FOUNDATION INVESTIGATION AND DESIGN 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

MTO GEOCRES No. 41A-215

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

Corporate Office
39-69 Bessemer Road
London, Ontario
N6E 2V6
tel: (519) 680-9991
fax: (519) 680-9993
email: info@lawengineering.com

FOUNDATION INVESTIGATION AND DESIGN 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

Prepared for:

Stantec Consulting Ltd.
49 Frederick Street
Kitchener, Ontario
N2H 6M7

Mr. Adam Barg, P.Eng.

Prepared by:

Infrastructure Engineering Group Inc.
39-69 Bessemer Road
London, Ontario
N6E 2V6

May 17, 2010
07-6-IEG1-B-CUT AND FILL

Distribution:

8	Copies -	Stantec Consulting Ltd.
2	Digital Copies -	Stantec Consulting Ltd.
3	Copies -	Infrastructure Engineering Group Inc.

Geocres No.: 41A-215

TABLE OF CONTENTS

Drawings & Appendices

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:

Borehole No.	Depth of Sampling (m)
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

Borehole No.	Depth of Sampling (m)
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 in 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, Kg/m^3)	1990	2150	2100
Maximum Wet Densities (MWD, 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^3, with an average of 19.4 kN/m^3.

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^3, with an average of 20.8 kN/m^3.

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
Liquid Limit (W_L)	18	32	22.9
Plastic Limit (W_P)	13	18	15.3
Plasticity Index (I_p)	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
Liquid Limit (W_L)	16	18	17.3
Plastic Limit (W_P)	13	17	15.0
Plasticity Index (I_p)	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.

PART B – FOUNDATION DESIGN

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of foundation design of the proposed deep cut and high fill in the St. Vincent Township, based on our interpretation of the factual information obtained during this investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

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 Plan, Drawings 1 and 3 presented in Appendix A.

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 left and right sides of Highway 26, in the vicinity of non-structural culvert C09B, with a fill height of between 5.5 and 7.1 m.

The embankment slopes of the high fill areas are typically 2.5H:1V to 3H:1V 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.

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 270.29 m on the north side.

5.2 Deep Cut Slope Design

Boreholes were put down within the cut area to determine the soils types and conditions. Standard Proctor tests were carried out on the various soils encountered for future reference and use during construction.

The soils encountered in the side-cut consist of compact to very dense sand and silt till to hard clayey silt till, with embedded gravel. Permeability of these till deposits is considered to be moderate to slow, and the estimated coefficient of permeability is in the order of between 10^{-5} cm/s and 10^{-7} cm/s. The soils encountered within the cut areas are considered moderately erodible. For design purposes, a K factor of 0.25 to 0.33 should be applied.

It is understood that a 2H:1V side slope is being contemplated and is considered to be globally stable in light of the compactness condition of the sand and silt till. However, this relatively steep side slope is susceptible to surficial creeping and slumping during the annual freeze-thaw cycles and this will result in high maintenance costs. Consequently, it is recommended that the cut slope be cut to 2.5H:1V.

5.3 High Fill Design

The proposed embankment widening will consist of generally 0.5 to 2 m of fill placed on top of the existing embankment and a fill height of between 5.5 and 7.1 m placed on the north and south sides of the existing embankment after stripping of the topsoil and unsuitable materials.

The profiles provided by Stantec indicate that it is proposed to construct the embankment widening with a design slope of 2H:1V. However, this relatively steep side slope is susceptible to surficial creeping and slumping during the annual freeze-thaw cycles and this will result in high maintenance costs. Consequently, it is recommended that an embankment side slope of 2.5H:1V be used.

There are no global slope stability issues provided that the high fill is founded on the native stiff to hard clayey silt to silty clay till. Localized firm clayey silt to silty clay till, where exposed at the subgrade, will have to be sub-excavated to expose the stiff to hard clayey silt to silty clay till for construction of the high fill.

5.4 Embankment Widening

The existing approach embankments are up to 7.1 m high. For the widening of the embankment, the surficial topsoil and any deleterious materials should be stripped or excavated prior to placing fill materials. The embankment widening should then be constructed as per OPSD 202.010, 202.030 and 208.010, with emphasis on adequate benching of the subgrade for receiving the embankment fill. The fill to be used for embankment construction can either be imported silty clay, sand and silt, or granular materials. Granular materials are preferred over silty clay or sand and silt for compaction and drainage.

Based on the findings of the field investigation, no foundation stability or settlement problems due to widening the on the native stiff to hard clayey silt to silty clay soils are anticipated for embankment slope of 2.5H:1V and up to 7.1 m high. The fill placement should begin at the toe of the embankment, in leveled lifts and each lift compacted to at least 98% of the materials' standard Proctor maximum dry densities (SPMDDs). Benching into the existing embankment slope at 1 m high steps is recommended as per OPSD 208.010.

After stripping, the exposed subgrade should be inspected and approved by the geotechnical engineer. The approved subgrade should then be proof-rolled using a heavy compactor, as directed by the engineer. Unless the excavation is carried out in wet weather conditions, no unusual dewatering is anticipated during stripping and preparation of the subgrade to receive the embankment fills. Where necessary, dewatering can be carried out using gravity drainage and pumping from open filtered sumps in accordance with OPSS 517 with emphasis on the requirements of OPSS 518.

Measures should be incorporated into the design and staging to ensure that the slope surfaces are protected from surface erosion in accordance with the requirements of OPSS 577. Proper erosion control measures should be implemented both during construction of the embankment fills and permanently. Sediment control during construction should be carried out by installing silt fences. Properly designed erosion control blankets could also be placed on newly cut slope, new embankments and adjacent disturbed embankments after completion of fill placement. A vegetative cover should be established as soon as practical upon completion of fill placement to minimize the chances of surface erosion.

Revetments such as rip-rap blanket may be required at the toe of the slope to line the side ditch invert due to potential erosion. The permissible velocity of the clayey silt to silty clay till is 1.8 m/s. The permissible velocity of the sand and silt till is 1.2 m/s. The design of the rip-rap blanket should be carried out cognizant of the surface water flow velocity in the side ditch.

Although groundwater was encountered locally in Borehole Cut 01 below the base of the proposed cut slope, concentrated seepage zones could potentially be encountered or exposed at the cut slope surface. Where these concentrated seepage zones are encountered, blanket drains should be employed to drain and prevent slumping of the slope surface. A schematic design of blanket drain is provided in Drawing 5.

5.5 Excavation, Groundwater Control and Temporary Support

Excavation for this project will involve general stripping and grubbing, and the removal of the 2.13 m of fill material at Borehole 09B-5 below the existing side ditch.

Excavation to depths of up to 3 m should not present any special difficulties using heavy excavation equipment, provided it is constructed in accordance with OPSS 501, 514, 517, 518, 539, 577 and, 902, SSP421S01, SSP422S01, and OPSD 803.010 and 3121.150. However, the buried utilities along the embankment will likely be in conflict with the excavation. Excavation

and protection procedures shall conform to SSP 105S19 and should be reviewed with the utility companies or authorities prior to construction.

Unstable subgrade condition may result from wet weather. The procedures for additional excavation and bedding material are covered in OPSS 421, 422 and 514, SSP421S01 and SSP422S01.

All excavation must be carried out in compliance with the requirements of the Occupational Health and Safety Act (OHSA). For this purpose, the unsaturated upper loose to compact fill soils encountered at this site are classified as Type 3 soils. The very stiff to hard clayey silt to silty clay till and the compact to very dense sand and silt till are classified as Type 2 soils. Saturated cohesionless soils are classified as Type 4 soils.

For the Type 2 soils, the excavation shall be cut to near vertical in the bottom 1.2 m and then trimmed back to 1H:1V. Within the Type 3 soils and above the water table, the excavation shall be cut to no steeper than 1H:1V throughout. Side slopes of 3H:1V or flatter shall be used for excavation within Type 4 soils.

The embankment widening will be carried out in conjunction with replacement of non-structural culvert 09B. Temporary support within the overfill of the existing and new culverts may be required to facilitate culvert construction and to maintain access for construction and local traffic, and emergency vehicles.

The staging of different phases of this work should be examined to determine if roadway protection is required. Roadway protection is generally a contractor design/build item in accordance with Performance Level 2 of SSP105S19 and current MTO practices.

5.6 Frost Protection

This project is located in the Owen Sound Operations District. The design frost penetration depth for this project is 1.4 m in accordance with OPSD 3090.101.

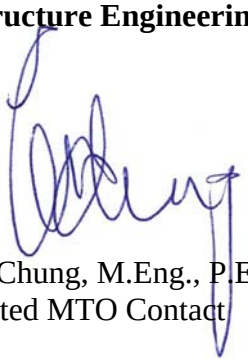
6.0 STATEMENT OF LIMITATION

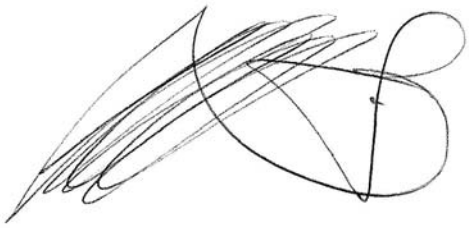
We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

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

Drawings

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

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

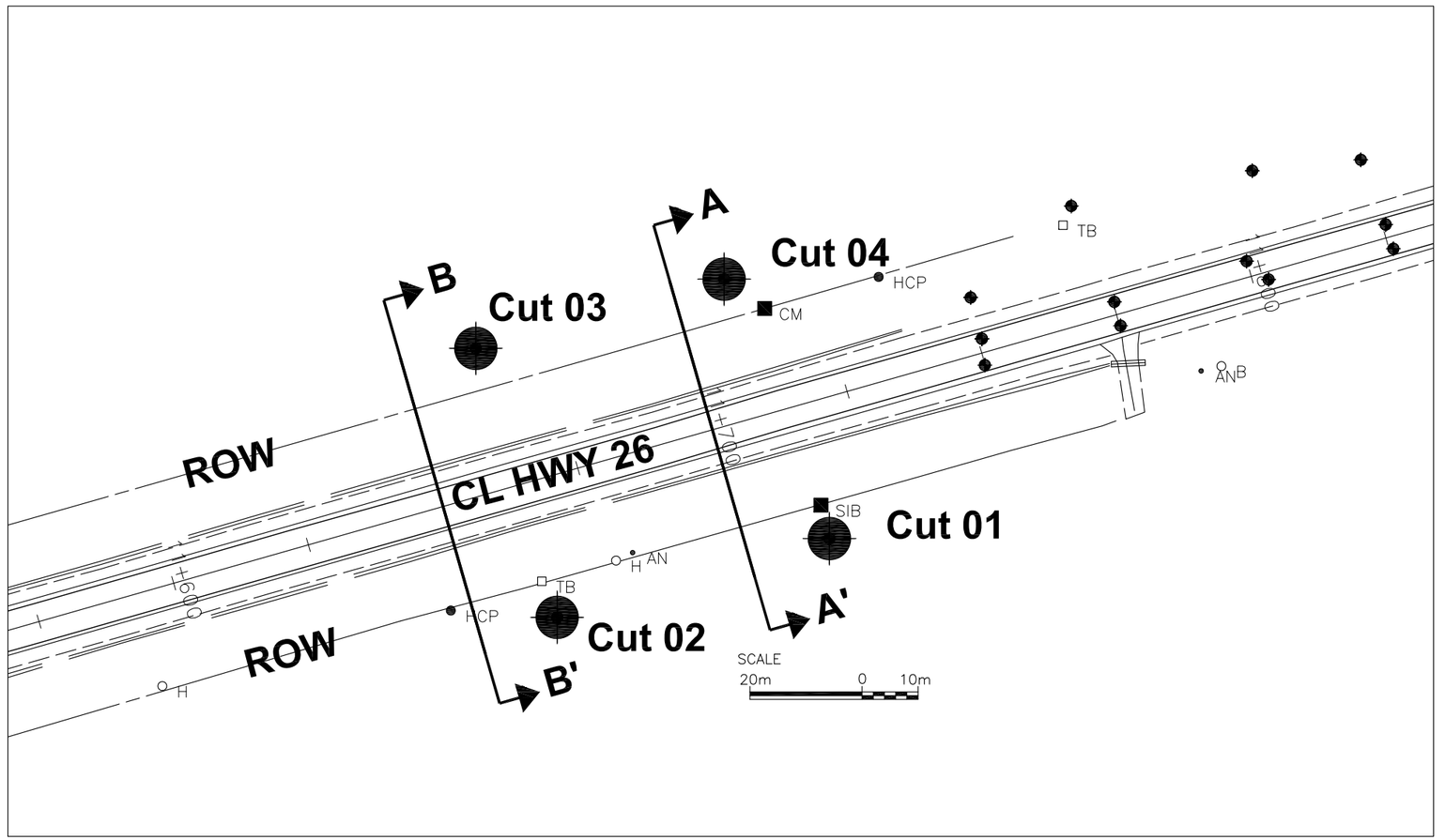
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

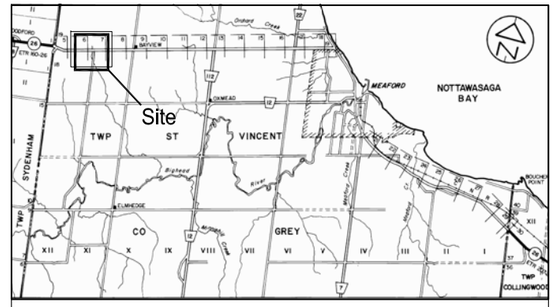
CONT No xxxx–xxxx
WP No GWP 167–91–00

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

SHEET 1

I.E. Group — 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
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe

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

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.**

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

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

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxx–xxxx
WP No GWP 167–91–00

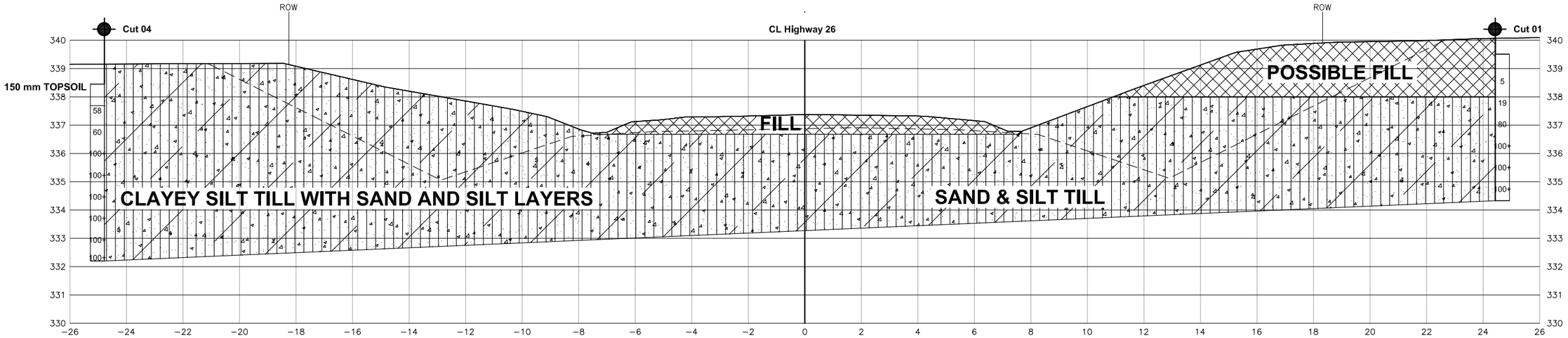
CUT PROFILE
Highway 26 – Part B
STA 11+675 TO 11+725

SHEET
2

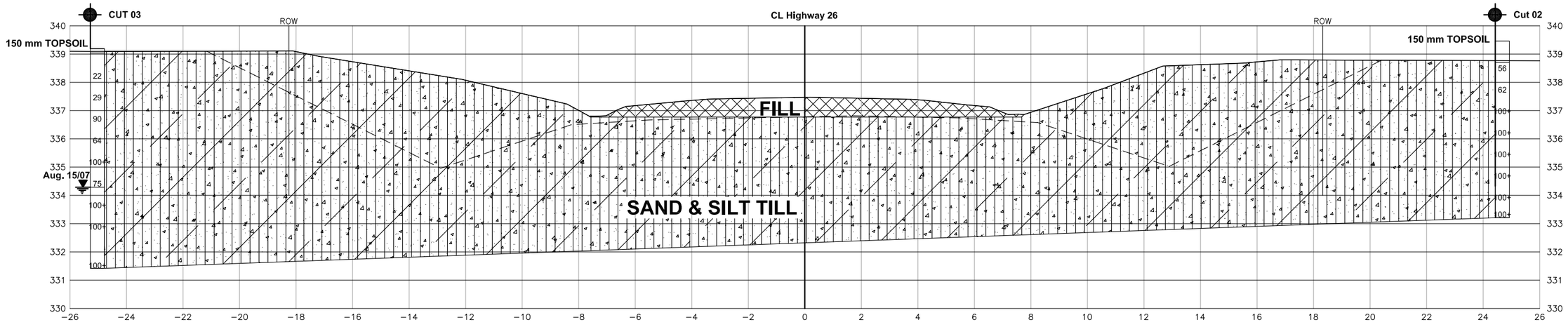
I.E. Group — Infrastructure Engineering Group Inc.
Pavement & Construction Materials Consulting Engineers
GTA • Kitchener • London • Windsor

MINISTRY OF TRANSPORTATION, ONTARIO

PROFILE A–A' 11+700



PROFILE B–B' 11+650



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.**

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

MTO GEOCRES No. 41A–215

LEGEND

— — — PROPOSED BOTTOM OF CUT

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	2

METRIC

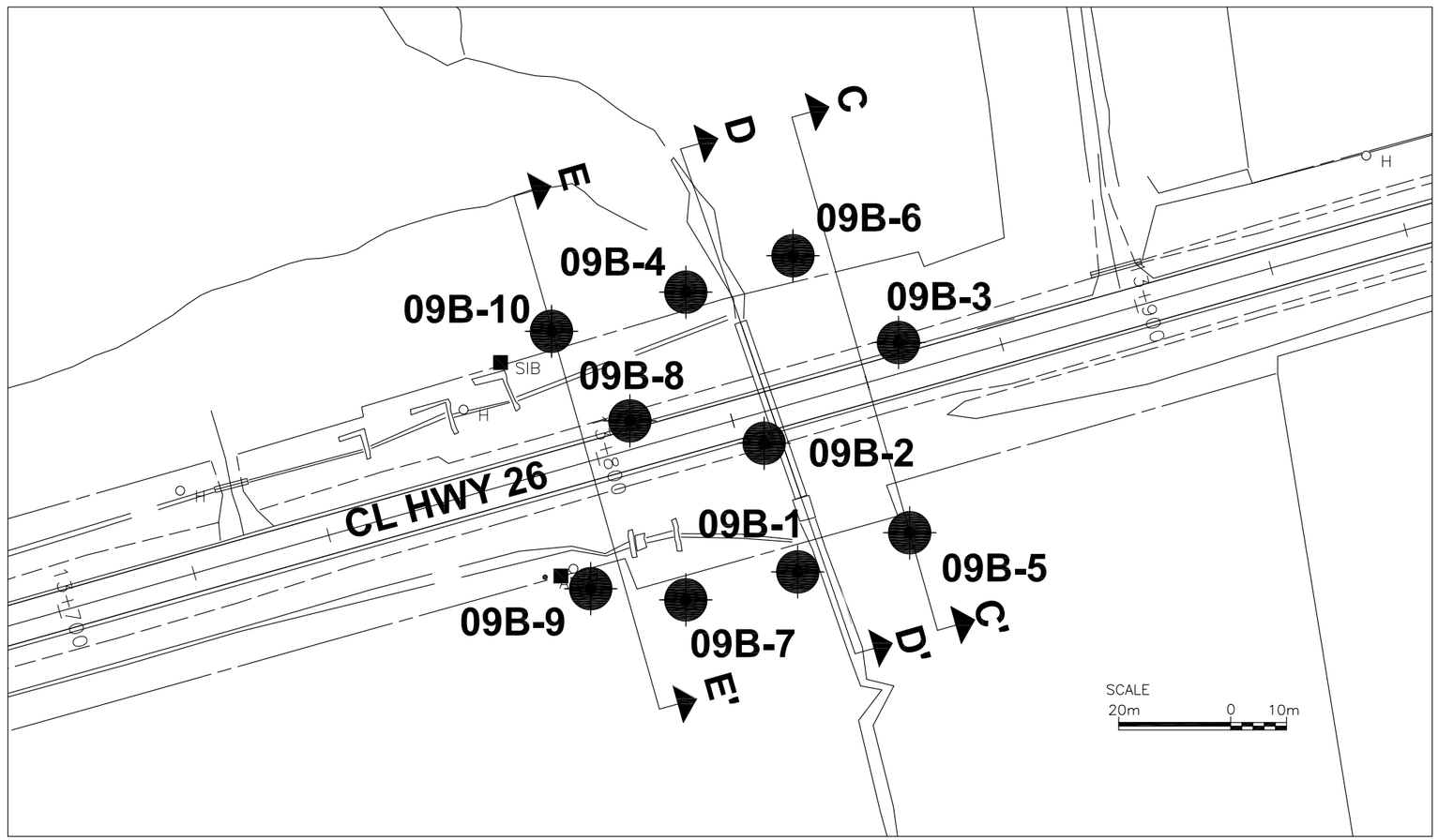
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

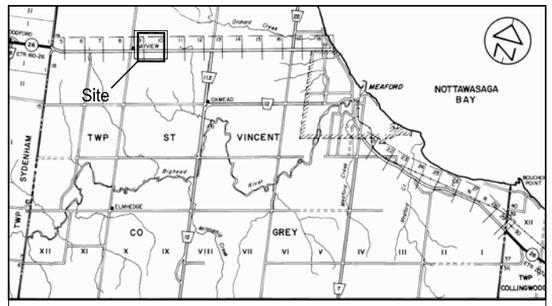
CONT No xxxx–xxxx
WP No GWP 167–91–00

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

SHEET 3

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





LEGEND

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

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

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.**

REVISIONS	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		SITE	HIGH FILL
DRAWN J.L.	CHECKED J.L.	APPROVED	E.C.	DWG	3

MINISTRY OF TRANSPORTATION, ONTARIO

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.**

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

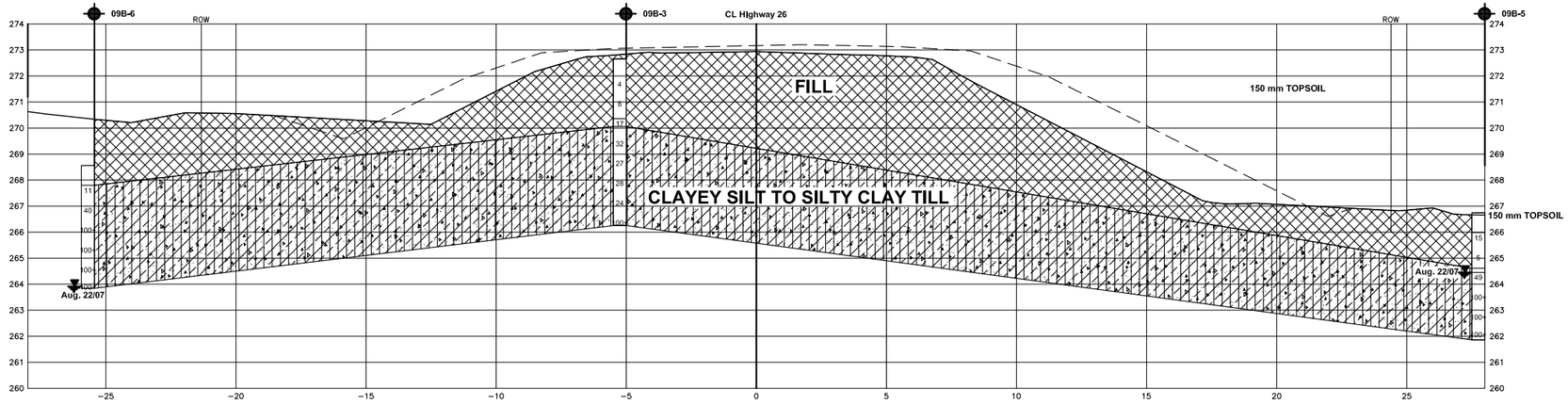
CONT No xxxx–xxxx
WP No GWP 167–91–00

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

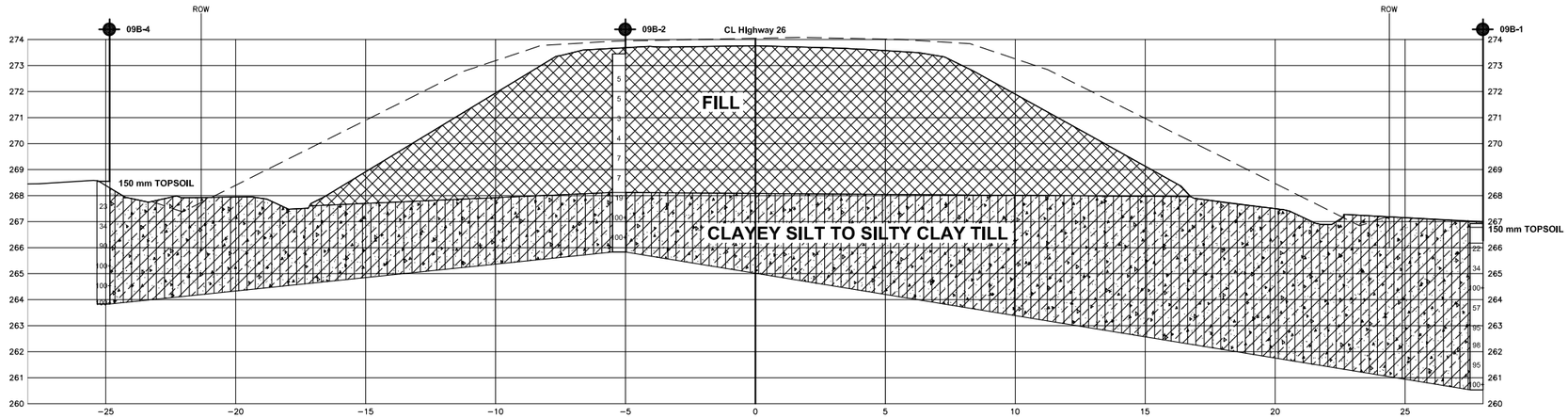
SHEET 4

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

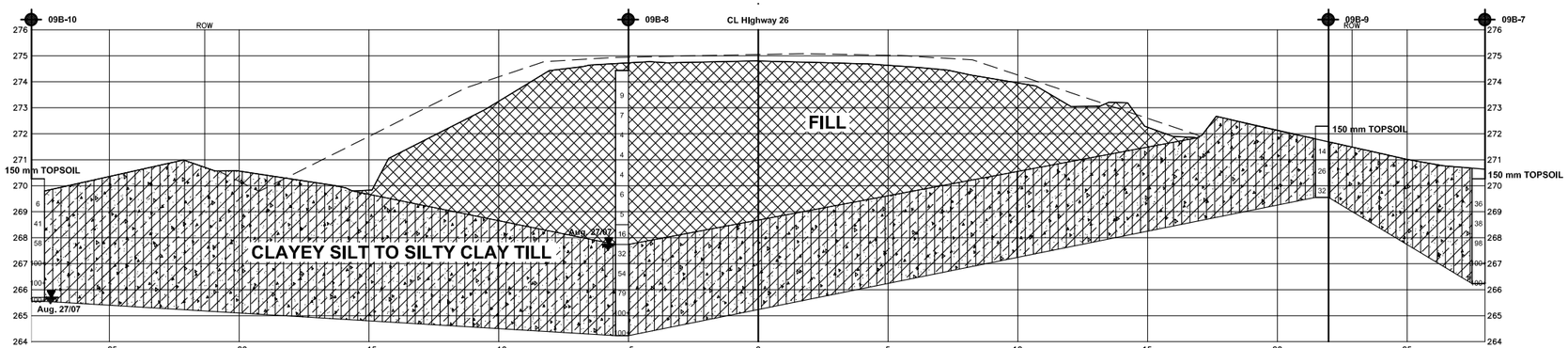
PROFILE C–C' 13+850

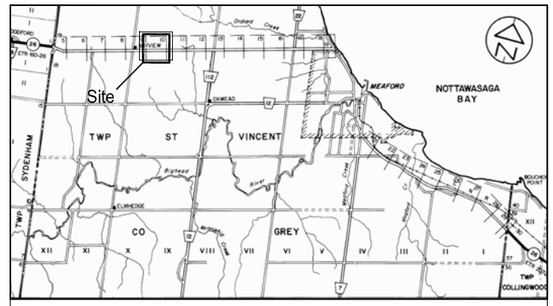


PROFILE D–D' 13+825



PROFILE E–E' 13+800





KEYPLAN NTS

LEGEND

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

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

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

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

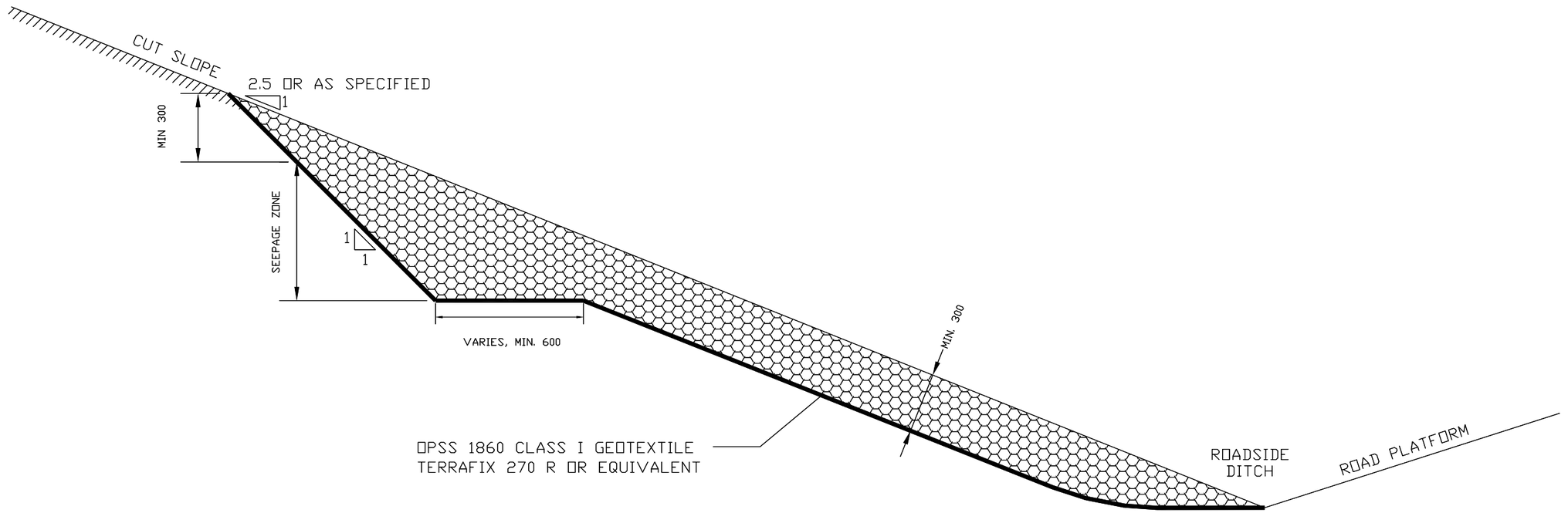
CONT No xxxx–xxxx
WP No GWP 167–91–00

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

SHEET 5

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

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 geotexile 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

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 'A' 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
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C		CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No Cut 01

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940477, Easting - 209200 ORIGINATED BY RB

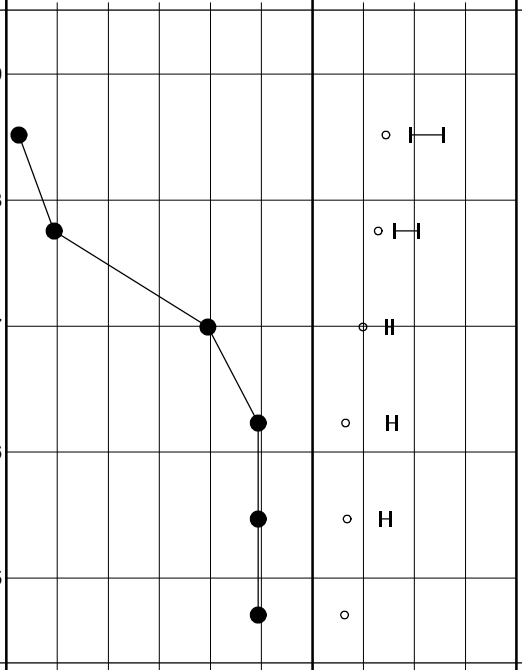
DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN

DATUM Geodetic DATE 16.8.07 - 16.8.07 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.51	Ground								
0.00	150 mm TOPSOIL.								
	POSSIBLE FILL Brown, moist, loose, consisting of mixed sand and silt, some clay, trace gravel.		1	SPT	5				2 32 52 15 (66)
337.99									
1.52	Bulk Sample MDD = 2130 Kg/m³ W_{opt} = 8.0% MWD = 2300 Kg/m³		2	SPT	19				16 35 37 11 (48)
	brown		3	SPT	80				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+				14 40 37 9 (46)
			5	SPT	100+				2 32 54 11 (65)
	grey		6	SPT	100+				
334.33									
5.18	End of borehole.								Borehole dry and open @ completion.

PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100)
SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)



$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.46	Ground								
0.00	150 mm TOPSOIL.								
	Bulk Sample MDD = 2130 Kg/m³ W_{opt} = 8.0% MWD = 2300 Kg/m³		1	SPT	56		339		
			2	SPT	62		338		11 38 43 8 (51)
	brown		3	SPT	100+		337		15 37 39 9 (48)
	SAND & SILT TILL, SM-ML Moist, very dense, with embedded gravel, trace clay.		4	SPT	100+		336		8 37 47 9 (56)
			5	SPT	100+		335		
			6	SPT	100+				
	grey		7	SPT	100+		334		
333.21			8	SPT	100+				
6.25	End of borehole.								Auger and sampler refusal. Borehole dry and open @ completion.

PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) (10 20 30)

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.19	Ground				
0.00	150 mm TOPSOIL.				
	Bulk Sample MDD = 1990 Kg/m^3 W_{opt} = 10.0% MWD = 2190 Kg/m^3	1	SPT	22	
		2	SPT	29	1 11 80 8 (88)
		3	SPT	90	
		4	SPT	64	13 32 43 12 (55)
	SAND & SILT TILL, SM-ML Light brown, moist, compact to very dense, with embedded gravel, slightly plastic to clayey, occasional cobbles.	5	SPT	100+	6 31 56 6 (63)
		6	SPT	75	Water level measured @ 4.9 m @ completion.
		7	SPT	100+	9 28 52 11 (62)
		8	SPT	100+	
331.42		9	SPT	100+	6 18 55 21 (75)
7.77	End of borehole.				Auger and Sampler Refusal.

GROUND WATER CONDITIONS: ▽

ELEVATION SCALE: 339, 338, 337, 336, 335, 334, 333, 332

PENETR. RESISTANCE STANDARD ● DYN. CONE
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m^3

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.45	Ground										
0.00	150 mm TOPSOIL.						338				
			1	SPT	58						11 32 47 10 (57)
	Bulk Sample MDD = 2150 Kg/m³ W_{opt} = 8.0% MWD = 2322 Kg/m³		2	SPT	60		337				12 35 41 12 (53)
			3	SPT	100+		336				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+		335				15 35 38 12 (50)
			5	SPT	100+						9 33 47 11 (58)
			6	SPT	100+		334				
			7	SPT	100+		333				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.

+ ³, × ³: Numbers refer to Sensitivity

○ ¹⁵⁰ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

JOE MTO 07-6-IEG1B.GPJ ONTARIO MOT.GDT 20/11/09

RECORD OF BOREHOLE No 09B-1

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4941050, Easting - 211235 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
266.93	Ground							
0.00	150mm TOPSOIL							
			1	SPT	22			
			2	SPT	34			13 22 49 16 (65)
			3	SPT	100+			
	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.		4	SPT	57		22.0	2 20 58 21 (79)
			5	SPT	95			
			6	SPT	98			7 24 49 20 (69)
			7	SPT	95			
			8	SPT	100+		23.6	
260.53								
6.40	End of Borehole.							Borehole dry and open @ completion.

ELEVATION SCALE: 266, 265, 264, 263, 262, 261

PENETR. RESISTANCE STANDARD ● DYN. CONE: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

175 225+ 225+ 225+ 225+ 225+ 225+ 225+

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
273.45	Ground							
0.00 / 273.15	300 mm Granular FILL.							
0.30	FILL Brown, moist to wet, very loose to loose, consisting of mixed gravel, sand, silt, clayey silt and silty clay.		1	SPT	5			15 32 37 16 (53)
			2	SPT	5			9 27 47 17 (64)
			3	SPT	3		18.6	24 32 30 14 (44)
			4	SPT	4			
			5	SPT	7			
			6	SPT	7			Organic layer @ 4.25 m extending to 4.5 m. 4 29 42 25 (68)
268.12 / 5.33	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist to wet, very stiff to hard, with embedded sand and gravel and occasional cobble layers.		7	SPT	19			
			8	SPT	100+		18.7	10 27 38 24 (63)
			9	SPT	100+			
265.83 / 7.62	End of Borehole.							Auger & Spoon refusal @ 7.62 m on presumed bedrock. Borehole dry and open @ completion.

ELEVATION SCALE: 273, 272, 271, 270, 269, 268, 267, 266

PENETR. RESISTANCE STANDARD ● DYN. CONE
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

125
225+
225+

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

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

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
272.65	Ground					
0.00 / 272.24	410 mm Granular FILL.					
0.41	FILL Brown, moist, very loose to loose, consisting of mixed gravel, sand silt and clay.	1	SPT	4		
		2	SPT	8		9 30 41 20 (61)
270.06		3	SPT	17		4 22 40 34 (74)
2.59	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	23.4	7 28 41 23 (65)
		5	SPT	27	23.1	12 29 38 21 (59)
		6	SPT	28		12 35 35 18 (53)
		7	SPT	24		18 26 37 18 (55)
266.27		8	SPT	100+		5 34 50 11 (61)
6.38	End of Borehole.					Borehole dry and open @ completion.

PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100)
SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
GROUND WATER CONDITIONS
ELEVATION SCALE 272 271 270 269 268 267

225+ 225+ 225+ 225+ 225+

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
268.55	Ground										
0.00	150mm TOPSOIL.						268				
			1	SPT	23					22.2	
							267				
			2	SPT	34					19.8	2 27 56 14 (71)
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, very stiff to hard, with embedded sand and gravel, and occasional cobble layers, interbedded with silt seams, pockets and layers.										
			3	SPT	90		266				
			4	SPT	100+						2 37 51 10 (61)
							265				
			5	SPT	100+						
263.83			6	SPT	100+		264				
4.72	End of Borehole.										Spoon and auger refusal @ 4.72 m. Borehole dry and open @ completion.

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

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
266.74	Ground				
0.00	150mm TOPSOIL				
	FILL Brown, moist, loose to compact, consisting of mixed gravel, sand, silt and clay.	1	SPT	15	37 40 17 6 (23)
		2	SPT	5	
264.61					
2.13		3	SPT	49	4 21 62 14 (76)
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, hard, with embedded sand and gravel, and occasional cobble layers, interbedded with silt seams, pockets and layers.	4	SPT	100+	Water level @ approximately 2.44 m.
		5	SPT	100+	9 27 47 17 (64)
261.86		6	SPT	100+	
4.88					

GROUND WATER CONDITIONS

ELEVATION SCALE: 266, 265, 264, 263, 262

PENETR. RESISTANCE STANDARD ● DYN. CONE
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

225+ 225+ 225+ 225+

UNIT WEIGHT γ kN/m^3

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE: STANDARD ● DYN. CONE (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
268.56	Ground										
0.00	150 mm TOPSOIL.										
	FILL Brown to light brown, moist, consisting of mixed sand and silt.										
267.80											
0.76			1	SPT	11		268	37.5		18.6	
			2	SPT	40		267	225+			2 27 59 12 (71)
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, stiff to hard, with embedded sand and gravel, and occasional cobble layers, interbedded with frequent sand and silt seams, pockets and layers.		3	SPT	100+		266	225+			
			4	SPT	100+			225+			12 61 21 6 (27)
			5	SPT	100+		265	225+			
263.91			6	SPT	100+	▽	264				
4.65	End of borehole.										Slight water inflow @ 4.57 m. Sampler refusal possible Bedrock @ 4.65 m.

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

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
270.27	Ground										
0.00	150 mm TOPSOIL.						270				
			1	SPT	36				200		14 23 41 21 (63)
							269				
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, hard, with embedded sand and gravel, and occasional cobble layers, interbedded with frequent sand and silt seams, pockets and layers.		2	SPT	38				225+		
							268				
			3	SPT	98				225+ H		9 33 45 12 (57)
							267				
			4	SPT	100+				225+		
266.23			5	SPT	100+						6 31 51 12 (63)
4.04	End of Borehole.										Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
274.44	Ground							
0.00 / 273.98	460 mm Granular FILL.							
0.46	FILL Brown, moist to wet, soft to firm, consisting of mixed silt, clay, sand and some to trace gravel, occasional organic lenses.		1	SPT	9			13 29 35 22 (58)
			2	SPT	7			
			3	SPT	4			5 31 40 25 (64)
			4	SPT	4			
			5	SPT	4			
			6	SPT	6			4 25 41 30 (71)
	organic layer		7	SPT	5			11 23 40 26 (66)
267.89			8	SPT	16		20.1	
6.55	sand seams		9	SPT	32	▽	19.6	Water level @ 6.71 m. 11 32 46 11 (57)
267.12 / 7.32	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, hard, with embedded sand and gravel, and occasional cobble layers, interbedded with frequent sand and silt seams, pockets and layers.		10	SPT	54		21.0	
			11	SPT	79			
			12	SPT	100+			
264.20			13	SPT	100+			5 14 64 17 (82)
10.24	End of Borehole.							

PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) (10 20 30)

ELEVATION SCALE: 274 273 272 271 270 269 268 267 266 265

112

225+

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

○ ^{150} UNCONFINE 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 (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
272.29	Ground										
0.00	150 mm TOPSOIL.						272				
	Clayey SILT to Silty CLAY TILL, CL-ML to CL Reddish brown, moist, stiff to hard, with embedded sand and gravel.		1	SPT	14			75			0 23 49 28 (77)
			2	SPT	26		271	225+		17.1	
			3	SPT	32		270	225+			15 27 42 16 (58)
269.55											
2.74	End of Borehole.										Borehole dry and open @ completion.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{150}$ UNCONFINE 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
269.82	Ground										
0.00	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+						11 33 48 8 (56)
			5	SPT	100+		266				
265.10			6	SPT	100+	▽					Minor seepage @ 4.57 m.
4.72	End of Borehole.										

+ 3, × 3: Numbers refer to Sensitivity

○ 150 UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

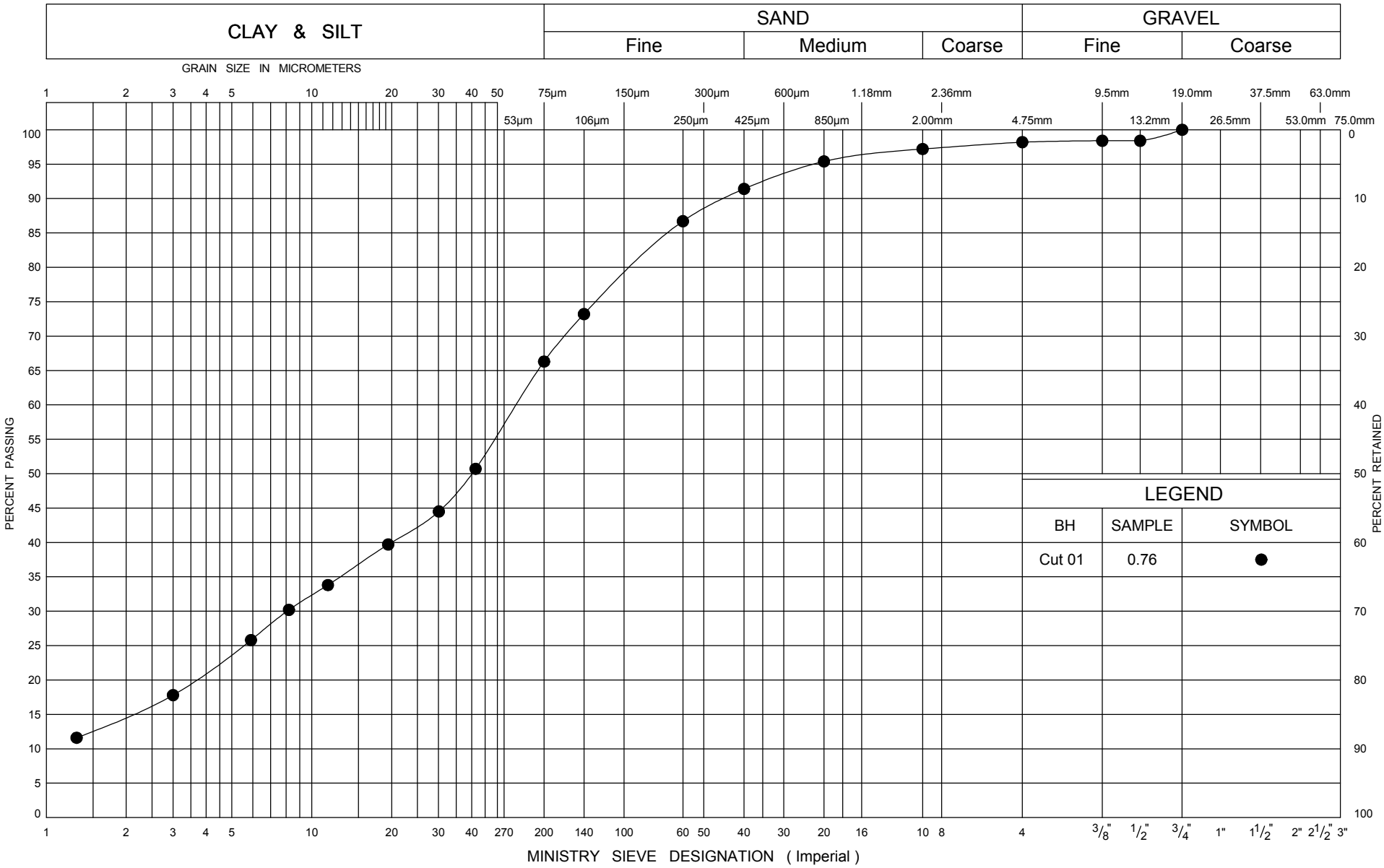
JOE MTO 07-6-IEG1B.GPJ ONTARIO MOT.GDT 30/3/10

Appendix B

Laboratory Test Results

Area	**Grain Size Figure**	**Atterberg Limits Figure**
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



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

FILL

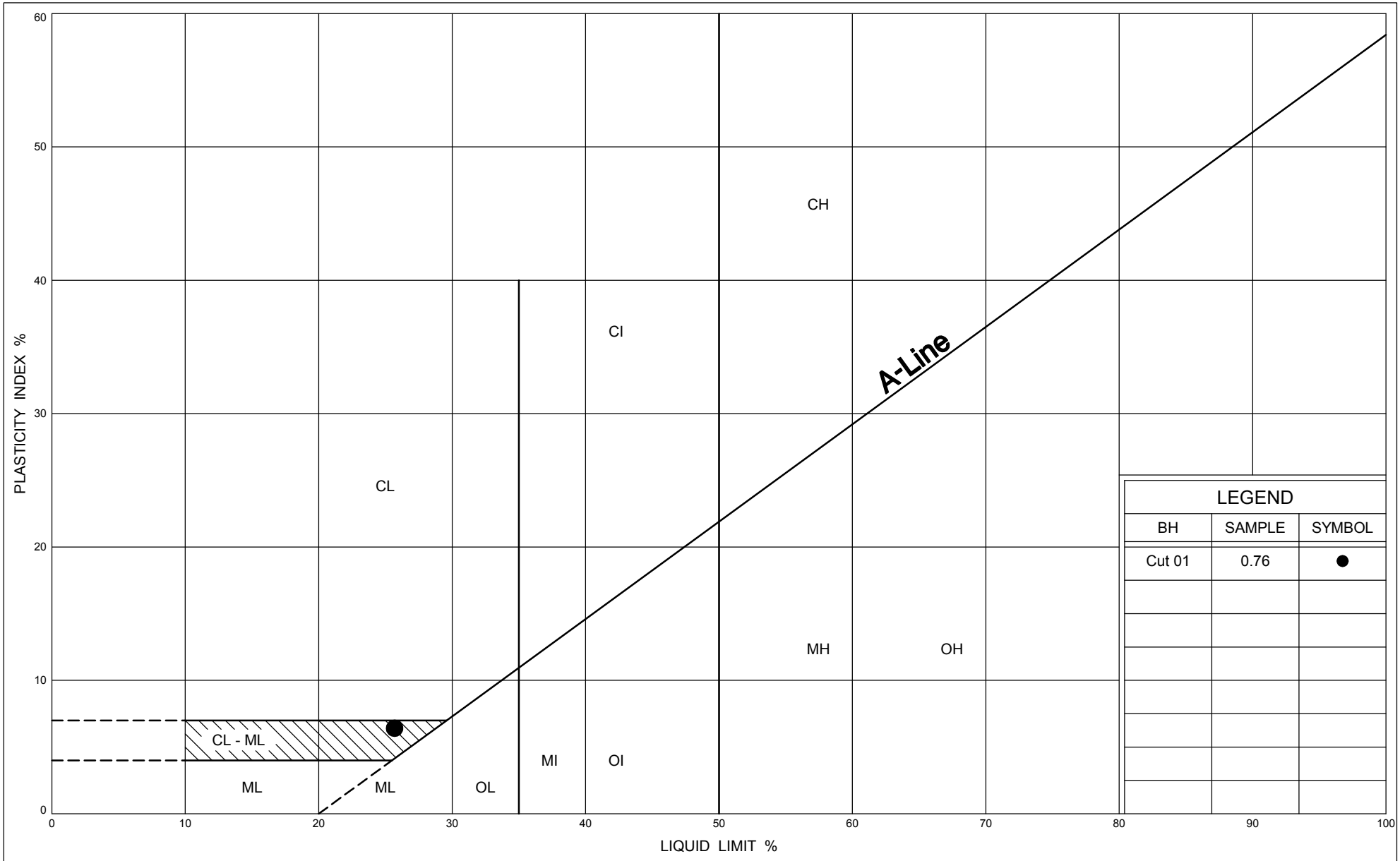
FIG No CUT.1

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 15/11/09

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

Ministry of Transportation
Ontario

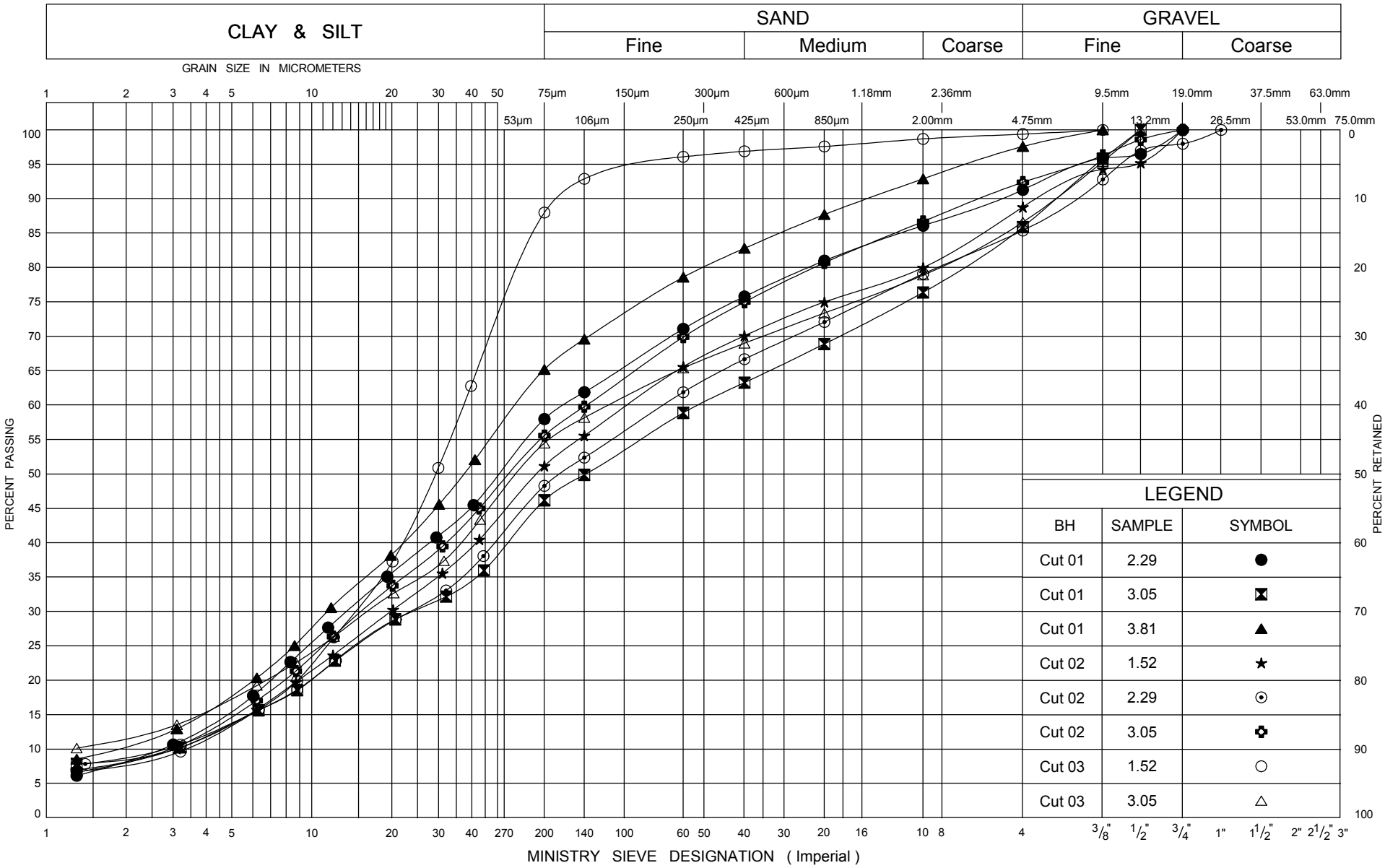
PLASTICITY CHART
FILL

FIG No CUT.2

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND & SILT TILL & LAYERS, SM-ML

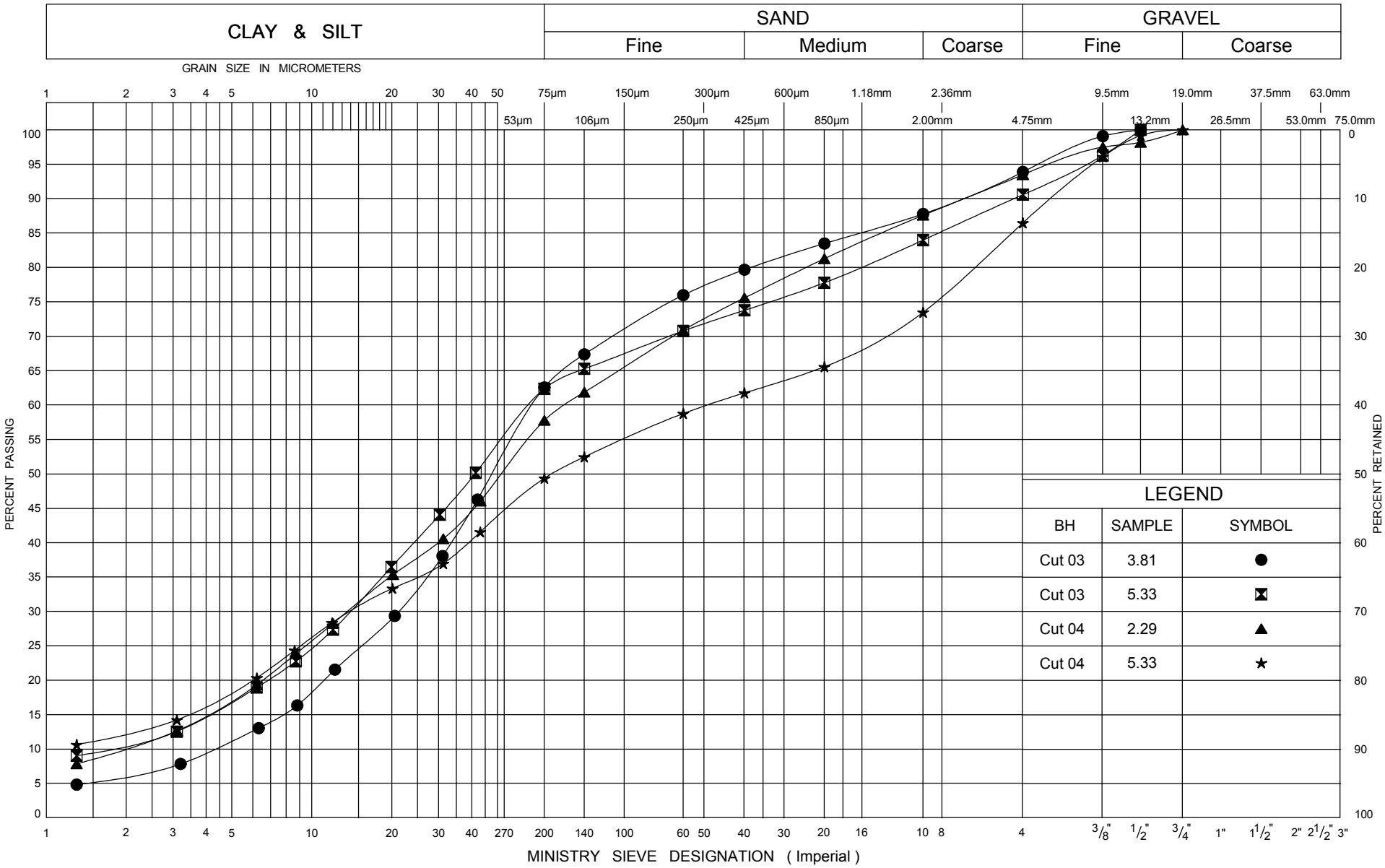
FIG No CUT.3

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND & SILT TILL AND LAYERS, SM-ML

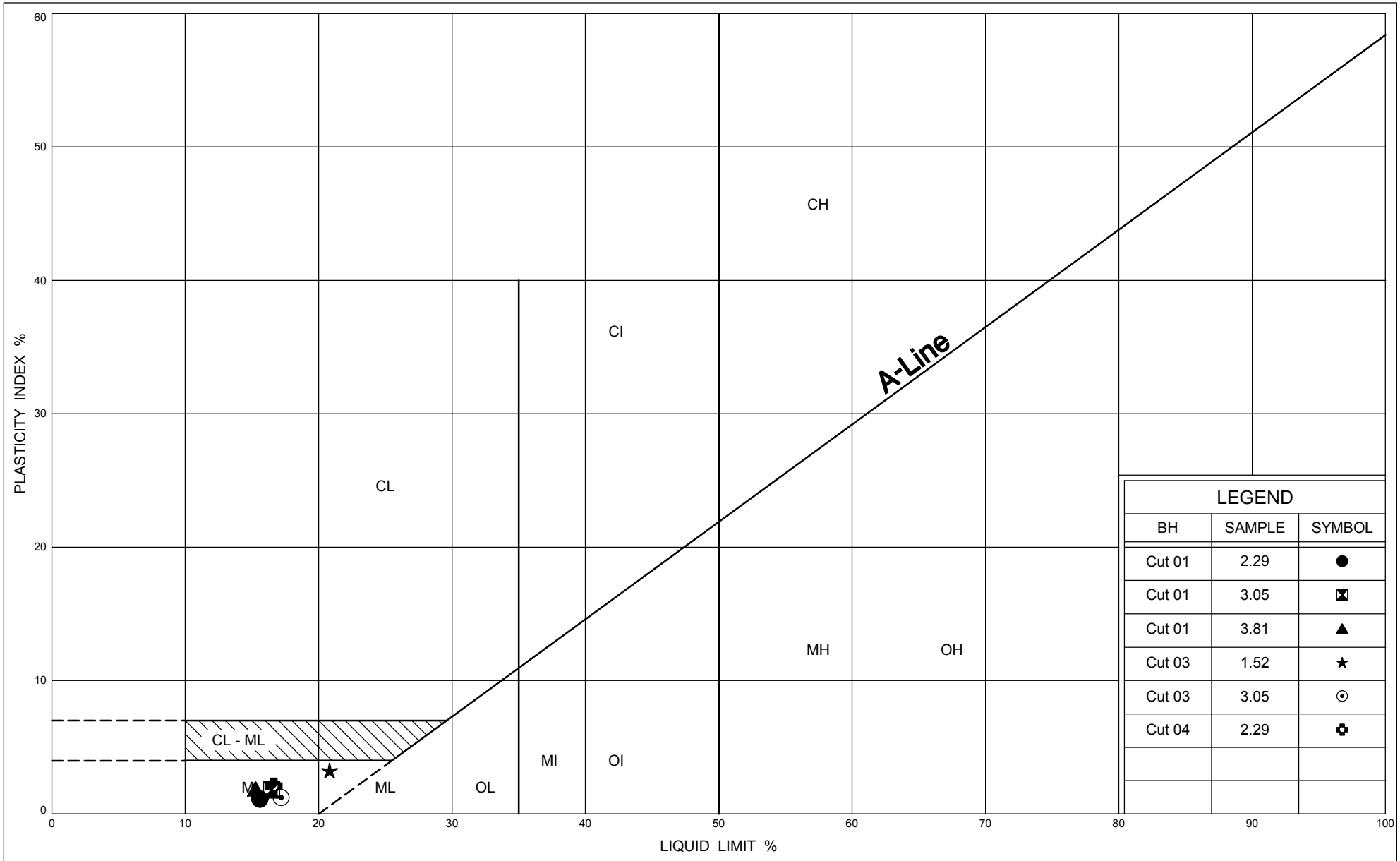
FIG No CUT.4

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

Ministry of Transportation
Ontario

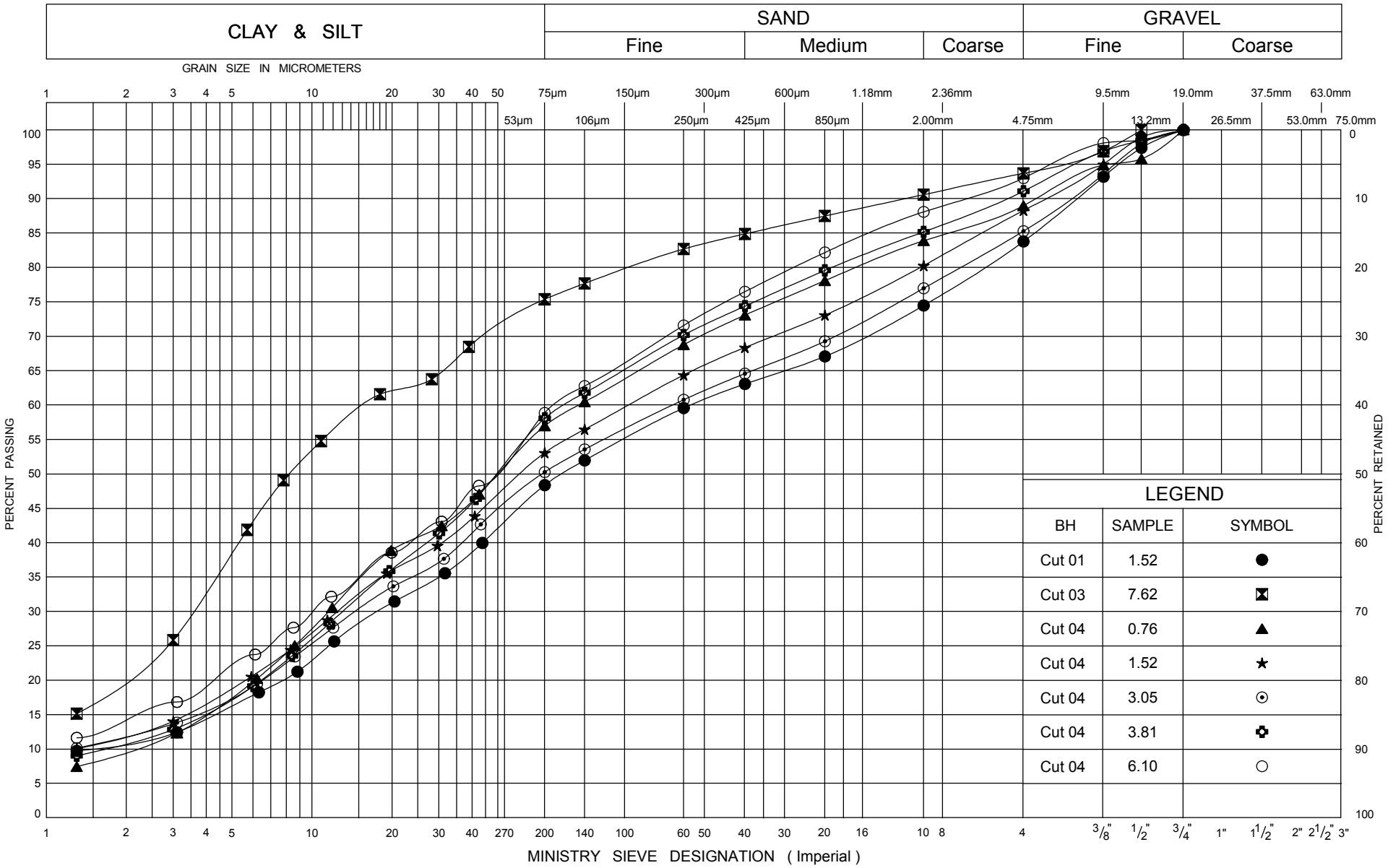
PLASTICITY CHART
SAND & SILT TILL & IAYERS SM-ML

FIG No CUT.5

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL & LAYERS, CL-ML

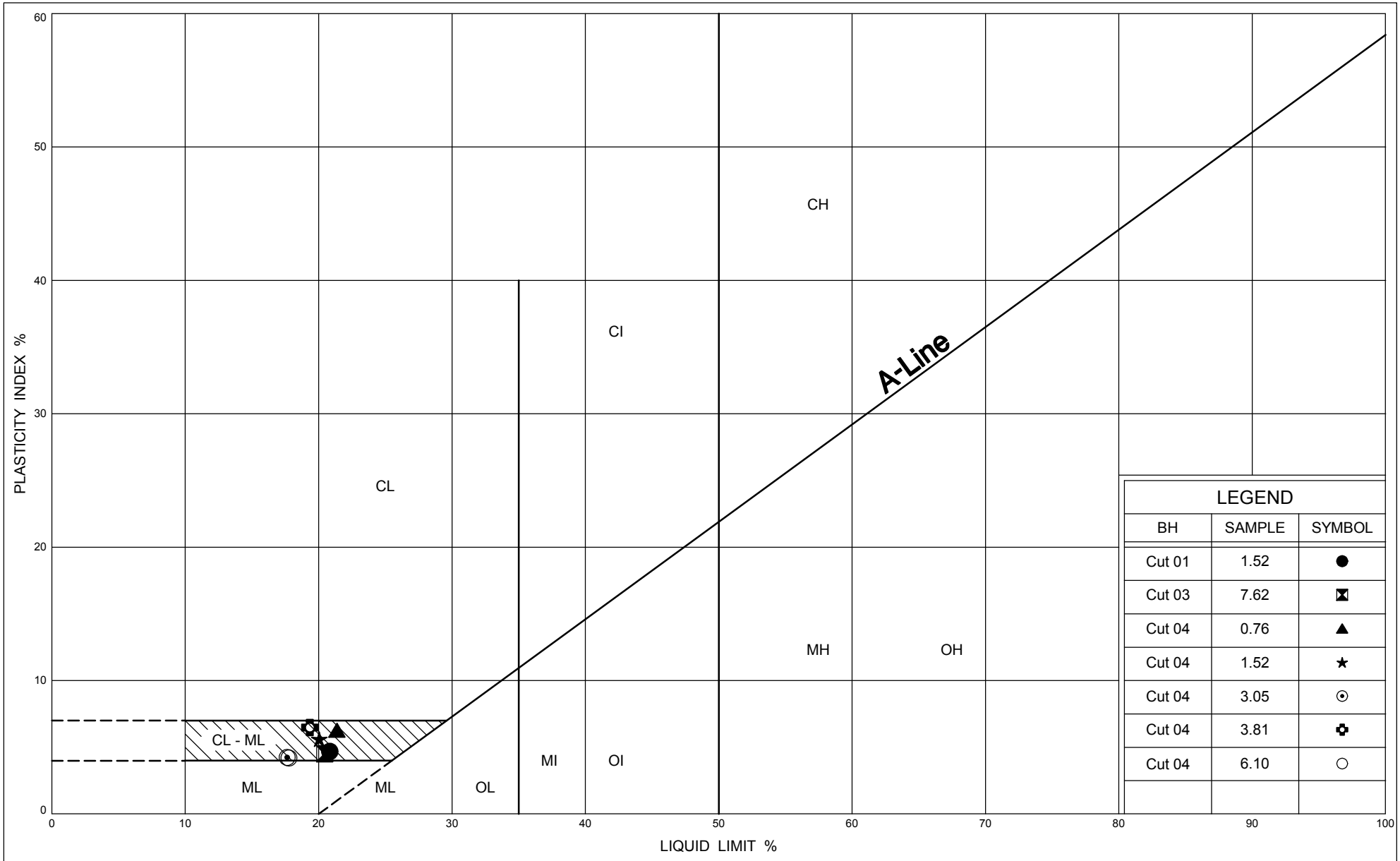
FIG No CUT.6

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 6/11/09

Ministry of Transportation
Ontario

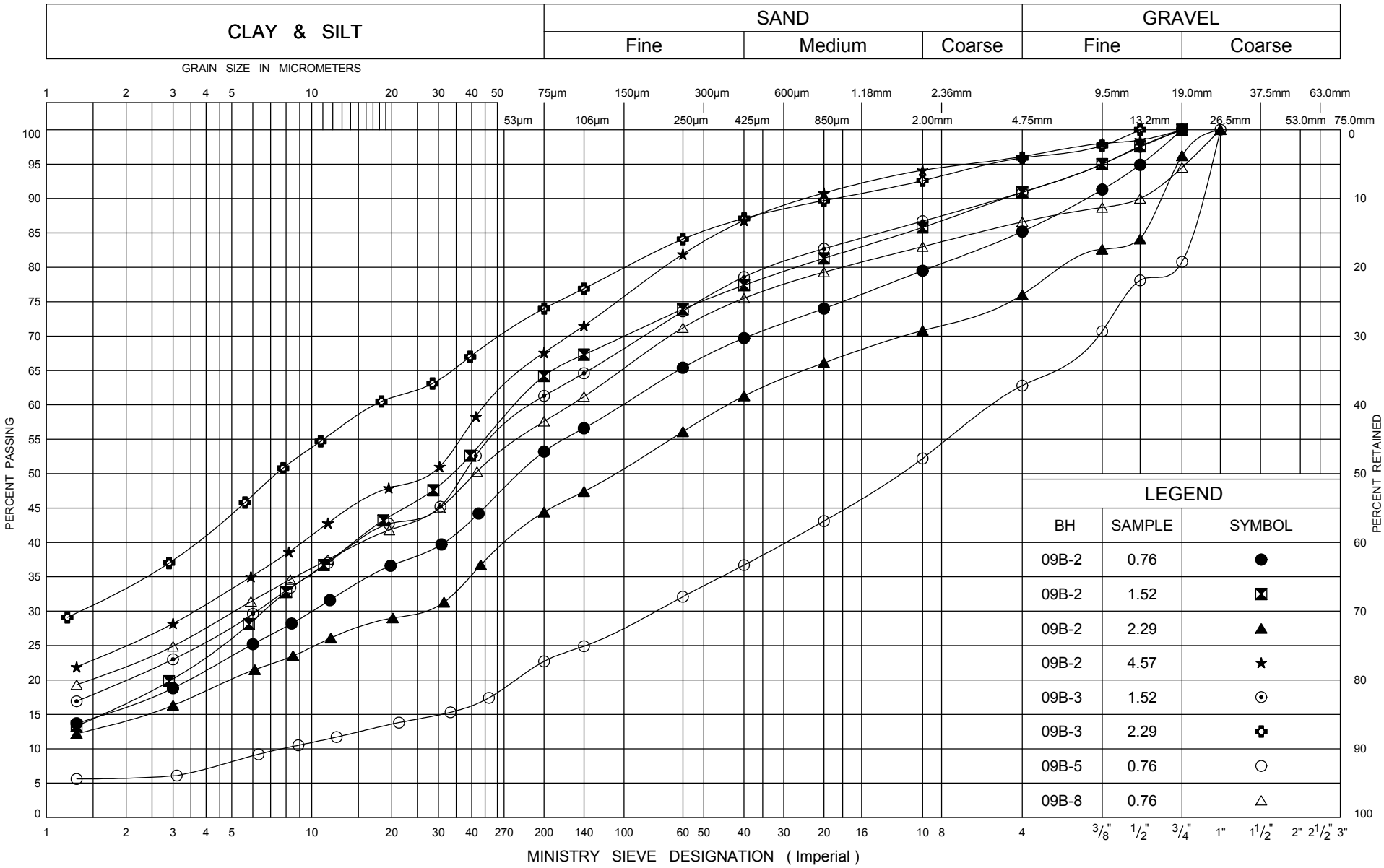
PLASTICITY CHART
CLAYEY SILT TILL & LAYERS, CL-ML

FIG No CUT.7

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

FILL

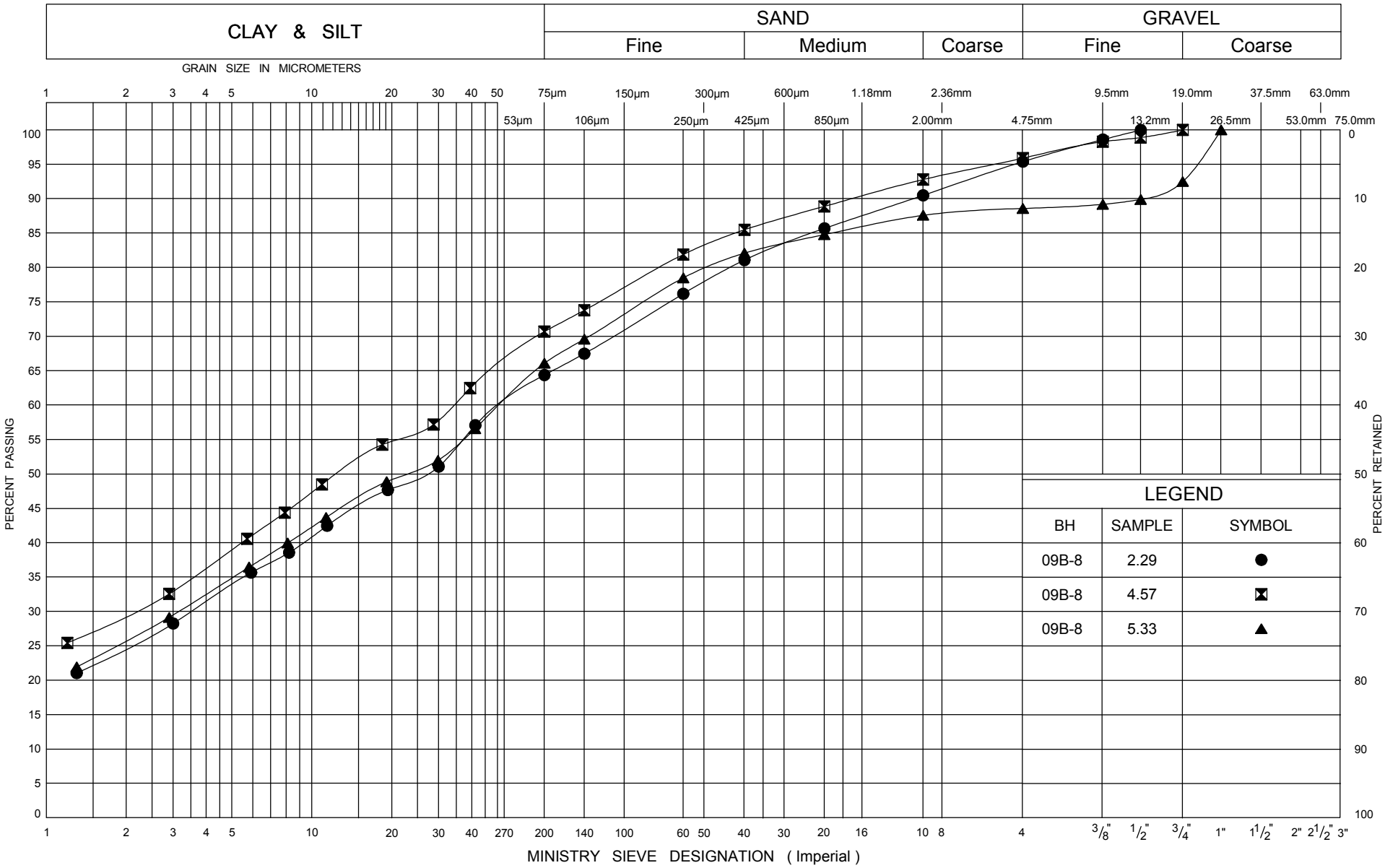
FIG No FILL.1

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

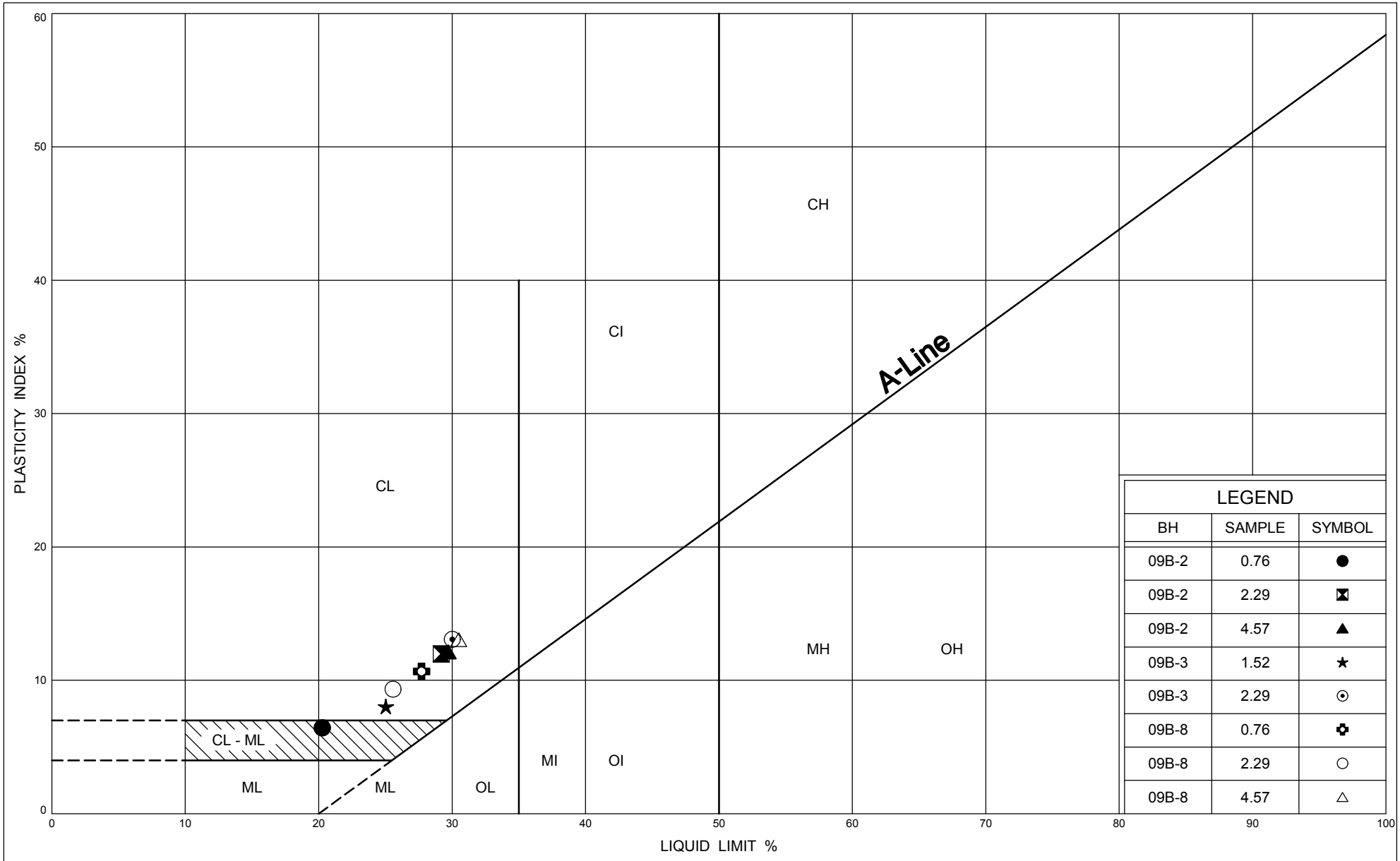
FILL

FIG No FILL.2

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09



ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

Ministry of Transportation
Ontario

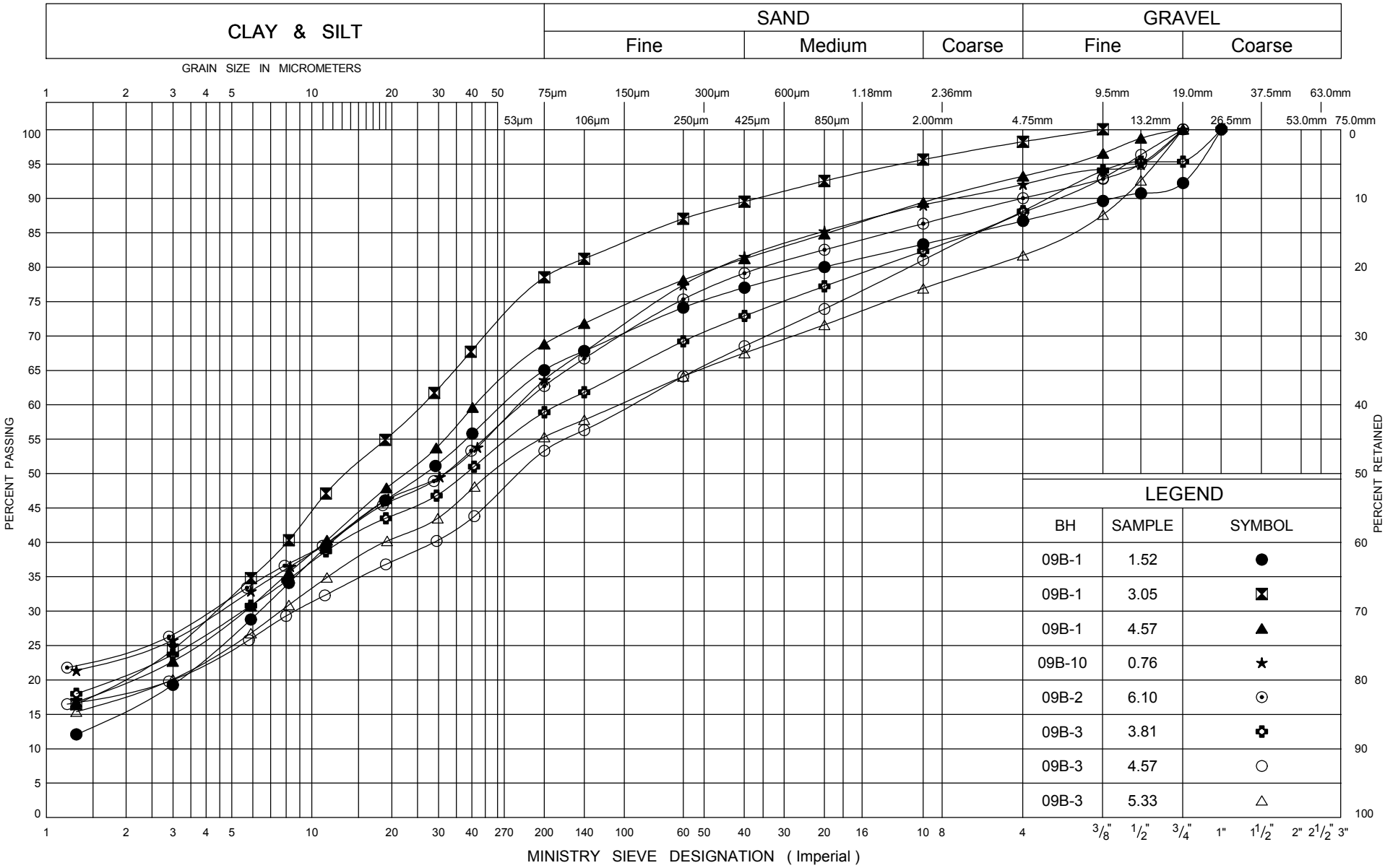
PLASTICITY CHART
FILL

FIG No FILL.3

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

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

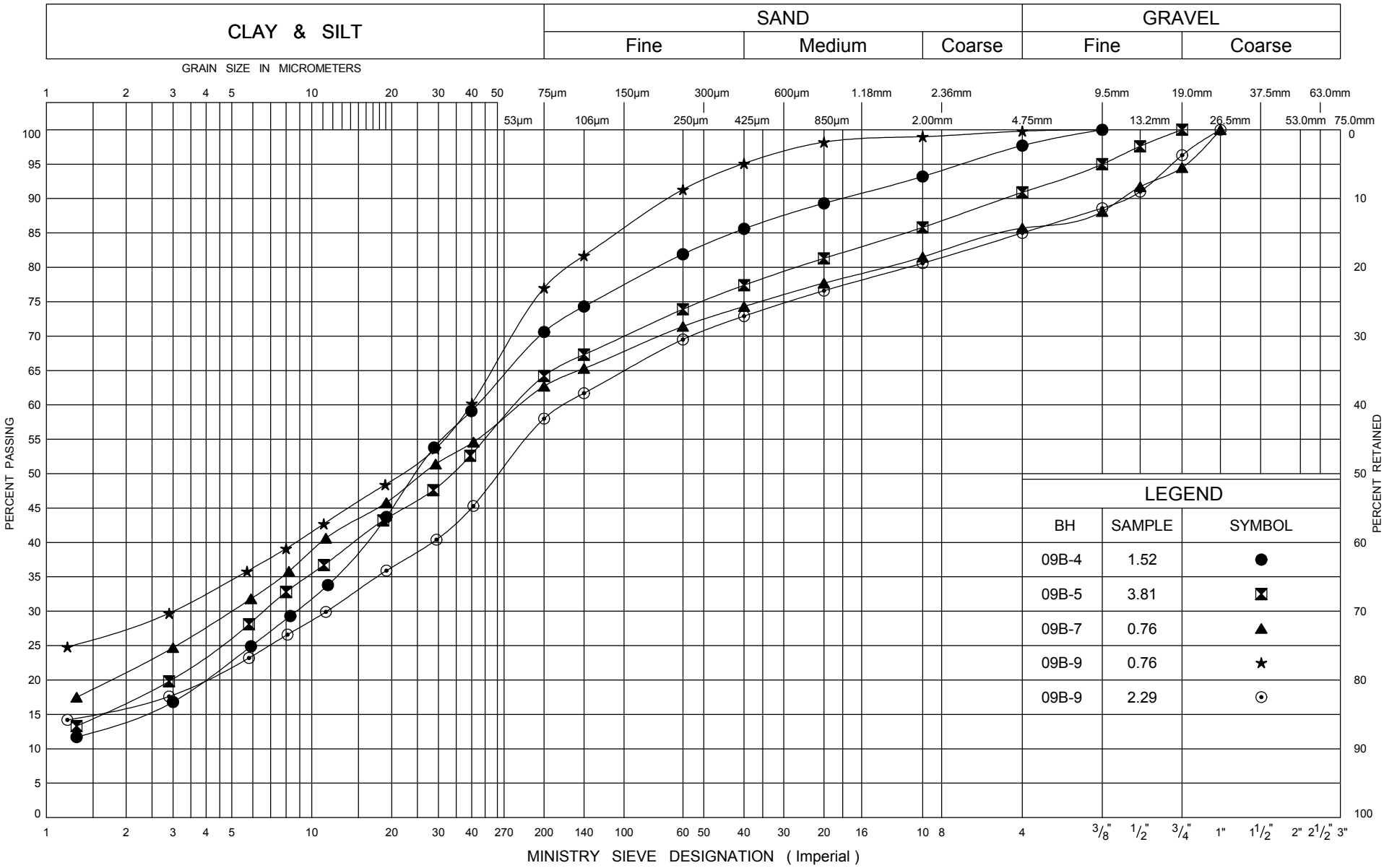
FIG No FILL.4

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

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

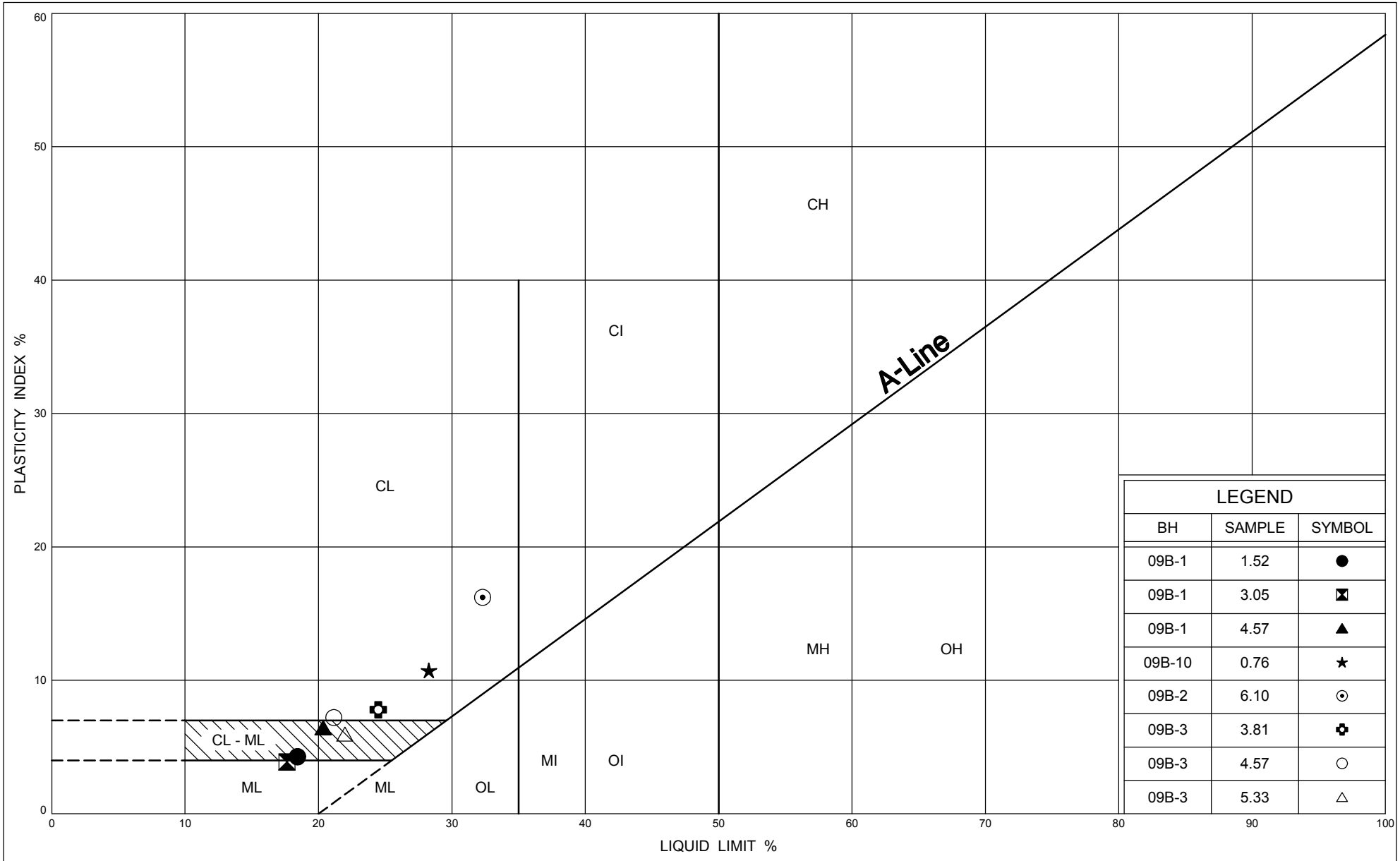
FIG No FILL.5

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 20/11/09

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
09B-1	1.52	●
09B-1	3.05	⊠
09B-1	4.57	▲
09B-10	0.76	★
09B-2	6.10	⊙
09B-3	3.81	✿
09B-3	4.57	○
09B-3	5.33	△

ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

Ministry of Transportation
Ontario

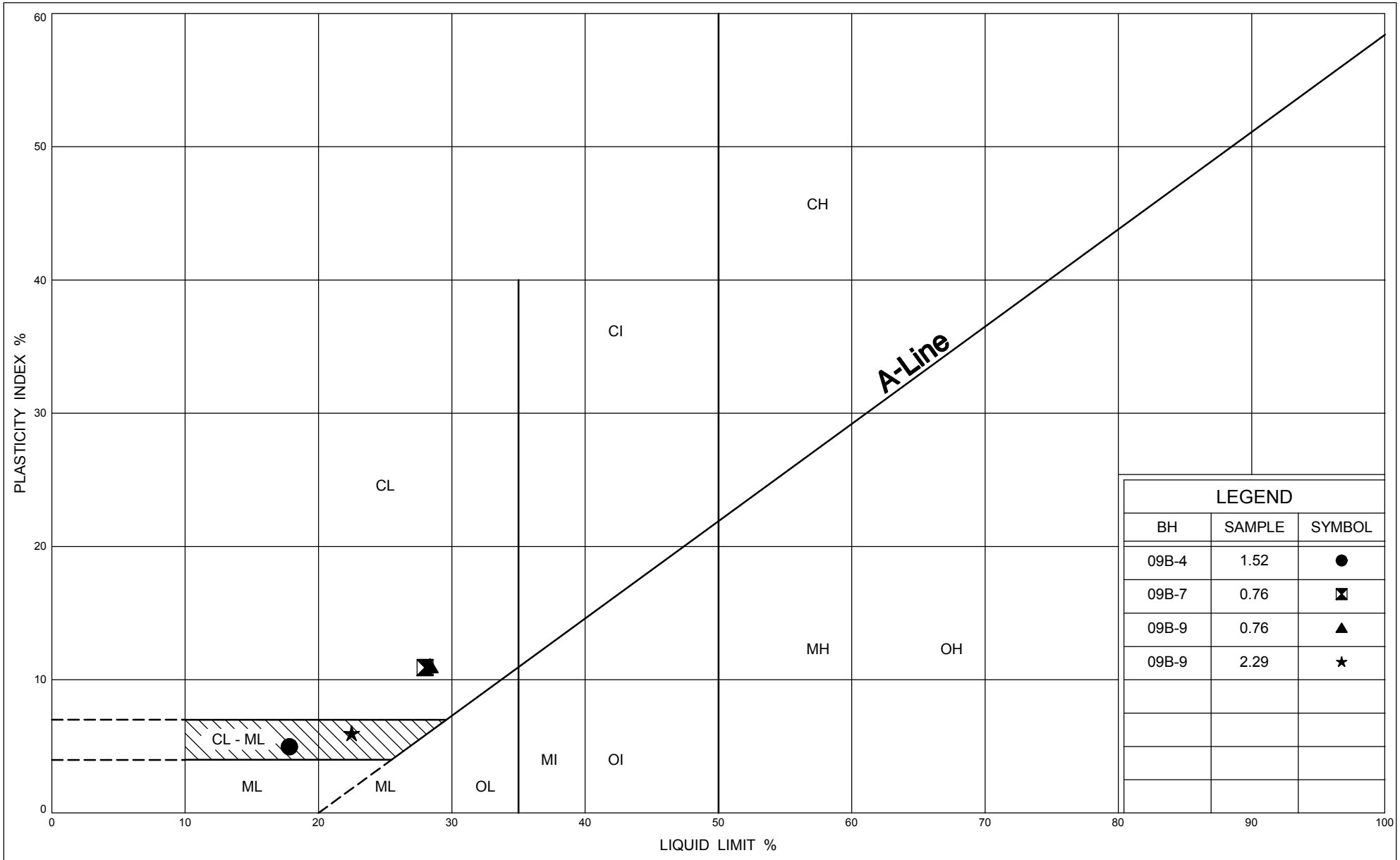
PLASTICITY CHART

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

FIG No FILL.6

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford



Ministry of Transportation
Ontario

PLASTICITY CHART

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

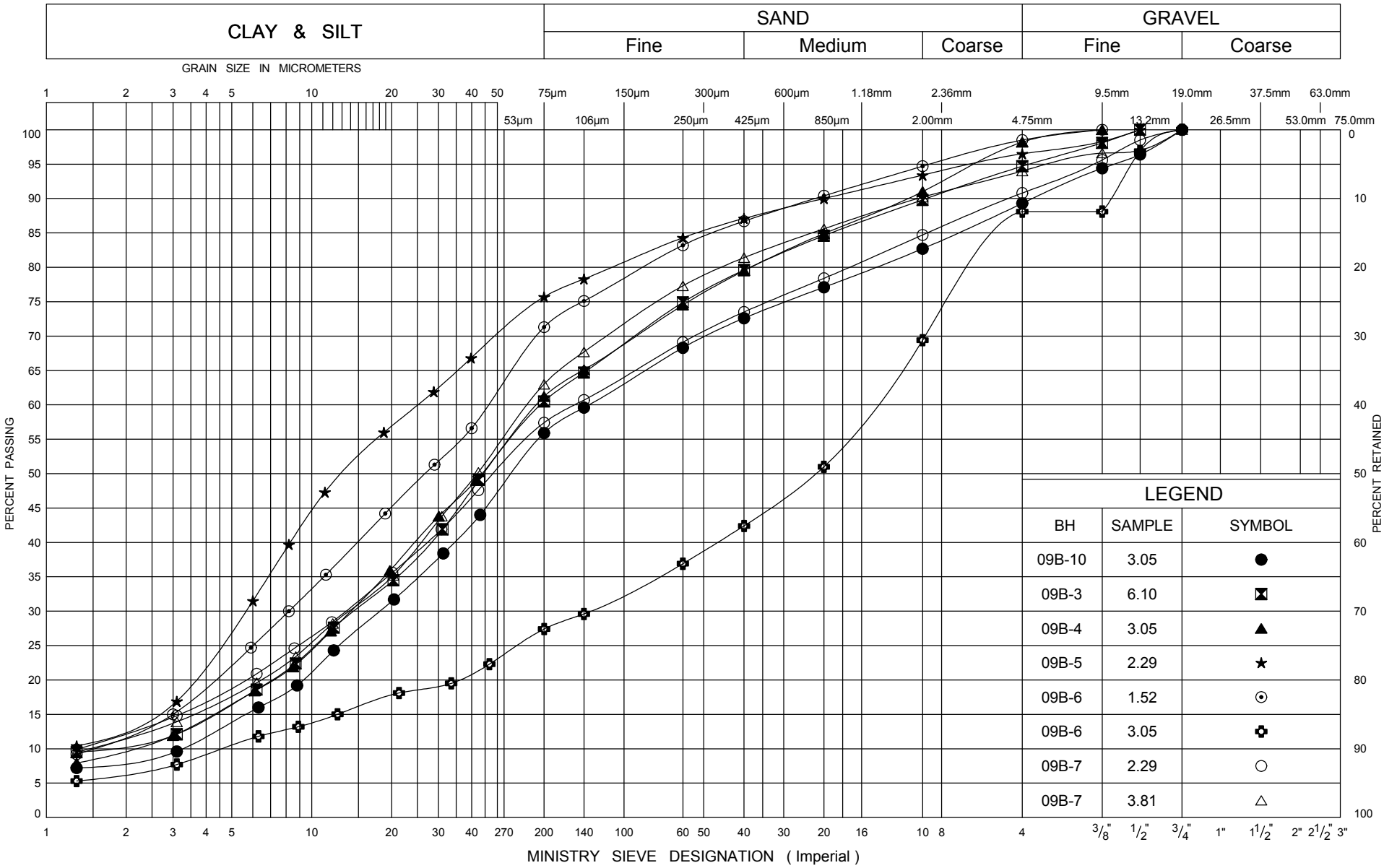
FIG No FILL.7

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

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

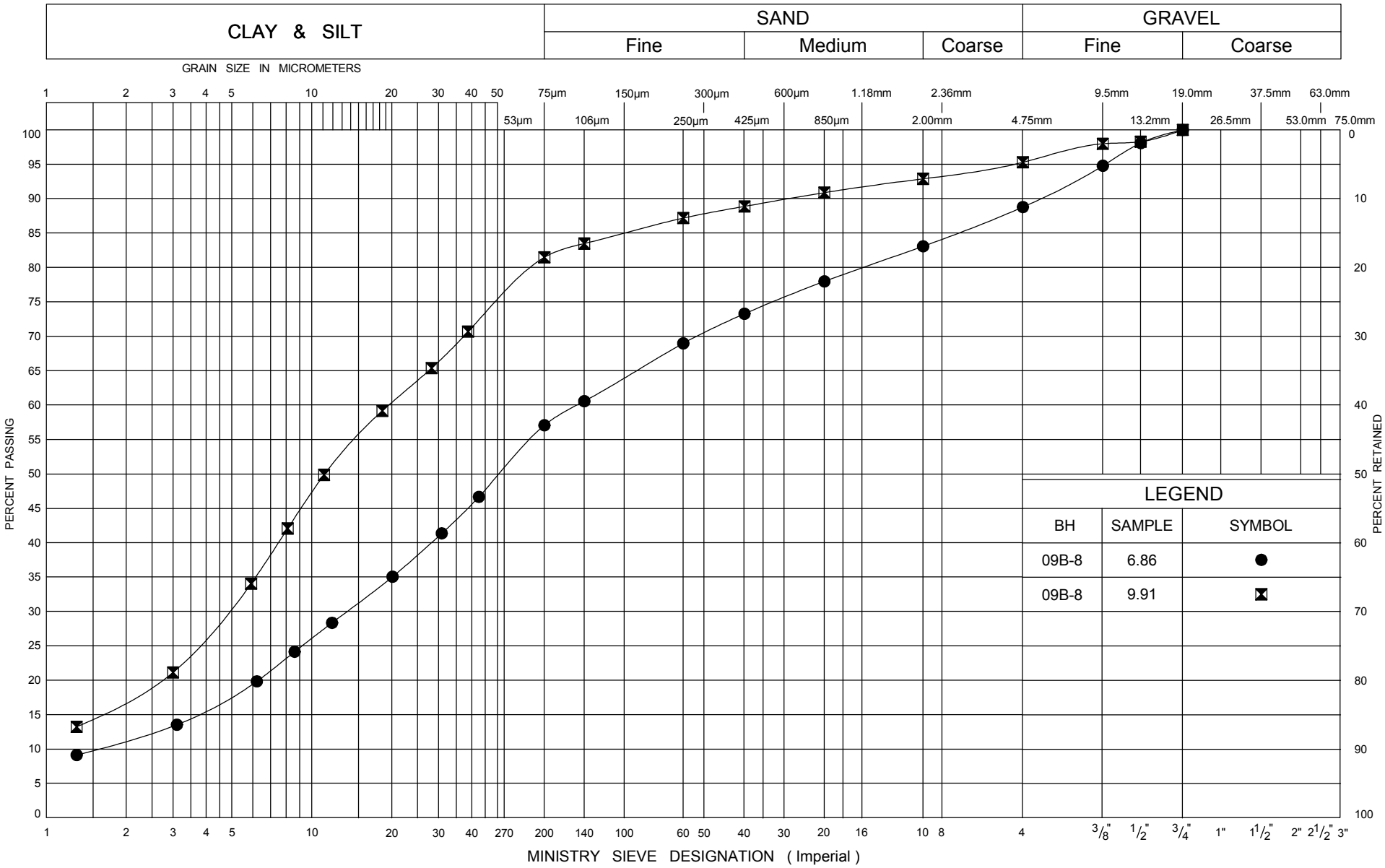
FIG No FILL.8

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

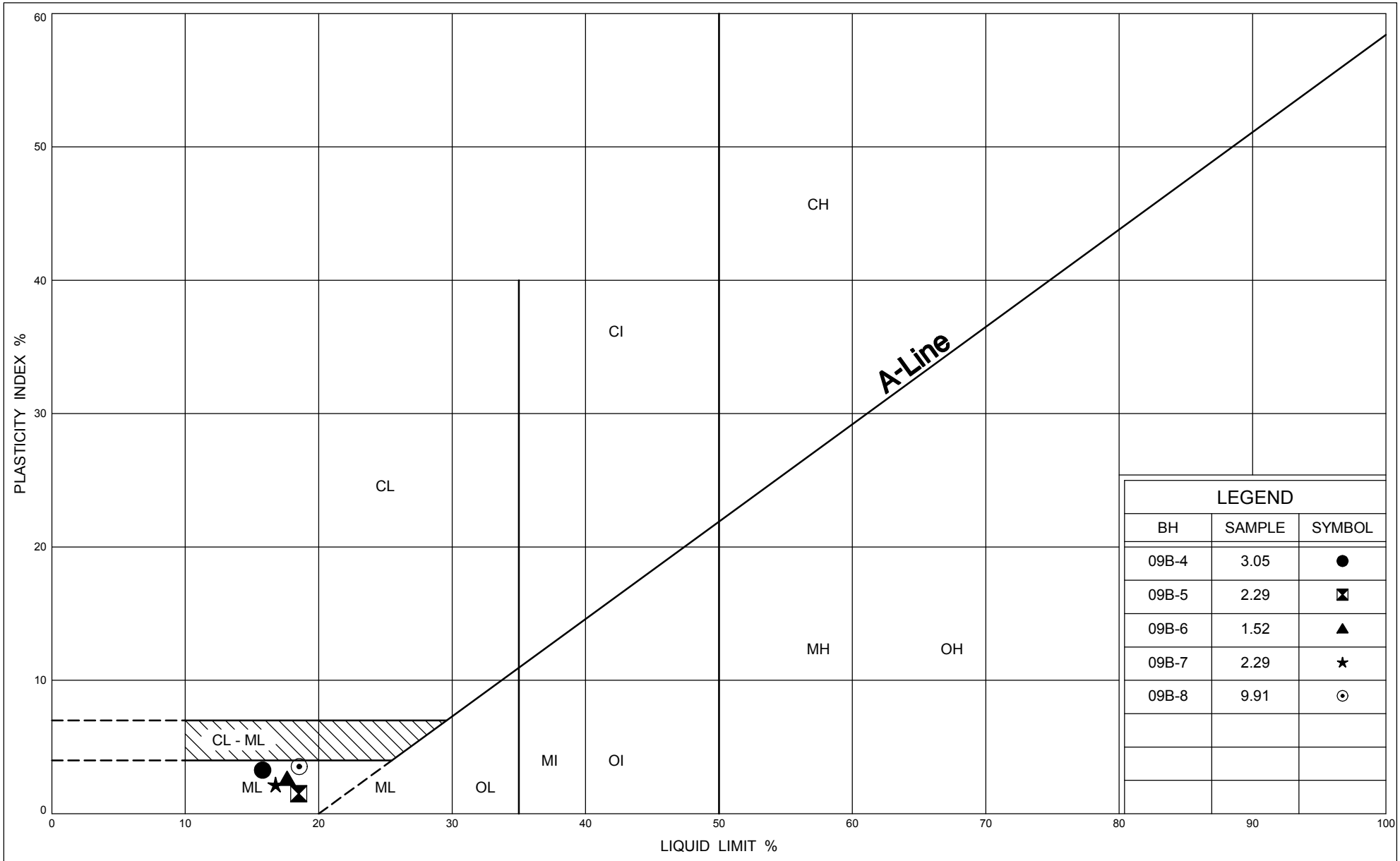
SAND AND SILT SEAMS, LAYERS AND POCKETS, SM TO ML

FIG No FILL.9

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford

ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09



Ministry of Transportation
Ontario

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

ONTARIO MOT PLASTICITY CHART LARGE CULVE 07-6-IEG1B.GPJ ONTARIO MOT.GDT 8/11/09

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.

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