



**Submitted To Triton Engineering Services Limited
18 Robb Blvd Unit 8, Orangeville, Ontario L9W 3L2
On Behalf of the Ontario Ministry of Transportation**

**Highway 144 Grading and Resurfacing
Culvert Replacement
Station 25+317 - TWP of Dowling
GWP 5081-06-00**

**Highway 144
GWP 5081-06-00
From 1.5 km South of Sudbury Municipal Road 8, Northerly 18.1 km to Cartier
West Entrance**

FINAL FOUNDATION INVESTIGATION REPORT

Date: October 7, 2013
Ref. N^o: 11/11/11209-F3

Geocres No. 41I-297

LVM | MERLEX



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On Behalf of the Ontario Ministry of Transportation**

**Highway 144 Grading and Resurfacing
Culvert Replacement
Station 25+317 - TWP of Dowling
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Final Foundation Investigation Report

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Test results mentioned herein are only valid for the sample(s) stated in this report.

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:

Triton Engineering Services Limited

18 Robb Blvd., Unit 8

Orangeville, Ontario

L9W 3L2

Attention: **Mr. Howard Wray, P.Eng.**

REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And/Or Publication Details
00	2013-03-18	DRAFT Report Issued
01	2013-10-07	Final Report Issued

REPORT DISTRIBUTION	
5 hard copies, 1 electronic copy	MTO Project Manager
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1 INTRODUCTION

LVM | MERLEX has been retained by Triton Engineering Services Limited, on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation for the proposed replacement of an existing culvert and design of a protection system. This culvert is located on Highway 144, some 1 km North of Elks Club Road, in the Township of Dowling.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5010-E-0051. The terms of reference for the scope of work are outlined in LVM | MERLEX's Proposal P-11-023, dated June 2011. The purpose of this investigation was to determine the subsurface conditions in the area of the culvert in order to provide design recommendations. LVM | MERLEX investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2 SITE DESCRIPTION

This CSP culvert is located at Station 25+317 in the Township of Dowling. The existing highway embankment currently supports two undivided lanes of highway, running in a north-south direction. The existing highway, at the culvert location, is constructed on a fill embankment some 4.4 m in height. The centerline elevation at the culvert location is 369.4 m. The culvert at this location is a 760 mm diameter CSP culvert, some 20.5 m in length. Flow through the culvert is from right (east) to left (west).

Infrastructure at the culvert location consists of overhead power and communication wires on the west (left) 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. There are exposed bedrock ridges. At many locations, significant layers of earth overlay the bedrock. Organic terrain was also observed. Within the project area, overburden consists primarily of silts and silty sands over bedrock.

Bedrock in the area, as indicated on OGS Map 2506, is of the Early Precambrian Era. At the location of this culvert foundation investigation, the bedrock comprises of Felsic Igneous and Metamorphic Rocks including: granitic, metasedimentary and minor metavolcanic migmatite.

3 INVESTIGATION PROCEDURES

The fieldwork for this investigation was carried out during the period of March 20th to June 6th, during which five (5) sampled boreholes, and DCPTs, were advanced. For the purposes of foundation design for the culvert replacement, one borehole was advanced through the

embankment slightly up chainage from the culvert, and one borehole was advanced at each the inlet and outlet ends of the culvert. Two boreholes were advanced through the embankment, one up and one down chainage from the culvert, to provide subsurface data to support the design of a protection system.

The field investigation was carried out using a Bombardier and a truck mounted CME drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment plus NQ casings and coring equipment. Soil samples were obtained at the borehole locations 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 the boreholes, a Dynamic Cone Penetration Test (DCPT) was carried out to give a continuous plot of the soil resistance with depth. When cohesive deposits were encountered, the in-situ strength was measured using an "N" size field vane, vane collar, and calibrated torque meter. All samples taken during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and select laboratory testing. When shallow auger refusal, on rock fill, was encountered at the culvert borehole NQ size diamond coring equipment was used to determine the nature of shallow refusal.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following, completion of the individual boreholes. 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 upper portion of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing pavement surface.

The field work for this investigation was 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 and particle size analysis, 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-5).

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. 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.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record 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 and Dynamic Cone Penetration Test (DCPT) 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 are shown on the drawings for illustration purposes only.

4.1 CULVERT STATION 25+317, TWP OF DOWLING

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, eight (8) sampled boreholes were put down at this site, with Borehole Nos. 1 and 2 advanced at the culvert ends. Boreholes No. 3, 3A, 3B, 4, 5, and 5A were advanced through the existing embankment. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 5A, inclusive, were recorded at 367.4, 365.7, 369.2, 369.3, 369.3, 369.2, 369.3, and 369.3 m, respectively.

4.1.1 Pavement Structure

At surface at Borehole Nos. 3, 3A, 3B, 5 and 5A, a pavement structure consisting of 75 to 150 mm of asphalt underlain by 150 to 250 mm of crushed gravel was encountered. At Borehole No. 4 a pavement base structure consisting of 150 mm of crushed gravel was encountered.

4.1.2 Surficial Layers

At Borehole Nos. 1 and 2 a surficial layer of silty organics some 100 to 300 mm thick was penetrated.

4.1.3 Fill

Underlying the pavement structure at Borehole Nos. 3 to 5A, inclusive, a deposit of fill consisting of brown sand and gravel trace silt was penetrated. Occasional cobbles/rock fill was encountered in this deposit. The natural moisture content measured on samples of this deposit was in the order of 2 to 6%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 46 to 47% gravel size particles, 45 to 49% sand size particles, and 5 to 8% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 5 to 18 blows per 300 mm penetration, the compactness of this deposit was described as loose to compact. Auger refusal was encountered in this deposit at depths of 1.9,

0.7, and 1.9 m below grade at Borehole Nos. 3, 4, and 5, respectively (elevations 367.3, 368.5, and 367.4 m, respectively). DCPT refusal was encountered in this deposit at depths of 1.2, 0.7, and 1.8 m below grade at Borehole Nos. 3, 4, and 5, respectively (elevations 368.0, 368.5, and 367.5 m, respectively). This deposit was encountered to depths of 0.9 and 0.8 m below grade at Borehole Nos. 3A and 5A, respectively (elevations 368.4 and 368.5 m, respectively).

4.1.4 **Rock Fill**

Borehole Nos. 3A, 3B, and 5A were advanced beyond auger refusal using NQ Coring equipment to determine the nature of shallow refusal encountered. Underlying the fill deposit, a deposit of rock fill was penetrated. This deposit was encountered to depths of 2.3, 4.4, and 2.4 m below grade at Borehole Nos. 3A, 3B, and 5A, respectively (elevations 367.0, 364.9, and 366.9 m, respectively). This deposit was underlain by bedrock at Borehole Nos. 3B and 5A.

4.1.5 **Sand Fill**

Underlying the rock fill at Borehole No. 3A, a deposit of fill consisting of brown sand trace silt trace gravel was penetrated. Occasional cobbles were encountered in this deposit. The natural moisture content measured on samples of this deposit was in the order of 11 to 27%. Gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 13% gravel size particles, 85% sand size particles, and 2% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 5 to 8 blows per 300 mm penetration the compactness of this deposit was described as loose. Refusal was encountered in this deposit at a depth of 4.4 m below grade (elevation 364.9 m).

4.1.6 **Silt**

Underlying the surficial organics at Borehole Nos. 1 and 2, a deposit of brown silt some to with sand trace gravel trace clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 22 to 40%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 0 to 3% gravel size particles, 16 to 24% sand size particles, 72 to 77% silt size particles, and 4% clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 18 blows per 300 mm penetration the compactness of this deposit was described as compact. This deposit was encountered to a depth of 0.6 m below grade at Borehole No. 1 (elevation 366.8 m). Auger refusal was encountered in this deposit at a depth of 1.9 m below grade at Borehole No. 2 (elevation 363.8 m).

4.1.7 **Silt and Sand**

Underlying the silt at Borehole No. 1, a deposit of brown silt and sand, some gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 22%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 15% gravel size particles, 40% sand size particles, and 45% silt and clay size particles (Figure No. L-4, Appendix 3). Auger refusal was encountered in this deposit at a depth of 1.1 m below grade (elevation 366.3 m). Two auger probes were advanced to the north of the

borehole location and refusal was encountered at depths of 1.1 and 1.2 below grade at the probe locations.

4.1.8 Bedrock

Bedrock was encountered underlying the rock fill at Borehole Nos. 3B and 5A. The bedrock is described as a pink to dark grey granite. Based on a RQD of 36 to 69%, the quality of the bedrock was described as poor to fair. Sampling was terminated in the bedrock at depths of 6.2 and 3.4 m below grade at Borehole Nos. 3B and 5A, respectively (elevation 363.1 and 365.9 m, respectively).

4.2 GROUNDWATER DATA

The water level at the culvert outlet was measured at an elevation of 365.8 m at the time of this investigation, however, no water was observed at the inlet at the time of this investigation.

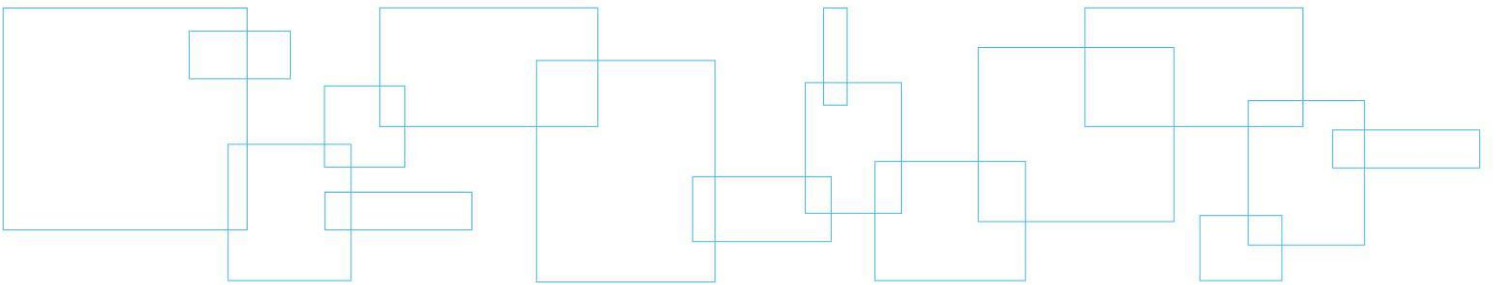
Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix B). The boreholes were dry upon completion, except Borehole No. 2, where the groundwater was encountered at elevation 365.5 m.

The groundwater and river water levels will fluctuate seasonally.

Appendix 1 Key Plan

Drawing No. 1

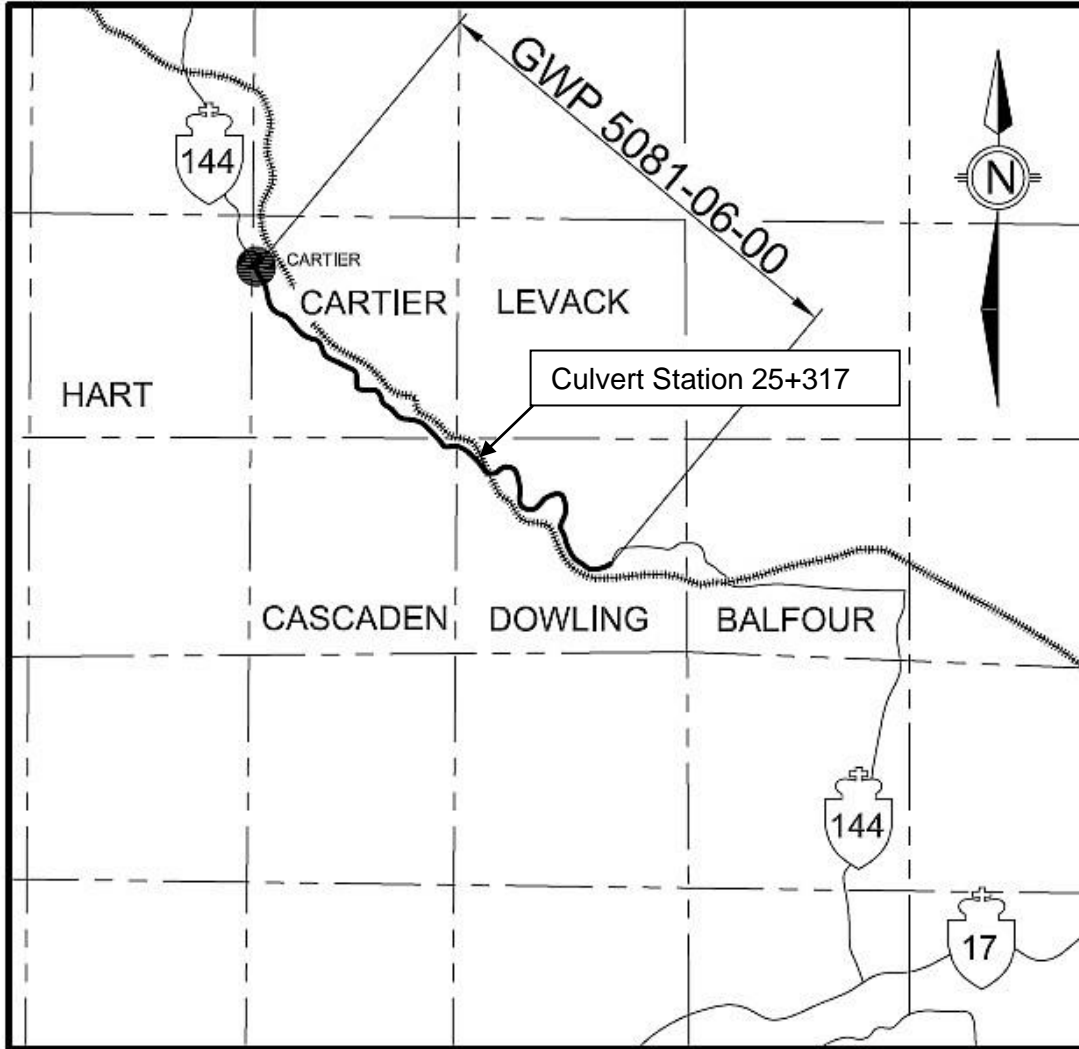
Key Plan



KEY PLAN

Drawing No. 1

NOT TO SCALE



**FINAL
FOUNDATION INVESTIGATION REPORT
GWP 5081-06-00**

Highway 144

From 1.5 km South of Sudbury Municipal Road 8,
Northerly 18.1 km To Cartier West Entrance

MEL Ref. No.: 11/11/11209-F3

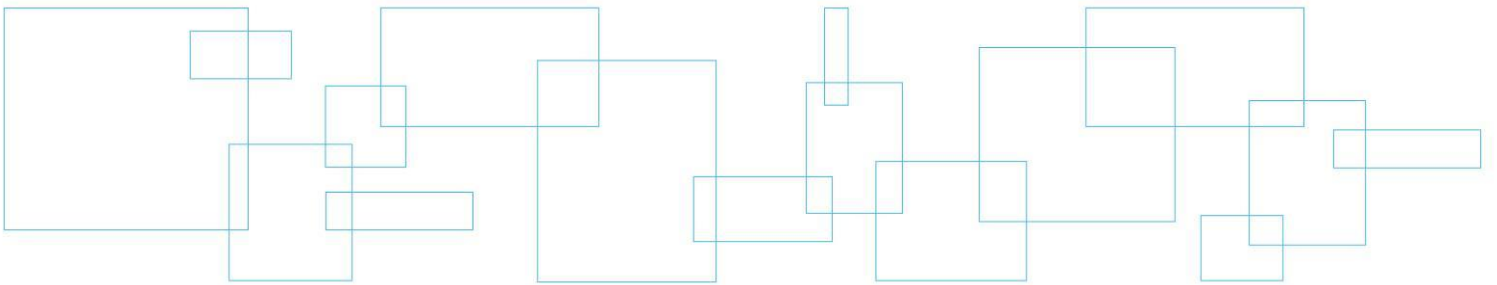
October 2013

LVM | MERLEX

Appendix 2 Subsurface Data

Enclosure No. 1
Enclosure Nos. 2 to 9

List of Abbreviations and Symbols
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 boulders is based on auger response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not impeded
Numerous	Obstructions are 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. 1



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164753.5 E 271194.1 - Dowling Township Station 25+313 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY MCM
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 20 TIME
 DATE (Completed) 2012 March 20 (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								
367.4	Ground Surface												
0.0	100 mm silty organics		1	AS			367						3 16 77 4
366.8	SILT - brown silt some sand trace gravel trace clay												
0.6	SILT and SAND - brown silt and sand some gravel		2	SS	20/25mm								15 40 (45)
366.3	Auger Refusal End of Borehole												
1.1	Auger probe advanced 1.5 m North of BH Auger Refusal at 1.2 m Auger probe advanced 3.5 m North of BH Auger Refusal at 1.1 m												
COMMENTS								+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE					
The stratification lines represent approximate boundaries. The transition may be gradual.								WATER LEVEL RECORDS					
								Date (dd/mm/yy)/Time		Water Depth (m)		Cave In (m)	
								1)		-		-	
								2)		-		-	
3)		-		-									

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 2



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164740.0 E 271175.5 - Dowling Township Station 25+319 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY MCM
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 20 TIME
 DATE (Completed) 2012 March 20 (Completed) 1:15:00 PM 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																		
365.7	Ground Surface																						
0.0	300 mm silty organics		1	AS																			
	SILT - brown silt with sand trace clay		2	SS	18																		
	(compact)																						
363.8			3	SS	50/50 mm						0 24 72 4												
1.9	Auger Refusal End of Borehole																						
	Auger probe advanced 2 m North of BH																						
	Auger Refusal at 1.5 m																						
	Auger probe advanced 5 m north of BH																						
	Auger Refusal at 1.4 m																						
COMMENTS								+ 3, x 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa O 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) 12/3/20 1:25:00 PM</td> <td>0.4</td> <td>1.5</td> </tr> <tr> <td>2) 12/3/22 3:00:00 PM</td> <td>0.2</td> <td>-</td> </tr> <tr> <td>3)</td> <td>-</td> <td>-</td> </tr> </tbody> </table>				Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)	1) 12/3/20 1:25:00 PM	0.4	1.5	2) 12/3/22 3:00:00 PM	0.2	-	3)	-	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																					
1) 12/3/20 1:25:00 PM	0.4	1.5																					
2) 12/3/22 3:00:00 PM	0.2	-																					
3)	-	-																					

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

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 3



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164747.7 E 271191.9 - Dowling Township Station 25+307 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 26 TIME (Completed) 2:55:00 PM CHECKED BY MAM
 DATE (Completed) 2012 March 26

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																		
369.2	Ground Surface																						
0.0	75 mm Asphalt 200 mm Crushed Gravel		1	AS	N/A																		
368.0	FILL - brown sand and gravel trace silt occasional cobbles and boulders /shot rock		2	SS	5						46 49 (5)												
1.2	DCPT Refusal																						
367.3	Auger Refusal End of Borehole		3	SS	100/225 mm																		
1.9																							
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 <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) 12/3/26 2:55:00 PM</td> <td>DRY</td> <td>0.9</td> </tr> <tr> <td>2)</td> <td>-</td> <td>-</td> </tr> <tr> <td>3)</td> <td>-</td> <td>-</td> </tr> </tbody> </table>				Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)	1) 12/3/26 2:55:00 PM	DRY	0.9	2)	-	-	3)	-	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																					
1) 12/3/26 2:55:00 PM	DRY	0.9																					
2)	-	-																					
3)	-	-																					

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

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 3A



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164744.0 E 271184.4 - Dowling Township Station 25+315 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - NQ Casing COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 11 TIME
 DATE (Completed) 2012 April 11 (Completed) 7:15:00 PM 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	80	100					
369.3	Ground Surface																
0.0	125 mm asphalt 175 mm crushed gravel																
368.4	FILL - brown sand and gravel trace silt																
0.9	ROCK FILL																
	Advanced NW casing through rock fill using diamond core drilling techniques from 0.9 to 2.3 m.																
367.0	(FILL) - brown sand trace silt trace gravel occasional cobbles (loose)		1	SS	8											13 85 (2)	
2.3			2	SS	5												
			3	SS	69/150 mm												
364.9	Auger Refusal End of Borehole																
4.4																	

COMMENTS		WATER LEVEL RECORDS	
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 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 3B



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164741.5 E 271184.2 - Dowling Township Station 25+315 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - NQ Casing COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 June 6 TIME
 DATE (Completed) 2012 June 6 (Completed) 5:30:00 PM 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										
369.3	Ground Surface																				
0.0	150 mm Asphalt 150 mm Crushed Gravel																				
368.7	FILL - brown sand and gravel trace silt																				
0.6	ROCK FILL																				
	Advanced NW casing through rock fill using diamond core drilling techniques from 0.6 to 4.4 m depth.																				
364.9																					
4.4	BEDROCK -pink to dark grey granite		1	RC	Rec = 95% RQD = 36%																
	poor to fair quality		2	RC	Rec = 100% RQD = 69%																
363.1			3	RC	Rec = 100% RQD = 52%																
6.2	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)	-	▽	-	
																	2)	-	▽	-	
The stratification lines represent approximate boundaries. The transition may be gradual.																	3)	-	▽	-	

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 4



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164750.1 E 271188.7 - Dowling Township Station 25+317 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 26 TIME
 DATE (Completed) 2012 March 26 (Completed) 3:50:00 PM 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								
369.2	Ground Surface												
0.0	150 mm Crushed Gravel		1	AS	N/A		369						
368.5	FILL - brown sand and gravel trace silt occasional cobbles/boulders/shot rock												
0.7	Auger Refusal on Rock Fill DCPT Refusal End of Borehole												

WATER LEVEL RECORDS	
Date (dd/mm/yy)/Time	Water Depth (m)
1) 12/3/26 3:30:00 PM	DRY
2)	-
3)	-

COMMENTS: 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

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC

RECORD OF BOREHOLE NO. 5



REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164745.0 E 271181.3 - Dowling Township Station 25+318 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 26 TIME
 DATE (Completed) 2012 March 26 (Completed) 5:00:00 PM 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								
369.3	Ground Surface												
0.0	100 mm Asphalt 150 mm Crushed Gravel		1	AS	N/A								
	FILL - brown sand and gravel trace silt occasional cobbles/boulders/shot rock		2	SS	18								47 45 (8)
367.5			3	SS	62/225 mm								
367.4	DCPT Refusal												
1.9	Auger Refusal End of Borehole												
	Auger probe advanced 1 m north of BH No. 5 Auger refusal at 1 m depth.												
	Auger probe advanced 2 m south of BH No. 5 Auger refusal at 1 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 1) 12/3/26 4:00:00 PM 2) 3)					
								Water Depth (m) DRY - -					
								Cave In (m) 0.8 - -					

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

MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



METRIC**RECORD OF BOREHOLE NO. 5A**

REFERENCE 11/11/11209-F3 DATUM Geodetic LOCATION N 5164751.9 E 271176.1 - Dowling Township Station 25+318 ORIGINATED BY JL
 PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - NQ Casing COMPILED BY AT
 CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 13 TIME
 DATE (Completed) 2012 April 13 (Completed) 1:45:00 PM 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		
369.3	Ground Surface																
0.0	75 mm Asphalt 250 mm Crushed Gravel																
368.5	FILL - brown sand trace silt trace gravel																
0.8	ROCK FILL																
	Advanced casing through rock fill using diamond core drilling techniques from 0.8 to 2.4 m depth.																
366.9	BEDROCK - pink to grey granite fair quality		1	RC	REC = 100% RQD = 51%												
2.4																	
365.9	End of Borehole																
3.4																	

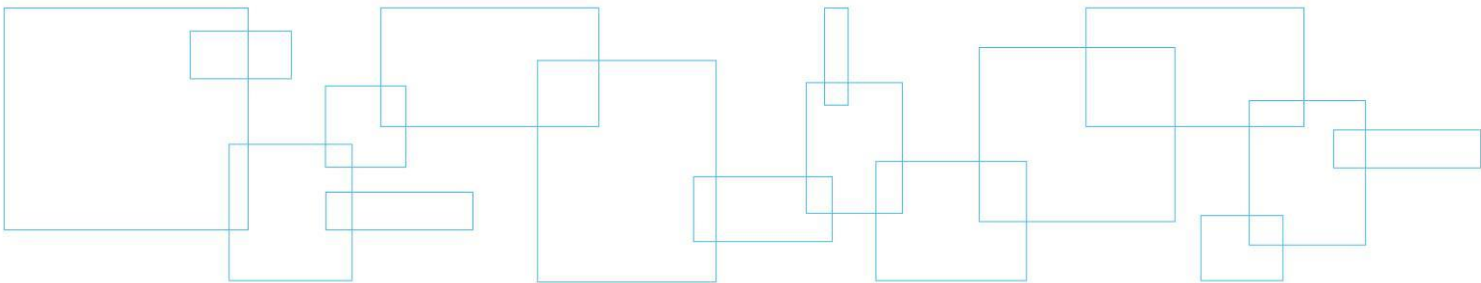
COMMENTS	+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE	WATER LEVEL RECORDS		
		Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
The stratification lines represent approximate boundaries. The transition may be gradual.		1)	-	-
		2)	-	-
		3)	-	-

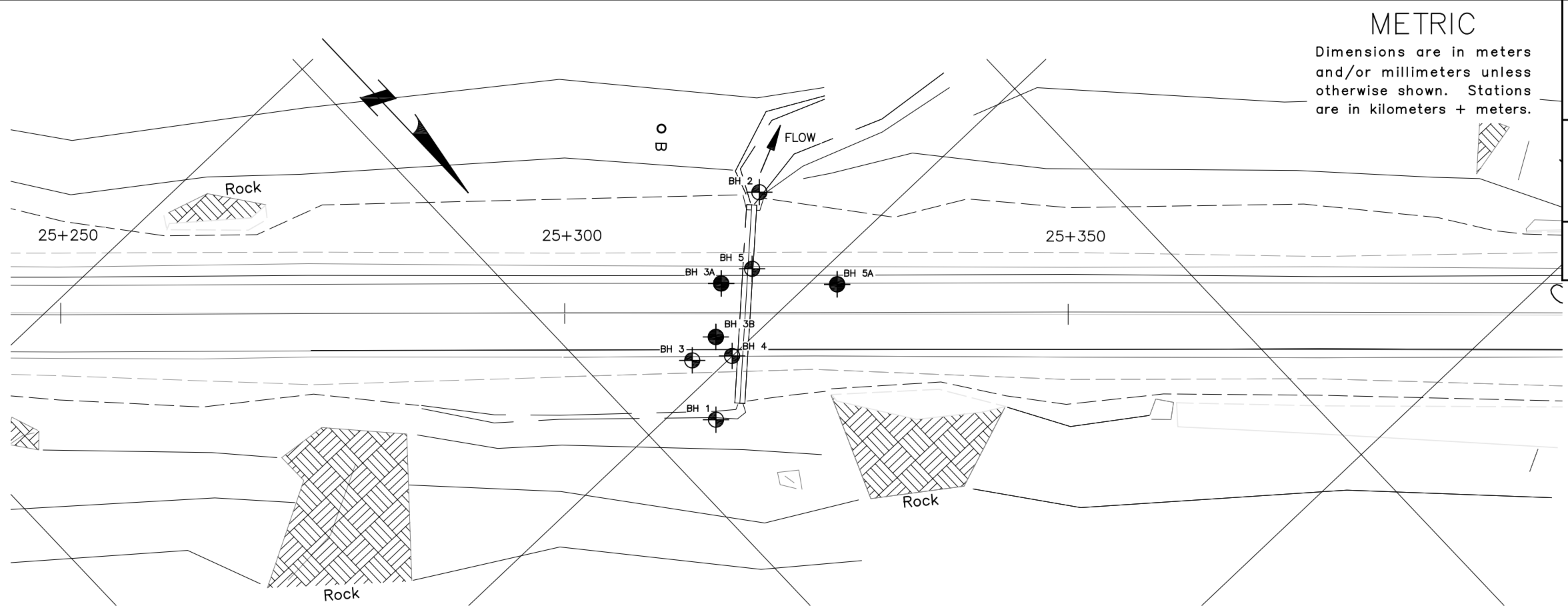
MEL-GEO 11209 - AREA 3 - BOREHOLE LOGS.GPJ MEL-GEO.GDT 13/10/4



Appendix 3 Lab Data

Drawing No. 2: Borehole Location and Soil Strata
Figure Nos. L-1 to L-4: Grain Size Distribution Curves
Figure No. L-5: Lab Test Summary Sheet





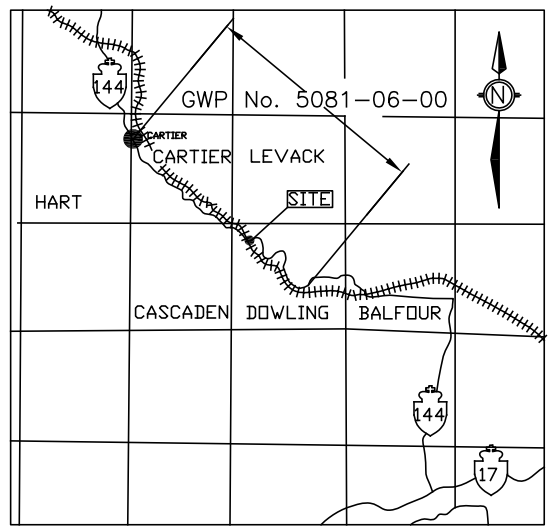
METRIC
Dimensions are in meters
and/or millimeters unless
otherwise shown. Stations
are in kilometers + meters.

CONT No
GWP No 5081-06-00

HWY NO. 144 – Township of
Dowling
Culvert at Station 25+317
BOREHOLE LOCATIONS & SOIL STRATA

Drawing
2

LVM | MERLEX



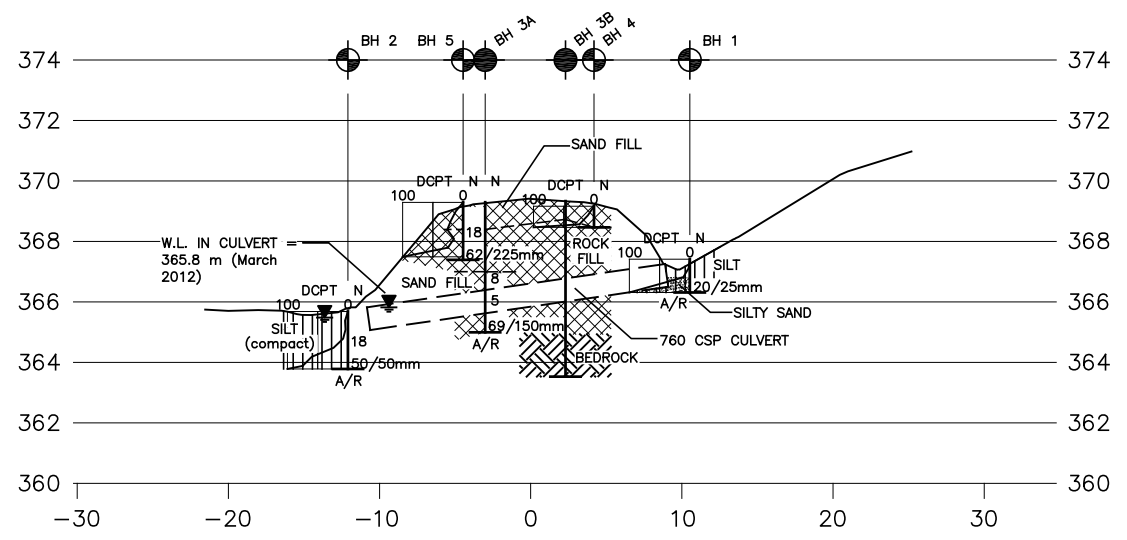
KEY PLAN –
LEGEND

- Borehole
- Dynamic Cone Penetration Test (DCPT)
- Borehole and DCPT
- 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
- Auger Refusal at Elevation
- End of Sampling

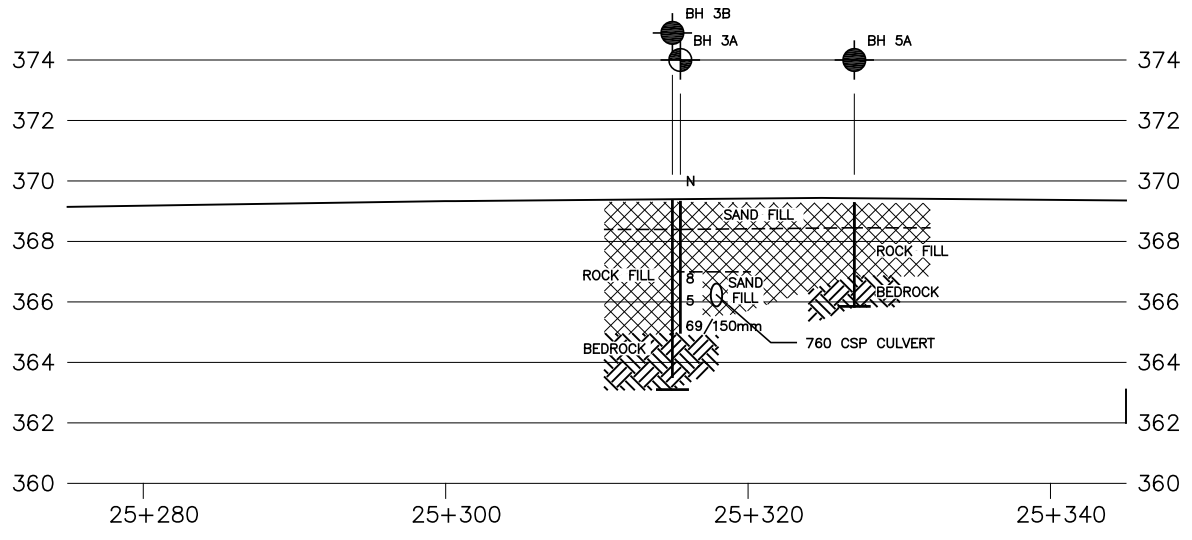
Borehole No.	Elev.	O/S	Co-ordinates	
			Northerly	Easterly
Borehole No. 1	367.4	10.7m Lt	5164753.5	271194.1
Borehole No. 2	365.7	12.0m Lt	5164740.0	271175.5
Borehole No. 3	369.2	4.6m Rt	5164747.7	271191.9
Borehole No. 3A	369.3	2.9m Lt	5164744.0	271184.4
Borehole No. 3B	369.3	2.3m Rt	5164741.5	271184.2
Borehole No. 4	369.2	4.6m Rt	5164750.1	271188.7
Borehole No. 5	369.3	3.7m Lt	5164745.0	271181.3
Borehole No. 5A	369.3	3.2m Rt	5164751.9	271176.1

NOTE 1:
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
	Aug 2012	RG	DRAFT
	Oct 2013	RG	FINAL
HWY No. 144 – Dowling Twp – Culvert at Sta. 25+317 REF 11209-F3			
SUBM'D		GEOCRES NO 411-297 SITE 46-414	
DRAWN RG		CHK MAM	DATE Jan 2013 DRAWING 2

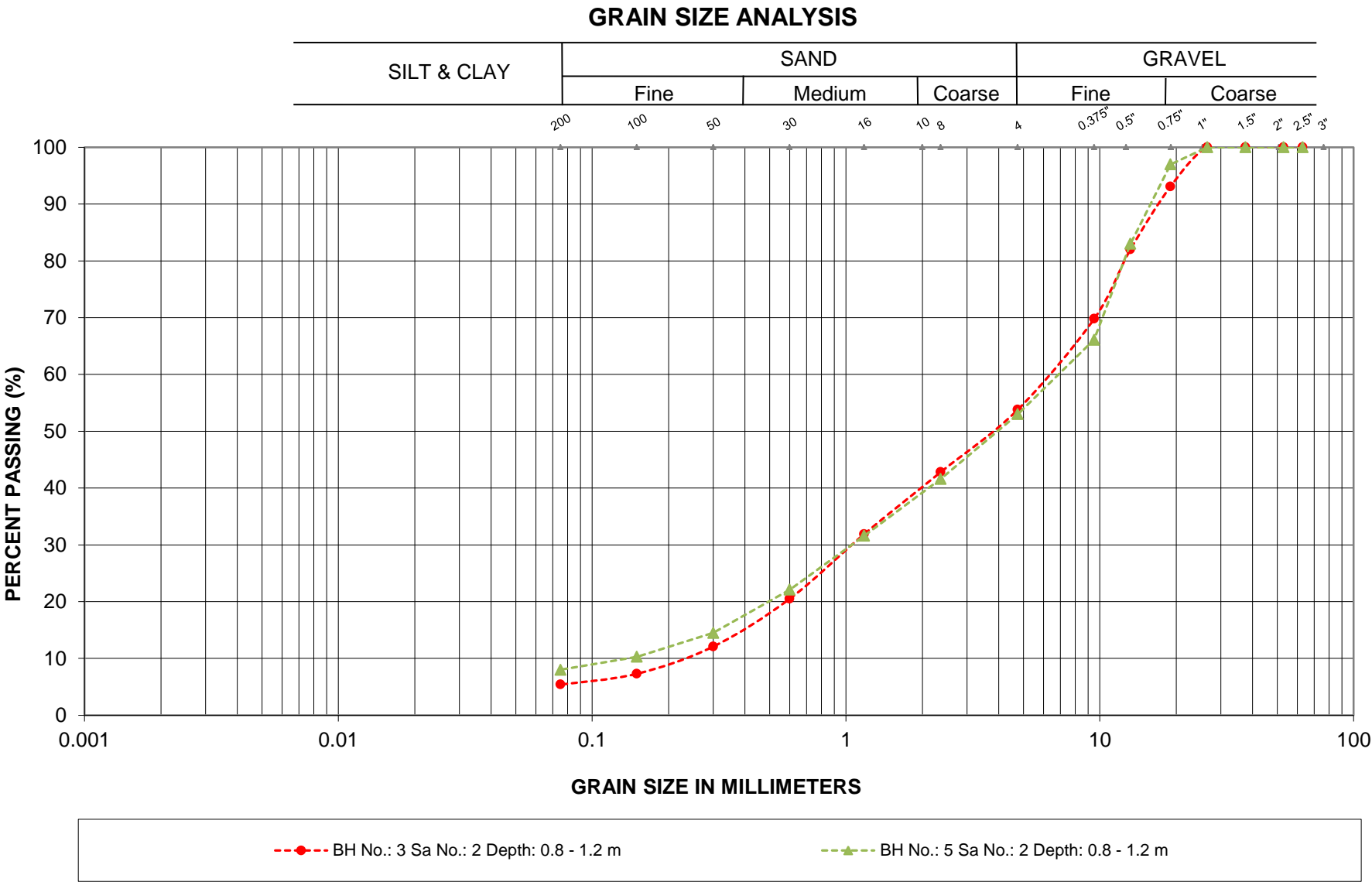


SECTION AT CULVERT (A) – (A)



PROFILE

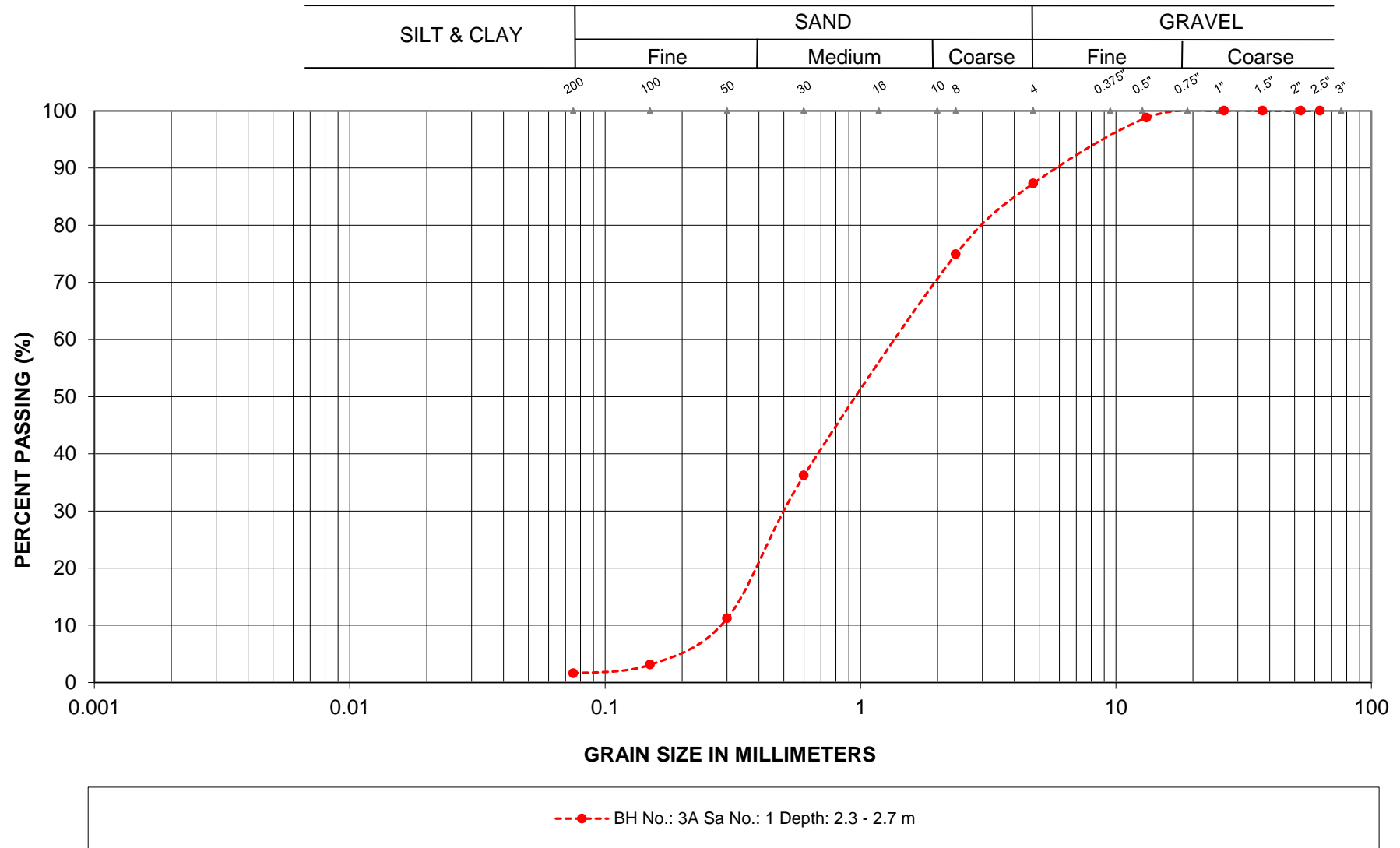
This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.



G.W.P.: 5081-06-00
LOCATION: Hwy 144

FILL

GRAIN SIZE ANALYSIS

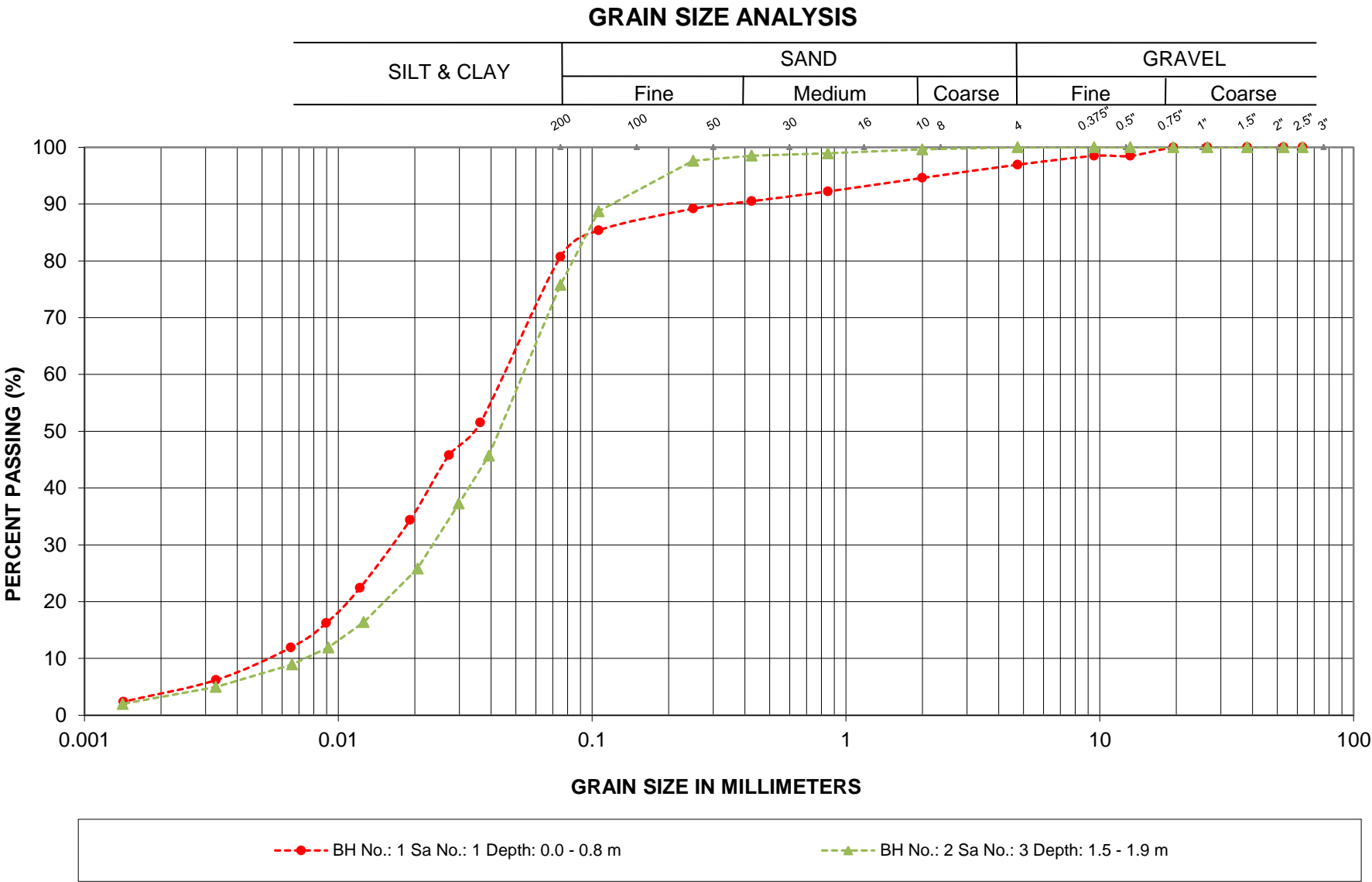


G.W.P.: 5081-06-00
LOCATION: Hwy 144

SAND FILL

LVM | MERLEX

FIGURE L-2

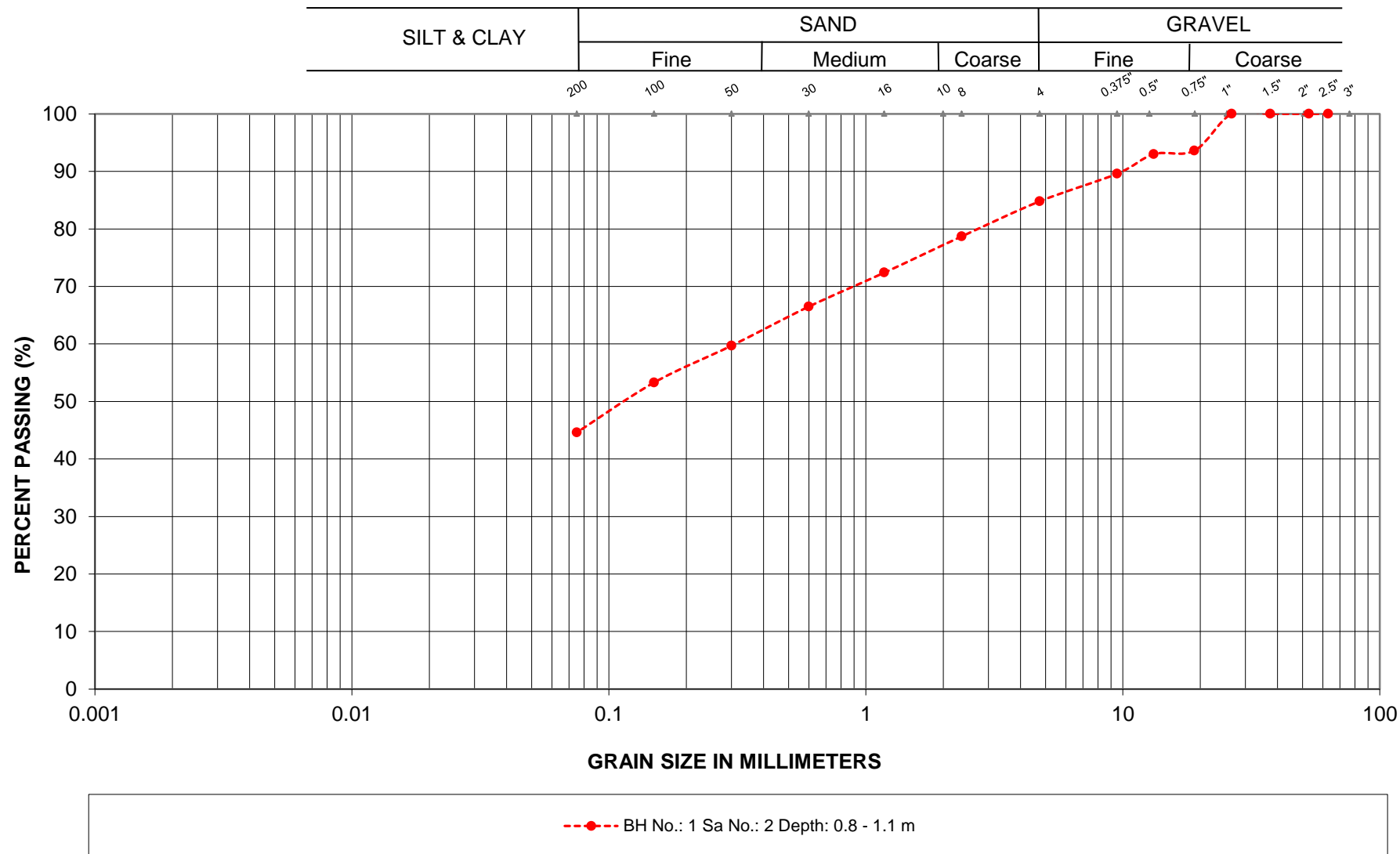


G.W.P.: 5081-06-00
LOCATION: Hwy 144

SILT

FIGURE L-3

GRAIN SIZE ANALYSIS



G.W.P.: 5081-06-00
LOCATION: Hwy 144

SILT and SAND

LVM | MERLEX

FIGURE L-4

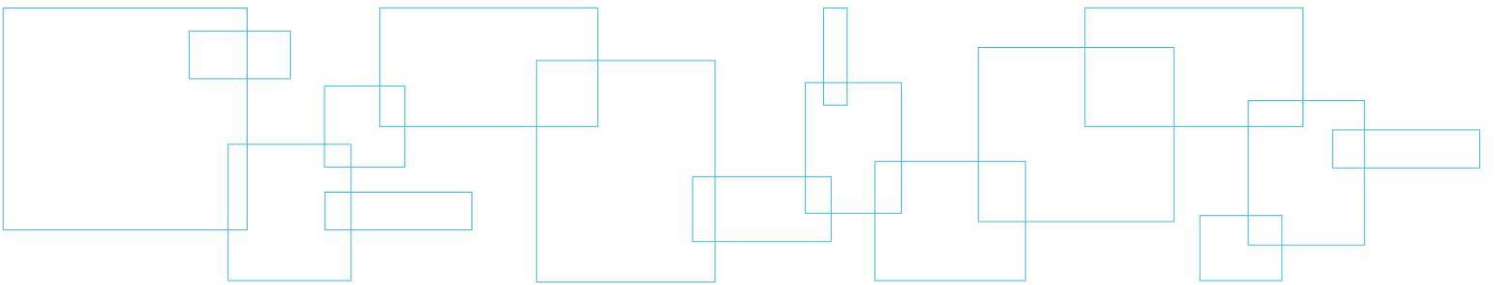
Laboratory Tests - Summary Sheet

[illegible]

Appendix 4 Photo Essay

Enclosure No. 10:

Photo Essay



Existing Embankment – Looking North

Photo: 1



Existing Embankment and Culvert Outlet – Left (West) Side, Looking South

Photo: 2



Project: Hwy 144 – Station 25+317, Twp of Dowling

Photos Provided By: LVM

Date: March 2012

Culvert Outlet – Looking West

Photo: 3



Existing Embankment and Culvert Inlet – Right (East) Side, Looking South

Photo: 4



Project: Hwy 144 – Station 25+317, Twp of Dowling

Photos Provided By: LVM

Date: March 2012

Existing Embankment and Culvert Inlet – Looking North

Photo: 5



Culvert Inlet – Looking West. Note: Inlet partially excavated to expose culvert end.

Photo: 6



Project: Hwy 144 – Station 25+317, Twp of Dowling

Photos Provided By: LVM

Date: March 2012