GEOCRES No.
30M3-229

DRAFT

Foundation Investigation and
Design Report
Proposed Cantilever Sign
Highway 406 at St. Paul Street,
St. Catharines, Ontario
District – St. Catherines
G.W.P. 2448-04-00

LEA CONSULTING LTD.

PROJECT NO. 1009683
GEOCRES NO. TBD

Jacques Whitford

REPORT NO. 1009683

REPORT TO	**Lea Consulting Limited** **625 Cochrane Drive Suite 900** **Markham, Ontario** **L3R 9R9**
FOR	**Draft** **Foundation Investigation and Design Report**
ON	**Proposed Cantilever Sign** **Highway 406 at St. Paul Street** **St. Catherines, Ontario** **District – St. Catherines** **G.W.P. 2448-04-00** **Geocres. No. TBD**

April 24, 2007

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Jacques Whitford

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Highway 406 Southbound Lanes at
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City of St. Catherines, Ontario
G.W.P. 2448-04-00
District – St. Catherines

1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by Lea Consulting Ltd. to complete a Foundation Investigation and Design Report for the design and construction of a proposed cantilever sign to be located on the right shoulder of the southbound lanes of Highway 406, just north of the St. Paul Street bridge structure, in the City of St. Catherines, Ontario, (G.W.P. No. 2448-04-00).

The work was carried out under Agreement No. 2004-E-0067 and in accordance with our fee estimate titled "Consolidated Intersections Scope Change 4, Geotechnical Investigation – Proposed Cantilever Sign", dated March 29, 2007. Authorization to proceed with the investigation was provided by Ms. Olga Garces, of the MTO via e-mail dated March 22, 2007, through Mr. Rick Hassall, P. Eng., of Lea Consulting Ltd., the prime consultant on this assignment.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the field investigation and the laboratory testing program.

2.0 SITE DESCRIPTION

It is understood that consideration is being given to replacing an existing overhead sign with a new cantilever sign. The existing sign is located on the southbound lanes of Highway 406 just north of the St. Paul Street bridge structure over Highway 406, in St. Catherines, Ontario.

In the area of the St. Paul Street overpass, Highway 406 is built to on low embankments with a semi-urban profile and paved shoulders. Based on visual observations, the embankments are approximately 1 m to 2 m high. In the area of the proposed sign Highway 406 is super-elevated. The southbound lanes slope downward from the southbound right shoulder to the left shoulder. There is a concrete barrier in the centre median that separates the southbound and northbound traffic. Drainage is provided by a series of catchbasins located along the central median.

A steel guard rail is located along the right edge of the paved shoulder of the south bound lanes. The ground surface beyond the steel guardrail is covered with grass and trees of varying maturity and slopes downward towards Twelve Mile Creek located approximately 150 m to 200 m from the site.

3.0 PHYSIOGRAPHY

Based on the physiography of Southern Ontario by Chapman and Putnam (1984), this section of Highway 406 is situated in the physiographic region known as the Iroquois clay plain.

Physiographic Map P. 2715, indicates that the site is situated on the boundary between a sand plain and a clay plain.

Based on Map 2544, Bedrock Geology of Ontario, dated 1991, the bedrock in the area of the site consists of shale, limestone and dolostone of the Queenstown Formation.

4.0 INVESTIGATION PROCEDURES

4.1 Field Program

The field investigation consisted of advanced single borehole in the approximate location of the planned sign, to a depth consistent with the requirements outlined in the MTO Sign Support Manual.

The borehole location was established in the field by Jacques Whitford personnel. The borehole location was cleared of underground utilities by the various utility companies.

The fieldwork for the investigation was carried out on April 5, 2007. Freeway traffic control was provided by OTS in accordance with Book 7 Guidelines.

The borehole was advanced to a depth of approximately 12.8 m using a track mounted drill rig equipped with 200 mm (outside diameter), hollow-stem augers. Soil samples were recovered from the borehole at regular intervals using a 50 mm Outside Diameter split-tube sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in the ASTM specification D1586.

Where cohesive soils were encountered, in situ shear vane testing was carried out using a vane meeting the MTO N-Vane design requirements and following the procedures outlined in ASTM D2573-94.

Jacques Whitford field personnel recorded the conditions encountered the borehole at the time of the investigation. Soils were described in accordance with the MTO Soils Classification System.

The groundwater level was measured in the open borehole upon completion of drilling. On completion of drilling, the borehole was backfilled with bentonite/cement slurry in accordance with Ontario Ministry of the Environment Regulation 903.

All soil samples recovered from the borehole was placed in moisture-proof bags and returned to our laboratory for detailed classification and testing as required.

4.2 Survey

The borehole location was established in the field by Jacques Whitford personal by measuring from the existing overhead sign and associated infrastructure.

The ground surface elevation at the borehole location was inferred from the profile drawings provided by Lea Consulting Limited. It is understood that the cross-section elevation was referenced to Geodetic datum.

4.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual examination and classification. Approximately 25% of the soil samples were submitted for routine testing including grain size distribution testing, Atterberg Limits testing and moisture content determination testing. The laboratory results are provided on the Record of Borehole sheet in **Appendix A**. The results of the grain size analyses and Atterberg Limits tests are shown on Figure Nos. 1 through 4 in **Appendix B**.

Unless requested in advance, all samples will be stored in our laboratory for a period of twelve months from the issue date of this report.

5.0 RESULTS OF THE INVESTIGATION

5.1 Subsurface Conditions

The subsurface conditions encountered in the borehole are summarized on the Record of Borehole sheet provided in **Appendix A**. An explanation of the terms used on the Record of Borehole sheet is provided in **Appendix A**.

A summary of the soil and groundwater conditions encountered in the borehole is provided below.

5.2 Soil

5.2.1 Asphaltic Concrete

Asphaltic concrete was encountered at the ground surface in the borehole. The asphalt was approximately 125 mm thick.

5.2.2 Sand and Gravel Fill

Sand and gravel fill was encountered underlying the asphaltic concrete. The sand and gravel fill was approximately 1.1 m thick and extended to a depth of approximately 1.2 m below existing grade, an elevation of about 82.0 m. The sand and gravel fill was generally damp.

Based on the N-values obtained from the Standard Penetration Test (SPTs), the compactness of the sand and gravel fill could be described as compact.

Laboratory testing performed on representative samples consisted of a single moisture content test. The test result was as follows:

- Moisture content: 5%

5.2.3 Clayey Silt Fill

A layer of clayey silt fill was encountered underlying the sand and gravel fill. The clayey silt fill contained some organic matter and was moist. The clayey silt fill was encountered at a depth of approximately 1.2 m below existing grade, an elevation of about 82.0 m, and was approximately 0.5 m thick.

Based on the N-values obtained from the SPTs, the consistency of the clayey silt fill could be described as firm.

Laboratory testing performed on representative samples consisted of a single moisture content test. The test result was as follows:

- Moisture content: 16%

5.2.4 Sand Fill

A layer of grey to black sand fill was encountered underlying the clayey silt fill. The sand fill was encountered at a depth of approximately 1.7 m below existing grade, an elevation of about 81.5 m, and was approximately 1.5 m thick. The sand fill typically contained some gravel, trace to some organic matter, and was generally moist to wet.

Based on the N-values obtained from the SPTs, the compactness of the sand fill could be described as compact to very loose.

Laboratory testing performed on representative samples consisted of a single moisture content test. The test result was as follows:

- Moisture content: 14%

5.2.5 Clayey Silt

Native clayey silt soil was encountered underlying the sand fill at a depth of approximately 3.2 m below existing grade, an elevation of about 80.0 m, and was approximately 1.4 m thick.

Based on the N-values obtained from the SPTs, the consistency of the native clayey silt soil could be described as firm to very soft.

Laboratory testing performed on selected samples consisted of two moisture content tests, a grain size distribution and an Atterberg Limits test. The test results were as follows:

- Moisture contents: 20% and 24%
- Grain Size Distribution:
  - 0% gravel;
  - 17% sand;
  - 69% silt; and,
  - 15% clay.
- Atterberg Limits:
  - Plastic limit: 18%

  - Liquid limit: 23%
  - Plasticity Index: 5%

The results of the moisture content tests are provided on the Record of Borehole sheet in **Appendix A**.

The results of the grain size distribution test are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 1 in **Appendix B.** The results of the Atterberg Limits test are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 2 in **Appendix B.**

5.2.6 Silty Sand/Sandy Silt

A layer of brown silty sand/sandy silt soil was encountered underlying the clayey silt. The silty sand/sandy silt was encountered at a depth of approximately 4.6 m below existing grade, an elevation of about 78.6 m, and was approximately 1.5 m thick. The silty sand/sandy silt was wet.

Based on the N-values obtained from the SPTs, the compactness of the silty sand/sandy silt could be described as very loose.

Laboratory testing performed on representative samples consisted of a single moisture content test. The test result was as follows:

- Moisture content: 22%

5.2.7 Silty Clay

Silty clay was encountered underlying the silty sand/sandy silt at a depth of approximately 6.1 m below existing grade, an elevation of about 77.1 m, and was approximately 4.6 m thick. The silty clay contained trace gravel and trace sand.

In-situ shear vane testing was carried out in the silty clay stratum. The results of the testing indicated that the initial shear strength of the silty clay ranged from approximately 36 kPa to 50 kPa. The sensitivity of the clay ranged from approximately 4 to 4.5. The in-situ shear vane testing indicated that the consistency of the silty clay could be described as firm.

Laboratory testing performed on selected samples consisted of moisture content tests, a grain size distribution and Atterberg Limits test. The test results were as follows:

- Moisture contents: 22% to 25%
- Grain Size Distribution:
  - 1% gravel;
  - 10% sand;
  - 51% silt; and,
  - 38% clay.
- Atterberg Limits:
  - Plastic limit: 17%
  - Liquid limit: 31%
  - Plasticity Index: 13%

The results of the moisture content tests are provided on the Record of Borehole sheet in **Appendix A**.

The results of the grain size distribution test are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 3 in **Appendix B.** The results of the Atterberg Limits test are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 4 in **Appendix B.**

5.2.8 Clayey Silt (Till)

Clayey silt till was encountered underlying the silty clay at a depth of approximately 10.7 m below existing grade, an elevation of about 72.5 m. The borehole was terminated in the clayey silt till stratum at a depth of approximately 12.8 m below existing grade, an elevation of about 70.4 m. The clayey silt till contained some sand, trace gravel and was moist to damp.

Based on the N-values obtained from the SPTs, the consistency of the clayey silt till could be described as very stiff.

Laboratory testing performed on selected samples consisted of moisture content tests, a grain size distribution and Atterberg Limits tests. The test results were as follows:

- Moisture Content: 21%
- Grain Size Distribution:
  - 4% gravel;
  - 23% sand;
  - 58% silt; and,
  - 15% clay.
- Atterberg Limits:
  - Plastic limit: 13%
  - Liquid limit: 18%
  - Plasticity Index: 5%

The results of the moisture content tests are provided on the Record of Borehole sheet in **Appendix A**.

The results of the grain size distribution are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 5 in **Appendix B.** The results of the Atterberg Limits test are shown on the Record of Borehole sheet in **Appendix A** and provided on Figure No. 6 in **Appendix B.**

5.3 Groundwater

Groundwater was measured in the open borehole on completion of drilling at a depth approximately 3.6 m below existing grade, an elevation of approximately 79.6 m. A standpipe to monitor the longer term groundwater conditions was not installed as it was beyond the scope of work.

6.0 CLOSURE

A soil investigation is a limited sampling of a site. The information is gathered at specific borehole locations and can only be extrapolated to an undefined limited area around the borehole locations. The extent of the limited area depends on the variability of the soil and ground water conditions as influenced by geological processes, as well as the history of the site reflecting natural conditions, construction activities and site use. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

We trust the above information meets with your present requirements. Should you have any questions or require further information, please do not hesitate to contact us at your convenience.

Regards,

JACQUES WHITFORD LIMITED

DRAFT

Geoffrey Creer, P.Eng.
Geotechnical Engineer

DRAFT

John J. Brisbois, M. Sc. Eng., P. Eng.
Principal

7.0 DISCUSSION

7.1 General

Highway 406 at the proposed sign location is built to a semi-urban profile on low embankments with paved shoulders. Based on visual observations, the embankments are approximately 1 m to 2 m high. In the area of the sign Highway 406 is super-elevated. The southbound lanes slope downward from the southbound right shoulder to the left shoulder. There is a concrete barrier in the centre median that separates the southbound and northbound traffic. Drainage is provided by a series of catchbasins located along the central median.

A steel guard rail is located along the right edge of the paved shoulder of the south bound lanes. The ground surface beyond the steel guardrail is covered with grass and trees of varying maturity and slopes downward towards Twelve Mile Creek.

7.2 Proposed Development

It is understood that the Ontario Ministry of Transportation (MTO) is proposing to replace an existing overhead sign, located on the southbound lanes of Highway 406 just north of the St. Paul Street bridge structure, with a new cantilever overhead sign. The construction of the cantilevered sign will disturb the asphalt shoulder. Therefore some resurfacing and reinstatement of the shoulder will be required.

7.3 Subsurface Conditions

The subsurface conditions encountered in the borehole advanced at the anticipated location of the proposed cantilevered sign consisted of the following:

Strata	Thickness (m)	Depth encountered (m - below existing grade)	Elevation Encountered (m)
Asphalt	125 mm	-	Grade
Fill (Sand and Gravel, Clayey Silt and sand fill)	3.1	0.13	83.1
Clayey Silt	1.4	3.2	80.0
Silty Sand/Sandy Silt	1.5	4.6	78.6
Silty Clay	4.6	6.1	77.1
Clayey Silt Till	Termination of borehole at 12.8 m (Elev. 70.4 m)	10.7	72.5

Groundwater was measured in the open borehole on completion of drilling at a depth of approximately 3.6 m below existing grade, elevation of approximately 79.6 m.

8.0 RECOMMENDATIONS

8.1 Soil Parameters

The results of the field and laboratory investigation described herein have been used to estimate soil parameters for use in the design of the foundations.

Soils at the site have been classified as cohesive or non-cohesive and have been assigned appropriate values of undrained shear strength (C_u) or angle of internal friction (Φ') and a bulk unit weight (γ). The Rankine passive earth pressure has been calculated based on the assigned angle of internal friction. The design parameters recommended for use on this project are shown in the table below. When using the table, the following should be considered:

- The soil parameters provided represent ultimate values and will need to be factored in accordance with the CHBDC.
- The unit weights provided are bulk unit weights and should be reduced by 9.81 kN/m^3 for each meter below the interpreted level of the groundwater table.

Depth (m)	Soil Type	Compactness or Consistency	Unit Weight (kN/m^3)	Effective Friction Angle	Rankine Passive Earth Pressure	Undrained Shear Strength (kPa)
0 - 3.2	Non-Cohesive	Compact to loose	18	28	2.7	- -
3.2 – 4.6	Cohesive	Firm to very soft	19	- -	- -	25
4.6 – 6.1	Non-cohesive	Very loose	18	28	2.7	- -
6.1 – 10.7	Cohesive	Firm	19	- -	- -	50
10.7 – 12.8	Cohesive	Very stiff	20	32	3.3	- -

8.2 MTO Standard Design

The MTO sign support manual stipulates that the standard footing for a ground-mounted, static, sign support consists of a cast-in-place 1.2 m diameter reinforced concrete caisson extending a minimum of 5 m below the frost penetration depth. The MTO Standard Drawing SS118-3, dated May 2000, is based on the following assumed soil parameters below the frost layer:

Length of Caisson Below the Frost Penetration Depth	Case 1 (Sand)	Case 2 (Clay)
Upper 2/3	$\Phi' = 28^{\circ}$	$C_u = 25$ kPa
Lower 1/3	$\Phi' = 30^{\circ}$	$C_u = 50$ kPa

Where:
Φ' = the angle of Internal friction
C_u = The undrained Shear Strength

At the borehole location, the soil conditions below the frost penetration depth met the strength requirements indicated in the above table. However, it will be necessary to extend the caisson a minimum of 1 m into the underlying clayey silt till.

Provided the caisson is extended into the underlying clayey silt till, the foundations details provided by MTO Standard Drawing SS118-3, dated May 2000, may be used at this site.

Alternatively or if other considerations preclude the use of the standard design, the footings may be redesigned using the suggested design methods and geotechnical design parameters provided in the following sections.

8.3 Cast-In-Place Concrete Caissons

8.3.1 Design Approach

The foundation must be designed to resist overturning moments caused by wind loads and should be designed in accordance with the CHBDC Section 6.13 and the method described by B. B. Broms in the following papers:

- Broms, B. B. 1964, "Lateral Resistance of Piles in Cohesive Soils." J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM2: 27-63.
- Broms, B. B. 1964, "Lateral Resistance of Piles in Cohesionless Soils." J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM3: 123-156.
- Broms, B. B. 1965, "Design of Laterally Loaded Piles." J. of Soil Mech. And Found. Div., ASCE, vol. 91, SM3: 79-99.

8.3.2 Lateral Deflections

The horizontal subgrade reaction may be calculated based on the procedures outlined in the Canadian Foundation Engineering Manual.

The coefficient of horizontal subgrade reaction that is used for deflection calculations may be estimated for cohesive soils as follows:

$$k_s = 67\ C_u/d$$

Where k_s = the coefficient of horizontal subgrade reaction (force per volume)
C_u = undrained shear strength of the soil = 50 kPa for this application
d = caisson diameter

The coefficient of horizontal subgrade reaction that is used for deflection calculations for non-cohesive soils may be estimated as follows:

$$k_s = n_h(z/d)$$

Where k_s = the coefficient of horizontal subgrade reaction (force per volume)
n_h = Coefficient related to soil density. This may be taken as 1,300 kN/m^3 for compact to loose sandy soils (Table 20.3, p. 315, of the Canadian Foundation Engineering Manual 1992)
z = depth below grade

d = caisson diameter

8.4 Frost Considerations

The site is located in an area with a mean freezing index of between 250 and 500 Degree days (°Days), (Canadian Foundation Engineering Manual 2006). Based on Figure 3.4 of the MTO Pavement Design and Rehabilitation Manual, the frost penetration depth for this area is approximately 1.2 m.

The material within the zone of frost penetration should not be included in the calculations of lateral resistance.

8.5 Soil Profile Type and Seismic Forces

The zonal acceleration ratio for the St. Catharines area, as obtained from CHBDC (2006) Table A3.1.1., is 0.05.

9.0 CONSTRUCTION RECOMMENDATIONS

9.1 Caisson Installation

Sloughing and cave of the granular fill and wet sands, and squeezing of the clays may occur during drilling of the caisson. In addition groundwater was measured in the open borehole at a depth of approximately 3.6 m or an elevation of approximately 79.6 m. In the respect, it is recommended that a temporary liner be used to keep the caisson open.

On completion of the foundation installation it is recommended that the ground surface surrounding the structure be graded to prevent surface water from ponding adjacent to the foundation.

9.2 Open Cut Excavations

Excavations and open trenches are not anticipated at this site.

9.3 Staging

Through discussions with representatives of Lea Consulting, it is understood that the work will be carried out on the right shoulder of the southbound lanes. Therefore, staging will likely be limited to right shoulder closure and periodic right lane closures.

9.4 Groundwater Control

Water was measured in the open borehole at a depth of approximately 3.6 m below existing grade, elevation of approximately 79.6 m. Perched groundwater conditions may be encountered within the fill materials.

Given the soil conditions, seepage above and below the elevation noted above is anticipated to be slow. Therefore the seepage should be readily handled by conventional sumps and pumping techniques.

9.5 Asphalt Reinstatement

Reinstatement of the asphalt shoulder will be required where it is disturbed during the construction of the cantilever sign. The following sections provide recommendations for the reinstatement of the asphalt shoulder.

9.5.1 Pavement Design

Given the planned scope of work, it is anticipated that a portion of the asphalt will be completely removed during construction of the cantilevered sign. Once construction is complete and the exposed granular material has been re-compacted to 98% of the materials Standard Proctor Maximum Dry Density, the following pavement design is recommended for the reinstatement of the shoulder asphalt on Highway 406:

- 40 mm Superpave 12.5 FC2;
- 80 mm Superpave 12.5 FC2 base course;

An asphalt cement grade of PG 64-34 would apply.

This pavement structure generally matches the existing shoulder pavement structure on Highway 406, which was encountered in the borehole advanced at the proposed sign location.

Where new pavement abuts the existing pavement, it should be keyed into the existing pavement.

9.5.2 Design Traffic Category

The Design Traffic Category is based on the number of Equivalent Single Axel Loads (ESALs) over a 20 year period. The following input parameters were considered to determine the Traffic Category:

Average Daily Traffic: 33,900 Vehicles – (based on MTO's 2004 Traffic Volume Publication)

Presumed Percentage of trucks: 5%

Presumed Average Growth: 2%

Design Life: 20 years

Based on these input parameters, the 20 year design calculated ESAL's was approximately 13.0 million. Table 1: Superpave and SMA Design Traffic Categories by ESAL's, in OPSS 1151 (revision dated November, 2003), indicates that the road may be classified as Ontario Design Traffic Category D.

10.0 CLOSURE

This report has been prepared for the sole benefit of Lea Consulting Ltd., the Ontario Ministry of Transportation and their agents, and may not be used by any third party without the express written consent of Jacques Whitford Limited, Lea Consulting Ltd. and the Ontario Ministry of Transportation. Any use that a third party makes of this report is the responsibility of the third party.

The information presented in this report is in accordance with our present understanding of the project.

A soils investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at specific borehole locations and can only be extrapolated to an undefined limited area around the locations. The extent of the limited area depends on the variability of the soil and ground water conditions as influenced by geological processes, as well as the history of the site reflecting natural conditions, construction activities, and site use.

Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

We trust the above information meets with your present requirements. Should you have any questions or require further information, please do not hesitate to contact us at your convenience.

Regards,

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John J. Brisbois, M. Sc. Eng., P. Eng.
Principal

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Appendix A

Terms and Symbols Used on the Record of Borehole Sheet

Record of Borehole Sheet

Jacques Whitford

RECORD OF BOREHOLE No BH1

1 OF 1 **METRIC**

W.P. 2448-04-00 LOCATION Hwy 406, St. Catherines, Ontario, Sta. 0+090 Rt. Shoulder ORIGINATED BY NH

DIST St. CatherineHWY 406 BOREHOLE TYPE Hollow Stem Auger COMPILED BY NH

DATUM Geodetic DATE 4.5.07 - 4.5.07 CHECKED BY GTC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	GR	SA	SI	CL
83.2	Southbound Rt. Shoulder									
83.0 / 0.1	125 mm ASPHALT									
	Brown, compact SAND and GRAVEL (FILL), damp	F	1	SS	17					
		F	2	SS	17					
82.0 / 1.2	Dark grey, very stiff, Clayey SILT (FILL), with organic matter, moist	F								
81.5 / 1.7	Grey to Black, compact to very loose SAND (FILL), some gravel and trace to some organic matter, moist to wet	F	3	SS	28					
		F	4	SS	0					
80.0 / 3.2	Brown, firm to very soft, Clayey SILT, some sand, wet		5	SS	6	∇				
			6	SS	0		0	17	69	15
78.6 / 4.6	Brown, very loose, Silty SAND/Sandy SILT, wet		7	SS	0					
77.1 / 6.1	Grey, firm, Silty CLAY, trace sand, trace gravel, wet		8	SS	2					
			1	VT						
			9	SS	6		1	10	51	38
			2	VT						
	- trace gravel		10	SS	5					
			3	VT						
72.5 / 10.7	Grey, very stiff, Clayey SILT (TILL), with sand, trace gravel, moist to damp		11	SS	16		4	23	58	15
			12	SS	17					
70.4 / 12.8	END OF BOREHOLE at approximately 12.8 m									

Groundwater level measured in open borehole at a depth of 3.6 m upon completion of drilling.

ELEVATION SCALE: 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72, 71

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

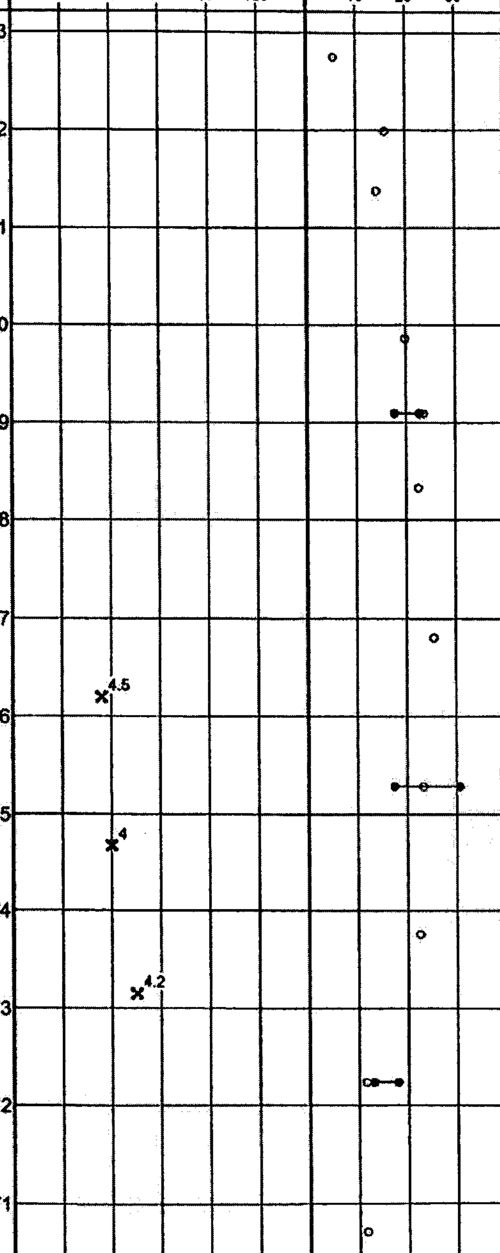
SHEAR STRENGTH kPa: ○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100

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

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL



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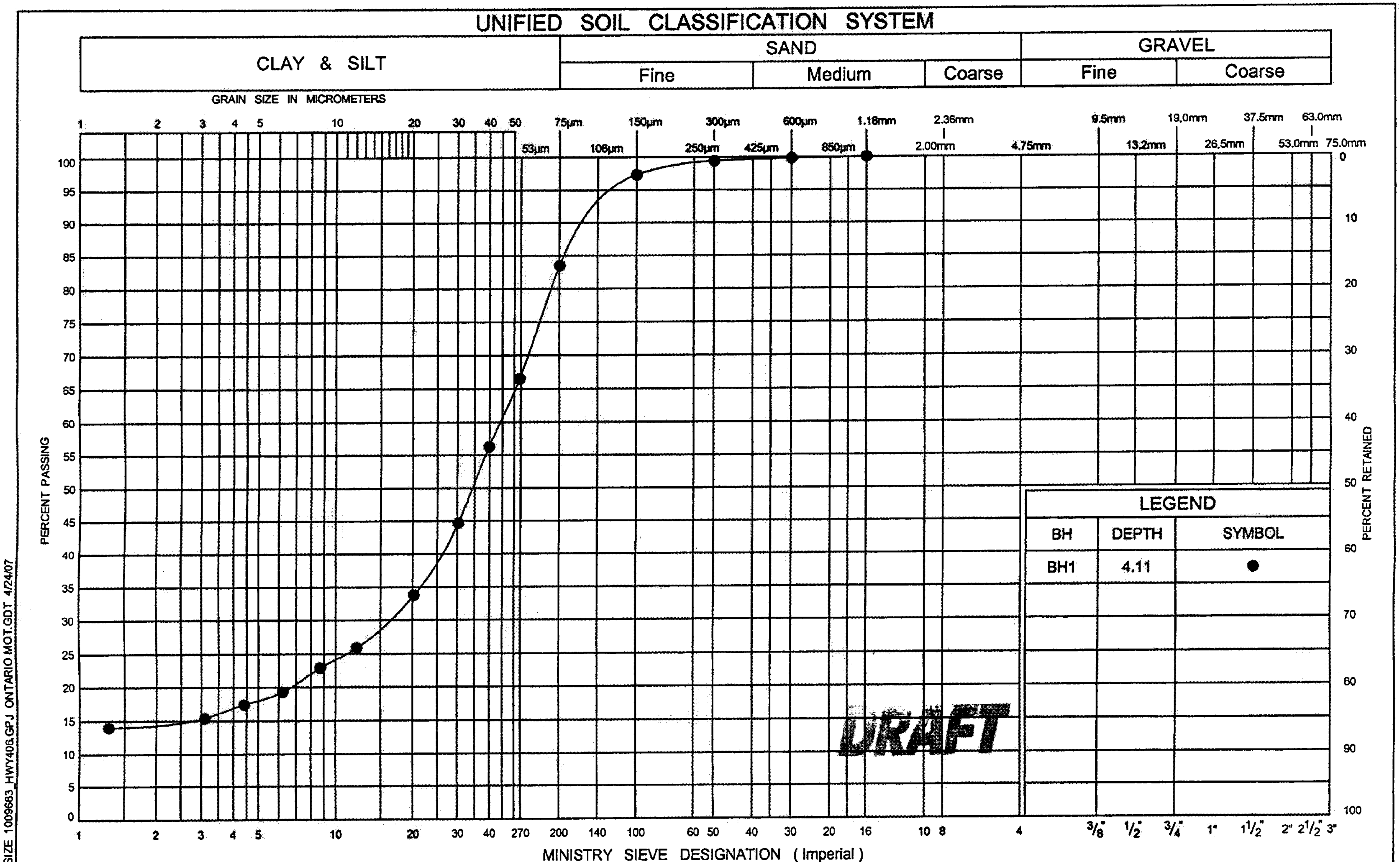
✖3, ×3: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

Appendix B

Geotechnical Laboratory Test Results

Jacques Whitford

78 12 M



ONTARIO MOT GRAIN SIZE 1009683 HWY406.GPJ ONTARIO MOT.GDT 4/24/07

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

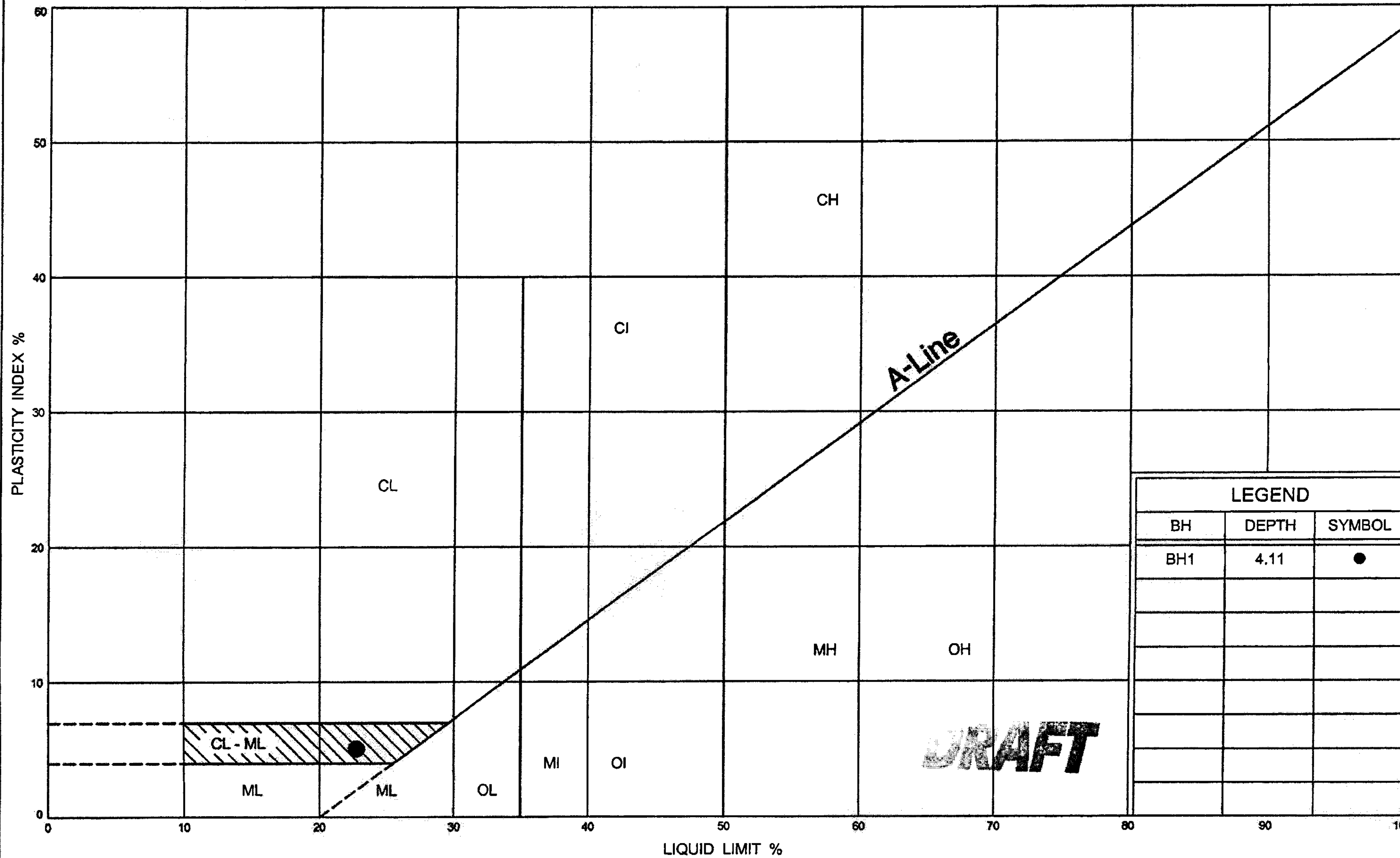
Clayey SILT

FIG No 1

W P 2448-04-00

Hwy 406

Oct 75, FF - S - 21



LEGEND		
BH	DEPTH	SYMBOL
BH1	4.11	●

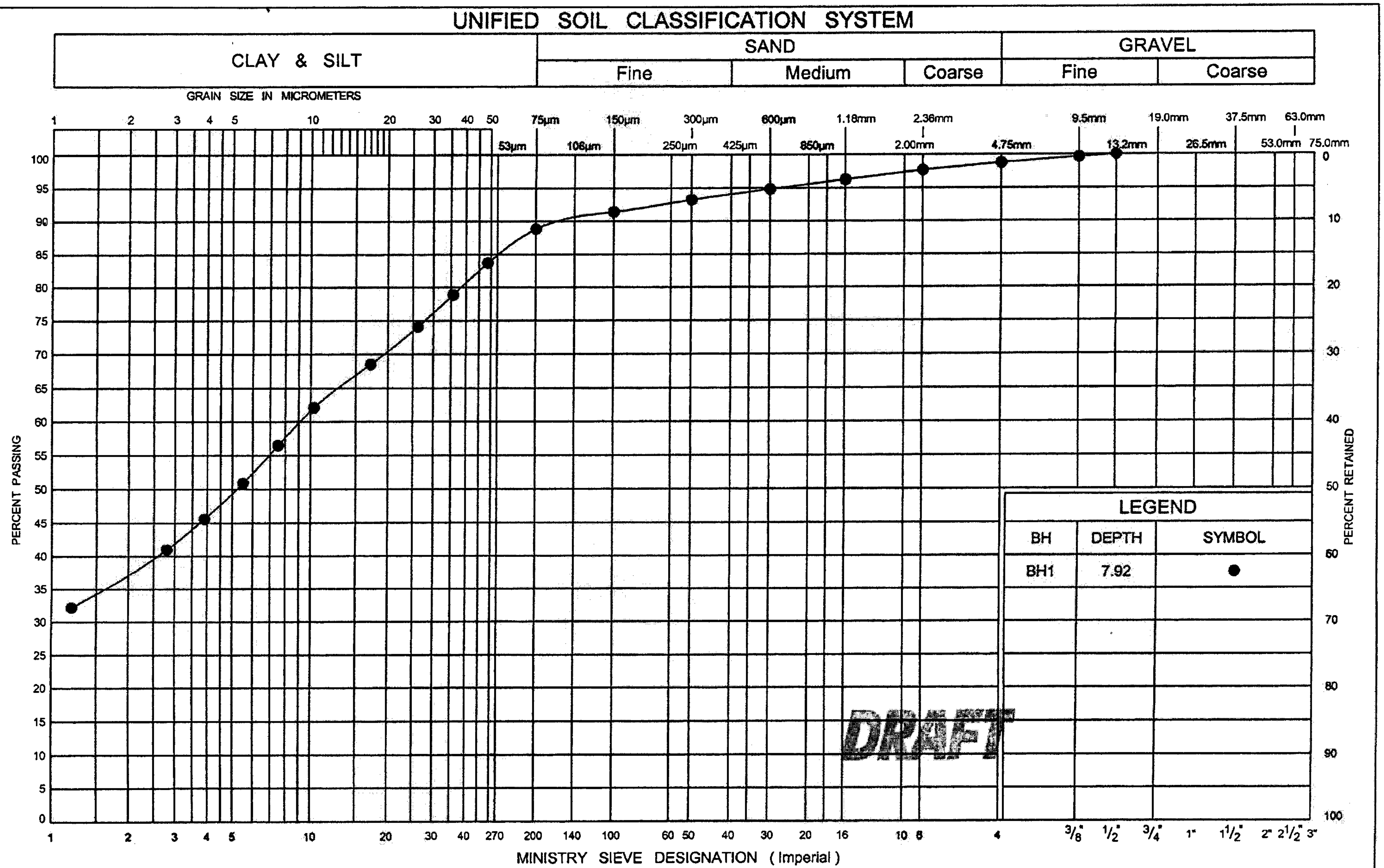
ONTARIO MOT PLASTICITY CHART 1009683_HWY406.GPJ ONTARIO MOT.GDT 4/24/07

Ministry of Transportation
Ontario

PLASTICITY CHART
Clayey SILT

FIG No 2
W P 2448-04-00
Hwy 406

78 12 M



ONTARIO MOT GRAIN SIZE 1009683_HWY406.GPJ ONTARIO MOT.GDT 4/24/07

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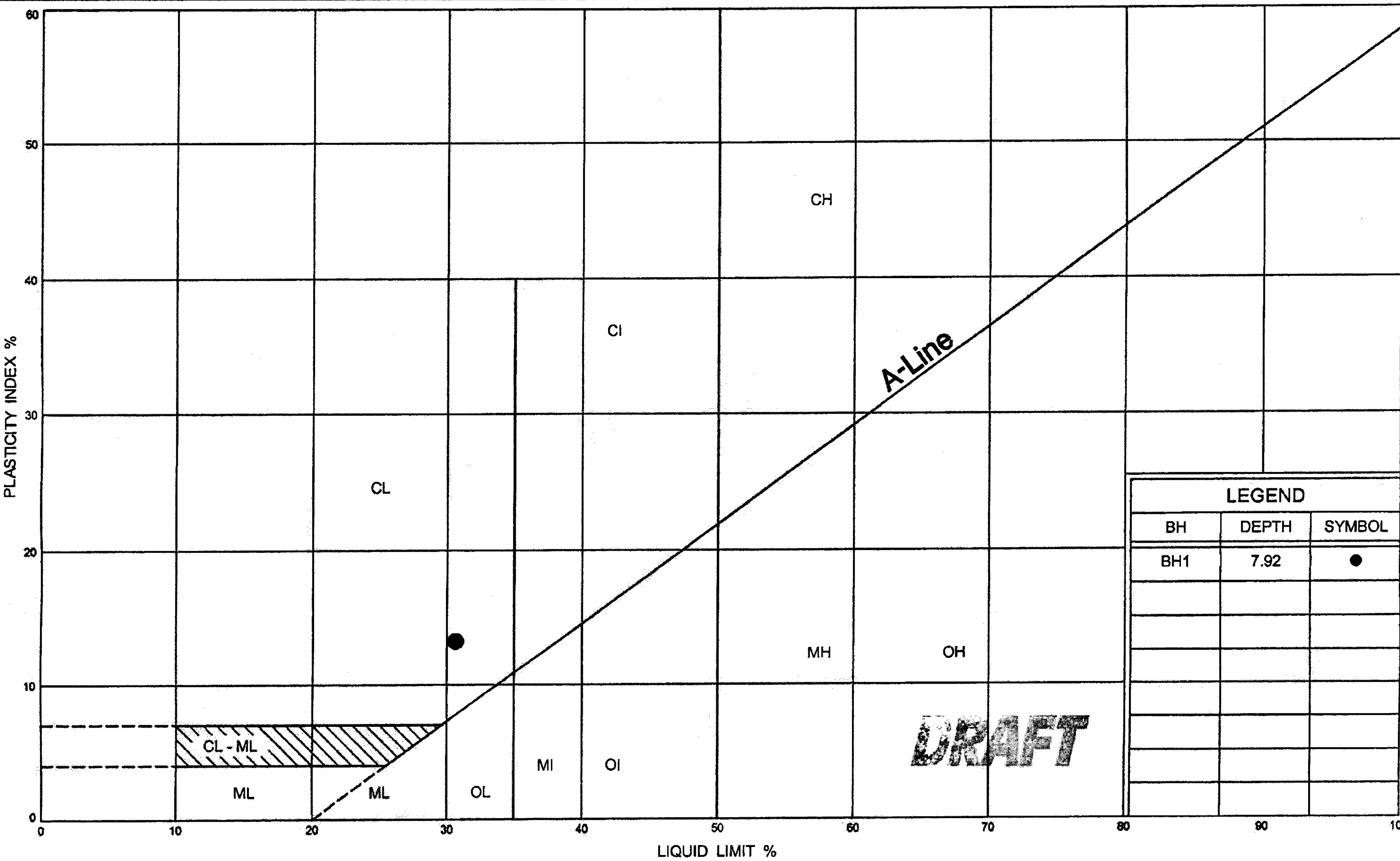
Ontario

GRAIN SIZE DISTRIBUTION
Silty CLAY

FIG No 3	
W P 2448-04-00	
Hwy 406	

Oct 75, FF - S - 21



LEGEND		
BH	DEPTH	SYMBOL
BH1	7.92	●

ONTARIO MOT PLASTICITY CHART 1009883_HWY406.GPJ ONTARIO MOT.GDT 4/24/07

Ministry of Transportation
Ontario

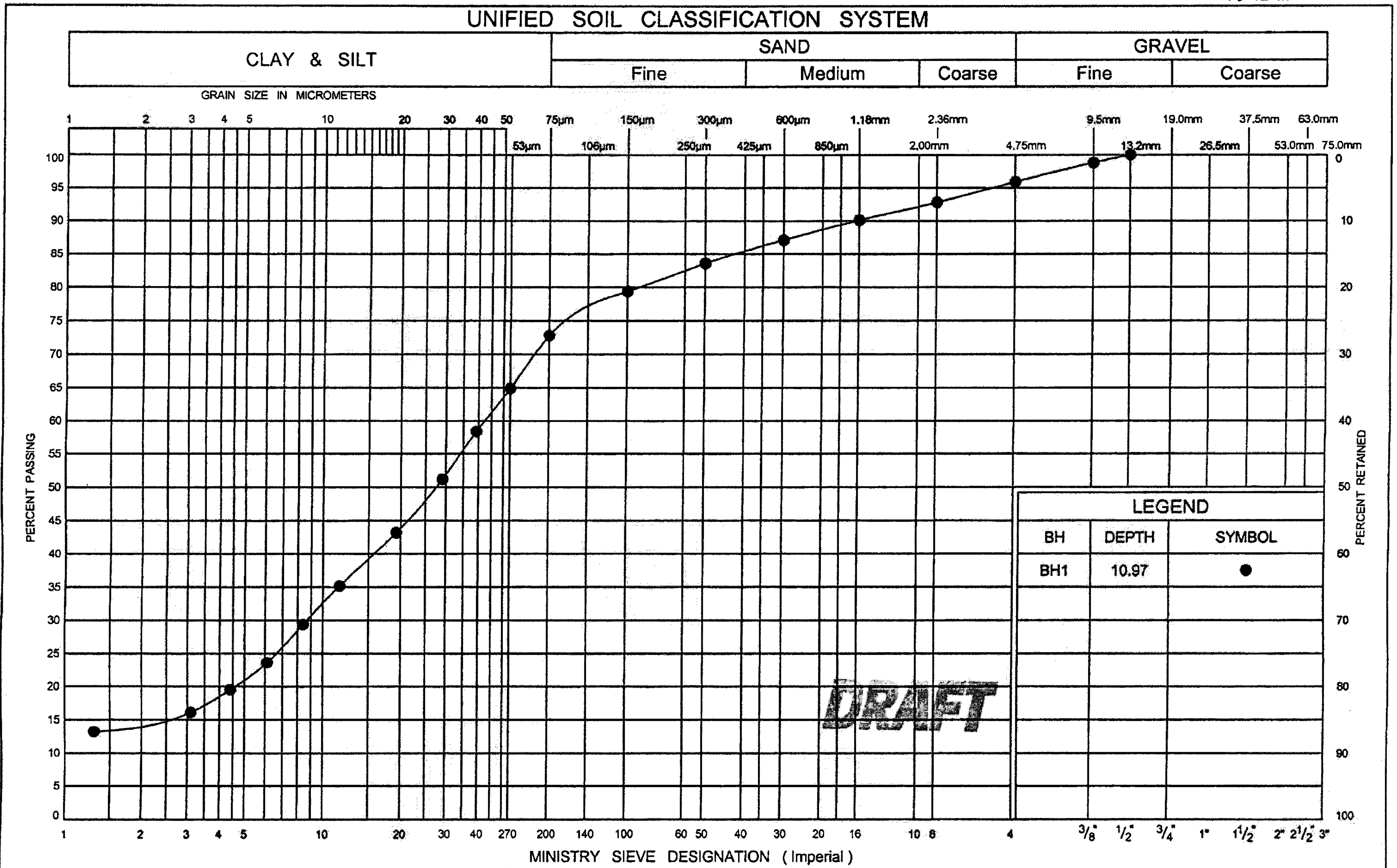
PLASTICITY CHART
Silty CLAY

FIG No 4

W P 2448-04-00

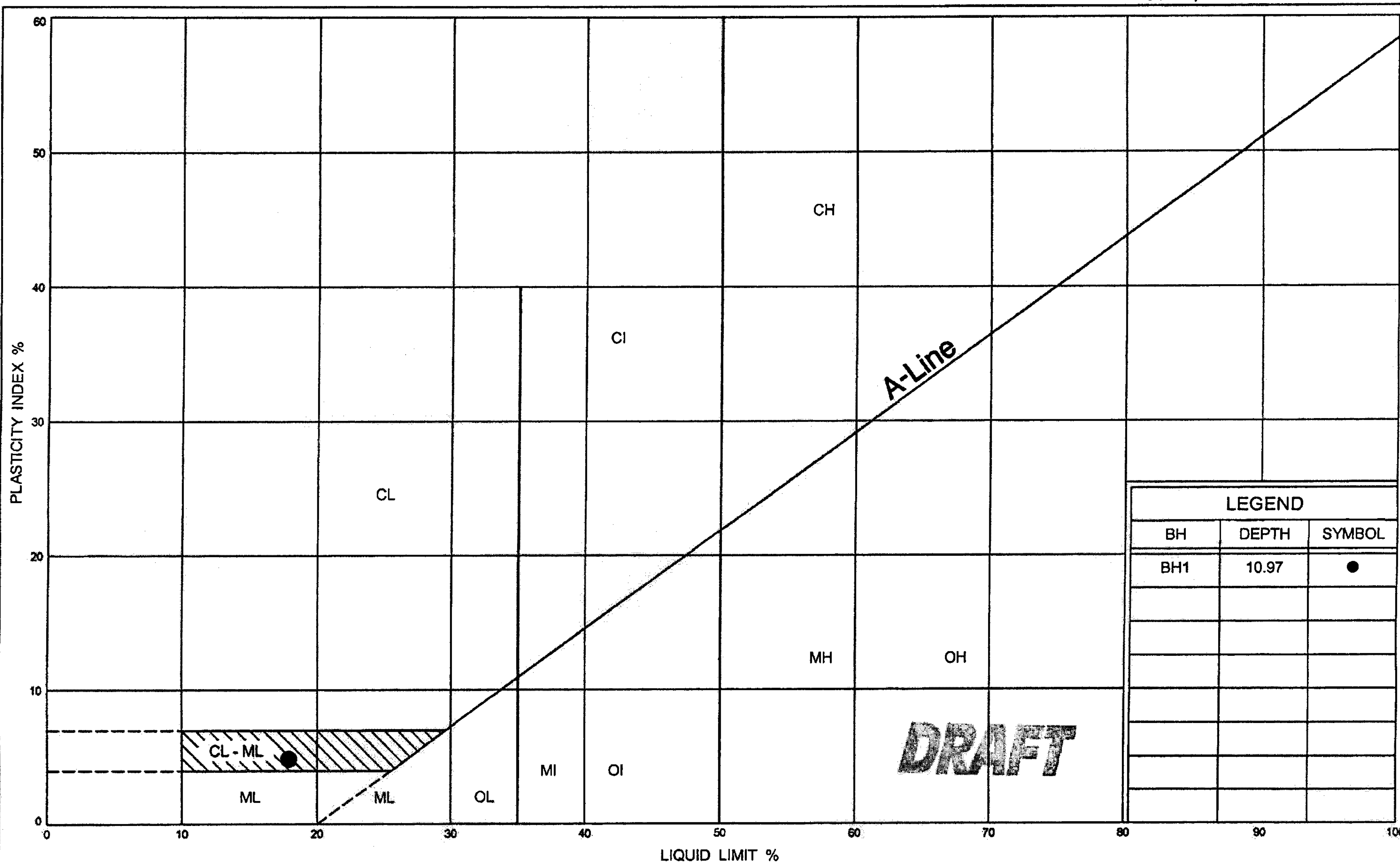
Hwy 406

78 12 M



Ministry of Transportation Ontario	GRAIN SIZE DISTRIBUTION Clayey SILT (TILL)	FIG No 5 W P 2448-04-00 Hwy 406

Oct 75, FF - S - 21



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty CLAY (TILL)

FIG No 6

W P 2448-04-00

Hwy 406

ONTARIO MOT PLASTICITY CHART 1009583_HWY406.GPJ ONTARIO MOT.GDT 4/24/07