



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
AGIMAK RIVER CULVERT REPLACEMENT
HIGHWAY 599, SITE No. 48W-242/C
TOWNSHIP OF IGNACE
ONTARIO
G.W.P. No. 6836-14-00**

GEOCRES Number: 52G-16

Latitude 49.424034 ° , Longitude -91.625292 °

Report

to

HATCH Corporation

Date: February 8, 2018
File: 17077



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Agimak River Culvert on Highway 599, located in the Township of Ignace, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert site and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by Hatch Corporation (Hatch) to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 6016-E-0030.

2. SITE DESCRIPTION

The site is located on Highway 599, approximately 2.3 km north of the intersection of Highway 599 and Highway 17 in Ignace, Ontario. The key plan showing the general location of the culvert site is presented on the Borehole Location and soil Strata Drawings in Appendix D.

Highway 599 runs in a general north-south direction with the culvert perpendicular to the centreline of the highway. The culvert allows the Agimak River to flow in an easterly direction beneath the highway.

The Ontario Structural Inspection Manual (OSIM) prepared by MTO on November 2, 2015, indicates that the existing structure is a 26 m long, two-span open footing, timber structure culvert. Each span is 1.8 m wide. The culvert is 1.8 m in height. The grade level of Highway 599 at the

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existing culvert is at an approximate Elevation 433.2 m. The height of the existing fill cover is approximately 1.5 m. The culvert invert is at approximately Elevation 429.66 m at the inlet (west end) and 429.54 m at the outlet (east end). The upstream and downstream water levels at Agimak River were measured at Elevations 430.36 and 430.12, respectively, in April 2016, as shown on drawings provided by Hatch.

The lands surrounding Agimak River and the culvert at the site predominantly consist of heavily forested areas with occasional marsh lands and lakes. Local topography is generally of low relief and consists of organic terrain. Photographs of the culvert and surrounding area are presented in Appendix C.

Based on published geological information, the subsurface soils at the site generally consist of organic deposits of peat overlying outwash plains of sand and gravel. Bedrock in the area has been identified as granodiorite to granite bedrock.

3. INVESTIGATION PROCEDURES

The borehole investigation and field testing program for this project was carried out between June 7 and August 1, 2017, and consisted of drilling and sampling eight (8) boreholes, designated as Boreholes AG17-01 to AG17-08. Boreholes AG17-01 to AG17-04 were drilled along the culvert alignment. Boreholes AG17-01 and AG17-04 were drilled at the inlet and outlet, respectively, and terminated at 12.8 m and 4.3 m depth (Elevations 419.1 and 426.0), respectively. Boreholes AG17-02 and AG17-03 were drilled through the highway embankment, and terminated at 14.3 m and 20.0 m (Elevations 418.9 and 413.3). Borehole AG17-04 was terminated upon casing refusal. Due to the site constraints and difficult access to the borehole location, the drilling operations for Borehole AG17-04 were conducted using portable tripod equipment. The tripod equipment allowed us to drill at the proposed borehole location, however it encountered refusal and was not able to advance further. Multiple attempts were made in the area to advance the borehole deeper, but were unsuccessful.

Boreholes AG17-05 to AG17-08 were drilled through the paved section of Highway 599, to the north and south of the existing culvert, at approximately 10.0 m intervals. These boreholes were advanced to assess the existence and extents of any frost taper near the culvert. Boreholes AG17-05 to AG17-08 were terminated at depths ranging from 3.7 m to 6.7 m (Elevations 426.4 to 430.0). Borehole AG17-06 was located 10.0 m south of the centreline of the existing culvert, near the alignment of the proposed river diversion pipe.



Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were derived from cross sections and topographic drawings provided to Thurber by Hatch. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D.

The boreholes on the highway platform and at the culvert inlet were drilled using a rubber track mounted drill rig equipped with continuous flight hollow and solid stem augers. The borehole drilled at the outlet was advanced using tripod equipment. Samples of the overburden soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). A Dynamic Cone Penetration Test (DCPT) was carried out in Borehole AG17-02 beyond the sampled depth of 14.3 m (Elevation 418.9) and advanced to refusal reached at approximately 23.1 m depth (Elevation 410.1). A DCPT, numbered AG17-02 DCPT, was conducted in proximity to Borehole AG17-02 to further assess the subsurface/soil conditions. This DCPT was conducted from 3.0 m (Elevation 430.2) and terminated upon refusal at 21.6 m depth (Elevation 411.6).

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations and upon completion of drilling. A piezometer was installed in Borehole AG17-01 on June 8, 2017, and a piezometric reading was taken on June 9, 2017. The piezometer was decommissioned on June 9, 2017. Upon completion of drilling, the boreholes were backfilled in general accordance with Ontario Regulation 903.

Completion details of the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
AG17-01	12.8 / 419.1	12.8 / 419.1	Screen from 12.8 m to 9.8 m, sand from 12.8 to 9.2 m, borehole sloughed from 9.2 m to surface.
AG17-02	23.1 / 410.1 ⁽¹⁾	None installed	Borehole backfilled with auger cuttings to 4.0 m, bentonite holeplug to 1.0 m, concrete to 0.2 m, then asphalt patch to surface.
AG17-02 DCPT	21.6/411.6	None installed	Borehole backfilled with slough to 0.9 m, concrete to 0.2 m, then asphalt patch to surface.
AG17-03	20.0 / 413.3	None installed	Borehole caved to 2.3 m. Borehole backfilled with auger cuttings to 1.5 m, concrete to 1.2 m, granular to 0.2 m, then asphalt patch to surface.
AG17-04	4.3 / 426.0	None installed	Borehole backfilled with sand and auger cuttings to surface.
AG17-05	3.7 / 429.2	None installed	Borehole backfilled with auger cuttings to 0.3 m, concrete to 0.2 m, then asphalt to surface.
AG17-06	6.7 / 426.4	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete to 0.2 m, then asphalt to surface.
AG17-07	3.7 / 429.8	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete to 0.2 m, then asphalt to surface.
AG17-08	3.7 / 430.0	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete to 0.2 m, then asphalt to surface.

(1) Dynamic Cone Penetration Test

4. LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture



content determination. Selected samples were also subjected to grain size distribution analyses (sieve and/or hydrometer). The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil, and a sample of the surface water from the river upstream of the existing culvert were collected. The samples were submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets 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 and should be used for interpretation of site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered in the boreholes below the existing embankment fill typically consist of silt and sand mixed with organics, underlain by layers of native sand, silt, and sand and gravel. Deposits of silty sand and sandy silt were also encountered within and beneath the sand deposits. Descriptions of the individual strata are presented below.

5.1 Asphalt

The boreholes that were drilled through the paved portion of Highway 599 encountered approximately 25 mm to 40 mm of asphalt at the ground surface. The ground surface elevations of the boreholes drilled on the highway platform ranged from 432.9 to 433.7.

5.2 Embankment Fill

Embankment fill was encountered below the asphalt in Boreholes AG17-02, AG17-03 and AG17-05 to AG17-08 drilled on Highway 599. Embankment fill was also encountered surficially in Borehole AG17-01, drilled at the inlet. The embankment fill generally consisted of sand to sand and gravel, containing trace silt and clay and occasional cobbles.



The granular embankment fill typically extended to depths ranging from 2.0 m to 3.5 m (Elevations 429.7 to 431.1) in the boreholes.

SPT 'N' values in the granular fill ranged from 3 to 45 blows for 0.3 m penetration, indicating a very loose to dense relative density. Measured moisture contents ranged from 2 percent to 14 percent.

The results of grain size distribution analyses conducted on samples of the granular fill are presented on the Record of Borehole sheets included in Appendix A and are summarized in the following table. The results are also presented on Figures B1 and B2 in Appendix B.

Soil Particle	Sand Fill (percent)	Sand and Gravel Fill (percent)
Gravel	7 to 17	27 to 49
Sand	79 to 90	48 to 66
Silt & Clay	3 to 6	3 to 7

5.3 Silt and Sand with organics

A layer of silt and sand mixed with organics was encountered beneath the embankment fill in Boreholes AG17-01, and AG17-06 to AG17-08. This layer is described as dark brown to black in colour. The silt and sand with organics ranged in thickness from 0.3 m to 1.1 m.

The depth to the base of the layer of silt and sand with organics ranged from 2.3 m to 4.5 m (Elevations 428.6 to 430.6), respectively.

SPT 'N' values recorded in the silt and sand with organics were 2 and 4 blows for 0.3 m penetration, indicating a very loose to loose state.

Measured moisture contents in the silt and sand with organics, ranged from 15 percent to 25 percent.

5.4 Sand and Silty Sand

Layers of native brown to grey sand containing trace to some gravel, trace silt to silty and trace to some clay, were encountered below the silt and sand with organics in most of the boreholes and sand and gravel (described in Section 5.5 in Boreholes AG17-02 and AG17-03). The



thickness of the upper sand, where penetrated through, was between 1.6 m and 2.0 m in Boreholes AG17-01, AG17-02, and AG17-03, with the base depth varying between 4.3 m and 7.2 m (Elevations 427.6 to 426.1). A lower layer of sand was encountered at 9.8 m and 8.7 m depth (Elevation 422.1 and 424.6) in Boreholes AG17-01, and AG17-03 respectively. This lower sand unit was penetrated through in AG17-03 with a base depth of 18.5 m (Elevation 414.8) and a thickness of 9.8 m.

Brown to gray sand to silty sand containing trace clay and occasional organics, was encountered in Boreholes AG17-05 to AG17-08.

Borehole AG17-01 was terminated within the lower sand layer at 12.8 m depth (Elevation 419.1). Boreholes AG17-05 to AG17-08 were terminated within the upper sand to silty sand layer at 3.7 m and 6.7 m depth (Elevations 426.4 to 430.0).

SPT 'N' values measured in the sand and silty sand ranged from 4 to 26 blows per 0.3 m of penetration, indicating a loose to compact state.

Moisture contents of the sand and silty sand ranged from 4 percent to 24 percent.

The results of a grain size analyses conducted on sand samples are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B3 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Sand (percent)
Gravel	0 to 8
Sand	70 to 94
Silt & Clay	6 to 22

5.5 Sand and Gravel

An upper layer of brown sand and gravel containing trace silt were encountered surficially in Borehole AG17-04 and at 3.0 m and 3.5 m depth (Elevations 430.2 and 429.8) in Boreholes AG17-02 and AG17-03, respectively. The thickness of the sand and gravel layer was 1.4 m and 2.1 m in Boreholes AG17-02 and AG17-03, respectively.



The depth to the base of the upper sand and gravel layer was 4.4 m and 5.6 m (Elevations 428.8 and 427.7) in Boreholes AG17-02 and AG17-03, respectively.

Borehole AG17-04 was terminated within the upper layer of sand and gravel at 4.3 m depth (Elevation 426.0) upon casing refusal. Borehole AG17-03, was terminated within the lower layer of sand and gravel at 20.0 m depth (Elevation 413.3), upon auger refusal.

SPT 'N' values measured in the upper sand and gravel ranged from 6 to 27 blows per 0.3 m of penetration, indicating a loose to compact state.

A lower layer of sand and gravel was encountered in Borehole AG17-03, at 18.5 m depth (Elevation 414.8).

SPT 'N' values, up to 100 blows per 0.1 m of penetration, indicating a very dense state, were measured in the lower sand and gravel unit.

Moisture contents of the sand and gravel layers ranged from 7 percent to 22 percent.

The results of a grain size analyses conducted on a sand and gravel sample are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B4 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Sand and Gravel (percent)
Gravel	41
Sand	56
Silt & Clay	3

5.6 Silt to Sandy Silt

A deposit of brown to grey silt to sandy silt containing trace to some clay, were encountered at 4.3 m and 6.4 m depth (Elevations 427.6 and 426.8) in Boreholes AG17-01 and AG17-02, respectively. The thickness of the sandy silt was 5.5 m in Borehole AG17-01. A 1.5-m thick layer of sandy silt was encountered within the sand at 7.2 m depth (Elevation 426.1) in Borehole AG17-03.

The depth to the base of the sandy silt was at 9.8 m (Elevation 422.1) in Borehole AG17-01.



Borehole AG17-02 was terminated within the silt layer at 14.3 m depth (Elevation 418.9).

SPT 'N' values recorded in the silt and sandy silt ranged from 0 to 15 blows for 0.3 m penetration, indicating a loose to compact relative density. Measure moisture contents in the silt and sandy silt ranged from 11 percent to 18 percent. The very loose conditions (SPT 'N' values of 0 to 1) were noted within approximate Elevations 419.0 to 426.0, and may have been the result of hydraulic ground disturbance during drilling operations. Moisture contents of the silt to sandy silt deposit ranged from 11 percent to 18 percent.

The results of grain size analyses conducted on samples of the silt to sandy silt are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B5 of Appendix B. The results are summarized as follows:

Soil Particle	Silt (percent)	Sandy Silt (percent)
Gravel	0	0
Sand	5	32 to 43
Silt	81	55 to 64
Clay	14	2 to 4

5.7 Auger Refusal and/or Probable Bedrock

Auger refusal and probable bedrock was encountered below the lower layer of sand and gravel, at 20.0 m depth (Elevation 413.3) in Borehole AG17-03. Casing refusal occurred at a depth of 4.3 m in Borehole AG17-04 where tri-pod equipment was used to auger the hole.

DCPT's conducted in and near Borehole AG17-02, were terminated upon refusal at 23.1 m and 21.6 m depth (Elevations 410.1 and 411.6).

5.8 Groundwater Conditions

Groundwater conditions were observed during drilling and upon completion of drilling. A piezometer was installed in Borehole AG17-01. The piezometer was decommissioned upon taking a water level measurement. The groundwater levels measured in the open boreholes and the piezometer are summarized in Table 5.2.

Table 5.2 - Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
AG17-01	June 9, 2017	1.0	430.9	Piezometer
AG17-02	June 7, 2017	2.7	430.5	Open borehole
AG17-03	June 11, 2017	-	-	Caved-in to 2.3 m
AG17-04	June 9, 2017	0.3	430.0	Open borehole
AG17-05	June 8, 2017	2.7	430.2	Open borehole
AG17-06	June 8, 2017	2.6	430.5	Open borehole
AG17-07	June 8, 2017	2.7	430.8	Open borehole
AG17-08	June 8, 2017	2.7	431.0	Open borehole

The upstream and downstream water levels at Agimak River were measured at Elevations 430.36 and 430.12, respectively, in April 2016, as shown on drawings provided by Hatch. The groundwater level should be assumed to reflect the local river water level.

Groundwater levels are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the sand fill from Borehole AG17-02 and a sample of the river water, taken from the inlet area, were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results	
			AG17-02 SS 4 Depth 2.3 m	Agimak River (upstream)
			(Soil Sample)	(River Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	µg/g	mg/L	150	7.8
Sulphate	µg/g	mg/L	6.1	1.9
pH	No unit	No unit	8.33	7.26
Electrical Conductivity	µS/cm	µS/cm	213	56
Resistivity	Ohms.cm	Ohms.cm	4690	17700
Redox Potential	mV	mV	290	345

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. Thurber obtained the northing and easting coordinates and ground surface elevations from measurements taken in the field relative to the topographic plans provided by Hatch.

RPM Drilling Inc. of Thunder Bay, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Mr. Ryan McCourt, P. Geo, and Stephen Hillier, EIT of Thurber. Overall supervision of the field program was provided by Mr. Cory Zanatta, EIT of Thurber.

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc. Interpretation of the field data and preparation of this report was carried out by Mr. Cory Zanatta, EIT and Mr. Jason Lee, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 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	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


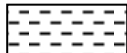



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	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	SILTS AND CLAYS W _L < 50%	ML	Inorganic silts and 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. (W _L < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W _L < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W _L > 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No AG17-01

1 OF 2

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 170.8 E 404 517.0 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY RPR

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	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
431.9	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.0	SAND , trace gravel, trace clay Very Loose to Compact Light Brown Moist (FILL)		1	SS	3		431							
			2	SS	10									
429.9			3	SS	2		430							
2.0	SAND and SILT , with organics Very Loose Dark Brown Wet													
429.6			4	SS	12		429							
2.3	SAND , some silt and clay, trace gravel Compact Grey Wet		5	SS	15		428							
427.6			6	SS	4		427							
							426							
			7	SS	1		425							
							424							
			8	SS	0		423							
			9	SS	15		422							
422.1														
9.8	SAND , trace silt and clay													

Continued Next Page

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

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 1/29/18

RECORD OF BOREHOLE No AG17-01

2 OF 2

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 170.8 E 404 517.0 ORIGINATED BY BRM
HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY RPR

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _p W W _L				
	Continued From Previous Page																
	SAND , trace silt and clay Compact Brown Wet		10	SS	16		421										
							420										
419.1			11	SS	20											0 94 6 (SI+CL)	
12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL MEASURED AT 1.2m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.09 1.0 430.9																

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 1/29/18

RECORD OF BOREHOLE No AG17-02 1 OF 3 METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 160.3 E 404 525.2 ORIGINATED BY BRM
HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2017.06.07 - 2017.06.07 CHECKED BY RPR

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 (%)						
								20 40 60 80 100				w _P w w _L						
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
433.2	GROUND SURFACE						433										7 90 3 (SI+CL)	
0.8	ASPHALT: (25mm)		1	GS														
	SAND, trace gravel, trace silt, trace clay Dense to Compact Brown Moist (FILL)		2	SS	32													
							432											
			3	SS	13													
	Very Loose		4	SS	3													
430.2																		
3.0	SAND and GRAVEL, trace silt Loose Brown Wet		5	SS	6													
							429											
428.8																		
4.4	SAND, some silt Compact to Loose Grey Wet		6	SS	14													
						428												
						427												
426.8			7	SS	9													
6.4	SILT, some clay, trace sand Loose Grey Wet																	
						426												
			8	SS	7													
						425												
						424												
			9	SS	7													

0 5 81 14

Continued Next Page

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

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE									
								● QUICK TRIAXIAL		× LAB VANE									
	Continued From Previous Page						20	40	60	80	100	20	40	60					
418.9 14.3	SILT , some clay, trace sand Compact to Very Loose Grey Wet <																		

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No AG17-02

3 OF 3

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 160.3 E 404 525.2 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2017.06.07 - 2017.06.07 CHECKED BY RPR

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	W _p	W	W _L	WATER CONTENT (%)		
	Continued From Previous Page						413							
							412							
							411							
410.1 23.1	END OF BOREHOLE AT 23.1m UPON DCPT REFUSAL. WATER LEVEL MEASURED AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 4.0m, BENTONITE HOLEPLUG TO 1.0m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.													

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No AG17-02 DCPT 2 OF 3

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 161.5 E 404 525.3 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2017.08.01 - 2017.08.01 CHECKED BY RPR

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			20 40 60 80 100	20 40 60 80 100					
	Continued From Previous Page													
							423							
							422							
							421							
							420							
							419							
							418							
							417							
							416							
							415							
							414							

Continued Next Page

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

RECORD OF BOREHOLE No AG17-02 DCPT 3 OF 3

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 161.5 E 404 525.3 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2017.08.01 - 2017.08.01 CHECKED BY RPR

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									
	Continued From Previous Page							20	40	60	80	100					
411.6							413										
							412										
21.6	END OF DCPT AT 21.6m UPON REFUSAL. BOREHOLE BACKFILLED WITH SLOUGH TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No AG17-03

1 OF 3

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 168.9 E 404 529.5 ORIGINATED BY SMP
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.11 - 2017.06.11 CHECKED BY RPR

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 (%)					
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE								
433.3	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (40mm)		1	SS	28												
	SAND and GRAVEL , trace silt, trace clay, occasional cobbles Compact to Dense (FILL)		2	SS	45												27 66 7 (SI+CL)
	Auger grinding at 1.4m		3	SS	29												
			4	SS	17												
			5	SS	18												49 48 3 (SI+CL)
429.8			6	SS	27												
3.5	SAND and GRAVEL , trace silt Compact Brown Moist		7	SS	7												
427.7			8	SS	5												0 32 64 4
5.6	SAND , some silt to silty, trace gravel Loose Brown Wet		9	SS	16												
426.1																	
7.2	Sandy SILT , trace clay Loose Brown to Grey Wet																
424.6																	
8.7	Compact																

Continued Next Page

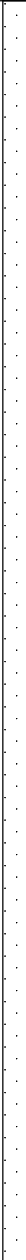





































+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No AG17-03

2 OF 3

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 168.9 E 404 529.5 ORIGINATED BY SMP
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.11 - 2017.06.11 CHECKED BY RPR

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 (%)				GR	SA	SI	CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _P W W _L									
	Continued From Previous Page							● QUICK TRIAXIAL × LAB VANE <td>20 40 60 80 100</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	20 40 60 80 100										
414.8	SAND , trace gravel, trace silt, trace clay Loose to Compact Grey Wet						423												
			10	SS	6														
			11	SS	8														
			12	SS	28														
18.5	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						419												
			13	SS	17														
413.3	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						418												
			14	SS	26														
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						417												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						416												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						415												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						414												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						413												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						412												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						411												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						410												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						409												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						408												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						407												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						406												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						405												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						404												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						403												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						402												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						401												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						400												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						399												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						398												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						397												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						396												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						395												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						394												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						393												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						392												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						391												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						390												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						389												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						388												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						387												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						386												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						385												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						384												
	SAND and GRAVEL , trace silt Very Dense Grey to Brown Wet						383</												

Continued Next Page

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

RECORD OF BOREHOLE No AG17-03 3 OF 3 METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 168.9 E 404 529.5 ORIGINATED BY SMP
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.11 - 2017.06.11 CHECKED BY RPR

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									
20.0	Continued From Previous Page END OF BOREHOLE AT 20.0m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE CAVED TO 2.3m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 1.5m, CEMENT TO 1.2m, AUGER CUTTINGS MIXED WITH CEMENT TO 0.5m, GRANULAR TO 0.2m, THEN ASPHALT PATCH TO SURFACE.				0.100												

RECORD OF BOREHOLE No AG17-04

1 OF 1

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 159.9 E 404 539.8 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.06.09 - 2017.06.09 CHECKED BY RPR

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										
430.3	GROUND SURFACE							20	40	60	80	100						
0.0	SAND and GRAVEL , trace silt, trace clay Loose to Compact Brown Moist to Wet		1	SS	6		430											
			2	SS	8		429											
			3	SS	10		428											
			4	SS	7		427											
			5	SS	19													
			6	SS	11													
			7	SS	15													
426.0	Unable to advance casing below 4.3m depth																	
4.3	END OF BOREHOLE AT 4.3m. WATER LEVEL MEASURED AT 0.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.																	

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

RECORD OF BOREHOLE No AG17-05

1 OF 1

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 145.1 E 404 525.1 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY RPR

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		
432.9	GROUND SURFACE							20	40	60	80	100					
0.8	ASPHALT: (25mm)																
	SAND, trace silt, trace clay, trace gravel Brown Moist (FILL)		1	GS			432										7 87 6 (SI+CL)
			2	GS													
			3	GS			431										
430.6																	
2.3	Silty SAND, trace clay, occasional organics Brown Moist		4	GS			430										
	Loose		1	SS	4												
429.2																	
3.7	END OF BOREHOLE AT 3.7m. WATER LEVEL MEASURED AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.3m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No AG17-06

1 OF 1

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 155.1 E 404 524.9 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY RPR

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							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
433.1	GROUND SURFACE					▽	433												
0.8	ASPHALT: (25mm)		1	GS			432												
	SAND and GRAVEL, trace silt, trace clay Compact to Very Loose Brown Moist to Wet (FILL)		1	SS	15														
			2	SS	7														
			3	SS	3														
			4	SS	4														
429.7								430											
3.4	SAND and SILT, with organics Loose Dark Brown to Black Wet							429											
428.6			5	SS	11			428											
4.5	SAND, trace clay, trace gravel Compact to Loose Grey Wet							427											
			6	SS	7														
426.4																			
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL MEASURED AT 2.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																		

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RECORD OF BOREHOLE No AG17-07

1 OF 1

METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 175.3 E 404 530.0 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2107.06.08 CHECKED BY RPR

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L					
433.5	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (25mm)																
	SAND and GRAVEL , trace silt, trace clay Brown Moist (FILL)		1	GS			433							○			
			2	GS			432							○			30 64 6 (SI+CL)
			3	GS										○			
431.1																	
2.4	SAND and SILT , with organics Dark Brown Wet		4	GS		▽	431							○			
430.5																	
3.0	SAND , trace gravel Loose Brown Moist		1	SS	5		430							○			
429.8																	
3.7	END OF BOREHOLE AT 6.7m. WATER LEVEL MEASURED AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																

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

RECORD OF BOREHOLE No AG17-08 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Agimak River Culvert, MTM NAD 83 Zone 16 N 5 477 185.3 E 404 530.1 ORIGINATED BY BRM
 HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY RPR

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			
433.7	GROUND SURFACE							20	40	60	80	100						
0.8	ASPHALT: (25mm)																	
	SAND, some gravel, trace silt, trace clay Brown Moist (FILL)		1	GS			433											
			2	GS			432											
			3	GS														
431.0			4	GS			431											
2.7	SAND and SILT, with organics Dark Brown Wet																	
430.6																		
3.1	SAND, trace gravel Loose Brown Moist		1	SS	9													
430.0																		
3.7	END OF BOREHOLE AT 6.7m. WATER LEVEL MEASURED AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																	

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 1/29/18



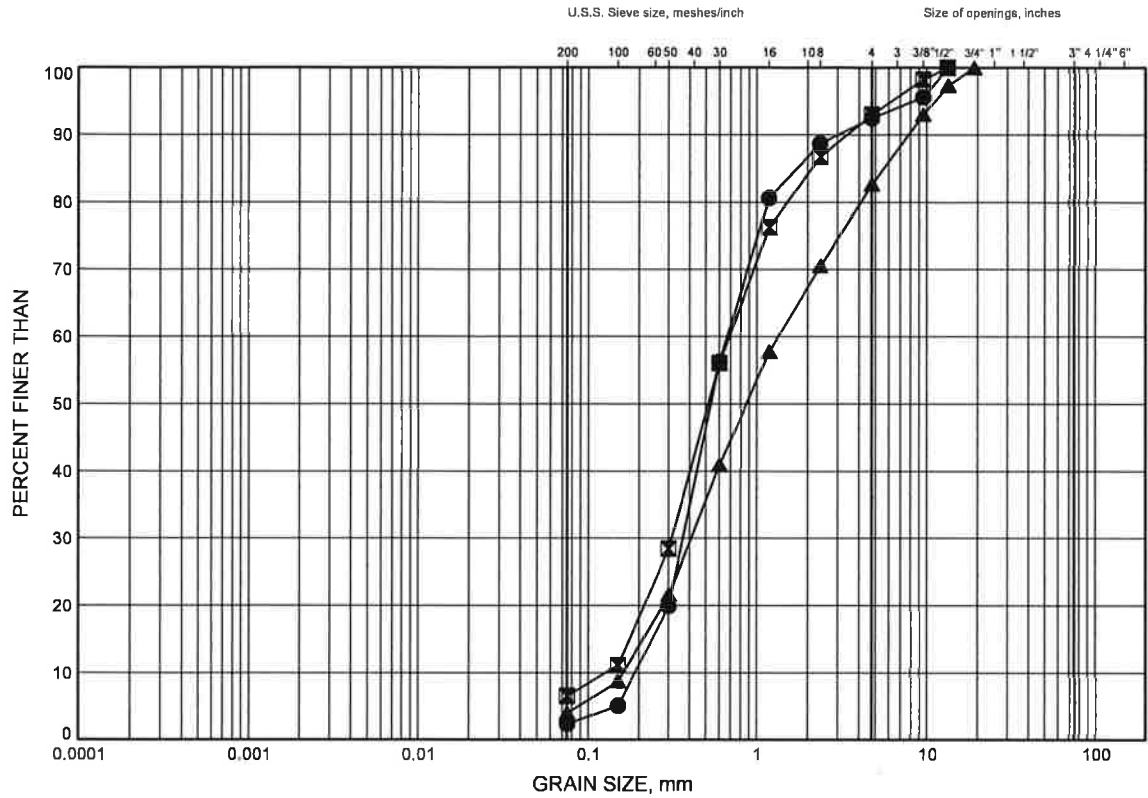
Appendix B

Geotechnical and Analytical Laboratory Test Results

Agimak River Culvert GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AG17-02	2.6	430.6
■	AG17-05	0.9	432.0
▲	AG17-08	1.9	431.8

Date September 2017

GWP# 6836-14-00



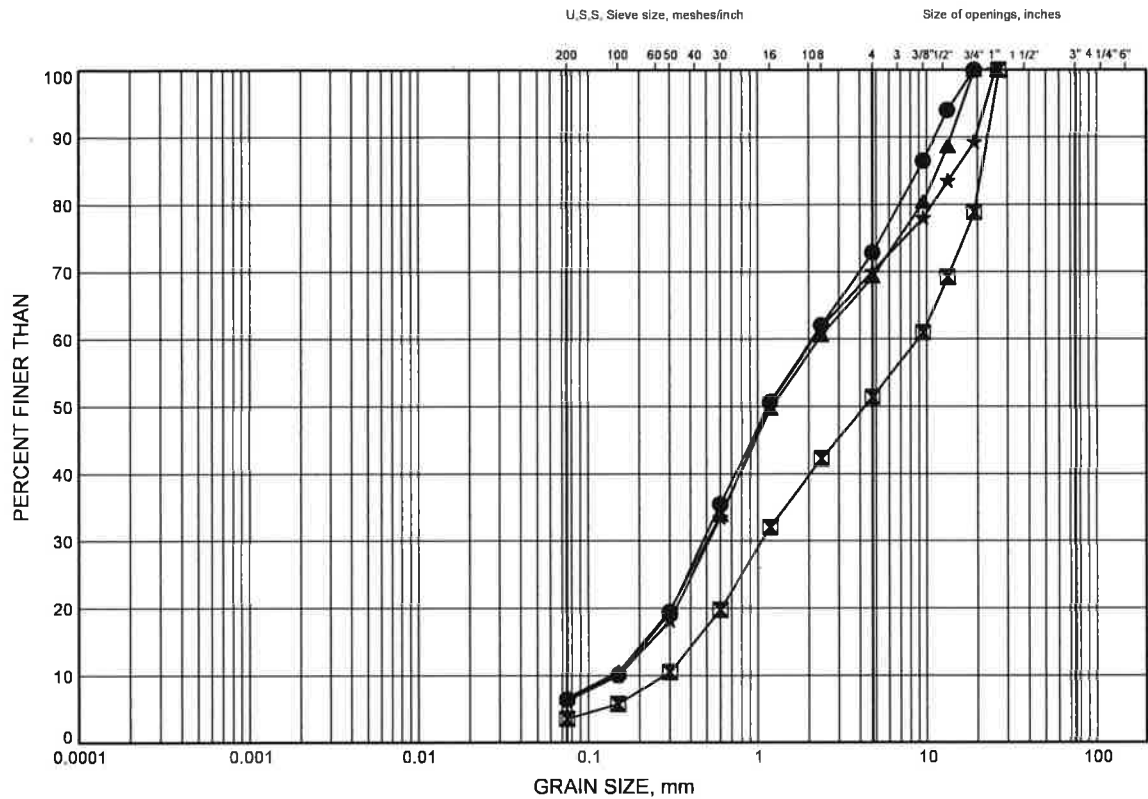
Prep'd AN

Chkd. RPR

Agimak River Culvert GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND and GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AG17-03	1.0	432.3
⊠	AG17-03	3.1	430.2
▲	AG17-06	1.8	431.3
★	AG17-07	1.1	432.4

Date September 2017

GWP# 6836-14-00

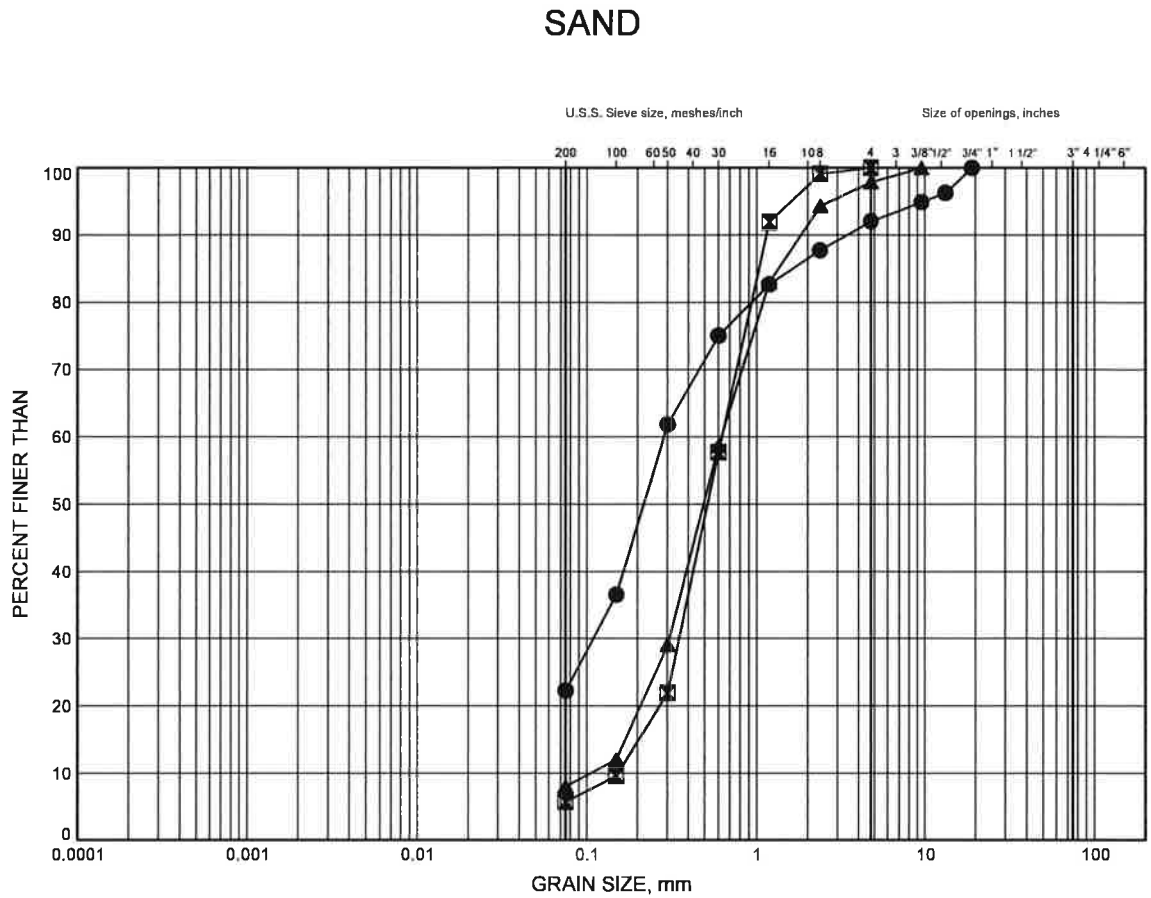


Prep'd AN

Chkd. RPR

Agimak River Culvert GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AG17-01	2.6	429.3
⊠	AG17-01	12.5	419.4
▲	AG17-03	16.9	416.4

Date September 2017

GWP# 6836-14-00



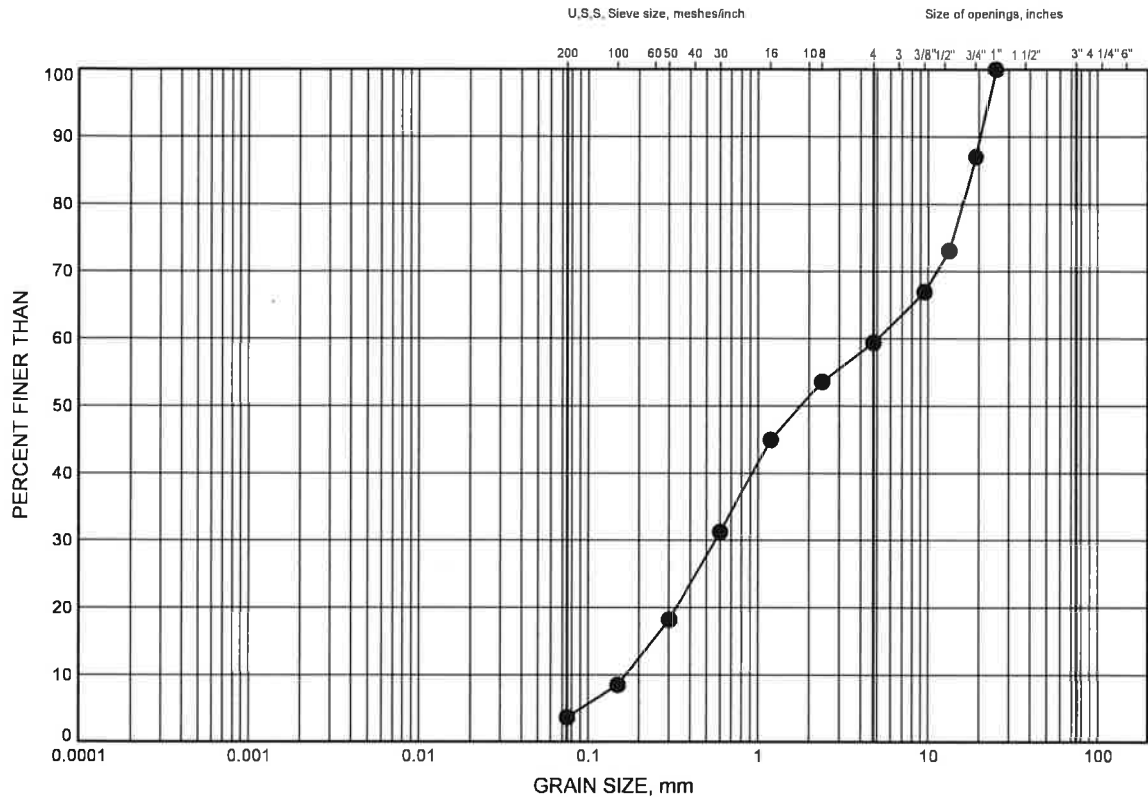
Prep'd AN

Chkd. RPR

Agimak River Culvert GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND and GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AG17-04	2.1	428.2

Date October 2017
GWP# 6836-14-00

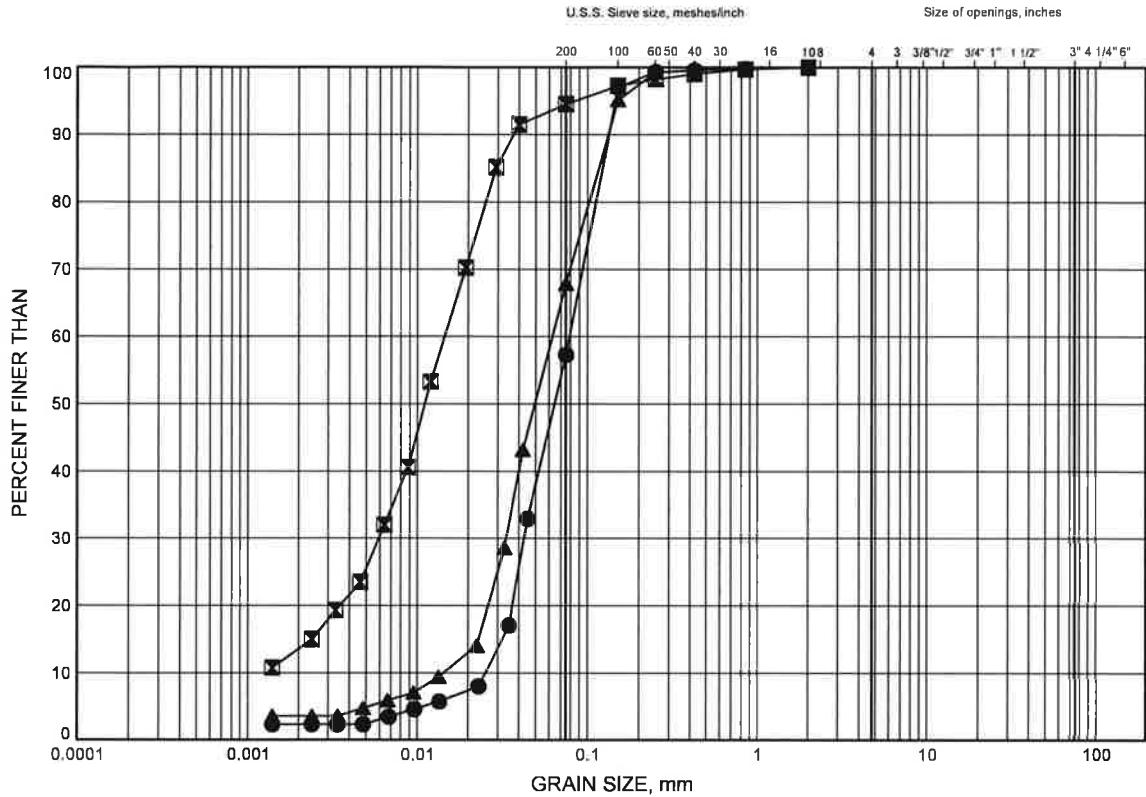


Prep'd AN
Chkd. RPR

Agimak River Culvert GRAIN SIZE DISTRIBUTION

FIGURE B5

SILT, Sandy SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AG17-01	7.9	424.0
⊠	AG17-02	9.4	423.8
▲	AG17-03	7.9	425.4

Date October 2017
GWP# 6836-14-00



Prep'd AN
Chkd. RPR

Certificate of Analysis

SGS Canada Inc.
185 Concession St. Box 4300
Lakefield, Ont., Canada, K0L 2H0



Client
SGS LIMS Number
Analysis Package:

Attention: Cory Zanatta
Project#: 17077 Hwy 599
Thurber Engineering Ltd.
CA15314-JUN17
Corrosivity (Solution)

Sample ID	Unit	RL	Tug Creek	Pratt Creek	Mile Creek	Cobb Bay	Kekwanzik Lake	Agimak River
			10-Jun-17 12:10	10-Jun-17 12:30	10-Jun-17 10:40	10-Jun-17 11:20	10-Jun-17 12:45	10-Jun-17 13:10
Sample Date/Time								
Temperature Upon Receipt	°C		10.0	10.0	10.0	10.0	10.0	10.0
Soil Redox Potential	mV		334	272	352	301	312	345
Sulphide	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
pH	no unit	0.05	7.78	7.81	7.62	7.70	7.38	7.26
Chloride	mg/L	0.04	2.1	2.9	2.7	1.7	8.8	7.8
Sulphate	mg/L	0.04	0.3	1.2	0.8	0.6	2.0	1.9
Conductivity	µS/cm	2	100	78	63	78	67	56
Resistivity (calculated)	ohms.cm		9990	12700	15800	12800	15000	17700

Corrosivity Index is based on the AWWA
Corrosivity Scale according to AWWA C-105.
An index greater than 10 indicates the
soil matrix may be corrosive to cast iron alloys.

Deanna Edwards

Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety

Data reported represents the sample submitted to SGS. Reproduction of this analytical report in full or in part is prohibited without prior written approval. Please refer to SGS General Conditions of Services located at http://www.sgs.com/terms_and_conditions_service.htm. (Printed copies are available upon request.). Test Method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.



Client
SGS LIMS Number
Analysis Package:

Attention: Cory Zanatta
Project#: 17077
Thurber Engineering Ltd.
CA15302-AUG17
Corrosivity (Soil)

SGS Canada Inc.
185 Concession St. Box 4300
Lakefield, Ont., Canada,
K0L 2H0

Sample ID	Unit	PR17-02 SS7	KE 17-03 SS5	ME 17-03 SS3	TU 17-02 SPT5	CO 17-03 SS4	AG 147-02 SS4
Sample Date/Time		30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17
Moisture	%	15.6	7.0	7.7	22.2	15.6	21.0
pH	no unit	8.25	6.40	8.27	8.14	8.65	8.33
Corrosivity Index	none	4.5	1.0	1.0	1.0	4.0	1.0
Soil Redox Potential	mV	325	338	303	301	295	290
Sulphide	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chloride	mg/L	6.9	240	2.4	25	1.2	150
Sulphate	mg/L	26	10	10	1.2	46	6.1
Conductivity	uS/cm	49	269	35	81	83	213
Resistivity (calculated)	ohms.cm	20300	3720	28700	12400	12000	4690

Corrosivity Scale according to AWWA C-105.

An index greater than 10 indicates the
soil matrix may be corrosive to cast iron alloys.

Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety



Appendix C

Selected Site Photographs



Photo 1: Highway 599 at Agimak River Culvert looking south



Photo 2: Highway 599 at Agimak River Culvert looking north



Photo 3: Agimak River Culvert inlet

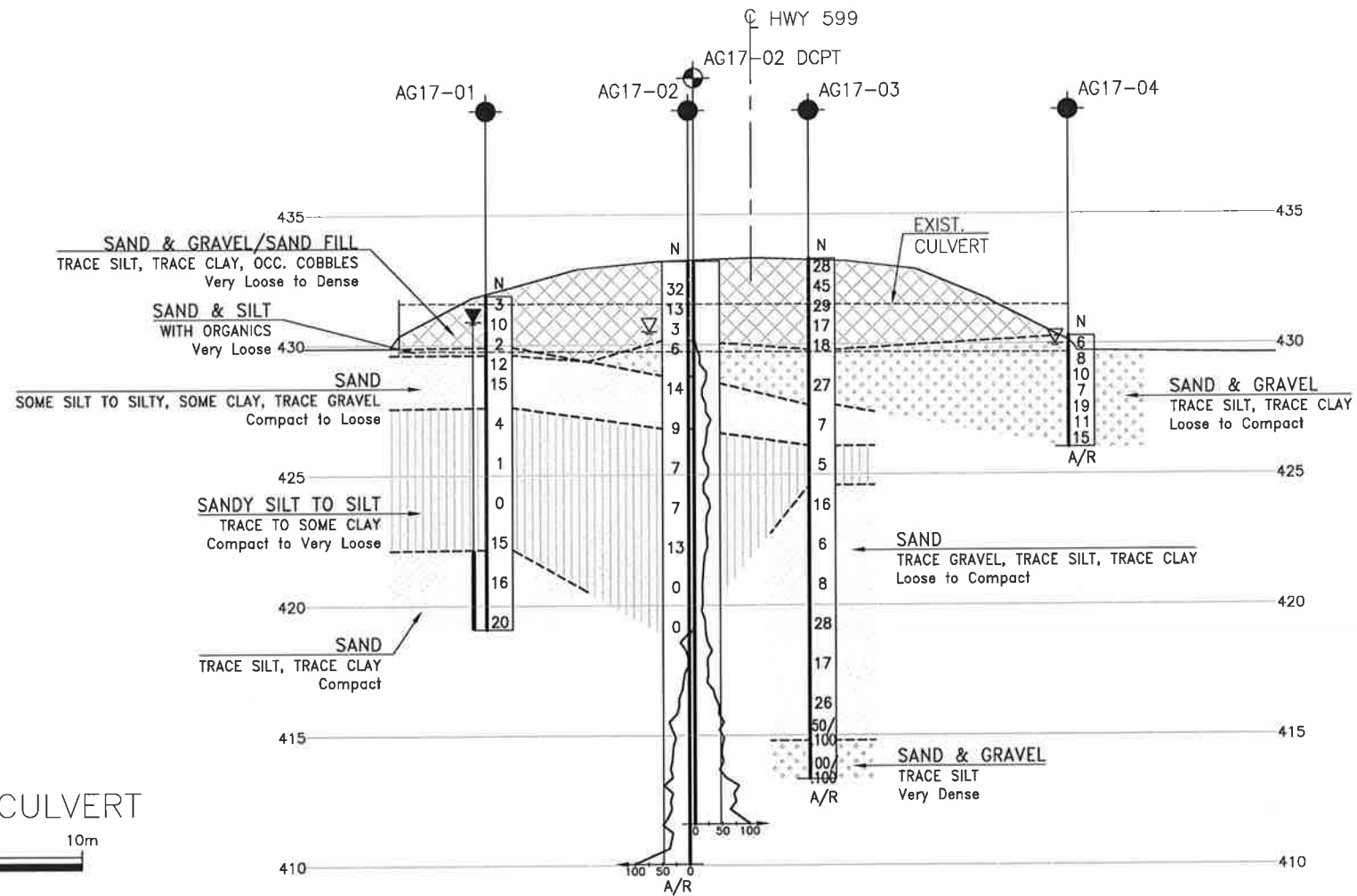
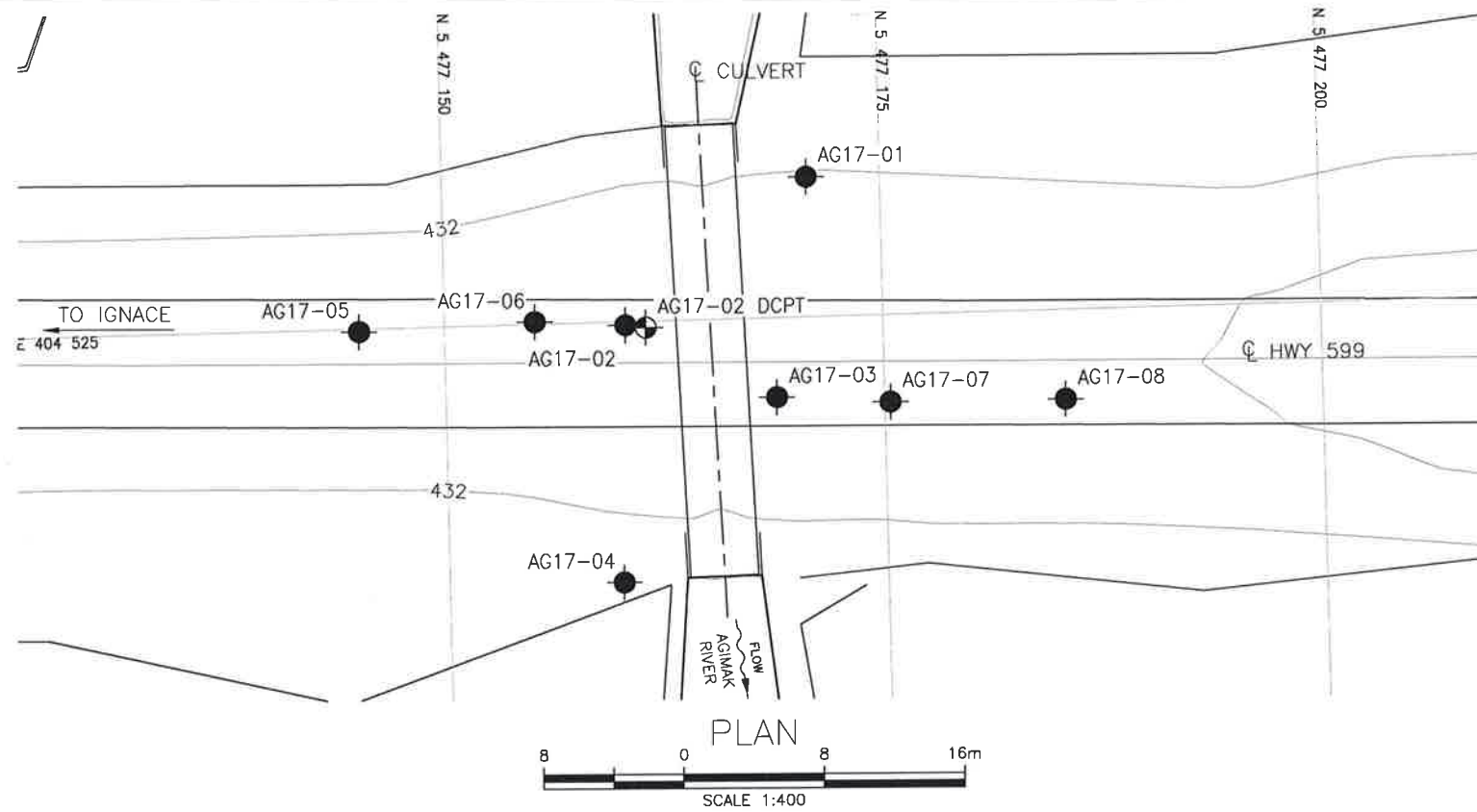


Photo 4: Agimak River culvert outlet



Appendix D

Borehole Locations and Soil Strata Drawings



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2017-6036
WP No 6836-14-01



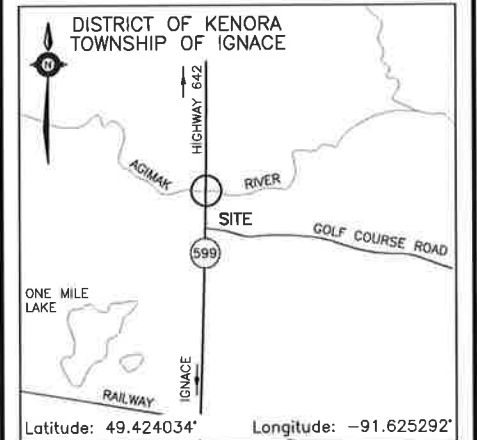
HIGHWAY 599
AGIMAK RIVER CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
9

HATCH








THURBER ENGINEERING LTD.



KEYPLAN

L E G E N D

	Borehole
	Borehole and 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/Casing/DCPT Refusal

NO	ELEVATION	NORTHING	EASTING
AG17-01	431.9	5 477 170.8	404 517.0
AG17-02	433.2	5 477 160.3	404 525.2
AG17-02 DCP1	433.2	5 477 161.5	404 525.3
AG17-03	433.3	5 477 168.9	404 529.5
AG17-04	430.3	5 477 159.9	404 539.8
AG17-05	432.9	5 477 145.1	404 525.1
AG17-06	433.1	5 477 155.1	404 524.9
AG17-07	433.5	5 477 175.3	404 530.0
AG17-08	433.7	5 477 185.3	404 530.1

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 16.

GEOCRES No. 52G-16

REVISIONS									
	DATE	BY	DESCRIPTION						
	DESIGN	RPR	CHK	JPL	CODE	LOAD	DATE JAN 2018		
	DRAWN	AN	CHK	RPR	SITE 48W-242C	STRUCT	DWG	2	

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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2017-6036
WP No 6836-14-01



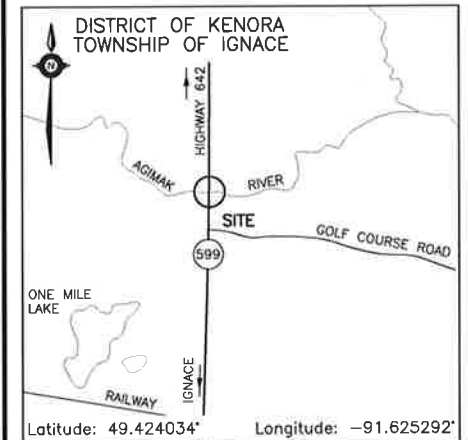
HIGHWAY 599
AGIMAK RIVER CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
10

HATCH



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

- Borehole
- ◆ Borehole and 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/Casing/DCPT Refusal

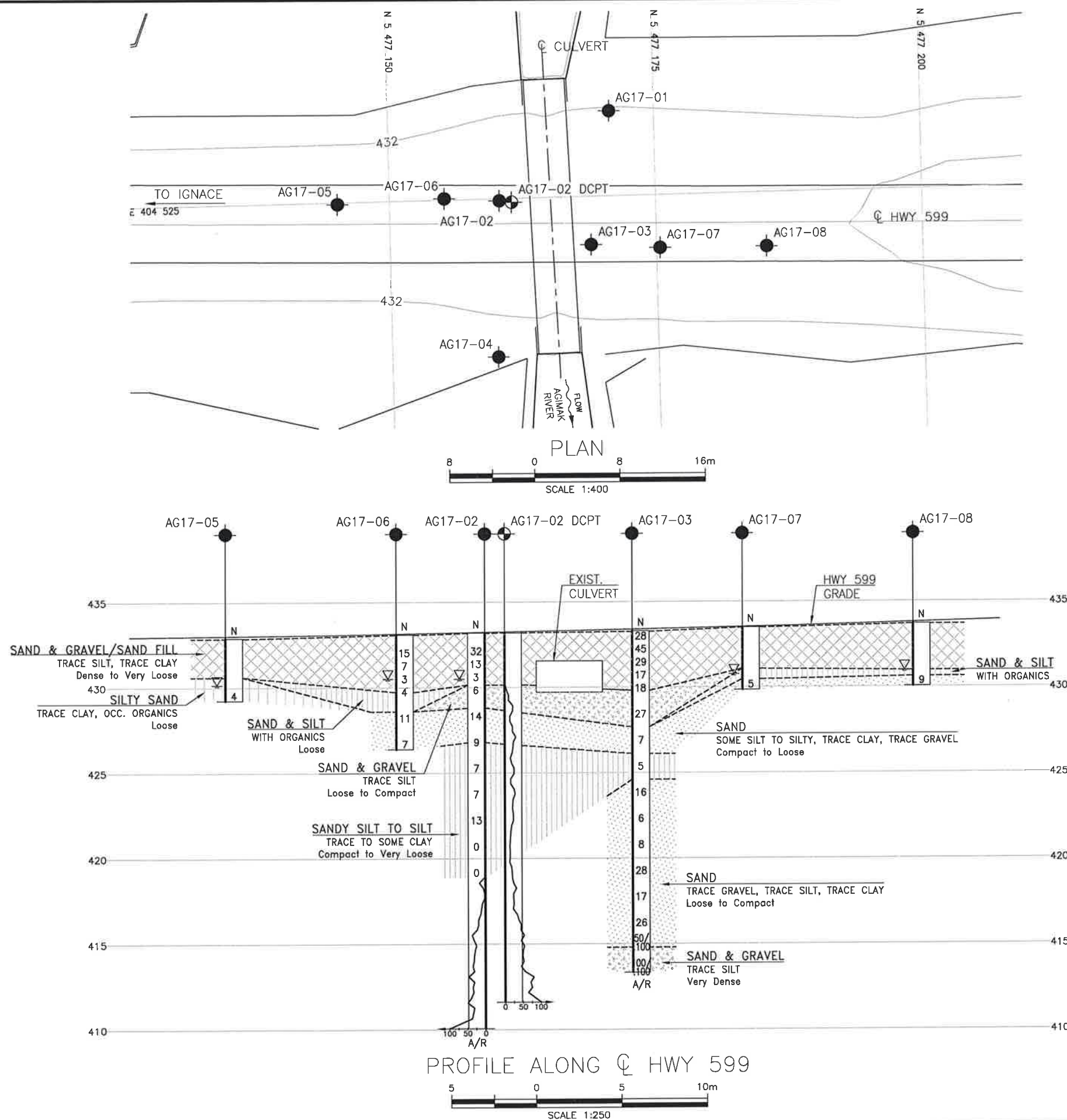
NO	ELEVATION	NORTHING	EASTING
AG17-01	431.9	5 477 170.8	404 517.0
AG17-02	433.2	5 477 160.3	404 525.2
AG17-02 DCPT	433.2	5 477 161.5	404 525.3
AG17-03	433.3	5 477 168.9	404 529.5
AG17-04	430.3	5 477 159.9	404 539.8
AG17-05	432.9	5 477 145.1	404 525.1
AG17-06	433.1	5 477 155.1	404 524.9
AG17-07	433.5	5 477 175.3	404 530.0
AG17-08	433.7	5 477 185.3	404 530.1

-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 16.

GEOCRES No. 52G-16

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK JPL	CODE
DRAWN	AN	CHK RPR	SITE 48W-242G/STRUCT
			LOAD
			DATE JAN 2018
			DWG 3



PROFILE ALONG C HWY 599

