



February 13, 2015

FOUNDATION INVESTIGATION REPORT

HIGHWAY 655 JOCKO CREEK CULVERT, SITE 39E-263/C
TOWNSHIP OF CARNEGIE, TIMMINS, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5151-11-00, WP 5151-11-01

Submitted to:

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REPORT





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PART A

FOUNDATION INVESTIGATION REPORT
HIGHWAY 655 JOCKO CREEK CULVERT, SITE 39E-263/C
TOWNSHIP OF CARNEGIE, TIMMINS, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5151-11-00, WP 5151-11-01



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the lining or replacement of the Highway 655 Jocko Creek culvert at Station 12+387 (Site # 39E-263/C), in the Township of Carnegie in Timmins, Ontario. The Key Plan showing the general location of this section of Highway 655 and the location of the investigated area are shown on Drawing 1.

This report addresses the investigation carried out for the proposed Jocko Creek culvert lining or replacement only. The General Arrangement drawing for the Jocko Creek culvert was provided to Golder by McIntosh Perry on February 11, 2015.

The purpose of this investigation is to establish the subsurface conditions at the location of the proposed culvert by borehole drilling, in situ testing and laboratory testing on selected samples.

The investigation was supplemented with information contained in the report by Jacques, Whitford and Associates Limited (Jaques, Whitford), dated January 2002 and titled "*W.P. 225-99-00, Highway 655, STA 12+388, Carnegie Township, Culvert Extension*", MTO GEOCRE 42A-54.

2.0 SITE DESCRIPTION

The Jocko Creek culvert is located in the Township of Carnegie on Highway 655, approximately 30 km north of Highway 101. In general, the topography in the area of the overall project limits is generally flat and tree covered. The creek flows from east to west and is approximately 4 m wide at the culvert location.

The existing highway grade at the culvert is at about Elevation 284 m with the Jocko Creek located about 11 m below the existing highway grade. The existing culvert, which was constructed in 1970 and was extended as part of MTO Contract 2006-5162 (8 m on the east and 7.5 m on the west), is a 3.67 m diameter by 64 m long Structural Plate Corrugated Steel Pipe (SPCSP) under approximately 8 m of fill (11 m high embankment). The existing inlet and outlet inverts are at about Elevation 272.9 m (east) and 272.6 m (west). A 2011 structural inspection indicated significant deterioration of the culvert barrel with cracking and crimping near each end and a breakdown of the structural steel coating. In late 2013, bracing was installed inside the culvert due to deformation of the culvert walls. Photographs taken at the site in November 2012 are included following the text of the report.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the current investigation was carried out by Golder on September 26 and 27, and on November 19 and 20, 2012, during which time a total of three boreholes (JC-1 to JC-3) were advanced at the culvert location. The results of Borehole 01-1 by Jacques, Whitford advanced on April 9, 2001, at the culvert inlet (east side) to 10 m below invert level are included in our report to supplement the current investigation. Boreholes 01-2 to 01-5 were also advanced by Jaques, Whitford at the site and were not used to supplement the investigation. The approximate locations of the boreholes are shown on Drawing 1 and the Record of Borehole sheets for Golder's current investigation and Jaques, Whitford's investigation are provided in Appendices A and B, respectively.



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Boreholes JC-1 and JC-2 were advanced using a truck-mounted CME-55 drill rig supplied and operated by Landcore Drilling Inc. (Landcore) of Sudbury, Ontario, and Borehole JC-3 was advanced using portable equipment also supplied and operated by Landcore. Boreholes JC-1 and JC-2 were advanced through the overburden using 108 mm inside diameter hollow-stem augers to a depth of 18.9 m and 20.4 m, respectively. Borehole JC-3 was advanced using NW casing with portable wash boring equipment to a depth of 14.3 m. Soil samples were obtained at intervals of depth of about 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler, operated by an automatic hammer on the drill rig, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Relatively undisturbed samples of the cohesive soils were obtained at selected locations using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling). Field vane shear tests were carried out in cohesive soils for assessment of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using an MTO Standard 'N' size vane.

Borehole 01-1 by Jaques, Whitford was advanced using portable wash boring equipment to a depth of 12.0 m. Soil samples were obtained using SPT procedures at intervals of up to 0.75 m and vane shear tests were carried out in cohesive soils.

The groundwater levels in the open boreholes were observed during the drilling operations as described on the Record of Borehole sheets in Appendix A. The boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended by Ontario Regulation 372).

The fieldwork was supervised throughout by members of our technical staff who: located the boreholes; arranged for the clearance of underground services; supervised the drilling and sampling 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 Sudbury 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 contents, Atterberg limits, Organic contents and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing are included on the Record of Borehole Sheets in Appendix A and in Appendix C.

A sample of the creek water was obtained during the field investigation using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of parameters. The results of the analytical testing are summarized in Table C1 in Appendix C.

The as-drilled borehole locations and ground surface elevations were measured and surveyed by members of our technical staff, referenced to stations on the highway (Boreholes JC-1 and JC-2) and the west end of the culvert (Borehole JC-3). The MTM NAD 83 northing and easting coordinates, ground surface elevations referenced to Geodetic datum and borehole depths at each borehole location are presented on the Record of Borehole sheets in Appendix A and are summarized below.



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Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
JC-1	5399222.9	278843.2	284.4	18.9
JC-2	5399203.6	278843.4	284.4	20.4
JC-3	5399190.0	278820.8	275.4	14.3
01-1	5399219	278873	274.0	12.0

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on the electronic geological mapping by the Ontario Ministry of Northern Development and Mines (Map 42ANW¹), ground moraine consisting of clayey till is the main soil deposit in the area.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced for this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets in Appendices A and B. The results of the laboratory testing are provided in Appendix C. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. The inferred soil stratigraphy based on the results of the boreholes is shown in profile on Drawing 1.

In general, the subsurface conditions encountered at both sites generally consist of embankment fill overlying silt to silty sand underlain by clayey silt to clay, silt, and sand and silt. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Asphalt

A 100 mm to 110 mm thick layer of asphalt was encountered from ground surface in Boreholes JC-1 and JC-2 at Elevation 284.4 m, which was advanced through the existing roadway.

4.2.2 Fill

The following provides a summary of the approximate fill layers encountered at the site:

¹ Ministry of Northern Development and Mines, 1991. Bedrock Geology of Ontario, Southern Sheet, Map 2544.



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- Underlying the asphalt in Boreholes JC-1 and JC-2, embankment fill material was encountered consisting of the following approximate layers:
 - 0.5 m to 0.6 m of sand and gravel;
 - 4.5 m to 5.0 m of sand fill;
 - 1.1 m to 1.8 m of clayey silt fill;
 - 0.6 m to 1.1 m of sand fill;
 - 0.2 m to 0.6 m of silty clay fill;
 - 2.3 m to 2.5 m of silty sand to sand fill; and
 - 1.3 m of organic clayey silt (Borehole JC-2 only).
- From ground surface in Borehole JC-3 at Elevation 275.4 m, a layer 0.3 m of gravel fill was encountered underlain by a 0.6 m layer of silty sand fill, underlain by a 1.6 m layer of silty clay fill.
- From ground surface in Borehole 01-1, a 0.1 m thick layer of organics fill was encountered at Elevation 274.0 m underlain by a 0.2 m thick layer of clayey silt fill.

The following provides a summary of the SPT testing within the fill in the boreholes advanced at the site:

- Within the sand to silty sand embankment fill in Boreholes JC-1 and JC-2, the SPT 'N'-values measured are between 28 blows and 61 blows per 0.3 m of penetration, indicating a compact to very dense relative density.
- Within the clayey silt to silty clay fill In Boreholes JC-1 and JC-2, two SPT 'N'-values measured are 18 blows and 29 blows per 0.3 m of penetration, suggesting a very stiff consistency.
- Within the organic clayey silt fill in Borehole JC-2, one SPT 'N'-value measured 17 blows per 0.3 m of penetration, suggesting a very stiff consistency.
- Within the silty clay fill in Borehole JC-3, two SPT 'N'-values measured within the silty clay fill are 3 blows and 7 blows suggesting a soft to firm consistency.

The grain size distribution of six samples of the sand fill is shown on Figure C1 and one sample of clayey silt fill is shown on Figure C2 in Appendix C.

Atterberg limits testing was carried out on three sample of the clayey silt to silty clay fill in the Boreholes JC-1 to JC-3 and the test results are shown on Figure C3 in Appendix C. The test results indicate a liquid limit ranging from 31 per cent to 45 per cent, a plastic limit ranging from 15 per cent to 19 per cent and plasticity indices ranging from 16 per cent to 26 per cent. The results of the Atterberg limits testing indicate that the material is classified as clayey silt with low plasticity to silty clay with intermediate plasticity.

The measured water content on samples of this fill deposit varies between about 4 per cent and 33 per cent. The organic content on one sample of the organic clayey silt fill deposit in Borehole JC-2 is 5.7 per cent.



4.2.3 Silt to Silty Sand

A 0.4 m to 0.8 m thick deposit of brown, grey and/or black, wet silt to silty sand was encountered underlying the fill material in Boreholes JC-2 and JC-3 at Elevation 272.7 m and Elevation 272.9 m, respectively. Cobbles were noted within the silty sand in Borehole JC-3. In Borehole 01-1, a 2.0 m thick deposit of brown, silt to silty sand was encountered below the fill at Elevation 273.7 m.

The SPT 'N'-values within the silt to silty sand deposit are between 5 blows and 10 blows per 0.3 m penetration, suggesting a loose to compact relative density. One SPT 'N'-value in Borehole JC-3 is 65 blows per 0.3 m penetration as a result of the cobbles within this deposit.

The measured water content on two samples of the silt to silty sand deposit are about 31 per cent and 35 per cent. The organic content testing on one sample of the silty sand in the Borehole JC-3 was 3.1 per cent.

4.2.4 Clay to Clayey Silt

A deposit of clay transitioning to clayey silt with depth was encountered underlying the fill material in Borehole JC-1, below the silty sand in Boreholes JC-2 and JC-3 and below the silt to silty sand in Borehole 01-1 with the top of this deposit ranging from Elevation 274.2 m and 271.7 m, with thickness between 3.8 m and 5.8 m. Silt varves were noted within the upper clay and silt seams were noted in the lower clayey silt.

The SPT 'N'-values measured within the deposit are generally between 0 (weight of hammer) blows and 15 blows per 0.3 m of penetration. In situ field tests carried out within the deposit measured undrained shear strengths ranging from about 34 kPa in the clay to 50 to 80 kPa in the clayey silt. The field vane test results together with the SPT results suggest that the clay to clayey silt deposit has a predominantly firm to stiff consistency.

Atterberg limits testing was carried out on three samples of the clay and two samples of the clayey silt and the test results are shown on Figures C4 and C5, respectively in Appendix C. The test results indicate liquid limits between about 54 per cent and 60 per cent for the clay and about 22 per cent and 30 per cent for the clayey silt, plastic limits between about 20 per cent and 23 per cent for the clay and about 18 per cent for the clayey silt and plasticity indices between about 31 per cent and 37 per cent for the clay and about 4 per cent and 12 per cent for the clayey silt. The results of the Atterberg limits testing indicate that the material is classified as clayey silt with low plasticity and clay with high plasticity.

The grain size distribution of one sample of the clayey silt deposit is shown on Figure C6 in Appendix C.

The measured natural water content on samples of the clayey silt to clay deposit is between about 24 per cent and 49 per cent.

4.2.5 Silt

A deposit of grey silt with clay seams was encountered underlying the clay to clayey silt in Boreholes JC-1 to JC-3 and 01-1 between Elevation 268.1 m and 266.7 m. The thickness of the deposit where fully penetrated is between 3.0 m and 4.0 m. Borehole JC-1 was terminated within this deposit.



The SPT 'N'-values recorded within the silt deposit range from 3 blows to 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distribution of four samples of the silt deposit is shown on Figure C7 in Appendix C.

Atterberg limits testing was carried out on two samples of this deposit and the test results are shown on Figure C8 in Appendix C. The test results indicate liquid limits of about 20 per cent, plastic limits of about 14 per cent and 18 per cent and plasticity indices of about 2 per cent and 6 per cent. The results of the Atterberg limits testing indicate that the material is classified as silt of low plasticity. An Atterberg limits test on one sample of the silt deposit in Borehole JC-3 indicates this material to be non-plastic.

The measured natural water content on samples of the silt deposit is between about 16 per cent and 34 per cent.

4.2.6 Sand and Silt

A deposit of grey sand and silt was encountered underlying the silt in Boreholes JC-2, JC-3 and 01-1 (classified as sandy silt). The top of the deposit was encountered at depths of about 8 m below invert level and between approximately Elevation 264.6 m and 263.7 m. The deposit was not penetrated after exploring between approximately 0.6 m and 2.9 m into the deposit.

The SPT 'N'-values measured within this deposit range from one value of 0 blow (weight of hammer) and between 17 blows and 21 blows per 0.3 m of penetration, indicating a very loose to compact relative density but generally compact.

A grain size distribution of two samples of this deposit is shown on Figure C9 in Appendix C.

The measured natural water content on samples of the sand and silt deposit is between about 16 per cent and 27 per cent.

4.2.7 Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized in the table below.

Borehole No.	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date
JC-1	17.1	267.3	September 26, 2012
JC-2	12.3	272.1	September 27, 2012
JC-3	0	275.4	November 20, 2012
01-1	0	274.0	April 9, 2001

Groundwater levels encountered in the boreholes shortly after drilling may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. The water in the creek at the time of the investigation in November 2012 was at about



Elevation 273.7 m, just above the culvert invert and the water levels in Boreholes JC-3 and 01-1 were 1.7 m and 0.3 m above this level, respectively. Groundwater levels in the area are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt.

5.0 CLOSURE

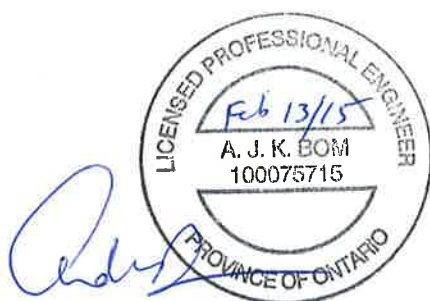
The field personnel supervising the drilling program was Mr. Ed Savard and Mr. Gabriel Mathieu. This report was prepared by Ms. Michelle He, and the technical aspects were reviewed by Mr. André Bom, P.Eng. Mr. Fintan Heffernan, P.Eng., Golder's Designated MTO Contact for this project, carried out a quality control review and reviewed the technical aspects of the report.



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Report Signature Page

GOLDER ASSOCIATES LTD.



André Bom, P.Eng., PMP
Geotechnical Engineer

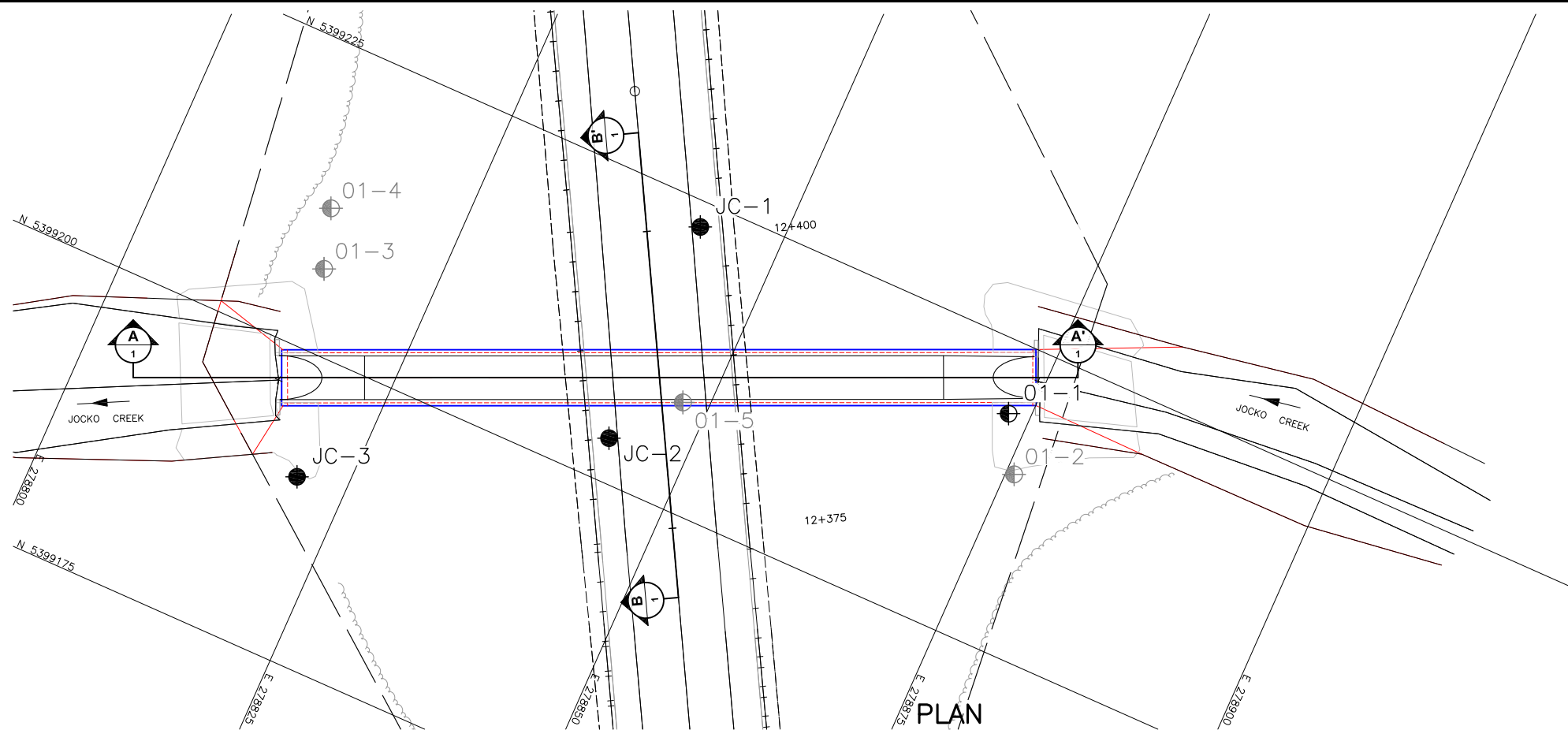


Fintan J. Heffernan, P.Eng.
Designated MTO Contact

MH/AB/FJH/kp

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

CONT No.
GWP No. 5151-11-00



HIGHWAY 655
JOCKO CREEK CULVERT STA. 12+387
BOREHOLE LOCATIONS AND
SOIL STRATA

SHEET



Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



KEY PLAN
N.T.S.

LEGEND

- Borehole - Golder Associates Ltd.
- ⊕ Borehole - Jacques, Whitford and Associates Ltd.
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
01-1	274.0	5399219.1	278873.2
JC-1	284.4	5399222.9	278843.2
JC-2	284.4	5399203.6	278843.4
JC-3	275.4	5399190.0	278820.8

NOTES

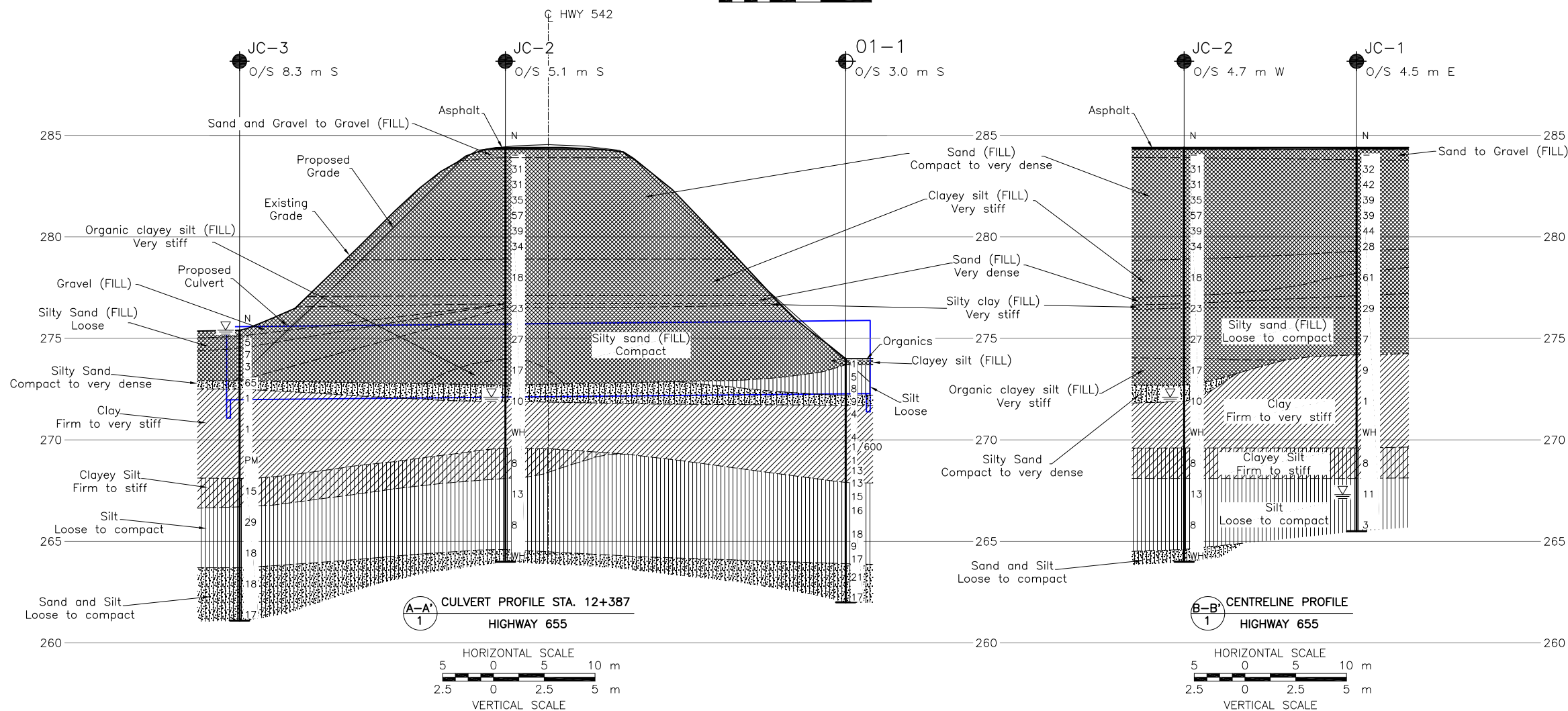
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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.

REFERENCE

Base plan and proposed culvert profile provided in digital format by McIntosh Perry, drawing file nos. 12-0960-6-JOCKO FEB05 2015 - 90%.dwg, received FEB 11, 2015. Keyplan named KM11684 - 39E-363C Location Map - June 27 2012.jpg received August 24, 2012. Previous borehole information acquired from Jacques, Whitford and Associates Limited dated Jan. 2002, MTO Geocres No. 42A-54.



NO.	DATE	BY	REVISION
1	FEB 11, 2015	JJL	ISSUED FOR CONSTRUCTION
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SITE PHOTOGRAPHS (Site 39E-263)

Photograph 1: Looking west at culvert outlet (November 2012)



Photograph 2: Looking south from culvert outlet (November 2012)





APPENDIX A

Record of Boreholes (Golder, 2012)



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

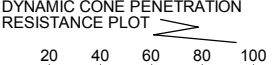
IV. SOIL TESTS

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 12-1191-0014			RECORD OF BOREHOLE No JC-1			1 OF 2 METRIC					
G.W.P. 5151-11-00			LOCATION N 5399222.9; E 278843.2			ORIGINATED BY EHS					
DIST _____ HWY 655			BOREHOLE TYPE 108 mm I.D. Continuous Hollow Stem Augers			COMPILED BY MH					
DATUM GEODETIC			DATE September 26, 2012			CHECKED BY AB					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
284.4	GROUND SURFACE										
0.0	ASPHALT (100 mm)										
283.8	Sand and gravel (FILL)		1	AS	-		284				
0.6	Brown Moist										
	Sand, trace to some silt (FILL)		2	SS	32		283				0 91 (9)
	Compact to dense										
	Brown Moist		3	SS	42						
							282				
			4	SS	39						
			5	SS	39		281				0 93 (7)
			6	SS	44		280				
			7	SS	28		279				
279.3	Clayey silt with sand, some gravel (FILL)										
5.1	Brown Moist										
278.2	Sand, trace to some gravel, trace to some silt (FILL)		8a				278				8 83 (9)
6.2	Very dense		8b	SS	61						
	Brown Moist										
277.1	Silty clay, trace to some sand (FILL)						277				
7.3	Very stiff										
276.5	Brown Moist		9a								
7.9	Sand, some silt (FILL)		9b	SS	29		276				
	Loose to compact										
	Brown Moist										
			10	SS	7		275				0 86 (14)
274.2	CLAY, trace sand, varved						274				
10.2	Firm to very stiff		11	SS	9						
	Grey Wet										
	Silt varves are 5 mm to 10 mm thick and spaced 20 mm to 25 mm apart.						273				
			12	SS	1		272				
							271				
			13	SS	WH		270				
269.6											
14.8											

SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:

Continued Next Page

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

PROJECT <u>12-1191-0014</u>			RECORD OF BOREHOLE No JC-1			2 OF 2 METRIC		
G.W.P. <u>5151-11-00</u>			LOCATION <u>N 5399222.9; E 278843.2</u>			ORIGINATED BY <u>EHS</u>		
DIST <u> </u> HWY <u>655</u>			BOREHOLE TYPE <u>108 mm I.D. Continuous Hollow Stem Augers</u>			COMPILED BY <u>MH</u>		
DATUM <u>GEODETIC</u>			DATE <u>September 26, 2012</u>			CHECKED BY <u>AB</u>		

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 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 (%)		
								20	40	60	80	100						20	40	60
	--- CONTINUED FROM PREVIOUS PAGE ---																			
268.1	CLAYEY SILT, silt seams Firm Grey Wet	▨	14	SS	8											0 0 64 36				
16.3	SILT, trace to some sand, clay seams Compact Grey Wet	▨	15	SS	11															
	Approximately 0.3 m of heave inside augers at 18.3 m depth.		16	SS	3											0 6 75 19				
265.5	END OF BOREHOLE																			
18.9	Note: 1. Water level at a depth of 17.1 m below ground surface (Elev. 267.3 m) upon completion of drilling.																			

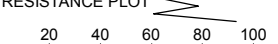
SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:

PROJECT 12-1191-0014			RECORD OF BOREHOLE No JC-2			1 OF 2 METRIC														
G.W.P. 5151-11-00			LOCATION N 5399203.6; E 278843.4			ORIGINATED BY EHS														
DIST _____ HWY 655			BOREHOLE TYPE 108 mm I.D. Continuous Hollow Stem Augers			COMPILED BY MH														
DATUM GEODETIC			DATE September 27, 2012			CHECKED BY AB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			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		ELEVATION SCALE	SHEAR STRENGTH kPa					W _p W W _L			γ	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%)			20 40 60							
284.4	GROUND SURFACE																			
0.0	ASPHALT (110 mm)																			
283.9	Sand and gravel, trace silt (FILL)		1	AS	-		284													
0.5	Brown Moist																			
	Sand, trace to some silt (FILL)		2	SS	31															
	Dense to very dense																			
	Brown Moist																			
			3	SS	31		283										0 93 (7)			
			4	SS	35		282													
			5	SS	57		281													
			6	SS	39		280										1 91 (8)			
			7	SS	34		279													
278.9	Clayey silt with sand, trace to some gravel (FILL)																			
5.5	Very stiff																			
	Brown Moist		8	SS	18		278										9 35 30 26			
277.1	Sand, some silt (FILL)						277													
276.7	Brown Moist																			
	Silty clay, trace sand (FILL)		9	SS	23		276													
7.9	Brown Moist																			
	Silty sand (FILL)						275													
	Compact																			
	Brown Moist		10	SS	27		274													
274.0	Organic clayey silt, trace sand (FILL)						273													
10.4	Very stiff																			
	Brown Moist		11	SS	17		272										OC = 5.7%			
272.7	Silty SAND, trace gravel, trace clay, trace to some organics																			
	Compact																			
	Brown to grey																			
271.9	Wet		12	SS	10		271													
12.5	CLAY, trace sand, varved																			
	Firm																			
	Grey																			
	Wet																			
	Silt varves are 5 mm to 10 mm thick and spaced 20 mm to 25 mm apart.		13	SS	WH		270													
269.6																				
14.8																				

Continued Next Page

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

SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:

PROJECT 12-1191-0014			RECORD OF BOREHOLE No JC-2			2 OF 2 METRIC						
G.W.P. 5151-11-00			LOCATION N 5399203.6; E 278843.4			ORIGINATED BY EHS						
DIST _____ HWY 655			BOREHOLE TYPE 108 mm I.D. Continuous Hollow Stem Augers			COMPILED BY MH						
DATUM GEODETIC			DATE September 27, 2012			CHECKED BY AB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
268.1	CLAYEY SILT, silt seams Grey Wet		14	SS	8		269					0 0 84 16
16.3	SILT, clay seams Loose to compact Grey Wet		15	SS	13		268	4 +				
							267					
			16	SS	8		266					
							265					
264.6	SAND and SILT, trace clay Loose Grey Wet		17	SS	WH		264					0 53 45 2
19.8	END OF BOREHOLE											
264.0												
20.4												
Note: 1. Water level at a depth of 12.3 m below ground surface (Elev. 272.1 m) upon completion of drilling.												

SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:

1 OF 2 METRIC

ORIGINATED BY GM

COMPILED BY MH

CHECKED BY AB

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

SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:

PROJECT <u>12-1191-0014</u>		RECORD OF BOREHOLE No JC-3				2 OF 2 METRIC	
G.W.P. <u>5151-11-00</u>		LOCATION <u>N 5399190.0; E 278820.8</u>				ORIGINATED BY <u>GM</u>	
DIST <u> </u> HWY <u>655</u>		BOREHOLE TYPE <u>Portable Equipment, NW Casing, Wash Boring</u>				COMPILED BY <u>MH</u>	
DATUM <u>GEODETIC</u>		DATE <u>November 19 and 20, 2012</u>				CHECKED BY <u>AB</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
	<p style="text-align: center;">--- CONTINUED FROM PREVIOUS PAGE ---</p> <p>END OF BOREHOLE</p> <p>Note:</p> <p>1. Water level at ground surface (Elev. 275.4 m) upon completion of drilling.</p>															

SUD-MTO 001 1211910014.GPJ GAL-MISS.GDT 13/02/15 DATA INPUT:



APPENDIX B

Record of Boreholes (Jaques, Whitford, 2002)

RECORD OF BOREHOLE No BH01-1

1 OF 2

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+382, 29 Rt C/L, N 5399219 E 278873 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04.09.01 - 04.09.01 CHECKED BY FG

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					
274.0	Ground Surface																
273.9	100 mm of ORGANICS, dark brown																
0.1	Clayey silt, with woody organics,																
273.7	loose, brown (FILL)		1	SS	1												
0.3	Silt, with organics, some sand, some																
	clay, loose, dark brown																
			2	SS	5												
							273										
			3	SS	8												
272.2																	
1.8	SILTY SAND, some gravel, trace																
	organics, loose, brown		4	SS	9		272										
271.7																	
2.3	SILTY CLAY, with silt seams, firm,																
	grey		5	SS	4												
							271										
			6	SS	4												
							270										
269.4			7	SS	1/600												
4.6	SILTY CLAY, with silt seams, stiff,																
	grey		8	SS	1												
							269										
			9	SS	13												
267.9																	
6.1	SILT, with clay, trace sand, compact,		10	SS	13												
	grey, with clay seams						268										
			11	SS	15												
							267										
			12	SS	16												

Continued Next Page

3, x 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MT0 11385A.GPJ ON MOT.GDT 09/01/02

RECORD OF BOREHOLE No BH01-1

2 OF 2

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+382, 29 Rt C/L, N 5399219 E 278873 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04.09.01 - 04.09.01 CHECKED BY FG

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20						40	60	80
			13	SS	18		265													
			14	SS	9															
			15	SS	17		264													
263.9 10.1	SANDY SILT, compact, grey		16	SS	21		263													
			17	SS	17															
262.0 12.0	End of Borehole																			

MTO 11385A.GPJ ON MOT.GDT 09/01/02

RECORD OF BOREHOLE No BH01-2

1 OF 1

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+377. 29 Rt C/L, N 5399214 E 278876 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04.10.01 - 04.10.01 CHECKED BY FG

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					
274.7	Ground Surface																
0.0	Silty sand and cobbles, some organics, loose, dark brown (FILL)																
274.0																	
0.6	CLAYEY SILT, trace sand, stiff, brown		1	SS	7		274										
273.4																	
1.2	SILT, some sand, some clay, compact, brown		2	SS	11		273										
273.0																	
1.6	SILT, some sand, some clay, compact to loose, grey, with clay seams		3	SS	8												
272.2																	
2.4	SILTY CLAY, with silt seams, firm, grey		4	SS	4		272										
			5	SS	1/600		271										
			6	SS	4		270										
			7	SS	4												
			8	SS	8		269										
268.7																	
5.9	End of Borehole																
	Installed Standpipe																
	Note: Water was at surface upon completion																

3. X 3

Numbers refer to
Sensitivity

3%

STRAIN AT FAILURE

RECORD OF BOREHOLE No BH01-3

1 OF 2

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+399, 27 LI C/L N 5399207 E 278816 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04.10.01 - 04.10.01 CHECKED BY FG

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			20	40	60	80	100					
274.0	Ground Surface															
0.0	Sand, trace silt, frequent cobbles, loose, brown (FILL)															
273.2																
0.8	Clayey silt, some sand, some organics, firm, brown (FILL)		1	SS	4	273										
272.0																
2.0	Silty clay, trace sand, firm, grey (FILL)		2	SS	5	272										
271.8																
2.2	Sand, some silt, some wood fragments, trace gravel, loose, brown (FILL)		3	SS	8											
270.9						271										
3.1	SILTY CLAY, with silt seams, firm, grey		4	SS	2											
			5	SS	1	270										
269.4																
4.6	SILTY CLAY, with silt seams, stiff, grey		6	SS	1	269										
			7	SS	18	268										
			8	SS	12											
267.1						267										
6.9	SILT, some clay, compact, grey, with clay seams		9	SS	24											
			10	SS	19	266										

Continued Next Page

3, x 3.

Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

MT0 11385A.GPJ ON MOT.GDT 09/01/02

RECORD OF BOREHOLE No BH01-3

2 OF 2

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+399 27 Lt C/L, N 5399207 E 278816 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04 10 01 - 04 10 01 CHECKED BY FG

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 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 (%)		
								20 40 60 80 100										15 30 45		
								○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
263.6 10.4	SILTY SAND, compact, grey		11	SS	21															
						265														
				12	SS	14														
				13	SS	22														
				14	SS	15														
			15	SS	20															
261.5 12.4	End of Borehole		16	SS	27															

MTO 11355A GPJ ON MOT GDT 09/01/02

RECORD OF BOREHOLE No BH01-4

1 OF 1

METRIC

W.P. 225-99-00 LOCATION Hwy 655 Station 12+404, 26 Lt C/L, N 5399212 E 278814 ORIGINATED BY BK
DIST 53 HWY 655 BOREHOLE TYPE HS Augers, Split Spoons COMPILED BY SS
DATUM Geodetic DATE 04.11.01 - 04.11.01 CHECKED BY FG

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 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 (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20						40	60	80
274.1	Ground Surface																			
0.0	Sand, some silt, frequent cobbles, compact, brown (FILL)		1	SS	14		274													
273.4																				
0.7	Clayey silt, some organics, firm, dark brown (FILL)																			
273.1			2	SS	8		273													
1.0	SILTY CLAY, with silt seams, firm, grey																			
			3	SS	2		272													
			4	SS	2															
							271													
			5	SS	1															
			6	SS	1/600		270													
269.6																				
4.5	SILTY CLAY, with silt seams, stiff, grey		7	SS	1		269													
			8	SS	12															
268.2																				
5.9	End of Borehole																			
	Installed Standpipe																			
	Note: Water was at surface upon completion.																			

MT0 11385A GPJ ON MOT GOT 09/01/02

METRIC

ORIGINATED BY BK

COMPILED BY SS

CHECKED BY EC

WTO 11385A.GPJ QN_MOT.GDT 09/01/02



APPENDIX C

Laboratory Test Results



FOUNDATION REPORT HIGHWAY 655 JOCKO CREEK CULVERT, SITE 39E-263/C

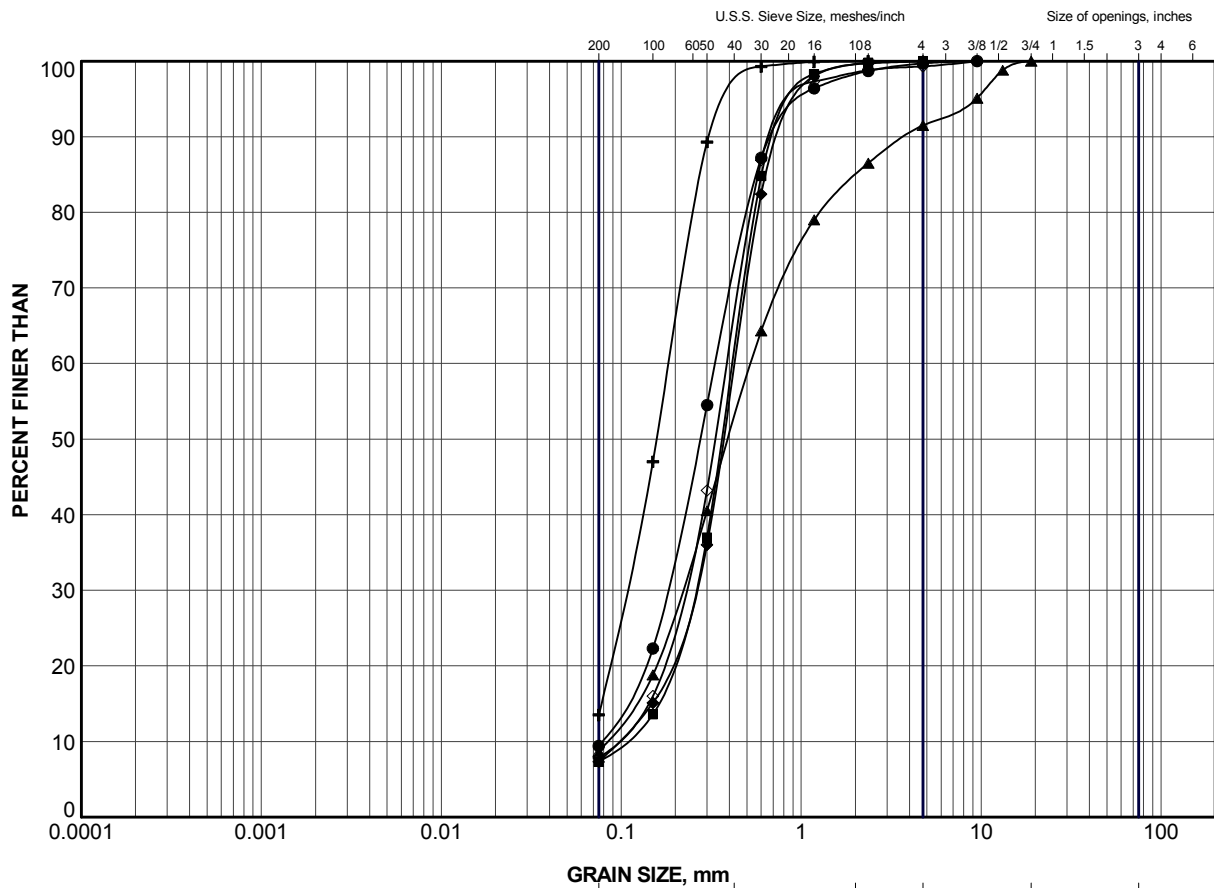
Table C1 - Summary of Analytical Testing of Creek Water

Parameter	Units	Method Detection Limit	Result
Resistivity	ohm-cm	n/a	22000
Conductivity	µmho/cm	1	45
pH	n/a	n/a	6.04
Sulphate	mg/L	1	ND
Chloride	mg/L	1	3

Notes:

1. Sample obtained November 20, 2012.
2. Analytical testing carried out by Maxxam Analytics Inc.
3. ND = Not detected

Prepared by: MH
Reviewed by: AB



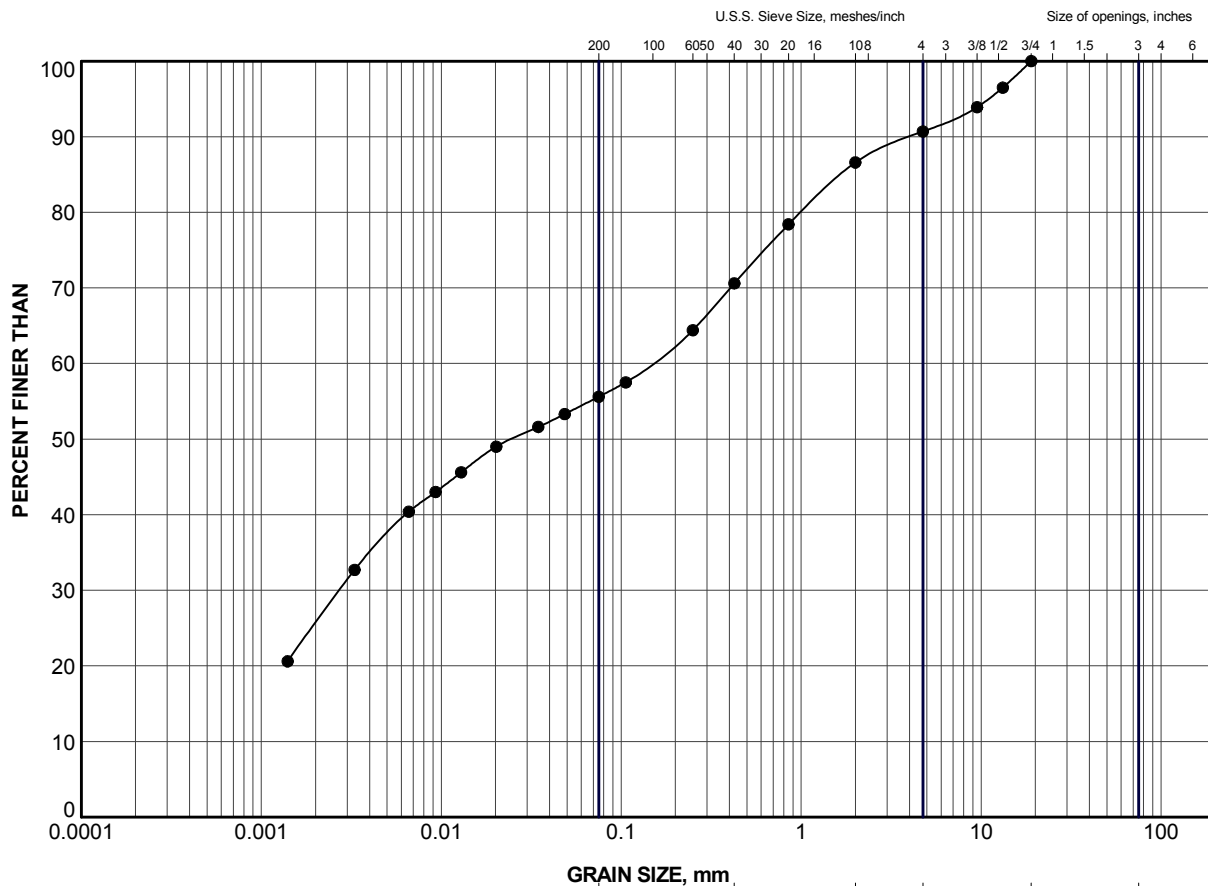
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	JC-1	2	283.3
■	JC-1	5	281.0
▲	JC-1	8b	277.9
+	JC-1	10	275.0
◆	JC-2	3	282.6
◇	JC-2	6	280.3

PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION SAND (FILL)					
PROJECT No.		12-1191-0014		FILE No. 1211910014.GPJ	
DRAWN	JJL	Sep 2013	SCALE	N/A	REV.
CHECK	AB	Sep 2013	FIGURE C1		
APPR	FJH	Sep 2013			




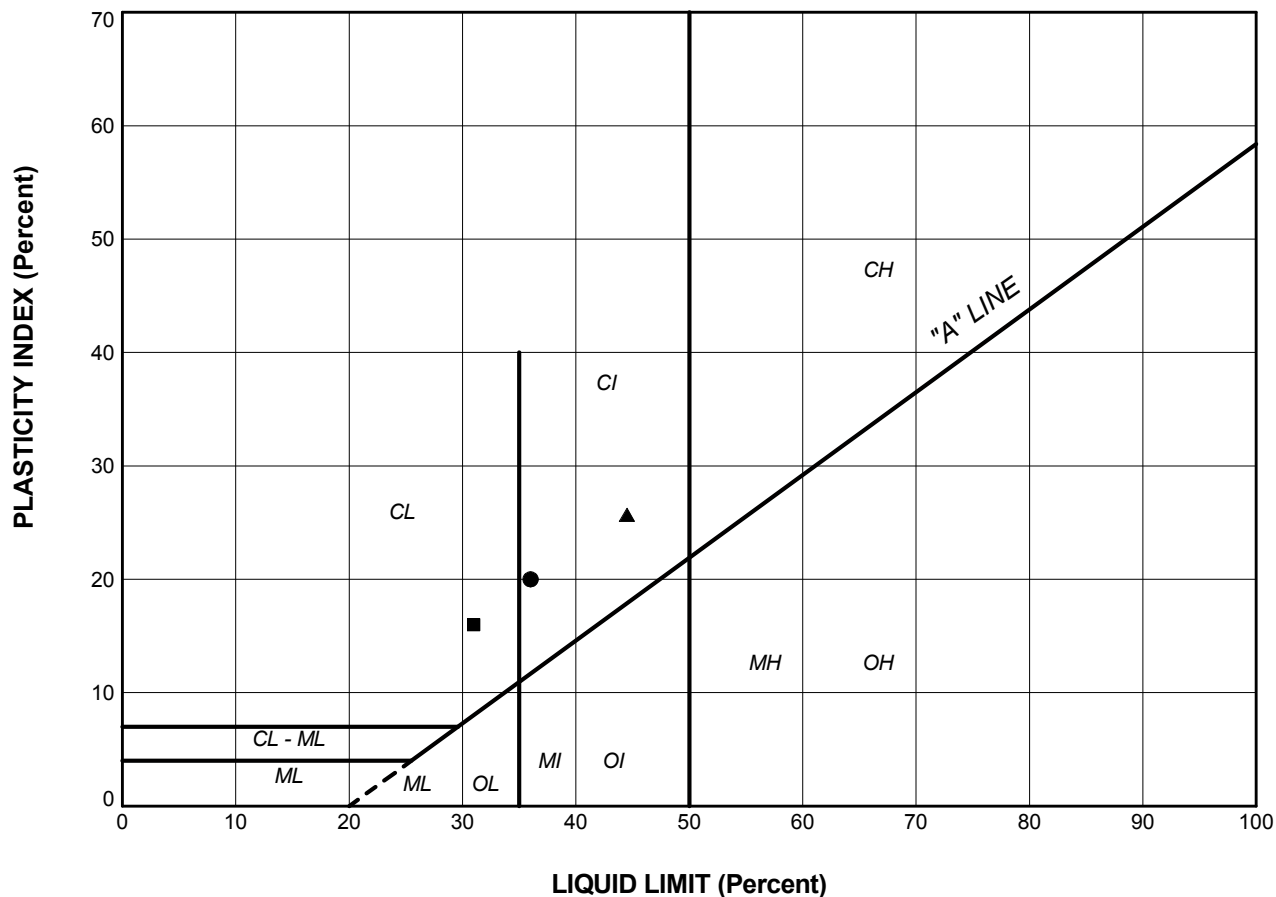


CLAY AND SILT	GRAIN SIZE, mm					
	fine		medium	coarse		
	SAND SIZE			GRAVEL SIZE		Cobble Size

LEGEND


SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	JC-2	8	278.0

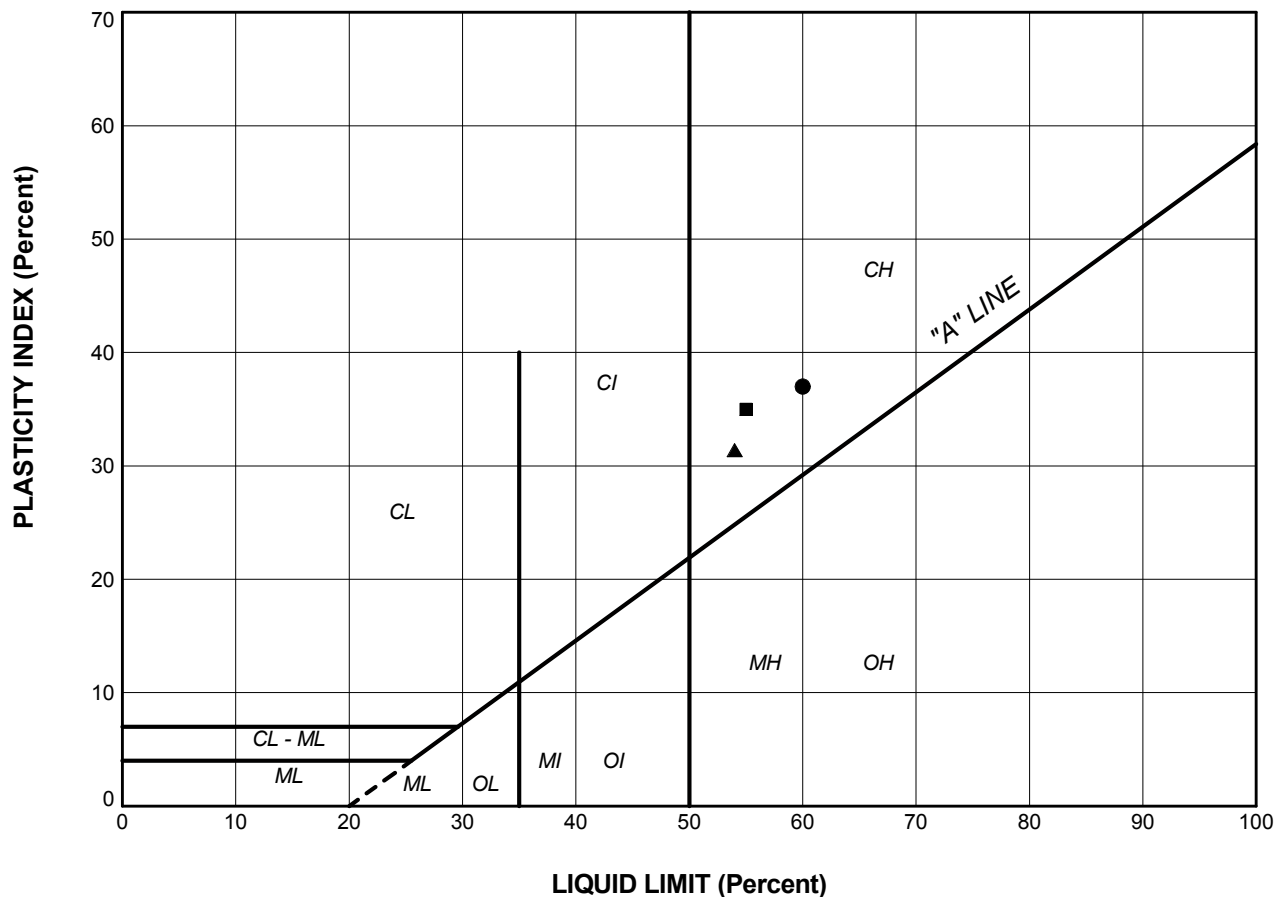
PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION CLAYEY SILT (FILL)					
PROJECT No.		12-1191-0014		FILE No. 1211910014.GPJ	
DRAWN	JJL	Sep 2013	SCALE	N/A	REV.
CHECK	AB	Sep 2013			
APPR	FJH	Sep 2013			
 Golder Associates SUDBURY, ONTARIO			FIGURE C2		



LEGEND


SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	JC-1	9a	36.0	16.0	20.0
■	JC-2	8	31.0	15.0	16.0
▲	JC-3	3	44.5	18.8	25.7

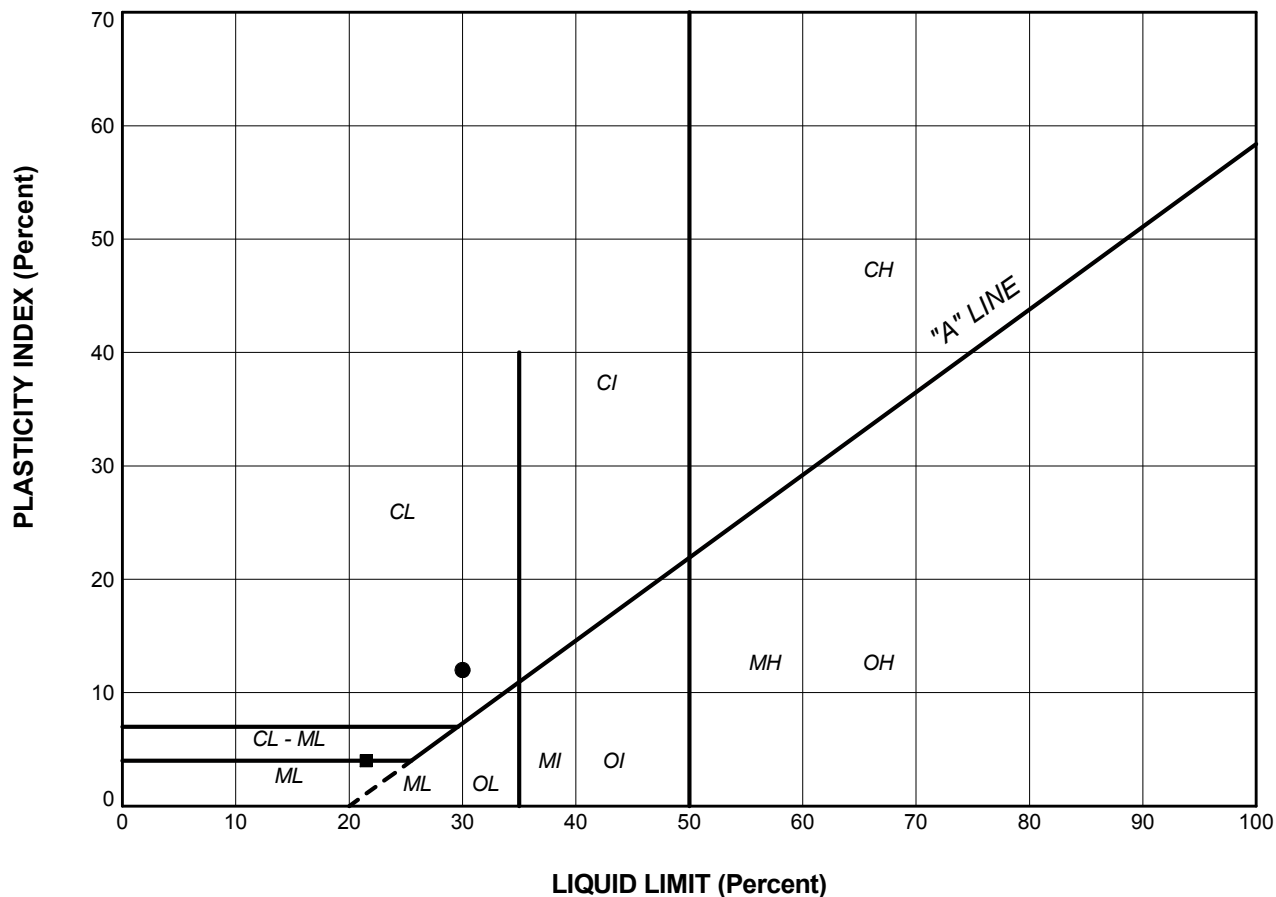
PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
PLASTICITY CHART CLAYEY SILT to SILTY CLAY (FILL)					
PROJECT No.		12-1191-0014		FILE No.	
DRAWN		JJL		Sep 2013	
CHECK		AB		Sep 2013	
APPR		FJH		Sep 2013	
 Golder Associates SUDBURY, ONTARIO				SCALE N/A REV.	
FIGURE C3					



LEGEND

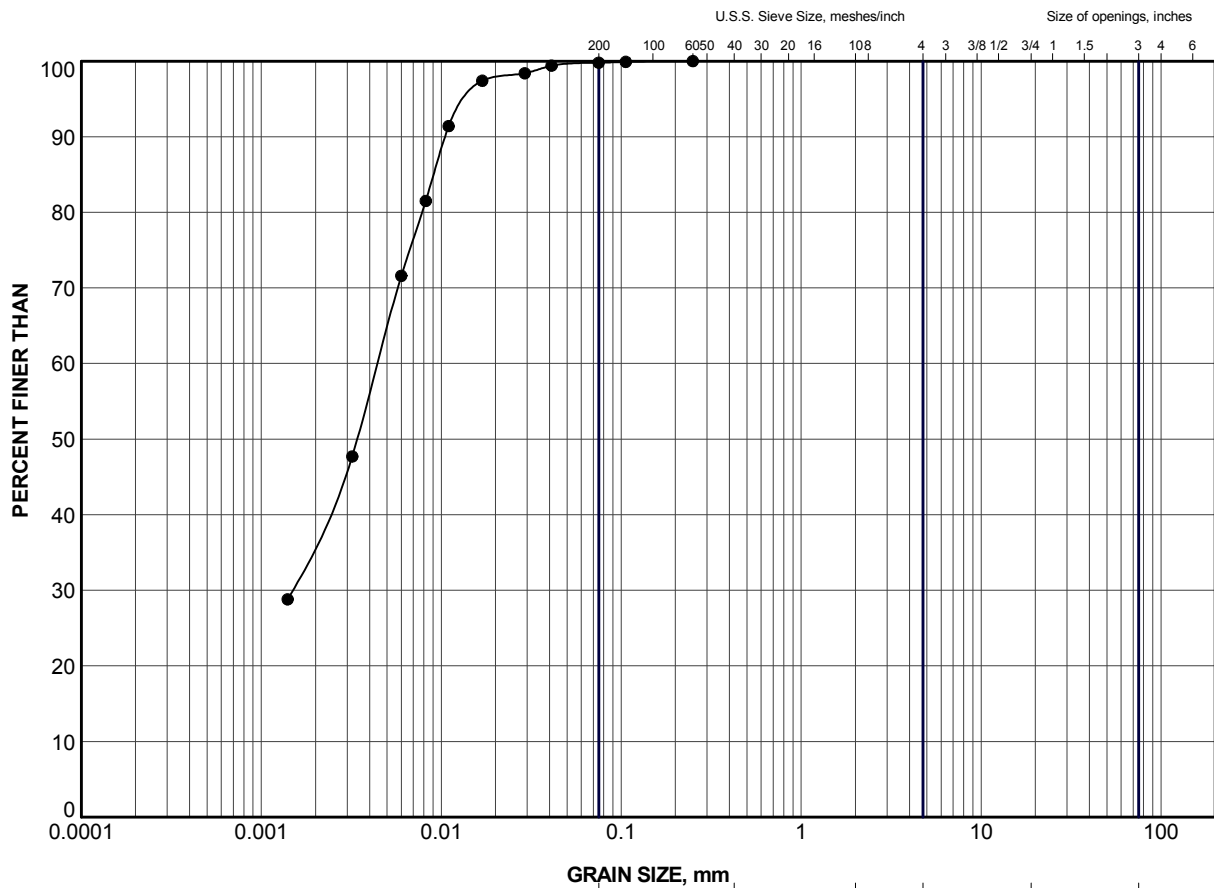
SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	JC-1	11	60.0	23.0	37.0
■	JC-2	13	55.0	20.0	35.0
▲	JC-3	6	54.0	22.6	31.4

PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
PLASTICITY CHART CLAY					
 Golder Associates SUDBURY, ONTARIO		PROJECT No.	12-1191-0014	FILE No.	1211910014.GPJ
		DRAWN	JJL	Sep 2013	SCALE N/A
		CHECK	AB	Sep 2013	REV.
		APPR	FJH	Sep 2013	
FIGURE C4					



PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
PLASTICITY CHART CLAYEY SILT					
PROJECT No.		12-1191-0014		FILE No.	
				1211910014.GPJ	
DRAWN	JJL	Sep 2013	SCALE	N/A	REV.
CHECK	AB	Sep 2013			
APPR	FJH	Sep 2013			
			FIGURE C5		




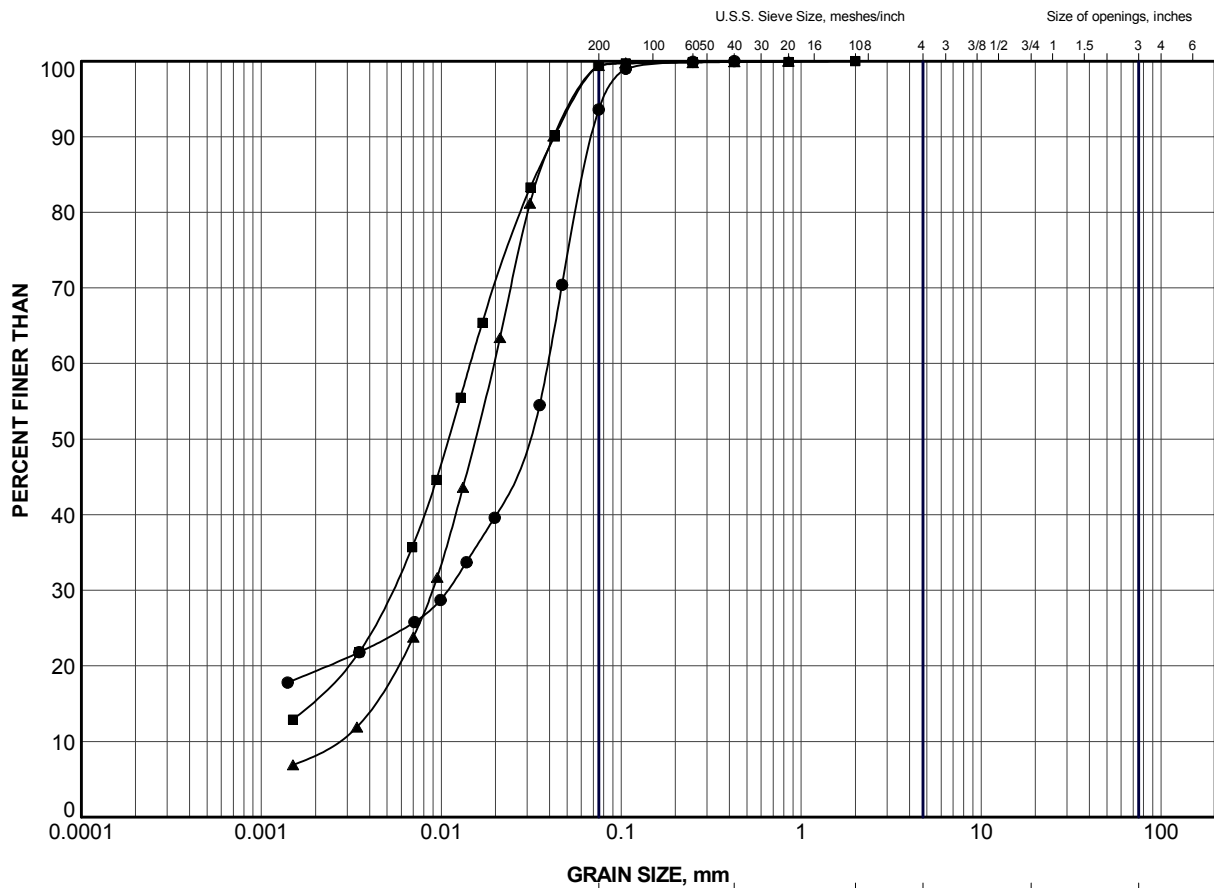


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	JC-1	14	268.9

PROJECT					HIGHWAY 655 JOCKO CREEK CULVERT				
TITLE					GRAIN SIZE DISTRIBUTION CLAYEY SILT				
PROJECT No.		12-1191-0014		FILE No.		1211910014.GPJ			
DRAWN	JJL	Sep 2013	SCALE	N/A	REV.				
CHECK	AB	Sep 2013							
APPR	FJH	Sep 2013							
 Golder Associates SUDBURY, ONTARIO			FIGURE C6						



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	JC-1	16	265.8
■	JC-2	15	267.3
▲	JC-3	9	266.0

PROJECT

HIGHWAY 655
JOCKO CREEK CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

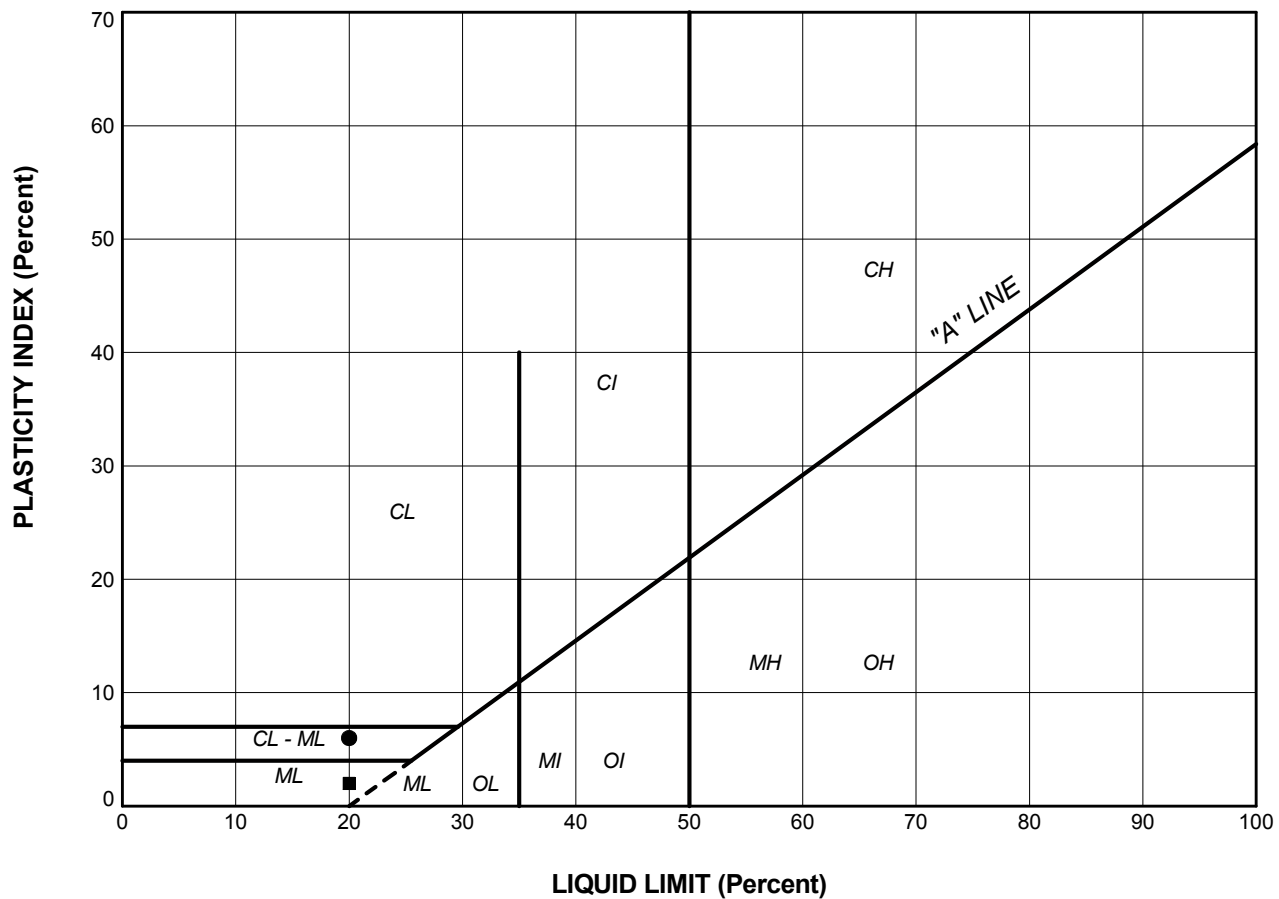
SILT




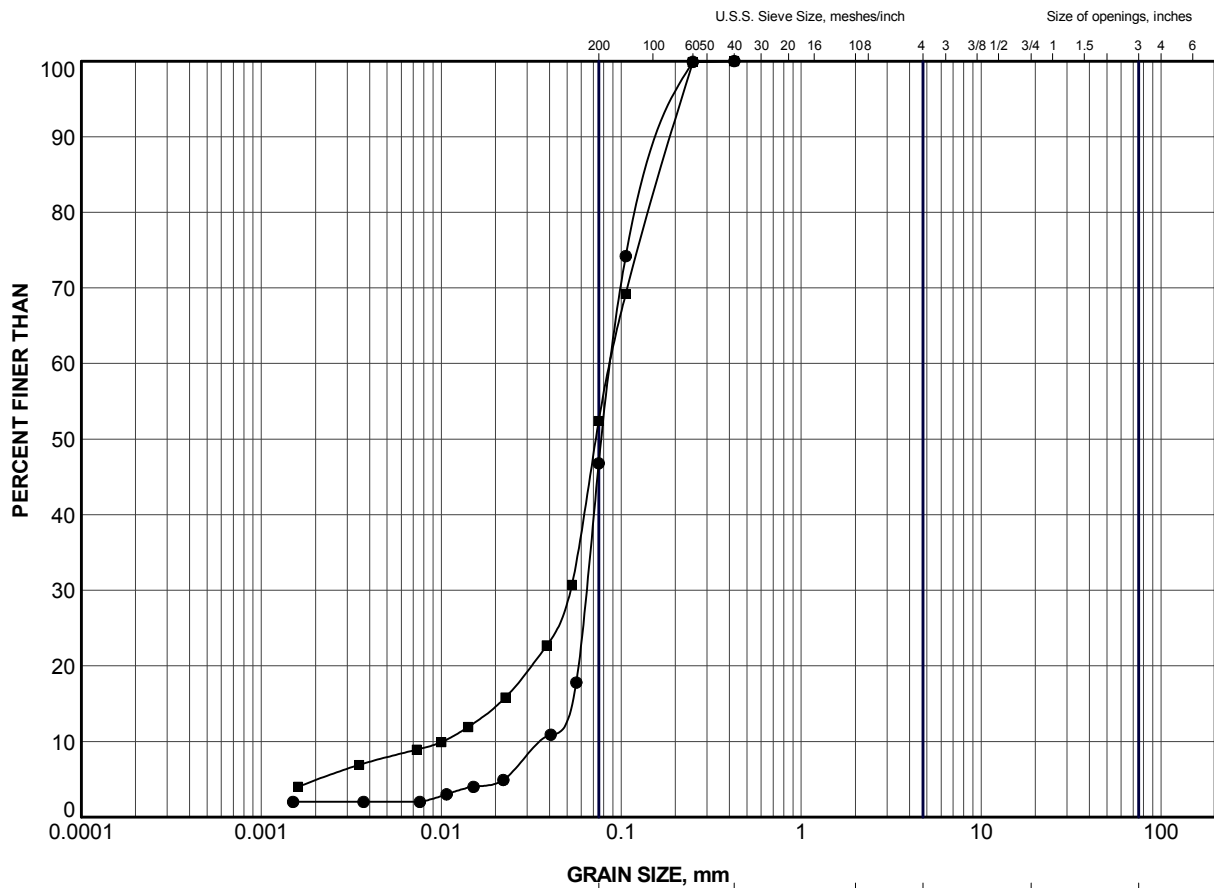
**Golder
Associates**
SUDBURY, ONTARIO

PROJECT No.	12-1191-0014	FILE No.	1211910014.GPJ
DRAWN	JJL	Sep 2013	SCALE N/A
CHECK	AB	Sep 2013	REV.
APPR	FJH	Sep 2013	

FIGURE C7



PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
PLASTICITY CHART SILT					
PROJECT No.		12-1191-0014		FILE No.	
DRAWN		JJL		Sep 2013	
CHECK		AB		Sep 2013	
APPR		FJH		Sep 2013	
 Golder Associates SUDBURY, ONTARIO				SCALE N/A REV.	
FIGURE C8					



GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	JC-2	17	264.3
■	JC-3	11	262.9

PROJECT					
HIGHWAY 655 JOCKO CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION SAND AND SILT					
PROJECT No.		12-1191-0014		FILE No. 1211910014.GPJ	
DRAWN	JJL	Sep 2013	SCALE	N/A	REV.
CHECK	AB	Sep 2013	FIGURE C9		
APPR	FJH	Sep 2013			



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