

FOUNDATION INVESTIGATION REPORT  
PROPOSED DEEP CUT AND HIGH FILL  
TOWNSHIP OF ST. VINCENT  
HIGHWAY 26 FROM  
FORMER ST. VINCENT/SYDENHAM  
TOWNLINE TO MEAFORD

G.W.P. 167-91-00  
Agreement # 3006-E-0002



I.E.  
Group



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## **PART A – FOUNDATION INVESTIGATION**

### **1.0 INTRODUCTION**

This report presents the results of a foundation investigation carried out between August 15 and 27, 2007 by Infrastructure Engineering Group Inc. (IEG) on behalf of Stantec Consulting Ltd. (Stantec).

This assignment involves the rehabilitation of the pavement structure on Highway 26 from 0.3 km west of the former St. Vincent/Sydenham to 0.8 m west of the Town of Meaford west limit.

This report includes the replacement/extension of a single existing structural culvert, as well as many non-structural culvert extensions and replacements. The project also includes intersection realignments, intersection improvements, construction of a new truck climbing lane, minor horizontal and vertical alignment improvements and electrical work.

Foundation investigation and recommendations are required for the design and construction of culvert replacements and extension as part of the improvement of Highway 26. A single structural culvert, nineteen (19) non-structural culverts, a swamp area, two high fill areas and a deep cut area are to be investigated. This report covers the deep cut and high fill area over 5.0 metres.

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes and, based on the findings, to provide geotechnical recommendations for the foundation elements.

The deep cut area is located, immediately west of the swamp area, approximately between Station 11+675 and 11+725 with a cut height of 5.1 m. The high fill areas are located approximately between Station 13+800 and 13+875 on both the north and south sides of Highway 26, in the vicinity of non-structural culvert C09B, with fill heights of between 5.5 m and 7.1 m. The foundations aspects for replacement or extension of culvert C09 is provided in a separate report.

The work presented herein was undertaken under MTO G.W.P. 167-91-00, Agreement No. 3006-E-0002.

Authorization to complete this assignment was given by Mr. Dan Green, P. Eng., of Stantec Consulting Ltd., the TPM Consultant who is completing this assignment for MTO under Agreement # 3006-E-0002.

## **2.0 SITE DESCRIPTION**

### **2.1 Site Location**

The deep cut and high fill sites are approximately between 1.4 km and 2.6 km east of the west limit of this Contract (Station 10+300). The east limit of this Contract is located 0.3 km east of the former St. Vincent/Sydenham Township Boundary (Station 10+000). Locations of the deep cut and high fill areas are illustrated in the Borehole Location Plans, Drawings 1 and 3.

The deep cut area is located approximately between Station 11+675 and 11+725, immediately west of the swamp area, with a cut height of 5.1 m. The high fill areas are located approximately between Station 13+800 and 13+875 on both the north and south sides of Highway 26, in the vicinity of non-structural culvert C09B, with a fill height of between 5.5 m and 7.1 m.

The embankment slopes of the high fill areas are typically 2.5H:1V to 3H:1V, with localized steeper sections, and are grass covered. No signs of embankment slope instability were observed at the time of this foundation investigation.

Site photographs were taken during the field work in 2007 and provided in Appendix D.

### **2.2 Physiography and Topography**

Physiography for the area includes from west to east, part of a limestone plain, a till plain and a clay plain. Drumlins occur throughout the region, but were not observed in the project corridor. The underlying bedrock geology is dominated by Silurian sandstone, shale, dolostone and siltstone for one-third of the project area. The remainder of the project area has Ordovician shale, limestone, dolostone and siltstone.

Overall, the physiographic regions include, from west to east, the Bruce Peninsula (i.e., part of the Niagara Escarpment with shallower soils, more irregular rock types, and more water bodies as compared to further south) and the northern tip of the Bighead Valley (i.e., an indentation in the Niagara Escarpment that only touches the east end of the project corridor).

For most of this region, soils are brunisols and podzols (i.e., brown forest soils and grey-brown podzols) that have formed on calcareous till. The pH is neutral to alkaline. Slopes tend to be moderate.

Only two of the Niagara Escarpment Plan zoning designations, Escarpment Natural and Escarpment Rural Area, are located within the project limits within a relatively short section adjacent to the highway right-of-way (ROW). This section of the ROW includes the area where the westbound truck climbing lane is proposed.

The project limit also encroaches onto the plains forest of the Bayview Escarpment Area of Natural and Scientific Interest (ANSI) which was expanded in 1998 to include sections of land adjacent to the north side of Highway 26 (i.e., approximately 1 km of ROW in total), located 1

km east of the Sydenham/St. Vincent Township Line, and falls within the area of the westbound truck Climbing Lane. Much of this area has been disturbed and it is possible that the ANSI boundary extends to the highway simply to act as a buffer to the more sensitive ANSI features that are located further north.

The asphalt pavement surface in the deep cut area is between Elevations 337.38 m and 337.47 m. The top of the high cut areas are between Elevations 338.77 m and 340.01 m on the south side, and between Elevations 339.10 m and 339.17 m on the north side. The existing ditch inverts are between Elevations 336.78 m and 336.86 m on the south side, and between Elevations 336.71 m and 336.80 m on the north side.

The asphalt pavement surface in the high fill area is between Elevations 272.94 m and 274.80 m. The base of the embankment is between Elevations 267.20 m and 271.82 m on the south side, and between Elevations 267.52 m and 270.29 m on the north side.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Field Investigation**

Between August 15 and 27, 2007, a Bombardier-mounted Diedrich drill rig and a truck-mounted CME 55 drill rig, supplied and operated by London Soil Test Ltd. of London, was used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586).

Four (4) boreholes (Boreholes Cut 01 to Cut04) were put down at the deep cut areas and ten (10) boreholes (Boreholes 09B-1 to 09B-10) and were put down in the high fill area. The boreholes were drilled and sampled to obtain data for foundation design of the proposed deep cut and high fill. The boreholes were drilled to a minimum depth of 100% of the embankment height in the fill area, and 50% of the cut height below the base of the cut with a minimum of 3.0 m (or deeper if required) into competent material, or sampling refusal at 100 blows per 300 mm.

The locations of the boreholes are shown on Drawings 1 and 3. The depths of sampling are as follows:

<b>Borehole No.</b>	<b>Depth of Sampling (m)</b>
Cut 01	5.18
Cut 02	6.25
Cut 03	7.77
Cut 04	6.25
09B-1 (Fill)	6.40
09B-2 (Fill)	7.62

<b>Borehole No.</b>	<b>Depth of Sampling (m)</b>
09B-3 (Fill)	6.38
09B-4 (Fill)	4.72
09B-5 (Fill)	4.88
09B-6 (Fill)	4.65
09B-7 (Fill)	4.04
09B-8 (Fill)	10.24
09B-9 (Fill)	2.74
09B-10 (Fill)	4.72

The boreholes were advanced using continuous flight solid stem augers. Soil samples were retrieved at selected intervals throughout the depths of the boreholes in conjunction with Standard Penetration Tests (SPT). Samples were generally taken at intervals of depth of 0.75 m to the maximum depth of exploration.

Seepage and water levels were noted in each borehole during and at the completion of drilling and sampling. All boreholes were grouted with a bentonite/cement mix at completion of sampling in accordance with Ontario Regulation 903.

Our field engineer, Mr. Ralph Billings, P. Eng., working under the direction of the project engineer, Mr. Eric Chung, P. Eng., supervised the fieldwork. Our field staff cleared the location of buried utilities and logged the boreholes. The soil samples obtained were placed in labeled containers and transported to our London Office for further examination and laboratory testing.

The stations, offsets and ground surface elevations at the as-drilled borehole locations were surveyed by AGM London and provided to Infrastructure Engineering Group Inc. for the purpose of this report.

The results of the drilling, sampling, in-situ testing and groundwater observations are summarized on the Record of Borehole sheets and enclosed in Appendix B.

### **3.2 Laboratory Analysis**

Geotechnical laboratory testing consisted of natural moisture content determinations and visual classifications of all retrieved soil samples. In addition, grain size analyses, Atterberg Limit tests, standard Proctor Density Testing and unit weight tests were performed on selected samples.

The results of the laboratory testing are presented on the Record of Borehole sheets (Appendix A) and in the respective figures presented in Appendix B.

#### **4.0 SUBSURFACE CONDITIONS**

Reference is made to the respective appendix of each cut and fill site for the Record of Borehole sheets (Appendix A) and Laboratory Test Results (Appendix B) for detailed subsurface soil and groundwater conditions encountered in the boreholes. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, consequently, represent transitions between soil types rather than exact planes of geological change. The soil profiles depicting the subsurface conditions on the respective Borehole Locations will vary between and beyond the borehole locations. The soil profiles depicting the subsurface conditions on Drawings 2 and 4 will vary between and beyond the borehole locations.

The ground surface at the location of the deep cut area is covered with a 100 mm thick layer of organic topsoil. The topsoil in Borehole Cut 01 is underlain by a 1.35 m thick layer of sand and silt and classified as a fill based on the loose compactness condition and a visual and tactile examination of a single soil sample. The topsoil and/or fill are underlain by a major deposit of generally dense to very dense sand and silt till with clayey silt zones. At Borehole Cut 04, the clayey silt zones dominate the deposit which becomes hard clayey silt till with sand and silt layers.

Groundwater was measured at a depth of 4.90 m (Elevation 334.29 m) in Borehole Cut 03 at the completion of drilling. The remaining boreholes put down in the cut areas were dry and open at the completion of drilling.

The boreholes put down on the shoulders of the high fill area consist of very loose to compact embankment fill placed on very stiff to hard clayey silt to silty clay till. With the exception of Boreholes 09B-5 and 09B-6, the ground surface of the boreholes put down in the vicinity of the existing ditches is covered with a 150 mm thick layer of topsoil underlain by firm to hard clayey silt to silty clay till. Boreholes 09B-5 and 09B-6 is covered with a 150 mm thick layer of topsoil respectively underlain by a 1.98 and 0.61 m thick layer of mixed fill, which is in turn underlain by a stiff to hard clayey silt to silty clay till.

Groundwater was measured in Boreholes 09B-5 and 09B-8 at depths of 2.29 m (Elevation 264.45 m) and 6.70 m (Elevation 267.74 m), respectively at the completion of drilling. Minor water ingress was observed in Boreholes 09B-6 and 09B-10 at depths of 4.57 m (Elevation 263.99 m) and 4.57 m (Elevation 265.25 m), respectively at the completion of drilling. The remaining boreholes put down in the high fill area were dry and open at the completion of drilling.

#### **4.1 Deep Cut Area**

Boreholes Cut 01 to Cut 04, inclusive, were put down in the deep cut area and the following is a detailed description of the subsurface conditions encountered.



#### **4.1.1 Topsoil and Fill**

The ground surface at all of the borehole locations is covered with a 150 mm thick layer of topsoil.

The topsoil in Borehole Cut 01 is underlain by a 1.52 m thick layer of mixed fill, consisting of sand and silt with some clay, with a bottom Elevation of 337.99 m.

A single standard penetration test taken within this layer yielded a single “N”-value of 5 blows per 0.3 m indicating a loose compactness condition.

A single moisture content determination yielded a result of 14%.

Unit weight of the fill was not determined due to the disturbance of the soil samples during sampling and sample retrieval.

A single grain size distribution analysis was carried out on the mixed sand and silt and the results are presented in Figure CUT.1 of Appendix B.

A single Atterberg limits determination yielded a liquid limit, a plastic limit and a plasticity index of 26%, 19% and 7%, respectively, and the results are presented in Figure CUT.2 of Appendix B.

#### **4.1.2 Sand and Silt Till to Clayey Silt Till**

The topsoil and/or fill layers at Boreholes Cut 01 to Cut 03 are underlain by a major deposit of sand and silt till with clayey silt zones. At Borehole Cut 04, the clayey silt zones dominate the deposit which becomes hard clayey silt till with sand and silt layers. The till deposits contain embedded gravel, and possibly cobbles as inferred by the refusal to augering. The till deposits extend beyond the vertical limit of the boreholes at a maximum depth of 7.77 m (Elevation 331.42 m).

The tills have a brown to light brown colour and change to grey at depths of between 3.8 m and 4.6 m below the ground surface of Boreholes Cut 01 and Cut 02

Standard penetration tests yielded “N”-values of between 19 and over 100 blows per 0.3 m. The natural moisture contents were between 5 and 16%.

Twelve (12) grain size distribution analyses and six (6) Atterberg limits determinations were carried out on the sand and silt till and the interbedded sand and silt layers (SM-ML), and the results are presented in Appendix B and summarized in the following table:

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Sand and Silt Till & Layers	CUT.3 and 4	CUT.5

The Atterberg limits determinations of the sand and silt till and the interbedded sand and silt layers (SM-ML) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	15	21	17.0
Plastic Limit ( $W_P$ )	13	18	15.2
Plasticity Index ( $I_P$ )	1	3	1.8

Seven (7) grain size distribution analyses and seven (7) Atterberg limits determinations were carried out on the clayey silt till and the interbedded clayey silt layers (CL-ML) and the results are presented in Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Clayey Silt Till & Layers	CUT.6	CUT.7

Atterberg Limits determinations carried out on the clayey silt till and the interbedded clayey silt layers (CL-ML) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	18	21	19.6
Plastic Limit ( $W_P$ )	13	16	14.4
Plasticity Index ( $I_P$ )	4	6	5.1

Based on the above field and laboratory test results, together with visual and tactile examination, the sand and silt till deposit generally exhibited a compact to very dense compactness condition, and whereas the clayey silt till was in hard consistency.

Four (4) laboratory standard Proctor tests, one on a bulk sample from each borehole, were performed and the results are presented in each borehole log and summarized below:

Standard Proctor Densities	Minimum	Maximum	Average
Maximum Dry Density (MDD, $\text{Kg/m}^3$ )	1990	2150	2100
Maximum Wet Densities (MWD, $\text{Kg/m}^3$ )	2190	2322	2278
Optimum Moisture Content ( $W_{opt}$ , %)	8.0	10.0	8.5

## 4.2 High Fill Area

Boreholes 09B-1 to 09B-10, inclusive, were put down in the high fill area and the following is a detailed description of the subsurface conditions encountered.

#### 4.2.1 Topsoil and Fill

Boreholes 09B-2, 09B-3 and 09B-8 were put down on the existing shoulder and encountered a 300 mm, 410 mm and 460 mm thick layer of granular fill, respectively. The granular fill in Boreholes 09B-2, 09B-3 and 09B-8 is underlain by a 5.03 m, 2.18 m and 6.09 m thick layer of embankment fill, and the bottom of the embankment fill is at Elevations 268.12 m, 270.06 m and 267.89 m, respectively. The embankment fill generally consists of mixed gravel, sand, silt and clay, with occasional organic stains, seams and layers. At Borehole 09B-8, an organic layer was encountered at the bottom of the embankment fill.

The ground surface of Boreholes 09B-5 and 09B-6, located in the side ditch area, is covered with a 150 mm thick layer of organic topsoil underlain by a 1.98 m and 0.61 m thick layer of fill consisting of mixed gravel, sand, silt and clay. The bottom of the fill layers in Boreholes 09B-5 and 09B-6 were found at Elevations 264.61 m and 267.8 m.

The ground surface at the locations of the remaining boreholes is covered with a 150 mm thick layer of organic topsoil.

Standard penetration tests taken within the fill layers yielded “N”-values of between 3 and 16 blows per 0.3 m, typically in a loose to very loose condition with occasional compact layers. The natural moisture contents were between 10 and 112%, the higher moisture contents were obtained in the organic layer within the fill material.

Unit weight of the fill materials was measured between 18.6 and 20.1 kN/m<sup>3</sup>, with an average of 19.4 kN/m<sup>3</sup>.

Eleven (11) grain size distribution analyses and eight (8) Atterberg limits determinations were performed and the results are plotted on the following figures of Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
FILL	FILL.1 and 2	FILL.3

The Atterberg limits determinations carried out on the fill layers yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	20	30	27.3
Plastic Limit ( $W_P$ )	14	18	16.6
Plasticity Index ( $I_P$ )	6	13	10.6

#### 4.2.2 Clayey Silt to Silty Clay Till

The topsoil and fill layers in all of the boreholes are underlain by clayey silt to silty clay till with embedded sand and gravel. Sand and silt seams are present within the clayey silt to silty clay till.

The clayey silt to silty clay till generally has a reddish brown colour. The unit weight was measured between 17.1 and 23.6 kN/m<sup>3</sup>, with an average of 20.8 kN/m<sup>3</sup>.

Standard penetration tests taken within the clayey silt to silty clay till yielded “N”-values of between 6 and over 100 blows per 0.3 m. The natural moisture contents were between 17 and 24%.

Thirteen (13) grain size distribution analyses and twelve (12) Atterberg limits determinations were carried out on the clayey silt to silty clay till and the results are presented in Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Clayey Silt to Silty Clayey Till	FILL.4 and 5	FILL.6 and 7

The Atterberg limits determinations carried out on the clayey silt to silty clay till yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
<b>Liquid Limit (W<sub>L</sub>)</b>	18	32	22.9
<b>Plastic Limit (W<sub>P</sub>)</b>	13	18	15.3
<b>Plasticity Index (I<sub>p</sub>)</b>	4	16	7.5

Ten (10) grain size distribution analyses and five (5) Atterberg limits determinations were carried out on the sand and silt seams, layers and pockets and the results are presented in Appendix B.

Soil Type	Grain Size Figure	Atterberg Limits Figure
Sand and Silt Seams, Layers and Pockets	FILL.8 and 9	FILL.10

The Atterberg limits determinations carried out on the sand and silt seams, layers and pockets yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
<b>Liquid Limit (W<sub>L</sub>)</b>	16	18	17.3
<b>Plastic Limit (W<sub>P</sub>)</b>	13	17	15.0
<b>Plasticity Index (I<sub>p</sub>)</b>	1	3	2.3

Based on the above field and laboratory test results, together with visual and tactile examination, the clayey silt to silty clay till deposit generally exhibited a firm to hard consistency. The firm to stiff layers were encountered locally at Boreholes 09B-6, 09B-9 and 09B-10.

### 4.3 Groundwater

The groundwater condition was monitored during and upon completion of sampling. On completion of drilling, groundwater levels noted in the boreholes are summarized in the following table:

Borehole No.	Groundwater Levels - Depth/Elevation (m)
Cut 01	BD&O
Cut 02	BD&O
Cut 03	4.90/334.29
Cut 04	BD&O
09B-1 (Fill)	BD&O
09B-2 (Fill)	BD&O
09B-3 (Fill)	BD&O
09B-4 (Fill)	BD&O
09B-5 (Fill)	2.29/264.45
09B-6 (Fill)	Minor water ingress @ 4.57/263.99
09B-7 (Fill)	BD&O
09B-8 (Fill)	6.70/267.74
09B-9 (Fill)	BD&O
09B-10 (Fill)	Minor water ingress @ 4.57/265.25

**Note:** BD&O means borehole dry and open at completion

In general, the groundwater was encountered as perched condition within the upper fill materials or within the more pervious sand and silt layers or pockets of the till deposits. The brown/grey interface encountered within the sand and silt till likely reflects a level of permanent saturation.

The groundwater condition will fluctuate seasonally and in response to weather events.

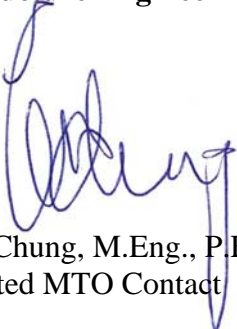
## 5.0 STATEMENT OF LIMITATION

We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

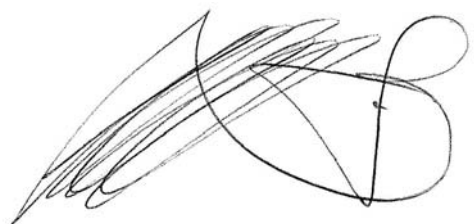
The Limitations of Report, as quoted in Appendix C, is an integral part of this report.


We trust that we have completed the assignment within the Terms of Reference for this project. If there are any questions concerning this report, please do not hesitate to contact our office.

Yours truly,  
**Infrastructure Engineering Group Inc.**

  
Eric Y. Chung, M.Eng., P.Eng.  
Designated MTO Contact



  
Joseph Law, P. Eng.  
Project Manager

  
Tom O'Dwyer, P. Eng.  
Quality Review Engineer



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## **2.0 SITE DESCRIPTION**

### **2.1 Site Location**

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Site photographs were taken during the field work in 2007 and provided in Appendix D.

### **2.2 Physiography and Topography**

Physiography for the area includes from west to east, part of a limestone plain, a till plain and a clay plain. Drumlins occur throughout the region, but were not observed in the project corridor. The underlying bedrock geology is dominated by Silurian sandstone, shale, dolostone and siltstone for one-third of the project area. The remainder of the project area has Ordovician shale, limestone, dolostone and siltstone.

Overall, the physiographic regions include, from west to east, the Bruce Peninsula (i.e., part of the Niagara Escarpment with shallower soils, more irregular rock types, and more water bodies as compared to further south) and the northern tip of the Bighead Valley (i.e., an indentation in the Niagara Escarpment that only touches the east end of the project corridor).

For most of this region, soils are brunisols and podzols (i.e., brown forest soils and grey-brown podzols) that have formed on calcareous till. The pH is neutral to alkaline. Slopes tend to be moderate.

Only two of the Niagara Escarpment Plan zoning designations, Escarpment Natural and Escarpment Rural Area, are located within the project limits within a relatively short section adjacent to the highway right-of-way (ROW). This section of the ROW includes the area where the westbound truck climbing lane is proposed.

The project limit also encroaches onto the plains forest of the Bayview Escarpment Area of Natural and Scientific Interest (ANSI) which was expanded in 1998 to include sections of land adjacent to the north side of Highway 26 (i.e., approximately 1 km of ROW in total), located 1

km east of the Sydenham/St. Vincent Township Line, and falls within the area of the westbound truck Climbing Lane. Much of this area has been disturbed and it is possible that the ANSI boundary extends to the highway simply to act as a buffer to the more sensitive ANSI features that are located further north.

The asphalt pavement surface in the deep cut area is between Elevations 337.38 m and 337.47 m. The top of the high cut areas are between Elevations 338.77 m and 340.01 m on the south side, and between Elevations 339.10 m and 339.17 m on the north side. The existing ditch inverts are between Elevations 336.78 m and 336.86 m on the south side, and between Elevations 336.71 m and 336.80 m on the north side.

The asphalt pavement surface in the high fill area is between Elevations 272.94 m and 274.80 m. The base of the embankment is between Elevations 267.20 m and 271.82 m on the south side, and between Elevations 267.52 m and 270.29 m on the north side.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Field Investigation**

Between August 15 and 27, 2007, a Bombardier-mounted Diedrich drill rig and a truck-mounted CME 55 drill rig, supplied and operated by London Soil Test Ltd. of London, was used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586).

Four (4) boreholes (Boreholes Cut 01 to Cut04) were put down at the deep cut areas and ten (10) boreholes (Boreholes 09B-1 to 09B-10) and were put down in the high fill area. The boreholes were drilled and sampled to obtain data for foundation design of the proposed deep cut and high fill. The boreholes were drilled to a minimum depth of 100% of the embankment height in the fill area, and 50% of the cut height below the base of the cut with a minimum of 3.0 m (or deeper if required) into competent material, or sampling refusal at 100 blows per 300 mm.

The locations of the boreholes are shown on Drawings 1 and 3. The depths of sampling are as follows:

<b>Borehole No.</b>	<b>Depth of Sampling (m)</b>
Cut 01	5.18
Cut 02	6.25
Cut 03	7.77
Cut 04	6.25
09B-1 (Fill)	6.40
09B-2 (Fill)	7.62

<b>Borehole No.</b>	<b>Depth of Sampling (m)</b>
09B-3 (Fill)	6.38
09B-4 (Fill)	4.72
09B-5 (Fill)	4.88
09B-6 (Fill)	4.65
09B-7 (Fill)	4.04
09B-8 (Fill)	10.24
09B-9 (Fill)	2.74
09B-10 (Fill)	4.72

The boreholes were advanced using continuous flight solid stem augers. Soil samples were retrieved at selected intervals throughout the depths of the boreholes in conjunction with Standard Penetration Tests (SPT). Samples were generally taken at intervals of depth of 0.75 m to the maximum depth of exploration.

Seepage and water levels were noted in each borehole during and at the completion of drilling and sampling. All boreholes were grouted with a bentonite/cement mix at completion of sampling in accordance with Ontario Regulation 903.

Our field engineer, Mr. Ralph Billings, P. Eng., working under the direction of the project engineer, Mr. Eric Chung, P. Eng., supervised the fieldwork. Our field staff cleared the location of buried utilities and logged the boreholes. The soil samples obtained were placed in labeled containers and transported to our London Office for further examination and laboratory testing.

The stations, offsets and ground surface elevations at the as-drilled borehole locations were surveyed by AGM London and provided to Infrastructure Engineering Group Inc. for the purpose of this report.

The results of the drilling, sampling, in-situ testing and groundwater observations are summarized on the Record of Borehole sheets and enclosed in Appendix B.

### **3.2 Laboratory Analysis**

Geotechnical laboratory testing consisted of natural moisture content determinations and visual classifications of all retrieved soil samples. In addition, grain size analyses, Atterberg Limit tests, standard Proctor Density Testing and unit weight tests were performed on selected samples.

The results of the laboratory testing are presented on the Record of Borehole sheets (Appendix A) and in the respective figures presented in Appendix B.

#### **4.0 SUBSURFACE CONDITIONS**

Reference is made to the respective appendix of each cut and fill site for the Record of Borehole sheets (Appendix A) and Laboratory Test Results (Appendix B) for detailed subsurface soil and groundwater conditions encountered in the boreholes. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, consequently, represent transitions between soil types rather than exact planes of geological change. The soil profiles depicting the subsurface conditions on the respective Borehole Locations will vary between and beyond the borehole locations. The soil profiles depicting the subsurface conditions on Drawings 2 and 4 will vary between and beyond the borehole locations.

The ground surface at the location of the deep cut area is covered with a 100 mm thick layer of organic topsoil. The topsoil in Borehole Cut 01 is underlain by a 1.35 m thick layer of sand and silt and classified as a fill based on the loose compactness condition and a visual and tactile examination of a single soil sample. The topsoil and/or fill are underlain by a major deposit of generally dense to very dense sand and silt till with clayey silt zones. At Borehole Cut 04, the clayey silt zones dominate the deposit which becomes hard clayey silt till with sand and silt layers.

Groundwater was measured at a depth of 4.90 m (Elevation 334.29 m) in Borehole Cut 03 at the completion of drilling. The remaining boreholes put down in the cut areas were dry and open at the completion of drilling.

The boreholes put down on the shoulders of the high fill area consist of very loose to compact embankment fill placed on very stiff to hard clayey silt to silty clay till. With the exception of Boreholes 09B-5 and 09B-6, the ground surface of the boreholes put down in the vicinity of the existing ditches is covered with a 150 mm thick layer of topsoil underlain by firm to hard clayey silt to silty clay till. Boreholes 09B-5 and 09B-6 is covered with a 150 mm thick layer of topsoil respectively underlain by a 1.98 and 0.61 m thick layer of mixed fill, which is in turn underlain by a stiff to hard clayey silt to silty clay till.

Groundwater was measured in Boreholes 09B-5 and 09B-8 at depths of 2.29 m (Elevation 264.45 m) and 6.70 m (Elevation 267.74 m), respectively at the completion of drilling. Minor water ingress was observed in Boreholes 09B-6 and 09B-10 at depths of 4.57 m (Elevation 263.99 m) and 4.57 m (Elevation 265.25 m), respectively at the completion of drilling. The remaining boreholes put down in the high fill area were dry and open at the completion of drilling.

#### **4.1 Deep Cut Area**

Boreholes Cut 01 to Cut 04, inclusive, were put down in the deep cut area and the following is a detailed description of the subsurface conditions encountered.

#### **4.1.1 Topsoil and Fill**

The ground surface at all of the borehole locations is covered with a 150 mm thick layer of topsoil.

The topsoil in Borehole Cut 01 is underlain by a 1.52 m thick layer of mixed fill, consisting of sand and silt with some clay, with a bottom Elevation of 337.99 m.

A single standard penetration test taken within this layer yielded a single “N”-value of 5 blows per 0.3 m indicating a loose compactness condition.

A single moisture content determination yielded a result of 14%.

Unit weight of the fill was not determined due to the disturbance of the soil samples during sampling and sample retrieval.

A single grain size distribution analysis was carried out on the mixed sand and silt and the results are presented in Figure CUT.1 of Appendix B.

A single Atterberg limits determination yielded a liquid limit, a plastic limit and a plasticity index of 26%, 19% and 7%, respectively, and the results are presented in Figure CUT.2 of Appendix B.

#### **4.1.2 Sand and Silt Till to Clayey Silt Till**

The topsoil and/or fill layers at Boreholes Cut 01 to Cut 03 are underlain by a major deposit of sand and silt till with clayey silt zones. At Borehole Cut 04, the clayey silt zones dominate the deposit which becomes hard clayey silt till with sand and silt layers. The till deposits contain embedded gravel, and possibly cobbles as inferred by the refusal to augering. The till deposits extend beyond the vertical limit of the boreholes at a maximum depth of 7.77 m (Elevation 331.42 m).

The tills have a brown to light brown colour and change to grey at depths of between 3.8 m and 4.6 m below the ground surface of Boreholes Cut 01 and Cut 02

Standard penetration tests yielded “N”-values of between 19 and over 100 blows per 0.3 m. The natural moisture contents were between 5 and 16%.

Twelve (12) grain size distribution analyses and six (6) Atterberg limits determinations were carried out on the sand and silt till and the interbedded sand and silt layers (SM-ML), and the results are presented in Appendix B and summarized in the following table:

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Sand and Silt Till & Layers	CUT.3 and 4	CUT.5

The Atterberg limits determinations of the sand and silt till and the interbedded sand and silt layers (SM-ML) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	15	21	17.0
Plastic Limit ( $W_P$ )	13	18	15.2
Plasticity Index ( $I_P$ )	1	3	1.8

Seven (7) grain size distribution analyses and seven (7) Atterberg limits determinations were carried out on the clayey silt till and the interbedded clayey silt layers (CL-ML) and the results are presented in Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Clayey Silt Till & Layers	CUT.6	CUT.7

Atterberg Limits determinations carried out on the clayey silt till and the interbedded clayey silt layers (CL-ML) yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	18	21	19.6
Plastic Limit ( $W_P$ )	13	16	14.4
Plasticity Index ( $I_P$ )	4	6	5.1

Based on the above field and laboratory test results, together with visual and tactile examination, the sand and silt till deposit generally exhibited a compact to very dense compactness condition, and whereas the clayey silt till was in hard consistency.

Four (4) laboratory standard Proctor tests, one on a bulk sample from each borehole, were performed and the results are presented in each borehole log and summarized below:

Standard Proctor Densities	Minimum	Maximum	Average
Maximum Dry Density (MDD, $\text{Kg/m}^3$ )	1990	2150	2100
Maximum Wet Densities (MWD, $\text{Kg/m}^3$ )	2190	2322	2278
Optimum Moisture Content ( $W_{opt}$ , %)	8.0	10.0	8.5

## 4.2 High Fill Area

Boreholes 09B-1 to 09B-10, inclusive, were put down in the high fill area and the following is a detailed description of the subsurface conditions encountered.

#### 4.2.1 Topsoil and Fill

Boreholes 09B-2, 09B-3 and 09B-8 were put down on the existing shoulder and encountered a 300 mm, 410 mm and 460 mm thick layer of granular fill, respectively. The granular fill in Boreholes 09B-2, 09B-3 and 09B-8 is underlain by a 5.03 m, 2.18 m and 6.09 m thick layer of embankment fill, and the bottom of the embankment fill is at Elevations 268.12 m, 270.06 m and 267.89 m, respectively. The embankment fill generally consists of mixed gravel, sand, silt and clay, with occasional organic stains, seams and layers. At Borehole 09B-8, an organic layer was encountered at the bottom of the embankment fill.

The ground surface of Boreholes 09B-5 and 09B-6, located in the side ditch area, is covered with a 150 mm thick layer of organic topsoil underlain by a 1.98 m and 0.61 m thick layer of fill consisting of mixed gravel, sand, silt and clay. The bottom of the fill layers in Boreholes 09B-5 and 09B-6 were found at Elevations 264.61 m and 267.8 m.

The ground surface at the locations of the remaining boreholes is covered with a 150 mm thick layer of organic topsoil.

Standard penetration tests taken within the fill layers yielded “N”-values of between 3 and 16 blows per 0.3 m, typically in a loose to very loose condition with occasional compact layers. The natural moisture contents were between 10 and 112%, the higher moisture contents were obtained in the organic layer within the fill material.

Unit weight of the fill materials was measured between 18.6 and 20.1 kN/m<sup>3</sup>, with an average of 19.4 kN/m<sup>3</sup>.

Eleven (11) grain size distribution analyses and eight (8) Atterberg limits determinations were performed and the results are plotted on the following figures of Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
FILL	FILL.1 and 2	FILL.3

The Atterberg limits determinations carried out on the fill layers yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
Liquid Limit ( $W_L$ )	20	30	27.3
Plastic Limit ( $W_P$ )	14	18	16.6
Plasticity Index ( $I_P$ )	6	13	10.6

#### 4.2.2 Clayey Silt to Silty Clay Till

The topsoil and fill layers in all of the boreholes are underlain by clayey silt to silty clay till with embedded sand and gravel. Sand and silt seams are present within the clayey silt to silty clay till.

The clayey silt to silty clay till generally has a reddish brown colour. The unit weight was measured between 17.1 and 23.6 kN/m<sup>3</sup>, with an average of 20.8 kN/m<sup>3</sup>.

Standard penetration tests taken within the clayey silt to silty clay till yielded “N”-values of between 6 and over 100 blows per 0.3 m. The natural moisture contents were between 17 and 24%.

Thirteen (13) grain size distribution analyses and twelve (12) Atterberg limits determinations were carried out on the clayey silt to silty clay till and the results are presented in Appendix B.

#### Table of Figures of Laboratory Test Results

Soil Type	Grain Size Figure	Atterberg Limits Figure
Clayey Silt to Silty Clayey Till	FILL.4 and 5	FILL.6 and 7

The Atterberg limits determinations carried out on the clayey silt to silty clay till yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
<b>Liquid Limit (W<sub>L</sub>)</b>	18	32	22.9
<b>Plastic Limit (W<sub>P</sub>)</b>	13	18	15.3
<b>Plasticity Index (I<sub>p</sub>)</b>	4	16	7.5

Ten (10) grain size distribution analyses and five (5) Atterberg limits determinations were carried out on the sand and silt seams, layers and pockets and the results are presented in Appendix B.

Soil Type	Grain Size Figure	Atterberg Limits Figure
Sand and Silt Seams, Layers and Pockets	FILL.8 and 9	FILL.10

The Atterberg limits determinations carried out on the sand and silt seams, layers and pockets yielded the following results:

Atterberg Limits	Minimum	Maximum	Average
<b>Liquid Limit (W<sub>L</sub>)</b>	16	18	17.3
<b>Plastic Limit (W<sub>P</sub>)</b>	13	17	15.0
<b>Plasticity Index (I<sub>p</sub>)</b>	1	3	2.3

Based on the above field and laboratory test results, together with visual and tactile examination, the clayey silt to silty clay till deposit generally exhibited a firm to hard consistency. The firm to stiff layers were encountered locally at Boreholes 09B-6, 09B-9 and 09B-10.



### 4.3 Groundwater

The groundwater condition was monitored during and upon completion of sampling. On completion of drilling, groundwater levels noted in the boreholes are summarized in the following table:

Borehole No.	Groundwater Levels - Depth/Elevation (m)
Cut 01	BD&O
Cut 02	BD&O
Cut 03	4.90/334.29
Cut 04	BD&O
09B-1 (Fill)	BD&O
09B-2 (Fill)	BD&O
09B-3 (Fill)	BD&O
09B-4 (Fill)	BD&O
09B-5 (Fill)	2.29/264.45
09B-6 (Fill)	Minor water ingress @ 4.57/263.99
09B-7 (Fill)	BD&O
09B-8 (Fill)	6.70/267.74
09B-9 (Fill)	BD&O
09B-10 (Fill)	Minor water ingress @ 4.57/265.25

**Note:** BD&O means borehole dry and open at completion

In general, the groundwater was encountered as perched condition within the upper fill materials or within the more pervious sand and silt layers or pockets of the till deposits. The brown/grey interface encountered within the sand and silt till likely reflects a level of permanent saturation.

The groundwater condition will fluctuate seasonally and in response to weather events.

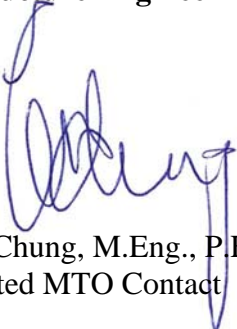
## 5.0 STATEMENT OF LIMITATION

We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

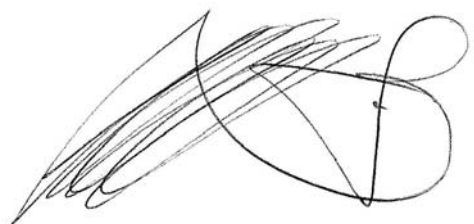
The Limitations of Report, as quoted in Appendix C, is an integral part of this report.


We trust that we have completed the assignment within the Terms of Reference for this project. If there are any questions concerning this report, please do not hesitate to contact our office.

Yours truly,  
**Infrastructure Engineering Group Inc.**

  
Eric Y. Chung, M.Eng., P.Eng.  
Designated MTO Contact



  
Joseph Law, P. Eng.  
Project Manager

  
Tom O'Dwyer, P. Eng.  
Quality Review Engineer



Ministry of Transportation/Stantec Consulting Ltd.  
G.W.P. 167-91-00 - Rehabilitation of Highway 26  
From Former St. Vincent/Sydenham Townline to Meaford  
Agreement # 3006-E-0002

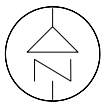
07-6-IEG-B-CUT AND FILL  
Final Report  
Drawings  
May 17, 2010

### Drawings

Borehole Location Plans	Drawings 1 and 3
Soil Profiles	Drawings 2 and 4
Schematic Design of Blanket Drain	Drawing 5

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UNLESS OTHERWISE SHOWN

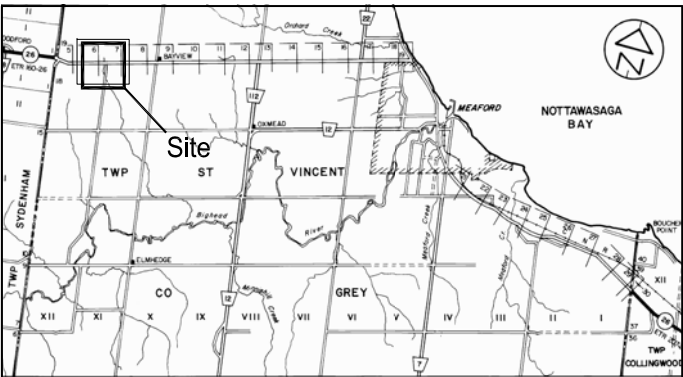
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CUT BOREHOLE LOCATION  
Highway 26 - Part B  
STA 11+675 TO 11+725

SHEET  
1

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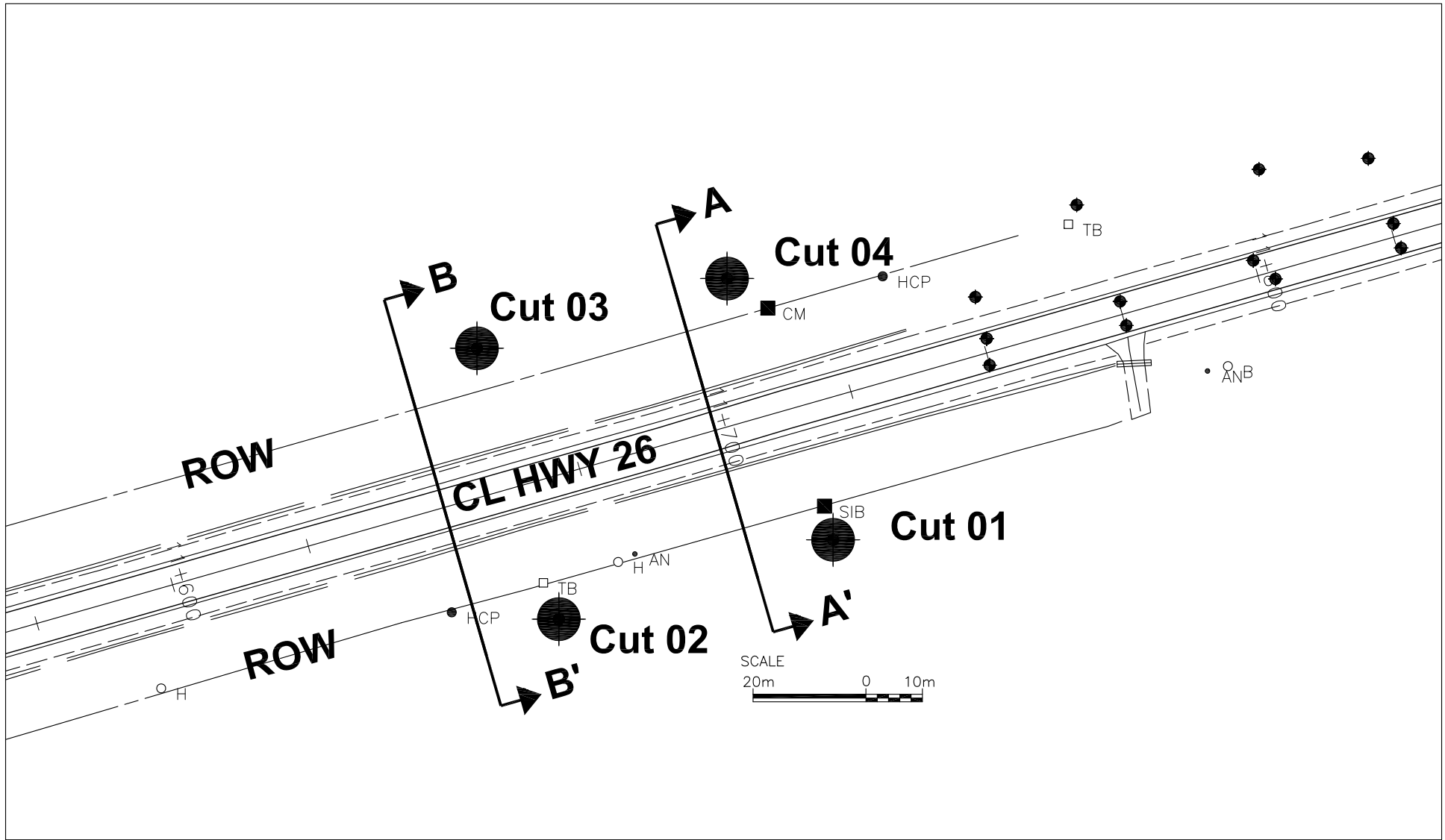


KEYPLAN

NTS

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



NOTES

- THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW. INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 of OPS GEN. COND.
- THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES AND BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES	
		NORTH	EAST
Cut 01	339.51	4940477	209200
Cut 02	339.46	4940463	209151
Cut 03	339.19	4940511	209137
Cut 04	338.45	4940524	209181

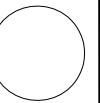
REVISIONS			
	DATE	BY	DISCRIPTION
	03/19/10	J.L.	Final
	06/11/09	J.L.	Draft

MTO GEOCRES No. 41A-215			
HWY No.	HWY 26		DIST Owen Sound
SUBM'D J.L.	CHECKED E.C.	DATE 06/11/09	SITE DEEP CUT
DRAWN J.L.	CHECKED J.L.	APPROVED E.C.	DWG 1

MINISTRY OF TRANSPORTATION, ONTARIO

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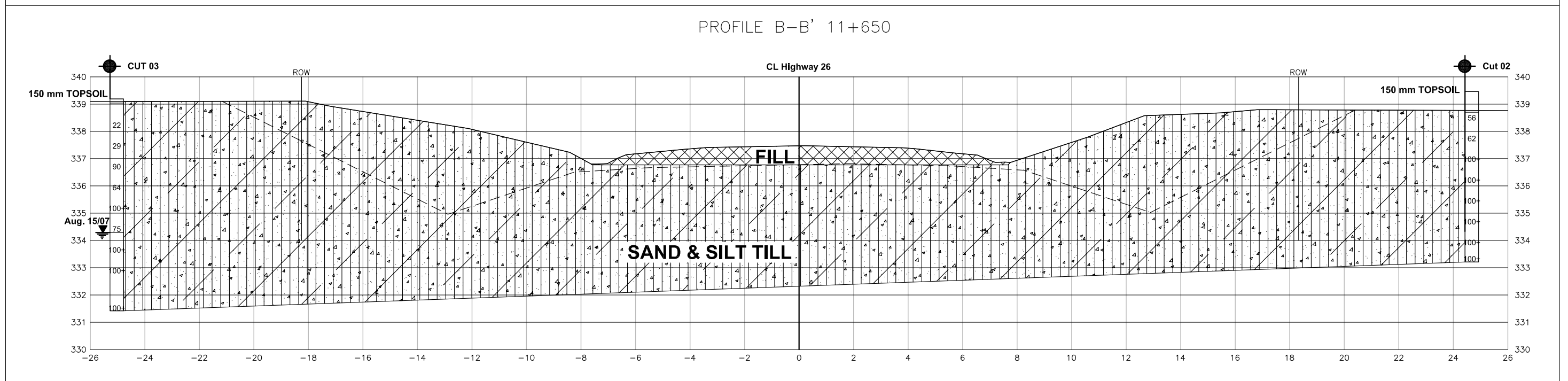
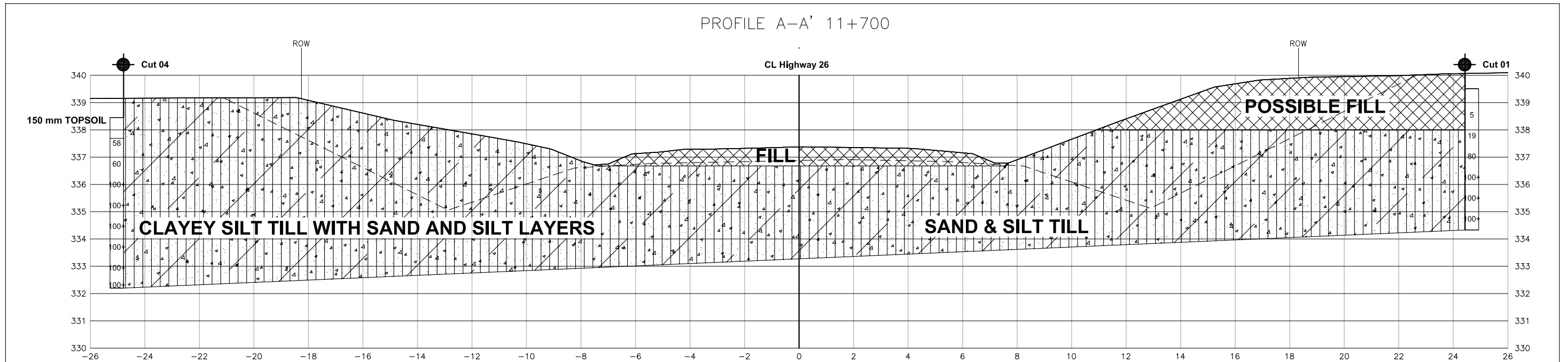
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CUT PROFILE  
Highway 26 - Part B  
STA 11+675 TO 11+725

SHEET  
2

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#### NOTES

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#### LEGEND

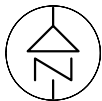
— — — PROPOSED BOTTOM OF CUT

REVISIONS	DATE	BY	DISCRIPTION
	03/19/10	J.L.	Final
	06/11/09	J.L.	Draft
MTO GEOCRES No. 41A-215			
HWY No.	HWY 26		DIST Owen Sound
SUBM'D	J.L.	CHECKED E.C.	DATE 06/11/09
DRAWN	J.L.	CHECKED J.L.	APPROVED E.C.
SITE	DEEP CUT		DWG 2

MINISTRY OF TRANSPORTATION, ONTARIO

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AND/OR MILLIMETRES  
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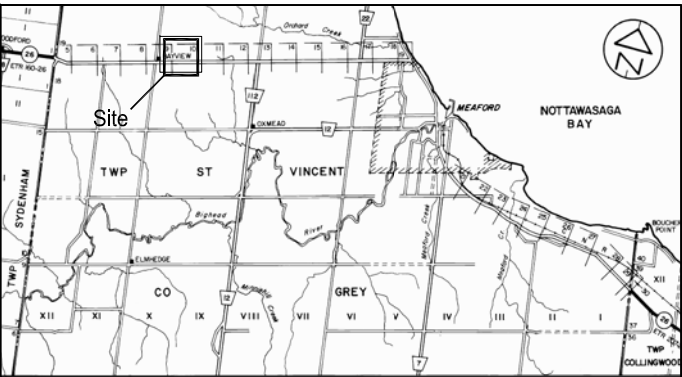
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WP No GWP 167-91-00



FILL BOREHOLE LOCATION  
Highway 26 - Part B  
STA 13+800 TO 13+875

SHEET  
3

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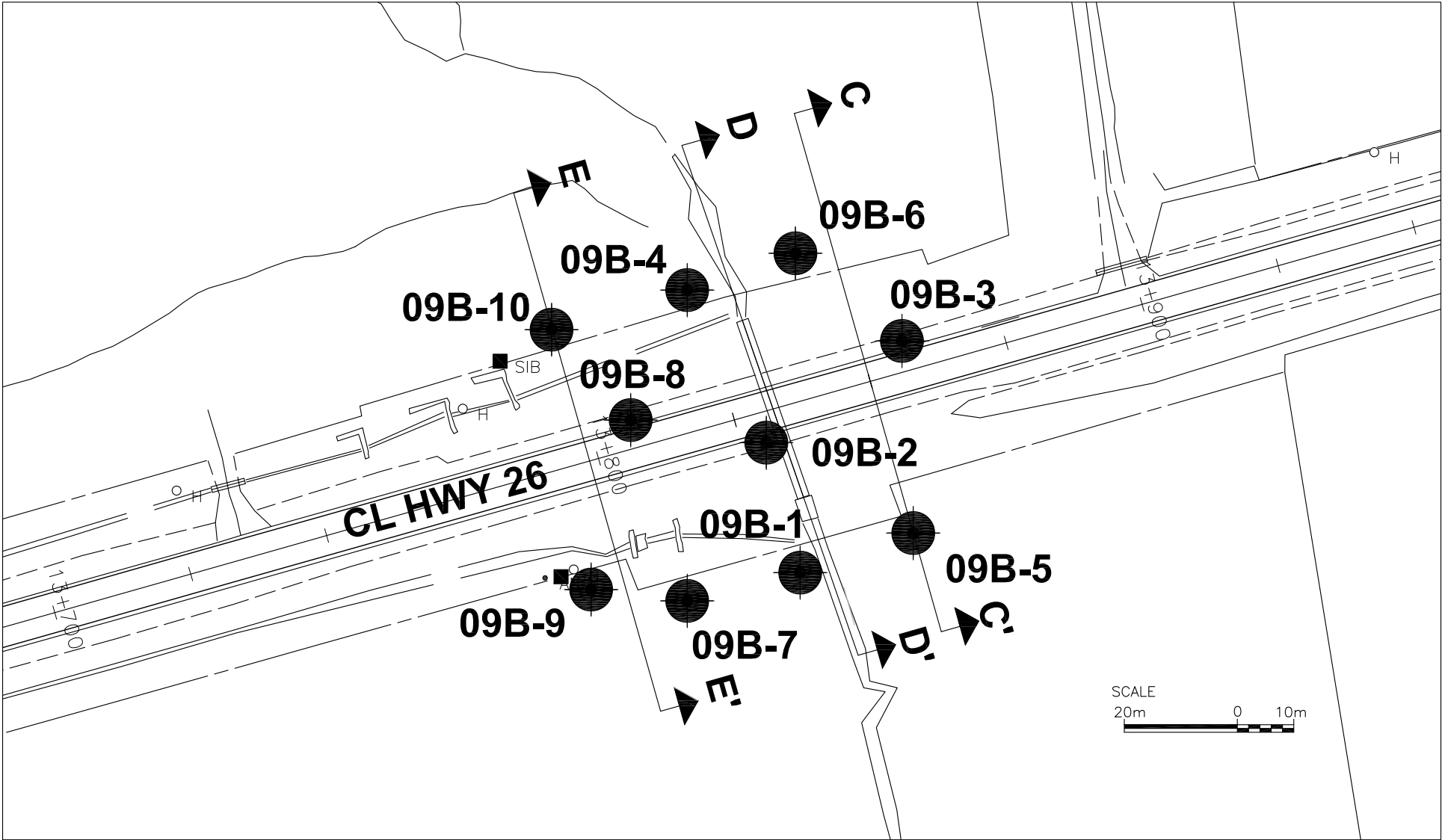


KEYPLAN

NTS

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



SCALE  
20m 0 10m

BOREHOLE NO.	ELEV.	UTM CO-ORDINATES	
		NORTH	EAST
09B-1	266.93	4941050	211235
09B-2	273.45	4941073	211229
09B-3	272.65	4941091	211253
09B-4	268.55	4941100	211215
09B-5	266.74	4941057	211255
09B-6	268.56	4941107	211234
09B-7	270.27	4941045	211215
09B-8	274.44	4941077	211205
09B-9	272.29	4941047	211198
09B-10	269.82	4941093	211191

REVISIONS			
	DATE	BY	DISCRIPTION
	DATE	BY	DISCRIPTION
	03/19/10	J.L.	Final
	09/11/09	J.L.	Draft

MTO GEOCRES No. 41A-215			
HWY No.	HWY 26		DIST Owen Sound
SUBM'D	J.L.	CHECKED E.C.	DATE 09/11/09
DRAWN	J.L.	CHECKED J.L.	APPROVED E.C.
			SITE HIGH FILL
			DWG 3

NOTES

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3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

NOTES

1. THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW. INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 of OPS GEN. COND.
2. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES AND BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

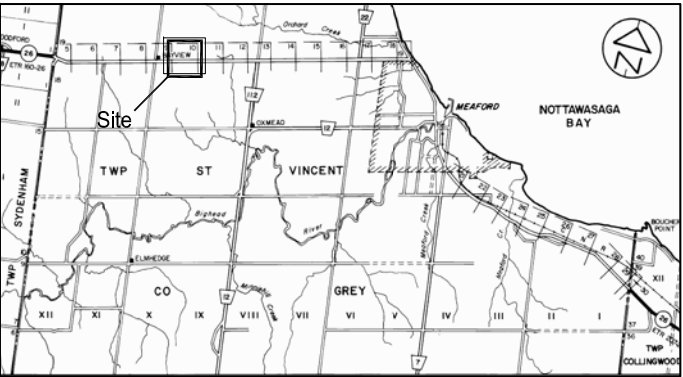
CONT No xxxx-xxxx  
WP No GWP 167-91-00

FILL PROFILE  
Highway 26 - Part B  
STA 13+800 TO 13+875

SHEET

4

I.E. Infrastructure Engineering Group Inc.  
Pavement & Construction Materials Consulting Engineers  
GTA • Kitchener • London • Windsor



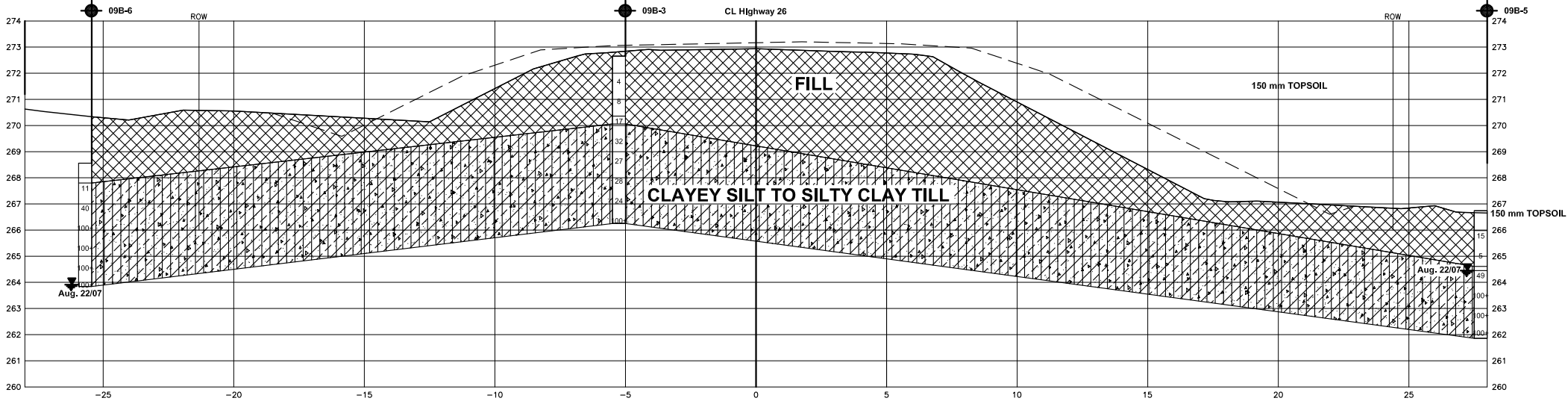
KEYPLAN

NTS

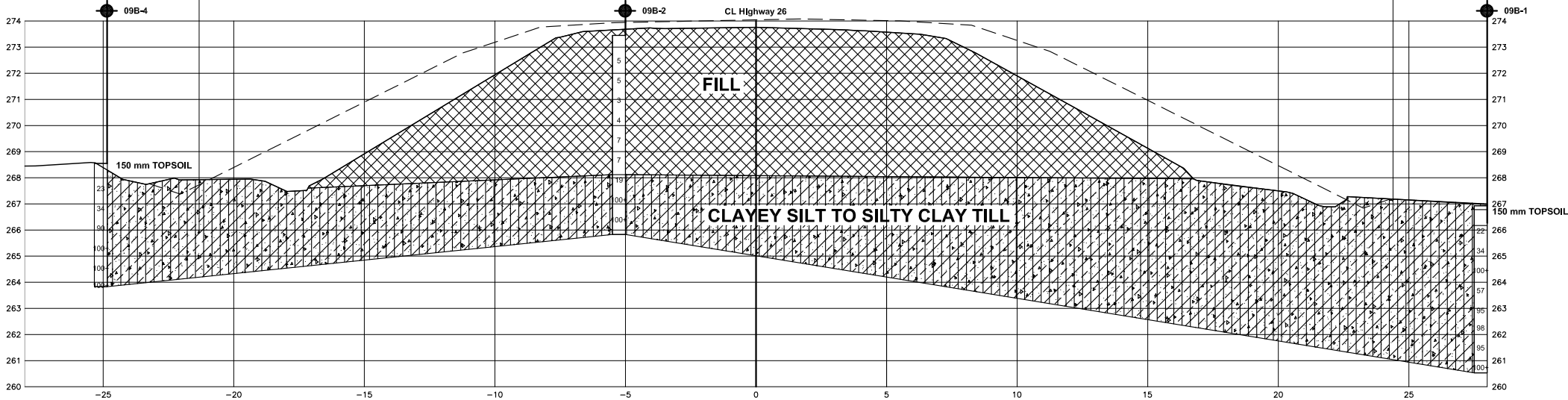
LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe
- PROPOSED TOP OF FILL

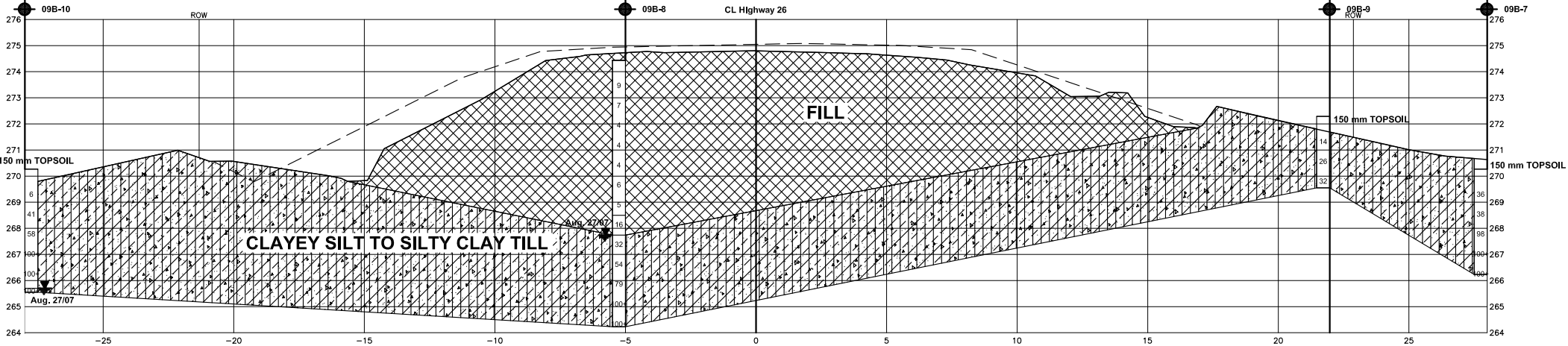
PROFILE C-C' 13+850



PROFILE D-D' 13+825



PROFILE E-E' 13+800

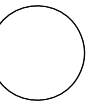


REVISIONS				
	03/19/10	J.L.	Final	
	09/11/09	J.L.	Draft	
	DATE	BY	DISCRPTION	
MTO GEOCRES No. 41A-215				
HWY No.		HWY 26		DIST Owen Sound
SUBM'D	J.L.	CHECKED	E.C.	DATE 09/11/09 SITE HIGH FILL
DRAWN	J.L.	CHECKED	J.L.	APPROVED E.C. DWG 4

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No xxxx-xxxx  
WP No GWP 167-91-00

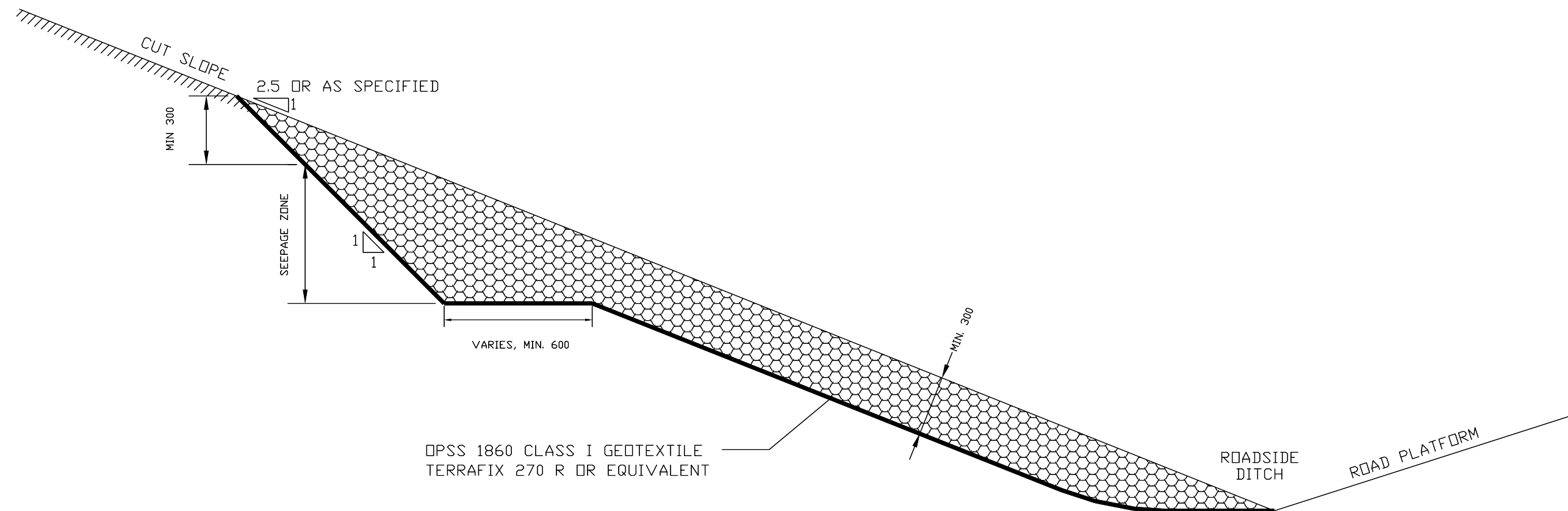


DEEP CUT  
STA 11+675 TO 11+725  
Highway 26  
SCHEMATIC DESIGN OF BLANKET DRAIN

SHEET  
5

I.E. Infrastructure Engineering Group Inc.  
Pavement & Construction Materials Consulting Engineers  
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## SCHEMATIC DESIGN OF BLANKET DRAIN



NOT TO SCALE

### Installation Notes

1. remove all wet and unstable materials exposed at the slope face
2. grade the protected soil surface to be smooth
3. place geotextile (filter cloth) to be as smooth and wrinkle free as possible
4. extend geotextile down the cut slope to the road side ditch
5. pin geotextile down as required
6. provide overlaps of at least 600 mm between adjacent strips of geotextile
7. place minimum 300 mm thick rip rap on geotextile
8. do not damage geotextile while placing rip rap

REVISIONS			
	03/19/10	J.L.	Final Report
	16/11/09	J.L.	Draft Report
	DATE	BY	DISCRIPTION

MTO GEOCRES No. 41A-215

HWY No.		HWY 26		DIST Owen Sound	
SUBM'D	J.L.	CHECKED	E.C.	DATE 16/11/09	SITE DEEP CUT
DRAWN	J.L.	CHECKED	J.L.	APPROVED E.C.	DWG 5



Ministry of Transportation/Stantec Consulting Ltd.  
G.W.P. 167-91-00 - Rehabilitation of Highway 26  
From Former St. Vincent/Sydenham Townline to Meaford  
Agreement # 3006-E-0002

07-6-IEG-B-CUT AND FILL  
Final Report  
Appendix A  
May 17, 2010

## Appendix A

### Explanation of Terms Used in Report

Record of Borehole Sheet

Boreholes Cut 01 to 04

Boreholes 09B-1 to 10

## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T.W. ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T.W. ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$C_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_r$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_c$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_c}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1. %	VOID RATIO	$e_{min}$	1. %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1. %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1. %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kn/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kn/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$i_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{i_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kn/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{i_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1. %	VOID RATIO IN LOOSEST STATE	j	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kn/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No Cut 01

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940477, Easting - 209200 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 16.8.07 - 16.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	10 20 30								
339.51 0.00	Ground														
	150 mm TOPSOIL.														
	POSSIBLE FILL Brown, moist, loose, consisting of mixed sand and silt, some clay, trace gravel.		1	SPT	5		339							2 32 52 15 (66)	
337.99 1.52	Bulk Sample MDD = 2130 Kg/m <sup>3</sup> W <sub>opt</sub> = 8.0% MWD = 2300 Kg/m <sup>3</sup>		2	SPT	19		338							16 35 37 11 (48)	
	brown		3	SPT	80		337							9 33 49 9 (58)	
	SAND & SILT TILL, SM-ML Moist, compact to very dense, with embedded gravel, trace clay to clayey.		4	SPT	100+		336							14 40 37 9 (46)	
	grey		5	SPT	100+		335							2 32 54 11 (65)	
334.33 5.18	End of borehole.		6	SPT	100+									Borehole dry and open @ completion.	

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/11/09

+ 3, × 3: Numbers refer to  
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No Cut 02

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940463, Easting - 209151 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 15.8.07 - 15.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			STANDARD 20 40 60 80 100	DYN. CONE 20 40 60 80 100					
339.46 0.00	Ground													
	150 mm TOPSOIL.													
			1	SPT	56									
	Bulk Sample MDD = 2130 Kg/m <sup>3</sup> W <sub>opt</sub> = 8.0% MWD = 2300 Kg/m <sup>3</sup>		2	SPT	62									11 38 43 8 (51)
	brown		3	SPT	100+									15 37 39 9 (48)
	SAND & SILT TILL, SM-ML Moist, very dense, with embedded gravel, trace clay.		4	SPT	100+									8 37 47 9 (56)
			5	SPT	100+									
			6	SPT	100+									
	grey		7	SPT	100+									
333.21 6.25	End of borehole.		8	SPT	100+									Auger and sampler refusal. Borehole dry and open @ completion.

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/11/09

+ 3, X 3: Numbers refer to  
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No Cut 03

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940511, Easting - 209137 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 15.8.07 - 15.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			STANDARD ● DYN. CONE	SHEAR STRENGTH kPa					
339.19 0.00	Ground							20 40 60 80 100	20 40 60 80 100					
	150 mm TOPSOIL.													
	Bulk Sample MDD = 1990 Kg/m <sup>3</sup> W <sub>act</sub> = 10.0% MWD = 2190 Kg/m <sup>3</sup>													
	SAND & SILT TILL, SM-ML Light brown, moist, compact to very dense, with embedded gravel, slightly plastic to clayey, occasional cobbles.													
			1	SPT	22		339							
			2	SPT	29		338							1 11 80 8 (88)
			3	SPT	90		337							
			4	SPT	64		336							13 32 43 12 (55)
			5	SPT	100+		335							6 31 56 6 (63)
			6	SPT	75		334							Water level measured @ 4.9 m @ completion.
			7	SPT	100+		333							9 28 52 11 (62)
			8	SPT	100+		332							
331.42 7.77	End of borehole.		9	SPT	100+									6 18 55 21 (75)
														Auger and Sampler Refusal.

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/11/09

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No Cut 04

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940524, Easting - 209181 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 15.8.07 - 15.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE											
								● QUICK TRIAXIAL	× LAB VANE											
338.45	Ground							20	40	60	80	100					GR SA SI CL			
0.00	150 mm TOPSOIL.																			
	Bulk Sample MDD = 2150 Kg/m <sup>3</sup> W <sub>opt</sub> = 8.0% MWD = 2322 Kg/m <sup>3</sup>		1	SPT	58												11 32 47 10 (57)			
			2	SPT	60												12 35 41 12 (53)			
			3	SPT	100+												7 36 48 10 (58)			
	Clayey SILT TILL, CL-ML Light brown to brown, moist, hard, with embedded sand and gravel, occasional silt alyers.		4	SPT	100+												15 35 38 12 (50)			
			5	SPT	100+												9 33 47 11 (58)			
			6	SPT	100+															
			7	SPT	100+												14 37 37 12 (49)			
332.20			8	SPT	100+												7 34 45 14 (59)			
6.25	End of borehole.																Auger and sampler refusal. Borehole dry and open @ completion.			

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/11/09

+ 3, X 3: Numbers refer to  
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

## 1 OF 1

METRIC

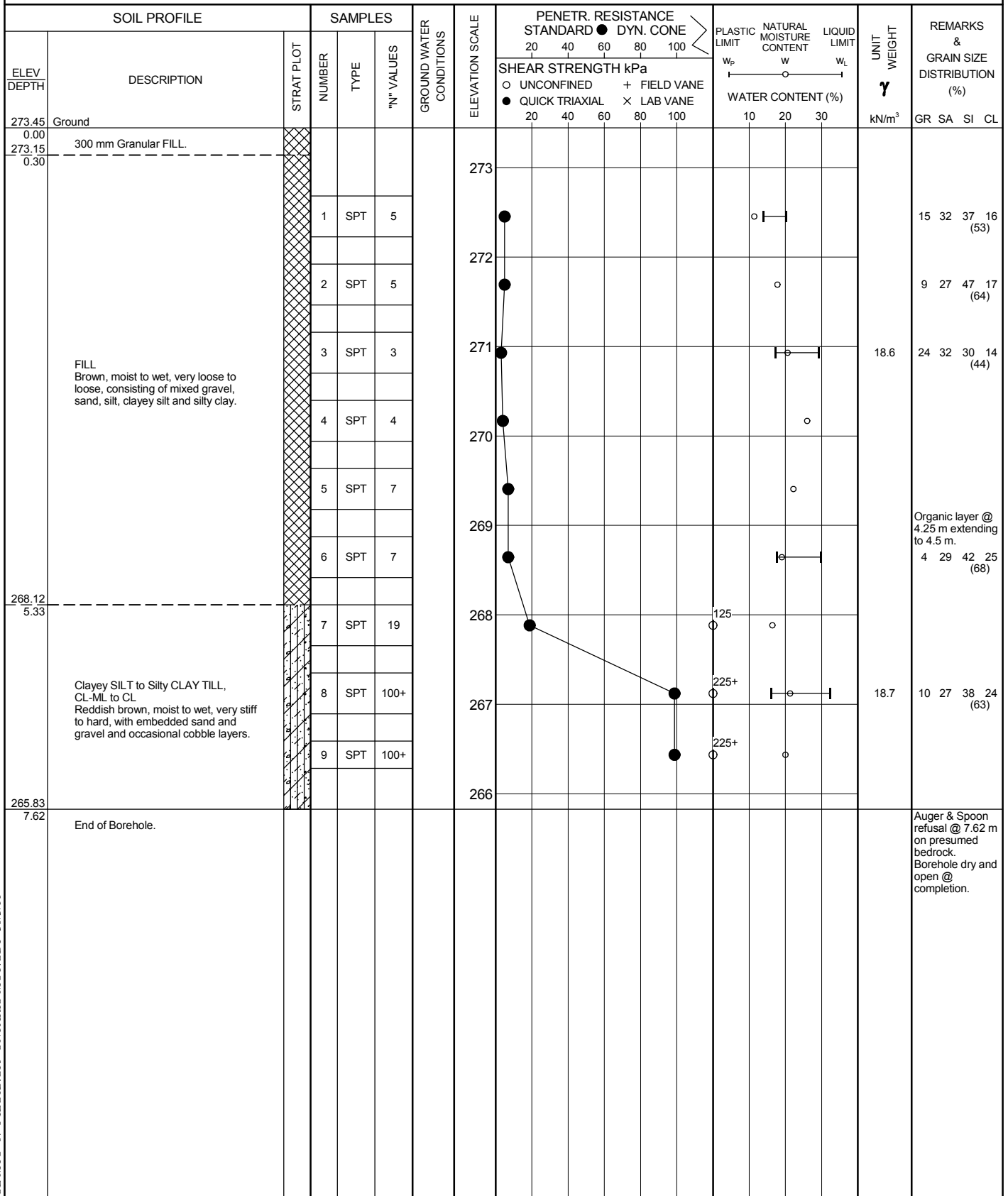
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						x LAB VANE		
266.93 0.00	Ground 150mm TOPSOIL																	
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, very stiff to hard, with embedded sand and gravel, silt seams pockets and layers, occasional cobble layers.		1	SPT	22													
			2	SPT	34													
			3	SPT	100+													
			4	SPT	57													
			5	SPT	95													
			6	SPT	98													
			7	SPT	95													
			8	SPT	100+													
260.53 6.40	End of Borehole.														Borehole dry and open @ completion.			

# RECORD OF BOREHOLE No 09B-2

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941073, Easting - 211229 ORIGINATED BY RB  
DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
DATUM Geodetic DATE 20.8.07 - 20.8.07 CHECKED BY JL



JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 30/3/10



# RECORD OF BOREHOLE No 09B-3

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941091, Easting - 211253 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 27.8.07 - 27.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			STANDARD 20 40 60 80 100	DYN. CONE 20 40 60 80 100					
272.65 0.00	Ground													
272.24 0.41	410 mm Granular FILL.													
	FILL Brown, moist, very loose to loose, consisting of mixed gravel, sand silt and clay.		1	SPT	4		272							
			2	SPT	8		271							9 30 41 20 (61)
270.06 2.59			3	SPT	17		270							4 22 40 34 (74)
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish Brown, moist, very stiff to hard, with embedded sand and gravel, occasional cobbles, and sandy layers.		4	SPT	32		269			225+			23.4	7 28 41 23 (65)
			5	SPT	27		268			225+			23.1	12 29 38 21 (59)
			6	SPT	28		267			225+				12 35 35 18 (53)
			7	SPT	24					225+				18 26 37 18 (55)
266.27 6.38	End of Borehole.		8	SPT	100+					225+				5 34 50 11 (61)
														Borehole dry and open @ completion.

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 30/3/10

+ 3, X 3: Numbers refer to  
Sensitivity

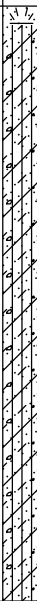
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No 09B-4

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941100, Easting - 211215 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	20 40 60 80 100	10 20 30							
268.55 0.00	Ground 150mm TOPSOIL.														
			1	SPT	23								22.2		
			2	SPT	34								19.8	2 27 56 14 (71)	
			3	SPT	90										
			4	SPT	100+									2 37 51 10 (61)	
			5	SPT	100+										
263.83 4.72	End of Borehole.		6	SPT	100+									Spoon and auger refusal @ 4.72 m. Borehole dry and open @ completion.	

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 30/3/10

+ 3, X 3: Numbers refer to  
Sensitivity

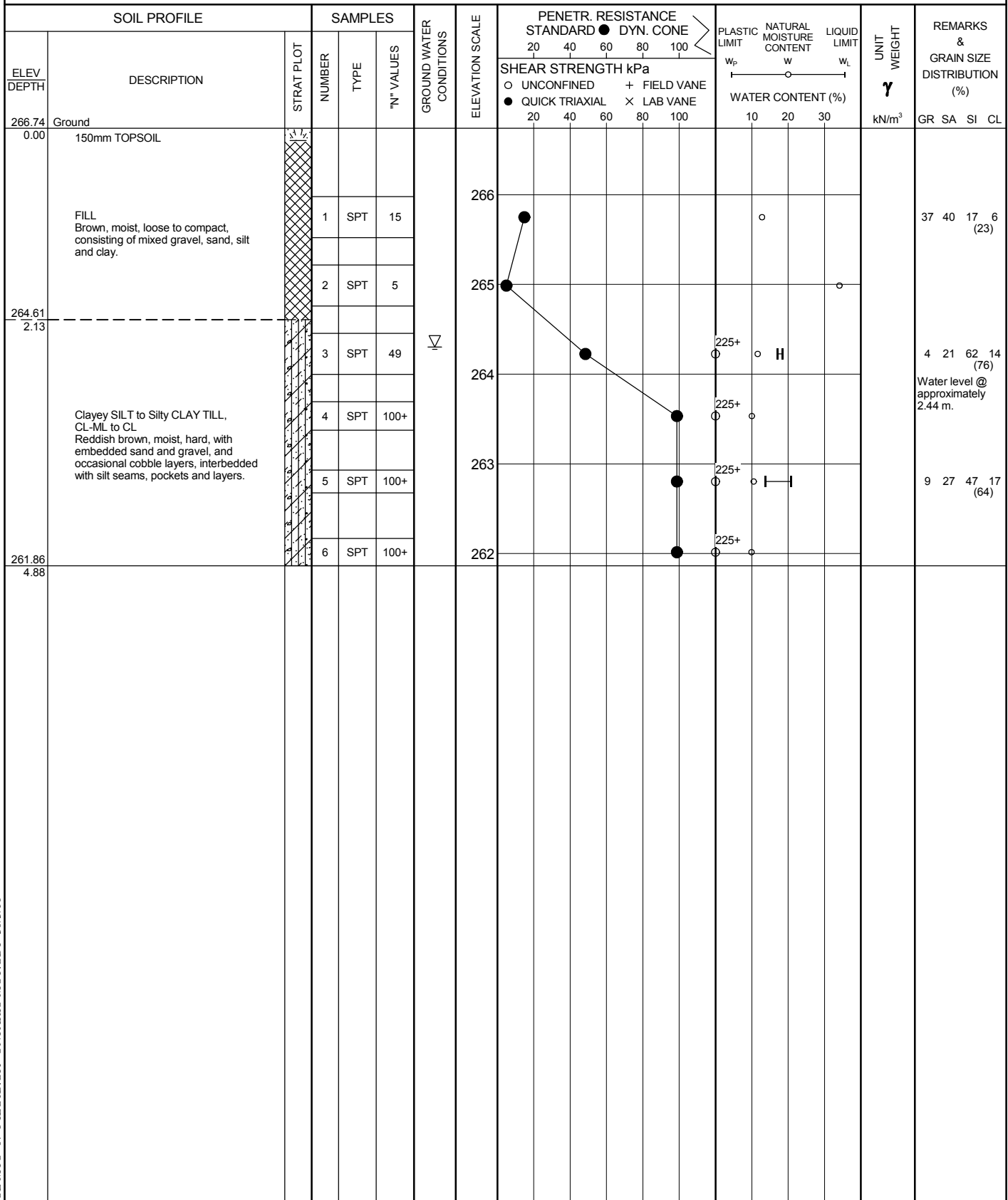
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No 09B-5

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941057, Easting - 211255 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL



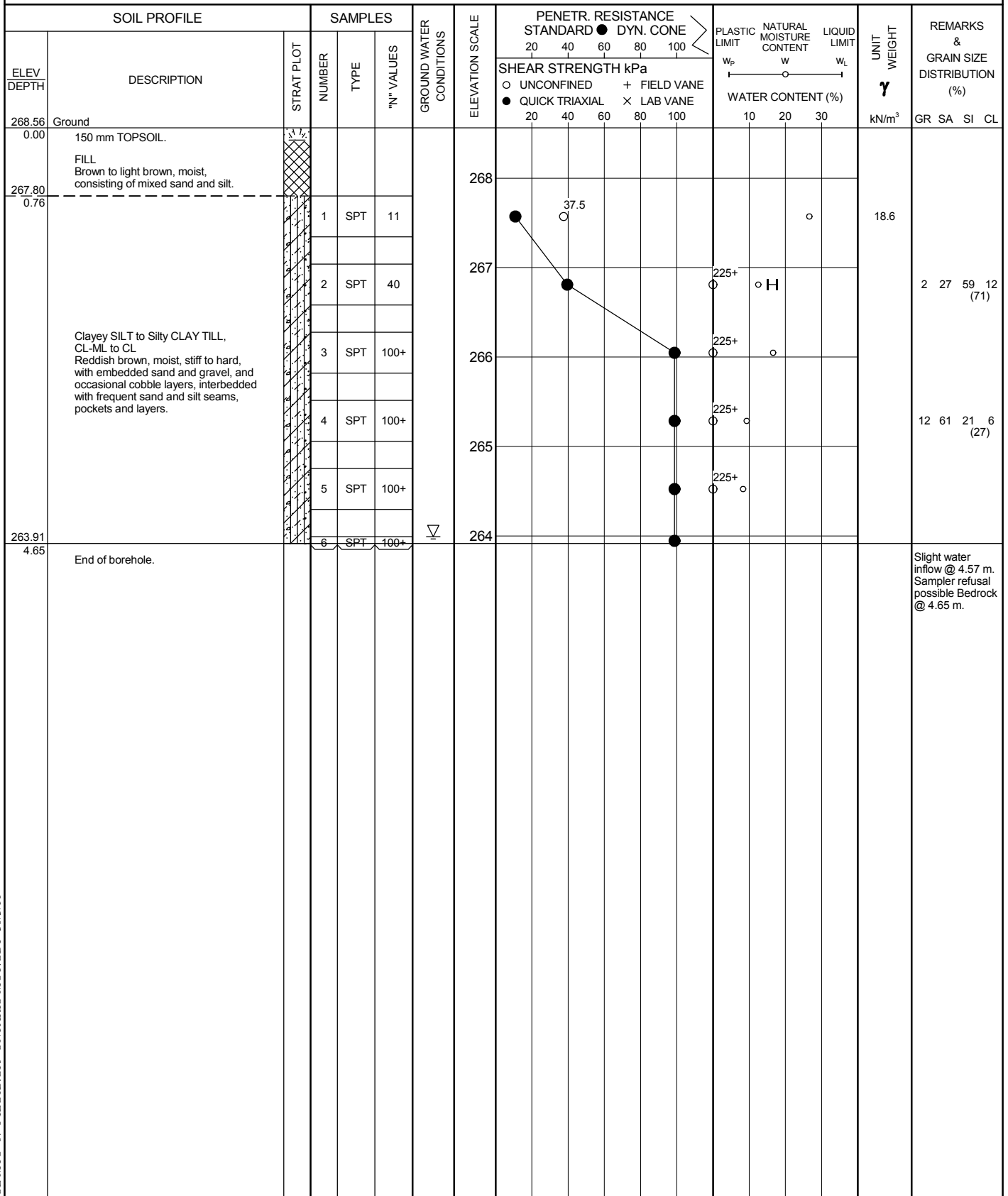
JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 30/3/10

# RECORD OF BOREHOLE No 09B-6

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941107, Easting - 211234 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL



+ 3, × 3: Numbers refer to  
Sensitivity

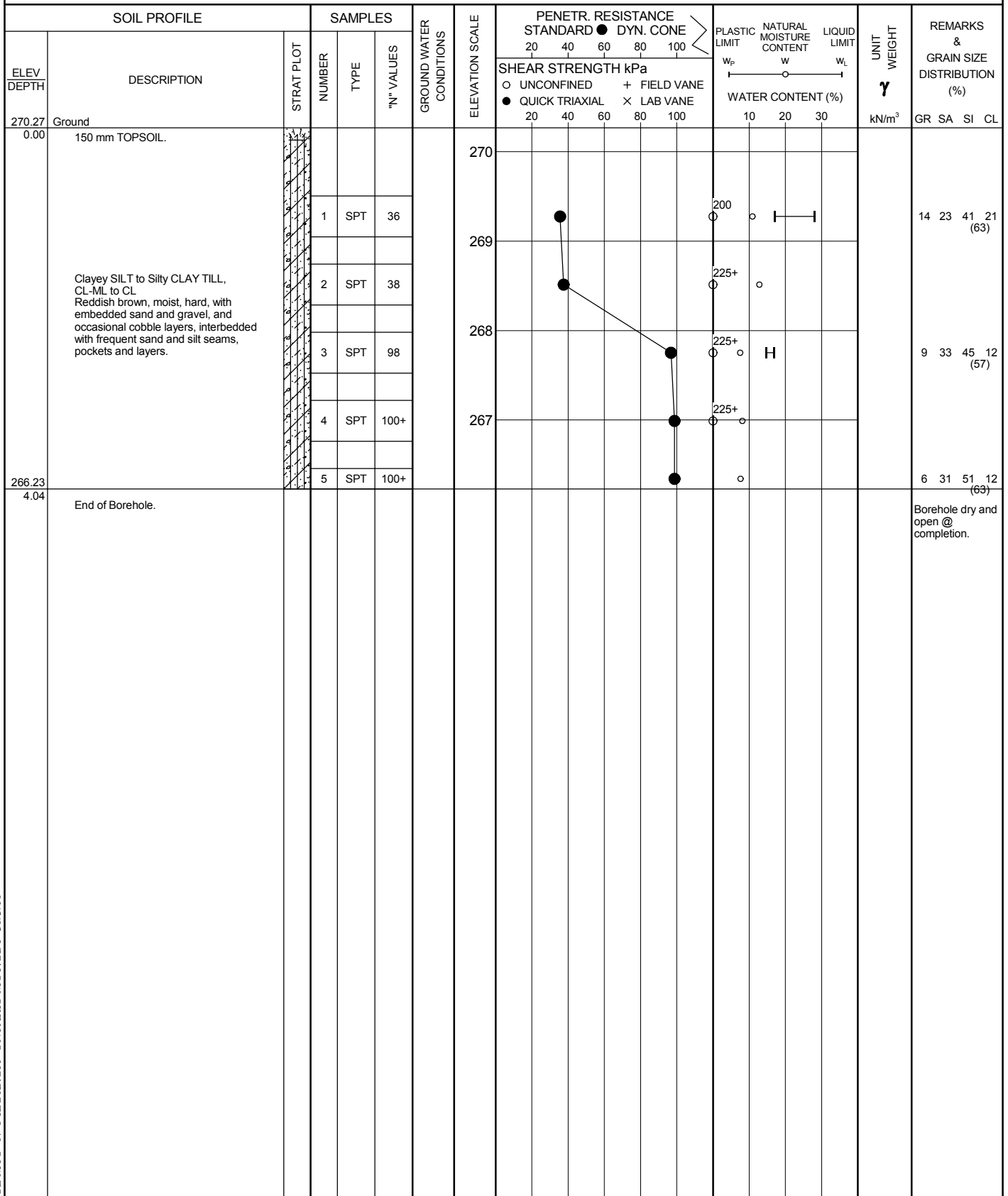
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No 09B-7

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941045, Easting - 211215 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL

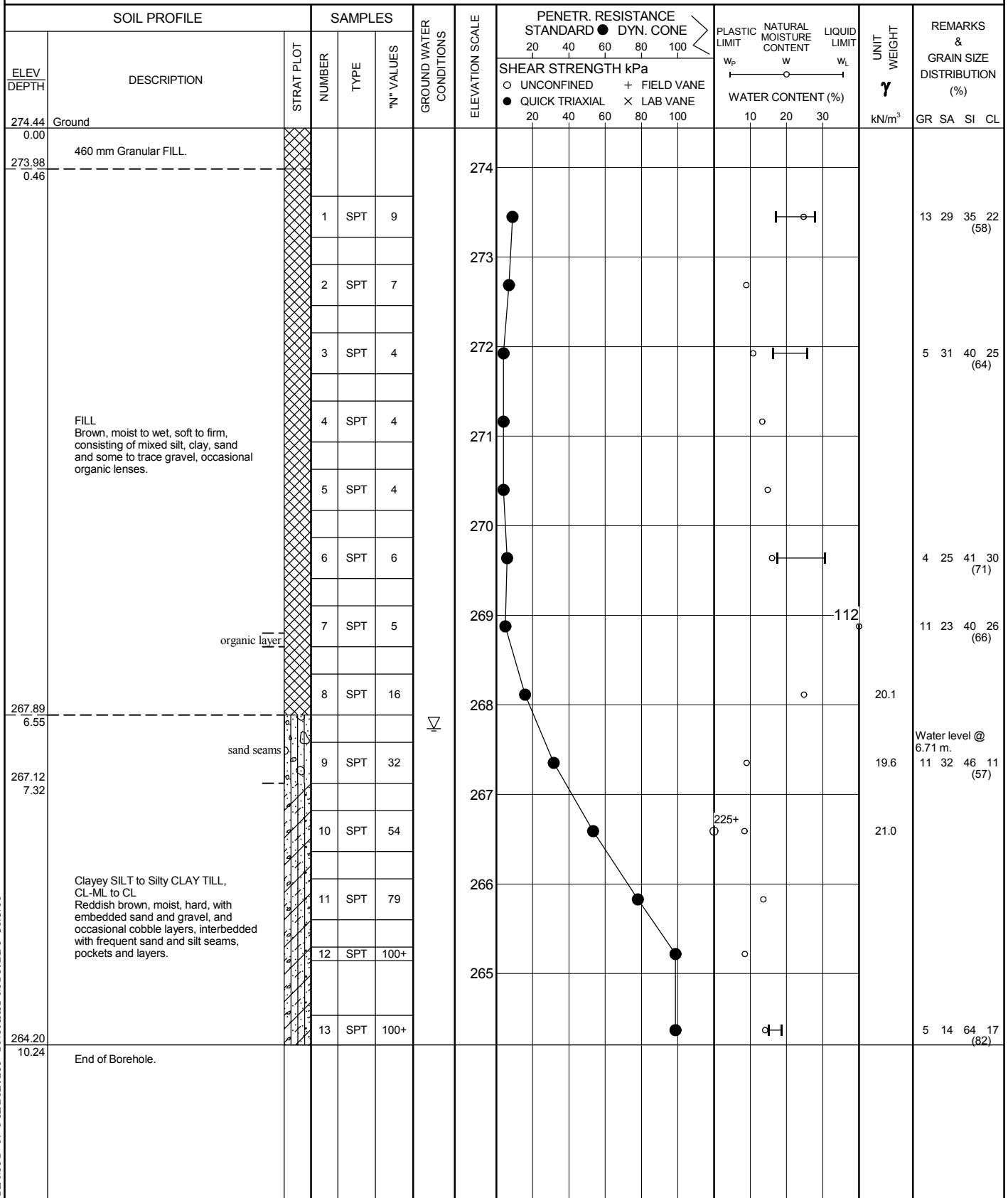


# RECORD OF BOREHOLE No 09B-8

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941077, Easting - 211205 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 27.8.07 - 27.8.07 CHECKED BY JL



JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 30/3/10

+ 3, X 3: Numbers refer to Sensitivity

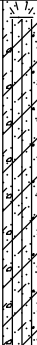
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No 09B-9

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941047, Easting - 211198 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
272.29 0.00	Ground							20 40 60 80 100								
	150 mm TOPSOIL.															
			1	SPT	14											
			2	SPT	26											
			3	SPT	32											
269.55 2.74	End of Borehole.															

+ 3, X 3: Numbers refer to  
Sensitivity

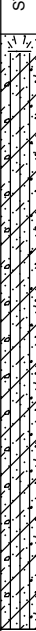
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

# RECORD OF BOREHOLE No 09B-10

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941093, Easting - 211191 ORIGINATED BY RB  
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN  
 DATUM Geodetic DATE 22.8.07 - 22.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	20 40 60 80 100	10 20 30							
269.82 0.00	Ground 150 mm TOPSOIL.														
			1	SPT	6		269							8 28 40 24 (64)	
			2	SPT	41		268								
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, firm to hard, with embedded sand and gravel, silt seams pockets and layers.		3	SPT	58		267								
	sandy silt layer		4	SPT	100+		266							11 33 48 8 (56)	
			5	SPT	100+										
265.10 4.72	End of Borehole.	6	SPT	100+									Minor seepage @ 4.57 m.		

JOE MTO 07-6-IEG1B.GPJ ONTARIO MOT.GDT 30/3/10

+ 3, x 3: Numbers refer to  
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

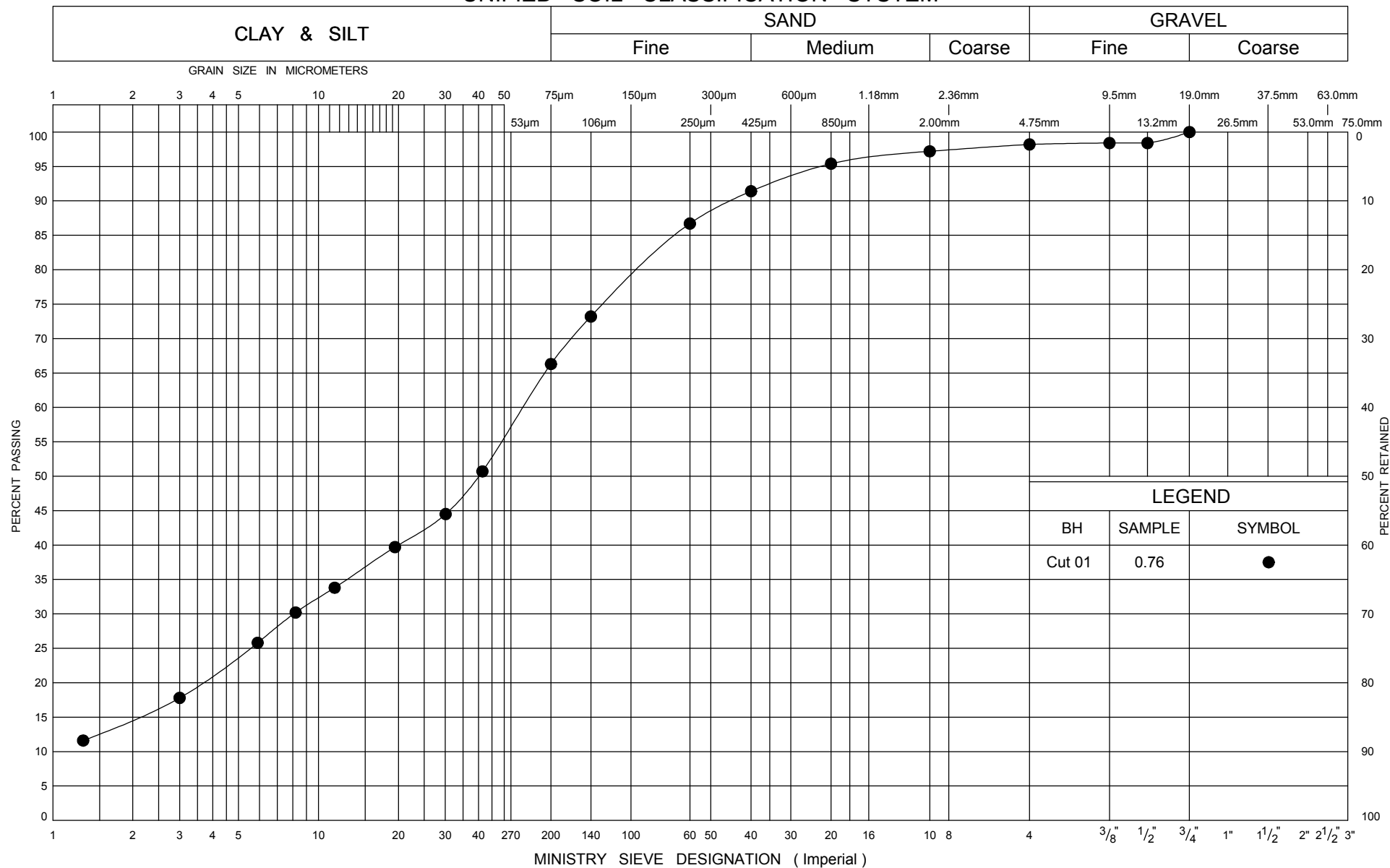


## Appendix B

### Laboratory Test Results

<b>Area</b>	<b>Grain Size Figure</b>	<b>Atterberg Limits Figure</b>
CUT	CUT.1, 3, 4, 6	CUT.2, 5, 7
FILL	FILL.1, 2, 4, 5, 8, 9	FILL.3, 6, 7, 10

## UNIFIED SOIL CLASSIFICATION SYSTEM



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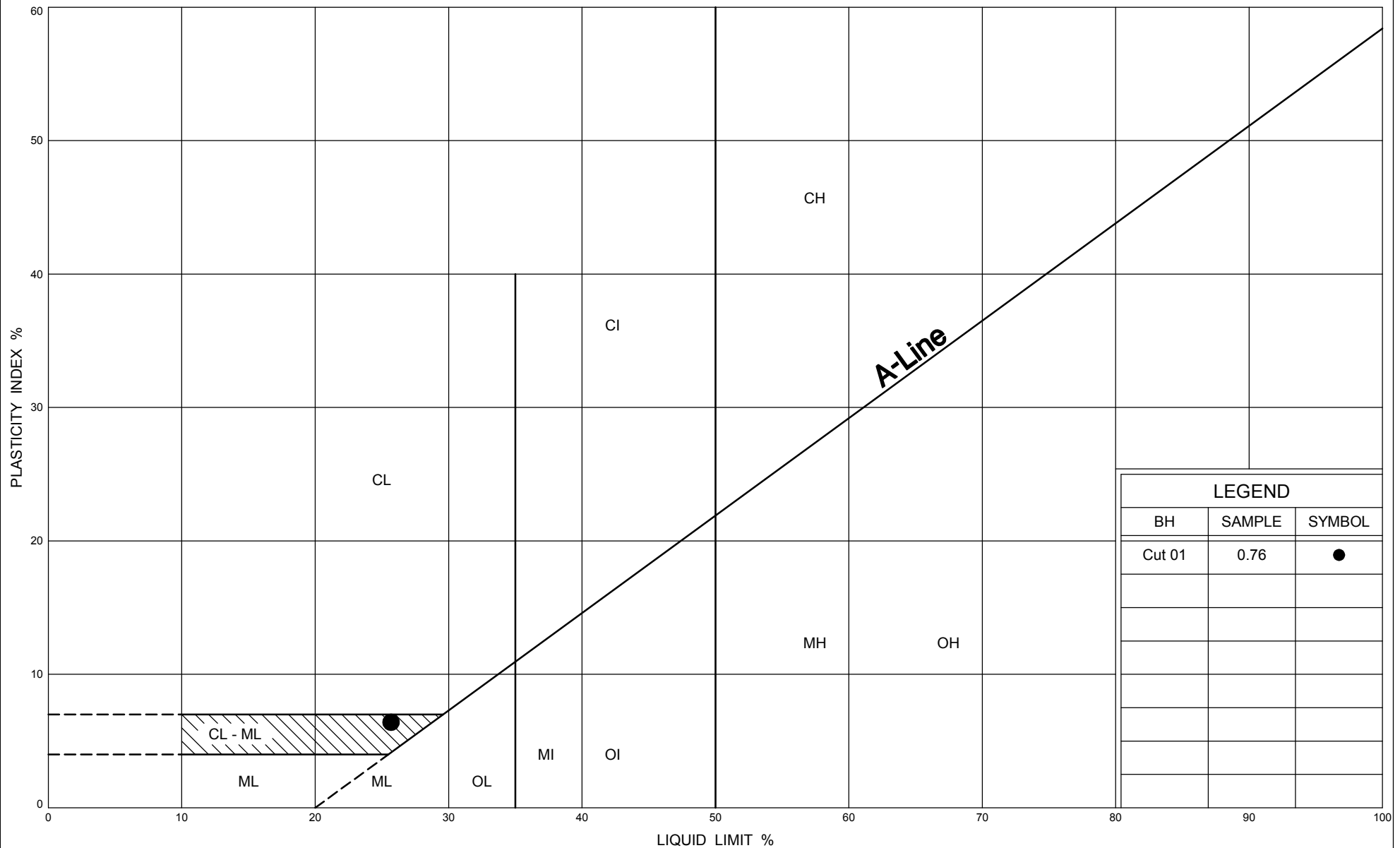
## GRAIN SIZE DISTRIBUTION

FILL

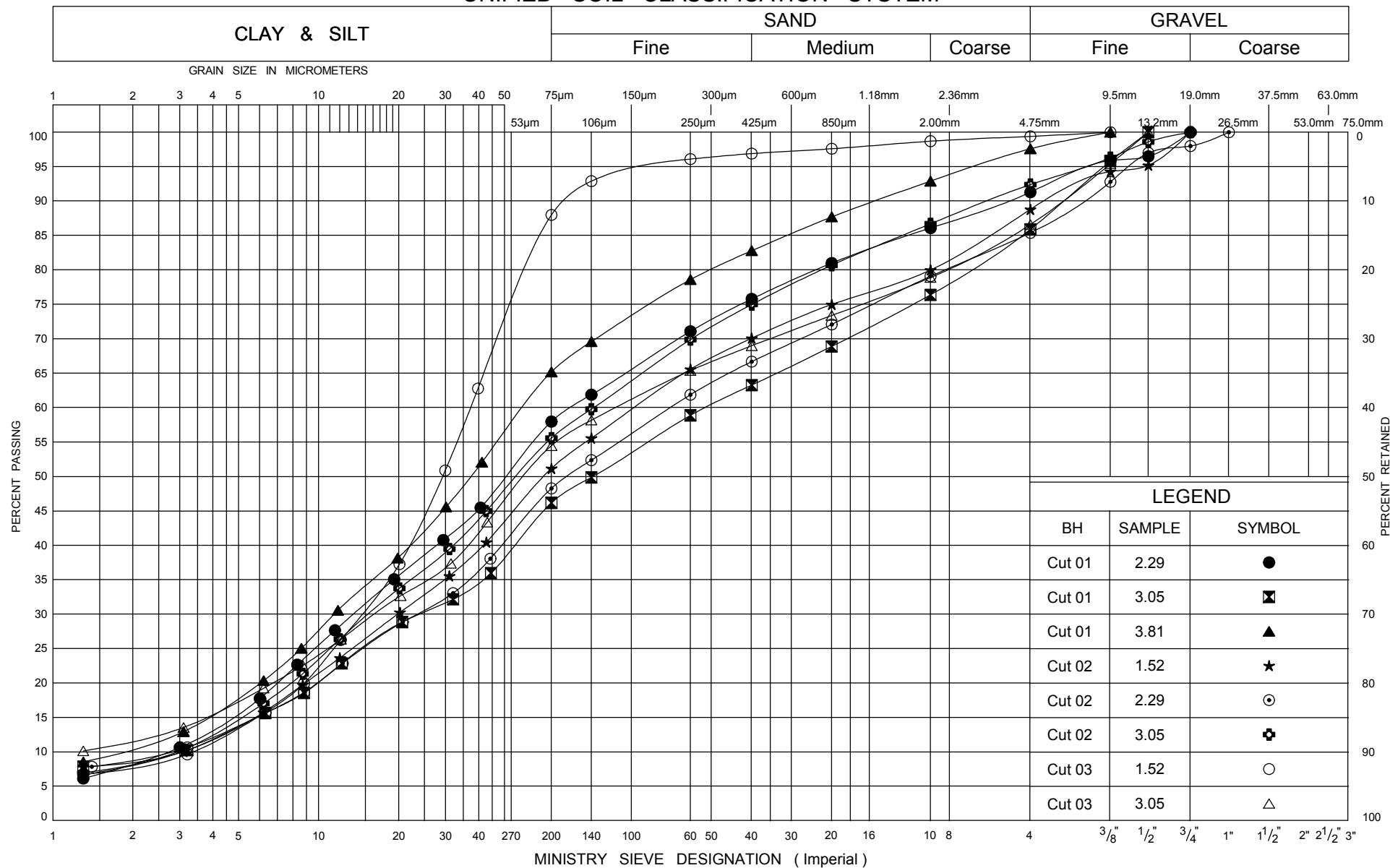
FIG No CUT.1

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Hwy 26 - Sydenham Townline to Meaford



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# GRAIN SIZE DISTRIBUTION

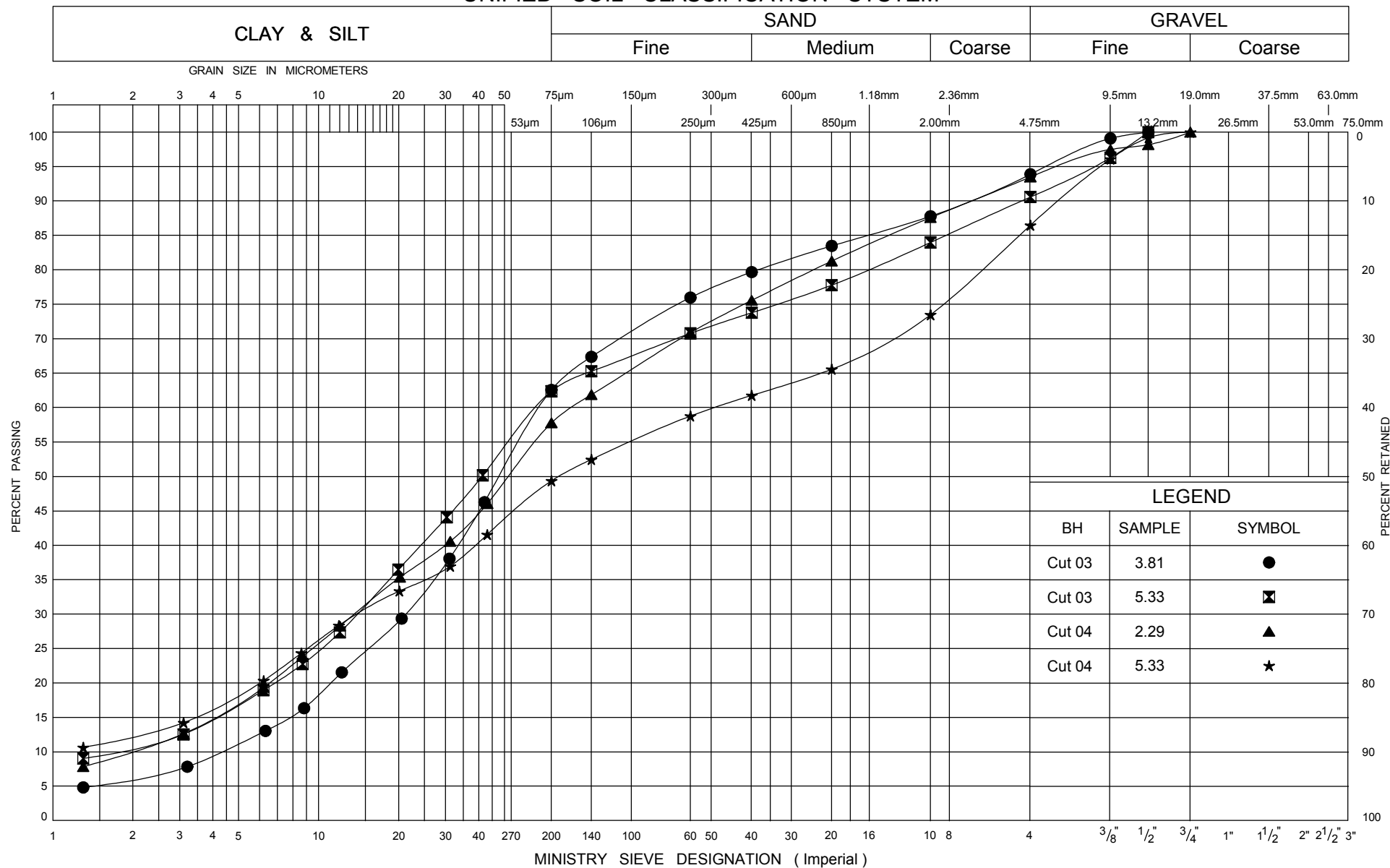
## SAND & SILT TILL & LAYERS, SM-ML

FIG No CUT.3

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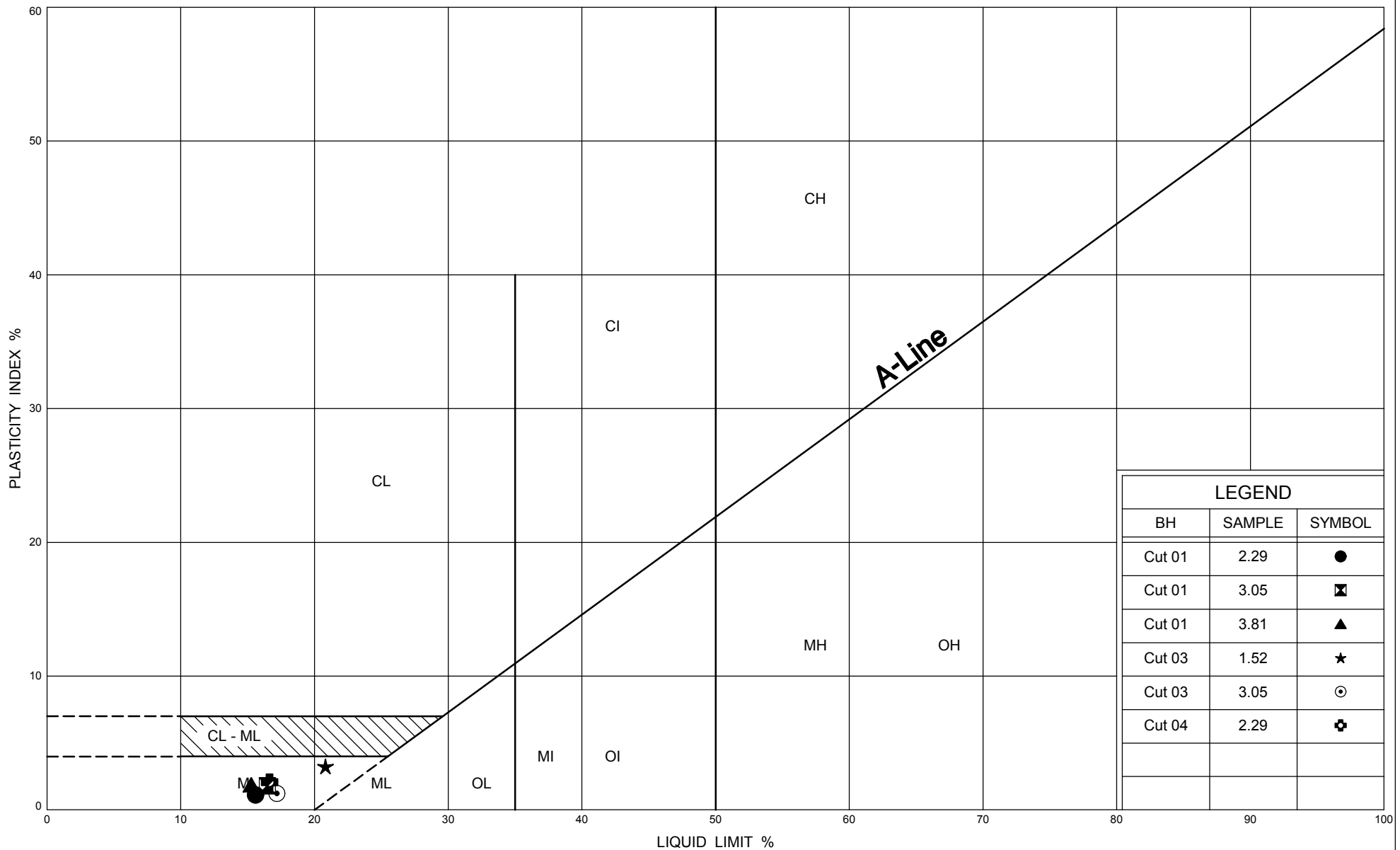
## GRAIN SIZE DISTRIBUTION

### SAND & SILT TILL AND LAYERS, SM-ML

FIG No CUT.4

GWP 167-91-00

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# PLASTICITY CHART

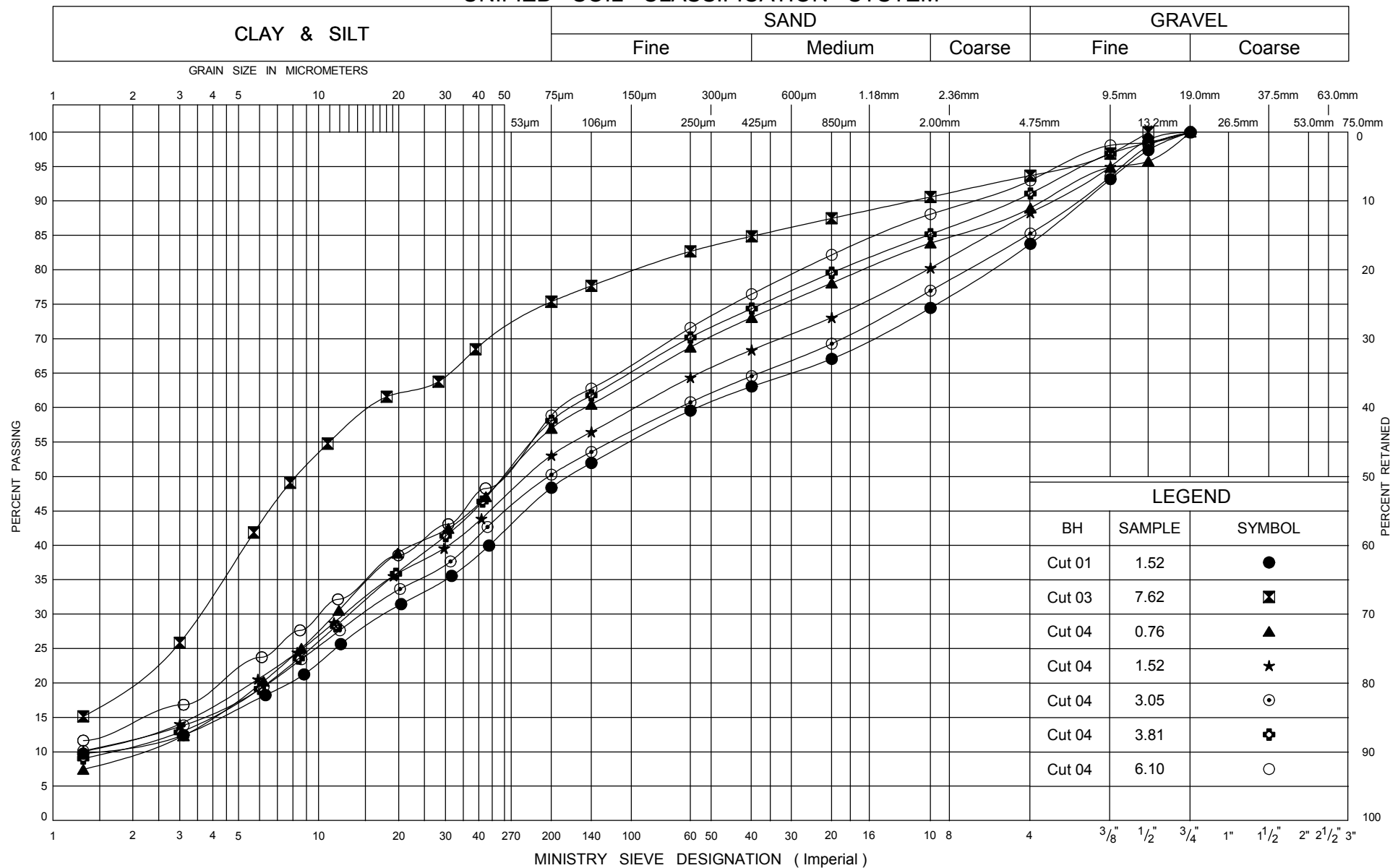
## SAND & SILT TILL & IAYERS SM-ML

FIG No CUT.5

GWP 167-91-00

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## UNIFIED SOIL CLASSIFICATION SYSTEM



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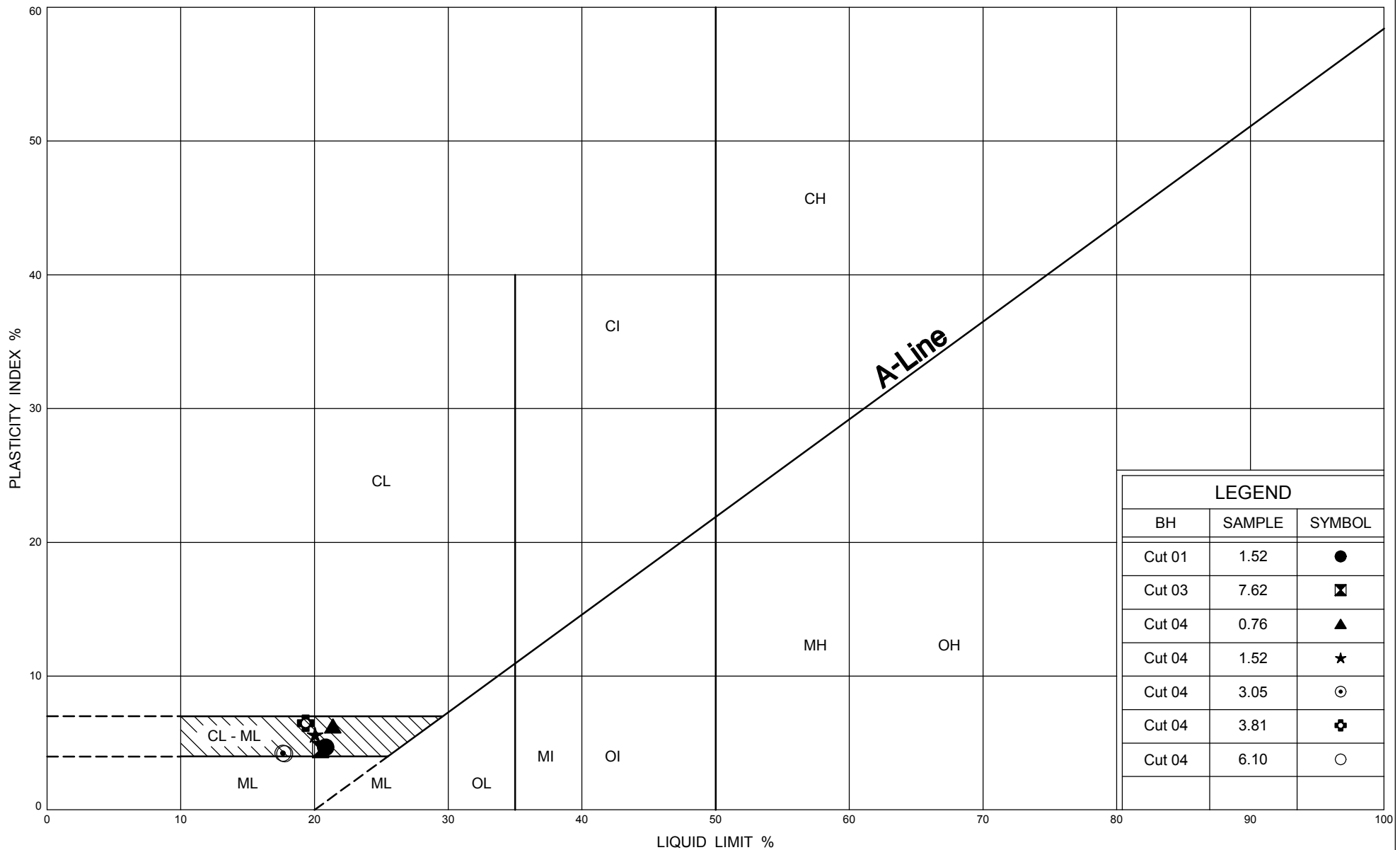
## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT TILL & LAYERS, CL-ML

FIG No CUT.6

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Hwy 26 - Sydenham Townline to Meaford



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# PLASTICITY CHART

## CLAYEY SILT TILL & LAYERS, CL-ML

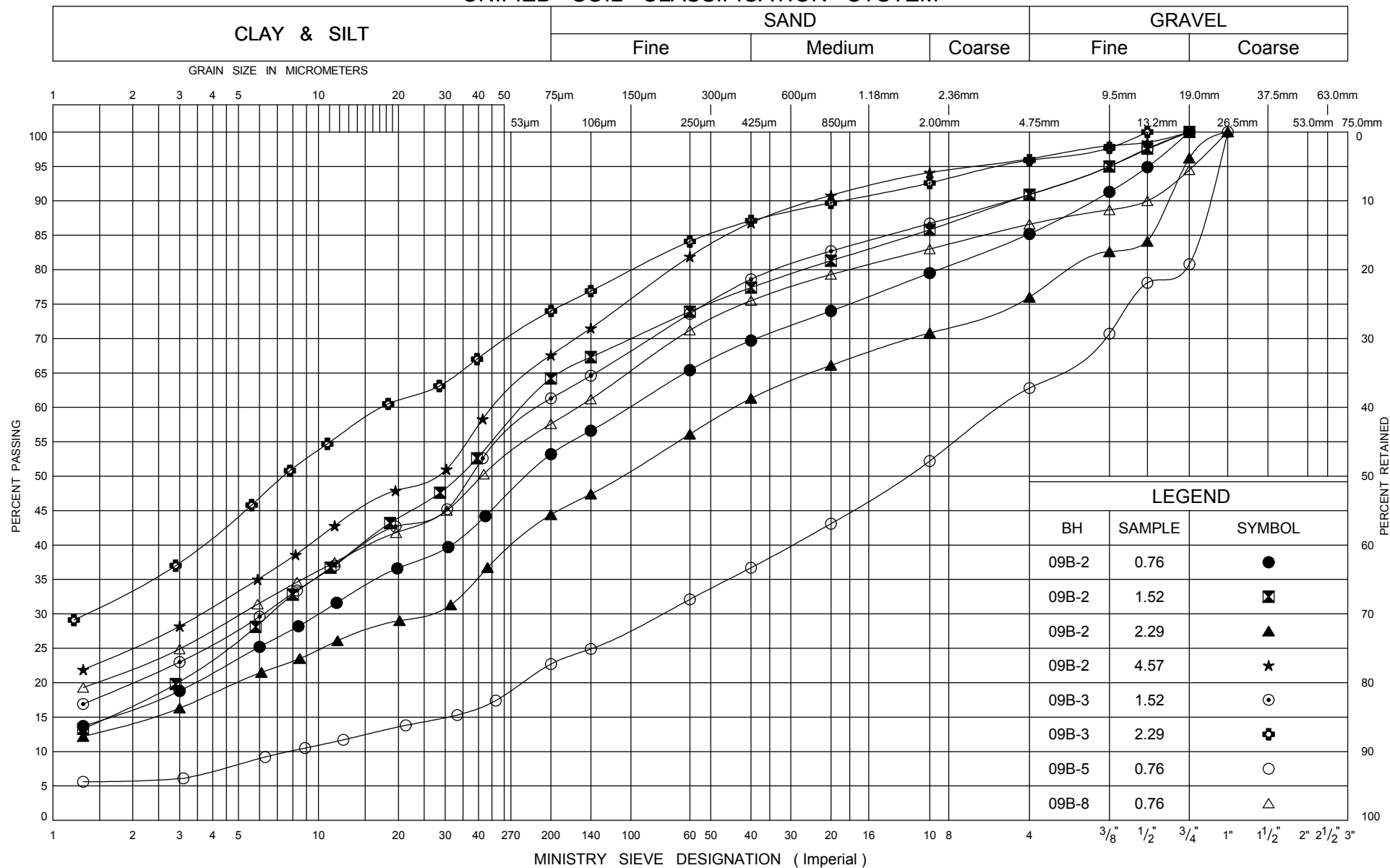
FIG No CUT.7

GWP 167-91-00

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## GRAIN SIZE DISTRIBUTION

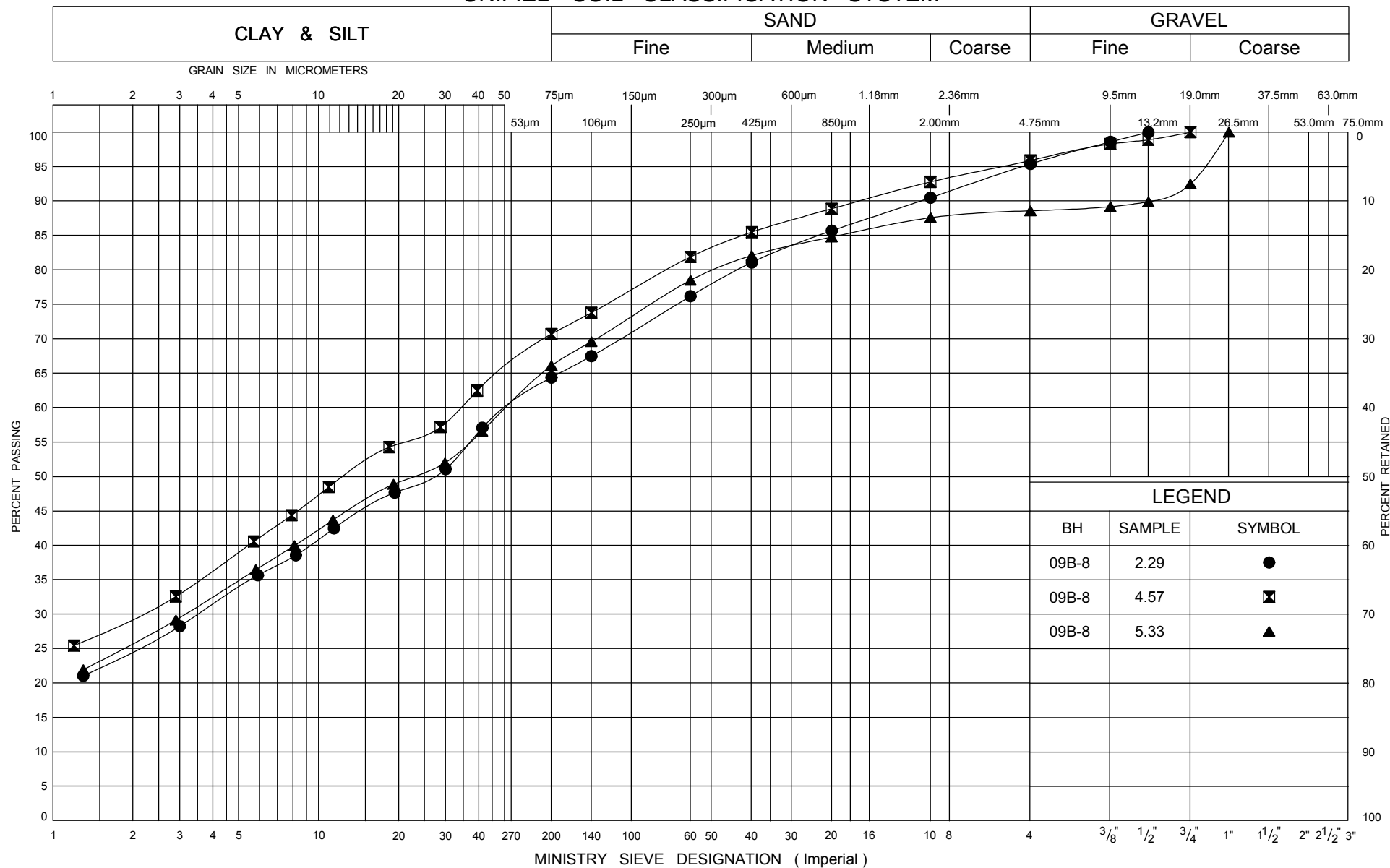
FILL

FIG No FILL.1

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

## UNIFIED SOIL CLASSIFICATION SYSTEM



## GRAIN SIZE DISTRIBUTION

FILL

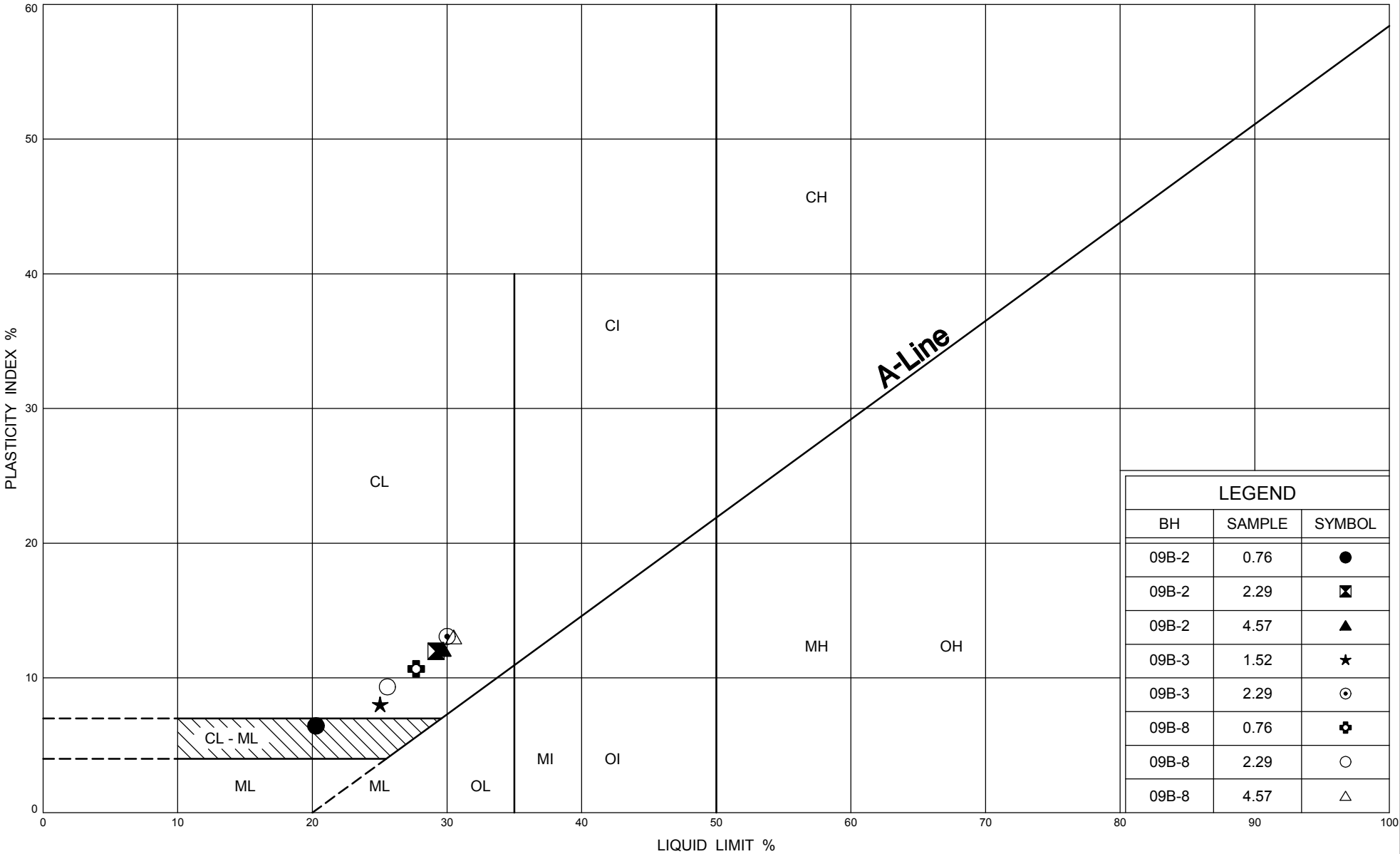
FIG No FILL.2

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford


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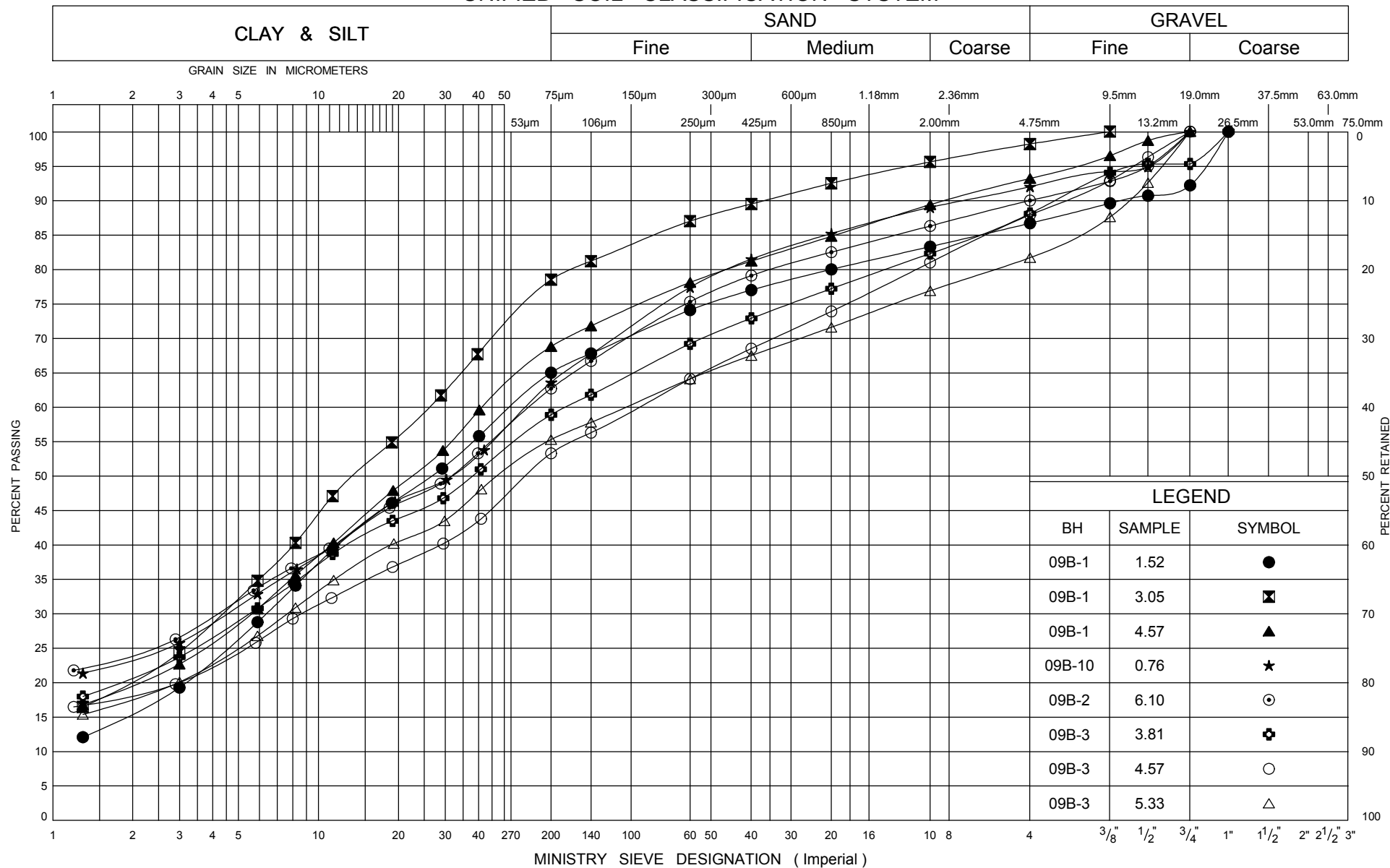
# PLASTICITY CHART FILL

FIG No FILL.3

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

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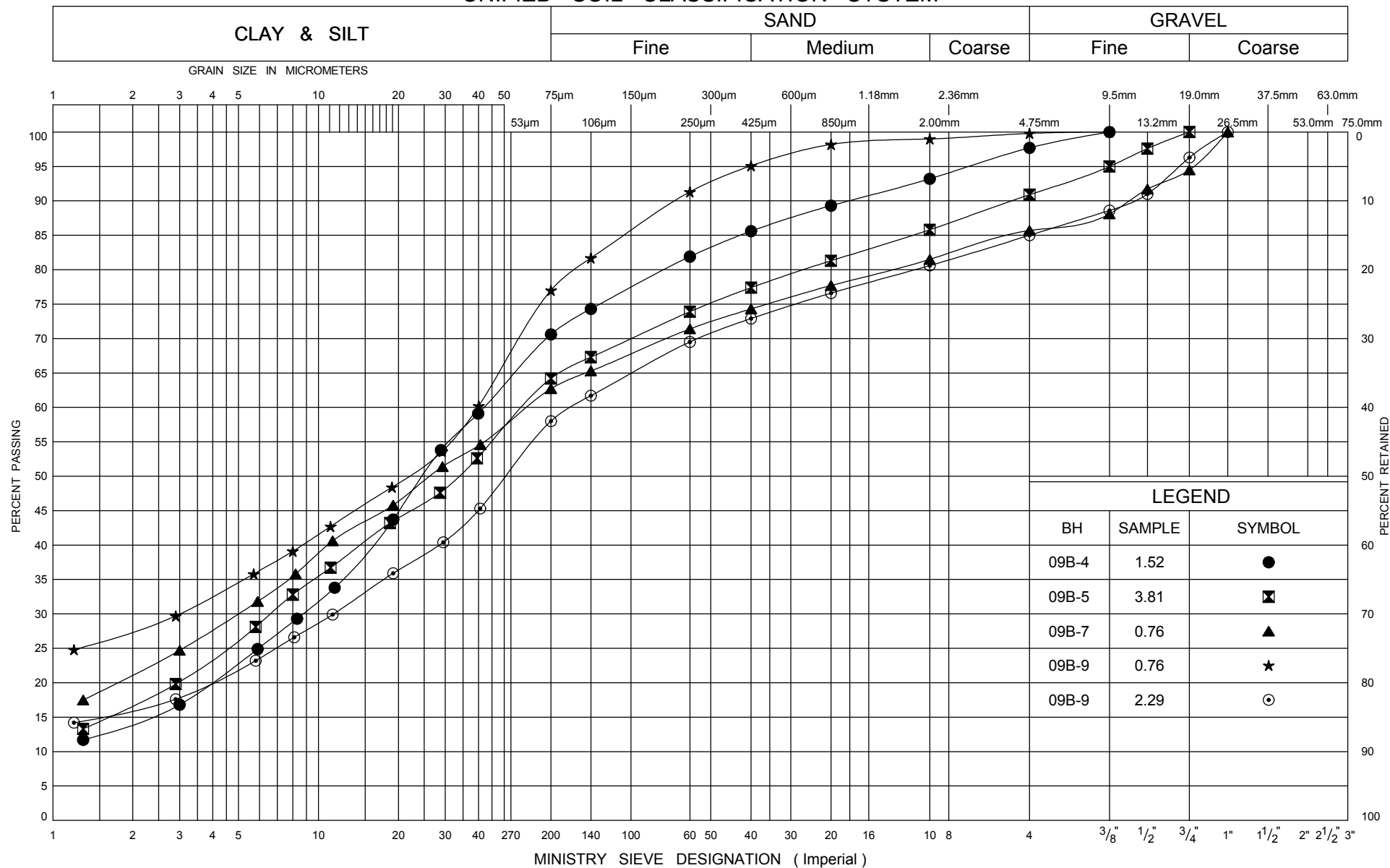
GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TO SILTY CLAY TILL, CL-ML TO CL

FIG No FILL.4

GWP 167-91-00

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## UNIFIED SOIL CLASSIFICATION SYSTEM



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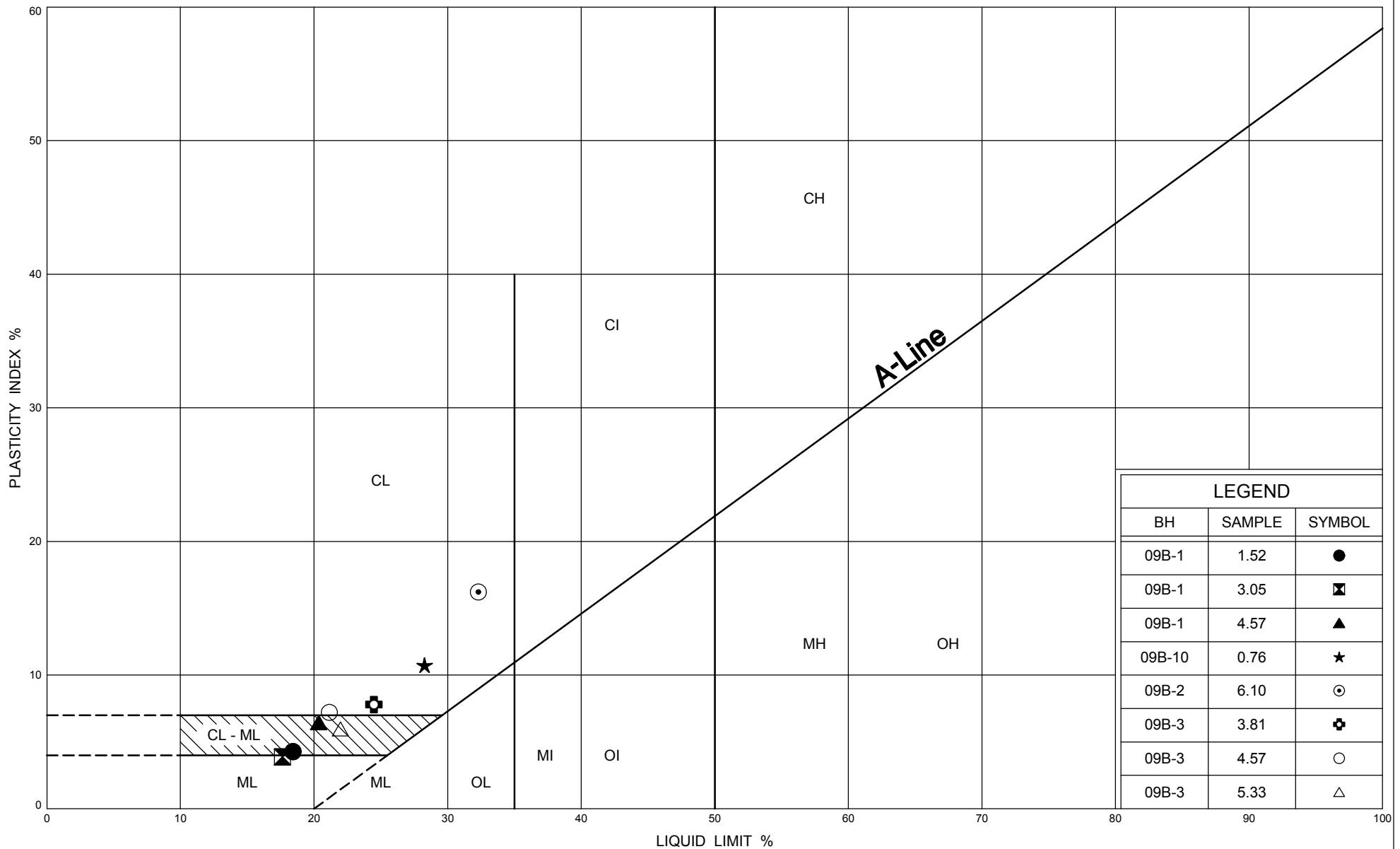
Ontario

GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TO SILTY CLAY TILL, CL-ML TO CL

FIG No FILL.5

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford



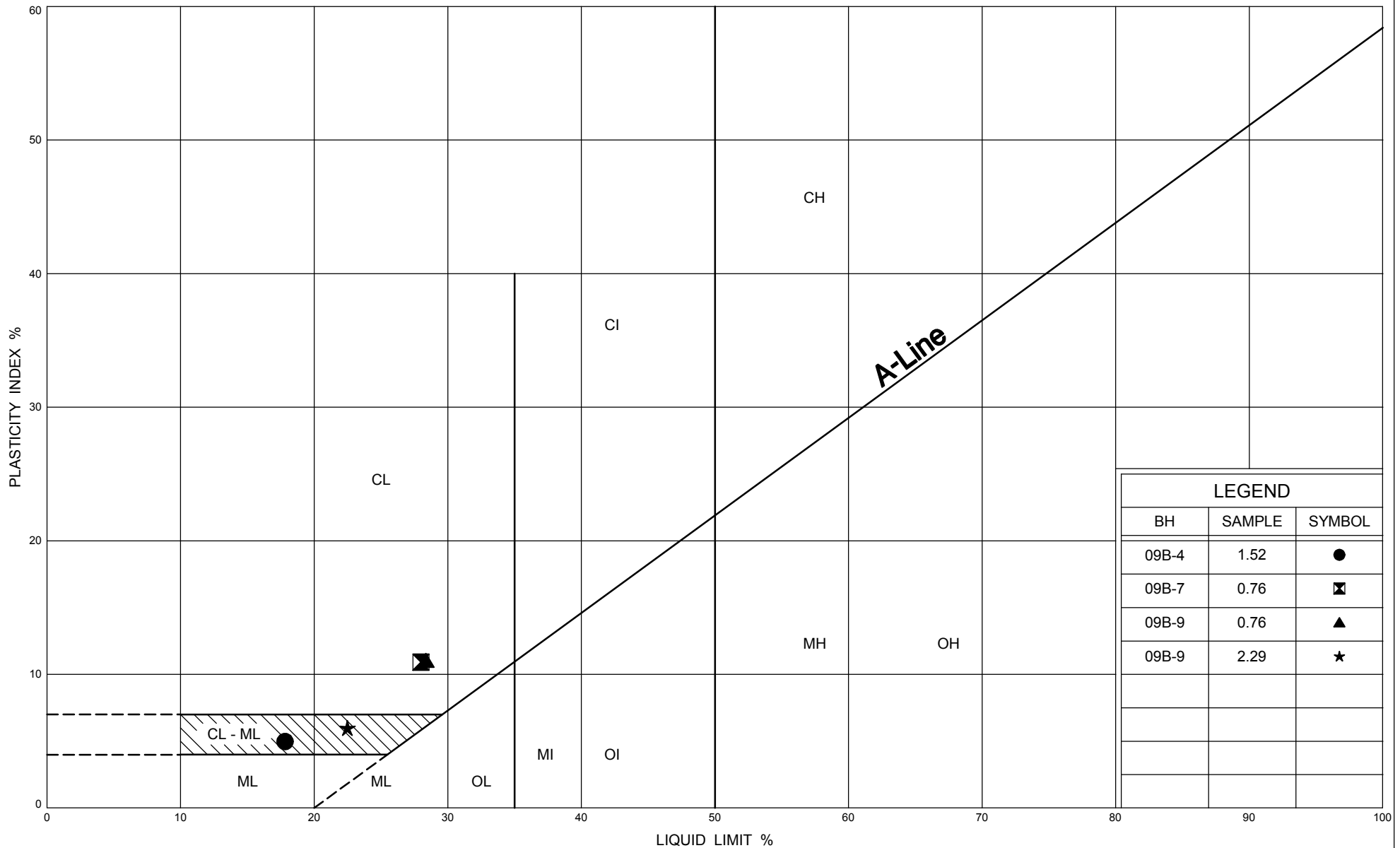
# PLASTICITY CHART

## CLAYEY SILT TO SILTY CLAY TILL, CL-ML TO CL

FIG No FILL.6

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## PLASTICITY CHART

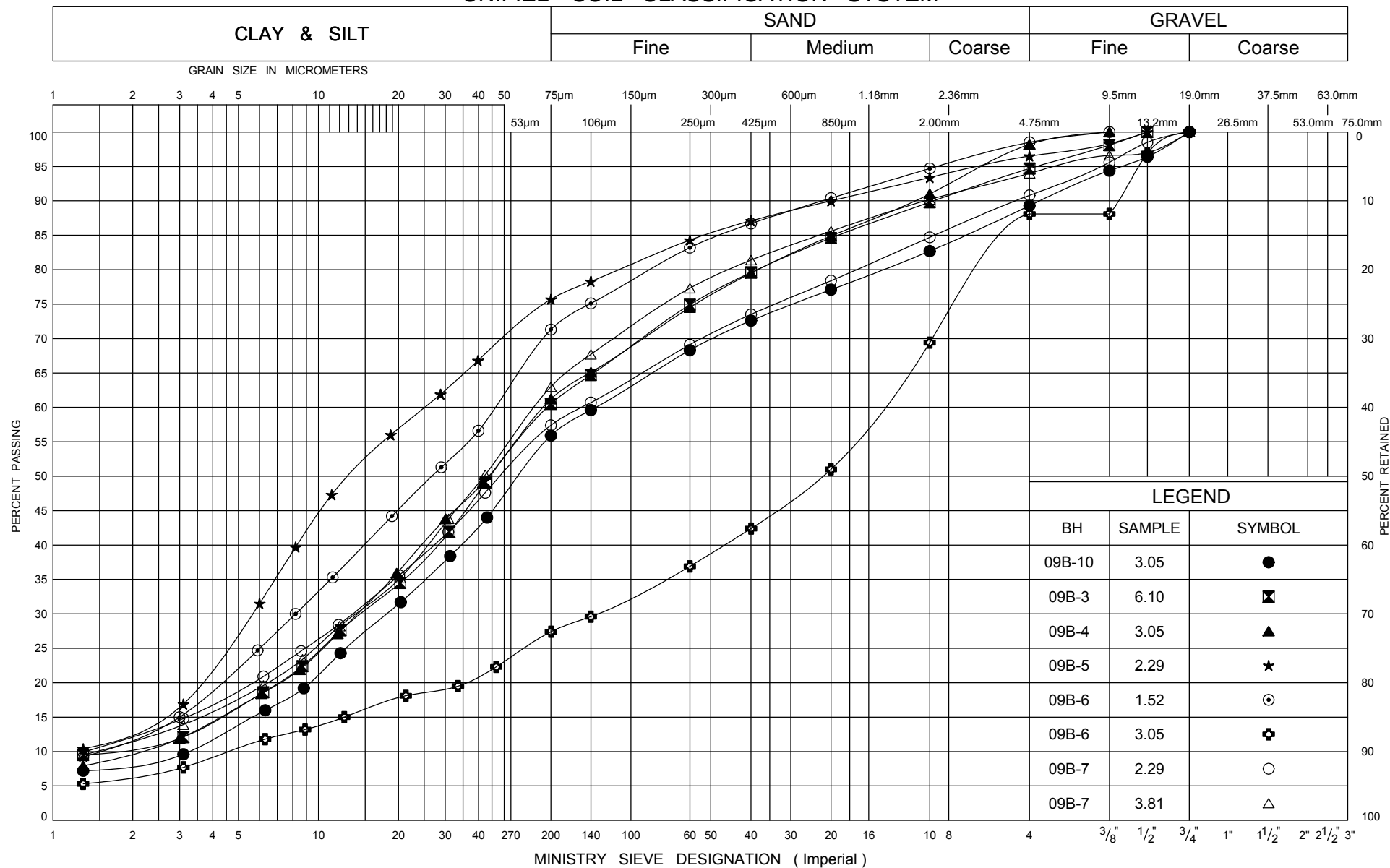
### CLAYEY SILT TO SILTY CLAY TILL, CL-ML TO CL

FIG No FILL.7

GWP 167-91-00

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## UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION**  
**SAND AND SILT SEAMS, LAYERS AND POCKETS, SM TO ML**

FIG No FILL.8

GWP 167-91-00

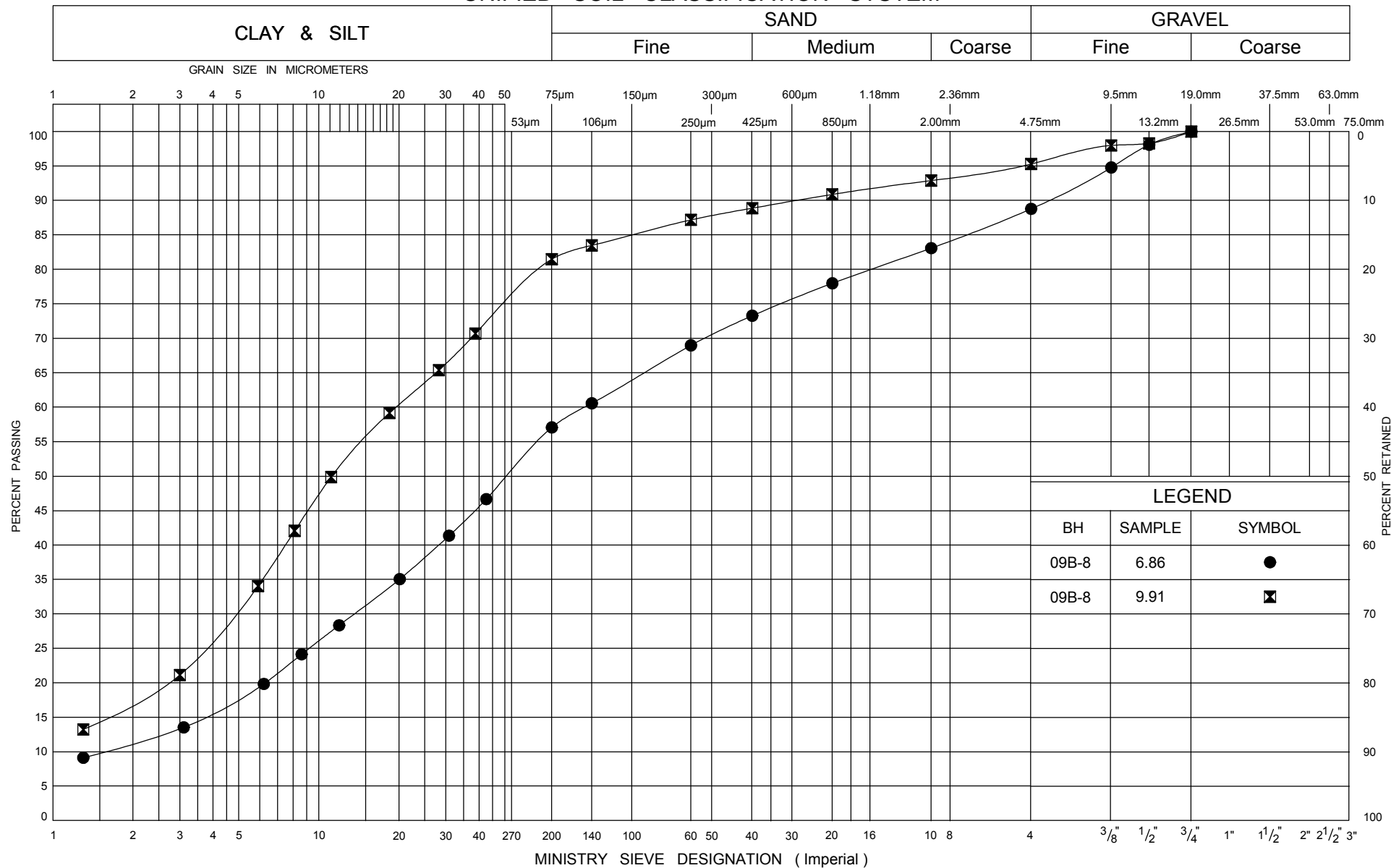
Hwy 26 - Sydenham Townline to Meaford



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## UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION**

**SAND AND SILT SEAMS, LAYERS AND POCKETS, SM TO ML**

FIG No FILL.9

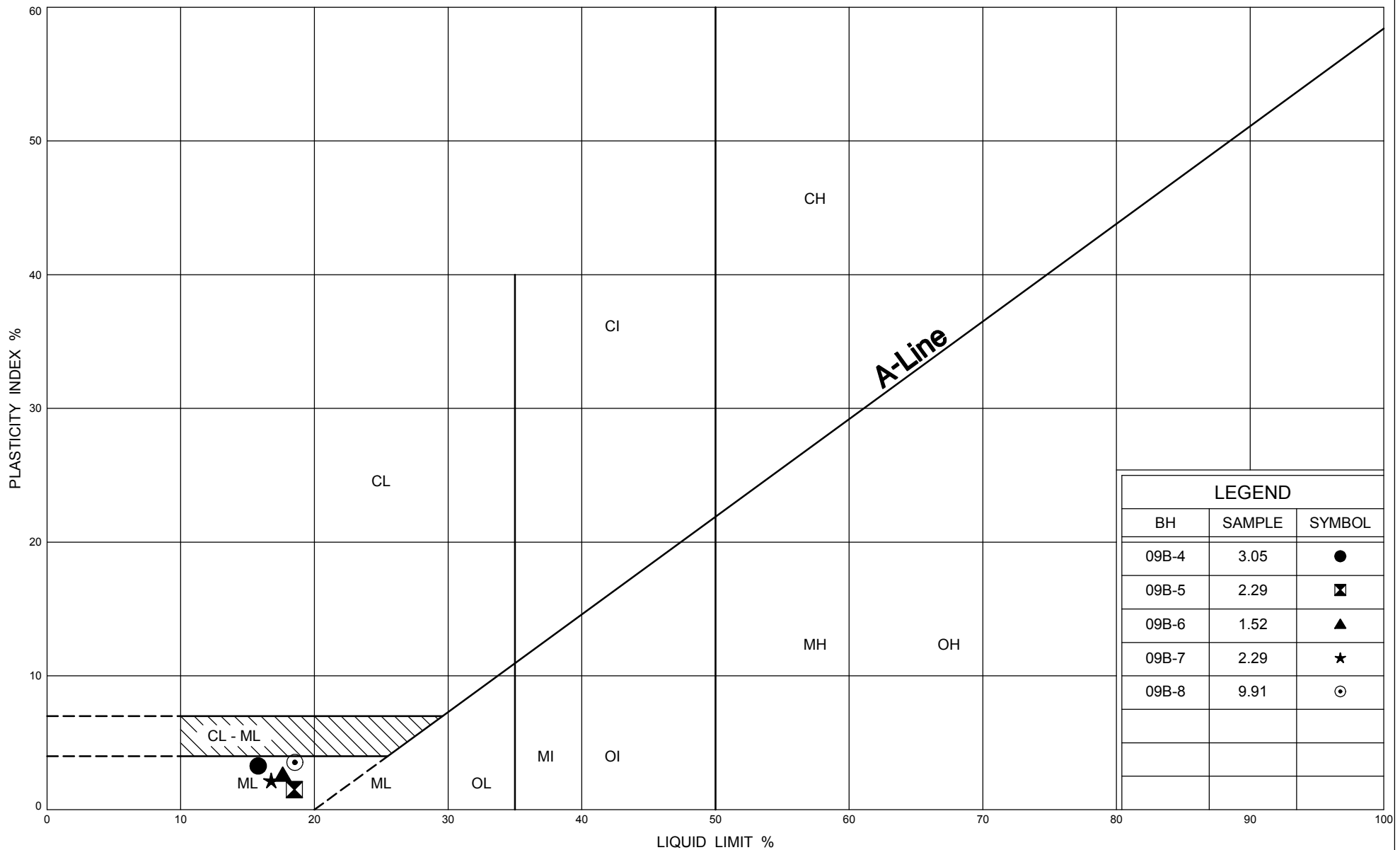
GWP 167-91-00

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PLASTICITY CHART  
SAND AND SILT SEAMS, LAYERS AND POCKETS, SM TO ML

FIG No FILL.10

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

Ministry of Transportation/Stantec Consulting Ltd.  
G.W.P. 167-91-00 - Rehabilitation of Highway 26  
From Former St. Vincent/Sydenham Townline to Meaford  
Agreement # 3006-E-0002

07-6-IEG-B-CUT AND FILL  
Final Report  
Appendix C  
May 17, 2010

## Appendix C

### Limitations of Report

## **APPENDIX C**

### **LIMITATIONS OF REPORT**

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Infrastructure Engineering Group Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, IEG recommends that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Ministry of Transportation/Stantec Consulting Ltd.  
G.W.P. 167-91-00 - Rehabilitation of Highway 26  
From Former St. Vincent/Sydenham Townline to Meaford  
Agreement # 3006-E-0002

07-6-IEG-B-CUT AND FILL  
Final Report  
Appendix D  
May 17, 2010

## Appendix D

### Site Photographs



Cut Area – South Embankment at West end of Swamp Section



Cut Area – North Embankment at West end of Swamp Section



High Fill Area - South Embankment



High Fill Area - North Embankment