



**Submitted To AECOM Canada Ltd.
189 Wyld Street Suite 103, North Bay, Ontario P1B 1Z2
On Behalf of the Ontario Ministry of Transportation**

**Highway 144 Rehabilitation
Culvert Replacement
Elboga Lake Culvert
Station 15+629 – Twp. Of Muldrew
GWP 5468-09-00**

**Highway 144
From 0.3 km North of Halfway Lake Channel Culvert,
Northerly 19.4 km
MTO Sudbury Area**

FINAL FOUNDATION INVESTIGATION REPORT

Date: March 17, 2014
Ref. N^o: 12/09/12182

Geocres No. 41P-55

LVM | MERLEX



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Final Foundation Investigation Report

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LVM inc.'s subcontractors who may have accomplished work either on site or in laboratory are duly qualified as stated in our Quality Manual's procurement procedure. Should you require any further information, please contact your Project Manager."

Client:

AECOM Canada Ltd.

189 Wyld Street, Suite 103

North Bay, Ontario

P1B 1Z2

Attention: **Mr. Al Rose**

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1 INTRODUCTION

LVM | Merlex Ltd. has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation at an existing Structural Plate Corrugated Steel Pipe (SPCSP) centreline culvert site. The site is located at Elboga Lake on Highway 144, some 38.2 km North of the Town of Cartier, in the Township of Muldrew.

The foundation investigation location was specified by the MTO in the Terms of Reference for additional work under Agreement No. 5011-E-0012. The terms of reference for the scope of work are outlined in LVM | Merlex Ltd.'s Proposal 12/09/12182-144, dated May, 2013 and submitted under Change Order No. 3. The purpose of this investigation was to determine the subsurface conditions in the area of the culvert and proposed detour. LVM | Merlex Ltd. investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2 SITE DESCRIPTION

The Elboga Lake Structural Plate Corrugated Steel Pipe (SPCSP) culvert is located on Highway 144 at Station 15+629, Township of Muldrew. The culvert is located in a bedrock controlled valley, with elevated bedrock outcroppings to the north and south of the culvert. The valley connects Elboga Lake to the east (right) with Shamberson Lake to the west (left). The existing highway embankment currently supports two undivided lanes, running in a north-south direction. The existing highway, at the culvert location, is constructed on a rock fill embankment some 8.1 m in height, with centerline elevation of approximately 431.2 m at the culvert location. The existing embankment slopes are at an average angle of approximately 1.4H:1V. The culvert at this location is reported as a 2.1 m diameter Structural Plate Corrugated Steel Pipe (SPCSP) culvert, some 47.9 m in length. Flow through the culvert is from west to east (left to right) (see Photo Essay, Appendix 4).

Infrastructure at the culvert location consists of overhead wires on the right (east) side of the highway.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Eastern Sandy Uplands. The topography on this section of Highway 144 is generally rolling. Significant layers of earth overlay the bedrock. There are numerous bedrock outcroppings throughout the site area. Organic terrain was also observed. Within the project area native overburden consists primarily of a sand and gravel containing various amounts of silt, cobbles, and boulders.

Bedrock in the area, as indicated on OGS Map 2506, is of the Early Precambrian Era consisting of Felsic Igneous and Metamorphic Rocks including; granitic rocks, syenite, pegmatite, and unsubdivided migmatite. At the location of this culvert foundation investigation, the bedrock generally comprises of granitic rock, based on the diamond core drilling carried out at the site.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out during the period of August 8th to September 25th, 2013 during which time ten (10) sampled boreholes were advanced. Four (4) boreholes were advanced through the embankment, two (2) boreholes were advanced to the right of the embankment, in the area of the culvert outlet, and four (4) boreholes were advanced along the detour to the left (west) of the embankment with one of these boreholes advanced at the inlet end of the culvert.

The field investigation was carried out using both a Bombardier mounted CME 45 drill rig and a truck mounted CME 75 drilling rig equipped with hollow stem augers, standard augers, NQ size coring equipment and routine geotechnical sampling equipment. Soil samples were obtained from the boreholes at regular intervals of depth using the standard 50 mm O.D. split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures (ASTM D-1586). The SPT method involves advancing a 50 mm O.D. split spoon sampler with the force of a 63.5 kg hammer freely dropping 760 mm mounted in a trip (automatic) hammer. The number of blows per 300 mm penetration was recorded as the “N” value. At some of the sample depths blow counts of 25 or greater blows for 0 mm penetration were encountered. This sample spoon refusal was shown on the Record of Borehole Logs as “25/0mm” and was due to a cobble or boulder size obstruction at the sample depth. To penetrate the obstructions NQ coring equipment was employed to advance the hole. This diamond core equipment was advanced at a constant feed rate. Because of the numerous voids in the rock fill no wash water was observed returning to the collar of the borehole. All boreholes were advanced to the predetermined depth or 3 metres into bedrock. All samples obtained during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and selected laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following, completion of the individual boreholes. Standpipes were installed in select boreholes prior to backfilling. All open boreholes were backfilled upon completion with compacted auger cuttings in the general order they were removed and, where necessary, bentonite pellet backfill was added to the boreholes to bring them up to grade. At the borehole(s) through the embankment, the surface of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing asphalt surface.

The field work for this investigation was completed under the full time direction of a senior member of our engineering staff, who was responsible for locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transport to our North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in our laboratory. Laboratory testing of select samples included routine testing for natural moisture content determination, particle size analysis, Atterberg Limits determination, as well as specific

gravity testing. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix 2), with a summary of results presented on the laboratory sheets in Appendix 3 (Figures Nos. L-1 to L-4).

The location of the individual boreholes were determined in the field using highway centreline chainage (established by others) and offset relative to highway centreline. The MTO co-ordinates, northing and easting, were then established for the boring locations. Elevations contained in this report are referenced to a geodetic datum. The borehole elevations are based on a survey carried out by exp. Services.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Records of Borehole Logs (Appendix 2) and on Drawing No. 2 (Appendix 3). Please note that stratigraphic delineation presented on the borehole logs and soil strata plot are the results of non-continuous sampling, response to drilling progress, the results of SPT, plus field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological unit. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location, and hence the interpreted stratigraphy is shown on the drawings for illustration purposes only.

4.1 ELBOGA LAKE CULVERT

A plan and profile illustrating the borehole locations and stratigraphic sequences is shown on Drawing No. 2, Appendix 3. During the course of the exploration program, four (4) sampled boreholes were put down at this site, with Borehole Nos. 1 and 7 advanced at the culvert ends (inlet (left/west) and outlet (right/east), respectively), Borehole Nos. 2, 3, 4, and 5 advanced through the embankment, Borehole No. 6 advanced to the right (east) of the embankment, and Borehole Nos. 8, 9, and 10 advanced along the proposed detour alignment to the left (west) of the embankment. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 10 were recorded at Elevations 424.1, 431.4, 432.7, 429.7, 430.9, 424.9, 424.0, 424.6, 423.4, and 431.6 m, respectively.

4.1.1 Pavement Structure

Borehole Nos. 2 to 5, inclusive, were advanced from the highway shoulder where a layer of asphalt some 100 to 200 mm thick was penetrated. At Borehole No. 2, the asphalt layer was underlain by a layer of crushed gravel approximately 100 mm thick.

4.1.2 Granular Fill

Underlying the pavement structure, at Borehole Nos. 2 to 5 inclusive, a layer of granular fill consisting of brown gravelly sand to gravel and sand trace silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 7 to 14%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 39

to 59% gravel size particles, 37 to 53% sand size particles, and 4 to 8% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 26 to 86 blows per 300 mm penetration, the compactness of this deposit was described as compact to very dense. This deposit was encountered to depths of 1.2, 2.0, 0.6, and 0.8 m below grade at Borehole Nos. 2 to 5, respectively (elevations 430.2, 430.7, 429.1, and 430.1 m, respectively).

4.1.3 **Rock Fill**

Underlying the granular fill at Borehole Nos. 2, 4, and 5, a layer of rock fill was penetrated. NQ size coring equipment was used to penetrate the rock fill. The rock fill contained numerous voids, based on the lack of wash water return. Sample recovery was very poor (0 to 10%) in the rock fill. A pocket of gravelly sand was encountered, partially filling a rock fill void, between 3.0 and 3.5 m depth at Borehole No. 2, indicating the rock fill was mixed with sands, gravel, and rock spall. The rock fill was encountered to depths of 5.8, 1.4, and 7.9 m below grade at Borehole Nos. 2, 4, and 5, respectively (elevations 425.6, 428.3, and 423.0 m, respectively).

4.1.4 **Fill**

Underlying the rock fill at Borehole No. 2, a layer of fill described as brown sand and gravel trace silt (likely embedment fill) was penetrated. The natural moisture content measured on samples of this deposit was in the order of 9%. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 43% gravel size particles, 50% sand size particles, and 7% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 3 to 32 blows per 300 mm penetration, the compactness of this deposit was described as very loose to dense, generally compact. This deposit was encountered to a depth of 7.6 m below grade (elevations 423.8 m).

4.1.5 **Surficial Organics**

At surface, at Borehole Nos. 9 and 10, a layer of surficial organics some 50 to 300 mm thick was penetrated.

4.1.6 **Sands**

Underlying the granular fill at Borehole No. 3, underlying the rock fill at Borehole Nos. 4 and 5, underlying the fill at Borehole No. 2, at surface at Borehole Nos. 1, 6, 7, and 8, and underlying the surficial organics at Borehole Nos. 9 and 10, a deposit of sands with varying silt and gravel content was penetrated. Numerous cobbles and boulders were encountered in this deposit, except at Borehole No. 9. Due to the concentration of cobbles and boulders, NQ size casing and coring equipment was required to advance the borehole through this stratum. A 600 mm length of boulder core was retrieved while coring through this deposit. It should be noted that due to the high concentration of cobbles and boulders, and coarse gravel content in this deposit, sample return in the 37.5 mm I.D. split spoon sampler was generally poor. The natural moisture content measured on samples of this deposit was in the order of 6 to 9%. Organics were encountered near surface in this deposit at several boreholes, resulting in elevated moisture contents. Gradation analyses were carried out on ten (10) samples of this deposit, the

results of which indicated 8 to 42% gravel size particles, 31 to 79% sand size particles, and 9 to 49% silt and clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 11 to 102 blows per 300 mm penetration, the compactness of this deposit was described as compact to very dense. The high concentrations of cobbles and boulders impacted the SPT values however generally the compactness of the sand stratum can be considered as dense. Sampling was terminated in this deposit at a depth of 8.1 m below grade at Borehole No. 7 (elevation 415.9 m). This deposit was encountered to depths of 5.8, 9.1, 4.4, 9.1, 8.5, 4.9, 3.1, 2.6, and 2.4 m below grade, where bedrock was encountered, at Borehole Nos. 1 to 6, inclusive, and Borehole Nos. 8, 9, and 10, respectively (elevations 418.3, 422.3, 428.3, 420.6, 422.4, 420.0, 421.5, 420.8, and 429.2 m, respectively).

4.1.7 Bedrock

Underlying the sand stratum at Borehole Nos. 1 to 6, inclusive, and Borehole Nos. 8, 9, and 10, bedrock was encountered. NQ size coring equipment was used to retrieve bedrock cores. The bedrock was described as grey granitic rock. Based on Rock Quality Designation (RQD) values of 13 to 91%, the quality of rock was described as very poor to excellent, generally fair quality. Sampling was terminated in the bedrock at depths of 9.1, 12.2, 7.4, 12.2, 11.3, 7.9, 5.9, 5.9, and 5.4 m below grade at Borehole Nos. 1 to 6, inclusive, and Borehole Nos. 8, 9, and 10, respectively (Elevations 415.0, 419.2, 425.3, 417.5, 419.6, 417.0, 418.7, 417.5, and 426.2 m, respectively).

4.2 GROUNDWATER DATA

At the time of this investigation, the water level in the culvert was measured at elevation 424.1 and 422.8 m at the inlet and outlet, respectively.

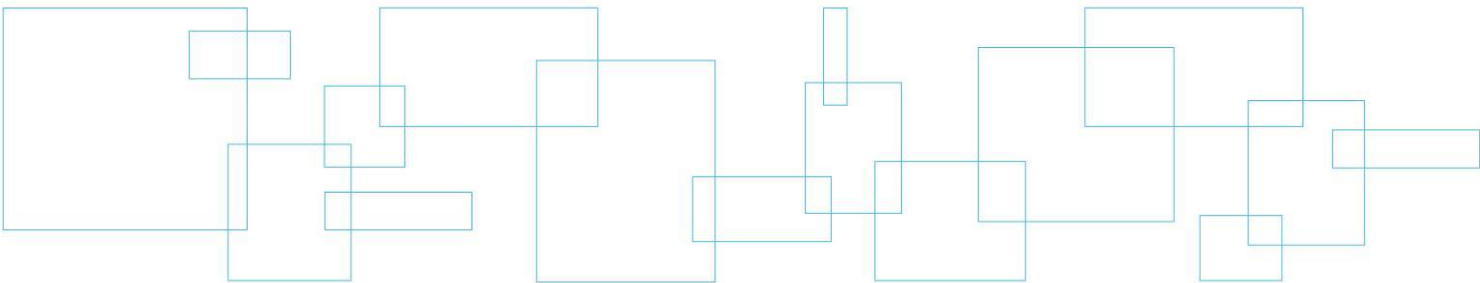
Measurements of the groundwater and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. A standpipe was installed in Borehole No. 2, to obtain post borehole completion water levels. At the time the field work was undertaken, the water level in the standpipe at Borehole No. 2 had stabilized at Elevation 422.7 m. Water levels are recorded on the individual Record of Borehole Log Sheets (Appendix B).

Along the detour alignment the water level was measured between Elevations 423.1 to 428.9 m. The latter water level, at Elevation of 428.9 m, indicates the water is perched in a granular pocket on the bedrock in the area of Borehole No. 10. Groundwater was not encountered in Borehole Nos. 3, 4, and 5.

The groundwater and stream water levels will fluctuate seasonally/yearly.

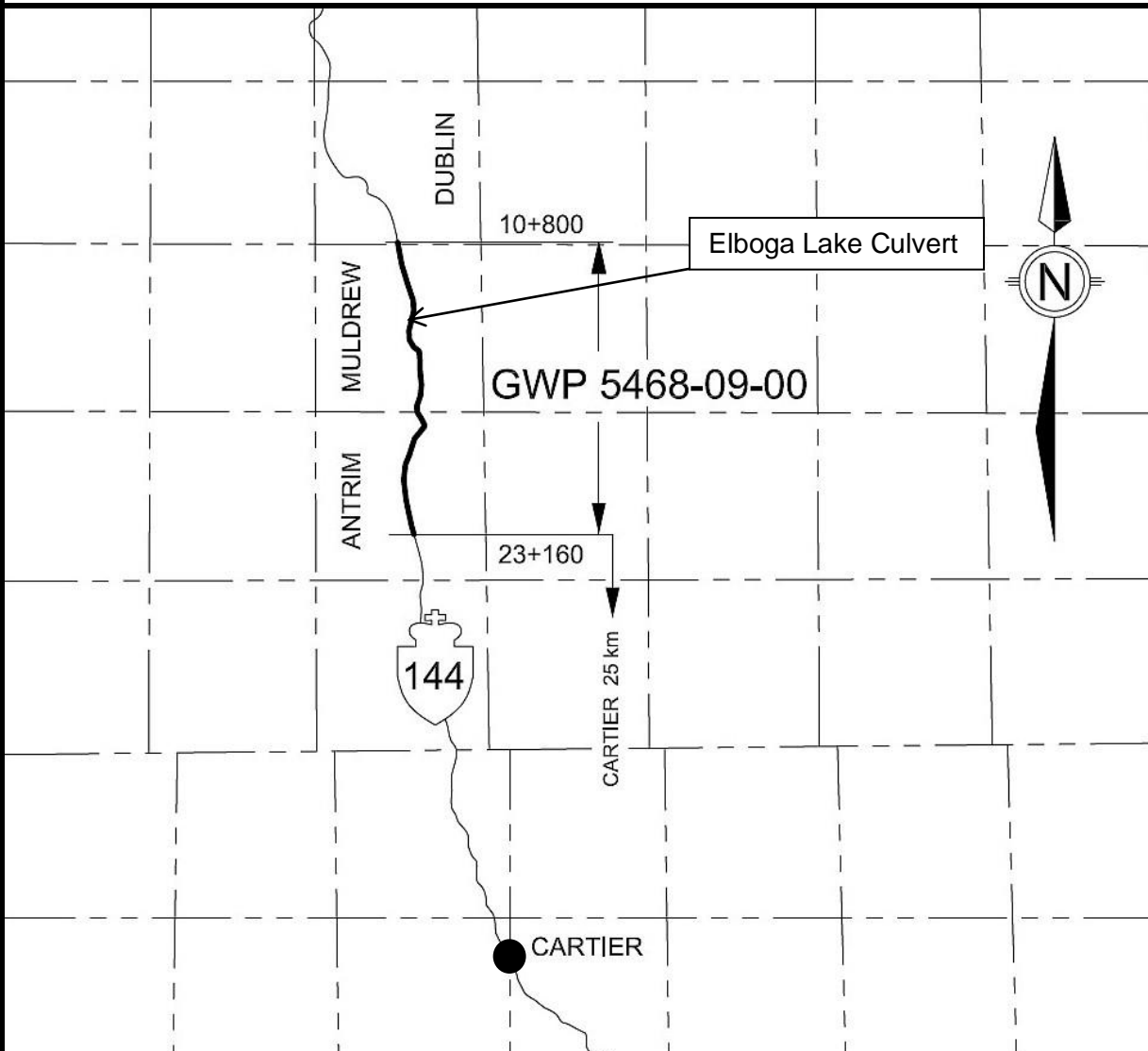
Appendix 1 Key Plan

Drawing No. 1 Key Plan



KEY PLAN

NOT TO SCALE



**FINAL
FOUNDATION INVESTIGATION REPORT
GWP 5468-09-00**

Highway 144 – Elboga Lake Culvert
From 0.3 km North of Halfway Lake
Channel Culvert, Northerly 19.4 km

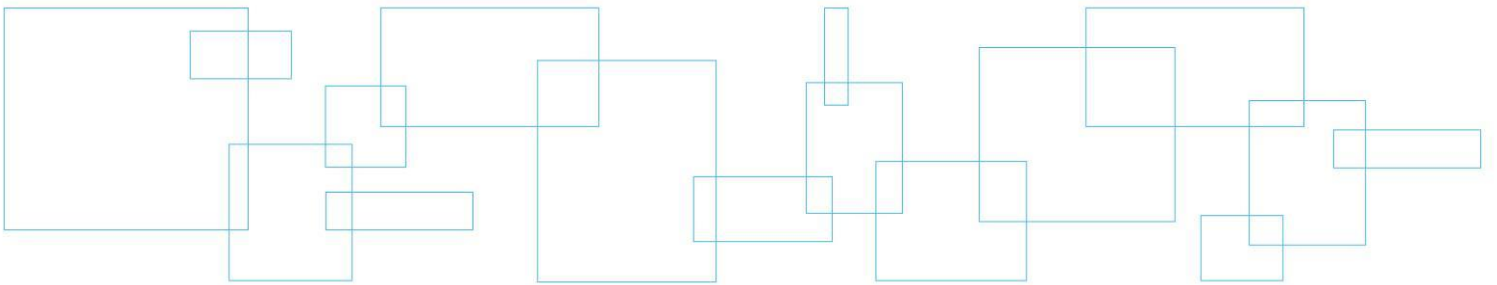
LVM Reference: 12/09/12182

March 2014

LVM | MERLEX

Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 11	Record of Borehole Sheet



LIST OF ABBREVIATIONS & DESCRIPTION OF TERMS

The abbreviations and terms, used to describe retrieved samples and commonly employed on the borehole logs, on the figures and in the report are as follows:

1. ABBREVIATIONS

AS	Auger Sample
CS	Chunk Sample
DS	Denison type sample
FS	Foil Sample
NFP	No Further Progress
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
RC	Rock core with size & percentage of recovery
SS	Split Spoon
ST	Slotted Tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash Sample

2. PENETRATION RESISTANCE/"N"

Dynamic Cone Penetration Test (DCPT):

A continuous profile showing the number of blows for each 300 mm of penetration of a 50 mm diameter 60° cone attached to AW rod driven by a 63 kg hammer falling 760 mm.

Plotted as —●—●—●—●—

Standard Penetration Test (SPT) or "N" Values

The number of blows of a 63 kg hammer falling 760 mm required to advance a 50 mm O.D. drive open sampler 300 mm.

3. SOIL DESCRIPTION

a) *Cohesionless Soils:*

"N" (blows/0.3 m)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

b) *Cohesive Soils:*

Undrained Shear Strength (kPa)	Consistency
Less than 12	very soft
12 to 25	soft
25 to 50	firm
50 to 100	stiff
100 to 200	very stiff
over 200	hard

3. SOIL DESCRIPTION (Cont'd)

c) *Method of Determination of Undrained Shear Strength of Cohesive Soils:*

+ 3.2 - Field Vane test in borehole.
The number denotes the sensitivity to remoulding.

D - Laboratory Vane Test

" - Compression test in laboratory

For a saturated cohesive soil the undrained shear strength is taken as one-half of the undrained compressive strength.

4. TERMINOLOGY

Terminology used for describing soil strata is based on the proportion of individual particle sizes present in the samples (please note that, with the exception of those samples subject to a grain-size analysis, all samples were classified visually and the accuracy of visual examination is not sufficient to determine exact grain sizing):

Trace, or occasional	Less than 10%
Some	10 to 20%
With	20 to 30%
Adjective (i.e. silty or sandy)	30 to 40%
And (i.e. sand and gravel)	40 to 60%

Terminology for cobbles and/or boulders frequency is an estimate based on drill response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not severely impeded
Numerous	Obstructions appear essentially continuous over drilled length

5. LABORATORY TESTS

P	Standard Proctor Test
A	Atterberg Limit Test
GS	Grain Size Analysis
H	Hydrometer Analysis
C	Consolidation

SAMPLE DESCRIPTION NOTES:

1. **FILL:** The term fill is used to designate all man-made deposits of natural soil and/or waste materials. The reader is cautioned that fill materials can be very heterogeneous in nature and variable in depth, density and degree of compaction. Fill materials can be expected to contain organics, waste materials, construction materials, shot rock, rip-rap, and/or larger obstructions such as boulders, concrete foundations, slabs, abandoned tanks, etc.; none of which may have been encountered in the borehole. The description of the material penetrated in the borehole therefore may not be applicable as a general description of the fill material on the site as boreholes cannot accurately define the nature of fill material. During the boring and sampling process, retrieved samples may have certain characteristics that identify them as 'fill'. Fill materials (or possible fill materials) will be designated on the Borehole Logs. If fill material is identified on the site, it is highly recommended that testpits be put down to delineate the nature of the fill material. However, even through the use of testpits defining the true nature and composition of the fill material cannot be guaranteed. Fill deposits often contain pockets or seams of organics, organically contaminated soils or other deleterious material that can cause settlement or result in the production of methane gas. It should be noted that the origins and history of fill material is frequently very vague or non-existent. Often fill material may be contaminated beyond environmental guidelines and the material will have to be disposed of at a designated site (i.e. registered landfill). Unless requested or stated otherwise in this report, fill material on this site has not been tested for contaminants however, environmental testing of the fill material can be carried out at your request. Detection of underground storage tanks cannot be determined with conventional geotechnical procedures.
2. **TILL:** The term till indicates a material that is an unstratified, glacial deposit, heterogeneous in nature and, as such, may consist of mixtures and pockets of clay, silt, sand, gravel, cobbles and/or boulders. These heterogeneous deposits originate from a geological process associated with glaciation. It must be noted that due to the highly heterogeneous nature of till deposits, the description of the deposit on the borehole log may only be applicable to a very limited area and therefore, caution must be exercised when dealing with a till deposit. When excavating in till, contractors may encounter cobbles/boulders or possibly bedrock even if they are not indicated on the borehole logs. It must be appreciated that conventional geotechnical sampling equipment does not identify the nature or size of any obstruction.
3. **BEDROCK:** Auger refusal may be due to the presence of bedrock, but possibly could also be due to the presence of very dense underlying deposits, boulders or other large obstructions. Auger refusal is defined as the point at which an auger can no longer be practically advanced. It must be appreciated that conventional geotechnical sampling equipment does not differentiate between nature and size of obstructions that prevent further penetration of the boring below grade. Bedrock indicated on the borehole logs will be labeled 'possibly' or 'probable' etc. based on the response of the boring and sampling equipment, surrounding topography, etc. Bedrock can be proven at individual borehole locations, at your request, by diamond core drilling operations or, possibly, by testpits. It must also be appreciated that bedrock surfaces can be, and most times are, very erratic in nature (i.e. sheer drops, isolated rock knobs, etc.) and caution must be used when interpreting subsurface conditions between boreholes. A bedrock profile can be more accurately estimated, at the clients' request, through a series of closely positioned unsampled auger probes combined with core drilling.
4. **GROUNDWATER:** Although the groundwater table may have been encountered during this investigation and the elevation noted in the report and/or on the record of boreholes, it must be appreciated that the elevation of the groundwater table will fluctuate based upon seasonal conditions, localized changes, erratic changes in the underlying soil profile between boreholes, underlying soil layers with highly variable permeabilities, etc. These conditions may affect the design and type and nature of dewatering procedures. Cave-in levels recorded in borings give a general indication of the groundwater level in cohesionless soils however, it must be noted that cave-in levels may also be due to the relative density of the deposit, drilling operations etc.

METRIC

RECORD OF BOREHOLE NO. 01



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209833.4 E 256233.4 - Muldrew Township Station 15+644 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 4 TIME 2013 September 4 (Completed) 2013 September 4 CHECKED BY MAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE								
424.1 0.0	Ground Surface SAND - Cobbles/boulders in sand and gravel matrix trace organic at surface		1	SS	27/150 mm	424						8 79 (13)
			2	SS	86/275 mm	423						42 47 (11)
			3	SS	70/150 mm 30/25 mm	422						40 51 (9)
			4	SS	80/125 mm	421						
			5	RC	Rec=10%	420						
			6	RC	Rec=10%	419						
			7	RC	Rec=10%	418						
418.3 5.8	BEDROCK - grey granitic rock fair to good quality		8	RC	Rec=100% ROD=83%	417						
			9	RC	Rec=100% ROD=58%	416						
			10	RC	Rec=100% ROD=65%	415						
415.0 9.1	End of Borehole											

start advancing NQ size coring equipment
600 mm diameter boulder at 2.5 m depth

COMMENTS

+ 3, × 3 : Numbers on right refer to Sensitivity
 Numbers on left refer to values greater than 120 kPa
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 13/9/4 5:30:00 PM	-0.05	2.7
2) 13/9/9 10:50:00 AM	-0.05	-
3) 13/9/11 9:15:00 AM	-0.05	-

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 02



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209811.2 E 256241.7 - Muldrew Township Station 15+633 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Truck Mounted CME 75 - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 August 8 TIME
 DATE (Completed) 2013 August 8 (Completed) CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 WATER CONTENT (%) 20 40 60 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	STRATA PLOT	NUMBER	TYPE	"N" VALUES					
431.4	Ground Surface									
0.0	150 mm Asphalt 100 mm Crushed Gravel FILL - brown gravel and sand trace silt (very dense)		1	SS	63					
430.2			2	SS	69					59 37 (4)
1.2	ROCK FILL cobble/boulder size rock fill		3	SS	25/0mm					
			4	SS	25/0mm					
	cobble/boulder size rock fill									
	void and 200 thick layer of gravelly sand encountered between 3.0 to 3.5 m depth		5	SS	11					
			6	SS	25/0mm					
	cobble/boulder size rock fill									
			7	SS	25/0mm					
	cobble/boulder size rock fill									
425.6										
5.8	FILL - brown sand and gravel trace silt (likely embedment granulars) (very loose/dense)		8	SS	3					
			9	SS	32					43 50 (7)
423.8	100 mm piece of asphalt SAND - cobble/boulder size rock in sand and gravel matrix (very dense)		10	RC	REC= 77%					
7.6										
			11	SS	50/100 mm					
422.3	BEDROCK - grey granitic rock poor to good quality		12	RC	REC= 92% ROD= 68%					
9.1										
Continued Next Page										
COMMENTS 1) No water return to surface during coring operations 2) Core advanced at constant rate								+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE		
								WATER LEVEL RECORDS		
								Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
								1) 13/8/8 12:30:00 PM	8.8	▽ -
								2) 13/8/8 4:10:00 PM	8.7	▽ -
								3) 13/8/9 8:30:00 AM	8.7	▽ -

The stratification lines represent approximate boundaries. The transition may be gradual.



METRIC

RECORD OF BOREHOLE NO. 02



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209811.2 E 256241.7 - Muldrew Township Station 15+633 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Truck Mounted CME 75 - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 August 8 TIME
 DATE (Completed) 2013 August 8 (Completed) CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	w_p	w	w_L		
	Continued from Previous Page																
	BEDROCK - grey granitic rock poor to good quality		13	RC	REC= 100% RQD= 88%												
			14	RC	REC= 100% RQD= 45%												
419.2 12.2	End of Borehole																

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 03



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209830.8 E 256258.9 - Muldrew Township Station 15+659 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Truck Mounted CME 75 - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 August 8 TIME
 DATE (Completed) 2013 August 8 (Completed) CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
432.7 0.0	Ground Surface 100 mm Asphalt		1	SS	86										
	FILL - brown sand and gravel trace silt (compact/very dense)		2	SS	26										
			3	SS	36										
430.7 2.0	SAND - cobble/boulder in sand and gravel matrix	4	SS	32											
		5	SS	25/0mm											
		6	SS	25/0mm											
428.3 4.4	BEDROCK - grey granitic rock fair to good quality	7	RC	REC= 100% ROD= 87%											
		8	RC	REC= 100% ROD= 63%											
425.3 7.4	And of Borehole														

COMMENTS

1) No water return to surface during coring operations 2) Core advanced at constant rate

The stratification lines represent approximate boundaries. The transition may be gradual.

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 13/8/8 6:30:00 PM	DRY	1.9
2)	-	-
3)	-	-

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 04



REFERENCE	12/09/12182	DATUM	Geodetic	LOCATION	N 5209780.9 E 256223.6 - Muldrew Township Station 15+598	ORIGINATED BY	JL
PROJECT	GWP 5468-09-00, Elboga Lake Culvert			BOREHOLE TYPE	Truck Mounted CME 75 - NW Casing, NQ Core	COMPILED BY	AT
CLIENT	AECOM Inc.	DATE (Started)	2013 August 9	TIME		CHECKED BY	MAM
		DATE (Completed)	2013 August 9	(Completed)			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa			W _p			W			W _L					
							○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)										
429.7	Ground Surface						20	40	60	80	100	20	40	60	20	40	60	KN/m ³	GR SA (SI CL)		
0.0	100 mm Asphalt		1	SS	85/250 mm																
429.1	FILL - brown sand and gravel trace silt																				
0.6	ROCK FILL - rock fill with gravel trace sand trace silt																				
			2	SS	20																
			3	SS	20																
			4	SS	19																
			5	SS	43																
			6	SS	29																
			7	SS	25/50 mm																
423.3	250 mm layer of asphalt		8	RC	Rec= 10%																
6.4	SAND - cobble/boulder size rock in sand and gravel matrix																				
420.6	BEDROCK - grey granitic rock		9	RC	REC= 93% RQD= 77%																
9.1	poor to good quality																				
Continued Next Page																					
COMMENTS						+ ³ , × ³ : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa						WATER LEVEL RECORDS									
1) No water return to surface during coring operations 2) Core advanced at constant rate						○ 3% STRAIN AT FAILURE						Date (dd/mm/yy)/Time						Water Depth (m)		Cave In (m)	
												1)						-		-	
												2)						-		-	
												3)						-		-	
The stratification lines represent approximate boundaries. The transition may be gradual																					

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17

METRIC**RECORD OF BOREHOLE NO. 04**

REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209780.9 E 256223.6 - Muldrew Township Station 15+598 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Truck Mounted CME 75 - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 August 9 TIME
 DATE (Completed) 2013 August 9 (Completed) CHECKED BY MAM

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	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	Continued from Previous Page																
	BEDROCK - grey granitic rock poor to good quality		10	RC	REC= 100% ROD= 86%												
			11	RC	REC= 100% ROD= 44%												
417.5 12.2	End of Borehole																

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



The stratification lines represent approximate boundaries. The transition may be gradual.

METRIC**RECORD OF BOREHOLE NO. 05**

REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209840.1 E 256202.2 - Muldrew Township Station 15+625 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Truck Mounted CME 75 - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 August 9 TIME
 DATE (Completed) 2013 August 9 (Completed) CHECKED BY MAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
	Continued from Previous Page															
419.6 11.3	BEDROCK - grey granitic rock good to excellent quality		12	RC	REC=100% ROD=77%	420										

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 06



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209799.7 E 256257.5 - Muldrew Township Station 15+635 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 24 TIME
 DATE (Completed) 2013 September 25 (Completed) CHECKED BY MAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						20	40	60	80	100	20	40	60
424.9	Ground Surface		1	SS	16								
0.0	SAND - cobble/boulder in sand and gravel matrix trace organics in upper 1 m (compact)		2	SS	25								
			3	SS	73								
			SS		25/0 mm								
			SS		25/0 mm								
			SS		25/0 mm								
			SS		25/0 mm								
420.0	BEDROCK - grey granitic rock		4	RC	Rec=60% RQD=13%								
4.9	very poor to poor quality		5	RC	Rec=100% RQ=48%								
417.0	End of Borehole												
7.9													

COMMENTS		WATER LEVEL RECORDS	
		Date (dd/mm/yy)/Time	Water Depth (m)
		1) 13/9/25 2:35:00 PM	0.4
		2)	-
		3)	-

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 07



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209785.1 E 256251.8 - Muldrew Township Station 15+618 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 23 TIME
 DATE (Completed) 2013 September 24 (Completed) CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
							20	40	60	80	100	20	40	60	GR SA (SI CL)
424.0	Ground Surface														
0.0	SAND - cobble/boulder in sand and gravel matrix		1	SS	12										
	(compact/very dense)		2	SS	15										22 58 (20)
	trace organics		3	SS	23										14 48 (38)
	(dense/very dense)		4	SS	50/100 mm										40 45 (15)
			5	SS	102										24 61 (15)
				SS	25/0 mm										
				SS	25/0 mm										
			6	SS	50/75 mm										
			7	SS	50/75 mm										
415.9	End of Sampling														
8.1	End of Borehole														
COMMENTS							+ 3, × 3 : Numbers on right refer to Sensitivity								
							Numbers on left refer to values greater than 120 kPa								
							○ 3% STRAIN AT FAILURE								
							WATER LEVEL RECORDS								
							Date (dd/mm/yy)/Time			Water Depth (m)			Cave In (m)		
							1) 13/9/24 2:30:00 PM			0.8			2.3		
							2) -			-			-		
							3) -								
The stratification lines represent approximate boundaries. The transition may be gradual.															

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC**RECORD OF BOREHOLE NO. 08**

REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209815.7 E 256223.3 - Muldrew Township Station 15+624 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 5 TIME
 DATE (Completed) 2013 September 5 (Completed) CHECKED BY MAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
424.6 0.0	Ground Surface SAND - cobble/boulder in sand and gravel matrix (compact/dense)		1	SS	12										kN/m ³	GR SA (SI CL)
			2	SS	25/0 mm											
			3	SS	70/150 mm											
			4	SS	57											
421.5 3.1	BEDROCK - grey granitic rock good to excellent quality		5	RC	Rec=100% RQD=80%											
			6	RC	Rec=100% RQD=92%											
418.7 5.9	End on Borehole															

COMMENTS		WATER LEVEL RECORDS		
+ 3, x 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE		Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
		1) 13/9/5 3:15:00 PM	0.7	1.9
		2) 13/9/9 10:50:00 AM	0.9	-
		3) 13/9/11 9:15:00 AM	0.9	-

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17



METRIC

RECORD OF BOREHOLE NO. 09



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209788.1 E 256200.2 - Muldrew Township Station 15+590 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 5 TIME
 DATE (Completed) 2013 September 6 (Completed) CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)											
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)										
							20	40	60	80	100		20	40	60													
423.4	Ground Surface																											
0.0	300 mm forest mat (organics)		1	SS	15																							
	SAND - brown sand varying silt and gravel content (compact/dense)		2	SS	36																							
			3	SS	47																							
			4	SS	50/125 mm																							
420.8	BEDROCK - grey granitic rock		5	RC	Rec=100% RQD=67%																							
2.6	poor to fair quality		6	RC	Rec=100% RQD=42%																							
			7	RC	Rec=98% RQD=56%																							
417.5	End of Borehole																											
5.9																												
COMMENTS							+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE					WATER LEVEL RECORDS <table border="1"> <thead> <tr> <th>Date (dd/mm/yy)/Time</th> <th>Water Depth (m)</th> <th>Cave In (m)</th> </tr> </thead> <tbody> <tr> <td>1) 13/9/6 3:30:00 PM</td> <td>0.3</td> <td>2.2</td> </tr> <tr> <td>2) 13/9/9 11:45:00 AM</td> <td>0.6</td> <td>-</td> </tr> <tr> <td>3) 13/9/11 9:15:00 AM</td> <td>0.5</td> <td>-</td> </tr> </tbody> </table>					Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)	1) 13/9/6 3:30:00 PM	0.3	2.2	2) 13/9/9 11:45:00 AM	0.6	-	3) 13/9/11 9:15:00 AM	0.5	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																										
1) 13/9/6 3:30:00 PM	0.3	2.2																										
2) 13/9/9 11:45:00 AM	0.6	-																										
3) 13/9/11 9:15:00 AM	0.5	-																										

The stratification lines represent approximate boundaries. The transition may be gradual.



METRIC

RECORD OF BOREHOLE NO. 10



REFERENCE 12/09/12182 DATUM Geodetic LOCATION N 5209845.6 E 250256.3 - Muldrew Township Station 15+684 ORIGINATED BY JL
 PROJECT GWP 5468-09-00, Elboga Lake Culvert BOREHOLE TYPE Track Mounted CME 45B - NW Casing, NQ Core COMPILED BY AT
 CLIENT AECOM Inc. DATE (Started) 2013 September 9 TIME
 DATE (Completed) 2013 September 10 (Completed) CHECKED BY MAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
431.6	Ground Surface															
0.0	50 mm forest mat (organics)		1	SS	19/250 mm											20 31 (49)
	SAND - cobble/boulder in sand and gravel matrix		2	SS	25/0 mm											
	(dense)		3	SS	25/0 mm											
429.2	BEDROCK - grey granitic rock		4	SS	25/50 mm											
2.4	fair to good quality		5	RC	Rec=100% RQD=71%											
			6	RC	Rec=97% RQD=82%											
426.2	End of Borehole															
5.4																
COMMENTS						+ 3, x 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE										
						WATER LEVEL RECORDS										
						Date (dd/mm/yy)/Time					Water Depth (m)			Cave In (m)		
						1) 13/9/10 9:45:00 AM					2.7			3.7		
2)					-			-								
3)					-			-								

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO 12182 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 14/3/17

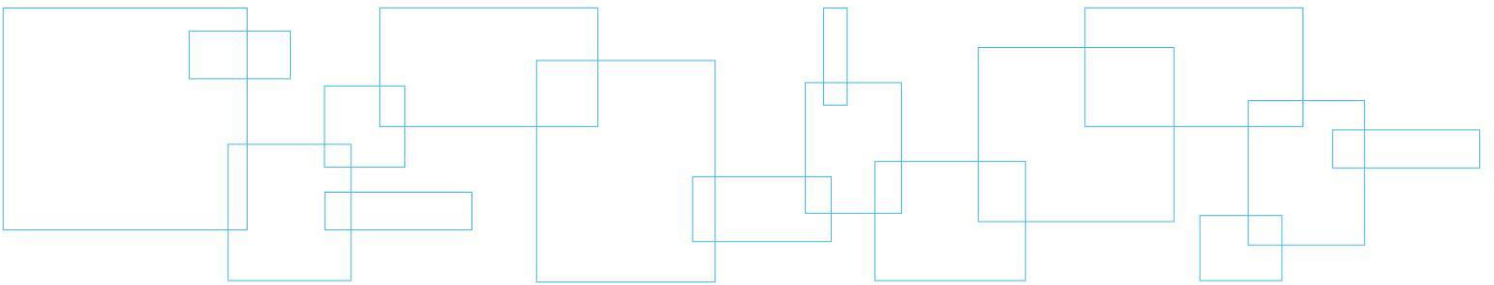


Appendix 3 Borehole Plan and Lab Data

Drawing No. 2: Borehole Location and Soil Strata

Figure Nos. L-1 and L-3: Grain Size Distribution Curves

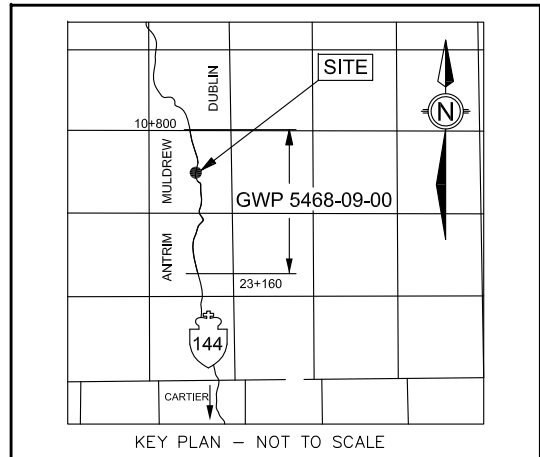
Figure No. L-4: Lab Test Summary Sheet



HWY 144
ELBOGA LAKE CULVERT & DETOUR
MULDREW TOWNSHIP

BOREHOLE LOCATIONS & SOIL STRATA

LVM



LEGEND

- Borehole
- N Blows/0.3 m (Std Pen Test, 475 J/blow)
- DCPT Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- A/R Auger Refusal at Elevation
- E/S End of Sampling

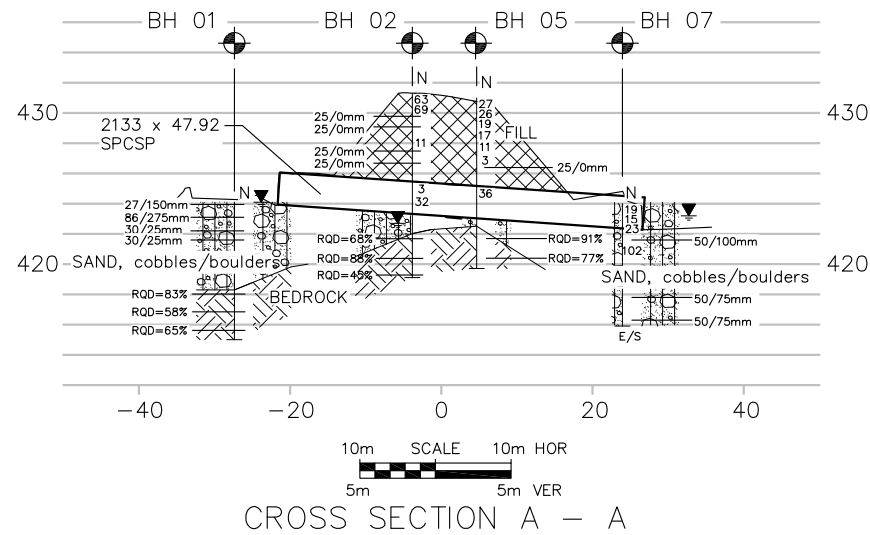
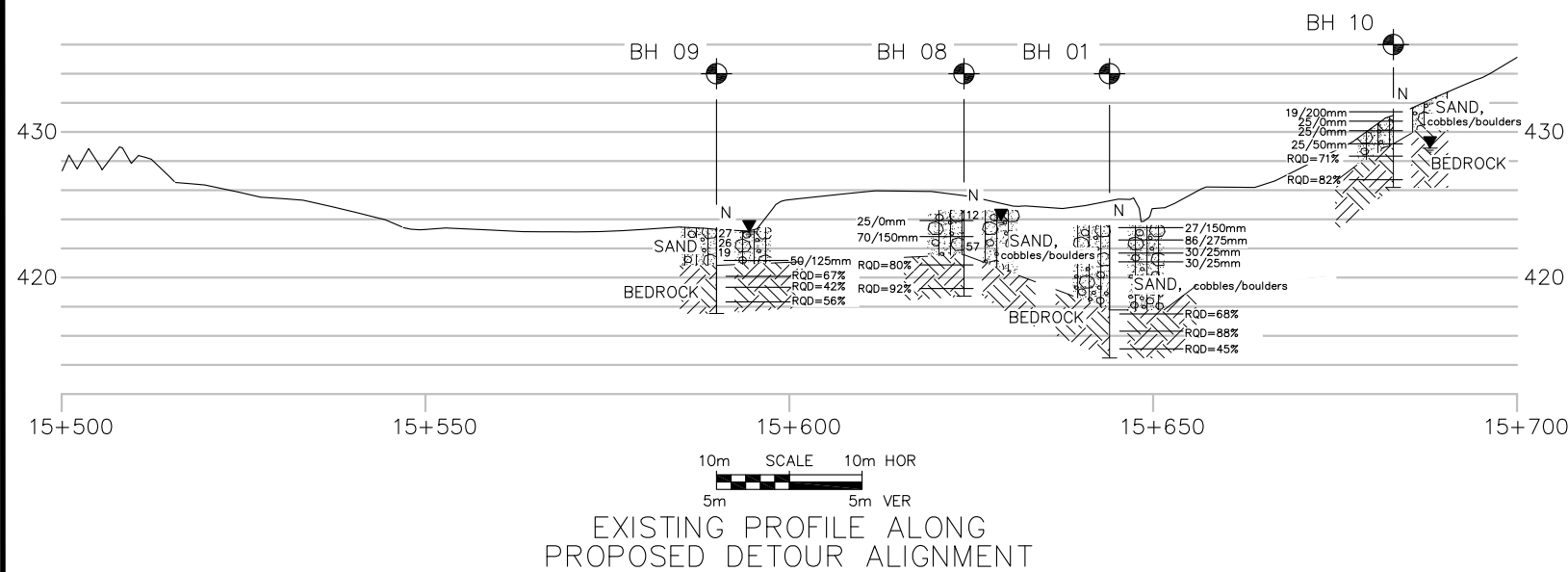
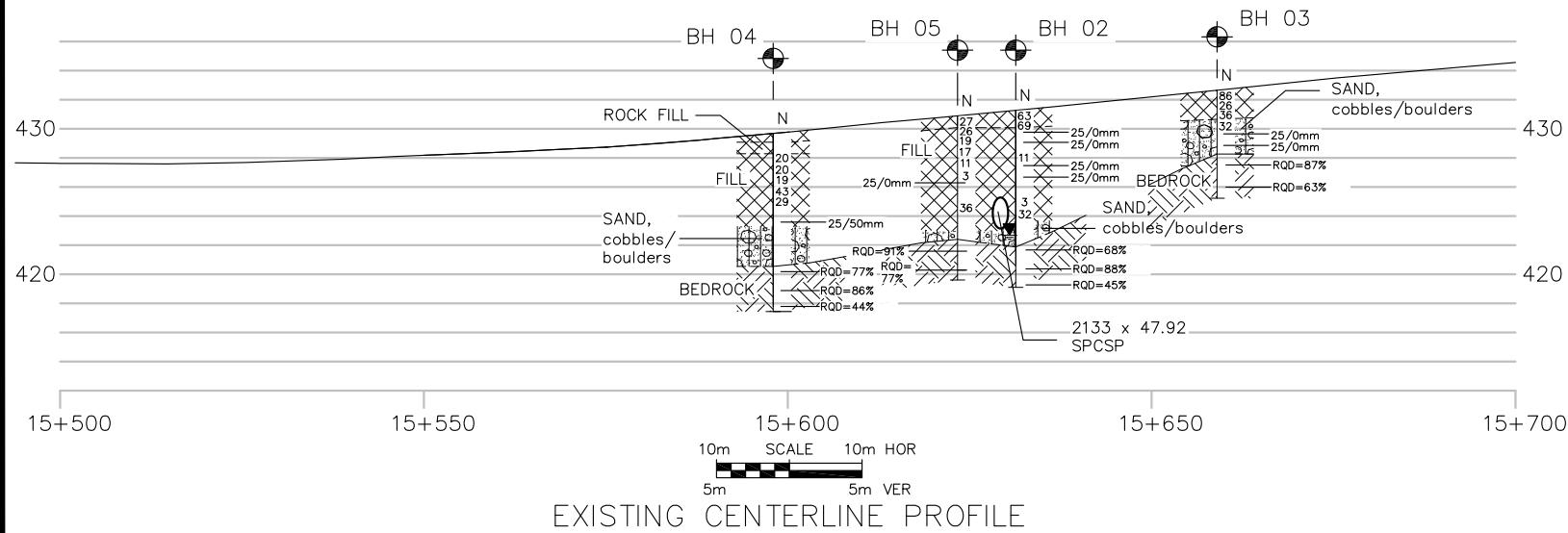
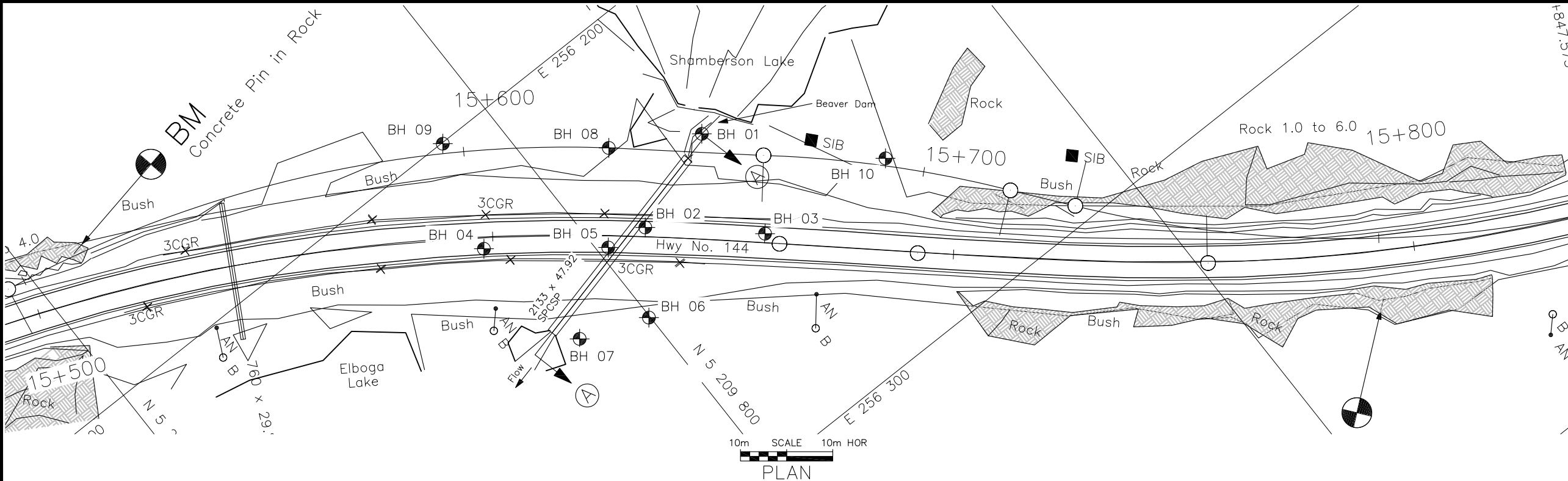
Borehole No.	Elev.	O/S	Co-ordinates	
			Northerly	Easterly
Borehole No. 1	424.1	23.0 m Lt	5209833.4	256233.4
Borehole No. 2	431.4	2.0 m Lt	5209811.2	256241.7
Borehole No. 3	432.7	2.0 m Lt	5209830.8	256258.9
Borehole No. 4	429.7	2.5 m Rt	5209780.9	256223.6
Borehole No. 5	430.9	2.6 m Rt	5209840.1	256202.2
Borehole No. 6	424.9	17.6 m Rt	5209799.7	256257.5
Borehole No. 7	424.0	22.5 m Rt	5209785.1	256251.8
Borehole No. 8	424.6	19.0 m Lt	5209815.7	256223.3
Borehole No. 9	423.4	21.0 m Lt	5209788.1	256200.2
Borehole No. 10	431.6	19.8 m Lt	5209845.6	250256.3

NOTE 1: This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

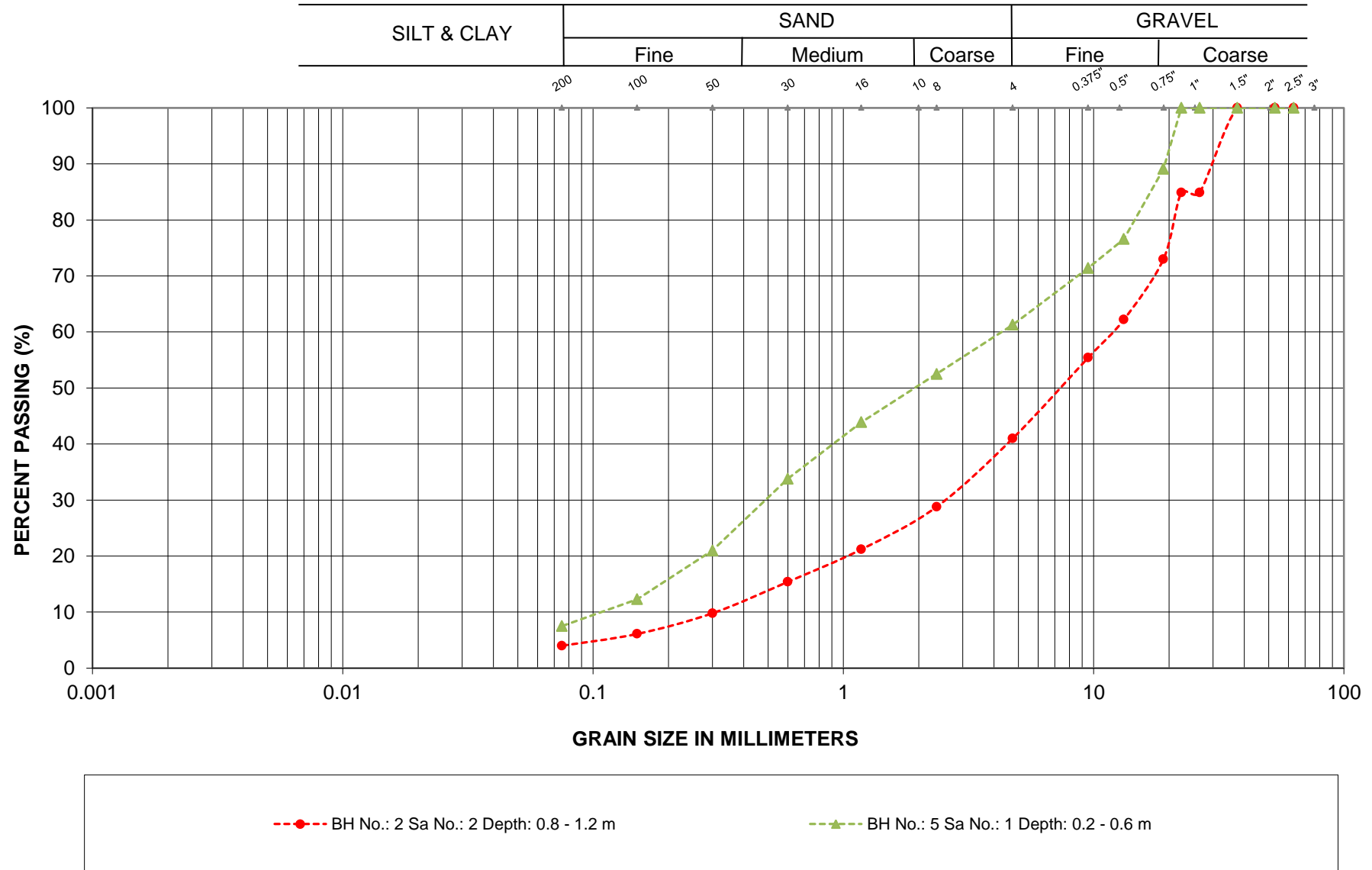
NOTE 2: The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

REVISIONS	DATE	BY	DESCRIPTION
	DEC 2013	IK	DRAFT
	MAR 2014	RG	FINAL

HWY NO. 144 – MULDREW TWP.		
GEOCRES NO.: 41P-55		
LVM REFERENCE NO.: 12/09/12182		
DRAWN: IK	CHECKED: AT	DATE: December 2013



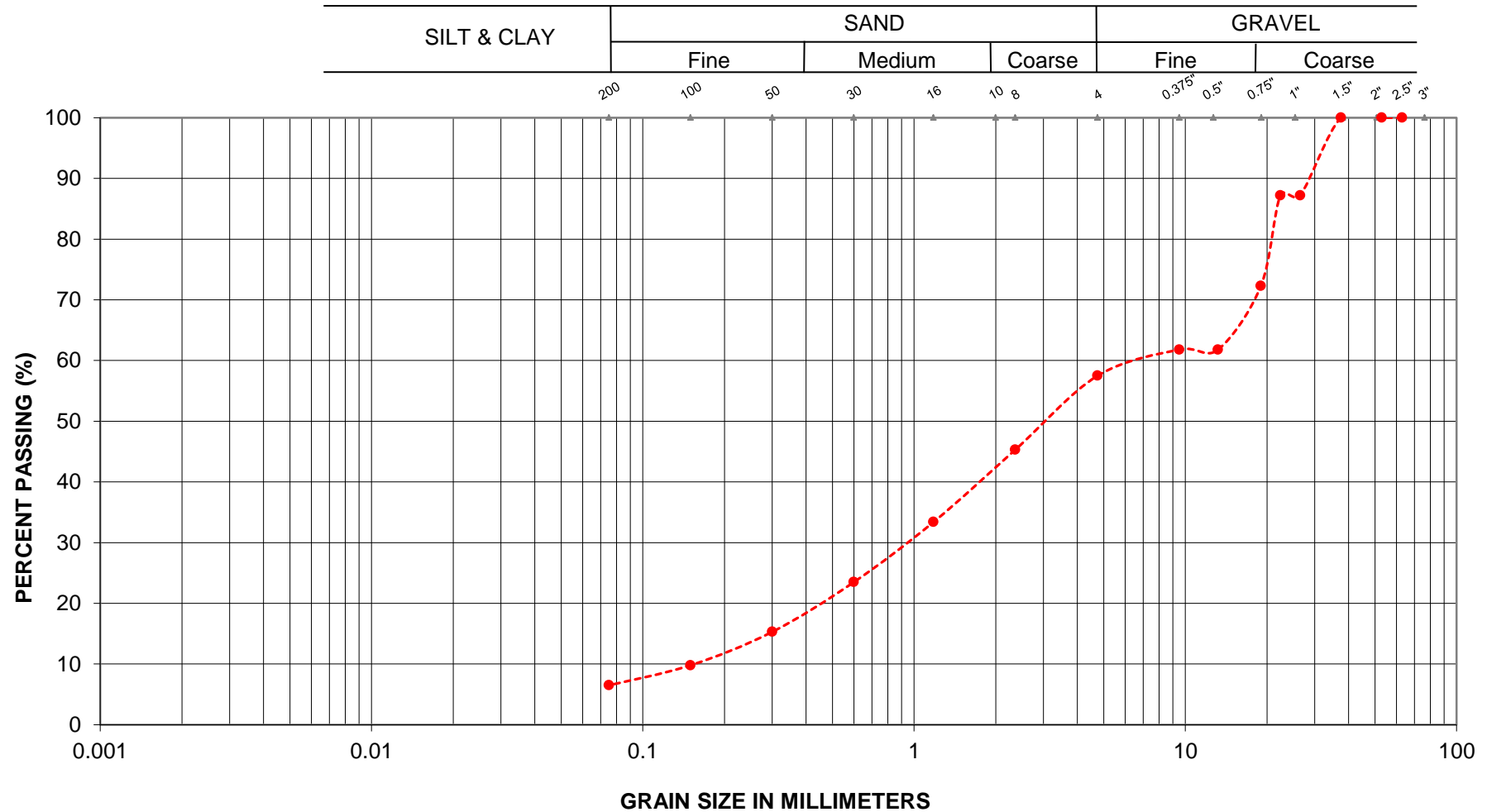
GRAIN SIZE ANALYSIS



LOCATION: Hwy 144, Elboga Lake Culvert

GRANULAR FILL

GRAIN SIZE ANALYSIS

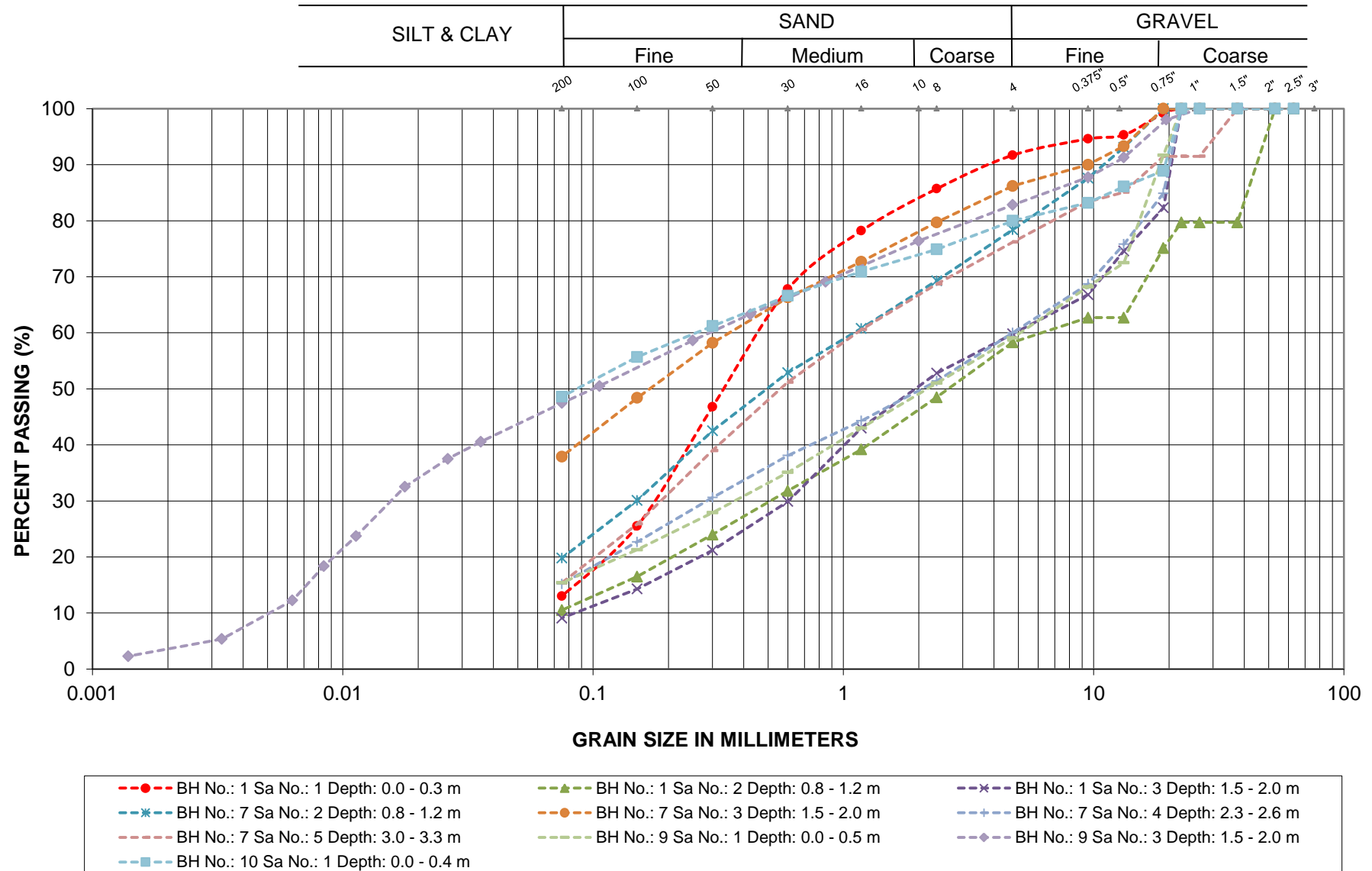


---●--- BH No.: 2 Sa No.: 5 Depth: 6.9 - 7.3 m

LOCATION: Hwy 144, Elboga Lake Culvert

FILL

GRAIN SIZE ANALYSIS



LOCATION: Hwy 144, Elboga Lake Culvert

SANDS

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
1	1	0.0	8	79	13		34.4				27/150 mm			Sample contains organics
	2	0.8	42	47	11		8.8				86/275 mm			
	3	1.5	40	51	9		8.3				30/25 mm			
	4	2.3									80/225 mm			Recovered 1 gravel piece
	5	2.8									RC			Core - rock pieces
	6	3.4									RC			Core - rock pieces
	7	4.9									RC			Core - rock pieces
	8	5.8									RC			Bedrock - Rec = 100%
	9	6.4									RC			Bedrock - Rec = 100%
	10	7.9									RC			Bedrock - Rec = 100%
2	1	0.2					7.4				63			
	2	0.8	59	37	4		7.2				69			
	3	1.5									25/0mm			No recovery
	4	2.3									25/0mm			No recovery
	5	3.1									11			No recovery
	6	3.8									25/0mm			No recovery
	7	4.6									25/0mm			No recovery
	8	6.1									3			No recovery
	9	6.9	43	50	7		9.0				32			
	10	7.6									RC			Core - rock pieces
	11	8.8					12.5				50/100 mm			
	12	9.07									RC			Bedrock - Rec = 92%
	13	10.06									RC			Bedrock - Rec = 100%
	14	11.6									RC			Bedrock - Rec = 100%

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
3	1	0.2					10.5				86			
	2	0.8					14.9				26			
	3	1.5									36			
	4	2.3									32			
	5	3.1									25/0mm			No recovery
	6	3.8									25/0mm			No recovery
	7	4.4									RC			Bedrock - Rec = 100%
	8	5.9									RC			Bedrock - Rec = 100%
4	1	0.2					7.4				85/250 mm			
	2	1.5									20			No recovery
	3	2.3									20			Recovered 1 gravel piece
	4	3.1									19			Recovered 3 gravel pieces
	5	3.8									43			Recovered 2 gravel pieces
	6	4.57									29			No recovery
	7	6.1									25/50 mm			No recovery
	8	6.43									RC			Core - rock pieces
	9	9.14									RC			Bedrock - Rec = 93%
	10	9.91									RC			Bedrock - Rec = 100%
	11	11.48									RC			Bedrock - Rec = 100%
5	1	0.15	39	53	8		11.25				27			
	2	0.76					10.11				26			
	3	1.52									19			Recovered 9 gravel pieces
	4	2.29									17			Recovered 1 gravel piece
	5	3.05									11			Recovered 5 gravel pieces
	6	3.81									3			No recovery

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
	7	4.6									25/0mm			No recovery
	8	6.1									36			No recovery
	9	8.1									50/100 mm			Gravel pieces with sand
	10	8.2									RC			Core - rock pieces
	11	8.5									RC			Bedrock - Rec = 100%
	12	10.1									RC			Bedrock - Rec = 100%
6	1	0.0					21.0				16			Sample contains organics
	2	0.8					18.7				25			Sample contains organics
	3	1.5					9.5				73			
	4	2.3									25/0mm			No recovery
	5	3.1									25/0mm			No recovery
	6	3.8									25/0mm			No recovery
	7	4.6									25/0mm			No recovery
	8	4.9									RC			Bedrock - Rec = 60%
	9	6.4									RC			Bedrock - Rec = 100%
7	1	0					9.63				12			
	2	0.76	22	58	20		9.7				15			
	3	1.52	14	48	38		22.12				23			
	4	2.29	40	45	15		14.24				50/100 mm			
	5	3.05	24	61	15		10.1				102			
	6	3.81									25/0mm			No recovery
	7	4.57									25/0mm			No recovery
	8	6.1					17.3				50/75 mm			
	9	7.62					9.49				50/75 mm			

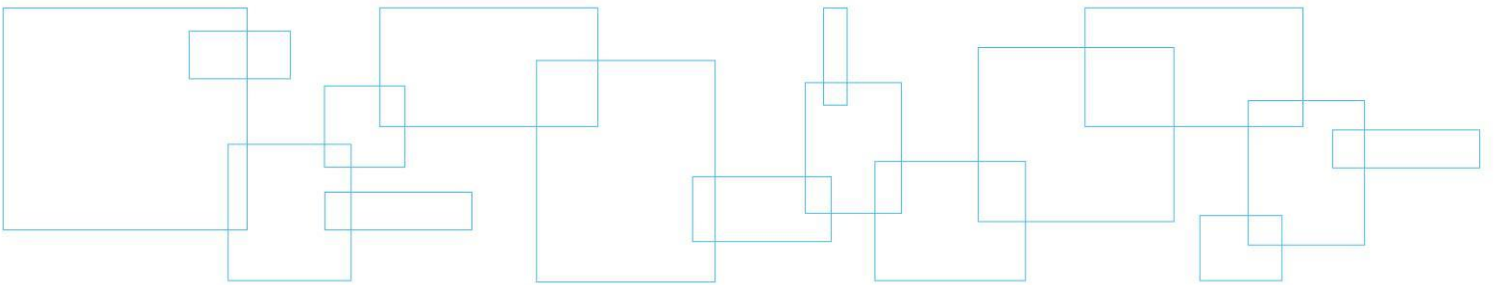
Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
8	1	0					5.64				12			
	2	0.76									25/0 mm			No recovery
	3	1.52					8.57				70/150 mm			
	4	2.29					10.69				57			
	5	3.1									RC			Bedrock - Rec = 100%
	6	4.6									RC			Bedrock - Rec = 100%
9	1	0	41	44		15	12.08				15			
	2	0.76					12.71				36			
	3	1.52	18	35	43	4	13.95				47			
	4	2.29					11.08				50/125 mm			
	5	2.6									RC			Bedrock - Rec = 100%
	6	4.1									RC			Bedrock - Rec = 100%
	7	4.7									RC			Bedrock - Rec = 98%
10	1	0	20	31		49	14.48				19/250 mm			
	2	0.76									25/0 mm			No recovery
	3	1.52									25/0 mm			No recovery
	4	2.29					15.89				25/50 mm			
	5	2.4									RC			Bedrock - Rec = 100%
	6	3.9									RC			Bedrock - Rec = 97%

Appendix 4 Photo Essay

Enclosure No. 12:

Photo Essay



West End of Culvert – Looking South

Photo: 1



View of Stream at Inlet – Looking West, Note Beaver Dam

Photo: 2



Project: Hwy 144 – Elboga Lake Culvert

Photos Provided By: LVM

Date: September 2013

View through Culvert – Looking East

Photo: 3



East End of Culvert – Looking South

Photo: 4



Project: Hwy 144 – Elboga Lake Culvert

Photos Provided By: LVM

Date: September 2013

East Embankment Slope – Looking North

Photo: 3



Project: Hwy 144 – Elboga Lake Culvert

Photos Provided By: LVM

Date: September 2013