



May 13, 2016

FOUNDATION INVESTIGATION REPORT

**PATROL YARD STRUCTURE
MUNICIPALITY OF DYSART PATROL YARD
HIGHWAY 118, WEST OF HALIBURTON
ASSIGNMENT NO. 16, AGREEMENT NO. 5013-E-0034
MINISTRY OF TRANSPORTATION, ONTARIO**

Submitted to:

Ministry of Transportation, Ontario
Pavements and Foundations Section
447 McKeown Avenue, Suite 301
North Bay, ON P1B 9S9

REPORT



GEOCRES NO.: 31E-362

Report Number: 14-1181-0014.16000

Distribution:

3 Copies - Ministry of Transportation, Ontario, North Bay, Ontario (Northeastern Region)

1 Copy - Ministry of Transportation, Ontario, Downsview, Ontario (Foundations Section)

1 Copy - Golder Associates Ltd., Barrie, Ontario



Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION	1
3.0 INVESTIGATION PROCEDURES	2
3.1 Foundation Investigation.....	2
4.0 SUBSURFACE CONDITIONS.....	3
4.1 Subsoil Conditions.....	3
4.2 Groundwater Conditions	4
5.0 CLOSURE	5

DRAWINGS

Drawing 1 Borehole Locations and Soil Strata

LIST OF APPENDICES

Appendix A Record of Boreholes

List of Symbols and Abbreviations
Record of Boreholes BH16-1 to BH16-4

Appendix B Laboratory Test Results

Figure B1	Grain Size Distribution – Gravelly Sand (Fill)
Figure B2	Grain Size Distribution – Sand
Figure B3	Grain Size Distribution – Silt and Sand
Figure B4	Grain Size Distribution – Sandy Silt and Gravel (Till)



PART A

PATROL YARD STRUCTURE
MUNICIPALITY OF DYSART PATROL YARD
HIGHWAY 118, WEST OF HALIBURTON
ASSIGNMENT NO. 16, AGREEMENT NO. 5013-E-0034
MINISTRY OF TRANSPORTATION, ONTARIO



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by The Ministry of Transportation, Ontario (MTO), Northeastern Region to provide foundation engineering services for a proposed sand/salt stockpile storage structure at the Municipality of Dysart Patrol Yard, located west of Haliburton on Highway 118 in the Geographic Township of Dysart. This work has been carried out as Retainer Assignment #16 under Agreement #5013-E-0034.

The purpose of this investigation is to establish the subsurface conditions at the proposed Patrol Yard structure by methods of borehole drilling, in situ testing and laboratory testing on selected samples. The location of the structure was provided to Golder as a hand sketch by the MTO and the corners were staked in the field by MTO as indicated on Drawing 1.

2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION

The proposed storage structure will be 8.5 m wide by 11.0 m long in plan dimensions and will be located within a cleared area in the existing Patrol Yard.

In general, the topography in the area of the proposed structure is flat. Overall, within the Patrol Yard property, the ground surface slopes down from the highway along the south perimeter of the yard to the north. The municipal garage and offices are located in the southern portion of the patrol yard with entrances at about the highway grade. The stockpile storage structure is to be located in the northern portion of the yard, about 6 m below the grade of the existing municipal garage and offices. Various materials stockpiles and other existing structures are present in the general area of the new stockpile storage facility.

A review of published geological information for the project area (OGS, 2013)¹ indicates that the site is located within an area of coarse textured glaciolacustrine deposit, primarily consisting of sand and gravel with minor amounts of clay and silt. The site borders on areas classified as a bedrock drift complex which consists of exposed bedrock or bedrock covered by a thin layer of surficial glacial till or stratified deposit (OGS, 2013)¹. Based on published geologic information (OGS, 2000)² the bedrock in the area is classified as early felsic plutonic rock consisting of derived gneisses and migmatites.

A search of MTO's Geocres database for relevant geotechnical information and a review of a Foundation Investigation and Design Report prepared for the MTO by exp Services Inc. (exp) titled Slope Instability, Highway 118, 0.5 km North of Haliburton County Road 121 District 52, Huntsville, dated April 10, 2013, GEOCREs No. 31E-326, indicates that subject area of exp's report is located on the shores of Head Lake about 2.3 to 2.6 km southeast of the Municipality of Dysart Patrol Yard. In this report, the native material encountered in boreholes drilled within the Highway 118 right of way consist of non-cohesive deposits of sand, silt and gravel, with occasional cobbles and boulders inferred from drilling progress or encountered during drilling. According to exp's report, bedrock was encountered or inferred from auger refusal at depths ranging from 2.4 m to 8.1 m below ground surface (bgs). The report shows groundwater conditions in the open boreholes drilled on the highway embankment ranging from dry to 1.8 m below ground surface upon completion of drilling, while for those boreholes drilled at the toe of slope the water level was taken as the water level elevation observed in Head Lake. The report indicates that stabilized water levels measured in two monitoring wells installed within the embankment of Highway 118 range from 3.9 m to 5.6 m bgs.

¹ Ontario Geologic Survey. 2003. Surficial Geology of Southern Ontario. Ontario Ministry of Northern Development and Mines. Miscellaneous Release –Data 128, Revised.

² Ontario Geologic Survey. 2000. 1:250,000 Scale Bedrock Geology of Ontario. Ontario Ministry of Northern Development and Mines. Miscellaneous Release – Data 126, Revision 1.



A detailed description of the subsurface conditions at the structure location within the Municipal Patrol Yard is presented in Section 4.0.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The investigation for the storage structure was carried out on March 8, 2016, during which time a total of four boreholes (BH16-1 to BH16-4) were advanced within the footprint of the proposed structure. The locations of the boreholes are shown on Drawing 1 and the coordinates are provided on the Record of Borehole sheets in Appendix A and in the table below.

The field investigation was carried out using a buggy-mounted CME 550 drill rig supplied and operated by Landcore Drilling of Chelmsford, Ontario. The boreholes were advanced through the soil using 108 mm inner diameter hollow-stem augers. Soil samples were obtained at depth intervals of 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer and carried out in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test). The boreholes were advanced with augers to depths ranging between 6.7 m and 8.9 m bgs. In three boreholes, dynamic cone penetration tests (DCPT) were conducted from the bottom of the boreholes to depths ranging from 10.4 m to 11.3 m bgs. All boreholes were backfilled with bentonite and cuttings upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets provided in Appendix A.

The fieldwork was observed by a member of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services using Ontario One Call and a private locator, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Whitby Geotechnical Laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, and grain size distribution) were carried out on selected samples. The results of the laboratory testing on samples from the boreholes are presented on the Record of Borehole sheets and shown on Figures B1 to B4 are included in Appendix B.

Representatives of MTO outlined the location of the structure in the field using stakes. Our staff located the boreholes close to the four corners of the staked footprint of the structure as best could be delineated prior to drilling and measured the boreholes to easily identifiable known points. The UTM coordinates of the as-drilled borehole locations were recorded with a handheld GPS (accuracy to ± 5 m) using NAD 83 datum. The borehole coordinates were subsequently converted into MTM NAD 83 in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to a temporary bench mark (TBH) consisting of the top of the floor slab at the northeast core of the entrance doorway of the existing municipal garage and office building which was taken as Elevation 100.0 m local datum. The borehole locations given in the Record of Borehole sheets and shown on Drawing 1 are positioned relative to MTM NAD 83 northing and easting coordinates and the elevations are referenced to the surface of the garage and office floor slab. The borehole locations, ground surface elevations and drilled borehole and DCPT depths are as follows:



FOUNDATION REPORT – PATROL YARD STRUCTURE MUNICIPALITY OF DYSART PATROL YARD, HIGHWAY 118

Borehole	Location (MTM NAD 83)		Ground Surface Elevation* (m)	Borehole Depth (m)	DCPT Depth (m)
	Northing	Easting			
BH16-1	4992380.6	381177.5	94.4	6.7	10.4
BH16-2	4992383.7	381170.5	94.3	6.7	11.3
BH16-3	4992374.8	381165.4	94.2	6.7	11.0
BH16-4	4992370.7	381171.3	93.8	8.9**	-

*Elevation is referenced to the top of floor slab of the municipal garage and office (relative to Elevation 100.0 m local datum).

**Hollow Stem Augers and SPT sampler were advanced to refusal in BH16-4.

4.0 SUBSURFACE CONDITIONS

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are provided on the Record of Borehole sheets contained in Appendix A. The results of geotechnical laboratory testing are contained in Appendix B. The results of the in situ tests (i.e., SPT 'N'-values) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

4.1 Subsoil Conditions

In general, the subsurface conditions encountered at the site consist of gravelly sand fill with trace organics, some cobbles exposed at surface, underlain by a deposit of generally compact orange/brown sand, trace to some gravel. The sand deposit is underlain by a deposit of brown/grey to grey, very loose to compact silt and sand, which in turn is underlain by a stratum of dense sandy silt and gravel till at one borehole location; the till deposit contains cobbles and/or boulders as inferred from observations of drilling progress. Sampling in three boreholes was terminated in the silt and sand deposit and DCPT were completed from the sampling depth to determine the depth to refusal and inferred approximate thickness of the deposit. One borehole was terminated within the sandy silt and gravel deposit due to auger and SPT refusal. A more detailed description of the soil deposits encountered in the boreholes is provided below.



**FOUNDATION REPORT – PATROL YARD STRUCTURE
MUNICIPALITY OF DYSART PATROL YARD, HIGHWAY 118**

Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Surface Elevation ¹ (m)	'N'-Values (blows)	Laboratory Testing ¹
				Consistency or Relative Density	
(FILL) Gravelly Sand , trace organics; some cobbles ² ; brown to grey; Frozen to moist	16-1 to 16-4	0.2 – 0.5	94.4 – 93.8	n/a	w = 8% – 17% 1 – MH (Fig. B1)
				Frozen	
Sand , trace to some gravel, some silt, trace clay; orange-brown to brown; moist to wet	16-1 to 16-4	0.9 – 4.3	94.1 – 93.6	N = 7 to 31	w = 11% - 28% 4 – MH (Fig. B2)
				Loose to Dense	
Silt and Sand , trace clay, layered, brown/grey to grey; wet ³	16-1 to 16-4	3.6 (BH16-4) – >5.3 (potentially to >8.0 m by DCPT) ³	93.0 – 89.3	N = 0 (weight of hammer) to 31 ⁴	w = 23% - 32% 6 – MH (Fig. B3)
				Very Loose to Compact	
Sandy Silt and Gravel (Till) , grey; wet	16-4	>0.8	85.7	N = 50/0.03	w = 12% - 15% 1 – MH (Fig. B4)
				Very Dense	

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration unless otherwise noted

w = Natural Moisture Content (%)

MH = Combined Sieve and Hydrometer analysis

Notes:

¹Elevations are referenced to the top of floor slab of the municipal garage and office (assumed to be Elevation 100.0 m).

²Cobbles were observed at ground surface.

³ SPT Sampling in Boreholes 16-1, 16-2, and 16-3 was terminated in the silt and sand stratum. The deposit thickness reported is inferred from results of the DCPTs completed from the bottom of the boreholes and is not be reflective of in-situ conditions.

⁴Typically the 'N'-values decreased with depth. The 'N'-value of 31 blows per 0.3 m of penetration as recorded at the base of the deposit in Borehole 16-4 and is associated in part with the underlying sandy silt and gravel till deposit.

4.2 Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized below. Water levels may vary depending on the time of year and precipitation events. Groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability.



FOUNDATION REPORT – PATROL YARD STRUCTURE MUNICIPALITY OF DYSART PATROL YARD, HIGHWAY 118

Borehole	Depth to Groundwater (mbgs)	Groundwater Elevation (m)*
BH16-1	1.3	93.1
BH16-2	1.8	92.5
BH16-3	1.7	92.5
BH16-4	1.6	92.2

* Elevations are referenced to the top of floor slab of the municipal garage and office (relative to be Elevation 100.0 m local datum).

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. David Marmor E.I.T., and the technical aspects were reviewed by Ms. Sarah E.M. Poot, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., a Senior Consultant of Golder and Designated MTO Foundations Contact for Golder, conducted an independent quality control review of this report.



Report Signature Page

GOLDER ASSOCIATES LTD.

David Marmor, EIT
Geotechnical Engineering Intern



Sarah E.M. Poot, P. Eng.
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P. Eng.
Designated MTO Foundations Contact, Senior Consultant

DPM/SEMP/JMAC/nh

\\Golder.gds\gal\Whitby\Active_2014\1181- Geotechnical & Pavement\14-1181-0014 MTO EOI 5013-E-0034 NER Retainer\Assignment 16\Report\final\14-1181-0014-16000 Final RPT May 13, 2016 FIDR Patrol Yard Structure.docx



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

CONT No. .
WP No. .

HIGHWAY 118 PATROL YARD
MUNICIPALITY OF DYSART
BOREHOLE LOCATIONS AND SOIL
STRATA



SHEET



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- R Refusal
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	LOCAL DATUM ELEVATION	NORTHING	EASTING
BH16-1	94.4	4992380.6	381177.5
BH16-2	94.3	4992383.7	381170.5
BH16-3	94.2	4992374.8	381165.4
BH16-4	93.8	4992370.7	381171.3

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

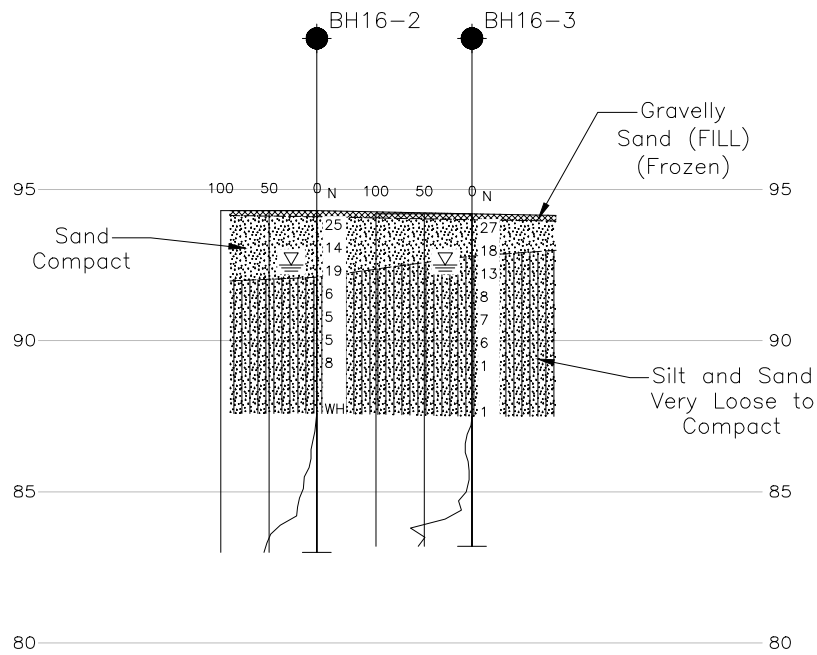
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

Elevation is relative to Elevation=100 m local datum.

REFERENCE

Image ©2016 DigitalGlobe
2015 DigitalGlobe satellite imagery supplied by GoogleEarth Pro.®

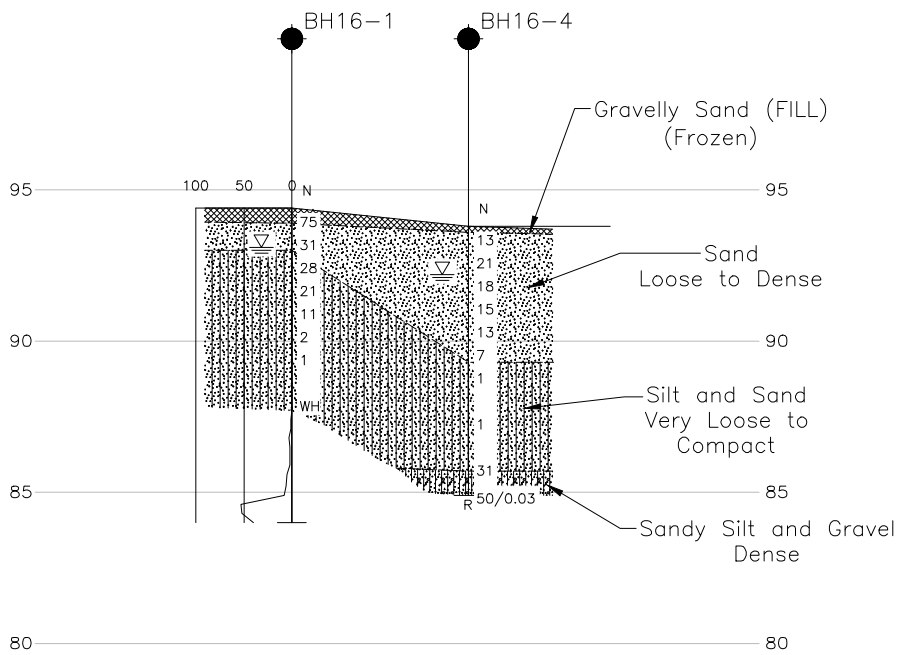


SECTION

HORIZONTAL SCALE

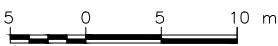


VERTICAL SCALE



SECTION

HORIZONTAL SCALE



VERTICAL SCALE



APPENDIX A

Record of Boreholes



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a)	Index Properties
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	C_u, S_u	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

PROJECT		14-1181-0014 / 16000		RECORD OF BOREHOLE No BH16-1		1 OF 1		METRIC				
G.W.P.				LOCATION		N 4992380.6; E 381177.5		ORIGINATED BY J.J.L.				
DIST		HWY 11		BOREHOLE TYPE		108 mm I.D. Hollow Stem Augers		COMPILED BY DM				
DATUM		GEODETIC		DATE		March 8, 2016		CHECKED BY SEMP				
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
94.4	GROUND SURFACE											
0.0	Gravelly sand, some cobbles (FILL) Brown to grey Frozen		1A	SS	75		94					29 62 8 1
93.9			1B									
0.5	SAND, some gravel, trace to some silt Dense Orange/brown Moist to wet		2	SS	31		93					12 81 6 1
93.0												
1.4	SILT and SAND, trace clay, layered Very loose to compact Grey/brown Wet		3	SS	28		92					0 49 50 1
			4	SS	21		91					
			5	SS	11		90					
			6	SS	2		89					
			7	SS	1		88					
			8	SS	WH		87					
87.7							86					
6.7	END OF BOREHOLE START OF DCPT						85					
							84					
84.0												
10.4	END OF DCPT											
Note: 1. Water level at a depth of 2.4 m below ground surface (Elev. 92.0 m) upon completion of drilling. 2. Water level at a depth of 1.3 m below ground surface (Elev. 93.1 m) after hole left open for 1 hour after completion of drilling.												

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

[illegible]

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

[illegible]

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

PROJECT		14-1181-0014 / 16000		RECORD OF BOREHOLE No BH16-4		1 OF 1 METRIC														
G.W.P.		LOCATION		N 4992370.7; E 381171.3		ORIGINATED BY JJL														
DIST		HWY 11		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY DM														
DATUM GEODETIC		DATE		March 8, 2016		CHECKED BY SEMP														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ	GR	SA	SI	CL
93.8	GROUND SURFACE							20	40	60	80	100	20	40	60					
0.0	Gravelly sand, trace organics (FILL)		1A	SS	13															
0.2	Brown to grey Frozen		1B																	
	SAND, some silt, trace gravel, trace clay																			
	Loose to compact		2	SS	21															
	Orange/brown																			
	Moist to wet																			
	Becoming grey/brown below 2.6 m depth.		3	SS	18															
			4A	SS	15															
			4B																	
			5	SS	13															
			6	SS	7															
89.3																				
4.5	SILT and SAND, trace clay, layered		7	SS	1															
	Very loose to compact																			
	Grey																			
	Wet																			
			8	SS	1															
			9A	SS	31															
85.7																				
8.1	Sandy SILT and GRAVEL, trace clay (TILL)		9B																	
	Very dense																			
	Grey																			
	Wet																			
84.9																				
8.9	Cobbles and/or boulders inferred from observation of drilling progress.		10	SS	50/0.03															
	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL																			
	Note:																			
	1. Water level at a depth of 1.6 m below ground surface (Elev. 92.2 m) upon completion of drilling.																			

SUD-MTO 001 14-1118-0014 ASS(GN16.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:



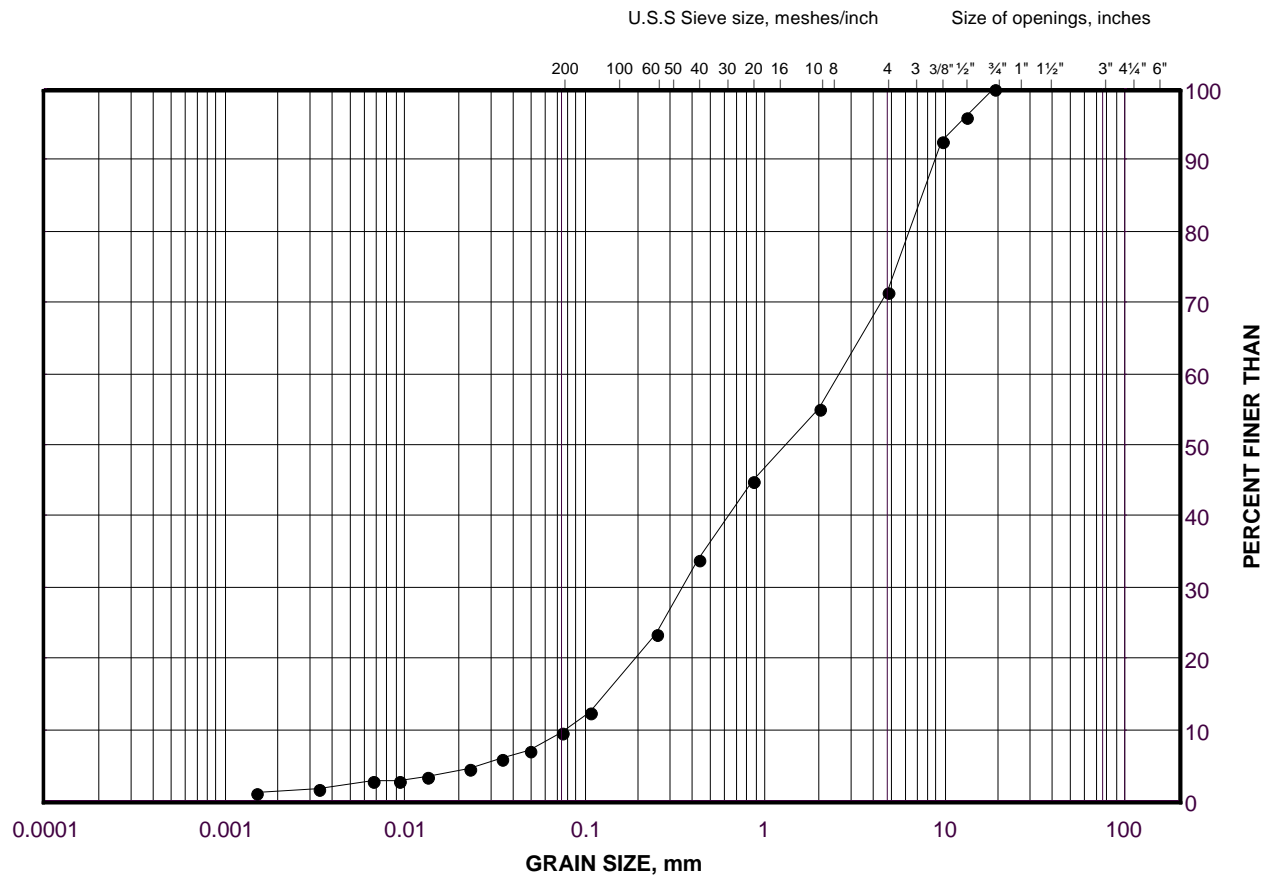
APPENDIX B

Laboratory Tests Results

GRAIN SIZE DISTRIBUTION

Gravelly Sand (FILL)

FIGURE B1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	16-1	1A	94.2

Project Number: 14-1181-0014 (16 000)

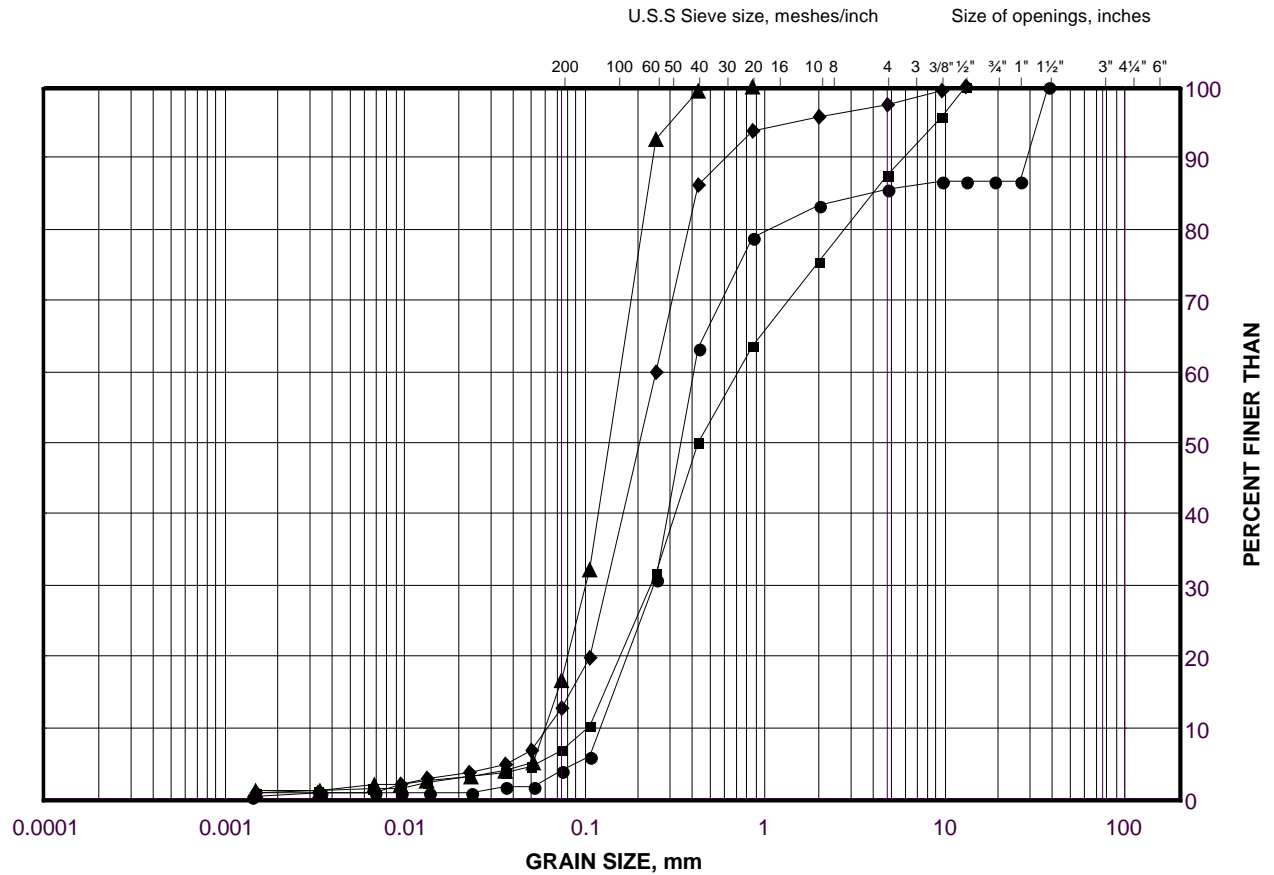
Checked By: SEMP

Golder Associates

Date: 14-Apr-16

GRAIN SIZE DISTRIBUTION SAND

FIGURE B2



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-3	2	93.1
■	16-1	2	93.3
◆	16-4	3	92.0
▲	16-4	6	84.7

Project Number: 14-1181-0014 (16 000)

Checked By: SEMP

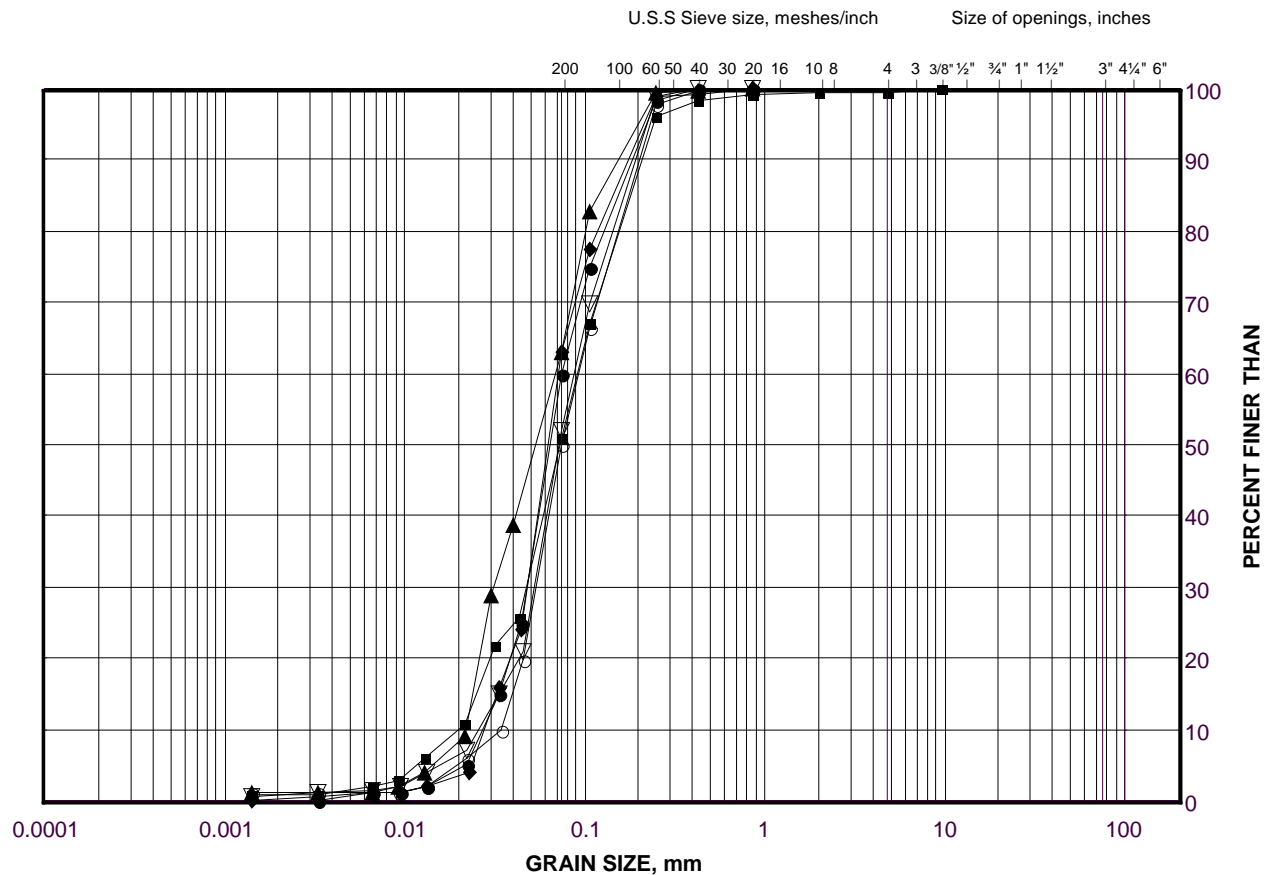
Golder Associates

Date: 14-Apr-16

GRAIN SIZE DISTRIBUTION

SILT and SAND

FIGURE B3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	16-3	3	92.4
■	16-1	3	92.6
◆	16-2	4	91.7
▲	16-1	5	91.0
▽	16-3	7	89.3
○	16-2	7	89.4

Project Number: 14-1181-0014 (16 000)

Checked By: SEMP

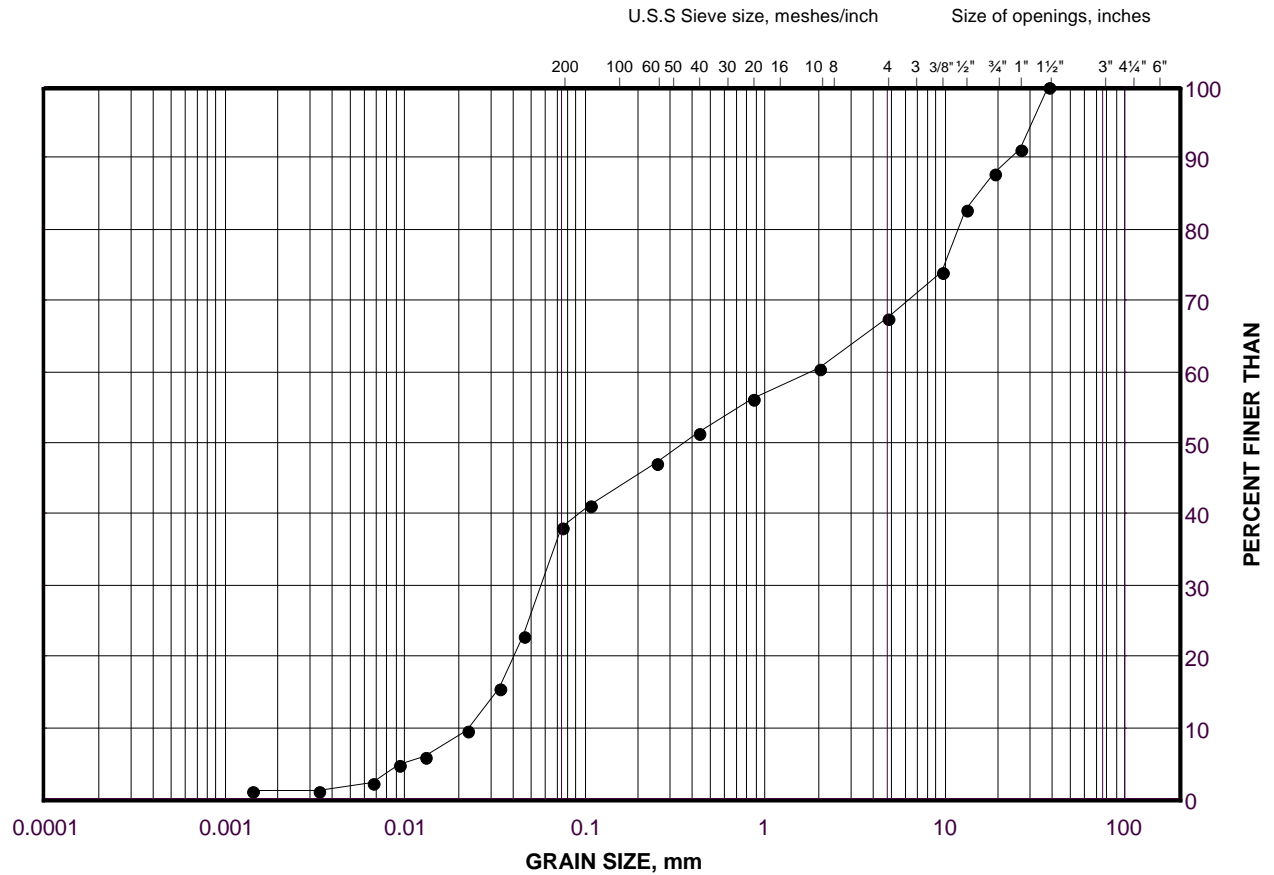
Golder Associates

Date: 14-Apr-16

GRAIN SIZE DISTRIBUTION

Sandy Silt and Gravel (TILL)

FIGURE B4



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	16-4	9B	85.6

Project Number: 14-1181-0014 (16 000)

Checked By: SEMP

Golder Associates

Date: 22-Apr-16

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
121 Commerce Park Drive
Barrie, Ontario, L4N 8X1
Canada
T: +1 (705) 722 4492

