



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 527 POSHKOKAGAN RIVER CULVERT
94.1 KM NORTH OF HIGHWAY 11/17, THUNDER BAY UNORGANIZED
SITE NO.: 48C-223/C
ASSIGNMENT NO. 6017-E-0013**

G.W.P. 6827-14-00

Geocres No.: 52H-44

Report to:

Hatch Corporation

Latitude: 49.192526°
Longitude: -89.413382°

December 2018
Thurber File: 19773

TABLE OF CONTENTS

PART 1. FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	1
3	SITE INVESTIGATION AND FIELD TESTING.....	2
4	LABORATORY TESTING.....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS	3
5.1	Embankment Fill.....	3
5.1.1	Asphalt.....	3
5.1.2	Fill: Sand with Gravel to Sand with Silt.....	3
5.1.3	Wood Fill.....	4
5.2	Organic Silt.....	4
5.3	Gravel	4
5.4	Silt and Sand	5
5.5	Silty Clay	5
5.6	Sand to Silty Sand (Glacial Till).....	6
5.7	Groundwater.....	6
5.8	Analytical Testing	7
6	MISCELLANEOUS	8

APPENDICES

Appendix A.	Drawings
Appendix B.	Record of Borehole Sheets
Appendix C.	Laboratory Testing
Appendix D.	Site Photographs

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation completed for Poshkokagan River Culvert (formerly known as Rinker Lake Culvert) on Highway 527. The culvert is located approximately 94.1 km north of Highway 11/17 within the Unorganized Thunder Bay District and conveys the Poshkokagan River between Rinker Lake and Core Lake. Thurber Engineering Limited (Thurber) carried out the current investigation as a sub-consultant to Hatch Corporation (Hatch) under Assignment No. 6017-E-0013.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction was developed in the course of the current investigation. No previous foundation investigation information was available for the subject culvert site within the online Geocres Library.

2 SITE DESCRIPTION

The existing twin culverts, conveying Poshkokagan River under Highway 527 from Rinker Lake to Core Lake, are twin Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culverts with an unknown construction date. A site survey plan from Hatch indicates that each culvert is approximately 4.4 m wide, 2.8 m high and approximately 23.7 m long. The culvert alignment is generally west to east with the flow through the culvert toward the east.

At the location of the culvert, Highway 527 is a two-lane highway with a rural cross-section and narrow paved shoulders. Steel cable guide rails are present along both sides of the highway in the area of the culvert. The embankment fill height above the culvert is approximately 2.0 m. The elevation of the road surface at the centreline is approximately 428.6 m. The existing embankment slopes are approximately inclined between 1.6H:1V and 2.8H:1V. The land adjacent to the highway is undeveloped and densely vegetated with trees. Traffic volumes on this section of Highway 527 are understood to less than 500 AADT (2016).

Photographs showing the existing conditions in the area of the culvert are included in Appendix D for reference.

3 SITE INVESTIGATION AND FIELD TESTING

Thurber contacted Ontario One Call in advance of the field investigation to obtain utility locate clearances in the vicinity of the intended boreholes.

The site investigation and field testing program was carried out between June 5th and August 11th, 2018. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1. The site is within MTM Zone 15.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth (m)
18-301	North of culvert – NB Lane	5 450 661.2	347 548.2	429.0	15.8
18-302A	Bypass culvert – SB Lane	5 450 626.7	347 550.1	427.9	4.8
18-302B	Bypass culvert – SB Lane	5 450 629.7	347 549.4	427.9	15.8
18-303	East end – culvert outlet	5 450 646.3	347 563.3	424.6	4.0
18-304	West end – culvert inlet	5 450 662.8	347 531.4	426.4	4.2

The drilling was carried out using a truck mounted CME 75 drill rig for on-road Boreholes 18-301, 18-302A and 18-302B and portable drilling equipment for off-road Boreholes 18-303 and 18-304.

Wood lumber was encountered in Borehole 18-302A which caused the casing to jam at a depth of 4.8 m, prohibiting advancing past elevation 423.1 m. The borehole was terminated and Borehole 18-302B was subsequently advanced 3.0 m north of Borehole 18-302A and sampled below a depth of 3.8 m.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Boreholes 18-303 and 18-304, which were drilled with portable equipment, also utilized a full-weight hammer for SPT testing.

A 19 mm diameter standpipe piezometer was installed in Borehole 18-304 to allow for measurements of the groundwater level after completion of drilling. The piezometer installation details are illustrated on the respective Record of Borehole sheet provided in Appendix B. All other boreholes were backfilled with a low-permeability mixture of cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903 as amended. Boreholes advanced within paved areas were capped with granular fill followed by 150 mm of cold patch asphalt to reinstate the travelling surface.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's geotechnical staff. The drilling supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. Testing for grain size distribution and Atterberg Limits was also carried out on selected samples to MTO and ASTM standards. Chemical analysis for determination of pH, conductivity, resistivity, sulphate and chloride concentrations was carried out on two soil samples and one water sample. Chemical analysis for determination of sulphide concentration was carried out on one soil sample.

A strong creosote odour was noted in all soil samples from Borehole 18-302A and 18-302B that encountered wood fill. Lab testing on these samples was limited to moisture content testing due to possible contamination. Additional gradation testing was performed in Borehole 18-301 to compensate for the lack of gradation testing performed in Boreholes 18-302A and 18-302B.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Locations and Soil Strata drawings included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

In general terms, subsurface conditions at the site consist of pavement structure and granular embankment fill overlying a thin layer of native organic silt, overlying native deposits of silty sand to sandy silt, which is underlain by glacial till.

5.1 Embankment Fill

5.1.1 Asphalt

Boreholes 18-301, 18-302A and 18-302B were drilled through the travelled lanes of Highway 527 and encountered a layer of asphalt with a thickness ranging from 25 mm to 125 mm.

5.1.2 Fill: Sand with Gravel to Sand with Silt

A layer of granular base (sand with gravel) was encountered below the asphalt in Boreholes 18-301, 18-302A and 18-302B. The underside depth of the granular base was 0.8 m below the existing ground surface (elev. 427.1 to 428.2 m). A layer of granular embankment fill

was encountered below the granular base in the on-road boreholes and from the ground surface in the off-road boreholes. The granular fill ranged in composition from sand with silt and gravel, to sand with silt trace to some gravel, to silty sand, to sand with gravel, to silty sand some gravel, to silty sand with gravel. The underside of the granular fill ranged from 1.8 to 4.7 m below the existing ground surface (elev. 422.7 to 424.3 m).

The SPT tests conducted in the fill gave N-values ranging from 6 blows for 300 mm of penetration to 100 blows for 150 mm of penetration indicating a relative density of loose to very dense. Recorded moisture contents ranged from 5 to 32%.

Gradation analyses were completed on six samples of the granular fill. The grain size distribution curves for these samples are included in Figure C1 of Appendix C. The results of the tests are summarized in Table 5-1 below and are presented on the corresponding Record of Borehole sheets in Appendix B.

Table 5-1: Gradation Results for Granular Fill

Soil Particle	Percentage (%)
Gravel	5 to 24
Sand	61 to 88
Silt and Clay	6 to 18

5.1.3 Wood Fill

Wood fill was encountered below the granular fill in Boreholes 18-302A and 18-302B. Borehole 18-302A was terminated due to the casing jamming at a depth of 4.8 m after penetrating 0.6 m into the wood fill (elev. 423.1 m). Borehole 18-302B was advanced approximately 3.0 m north of Borehole 18-302A to reach the target drilling depth and also encountered a 0.7 m thick layer of wood fill directly below the granular fill with an underside depth of 5.0 m (elev. 422.9 m). A strong creosote odour was encountered during drilling and was noted to originate from the wood samples.

5.2 Organic Silt

A thin layer of organic silt was encountered below the fill in Borehole 18-301. The layer had a thickness of 0.2 m with an underside depth of 4.9 m below the existing ground surface (elev. 424.1 m). The moisture content of the organic silt was measured to be 44%. The organic content of this layer was measured to be 13.0%.

5.3 Gravel

A layer consisting of gravel with sand, occasional cobbles and boulders was encountered below the fill in Borehole 18-304. Borehole 18-304 was terminated upon encountering spoon refusal within this layer at a depth of 4.2 m below ground surface (elev. 422.2 m). Poor sample recovery was noted in this layer.

An SPT test conducted in this layer gave an N-value of 100 blows for 225 mm of penetration indicating a relative density of very dense; however, this could represent the presence of cobbles or a boulder rather than the state of packing of the soil matrix. A single moisture content of 8% was measured in this layer.

5.4 Silt and Sand

Interbedded silt and sand layers were encountered below the organic silt in Borehole 18-301 and below the embankment fill in Boreholes 18-302B and 18-303. The composition of these deposits ranged from silty sand some gravel, to sandy silt, to silt. A thin layer of silty clay was interbedded within the silt and sand deposits (see Section 5.5). Borehole 18-303 was terminated upon encountering spoon refusal within the silt and sand layer. Borehole 18-302B was terminated in this stratum at a depth of 15.8 m below existing ground surface (elev. 412.1 m). Where fully penetrated in Borehole 18-301, the underside depth extended to 12.0 m below ground surface (elev. 417.0 m).

SPT tests conducted in the silt and sand gave N-values ranging from 13 blows for 300 mm of penetration to 100 blows for 280 mm of penetration, indicating a relative density of compact to very dense; but typically compact to dense. Recorded moisture contents ranged from 8 to 27%.

Gradation analysis completed on one sample of the silty sand found the sample to be composed of 0% gravel, 52% sand, 44% silt and 4% clay. The grain size distribution curve for this sample is included in Figure C2 of Appendix C. Gradation analyses were completed on two samples of the silt to sandy silt. The grain size distribution curves are included in Figure C3 of Appendix C. The results of the tests are summarized in Table 5-2 below. The results of the gradation tests are also presented on the corresponding Record of Borehole sheets in Appendix B.

Table 5-2: Gradation Results for Silt to Sandy Silt

Soil Particle	Percentage (%)
Gravel	0 to 1
Sand	10 to 22
Silt	74 to 77
Clay	3 to 13

Atterberg Limit testing completed on three samples of the silt and sand found the material to be non-plastic.

5.5 Silty Clay

A thin deposit of silty clay with sand was encountered within the silt and sand in Boreholes 18-301, 18-302B and 18-303. The thickness of this layer ranged from 0.2 to 0.6 m with underside depths ranging from 3.7 to 6.7 m below ground surface (elev. 420.9 to 422.9 m).

SPT tests conducted in this deposit gave N-values of 30 and 37 blows indicating a very stiff consistency. The recorded moisture contents ranged from 23 to 42%.

Gradation analysis completed on one sample of the silty clay found the sample to be composed of 0% gravel, 19% sand, 68% silt and 13% clay. The grain size distribution curve is included in Figure C4 of Appendix C. The results of the test are also presented on the corresponding Record of Borehole sheet in Appendix B.

Atterberg Limit testing was completed on one sample of the native silty clay deposit. The tested sample was found to have a liquid limit of 22%, a plastic limit of 18% and a plasticity index of 4% indicating a low plasticity (CL-ML). The results of the Atterberg Limit testing are summarized on the Record of Borehole sheet in Appendix B and the plasticity chart included in Figure C6 of Appendix C.

5.6 Sand to Silty Sand (Glacial Till)

A deposit of glacial till was encountered below the silt to sandy silt layer in Borehole 18-301. The glacial till varies in composition from sand with silt and gravel to silty sand with gravel. Cobbles and boulders were noted to be present within the till layer.

Borehole 18-301 was terminated at 15.8 m below ground surface within the glacial till at a base elevation of 413.2 m upon reaching the target depth.

SPT tests conducted in the till deposit gave N-values ranging from 72 blows for 300 mm of penetration to 100 blows for 75 mm of penetration indicating a relative density of very dense. The recorded moisture contents ranged from 8 to 9%.

Gradation analyses were completed on two samples of the till. The grain size distribution curves are included in Figure C5 of Appendix C. The results of the tests are summarized in Table 5-3 below and are presented on the corresponding Record of Borehole sheets in Appendix B.

Table 5-3: Gradation Results for Glacial Till

Soil Particle	Percentage (%)
Gravel	18 to 22
Sand	47 to 74
Silt & Clay	8 to 31

5.7 Groundwater

The piezometer installed in Borehole 18-304 was blocked at a depth of 2.0 m below ground surface (elev. 424.4 m) on August 10, 2018. The piezometer was dry to this depth. The piezometer was subsequently decommissioned in accordance with MOE Regulation 903, as amended.

The water level on completion of drilling in Borehole 18-303 was measured at 0.3 m below ground surface (elev. 424.3 m) on August 11th, 2018.

The creek water level was surveyed at the culvert inlet and outlet and the measured elevations are provided in Table 5-4 below:

Table 5-4: Creek Water Level Observations

Location	Surface Water Elevation (m)	Date of Measurement
Culvert Inlet	424.4	June 16, 2018
Culvert Outlet	424.1	June 16, 2018

The groundwater level at this site is expected to closely reflect the creek water level. These observations are considered short term and it should be noted that fluctuations of the creek level and the groundwater level are to be expected. In particular, the water levels may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.8 Analytical Testing

Two samples of soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, resistivity and conductivity. One of the submitted samples was also tested for sulphide content. The analysis results are provided in Appendix C and are summarized in Table 5-5 below:

Table 5-5: Analytical Results Summary (Soil)

Borehole	18-301	18-304
Sample	SS8A	SS5
Depth (m)	5.3 – 5.9	2.4 – 3.0
Chloride (µg/g)	19	26
Sulphate (µg/g)	6	52
Sulphide (%)	< 0.02	-
pH (-)	7.4	7.3
Resistivity (Ohm-cm)	19800	5510
Conductivity (µS/cm)	50	181

A surface water sample obtained on November 30, 2018 upstream of the existing culvert was also submitted to Paracel Laboratories in Ottawa, Ontario for analysis of conductivity, pH, resistivity, chloride and sulphate. The analysis results are provided in Appendix C (identified as the Rinker sample) and are summarized in Table 5-6 below.

Table 5-6: Analytical Results Summary (Surface Water)

Parameter	Result
Chloride (mg/L)	1
Sulphate (mg/L)	1
pH (-)	7.3
Resistivity (Ohm-cm)	19,300
Conductivity (µS/cm)	52

6 MISCELLANEOUS

Borehole locations were selected in consultation with Hatch and the Ministry of Transportation relative to the existing culvert and the existing site features. The as-drilled locations and ground surface elevations were surveyed by Thurber.

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment for the on-road boreholes; OGS Drilling of Almonte, Ontario and CCC Drilling of Ottawa, Ontario supplied and operated the drilling equipment for the off-road boreholes. These subcontractors carried out the drilling, soil sampling, in-situ testing, piezometer installation and borehole decommissioning. Traffic control was provided by NC Traffic Management Inc of Kirkland Lake, Ontario. The field investigation was supervised on a full-time basis by Mr. Nick Weil and Mr. Sean O'Bryan, C.E.T., of Thurber. Overall supervision of the investigation program was conducted by Mr. Stephen Dunlop, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario.

Interpretation of the factual data and preparation of this report were carried out by Mr. Christopher Murray, P.Eng. and Mr. Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer



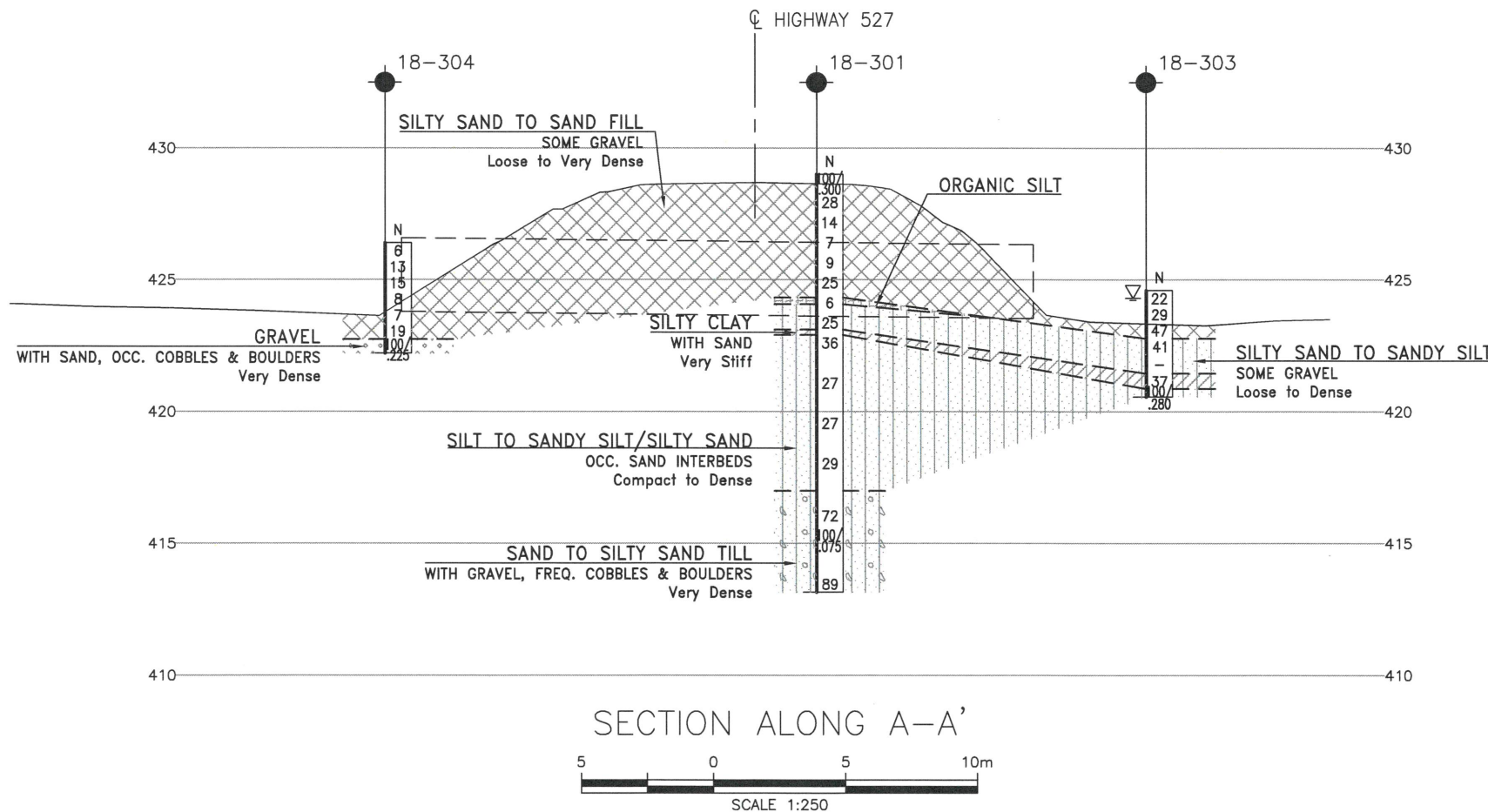
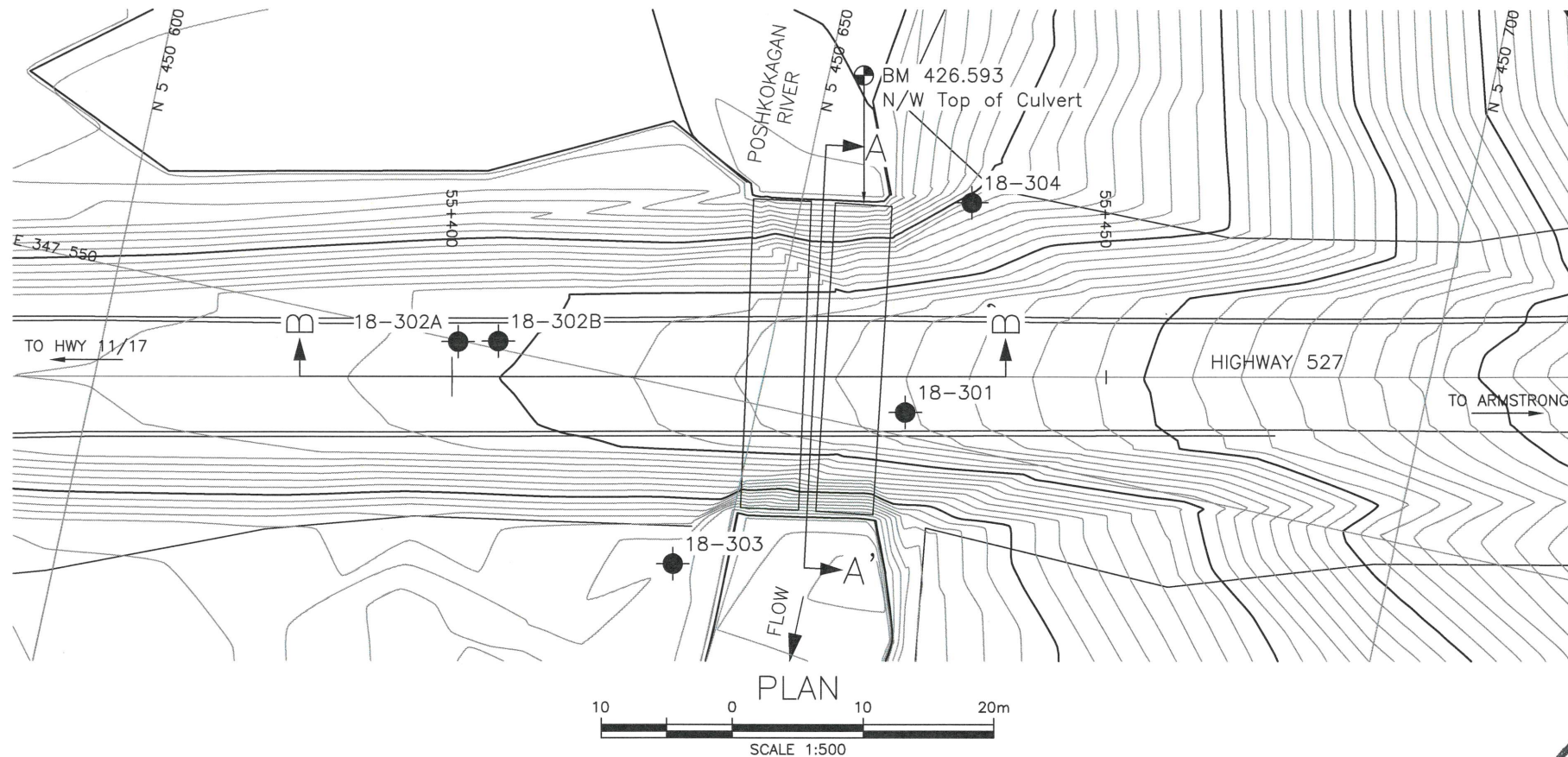
Stephen Dunlop, M.A.Sc., P.Eng.
Senior Geotechnical Engineer



Dr. Fred Griffiths, P.Eng.
Senior Associate
Senior Geotechnical Engineer

Appendix A.

Drawings

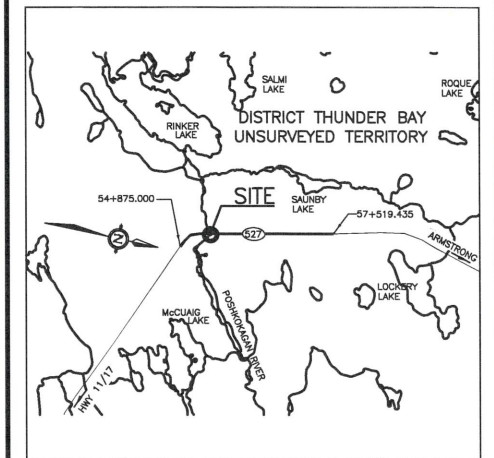


METRIC
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 6827-14-00

HIGHWAY 527
POSHKOKAGAN RIVER CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH



KEYPLAN
LEGEND

●	Borehole
⊕	Borehole & Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
⌵	Head Artesian Water
⌵	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-301	429.0	5 450 661.2	347 548.2
18-302A	427.9	5 450 626.7	347 550.1
18-302B	427.9	5 450 629.7	347 549.4
18-303	424.6	5 450 646.3	347 563.3
18-304	426.4	5 450 662.8	347 531.4

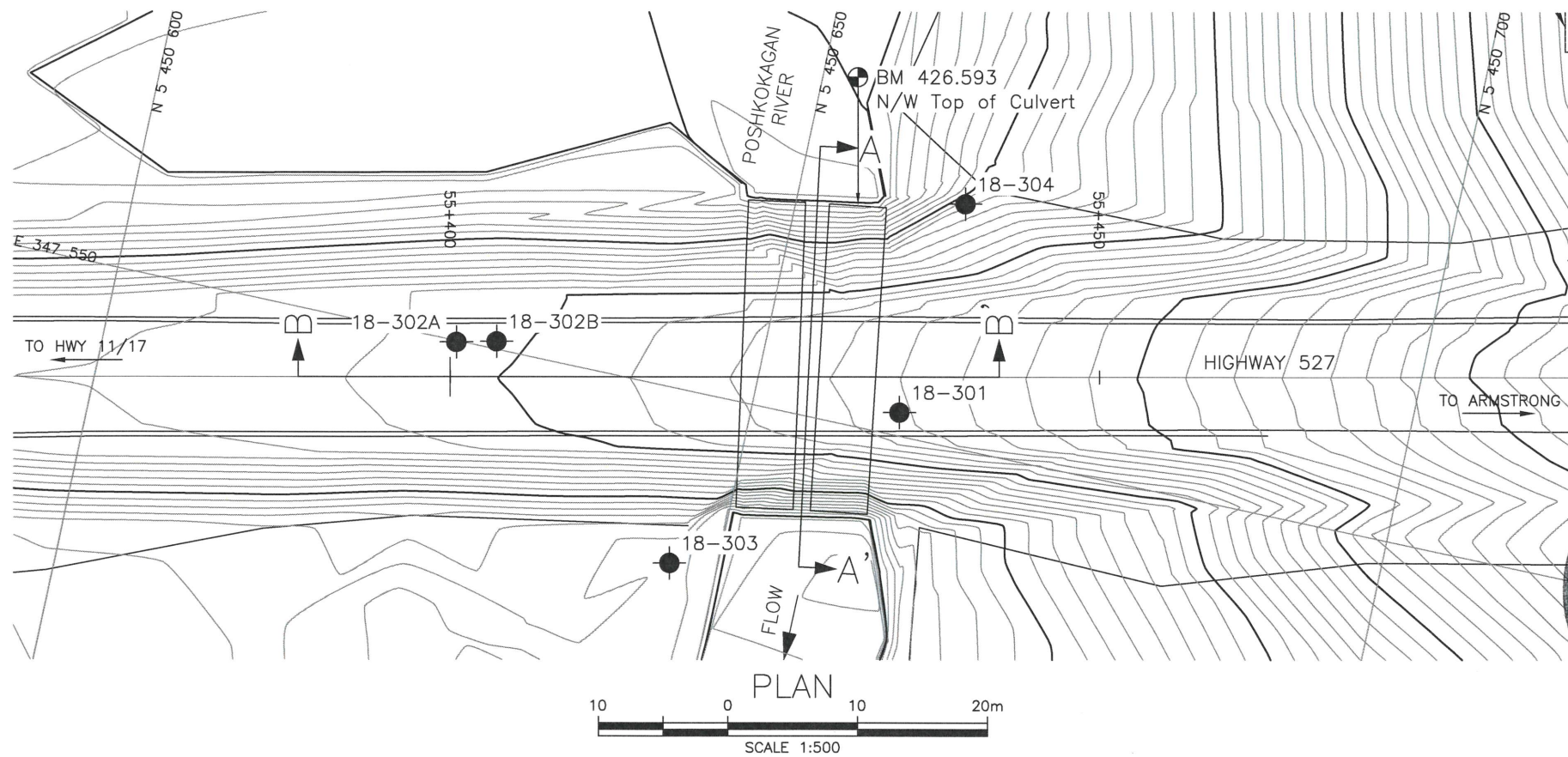
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 15.

GEOCRES No. 52H-44



REVISIONS	DATE	BY	DESCRIPTION
DESIGN DP	CHK SP	CODE	LOAD
DRAWN AN	CHK CM	SITE	STRUCT
			DWG 1



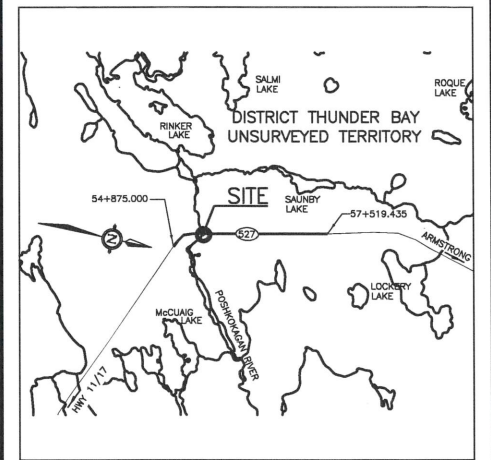
METRIC
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CONT No
GWP No 6827-14-00

HIGHWAY 527
POSHKOKAGAN RIVER CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH



KEYPLAN
LEGEND

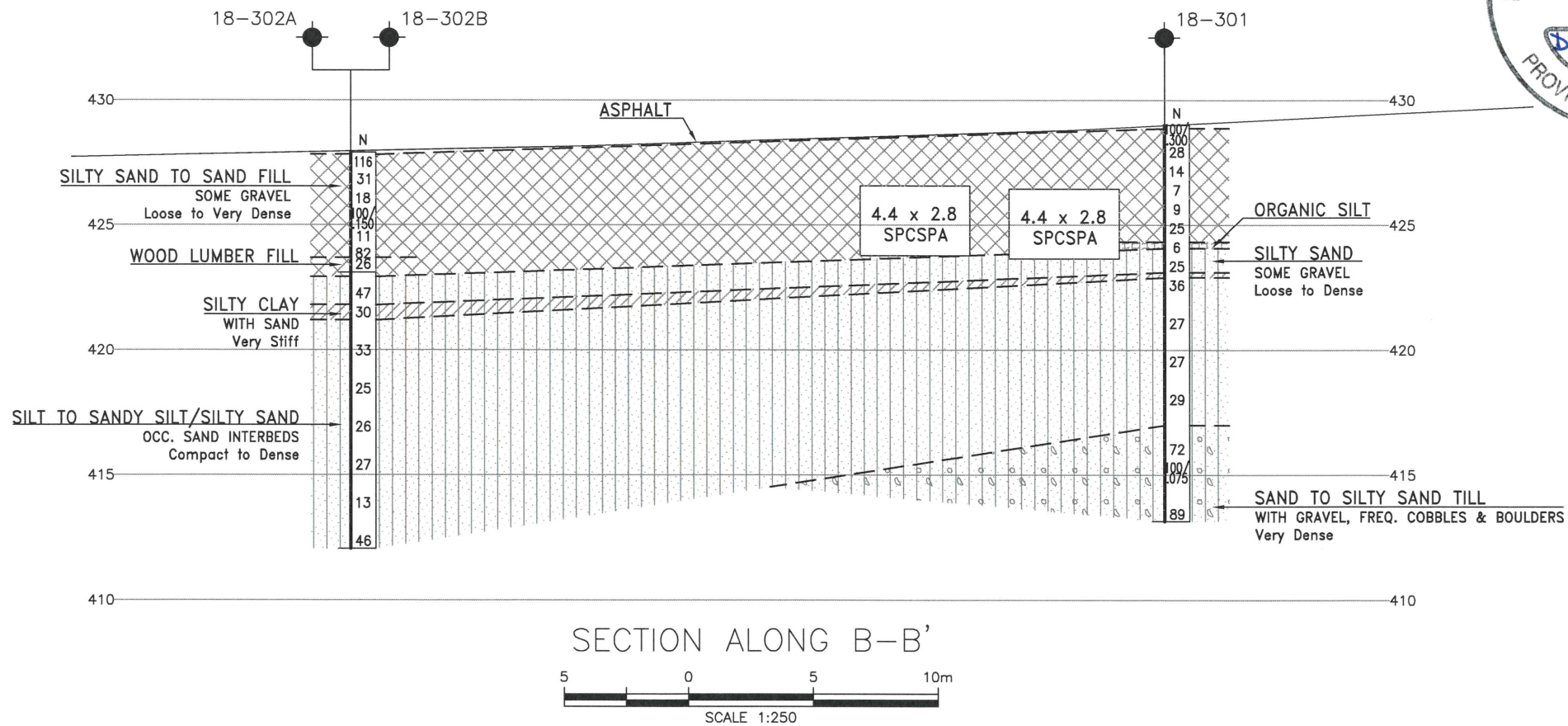
●	Borehole
⊕	Borehole & Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
⊕	Water Level
⊕	Head Artesian Water
⊕	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-301	429.0	5 450 661.2	347 548.2
18-302A	427.9	5 450 626.7	347 550.1
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GEOCRES No. 52H-44



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DP	CHK SP	CODE
DRAWN	AN	CHK CM	SITE
			LOAD
			STRUCT
			DWG 2
			DATE DEC 2018

Appendix B.

Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

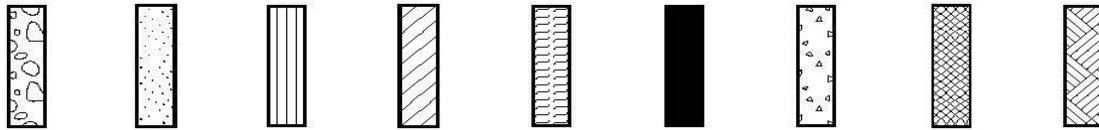
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

METRIC

Lat: 49.1925435°, Long: -89.4134593°
Poshkokagan River Culvert. MTM z15: N 5 450 661.2 E 347 548.2

DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 18-301

2 OF 2

METRIC

GWP# 6827-14-00 LOCATION Lat: 49.1925435°, Long: -89.4134593°
Poshkokagan River Culvert, MTM z15: N 5 450 661.2 E 347 548.2 ORIGINATED BY NW
HWY 527 BOREHOLE TYPE NW Casing COMPILED BY SOB
DATUM Geodetic DATE 2018.06.05 - 2018.06.05 CHECKED BY SD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L		
	Continued From Previous Page							20	40	60	80	100					
	SILT to Sandy SILT (ML) , occasional Sand interbeds Compact Grey		12	SS	29		418							○			
417.0																	
12.0	SAND (SW) with Silt and Gravel, occasional Cobbles, TILL Very Dense Grey - 180 mm Cobble at 12.2 m		13	SS	72		417										
415.7														○			
13.3	SILTY SAND (SM) with Gravel, frequent Cobbles and Boulders, TILL Very Dense Grey		14	SS	100/ 75mm		416										
														○			
							415										
							414										
413.2			15	SS	89									○			
15.8	End of Borehole A representative groundwater level could not be taken due to introduction of water during drilling operations																
															</		

DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

RECORD OF BOREHOLE No 18-302A

1 OF 1

METRIC

GWP# 6827-14-00 LOCATION Lat: 49.1922333°, Long: -89.4134368°
Poshkokagan River Culvert, MTM z15: N 5 450 626.7 E 347 550.1 ORIGINATED BY NW
HWY 527 BOREHOLE TYPE NW Casing COMPILED BY SOB
DATUM Geodetic DATE 2018.06.06 - 2018.06.06 CHECKED BY SD

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			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W P	W	W L		
427.9																	
0.0 0.1	25 mm ASPHALT																
	SAND with Gravel, FILL Very Dense Brown		1	SS	116							o					
427.1																	
0.8	SAND with Silt and Gravel, FILL Compact to Very Dense Brown		2	SS	31							o					
			3	SS	18							o					
			4	SS	100/ 150mm							o					
			5	SS	11							o					
423.7			6	SS	82							o					
4.2	WOOD Lumber, strong creosote odour, FILL																
423.1																	
4.8	Casing jammed at 4.8 m depth and could not be advanced, Borehole Terminated at 4.8 m Continued in BH 18-302B																

DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity


DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

RECORD OF BOREHOLE No 18-302B

2 OF 2

METRIC

GWP# 6827-14-00 LOCATION Lat: 49.1922603°, Long: -89.4134453°
Poshkokagan River Culvert, MTM z15: N 5 450 629.7 E 347 549.4 ORIGINATED BY NW
HWY 527 BOREHOLE TYPE NW Casing COMPILED BY SOB
DATUM Geodetic DATE 2018.06.06 - 2018.06.07 CHECKED BY SD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
								20 40 60 80 100							
	Continued From Previous Page														
412.1 15.8	SILT to Sandy SILT (ML), occasional Sand interbeds Compact to Dense Grey		11	SS	26		417								
							416								
			12	SS	27		415								
							414								
			13	SS	13		413								
			14	SS	46										
	End of Borehole A representative groundwater level could not be taken due to introduction of water during drilling operations														






DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

RECORD OF BOREHOLE No 18-303

1 OF 1

METRIC

GWP# 6827-14-00 LOCATION Lat: 49.1924079°, Long: -89.4132528°
Poshkokagan River Culvert, MTM z15: N 5 450 646.3 E 347 563.3 ORIGINATED BY SOB
HWY 527 BOREHOLE TYPE Portable COMPILED BY AC
DATUM Geodetic DATE 2018.08.10 - 2018.08.11 CHECKED BY SD

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
424.6								20	40	60	80	100		W _P	W	W _L		
0.0	SAND with Silt, trace Gravel, FILL Compact to Dense Brown		1	SS	22													
			2	SS	29		424											
			3	SS	47		423											5 87 8 (SI+CL)
422.8																		
1.8	SILT to Sandy SILT (ML) Dense Brown		4	SS	41		422											
421.5																		
3.1	SILTY CLAY (CL-ML) with Sand Very Stiff Grey		5	SS	37		421											0 19 68 13
420.9																		
3.7	SILTY SAND (SM) Very Dense Brown		6	SS	100/													0 52 44 4 non-plastic
420.6																		
4.0	End of Borehole Water at 0.3 m B.G.S. (Elev. 424.3 m) on completion of drilling					280 mm												

DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-304

1 OF 1

METRIC

GWP# 6827-14-00 LOCATION Lat: 49.1925587°, Long: -89.4136894°
 HWY 527 BOREHOLE TYPE Portable Poshkokagan River Culvert, MTM z15: N 5 450 662.8 E 347 531.4
 DATUM Geodetic DATE 2018.06.16 - 2018.06.16

ORIGINATED BY SOB
 COMPILED BY SOB
 CHECKED BY SD

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
426.4								20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
0.0	SILTY SAND some Gravel, FILL Loose to Compact Brown		1	SS	6			426								○																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

DOUBLE LINE 19773 POSHKOKAGAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 13/12/18

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

Appendix C.

Laboratory Testing

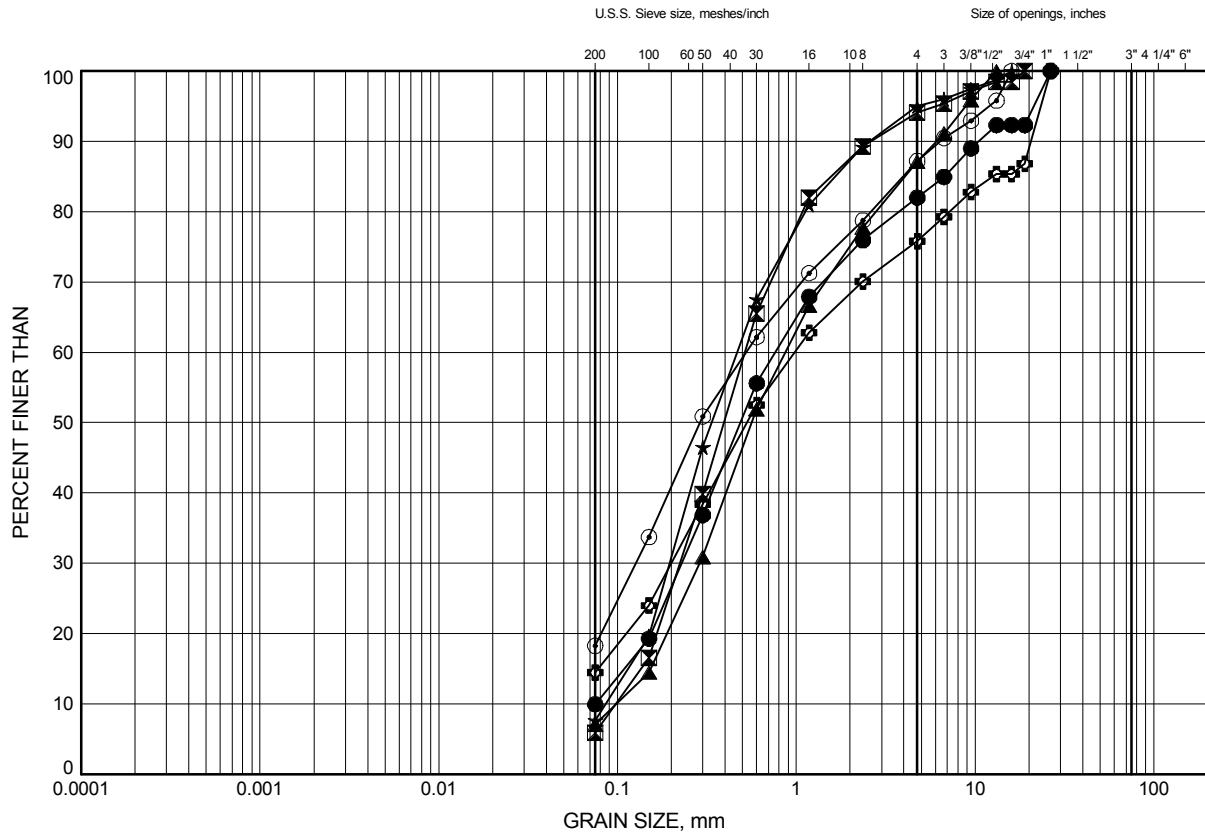
Appendix C.1

Particle Size Analysis Figures

Poshkokagan River Culvert GRAIN SIZE DISTRIBUTION

FIGURE C1

Granular Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-301	1.07	427.93
⊠	18-301	2.59	426.41
▲	18-301	3.35	425.65
★	18-303	1.52	423.08
⊙	18-304	0.91	425.49
⊕	18-304	2.13	424.27

Date December 2018

GWP# 6827-14-00



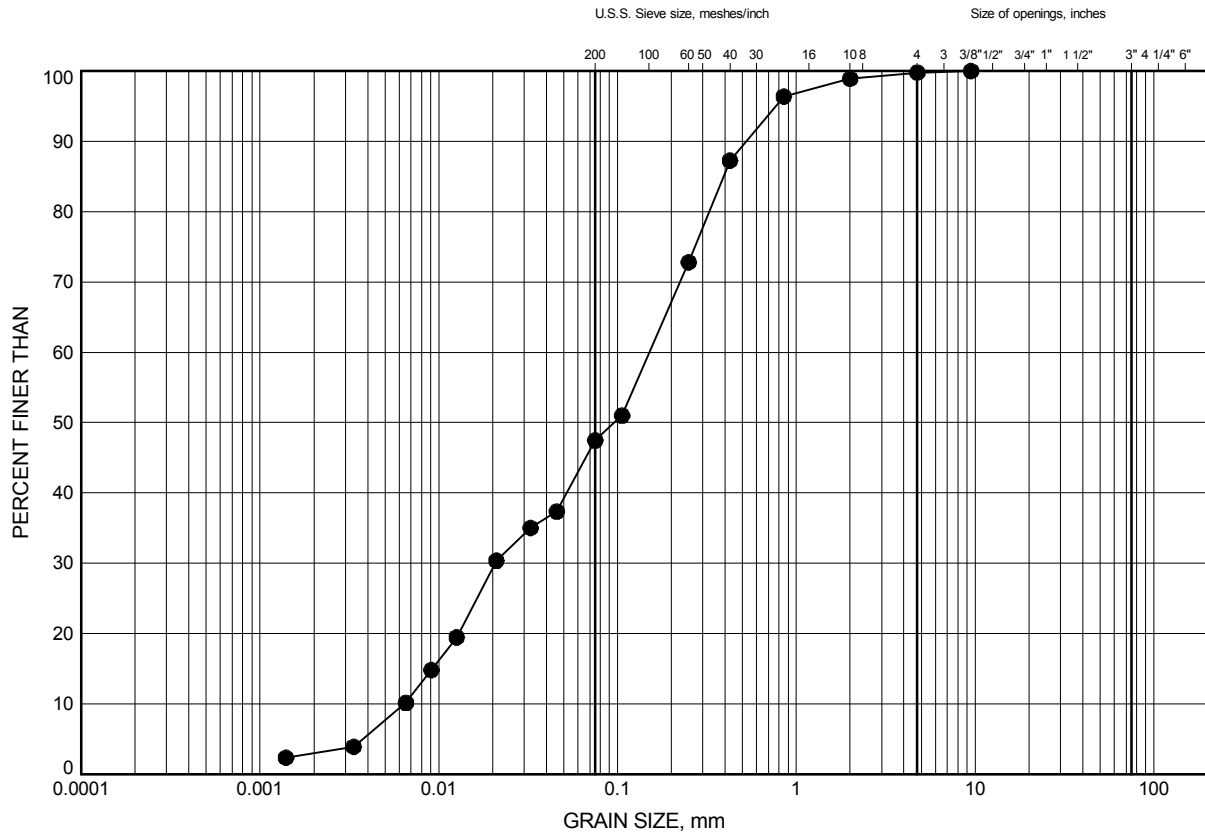
Prep'd CM

Chkd. SD

Poshkokagan River Culvert GRAIN SIZE DISTRIBUTION

FIGURE C2

Silty Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-303	3.90	420.70

Date December 2018
GWP# 6827-14-00

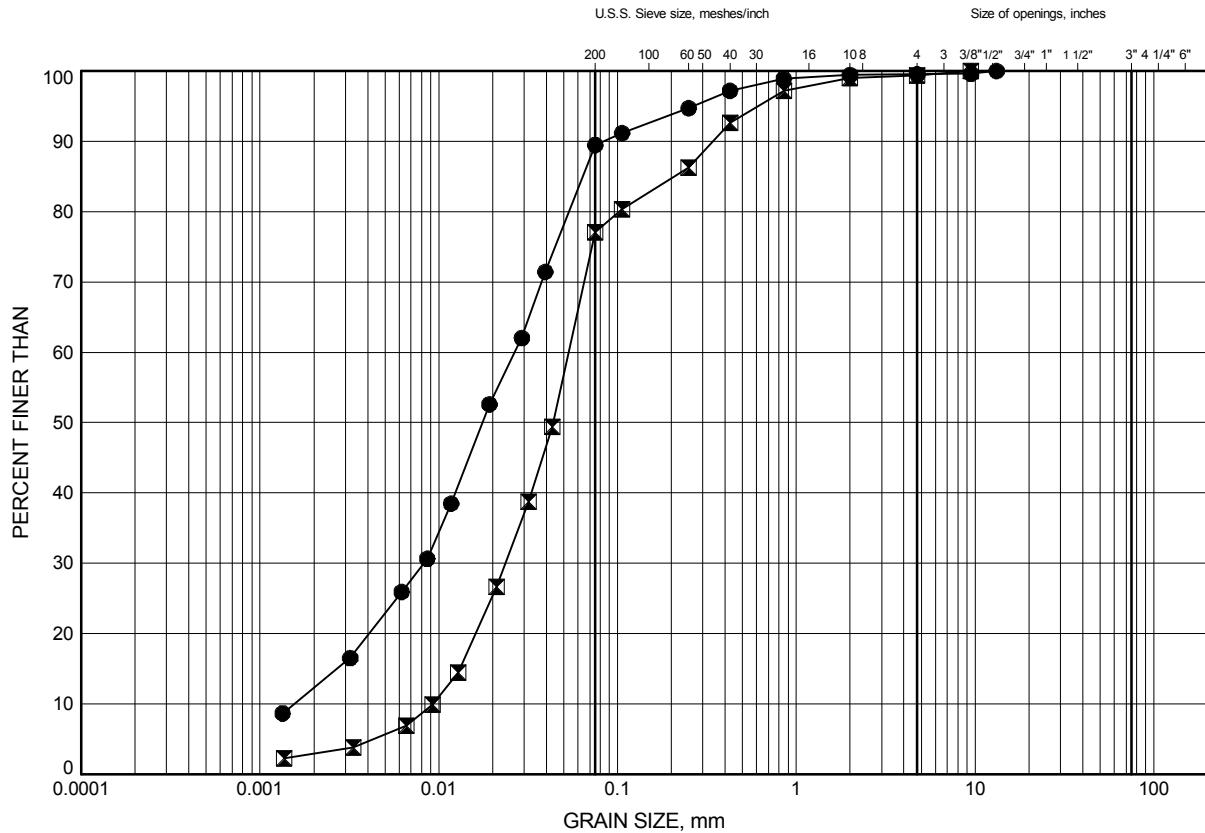


Prep'd CM
Chkd. SD

Poshkokagan River Culvert GRAIN SIZE DISTRIBUTION

FIGURE C3

Silt to Sandy Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-301	8.08	420.92
⊠	18-301	9.45	419.55

Date December 2018

GWP# 6827-14-00



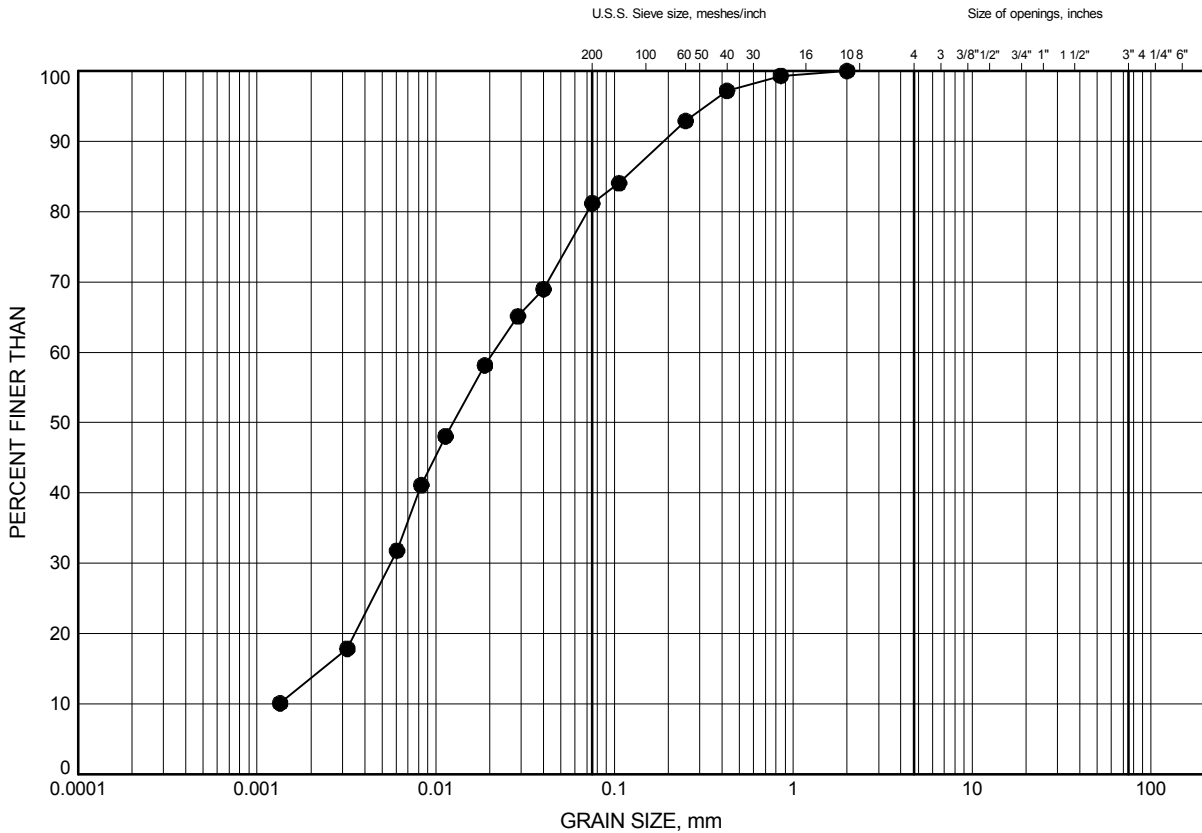
Prep'd CM

Chkd. SD

Poshkokagan River Culvert GRAIN SIZE DISTRIBUTION

FIGURE C4

Silty Clay with Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-303	3.45	421.15

Date December 2018
GWP# 6827-14-00

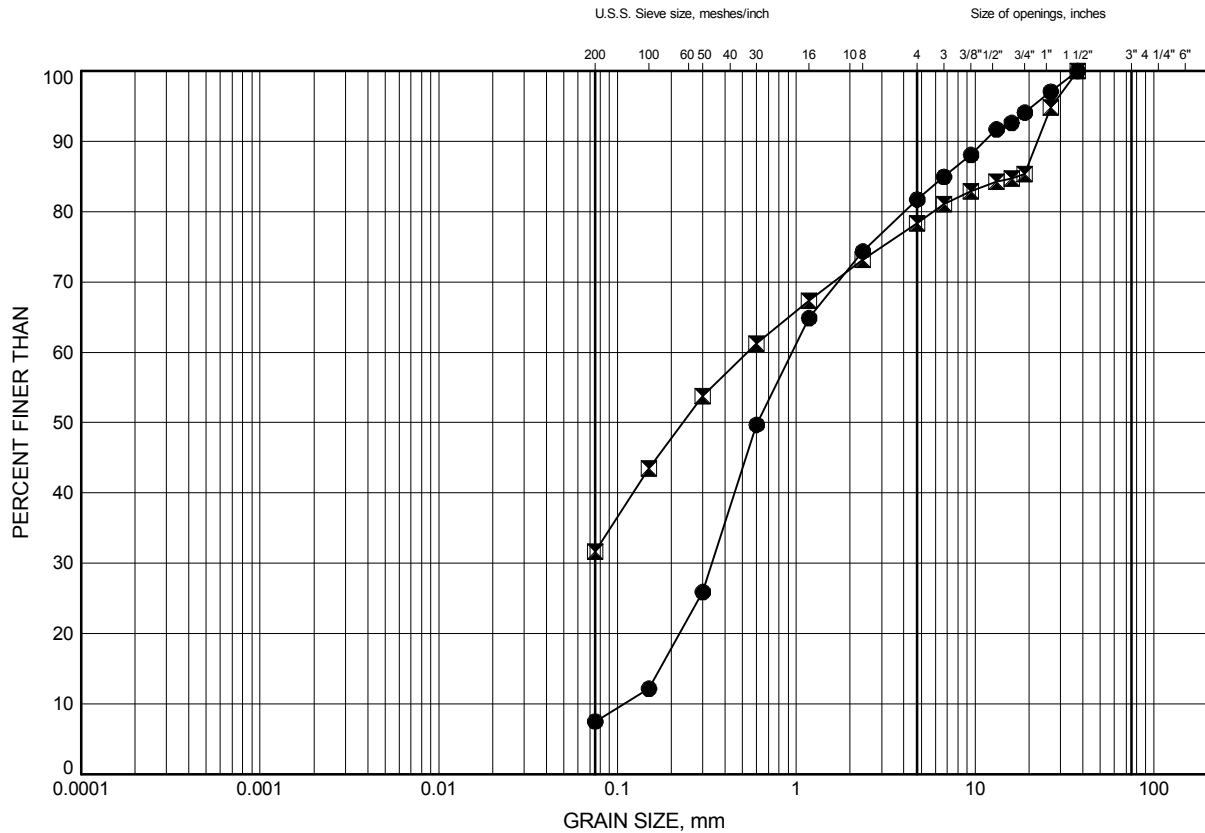


Prep'd CM
Chkd. SD

Poshkokagan River Culvert GRAIN SIZE DISTRIBUTION

FIGURE C5

Glacial Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-301	12.93	416.07
⊠	18-301	15.54	413.46

Date December 2018

GWP# 6827-14-00



Prep'd CM

Chkd. SD

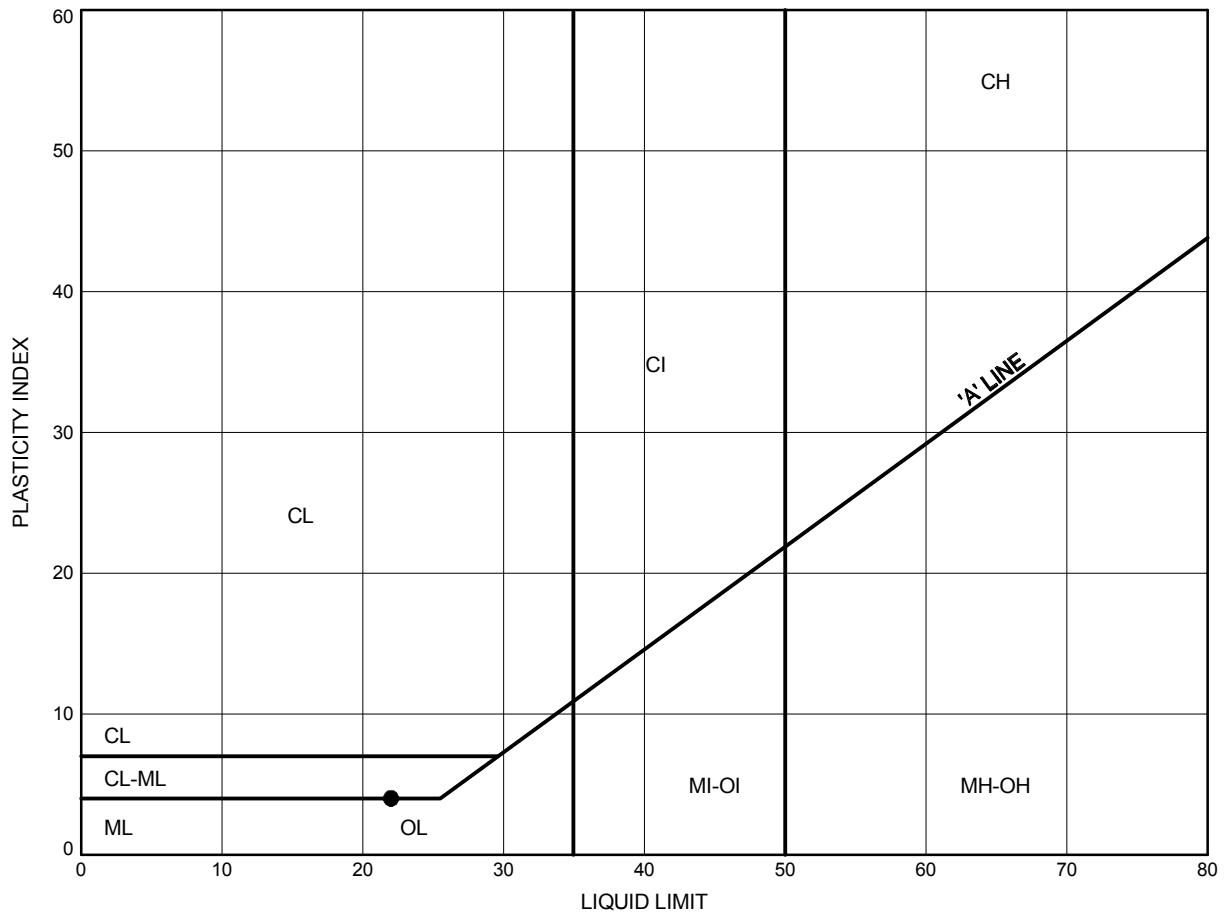
Appendix C.2

Atterberg Limit Analysis Figures

Poshkokagan River Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE C6

Silty Clay with Sand



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-303	3.45	421.15

Date December 2018

GWP# 6827-14-00



Prep'd CM

Chkd. SD

Appendix C.3

Analytical Testing Results

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 26-Jun-2018

Order Date: 20-Jun-2018

Project Description: 19773

Client ID:		18-101, SS6, 12'6"-14'6"	18-203, SS3, 5'10"-7'10"	18-204, SS4, 10'4"-12'4"	18-401, SS5, 10'-12'
Sample Date:		05/30/2018 11:00	06/12/2018 14:30	06/13/2018 09:45	06/07/2018 13:30
Sample ID:		1825441-01	1825441-02	1825441-03	1825441-04
MDL/Units		Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	80.0	88.0	89.3	92.4
General Inorganics					
Conductivity	5 uS/cm	135	156	98	90
pH	0.05 pH Units	7.81	7.76	7.76	7.56
Resistivity	0.10 Ohm.m	74.3	64.3	102	111
Anions					
Chloride	5 ug/g dry	9	25	29	9
Sulphate	5 ug/g dry	16	46	7	28
Client ID:		18-502, SS8, 17'6"-19'6"	18-301, SS8A, 17'6"-19'4"	-	-
Sample Date:		06/12/2018 11:15	06/05/2018 15:30	-	-
Sample ID:		1825441-05	1825441-06	-	-
MDL/Units		Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	89.9	90.0	-	-
General Inorganics					
Conductivity	5 uS/cm	47	50	-	-
pH	0.05 pH Units	7.14	7.38	-	-
Resistivity	0.10 Ohm.m	213	198	-	-
Anions					
Chloride	5 ug/g dry	13	19	-	-
Sulphate	5 ug/g dry	10	6	-	-

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6,

Phone: 613-731-9577
Fax:613-731-9064

28-June-2018

Date Rec. : 22 June 2018
LR Report: CA12773-JUN18
Reference: Project#:1825441

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		28-Jun-18
2: Analysis Start Time		13:23
3: Analysis Completed Date		28-Jun-18
4: Analysis Completed Time		14:45
5: QC - Blank		< 0.02
6: QC - STD % Recovery		105%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 18-101,SS6, 12'6"-14'16"	30-May-18	< 0.02
10: 18-204,SS4, 10'4"-12'4"	13-Jun-18	< 0.02
11: 18-401,SS5, 10'-12'	07-Jun-18	< 0.02
12: 18-502,SS8, 17'6"-19'6"	12-Jun-18	< 0.02
13: 18-301,SS8A, 17'6"-19'4"	05-Jun-18	< 0.02

RL - SGS Reporting Limit
ND - Not Detected

Kimberley Didsbury
Project Specialist
Environmental Services, Analytical

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 06-Jul-2018

Order Date: 29-Jun-2018

Project Description: 19773

		Client ID:	18-103,SS5, 8'2"-10'2"	18-304,SS5,8'10"	-	-
		Sample Date:	06/15/2018 10:00	06/16/2018 12:15	-	-
		Sample ID:	1826630-01	1826630-02	-	-
		MDL/Units	Soil	Soil	-	-
Physical Characteristics						
% Solids	0.1 % by Wt.		82.2	78.1	-	-
General Inorganics						
Conductivity	5 uS/cm		181	181	-	-
pH	0.05 pH Units		7.44	7.28	-	-
Resistivity	0.10 Ohm.m		76.1	55.1	-	-
Anions						
Chloride	5 ug/g dry		8	26	-	-
Sulphate	5 ug/g dry		12	52	-	-

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 07-Dec-2018

Order Date: 3-Dec-2018

Project Description: 19773

Client ID:	Rousseau	Max	Rinker	Wabikon
Sample Date:	11/30/2018 12:00	11/30/2018 11:45	11/30/2018 11:30	11/30/2018 11:00
Sample ID:	1849062-01	1849062-02	1849062-03	1849062-04
MDL/Units	Water	Water	Water	Water

General Inorganics

Conductivity	5 uS/cm	125	74	52	84
pH	0.1 pH Units	7.5	7.4	7.3	7.5
Resistivity	0.01 Ohm.m	79.9	135	193	119

Anions

Chloride	1 mg/L	7	2	1	4
Sulphate	1 mg/L	1	1	1	1

Client ID:	Waweig	-	-	-
Sample Date:	11/30/2018 10:00	-	-	-
Sample ID:	1849062-05	-	-	-
MDL/Units	Water	-	-	-

General Inorganics

Conductivity	5 uS/cm	56	-	-	-
pH	0.1 pH Units	7.4	-	-	-
Resistivity	0.01 Ohm.m	180	-	-	-

Anions

Chloride	1 mg/L	1	-	-	-
Sulphate	1 mg/L	<1	-	-	-

Appendix D.

Site Photographs



Photo 1. Looking at culvert inlet from BH 18-304 (2018/08/12)



Photo 2. Looking at culvert outlet from BH18-303 (2018/08/12)



Photo 3. Looking south along Highway 527 over the culvert (2018/08/12)



Photo 4. Looking west upstream from culvert inlet (2018/08/12)