



# MERLEX ENGINEERING LTD.

CONSULTING GEOTECHNICAL ENGINEERS

**FINAL  
FOUNDATION INVESTIGATION REPORT  
SITE B**

**CULVERT STATION 19+760 – TWP. OF SPRINGER  
CULVERT SITE NO. 43-312  
GWP 5106-06-00**

**Highway 64, From 1.8 km North of Highway 17, Sturgeon Falls  
North Limit, Northerly 19.4 km**

MEL Ref. No.: 08/12/08180B

November 24, 2009

Submitted to:

AECOM Canada Ltd.  
189 Wyld Street  
North Bay, Ontario  
P1B 1Z2

**Geocres No.31L-135**





## 1.0 INTRODUCTION

Merlex Engineering Ltd. (MEL) has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation at a culvert located at Station 19+760, Township of Springer. The GWP 5106-06-00 on Highway 64 passes through parts of the Townships of Springer and Field. The project is located from 1.8 km north of Highway 17, Station 11+660 in Springer Township (LHRS 34380 - o/s 1.8) northerly a distance of 19.4 km to Station 21+165 in Field Township (LHRS 34390 - o/s 11.0). The chainage equation between the two townships: Station 20+087.427 Springer Township = Station 10+000 Field Township. This project involved the replacement of a single 3000 X 2200 Structural Plate CSP Arch in a 4 m high embankment, at Station 19+760 Township of Springer.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5007-E-0061. The terms of reference for the scope of work are outlined in MEL's proposal P-08-078, dated July 2008. The purpose of the investigation was to determine the subsurface conditions in the area of the culvert and along the centerline of the embankment for a roadway protection system. MEL investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

## 2.0 SITE DESCRIPTION

The Structural Plate CSP Arch culvert is located on Highway 64, approximately 9.9 km north of Highway 17. The topography at the site is generally of moderate relief and the direction of flow in the culvert is from west to east. The existing highway embankment supports two undivided lanes of highway, running in a north south direction. The existing road embankment is some 4 m higher than the grade level to the west and east sides of the road.



The embankment, at the culvert location, crosses a relatively shallow, wide valley area as can be seen from Photos 1 and 2, Enclosure No. 7, Appendix C. These photos were captured after flood conditions washed out the highway embankment and culvert (April 2009).

In early April 2009, high water levels over topped the embankment and the structural plate CSP arch and embankment were washed out requiring immediate replacement. The MTO replaced the culvert at Brule Creek with a 3.6 m x 2.4 m concrete box culvert during Spring 2009.

## **2.1 Site Physiography and Surficial Geology**

This Highway 64 project falls within the limits of the geomorphic sub-province known as the Eastern Sandy Uplands, skirted by the east edge of the North Shore - Sudbury Ridges and Pockets. The topography at the site is generally rolling. There are exposed bedrock ridges. At many locations, significant layers of earth overlay the bedrock. Within the project area overburden conditions consist primarily of earth containing varying amounts of silt and clay.

Bedrock in the area is of the Late to Middle Precambrian Era. The southern part of the project area comprises of Felsic Igneous rocks, granitic rocks whereas to the northern part of the project area the rocks are Metasediments comprising of conglomerates, chert, and iron formation (OGS Map 2506)

## **3.0 INVESTIGATION PROCEDURES**

The field work for this investigation was carried out during the period of February 26 and March 3, 2009, when ice conditions were sufficient to support the drilling equipment and allow advance of the boreholes at the culvert ends. During July 22 and 23, 2009 the remaining boreholes were



advanced through the embankment. A total of five (5) boreholes were advanced at this culvert location.

The field investigation was carried out using a Bombardier mounted CME 45B drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Soil samples were obtained 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 at the borehole locations. The SPT method involves advancing a 50 mm diameter 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 is recorded as the "N" value. At all 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 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.

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, particle size analysis and Atterberg limit tests where appropriate. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix B), with a summary of results presented on the laboratory sheets in Appendix C (Figures L-1 to L4).



Groundwater conditions in the open boreholes were observed during 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, additional granular backfill was added to the boreholes to bring them up to grade. At the boreholes through the embankment, the upper portion of the hole, where necessary, was backfilled with a cold patch to seal the existing asphalt surface.

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. Elevations contained in this report are referenced to a geodetic datum.

#### **4.0 SUBSURFACE CONDITIONS**

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix B) and on Figure No. B-1 (Appendix C). 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 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 design purposes only.



#### **4.1 Culvert, Station 19+760, Township of Springer- SITE B**

A plan and profile showing the borehole locations and stratigraphic sequences is shown on Figure No. B-1, Appendix C. During the course of the exploration program, five (5) sampled boreholes and DCPT were put down at this site. Borehole Nos. B3, B4, and B5 were advanced from the surface of the existing highway embankment. Borehole Nos. B1 and B2 were advanced at the east and west ends of the existing culvert respectively.

At the culvert outlet and inlet, Borehole Nos. B1 and B2 respectively, a thin 100 mm thick layer of sands with organics was penetrated at Borehole No. B1, but was absent at Borehole B2. Borehole Nos. B3, B4 and B5 were advanced through the existing embankment. Underlying the pavement structure, which consisted of from 70 to 80 mm of asphalt and 180 to 250 mm of crushed gravel, a deposit of sand backfill with some gravel to gravelly, and cobbles with depth was penetrated. Typical gradation curves of the portion of embankment fill which was retained in the split spoon sampler (37 mm inside diameter) are found on Figure L-1 and indicate 26 to 53% gravel size particles, 43 to 70% sand size particles, and 4 to 10% silt and clay size particles. Based on the SPT values, which ranged from 0 (weight of hammer) to 37 blows per 300 mm penetration, the compactness of the embankment fill was described as very loose to dense, generally compact. This deposit extended to depths of 3.0 to 4.3 m below existing embankment grade.

Underlying the embankment fill at Borehole Nos. B2, B3, B4, and B5, and the thin surficial layer of fluvial sands and organics at Borehole No. B1, a deposit of grey silty clay, some 2.1 to 5.2 m in thickness was encountered. Atterberg limits testing carried out on retrieved samples indicates the clay is a fat to plastic clay, with medium to high plasticity. The Atterberg limit tests returned values of 19 to 26% plastic limit and 34 to 68% liquid limit. In the lower part of the deposit the silt



content increased sharply indicating a transition to silt, ML-CL (see Figure L-5, Appendix C for plot of Atterberg limits test results). The natural moisture content of the fat to plastic clay ranged from 31 to 71% and generally just slightly exceeded the liquid limit. Typical gradation curves are found on Figure L-2, Appendix C, and indicate values of 0 to 4% gravel size particles (only one sample with gravel), 0 to 5% fine sand size particles, 22 to 54 % silt size particles, and 45 to 78% clay size particles. Based on the in-situ (undrained) vane shear strengths, which ranged from 20 to 44 kPa the consistency of the deposit can be described as soft to firm (see Figure L-6, Appendix C for plot of shear strengths with depth).

Below the clay deposit a transition to fine sands some silt to silty fine sands was encountered. This transition occurred at between elevation 233.4 and 229.2 m, at Borehole No B2 and B5 respectively. Typical gradation curves of the portion of the sands which was retained in the split spoon sampler (37 mm inside diameter) are found on Figure L-3 and indicate 0 to 7% gravel size particles, 36 to 97% sand size particles, 3 to 45% silt and clay size particles. Based on the SPT values, which ranged from 0 (weight of hammer) to 24 blows per 300 mm penetration, the compactness of the sands was described as very loose to compact, generally loose. This deposit extended to depths at which sampling was terminated, 8.1 to 12.2 m below grade, except at Borehole No. B1, where a very dense grey sand with silt and some gravel was penetrated below elevation 227.2 m. A typical grain size curve is shown on Figure L-4 and indicates 14% gravel size particles, 56% sand size particles, and 30% silt and clay size particles. The STP value in this deposit was 90 blows per 300 mm penetration. Refusal to auger and DCPT advance was met at a depth of 10.1 m in this deposit at Borehole No. B1. At Borehole Nos. B2, B3, B4 and B5 refusal to DCPT penetration was encountered at depths ranging from 15.6 to 18.6 m below grade.



#### **4.2 Groundwater Conditions**

Groundwater and cave-in levels in the open boreholes were taken during the advance of the individual borings and upon completion. These levels were recorded on the individual Record of Borehole Log Sheets (Appendix B).

At Borehole Nos. B1 and B2, advanced during winter months (February/March 2009) the water level was at or close to the top of ice, varying between elevation 235.7 and 236.3 m.

At the boreholes advanced through the embankment the water level/cave-in level was recorded at depths varying between 2.9 and 3.5 m below the top of the embankment. These groundwater levels will fluctuate seasonally.

#### **MERLEX ENGINEERING LTD.**

M. A. Merleau, P. Eng.  
Principal

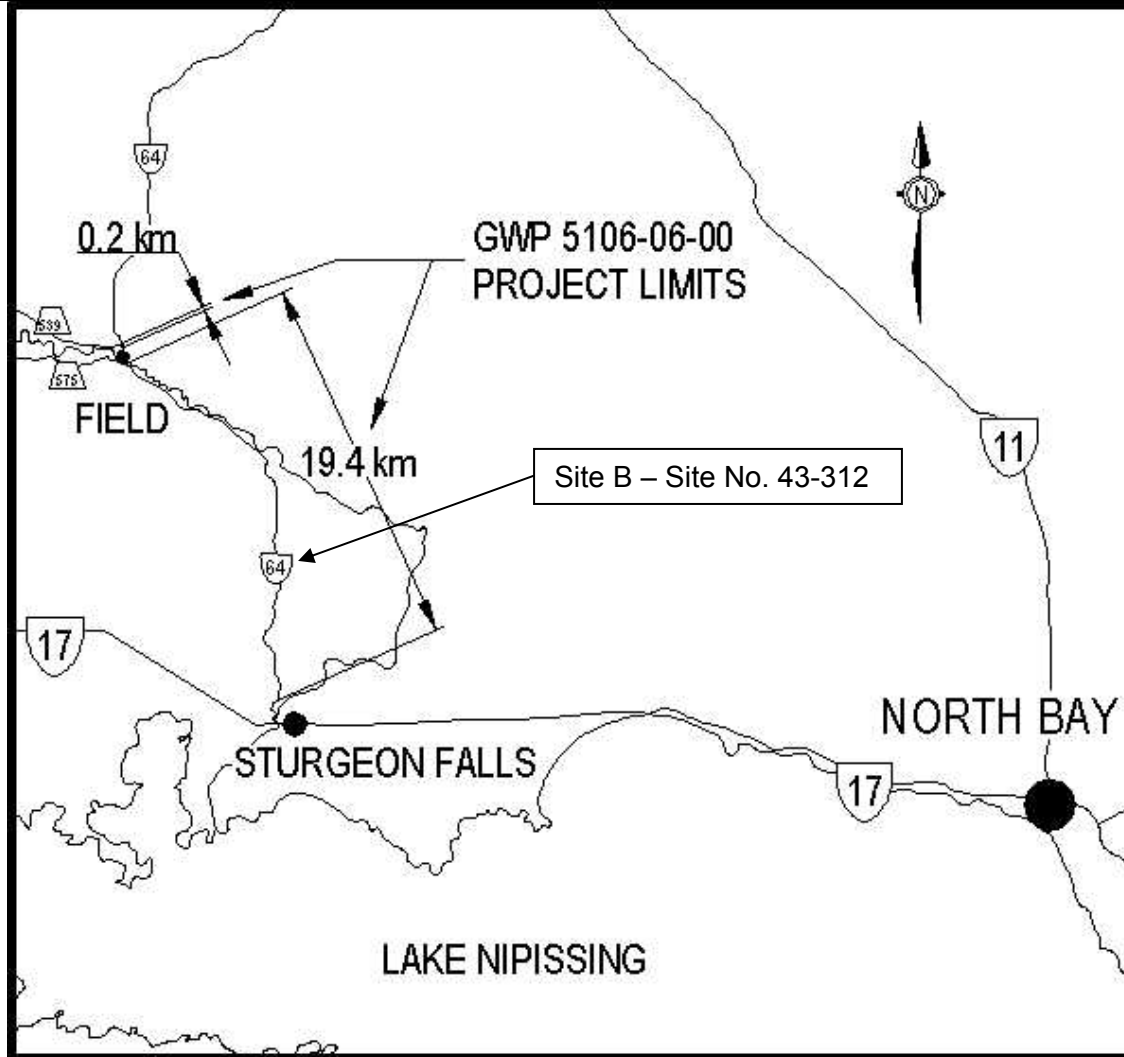
J. R. Berghamer, P. Eng.  
Project Engineer

## **APPENDIX A**

Figure No. 1: Key Plan

# KEY PLAN

NOT TO SCALE



**FINAL  
FOUNDATION INVESTIGATION AND  
DESIGN REPORT  
SITE B – CULVERT STATION 19+760  
TWP. OF SPRINGER  
CULVERT SITE NO. 43-312  
GWP 5106-06-00**

Highway 64, From 1.8 km N of Highway 17,  
Sturgeon Falls North Limit, Northerly 19.4 km

MEL Ref. No.: 08/12/08180B      November 2009



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## **APPENDIX B**

Enclosure No. 1: List of Abbreviations and Symbols

Enclosure Nos. 2 to 6: Record of Borehole Sheets



## 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  |
| HB  | Hammer Bouncing  |
| 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  |
| WH  | Sampler Advanced by static weight (weight of hammer and/or rods) |
| 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 90° point cone 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       |

### 3. SOIL DESCRIPTION (Cont'd)

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        |

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%     |

### 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. B1**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 February 26 TIME 2:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 February 26

| SOIL PROFILE |  |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT<br>NATURAL MOISTURE CONTENT<br>LIQUID LIMIT | UNIT WEIGHT<br>$\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|--|-------------|---------|------|------------|-------------------------|-----------------|--|---|-------------------------|---------------------------------------|
| ELEV DEPTH   | DESCRIPTION  | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 |  |   |                         |                                       |
|              | Continued from Previous Page   |             |         |      |            |                         |                 |  |   |                         |                                       |
| 227.2        | SANDS - grey fine and medium sands trace silt and gravel<br><br>(compact)        |             |         |      |            |                         |                 |  |   |                         |                                       |
| 9.1          | SAND - grey sands with silt, some gravel<br>(TILL STRUCTURE)<br><br>(very dense) |             | 7       | SS   | 90         |                         |                 |  |   |                         | 14 56 (30)                            |
| 226.2        | Auger Refusal<br>DCPT Refusal<br>End of Borehole                                 |             |         |      |            |                         |                 |  |   |                         |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B2**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 February 26 DATE (Completed) 2009 March 4 TIME 1:00:00 PM CHECKED BY MAM

| SOIL PROFILE  |   |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |  | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|---|---|-------------|---------|------|------------|-------------------------|---|--|----|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|----------------------|-----------------|-------------|----------------------|-----|---------------|----|---|-----|----|---|-----|
| ELEV DEPTH  | DESCRIPTION   | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |   | 20                                       | 40 | 60   |                                 |                               |                                |                  |                                       | 80                   | 100             | 20          | 40                   | 60  | GR SA (SI CL) |    |   |     |    |   |     |
| 235.9<br>0.0  | Ground Surface<br>ICE   |             |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 235.3<br>0.6  | WATER   |             |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 234.4<br>1.5  | CLAY - grey silty clay, fat to plastic<br><br>(firm/soft)                         |             | 1       | SS   | 21         |                         |   |  |    |  |                                 |                               |                                | 0 2 40 58        |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   |   |             | 2       | SS   | WH         |                         |   |  |    |  |                                 |                               |                                | 0 4 50 46        |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   |   |             | 3       | TW   | WH         |                         |   |  |    |  |                                 |                               |                                | 0 0 22 78        |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   |   |             | 4       | TW   |            |                         |   |  |    |  |                                 |                               |                                | 0 0 93 7         |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   | Silt Content Increasing   |             |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 229.3<br>6.6  | transition to<br>SILTY FINE SAND - grey silty fine sand<br><br>(loose/very loose) |             | 5       | TW   | 6          |                         |   |  |    |  |                                 |                               |                                | 0 17 79 4        |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   |   |             | 6       | SS   | WH         |                         |   |  |    |  |                                 |                               |                                | 0 87 (13)        |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
|   | Continued Next Page   |             |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| COMMENTS  |   |             |         |      |            |                         | + <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity<br>Numbers on left refer to values greater than 120 kPa<br>○ 3% STRAIN AT FAILURE |  |    | WATER LEVEL RECORDS<br><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) 09/3/4 1:20:00 PM</td> <td>0.2</td> <td>▼ -</td> </tr> <tr> <td>2)</td> <td>-</td> <td>▼ -</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) 09/3/4 1:20:00 PM | 0.2 | ▼ -           | 2) | - | ▼ - | 3) | - | ▼ - |
| Date (yy/mm/dd) Time  | Water Depth (m)   | Cave In (m) |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 1) 09/3/4 1:20:00 PM  | 0.2   | ▼ -         |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 2)  | -   | ▼ -         |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| 3)  | -   | ▼ -         |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |
| The stratification lines represent approximate boundaries. The transition may be gradual. |   |             |         |      |            |                         |   |  |    |  |                                 |                               |                                |                  |                                       |                      |                 |             |                      |     |               |    |   |     |    |   |     |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B2**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 February 26 TIME 1:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 March 4

| SOIL PROFILE  |   |                               | SAMPLES |      | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                    |  | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|-------------------------------|---------|------|-------------------------|-----------------|--|--------------------|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH    | DESCRIPTION   | STRATA PLOT                   | NUMBER  | TYPE |                         |                 | "N" VALUES                               | SHEAR STRENGTH kPa |  |                                 |                               |                                |                  |                                       |
|               | Continued from Previous Page                                    |                               |         |      |                         |                 |  |                    |  |                                 |                               |                                |                  |                                       |
|               | FINE SAND - grey fine sand, trace to some silt<br><br>(compact) | [Strata Plot: Dotted pattern] | 7       | SS   | 24                      |                 |  |                    |  |                                 |                               |                                | 0 92 (8)         |                                       |
|               |   |                               | 8       | SS   | 10                      |                 |  |                    |  |                                 |                               |                                |                  | 0 81 (19)                             |
| 223.7<br>12.2 | End of Sampling<br>Continuation of DCPT                         |                               |         |      |                         |                 |  |                    |  |                                 |                               |                                |                  |                                       |
|               | Probably Sands trace to some silt<br><br>(compact)              |                               |         |      |                         |                 |  |                    |  |                                 |                               |                                |                  |                                       |
|               | Continued Next Page   |                               |         |      |                         |                 |  |                    |  |                                 |                               |                                |                  |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B2**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 February 26 TIME 1:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 March 4

| SOIL PROFILE |                                 |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT<br>NATURAL MOISTURE CONTENT<br>LIQUID LIMIT | UNIT WEIGHT<br>$\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|---------------------------------|-------------|---------|------|------------|-------------------------|-----------------|--|---|-------------------------|---------------------------------------|
| ELEV DEPTH   | DESCRIPTION                     | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 |  |   |                         |                                       |
| 217.3        | Continued from Previous Page    |             |         |      |            |                         |                 | $w_p$ $w$ $w_L$<br>WATER CONTENT (%)     |   |                         |                                       |
| 18.6         | DCPT Refusal<br>End of Borehole |             |         |      |            |                         |                 |  |   |                         |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B3**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 12:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE        |  |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT  |    |    | PLASTIC LIMIT<br>W <sub>p</sub>   | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------------|--|-------------|---------|------|------------|-------------------------|-----------------|---|----|----|---|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH          | DESCRIPTION  | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 | 20  | 40 | 60 |   |                               |                                |                  |                                       |
| 238.5<br>0.0        | Ground Surface<br>EMBANKMENT FILL<br>±80 mm Asphalt<br>±250 mm Crushed Gravel<br><br>SAND - brown sands with gravel trace to some fines with depth frequent cobble/rock fill pieces<br><br>(compact) |             | 1       | AS   |            |                         |                 |   |    |    |   |                               |                                |                  |                                       |
|                     |  |             | 2       | SS   | 16         |                         |                 |   |    |    |   |                               |                                |                  |                                       |
|                     |  |             | 3       | SS   | 18         |                         |                 |   |    |    |   |                               |                                |                  |                                       |
|                     |  |             | 4       | SS   | 11         |                         |                 |   |    |    |   |                               |                                | 53               | 43 (4)                                |
|                     |  |             | 5       | SS   | 16         |                         |                 |   |    |    |   |                               |                                | 27               | 67 (6)                                |
|                     |  |             | 6       | SS   | 37         |                         |                 |   |    |    |   |                               |                                | 30               | 70 (10)                               |
| 234.2<br>4.3        | CLAY - grey silty clay, plastic to fat<br><br>(firm)   |             | 7       | SS   | WH         |                         |                 |   |    |    |   |                               |                                | 0                | 1 33 66                               |
|                     |  |             | 8       | SS   | PM         |                         |                 |   |    |    |   |                               |                                | 0                | 4 48 48                               |
| 231.4<br>7.1        | SANDS - grey sands some silt<br><br>(very loose)   |             | 9       | SS   | WH         |                         |                 |   |    |    |   |                               |                                | 0                | 55 42 3                               |
| Continued Next Page |  |             |         |      |            |                         |                 |   |    |    |   |                               |                                |                  |                                       |
| COMMENTS            |  |             |         |      |            |                         |                 | + <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity<br>Numbers on left refer to values greater than 120 kPa<br>○ 3% STRAIN AT FAILURE |    |    | WATER LEVEL RECORDS<br>Date (yy/mm/dd) Time      Water Depth (m)      Cave In (m)<br>1) 09/7/22 10:49:00 AM      1.2      ▽ 4.1<br>2)                                      -      ▽ -<br>3)                                      -      ▽ - |                               |                                |                  |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B3**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 12:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE |  |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|--|-------------|---------|------|------------|-------------------------|-----------------|--|----|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH   | DESCRIPTION                                      | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 | 20                                       | 40 | 60 |                                 |                               |                                |                  |                                       |
|              | Continued from Previous Page                     |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
|              | SANDS - grey sands some silt<br><br>(very loose) |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
|              |  |             | 10      | SS   | 2          |                         |                 |  |    |    |                                 |                               |                                | 0 89 (11)        |                                       |
| 227.8        | End of Sampling<br>Commencement of DCPT          |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
| 10.7         | Probably Sands trace to with silt                |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
| 222.3        | Probably Sands with cobble and gravel            |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
| 16.2         | DCPT Refusal<br>End of Borehole                  |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |

MEL-GEO 08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B4**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 3:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE  |   |                            | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT  |    |    | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|----------------------------|---------|------|------------|-------------------------|-----------------|---|----|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH  | DESCRIPTION   | STRATA PLOT                | NUMBER  | TYPE | "N" VALUES |                         |                 | 20  | 40 | 60 |                                 |                               |                                |                  |                                       |
| 238.7<br>0.0  | Ground Surface<br>EMBANKMENT FILL<br>±70 mm Asphalt<br>±180 mm Crushed Gravel<br><br>SANDS - brown sands trace silt;<br>occasional cobble / rock fill pieces<br><br>(compact) | [Cross-hatched pattern]    | 1       | AS   |            |                         |                 |   |    |    |                                 |                               |                                |                  |                                       |
|   |   |                            | 2       | SS   | 13         |                         |                 |   |    |    |                                 |                               |                                | 33               | 60 (7)                                |
|   |   |                            | 3       | SS   | 24         |                         |                 |   |    |    |                                 |                               |                                |                  |                                       |
|   |   |                            | 4       | SS   | 7          |                         |                 |   |    |    |                                 |                               |                                | 32               | 60 (8)                                |
| 235.3<br>3.4  | CLAY - grey silty clay, plastic<br><br>(firm)   | [Diagonal hatched pattern] | 5       | SS   | 4          |                         |                 |   |    |    |                                 |                               |                                |                  |                                       |
|   |   |                            | 6       | SS   | WH         |                         |                 |   |    |    |                                 |                               |                                | 4                | 4 47 45                               |
|   |   |                            | 7       | SS   | PM         |                         |                 |   |    |    |                                 |                               |                                | 0                | 0 50 50                               |
| 231.4<br>7.3  | SANDS - grey silt and sands, trace<br>of clay and gravel<br><br>(very loose)  | [Dotted pattern]           | 8       | SS   | 2          |                         |                 |   |    |    |                                 |                               |                                | 2                | 36 57 5                               |
| Continued Next Page   |   |                            |         |      |            |                         |                 |   |    |    |                                 |                               |                                |                  |                                       |
| COMMENTS  |   |                            |         |      |            |                         |                 | + <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity<br>Numbers on left refer to values greater than 120 kPa<br>○ 3% STRAIN AT FAILURE                               |    |    |                                 |                               |                                |                  |                                       |
|   |   |                            |         |      |            |                         |                 | WATER LEVEL RECORDS<br>Date (yy/mm/dd) Time      Water Depth (m)      Cave In (m)<br>1) 09/7/22 3:00:00 PM      2      ▽      3.5<br>2)      -      ▽      -<br>3)      -      ▽      - |    |    |                                 |                               |                                |                  |                                       |
| The stratification lines represent approximate boundaries. The transition may be gradual. |   |                            |         |      |            |                         |                 |   |    |    |                                 |                               |                                |                  |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B4**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 3:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE  |   |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|-------------|---------|------|------------|-------------------------|-----------------|--|----|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH    | DESCRIPTION   | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 | 20                                       | 40 | 60 |                                 |                               |                                |                  |                                       |
| 230.6<br>8.1  | Continued from Previous Page<br><br>End of Sampling<br>Commencement of DCPT |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
|               | Probably Sands trace to with silt<br><br>(very loose to compact)            |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |
| 223.1<br>15.6 | DCPT Refusal<br>End of Borehole   |             |         |      |            |                         |                 |  |    |    |                                 |                               |                                |                  |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. B5**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 5:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE |   |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |                       | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|---|-------------|---------|------|------------|-------------------------|---|--|----|-----------------------|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH   | DESCRIPTION   | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |   | 20                                       | 40 | 60                    |                                 |                               |                                |                  |                                       |
| 238.6<br>0.0 | Ground Surface  |             |         |      |            |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              | EMBANKMENT FILL<br>±70 mm Asphalt<br>±200 mm Crushed Gravel |             | 1       | AS   |            |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              | SANDS - brown sands trace of silt and gravel<br><br>(loose) |             | 2       | SS   | 16         |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              |   |             | 3       | SS   | 8          |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              |   |             | 4       | SS   | WH         |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
| 235.6<br>3.0 | CLAY - dark grey silty clay, plastic to fat<br><br>(firm)   |             | 5       | SS   | 5          |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              |   |             | 6       | SS   | WH         |                         |   |  |    |                       |                                 |                               |                                |                  | 0 0 27 73                             |
| 233.4<br>5.2 | SANDS - grey fine sands some silt<br><br>(very loose)       |             |         |      |            |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              | Increase in sand content with depth                         |             | 7       | SS   | WH         |                         |   |  |    |                       |                                 |                               |                                |                  |                                       |
|              | Continued Next Page   |             | 8       | SS   | 2          |                         |   |  |    |                       |                                 |                               |                                |                  | 0 98 (2)                              |
| COMMENTS     |   |             |         |      |            |                         | + <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity<br>Numbers on left refer to values greater than 120 kPa |  |    | WATER LEVEL RECORDS   |                                 |                               |                                |                  |                                       |
|              |   |             |         |      |            |                         | ○ 3% STRAIN AT FAILURE  |  |    | Date (yy/mm/dd) Time  |                                 |                               | Water Depth (m) Cave In (m)    |                  |                                       |
|              |   |             |         |      |            |                         |   |  |    | 1) 09/7/22 5:05:00 PM |                                 |                               | 2.5 ▽ 3.2                      |                  |                                       |
|              |   |             |         |      |            |                         |   |  |    | 2)                    |                                 |                               | - ▽ -                          |                  |                                       |
|              |   |             |         |      |            |                         |   |  |    | 3)                    |                                 |                               | - ▽ -                          |                  |                                       |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2



**METRIC**

**RECORD OF BOREHOLE NO. B5**



REFERENCE 08/12/08180-B DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 19+760 - Brule Creek - Site B ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 22 TIME 5:00:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 22

| SOIL PROFILE  |   |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT<br>NATURAL MOISTURE CONTENT<br>LIQUID LIMIT | UNIT WEIGHT<br>$\gamma$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|-------------|---------|------|------------|-------------------------|---|--|---|-------------------------|---------------------------------------|
| ELEV DEPTH    | DESCRIPTION   | STRATA PLOT | NUMBER  | TYPE | "N" VALUES |                         |   |  |   |                         |                                       |
| 221.1<br>17.5 | Continued from Previous Page<br><br>DCPT Refusal<br>End of Borehole |             |         |      |            |                         | <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED + FIELD VANE<br/>● QUICK TRIAXIAL × LAB VANE</p> <p>20 40 60 80 100</p> <p>WATER CONTENT (%)</p> <p>20 40 60</p> |  |   |                         | GR SA (SI CL)                         |

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

## **APPENDIX C**

|                    |                                   |
|--------------------|-----------------------------------|
| Figure B-1         | Borehole Locations & Soil Strata  |
| Figures L-1 to L-4 | Summary Grain Size Analysis Graph |
| Figure L-5         | Atterberg Limits Test Results     |
| Figure L-6         | In-Situ Shear Strength            |
| Enclosure No. 7    | Photo Essay                       |

CONT No  
WP No 5106-06-00

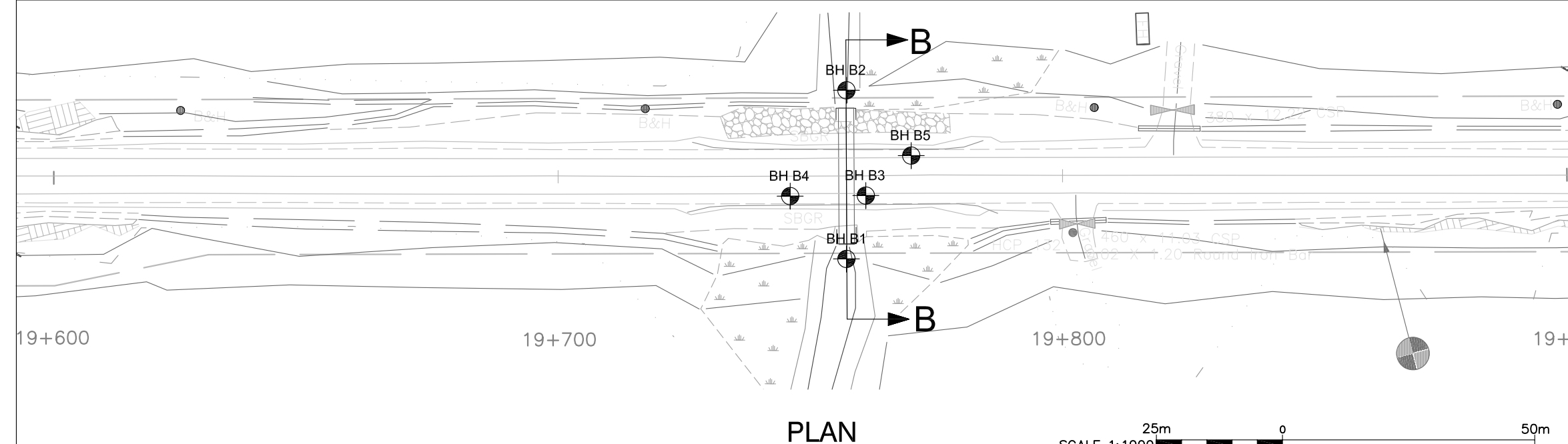


HWY 64 Twp. of Springer  
Foundation Area Site B - Brule Creek  
Culvert 19+760 - Site No. 43-312  
BOREHOLE LOCATIONS & SOIL STRATA

Figure  
B-1

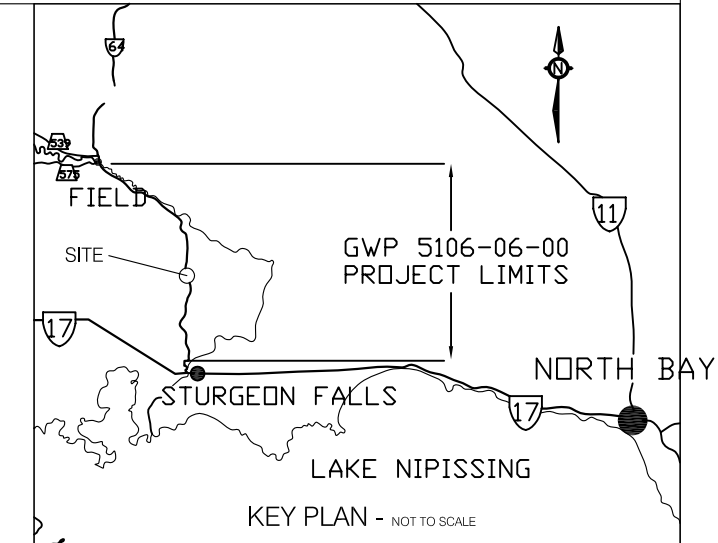


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Consulting Geotechnical Engineers



PLAN

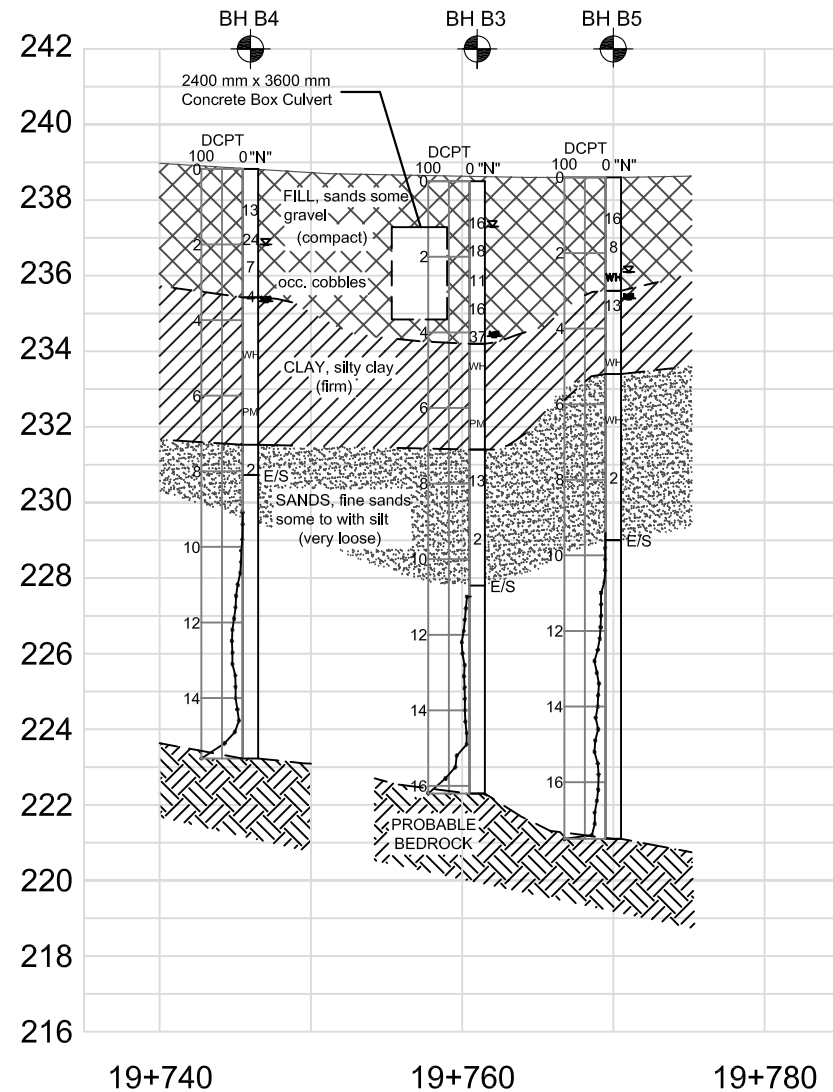
SCALE 1:1000



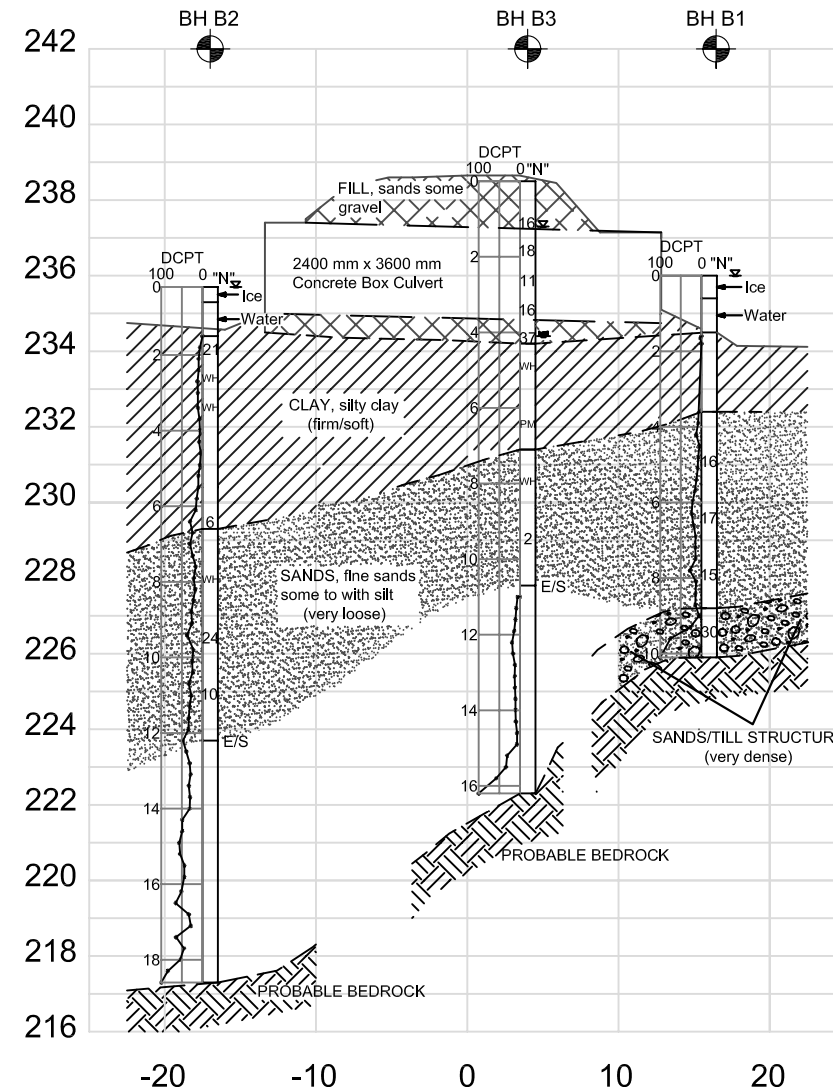
KEY PLAN - NOT TO SCALE

STRATIGRAPHY LEGEND

- FILL, SAND some gravel occ. cobbles
- SANDS
- CLAYS
- SANDS/TILL STRUCTURE
- BEDROCK (ASSUMED PROFILE)



CENTERLINE PROFILE



CROSS SECTION B-B

SCALE HORT 1:500  
SCALE VERT 1:200

LEGEND

- Borehole and Dynamic Cone Penetration Test
- N Blows/0.3 m (Std Pen Test, 475 J/blow)
- CONE 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.    | Co-ordinates |        | Elevation |
|-----------------|--------------|--------|-----------|
|                 | Station      | Offset |           |
| Borehole No. B1 | 19+760       | 16m Rt | 236.3     |
| Borehole No. B2 | 19+764       | 17m Lt | 235.9     |
| Borehole No. B3 | 19+761       | 4m Rt  | 238.5     |
| Borehole No. B4 | 19+746       | 4m Rt  | 238.7     |
| Borehole No. B5 | 19+770       | 4m Rt  | 238.6     |

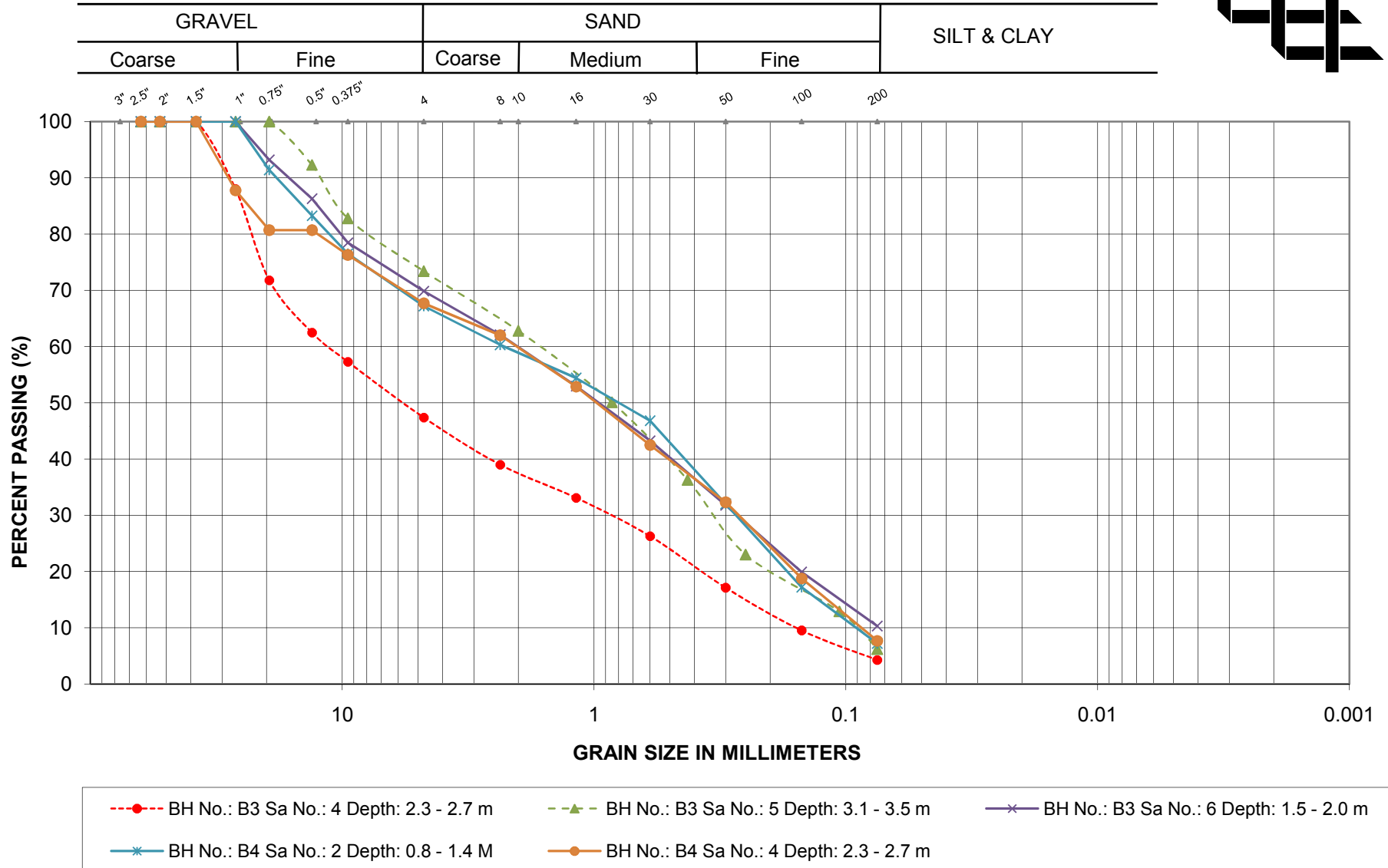
NOTE 1:  
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data and may vary and are intended for design only.

| REVISIONS | DATE | BY       | DESCRIPTION |
|-----------|------|----------|-------------|
|           |      | 09/11/24 | RG          |
|           |      |          |             |
|           |      |          |             |

|   |               |
|---|---------------|
| HWY No. 64 FOUNDATION SITE B - CULVERT 19+760 | DIST          |
| SUBM'D  | DATE 00/00/00 |
| DRAWN RG                                      | CHK MAM       |
| DATE 09/07/31                                 | FIG B-1       |

### GRAIN SIZE ANALYSIS



PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 19+760  
 LOCATION: Twp. of Springer

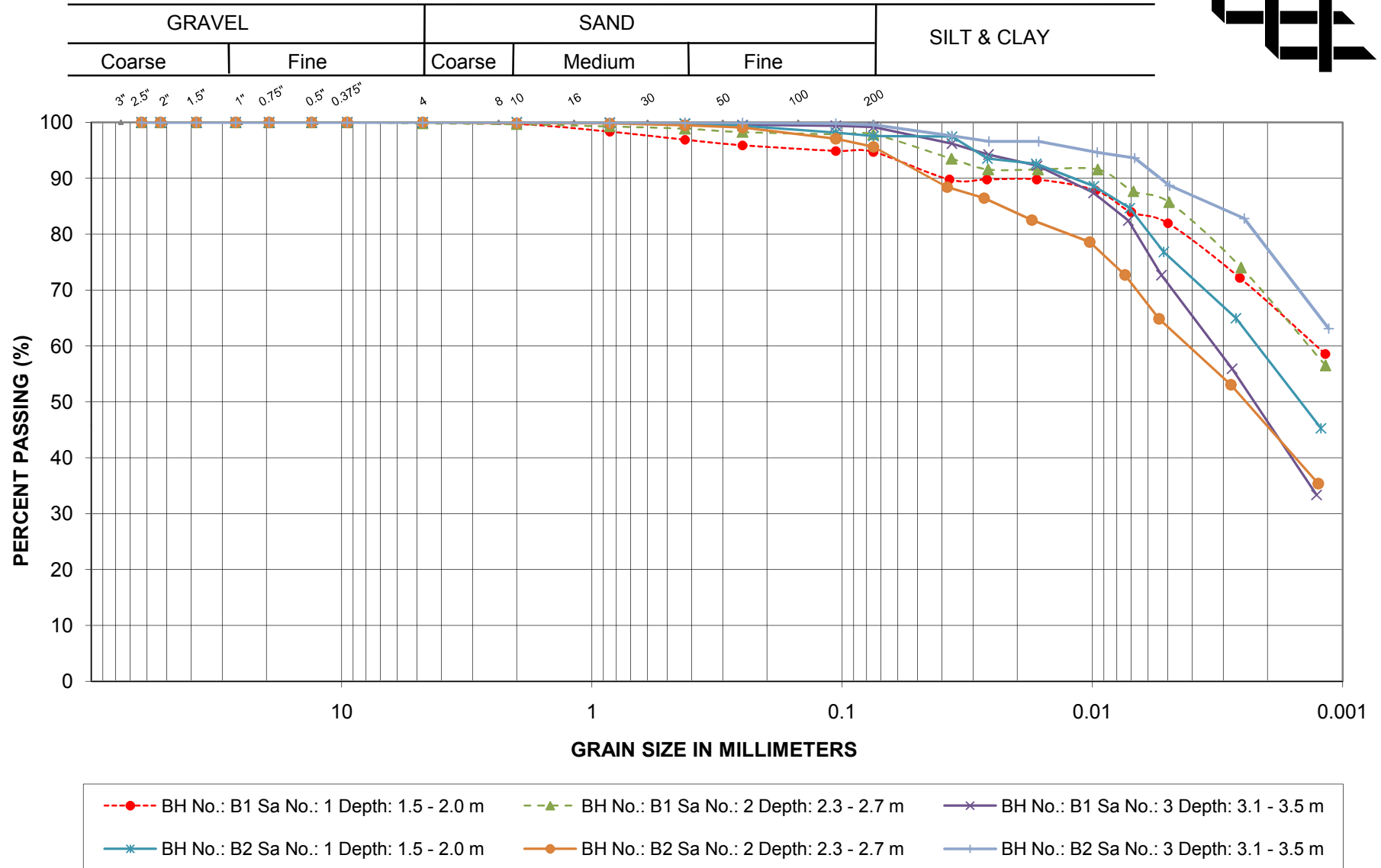
EMBANKMENT FILL

MERLEX ENGINEERING LTD.

FIGURE L-1



### GRAIN SIZE ANALYSIS



PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 19+760  
 LOCATION: Twp. of Springer

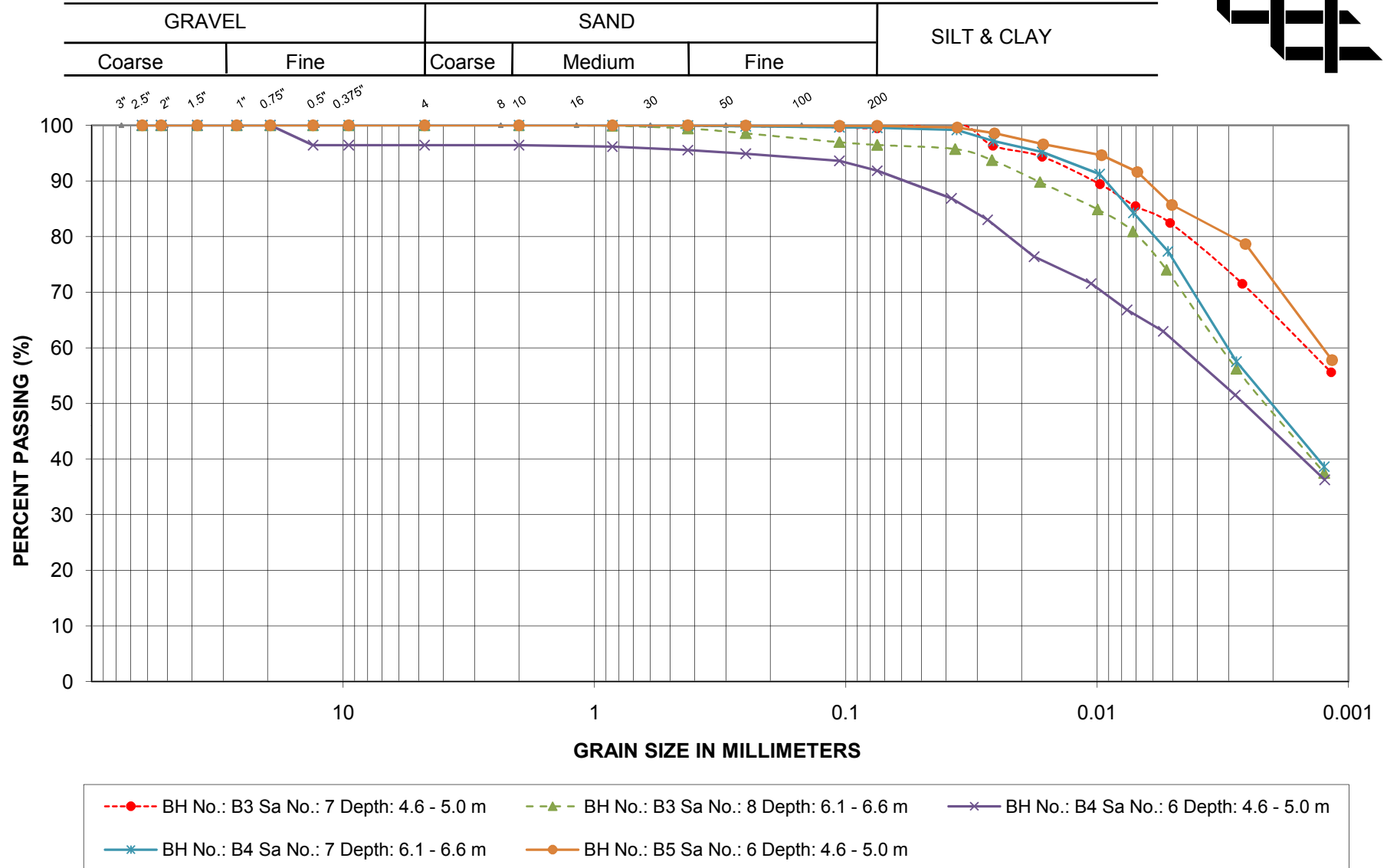
CLAYS

MERLEX ENGINEERING LTD.

FIGURE L-2  
 (page 1 of 2)



### GRAIN SIZE ANALYSIS



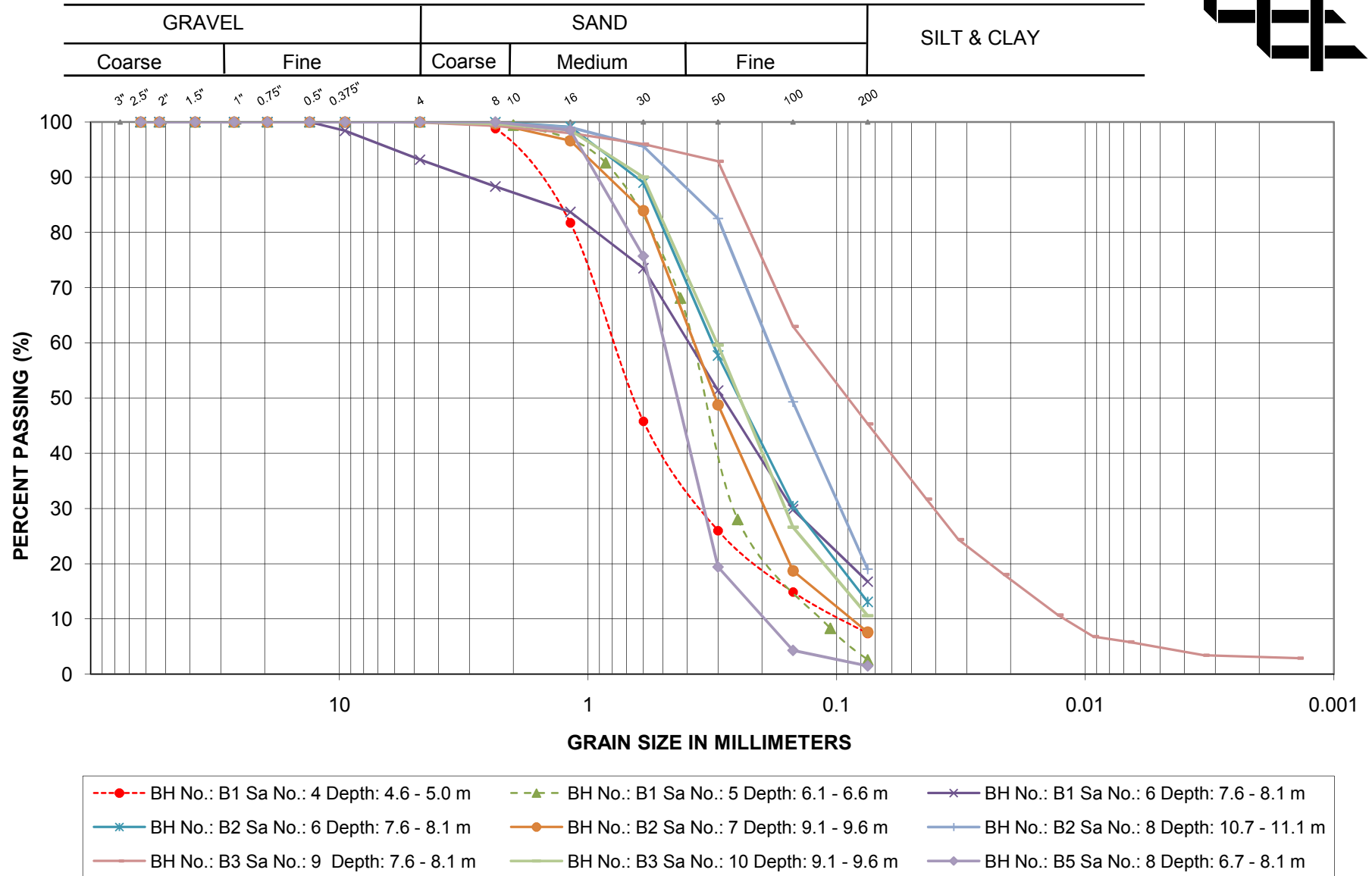
PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 19+760  
 LOCATION: Twp. of Springer

CLAYS

MERLEX ENGINEERING LTD.



### GRAIN SIZE ANALYSIS



PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 19+760  
 LOCATION: Twp. of Springer

SANDS

MERLEX ENGINEERING LTD.

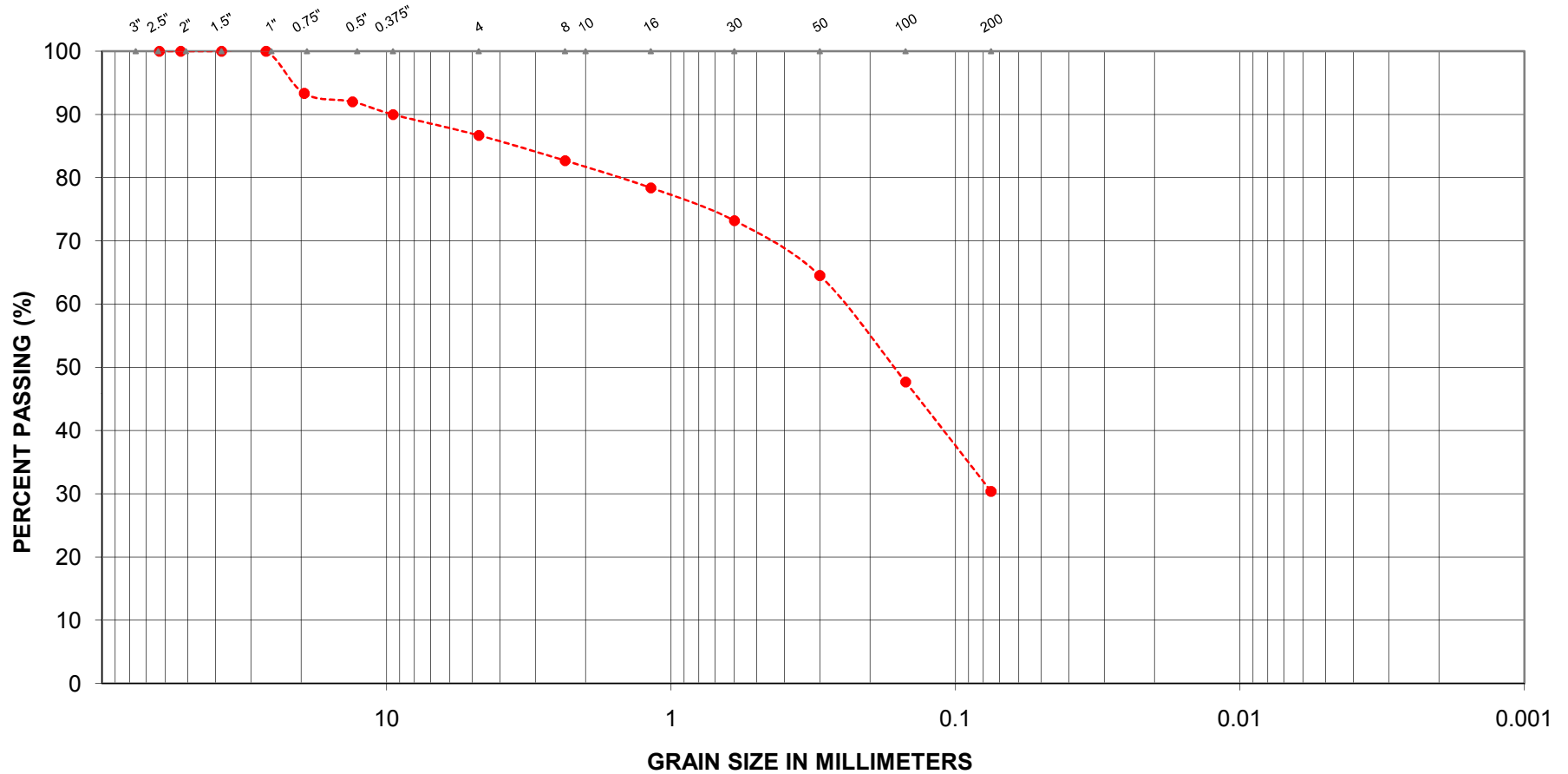
FIGURE L-3

Reference No.: 08180-B  
 Date: August 2009



### GRAIN SIZE ANALYSIS

| GRAVEL |  |      |  | SAND   |        |      | SILT & CLAY |
|--------|--|------|--|--------|--------|------|-------------|
| Coarse |  | Fine |  | Coarse | Medium | Fine |             |



---●--- BH No.: B1 Sa No.: 7 Depth: 9.1 - 9.6

PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 19+760  
 LOCATION: Twp. of Springer

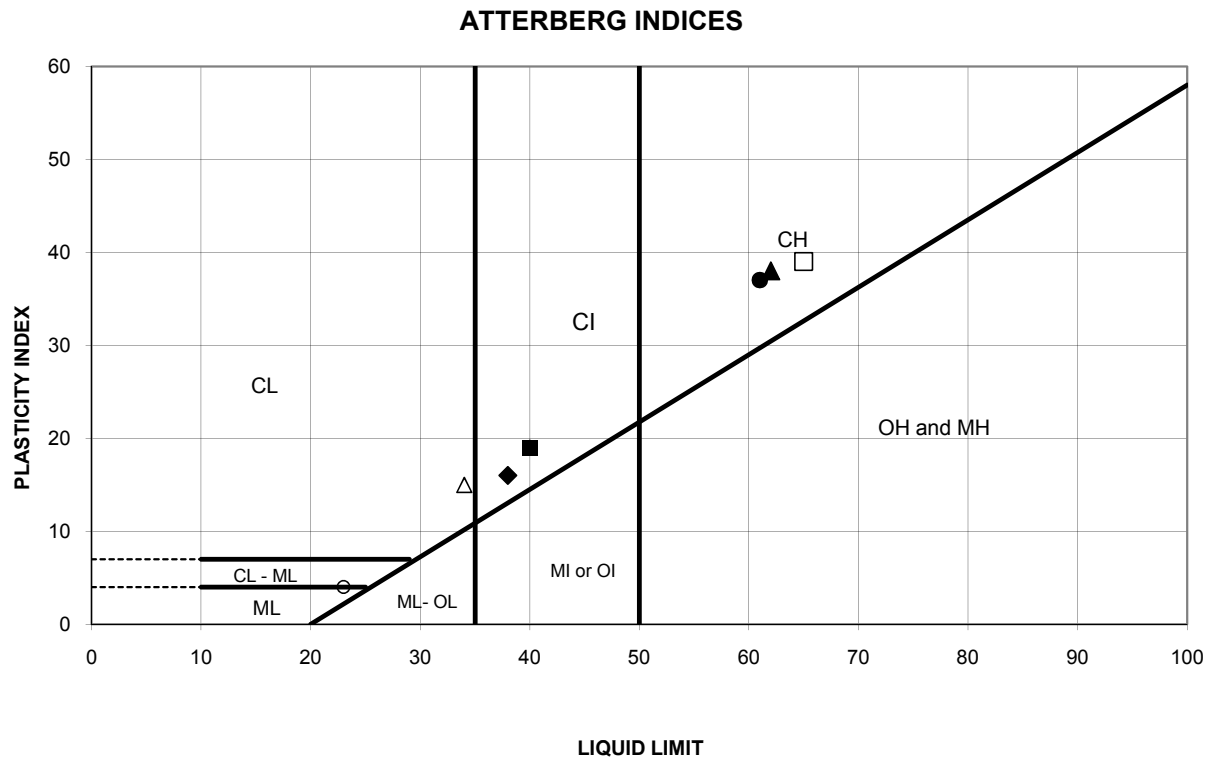
SAND, with silt some gravel  
 (TILL STRUCTURE)

MERLEX ENGINEERING LTD.

FIGURE L-4

**ATTERBERG LIMITS TEST RESULTS**

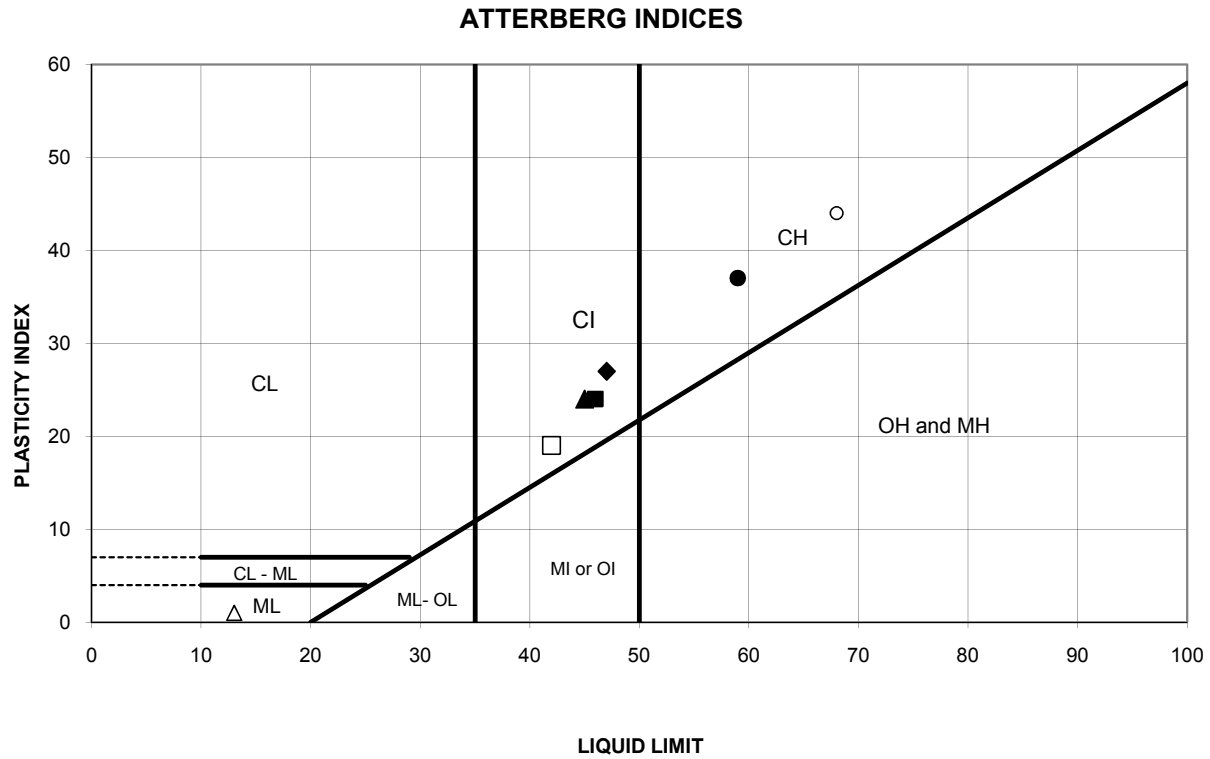
**FIGURE L- 5 (page 1 of 2)**



| SYMBOL | BH | Sa. No. | Depth(m) | Elev.(m) | Plasticity Index | Plastic Limit | Liquid Limit | NMC % |
|--------|----|---------|----------|----------|------------------|---------------|--------------|-------|
| ●      | B1 | 1       | 1.8      | 234.6    | 37               | 24            | 61           | 76    |
| ▲      | B1 | 2       | 2.5      | 233.8    | 38               | 24            | 62           | 70    |
| ◆      | B1 | 3       | 3.3      | 233.0    | 16               | 22            | 38           | 50    |
| ■      | B2 | 1       | 1.8      | 234.2    | 19               | 21            | 40           | 33    |
| △      | B2 | 2       | 2.5      | 233.4    | 15               | 19            | 34           | 37    |
| □      | B2 | 3       | 3.3      | 232.6    | 39               | 26            | 65           | 71    |
| ○      | B2 | 4       | 4.8      | 231.1    | 4                | 19            | 23           | 28    |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |

Date: Aug-09  
 Project: Hwy 64 - Culvert at Sta. 19+760

Prep'd: RG  
 Chkd: MAM  
 Ref. No.: 08180-B



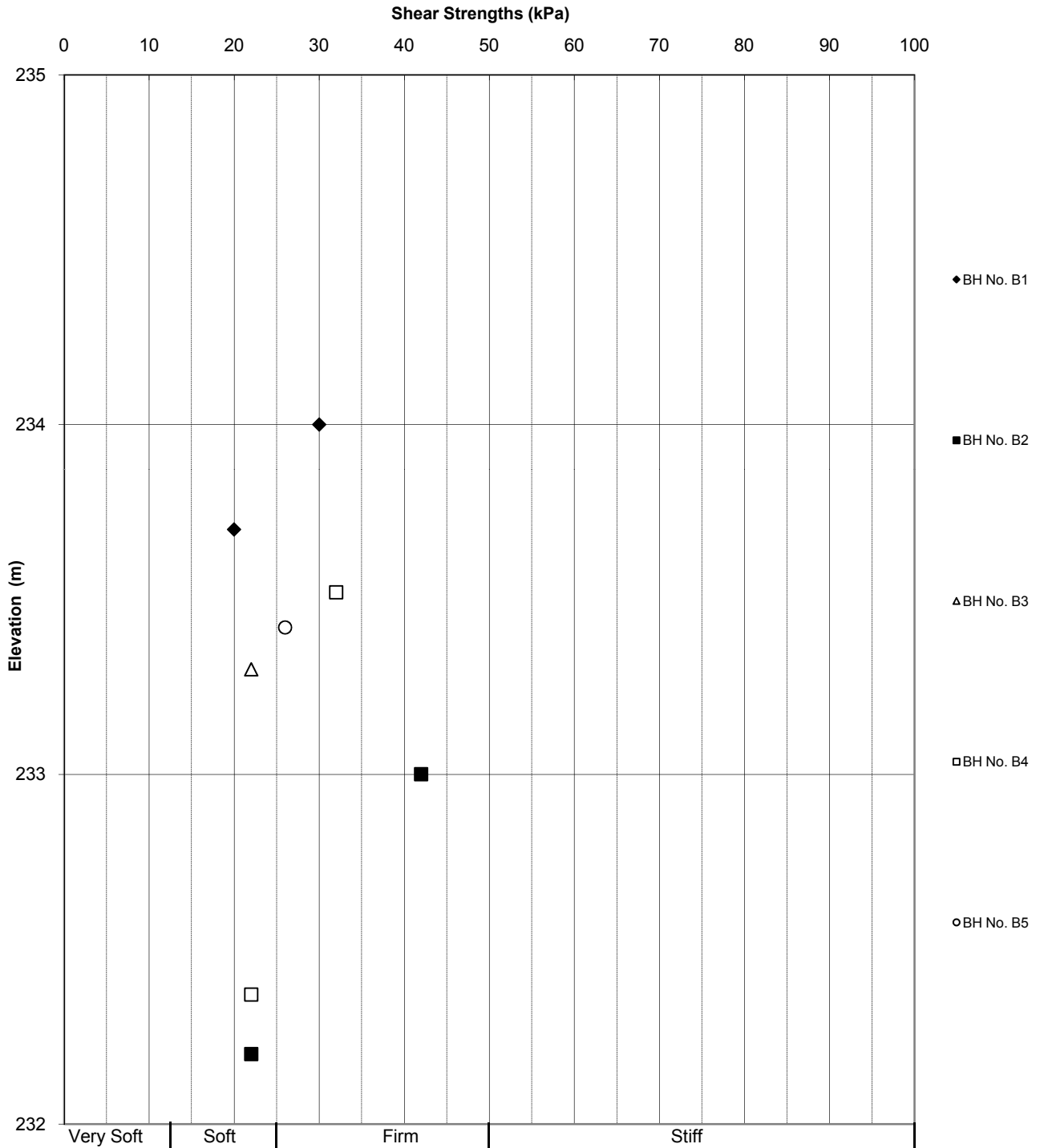
| SYMBOL | BH | Sa. No. | Depth(m) | Elev.(m) | Plasticity Index | Plastic Limit | Liquid Limit | NMC % |
|--------|----|---------|----------|----------|------------------|---------------|--------------|-------|
| ●      | B3 | 7       | 4.8      | 233.7    | 37               | 22            | 59           | 61    |
| ▲      | B3 | 8       | 6.3      | 232.2    | 24               | 21            | 45           | 56    |
| ◆      | B4 | 6       | 4.8      | 233.9    | 27               | 20            | 47           | 41    |
| ■      | B4 | 7       | 6.3      | 232.4    | 24               | 22            | 46           | 52    |
| △      | B4 | 8       | 7.9      | 230.9    | 1                | 12            | 13           | 26    |
| □      | B5 | 5       | 3.3      | 235.3    | 19               | 23            | 42           | 31    |
| ○      | B5 | 6       | 4.8      | 233.8    | 44               | 24            | 68           | 68    |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |
|        |    |         |          |          |                  |               |              |       |

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### In-Situ Shear Strengths vs. Depth





Top: Upstream Watershed  
Bottom: Downstream Watershed

Photos: 1 - 2



Reference No.: 08/12/08180B

Provided By: AECOM

Project: Foundation Investigation and Design Report, Highway 64 from 1.8 km north of Highway 17, Sturgeon Falls north limit, northerly 19.4 km.  
GWP 5106-06-00