table 1

Summary of Borehole Data

Borehole	Ground Surface Elevation (m)	Bottom of Borehole (m)	
		Depth (m)	Elevation (m)
BH-1	266.07	8.23	257.84
BH-2	266.26	6.70	259.56
BH-3	267.71	14.32	253.34
BH-4	266.22	7.00	259.22

Appendix A

Record of Boreholes

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL





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

PHYSICAL PROPERTIES OF SOIL

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

METRIC

WP 3 Sand / Salt Structures. LOCATION Powassan Patrol Yard ORIGINATED BY R.S
DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.S
DATUM Geodetic DATE Sept. 20, 2000 CHECKED BY LF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT KN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			SHEAR STRENGTH (kPa)							WATER CONTENT(%)	
266.07																
0.00	Fill, gravelly sand, brown, compact and moist.		1	SS	15											
265.47	Silty sand (SM), grayish brown, loose to compact, moist to wet.		2	SS	16											
.60																
			3	SS	17											
			4	SS	15											
263.02	Sand,(SP), reddish brown, compact, moist.															
3.05			5	SS	14											
			6	SS	22											
			7	SS	20											
260.89	Silty sand (SM), grayish brown, compact to dense, moist.															
5.18			8	SS	22											
			9	SS	27											
			10	SS	43											
			11	SS	37											
257.84																
8.23																
							END OF BOREHOLE									

RECORD OF BOREHOLE No 2

METRIC

WP 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY R.S
 DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.S
 DATUM Geodetic DATE Sept 20 2000 CHECKED BY LF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			SHEAR STRENGTH (kPa)		WATER CONTENT (%)					
								FIELD VANE POCKET PEN.	LAB VANE CONE PENETRATION	W _P	W _N	W _L			
266.26 0.00 265.96 .3	Fill, gravelly sand, brown, compact and moist.													Wet condition of soil from 1.52 to 2.28m possibly perched water. 0 40 60 0	
	Silty sand (SM), grayish brown, loose to compact, moist to wet.		2	SS	8										
264.14 2.12	Sand,(SP), reddish brown, compact, moist.												No freestanding water in borehole at end of drilling 1 45 50 4		
			3	SS	20										
			4	SS	28										
			5	SS	33										
259.56 6.70							END OF BOREHOLE								

METRIC

WP 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY R.S
DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.S
DATUM Geodetic DATE Sept. 20, 2000 CHECKED BY J.F

[illegible]

RECORD OF BOREHOLE No 3

METRIC

W P 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY B.S
 DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY B.S
 DATUM Geodetic DATE Sept 20, 2000 CHECKED BY J.F

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20 40 60 80 100	25 50 75 100 125	W _p W _N W _L	20 40 60			
253.99 14.32			10	SS	73		254.0							
							END OF BOREHOLE							

RECORD OF BOREHOLE No4

METRIC

W P 3 Sand / Salt Structures LOCATION Powassan Patrol Yard ORIGINATED BY R.S
 DIST Northern Region HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.S
 DATUM Geodetic DATE Sept. 20, 2000 CHECKED BY LF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	STANDARD PENETRATION TEST (N) VALUE ●			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH (kPa)						WATER CONTENT(%)	
								20	40	60	80				100
266.22															
266.14 .08	Fill, gravelly sand, brown, compact and moist.		1	SS	2		266.0						Wet condition of soil from 2.13 to 3.65m possibly perched water. "N" values not reliable, pushing something but still recovering small samples. Samples 5 to 8.		
	Silty sand with trace of clay (SM-ML), grayish brown, loose to compact, moist.						265.0								
			2	SS	11		264.0								
		3	SS	13		263.0									
263.33 2.89	Silty sand (SM) with occasional cobble or boulder. Grayish brown, loose to compact, moist to wet.	4	SS	11		262.0									
		5	SS			261.0									
		6	SS			260.0									
		7	SS			259.0									
259.22 7.0	Sand,(SP), reddish brown, compact, moist.					258.0						No freestanding water in borehole at end of drilling			
257.99 8.23			9	SS	26										
							END OF BOREHOLE								

Appendix B

Chemical Test Results



Acres & Associates
525-21 Four Seasons Pl
Etobicoke, ON
M9B 6J8

Attention: Louise Pearce

Report Date: 2000/10/06

Your Project #: MTO WELL 005A32

ANALYTICAL REPORT

MAXXAM JOB #: A018512

Received: 2000/09/20, 13:21

Sample Matrix: LIQUID

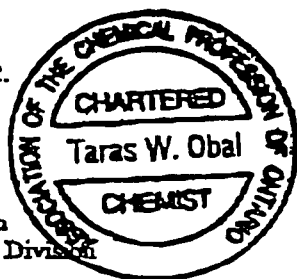
Samples Received: 3

<u>Analytes</u>	<u>Number of Tests</u>	<u>Date Extracted</u>	<u>Date Analyzed</u>	<u>Laboratory Method</u>	<u>Method Analytical Method</u>
ALKALINITY	3	N/A	2000/09/28	APHA 2320 B	TITRATION
ANIONS	3	N/A	2000/09/29	EPA 300.0	Ion Chromatography
AQUA-PAK - CALCULATION (mg/L)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (mg/L)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (%)	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION	3	N/A	2000/10/04		
AQUA-PAK - CALCULATION (umho/cm)	3	N/A	2000/10/04		
COLOUR	3	N/A	2000/10/02	APHA 2120	COLOURIMETRIC
CONDUCTIVITY	3	N/A	2000/09/21	APHA 2510	CONDUCTIVITY METER
GRAPHITE FURNACE METALS	3	2000/10/03	2000/10/03		GRAPHITE FURNACE
ICP METALS (SELECTED)	3	2000/10/02	2000/10/02	EPA 6010	ICP
SOLUBLE ICP METALS (SELECTED)	3	2000/09/22	2000/09/22	EPA 6010	ICP
AMMONIA-N	3	N/A	2000/09/28	APHA 4500	COLOURIMETRIC
NITRITE-N - COLOUR	3	N/A	2000/09/28	APHA 4500	COLOURIMETRIC
pH	3	N/A	2000/09/21	APHA 4500B	PH METER
ORTHOPHOSPHATE-P	3	N/A	2000/09/21	APHA 4500 PE	COLOURIMETRIC
TOC	3	N/A	2000/09/27	EPA 9060	UV/PEROX/FID
TURBIDITY	3	N/A	2000/09/21	APHA 2130	TURBIDITY METER

MAXXAM ANALYTICS INC.

T. W. Obal

TERRY OBAL, Ph.D., C. Chem
General Manager, Environment Division



Total pages: 1



REPORT DATE: 2000/10/06

PROJECT #: MTO WELL 005A32

MAXXAM JOB #: A018512

RESULTS OF CHEMICAL ANALYSES OF LIQUID

Maxxam ID		448189		448191		448192		
COC Number		107867		107867		107867		
Sampling Date		2000/09/18		2000/09/19		2000/09/19		
Parameter	Units	BRITT	MDL	FIELD	POWASSAN	MDL	SPIKED BLANK %REC	
Alkalinity (Total as CaCO ₃)	mg/L	197	1	202	110	1	N/A	
Nitrate (N)	mg/L	<1	1	0.2	<0.1	0.1	N/A	
bromide (Br ⁻)	mg/L	<0.35	0.35	<0.35	<0.35	0.35	N/A	
Fluoride (F ⁻)	mg/L	2	1	1.3	1.6	0.1	N/A	
Chloride (Cl ⁻)	mg/L	13500	0.15	626	4.97	0.15	N/A	
Sulfates (SO ₄)	mg/L	191	0.5	62.6	11.3	0.5	N/A	
Hardness (CaCO ₃)	mg/L	1020	1	609	96.1	1	N/A	
Carbonate (CaCO ₃)	mg/L	<1	1	<1	<1	1	N/A	
Bicarbonate (CaCO ₃)	mg/L	197	0.05	202	109	0.05	N/A	
Calculated TDS	mg/L	21800	1	1280	135	1	N/A	
Cation Sum	me/L	350	N/A	23.2	2.55	N/A	N/A	
Anion Sum	me/L	388	N/A	23.0	2.58	N/A	N/A	
% Difference	%	5.25	N/A	0.454	0.507	N/A	N/A	
Ion Ratio	N/A	0.800	N/A	1.01	0.950	N/A	N/A	
Saturation pH @ 4C	N/A	6.90	N/A	7.20	8.19	N/A	N/A	
Langelier Index @ 4C	N/A	0.158	N/A	0.0770	-0.457	N/A	N/A	
Calculated Conductivity	umho/cm	48600	N/A	2770	251	N/A	N/A	
Colour	TCU	53.7	1	12.1	3	1	99	
Conductivity	umho/cm	31800	0.01	2570	260	0.01	N/A	
Lead (Pb)	mg/L	<0.002	0.002	<0.002	<0.002	0.002	103	
Aluminum (Al)	mg/L	38.7	0.025	0.082	<0.025	0.025	101	
Copper (Cu)	mg/L	0.108	0.003	<0.003	<0.003	0.003	123	
Iron (Fe)	mg/L	42.1	0.005	0.300	0.012	0.005	108	
Manganese (Mn)	mg/L	2.36	0.001	0.512	0.014	0.001	102	
Zinc (Zn)	mg/L	1.14	0.003	0.035	0.031	0.003	105	
Magnesium (Mg)	mg/L	32.7	0.003	43.5	8.61	0.003	N/A	
Potassium (K)	mg/L	27.8	1	8	<1	1	N/A	
Silicon (Si)	mg/L	5.40	0.015	3.26	5.45	0.015	N/A	
Sodium (Na)	mg/L	7550	0.6	247	13.8	0.08	N/A	
Calcium (Ca)	mg/L	353	0.04	172	24.9	0.04	N/A	
Ammonia-N	mg/L	1.93	0.05	0.63	<0.05	0.05	N/A	
Nitrite (N)	mg/L	<0.1	0.1	<0.1	<0.1	0.1	101	
pH	pH	7.08	0.01	7.28	7.73	0.01	N/A	
orthophosphate (P)	mg/L	0.010	0.005	0.012	0.009	0.005	N/A	
Total Organic Carbon	mg/L	14.9	0.1	5.2	0.4	0.1	94	
Turbidity	NTU	1060	0.1	5.5	0.2	0.1	N/A	

N/A = Not Applicable

MDL = METHOD DETECTION LIMIT



REPORT DATE: 2000/10/08

PROJECT #: MTO WELL 005A32

MAXXAM JOB #: A018512

RESULTS OF CHEMICAL ANALYSES OF LIQUID

Maxxam ID					
COC Number					
Sampling Date					

Parameter	Units	METHOD BLANK	MDL	MATRIX SPIKE %REC	QC %REC
Alkalinity (Total as CaCO ₃)	mg/L	<1	1	N/A	103
Nitrate (N)	mg/L	<0.1	0.1	94	98
Bromide (Br ⁻)	mg/L	<0.35	0.35	98	98
Fluoride (F ⁻)	mg/L	<0.1	0.1	95	99
Chloride (Cl)	mg/L	<0.15	0.15	99	99
Sulfates (SO ₄)	mg/L	<0.5	0.5	100	102
Hardness (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Carbonate (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Bicarbonate (CaCO ₃)	mg/L	N/A	N/A	N/A	N/A
Calculated TDS	mg/L	N/A	N/A	N/A	N/A
Carbon Sum	me/L	N/A	N/A	N/A	N/A
Anion Sum	me/L	N/A	N/A	N/A	N/A
% Difference	%	N/A	N/A	N/A	N/A
Ion Ratio	N/A	N/A	N/A	N/A	N/A
Saturation pH @ 4C	N/A	N/A	N/A	N/A	N/A
Langelier Index @ 4C	N/A	N/A	N/A	N/A	N/A
Calculated Conductivity	umho/cm	N/A	N/A	N/A	N/A
Colour	TCU	<1	1	98	101
Conductivity	umho/cm	1.80	0.01	N/A	100
Lead (Pb)	mg/L	<0.002	0.002	99	110
Aluminum (Al)	mg/L	<0.025	0.025	109	99
Copper (Cu)	mg/L	<0.003	0.003	110	98
Iron (Fe)	mg/L	<0.005	0.005	117	102
Manganese (Mn)	mg/L	<0.001	0.001	111	99
Zinc (Zn)	mg/L	0.003	0.003	114	98
Magnesium (Mg)	mg/L	<0.003	0.003	N/A	102
Potassium (K)	mg/L	<1	1	N/A	103
Boron (Si)	mg/L	<0.015	0.015	N/A	98
Sodium (Na)	mg/L	<0.06	0.06	N/A	99
Calcium (Ca)	mg/L	<0.04	0.04	N/A	100
Ammonia-N	mg/L	<0.05	0.05	100	102
Nitrite (N)	mg/L	<0.1	0.1	100	102
pH	pH	N/A	N/A	N/A	100
Orthophosphate (P)	mg/L	<0.005	0.005	102	104
Total Organic Carbon	mg/L	<0.1	0.1	99	100
Turbidity	NTU	N/A	N/A	N/A	103

N/A = Not Applicable

MDL = METHOD DETECTION LIMIT

QC = QC Standard