

**FOUNDATION INVESTIGATION REPORT
KENEL CREEK CULVERT REPLACEMENT**

Highway 17, Site 48E-66/C

G.W.P. 6026-07-00

Township of Bomby

East of Marathon, Ontario

Geocres Number: 42C-25

Report to

GENIVAR

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed culvert replacement at Kenel Creek in the Township of Bomby, Ontario. The existing culvert carries Kenel Creek under Highway 17.

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 was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to Genivar, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0012.

2 SITE DESCRIPTION

The Kenel Creek culvert is located approximately 40 m east of the intersection of Highway 17 and Highway 614 in the Township of Bomby, Ontario. The site is approximately 40 km east of the Town of Marathon, Ontario.

The existing highway is a two-lane paved road and crosses the creek on embankments about 3.0 m to 4.0 m high.

Currently a CSP elliptical arch culvert carries Kenel Creek under Highway 17. The culvert is approximately 4.0 m wide, 2.4 m high and 31.2 m long. Kenel Creek flows to the south.

Lands surrounding the culvert site are generally flat and undeveloped forested areas.

Photographs in Appendix C show the general nature of the surrounding land.

The site lies within the Michipicoten greenstone belt part of the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of overburden. At this site, the overburden primarily consists of glaciolacustrine silts and clays.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on April 30 and May 1, 2011 and consisted of drilling and sampling a total of three boreholes (identified as KN11-01 to KN11-03) in the area of the existing culvert. One borehole was drilled near each end of the culvert and one borehole was drilled on the eastbound lane of Highway 17. Boreholes were extended to depths ranging from 6.1 m to 10.4 m (elevations 91.1 to 92.9).

Dynamic cone penetration tests (DCPT) were conducted adjacent to Boreholes KN11-01 and KN11-03 from ground surface to 7.6 m and 6.8 m depth (elevations 91.7 and 92.2), respectively.

The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

Drilling was carried out using a track mounted CME 55 drill rig and hollow-stem augers were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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 were observed in the open boreholes upon completion of the drilling operations. One standpipe piezometer consisting of 19 mm PVC pipe with a slotted screen was installed in Borehole KN11-03 and enclosed in filter sand to permit longer term groundwater level monitoring. The boreholes were backfilled in accordance with O.Reg. 903 upon completion and the details are shown in Table 3.1.

Table 3.1 –Borehole Decommissioning Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Borehole Decommissioning Details
KN11-01	None installed	Backfilled with bentonite holeplug to surface.
KN11-02	None installed	Backfilled with bentonite holeplug from 10.4 m to 0.15 m, then asphalt patch to surface.
KN11-03	6.1 / 92.9	Piezometer with 1.5 m slotted screen installed with sand filter to 4.3 m, bentonite from 4.3 m to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

In general terms, the site was found to be underlain by native silt overlying deposits of sandy silt and sand. A thin layer of organics mixed with sand and clay was encountered at surface near the culvert inlet and outlet areas. Pavement structure overlying sand fill was encountered surficially in the borehole advanced through the highway embankment. Boreholes were terminated upon auger refusal on probable bedrock or boulders. More detailed descriptions of the individual strata are presented below.

5.1 Pavement structure

Pavement structure consisting of approximately 40 mm of asphalt overlying granular (sand fill) road base was encountered in Boreholes KN11-02 drilled through the existing Highway 17 eastbound lane.

5.2 Organics

A thin layer of dark brown organics mixed with sand and clay and trace of silt was contacted surficially in Boreholes KN11-01 and KN11-03 drilled at the south and north ends of the culvert, respectively. The thickness of the organic layer was 0.3 m and 0.4 m in KN11-01 and KN11-03, respectively.

The moisture contents of samples collected from the organics layer were 32% and 41%.

5.3 Sand Fill

Sand fill containing some gravel and trace to some silt and clay was encountered below the asphalt in Borehole KN11-02. Occasional cobbles and boulders were encountered within the sand fill between 1.8 m and 2.9 m depth. The thickness of the sand fill was 3.7 m.

The depth to the base of the fill was 3.7 m (elevation 97.8).

Standard Penetration tests performed in the sand fill layer gave SPT N-values of 18 blows per 0.3 m penetration to 50 blows for less than 0.1 m penetration. These N-values indicate a compact to very dense relative density. N-values of 50 blows for less than 0.1 m penetration appear to correspond to the presence of cobbles and boulders in the fill.

The moisture content of samples of the sand fill generally varies between 5% and 12%.

A sample of the sand fill underwent gradation analysis testing. These results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curve for this sample is included in Figure B1 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	19
Sand	64
Silt and Clay	17

5.4 Silt

Native silt containing trace to some clay was encountered below the layer of organics in Boreholes KN11-01 and KN11-03 and below the sand fill in Borehole KN11-02. The thickness of the silt layer varied from 3.8 m to 5.7 m.

The depth to the base of the silt was 4.6 m and 7.5 m (elevations 94.7 and 94.0) in Boreholes KN11-01 and KN11-02, respectively.

Borehole KN11-03 was terminated within the silt layer at 6.1 m depth (elevation 92.9) upon refusal on probable bedrock or boulders.

Standard Penetration tests recorded in the silt layer gave SPT N-values of 5 to 22 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The moisture content of samples from the silt layer generally varies between 18% and 24%.

Selected samples of the silt underwent gradation analysis testing, the results of which are summarized below. These results are also summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for the tested samples are included in Figure B2 of Appendix B.

Soil Particles	Percentage (%)
Gravel	0
Sand	0
Silt	88 to 91
Clay	9 to 12

5.5 Sandy Silt

Grey sandy silt containing trace clay was encountered in Borehole KN11-01 below the silt layer at 4.6 m depth (elevation 94.7). The thickness of the sandy silt layer was 3.0 m.

Borehole KN11-01 was terminated within the sandy silt layer at 7.6 m depth (elevation 91.7) upon refusal on probable bedrock or boulder.

Standard Penetration tests recorded in the sandy silt layer gave SPT N-values of 3 and 5 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The moisture contents of samples from the sandy silt were 19% and 21%.

One sample of the sandy silt was selected for laboratory gradation analysis testing, the results of which are summarized below. These results are also summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curve for this sample is presented in Figure B3 of Appendix B.

Soil Particles	Percentage (%)
Gravel	0
Sand	29
Silt	67
Clay	4

5.6 Sand

Grey sand containing trace silt was encountered in Borehole KN11-02 below the silt at 7.5 m depth (elevation 94.0). The thickness of the sand layer was 2.9 m.

Borehole KN11-02 was terminated within the sand layer at 10.4 m depth (elevation 91.1) upon refusal on probable bedrock or boulders.

Standard Penetration tests recorded in the sand gave SPT N-values of 4 blows per 0.3 m of penetration, indicating a loose relative density.

The moisture content of a sample from the sand layer was 21%.

5.7 Water Levels

Water levels were observed in the open boreholes upon completion of the drilling operations. One standpipe piezometer was installed in Borehole KN11-03 to monitor water levels after completion of drilling. The water levels measured in the open boreholes and piezometers are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
KN11-01	April 30, 2011	4.5	94.8	Open borehole
KN11-02	May 1, 2011	4.0	97.5	Open borehole
KN11-03	April 30, 2011	0.3	98.7	Open borehole
	May 3, 2011	0.3*	99.3	Piezometer
	May 4, 2011	0.3*	99.3	Piezometer
	May 5, 2011	0.3*	99.3	Piezometer

*Indicates artesian conditions (water level above ground surface)

The piezometric readings reveal that the groundwater level is 0.3 m above ground surface, indicating artesian conditions at this site.

The GA indicates that water level of Kennel Creek at this site on July 20, 2011 was at elevation 98.38.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and marked in the field by Thurber Engineering Ltd. Upon completion of drilling, the borehole elevations were established from a contour plan provided by Genivar.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Mr. George Azzopardi of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of this report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. R. Palomeque Reyna, P.Eng.

Thurber Engineering Ltd.

L. Blaine Dec. 16/11
Lindsey Blaine, E.I.T.
Project Manager

R. Palomeque Reyna, P.Eng.
Geotechnical Engineer



P. K. Chatterji, P.Eng.
Review Principal



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

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
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)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
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				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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 0.1m in length or larger as a percentage of total core run length.
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 KN11-01

1 OF 1

METRIC

W.P. 6026-07-00 LOCATION N 4 990.1 E 1 021.3 Kenel Creek Culvert ORIGINATED BY GA
 HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.04.30 - 2011.04.30 CHECKED BY LRB

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)	
99.3								20	40	60	80	100	20	40	60		
0.0	ORGANICS, mixed with silty clay		1	SS	12		99										
99.0	Dark Brown																
0.3	SILT, some clay																
	Compact		2	SS	18		98										
	Grey																
	Damp to Moist		3	SS	20		97										
			4	SS	20		96										0 0 89 11
			5	SS	18		95										
94.7							94										
4.6	Sandy SILT, trace clay		6	SS	5		93										0 29 67 4
	Loose to Very Loose																
	Grey																
	Wet		7	SS	3		92										
91.7																	
7.6	END OF BOREHOLE AT 7.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN TO 7.6m AND WATER LEVEL AT 4.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

ONTMT4S 0940.GPJ 12/12/11

1 OF 1

W.P.	6026-07-00	LOCATION	N 4 990.2 E 1 019.1 Kenel Creek Culvert	ORIGINATED BY	GA
HWY	617	BOREHOLE TYPE	Dynamic Cone Penetration Test	COMPILED BY	AN
DATUM	Geodetic	DATE	2011.04.30 - 2011.04.30	CHECKED BY	LRB

[illegible]

ONTMT4S 0840.GPJ 12/12/11

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No KN11-02

1 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 4 997.4 E 1 024.4 Kenel Creek Culvert ORIGINATED BY GA
 HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.05.01 - 2011.05.01 CHECKED BY LRB

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								
								WATER CONTENT (%)								
101.5							20	40	60	80	100	20	40	60		
101.5	ASPHALT: (40mm)		1	SS	18											
	SAND, some gravel, trace to some silt and clay Compact to Dense Brown Damp (FILL)		2	SS	40											
	Very Dense Occasional cobbles and boulders from 1.8m to 2.9m		3	SS	50/ 0.150											
			4	SS	50/ 0.100											
	Compact		5	SS	21											
97.8																
97.8	SILT, some clay Compact Light Grey Wet															
			6	SS	18											
			7	SS	13											

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KN11-02

2 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 4 997.4 E 1 024.4 Kenel Creek Culvert ORIGINATED BY GA
HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.05.01 - 2011.05.01 CHECKED BY LRB

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		
	Continued From Previous Page															
91.1	SAND, trace silt Loose															
10.4	Grey Wet					91										
	END OF BOREHOLE AT 10.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN TO 10.4m AND WATER LEVEL AT 4.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 10.4m TO 0.15m, THEN ASPHALT PATCH TO SURFACE.															

RECORD OF BOREHOLE No KN11-03

1 OF 1

METRIC

W.P. 6026-07-00 LOCATION N 5 020.9 E 1 029.1 Kenel Creek Culvert ORIGINATED BY GA
 HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.04.30 - 2011.04.30 CHECKED BY LRB

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
99.0														
0.0	ORGANICS, mixed with sand Grey		1	SS	5		99							
98.6														
0.4	SILT, trace to some clay Loose to Compact Light Grey Wet		2	SS	13		98							
			3	SS	17		97							
			4	SS	16		96							0 0 91 9
			5	SS	22		95							
							94							0 0 89 11
92.9	Loose		6	SS	5		93							
6.1	END OF BOREHOLE AT 6.1m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDERS. WATER LEVEL OBSERVED AT 0.3m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May03/ 11 0.3* 99.3 May04/ 11 0.3* 99.3 May05/ 11 0.3* 99.3 * Artesian condition (Above ground surface)													

+ ³, x ³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No DCPT-KN11-03

1 OF 1

METRIC

W.P. 6026-07-00 LOCATION N 5 021.1 E 1 026.5 Kenel Creek Culvert ORIGINATED BY GA
HWY 617 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2011.04.30 - 2011.04.30 CHECKED BY LRB

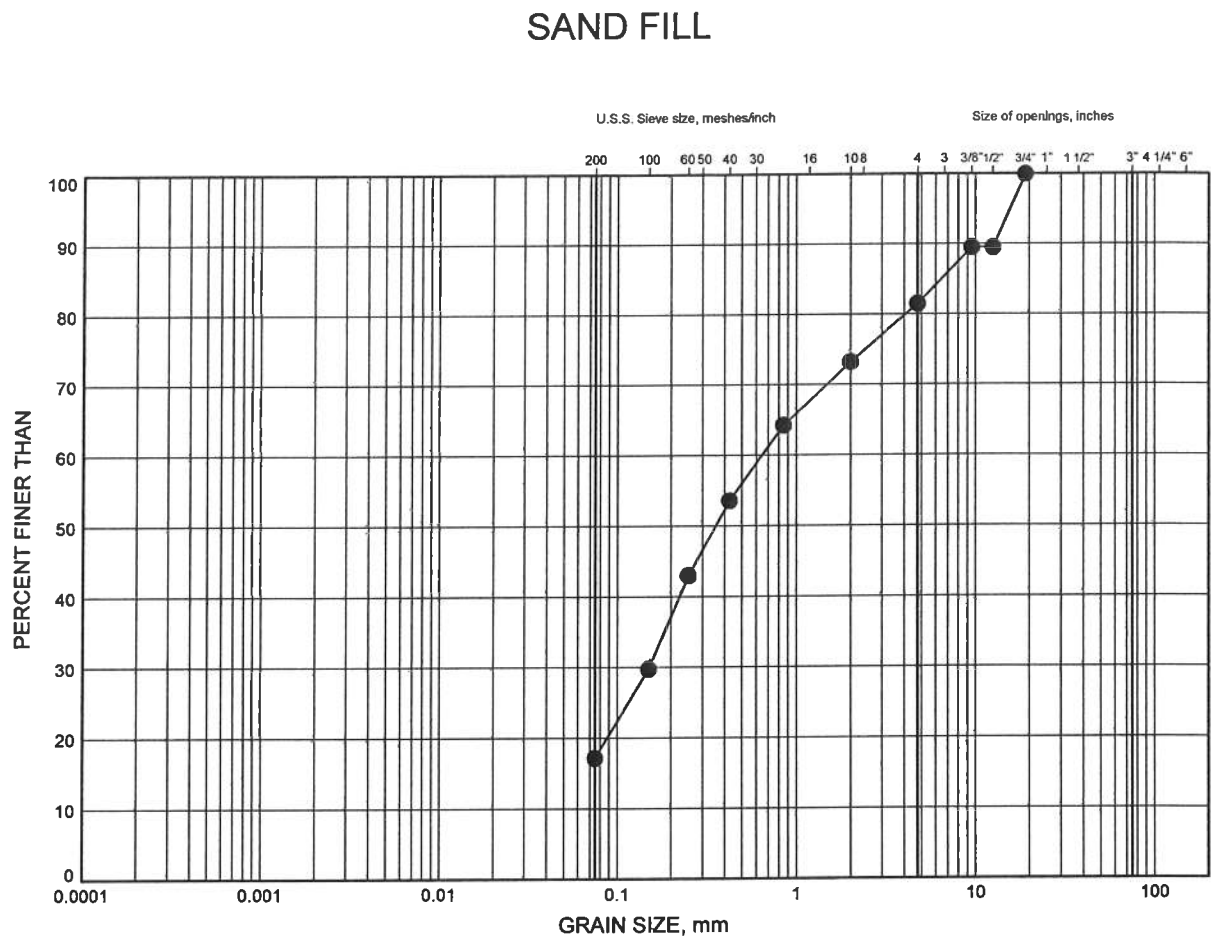
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
99.0 0.0	Start DCPT from surface.												
92.2 6.8	END OF DCPT AT 6.7m.												

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

Appendix B
Laboratory Test Results

NWR HWY 11 Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KN11-02	3.35	98.15

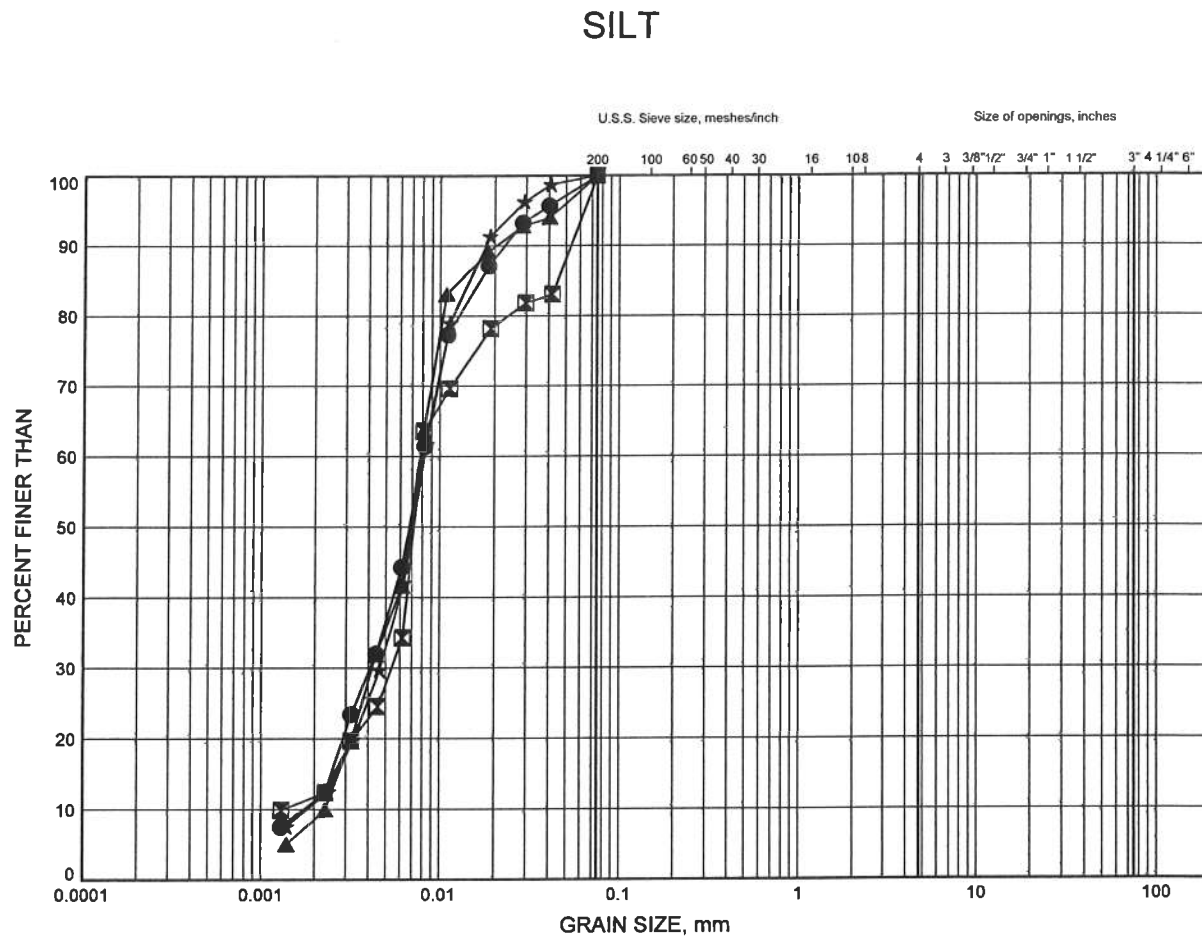
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 7/14/11

W.P.# 19-5308-40
Prepared By AN
Checked By LRB



NWR HWY 11 Bridge GRAIN SIZE DISTRIBUTION

FIGURE B2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KN11-01	2.57	96.73
⊠	KN11-02	4.88	96.62
▲	KN11-03	2.57	96.43
★	KN11-03	4.88	94.12

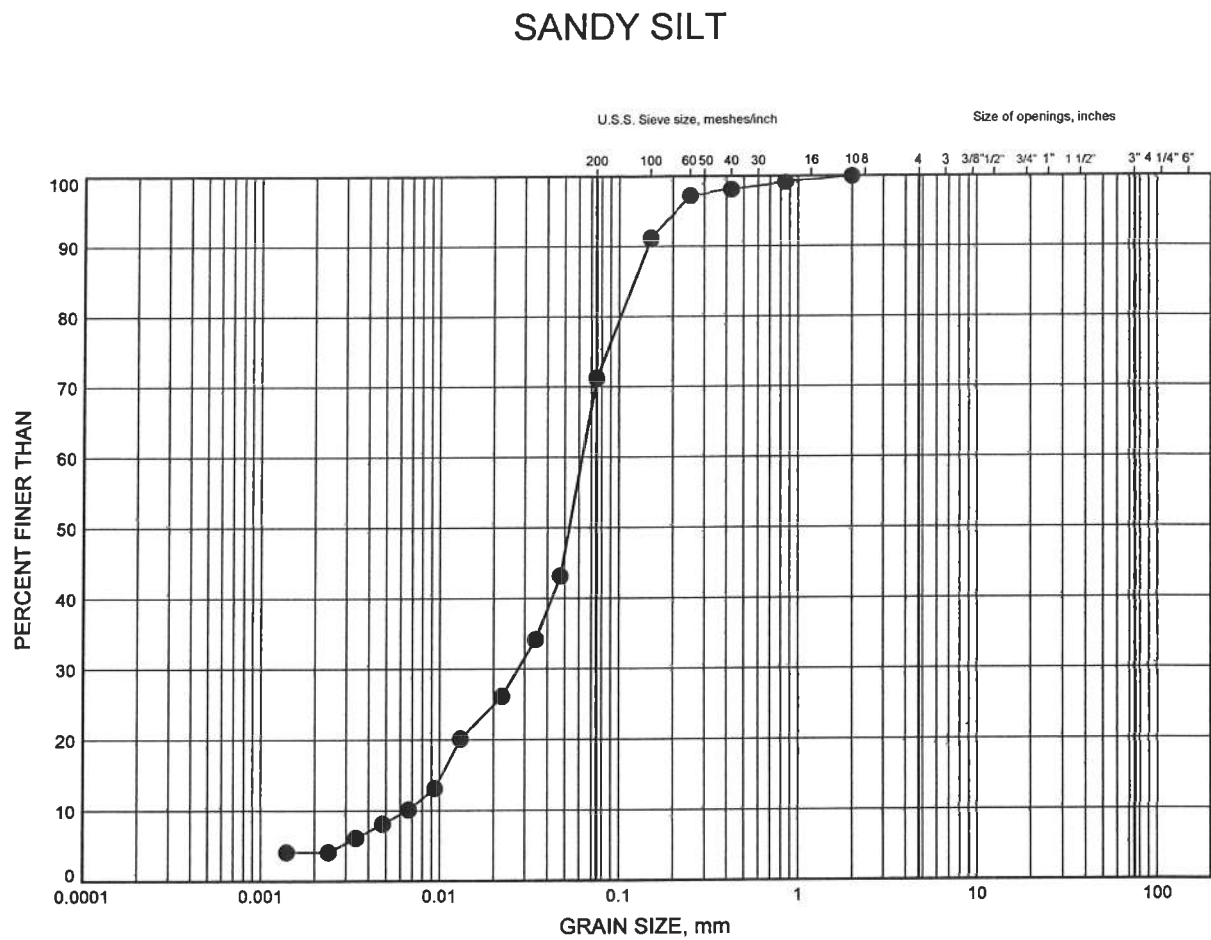


W.P.# 19-5308-40
Prepared By AN
Checked By LRB

NWR HWY 11 Bridge

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)
●	KN11-01	6.40	92.90



W.P.# 19-5308-40
Prepared By AN
Checked By LRB

Appendix C
Site Photographs



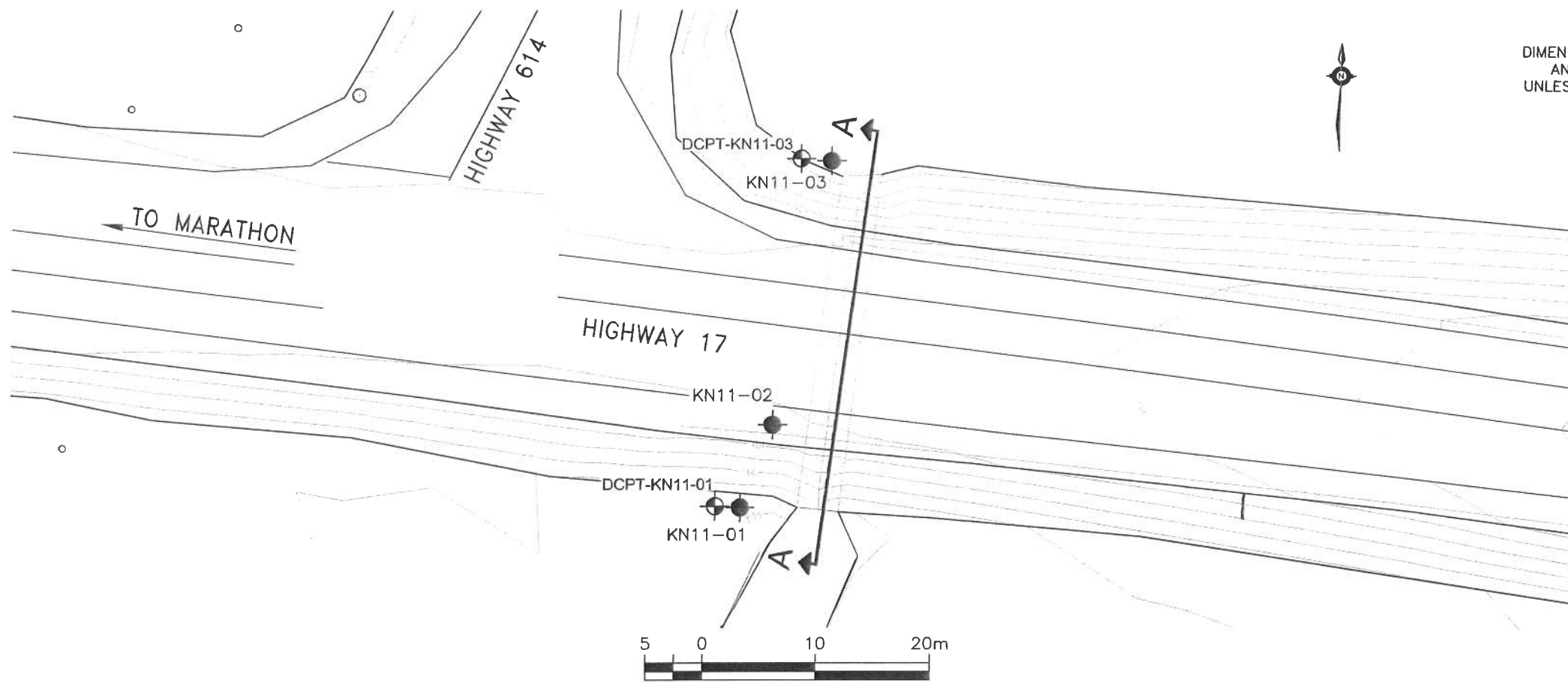
Photograph 1 – Kenel Creek Culvert, north end



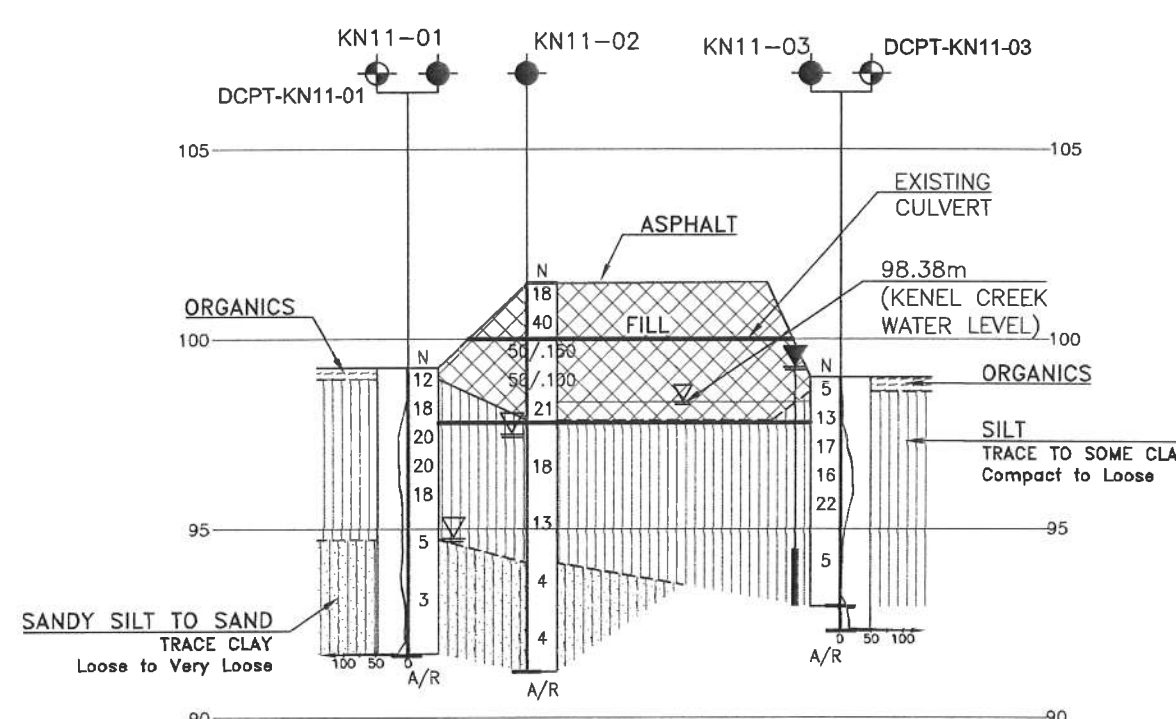
Photograph 2 – Kenel Creek Culvert, south end

Appendix D

Borehole Locations and Soil Strata Drawings



SCALE: 1:500
PLAN

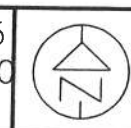


SECTION A-A
HOR 1:500
VER 1:200

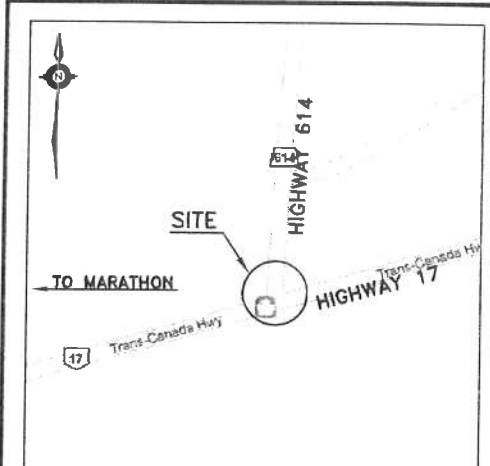
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2011-6025
GWP No 6026-07-00
WP No 6026-07-01

KENEL CREEK CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET
20



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
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
KN11-01	99.3	4 990.1	1 021.3
KN11-02	101.5	4 997.4	1 024.4
KN11-03	99.0	5 020.9	1 029.1
DCPT-KN11-01	99.3	4 990.2	1 019.1
DCPT-KN11-03	99.0	5 021.1	1 026.5

-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.

GEOCRES No. 42C-25



DATE	BY	DESCRIPTION
DESIGN	LRB	CHK LRB
DRAWN	AN	CHK
CODE	LOAD	DATE DEC. 2011
SITE	STRUCT	JDWG 1