

February 9, 2022

Project No. 12-1132-0076-5000-L01-Rev0

Mr. Clarke Campbell, P.Eng.Dillon Consulting Limited
130 Dufferin Avenue, Suite 1400
London, ON N6A 5R2**GEOTECHNICAL EXPLORATION****HIGHWAY 401/COLONEL TALBOT ROAD INTERCHANGE RECONSTRUCTION****GWP 3030-11-00****GEOCRES NO. 40114-200**

Dear Mr. Campbell:

This letter provides the results of the geotechnical exploration and testing program carried out for the above-noted project as part of Change Order 10, dated June 7, 2021.

1.0 SITE GEOLOGY

This project lies within the physiographic region of southern Ontario known as the Westminster Moraine. The physiographic mapping indicates that the site is situated on a till moraine.¹ The available surficial geological mapping indicates that glaciolacustrine silt and sand as well as silty clay till is present at the site.²

Bedrock in the area of the site is described as medium brown, microcrystalline limestone of the Dundee Formation which belongs to the Hamilton Group of Middle Devonian Age.³ The bedrock surface is estimated, based on the available mapping, to be at about elevation 160 metres (m) or some 90 m below ground surface.

¹ Chapman, L.J. and Putnam, D.F., 1984: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2.

² Dreimanis, A., 1963: Pleistocene Geology of the St. Thomas Area (West Half), Southern Ontario. Ontario Department of Mines, Preliminary Geological Map 238, scale 1:50,000.

³ Sanford, B.V., 1969: Geology, Toronto-Windsor Area, Ontario. Geological Survey of Canada, Map 1263A, scale 1:250,000.

2.0 INVESTIGATION PROCEDURES

The field work was carried out between September 21 and December 3, 2021 during which time seven boreholes, identified as BH-101 to BH-107, were drilled. The Record of Borehole sheets are attached to this report and the results of geotechnical laboratory testing are provided in Appendix A.

The approximate locations of the boreholes are shown on the Borehole Location Plan, Drawing 1. The table below summarizes the approximate borehole location Universal Transverse Mercator (UTM) coordinates, geodetic ground surface elevations at the borehole locations and borehole depths.

Borehole	Approximate Location		Ground Surface Elevation (m)	Depth (m)
	Northing (m)	Easting (m)		
BH-101	4,747,163.1	405,102.8	262.38	8.1
BH-102	4,747,192.4	405,295.8	259.87	8.1
BH-103	4,746,226.8	404,987.0	248.29	5.8
BH-104	4,747,223.4	405,174.3	256.15	8.8
BH-105	4,746,349.0	404,716.0	250.52	8.8
BH-106	4,746,710.6	404,905.3	252.08	10.4
BH-107	4,746,696.0	404,895.1	252.07	10.4

The field work was carried out using truck-mounted drilling equipment supplied and operated by a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at generally 0.76-m intervals of depth using 50-millimetre (mm) outside diameter split spoon sampling equipment in accordance with ASTM D1586, using an automatic hammer. The results of the Standard Penetration Testing (SPT), as presented on the Record of Borehole sheets and in Section 4 of this letter, are the values measured directly in the field and are not factored (i.e., not standardized for hammer efficiency, borehole diameter, rod length, etc.).

The samplers limit the maximum particle size that can be sampled and tested to about 40 mm. Therefore, particles that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions presented in Appendix A. Larger particle sizes, including cobbles and boulders, are known to be present in the native soils, as discussed in the text of this letter.

The boreholes were terminated about 5.8 to 10.4 m below the existing ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations. Upon completion of drilling and sampling, the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation (O. Reg.) 903 (as amended).

The field work was monitored on a full-time basis by Golder staff who also located the boreholes in the field, monitored the drilling, sampling and in situ testing operations and logged the boreholes. The samples were identified in the field, placed in labelled containers and transported to Golder's London laboratory for further

examination and testing. Index and classification tests, consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations, were carried out on selected soil samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A. Sub-sampling for possible chemical analyses was carried out in accordance with accepted industry practices and applicable Canadian Standards Association (CSA) standards for subsurface environmental investigations. These sub soil sub-samples were retained in pre-cleaned glass jars, supplied by the analytical laboratory, and stored in the field in a cooler with ice. Soil samples selected for chemical analysis were delivered under chain-of-custody procedures to the analytical laboratory. The certificates of analysis from the analytical laboratory are attached in Appendix B.

3.0 SUBSURFACE CONDITIONS

3.1 General

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the geotechnical laboratory testing carried out on selected samples, are presented on the borehole records and on the figures in Appendix A. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous samples and, therefore, typically represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations. Descriptions of the subsurface conditions encountered in the boreholes are provided in the following subsections of this report.

Groundwater levels/conditions encountered in the boreholes during and shortly after drilling may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized. Groundwater levels and seepage conditions in the area will fluctuate seasonally and in response to precipitation events.

Materials designated as topsoil in this letter were classified based solely on visual and textural evidence. Testing of organic or nutrient contents was not carried out. Accordingly, the materials classified herein as topsoil cannot necessarily be relied upon for the support and growth of landscaping vegetation without confirmatory soil fertility analyses.

In general, the subsurface conditions encountered in the boreholes consisted of fill materials overlying a deposit of silty clay to clayey silt (inferred to be glacial till). These ground conditions are described in additional detail below.

3.2 Existing Glanworth Drive Approach Embankments (BH-101 and BH-102)

3.2.1 SOIL CONDITIONS

Pavement Structure and Fill

Asphalt was encountered at the pavement surface in both boreholes and was about 80 to 100 mm thick. Beneath the asphalt, sandy gravel fill materials, about 660 to 680 mm thick, were encountered.

Beneath the pavement structure, fill materials associated with the existing approach embankments were encountered. The fill materials consisted of clayey silt to silty clay with pockets of topsoil and were about 6.1 and 1.5 m thick in BH-101 and BH-102, respectively. The stiff to very stiff cohesive fill materials had Standard

Penetration Test (SPT) N values ranging from 8 to 18 blows per 0.3 m of penetration. Samples of the cohesive fill had water contents ranging from about 16 to 24 per cent. The cohesive fill had average plastic and liquid limits of about 19 and 32 per cent, respectively, based on two Atterberg limits determinations. These data are shown on the Plasticity Chart on Figure A-4 in Appendix A. Grain size distribution curves for samples of the cohesive fill are shown on Figure A-1.

Buried Topsoil

A layer of buried topsoil was encountered beneath the cohesive fill in BH-102 at about elevation 257.6 m. The buried topsoil had an SPT N value of 16 blows per 0.3 m and a water content of about 16 per cent.

Silty Clay to Clayey Silt Till

Silty clay to clayey silt till was encountered at about elevation 255.5 to 257.0 m. Both of the boreholes were terminated in the silty clay to clayey silt till at elevations ranging from about 251.8 to 254.3 m. The stiff to hard clayey silt to silty clay till had SPT N values ranging from 10 to 37 blows per 0.3 m of penetration. Samples of the silty clay to clayey silt till had water contents that ranged from about 15 to 21 per cent. Two Atterberg limits determinations completed on samples of the silty clay to clayey silt till indicated average plastic and liquid limits of about 17 and 35 per cent, respectively. These data are shown on the Plasticity Chart on Figure A-4 in Appendix A. Grain size distribution curves for samples of the clayey silt to silty clay till are shown on Figure A-2.

Although not explicitly encountered during the investigation, cobbles and boulders should be expected in the glacial till strata.

3.2.2 Groundwater Conditions

BH-101 and BH-102 remained free of observable water during drilling in October 2021.

3.3 Former Gas Station (BH-103)

3.3.1 SOIL CONDITIONS

Topsoil and Fill

A layer of sandy topsoil about 0.1 m thick was encountered at the ground surface at BH-103. Sandy gravel fill materials were encountered to about elevation 247.1 m. The compact granular fill materials had an SPT N value of 29 blows per 0.3 m of penetration and a water content of about 5 per cent.

Silty Clay

A layer of silty clay with traces of organic material was encountered at about elevation 247.1 m and was about 2.3 m thick. The soft to firm silty clay had SPT N values of 4 and 8 blows per 0.3 m and water contents of about 36 to 37 per cent.

Silty Clay to Clayey Silt Till

Beneath the silty clay, silty clay to clayey silt till was encountered at about elevation 244.8. BH-103 was terminated in the silty clay to clayey silt till at about elevation 242.5 m. The very stiff to hard clayey silt to silty clay till had SPT N values ranging from 29 to 36 blows per 0.3 m of penetration. Samples of the silty clay to clayey silt till had water contents that ranged from about 16 to 19 per cent. An Atterberg limits determination completed on a sample of the silty clay to clayey silt till indicated a plastic limit of about 18 per cent and a liquid limit of about 34

per cent. These data are shown on the Plasticity Chart on Figure A-4 in Appendix A. A grain size distribution curve for a sample of the clayey silt to silty clay till is shown on Figure A-2.

Although not explicitly encountered during the investigation, cobbles and boulders should be expected in the glacial till strata.

3.3.2 Groundwater Conditions

Groundwater seepage was encountered in BH-103 at about elevation 246.0 m on December 3, 2021. This is not considered to represent the long-term, stabilized groundwater level.

3.4 New Overhead Signs (BH-104 and BH-105)

3.4.1 SOIL CONDITIONS

Topsoil and Fill

A layer of silty topsoil about 80 mm thick was encountered at the ground surface at BH-104. The surficial topsoil was underlain by silty clay fill materials to about 0.8 m in depth. The cohesive fill was noted to contain topsoil pockets and rootlets. Beneath the cohesive fill, a layer of compact buried topsoil was encountered. The buried topsoil was about 0.6 m thick and had an SPT N value of 12 blows per 0.3 m and a water content of about 27 per cent.

BH-105 encountered a layer of sandy gravel fill about 0.8 m thick at the ground surface which was underlain by stiff silty clay fill with topsoil pockets. The cohesive fill was about 1.2 m thick at the borehole location. The cohesive fill had SPT N values of 9 and 12 blows per 0.3 m of penetration with water contents that ranged from about 15 to 19 per cent.

Silty Clay to Clayey Silt Till

Beneath the buried topsoil in BH-104 and the cohesive fill in BH-105, silty clay to clayey silt till was encountered at about elevations 254.8 and 248.4 m, respectively. The boreholes were terminated in the silty clay to clayey silt till at elevations 247.3 and 241.7 m in BH-104 and BH-105, respectively. The soft to very stiff clayey silt to silty clay till had SPT N values ranging from 3 to 26 blows per 0.3 m of penetration. Samples of the silty clay to clayey silt till had water contents that ranged from about 15 to 25 per cent. Atterberg limits determinations completed on three samples of the silty clay to clayey silt till indicated an average plastic limit of about 18 per cent and an average liquid limit of about 34 per cent. These data are shown on the Plasticity Chart on Figure A-4 in Appendix A. Grain size distribution curves for samples of the clayey silt to silty clay till are shown on Figure A-2.

Although not explicitly encountered during the investigation, cobbles and boulders should be expected in the glacial till strata.

3.4.2 Groundwater Conditions

BH-104 and BH-105 remained free of observable water during drilling in September 2021.

3.5 Colonel Talbot Road Median Pier (BH-106 and BH-107)

3.5.1 SOIL CONDITIONS

Pavement Structure and Topsoil

Asphalt was encountered at the pavement surface in both boreholes and was about 80 mm thick. Beneath the asphalt, gravelly sand fill materials about 0.8 to 1.4 m thick were encountered.

Buried topsoil was encountered beneath the pavement structure in both boreholes. The buried topsoil layers were about 0.2 and 0.6 m thick in BH-106 and BH-107, respectively. A sample of the buried topsoil had a water content of about 21 per cent.

Silty Clay to Clayey Silt Till

Beneath the buried topsoil in the above-noted boreholes, silty clay to clayey silt till was encountered at about elevation 250.0 to 250.6 m. The boreholes were terminated in the silty clay to clayey silt till at about elevation 241.7 m. The stiff to very stiff clayey silt to silty clay till had SPT N values ranging from 8 to 29 blows per 0.3 m of penetration. Samples of the silty clay to clayey silt till had water contents that ranged from about 12 to 22 per cent. Atterberg limits determinations completed on four samples of the silty clay to clayey silt till indicated an average plastic limit of about 16 per cent and an average liquid limit of about 32 per cent. These data are shown on the Plasticity Chart on Figure A-4 in Appendix A. Grain size distribution curves for samples of the clayey silt to silty clay till are shown on Figure A-3.

Although not explicitly encountered during the investigation, cobbles and boulders should be expected in the glacial till strata.

3.5.2 Groundwater Conditions

Seepage was encountered in BH-106 and BH-107 at elevations 248.1 and 245.7 m, respectively, during drilling on September 30, 2021. These are not considered to represent long-term, stabilized groundwater levels.

4.0 ANALYTICAL TESTING

The results of the analytical testing carried out on selected soil samples are provided in Appendix B. The analytical testing included:

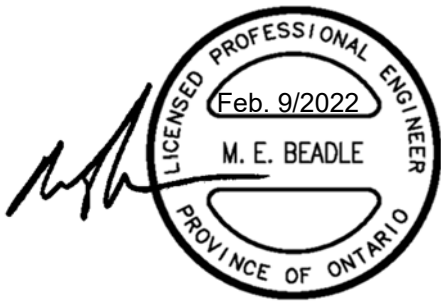
Borehole	Sample	Analytical Testing
101	1	O. Reg. 153 Metals and Inorganics
101	2	O. Reg. 153 Metals and Inorganics
101	3	O. Reg. 153 Metals and Inorganics
102	1	O. Reg. 153 Metals and Inorganics
102	2	O. Reg. 153 Metals and Inorganics

Borehole	Sample	Analytical Testing
102	3	O. Reg. 153 Metals and Inorganics
103	2	O. Reg. 153 Petroleum Hydrocarbons, fractions F1 – F4
106	3	Corrosivity Package
107	2	Corrosivity Package

5.0 CLOSURE

We trust that this letter provides all of the information that you currently require. Should any point require clarification, or if we can be of additional assistance, please contact the undersigned.

Yours truly,
Golder Associates Ltd.



Michael Beadle, P.Eng.
Associate



Mark A. Swallow, P.E., P.Eng.
Principal and Senior Practice Leader

MEB/RA/MAS/cr

- Attachments: Drawing 1 – Location Plan (*not included – still being edited by drafting*)
MTO List of Abbreviations and Symbols
Records of Boreholes
Appendix A – Results of Laboratory Testing
Appendix B – Certificates of Analysis

[https://golderassociates.sharepoint.com/sites/147619/ph 5000coltalbotglnworth interchange/I01-rev0 geo exp/1211320076-5000-I01-rev0 \(final\) geo exp hwy 401 colonel talbot_09feb2022.docx](https://golderassociates.sharepoint.com/sites/147619/ph%205000coltalbotglnworth%20interchange/I01-rev0%20geo%20exp/1211320076-5000-I01-rev0%20(final)%20geo%20exp%20hwy%20401%20colonel%20talbot_09feb2022.docx)



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

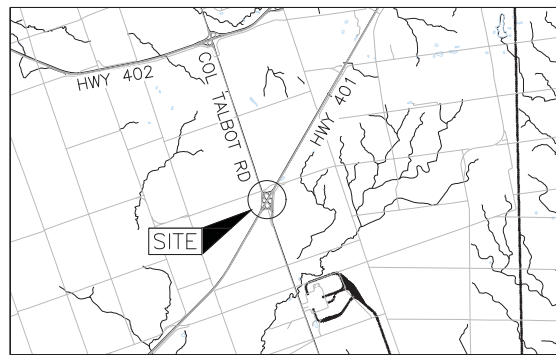
CONT No. _____
GWP No. 3030-11-00



HIGHWAY 401 / COLONEL TALBOT ROAD
INTERCHANGE RECONSTRUCTION

SHEET

BOREHOLE LOCATION PLAN



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH-101	262.4	4747163.1	405102.8
BH-102	259.9	4747192.4	405295.8
BH-103	248.3	4746226.8	404987.0
BH-104	256.2	4747223.4	405174.3
BH-105	250.5	4746349.0	404716.0
BH-106	252.1	4746710.6	404905.3
BH-107	252.1	4746696.0	404895.1



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.

REFERENCE

Base plans provided in digital format by ?, drawing file nos. ? and ?, dated MMM DD, YYYY, received MMM DD, YYYY.

NO.	DATE	BY	REVISION
Geocres No. 40114-200			
HWY. 401	PROJECT NO. 12-1132-0076		DIST. .
SUBM'D. MEB	CHKD. MEB	DATE: 6/14/2013	SITE: .
DRAWN: JM	CHKD. MEB	APPD. .	DWG. 1

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (i.e., SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (i.e., some sand)
≤ 10	trace (i.e., trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An 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 (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); 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

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL , w _p	plastic limit
LL , 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
GS	specific gravity
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 (FV)	field vane (LV-laboratory vane test)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

3. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS MINISTRY OF TRANSPORTATION, ONTARIO			
Unless otherwise stated, the symbols employed in the report are as follows:			
I.	GENERAL	(a)	Index Properties (continued)
π	3.1416	w	water content
ln x	natural logarithm of x	w _l or LL	liquid limit
log ₁₀	x or log x, logarithm of x to base 10	w _p or PL	plastic limit
g	acceleration due to gravity	I _p or PI	plasticity index = (w _l – w _p)
t	time	NP	non-plastic
FoS	factor of safety	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)
II.	STRESS AND STRAIN	(b)	Hydraulic Properties
γ	shear strain	h	hydraulic head or potential
Δ	change in, e.g. in stress: Δσ	q	rate of flow
ε	linear strain	v	velocity of flow
ε _v	volumetric strain	i	hydraulic gradient
η	coefficient of viscosity	k	hydraulic conductivity (coefficient of permeability)
υ	Poisson's ratio	j	seepage force per unit volume
σ	total stress		
σ'	effective stress (σ' = σ - u)	(c)	Consolidation (one-dimensional)
σ'vo	initial effective overburden stress	C _c	compression index (normally consolidated range)
σ ₁ , σ ₂ , σ ₃	principal stress (major, intermediate, minor)	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
(a)	Index Properties	(d)	Shear Strength
ρ(γ)	bulk density (bulk unit weight)*	τ _p , τ _r	peak and residual shear strength
ρ _d (γ _d)	dry density (dry unit weight)	φ'	effective angle of internal friction
ρ _w (γ _w)	density (unit weight) of water	δ	angle of interface friction
ρ _s (γ _s)	density (unit weight) of solid particles	μ	coefficient of friction = tan δ
γ'	unit weight of submerged soil (γ' = γ - γ _w)	c'	effective cohesion
D _R	relative density (specific gravity) of solid particles (D _R = ρ _s / ρ _w) (formerly G _s)	C _u , S _u	undrained shear strength (φ = 0 analysis)
E	void ratio	p	mean total stress (σ ₁ + σ ₃)/2
N	porosity	p'	mean effective stress (σ' ₁ + σ' ₃)/2
S	degree of saturation	q	(σ ₁ - σ ₃)/2 or (σ' ₁ - σ' ₃)/2
		q _u	compressive strength (σ ₁ - σ ₃)
		S _t	sensitivity
* Density symbol is ρ. Unit weight symbol is γ where γ = ρg (i.e. mass density multiplied by acceleration due to gravity)		Notes: 1 2	τ = c' + σ' tan φ' shear strength = (compressive strength)/2

PROJECT12-1132-0076

W.P.3030-11-00

DIST

DATUMGEODETIC

RECORD OF BOREHOLE BH-101

LOCATIONN 4747163.1, E 405102.8

BOREHOLE TYPEPOWER AUGER (HOLLOW STEM)

DATEOctober 4, 2021

1 OF 1

METRIC

ORIGINATED BYMD

COMPILED BYMEB

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								20 40 60 80 100									Wp W WL			
262.38	GROUND SURFACE																			
0.10	ASPHALT						262													
261.62	FILL - sandy gravel, some silt Brown																			
0.76	FILL - silty clay, trace sand, trace gravel Brown Stiff		1	SS	8		261													
			2	SS	10															
			3	SS	9		260													
			4	SS	9		259										1	11 45 45		
			5	SS	9		258													
257.81	FILL - clayey silt, some sand, trace gravel, with topsoil pockets Brown and black Very Stiff		6	SS	18		257													
257.05	FILL - clayey silt with silt and topsoil pockets Grey and black Stiff		7	SS	9		256										0	12 72 16		
5.33			8	SS	13															
255.52	CI - SILTY CLAY, trace sand, trace gravel Brown Very Stiff To Hard		9	SS	27		255													
6.86			10	SS	33															
254.30	END OF BOREHOLE																			
8.08	Borehole dry during drilling on October 4, 2021.																			

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

PROJECT12-1132-0076

W.P.3030-11-00

DIST

DATUMGEODETIC

RECORD OF BOREHOLE BH-102

LOCATIONN 4747192.4, E 405295.8

BOREHOLE TYPEPOWER AUGER (HOLLOW STEM)

DATEOctober 4, 2021

1 OF 1

METRIC

ORIGINATED BYMD

COMPILED BYMEB

CHECKED BY

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	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
259.87	GROUND SURFACE						20	40	60	80	100						GR	SA	SI	CL
0.08	ASPHALT																			
259.11	FILL - sandy gravel, some silt Brown																			
0.76	FILL - silty clay, trace sand, trace gravel, trace topsoil Brown Very stiff		1	SS	18															
			2	SS	18															
257.58																				
2.29	silty TOPSOIL Black Compact		3	SS	16															
256.97	CL-CI - CLAYEY SILT to SILTY CLAY, trace sand, trace gravel Brown becoming grey at 6.7m Stiff to hard		4	SS	12															
2.90																				
			5	SS	18															
			6	SS	33															
			7	SS	37															
			8	SS	21															
			9	SS	17															
251.79	END OF BOREHOLE		10	SS	10															
8.08	Borehole dry during drilling on October 4, 2021.																			

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

PROJECT

12-1132-0076

W.P.

3030-11-00

DIST

HWY 401

DATUM

GEODETIC

LOCATION

N 4746226.8, E 404987.0

BOREHOLE TYPE

POWER AUGER (HOLLOW STEM)

DATE

December 3, 2021


ORIGINATED BY

MD

COMPILED BY

MEB

CHECKED BY



RECORD OF BOREHOLE BH-103

1 OF 1

METRIC

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES	SHEAR STRENGTH kPa					W _p	W	W _L	WATER CONTENT (%)	GR	SA		SI	CL			
248.29	GROUND SURFACE																					
0.08	sandy TOPSOIL Brown						248															
	FILL - gravelly sand with silt Brown Compact		1	SS	29								○									
247.07							247															
1.22	CI - SILTY CLAY, trace sand, organics Grey Firm		2	SS	8													○				
			3	SS	4		246											○				
244.78							245															
3.51	CL - CLAYEY SILT, trace sand, trace gravel Brown Very stiff to hard		4	SS	36									○								
			5	SS	29		244															
243.11							243							○								
5.18	CL - CLAYEY SILT, trace sand, trace gravel, with silt layers Grey Hard		6	SS	31									○								
242.50	END OF BOREHOLE																					
5.79	Groundwater encountered at about elev. 246.0m during drilling on December 3, 2021.																					

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

PROJECT

12-1132-0076

W.P.

3030-11-00

DIST

HWY 401

DATUM

GEODETIC

LOCATION

N 4747223.4, E 405174.3

BOREHOLE TYPE

POWER AUGER (HOLLOW STEM)

DATE

September 21, 2021

ORIGINATED BY

MD

COMPILED BY

MEB

CHECKED BY

RECORD OF BOREHOLE BH-104

1 OF 1

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%)	GR	SA	SI	CL
								20	40	60	80	100									
256.15	GROUND SURFACE						256														
0.08	silty TOPSOIL Brown																				
255.39	FILL - silty clay, some sand, trace gravel, topsoil, rootlets Brown		1	SS	9																
0.76	Firm						255														
254.78	silty TOPSOIL Black		2	SS	16																
1.37	Loose																				
	CL - CLAYEY SILT, trace sand, trace gravel Brown becoming grey at 4.4m depth Soft to very stiff		3	SS	20		254														
			4	SS	26		253														
			5	SS	10		252														
			6	SS	7																
			7	SS	3		251														
			8	SS	3		250														
			9	SS	4		249														
			10	SS	15		248														
			11	SS	10																
247.31	END OF BOREHOLE																				
8.84	Borehole dry during drilling on September 21, 2021.																				

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

PROJECT12-1132-0076

W.P.3030-11-00

DIST

DATUMGEODETIC

RECORD OF BOREHOLE BH-105

LOCATIONN 4746349.0, E 404716.0

BOREHOLE TYPEPOWER AUGER (HOLLOW STEM)

DATESeptember 21, 2021

1 OF 1

METRIC

ORIGINATED BYMD

COMPILED BYMEB

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)									
								○ UNCONFINED + FIELD VANE									● QUICK TRIAXIAL × LAB VANE									
250.52 0.00	GROUND SURFACE FILL - sandy gravel, some silt Brown						20	40	60	80	100					GR	SA	SI	CL							
249.76 0.76	FILL - silty clay, some sand, trace gravel, with topsoil pockets Brown Stiff		1	SS	12								○			0 7 51 42										
			2	SS	9								○													
248.39 2.13	CL-CI - CLAYEY SILT to SILTY CLAY, trace sand, trace gravel Brown becoming grey at 4.4m depth Stiff to very stiff		3	SS	15								○													
			4	SS	19								○	—												
			5	SS	14								○													
			6	SS	10								○													
			7	SS	10								○													
			8	SS	10								○													
			9	SS	14								○	—												
			10	SS	10								○													
			11	SS	11								○													
241.68 8.84	END OF BOREHOLE Borehole dry during drilling on September 21, 2021.															0 5 47 48										

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

PROJECT12-1132-0076

W.P.3030-11-00

DIST

DATUMGEODETIC

RECORD OF BOREHOLE BH-106

LOCATIONN 4746710.6, E 404905.3

BOREHOLE TYPEPOWER AUGER (HOLLOW STEM)

DATESeptember 30, 2021

1 OF 1

METRIC

ORIGINATED BYMD

COMPILED BYMEB

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa												PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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252.08	GROUND SURFACE						20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</

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

PROJECT12-1132-0076

W.P.3030-11-00

DIST

DATUMGEODETIC

RECORD OF BOREHOLE BH-107

LOCATIONN 4746696.0, E 404895.1

BOREHOLE TYPEPOWER AUGER (HOLLOW STEM)

DATESeptember 30, 2021

1 OF 1

METRIC

ORIGINATED BYMD

COMPILED BYMEB

CHECKED BY

Mr. Clarke Campbell, P.Eng.

Project No. 12-1132-0076-5000-L01-Rev0

Dillon Consulting Limited

February 9, 2022

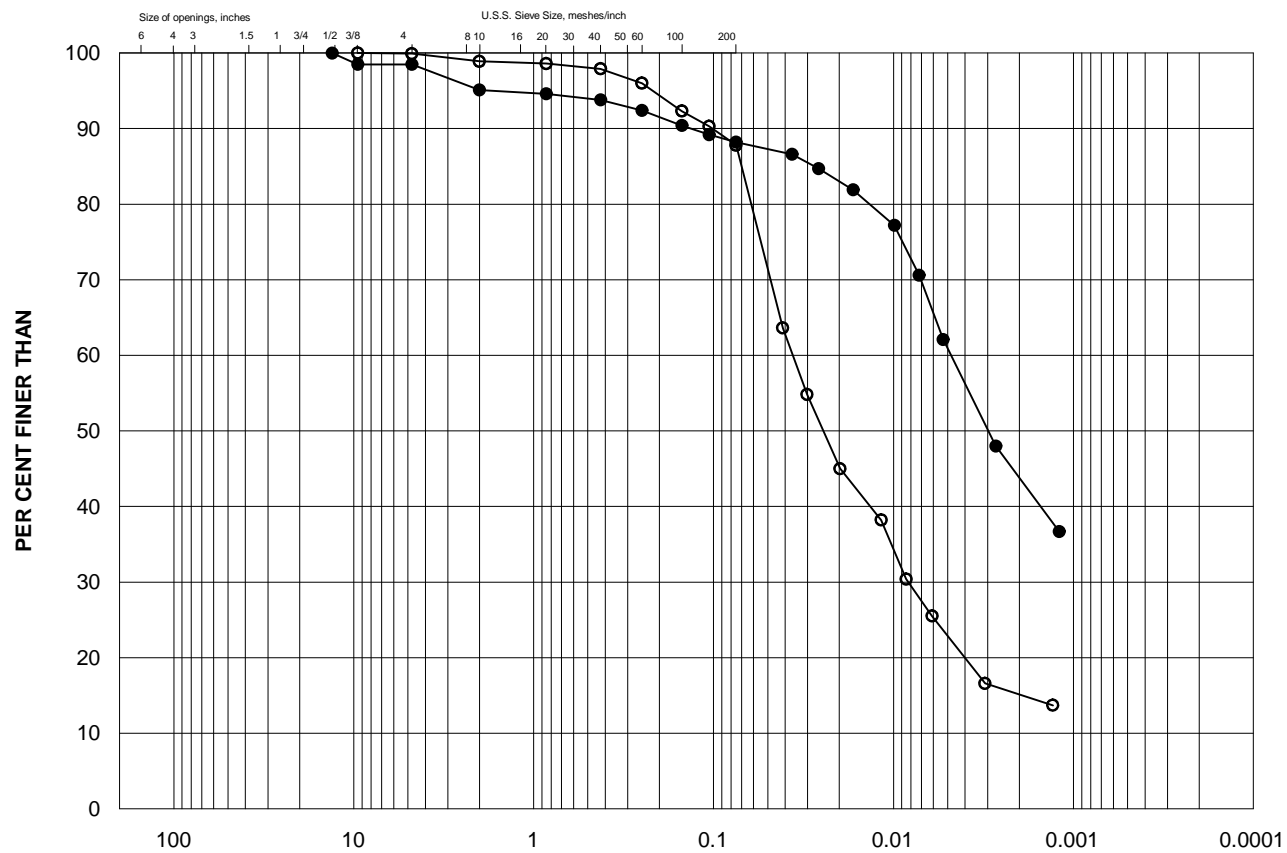
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L							
252.07	GROUND SURFACE						252										
0.08	ASPHALT																
251.16	FILL - gravelly sand, some silt Brown Dense																
0.91	silty TOPSOIL		1	SS	7		251										
250.55	Black Loose																
1.52	CL - CLAYEY SILT, trace sand, trace gravel Brown becoming grey at 4.4m depth Stiff to very stiff		2	SS	11		250										
			3	SS	20												
			4	SS	16		249										
			5	SS	13		248										
			6	SS	12		247										
			7	SS	9		246										
			8	SS	12		245										
			9	SS	12		244										
			10	SS	14		243										
			11	SS	27		242										
			12	SS	22												
			13	SS	29												
241.71	END OF BOREHOLE																
10.36	Groundwater encountered at about elev. 245.7m during drilling on September 30, 2021.																

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

APPENDIX A

Results of Geotechnical Laboratory Testing

C:\Users\lbeadle\OneDrive - Golder Associates\User Drive\Glanworth\1211320076-5000-L01001.grf



GRAIN SIZE (mm)						
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE		FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	4	259.1
○	101	7	256.8

PROJECT

HIGHWAY 401/COLONEL TALBOT ROAD
INTERCHANGE RECONSTRUCTION
GWP 3030-11-00

TITLE

GRAIN SIZE DISTRIBUTION
FILL

GOLDER

PROJECT No.

1211320076

FILE No.

1211320076-5000-L01001

SCALE

AS SHOWN

REV.

0

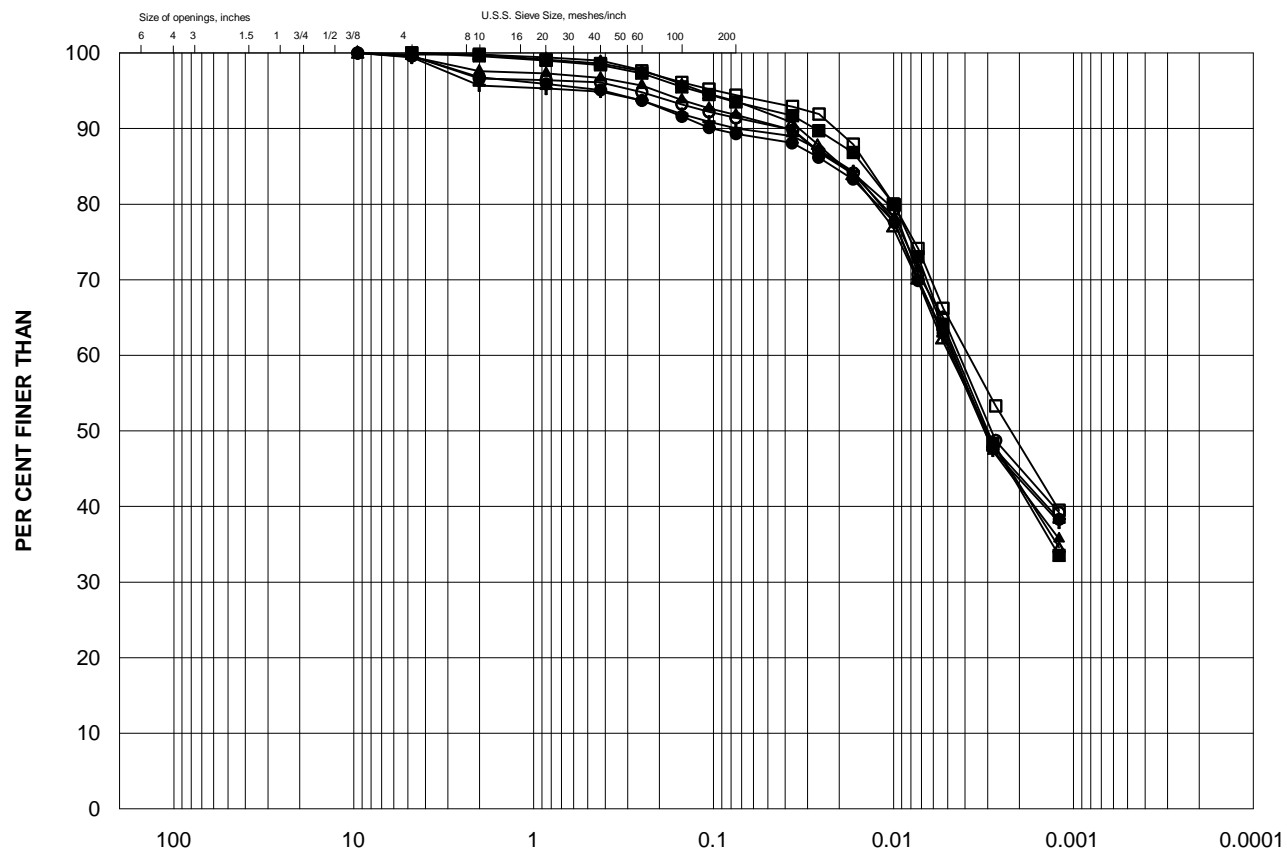
DRAWN

MEB

JAN 14-22

CHECK

FIGURE A-1



GRAIN SIZE (mm)						
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE		FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	102	4	256.6
○	102	9	252.8
▲	103	4	244.3
△	104	2	254.4
+	104	6	251.4
■	105	4	247.2
□	105	9	243.4

PROJECT

HIGHWAY 401/COLONEL TALBOT ROAD
INTERCHANGE RECONSTRUCTION
GWP 3030-11-00

TITLE

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY

GOLDER

PROJECT No.

1211320076

FILE No.

1211320076-5000-L01002

SCALE

AS SHOWN

REV.

0

DRAWN

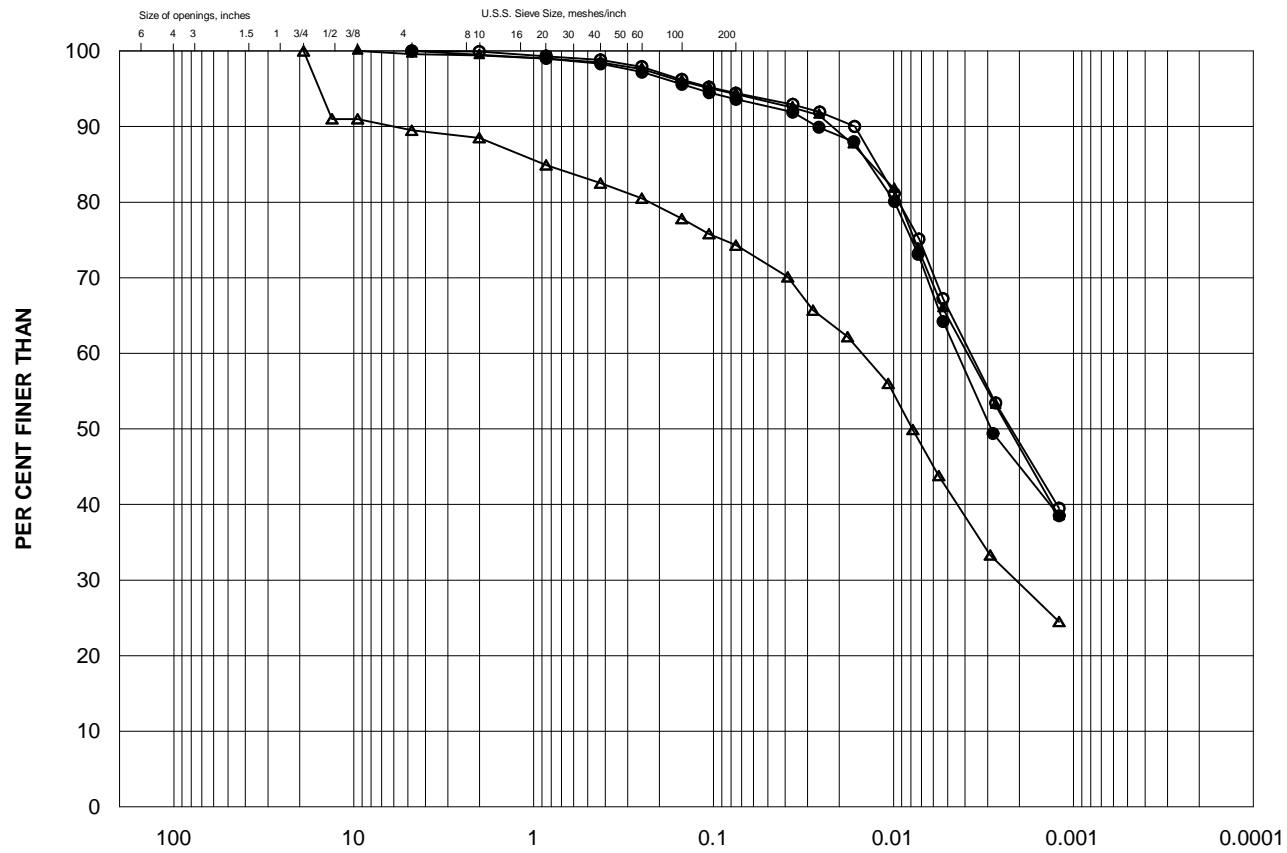
MEB

JAN 14-22

CHECK

FIGURE A-2

C:\Users\lbeadle\OneDrive - Golder Associates\User Drive\Glanworth\1211320076-5000-L01003.grf



GRAIN SIZE (mm)					
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE
	GRAVEL SIZE		SAND SIZE		SILT AND CLAY SIZES
					FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	106	6	247.3
○	106	8	245.8
▲	107	7	246.5
△	107	12	242.7

PROJECT

HIGHWAY 401/COLONEL TALBOT ROAD
INTERCHANGE RECONSTRUCTION
GWP 3030-11-00

TITLE

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY

GOLDER

PROJECT No.

1211320076

FILE No.

1211320076-5000-L01003

SCALE

AS SHOWN

REV.

0

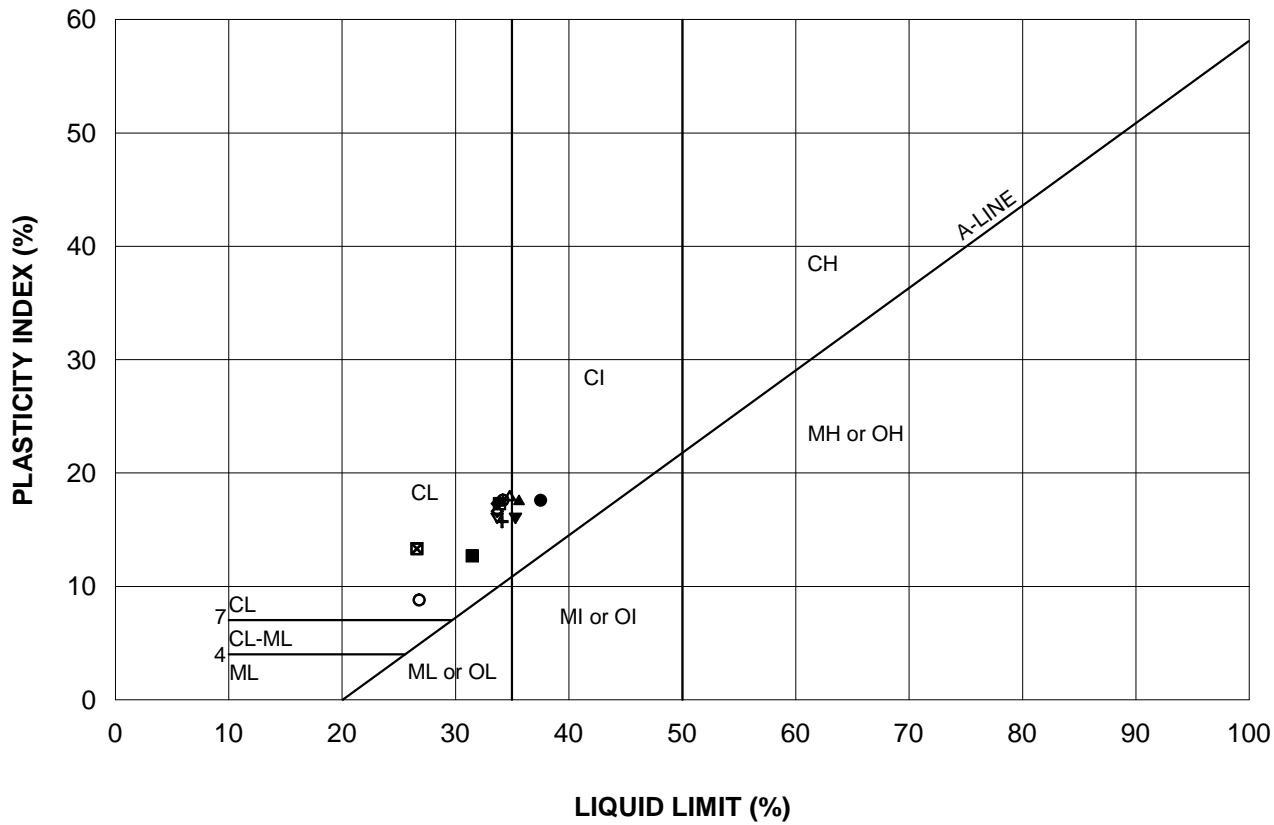
DRAWN

MEB

JAN 14-22

CHECK

FIGURE A-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE
●	101	4
○	101	7
▲	102	4
△	102	9
+	103	4
■	104	2
□	104	6
▼	105	4
▽	105	9
◆	106	6
◇	106	8
⊕	107	7
⊗	107	12

PROJECT

HIGHWAY 401/COLONEL TALBOT ROAD
INTERCHANGE RECONSTRUCTION
GWP 3030-11-00

TITLE

PLASTICITY CHART

GOLDER

PROJECT No.

1211320076

FILE No.

1211320076-5000-L01004

SCALE

AS SHOWN

REV.

0

DRAWN

MEB

JAN 14-22

CHECK

FIGURE A-4



CLIENT NAME: **GOLDER ASSOCIATES LTD.**
309 EXETER ROAD, UNIT #1
LONDON, ON N6L1C1
(519) 652-0099

ATTENTION TO: **Randy Axford**

PROJECT: **12-1132-0076**

AGAT WORK ORDER: **21L840641**

SOIL ANALYSIS REVIEWED BY: **Jacky Zhu, Spectroscopy Technician**

TRACE ORGANICS REVIEWED BY: **Inga Kuzmina, Trace Organics Lab Manager**

DATE REPORTED: **Dec 20, 2021**

PAGES (INCLUDING COVER): **14**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

APPENDIX B

Certificates of Analysis

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.



Certificate of Analysis

AGAT WORK ORDER: 21L840641

PROJECT: 12-1132-0076

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:

ATTENTION TO: Randy Axford
SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2021-12-06				DATE REPORTED: 2021-12-20			
SAMPLE DESCRIPTION:		107-2	106-3				
SAMPLE TYPE:		Soil	Soil				
DATE SAMPLED:		2021-12-06 12:00	2021-12-06 12:00				
Parameter	Unit	G / S	RDL	3309883	3309930		
Chloride (2:1)	µg/g	2	1680	2	2080		
Sulphate (2:1)	µg/g	2	24	24	105		
pH (2:1)	pH Units	NA	7.85	7.85	8.16		
Electrical Conductivity (2:1)	mS/cm	0.005	2.54	2.54	3.14		
Resistivity (2:1) (Calculated)	ohm.cm	1	394	394	318		
Redox Potential 1	mV	NA	300	300	267		
Redox Potential 2	mV	NA	300	300	268		
Redox Potential 3	mV	NA	300	300	268		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3309883-3309930 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)



Certified By:

AGAT CERTIFICATE OF ANALYSIS (V1)

Results relate only to the items tested. Results apply to samples as received.



Certificate of Analysis

AGAT WORK ORDER: 21L840641

PROJECT: 12-1132-0076

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:

ATTENTION TO: Randy Axford
SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2021-12-06				DATE REPORTED: 2021-12-20			
SAMPLE DESCRIPTION:		101-1	101-2	101-3	102-1	102-2	102-3
SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:		2021-12-06 12:00	2021-12-06 12:00	2021-12-06 12:00	2021-12-06 12:00	2021-12-06 12:00	2021-12-06 12:00
Parameter	Unit	G / S	RDL	3309932	3309933	3309934	3309935
Antimony	µg/g	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	1	5	5	5	5	5
Barium	µg/g	2.0	104	110	117	110	110
Beryllium	µg/g	0.4	0.8	0.7	0.8	0.6	0.7
Boron	µg/g	5	16	17	18	14	14
Boron (Hot Water Soluble)	µg/g	0.10	<0.10	0.19	<0.10	0.16	0.23
Cadmium	µg/g	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	5	30	31	33	28	29
Cobalt	µg/g	0.5	12.5	13.2	13.5	11.8	11.7
Copper	µg/g	1.0	21.6	22.4	23.4	20.9	21.0
Lead	µg/g	1	9	9	10	10	10
Molybdenum	µg/g	0.5	<0.5	0.5	<0.5	0.5	0.6
Nickel	µg/g	1	25	25	27	24	24
Selenium	µg/g	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Silver	µg/g	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	µg/g	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Uranium	µg/g	0.50	0.66	0.77	0.75	0.65	0.71
Vanadium	µg/g	0.4	38.8	40.1	42.4	36.2	37.0
Zinc	µg/g	5	62	66	67	61	62
Chromium, Hexavalent	µg/g	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide, Free	µg/g	0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity (2:1)	mS/cm	0.005	1.76	1.76	1.57	1.22	1.33
Sodium Adsorption Ratio (2:1) (Calc.)	N/A	N/A	36.3	10.2	8.53	11.2	2.97
pH, 2:1 CaCl2 Extraction	pH Units	NA	NA	7.51	7.38	6.72	6.99
							7.19



Certified By:

AGAT CERTIFICATE OF ANALYSIS (V1)

Results relate only to the items tested. Results apply to samples as received.



Certificate of Analysis

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:

ATTENTION TO: Randy Axford
SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)	
DATE RECEIVED: 2021-12-06	DATE REPORTED: 2021-12-20

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
3309932-3309937 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)



Certified By:

Results relate only to the items tested. Results apply to samples as received.



Certificate of Analysis

5835 COOPERS AVENUE
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CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:

ATTENTION TO: Randy Axford
SAMPLED BY:

Moisture content (Soil)				
DATE RECEIVED: 2021-12-06		DATE REPORTED: 2021-12-20		
SAMPLE DESCRIPTION: 107-2 106-3				
SAMPLE TYPE: Soil Soil				
DATE SAMPLED: 2021-12-06 2021-12-06				
12:00 12:00				
Parameter	Unit	G / S	RDL	
	%		0.1	17.7
			3309883	3309930
				18.4
Moisture Content				



Certified By:

Results relate only to the items tested. Results apply to samples as received.



Certificate of Analysis

AGAT WORK ORDER: 21L840641

PROJECT: 12-1132-0076

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MISSISSAUGA, ONTARIO
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CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:
ATTENTION TO: Randy Axford
SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)									
DATE RECEIVED: 2021-12-06				DATE REPORTED: 2021-12-20					
SAMPLE DESCRIPTION: 103-2									
SAMPLE TYPE: Soil									
DATE SAMPLED: 2021-12-06 12:00									
Parameter	Unit	G / S	RDL	3309931					
Benzene	µg/g		0.02	<0.02					
Toluene	µg/g		0.05	<0.05					
Ethylbenzene	µg/g		0.05	<0.05					
m & p-Xylene	µg/g		0.05	<0.05					
o-Xylene	µg/g		0.05	<0.05					
Xylenes (Total)	µg/g		0.05	<0.05					
F1 (C6 - C10)	µg/g		5	7					
F1 (C6 to C10) minus BTEX	µg/g		5	7					
F2 (C10 to C16)	µg/g		10	<10					
F3 (C16 to C34)	µg/g		50	<50					
F4 (C34 to C50)	µg/g		50	<50					
Gravimetric Heavy Hydrocarbons	µg/g		50	NA					
Moisture Content	%		0.1	27.9					
Surrogate	Unit	Acceptable Limits							
Toluene-d8	% Recovery	60-140		124					
Terphenyl	%	60-140		97					

Certified By:

AGAT CERTIFICATE OF ANALYSIS (V1)

Results relate only to the items tested. Results apply to samples as received.



Certificate of Analysis

AGAT WORK ORDER: 21L840641

PROJECT: 12-1132-0076

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
SAMPLING SITE:
ATTENTION TO: Randy Axford
SAMPLED BY:

DATE RECEIVED: 2021-12-06				O. Reg. 153(511) - PHCs F1 - F4 (Soil)				DATE REPORTED: 2021-12-20			
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Comments: 3309931 RDL - Reported Detection Limit; G / S - Guideline / Standard

Results are based on sample dry weight.

The C6-C10 fraction is calculated using Toluene response factor.

Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.

C6-C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.

The calculated parameters are non-accredited. The parameters that are components of the calculation are accredited.

The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.

Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.

The chromatogram has returned to baseline by the retention time of nC50.

Total C6 - C50 results are corrected for BTEX contribution.

This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.

nC6 and nC10 response factors are within 30% of Toluene response factor.

nC10, nC16 and nC34 response factors are within 10% of their average.

C50 response factor is within 70% of nC10 + nC16 + nC34 average.

Linearity is within 15%.

Extraction and holding times were met for this sample.

Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.

Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

AGAT CERTIFICATE OF ANALYSIS (V1)

Results relate only to the items tested. Results apply to samples as received.

Certified By:

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.
PROJECT: 12-1132-0076
SAMPLING SITE:

AGAT WORK ORDER: 21L840641
ATTENTION TO: Randy Axford
SAMPLED BY:

Soil Analysis															
RPT Date: Dec 20, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Corrosivity Package														
Chloride (2:1)	3312865		209	211	1.0%	< 2	98%	70%	130%	105%	80%	120%	107%	70% 130%
Sulphate (2:1)	3312865		653	659	0.9%	< 2	100%	70%	130%	104%	80%	120%	NA	70% 130%
pH (2:1)	3309883	3309883	7.85	7.90	0.6%		101%	80%	120%					
Electrical Conductivity (2:1)	3315413		0.106	0.108	1.9%	< 0.005	106%	80%	120%					
Redox Potential 1							100%	90%	110%					

O. Reg. 153(511) - Metals & Inorganics (Soil)

Antimony	3337540		<0.8	<0.8	NA	< 0.8	133%	70%	130%	99%	80%	120%	85%	70% 130%
Arsenic	3337540		3	3	NA	< 1	126%	70%	130%	103%	80%	120%	106%	70% 130%
Barium	3337540		53.2	51.4	3.4%	< 2.0	106%	70%	130%	99%	80%	120%	106%	70% 130%
Beryllium	3337540		0.5	0.5	NA	< 0.4	104%	70%	130%	101%	80%	120%	90%	70% 130%
Boron	3337540		6	7	NA	< 5	92%	70%	130%	102%	80%	120%	92%	70% 130%

Boron (Hot Water Soluble)	3309932	3309932	<0.10	0.13	NA	< 0.10	93%	60%	140%	93%	70%	130%	99%	60% 140%
Cadmium	3337540		<0.5	<0.5	NA	< 0.5	111%	70%	130%	103%	80%	120%	105%	70% 130%
Chromium	3337540		19	19	NA	< 5	116%	70%	130%	104%	80%	120%	112%	70% 130%
Cobalt	3337540		6.7	6.5	3.0%	< 0.5	113%	70%	130%	101%	80%	120%	107%	70% 130%
Copper	3337540		9.8	9.7	1.0%	< 1.0	104%	70%	130%	103%	80%	120%	102%	70% 130%

Lead	3337540		10	10	0.0%	< 1	104%	70%	130%	96%	80%	120%	95%	70% 130%
Molybdenum	3337540		<0.5	<0.5	NA	< 0.5	122%	70%	130%	109%	80%	120%	116%	70% 130%
Nickel	3337540		13	13	0.0%	< 1	110%	70%	130%	101%	80%	120%	105%	70% 130%
Selenium	3337540		<0.8	<0.8	NA	< 0.8	110%	70%	130%	107%	80%	120%	109%	70% 130%
Silver	3337540		<0.5	<0.5	NA	< 0.5	100%	70%	130%	103%	80%	120%	102%	70% 130%

Thallium	3337540		<0.5	<0.5	NA	< 0.5	111%	70%	130%	106%	80%	120%	106%	70% 130%
Uranium	3337540		0.58	<0.50	NA	< 0.50	111%	70%	130%	101%	80%	120%	106%	70% 130%
Vanadium	3337540		31.2	30.4	2.6%	< 0.4	114%	70%	130%	94%	80%	120%	99%	70% 130%
Zinc	3337540		44	44	0.0%	< 5	110%	70%	130%	104%	80%	120%	105%	70% 130%
Chromium, Hexavalent	3314863		<0.2	<0.2	NA	< 0.2	102%	70%	130%	94%	80%	120%	79%	70% 130%

Cyanide, Free	3317042		<0.040	<0.040	NA	< 0.040	98%	70%	130%	94%	80%	120%	100%	70% 130%
Mercury	3337540		<0.10	<0.10	NA	< 0.10	104%	70%	130%	100%	80%	120%	102%	70% 130%
Electrical Conductivity (2:1)	3315413		0.106	0.108	1.9%	< 0.005	106%	80%	120%					
Sodium Adsorption Ratio (2:1) (Calc.)	3309932	3309932	36.3	36.7	1.1%	NA								
pH, 2:1 CaCl2 Extraction	3317058		7.56	7.98	5.4%	NA	100%	80%	120%					

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.
Duplicate NA: results are under 5X the RDL and will not be calculated.
Matrix spike: Spike level < native concentration. Matrix spike acceptance limits do not apply.
For a multi-element scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.
PROJECT: 12-1132-0076
SAMPLING SITE:

AGAT WORK ORDER: 21L840641
ATTENTION TO: Randy Axford
SAMPLED BY:

Soil Analysis (Continued)															
RPT Date: Dec 20, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Certified By:  

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 12-1132-0076

SAMPLING SITE:

AGAT WORK ORDER: 21L840641

ATTENTION TO: Randy Axford

SAMPLED BY:

Trace Organics Analysis															
RPT Date: Dec 20, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	3346586		<0.02	<0.02	NA	< 0.02	84%	60%	140%	85%	60%	140%	106%	60%	140%
Toluene	3346586		<0.05	<0.05	NA	< 0.05	94%	60%	140%	95%	60%	140%	83%	60%	140%
Ethylbenzene	3346586		<0.05	<0.05	NA	< 0.05	110%	60%	140%	104%	60%	140%	80%	60%	140%
m & p-Xylene	3346586		<0.05	<0.05	NA	< 0.05	104%	60%	140%	94%	60%	140%	103%	60%	140%
o-Xylene	3346586		<0.05	<0.05	NA	< 0.05	88%	60%	140%	82%	60%	140%	83%	60%	140%
F1 (C6 - C10)	3346586		<5	<5	NA	< 5	99%	60%	140%	98%	60%	140%	107%	60%	140%
F2 (C10 to C16)	3317057		< 10	< 10	NA	< 10	110%	60%	140%	85%	60%	140%	75%	60%	140%
F3 (C16 to C34)	3317057		< 50	< 50	NA	< 50	108%	60%	140%	75%	60%	140%	85%	60%	140%
F4 (C34 to C50)	3317057		< 50	< 50	NA	< 50	104%	60%	140%	79%	60%	140%	95%	60%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By:



QC Exceedance

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 12-1132-0076

AGAT WORK ORDER: 21L840641

ATTENTION TO: Randy Axford

RPT Date: Dec 20, 2021				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits			
			Lower	Upper		Lower	Upper		Lower	Upper		
O. Reg. 153(511) - Metals & Inorganics (Soil)												
Antimony		133%	70%	130%	99%	80%	120%	85%	70%	130%		
Comments: NA signifies Not Applicable. pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document. Duplicate NA: results are under 5X the RDL and will not be calculated. Matrix spike: Spike level < native concentration. Matrix spike acceptance limits do not apply. For a multi-element scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.												

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 12-1132-0076

SAMPLING SITE:

AGAT WORK ORDER: 21L840641

ATTENTION TO: Randy Axford

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Antimony	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Arsenic	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Barium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Beryllium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	modified from EPA 6010D and MSA PART 3, CH 21	ICP/OES
Cadmium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Cobalt	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Copper	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Lead	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Molybdenum	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Nickel	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Selenium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Silver	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Thallium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Uranium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Vanadium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Zinc	MET 93 -6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium, Hexavalent	INOR-93-6068	modified from EPA 3060 and EPA 7196	SPECTROPHOTOMETER
Cyanide, Free	INOR-93-6052	modified from ON MOECC E3015, SM 4500-CN- I, G-387	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	modified from EPA 7471B and SM 3112 B	ICP-MS

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 12-1132-0076

SAMPLING SITE:

AGAT WORK ORDER: 21L840641

ATTENTION TO: Randy Axford

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Sodium Adsorption Ratio (2:1) (Calc.)	INOR-93-6007	modified from EPA 6010D & Analytical Protocol	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Trace Organics Analysis			
Moisture Content	ORG-91-5009	CCME Tier 1 Method	BALANCE
Benzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Toluene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Ethylbenzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
m & p-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
o-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Xylenes (Total)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
F1 (C6 - C10)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	modified from CCME Tier 1 Method	P&T GC/FID
Toluene-d8	VOL-91-5009	modified from EPA SW-846 5030C & 8260D	(P&T)GC/MS
F2 (C10 to C16)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID