



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

**Highway 560
Six Mile Creek Culvert – Site No. 47-406/C
Twp. of Mickle
GWP 5242-11-00**

FINAL FOUNDATION INVESTIGATION AND DESIGN REPORT

Date: June 4, 2014
Ref. N^o: 13/05/13073-F4

Geocres No. 41P-58

LVM | MERLEX

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Final Foundation Investigation and Design 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.

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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 the site of an existing centerline culvert. The site is located in the Township of Mickle on Highway 560, some 9.1 km west of the west junction of Highway 65 and 560.

The foundation investigation location was specified by the MTO in the Terms of Reference for work under Agreement No. 5012-E-0025. The terms of reference for the scope of work are outlined in LVM | Merlex Ltd.'s Proposal P-13-022, dated February, 2013. The purpose of this investigation was to determine the subsurface conditions in the area of the culvert ends in order to provide design recommendations for construction of a dewatering system for use during culvert rehabilitation. It is understood that the culvert rehabilitation will consist of cell lining. 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 site of this foundation investigation is located on Highway 560 some 9.1 km west of the west junction of Highway 65 and 560, in the Township of Mickle. The local topography at the site is a low wooded area to the left and right (north and south) of the embankment. The existing highway embankment currently supports two undivided lanes of highway, running in a west to east direction. The existing highway, at the culvert location, is constructed on an embankment some 4.7 m in height, with centerline elevation of 297.7 m at the culvert location. The culvert at this location has been described, as a 5050x3330 mm Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culvert, some 19.5 m in length.

Infrastructure at the culvert location consists of overhead wires on the right (north) 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 560 is generally flat. Significant layers of earth overlay the bedrock. Organic terrain was also observed. Within the project area native overburden consists primarily of sand deposits.

Bedrock in the area, as indicated on OGS Map 2506, is of the Late to Middle Precambrian period, Huronian Supergroup, consisting of conglomerate, sandstone, siltstone, and argillite.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between February 10th and March 12th, 2014 during which time four (4) sampled boreholes were advanced. Two (2) boreholes were advanced at each the inlet and outlet ends of the culvert.

The field investigation was carried out using a Bombardier mounted CME drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling 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. When shallow auger refusal was encountered at the boreholes located at the culvert ends, NQ size diamond coring equipment was used to determine the nature of shallow refusal. 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.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following, completion of the individual boreholes. At select boreholes 19 mm diameter standpipes were installed prior to backfilling to allow for further monitoring of the shallow groundwater levels. 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 in accordance with Ontario Regulation 903.

The field work for this investigation was under the full time direction of a senior member of the LVM | Merlex 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. 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 and Table No. L-6).

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 established by others.

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, 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 10+000, TWP OF MICKLE

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 4 advanced at the culvert outlet (right/south) and Borehole Nos. 2 and 3 advanced at the culvert inlet (left/north). At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at 295.2, 294.9, 294.8, and 295.3 m, respectively.

4.1.1 Sand Fill

At surface at Borehole No. 2, a layer of fill described as sand some silt trace gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 15%. This layer was encountered to a depth of 0.4 m below grade (elevation 294.5 m).

4.1.2 Silt and Sand Fill

Underlying the sand fill at Borehole No. 2 and at surface at Borehole No. 3, a layer of fill described as silt and sand some clay was penetrated. Cobbles and boulders were encountered in this fill layer at Borehole No. 2. The natural moisture content measured on samples of this deposit was in the order of 31 to 45%. Hydrometer analyses were carried out on two (2) samples of this deposit, the results of which indicated 0% gravel size particles, 41 to 45% sand size particles, 42 to 45% silt size particles and 13 to 15% clay size particles (Figure No. L-1, Appendix 3). Atterberg Limits testing was carried out on two samples of this deposit, the results indicated that one sample was non-plastic (NP) while the second was slightly plastic. The results of the Atterberg testing on the plastic sample indicated a Liquid Limit in the order of 26% and a Plastic Limit in the order of 20% (Figure No. L-5, Appendix 3). Based on SPT 'N' values of 3 to 6 blows per 300 mm penetration, the compactness of this deposit was described as very loose to loose. This layer was encountered to depths of 1.7 and 0.8 m below grade at Borehole Nos. 2 and 3, respectively (elevations 293.2 and 294.0 m, respectively).

4.1.3 Gravelly Sand Fill

At surface at Borehole No. 4, a layer of fill described as gravelly sand trace silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 13 to

18%. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 37% gravel size particles, 56% sand size particles, and 7% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 6 blows per 300 mm penetration, the compactness of this deposit was described as loose. This layer was encountered to a depth of 1.1 m below grade (elevation 294.2 m).

4.1.4 **Peat**

At ground surface, at Borehole No. 1, underlying the silt and sand fill at Borehole Nos. 2 and 3, and underlying the gravelly sand fill at Borehole No. 4, a layer of peat was encountered. This layer was described as brown to black silty to sandy peat. Cobbles and boulders were encountered in this deposit at Borehole No. 4. The natural moisture content measured on samples of this peat deposit was in the order of 63 to 240%. The peat deposit was encountered to depths of 0.7, 2.4, 1.5, and 1.8 m below grade at Borehole Nos. 1, 2, 3, and 4, respectively (elevations 294.5, 292.5, 293.3 and 293.5 m, respectively).

4.1.5 **Silty Clay and Gravel**

Underlying the peat at Borehole Nos. 2, 3, and 4, a deposit described as silty clay and gravel some sand was penetrated. The natural moisture content measured on samples of this deposit was in the order of 15 to 35%. Cobbles and boulders were encountered in the lower reaches of this deposit at Borehole Nos. 3 and 4. Difficulties drilling were encountered in this deposit between 1.5 and 2.1 m depths below grade at Borehole No. 3, due to the cobbles and boulders encountered. A hydrometer analysis was carried out on one (1) sample of this deposit, the results of which indicated 37% gravel size particles, 19% sand size particles, 25% silt size particles and 19% clay size particles (Figure No. L-3, Appendix 3). Atterberg Limits Testing was carried out on one sample of the plastic portion of this deposit, the results of which indicated a Liquid Limit in the order of 28% and a Plastic Limit in the order of 14% (Figure No. L-5, Appendix 3). Based on the results of the Atterberg Limits Testing, the plastic portion of this deposit was described as a silty clay of low plasticity (CL). This deposit was encountered to depths of 3.2, 2.6, and 2.6 m below grade at Borehole Nos. 2, 3, and 4, respectively (elevations 291.7, 292.2, and 292.7 m, respectively).

4.1.6 **Sand to Sand and Gravel**

Underlying the peat layer at Borehole No. 1, and underlying the silty clay and gravel deposit at Borehole Nos. 2, 3, and 4, a deposit of sand described as sand with gravel with silt to sand and gravel trace silt was penetrated. Cobbles and boulders were encountered in this deposit. The natural moisture content measured on samples of this deposit was in the order of 11 to 21%. Gradation analyses were carried out on four (4) samples of this deposit, the results of which indicated 24 to 44% gravel size particles, 49 to 66% sand size particles, and 6 to 27% silt and clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 12 to 42 blows per 300 mm penetration, this deposit was described as compact to dense. This deposit was encountered to depths of 3.3, 4.4, 4.4, and 4.6 m below grade at Borehole No. 1, 2, 3, and 4,

respectively, where bedrock was encountered (elevations 291.9, 290.5, 290.4, and 290.7 m, respectively).

4.1.7 Bedrock

The NQ size diamond coring equipment was used to advance the boreholes into bedrock. The bedrock was described as pink to purple sandstone. Based on Rock Quality Designation (RQD) of 59 to 100%, the quality of the bedrock was described as fair to excellent, generally good. Sampling was terminated in the boreholes at depths of 6.3, 5.9, 5.9, and 6.1 m below grade at Borehole Nos. 1, 2, 3, and 4, respectively (elevations 288.9, 289.0, 288.9, and 289.2 m, respectively).

4.2 GROUNDWATER DATA

The water level in Six Mile Creek was reported at elevation 293.6 m on October 2nd, 2013, by others.

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 at Borehole No. 2 to further measure the groundwater levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix 2). The water levels in Borehole Nos. 1 to 4 were measured between elevations 293.2 to 294.0 m.

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

5 DISCUSSION AND RECOMMENDATIONS

5.1 GENERAL

The culvert at this location is a 5050x3330 mm Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culvert, some 19.5 m in length. Flow through the culvert is from left to right (i.e. north to south) (see Photo Essay, Appendix 1). The subsurface conditions at this site generally consist of layers of fill overlying peat that are underlain by deposits of silty clays and gravels and deposits of sands to sand and gravels. Cobbles and boulders were encountered in the native materials at this site.

It is understood that the present plans propose a culvert rehabilitation consisting of cell lining the lower half of pipe.

In order to plan for this work geotechnical information for a dewatering system was required.

5.2 DEWATERING

The culvert must be maintained in a dewatered condition during culvert rehabilitation. The groundwater level in the boreholes, at the time of this investigation, was recorded between approximately elevations 293.2 to 294.0 m in February 2014 (Borehole No. 3 and 2, respectively). The culvert outlet has an invert elevation of 292.8 m and the water level in the creek was established by others at elevation 293.6 m on October 2nd, 2013. As such, a head of water some 0.8 m in depth will have to be controlled during construction. Dewatering, in accordance with OPSS 517 and 518, will be required during rehabilitation activities.

In order to dewater the culvert location, a cofferdam will be required at the inlet and outlet. A complete cofferdam at the inlet and outlet with bypass pumping is the suggested method of controlling the creek flow. A bypass pipe could be suspended from the roof of the existing culvert, considering the culvert size, or alternately installed through the existing embankment. The former bypass approach is favoured to prevent damaging the existing pavement structure during construction. Consideration could also be given to constructing a cofferdam along the center of the culvert, in consideration of the 5.1 m width of the arch. This would allow work in the dry condition on one side and permit bypass flow along the other side. Since the existing culvert is a closed SPCSPA, a gravity type cofferdam (i.e. sand bag or other sufficiently narrow gravity cofferdam system) could be used along the center of the culvert to control flow to one side. Considering the corrugated cross section of the existing culvert, a seal (i.e. bentonite seal) would likely be required between the gravity cofferdam base and existing culvert, for the dam to effectively contain water. A sheet pile wall, that conforms to the culvert corrugations, fixed to the interior of the existing culvert, could also be considered.

A temporary gravity type cofferdam is the recommended method of controlling the creek flow at this culvert location. A gravity type cofferdam can be constructed of: earth fill with a low permeable core, sand bag/metre bag, or aquadam (water filled bladder) type dam. Depending

upon the base width of the cofferdam seepage may develop below the temporary sand bag wall. This may require pumping from filtered sump holes within the dewatered area.

Some difficulties were experienced in advancing the borings during this investigation, due to the presence of cobbles and boulders in the fills and native deposits and also in consideration of the shallow overburden depth above the bedrock, a sheet pile type coffer dam is not considered feasible, at the culvert ends, at this site.

A conceptual cofferdam sketch has been included in Appendix 5.

6 STATEMENT OF LIMITATIONS

The design recommendations given in this geotechnical report are applicable only to the project described in the text and only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions may however, vary from those assumed, in which case changes and modifications may be required to our geotechnical recommendations. We recommend, therefore, that we be retained and provided the opportunity during the design stage to review the design drawings, site survey information, proposed elevations, etc. to verify that they are consistent with our recommendations or the assumptions made in our analysis. It is further recommended that we be retained to review the final design drawings and specifications relative to the geotechnical recommendations.

If, during construction, conditions in the field vary from those assumed at the design stage, an engineer from this office must be notified immediately.

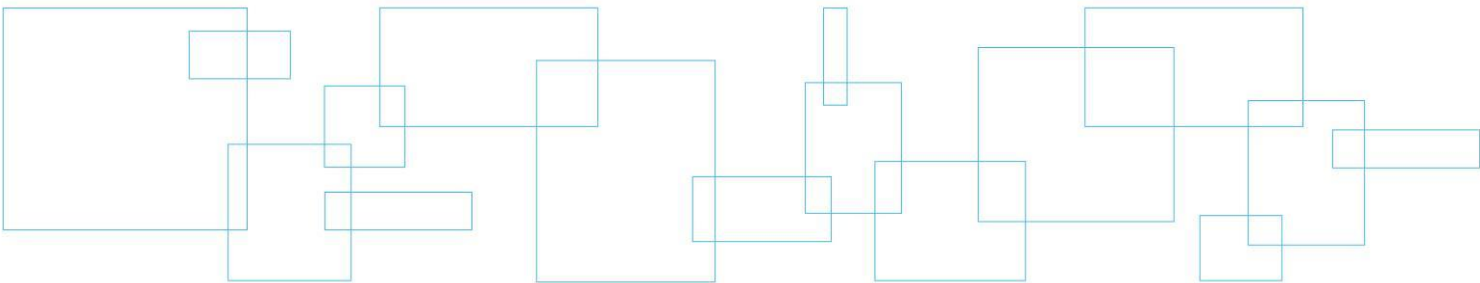
Proper subgrade preparation, groundwater control, compaction, etc. are all critical aspects of the bearing capacity of native soils. It must be noted that different aspects of the geotechnical design are based on the assumption that LVM | Merlex Ltd. will be retained during site preparation and construction of the proposed works to ensure that both the geotechnical site characteristics and the construction operations/techniques are consistent with our recommendations. Should LVM | Merlex Ltd. not be involved during the full construction phase, our liability is strictly limited to the factual information contained herein only.

The comments in this report are intended solely for the guidance of the design engineer and address the geotechnical conditions only. The number of boreholes required to determine the localized conditions between boreholes directly affecting construction costs, equipment, scheduling, etc. would in fact be greater than what has been carried out for design purposes. Therefore, contractors bidding on this project or undertaking this work should make their own interpretations of the factual borehole results and carry out further work as they deem necessary to assess the scope of the project.

Section 5 of this reported is intended for the use of the client and the design team only and is not intended to be included in the tender documents. Inclusion of the factual information (Sections 1 to 5 inclusive) in the tender documents is furnished merely for the general information of bidders and is not in any way warranted or guaranteed by or on behalf of the owner or the owner's consultants and its subconsultants or the consultants' or subconsultants' employees, and neither the owner nor its consultants or its employees shall be liable for any representations negligent or otherwise contained in the documents.

Appendix 1 Key Plan

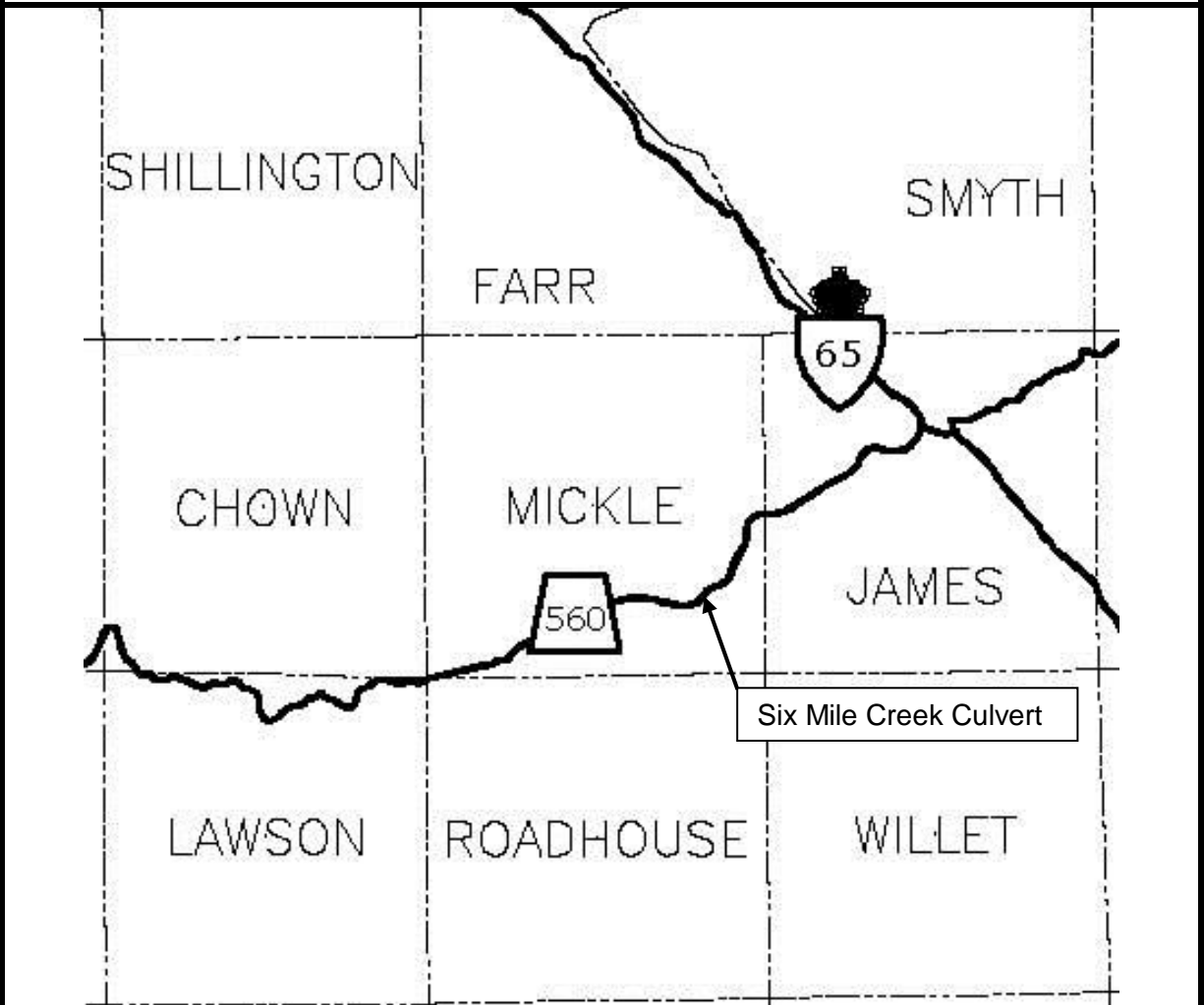
Drawing No. 1 Key Plan



KEY PLAN

Drawing No. 1

NOT TO SCALE



**FINAL
FOUNDATION INVESTIGATION
AND DESIGN REPORT**
GWP 5242-11-00
Highway 560
Six Mile Creek Culvert

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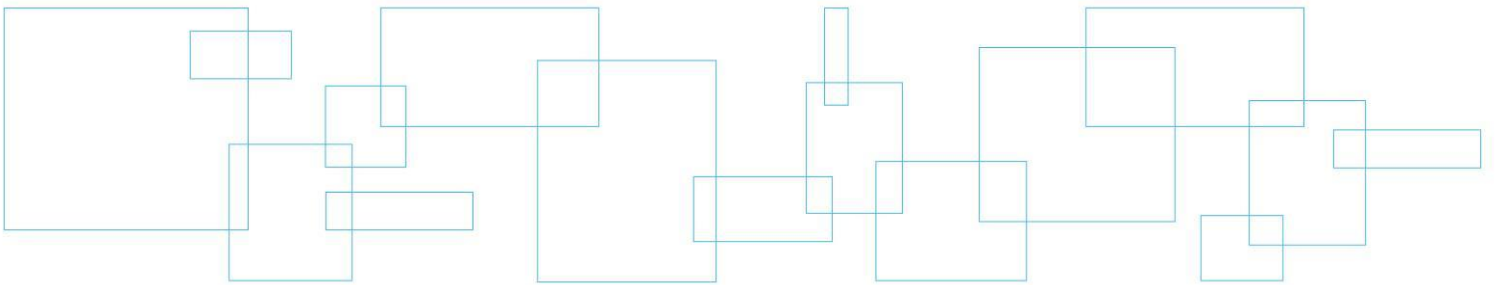
Reference No: 13/05/13073-F4

June 2014

Appendix 2 Subsurface Data

Enclosure No. 1
Enclosure Nos. 2 to 5

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
Rec	% recovery from individual run of rock core
RQD	Rock quality designation (%)

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) *Cohesive Soils:*

RQD (%)	Classification
Less than 25	Very poor quality
25 to 50	Poor quality
50 to 75	Fair quality
75 to 90	Good quality
90 to 100	Excellent quality

d) *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.

e) *Soil Moisture:*

Moisture	Described as
Dry	Below optimum moisture content
Moist	Near optimum moisture content
Wet	Above optimum moisture content

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

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 13/05/13073-F4 DATUM Geodetic LOCATION N 5283385.3 E 347842.0 - Mickle Twp - Station 9+995, 19.0 m Rt ORIGINATED BY JL
 PROJECT GWP 5242-11-00, Hwy 560 - Six Mile Creek Culvert BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT AECOM Canada Inc. DATE (Started) 2014 February 10 TIME
 DATE (Completed) 2014 February 24 (Completed) 3:45:00 PM 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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)												
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES																		
295.2	Ground Surface																						
0.0	PEAT - sandy peat brown		1	AS			295			136													
294.5	SAND - some to with silt, some to with gravel boulders encountered between 0.7 to 3.3 m depth brown, moist (compact) grey		2	SS	13		294		○		24 49 (27)												
			3	SS	25/50 mm				○														
			4	SS	12		293			○													
			5	SS	50/75 mm		292		○														
291.9	BEDROCK - sandstone pink/purple (fair/good quality)		6	RC	REC= 100% ROD= 59%		291																
			7	RC	REC= 100% ROD= 77%		290																
288.9	End of Borehole						289																
6.3																							
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 (yy/mm/dd)Time</th> <th>Water Depth (m)</th> <th>Cave In (m)</th> </tr> </thead> <tbody> <tr> <td>1) 14/2/11 12:00:00 PM</td> <td>1.3</td> <td>1.3</td> </tr> <tr> <td>2) 14/2/24 3:45:00 PM</td> <td>1.6</td> <td>6.3</td> </tr> <tr> <td>3)</td> <td>-</td> <td>-</td> </tr> </tbody> </table>				Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)	1) 14/2/11 12:00:00 PM	1.3	1.3	2) 14/2/24 3:45:00 PM	1.6	6.3	3)	-	-
Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)																					
1) 14/2/11 12:00:00 PM	1.3	1.3																					
2) 14/2/24 3:45:00 PM	1.6	6.3																					
3)	-	-																					

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

MEL-GEO 13073-F4 - BOREHOLE LOGS - SIX MILE GPJ MEL-GEO.GDT 14/6/6



METRIC

RECORD OF BOREHOLE NO. 02



REFERENCE 13/05/13073-F4 DATUM Geodetic LOCATION N 5283402.0 E 347812.2 - Mickle Twp - Station 9+992, 15.0 m Lt ORIGINATED BY JL
 PROJECT GWP 5242-11-00, Hwy 560 - Six Mile Creek Culvert BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT AECOM Canada Inc. DATE (Started) 2014 February 19 TIME
 DATE (Completed) 2014 February 19 (Completed) 2:20:00 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								
294.9	Ground Surface												
0.0	FILL - sand some silt trace gravel brown, wet		1	AS									
294.5													
0.4	FILL - mixture of sand and silt some clay cobbles/boulders encountered between 0.5 and 0.9 m		2	SS	6								
			3	SS	3								
293.2													
1.7	PEAT - silty peat black		4	SS	WH								
292.5													
2.4	SILTY CLAY AND GRAVEL - some sand grey, wet		5	SS	15								
291.7													
3.2	SAND AND GRAVEL - trace silt grey, wet (compact)		6	SS	19								
			7	SS	100/175 mm								
290.5													
4.4	BEDROCK - sandstone pink/purple (good quality)		8	RC	Rec= 100% ROD= 77%								
289.0													
5.9	End of Borehole												

COMMENTS		WATER LEVEL RECORDS	
Standpipe installed to 0.5 m above grade.		Date (yy/mm/dd)/Time	Water Depth (m) Cave In (m)
+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE		1) 14/2/19 2:20:00 PM	0.9 5.9
		2)	- -
		3)	- -

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

MEL-GEO 13073-F4 - BOREHOLE LOGS - SIX MILE GPJ MEL-GEO.GDT 14/6/6



METRIC

RECORD OF BOREHOLE NO. 03



REFERENCE 13/05/13073-F4 DATUM Geodetic LOCATION N 5283412.2 E 347820.4 - Mickle Twp - Station 10+005, 14.0 m Lt ORIGINATED BY JL
 PROJECT GWP 5242-11-00, Hwy 560 - Six Mile Creek Culvert BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT AECOM Canada Inc. DATE (Started) 2014 February 25 TIME
 DATE (Completed) 2014 February 25 (Completed) 4:15:00 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					
294.8	Ground Surface													
0.0	FILL - mixture of sand and silt some clay brown, wet		1	AS										
294.0	(loose)		2	SS	4									
0.8	PEAT - silty peat black													
293.3			3	SS	50/100 mm									
1.5	SILTY CLAY AND GRAVEL - some sand occasional cobbles and difficulties drilling from 1.5 to 2.1 m depth grey, wet		4	SS	11									
292.2														
2.6	SAND - trace silt with gravel grey, wet (dense)		5	SS	41									
			6	SS	42									
290.4			7	SS	25/25 mm									
4.4	BEDROCK - sandstone pink/purple (excellent quality)		8	RC	Rec=100% ROD=100%									
288.9														
5.9	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 (yy/mm/dd)/Time Water Depth (m) Cave In (m) 1) 29/2/1 4:15:00 PM 1.6 5.9 2) - - - 3) - - -						

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



METRIC

RECORD OF BOREHOLE NO. 04



REFERENCE 13/05/13073-F4 DATUM Geodetic LOCATION N 5283395.2 E 347845.2 - Mickle Twp - Station 10+005, 16.0 m Rt ORIGINATED BY JL
 PROJECT GWP 5242-11-00, Hwy 560 - Six Mile Creek Culvert BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT
 CLIENT AECOM Canada Inc. DATE (Started) 2014 February 26 TIME 2014 February 26
 DATE (Completed) 2014 February 26 (Completed) 4:25:00 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									
							20	40	60	80	100						
295.3	Ground Surface																
0.0	FILL - gravelly sand trace silt cobbles/boulders encountered between 0 to 1.1 m depth		1	AS													
	brown		2	SS	6												
	(loose)																
294.2																	
1.1	PEAT - silty peat trace wood pieces cobbles/boulders encountered between 1.1 and 1.8 m depth		3	SS	42												
293.5																	
1.8	black SILTY CLAY AND GRAVEL - some sand		4	SS	23												
	cobbles/boulders encountered between 1.8 to 2.6 m depth																
292.7																	
2.6	grey, moist GRAVELLY SAND - some silt cobbles/boulders encountered between 2.6 to 4.6 m depth		5	SS	13												
	grey, wet (compact)		6	SS	23/50 mm												
290.7																	
4.6	BEDROCK - sandstone pink/purple		7	RC	Rec=100% RQD=80%												
	(good quality)																
289.2																	
6.1	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 (yy/mm/dd)Time					Water Depth (m)		Cave In (m)			
							1) 14/3/12 4:25:00 PM					1.9		3.5			
							2)					-		-			
							3)					-		-			

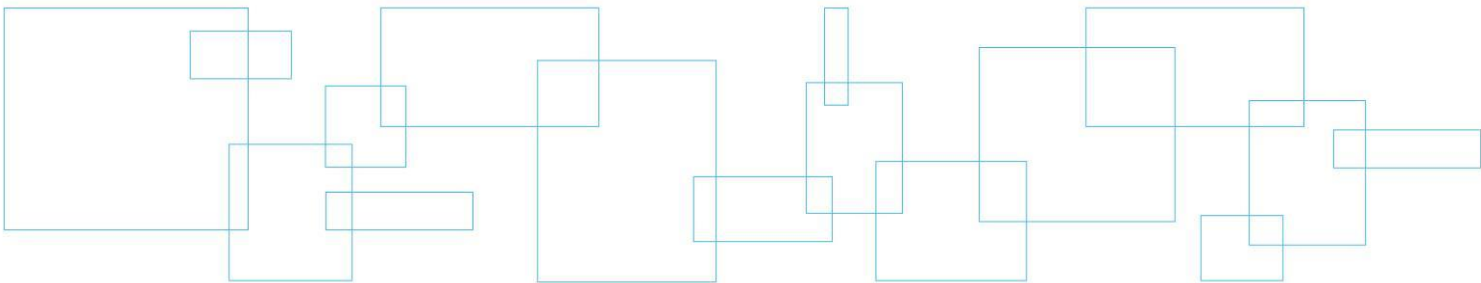
The stratification lines represent approximate boundaries. The transition may be gradual.

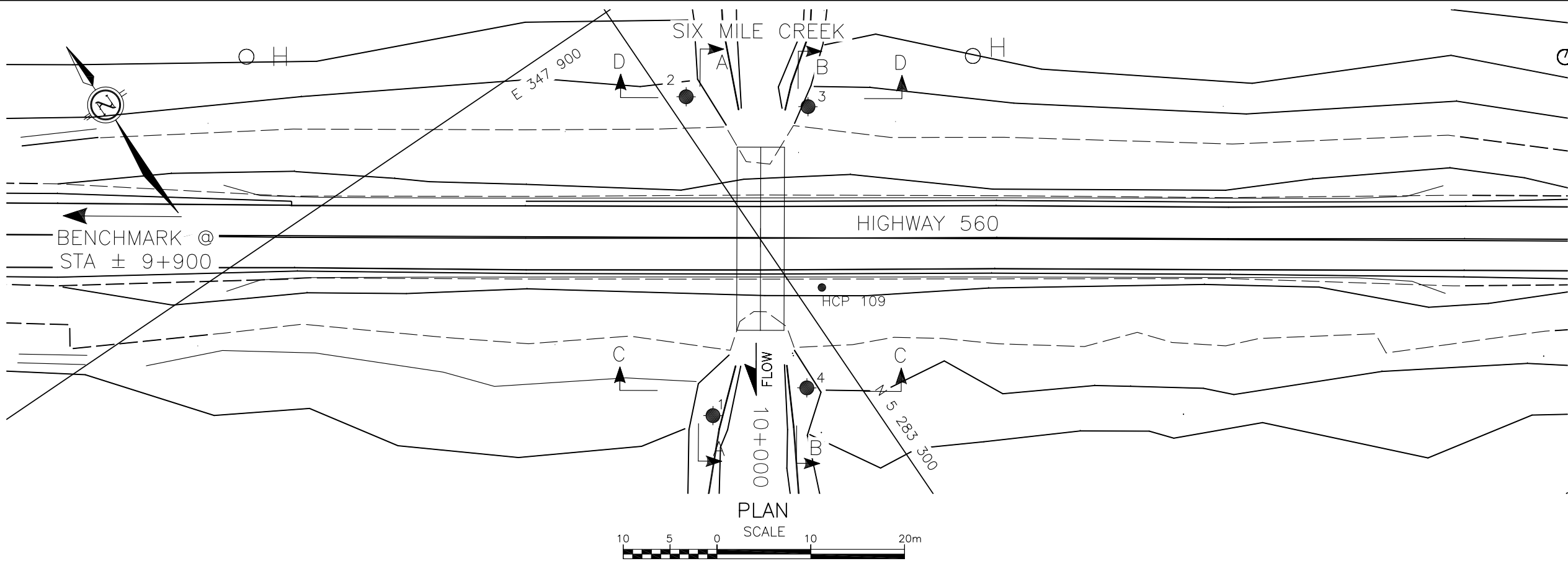
MEL-GEO 13073-F4 - BOREHOLE LOGS - SIX MILE GPJ MEL-GEO.GDT 14/6/6



**Appendix 3 Borehole Plan and
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:	Atterberg Limits Summary
Table No. L-6:	Lab Test Summary Sheet





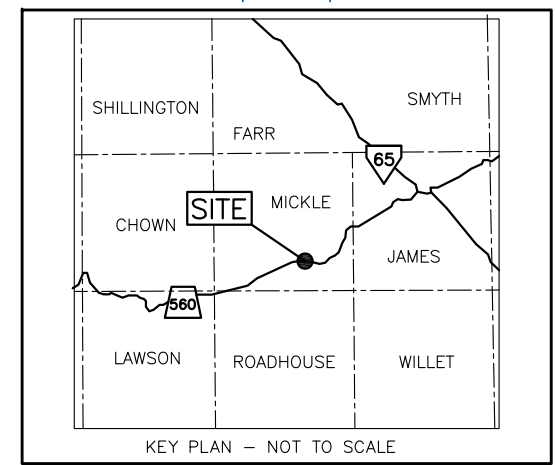
CONT. No.
XXXX-XXXX

GWP. No.
5242-11-00

HWY 560
SIX MILE CREEK CULVERT
(SITE 47-406)
MICKLE TOWNSHIP
BOREHOLE LOCATIONS & SOIL STRATA

N

DRAWING
2



LEGEND

Borehole

Blows/0.3 m (Std Pen Test, 475 J/blow)

Blows/0.3 m (60° Cone, 475 J/blow)

Water Level at Time of Investigation

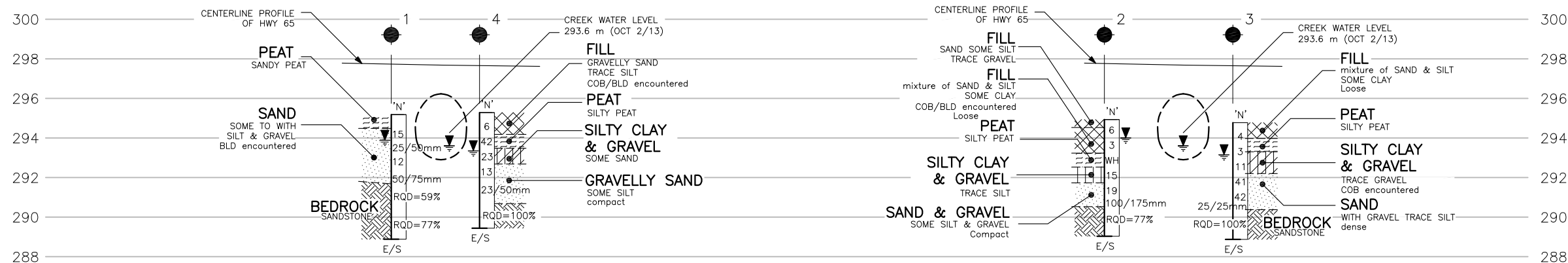
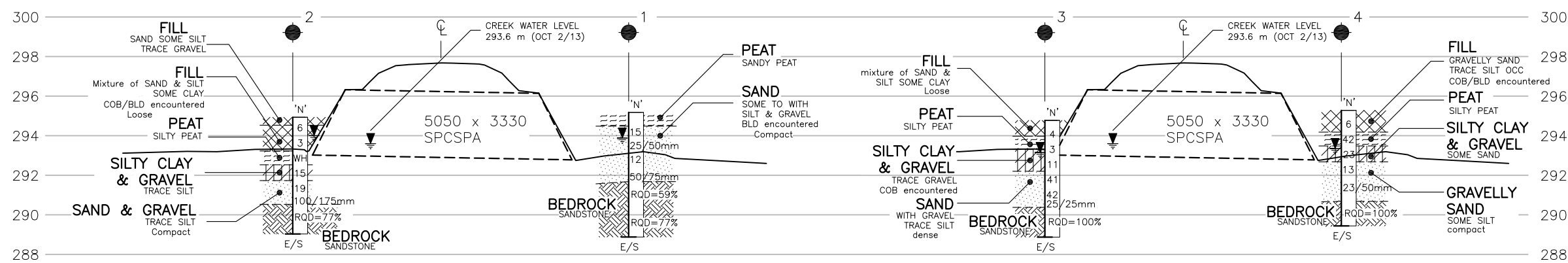
Piezometer

Auger Refusal at Elevation

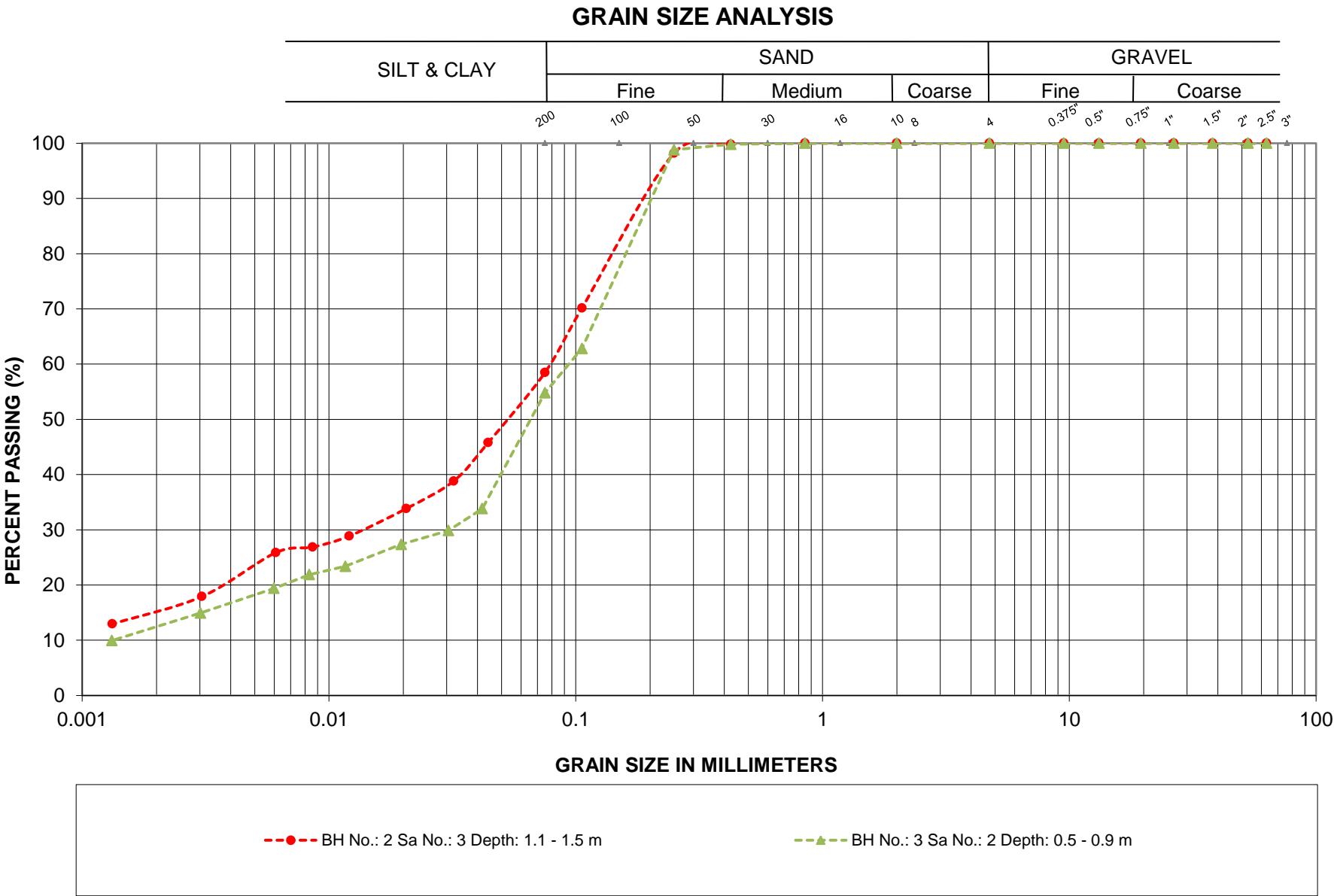
End of Sampling

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.



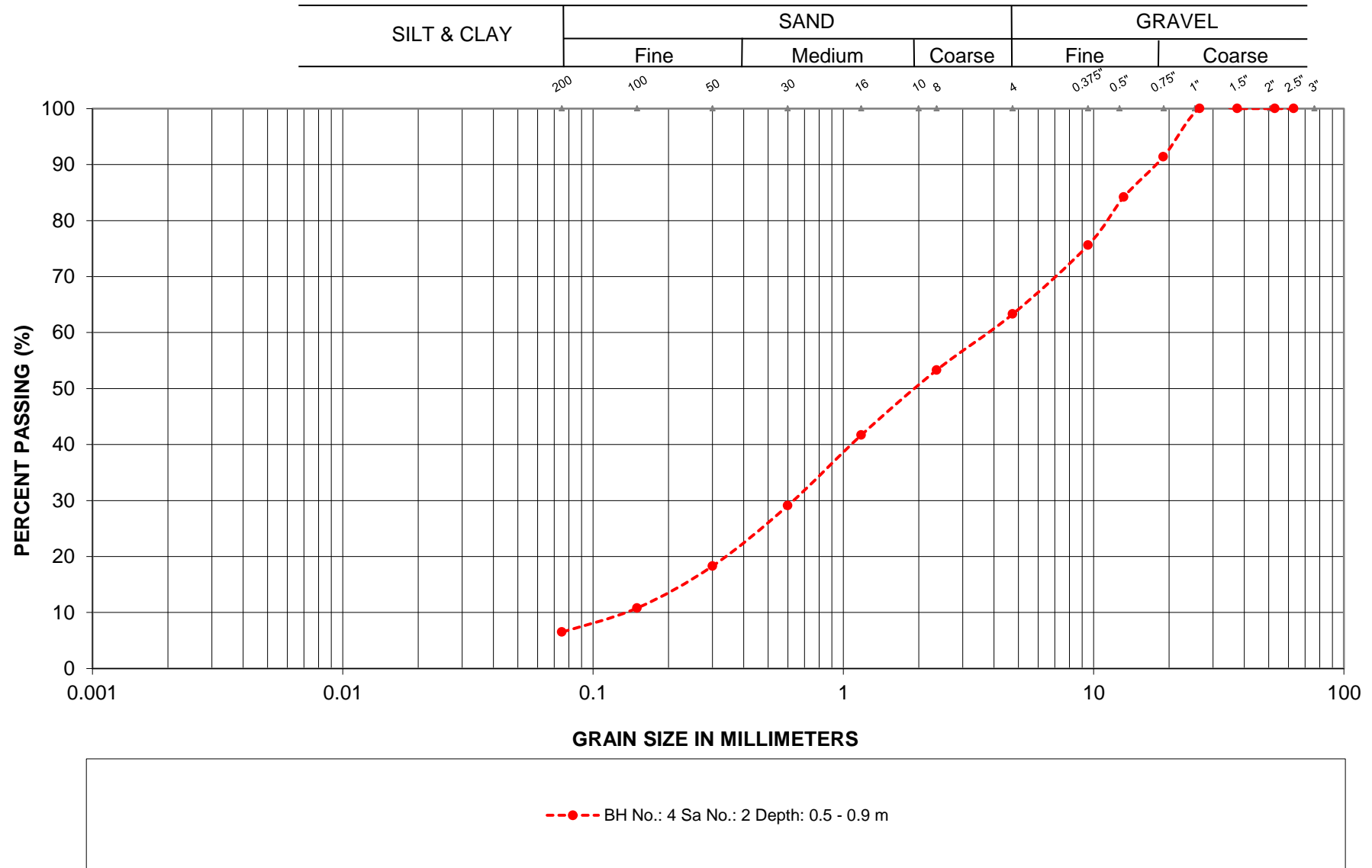
REVISIONS	DATE	BY	DESCRIPTION
HWY NO. 560 - MICKLE TOWNSHIP			
GEOCRES NO.: 41P-58			
L V M REF. NO.: 13/05/13073-F4			
DRAWN: RG CHECKED: AT DATE: MARCH 2014			



G.W.P.: 5242-11-00
LOCATION: Hwy 560, Six Mile Creek

SILT AND SAND FILL

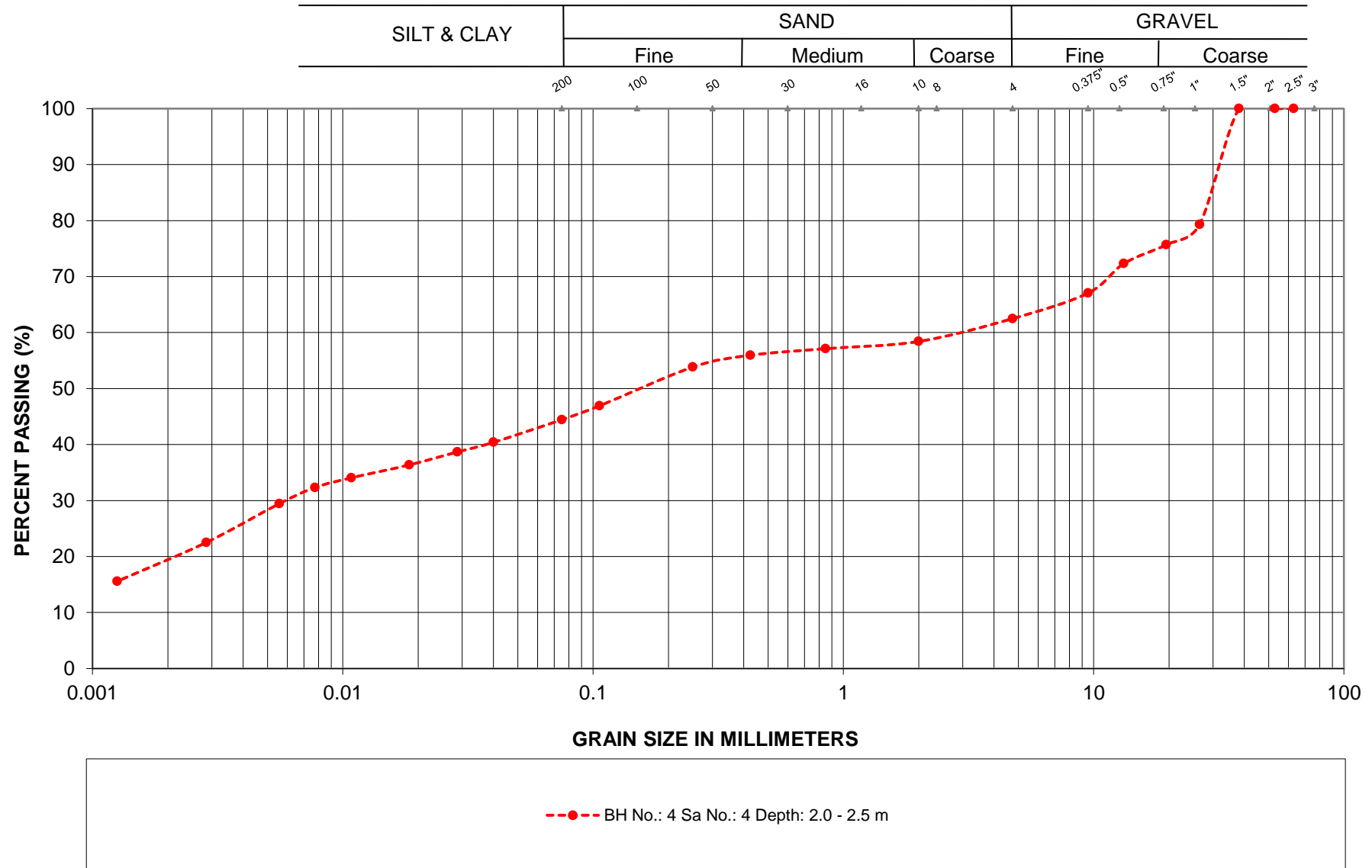
GRAIN SIZE ANALYSIS



G.W.P.: 5242-11-00
LOCATION: Hwy 560, Six Mile Creek

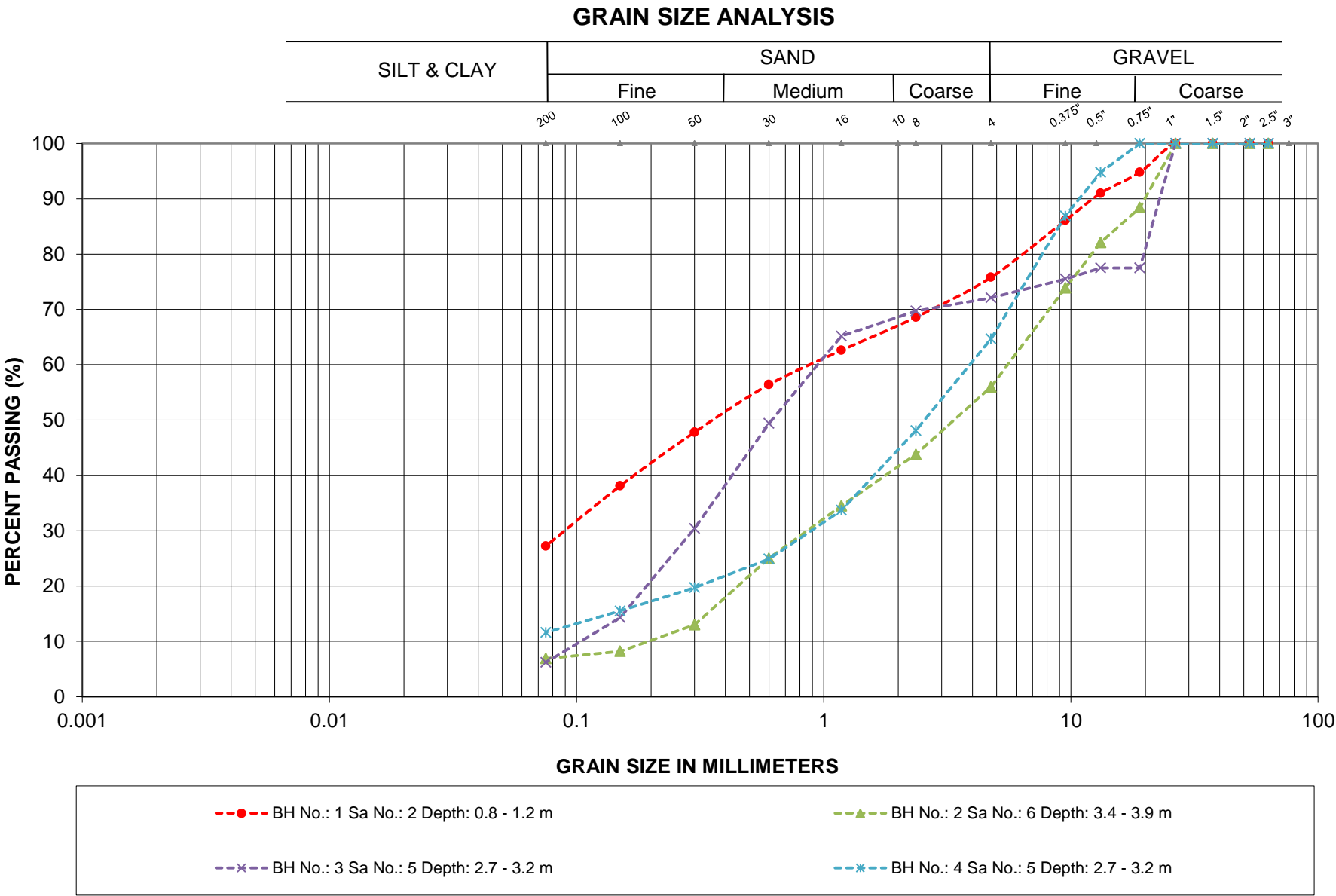
GRAVELLY SAND FILL

GRAIN SIZE ANALYSIS



G.W.P.: 5242-11-00
LOCATION: Hwy 560, Six Mile Creek

SILTY CLAY AND GRAVEL

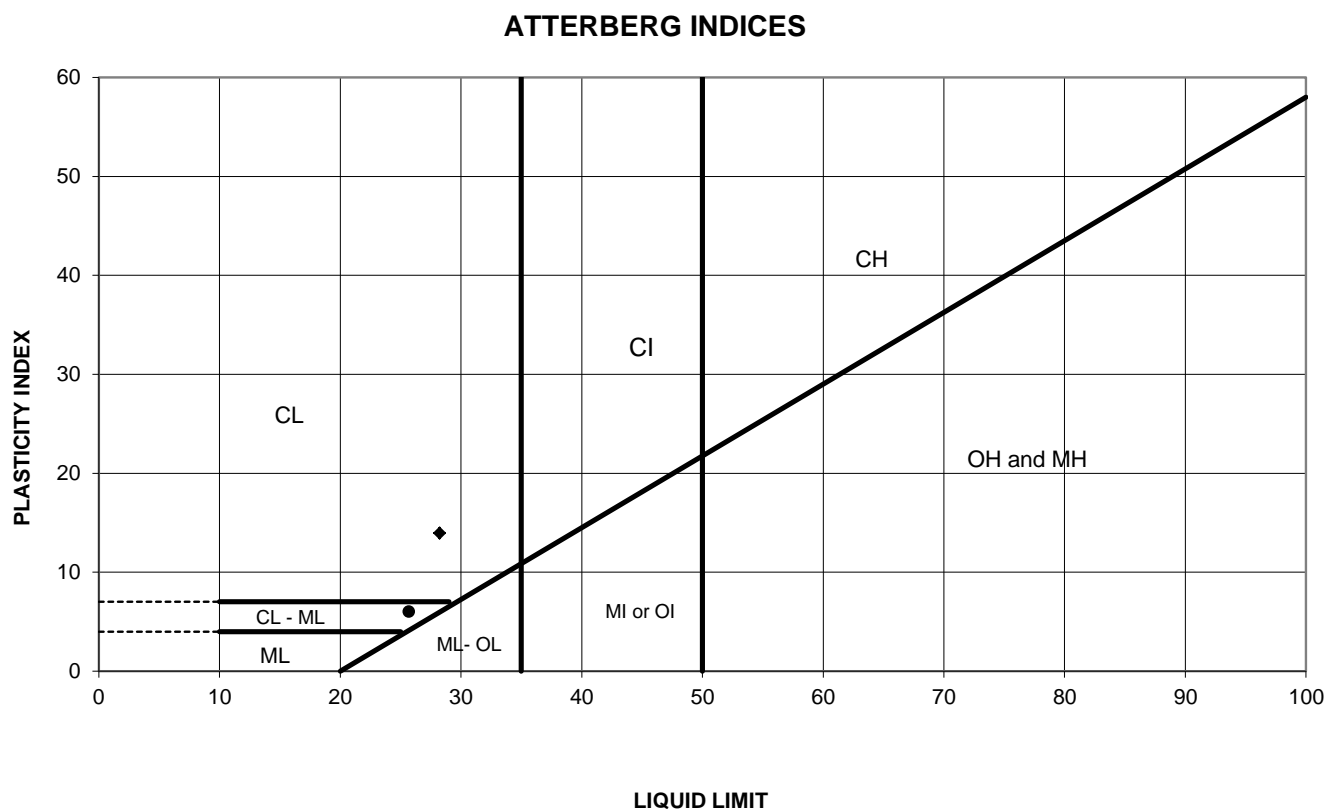


G.W.P.: 5242-11-00
LOCATION: Hwy 560, Six Mile Creek

SANDS TO SANDS AND GRAVELS

ATTERBERG LIMITS TEST RESULTS

FIGURE L-5



SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plastic Limit	Plasticity Index	NMC %
●	2	3	1.3	293.6	25.7	19.7	6.0	25.2
◆	4	4	2.2	293.1	28.2	14.3	14.0	44.4

Date: Jun-14
Project: Hwy 560, Six Mile Creek
G.W.P: 5242-11-00

Prep'd: AT
Chkd: MAM
Ref. No.: 13/05/13073-F4

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					136.0							
	2	0.8	24	49	27		11.9				13			
	3	1.5					11.4				25/50 mm			
	4	2.3					20.7				12			
	5	3.1					14.4				50/75 mm			
	6	3.3												Rec= 100% RQD= 59%
	7	4.8												Rec= 100% RQD= 77%
2	1	0.0					14.8				6			
	2	0.3					45.1				3			
	3	1.1	0	41	44	15	30.9	25.7	19.7	6.0	WH			
	4	1.8					115.0				15			
	5	2.6					34.8				19			
	6	3.4	44	49	7		15.3				100/175			
	7	4.1												Rec= 100% RQD=77%
	8	4.4												
3	1	0.0					42.0							
	2	0.5	0	45	42	13	43.3				4			
	3	1.2					240.0				50/100 mm			
	4	2.0					32.6				11			
	5	2.7	28	66	6		20.3				41			
	6	3.51					16.9				42			
	7	4.27									25/25 mm			
	8	4.4												Rec= 100% RQD= 100%

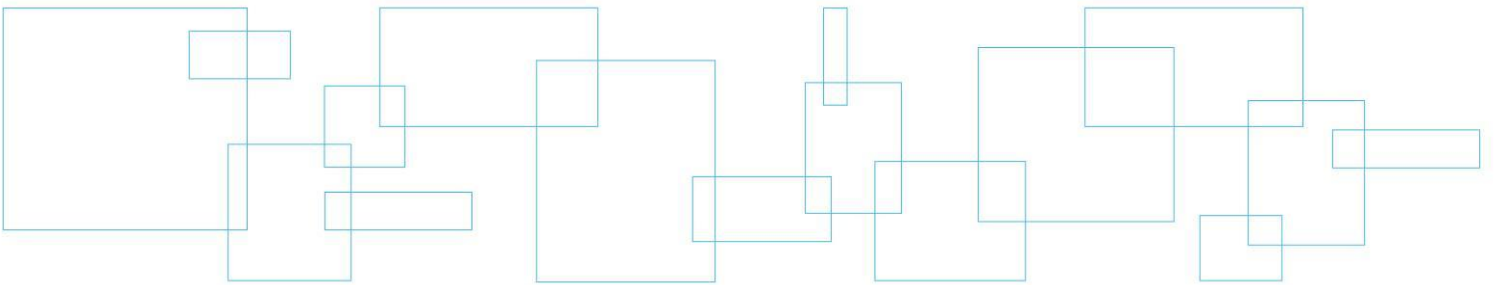
Laboratory Tests - Summary Sheet

[illegible]

Appendix 4 Photo Essay

Enclosure No. 6:

Photo Essay



Culvert Inlet – Looking North

Photo: 1



Culvert Outlet – Looking South

Photo: 2



Project: Hwy 560 – Six Mile Creek Culvert

Photos Provided By: LVM

Date: July 2013

Culvert Inlet – Looking East

Photo: 3



Culvert Outlet – Note cobble/boulders in and around creek

Photo: 4



Project: Hwy 560 – Six Mile Creek Culvert

Photos Provided By: LVM

Date: July 2013

Appendix 5 Design Data

Sketch No. 1: Conceptual Cofferdam Sketch

