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

Corporate Office
35-69 Bessemer Road
London, Ontario
N6E 2V6
tel: (519) 680-9991
fax: (519) 680-9993
email: info@lawengineering.com

FOUNDATION INVESTIGATION REPORT
PROPOSED RECONSTRUCTION OF
CULVERTS 1 AND 2
G.W.P. 3097-03-00
Agreement # 3005-A-000403

Prepared for:

SNC-Lavalin Engineers & Contractors Inc.
2200 Lake Shore Blvd. West
Toronto, Ontario
Canada M8V 1A4

Mr. Bing Wong, P.Eng

Prepared by:

Infrastructure Engineering Group Inc.
35-69 Bessemer Road
London, Ontario
N6E 2V6

January 7, 2005
04-5-IEG3-C1&2

Distribution:
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Geocres: 41A-180

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Drawings & Appendices

1. INTRODUCTION

This report presents the results of a foundation investigation carried out in October 2004 by Infrastructure Engineering Group Inc. on behalf of SNC-Lavalin Engineers & Contractors Inc. The entire scope of the work consists of one (1) culvert on Highway 9 at 4.5 km East of Highway 21 Intersection in Kincardine, and sixteen (16) culverts on Highway 21 from Kingsbridge Northerly to Amberley, Length - 11.8 km. According to the Request for Proposal, Culverts 1 to 3 are to be rehabilitated, while Culverts 4 to 17 are to be reconstructed. Subsequently, the existing condition of Culverts 1 and 2 were assessed structurally and hydraulically by SNC-Lavalin Engineers & Contractors Inc. and recommended for reconstruction. All of the replacement culverts will be lengthened in order to accommodate the future pavement widening to design standards. This report covers the site of Culvert 1 (Structure 12-436-C) and Culvert 2 (Structure 12-538-C).

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 work presented herein was undertaken under MTO G.W.P. # 3097-03-00, Agreement No. 3005-A-000403. Authorization to proceed was given verbally by Mr. Bing Wong of SNC-Lavalin Engineers & Contractors Inc. and confirmed in an email dated May 12, 2004, along with the MTO letter of Conditional Award dated May 12, 2004. Approval of the additional work was received in an email dated October 4, 2004.

2. SITE DESCRIPTION

2.1 Site Location

Culvert 1 (Structure 12-436-C) and Culvert 2 (Structure 12-538-C) are located on Highway 21 at the south end of the project respectively at Station 20+131.5 and Station 20+579. The existing culverts are reinforced concrete, open footing box culverts. Culvert 1 has existing dimensions of 6.0 m wide by 2.1 m high by 20.21 m long, with an approximate overfill height of 1.7 m. Culvert 2 has existing dimensions of 2.84 m wide by 1.1 m high by 22.11 m long, with an approximate overfill height of 1.7 m.

The approach embankments were built on both north and south sides of the culverts, with a maximum height of approximately 2.6 m at Culvert 1 and 2.0 m at Culvert 2. The embankment slopes are typically 2.5H:1V and are grass covered. No signs of embankment slope instability were observed at the time of this foundation investigation.

2.2 Physiography and Topography

The site is located within the Physiographic Region known as the "Huron–slope" (Chapman and Putnam, 1984) which occupies the area east of Lake Huron between Sarnia and Tobermory. The area is characterized by a flat topography, heavy textured soil and poor drainage. The surficial deposits consist of brown, calcareous clayey tills, which contain very few cobbles and boulders. The tills are known to be underlain by grey stratified clays of lacustrine origin.

The asphalt pavement surface over Culvert 1 is near elevation 206.4 m while the ground surface at the base of the embankment and in the flood plain is between elevations 204.0 and 204.4 m. At Culvert 2, the asphalt pavement surface is near elevation 208.0 m and the ground surface at the base of the embankment and in the flood plain is between elevations 206.0 and 206.6 m.

3. INVESTIGATION PROCEDURES

3.1 Field Investigation

On October 6 and 7, 2004, a CME 55 drill rig was used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586). Three (3) boreholes were drilled and sampled at each site to obtain data for foundation design of the proposed replacement culvert. The boreholes were drilled to depths of a minimum 6 m depth (or deeper if required) below the culvert inverts to provide sufficient subsurface information for the evaluation of bearing resistances.

The boreholes were drilled 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 between 0.75 and 1.5 m to the maximum depth of exploration.

Field pocket penetrometer was used on the retrieved SPT samples to determine the undrained shear strength of the cohesive soil deposits. It is noted that the measured shear strength value would be slightly lower than the actual value due to sampling disturbance.

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 Appendices 1 and 2.

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 and unit weight tests were performed on selected samples.

The results of the laboratory testing are presented on the Record of Borehole sheets and in the respective figures presented in Appendices 1 and 2.

4. SUBSURFACE CONDITIONS

Reference is made to the respective appendix of each culvert site for the Record of Borehole sheets and Laboratory Test Results (Appendices 1 and 2) 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 and Soil Data drawings will vary between and beyond the borehole locations.

In general, the subsurface deposits at these two (2) culvert sites consist of loose to compact embankment fill placed on very stiff to hard silty clay till.

4.1 Culvert 1, Structure 12-436-C

Borehole C01-1, which was located at the edge of existing pavement in the shoulder area, encountered 750 mm shoulder gravel. Underlying the shoulder gravel is the embankment fill material that extended to a depth of 3.66 m (elevation 202.67 m). Boreholes C01-2 and C01-3 were located at the toe of the embankment (ends of the existing culvert). These two (2) boreholes encountered organic topsoil and mixed fill at the ground surface, extending to depths of 1.68 and 1.83 m, respectively.

The fill typically consists of silty clay. One (1) typical grain size distribution of the embankment fill is shown on Figure 1.1 of Appendix 1. The unit weight of the fill was measured to be 21.4 kN/m^3 based on a single test. Standard penetration test yielded "N"-values of 4 to 6 blows per

0.3 m.

This brown to grey fill had natural moisture contents in the range of 20 to 32%. One (1) Atterberg Limit test (Figure 1.3 of Appendix 1) on the silty clay fill sample reveals that the liquid limit is 25% and the plastic limit is 15%, with a plasticity index of 10%.

A major stratum of brown to grey silty clay was contacted below the fill material at all three (3) boreholes. The silty clay extended to the full depth of the boreholes (i.e., 9.60 m below the ground surface at Borehole C01-1 and elevation 195.91 m at Borehole C01-2). Five (5) grain size analyses were performed and the results are plotted on Figure 1.2 of Appendix 1. Within the silty clay, embedded sand and gravel particles were found.

Standard penetration tests within the silty clay stratum yielded "N"-values from 10 to 27 blows per 0.3 m. Undrained shear strength as determined from field pocket penetrometer ranged from over 225 kPa to 12.5 kPa. The unit weight was measured to be between 21.6 and 23.2 kN/m^3.

Five (5) silty clay samples were tested and exhibited the following Atterberg Limits. These results are shown in Figure 1.4 of Appendix 1 and summarized below:

Liquid Limit (W_L)	23 to 26%, average at 24.0%
Plastic Limit (W_P)	14 to 15%, average at 14.2%
Plasticity Index (I_p)	10 to 12%, average at 11.0%

The natural moisture contents were in the range of 11 to 28%. These results are characteristic of clayey soils of low to medium plasticity (CL). The measured natural moisture contents are generally at or slightly above the measured plastic limits and indicate that the deposit is pre-consolidated.

Based on the above field and laboratory test results and tactile examination, the silty clay deposit has a desiccated, brown, very stiff to hard crust of approximately 2.5 to 3 m thick. Below the crust, the stratum becomes grey and decreases in consistency to very stiff to stiff.

The groundwater condition was monitored during and upon completion of sampling. On completion of drilling, groundwater levels were noted in all three (3) boreholes at depths of 4.9 to 5.5 m below ground surface. The water entered the boreholes from the upper silty sand to silty clay fill layers in which groundwater was perched.

Water level in the watercourse is generally within 300mm from the invert of the culvert. The watercourse became dry at the time of elevation survey by Archibald, Gray & McKay Ltd. about 2 weeks after completion of the field work.

4.2 Culvert 2, Structure 12-538-C

Borehole C02-1, which was located at the edge of existing pavement in the shoulder area, encountered 750 mm shoulder gravel. Underlying the shoulder gravel is the embankment fill material that extended to a depth of 2.90 m (elevation 204.75 m). The fill typically consists of silty clay with a trace to some organics. This fill is generally brown in colour with the natural moisture contents measured between 11 and 30%. Standard penetration test yielded "N"-values of 12 and 14 blows per 0.3 m. The unit weight was measured to be 18.1 kN/m^3 based on a single test.

Boreholes C02-2 and C02-3 were located at the toe of the embankment (ends of the existing culvert). These two (2) boreholes encountered organic topsoil at the ground surface, with measured thickness of 200 and 150 mm, respectively.

One (1) grain size analysis on the fill material was performed and the results are plotted on Figure 2.1 of Appendix 2. One (1) Atterberg Limit test on the silty clay fill sample reveals that the liquid limit is 42%; plastic limit is 15%, with a plasticity index of 17%, (Figure 2.3 of Appendix 2).

A major stratum of brown to grey silty clay was contacted below the fill material at Borehole C02-1 and the topsoil layer at Boreholes C02-2 and C02-3 and extended to the full depth of the boreholes (i.e., 8.84 m below the ground surface at Borehole C02-1 and elevation 198.29 m at Borehole C02-2). Six (6) grain size analyses were performed and the results are plotted on Figure 2.2 of Appendix 2. Within the silty clay, embedded sand and gravel particles were found.

Standard penetration tests within the silty clay stratum yielded "N"-values from 14 to 52 blows per 0.3 m. Undrained shear strength as determined from field pocket penetrometer ranged from over 225 kPa to 25 kPa. The unit weight was measured to be between 20.4 and 22.2 kN/m^3.

Six (6) silty clay samples were tested and exhibited the following Atterberg Limits. These results are shown in Figure 2.4 of Appendix 2 and summarized below:

Liquid Limit (W_L)	23 to 27%, average at 26.3%
Plastic Limit (W_P)	14%
Plasticity Index (I_p)	9 to 13%, average at 11.0%

The natural moisture contents were in the range of 12 to 18%. These results are characteristic of clayey soils of low to medium plasticity (CL). The measured natural moisture contents are generally at or slightly above the measured plastic limits and indicate that the deposit is pre-consolidated.

Based on the above field and laboratory test results and tactile examination, the silty clay deposit

has a desiccated, brown, very stiff to hard crust of approximately 4 to 5.5 m thick. Below the crust, the stratum becomes grey and decreases in consistency to very stiff to stiff.

The groundwater condition was monitored during and upon completion of sampling. All three (3) boreholes remained dry and open throughout the sampling operations.

Water level in the watercourse is generally within 300mm from the invert of the culvert. The watercourse became dry with only puddles at both ends of the culvert at the time of elevation survey by Archibald, Gray & McKay Ltd. about 2 weeks after completion of the field work.

5. 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 3, 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

Appendix 1

Data for Culvert 1, Structure 12-436-C

Borehole Locations and Soil Data	Drawing C1.1
Record of Borehole Sheets	Boreholes C01-1 to C01-3
Laboratory Test Results	
Grain Size Distribution	Figures 1.1 to 1.2
Plasticity Chart	Figures 1.3 to 1.4

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No 3097-03-00

SHEET 1

Culvert #1-Griffins Creek
Highway 21
BORE HOLE LOCATIONS & SOIL STRATA

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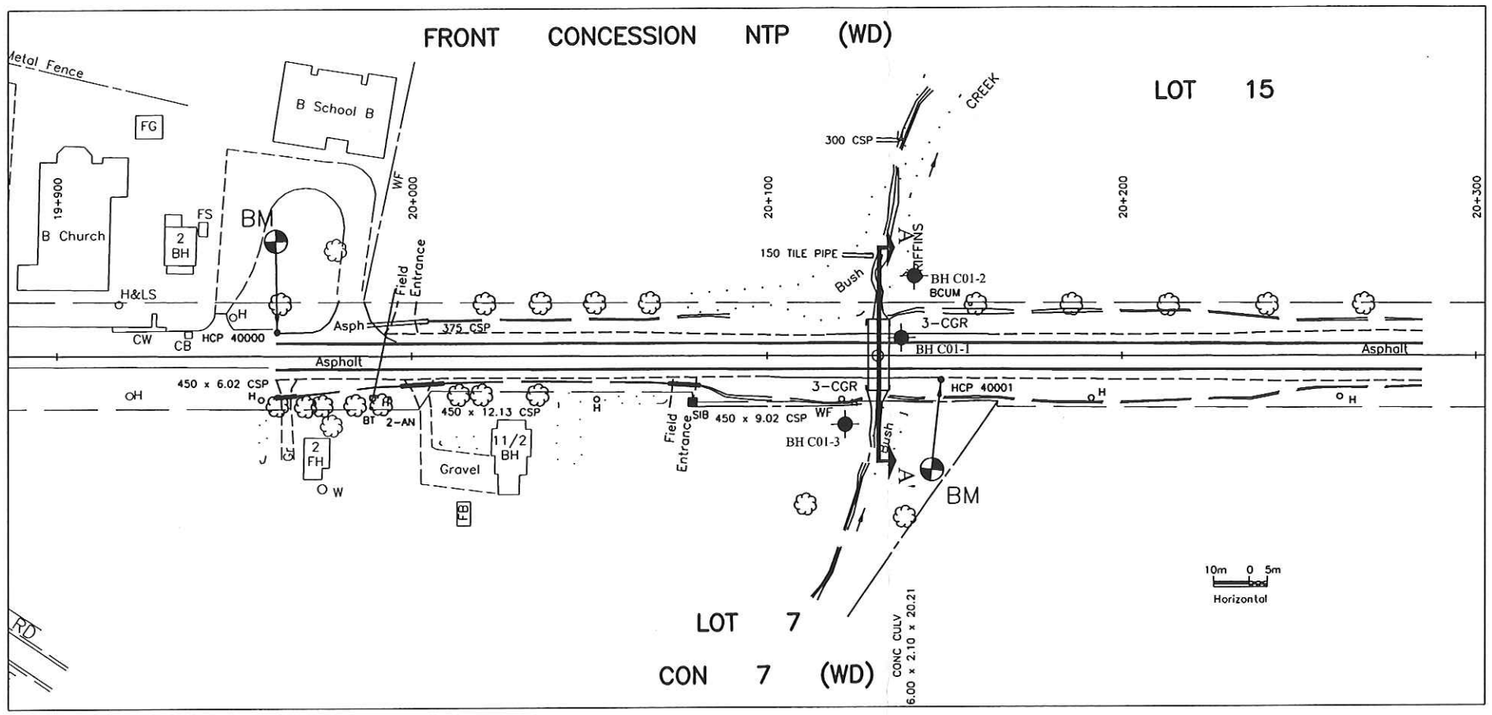
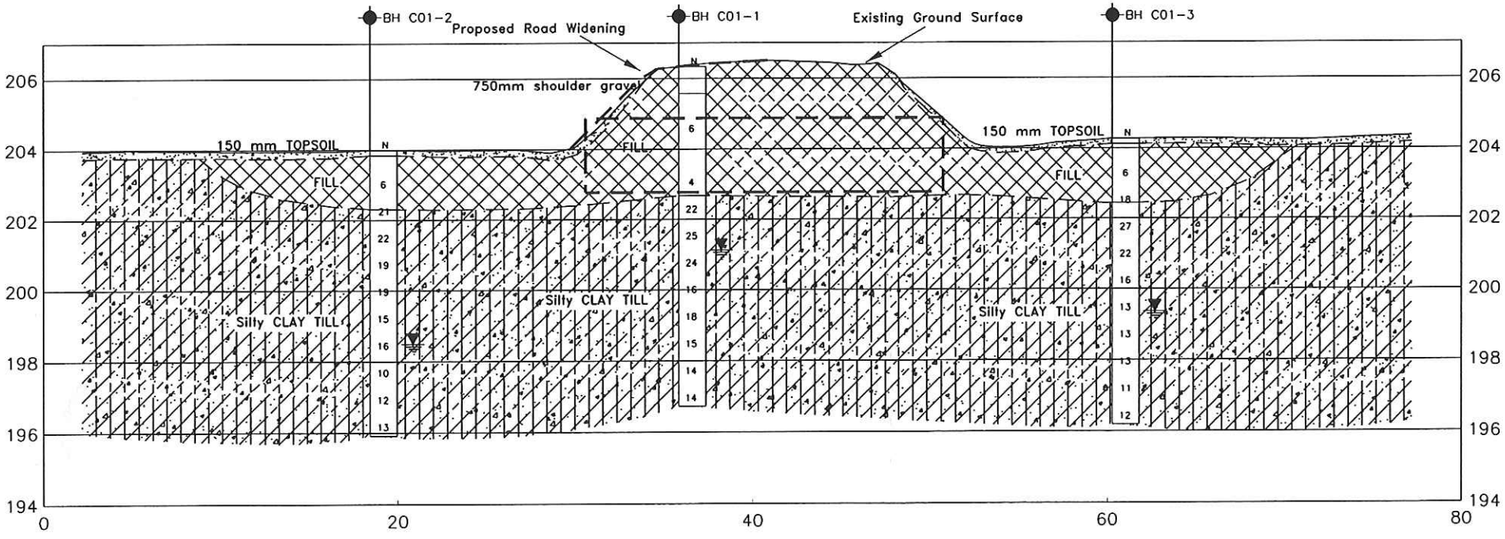
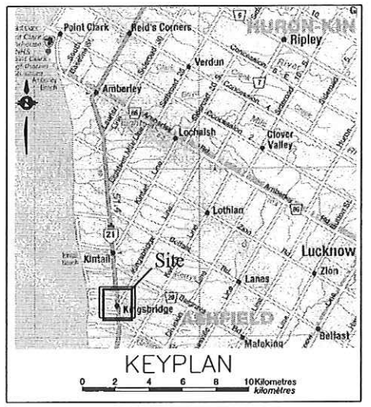




SECTION A-A'

10m 0 5m
Horizontal

BH C01-3 is brought into the view of section A-A'



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

No.	ELEVATION	CO-ORDINATES NORTH	EAST
C01-1	206.33	4866079.085	369045.553
C01-2	203.99	4866080.966	369027.897
C01-3	204.27	4866065.557	369071.417

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS		
11/05/04	AL	Draft
DATE	BY	DISCRIPTION

Geocres : 41A-180

NOTE: 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 is specifically excluded in accordance with the conditions of Section GC2.01 of OPS Gen. Cond.

HWY No.	HWY 21		DIST Owen Sound
SUBM'D AL	CHECKED J.L.	DATE November 05, 2004	SITE 12-436-C
DRAWN AL	CHECKED J.L.	APPROVED E.C.	DWG C1.1

RECORD OF BOREHOLE No C01-1 1 OF 1 METRIC

W.P. G.W.P. 3097-03-00 LOCATION STA 20+137.9, OFFSET -5.0 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.6.04 - 10.6.04 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O 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
206.33	Ground Surface										
0.00	750mm shoulder gravel						206				
205.58											
0.75	Brown Moist, loose to very loose, FILL, consisting of silty clay.		1	SS	6		205				
	Greenish Brown		2	SS	4		204			21.4	3 52 28 17 (46)
202.67							203				
3.66			3	SS	22			162.5			
			4	SS	25	▽	202	137.5		21.9	2 12 52 34 (86)
			5	SS	24		201	87.5			
	Grey, moist, very stiff to stiff, Silty CLAY with embedded sand and gravel (TILL)		6	SS	16		200	75		21.8	3 13 53 32 (85)
			7	SS	18		199	25			
			8	SS	15			12.5		23.2	2 13 55 31 (86)
			9	SS	14		198	25			
196.73			10	SS	14		197	25			
9.60	End of Borehole. Water level measured at 5.2m at completion of drilling.										

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

O^{150} UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

JOE MTO FINAL 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/2/04

RECORD OF BOREHOLE No C01-2 1 OF 1 METRIC

W.P. G.W.P. 3097-03-00 LOCATION STA 20+141.5, OFFSET -22.4 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.6.04 - 10.6.04 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O 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
203.99	Ground Surface										
203.84 / 0.15	150 mm TOPSOIL										
	Brown/grey, moist, loose, FILL, consisting of silt, trace sand, clay and organics.		1	SS	6		203				
202.31 / 1.68			2	SS	21		202				
			3	SS	22		201				
			4	SS	19					23.2	4 13 51 32 (83)
			5	SS	19		200				
	Grey, moist, very stiff to stiff, Silty CLAY with embedded sand and gravel (TILL)		6	SS	15		199	62.5			
			7	SS	16	▽		25			
			8	SS	10		198	12.5			
			9	SS	12		197	12.5			
195.91			10	SS	13		196				
8.08	End of Borehole. Water level measured at 5.5m at completion of drilling.										

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

O^{150} UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

JOE MTO FINAL 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/2/04

RECORD OF BOREHOLE No C01-3 1 OF 1 METRIC

W.P. G.W.P. 3097-03-00 LOCATION STA 20+122.0, OFFSET 19.4 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.6.04 - 10.6.04 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.27	Ground Surface							
204.12 / 0.15	150 mm TOPSOIL							
	Brown, moist to wet, loose, FILL, consisting of sandy silt.		1	SS	6			
			2	SS	18			
202.44 / 1.83			3	SS	27			
			4	SS	22			
			5	SS	16			
	Grey, moist, very stiff to stiff, Silty CLAY with embedded sand and gravel (TILL)		6	SS	13	▽	21.6	2 12 54 31 (86)
			7	SS	13			
			8	SS	13			
			9	SS	11			
196.19			10	SS	12			
8.08	End of Borehole. Water level measured at 4.9m at completion of drilling.							

DYNAMIC CONE PENETRATION RESISTANCE PLOT (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)

ELEVATION SCALE: 204, 203, 202, 201, 200, 199, 198, 197

225+ 125 68.75 37.5 25 18.75 25

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

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

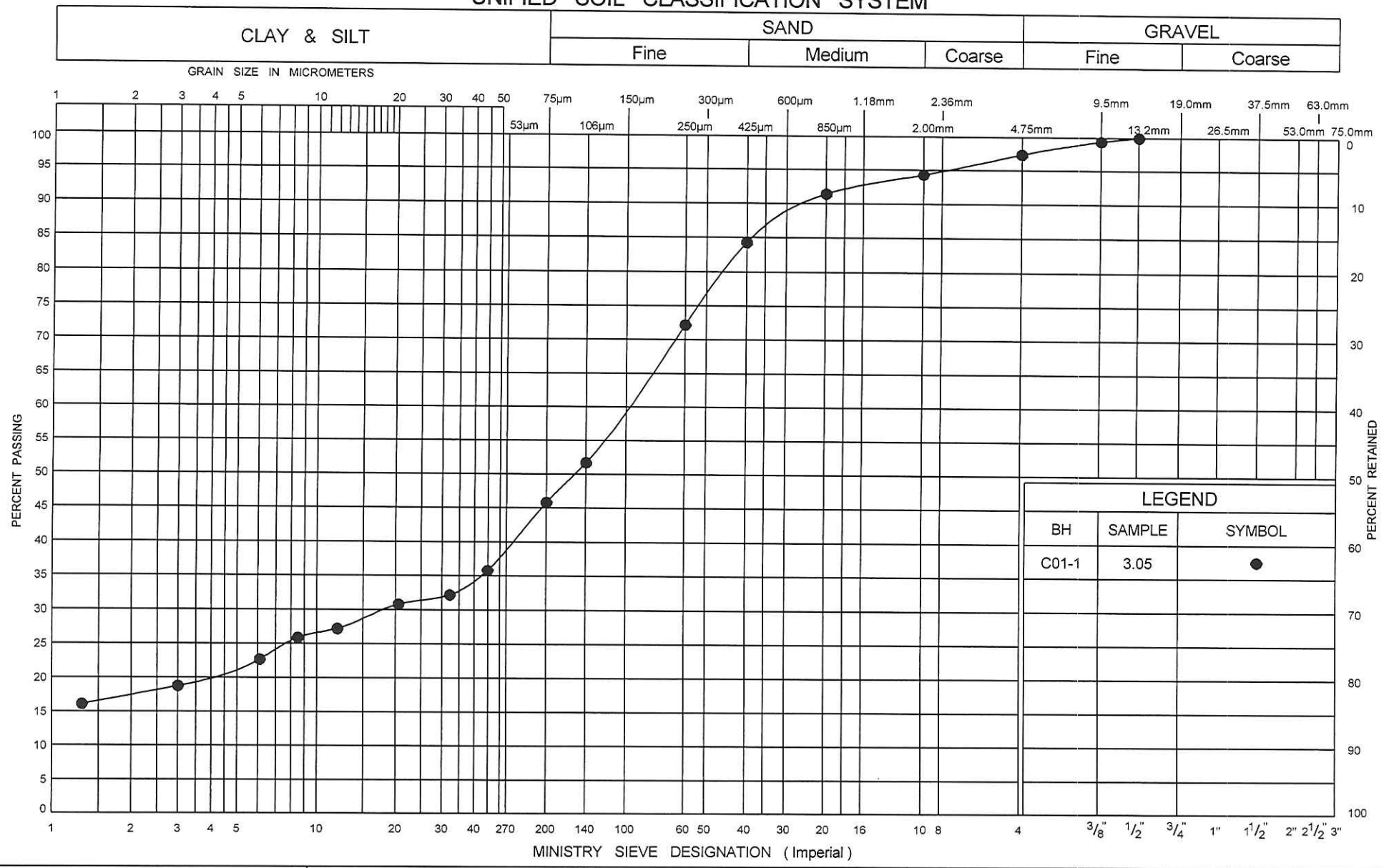
Appendix 2

Data for Culvert 2 (<3m)

Borehole Locations and Soil Data	Drawing C2.1
Record of Borehole Sheets	Boreholes C02-1 to C02-3
Laboratory Test Results	
Grain Size Distribution	Figures 2.1 to 2.2
Plasticity Chart	Figures 2.3 to 2.4

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

FIG No 1.1

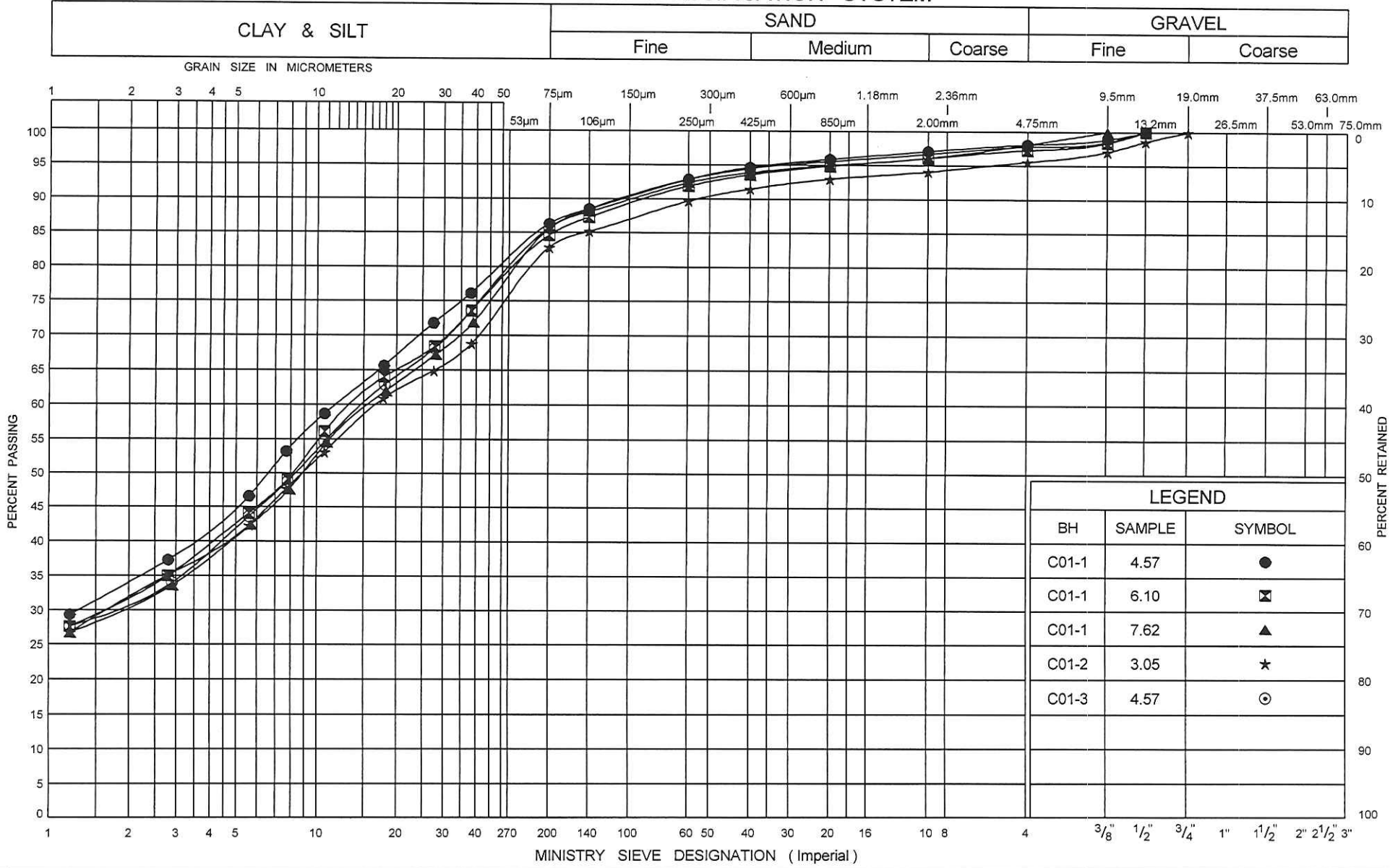
G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

ONTARIO MOT GRAIN SIZE 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
C01-1	4.57	●
C01-1	6.10	⊠
C01-1	7.62	▲
C01-2	3.05	★
C01-3	4.57	⊙

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Ontario

GRAIN SIZE DISTRIBUTION

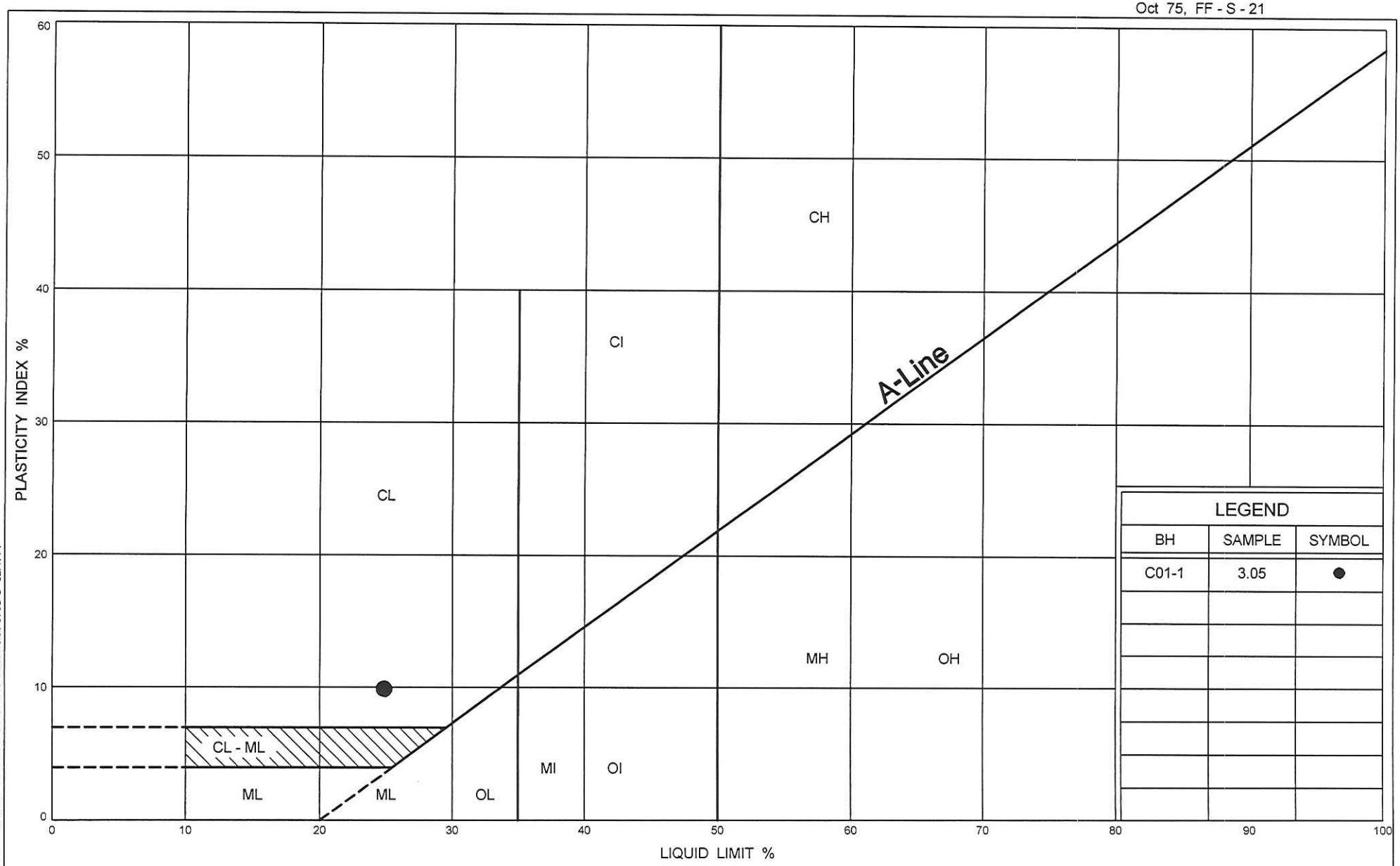
FIG No 1.2

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

ONTARIO MOT GRAIN SIZE 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

Oct 75, FF - S - 21



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PLASTICITY CHART

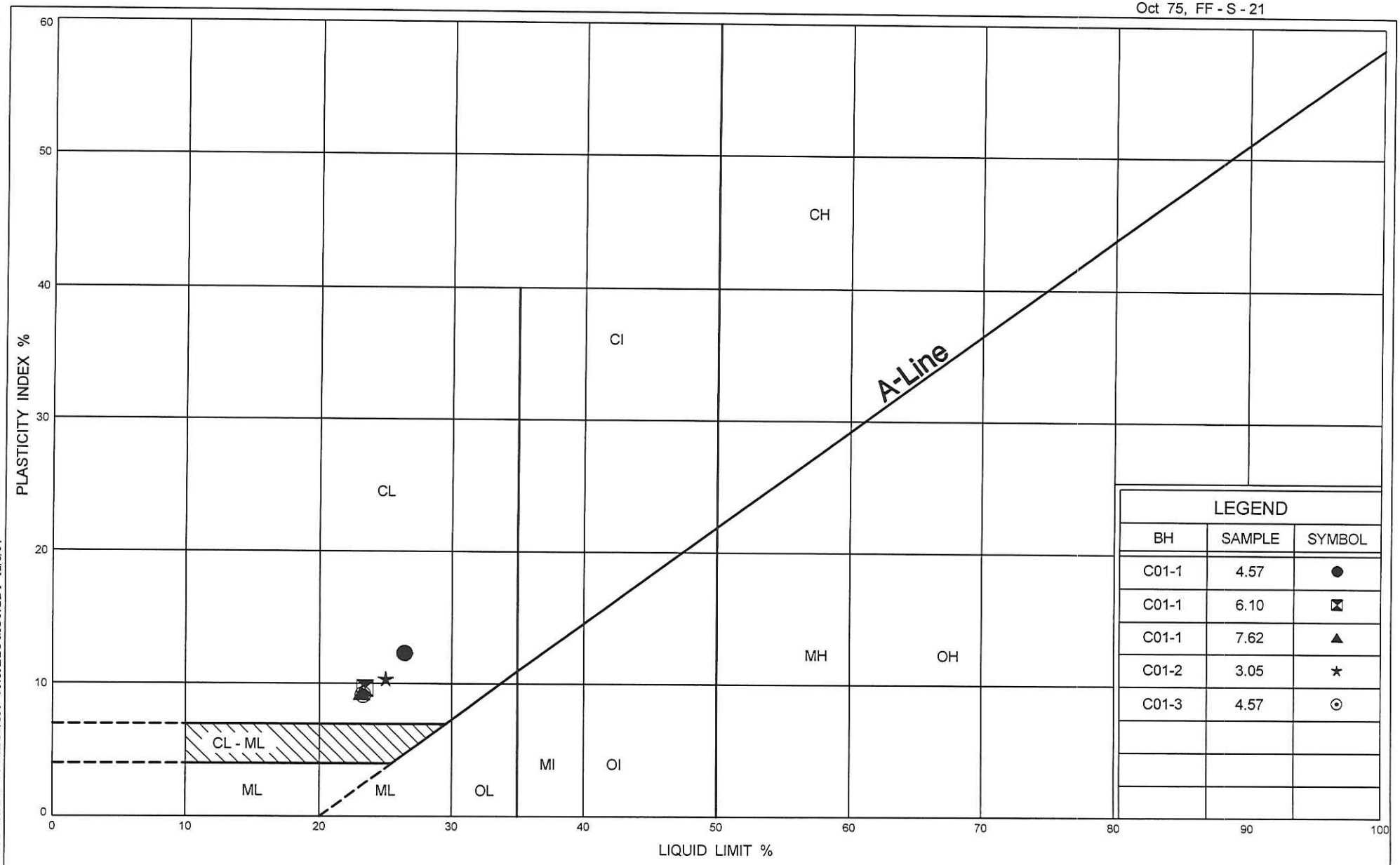
FIG No 1.3

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

ONTARIO MOT PLASTICITY CHART 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
C01-1	4.57	●
C01-1	6.10	⊠
C01-1	7.62	▲
C01-2	3.05	★
C01-3	4.57	⊙

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PLASTICITY CHART

FIG No 1.4

G.W.P. 3097-03-00

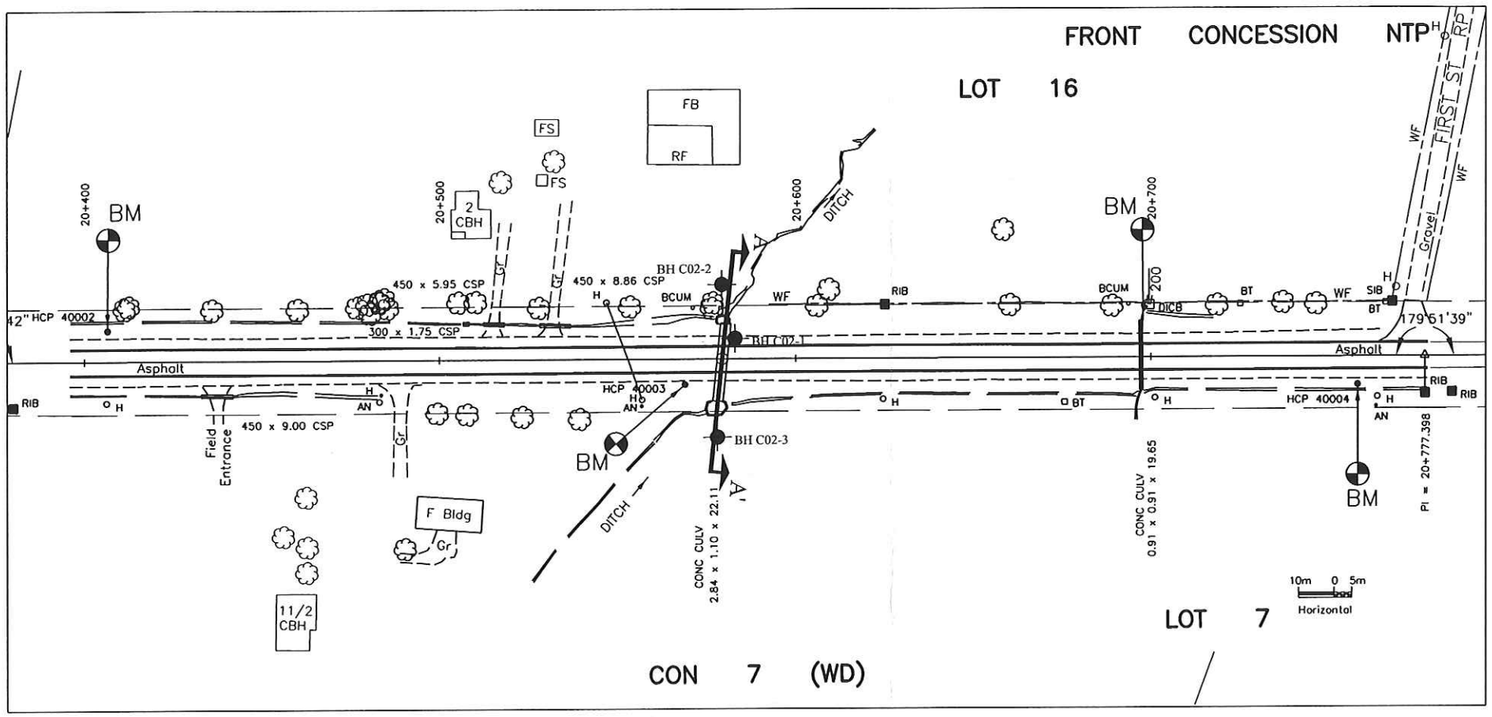
Concrete Culvert Replacements & Rehabilitations

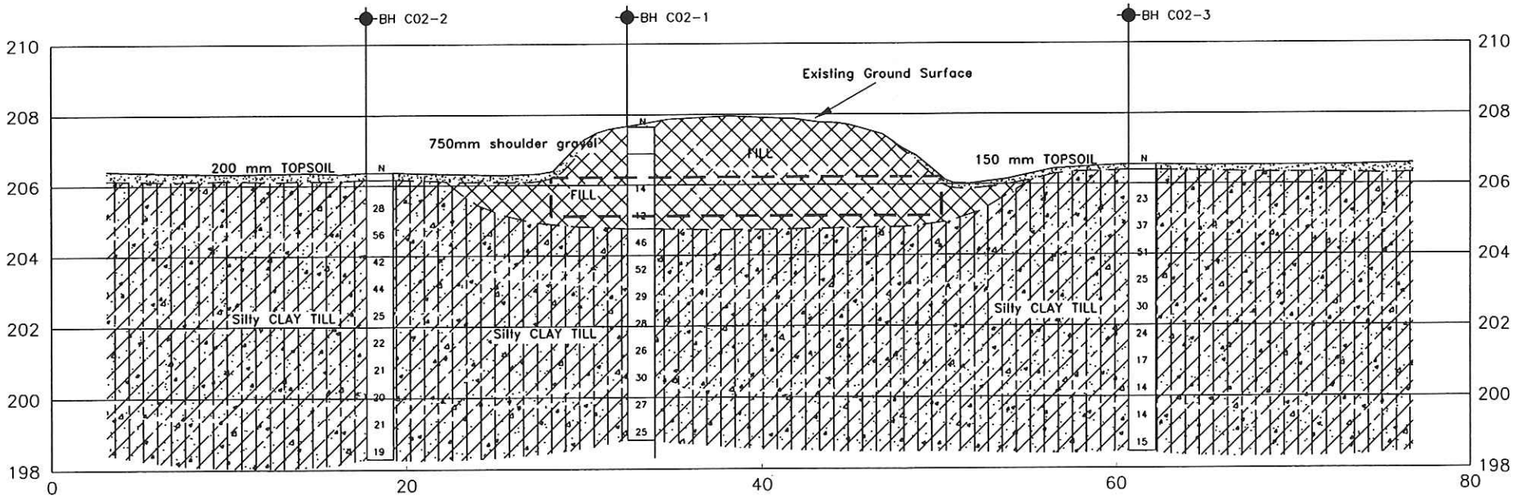
ONTARIO MOT PLASTICITY CHART 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

Appendix 2

Data for Culvert 2, Structure 12-538-C

Borehole Locations and Soil Data	Drawing C2.1
Record of Borehole Sheets	Boreholes C02-1 to C02-3
Laboratory Test Results	
Grain Size Distribution	Figures 2.1 to 2.2
Plasticity Chart	Figures 2.3 to 2.4





BH C02-2 is brought into the view of section A-A'

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No 3097-03-00

Culvert #2
Highway 21
BORE HOLE LOCATIONS & SOIL STRATA

SHEET 1

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Pavement & Construction Materials Consulting Engineers
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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

No.	ELEVATION	CO-ORDINATES NORTH	EAST
C02-1	207.65	4866521.805	369001.234
C02-2	206.37	4866516.683	368986.502
C02-3	206.55	4866519.729	369029.460

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS		
11/05/04	AL	Draft
DATE	BY	DISCRIPTION

Geocres : 41A-180

HWY No.	HWY 21		DIST Owen Sound
SUBM'D AL	CHECKED J.L.	DATE November 05, 2004	SITE 12-538
DRAWN AL	CHECKED J.L.	APPROVED E.C.	DWG C2.1

NOTE: 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 is specifically excluded in accordance with the conditions of Section GC2.01 of OPS Gen. Cond.

RECORD OF BOREHOLE No C02-1 1 OF 1 METRIC

W.P. G.W.P. 3097-03-00 LOCATION STA 20+582.9, OFFSET -5.74 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.7.04 - 10.7.04 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (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
207.65	Ground Surface										
0.00	750mm shoulder gravel										
206.90							207				
0.75	Brown, moist, compact, FILL, consisting of silty clay, trace to some organics.		1	SS	14		206				
			2	SS	12		205		42	18.1	5 30 40 26 (65)
204.75											
2.90	Brown		3	SS	46			225+			
			4	SS	52		204	225+		20.4	1 12 54 33 (88)
			5	SS	29		203	162.5			
	Moist, hard to very stiff, Silty CLAY with embedded sand and gravel (TILL)		6	SS	28		202	112.5		22.2	1 12 55 32 (88)
			7	SS	26			100			
	Grey		8	SS	30		201			21.9	3 12 53 31 (85)
			9	SS	27		200	100			
198.81			10	SS	25		199			21.6	1 12 56 32 (88)
8.84	End of Borehole. Borehole dry and open at completion.										

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

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

JOE MTO FINAL 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/3/04

RECORD OF BOREHOLE No C02-2

1 OF 1 **METRIC**

W.P. G.W.P. 3097-03-00 LOCATION STA 20+597.2, OFFSET -20.9 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.7.04 - 10.7.04 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O 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
206.37	Ground Surface										
206.17	200 mm TOPSOIL										
0.20	Brown		1	SS	28		206		225+		
			2	SS	56		205		225+		
			3	SS	42		204		225+		
			4	SS	44		203		225+	21.6	5 11 52 32 (84)
	Moist, hard to very stiff, Silty CLAY with embedded sand and gravel (TILL)		5	SS	25				137.5		
			6	SS	22		202		187.5		
	Grey		7	SS	21		201	100			
			8	SS	20		200				
			9	SS	21			50			
							199				
			10	SS	19			75			
198.29											
8.08	End of Borehole. Borehole dry and open at completion.										

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

O^{150} UNCONFINE SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No C02-3 1 OF 1 METRIC

W.P. G.W.P. 3097-03-00 LOCATION STA 20+578.0, OFFSET 22.1 ORIGINATED BY RB

DIST Owen Sound HWY 9 & 21 BOREHOLE TYPE 100mm SST Auger COMPILED BY JL

DATUM Geodetic DATE 10.7.04 - 10.7.04 CHECKED BY EC

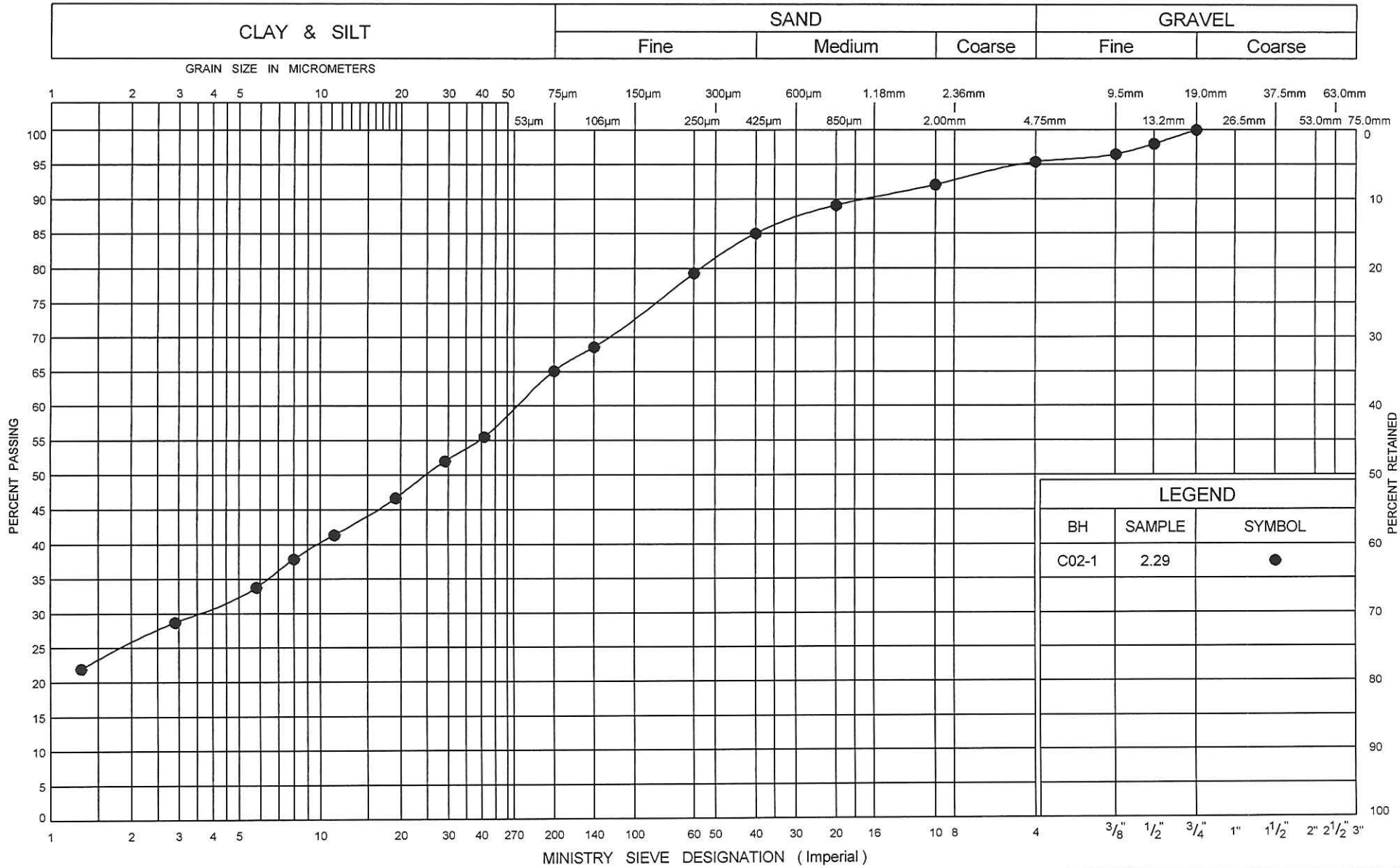
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.55	Ground Surface										
206.40 / 0.15	150 mm TOPSOIL										
	Brown		1	SS	23		206		225+		
			2	SS	37		205		225+		
			3	SS	51		204		225+		
			4	SS	25				200		
	Moist, hard to stiff, Silty CLAY with embedded sand and gravel (TILL)		5	SS	30		203	100			
			6	SS	24		202	100		21.5	2 12 55 32 (87)
	Grey		7	SS	17		201	75			
			8	SS	14			50			
			9	SS	14		200	25			
			10	SS	15		199	37.5			
198.47 / 8.08	End of Borehole. Borehole dry and open at completion.										

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

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

JOE MTO FINAL 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/2/04

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

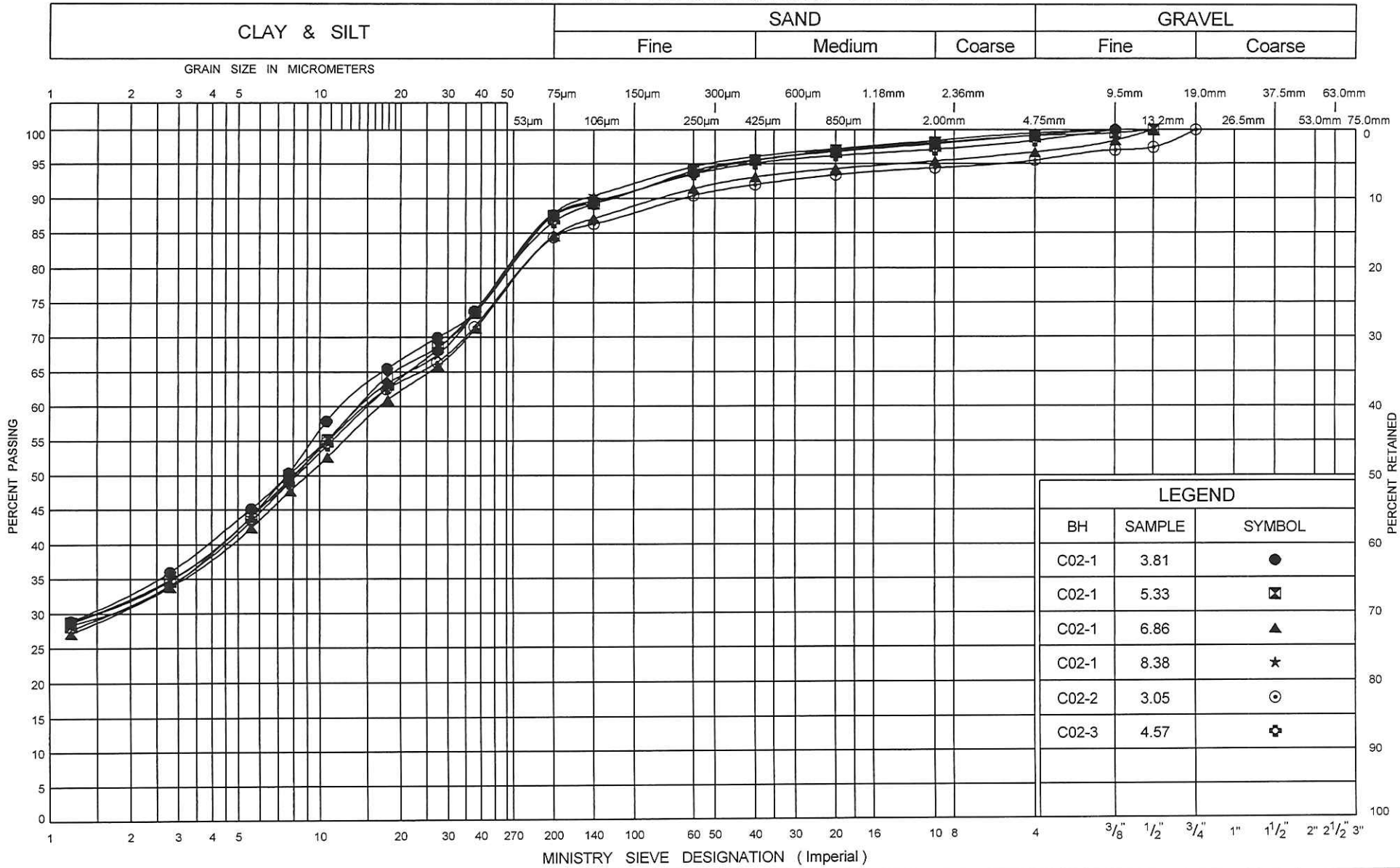
FIG No 2.1

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

ONTARIO MOT GRAIN SIZE 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

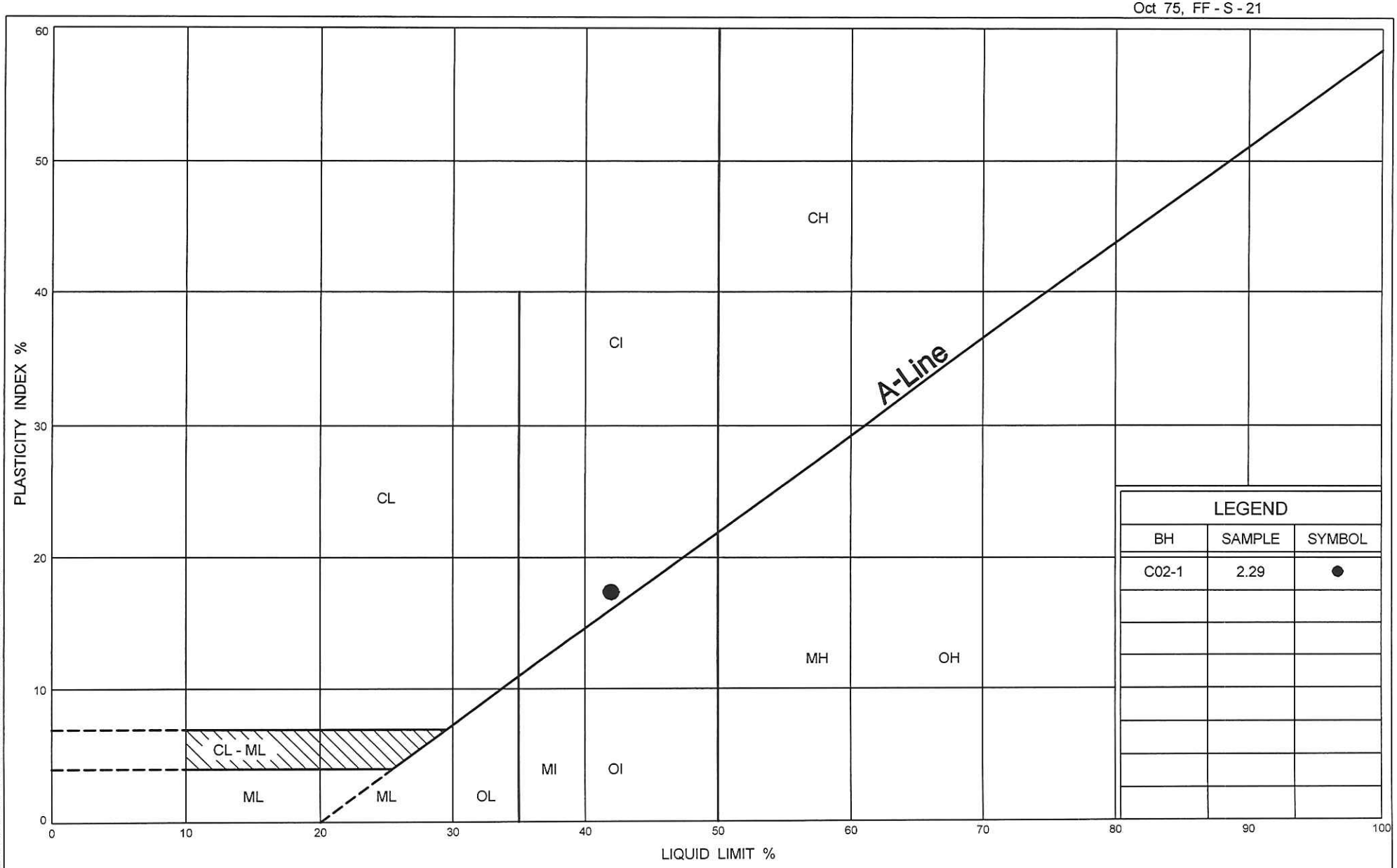
GRAIN SIZE DISTRIBUTION

FIG No 2.2

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 04-5-IEG3.GPJ ONTARIO.MOT.GDT 12/8/04

Ministry of Transportation
Ontario

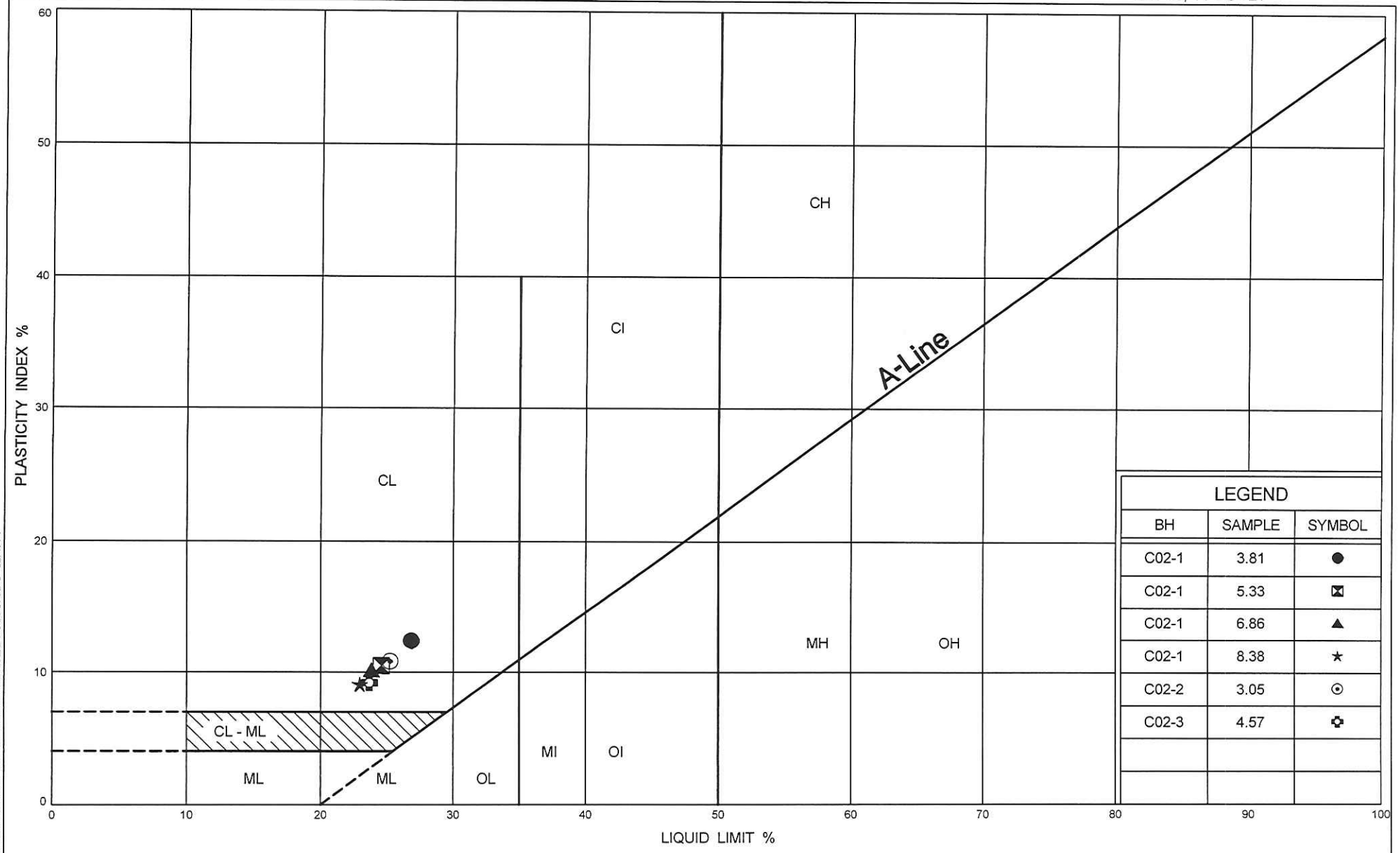
PLASTICITY CHART

FIG No 2.3

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
C02-1	3.81	●
C02-1	5.33	⊠
C02-1	6.86	▲
C02-1	8.38	★
C02-2	3.05	⊙
C02-3	4.57	✿

Ministry of Transportation
Ontario

PLASTICITY CHART

FIG No 2.4

G.W.P. 3097-03-00

Concrete Culvert Replacements & Rehabilitations

ONTARIO MOT PLASTICITY CHART 04-5-IEG3.GPJ ONTARIO MOT.GDT 12/8/04

Appendix 3

Limitations of Report

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, I.E. Group 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.