



GeoCres 31D-490

BOREHOLE SOIL INVESTIGATION REPORT

NEW SALT/SAND STORAGE STRUCTURE AT

COOKSTOWN PATROL YARD

COOKSTOWN, ONTARIO

MINISTRY OF TRANSPORTATION ONTARIO

CENTRAL REGION

AGREEMENT NUMBER 2009-C-0092

GWP NUMBER 2030-09-00

Submitted to:

Ministry of Transportation Ontario

Central Region

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22 December 2009
AMEC Reference No.: TT93045

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1.0 INTRODUCTION

AMEC Earth & Environmental, a Division of AMEC Americas Limited (AMEC), Consulting Geotechnical, Construction Quality Control and Environmental Engineers, was retained by the Ministry of Transportation Ontario, Central Region (MTO) to conduct a geotechnical investigation at the MTO Cookstown Patrol Yard, located approximately 400 m west of 5 Sideroad and on the north side of Highway 89 in Cookstown, Ontario (Drawing No. 1).

This project involved soil investigation for the construction of a new salt/sand storage structure at the Cookstown Patrol Yard. The envelope of the proposed structure would be roughly rectangular with a plan area of approximately 960 m² (24 m by 40 m), as shown in Drawing No. 2 (provided by MTO).

A total of four (4) boreholes with the provision for a fifth (5th) borehole were specified by the MTO in the Terms of Reference (TOR) of Request for Quotation (*Agreement Number: 2009-C-0092, dated July 31, 2009*). The work was carried out by AMEC according to the MTO Terms of Reference and AMEC's Proposal No. P29176 dated 17 August 2009. A total of five (5) boreholes were advanced to a depth of about 11.1 m and Dynamic Cone Penetration Test (DCPT) was carried out in one borehole to a depth of about 13.7 m.

There was no subsurface soil information available from MTO for the existing site prior to this investigation.

The investigation was carried out by means of a limited number of boreholes, in-situ tests and laboratory tests on selected samples. The factual results of the soil conditions encountered in the boreholes and laboratory tests are presented in this report.

2.0 SITE DESCRIPTION

The site is located on the north side of Highway 89, about 400 m west of 5 Sideroad in Cookstown, Ontario. The surrounding area is mainly vacant or farm lands with industrial/commercial areas located at the south side of the yard, south of Highway 89.

At the time of the investigation, three salt/sand storage domes were located at the north portion of the Patrol Yard. Two one-storey office/storage buildings were located to the south of the domes. The remaining areas of the yard were generally vacant land, stockpile areas, paved access roads and vehicle parking areas.

As per the drawing provided by MTO (Drawing No. 2), the proposed new structure would be constructed between the two existing north salt/sand storage domes of the site.

Site photographs of the site are attached in Appendix C.

3.0 QUATERNARY AND BEDROCK GEOLOGY

Maps of the Quaternary Geology indicate the overburden soils in this area consist of Newmarket Till (Simcoe Lobe), sandy silt to silt matrix, moderate to high in matrix carbonate content, clast content moderate to high. Bedrock Geology maps indicate the bedrock in the area comprises shale, limestone, dolostone and/or siltstone of the Shadow Lake Formation.

4.0 INVESTIGATION PROCEDURES

4.1 Field Investigation

The field investigation work for the Cookstown Patrol Yard site was conducted on 15 and 16 October 2009. A total of five (5) boreholes (BH 1 to BH 5) were advanced to a depth of about 11.1 m within or close to the proposed building footprint. A DCPT was carried out in BH 4, below the drilled borehole depth to a depth of about 13.7 m. Boreholes BH 1 to BH 4 were drilled at the four corners, while Borehole BH 5 was located near the centre of the proposed building envelope.

The locations of the boreholes were established in the field by AMEC Field supervisor based on the drawing provided by MTO (Drawing No. 2). An additional borehole (BH 5) was also drilled to confirm the soil conditions. BH 5 was located approximately in the central area of the proposed structure based on accessibility for drilling at the site. The fieldwork was conducted after clearing underground utilities and informing the appropriate site authorities. The boreholes were advanced using a truck-mounted drilling rig with continuous-flight solid-stem augers. The ground surface elevations at the borehole locations were surveyed in the field by AMEC using the nearest benchmark provided by MTO (Station 00819798417, Name - 798417, Cookstown, see *Drawing No. 4*). The benchmark (elevation of 227.746 m) consisted of a steel rod with brass cap, set 42 cm east of a wire fence running northerly, 138.5 m west of the centerline of entrance to the Patrol Yard. The benchmark was located 22.9 m north of north Right-of-Way fence and 42 cm south of a steel marker. The co-ordinates of the boreholes were established in the field by AMEC using hand-held GPS equipment and shown on the Record of Borehole. The borehole locations are presented on Drawing No. 2. The soil profiles are presented on Drawing No. 3.

The borehole investigation was conducted under the full-time supervision of experienced geotechnical personnel from AMEC (See Section 7.0).

Soil samples were normally taken at 0.76 intervals up to a depth of 6 m and 1.5 m intervals thereafter, during the performance of Standard Penetration Test (SPT) in accordance with ASTM D1586. This consisted of freely dropping a 63.5 kg (140 lbs.) hammer for a vertical distance of 0.76 m (30 inches) to drive a 51 mm (2 inches) diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m (12 inches) was recorded as SPT 'N' value of the soil which indicated the consistency of cohesive soils or the compactness of non-cohesive soils.

The collected soil samples were screened in the field by a gas detector for the total organic vapour (TOV), the results of which are shown on the Record of Boreholes.

Upon completion of drilling, the boreholes were backfilled in accordance with the general requirements of Ministry of the Environment Regulation 903. The borehole areas were cleaned and the soil cutting transported off the site.

The soil samples were transported to AMEC's Advanced Soil Laboratory in Scarborough (Toronto) for further examination and laboratory soil testing. The program of laboratory testing included, where applicable, grain size analyses, Atterberg Limits, natural water content determination and soil corrosivity analyses.

The results of the in-situ and laboratory tests are presented on the corresponding Record of Boreholes (Appendix A) and Laboratory Test Results (Appendix B).

4.2 Laboratory Tests

Representative soil samples were subject to laboratory testing in AMEC's Advanced Soil Laboratory in Scarborough (Toronto) for soil classification. The following tests were conducted:

- Natural water content determination (43);
- Grain size distribution analysis (15);
- Liquid and Plastic Limits (13); and
- Soil corrosivity test (1).

The results of the laboratory tests are included in the Record of Boreholes in Appendix A. The grain size distribution curves and Plasticity Charts are shown in Appendix B.

One soil sample (BH2-SS3) was analysed by AMEC's chemical laboratory in Mississauga to determine the soil corrosivity with respect to concrete and steel.

5.0 SUB-SURFACE CONDITIONS

The soil profile generally consisted (in descending order) of a surficial asphaltic concrete, sand and gravel fill, sand fill overlying native sandy silt which were further underlain by silty clay/clayey silt/silt and clay.

The stratigraphic units and groundwater conditions at the borehole locations are discussed in the following sections. Detailed information is provided in the Record of Boreholes (Appendix A). The total organic vapour (TOV) results are also shown on the Record of Boreholes.

The following summary is to assist the designers of the project with an understanding of the

anticipated soil conditions across the site. However, it should be noted that the soil and groundwater conditions may vary between the borehole locations.

5.1 Asphaltic Concrete

Surficial asphaltic concrete pavement was encountered in all boreholes. The thickness of the pavement varied between 80 mm and 110 mm.

5.2 Fill Soils

5.2.1 Sand and Gravel Fill

A 0.2 m to 0.3 m thick sand and gravel fill was contacted underneath the asphaltic concrete in all boreholes.

5.2.2 Sand Fill

Brown sand fill, mixed with some silt, trace clay and gravel, was contacted below the sand and gravel fill in all boreholes. The sand fill extended to depths of about 1.1 m to 1.7 m (Elevations 226.8 m to 227.4 m). The SPT 'N' values ranged from 5 to 30 blows per 0.3 m (loose to compact).

Natural moisture content (%): 5.7 to 13.3

Grain size distribution (2 samples):	Gravel (%):	9 and 10
	Sand (%):	76 and 77
	Silt (%):	11
	Clay (%):	4 and 2

The grain size distribution curves (Figure No. B4) are presented in Appendix B.

5.3 Sandy Silt

A brown sandy silt deposit, with trace clay and gravel, was identified below the fill soils in all boreholes except for BH 4 and extended to depths of approximately 2.1 m to 3.7 m (Elevations 224.8 m to 226.4 m). The SPT 'N' values of the sandy silt generally ranged from 5 to 17 blows per 0.3 m (loose to compact).

The results of laboratory tests conducted on soil samples are as follows:

Natural moisture content (%):	18.1 to 21.5
Plastic Limit:	11 to 17
Liquid Limit:	14 to 18

Grain size distribution (3 samples):	Gravel (%):	0 to 1
	Sand (%):	23 to 39
	Silt (%):	53 to 69
	Clay (%):	6 to 7

The Plasticity Charts (Figure Nos. B1 to B3) and grain size distribution curves (Figure No. B5) are presented in Appendix B. The result of the corrosivity analysis on one soil sample retrieved from this deposit (BH2-SS3) is shown in Section 6 of this report.

5.4 Silty Clay / Clayey Silt / Silt and Clay

Silty clay/clayey silt/silt and clay was encountered underneath the sandy silt in Boreholes BH 1 to BH 3 and BH 5, and underneath the sand fill in BH 4. It extended to the termination depths of all boreholes, which was about 11.1 m (Elevations 217.3 m to 217.4 m). The silt and clay was brown to grey in color, and contained trace to some sand. DCPT was carried out in BH 4, below the drilled depth, to a depth of about 13.7 m (Elevation 214.9 m), to confirm consistency of the soil below the drilled depth. The DCPT indicated a generally linear increase in the consistency of the soil up to the end of the test (refer to Record of Borehole).

The SPT 'N' values of the silty clay/clayey silt/silt and clay varied widely from 6 blows to greater than 50 blows per 0.3 m, indicating a firm to hard consistency.

The results of laboratory tests conducted on soil samples are as follows:

Natural moisture content (%):	19.2 to 30.6
Plastic Limit:	10 and 18
Liquid Limit:	25 and 44

Grain size distribution (10 samples):	Gravel (%):	0 to 1
	Sand (%):	0 to 11
	Silt (%):	35 to 57
	Clay (%):	32 to 61

The Plasticity Charts (Figure No. B1 to B3) and the grain size distribution curves (Figure No. B6 and B7) are presented in Appendix B.

5.5 Groundwater

Free groundwater was encountered in all boreholes in the open boreholes immediately upon completion of drilling. The measured groundwater levels are shown on the Record of Boreholes (Appendix A) and are summarized in the following table:

Borehole No.	Groundwater Depth Below Existing Ground Surface, m	Elevation, m
1	2.7	225.8
2	2.7	225.8
3	1.8	226.8
4	3.1	225.5
5	1.8	226.7

It should be noted that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring thaw and in response to major weather events.

5.6 Limited Environmental Investigation

In accordance with the Terms of Reference, soil samples obtained during the geotechnical field drilling program were field screened for evidence of environmental impact. The field screening activities included measuring the total organic vapours (TOV) in the headspace of samples with a portable hydrocarbon surveyor instrument (Thermo Gastechtor 1238ME). The borehole locations were positioned at the site as required by the geotechnical investigation.

Based on the soil conditions encountered in all the boreholes, the soil profile at the site comprised predominantly existing fill soils, native sandy silt overlying silty clay/clayey silt/silt and clay. No visual or olfactory evidence of environmental impact was observed in the fill and native soil samples recovered from the boreholes. The measured TOV concentrations in all soil samples were 40 ppm or less as shown in the Record of Boreholes in Appendix A. The TOV results are semi-quantitative at best and are generally only used for relative sample comparison purposes when selecting samples for laboratory analysis.

6.0 SOIL CORROSIVITY

One soil sample (BH 2 – SS3) was analysed by AMEC's chemical laboratory in Mississauga to determine the soil corrosivity potential with respect to concrete and steel. The results are presented in the following table and the laboratory Certificate of Analysis is included in Appendix B:

Soil Sample No.	pH	Resistivity (ohms-cm)	Chloride (µg/g)	Sulphate (µg/g)
BH2-SS3	8.4	1650	943	64

According to Table 3 - "Requirements for Concrete Subject to Sulphate Attack", Clause 15.5.2, of CSA Standard Specification A23.1-04, concrete is considered to be under sulphate attack when sulphate concentration in the soil is over 0.10 % or 1000 ppm (µg/g). The measured soil resistivity shows that the soil corrosivity could be "severe". Additional testing should be conducted and the

soil corrosivity on concrete and steel should be studied in detail, if necessary, by a corrosivity expert.

7.0 MISCELLANEOUS INFORMATION

The drilling work was done by Strong Soil Search Inc. (5265 SideLine 16, Claremount, Whitby, Ontario L1Y 1A1).

The field investigation was supervised by Mr. Muhammad Saleem, P.Eng. and Mr. Javad Farhoodi, B.Eng. The boreholes were surveyed by AMEC supervisors, with reference to the nearest benchmark provided by MTO. The overall field operation was supervised by Mr. Shami Malla, P.Eng.

All laboratory soil tests were carried out at AMEC's Scarborough laboratory. Soil corrosivity test was performed by AMEC's Mississauga chemical laboratory.

This report was prepared by Shami Malla, P.Eng. and reviewed by Prapote Boonsinsuk, P.Eng. and George Chow, P.Eng.

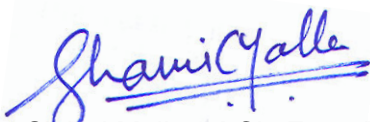
8.0 CLOSURE

The sub-soil information and recommendations contained in this report should be used solely for the purpose of foundation assessment of this site.

The attached Report Limitations is an integral part of this report.

Sincerely,

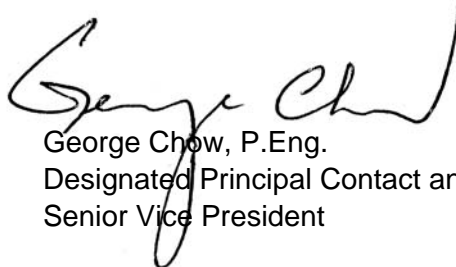
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Shami Malla, M.Civ.Eng., P.Eng.
Geotechnical Engineer



Prapote Boonsinsuk, Ph.D., P.Eng.
Project Manager and Technical Reviewer
Group Leader, Geotechnical Engineering



George Chow, P.Eng.
Designated Principal Contact and Project Reviewer
Senior Vice President



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REPORT LIMITATIONS

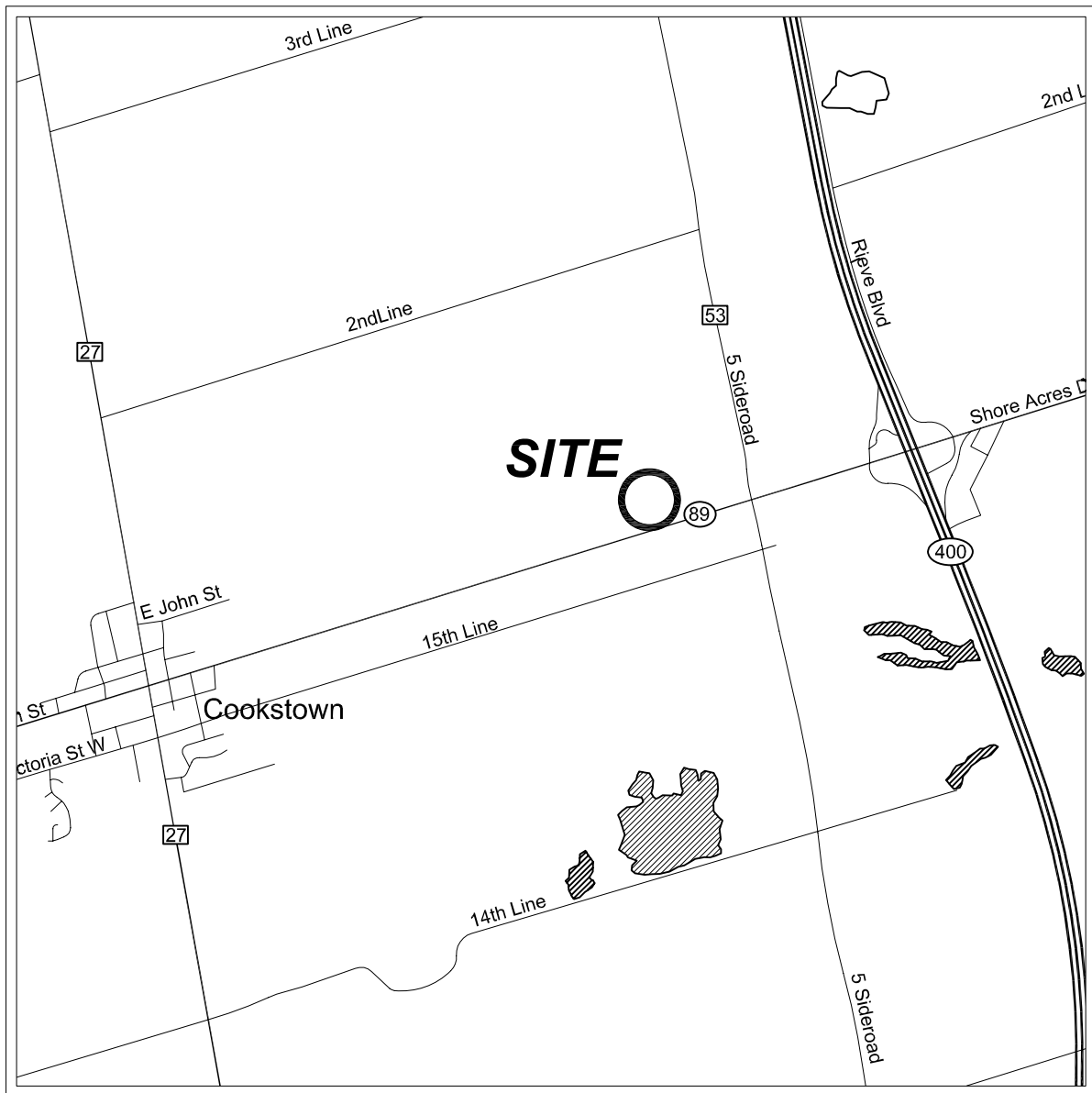
The factual information given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes 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 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 provided by the Ministry of Transportation.

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 accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

DRAWINGS



KEY PLAN

500 0 500 1000 1500 2000m

Approximate Scale

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CLIENT LOGO



CLIENT

**MINISTRY OF
TRANSPORTATION ONTARIO**

TITLE
SITE PLAN

PROJECT
**BOREHOLE SOIL INVESTIGATION FOR
NEW SALT/SAND STORAGE STRUCTURE AT COOKSTOWN PATROL YARD**
AGREEMENT NUMBER 2009-C-0092, G.W.P. No. 2030-09-00

DWN BY:
KW

CHK'D BY:
PB

PROJECTION:
-

DATUM:
-

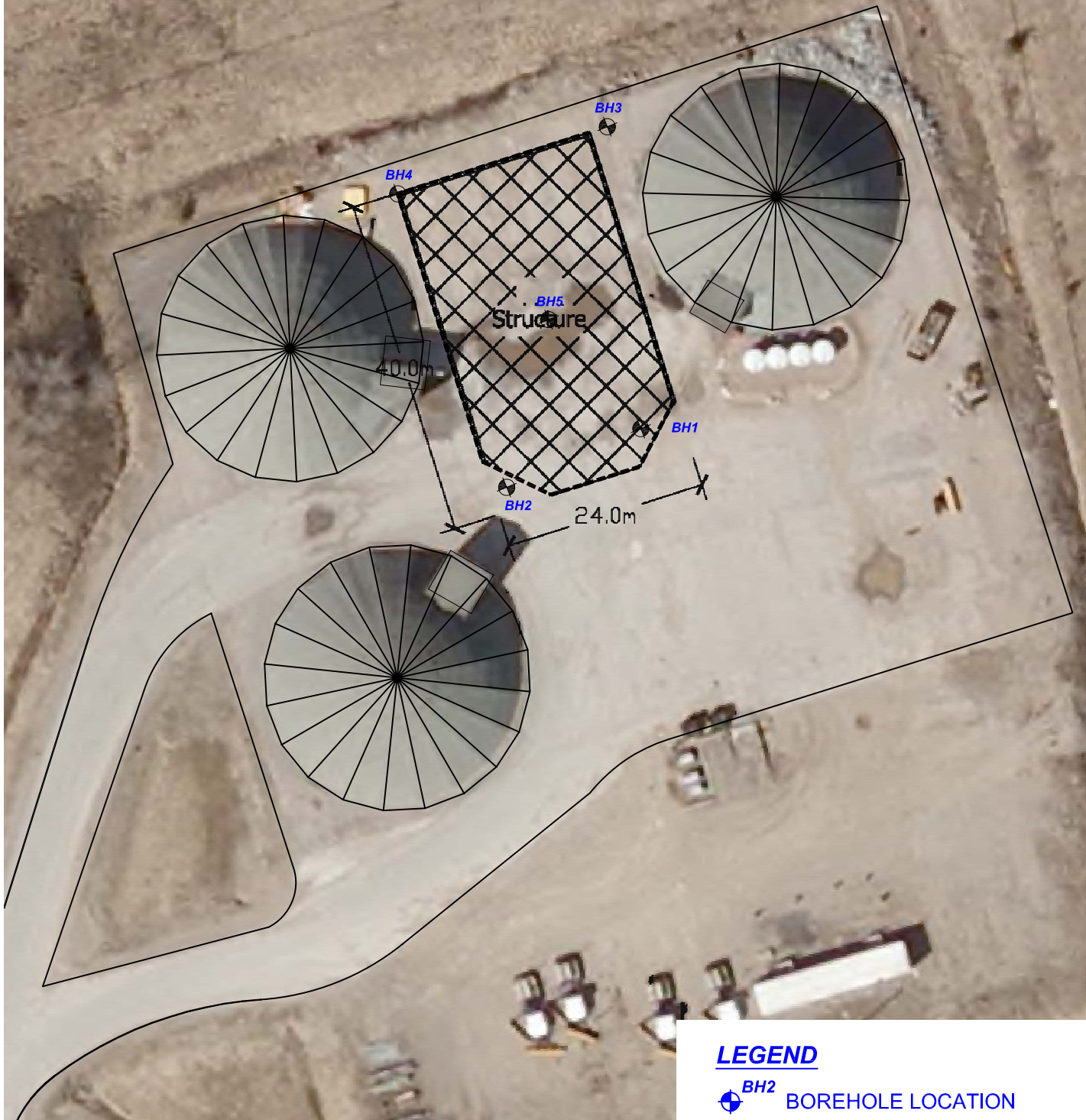
REV. NO.:
A

SCALE:
AS SHOWN

DATE:
November 2009

PROJECT NO:
TT93045

DRAWING No.
1



LEGEND

 **BH2** BOREHOLE LOCATION

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CLIENT

MINISTRY OF
TRANSPORTATION ONTARIO

TITLE
BOREHOLE LOCATION PLAN

DWN BY:
KW

DATUM:
-

DATE:
November 2009

PROJECT
BOREHOLE SOIL INVESTIGATION FOR
NEW SALT/SAND STORAGE STRUCTURE AT COOKSTOWN PATROL YARD
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CHK'D BY:
PB

REV. NO.:
A


PROJECT NO:
TT93045

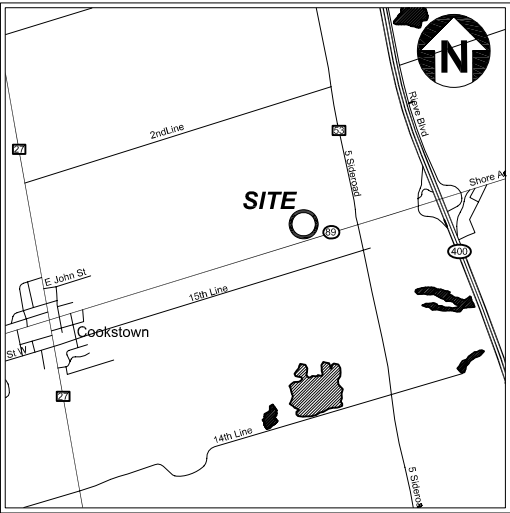
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DRAWING No.
2



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

AGREEMENT No.	2009-C-0092	SHEET
G.W.P. No.	2030-09-00	
BOREHOLE SOIL INVESTIGATION FOR NEW SALT/SAND STORAGE STRUCTURE AT COOKSTOWN PATROL YARD		
 AMEC Earth & Environmental, a Division of AMEC Americas Limited		



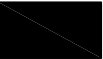



KEY PLAN
500 0 500 1000 1500 2000m
Approximate Scale

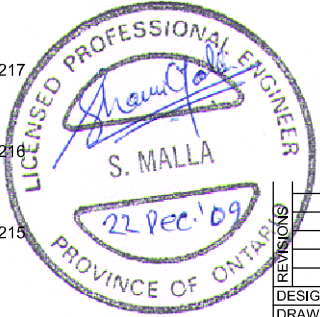
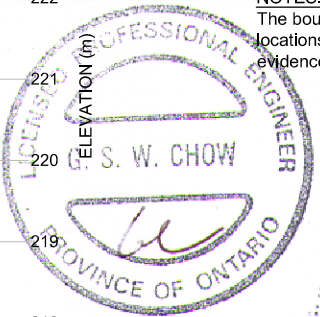
LEGEND

-  BOREHOLE LOCATION
-  GROUNDWATER LEVEL IN BOREHOLE AT TIME OF INVESTIGATION

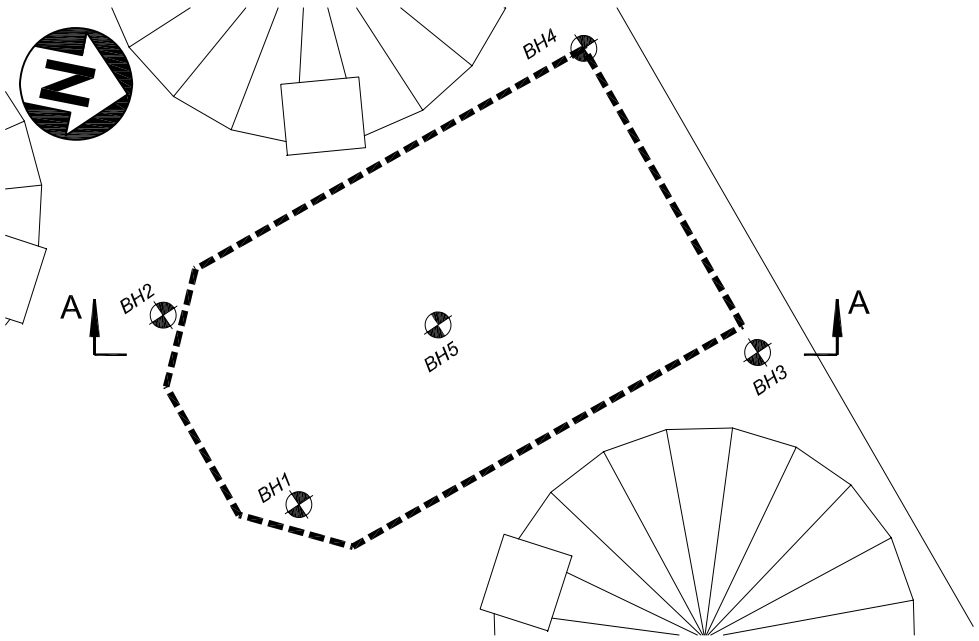
NOTES:
The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.

SOIL STRATIGRAPHY

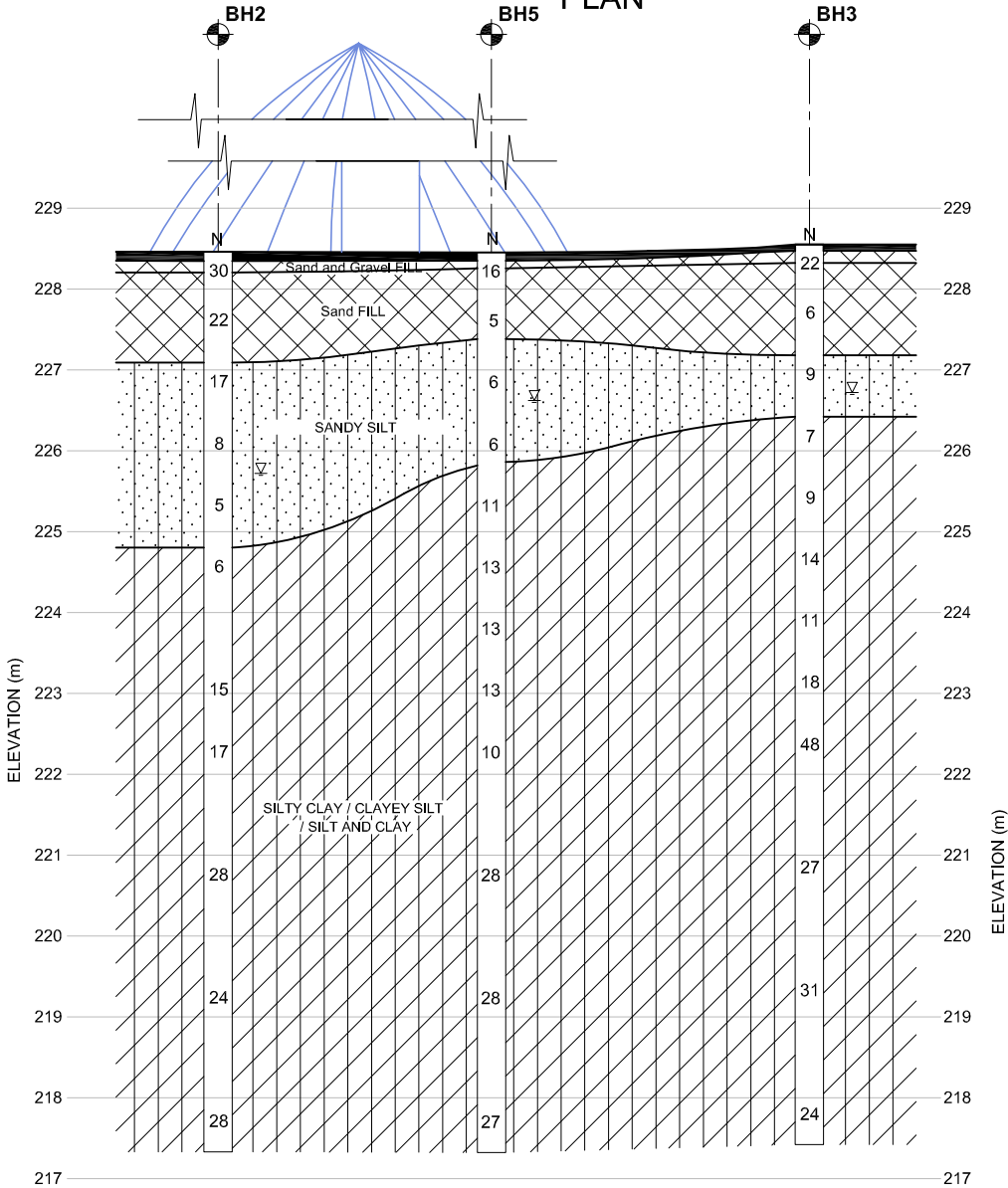
-  ASPHALTIC CONCRETE
-  FILL
-  SILTY CLAY / CLAYEY SILT / SILT AND CLAY
-  SANDY SILT



DESIGN	CHK PB	CODE	CL	DATE DEC. 2009
DRAWN KW	CHK GC	SITE	DWG	3

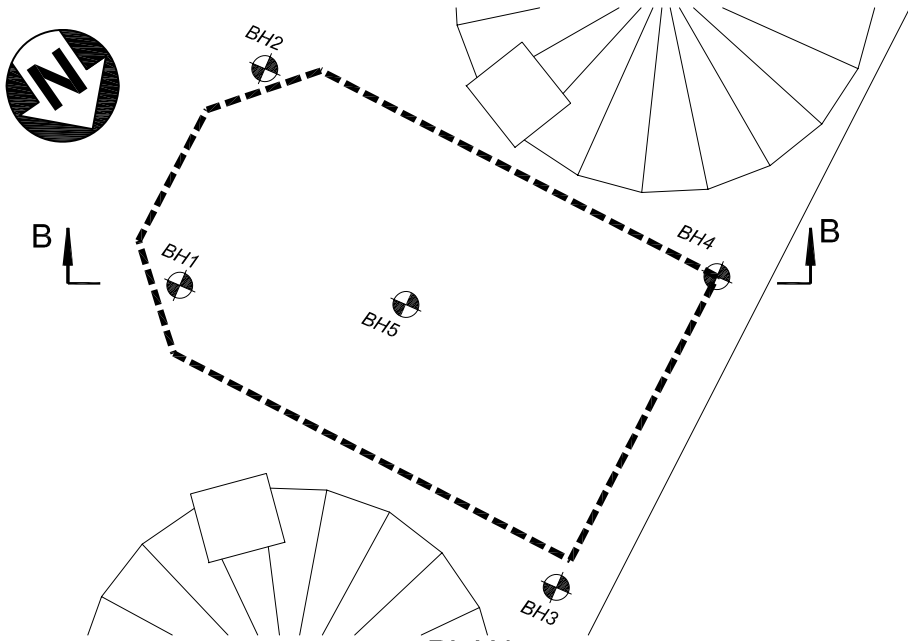


PLAN

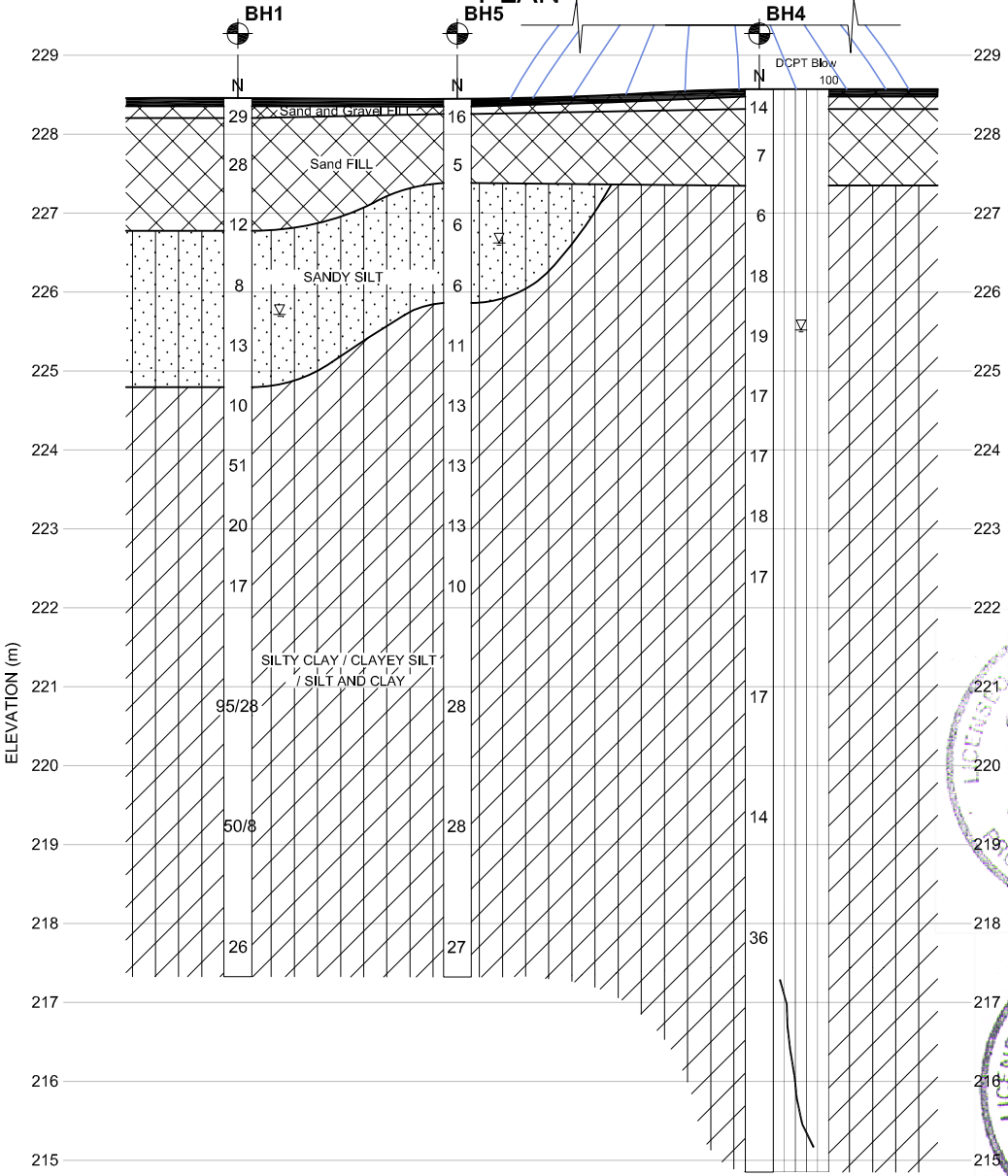


0 6 12 18m
SCALE

SECTION A-A



PLAN



SECTION B-B

P:\GEO\Projects\2007\T271046 - Hwy.417, Ottawa\Drawings\T271046 - BH07-1 - BH07-8.DWG



Station: 00819798417
Name: 798417
MTO Route: 194
Highway: 89

EMR Quad: 44079
EMR Line:
Datum: SOA78
Order: 1

Location: Cookstown
Latitude: N44-11-48.00000
Longitude: W79-40-18.00000
Ortho Hgt: 227.746

798417: STEEL ROD WITH BRASS CAP BENCH MARK IN MTC PATROL YARD ON NORTH SIDE OF HWY 89, 2.6 KM EAST OF JCT OF HWYS 27 AND 89 IN COOKSTOWN, 1.3 KM WEST OF JCT OF HWYS 89 AND 400, AND 37.0 M NORTH OF CENTRELINE OF HWY 89. BENCH MARK IS SET 42 CM EAST OF WIRE FENCE RUNNING NORTHERLY, 138.5 M WEST OF CENTRELINE OF ENTRANCE TO MTC PATROL YARD, 22.9 M NORTH OF NORTH RIGHT-OF-WAY FENCE AND 42 CM SOUTH OF A STEEL MARKER.

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CLIENT LOGO



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MINISTRY OF
TRANSPORTATION ONTARIO

TITLE
BENCHMARK LOCATION

PROJECT
BOREHOLE SOIL INVESTIGATION FOR
NEW SALT/SAND STORAGE STRUCTURE AT COOKSTOWN PATROL YARD
AGREEMENT NUMBER 2009-C-0092, G.W.P. No. 2030-09-00

DWN BY:
KW

CHK'D BY:
PB

PROJECTION:
-

DATUM:
-

REV. NO.:
A

SCALE:
AS SHOWN

DATE:
November 2009

PROJECT NO:
TT93045

DRAWING No.
4

APPENDIX A
RECORD OF BOREHOLES

EXPLANATION OF BOREHOLE LOG

This form describes some of the information provided on the borehole logs, which is based primarily on examination of the recovered samples, and the results of the field and laboratory tests. Additional description of the soil/rock encountered is given in the accompanying geotechnical report.

GENERAL INFORMATION

Project details, borehole number, location coordinates and type of drilling equipment used are given at the top of the borehole log.

SOIL LITHOLOGY

Elevation and Depth

This column gives the elevation and depth of inferred geologic layers. The elevation is referred to the datum shown in the Description column.

Lithology Plot

This column presents a graphic depiction of the soil and rock stratigraphy encountered within the borehole.

Description

This column gives a description of the soil strata, based on visual and tactile examination of the samples augmented with field and laboratory test results. Each stratum is described according to the *Modified Unified Soil Classification System*.

The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined as follows (*Ref. Canadian Foundation Engineering Manual*):

Compactness of	
<u>Cohesionless</u>	<u>SPT N-Value*</u>
<u>Soils</u>	
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

Consistency of		<u>Undrained Shear Strength</u>
<u>Cohesive Soils</u>	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	Over 200	Over 4000

* For penetration of less than 0.3 m, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimeter penetration).

Soil Sampling

Sample types are abbreviated as follows:

SS	Split Spoon	TW	Thin Wall Open (Pushed)	RC	Rock Core	GS	Grab Sample
AS	Auger Sample	TP	Thin Wall Piston (Pushed)	WS	Washed Sample	AR	Air Return Sample

Additional information provided in this section includes sample numbering, sample recovery and numerical testing results.

Field and Laboratory Testing

Results of field testing (e.g., SPT, pocket penetrometer, and vane testing) and laboratory testing (e.g., natural moisture content, and limits) executed on the recovered samples are plotted in this section.

Instrumentation Installation

Instrumentation installations (monitoring wells, piezometers, inclinometers, etc.) are plotted in this section. Water levels, if measured during fieldwork, are also plotted. These water levels may or may not be representative of the static groundwater level depending on the nature of soil stratum where the piezometer tips are located, the time elapsed from installation to reading and other applicable factors.


Comments

This column is used to describe non-standard situations or notes of interest.

MODIFIED * UNIFIED CLASSIFICATION SYSTEM FOR SOILS						
*The soil of each stratum is described using the Unified Soil Classification System (Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S Army. Vol. 1 March 1953,) modified slightly so that an inorganic clay of "medium plasticity" is recognized.						
MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM	SILTY GRAVELS, GRAVEL-SAND- SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 4	
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 7	
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP	POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 4	
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L < 50\%$	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L < 50\%$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$W_L < 50\%$	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L < 50\%$	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
	HIGH ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

SOIL COMPONENTS					
FRACTION	U.S STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS		
GRAVEL	COARSE	PASSING	RETAINED	PERCENT	DESCRIPTOR
		76 mm	19 mm	35-50	AND
	FINE	19 mm	4.75 mm	20-35	Y/EY
SAND	COARSE	4.75 mm	2.00 mm	10-20	SOME
	MEDIUM	2.00 mm	425 µm	1-10	TRACE
	FINE	425 µm	75 µm		
FINES (SILT OR CLAY BASED ON PLASTICITY)		75 µm			
OVERSIZED MATERIAL					
ROUNDED OR SUBROUNDED: COBBLES 76 mm TO 200 mm BOULDERS > 200 mm				NOT ROUNDED: ROCK FRAGMENTS > 76 mm ROCKS > 0.76 CUBIC METRE IN VOLUME	

Plasticity Chart for Soil Passing 425 Micron Sieve

AMEC Earth & Environmental 104 Crockford Boulevard Scarborough, ON M1R 3C3 Ph: (416) 751-6565 Fax: (416) 751-7592 www.amec.com		Note 1: Soils are classified and described according to their engineering properties and behaviour. Note 2: The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual (4th Edition, Canadian Geotechnical Society, 2006.)
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+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 2

1 OF 1

G.W.P. 2030-09-00 LOCATION Cookstown Patrol Yard, Cookstown, Ontario (N:4894821 E:606366) ORIGINATED BY SAL
 DIST _____ HWY _____ BOREHOLE TYPE Solid Stem Augering COMPILED BY SN
 DATUM Geodetic DATE 15 October 2009 - 15 October 2009 CHECKED BY PB
 PROJECT Borehole Soil Investigation for New Sand/Salt Storage Structures JOB NO. TT93045

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	SOIL VAPOUR READING	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa						
									○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
228.5									20 40 60 80 100	20 40 60 80 100	10 20 30				
228.4	about 110 mm ASPHALT														
228.3	brown Sand and Gravel FILL		1	SS	30		228				5		0		
	trace to some silt														
	dense moist		2	SS	22		1				13		10		
	brown Sand FILL														
227.1	some silt, trace clay and gravel		3	SS	17		227				18		40		
	compact moist														
	brown SANDY SILT														
	trace clay		4	SS	8		226				20		15		Spoon was wet.
	loose to compact moist to wet														
	trace gravel		5	SS	5		225				18 19		10	1 39 53 7	
224.8	grey SILTY CLAY / CLAYEY SILT / SILT AND CLAY														
	trace sand		6	SS	6		224				26		5		
	firm to very stiff moist														
			7	TW			223				16 23 35		5	1 57 42	
			8	SS	15										
			9	SS	17		222				31		5		
			10	SS	28		221				20		10		
			11	SS	24		219				16 25 38		10	44 56	
			12	SS	28		218				26		10		
217.3	End of Borehole														
11.1	Groundwater in open borehole on completion: 2.7 m														
	Borehole was backfilled with bentonite at the completion of drilling.														

RECORD OF BOREHOLE No BH 3

1 OF 1

G.W.P. 2030-09-00	LOCATION Cookstown Patrol Yard, Cookstown, Ontario (N:4894864 E:606378)	ORIGINATED BY SAL
DIST _____ HWY _____	BOREHOLE TYPE Solid Stem Augering	COMPILED BY SN
DATUM Geodetic	DATE 16 October 2009 - 16 October 2009	CHECKED BY PB
PROJECT Borehole Soil Investigation for New Sand/Salt Storage Structures		JOB NO. TT93045

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT				SOIL VAPOUR READING	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa					WATER CONTENT (%)						
228.6									20	40	60	80	100							
228.6	about 80 mm ASPHALT																			
228.3	brown Sand and Gravel FILL trace to some silt compact moist		1	SS	22		228							6						
228.2			2	SS	6		1							9				9	76	11 4
227.2	brown Sand FILL some silt, trace clay and gravel loose to compact moist		3	SS	9		227							118	22				31	63 6
226.4	brown SANDY SILT trace clay, trace organics loose moist to wet		4	SS	7		226							25						
225.1	brown SILTY CLAY / CLAYEY SILT / SILT AND CLAY trace sand and gravel firm to hard moist		5	SS	9		225							30						
			6	SS	14		224							21						
			7	SS	11		223							24						
	grey		8	SS	18		222							24						
			9	SS	48		221							16	38				48	52
							220							19						
			10	SS	27		219							26						
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RECORD OF BOREHOLE No BH 4

1 OF 2

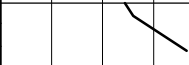
G.W.P. 2030-09-00 LOCATION Cookstown Patrol Yard, Cookstown, Ontario (N:4894856 E:606353) ORIGINATED BY SAL
 DIST _____ HWY _____ BOREHOLE TYPE Solid Stem Augering and Dynamic Cone Penetration COMPILED BY SN
 DATUM Geodetic DATE 15 October 2009 - 15 October 2009 CHECKED BY PB
 PROJECT Borehole Soil Investigation for New Sand/Salt Storage Structures JOB NO. TT93045

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	SOIL VAPOUR READING	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa						
228.6									20 40 60 80 100	20 40 60 80 100					
228.5	about 100 mm ASPHALT								○ UNCONFINED + FIELD VANE						
228.3	brown		1	SS	14		228		● QUICK TRIAXIAL × LAB VANE						
228.1	Sand and Gravel FILL														
228.0	trace to some silt		2	SS	7		1								
227.9	compact														
227.4	moist														
227.3	brown														
227.2	Sand FILL														
227.1	some silt, trace clay and gravel		3	SS	6		2								
227.0	loose to compact														
226.9	moist														
226.8	brown														
226.7	SILTY CLAY / CLAYEY SILT /		4	SS	18		226								
226.6	SILT AND CLAY														
226.5	trace sand														
226.4	firm to hard		5	SS	19		3								
226.3	moist														
226.2															
226.1															
226.0	grey		6	SS	17		4								
225.9															
225.8															
225.7			7	SS	17		5								
225.6															
225.5															
225.4															
225.3			8	SS	18		6								
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225.1															
225.0			9	SS	17		7								
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RECORD OF BOREHOLE No BH 4

2 OF 2

G.W.P. 2030-09-00 LOCATION Cookstown Patrol Yard, Cookstown, Ontario (N:4894856 E:606353) ORIGINATED BY SAL
DIST HWY BOREHOLE TYPE Solid Stem Augering and Dynamic Cone Penetration COMPILED BY SN
DATUM Geodetic DATE 15 October 2009 - 15 October 2009 CHECKED BY PB
PROJECT Borehole Soil Investigation for New Sand/Salt Storage Structures JOB NO. TT93045

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			SOIL VAPOUR READING	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa					W _p	W	W _L			PPM	GR	SA
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					10 20 30 WATER CONTENT (%)										
214.9								215													
13.7	End of DCPT Groundwater in open borehole on completion: 3.1 m Borehole was backfilled with bentonite at the completion of drilling.																				

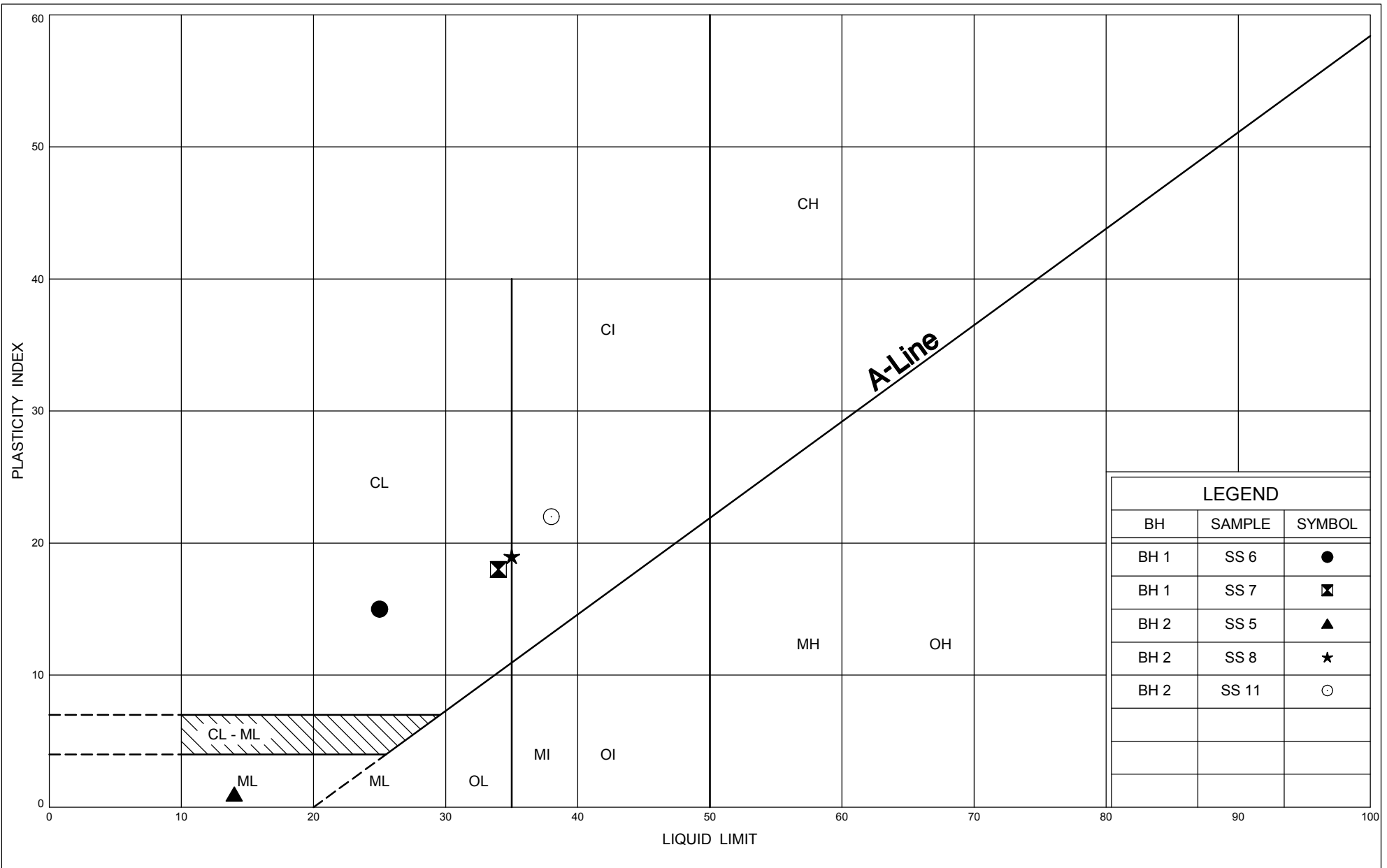
G.W.P.	2030-09-00	LOCATION	Cookstown Patrol Yard, Cookstown, Ontario (N:4894841 E:606371)	ORIGINATED BY	SAL
DIST		HWY		COMPILED BY	SN
DATUM	Geodetic	DATE	16 October 2009 - 16 October 2009	CHECKED BY	PB
PROJECT	Borehole Soil Investigation for New Sand/Salt Storage Structures			JOB NO	TT93045

[illegible]

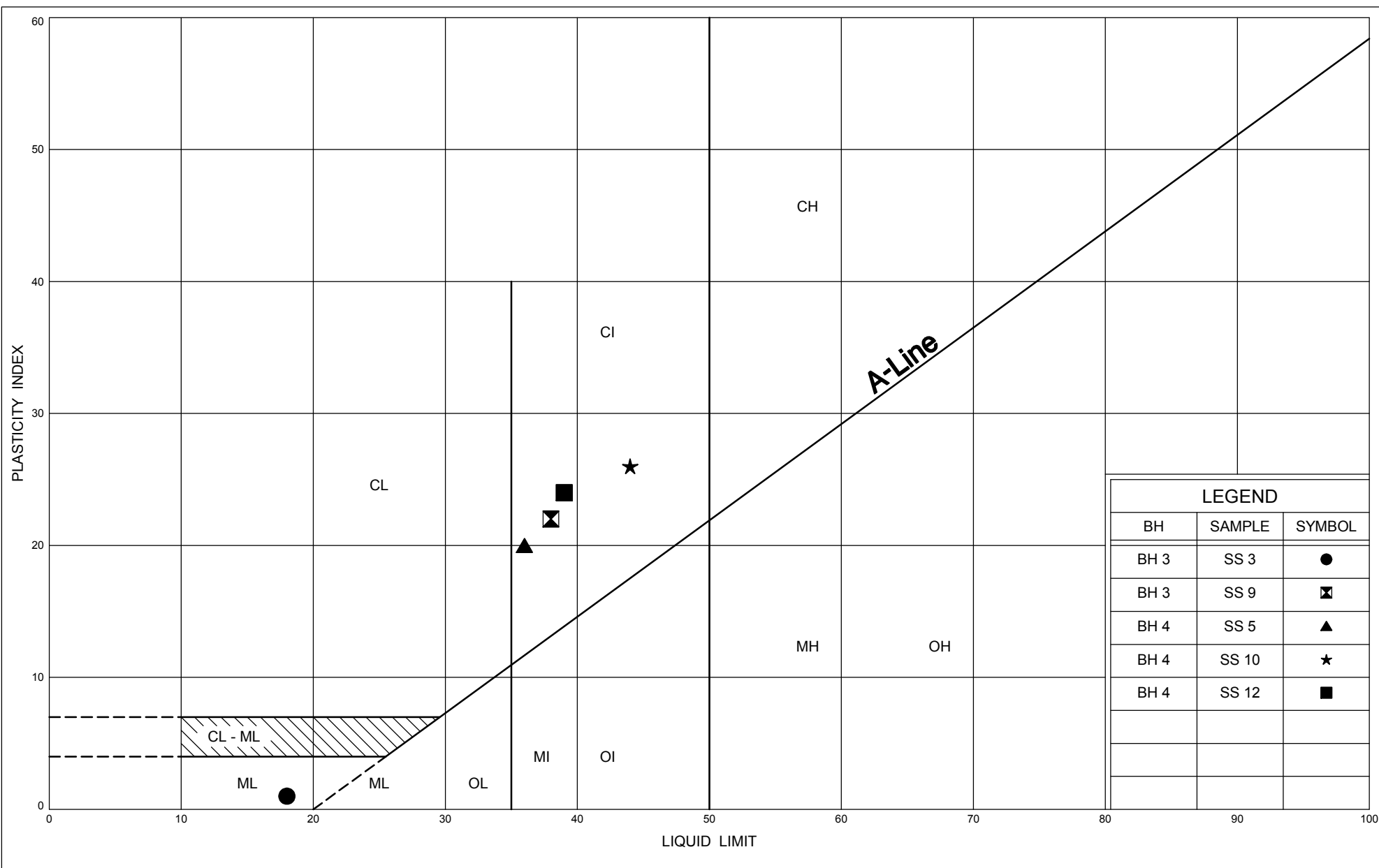
+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

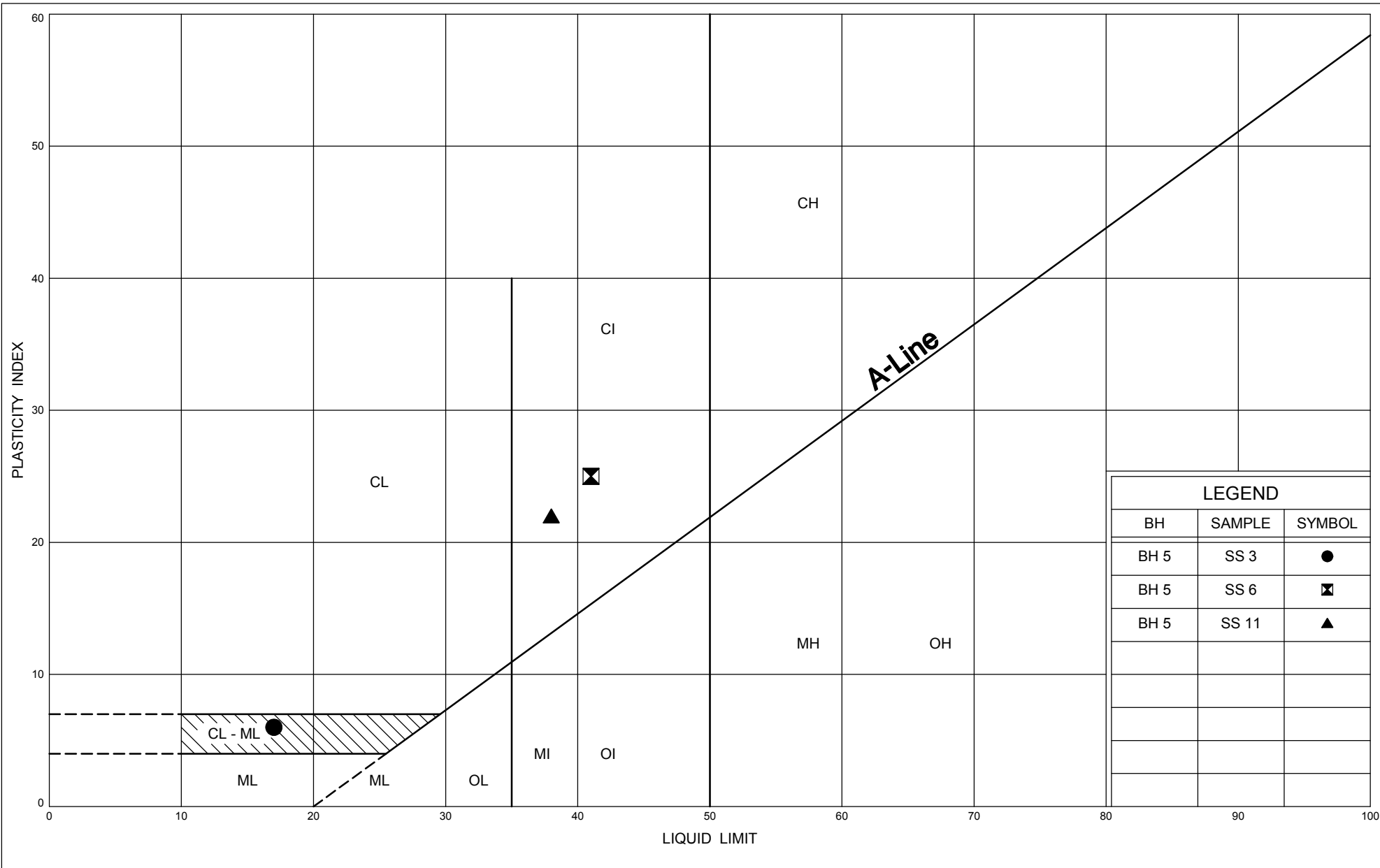
APPENDIX B

LABORATORY TEST RESULTS

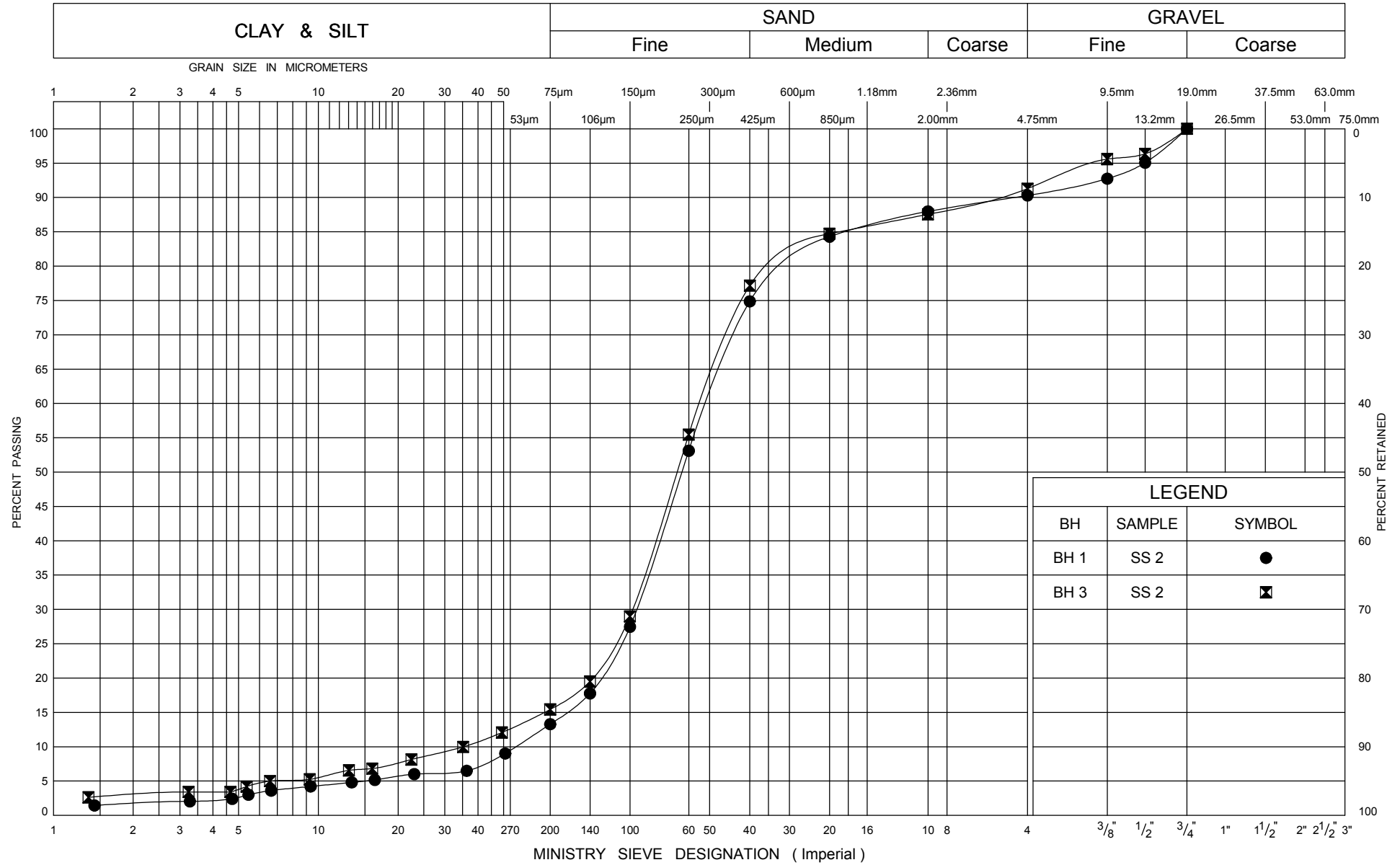


LEGEND		
BH	SAMPLE	SYMBOL
BH 1	SS 6	●
BH 1	SS 7	⊠
BH 2	SS 5	▲
BH 2	SS 8	★
BH 2	SS 11	○

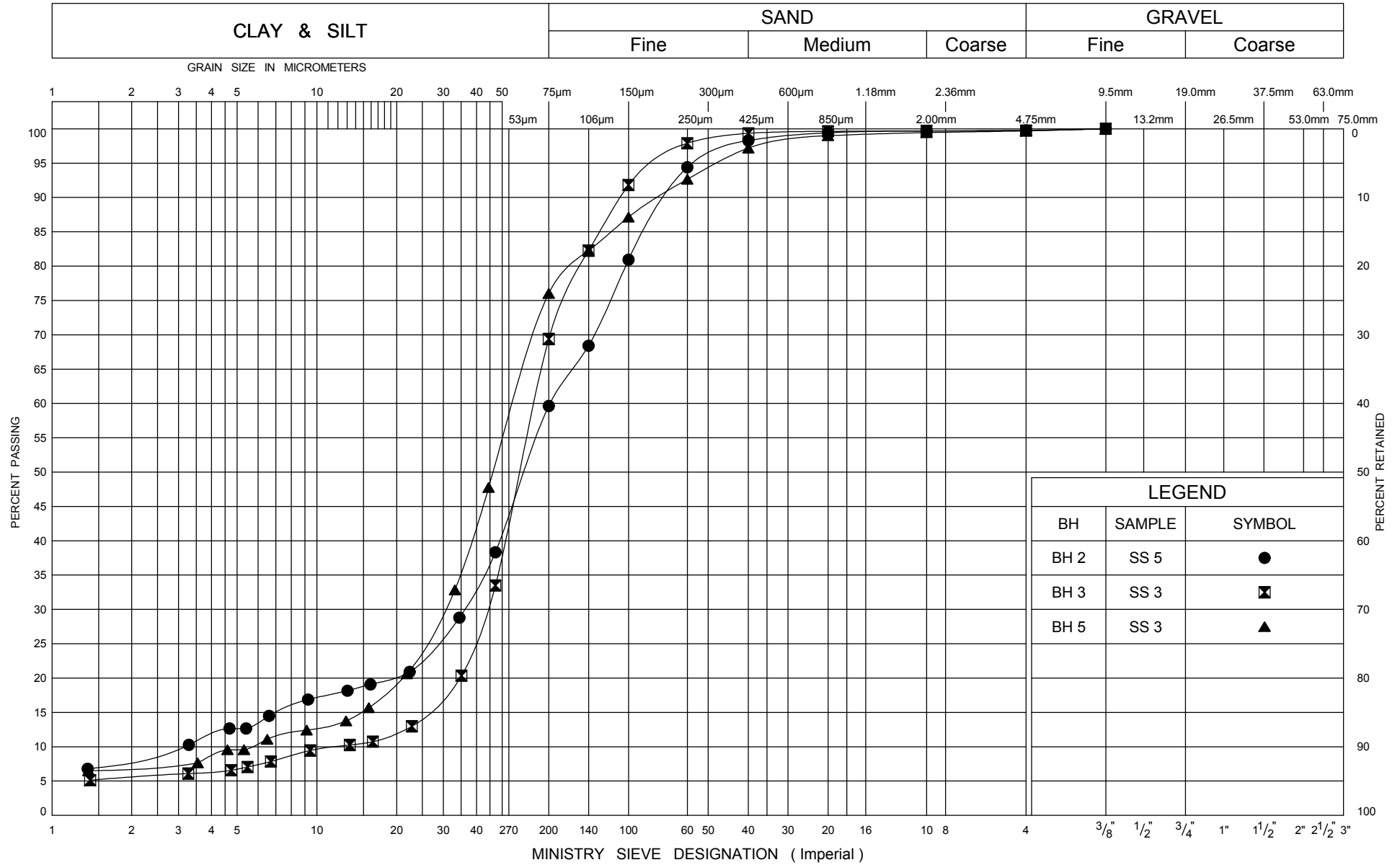




UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



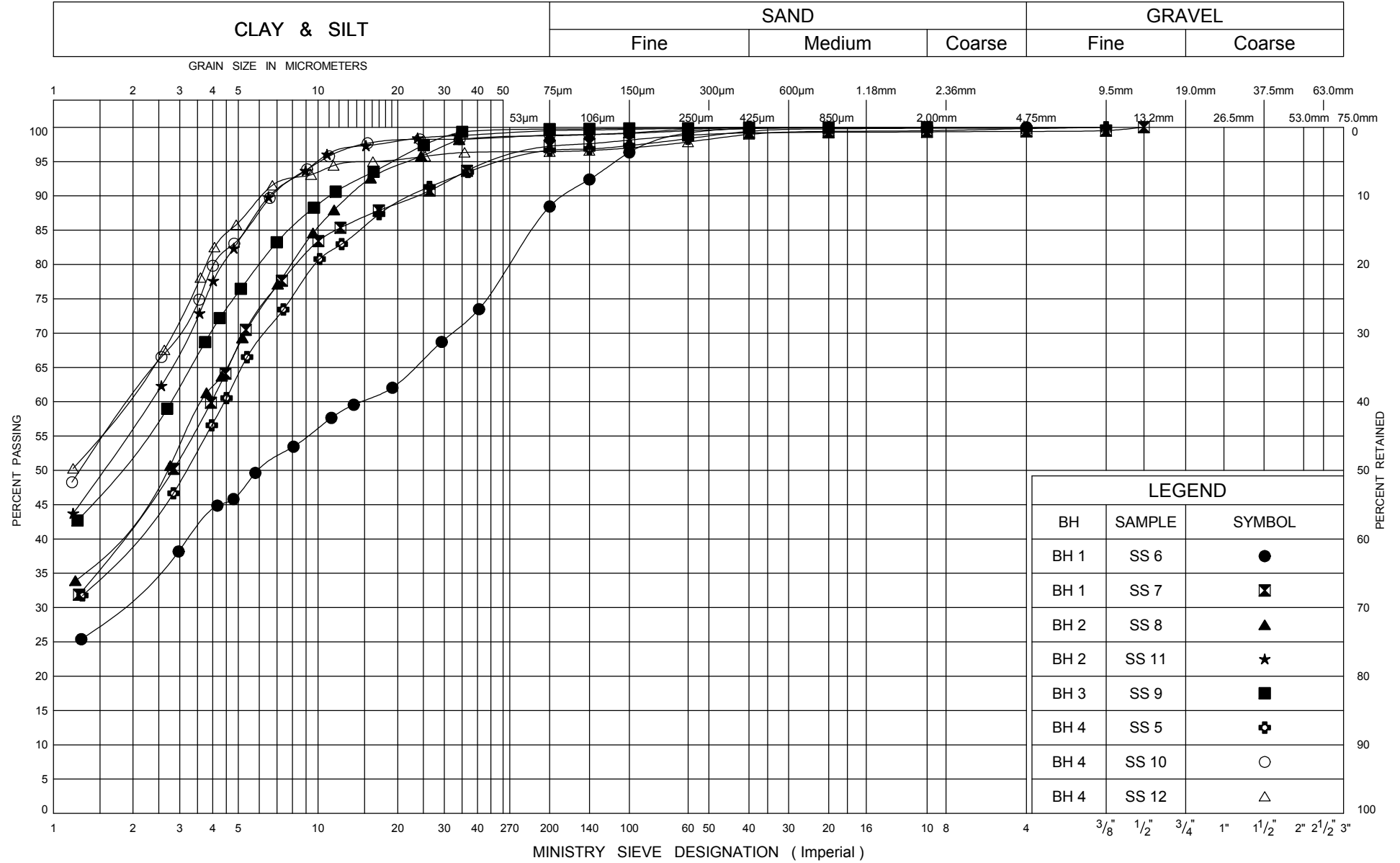
GRAIN SIZE DISTRIBUTION
SANDY SILT
 trace clay and gravel

Figure No. B5

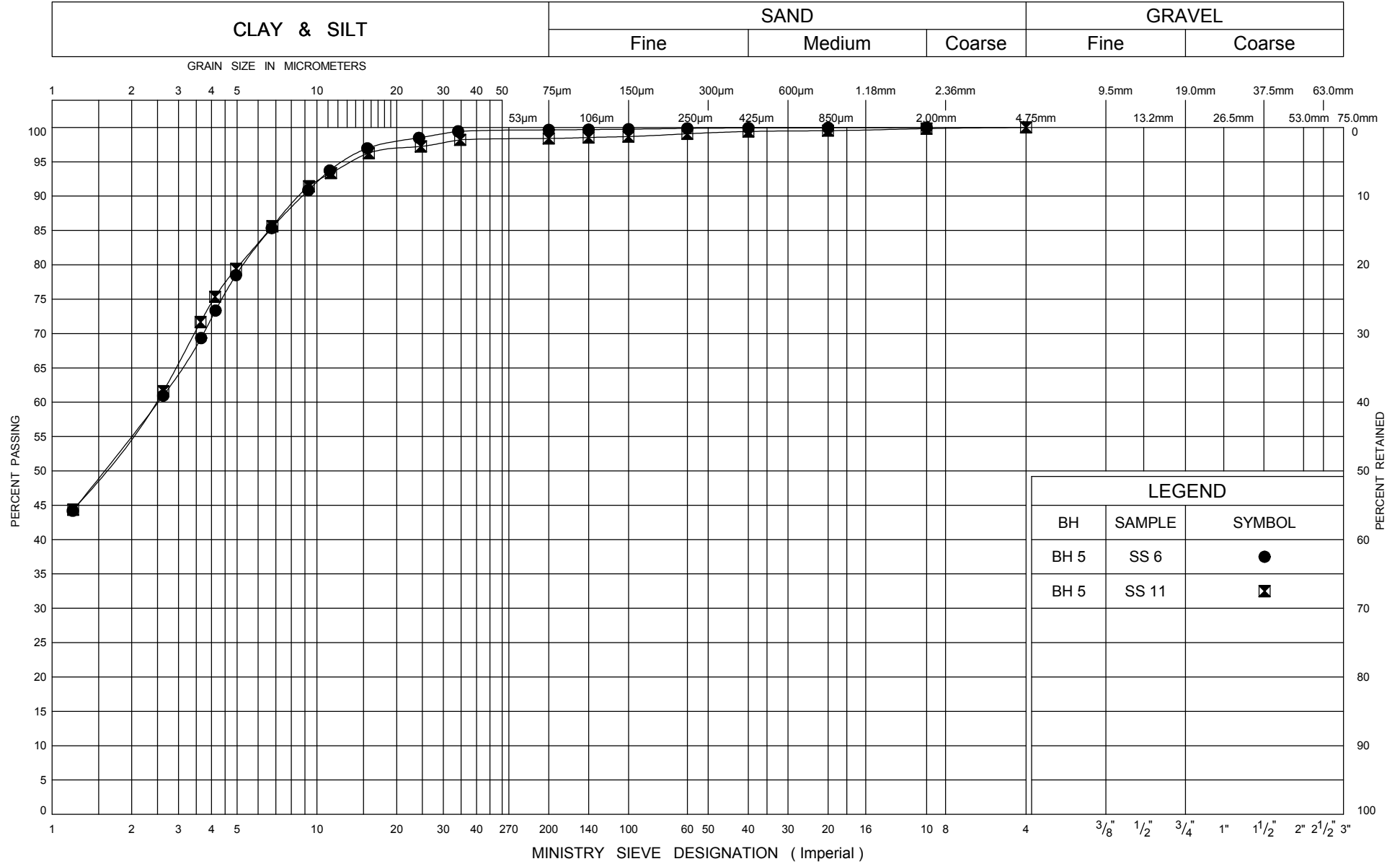
G.W.P. 2030-09-00

Cookstown Patrol Yard

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Client: AMEC Earth and Environmental,
a division of AMEC Americas Limited
104 Crockford Boulevard
Scarborough, Ontario M1R 3C3

Report Date: November 04, 2009
Received Date: October 28, 2009

Page: 1 of 2

Project Name: MTO Patrol Yards

Sample Type: Soil

Project Number: TT 93045

Lab Ref.: FN09-2633

Contact: Siva Nadarajah

Final

CERTIFICATE OF ANALYSIS

Cookstown Patrol Yard

Corrosivity Package

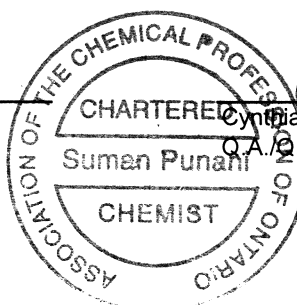
Lab Number			09-16238	09-16239	09-16240	09-16240
Sample ID			BH3 SS3	BH2C SS3	BH2B SS3	BH2B SS3
Date Collected			NP	NP	NP	NP
Parameters	Unit	MDL				(Replicate)
Chloride	(µg/g)	1	2170	943	311	313
pH	-	-	8.4	8.4	8.3	NR
Resistivity	(ohmscm)	-	2790	1650	738	NR
Sulphate	(µg/g)	1	64	64	13	12

			Lab Blank	Q. C. Standard Actual	Q. C. Standard Expected	Date of Analysis
			(µg/g)	(mg/L)	(mg/L)	
Parameters	Unit	MDL				
Chloride	(µg/g)	1	<1	3.9	4.2	03-Nov-09
pH	-	-	7.2	6.0	6.0	02-Nov-09
Resistivity	(ohmscm)	-	-	-	-	02-Nov-09
Sulphate	(µg/g)	1	<1	21.7	24.0	03-Nov-09

			Method References
Parameters	Unit	MDL	
Chloride	(µg/g)	1	MOE 3013, APHA 4110 C
pH	-	-	MOE 9045
Resistivity	(ohmscm)	-	MOE 3137
Sulphate	(µg/g)	1	MOE 3013, APHA 4110 C

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Suman Punani, C. Chem.
Laboratory Manager



Cynthia Ridge, C. Chem.
Q.A./C. Manager

Client:	AMEC-Scarborough	Report Date:	November 04, 2009
Lab Ref:	FN09-2633	Page:	2 of 2
Samples average temperature upon receipt		<div style="border: 1px solid black; padding: 2px; display: inline-block;">17.8 °C</div>	
Results relate only to the items tested.			
~ GENERAL COMMENTS ~			
MDL	Method Detection Limit		
ANR	Analysis not required		
NA	Analysis not applicable		
NP	Not Provided		
NR	No Lab Replicate		

APPENDIX C
SITE PHOTOGRAPHS



Photograph No. 1: View of the site, looking north.



Photograph No. 2: View of the site, looking west.