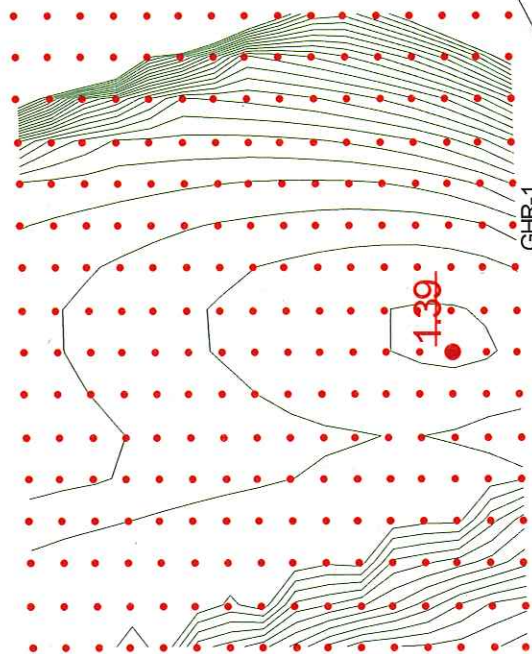


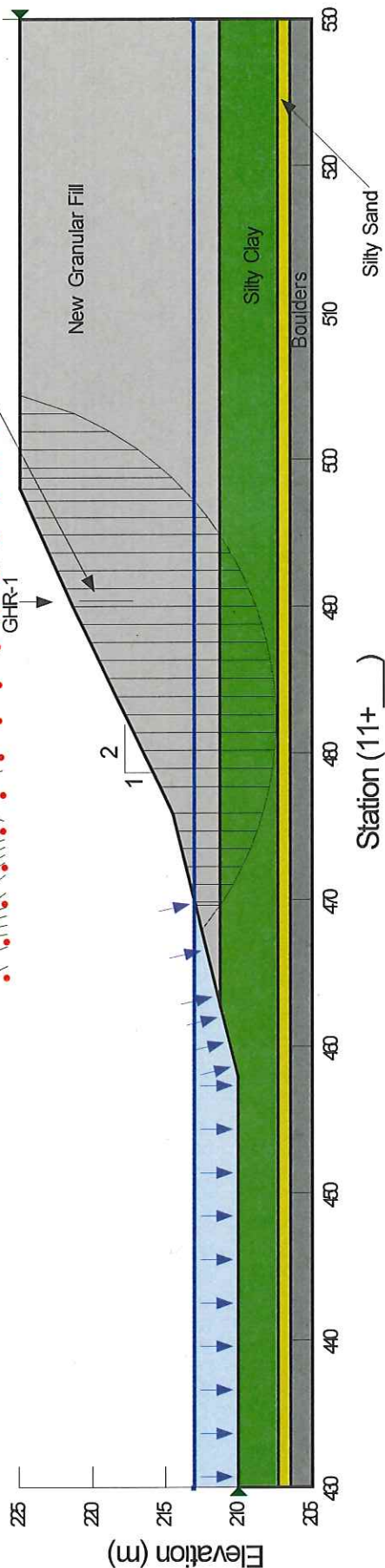
Silty Sand
Unit Weight: 19 kN/m³
Phi: 30°

Silty Clay
Unit Weight: 17 kN/m³
s_u: 60 kPa

New Granular Fill
Unit Weight: 21 kN/m³
Phi: 35°



Approximate Abutment CL



PROJECT

Highway 11 Groundhog River Bridge

TITLE

Stability Analysis – Front Slope of
East Approach Embankment,
Full Sub-Excavation



PROJECT No.	11-191-0025	FILE No.	---
DESIGN	AC	SCALE	AS SHOWN
CAAD	---	REV.	---
CHECK	AB	May 2013	---
REVIEW	JMAC	May 2013	---

Figure 1

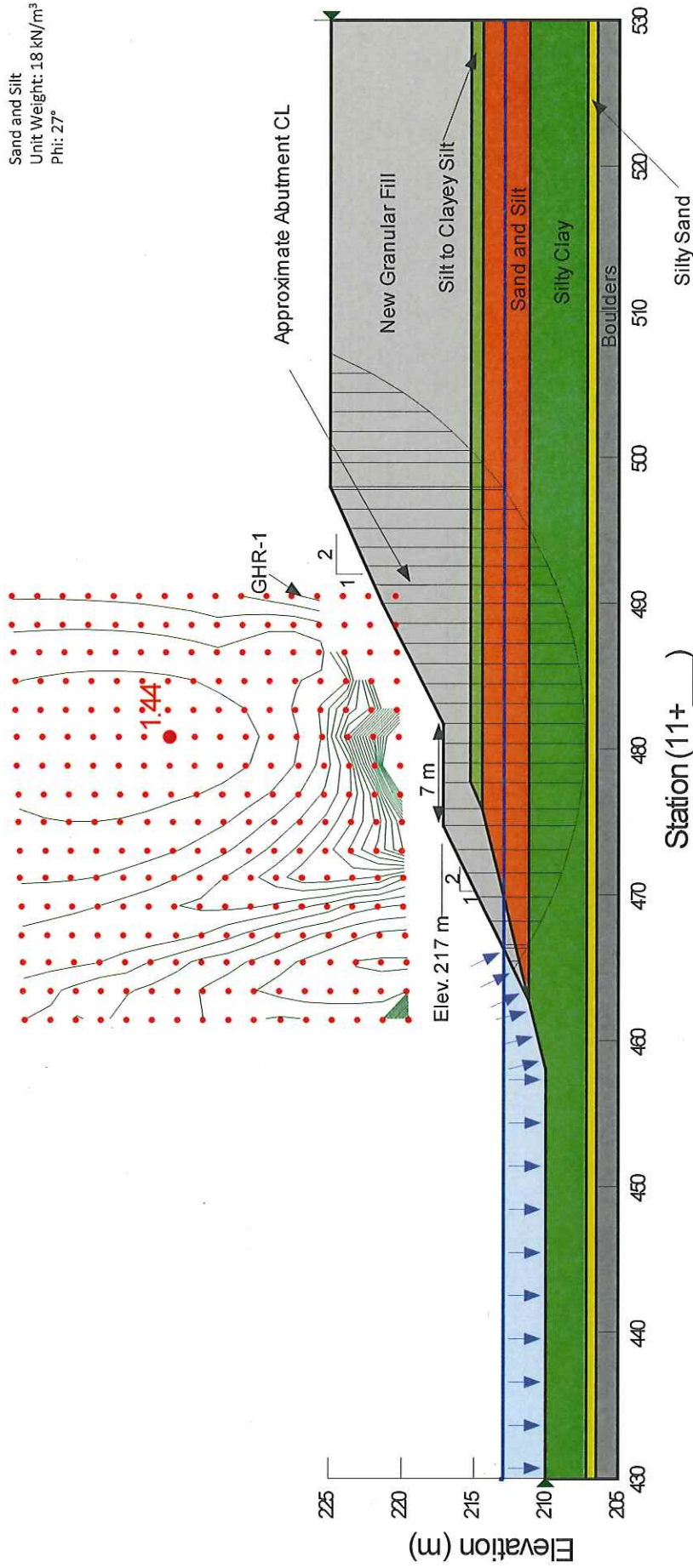
New Granular Fill
 Unit Weight: 21 kN/m³
 ϕ_u : 35°

Silty Clay
 Unit Weight: 17 kN/m³
 s_u : 60 kPa

Silty Sand
 Unit Weight: 19 kN/m³
 ϕ_u : 30°

Silt to Clayey Silt
 Unit Weight: 17 kN/m³
 s_u : 20 kPa

Sand and Silt
 Unit Weight: 18 kN/m³
 ϕ_u : 27°



PROJECT

Highway 11 Groundhog River Bridge

TITLE

Stability Analysis – Front Slope of
East Approach Embankment,
Toe Berm

PROJECT No. 11-1191-0025

FILE No. ---

DESIGN AC May 2013 SCALE AS SHOWN REV.

CADD AB May 2013

CHECK JMAC May 2013

REVIEW JMAC May 2013

REVIEW JMAC May 2013

REVIEW JMAC May 2013

REVIEW JMAC May 2013

REVIEW JMAC May 2013

REVIEW JMAC May 2013

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REVIEW JMAC May 2013

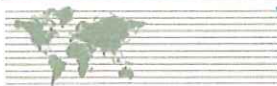


Figure 2



APPENDIX A

Record of Boreholes and Drillholes



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
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
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) 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

	kPa	C_u, S_u	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

Percent 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 (cohesionless) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



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

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_a	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}

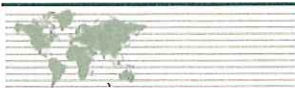
(d) Shear Strength

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

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT 11-1191-0025		RECORD OF BOREHOLE No GHR-1		1 OF 1 METRIC	
W.P. 5049-07-00		LOCATION N 5464438.5; E 229164.2		ORIGINATED BY EHS	
DIST HWY 11		BOREHOLE TYPE 108 mm I.D. HOLLOW STEM AUGERS		COMPILED BY AC	
DATUM GEODETIC		DATE JULY 25, 2012		CHECKED BY AB	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED												
216.8	GROUND SURFACE						20	40	60	80	100	20	40	60	kn/m ³	GR SA SI C				
0.0	Silty topsoil (FILL)																			
0.2	Silt, some sand, trace gravel, trace organics (FILL) Loose to compact Brown Moist to wet		1	SS	11															
			2	SS	8															
215.1																				
1.7	CLAYEY SILT, some sand, trace organics Very soft Brown Wet		3	SS	WH										OC=0.5%					
214.6																				
2.2	SAND and SILT, some clay, trace organics, clay seams / layers Very loose Brown to grey Wet		4	SS	WH															
			5	SS	WH															
			6	SS	WH															
			7	SS	2															
211.2																				
5.6	SILTY CLAY, trace sand Firm to stiff Brown to grey Wet		8	SS	5															
			9	SS	2															
207.3			10	TO	PH															
9.5	Silty SAND, some gravel, trace clay Grey Wet		11	AS	-															
206.4																				
10.4	END OF BOREHOLE AUGER REFUSAL																			
	Note: 1. Water level at a depth of 8.6 m below ground surface (Elev. 208.2 m) upon completion of drilling. 2. On December 13, 2012, Borehole GHR-1a advanced 1.2 m north of Borehole GHR-1.																			

SUD-MTO 001 11-1191-0025.GPJ GAL-MISS.GDT 16/04/13 DATA INPUT:

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

PROJECT 11-1191-0025			RECORD OF BOREHOLE No GHR-2				1 OF 1 METRIC											
W.P. 5049-07-00		LOCATION N 5464505.7; E 228986.5		ORIGINATED BY EHS														
DIST HWY 11		BOREHOLE TYPE 108 mm I.D. HOLLOW STEM AUGERS		COMPILED BY AC														
DATUM GEODETIC		DATE JULY 25 and 26, 2012		CHECKED BY AB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80	100	20
216.1	GROUND SURFACE																	
0.0	Silty TOPSOIL, trace sand, roots / rootlets Loose to compact Brown Moist		1	SS	8													
214.7			2	SS	10													
1.4	SAND and SILT, some clay Loose Brown Moist		3	SS	8													
213.9																		
2.2	CLAYEY SILT, trace sand, trace gravel Firm Brown Moist to wet		4	SS	8													
212.7			5	SS	8													
212.3	SAND, trace silt Brown Wet																	
3.8	GNEISS (BEDROCK) Bedrock cored from 3.8 m depth to 5.4 m depth. For coring details see Record of Drillhole GHR-2.		1	RC	REC 100%													RQD = 100%
210.7																		
5.4	END OF BOREHOLE Note: 1. Water level at a depth of 2.4 m below ground surface (Elev. 213.7 m) upon completion of drilling. 2. Water level in piezometer at a depth of 3.1 m (Elev. 213.0 m) on August 1, 2012.																	

SUD-MTO 001 11-1191-0025.GPJ GAL-MISS.GDT 16/04/13 DATA INPUT:

PROJECT: 11-1191-0025

RECORD OF DRILLHOLE: GHR-2

SHEET 1 OF 1

LOCATION: N 5464505.7 ;E 228986.5

DRILLING DATE: JULY 25 and 26, 2012

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-850

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break	BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols	RECOVERY TOTAL CORE %	SOLID CORE %	R.O.D. %	FRACT INDEX METRES	DISCONTINUITY DATA B Angle DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Ja	Jb	Jc	Jd	Jf	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' kV/G	NOTES WATER LEVELS INSTRUMENTATION
4	NW NQ Coring JULY 26, 2012	GROUND SURFACE		212.3																						
5		GNEISS Very coarse grained Fresh Strong Grey		3.8	1	GREY 100%											JIR									UCS=97 MPa
6		END OF DRILLHOLE		210.7																						
7				5.4																						
8																										
9																										
10																										
11																										
12																										
13																										

SUD-RCK 11-1191-0025.GPJ GAL-MISS.GDT 03/05/13 DATA INPUT:

DEPTH SCALE

1 : 50



LOGGED: EHS

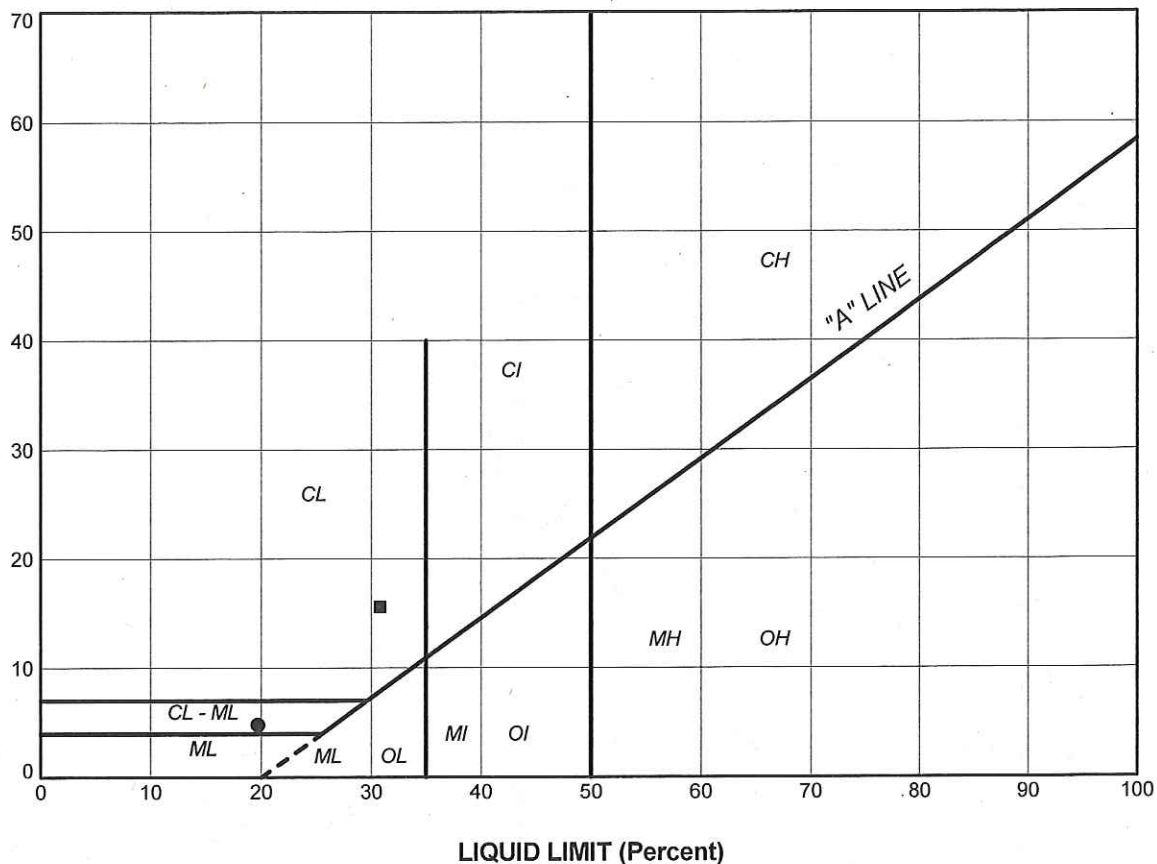
CHECKED: AB



APPENDIX B

Laboratory Test Results

PLASTICITY INDEX (Percent)




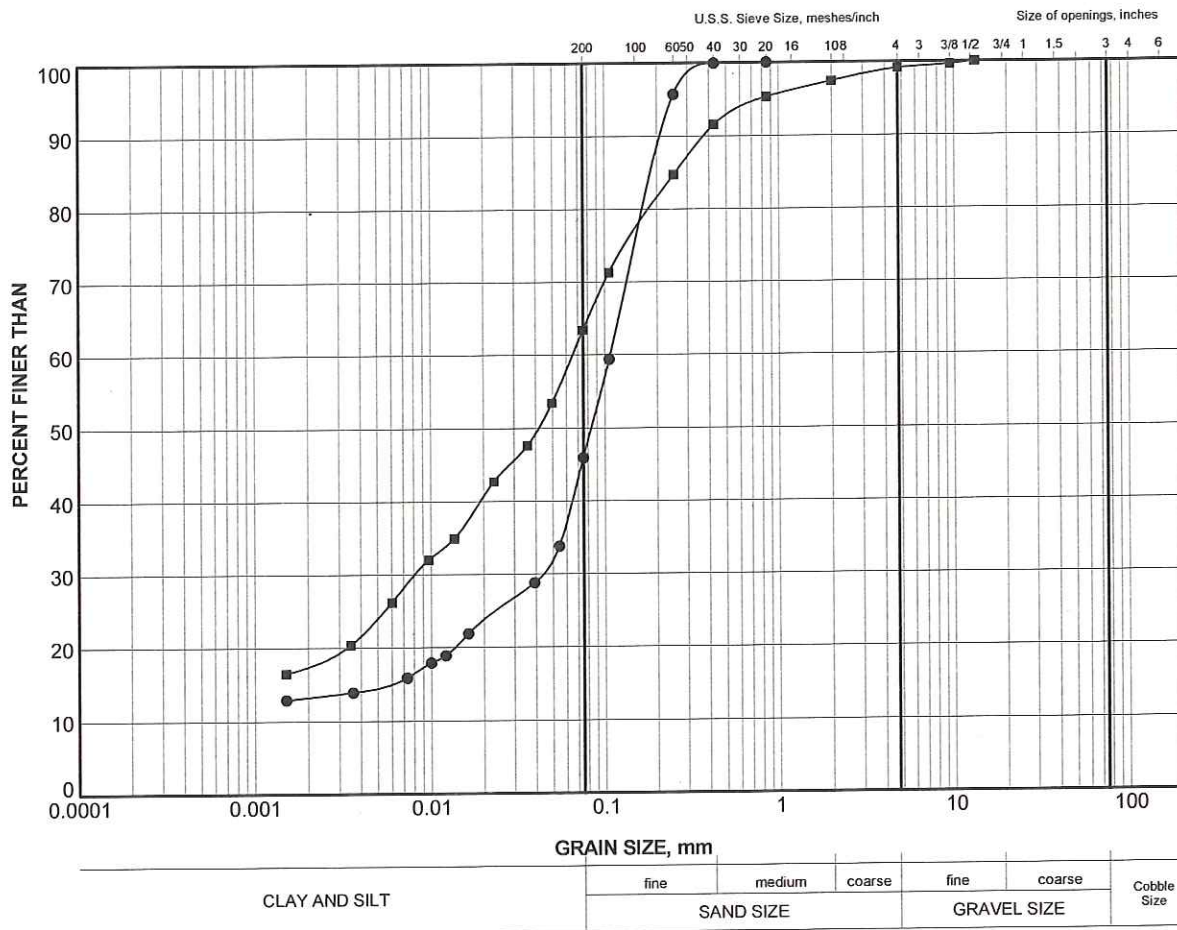
SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	GHR-1	3	20	15	5
■	GHR-2	4	31	15	16

PROJECT				
HIGHWAY 11 GROUNDHOG RIVER BRIDGE				
TITLE				
PLASTICITY CHART CLAYEY SILT				
PROJECT No. 11-1191-0025		FILE No. 11-1191-0025.GPJ		
DRAWN	JJL	Nov 2012	SCALE	N/A
CHECK	AB	Nov 2012	REV.	
APPR	JMAC	Nov 2012		
 Golder Associates SUDBURY, ONTARIO			FIGURE B1	



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	GHR-1	6	212.7
■	GHR-2	3	214.3

PROJECT

HIGHWAY 11
GROUNDHOG RIVER BRIDGE

TITLE

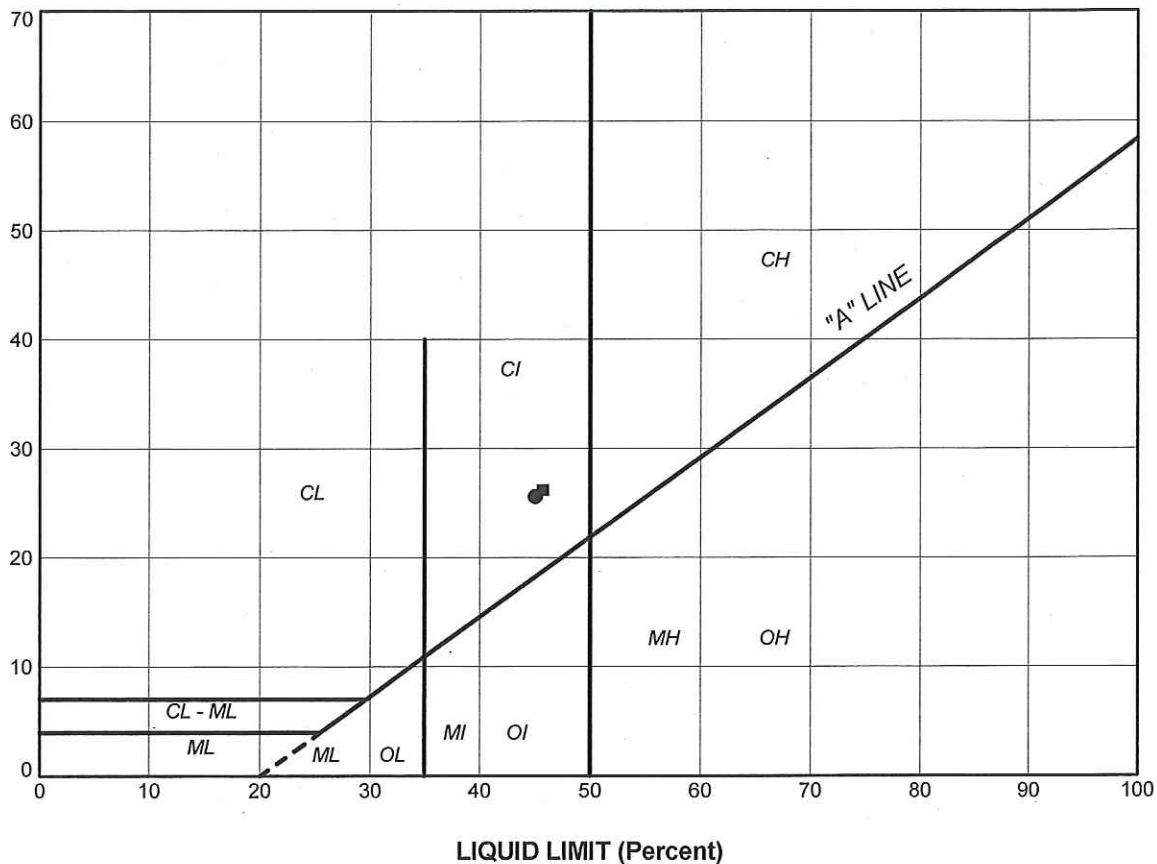
GRAIN SIZE DISTRIBUTION
SAND AND SILT



PROJECT No.	11-1191-0025	FILE No.	11-1191-0025.GPJ
DRAWN	JJL	Nov 2012	SCALE N/A
CHECK	AB	Nov 2012	REV.
APPR	JMAC	Nov 2012	

FIGURE B2

PLASTICITY INDEX (Percent)




SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	GHR-1	8	45	19	26
■	GHR-1	9	46	20	26


PROJECT				
HIGHWAY 11 GROUNDHOG RIVER BRIDGE				
TITLE				
PLASTICITY CHART SILTY CLAY				
PROJECT No. 11-1191-0025		FILE No. 11-1191-0025.GPJ		
DRAWN	JJL	Nov 2012	SCALE	N/A
CHECK	AB	Nov 2012	REV.	
APPR	JMAC	Nov 2012		
 Golder Associates SUDBURY, ONTARIO			FIGURE B3	

Borehole GHR-1
Elevation 206.8 m to 205.4 m



Borehole GHR-1a
Elevation 212.3 m to 210.7 m



PROJECT		HIGHWAY 11 GROUNDHOG RIVER BRIDGE	
TITLE		CORE PHOTOGRAPHS	
	PROJECT No.	11-1191-0025	FILE No. ----
	DESIGN	AC	NOV 2012
	CADD	+	
	CHECK	AB	April 2013
	REVIEW	JMAC	April 2013
			SCALE AS SHOWN REV.
			FIGURE B4

