

DOCUMENT MICROFILMING  
GEOCRES No. 30M12-244

DIST. CR REGION                     

W.P. No. 130-99-00(D)

CONT. No.                     

W. O. No.                     

STR. SITE No.                     

HWY. No. 410

LOCATION Proposed High Mast Lighting  
From BOVAIRD DR to SANDALWOOD PARKWAY

No of PAGES -                     

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

REMARKS:                     

G.I-30 SEPT. 1976

**FOUNDATION INVESTIGATION REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION  
FROM BOVAIRD DRIVE TO SANDALWOOD PARKWAY  
BRAMPTON, ONTARIO  
W.P. 130-99-00 (D)**

**Prepared For:**

**MINISTRY OF TRANSPORTATION OF ONTARIO  
Pavements and Foundations Section  
1201 Wilson Avenue  
Downsview, Ontario M3M 1J8**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SP2960D  
February 15, 2000  
Geocres No. 30M12-244**

**250 Galaxy Boulevard  
Etobicoke, Ontario  
M9W 5R8  
Tel: (416) 213-1255  
Fax: (416) 213-1260**

## Table of Contents

### FOUNDATION INVESTIGATION REPORT

1. INTRODUCTION	1
2. SITE DESCRIPTION AND PHYSIOGRAPHY	2
3. INVESTIGATION PROCEDURES	3
4. SUMMARIZED SUBSURFACE CONDITIONS	5

### APPENDICES

Borehole Log Sheets	Appendix A
Laboratory Test Results	Appendix B
Explanation of Terms Used in Report	Appendix C

**FOUNDATION INVESTIGATION REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION FROM BOVAIRD DRIVE  
TO SANDALWOOD PARKWAY, BRAMPTON  
WP 130-99-00 (D)**

**1. INTRODUCTION**

As part of the northerly extension of Highway 410 in Peel Region a new interchange is proposed at Sandalwood Parkway, immediately north of the existing Bovaird Drive interchange. The overall project entails the construction of an underpass bridge structure at the Sandalwood Parkway interchange along with seven culverts. The project also includes three culverts at Bovaird Drive interchange and provision for highmast light poles at and in between the two interchanges. The overall project limits lie between approximate Stations 17+350 and 19+450.

Shaheen & Peaker Limited (S&P) was retained by the Ministry of Transportation of Ontario (MTO) Pavements and Foundations Section to carry out a foundation investigation for the proposed interchange. This report deals with the proposed Highmast Lighting (HML's). The work was performed in accordance with Consultant Assignment Agreement Number 2005-A-000142, Highway 410: Bovaird Drive to Sandalwood Parkway – Foundation Investigation and Recommendations, WP130-99-00.

The site is located immediately east of Heart Lake Road between Bovaird Drive and Sandalwood Parkway in the City of Brampton. The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes.

The findings of the investigation are presented in this report.

## **2. SITE DESCRIPTION AND PHYSIOGRAPHY**

The site is located immediately north of the existing intersection of Highway 410 and Bovaird Drive in the City of Brampton, Regional Municipality of Peel.

The land use in the area has recently changed from predominantly farming to industrial and suburban residential. The topography here is flat with ground surface sloping gently towards Lake Ontario. The existing ground surface elevations at the project site generally range from about 247 at the most northerly location (i.e. about 500 m north of the Highway 410 and Sandalwood Parkway intersection), falling to about 246 at the intersection of the proposed Highway 410 and Sandalwood Parkway centerline, to generally between 245 and 244 m toward the south end of the project at the Bovaird Drive interchange (i.e. an elevation difference of about 2 to 3 m over a distance of about 2.1 km). There are, however, some minor undulations within the site itself where the grade falls locally towards two small watercourses. One of these watercourses, located about 500 m north of the Bovaird Drive intersection, intersects the proposed highway alignment in an east-west direction and here the grade falls to between Elevations 243 and 240 m. The second creek runs in a north-south direction at the north end of the project site, some 200 m west of the proposed highway alignment, where it crosses the Sandalwood Parkway extension, turns east and crosses the highway alignment about 200 m south of the proposed Sandalwood Parkway alignment. The grade along this creek generally ranges from about 243 m on the north side to about 240 m southeast.

The site is located within the physiographic region known as the "Peel Plain." In general, this region is underlain by glacial till deposits containing frequent shale and limestone fragments. Much of the surface has been modified by post-glacial, shallow silty clay/clayey silt soils. In the general project area, the significant deposit underlying shallow recent clayey soils is a ground moraine composed of glacial till of generally cohesive nature, laid down during the Wisconsin glacial age. Silt and sand layers are often found interbedded with the glacial till. The project area is located at the interface of the red Queenston and grey Georgian Bay bedrock formations. These formations belong to the Upper Ordovician Period of the Paleozoic Era and are approximately 450 million years old. These shales are

interbedded with some limestone, siltstone, sandstone and dolostone layers and seams. These hard layers are usually less than about 150 mm thick but some layers are much thicker.

### 3. INVESTIGATION PROCEDURES

The fieldwork for the project was performed during the period of October 12 and November 9, 1999 and consisted of drilling and sampling 36 boreholes. An additional borehole (i.e. Borehole 26A) adjacent to Borehole 26 was also drilled in order to explore the subsurface conditions to greater depths.

The depths of the boreholes ranged from 6.6 m to 23.5 m. In addition, dynamic cone penetration tests were performed from the bottom of some of the boreholes and this increased the maximum depth of testing to 25.3 m below the ground surface. The boreholes were drilled at various proposed structure locations as tabulated below:

Proposed Structure	Borehole Number
Bridge and	26, 26A, 27, 28, 29, 30, 31
Approach Fills	32, 33
Culvert B2	1, 2
Culvert B3	3, 4
Culvert B4	5, 6, 7
Culvert S1	9, 10, 11, 12
Culvert S2	13, 14
Culvert S3	15, 16
Culvert S4	17, 18
Culvert S5	19, 20, 21, 22, 23
Culvert S6	24, 25
Culvert S7	35, 36
HML	8, 34

The location of each borehole is indicated on the individual borehole log sheet in Appendix A. The boreholes were advanced using a track-mounted drilling rig owned and operated by Groundworks Inc., under the full time supervision of a geotechnical engineer from Shaheen & Peaker Limited. In general, solid-stem augering was utilized to advance the boreholes but where hydrostatic pressures in

cohesionless soil caused excessive cave-ins and/or soil back up, drilling was switched to hollow stem augering and water was used for counter-balancing purposes. Sampling in the boreholes was effected at frequent intervals of depth (i.e. at 0.76 m intervals starting at ground surface to 6 to 9 m depth, and at 1.5 m intervals, thereafter) by the Standard Penetration test method (SPT) as outlined in ASTM Method D1586. In essence, this consists of freely dropping a 63.5 kg. hammer a vertical distance of 760 mm to drive a 51 mm O.D. split-spoon (split-barrel) sampler into the ground. The number of blows required to drive the sampler into the relatively undisturbed ground by a vertical distance of 300 mm is recorded as Standard Penetration Resistance or the N-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. Where the consistency permitted, several undisturbed open-drive thin-walled Shelby tube samples were also taken in cohesive soils.

Dynamic cone penetration tests (DCPT) were performed in Boreholes 7, 22, 23, 25, 26A, 27 and 29. This test consists of driving a 60 degree point, 51 mm diameter cone attached to the drill rig continuously into the undisturbed ground with the same driving energy as in SPT. The number of blows for each 300 mm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

The borehole locations in the field were established by MTO surveyors and ground surface elevations at the borehole locations were provided to us. Several of the boreholes had to be somewhat relocated from their original, staked-out location due to access difficulties. In these instances, allowance was made by our field staff for location and elevation differences.

Water level observations in the open boreholes were made during the drilling and at the completion of each borehole and, wherever possible, several hours thereafter. To enable us to monitor groundwater levels over a prolonged period of time without interference from surface water, piezometers were installed in some of the boreholes and the water level in these piezometers were monitored during subsequent site visits.

The results of drilling, sampling, in-situ testing and water level measurements are summarized on the Record of Borehole Sheets in Appendix A.

The soil samples were shipped to our laboratory for further examination and classification. A laboratory testing programme consisting of natural moisture content, bulk unit weight and Atterberg limit tests and grain-size analyses was performed on selected soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also in Appendix B.

#### 4. SUMMARIZED SUBSURFACE CONDITIONS

A total of thirty-six boreholes was drilled between Bovaird Drive and northerly about 500 metres north of Sandalwood Parkway Intersection at the proposed interchanges and the stretch of highway in between, for the proposed HMLs, culverts and a proposed underpass (bridge) structure. The locations of the boreholes are indicated on the individual Borehole Log sheets in Appendix A.

In general, soil conditions at the site consist of a veneer of topsoil and surficial clayey silt/silty clay followed by glacial till deposits. The glacial till is frequently interbedded with thin sand, silty sand, sandy silt and occasional silty clay seams. Some thicker, water bearing sand, silty sand and sandy silt layers were also encountered.

To a depth of 6 m, the glacial tills generally consist of basically cohesive clayey silt till or fine grained granular (cohesionless) sandy silt till. Below this depth, the till generally attains a somewhat coarser texture and is described as sandy silt/silty sand till. The till is generally competent (i.e. very stiff to hard or dense to very dense) with occasional weaker (stiff or compact) zones.

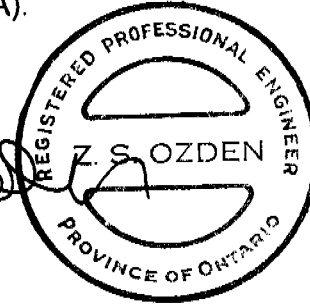
Occasional cobbles and boulders were encountered in the boreholes. The presence of cobbles should always be anticipated, especially in the glacial till deposits due to their mode of deposition.

The groundwater table at the site is believed to be generally between Elevations 242 and 240 m.



Details of the subsurface conditions encountered in each borehole are given on the individual Borehole Log Sheets (Appendix A).

**Shaheen & Peaker Limited**



Zuhtu Ozden, P.Eng.



Ivan Lieszkowszky, P.Eng.



trzip#hd

# APPENDICES

# APPENDIX A

## Borehole Log Sheets

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4842911N;283337E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20						40	60	80
242.8	Ground Surface																			
242.6	75 mm TOPSOIL		1	SS	18															
0.1	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some sand and silt seams/lenses, occasional cobbles and boulders, brown to 2.2 m, grey below, compact to 0.9 m, very dense to dense below, damp to moist		2	SS	63															
			3	SS	50/3															
			4	SS	41															
			5	SS	38															
			6	SS	82/26															
238.2	SILTY SAND AND SANDY SILT some Silt and Sand seams/lenses, occasional till zones, grey, dense to very dense, wet		7	SS	70															
4.6			8	SS	51															
			9	SS	48															
			10	SS	35															
233.2	End of borehole Water level in open hole at 6.0 m upon completion Water level not stabilized N=82/26 denotes 82 blows for 26 cm penetration		11	SS	58															
9.6																				

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4842945N, 283327E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 09.11.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL × LAB VANE											
244.3	Ground Surface						20	40	60	80	100								
244.0	150 mm ASPHALT																		
0.2	FILL:		1	SS	37		244								21.6				
243.4	Sand and Gravel, brown, moist																		
0.9	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some Silt and Sand seams/lenses, occasional cobbles and boulders, brown to 3.6 m, grey below, damp to 0.9 m, moist below, dense to very dense		2	SS	36		243												
			3	SS	38														
			4	SS	64		242								22.4				
			5	SS	88/28		241												
			6	SS	96														
			7	SS	87		240												
			8	SS	53		239								21.6				
			9	SS	47		238												
237.6		frequent wet sand seams																	
6.7	SILTY SAND AND SANDY SILT some Silt and Sand seams/lenses, grey, very dense, wet		10	SS	75		237								21.1				
			11	SS	91/28														
							236												
234.9			12	SS	50/13		235								21.0				
9.4	End of borehole Borehole dry on completion Water level not stabilized																		

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843066N;283267E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
245.0	Ground surface						20	40	60	80	100		
246.6	225 mm TOPSOIL						20	40	60	80	100		
0.2			1	SS	8							20.6	
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) occasional Silt and Clayey Silt lenses, brown to 3.5 m, grey below, firm to 0.7 m, hard below, damp to moist, occasional cobbles and boulders		2	SS	45								
			3	SS	43							21.7	
			4	SS	39								
			5	SS	64							21.8	5 34 47 14
	Sandy Silt Till zones below 4.0 m		6	SS	55/13								
			7	SS	43							22.3	boulder @ 4.0 m
239.7			8	SS	96/26								
5.3	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some Silt and Sand seams/lenses, grey, very dense, moist to 6.5 m, wet below, occasional cobbles and boulders		9	SS	90/26								
237.0			10	SS	86								
8.1	End of borehole Borehole dry on completion and six hours after completion. Water level not stabilized Auger refusal at 4.0 m on a boulder, relocated and redrilled. Auger refusal at 5.3 m on a boulder, relocated and redrilled.												

+ 3 . x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843069N, 283297E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
244.7	Ground Surface						20	40	60	80	100						
240.8	225 mm TOPSOIL						20	40	60	80	100						
0.2	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) occasional cobbles and boulders, brown, firm to 0.6 m, stiff from 0.6 to 1.0 m and hard below damp		2	SS	7											21.5	
			1	SS	37												
			3	SS	48												
242.2			4	SS	36											20.8	
2.5	Heterogeneous mixture of Silt and Sand with some gravel, trace clay (SANDY SILT TILL) with Clayey Silt Till zones, occasional cobbles and boulders, brown to 4.5 m. grey below, very dense to dense, damp to 4.5 m, moist below		5	SS	63												
			6	SS	50/13											21.7	
			7	SS	33												
			8	SS	55											22.1	
			9	SS	47												
	occasional sand seams/lenses		10	SS	38											22.5	
235.1	Silty Sand Till, wet		11	SS	40												
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed Water level in piezometer at 9.0 m, seven hours after completion Water level in piezometer at 8.6 m, Nov 9/99																

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843305N;283131E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								UNCONFINED ○	FIELD VANE +	LAB VANE ×		
242.6	Ground Surface											
242.3	300 mm TOPSOIL		1	SS	7						19.5	
0.3	SILTY CLAY											
241.6	some topsoil and organics, dark brown, stiff		2	SS	12							
1.0			3	SS	33						21.2	
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 2.1 m, grey below, stiff to hard, damp to moist to 5.0 m, moist to wet below primarily Sandy Silt Till from 2.8 to 4.4 m		4	SS	53						22.2	
			5	SS	52							
			6	SS	39							12 46 34 8
			7	SS	27						22.0	
			8	SS	24							
			9	SS	19						21.5	
			10	SS	19							



# RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 130-89-00 LOCATION 4843363N;263164E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 26.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE													
								● QUICK TRIAXIAL × LAB VANE													
241.7	Ground Surface						20	40	60	80	100	20	40	60							
240.8	150 mm TOPSOIL		1	SS	5																
0.1	Heterogeneous mixture of Clayey Silt with some sand and gravel CLAYEY SILT TILL occasional sand seams and cobbles, brown to 2.7 m, grey below, firm to 0.6 m, hard below		2	SS	48		241								21.1						
			3	SS	75		240														
			4	SS	50/ 10		239														
			5	SS	57		238														
			6	SS	31		238								23.0	6 41 41 12					
237.3			7	SS	31		237									0 78 20 2					
4.4	FINE SAND some silt, grey, dense to compact, wet		8	SS	27		236														
235.5			9	SS	11		235														
6.2	Heterogeneous mixture of Silty Clay with some Sand and Gravel (SILTY CLAY TILL) frequent sand, silt and clay seams/lenses, grey, stiff to very stiff		10	SS	19		234								22.7						
233.2			11	SS	50		233														
8.5	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) occasional cobbles and boulders, grey, dense to very dense, wet to		12	SS	73		232								23.1						
231.6	9.5 m, damp below																				
10.1	End of borehole Auger refusal at 10.1 m, probably on a boulder Standpipe piezometer installed Water level in piezometer at 5.2 m on Oct 27 and Nov 09/99 Shelby tube attempted at 8.4 m, sample did not stay in sampler																				

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## METRIC

[illegible]

+ 3, x 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843871N;282954E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 26.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
245.1	Ground Surface						20 40 60 80 100							
244.8	350 m TOPSOIL		1	SS	7									
0.3	SILTY CLAY													
244.3	trace of gravel and organics, brown, firm		2	SS	25							20.8		
0.8	clayey, very stiff													
	clayey, hard		3	SS	36									
	Heterogeneous mixture of Silt and Sand		4	SS	48							21.6		
	some gravel, trace clay (SANDY SILT TILL)		5	SS	96/26								5 43 43 9	
	some Clayey Silt Till zones, occasional Sand and Silt		6	SS	52/13									
	seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, dense to 3.0 m, very dense below, moist to wet to 3.5 m, damp below		7	SS	72									
			8	SS	65							21.6		
			9	SS	50/13									
			10	SS	89/28									
			11	SS	50/11									
235.5	Silty Clay Till, hard		12	SS	38									
9.8	End of borehole Borehole dry on completion and nine hours after completion Water level not stabilized													

+ 3 . x 3 : Numbers refer to  
Sensitivity

20  
15 10 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 9

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844094N;282509E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
241.5	Ground surface													
241.2	300 mm TOPSOIL		1	SS	2									
0.3	SAND													
240.6	with Clayey Silt seams, brown/grey, very loose, wet		2	SS	38									8 39 45 8
0.7														
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, some sand and silt seams, brown to 2.3 m, grey below, very stiff to hard		3	SS	46								22.4	
			4	SS	35									
			5	SS	24								22.8	
			6	SS	24									
	Silty clay till seams from 4.5 m to 6.0 m		7	SS	27									
			8	SS	50									Oct 12/Oct 13
			9	SS	71									
			10	SS	31								22.2	
	Sandy Silt Till zones, wet sand and gravel seams		11	SS	95/28									
231.9														
9.6	End of borehole Water level at 2.1 m and hole caved at 2.1 m on completion Wet sand seams at 2.0m Water seepage at 3.6 m while drilling													

# RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844112N,282543E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
241.3	Ground surface							20 40 60 80 100								
240.0	225 mm TOPSOIL		1	SS	5		241								22.8	
0.2	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, occasional sand seams, occasional cobbles and boulders, brown to 1.3 m, grey below, firm to 0.8 m, very stiff from 0.8 m to 3.6 m, hard below		2	SS	29		240								22.2	2 26 56 16
			3	SS	21		239									
			4	SS	25		238								22.6	
			5	SS	27		237									
			6	SS	65/25		236									
236.9	sampler wet at 4.5 m		7	SS	50/13		235								22.6	25 43 28 4
4.4	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) with Sandy Silt Till zones, some sand seams, occasional cobbles and boulders, grey, very dense, moist to wet		8	SS	50/13		234								22.4	
			9	SS	50/10		233									
			10	SS	50/13											
232.0	End of borehole		11	SS	50/13										22.0	
9.3	Water level at 8.5 m on completion Standpipe piezometer installed Water level in piezometer at 0.7 m on Oct 25 and 27/99															

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 11

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844132N, 282577E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
241.1	Ground surface													
240.9	250 mm TOPSOIL													
0.2			1	SS	5		241							
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) occasional Silt and Sand seams, brown to 1.7 m, grey below, firm to 0.7 m, very stiff to hard below		2	SS	31		240						22.5	
			3	SS	35		239							
			4	SS	40		238							
237.5	Sandy Silt Till, silt and silty clay lenses		5	SS	26		237							
3.6	wet seam at 3.6 m		6	SS	50/13		236							
	Heterogeneous mixture of Sand and Silt trace to some gravel (SILTY SAND TILL) some Sandy Silt Till zones, some sand and silt seams, occasional cobbles and boulders, grey, very dense, damp to moist		7	SS	50/13		235							
			8	SS	50/13		234							
			9	SS	50/10		233							
			10	SS	55/15		232							
231.8			11	SS	50/13									
9.3	End of borehole Water level at 8.2 m on completion Water level at 2.7 m three hours after completion													

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 12

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844148N;282808E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)
								20 40 60 80 100						
241.1	Ground surface													
240.8	250 mm TOPSOIL		1	SS	3							20.9		
0.3	CLAYEY SILT													
240.3	some sand, trace of rootlets, organics, dark brown, soft		2	SS	22								3 41 46 10	
0.8	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, sand and silt seams/lenses, brown to 2.3 m, grey below, very stiff to 1.3 m, hard below		3	SS	32							22.5		
			4	SS	38									
			5	SS	35							22.9	7 36 43 14	
237.5			6	SS	62									
3.8			7	SS	50/13							22.5		
	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) with Sandy Silt Till zones, some silt, sand and gravelly sand seams/lenses, occasional cobbles and boulders, grey, very dense, damp to 5.0 m and wet below		8	SS	97/28							22.3		
			9	SS	50/5									
			10	SS	50/5									
231.9			11	SS	50/10							23.2		
9.2	End of borehole Water level at 7.3 m on completion Water level at 2.4 m six hours after completion													

RECORD OF BOREHOLE No 13

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844240N;282548E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
244.5	Ground surface													
244.8	150 mm TOPSOIL		1	SS	8		244							4 31 51 14
0.1			2	SS	21									
	Heterogeneous mixture of Clayey Silt with sand and trace gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams, occasional cobbles and boulders, brown to 4.0 m, grey below, stiff to very stiff to 1.5 m, hard below		3	SS	45		243						21.7	5 39 45 11
			4	SS	53		242							
			5	SS	50/13		241							
			6	SS	64		240							
			7	SS	36		239						22.1	
			8	SS	46									
			9	SS	33		238						22.5	
	wet fine sand layer from 7.3 to 7.7 m		10	SS	34		237							
							236							
234.9			11	SS	40		235						22.1	
9.6	End of borehole Borehole dry on completion Water level not stabilized													



# RECORD OF BOREHOLE No 14

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844239N, 282595E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
244.4	Ground surface												
244.0	150 mm TOPSOIL												
0.1			1	SS	10								
	Heterogeneous mixture of Clayey Silt with sand and trace gravel (CLAYEY SILT TILL) occasional Sand, Silt and Clay seams/lenses, brown to 4.5 m, grey below, stiff to very stiff to 1.5 m, hard below		2	SS	28							21.5	
			3	SS	33								5 40 44 11
			4	SS	42							22.2	
			5	SS	78								
			6	SS	80								4 40 44 12
			7	SS	44								
			8	SS	28							22.0	
			9	SS	34								
237.8	End of borehole Borehole dry on completion Water level not stabilized												
6.6													

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 15

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844233N;282507E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
245.0	Ground surface												
244.7	300 mm TOPSOIL												
0.3	CLAYEY SILT TILL brown, stiff		1	SS	11							19.6	
244.0			2	SS	26								
1.0			3	SS	50								5 37 58 0
	Heterogeneous mixture of Silt and Sand with some gravel (SANDY SILT TILL) some Clayey Silt Till zones, occasional cobbles and boulders, brown to 4.4 m, grey below, compact to 1.7 m, dense to very dense below, damp		4	SS	59							22.5	
			5	SS	69								4 39 43 14
			6	SS	43								
			7	SS	35							22.5	
			8	SS	46								
	occasional sand and silt seams below 5.5m		9	SS	56								
			10	SS	66							22.0	
238.9													
8.1	End of borehole Borehole dry on completion Water level in open hole at 6.7 m seven hours after completion Water level not stabilized												

# RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844257N, 282503E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
							PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT W <sub>P</sub> W                      W <sub>L</sub>							
							WATER CONTENT (%) 20 40 60							
							○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      x LAB VANE							
245.0	Ground surface													
244.8	150 mm TOPSOIL													
0.1			1	SS	3								19.9	
			2	SS	23		244							8 42 41 9
			3	SS	35		243							
	Heterogeneous mixture of Silt and Sand with some gravel (SANDY SILT TILL) some Clayey Silt Till zones, occasional sand seams/lenses, occasional cobbles and boulders, brown to 3.4 m, grey below, very loose to 0.7 m, compact to very dense below, damp to 5.5 m, moist below		4	SS	40		242						22.4	4 43 48 5
			5	SS	75/23		241							
			6	SS	62		240						22.2	
			7	SS	44		239							
			8	SS	49		238							
	clayey below 6.0 m		9	SS	30									
236.9			10	SS	25		237							
8.1	End of borehole Borehole dry on completion Water level not stabilized													

# RECORD OF BOREHOLE No 17

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844181N;282480E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
245.0	Ground surface												
244.7	300 mm TOPSOIL		1	SS	10							19.3	
0.3	CLAYEY SILT		2	SS	19								
244.0	with silt seams, brown, stiff, moist		3	SS	33								
1.0	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) with some Silty Sand Till and Clayey Silt Till zones, occasional Sandy Silt and Clay seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, compact to 1.5 m, dense to very dense below, moist to 5.0 m, wet below		4	SS	41							21.8	2 36 60 2
			5	SS	76								
			6	SS	43								
			7	SS	36								
			8	SS	70							22.7	3 28 66 3
239.0													
6.0	FINE SAND		9	SS	55								
	some Silt, grey, very dense, wet												
237.7													
7.3	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) with Sand and Silt seams/lenses, occasional cobbles and boulders, grey, very dense, wet		10	SS	55/13								
235.7													
9.3	End of borehole Borehole dry on completion Water level at 4.8 m and hole caved at 5.4 m five hours after completion		11	SS	53/13							21.7	

+ 3 x 3. Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18										1 OF 1		METRIC				
W.P. 130-99-00		LOCATION 4844217N;282498E				ORIGINATED BY M.T										
DIST Central HWY 410		BOREHOLE TYPE Solid Stem Augers				COMPILED BY G.T										
DATUM Geodetic		DATE 14.10.99				CHECKED BY Z.O										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
245.0	Ground surface															
244.9	250 mm TOPSOIL															
0.3	clayey		1	SS	8										19.6	
			2	SS	24											
			3	SS	42										21.7	
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) occasional Sand and Silt seams, occasional cobbles and boulders, brown to 3.6 m, grey below, compact to 1.7 m, dense to very dense below, damp to moist		4	SS	46											
			5	SS	100/25										22.7	9 41 50 0
			6	SS	100											3 44 51 2
			7	SS	70										21.7	
			8	SS	47											
238.7			9	SS	51/13										21.9	
6.3	End of borehole Borehole dry on completion Water level at 5.5 m seven hours after completion Water level not stabilized															

# RECORD OF BOREHOLE No 19

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844150N, 282314E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
242.2	Ground Surface																	
0.0	500 mm TOPSOIL and Silty Clay		1	SS	7		242							21.3				
241.7																		
0.5			2	SS	16		241							22.1				
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, occasional Sand and Silt seams/lenses, occasional cobbles and boulders, brown/grey to 2.0 m, grey below, stiff to very stiff		3	SS	21		240							22.3	8 37 42 13			
			4	SS	28		239											
238.2			5	SS	20		238											
4.0			6	SS	15		237											
	Heterogeneous mixture of Silty Clay some sand and gravel (SILTY CLAY TILL) grey, stiff to very stiff		7	TW	PH		236							21.7				
			8	SS	14		235											
			9	SS	12		234											
234.4							233											
7.8			10	SS	29													
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) grey, hard																	
232.6			11	SS	35									22.6				
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed. Water level in piezometer at 5.6 m-Oct 27/99 P.H.=Pushed Hydraulically																	

# RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844191N;282288E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100					
242.4	Ground Surface															
0.0	500 mm TOPSOIL		C	SS	10	242										
241.9	and dark brown Silty Clay															
0.5	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional Silt and Sand seams/lenses, brown to 1.0 m, grey below, stiff to 1.1 m, very stiff to 1.6 m, hard below damp to moist to 2.4 m, moist to wet below		2	SS	20										22.1	
			3	SS	41	241										
			4	SS	35	240									22.1	
			5	SS	33	239										5 40 43 12
			6	SS	47	238									22.2	
			7	SS	52	237										
			8	SS	34	236									22.5	
			9	SS	34	235										
			10	SS	22										22.0	
234.3	very stiff															
8.1	End of borehole Water level at 5.7 m upon completion Water level not stabilized Wet sand seam at 2.4 m															

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844231N, 282267E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
242.3	Ground Surface													
0.0	450 mm TOPSOIL		1	SS	3		242							
241.9														
0.4	SILTY CLAY		2	SS	12		241							
241.5	brown, firm													
0.8			3	SS	15		240							
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional cobbles and boulders, brown to 1.5 m, grey below, stiff to very stiff to 7.0 m, hard below		4	SS	16		239							
			5	SS	12		238							
			6	SS	15		237							
			7	SS	16		236							
			8	SS	22		235							
			9	SS	29									
234.2			10	SS	34									
8.1	End of borehole Borehole dry on completion Water level not stabilized													

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 22

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844274N, 282246E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T  
 DATUM Geodetic DATE 23.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
242.6	Ground Surface																
0.0	400 mm TOPSOIL		1	SS	5											20.0	
242.2																	
0.4	CLAYEY SILT																
241.8	brown, firm		2	SS	24												
0.8																	
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 2.0 m, grey below, very stiff to hard, damp to moist		3	SS	27											22.1	
			4	SS	46												
			5	SS	38											22.3	
			6	SS	26												
			7	SS	32											22.4	
236.7	Sandy Silt Till, compact, wet		8	SS	26												
5.9			9	SS	6*												0 82 18 0
	FINE SAND some silt, grey, compact to dense, wet		10	SS	13*												
			11	AS													
	Silty																
230.5																	
12.1	End of borehole Water level at 7.6 m and hole caved at 7.6 m on completion Water level not stabilized * N-values probably too low due to hydrostatic uplift																

# RECORD OF BOREHOLE No 23

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844302N, 282208E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T.  
 DATUM Geodetic DATE 23.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
242.6	Ground Surface																
0.0	TOPSOIL		1	SS	2		242									22.3	
241.9	clayey, low organic																
0.7	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, brown to 1.1 m, grey below, very stiff to hard		2	SS	35												
			3	SS	23		241										
			4	SS	42		240										
			5	SS	30		239										
			6	SS	28		238										
			7	SS	40		237										
237.4			8	SS	26		236										
5.2	SANDY SILT		9	SS	16		235										
	grey, wet, compact																
234.5			10	SS	19		234									20.5	
8.1	End of borehole						233										
	Dynamic Cone Penetration Test performed from 8.1 to 10.5 m.																
232.1																	
10.5	End of Dynamic Cone Penetration Test																
	Water level at 6.7 m upon completion. Standpipe piezometer installed. Water level in piezometer at 5.6 m on Oct 27/99																

+ 3, x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 24

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844373N;282114E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%) W <sub>p</sub> W    W <sub>L</sub>
243.1	Ground Surface						20	40	60	80	100		
0.0	450 mm TOPSOIL		1	SS	3							19.8	
242.6	SILTY CLAY												
0.5	trace organic, brown, soft		2	SS	8								
242.4	CLAYEY SILT												
0.7	brown, soft to firm, wet		3	SS	6								
241.4													
1.7	CLAYEY SILT AND SANDY SILT with some Silty Sand and Silt seams, occasional very thin black organic seams, grey,		4	SS	7								
240.2	firm/loose, wet												
2.9	SAND		5	SS	8								
239.4	some gravel, grey, loose, wet												
3.7	CLAYEY SILT AND SANDY SILT with some Silty Clay, Silt and Silty Fine Sand seams, grey, stiff, compact, wet		6	SS	10							20.9	
			7	SS	15								
			8	SS	12								
236.9													
6.2	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional silt and sand seams, grey, very stiff to hard		9	TW	PH							22.4	
			10	SS	30								
			11	SS	32								
233.5			12	SS	27								
9.6	End of borehole Water level on completion at 1.5 m and hole caved at 6.0 m												

# RECORD OF BOREHOLE No 25

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844380N, 282096E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T.  
 DATUM Geodetic DATE 22.10.99 23.10.99 CHECKED BY Z.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
243.8	Ground surface										
243.5	300 mm TOPSOIL		1	SS	2						
0.3	SILTY CLAY some topsoil, brown/dark brown, very soft to stiff (probably fill)		2	SS	9						
242.4			3	SS	10						
1.4	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) occasional Sandy Silt Till zones, brown/grayish brown, stiff to hard		4	SS	12						
			5	SS	16						
			6	SS	44						
238.8			7	SS	18						
5.0	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) some Sand and Silt seams/lenses, occasional cobbles and boulders, grey, compact, wet		8	SS	26						
			9	SS	18						
			10	SS	24						
235.8											
8.2	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) grey, compact, wet		11	SS	23						
			12	SS	16						
232.6	sand and silt seams										
11.2	SILTY FINE SAND some Silt and Clayey Silt lenses, grey, compact, wet		13	SS	17						
			14	SS	13						
231.2	End of borehole Dynamic Cone Penetration test extended from 12.6 to 16.8 m.										
12.6											

Continued Next Page

+ 3 x 3 : Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 25

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844380N, 282096E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T.  
 DATUM Geodetic DATE 22.10.99 23.10.99 CHECKED BY Z.O.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
227.0							228							
16.8	End of Dynamic Cone Penetration Test Water level at 5.8 m and hole caved at 9.4 m upon completion Water level not stabilized						227							

# RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844263N, 282381E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 18.10.99 19.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)	
								20	40	60				80
245.9	Ground surface													
0.0 245.8	250 mm TOPSOIL		1	SS	6							20.0		
0.3	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) some Clayey Silt Till zones, occasional cobbles and boulders, brown to 2.7 m, grey below, dense to 0.9 m, compact to 1.5 m, dense below, moist to 2.2 m, damp below		2	SS	16								8 44 48 0	
			3	SS	36								21.0	
			4	SS	51									7 43 50 0
			5	SS	38								22.5	5 42 53 0
			6	SS	37									8 38 52 2
			7	SS	46								21.8	4 35 61 0
			8	SS	78									
240.6	Heterogeneous mixture of Sand and silt with some gravel (SILTY SAND TILL) some Clayey Silt Till zones, some Sand and Silt seams/lenses, occasional gravelly sand seams, occasional cobbles and boulders, grey, dense to very dense, moist to wet		9	SS	33							22.0		
		10	SS	50/13										
		11	SS	78/25								23.2	19 50 30 1	
		12	SS	54										
235.3	End of borehole Refusal to further augering at 10.6m on a boulder. Standpipe piezometer installed Water level at 10.0 m upon completion and at 4.8 m on Oct 22/99 Water level in piezometer at 5.1 m on Oct 20 and 21/99 Water level at 5.1 m on Oct 27/99 Sample 13=no recovery N.P. denotes no penetration		13	GC	50/N.P.								Change to Hollow-Steam augering	
10.6														

## RECORD OF BOREHOLE No 26A

1 OF 2

**METRIC**

W.P. 130-99-00

LOCATION 4844265N;282378E

ORIGINATED BY M.T

DIST Central HWY 410

BOREHOLE TYPE Solid and Hollow Stem Augers &amp; D.C.P.T.

COMPILED BY G.T

DATUM Geodetic

DATE 25.10.99

CHECKED BY      Z.O

[illegible]

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

## 2 OF 2

## METRIC

LOCATION 4844265N:282379E

ORIGINATED BY M.T

BOREHOLE TYPE Solid and Hollow Stem Augers &amp; D.C.P.T.

COMPILED BY G.T

DATE 25.10.99 25.10.99

CHECKED BY      Z.O

+ 3, x 3: Numbers refer to Sensitivity



# RECORD OF BOREHOLE No 27

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844285N, 282359E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T  
 DATUM Geodetic DATE 19.10.99 20.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
246.0	Ground surface.												
245.7	325 mm TOPSOIL		1	SS	5		246					20.3	
0.3	SILTY CLAY						245						
245.0	with Clayey Silt and Silt seams, brown, firm to stiff		2	SS	20		244						
1.0			3	SS	29		243						
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) with Clayey Silt Till zones, some Sand and Silt seams, occasional cobbles and boulders, brown to 3.3 m, grey below, compact to very dense		4	SS	46		242					21.6	
			5	SS	50/13		241						
			6	SS	27		240						
			7	SS	30		239						
240.5	wet sand and silt seams		8	SS	16		238					22.8	5 39 44 12
5.5	SILTY CLAY						237						
240.0	with till seams, grey, very stiff		9	SS	29		236						
6.0			10	SS	33		235						
	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) some Sandy Silt Till and Clayey Silt Till zones, some Sand seams, occasional Silt and Silty Clay seams/lenses, occasional cobbles and boulders, grey, dense to very dense, wet		11	SS	40		234						
			12	SS	29		233						
			13	SS	74		232						
			14	SS	55								
			15	SS	98								10 36 52 2
			16	SS	96								Oct 19/Oct 20

Continued Next Page

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 28

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844280N, 282402E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 18.10.99 CHECKED BY Z.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
245.7	Ground surface												
245.4	300 mm TOPSOIL		1	SS	10								
0.3	CLAYEY SILT with Clayey Silt Till, Silt and Silty clay seams, brown, stiff to hard, moist		2	SS	26	245							
243.6			3	SS	36	244						23.6	
2.1			4	SS	56	243							9 42 48 1
			5	SS	50/13	242						21.6	6 44 50 0
			6	SS	70	241							2 40 58 0
			7	SS	70	240							
			8	SS	52	239						22.6	
			9	SS	91	238							1 42 56 1
			10	SS	50/13	237							
			11	SS	50/13	236						22.5	
			12	SS	50/11	235							13 42 43 2
			13	SS	50/15	234							
233.3			14	SS	50/13								
12.4	End of borehole Hole caved in and water level at 7.0 m upon completion Water level at 6.8 m and hole caved at 7.0 m two hours after completion Water level not stabilized Sand and clay lenses at 5.5 m												

+ 3 x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

**METRIC**[illegible]

+ 3, x 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 29

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844303N,262381E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T  
 DATUM Geodetic DATE 20.10.99 21.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
						20	40	60	80	100	20	40	60	
			16	SS	55									
						230								
			17	SS	43									
						229								
						228								
			18	SS	44									
						227								
						226								
			19	SS	38									
						225								
						224								
			20	SS	38									
						223								
222.8			21	SS	88									
23.3	End of borehole													
222.1	Dynamic Cone Penetration Test													
23.6	extended from 23.3 to 23.6 m													
	End of Dynamic Cone Penetration Test													
	Standpipe piezometer installed.													
	Water level in piezometer at													
	4.8 m on Oct 22 and Oct 25 and at													
	5.0 m on Oct 27/99													
	wet sand layer at 18.3 m													

# RECORD OF BOREHOLE No 30

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844289N, 282423E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
245.7	Ground surface.												
245.4	300 mm TOPSOIL		1	SS	11							19.5	
0.3	SILTY CLAY												
245.0	organic stained, brown, stiff		2	SS	29								
0.7	CLAYEY SILT												
244.6	with Silt seams, brown, very stiff												
1.1			3	SS	36								5 45 47 3
			4	SS	39							22.1	6 41 51 2
			5	SS	91								10 41 47 2
	Heterogeneous mixture of Silt and Sand with some gravel, trace clay (SANDY SILT TILL)		6	SS	58							22.5	
	some Clayey Silt Till zones, occasional cobbles and boulders, brown to 3.5 m, grey below, dense to very dense, damp		7	SS	51								
			8	SS	44								9 44 45 2
	wet sand layer at 6.0 m		9	SS	52								
			10	SS	38							22.2	
			11	SS	32								10 40 47 3
237.5	clayey												
8.2	wet sand layer at 8.6 m		12	SS	50/5								
	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL)		13	SS	50/13								5 49 45 1
	with Sandy Silt Till and some sand seams/lenses, occasional cobbles and boulders, grey, very dense, wet		14	SS	50/6								20 42 37 1
231.9			15	SS	50/11							22.8	
13.8	End of borehole Hole caved-in and water level at 8.9 m on upon completion Standpipe piezometer installed.												

Continued Next Page

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 10 5 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 30

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844299N, 262423E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%) W <sub>p</sub> W W <sub>L</sub>				
							20	40	60	80	100	20	40	60			
	Water level in piezometer at 4.6 m on Oct 20/99 and 4.3 m on Oct 25 and 27/99																

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 31

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844320N/262402E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 21.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
245.7	Ground Surface													
0.0	TOPSOIL		1	SS	8									
245.2														
0.5	clayey		2	SS	32									
			3	SS	43									
			4	SS	43									
	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL)		5	SS	50/13									
	some Clayey Silt Till zones to 8.5 m, frequent Silty Sand Till zones below, some sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, dense to very dense to 8.5 m, very dense below, damp to moist to 8.5 m, moist to wet below		6	SS	50/13									
			7	SS	52									
			8	SS	50/13									
			9	SS	69									
			10	SS	36									
			11	SS	33									
			12	SS	50/13									
			13	SS	50/13									
			14	SS	50/13									
			15	SS	50/13									
231.9														
13.8	End of Borehole													
	Water level at 7.7 m and hole caved at 8.9 m on completion Water level not stabilized													

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 32

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844259N;282358E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 19.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
246.0	Ground surface																
245.7	300 mm TOPSOIL		1	SS	12												
0.3	SILTY CLAY																
245.0	with Clayey Silt and Silt seams, brown, stiff		2	SS	20												
1.0																	
	Heterogeneous mixture of Silt and Sand		3	SS	20												
	some gravel, trace clay (SANDY SILT TILL)																
	with Clayey Silt Till zones, some Sand and Silt		4	SS	54												
	seams/lenses, brown, compact to 2.6 m, very dense below,																
242.6	damp to moist		5	SS	50												
3.4	Heterogeneous mixture of Sand and Silt		6	SS	66												
	some gravel (SILTY SAND TILL)																
	frequent Sand, Silt, and Clayey Silt lenses, occasional cobbles and boulders, grey, compact to very dense, wet		7	SS	64												
			8	SS	19												
			9	SS	54												
239.4																	
6.6	End of borehole																
	Water level at 5.5 m four hours after completion																
	0.3 m thick wet silty sand layer at 1.4 m																
	Silty clay seam at 5.5 m																
	Wet sand seam at 6.0 m																

+ 3 . x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 33

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844327N;282426E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
245.4	Ground surface													
245.1	300 mm TOPSOIL		1	SS	6		245						20.1	
0.3	SILTY CLAY													
244.7	trace gravel and organics, brown, firm		2	SS	25		244							
0.7			3	SS	31									
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) some Clayey Silt Till zones, brown to 3.5 m, grey below, compact to very dense, damp		4	SS	59		243						22.1	2 46 50 2
			5	SS	91		242							4 44 51 1
241.0			6	SS	42									
4.4	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) occasional Sand and Silt seams/lenses, grey, dense		7	SS	42		241						22.5	
			8	SS	42		240							
238.8			9	SS	46		239						22.2	
6.6	End of borehole Borehole dry on completion. Water level in open borehole at 5.2 m one hour after completion													

# RECORD OF BOREHOLE No 34

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844632N;282082E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100					
246.6	Ground Surface															
0.0	400 mm TOPSOIL		1	SS	7											
246.2			2	SS	17											
0.4			3	SS	32											
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, some sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.3 m, grey below, firm to stiff to 1.1 m, very stiff to hard below, damp to moist to 7.0 m, moist to wet below		4	SS	42											
			5	SS	52											
			6	SS	66/25											
			7	SS	36											
			8	SS	30											
			9	SS	26											
			10	SS	30											
237.0			11	SS	68											
9.8	End of borehole Water level on completion at 8.8 m Water level not stabilized															

# RECORD OF BOREHOLE No 35

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844403N/262364E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80					
245.8	Ground Surface															
245.5	300 mm TOPSOIL		1	SS	9											
0.3	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, stiff to 1.0 m, hard below, damp to moist to 8.0 m, moist to wet below, wet sand seams		2	SS	32											
			3	SS	33											
			4	SS	38											
			5	SS	96											
			6	SS	61											
			7	SS	57											
			8	SS	54											
			9	SS	39											
			10	SS	32											
236.2			11	SS	32											
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed Water level in piezometer at 4.0 m on Oct 25 and 27/99															

# RECORD OF BOREHOLE No 36

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844437N;282369E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100										

245.5	Ground Surface														
245.2	300 mm TOPSOIL														
0.3	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, stiff to 1.0 m, hard below, damp to moist		1	SS	11										
			2	SS	34										
			3	SS	36										
			4	SS	36										
			5	SS	91										
			6	SS	77										
			7	SS	59										
			8	SS	46										
			9	SS	39										
237.4			10	SS	33										
8.1	End of borehole Borehole dry on completion Water level not stabilized														

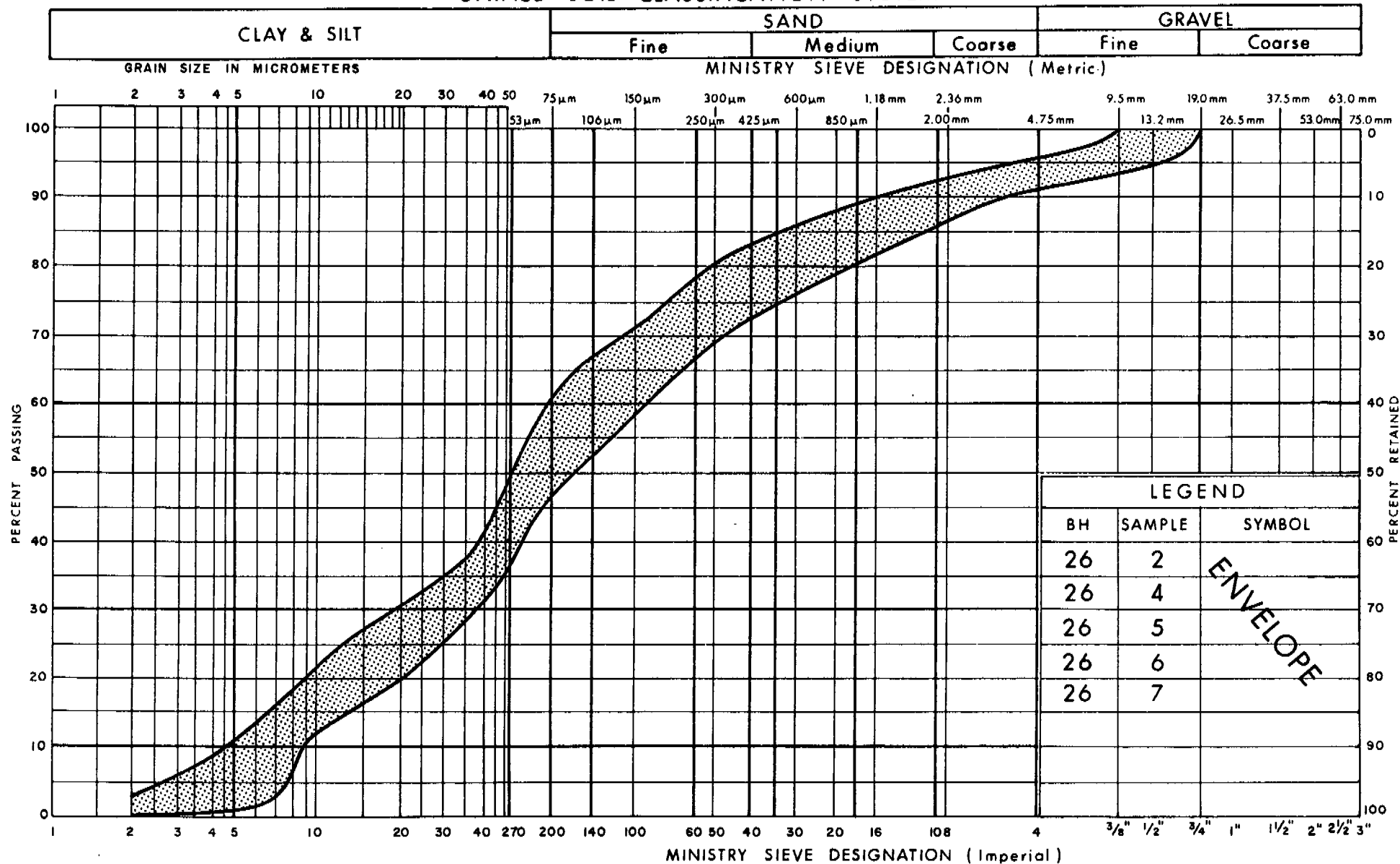
+ 3 . x 3 : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

# APPENDIX B

## Laboratory Test Results

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION

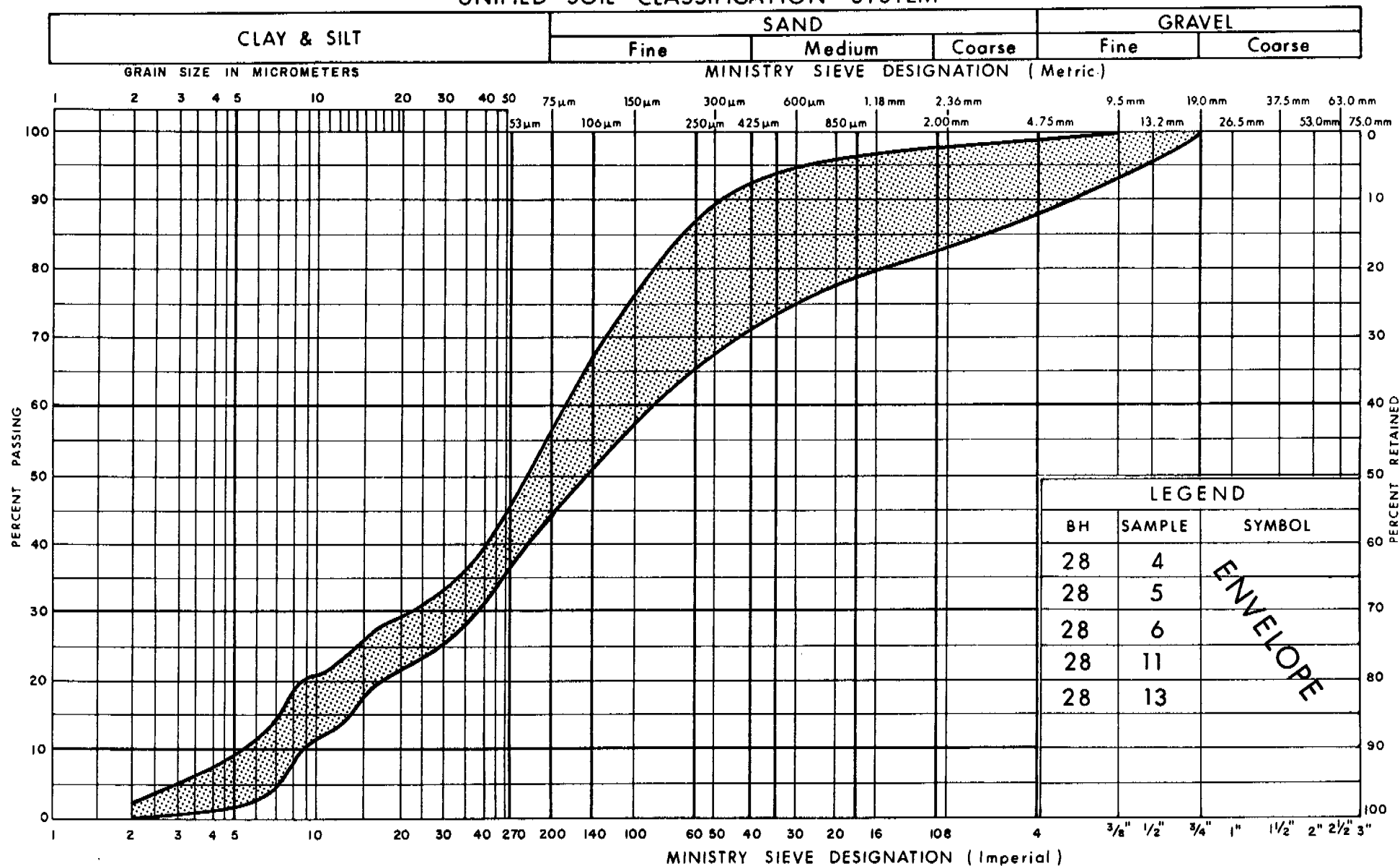
## SANDY SILT TILL

FIG No B1

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION SANDY SILT TILL

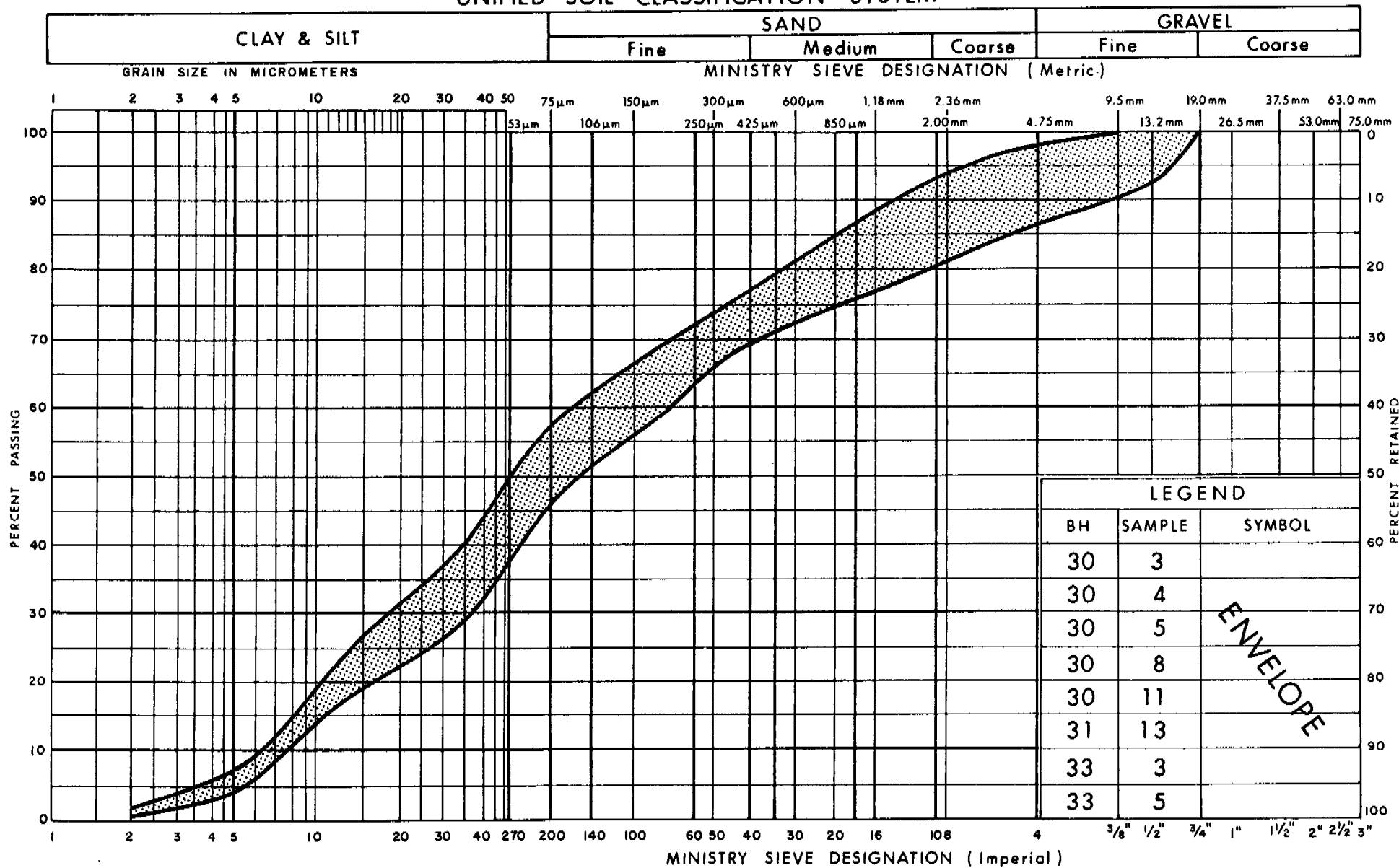
FIG No B2

W P 130-99-00 (D)

Sandalwood Pkwy



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

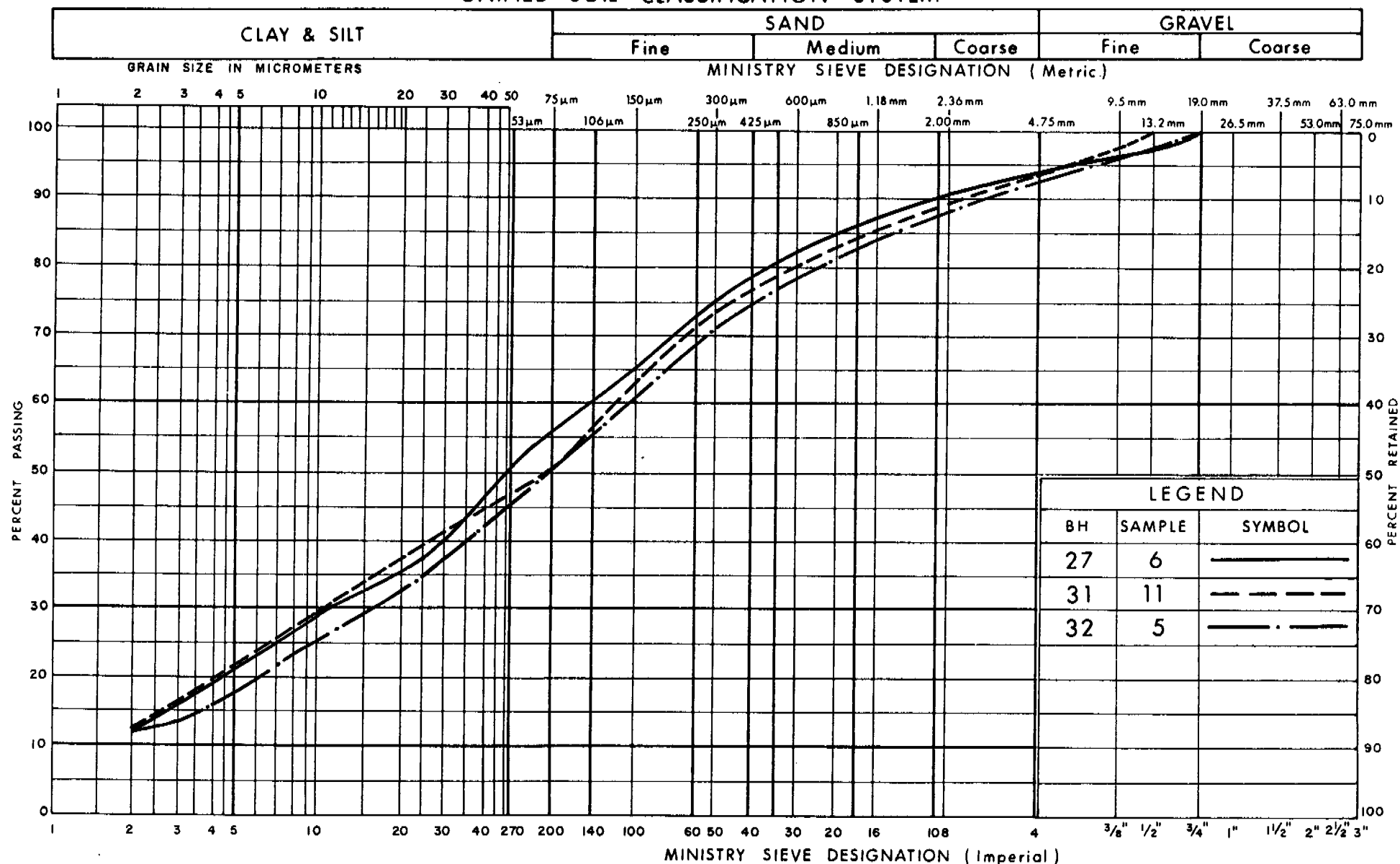
# GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B3

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

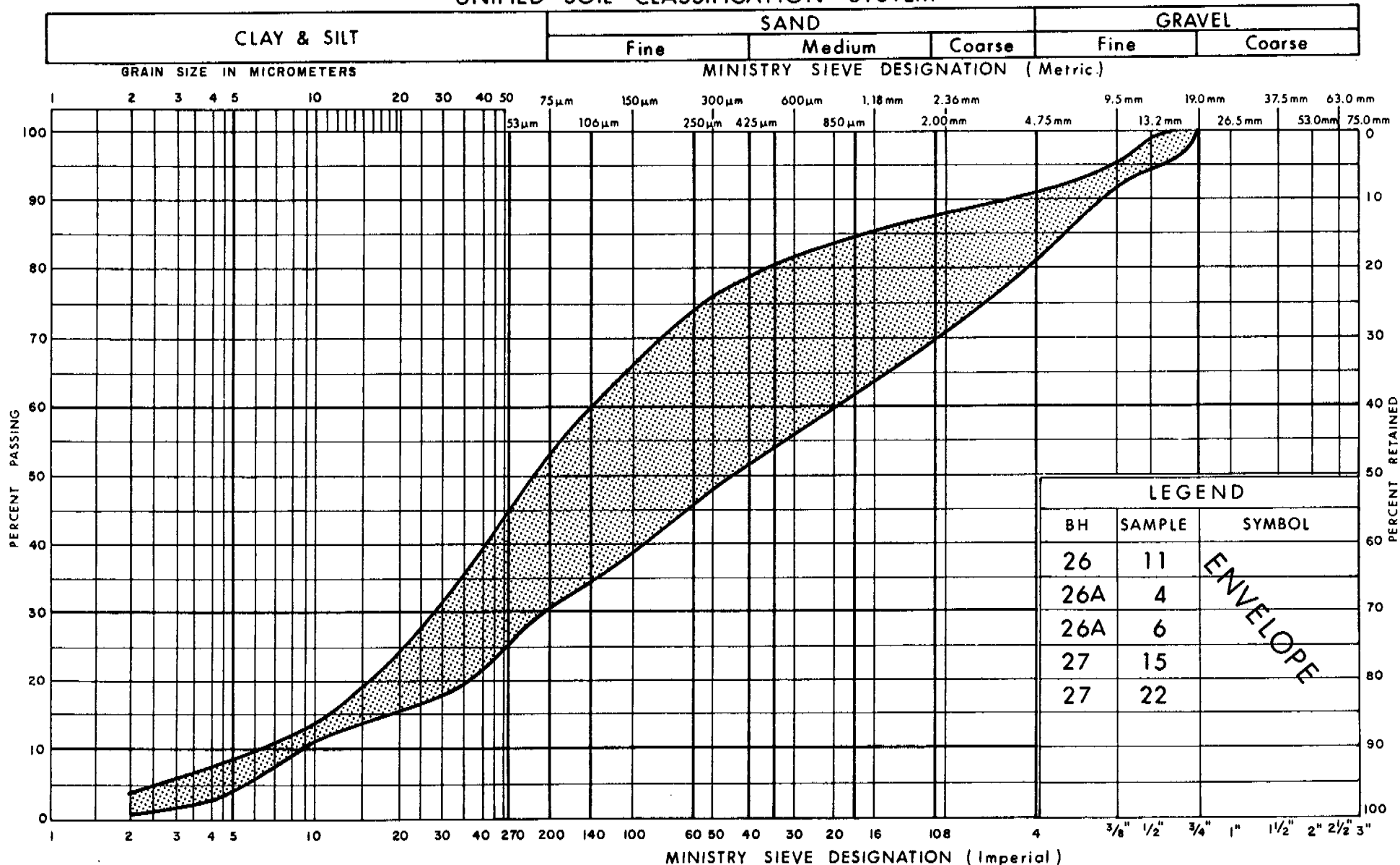
# GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL ZONES IN SANDY SILT TILL

FIG No B4

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

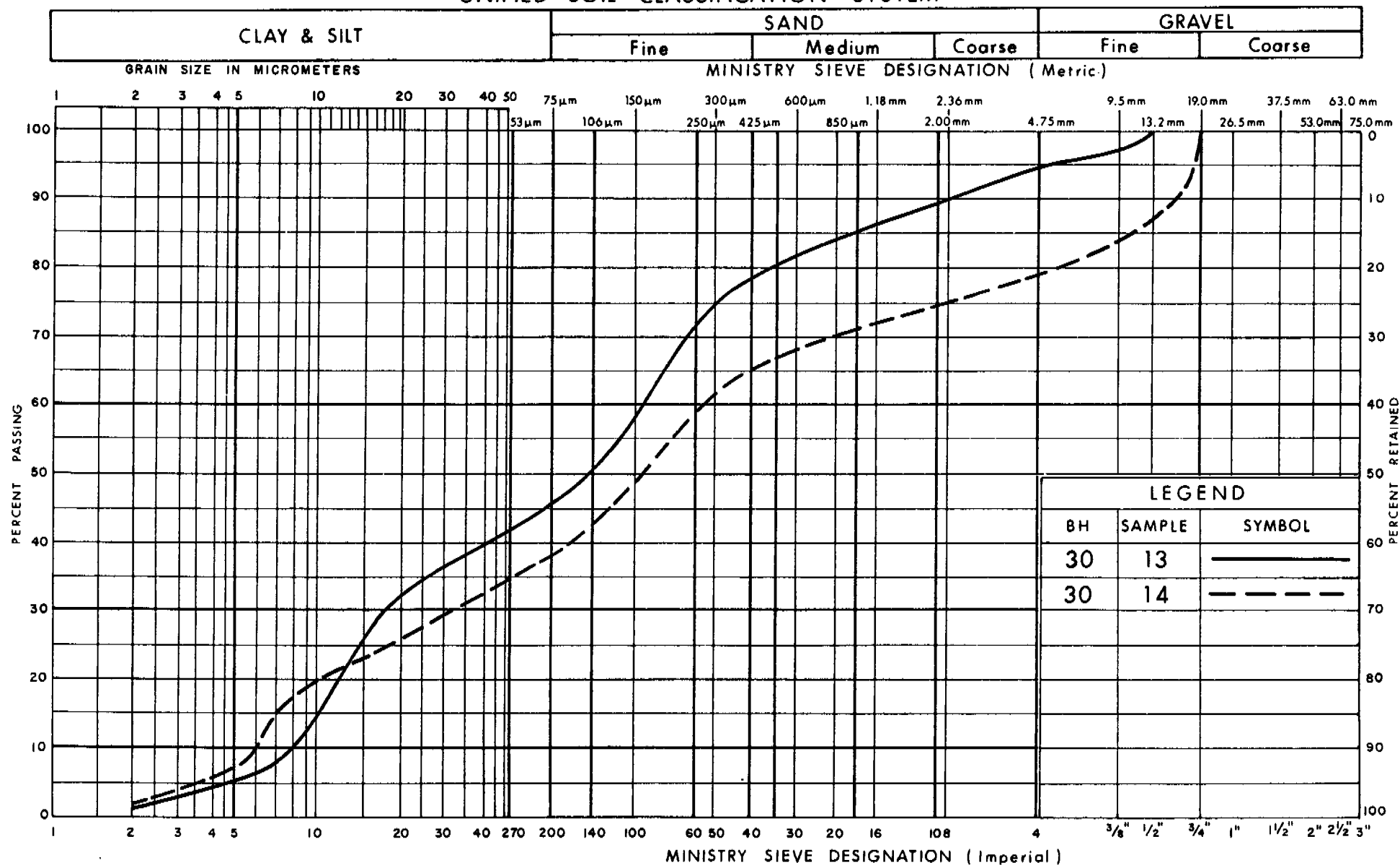
### SILTY SAND TILL

FIG No B5

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

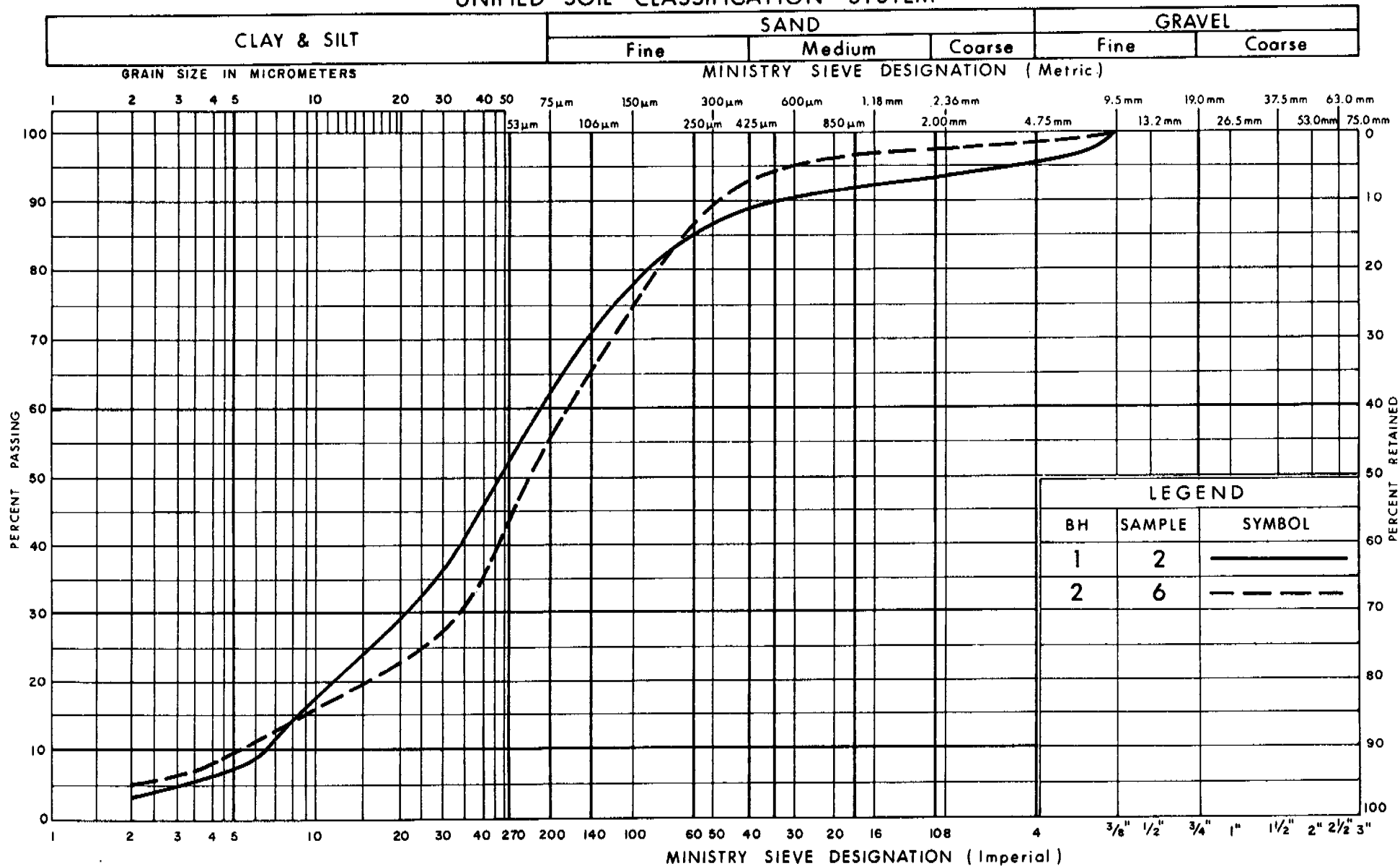
Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
SILTY SAND TILL

FIG No B6

W P 130-99-00(D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

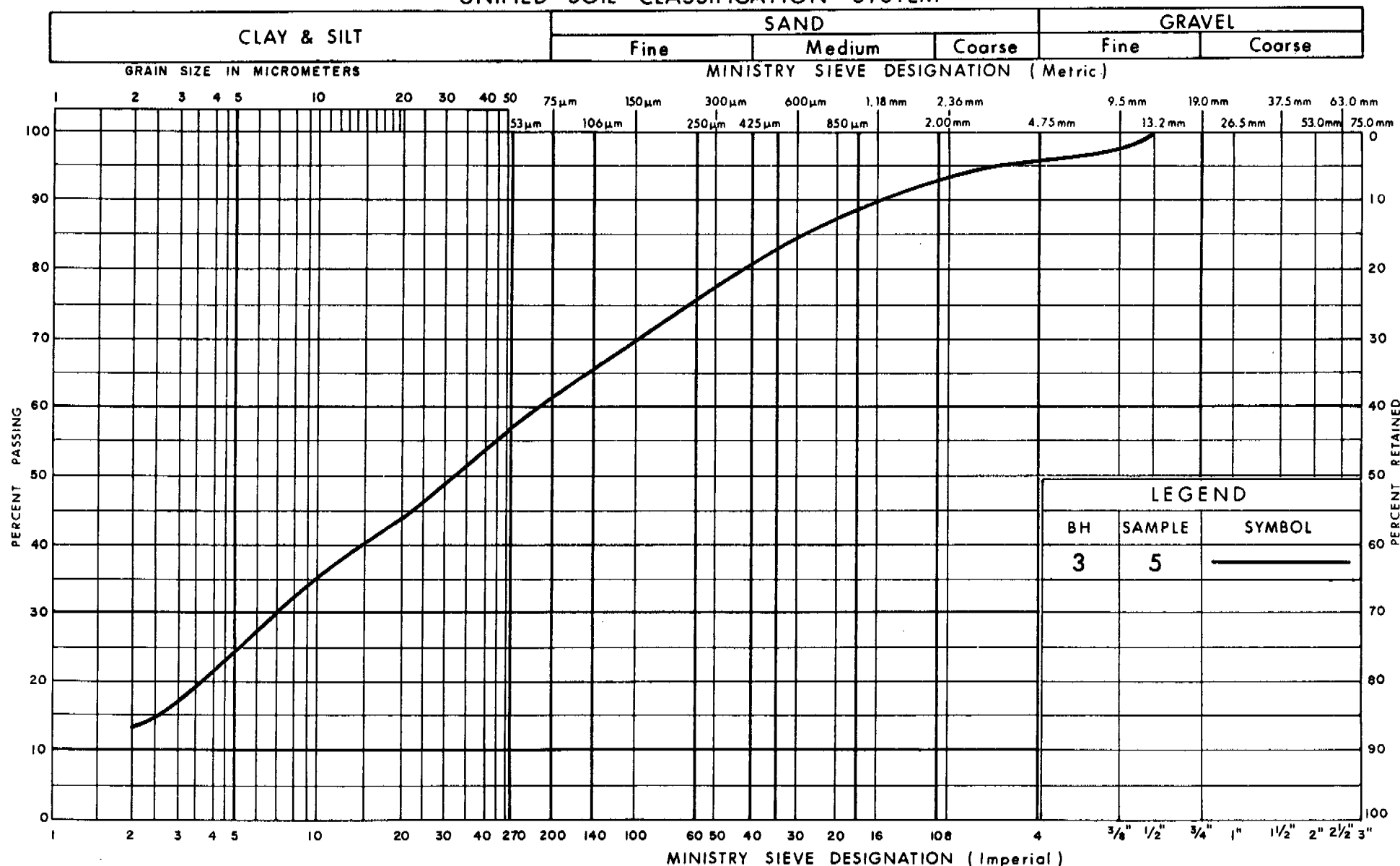
# GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B7

W P 130-99-00(D)

Culvert B2

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

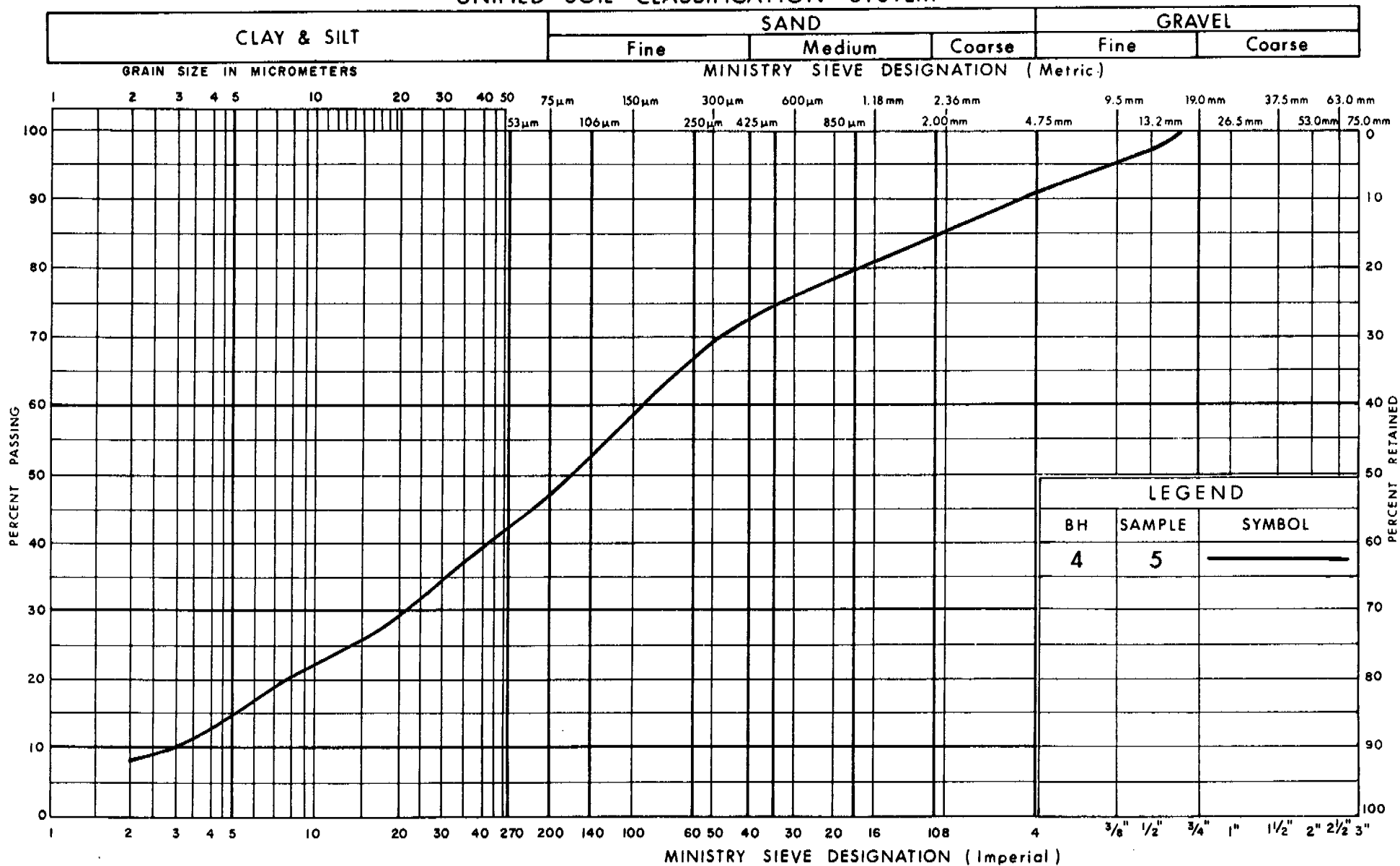
## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B8

W P 130-99-00 (D)

Culvert B3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

Ontario

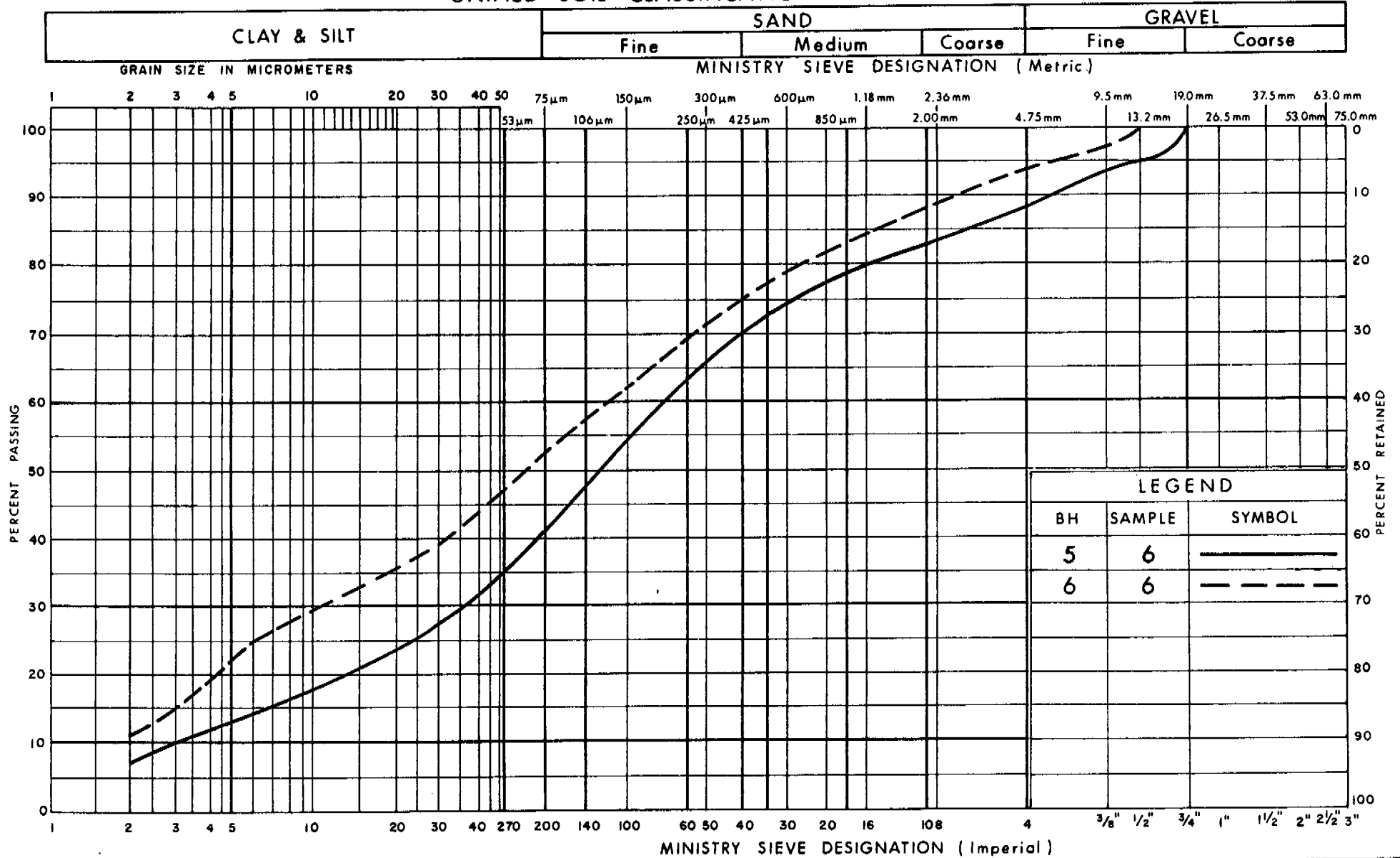
## GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B9

W P 130-99-00(D)

Culvert B3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

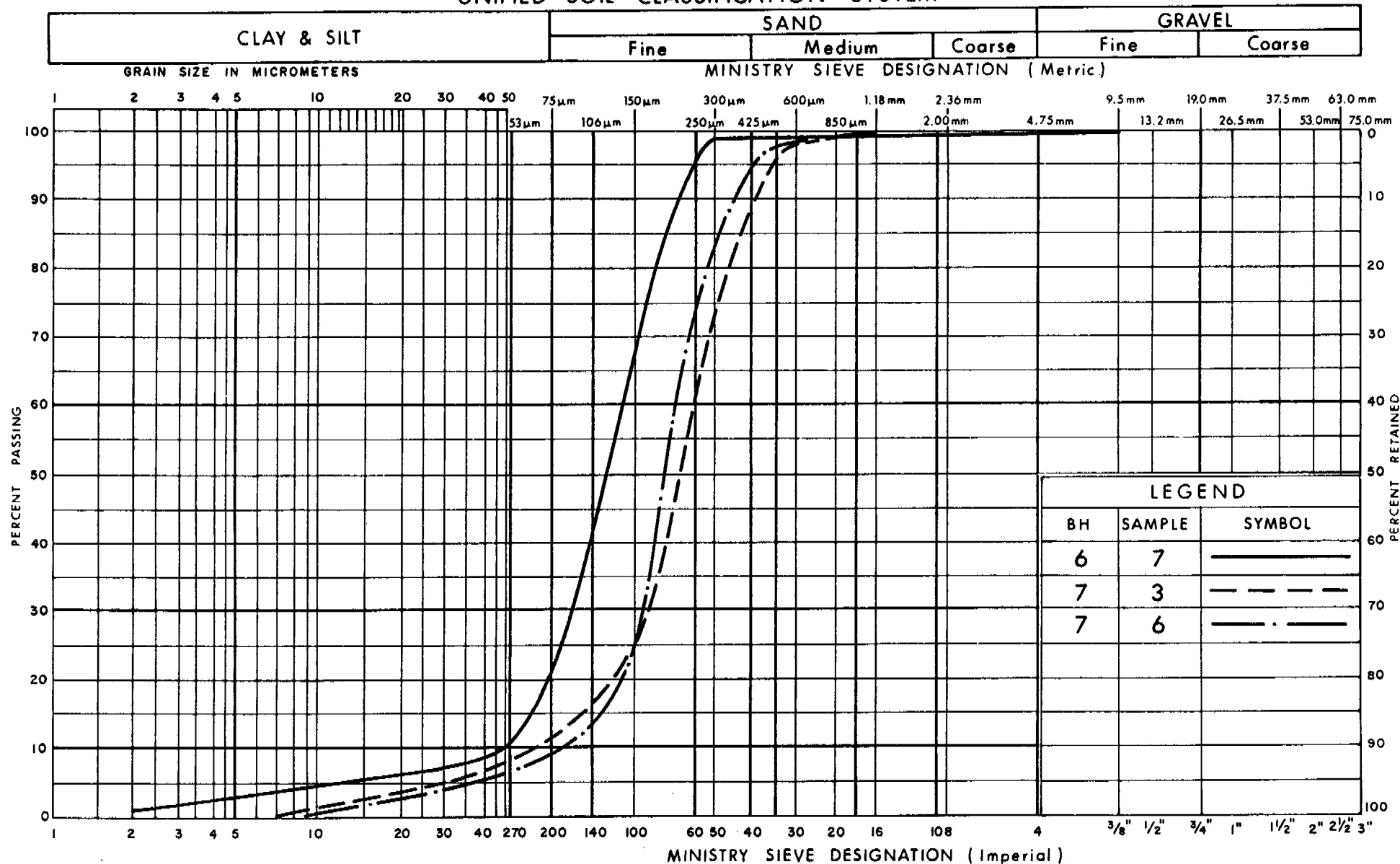
FIG No B 10

W P 130-99-00(D)

Culvert B4



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

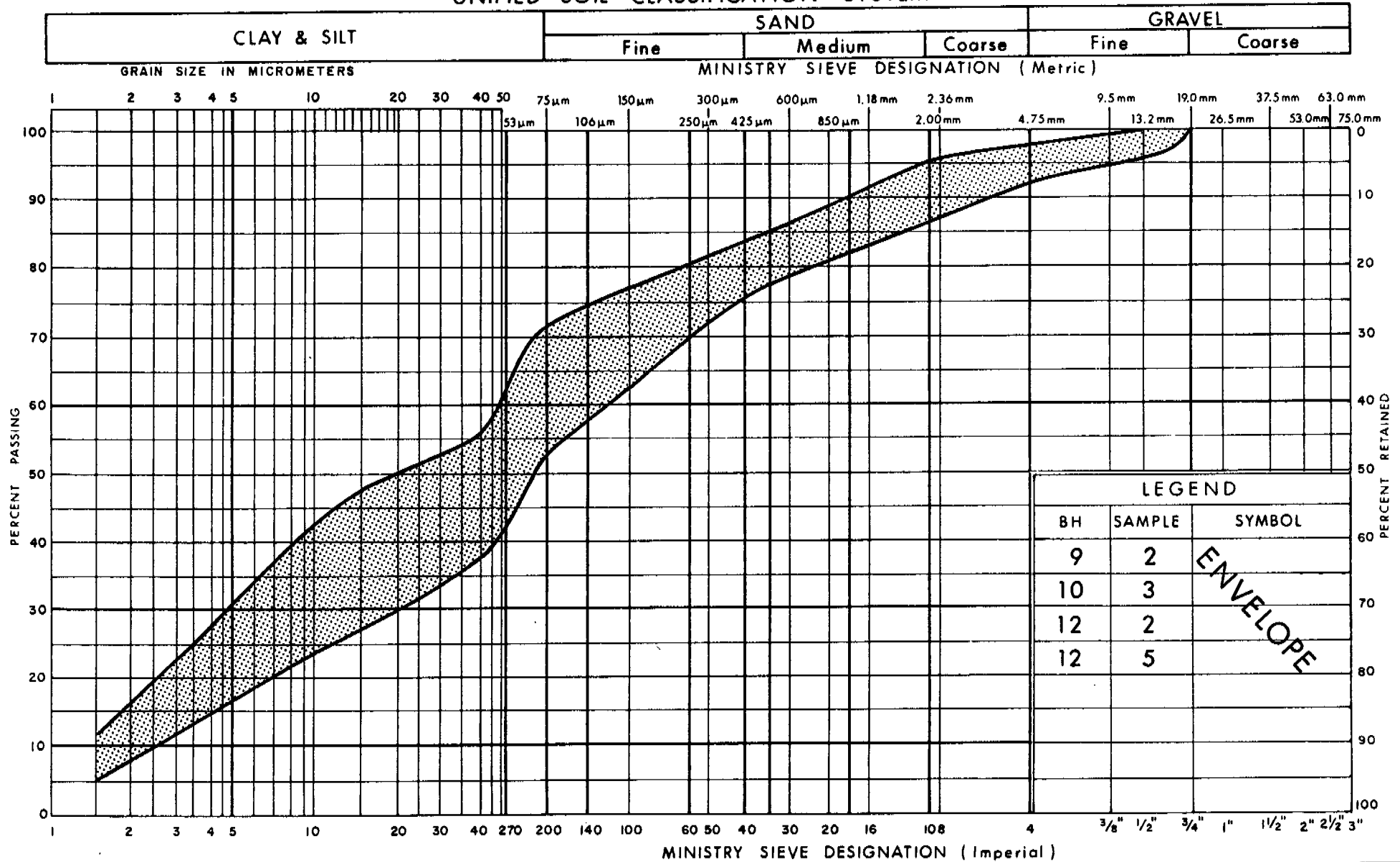
## GRAIN SIZE DISTRIBUTION FINE SAND

FIG No B 11

W P 130-99-00 (D)

Culvert B4

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

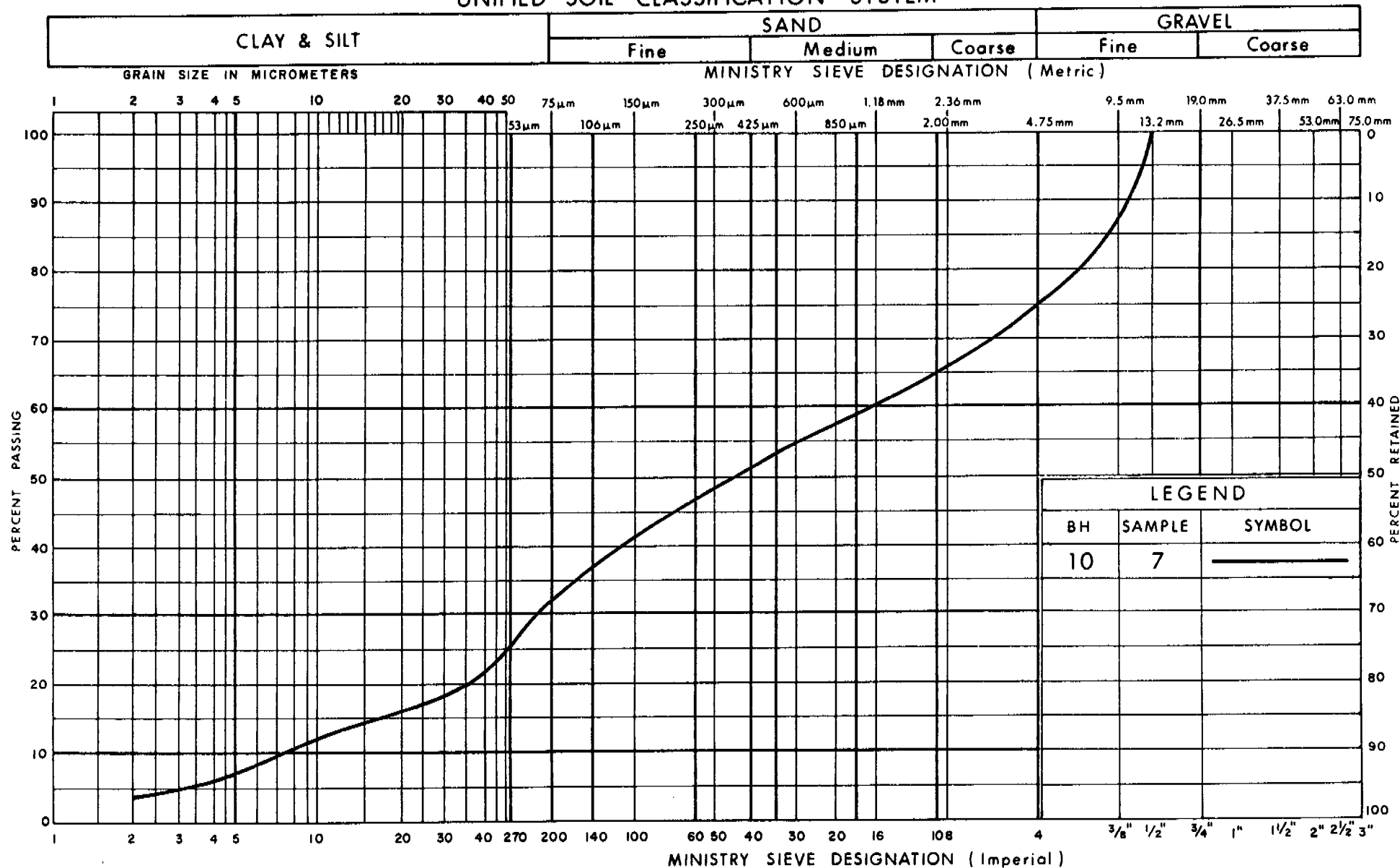
## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B12

W P 130-99-00(D)

Culvert S1

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

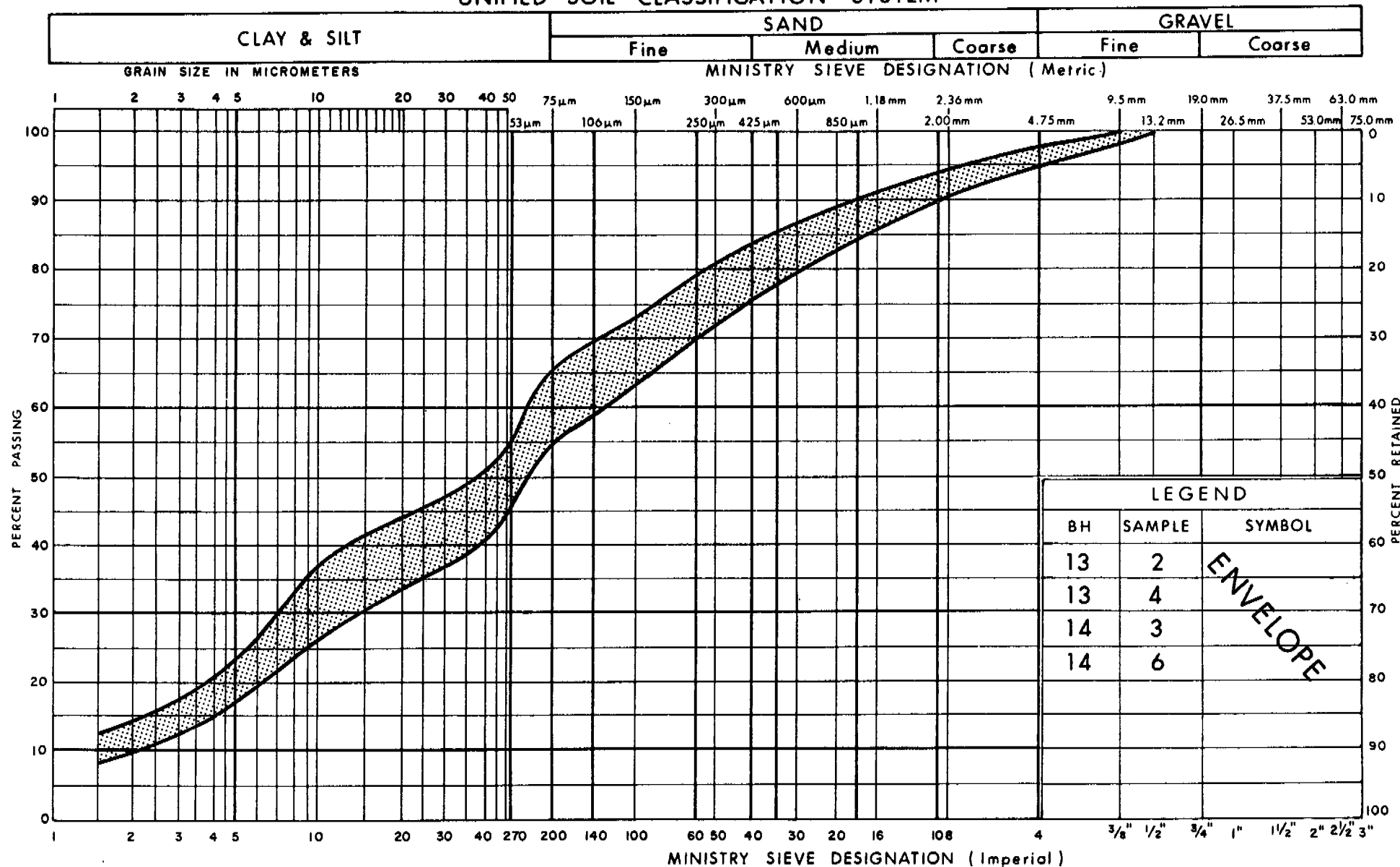
## GRAIN SIZE DISTRIBUTION SILTY SAND TILL

FIG No B 13

W P 130-99-00 (D)

Culvert S1

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

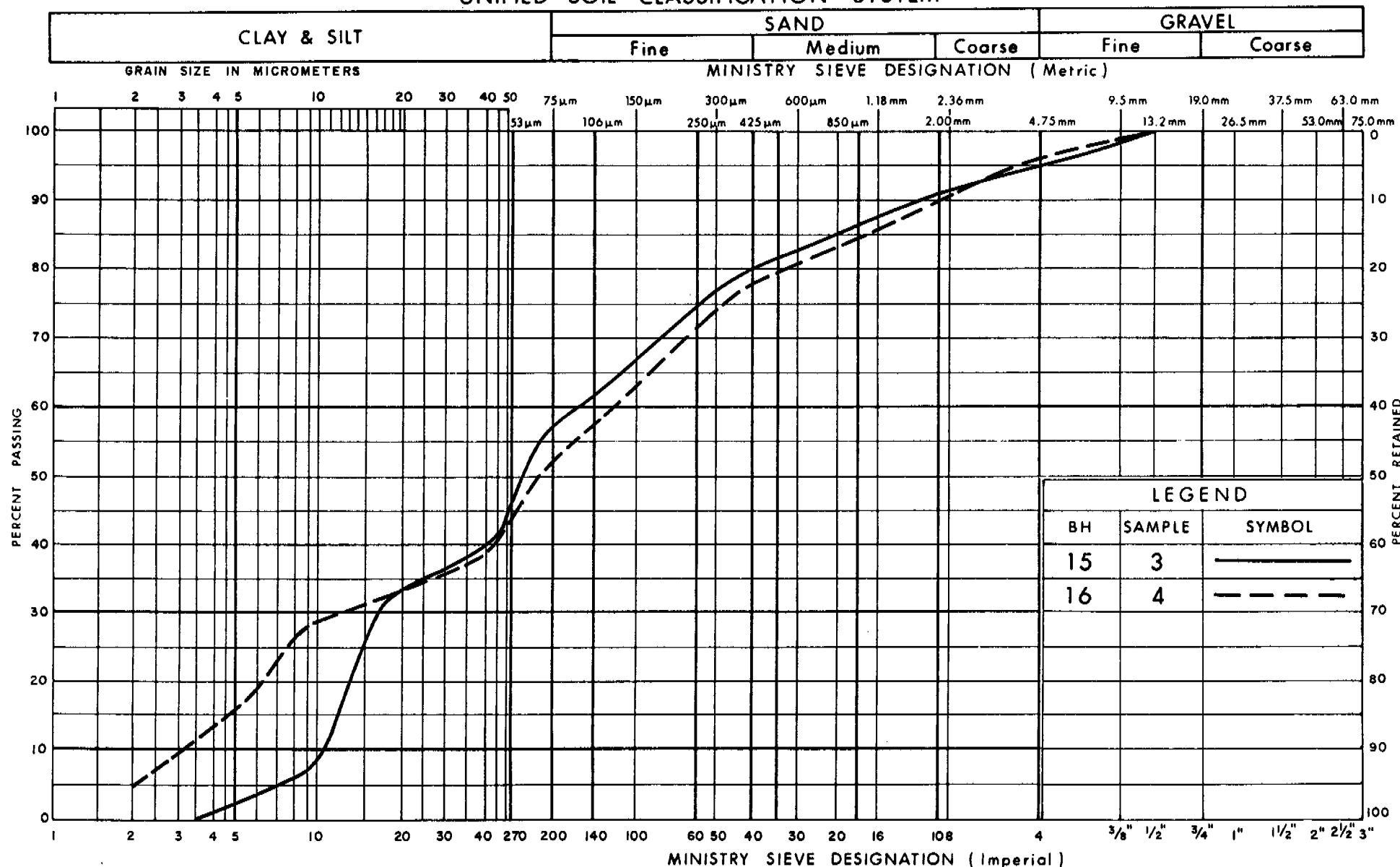
# GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B 14

W P 130-99-00(D)

Culvert S2

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

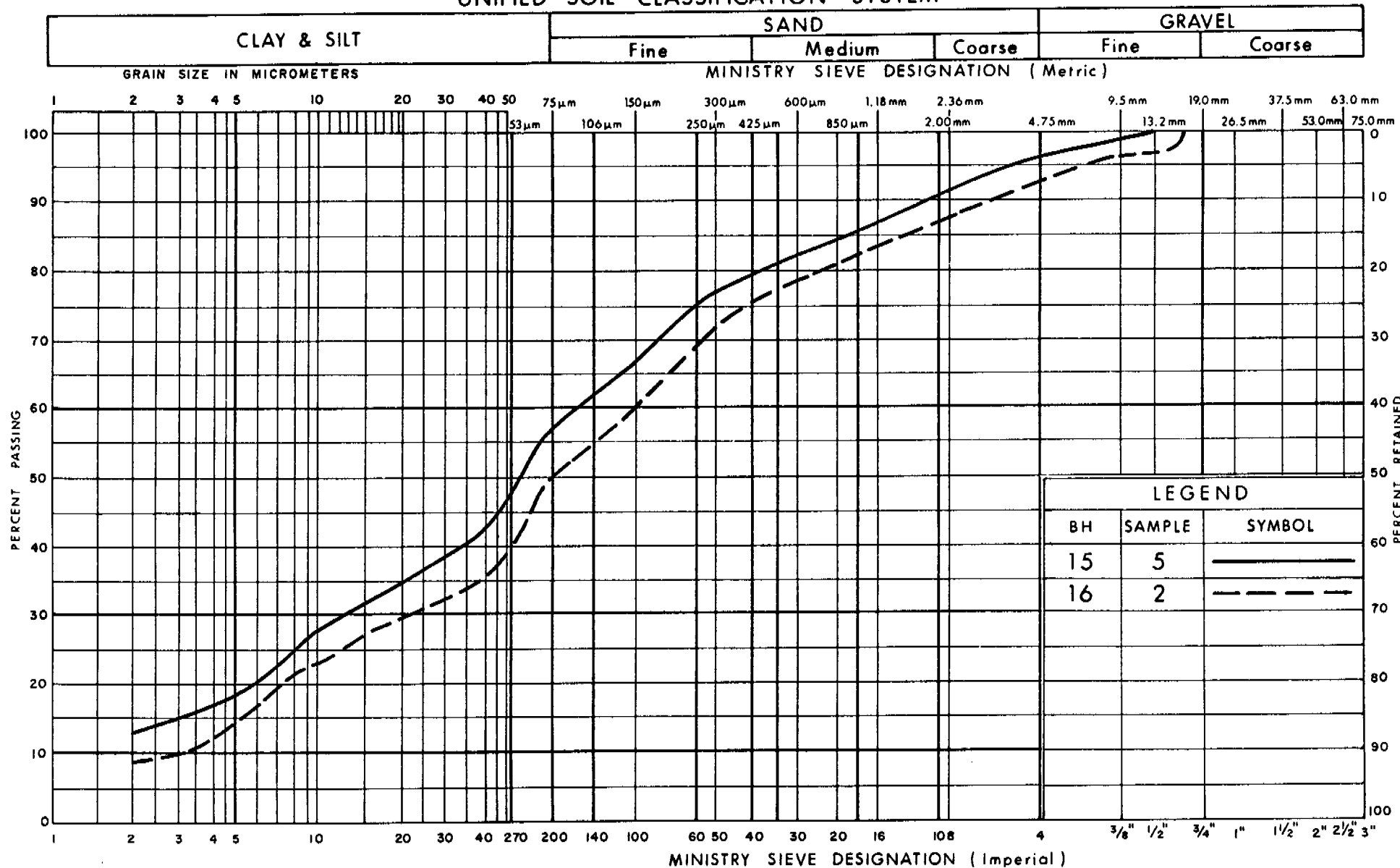
Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
SANDY SILT TILL

FIG No B15A

WP 130-99-00 (D)

Culvert S3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

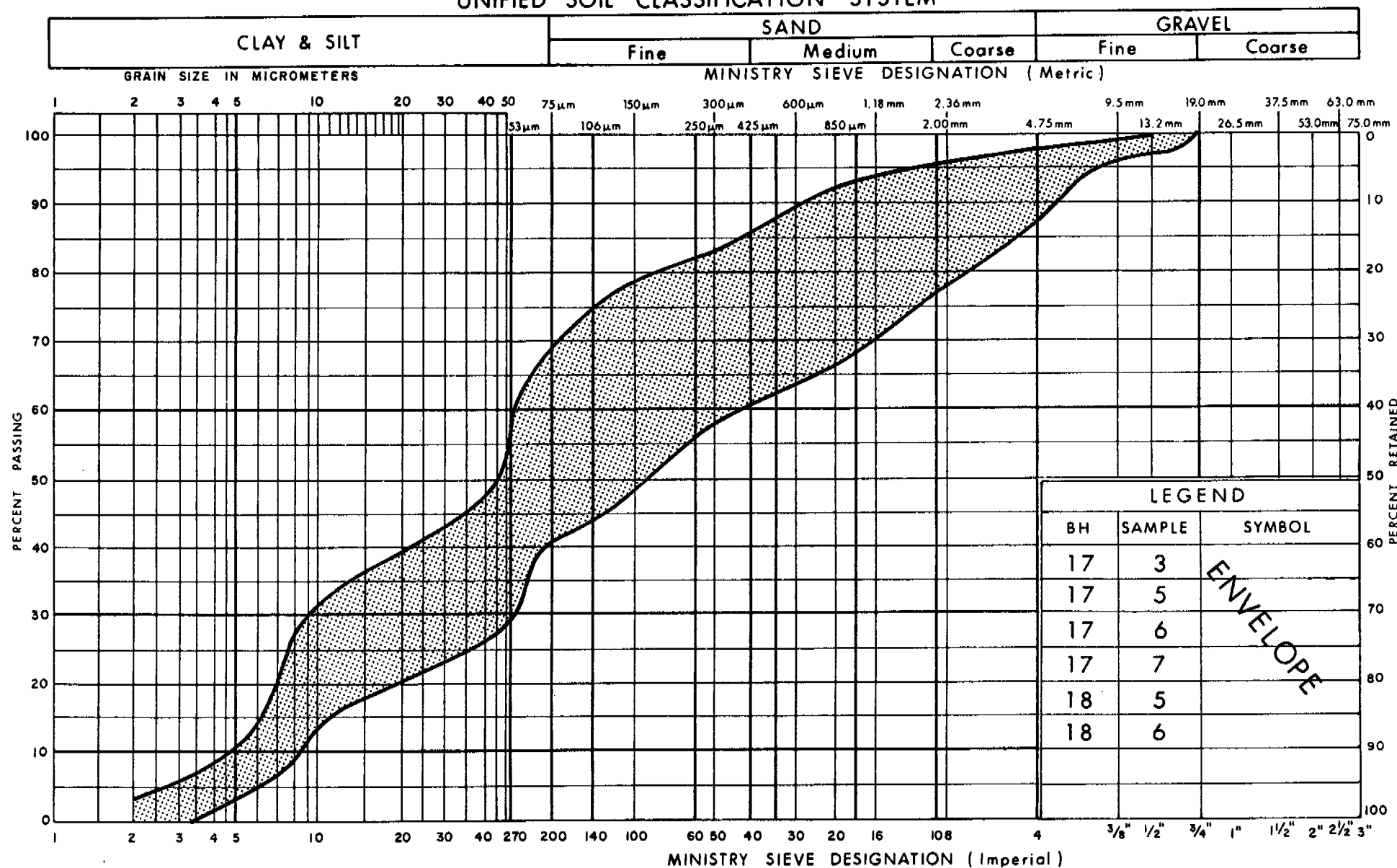
### CLAYEY SILT TILL ZONES IN SANDY SILT TILL

FIG No B15B

W P 130-99-00(D)

Culvert S3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION

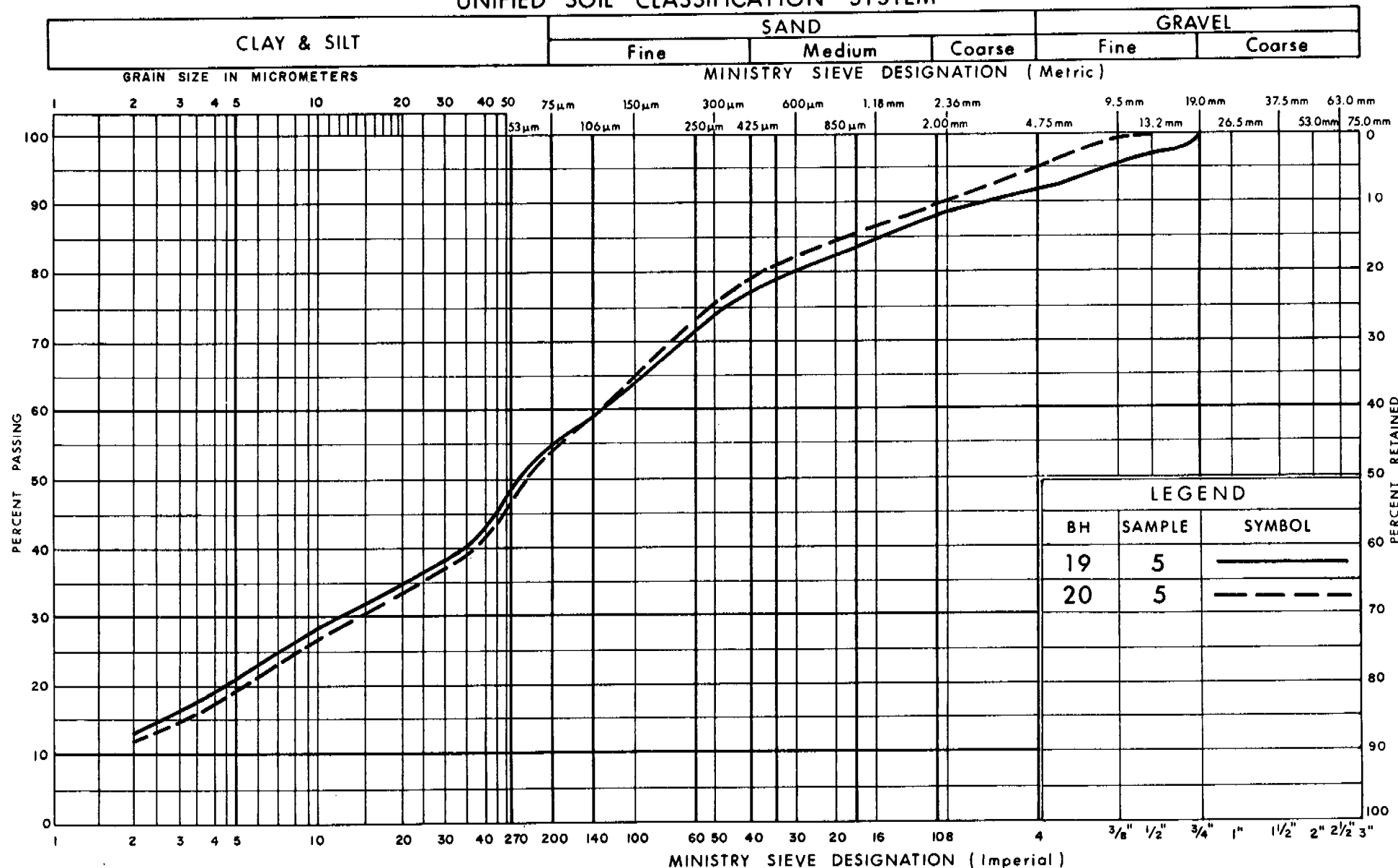
SANDY SILT TILL

FIG No B16

W P 130-99-00 (D)

Culvert S4

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT TILL

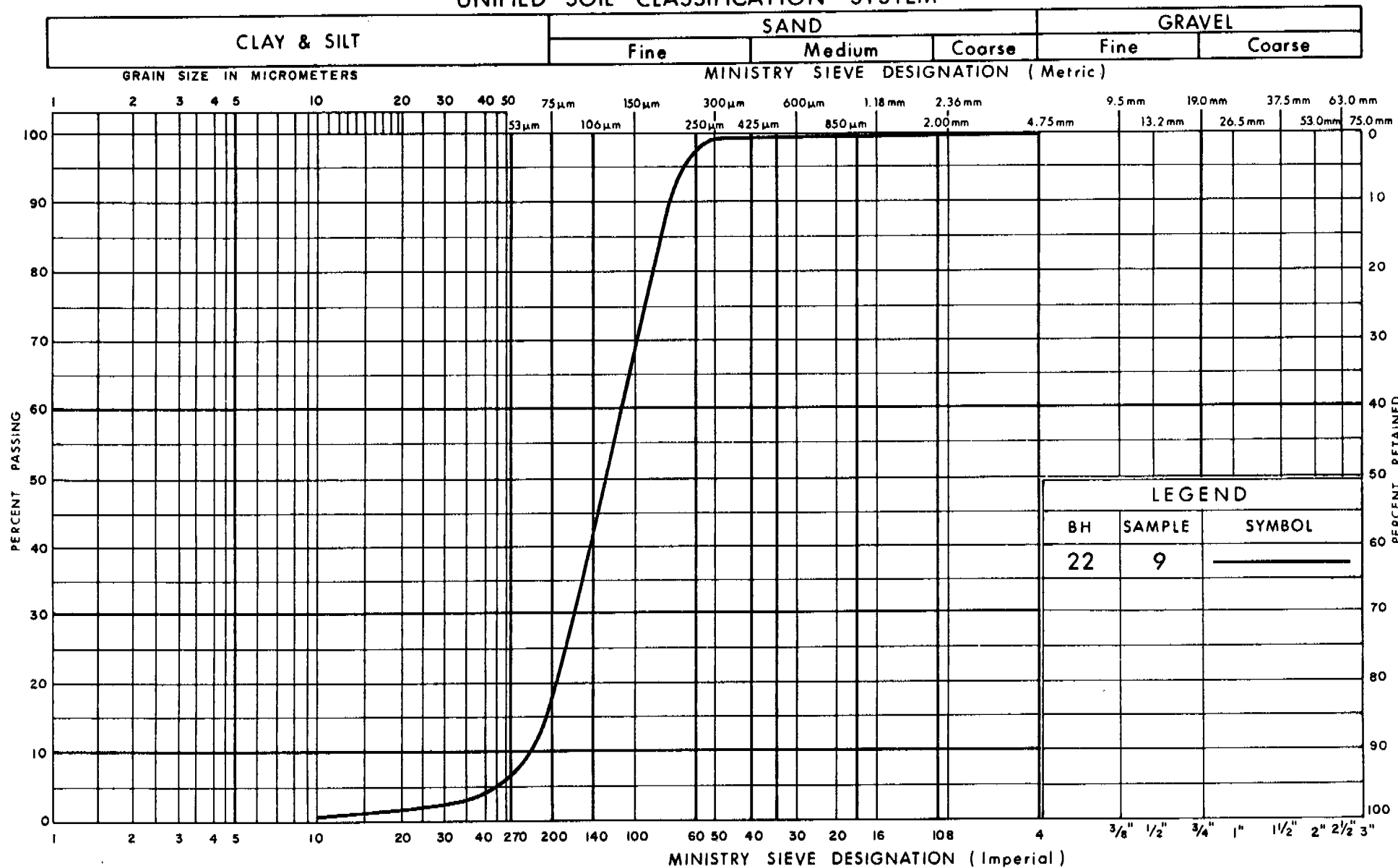
FIG No B17

W P 130-99-00(D)

Culvert S5



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

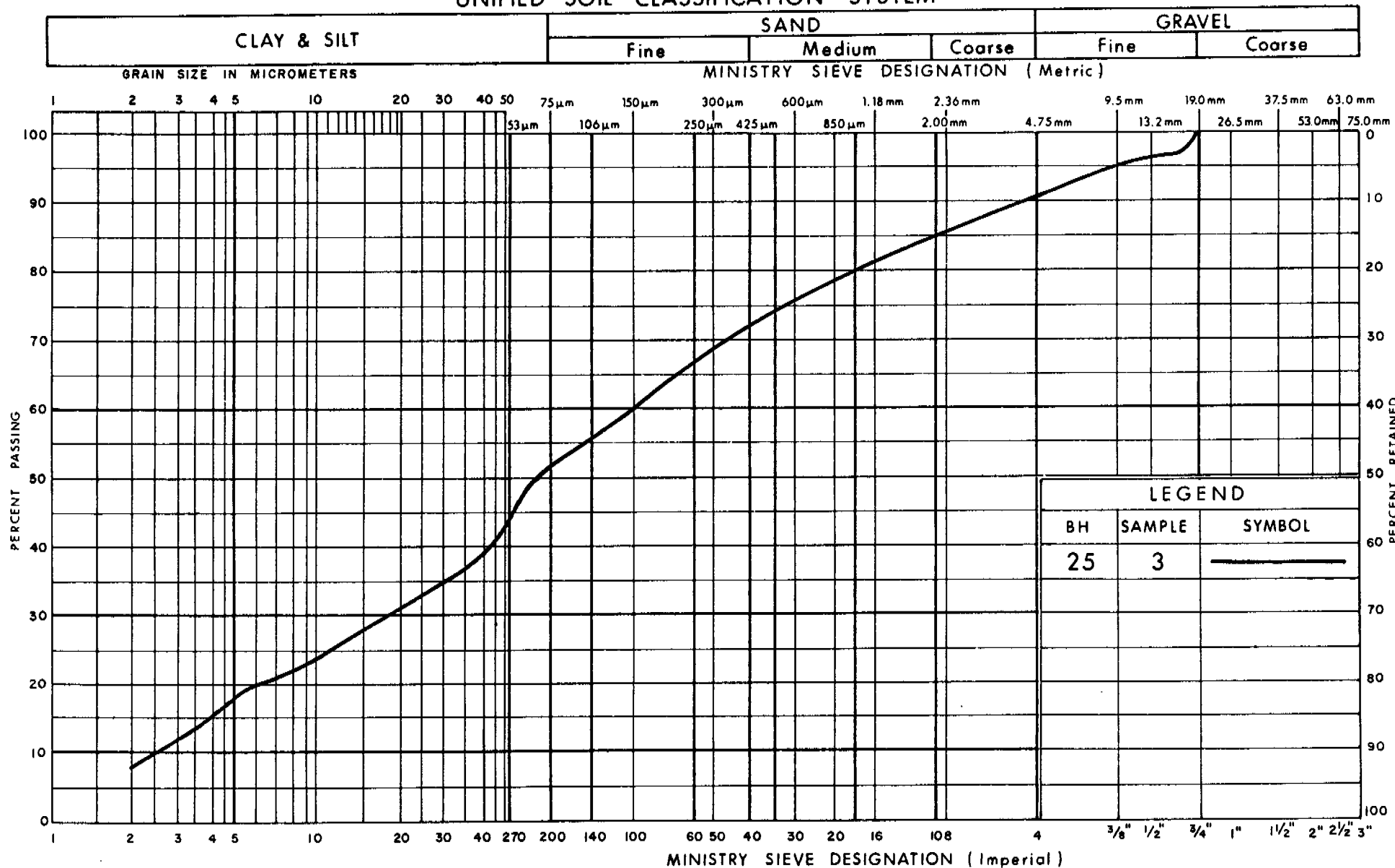
### FINE SAND

FIG No B 18

W P 130-99-00 (D)

Culvert S5

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

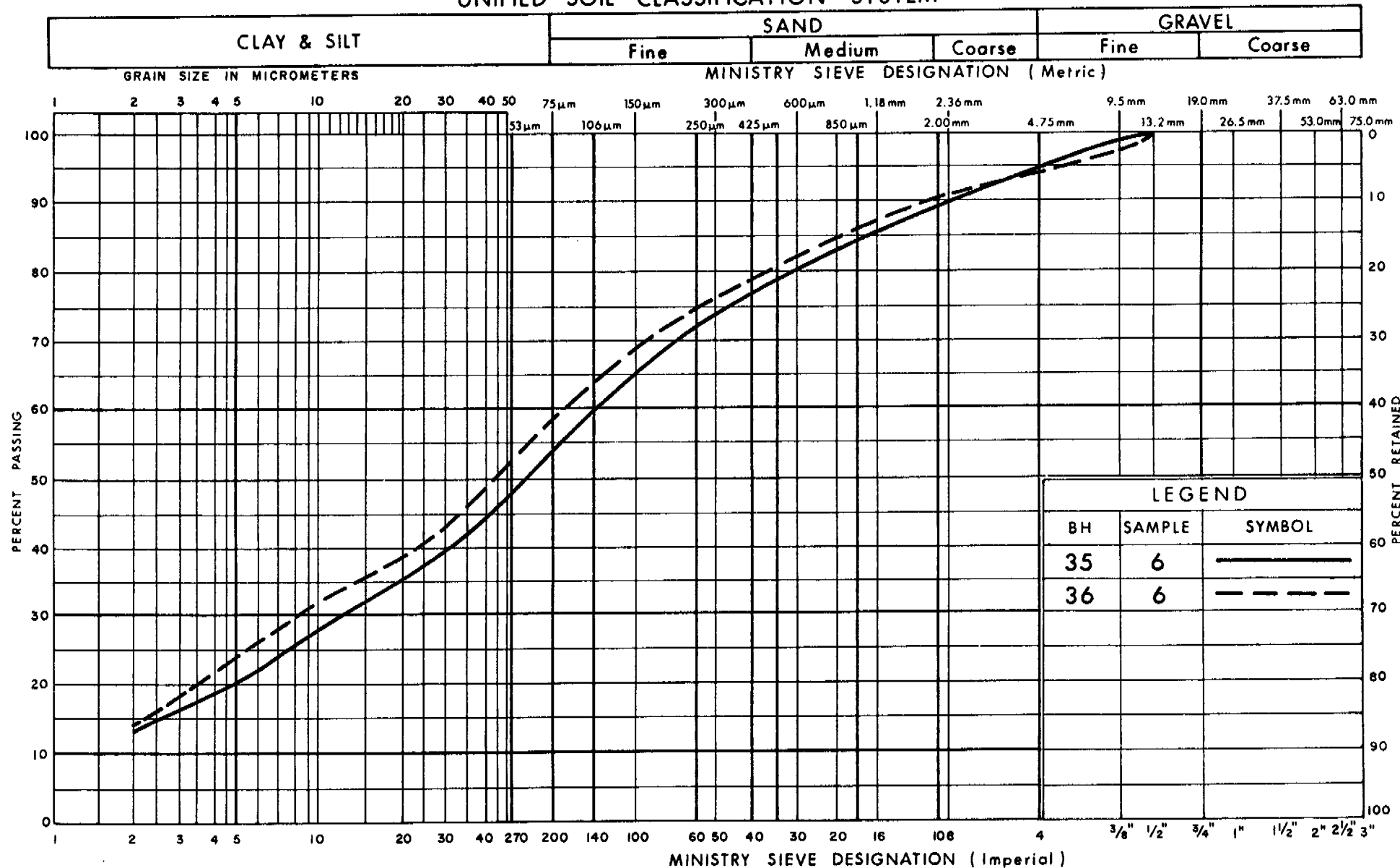
### CLAYEY SILT TILL

FIG No B19

W P 130-99-00(D)

Culvert S6

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

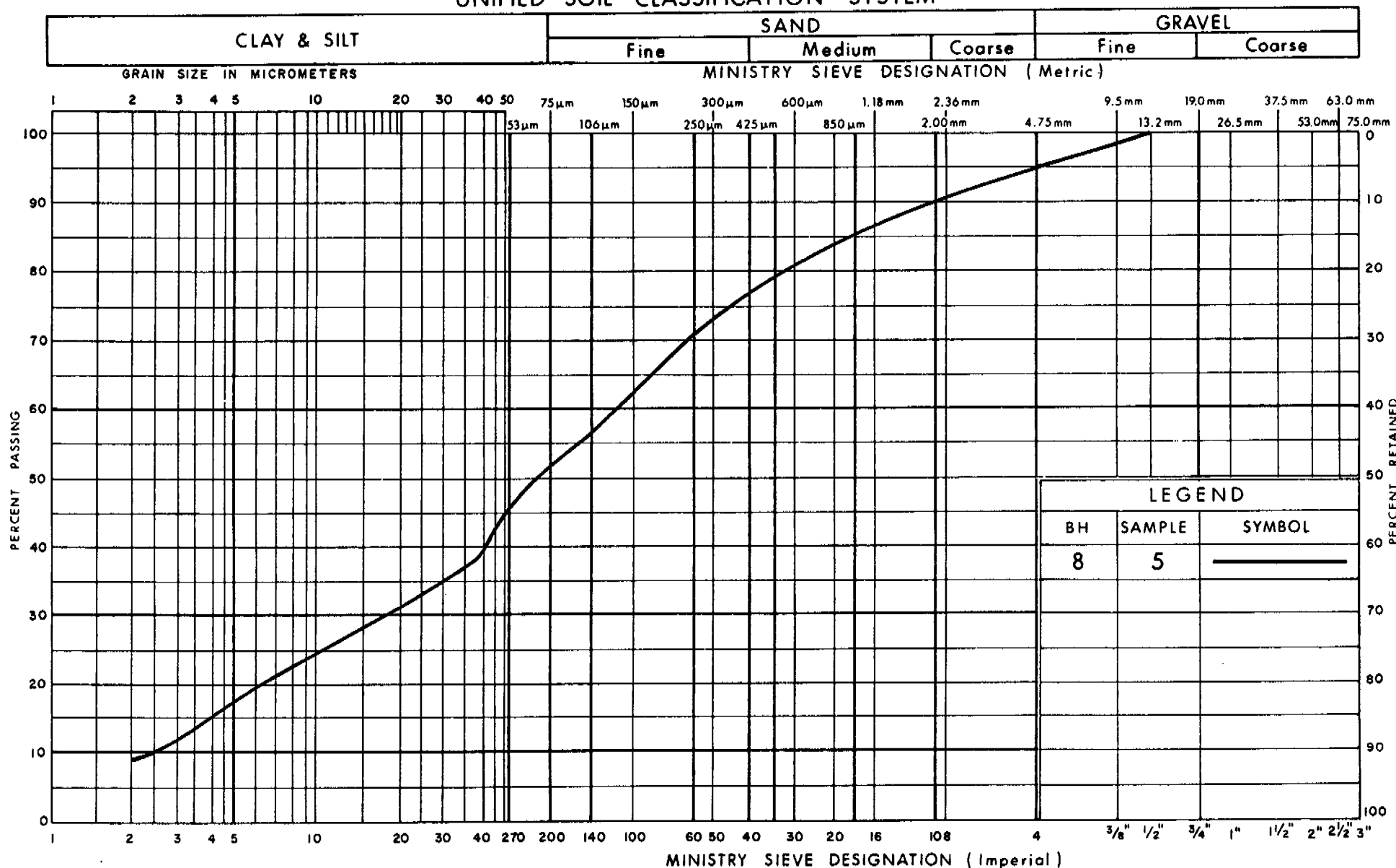
# GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B 20

W P 130-99-00 (D)

Culvert S7

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

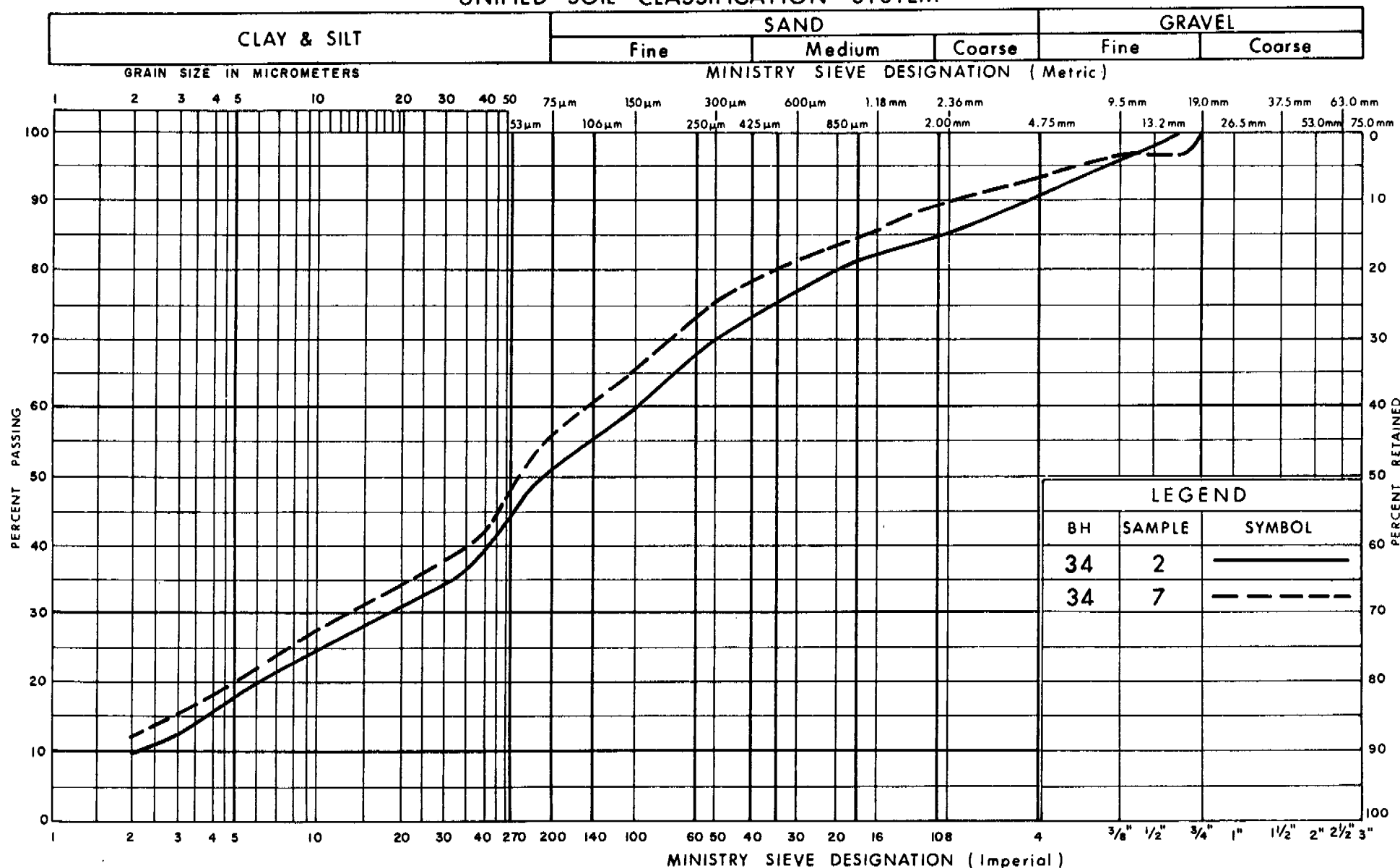
### SANDY SILT TILL

FIG No B 21

W P 130-99-00(D)

H.M.L.

## UNIFIED SOIL CLASSIFICATION SYSTEM



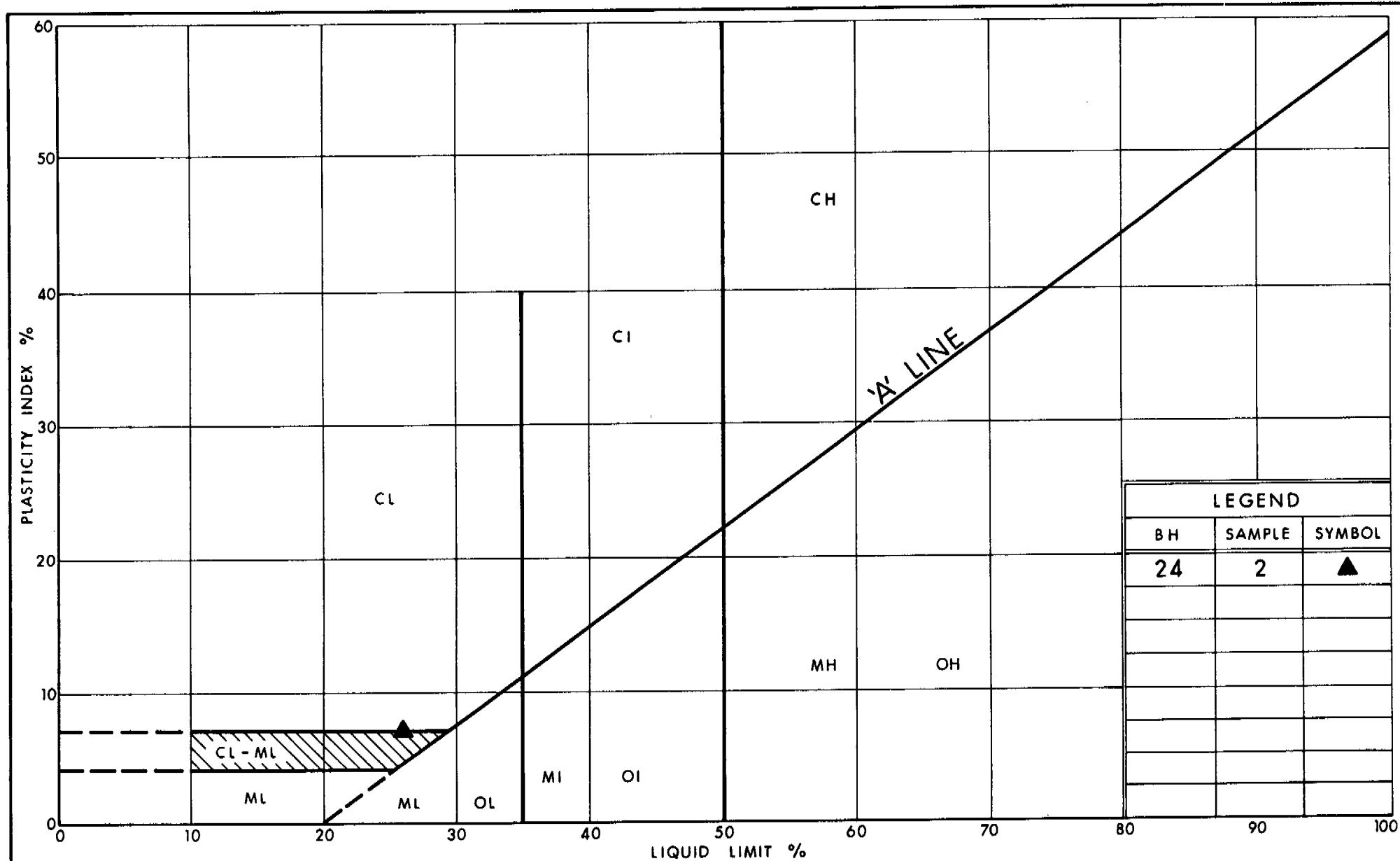
Ontario

Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
CLAYEY SILT TILL

FIG No B 22

W P 130-99-00(D)

H.M.L.

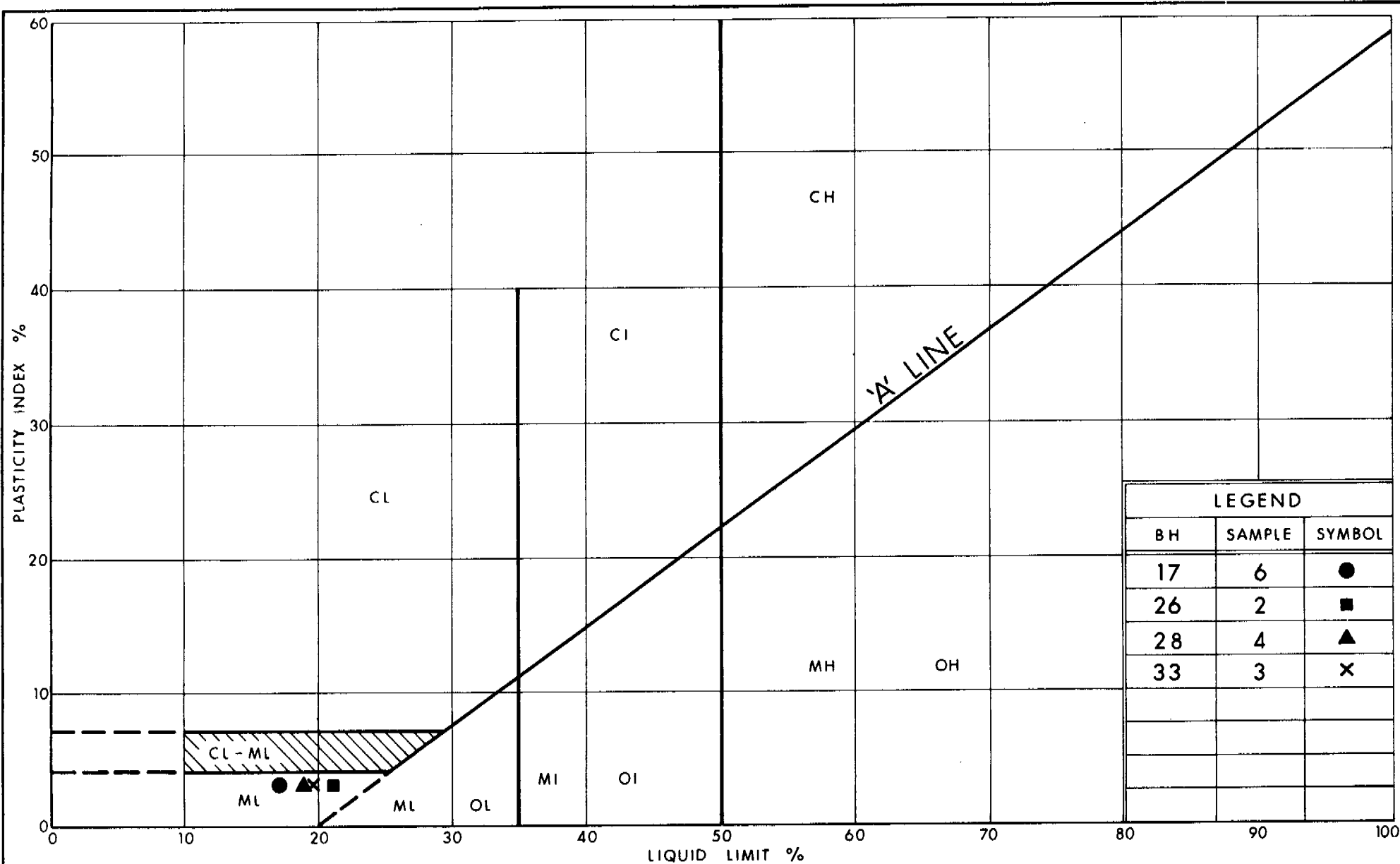


Ministry of  
Transportation

# PLASTICITY CHART CLAYEY SILT

FIG No B 23

W P 130-99-00 (D)

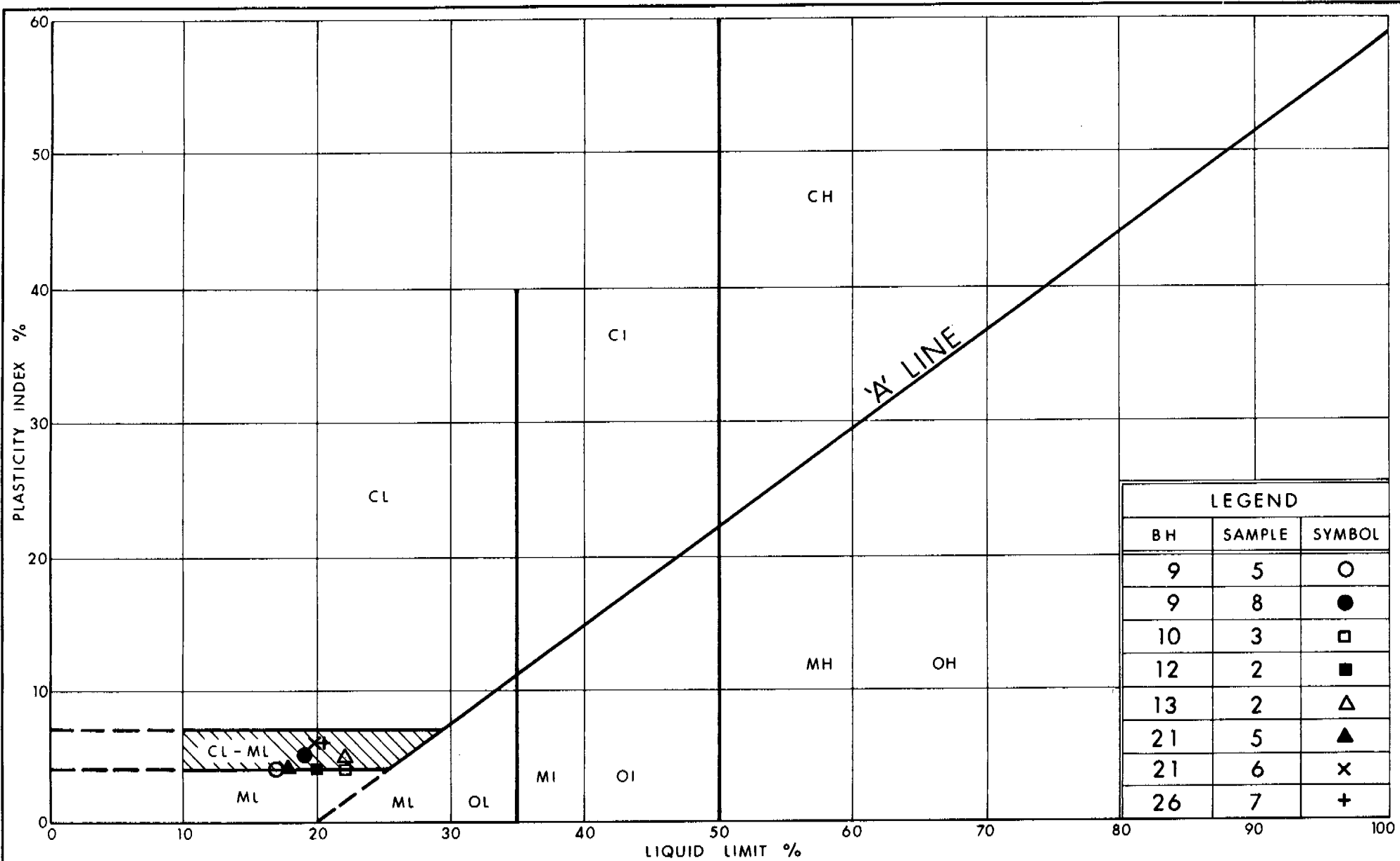


Ministry of  
Transportation

# PLASTICITY CHART SANDY SILT TILL

FIG No B 24

W P 130-99-00(D)



Ministry of  
Transportation

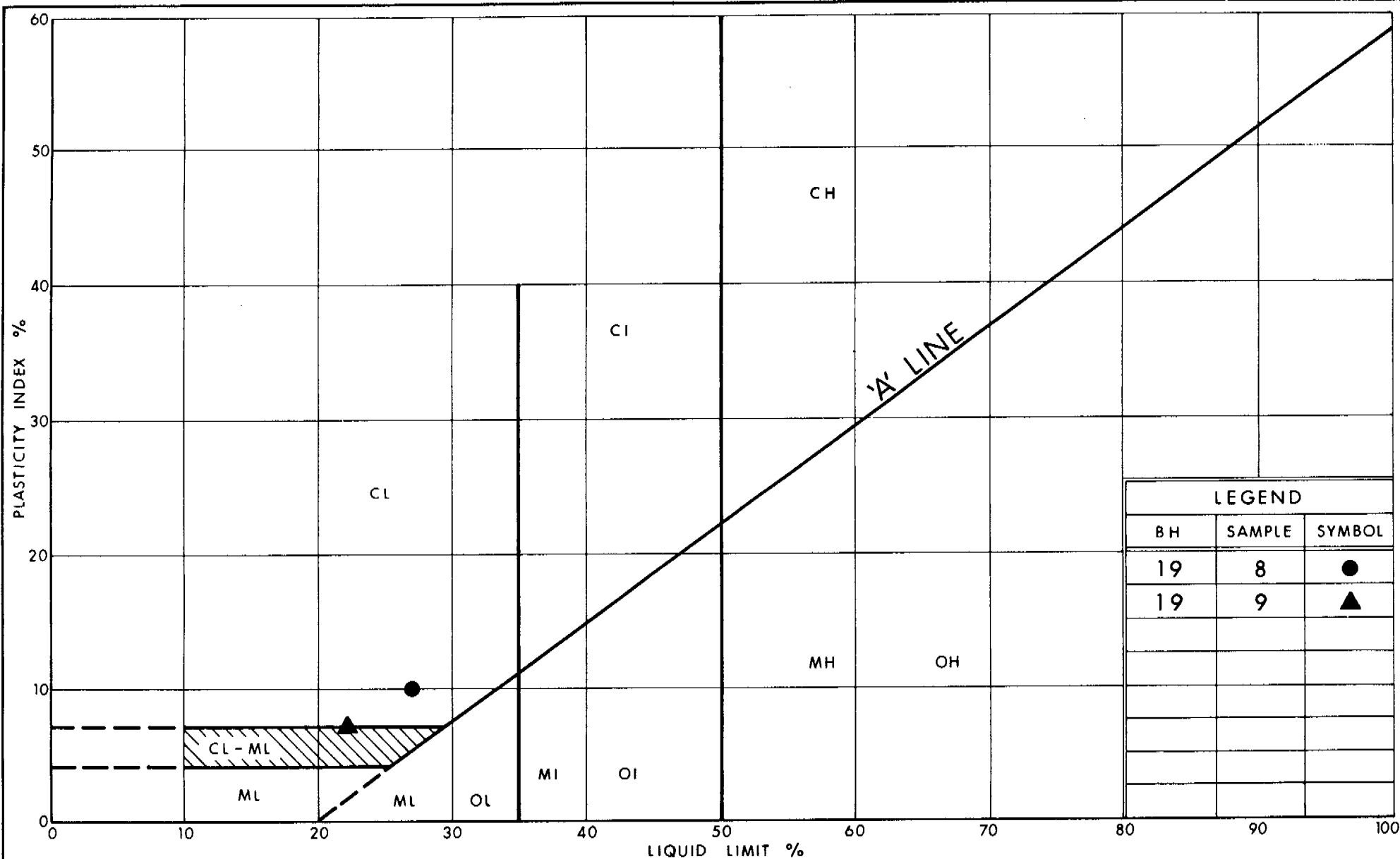
Ontario

# PLASTICITY CHART CLAYEY SILT TILL

FIG No B 25

W P 130-99-00(D)





LEGEND		
BH	SAMPLE	SYMBOL
19	8	●
19	9	▲



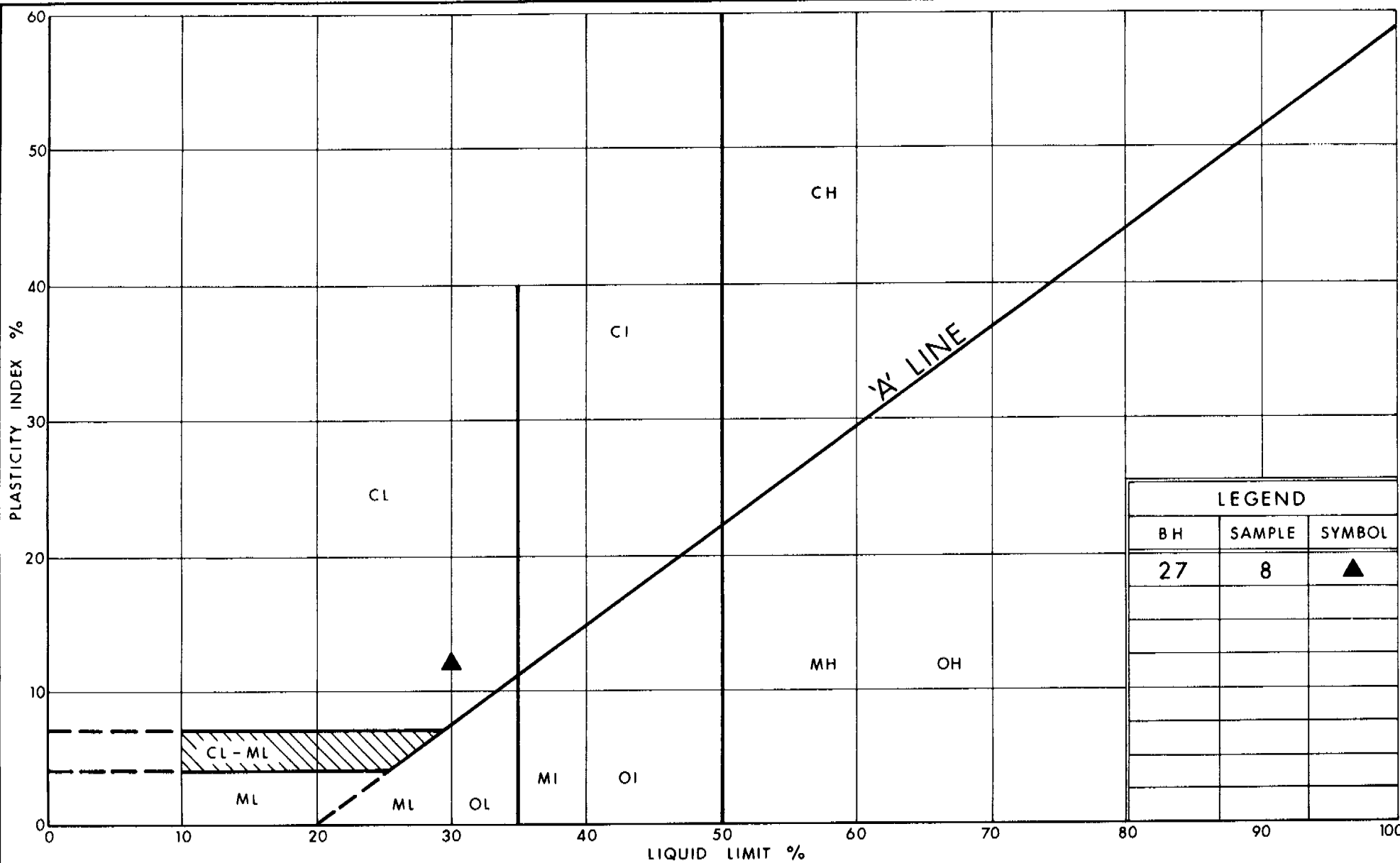
Ministry of  
Transportation

Ontario

## PLASTICITY CHART SILTY CLAY TILL

FIG No B26

W P 130-99-00 (D)



LEGEND		
BH	SAMPLE	SYMBOL
27	8	▲

## APPENDIX C

### Explanation of Terms Used in Report

## 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

### MECHANICAL PROPERTIES OF SOIL

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

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

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

**FOUNDATION DESIGN REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION  
FROM BOVAIRD DRIVE TO SANDALWOOD PARKWAY  
BRAMPTON, ONTARIO  
W.P. 130-99-00 (D)**

**Prepared For:**

**MINISTRY OF TRANSPORTATION OF ONTARIO  
Pavements and Foundations Section  
1201 Wilson Avenue  
Downsview, Ontario M3M 1J8**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SP2960D  
February 15, 2000  
Geocres No. 30M12-244**

**250 Galaxy Boulevard  
Etobicoke, Ontario  
M9W 5R8  
Tel: (416) 213-1255  
Fax: (416) 213-1260**

# Table of Contents

## FOUNDATION DESIGN REPORT

<b>5.</b>	<b>DISCUSSION AND RECOMMENDATIONS</b>	<b>7</b>
5.1	SUMMARIZED SUBSURFACE CONDITIONS.....	7
5.2	DESIGN CONSIDERATIONS.....	8
5.3	CONSTRUCTION CONSIDERATIONS.....	11
<b>6.</b>	<b>CLOSURE</b>	<b>13</b>

## APPENDICES

Limitations of Report

Appendix D

**FOUNDATION DESIGN REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION FROM BOVAIRD DRIVE  
TO SANDALWOOD PARKWAY, BRAMPTON, ONTARIO  
WP 130-99-00 (D)**

**5. DISCUSSION AND RECOMMENDATIONS**

Approximately twenty highmast lighting (HML) will be constructed along the section of proposed highway at and between Sandalwood Parkway and Bovaird Drive interchanges. Thirty six boreholes were drilled for proposed ten culverts and a bridge structure together with the proposed HMLs. The locations of each borehole are also indicated on the individual Borehole Log sheets.

**5.1 SUMMARIZED SUBSURFACE CONDITIONS**

In general, below a veneer of topsoil and some surficial clayey silt/silty clay extending to generally less than 1.0 m below the ground surface, the site is underlain by glacial till. The glacial till is interbedded with thin sand, silt and occasional silty clay interbeds. Some thicker sand, silty sand and sandy silt layers were also encountered, most of which were water bearing.

Within the upper 6 m, the glacial till generally consists of basically cohesive clayey silt till or fine grained granular (cohesionless) sandy silt till. Below this depth, the till attains a somewhat coarser texture and is described as granular (cohesionless) sandy silt/silty sand till. The till is generally competent (i.e. very stiff to hard or dense to very dense) with occasional weaker (stiff or compact) zones.

The groundwater table at the site is believed to be generally between Elevations 242 and 240 m.

Details of the subsurface conditions encountered in each borehole are given on the individual Borehole Log sheets in Appendix A.

## 5.2 DESIGN CONSIDERATIONS

In general, each HML is supported on a single caisson (i.e. drilled and cast-in-place concrete pile) foundation and the depth of caisson is typically 8 to 9 m. As per MTO practice, the design is carried out in accordance with the method described by Broms, as detailed in the following papers.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90 No. SM2, Paper No. 3825, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90 No. SM3, Paper No. 3909, March 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91. Paper No. SM3, May 1965.

The soil parameters provided in Table 5.2.1 are recommended for the design of the HML foundations. The following notation has been adopted:

$\phi$  = apparent angle of friction for cohesionless soils in degrees

$q_u$  = unconfined compressive strength in kPa ( $q_u=2c_u$ ) for cohesive soils

$\gamma$  = bulk unit weight in  $\text{kN/m}^3$

To enable the designer to select the appropriate borehole(s) for each HML, once their positions are finalized, recommended soil parameters at each borehole location have been provided.



TABLE 5.2.1

B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/ m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
1	4842911N 283337E	242.7	242.0	Cohesionless	Compact	---	32	21.5	241.0
		242.0	238.2	Cohesionless	Dense to v. dense	---	35	22.0	
		238.2	233.2	Cohesionless	Dense to v. dense	---	33	21.5	
2	4842945N 283327E	244.3	237.6	Cohesionless	Dense to v. dense	-	35	22.0	241.0
		237.6	234.9	Cohesionless	V. dense	---	34	21.6	
3	4843066N 283267E	244.8	244.1	Cohesive	Firm	60	---	19.0	241.0
		244.1	239.7	Cohesive	Hard	400	---	22.0	
		239.7	236.9	Cohesionless	V. dense	---	36	22.5	
4	4843069N 283297E	244.5	243.8	Cohesive	Firm to stiff	80	---	19.0	240.5
		243.8	242.2	Cohesive	Hard	400	---	22.0	
		242.2	235.1	Cohesionless	Dense to v. dense	---	35	22.0	
5	4843305N 283131E	242.3	241.6	Cohesive	Stiff	60	---	18.0	240.0
		241.6	241.0	Cohesive	V. Stiff	200	---	21.0	
		241.0	233.0	Cohesive	V. Stiff to hard	300	---	21.8	
6	4843363N 283164E	241.5	240.8	Cohesive	Firm	60	---	19.0	240.0
		240.8	237.4	Cohesive	Hard	400	---	22.0	
		237.4	235.5	Cohesionless	Dense to compact	---	33	21.0	
		235.5	233.2	Cohesive	Stiff to v. stiff	180	---	21.0	
		233.2	231.6	Cohesionless	Dense to v. dense	---	35	22.0	
7	4843400N 283184E	239.6	232.6	Cohesionless	Compact to v. dense	---	33	21.0	240.5
8	4843671N 282954E	244.8	244.8	Cohesive	Firm	60	---	18.0	241.0
		244.4	243.6	Cohesive	V. Stiff	200	---	21.0	
		243.6	243.0	Cohesive	Hard	400	---	21.8	
		243.0	235.5	Cohesionless	Dense to v. dense	---	35	22.0	
9	4844094N 282509E	241.5	240.8	Cohesionless	V. loose	---	26	18.0	240.0
		240.8	231.9	Cohesive	V. stiff to hard	300	---	22.0	
10	4844112N 282543E	241.1	240.5	Cohesive	Firm	60	---	19.0	240.5
		240.5	236.9	Cohesive	V. stiff to hard	350	---	22.0	
		236.9	232.0	Cohesionless	V. dense	---	36	22.5	
11	4844132N 282577E	240.9	240.5	Cohesive	Firm	60	---	19.0	239.5
		240.5	237.5	Cohesive	V. stiff to hard	360	---	22.0	
		237.5	231.8	Cohesionless	V. dense	---	36	22.5	
12	4844148N 282608E	240.8	240.3	Cohesive	Soft	50	---	17.5	239.5
		240.3	239.6	Cohesive	V. stiff	240	---	20.5	
		239.6	237.5	Cohesive	Hard	360	---	22.0	
		237.5	231.9	Cohesionless	V. dense	---	36	22.5	
13	4844240N 282548E	244.4	243.7	Cohesive	Firm to stiff	100	---	19.0	241.5
		243.7	243.0	Cohesive	V. stiff	240	---	21.0	
		243.0	234.9	Cohesive	Hard	400	---	22.0	
14	4844239N 282595E	244.3	243.4	Cohesive	Stiff	100	---	19.0	241.5
		243.4	242.8	Cohesive	V. stiff	300	---	21.0	
		242.8	237.8	Cohesive	Hard	400	---	22.0	
15	4844233N 282507E	244.7	244.0	Cohesive	Stiff	100	---	19.0	241.5
		244.0	236.9	Cohesionless	Dense to v. dense	---	35	22.0	
16	4844257N 282503E	244.8	244.3	Cohesionless	V. loose	---	27	18.5	241.5
		244.3	243.7	Cohesionless	Compact	---	32	21.0	
		243.7	236.9	Cohesionless	Compact to v. dense	---	35	22.0	

B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
17	4844181N 282460E	244.7	244.0	Cohesive	Stiff	100	—	18.5	241.5
		244.0	243.5	Cohesionless	Compact	—	33	21.0	
		243.5	239.0	Cohesionless	Dense to v. dense	—	35	22.0	
		239.0	237.7	Cohesionless	V. dense	—	34	21.5	
		237.7	235.7	Cohesionless	V. dense	—	36	22.5	
18	4844217N 282498E	244.8	244.0	Cohesive	Firm	80	—	18.5	241.5
		244.0	243.5	Cohesionless	Compact	—	33	21.5	
		243.5	238.7	Cohesionless	Dense to v. dense	—	35	22.0	
19	4844150N 282314E	241.9	241.7	Cohesive	Firm	60	—	18.0	241.0
		241.7	241.0	Cohesive	Stiff to v. stiff	150	—	20.0	
		241.0	238.2	Cohesive	V. stiff	280	—	21.0	
		238.2	234.2	Cohesive	Stiff to v. stiff	140	—	20.8	
		234.2	232.6	Cohesive	Hard	400	—	22.0	
20	4844191N 282288E	242.0	241.7	Cohesive	Firm	60	—	18.0	241.0
		241.7	240.6	Cohesive	Stiff to v. stiff	150	—	19.5	
		240.6	234.3	Cohesive	V. stiff to hard	360	—	22.0	
21	4844231N 282267E	241.9	241.2	Cohesive	Firm	70	—	18.5	241.0
		241.2	237.0	Cohesive	Stiff to v. stiff	220	—	20.5	
		237.0	234.2	Cohesive	V. stiff to hard	350	—	21.5	
22	4844274N 282246E	242.2	241.9	Cohesive	Firm	70	—	18.5	241.0
		241.9	240.5	Cohesive	V. stiff	240	—	21.0	
		240.5	236.9	Cohesive	V. stiff to hard	400	—	22.0	
		236.9	230.5	Cohesionless	Compact to dense	—	31	20.5	
23	4844302N 282208E	242.1	241.9	Cohesive	Soft	30	—	17.5	241.0
		241.9	237.4	Cohesive	V. stiff to hard	400	—	22.0	
		237.4	234.4	Cohesionless	Compact	—	32	20.5	
24	4844373N 2822114E	242.7	240.2	Cohesive	Soft to firm	50	—	18.0	242.0
		240.2	239.4	Cohesionless	Loose	—	29	18.5	
		239.4	236.9	Cohesive	Stiff	100	—	19.5	
		236.9	233.5	Cohesive	V. stiff to hard	360	—	22.0	
25	4844380N 282096E	243.5	242.4	Cohesive	Soft to stiff	50	—	17.5	242.5
		242.4	240.0	Cohesive	Firm to v. stiff	200	—	19.0	
		240.0	238.8	Cohesive	Hard	400	—	22.0	
		238.8	232.6	Cohesionless	Compact	—	33	21.5	
		232.6	231.2	Cohesionless	Compact	—	32	21.0	
26	4844263N 282381E	245.6	244.5	Cohesionless	Compact	—	31	20.0	241.0
		244.5	240.6	Cohesionless	Dense to v. dense	—	35	22.0	
		240.6	230.0	Cohesionless	Dense to v. dense	—	36	22.5	
27	4844285N 282359E	245.6	245.0	Cohesive	Firm to stiff	100	—	18.5	241.0
		245.0	244.0	Cohesionless	Compact	—	32	21.0	
		244.0	240.5	Cohesionless	Compact to v. dense	—	34	22.0	
		240.5	240.0	Cohesive	V. stiff	260	—	20.5	
		240.0	236.0	Cohesionless	Compact to dense	—	33	21.8	
		236.0	231.0	Cohesionless	V. dense	—	35	22.2	
28	4844280N 282402E	245.4	245.0	Cohesive	Stiff	80	—	18.0	241.0
		245.0	243.6	Cohesive	V. stiff to hard	240	—	21.0	
		243.6	239.0	Cohesionless	V. dense	—	35	22.0	
		239.0	233.3	Cohesionless	V. dense	—	36	22.5	
29	4844303N 282381E	245.5	244.8	Cohesive	Firm to stiff	100	—	18.5	241.0
		244.8	243.0	Cohesive	V. stiff to hard	360	—	21.5	
		243.0	230.0	Cohesionless	Dense to v. dense	—	35	22.0	

B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
30	4844299N 282423E	245.4	245.0	Cohesive	Stiff	100	---	18.0	241.5
		245.0	244.6	Cohesive	V. stiff	200	---	20.0	
		244.6	237.5	Cohesionless	Dense to v. dense	---	35	22.0	
		237.5	231.9	Cohesionless	V. dense	---	36	22.5	
31	4844320N 282402E	245.2	244.5	Cohesive	Hard	300	---	21.5	242.0
		244.5	237.0	Cohesionless	Dense to v. dense	---	35	22.0	
		237.0	231.9	Cohesionless	V. dense	---	36	22.5	
32	4844256N 282356E	245.7	245.0	Cohesive	Stiff	100	---	19.5	242.0
		245.0	239.4	Cohesionless	Compact to v. dense	---	34	22.0	
33	4844327N 282426E	245.1	244.7	Cohesive	Firm	60	---	18.0	242.0
		244.7	241.0	Cohesionless	Compact to v. dense	---	34	22.0	
		241.0	238.8	Cohesive	hard	400	---	22.0	
34	4844632N 282082E	246.2	245.5	Cohesive	Stiff to v. stiff	100	---	22.0	242.5
		245.5	237.0	Cohesive	V. stiff to hard	400	---	19.0	
35	4844403N 282364E	245.5	244.7	Cohesive	Stiff to v. stiff	100	---	19.0	242.0
		244.7	236.2	Cohesive	Hard	400	---	22.0	
36	4844437N 282369E	245.2	244.6	Cohesive	Stiff to v. stiff	100	---	19.0	242.0
		244.6	237.4	Cohesive	Hard	400	---	22.0	

\* q<sub>u</sub> = unconfined compressive strength in kPa (q<sub>u</sub> = 2xC<sub>u</sub>) for cohesive soils

\*\* Ø = angle of internal friction for cohesionless (ie granular) soils in degrees

\*\*\* γ = bulk unit weight of soil in kN/m<sup>3</sup>

The contribution to lateral resistance of the soil within the frost depth (i.e. 1.2 m) should not be included in the calculations, except of course, for the weight of the soil. Research shows, however, that restraint (fixity) provided at the ground surface level plays a significant role in the performance of high pole structures and, therefore, the placement of well compacted, competent material at and near the ground surface immediately around the pole is recommended.

### 5.3 CONSTRUCTION CONSIDERATIONS

The boreholes show in the general area, beneath some surficial organic or otherwise weak near surface soils, the presence of essentially cohesive clayey silt till and fine granular cohesionless sandy silt till deposits. The clayey silt till and sandy silt till deposits can be expected to be essentially self-supporting and should not yield significant amounts of water in the short term, in caisson holes, even below the groundwater table, provided that the concrete is poured expeditiously on completion of the caisson hole, without undue delay. The sand seams in the till or the coarse silty sand till generally encountered with increased depth will yield more water but significant dewatering problems are not anticipated

provided that the concrete is poured rapidly upon completion of the excavation of the caisson holes. If, however, weak zones in the silty sand till or sand layers cause cave-ins or excessive groundwater seepage in unlined caisson holes, special precautions may be required. The use of dewatering techniques to lower the groundwater table during construction is, however, unlikely to be economically feasible due to the limited construction effort required.

The chances for problems due to excessive groundwater seepage and instability will generally increase within the water bearing sand and sandy silt layers. These layers/lenses occur within the till deposits rather sporadically across the site. A summary of relatively thicker sand and silt layers encountered in the boreholes is given in Table 5.3.1 below. This is meant to be for general guidance purposes only, as the presence of such layers/lenses can be expected elsewhere and conditions may change within short distances in between and beyond borehole locations.

**Table 5.3.1**

Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth of Cohesionless sand and/or silt layer (m)	Elevation (m)
1	242.8	4.6-9.6*	238.2-233.2*
2	244.3	6.7-9.4*	237.6-237.3*
6	241.7	4.4-6.2	237.3-235.5
7	239.6	1.1-6.5	238.5-233.1
13	244.5	7.3-7.7	237.2-236.8
17	245.0	6.0-7.3	239.0-237.7
22	242.6	5.9-12.1*	236.7-230.5*
23	242.6	5.2-8.1*	237.4-234.5*
24	243.1	1.7-6.2	241.4-236.9
25	243.8	11.2-12.6*	232.6-231.2*

\*end of borehole

Within the weak coarse textured till and the sand and silt layers below water table the soil is susceptible to disturbance due to unbalanced hydrostatic head and seepage and will likely become unstable, especially with increased depth of excavation below water table. The contractor should maintain the stability of the soil at the sides and bases of the holes for the concrete footings at all times from the commencement of excavation to the completion of the pouring of the concrete. We recommend that in view of these, the following special provisions be included in the contract documents:

- The contractor shall install concrete footings in earth for HML foundations. At the various foundation locations, soil deposits may consist of sand or silt or mixtures of these soils. Groundwater is likely to be encountered above the base of the excavations.
- The soil is susceptible to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The contractor shall maintain the stability of the soil in the sides and bases of the holes for the concrete footings at all times from the commencement of their construction to the placing of the concrete.

In addition, the contractor should be made aware that the presence of cobbles and boulders can always be expected which can cause problems during the installation of the caissons.

## 6. CLOSURE

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

**Shaheen & Peaker Limited**



Zuhtu Ozden, P.Eng.



Ivan Lieszkowsky, P.Eng.



trzip#hd

# APPENDIX D

## Limitations of Report

## **LIMITATIONS OF REPORT**

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. 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. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

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.

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 conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

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. Shaheen & Peaker Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

**FOUNDATION INVESTIGATION REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION  
FROM BOVAIRD DRIVE TO SANDALWOOD PARKWAY  
BRAMPTON, ONTARIO  
W.P. 130-99-00 (D)**

**Prepared For:**

**MINISTRY OF TRANSPORTATION OF ONTARIO  
Pavements and Foundations Section  
1201 Wilson Avenue  
Downsview, Ontario M3M 1J8**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SP2960D  
February 15, 2000  
Geocres No. 30M12-244**

**250 Galaxy Boulevard  
Etobicoke, Ontario  
M9W 5R8  
Tel: (416) 213-1255  
Fax: (416) 213-1260**



## Table of Contents

### FOUNDATION INVESTIGATION REPORT

1. INTRODUCTION	1
2. SITE DESCRIPTION AND PHYSIOGRAPHY	2
3. INVESTIGATION PROCEDURES	3
4. SUMMARIZED SUBSURFACE CONDITIONS	5

### APPENDICES

Borehole Log Sheets

Appendix A

Laboratory Test Results

Appendix B

Explanation of Terms Used in Report

Appendix C

**FOUNDATION INVESTIGATION REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION FROM BOVAIRD DRIVE  
TO SANDALWOOD PARKWAY, BRAMPTON  
WP 130-99-00 (D)**

**1. INTRODUCTION**

As part of the northerly extension of Highway 410 in Peel Region a new interchange is proposed at Sandalwood Parkway, immediately north of the existing Bovaird Drive interchange. The overall project entails the construction of an underpass bridge structure at the Sandalwood Parkway interchange along with seven culverts. The project also includes three culverts at Bovaird Drive interchange and provision for highmast light poles at and in between the two interchanges. The overall project limits lie between approximate Stations 17+350 and 19+450.

Shaheen & Peaker Limited (S&P) was retained by the Ministry of Transportation of Ontario (MTO) Pavements and Foundations Section to carry out a foundation investigation for the proposed interchange. This report deals with the proposed Highmast Lighting (HML's). The work was performed in accordance with Consultant Assignment Agreement Number 2005-A-000142, Highway 410: Bovaird Drive to Sandalwood Parkway – Foundation Investigation and Recommendations, WP130-99-00.

The site is located immediately east of Heart Lake Road between Bovaird Drive and Sandalwood Parkway in the City of Brampton. The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes.

The findings of the investigation are presented in this report.

## 2. SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located immediately north of the existing intersection of Highway 410 and Bovaird Drive in the City of Brampton, Regional Municipality of Peel.

The land use in the area has recently changed from predominantly farming to industrial and suburban residential. The topography here is flat with ground surface sloping gently towards Lake Ontario. The existing ground surface elevations at the project site generally range from about 247 at the most northerly location (i.e. about 500 m north of the Highway 410 and Sandalwood Parkway intersection), falling to about 246 at the intersection of the proposed Highway 410 and Sandalwood Parkway centerline, to generally between 245 and 244 m toward the south end of the project at the Bovaird Drive interchange (i.e. an elevation difference of about 2 to 3 m over a distance of about 2.1 km). There are, however, some minor undulations within the site itself where the grade falls locally towards two small watercourses. One of these watercourses, located about 500 m north of the Bovaird Drive intersection, intersects the proposed highway alignment in an east-west direction and here the grade falls to between Elevations 243 and 240 m. The second creek runs in a north-south direction at the north end of the project site, some 200 m west of the proposed highway alignment, where it crosses the Sandalwood Parkway extension, turns east and crosses the highway alignment about 200 m south of the proposed Sandalwood Parkway alignment. The grade along this creek generally ranges from about 243 m on the north side to about 240 m southeast.

The site is located within the physiographic region known as the "Peel Plain." In general, this region is underlain by glacial till deposits containing frequent shale and limestone fragments. Much of the surface has been modified by post-glacial, shallow silty clay/clayey silt soils. In the general project area, the significant deposit underlying shallow recent clayey soils is a ground moraine composed of glacial till of generally cohesive nature, laid down during the Wisconsin glacial age. Silt and sand layers are often found interbedded with the glacial till. The project area is located at the interface of the red Queenston and grey Georgian Bay bedrock formations. These formations belong to the Upper Ordovician Period of the Paleozoic Era and are approximately 450 million years old. These shales are

interbedded with some limestone, siltstone, sandstone and dolostone layers and seams. These hard layers are usually less than about 150 mm thick but some layers are much thicker.

### 3. INVESTIGATION PROCEDURES

The fieldwork for the project was performed during the period of October 12 and November 9, 1999 and consisted of drilling and sampling 36 boreholes. An additional borehole (i.e. Borehole 26A) adjacent to Borehole 26 was also drilled in order to explore the subsurface conditions to greater depths.

The depths of the boreholes ranged from 6.6 m to 23.5 m. In addition, dynamic cone penetration tests were performed from the bottom of some of the boreholes and this increased the maximum depth of testing to 25.3 m below the ground surface. The boreholes were drilled at various proposed structure locations as tabulated below:

<b>Proposed Structure</b>	<b>Borehole Number</b>
Bridge and	26, 26A, 27, 28, 29, 30, 31
Approach Fills	32, 33
Culvert B2	1, 2
Culvert B3	3, 4
Culvert B4	5, 6, 7
Culvert S1	9, 10, 11, 12
Culvert S2	13, 14
Culvert S3	15, 16
Culvert S4	17, 18
Culvert S5	19, 20, 21, 22, 23
Culvert S6	24, 25
Culvert S7	35, 36
HML	8, 34

The location of each borehole is indicated on the individual borehole log sheet in Appendix A. The boreholes were advanced using a track-mounted drilling rig owned and operated by Groundworks Inc., under the full time supervision of a geotechnical engineer from Shaheen & Peaker Limited. In general, solid-stem augering was utilized to advance the boreholes but where hydrostatic pressures in

cohesionless soil caused excessive cave-ins and/or soil back up, drilling was switched to hollow stem augering and water was used for counter-balancing purposes. Sampling in the boreholes was effected at frequent intervals of depth (i.e. at 0.76 m intervals starting at ground surface to 6 to 9 m depth, and at 1.5 m intervals, thereafter) by the Standard Penetration test method (SPT) as outlined in ASTM Method D1586. In essence, this consists of freely dropping a 63.5 kg. hammer a vertical distance of 760 mm to drive a 51 mm O.D. split-spoon (split-barrel) sampler into the ground. The number of blows required to drive the sampler into the relatively undisturbed ground by a vertical distance of 300 mm is recorded as Standard Penetration Resistance or the N-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. Where the consistency permitted, several undisturbed open-drive thin-walled Shelby tube samples were also taken in cohesive soils.

Dynamic cone penetration tests (DCPT) were performed in Boreholes 7, 22, 23, 25, 26A, 27 and 29. This test consists of driving a 60 degree point, 51 mm diameter cone attached to the drill rig continuously into the undisturbed ground with the same driving energy as in SPT. The number of blows for each 300 mm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

The borehole locations in the field were established by MTO surveyors and ground surface elevations at the borehole locations were provided to us. Several of the boreholes had to be somewhat relocated from their original, staked-out location due to access difficulties. In these instances, allowance was made by our field staff for location and elevation differences.

Water level observations in the open boreholes were made during the drilling and at the completion of each borehole and, wherever possible, several hours thereafter. To enable us to monitor groundwater levels over a prolonged period of time without interference from surface water, piezometers were installed in some of the boreholes and the water level in these piezometers were monitored during subsequent site visits.

The results of drilling, sampling, in-situ testing and water level measurements are summarized on the Record of Borehole Sheets in Appendix A.

The soil samples were shipped to our laboratory for further examination and classification. A laboratory testing programme consisting of natural moisture content, bulk unit weight and Atterberg limit tests and grain-size analyses was performed on selected soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also in Appendix B.

#### 4. SUMMARIZED SUBSURFACE CONDITIONS

A total of thirty-six boreholes was drilled between Bovaird Drive and northerly about 500 metres north of Sandalwood Parkway Intersection at the proposed interchanges and the stretch of highway in between, for the proposed HMLs, culverts and a proposed underpass (bridge) structure. The locations of the boreholes are indicated on the individual Borehole Log sheets in Appendix A.

In general, soil conditions at the site consist of a veneer of topsoil and surficial clayey silt/silty clay followed by glacial till deposits. The glacial till is frequently interbedded with thin sand, silty sand, sandy silt and occasional silty clay seams. Some thicker, water bearing sand, silty sand and sandy silt layers were also encountered.

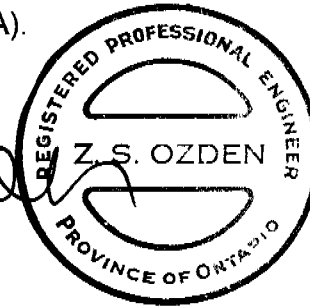
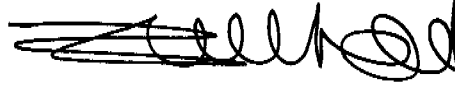
To a depth of 6 m, the glacial tills generally consist of basically cohesive clayey silt till or fine grained granular (cohesionless) sandy silt till. Below this depth, the till generally attains a somewhat coarser texture and is described as sandy silt/silty sand till. The till is generally competent (i.e. very stiff to hard or dense to very dense) with occasional weaker (stiff or compact) zones.

Occasional cobbles and boulders were encountered in the boreholes. The presence of cobbles should always be anticipated, especially in the glacial till deposits due to their mode of deposition.

The groundwater table at the site is believed to be generally between Elevations 242 and 240 m.

Details of the subsurface conditions encountered in each borehole are given on the individual Borehole Log Sheets (Appendix A).

Shaheen & Peaker Limited



Zuhtu Ozden, P.Eng.



Ivan Lieszkowszky, P.Eng.



trzip#hd

# APPENDICES



# APPENDIX A

## Borehole Log Sheets

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4842911N;283337E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100							
242.8	Ground Surface														
242.6	75 mm TOPSOIL		1	SS	18										
0.1			2	SS	63										
	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some sand and silt seams/lenses, occasional cobbles and boulders, brown to 2.2 m, grey below, compact to 0.9 m, very dense to dense below, damp to moist		3	SS	50/3										
			4	SS	41										
			5	SS	38										
			6	SS	82/26										
238.2			7	SS	70										
4.6	SILTY SAND AND SANDY SILT some Silt and Sand seams/lenses, occasional till zones, grey, dense to very dense, wet		8	SS	51										
			9	SS	48										
			10	SS	35										
			11	SS	58										
233.2	End of borehole Water level in open hole at 6.0 m upon completion Water level not stabilized N=82/26 denotes 82 blows for 26 cm penetration														
9.6															

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4842945N,283327E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 09.11.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
244.3	Ground Surface																
244.1	150 mm ASPHALT																
0.2	FILL:		1	SS	37		244										
243.4	Sand and Gravel, brown, moist																
0.9	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some Silt and Sand seams/lenses, occasional cobbles and boulders, brown to 3.6 m, grey below, damp to 0.9 m, moist below, dense to very dense		2	SS	36		243									21.6	
			3	SS	38												
			4	SS	64		242									22.4	
			5	SS	88/28		241										
			6	SS	96		240										
			7	SS	87		239										
			8	SS	53		238									21.6	
			9	SS	47		237									21.1	
237.6	SILTY SAND AND SANDY SILT some Silt and Sand seams/lenses, grey, very dense, wet		10	SS	75												
6.7			11	SS	91/28		236										
	frequent wet sand seams																
234.9			12	SS	50/13		235									21.0	
9.4	End of borehole Borehole dry on completion Water level not stabilized																

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843068N;283267E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
245.0	Ground surface						20	40	60	80	100											
240.8	225 mm TOPSOIL						20	40	60	80	100											
0.2			1	SS	8											20.6						
	Hetèroogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) occasional Silt and Clayey Silt lenses, brown to 3.5 m, grey below, firm to 0.7 m, hard below, damp to moist, occasional cobbles and boulders		2	SS	45																	
			3	SS	43											21.7						
			4	SS	39																	
			5	SS	64											21.6	5 34 47 14					
	Sandy Silt Till zones below 4.0 m		6	SS	55/13												boulder @ 4.0 m					
			7	SS	43											22.3						
239.7																	boulder @ 5.3 m					
5.3	Heterogeneous mixture of Silt and Sand some gravel (SANDY SILT TILL) with Silty Sand Till zones, some Silt and Sand seams/lenses, grey, very dense, moist to 6.5 m, wet below, occasional cobbles and boulders		8	SS	96/26																	
			9	SS	90/26																	
237.0			10	SS	86																	
8.1	End of borehole Borehole dry on completion and six hours after completion. Water level not stabilized Auger refusal at 4.0 m on a boulder, relocated and redrilled. Auger refusal at 5.3 m on a boulder, relocated and redrilled.																					

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843069N/283297E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
				○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) W P W W L						
244.7	Ground Surface													
246.6	225 mm TOPSOIL													
0.2	Heterogeneous mixture of  Clayey Silt some sand and gravel (CLAYEY SILT TILL) occasional cobbles and boulders, brown, firm to 0.6 m, stiff from 0.6 to 1.0 m and hard below damp		2	SS	7		244						21.5	
			1	SS	37		243							
			3	SS	48									
242.2			4	SS	36		242						20.8	
2.5	Heterogeneous mixture of  Silt and Sand with some gravel, trace clay (SANDY SILT TILL) with Clayey Silt Till zones, occasional cobbles and boulders, brown to 4.5 m. grey below, very dense to dense, damp to 4.5 m, moist below		5	SS	63		241						21.7	9 44 39 8
			6	SS	50/13		240							
			7	SS	33		239						22.1	
			8	SS	55									
			9	SS	47		238							
							237						22.5	
	occasional sand seams/lenses		10	SS	38		236							
235.1	Silty Sand Till, wet		11	SS	40									
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed Water level in piezometer at 9.0 m, seven hours after completion Water level in piezometer at 8.6 m, Nov 9/99													

+ 3 x 3: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 130-89-00 LOCATION 4843305N;283131E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 27.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
242.6	Ground Surface							20 40 60 80 100					
242.3	300 mm TOPSOIL		1	SS	7		242					19.5	
0.3	SILTY CLAY												
241.6	some topsoil and organics, dark brown, stiff		2	SS	12								
1.0			3	SS	33		241					21.2	
	Heterogeneous mixture of Clayey Silt		4	SS	53		240						
	some sand and gravel (CLAYEY SILT TILL)		5	SS	52							22.2	
	with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 2.1 m, grey below, stiff to hard, damp to moist to 5.0 m, moist to wet below primarily Sandy Silt Till from 2.8 to 4.4 m		6	SS	39		239						12 46 34 8
			7	SS	27		238					22.0	
			8	SS	24		237						
			9	SS	19		236					21.5	
			10	SS	19		235						
							234						
233.0	Sandy Silt Till with wet sandy silt lenses		11	SS	18							23.3	
9.6	End of borehole Water level on completion 8.8 m Water level at 8.2 m and hole caved at 8.8 m four hours after completion Water level not stabilized												

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843363N, 283164E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 28.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
241.7	Ground Surface							20 40 60 80 100				
240.6	150 mm TOPSOIL							20 40 60 80 100				
0.1	Heterogeneous mixture of Clayey Silt with some sand and gravel CLAYEY SILT TILL occasional sand seams and cobbles, brown to 2.7 m, grey below, firm to 0.6 m, hard below		1	SS	5		241				21.1	
			2	SS	48		240					
			3	SS	75		239					
			4	SS	50/ 10		238					
			5	SS	57		237					
			6	SS	31		236				23.0	6 41 41 12
237.3			7	SS	31		235					0 78 20 2
4.4	FINE SAND some silt, grey, dense to compact, wet		8	SS	27		234					
							233					
235.5			9	SS	11		232					
6.2	Heterogeneous mixture of Silty Clay with some Sand and Gravel (SILTY CLAY TILL) frequent sand, silt and clay seams/lenses, grey, stiff to very stiff		10	SS	19						22.7	
233.2			11	SS	50							
8.5	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) occasional cobbles and boulders, grey, dense to very dense, wet to		12	SS	73						23.1	
231.6												
10.1	9.5 m, damp below End of borehole Auger refusal at 10.1 m, probably on a boulder Standpipe piezometer installed Water level in piezometer at 5.2 m on Oct 27 and Nov 09/99 Shelby tube attempted at 8.4 m, sample did not stay in sampler											

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## RECORD OF BOREHOLE No 7

1 OF 1

**METRIC**

W.P.	130-99-00	LOCATION	4843400N;283184E	ORIGINATED BY	M.T
DIST	Central	HWY	410	BOREHOLE TYPE	Solid Stem Augers & D.C.P.T
DATUM	Geodetic	DATE	28.10.99	COMPILED BY	G.T
				CHECKED BY	Z.O

[illegible]

+ 3, x 3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4843671N;282954E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 26.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
245.1	Ground Surface																
244.8	350 m TOPSOIL		1	SS	7		245										
0.3	SILTY CLAY																
244.3	trace of gravel and organics, brown, firm		2	SS	25		244									20.8	
0.8	clayey, very stiff																
	clayey, hard		3	SS	36		243										
	Heterogeneous mixture of Silt and Sand		4	SS	48		242									21.6	
	some gravel, trace clay (SANDY SILT TILL)		5	SS	96/28												
	some Clayey Silt Till zones, occasional Sand and Silt		6	SS	52/13		241										5 43 43 9
	seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, dense to 3.0 m, very dense below, moist to wet to 3.5 m, damp below		7	SS	72		240										
			8	SS	65											21.6	
			9	SS	50/13		239										
			10	SS	89/28		238										
			11	SS	50/11		237										
							236										
235.5	Silty Clay Till, hard		12	SS	38												
9.6	End of borehole Borehole dry on completion and nine hours after completion Water level not stabilized																

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 9

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844094N;282509E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
241.5	Ground surface						20	40	60	80	100	20	40	60	GR SA SI CL	
241.2	300 mm TOPSOIL		1	SS	2											
0.3	SAND															
240.6	with Clayey Silt seams, brown/grey, very loose, wet		2	SS	38										8 39 45 8	
0.7																
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, some sand and silt seams, brown to 2.3 m, grey below, very stiff to hard		3	SS	46											
			4	SS	35											
			5	SS	24											
			6	SS	24											
			7	SS	27											
			8	SS	50											
			9	SS	71											
			10	SS	31											

# RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844112N,282543E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
241.3	Ground surface						20	40	60	80	100					
240.0	225 mm TOPSOIL						○ UNCONFINED	+	FIELD VANE							
							● QUICK TRIAXIAL	x	LAB VANE							
0.2			1	SS	5										22.8	
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, occasional sand seams, occasional cobbles and boulders, brown to 1.3 m, grey below, firm to 0.6 m, very stiff from 0.8 m to 3.6 m, hard below		2	SS	29										22.2	2 26 56 16
			3	SS	21											
			4	SS	25											
			5	SS	27										22.6	
236.9			6	SS	66/25											
4.4	sampler wet at 4.5 m		7	SS	50/13										22.6	25 43 28 4
			8	SS	50/13											
	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) with Sandy Silt Till zones, some sand seams, occasional cobbles and boulders, grey, very dense, moist to wet		9	SS	50/10										22.4	
			10	SS	50/13											
232.0			11	SS	50/13										22.0	
9.3	End of borehole Water level at 8.5 m on completion Standpipe piezometer installed Water level in piezometer at 0.7 m on Oct 25 and 27/99															

# RECORD OF BOREHOLE No 11

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844132N,282577E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL x LAB VANE									
							20 40 60 80 100					WATER CONTENT (%) 20 40 60					
241.1	Ground surface																
240.9	250 mm TOPSOIL		1	SS	5		241										
0.2			2	SS	31		240										
	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) occasional Silt and Sand seams, brown to 1.7 m, grey below, firm to 0.7 m, very stiff to hard below		3	SS	35		239							22.5			
			4	SS	40		238										
			5	SS	26		237										
237.5	Sandy Silt Till, silt and silty clay lenses		6	SS	50/13		236										
3.6	wet seam at 3.6 m		7	SS	50/13		235										
	Heterogeneous mixture of Sand and Silt trace to some gravel (SILTY SAND TILL) some Sandy Silt Till zones, some sand and silt seams, occasional cobbles and boulders, grey, very dense, damp to moist		8	SS	50/13		234										
			9	SS	50/10		233										
			10	SS	55/15		232										
231.8	End of borehole		11	SS	50/13												
9.3	Water level at 8.2 m on completion Water level at 2.7 m three hours after completion																

+ 3 x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 12

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844148N;282608E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 12.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE	
241.1	Ground surface						20	40	60	80	100				GR SA SI CL			
240.8	250 mm TOPSOIL																	
0.3	CLAYEY SILT		1	SS	3									20.9				
240.3	some sand, trace of rootlets, organics, dark brown, soft		2	SS	22										3 41 46 10			
0.8	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, sand and silt seams/lenses, brown to 2.3 m, grey below, very stiff to 1.3 m, hard below		3	SS	32									22.5				
			4	SS	38													
			5	SS	35									22.9	7 36 43 14			
237.5			6	SS	62													
3.6			7	SS	50/13									22.5				
	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) with Sandy Silt Till zones, some silt, sand and gravelly sand seams/lenses, occasional cobbles and boulders, grey, very dense, damp to 5.0 m and wet below		8	SS	97/28													
			9	SS	60/5									22.3				
			10	SS	60/6													
231.9			11	SS	50/10									23.2				
9.2	End of borehole Water level at 7.3 m on completion Water level at 2.4 m six hours after completion																	

RECORD OF BOREHOLE No 13

1 OF 1

METRIC

W.P. 130-89-00 LOCATION 4844240N;282548E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
244.5	Ground surface													
243.6	150 mm TOPSOIL													
0.1			1	SS	8		244							
			2	SS	21									
			3	SS	45		243							
			4	SS	53		242							
			5	SS	50/13		241							
			6	SS	64		240							
			7	SS	36		239							
			8	SS	46		238							
			9	SS	33		237							
			10	SS	34		236							
			11	SS	40		235							
234.9														
9.6	End of borehole Borehole dry on completion Water level not stabilized													

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 14

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844239N;282595E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
244.4	Ground surface												
244.0	150 mm TOPSOIL												
0.1			1	SS	10								
	Heterogeneous mixture of Clayey Silt with sand and trace gravel (CLAYEY SILT TILL) occasional Sand, Silt and Clay seams/lenses, brown to 4.5 m, grey below, stiff to very stiff to 1.5 m, hard below		2	SS	28							21.5	
			3	SS	33								5 40 44 11
			4	SS	42							22.2	
			5	SS	78								
			6	SS	80								4 40 44 12
			7	SS	44								
			8	SS	28							22.0	
			9	SS	34								
237.8	End of borehole Borehole dry on completion Water level not stabilized												
6.6													

3, x 3, Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 15

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844233N 282507E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
245.0	Ground surface							20	40	60	80	100								
244.7	300 mm TOPSOIL		1	SS	11											19.6				
0.3	CLAYEY SILT TILL brown, stiff		2	SS	26															
244.0			3	SS	50															
1.0	Heterogeneous mixture of Silt and Sand with some gravel (SANDY SILT TILL) some Clayey Silt Till zones, occasional cobbles and boulders, brown to 4.4 m, grey below, compact to 1.7 m, dense to very dense below, damp		4	SS	59											22.5				
			5	SS	69															
			6	SS	43															
			7	SS	35											22.5				
			8	SS	46															
	occasional sand and silt seams below 5.5m		9	SS	56															

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 16

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844257N;282503E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 13.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								20 40 60 80 100						
							WATER CONTENT (%)							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT							
							w <sub>p</sub> w w <sub>L</sub>							
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
							20 40 60 80 100							
245.0	Ground surface													
244.8	150 mm TOPSOIL													
0.1			1	SS	3								19.9	
			2	SS	23		244							8 42 41 9
			3	SS	35		243							
	Heterogeneous mixture of Silt and Sand with some gravel (SANDY SILT TILL)		4	SS	40		242						22.4	4 43 48 5
	some Clayey Silt Till zones, occasional sand seams/lenses, occasional cobbles and boulders, brown to 3.4 m, grey below, very loose to 0.7 m, compact to very dense below, damp to 5.5 m, moist below		5	SS	75/23		241							
			6	SS	62		240						22.2	
			7	SS	44		239							
	clayey below 6.0 m		8	SS	49		238							
			9	SS	30									
236.9			10	SS	25		237							
8.1	End of borehole Borehole dry on completion Water level not stabilized													

# RECORD OF BOREHOLE No 17

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844181N;282460E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
245.0	Ground surface												
244.7	300 mm TOPSOIL		1	SS	10							19.3	
0.3	CLAYEY SILT with silt seams, brown, stiff, moist		2	SS	19								
244.0			3	SS	33								
1.0	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) with some Silty Sand Till and Clayey Silt Till zones, occasional Sandy Silt and Clay seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, compact to 1.5 m, dense to very dense below, moist to 5.0 m, wet below		4	SS	41							21.8	2 36 60 2
			5	SS	76								
			6	SS	43								
			7	SS	36								
			8	SS	70							22.7	13 46 41 0
239.0													
6.0	FINE SAND some Silt, grey, very dense, wet		9	SS	55								
237.7													
7.3	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) with Sand and Silt seams/lenses, occasional cobbles and boulders, grey, very dense, wet		10	SS	55/13								
235.7													
9.3	End of borehole Borehole dry on completion Water level at 4.8 m and hole caved at 5.4 m five hours after completion		11	SS	57/13							21.7	

RECORD OF BOREHOLE No 18										1 OF 1	METRIC					
W.P. 130-99-00		LOCATION 4844217N, 282498E				ORIGINATED BY M.T										
DIST Central HWY 410		BOREHOLE TYPE Solid Stem Augers				COMPILED BY G.T										
DATUM Geodetic		DATE 14.10.99				CHECKED BY Z.O										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)	
245.0	Ground surface						20	40	60	80	100					
244.9	250 mm TOPSOIL		1	SS	8										19.6	
0.3	clayey		2	SS	24											
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) occasional Sand and Silt seams, occasional cobbles and boulders, brown to 3.6 m, grey below, compact to 1.7 m, dense to very dense below, damp to moist		3	SS	42										21.7	
			4	SS	46											
			5	SS	100/25										22.7	9 41 50 0
			6	SS	100											3 44 51 2
			7	SS	70										21.7	
			8	SS	47											
			9	SS	51/13										21.9	
238.7		End of borehole														
6.3	Borehole dry on completion Water level at 5.5 m seven hours after completion Water level not stabilized															

# RECORD OF BOREHOLE No 19

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844150N, 282314E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
242.2	Ground Surface																
0.0	500 mm TOPSOIL and Silty Clay		1	SS	7		242									21.3	
241.7			2	SS	16		241									22.1	
0.5	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) some Sandy Silt Till zones, occasional Sand and Silt seams/lenses, occasional cobbles and boulders, brown/grey to 2.0 m, grey below, stiff to very stiff		3	SS	21		240									22.3	8 37 42 13
			4	SS	28		239										
238.2			5	SS	20		238										
4.0			6	SS	15		237										
	Heterogeneous mixture of Silty Clay some sand and gravel (SILTY CLAY TILL) grey, stiff to very stiff		7	TW	PH		236									21.7	
			8	SS	14		235										
			9	SS	12		234										
234.4			10	SS	29		233									22.6	
7.8	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) grey, hard		11	SS	35												
232.6																	
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed. Water level in piezometer at 5.6 m-Oct 27/99 P.H.=Pushed Hydraulically																

# RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844191N;282288E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
242.4	Ground Surface												
0.0	500 mm TOPSOIL												
241.9	and dark brown Silty Clay		C	SS	10								
0.5	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional Silt and Sand seams/lenses, brown to 1.0 m, grey below, stiff to 1.1 m, very stiff to 1.6 m, hard below damp to moist to 2.4 m, moist to wet below		2	SS	20							22.1	
			3	SS	41								
			4	SS	35							22.1	
			5	SS	33								5 40 43 12
			6	SS	47							22.2	
			7	SS	52								
			8	SS	34							22.5	
			9	SS	34								
234.3	very stiff		10	SS	22							22.0	
8.1	End of borehole Water level at 5.7 m upon completion Water level not stabilized Wet sand seam at 2.4 m												

# RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844231N;282267E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 25.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
242.3	Ground Surface												
0.0	450 mm TOPSOIL		1	SS	3	242							
241.9													
0.4	SILTY CLAY		2	SS	12	241							
241.5	brown, firm												
0.8			3	SS	15	240							
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional cobbles and boulders, brown to 1.5 m, grey below, stiff to very stiff to 7.0 m, hard below		4	SS	16	239							
			5	SS	12	238							
			6	SS	15	237							
			7	SS	16	236							
			8	SS	22	235							
			9	SS	29								
234.2			10	SS	34								
8.1	End of borehole Borehole dry on completion Water level not stabilized												

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 23

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844302N, 282208E ORIGINATED BY M.T.  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T.  
DATUM Geodetic DATE 23.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
242.6	Ground Surface													
0.0	TOPSOIL		1	SS	2		242							
241.9	clayey, low organic													
0.7			2	SS	35								22.3	
			3	SS	23		241							
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, brown to 1.1 m, grey below, very stiff to hard		4	SS	42		240							
			5	SS	30		239							
			6	SS	28		238						22.2	
			7	SS	40		237							
237.4			8	SS	26		236							
5.2	SANDY SILT		9	SS	18		235							
	grey, wet, compact		10	SS	19		234						20.5	
234.5							233							
8.1	End of borehole													
	Dynamic Cone Penetration Test performed from 8.1 to 10.5 m.													
232.1														
10.5	End of Dynamic Cone Penetration Test													
	Water level at 6.7 m upon completion. Standpipe piezometer installed. Water level in piezometer at 5.6 m on Oct 27/99													



# RECORD OF BOREHOLE No 24

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844373N;282114E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)
								20	40	60			
243.1	Ground Surface												
0.0	450 mm TOPSOIL		1	SS	3						19.8		
242.6													
0.5	SILTY CLAY												
242.4	trace organic, brown, soft		2	SS	8								
0.7	CLAYEY SILT												
241.4	brown, soft to firm, wet		3	SS	6								
1.7	CLAYEY SILT AND SANDY SILT with some Silty Sand and Silt seams, occasional very thin black organic seams, grey,		4	SS	7								
240.2	firm/loose, wet												
2.9	SAND		5	SS	8								
239.4	some gravel, grey, loose, wet												
3.7	CLAYEY SILT AND SANDY SILT with some Silty Clay, Silt and Silty Fine Sand seams, grey, stiff, compact, wet		6	SS	10								
			7	SS	15						20.9		
			8	SS	12								
236.9													
6.2			9	TW	PH								
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional silt and sand seams, grey, very stiff to hard		10	SS	30								
			11	SS	32						22.4		
233.5			12	SS	27								
9.6	End of borehole  Water level on completion at 1.5 m and hole caved at 6.0 m												

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 25

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844380N; 282086E ORIGINATED BY M.T.  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T.  
DATUM Geodetic DATE 22.10.99 23.10.99 CHECKED BY Z.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100	
243.8	Ground surface											
243.5	300 mm TOPSOIL		1	SS	2							
0.3	SILTY CLAY some topsoil, brown/dark brown, very soft to stiff (probably fill)		2	SS	9							
242.4												
1.4			3	SS	10							
	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) occasional Sandy Silt Till zones, brown/grayish brown, stiff to hard		4	SS	12							
			5	SS	16							
			6	SS	44							
238.8			7	SS	18							
5.0												
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) some Sand and Silt seams/lenses, occasional cobbles and boulders, grey, compact, wet		8	SS	26							
			9	SS	18							
			10	SS	24							
235.6												
8.2												
	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) grey, compact, wet		11	SS	23							
			12	SS	16							
232.6	sand and silt seams											
11.2	SILTY FINE SAND some Silt and Clayey Silt lenses, grey, compact, wet		13	SS	17							
			14	SS	13							
231.2												
12.6	End of borehole Dynamic Cone Penetration test extended from 12.6 to 16.8 m.											

Continued Next Page

+ 3 x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 25

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844380N, 282098E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T  
 DATUM Geodetic DATE 22.10.99 23.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LMT	NATURAL MOISTURE CONTENT	LIQUID LMT	UNIT WEIGHT  γ kn/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
227.0														
16.8	End of Dynamic Cone Penetration Test Water level at 5.8 m and hole caved at 9.4 m upon completion Water level not stabilized													

# RECORD OF BOREHOLE No 26

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844263N, 282381E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 18.10.99 19.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
								WATER CONTENT (%)						
245.9	Ground surface													
245.8	250 mm TOPSOIL		1	SS	6							20.0		
0.3	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) some Clayey Silt Till zones, occasional cobbles and boulders, brown to 2.7 m, grey below, dense to 0.9 m, compact to 1.5 m, dense below, moist to 2.2 m, damp below		2	SS	16									
			3	SS	36									21.0
			4	SS	51									
			5	SS	38									22.5
			6	SS	37									
			7	SS	46									21.6
			240.6	Heterogeneous mixture of Sand and silt with some gravel (SILTY SAND TILL) some Clayey Silt Till zones, some Sand and Silt seams/lenses, occasional gravelly sand seams, occasional cobbles and boulders, grey, dense to very dense, moist to wet		8	SS	78						
9	SS	33											22.0	
10	SS	50/13												
11	SS	78/25											23.2	
12	SS	54												
235.3	End of borehole Refusal to further augering at 10.6m on a boulder. Standpipe piezometer installed Water level at 10.0 m upon completion and at 4.8 m on Oct 22/99 Water level in piezometer at 5.1 m on Oct 20 and 21/99 Water level at 5.1 m on Oct 27/99 Sample 13=no recovery N.P. denotes no penetration		13			SS	50/N.P.							
10.6														

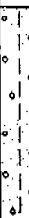


RECORD OF BOREHOLE No 26A

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844265N, 282379E ORIGINATED BY M.T.  
DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T.  
DATUM Geodetic DATE 25.10.99 25.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W <sub>P</sub> — W — W <sub>L</sub>		
						20 40 60 80 100				20 40 60					
228.7	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) grey, very dense to compact, wet		7	SS	81						22.7				
17.2	End of borehole at 17.2 m Dynamic Cone Penetration Test performed from 17.2 to 22.9m		8	SS	20										
223.0															
22.9	End of Dynamic Cone Penetration Test Water level on completion at 8.8 m and hole caved at 9.1 m Water level not stabilized														

# RECORD OF BOREHOLE No 27

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844285N, 282359E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers & D.C.P.T. COMPILED BY G.T.  
 DATUM Geodetic DATE 19.10.99 20.10.99 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
246.0	Ground surface						246							
245.9	325 mm TOPSOIL		1	SS	5		245						20.3	
0.3	SILTY CLAY with Clayey Silt and Silt seams, brown, firm to stiff		2	SS	20		244						21.6	
245.0	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL) with Clayey Silt Till zones, some Sand and Silt seams, occasional cobbles and boulders, brown to 3.3 m, grey below, compact to very dense		3	SS	29		243							
1.0			4	SS	46		242						22.8	5 39 44 12
			5	SS	50/13		241							
			6	SS	27		240						20.6	
			7	SS	30		239							
240.5	wet sand and silt seams		8	SS	16		238							
5.5	SILTY CLAY		9	SS	29		237							
240.0	with till seams, grey, very stiff		10	SS	33		236							
6.0	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL) some Sandy Silt Till and Clayey Silt Till zones, some Sand seams, occasional Silt and Silty Clay seams/lenses, occasional cobbles and boulders, grey, dense to very dense, wet		11	SS	40		235							
			12	SS	29		234							
			13	SS	74		233							
			14	SS	55		232							
			15	SS	98		231							10 36 52 2
			16	SS	96		230							
							229							Oct 19/Oct20

Continued Next Page

Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

## 2 OF 2

## METRIC

[illegible]

+ 3, x 3: Numbers refer to Sensitivity



# RECORD OF BOREHOLE No 28

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844260N;282402E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 18.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
245.7	Ground surface													
245.4	300 mm TOPSOIL		1	SS	10									
0.3	CLAYEY SILT with Clayey Silt Till, Silt and Silty clay seams, brown, stiff to hard, moist		2	SS	26									
243.6			3	SS	36							23.6		
2.1			4	SS	56								9 42 48 1	
			5	SS	50/13							21.6	6 44 50 0	
			6	SS	70								2 40 58 0	
			7	SS	70							21.5		
			8	SS	52									
			9	SS	91							22.6		
			10	SS	50/13									
			11	SS	50/13							22.5	1 42 56 1	
			12	SS	50/11									
			13	SS	50/15							22.4	13 42 43 2	
233.3			14	SS	50/13									
12.4	End of borehole Hole caved in and water level at 7.0 m upon completion Water level at 6.8 m and hole caved at 7.0 m two hours after completion Water level not stabilized Sand and clay lenses at 5.5 m													

# RECORD OF BOREHOLE No 29

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844303N;282381E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T  
DATUM Geodetic DATE 20.10.99 21.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
245.9	Ground surface											
0.0 245.5	350 mm TOPSOIL		1	SS	6						18.9	
0.4 244.8	SILTY CLAY brown, firm to stiff		2	SS	24		245					
1.1 243.0	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, brown, very stiff to 1.6 m, hard below		3	SS	36		244				20.7	
			4	SS	38		243					
2.9 237.6	Heterogeneous mixture of Silt and Sand with some gravel, trace clay (SANDY SILT TILL) occasional cobbles and boulders, grey, dense to very dense, damp with occasional wet zones below 7.0 m		5	SS	59		242				22.3	
			6	SS	33		241					
			7	SS	50/8		240				22.4	
			8	SS	72		239					
			9	SS	50/5		238					
			10	SS	49		237				22.5	
			11	SS	78		236					
8.3	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL) some Sand and Silt seams/lenses, occasional cobbles and boulders, grey, dense to very dense, wet		12	SS	34		235					
			13	SS	51		234					
			14	SS	56		233					
			15	SS	60		232				23.1	
							231					

Continued Next Page

+ 3 x 3 Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

Change to  
Hollow Stem

# RECORD OF BOREHOLE No 29

2 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844303N;282381E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid and Hollow Stem Augers & D.C.P.T. COMPILED BY G.T  
DATUM Geodetic DATE 20.10.99 21.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
			16	SS	55											
						230										
			17	SS	43	229									23.0	
						228										
			18	SS	44	227										
						226										
			19	SS	38	225										
						224										
			20	SS	38	223										
						222										
222.6			21	SS	88										22.1	
23.3	End of borehole															
222.1	Dynamic Cone Penetration Test															
23.6	extended from 23.3 to 23.6 m															
	End of Dynamic Cone Penetration Test															
	Standpipe piezometer installed.															
	Water level in piezometer at															
	4.8 m on Oct 22 and Oct 25 and at															
	5.0 m on Oct 27/99															
	wet sand layer at 18.3 m															

# RECORD OF BOREHOLE No 30

1 OF 2

METRIC

W.P. 130-99-00 LOCATION 4844299N, 282423E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
245.7	Ground surface.												
245.4	300 mm TOPSOIL		1	SS	11							19.5	
0.3	SILTY CLAY												
245.0	organic stained, brown, stiff		2	SS	29								
0.7	CLAYEY SILT												
244.6	with Silt seams, brown, very stiff												
1.1			3	SS	36								5 45 47 3
			4	SS	39							22.1	6 41 51 2
			5	SS	91								10 41 47 2
	Heterogeneous mixture of Silt and Sand with some gravel, trace clay (SANDY SILT TILL)		6	SS	58							22.5	
	some Clayey Silt Till zones, occasional cobbles and boulders, brown to 3.5 m, grey below, dense to very dense, damp		7	SS	51								9 44 45 2
	wet sand layer at 6.0 m		8	SS	44								
			9	SS	52								
			10	SS	38							22.2	
			11	SS	32								10 40 47 3
237.5	clayey												
8.2	wet sand layer at 8.6 m		12	SS	50/5								
	Heterogeneous mixture of Sand and Silt with some gravel (SILTY SAND TILL)		13	SS	50/13								5 49 45 1
	with Sandy Silt Till and some sand seams/lenses, occasional cobbles and boulders, grey, very dense, wet		14	SS	50/6								20 42 37 1
231.9													
13.8	End of borehole		15	SS	50/11							22.8	
	Hole caved-in and water level at 8.9 m on upon completion Standpipe piezometer installed.												

Continued Next Page

$\times 10^3$  : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 30

2 OF 2

METRIC

W.P. 130-89-00 LOCATION 4844299N, 282423E ORIGINATED BY M.T.  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T.  
 DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
						20	40	60	80	100							
	Water level in piezometer at 4.6 m on Oct 20/99 and 4.3 m on Oct 25 and 27/99																

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 31

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844320N, 282402E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 21.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
245.7	Ground Surface							20 40 60 80 100				
0.0	TOPSOIL		1	SS	8			20 40 60 80 100				
245.2												
0.5	clayey											

# RECORD OF BOREHOLE No 32

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844256N,282356E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 19.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
246.0	Ground surface													
245.7	300 mm TOPSOIL		1	SS	12									
0.3	SILTY CLAY													
245.0	with Clayey Silt and Silt seams, brown, stiff		2	SS	20									
1.0														
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL)		3	SS	20									
	with Clayey Silt Till zones, some Sand and Silt		4	SS	54									
242.6	seams/lenses, brown, compact to 2.6 m, very dense below, damp to moist		5	SS	59									
3.4	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL)		6	SS	66									
	frequent Sand, Silt, and Clayey Silt lenses, occasional cobbles and boulders, grey, compact to very dense, wet		7	SS	64									
			8	SS	19									
239.4			9	SS	54									
6.6	End of borehole													
	Water level at 5.5 m four hours after completion													
	0.3 m thick wet silty sand layer at 1.4 m													
	Silty clay seam at 5.5 m													
	Wet sand seam at 6.0 m													

+ 3 x 3 Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 33

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844327N;282426E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 14.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
245.4	Ground surface													
245.1	300 mm TOPSOIL		1	SS	6								20.1	GR SA SI CL
0.3	SILTY CLAY													
244.7	trace gravel and organics, brown, firm		2	SS	25									
0.7														
			3	SS	31									2 46 50 2
	Heterogeneous mixture of Silt and Sand some gravel, trace clay (SANDY SILT TILL)		4	SS	59								22.1	
	some Clayey Silt Till zones, brown to 3.5 m, grey below, compact to very dense, damp		5	SS	91									4 44 51 1
			6	SS	42									
241.0														
4.4	Heterogeneous mixture of Sand and Silt some gravel (SILTY SAND TILL)		7	SS	42								22.5	
	occasional Sand and Silt seams/lenses, grey, dense		8	SS	42									
238.8			9	SS	46								22.2	
6.6	End of borehole Borehole dry on completion. Water level in open borehole at 5.2 m one hour after completion													



# RECORD OF BOREHOLE No 34

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844632N; 262062E ORIGINATED BY M.T  
 DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
 DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
246.6	Ground Surface												
0.0	400 mm TOPSOIL												
246.2			1	SS	7								
0.4	Heterogeneous mixture of Clayey Silt some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, some sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.3 m, grey below, firm to stiff to 1.1 m, very stiff to hard below, damp to moist to 7.0 m, moist to wet below		2	SS	17							21.6	9 40 41 10
			3	SS	32								
			4	SS	42							21.3	
			5	SS	52								
			6	SS	66/25							21.5	
			7	SS	36								7 37 44 12
			8	SS	30							22.6	
			9	SS	26								
			10	SS	30							21.6	
237.0			11	SS	68								
9.6	End of borehole Water level on completion at 8.8 m Water level not stabilized												

+ 3 . x 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 35

1 OF 1

METRIC

W.P. 130-99-00 LOCATION 4844403N/282364E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						20	40	60	80
245.8	Ground Surface																			
0.0 245.5	300 mm TOPSOIL		1	SS	9															
0.3	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, stiff to 1.0 m, hard below, damp to moist to 8.0 m, moist to wet below, wet sand seams		2	SS	32															
			3	SS	33															
			4	SS	38															
			5	SS	96															
			6	SS	61															
			7	SS	57															
			8	SS	54															
			9	SS	39															
			10	SS	32															
236.2			11	SS	32															
9.6	End of borehole Borehole dry on completion Standpipe piezometer installed Water level in piezometer at 4.0 m on Oct 25 and 27/99																			

RECORD OF BOREHOLE No 36

1 OF 1

METRIC

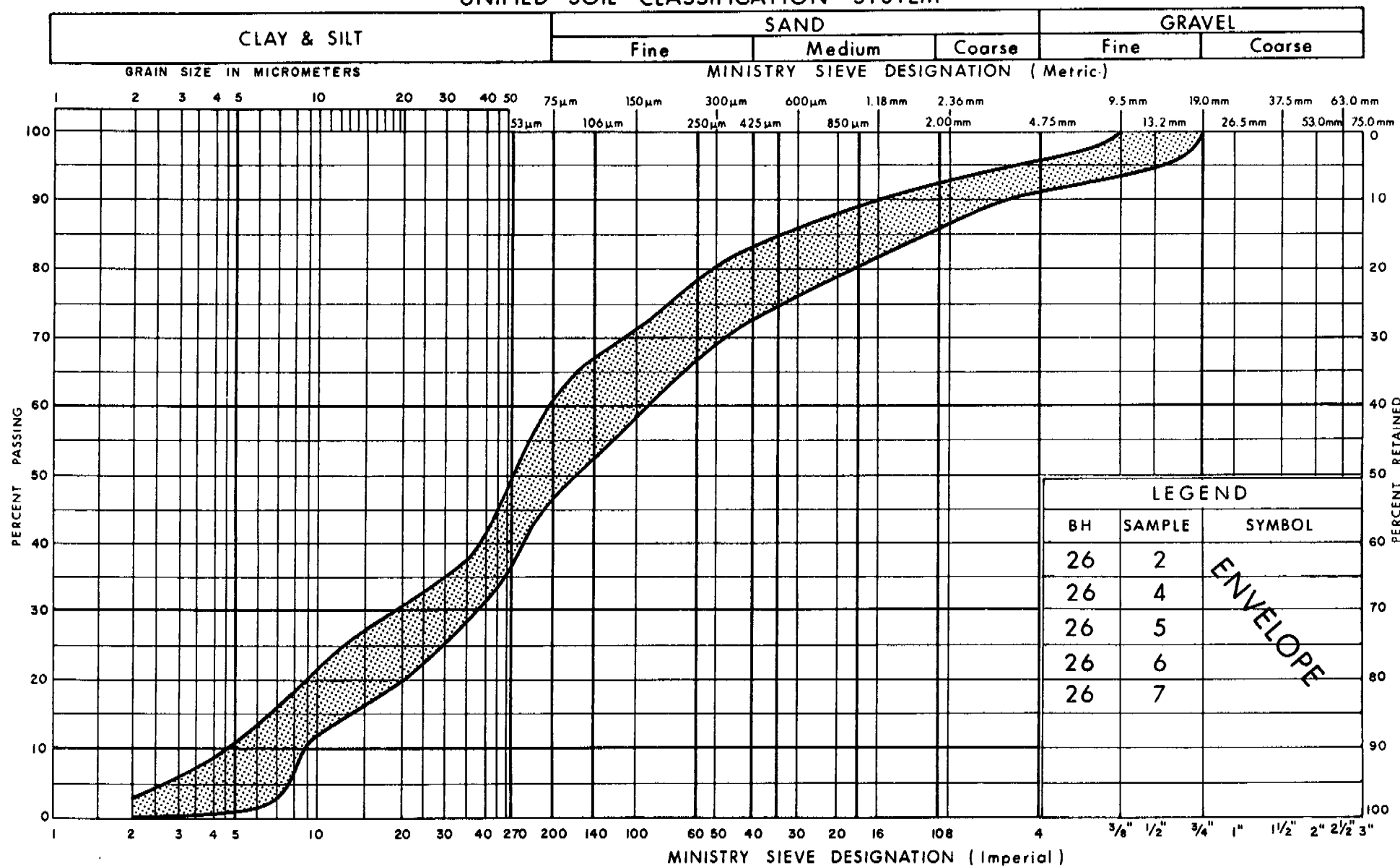
W.P. 130-99-00 LOCATION 4844437N;282369E ORIGINATED BY M.T  
DIST Central HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY G.T  
DATUM Geodetic DATE 22.10.99 CHECKED BY Z.O

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							
245.5	Ground Surface							20 40 60 80 100							
245.2	300 mm TOPSOIL		1	SS	11		245								
0.3	Heterogeneous mixture of Clayey Silt with some sand and gravel (CLAYEY SILT TILL) with Sandy Silt Till zones, occasional sand and silt seams/lenses, occasional cobbles and boulders, brown to 3.5 m, grey below, stiff to 1.0 m, hard below, damp to moist		2	SS	34		244								
			3	SS	36		243								
			4	SS	36		242								
			5	SS	91		241								
			6	SS	77		240								
			7	SS	59		239								
			8	SS	46		238								
			9	SS	39										
237.4			10	SS	33										
8.1	End of borehole Borehole dry on completion Water level not stabilized														

# APPENDIX B

## Laboratory Test Results

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

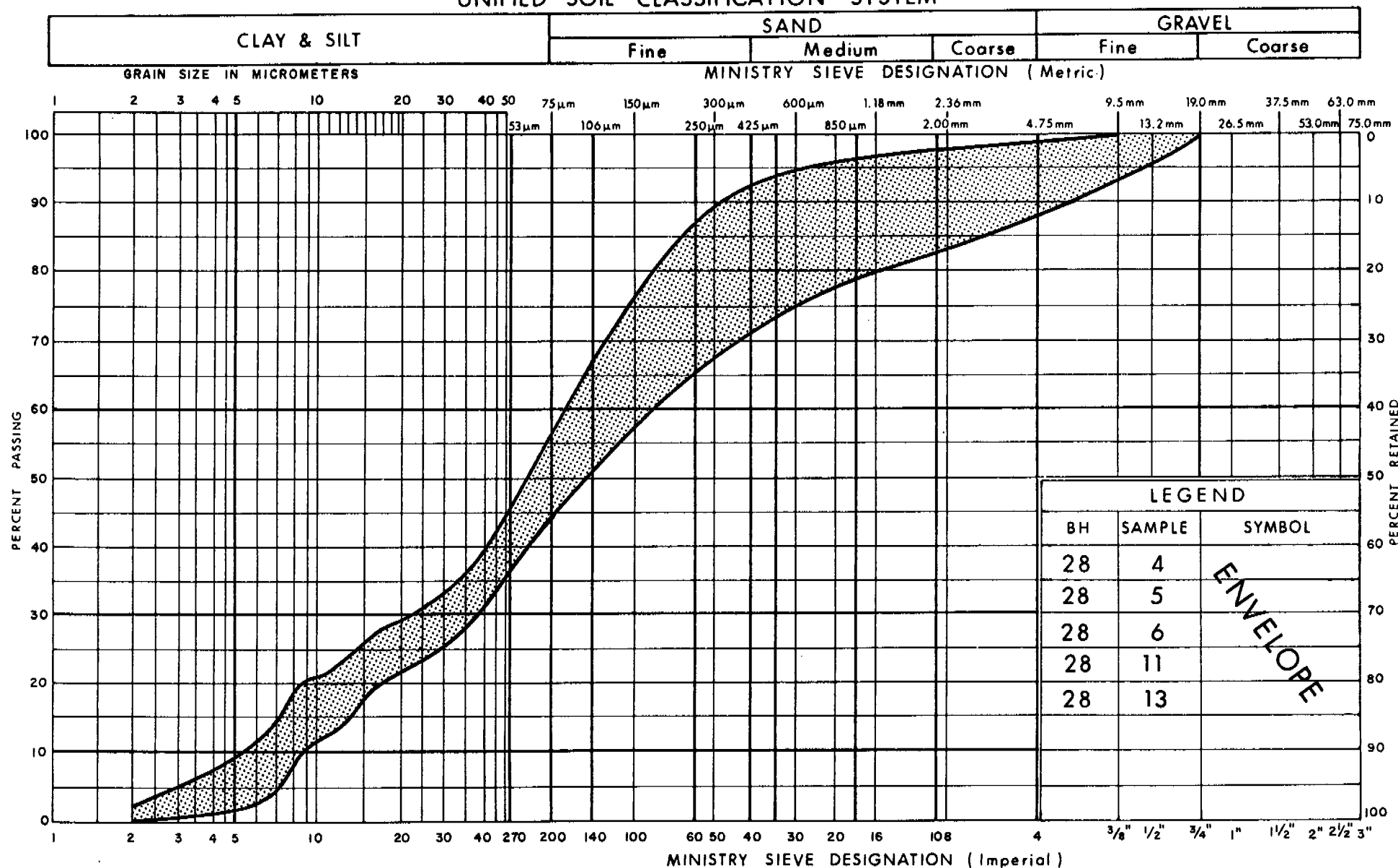
# GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B1

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

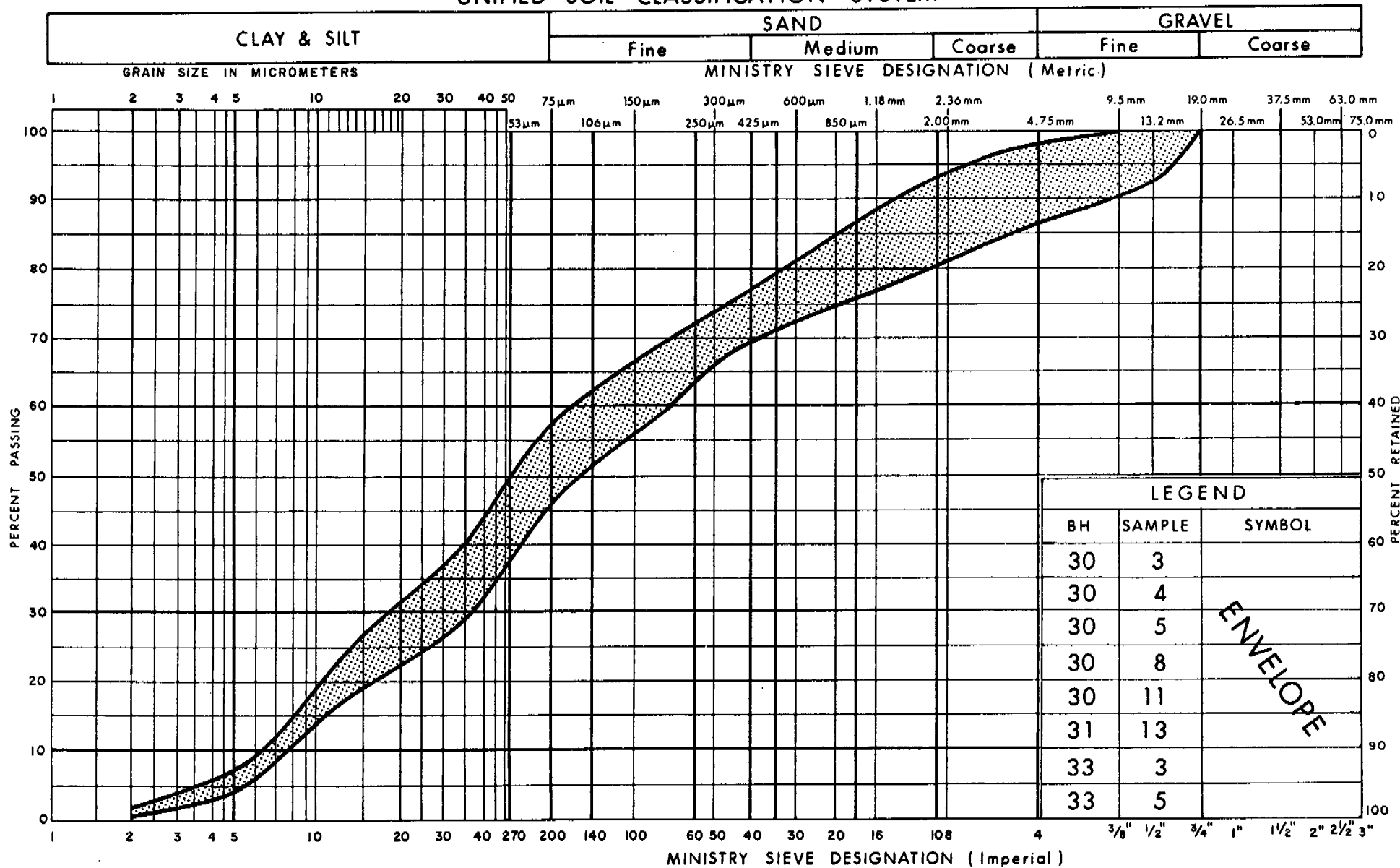
# GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B2

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

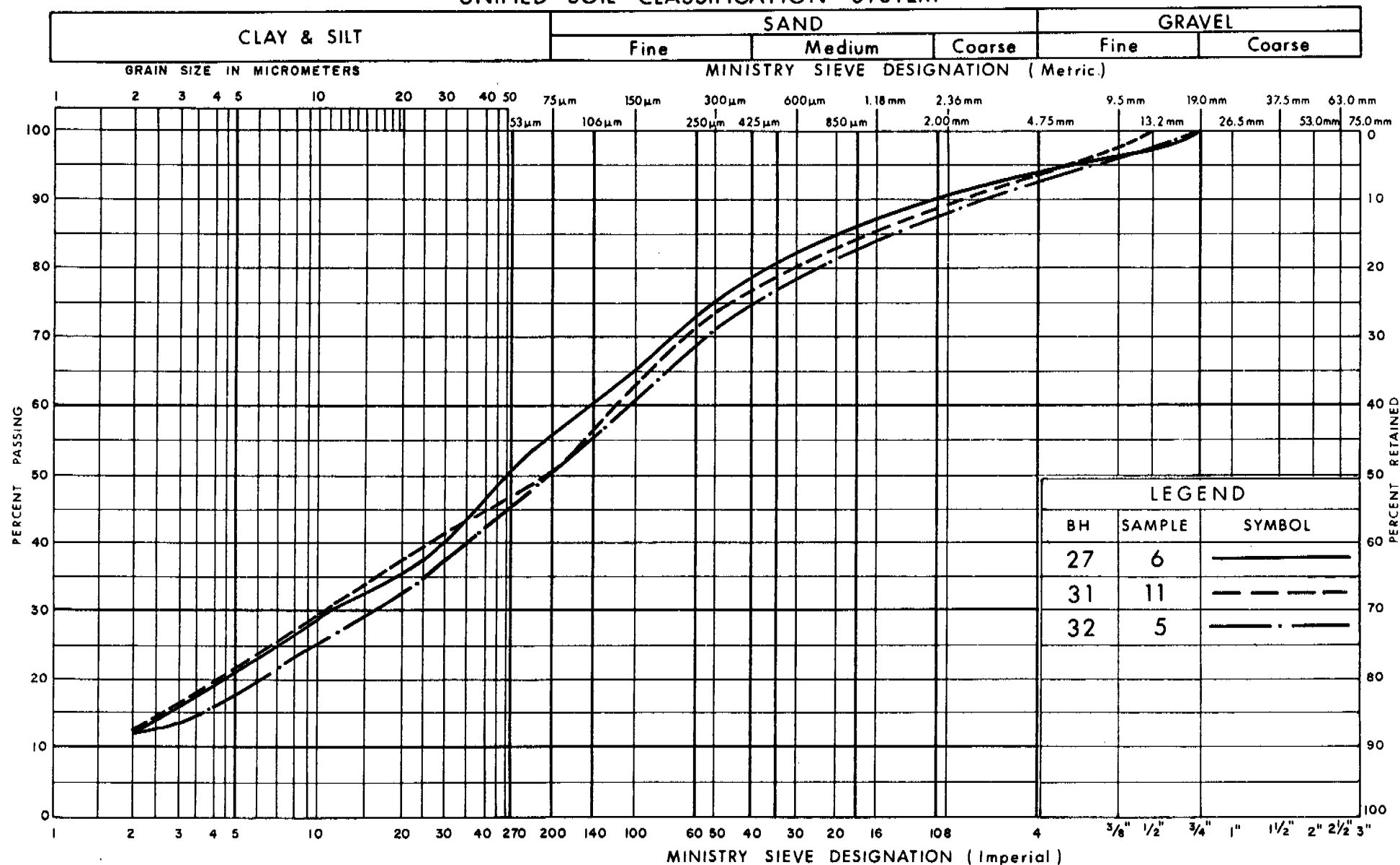
## GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B3

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL ZONES IN SANDY SILT TILL

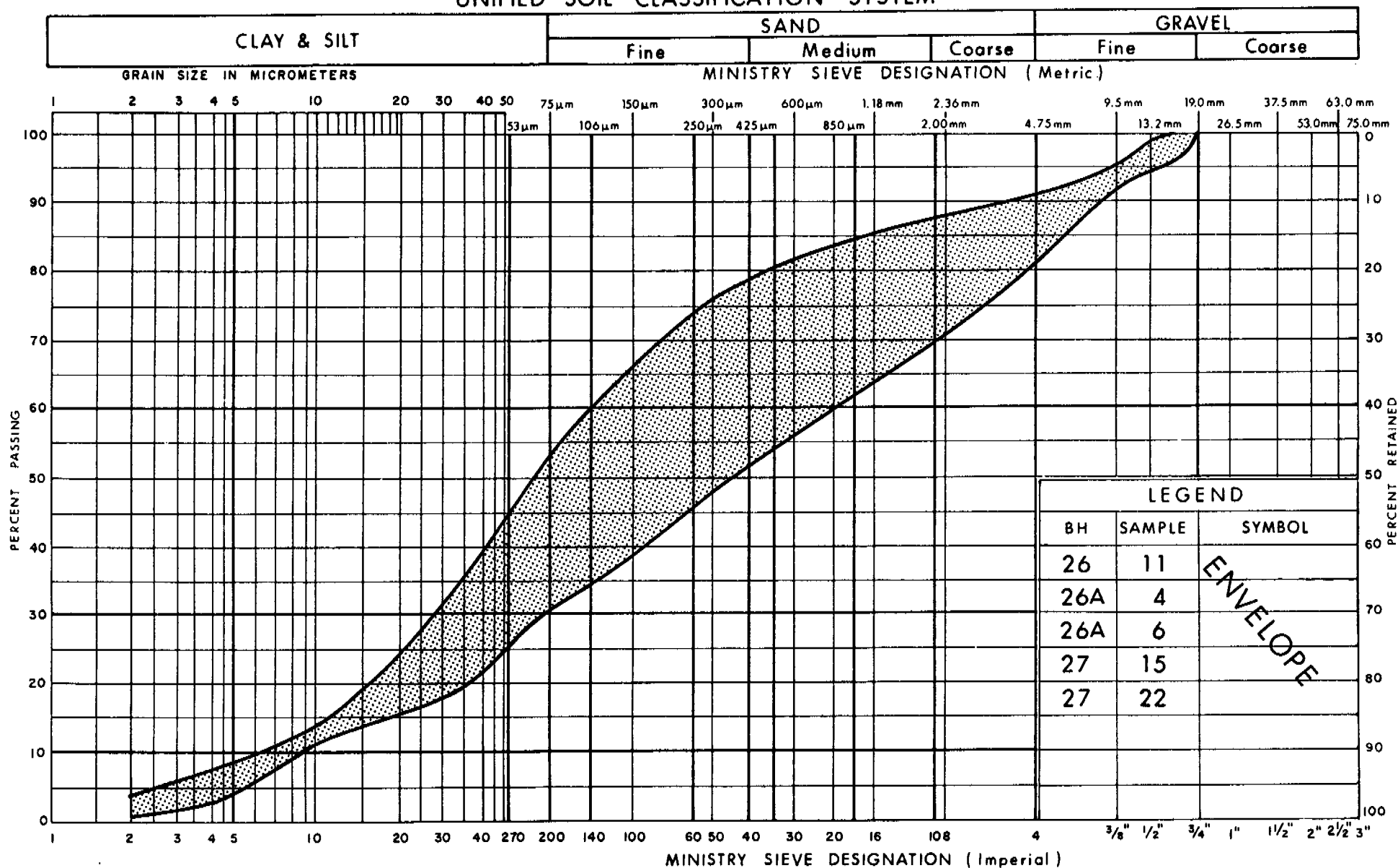
FIG No B4

W P 130-99-00 (D)

Sandalwood Pkwy



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

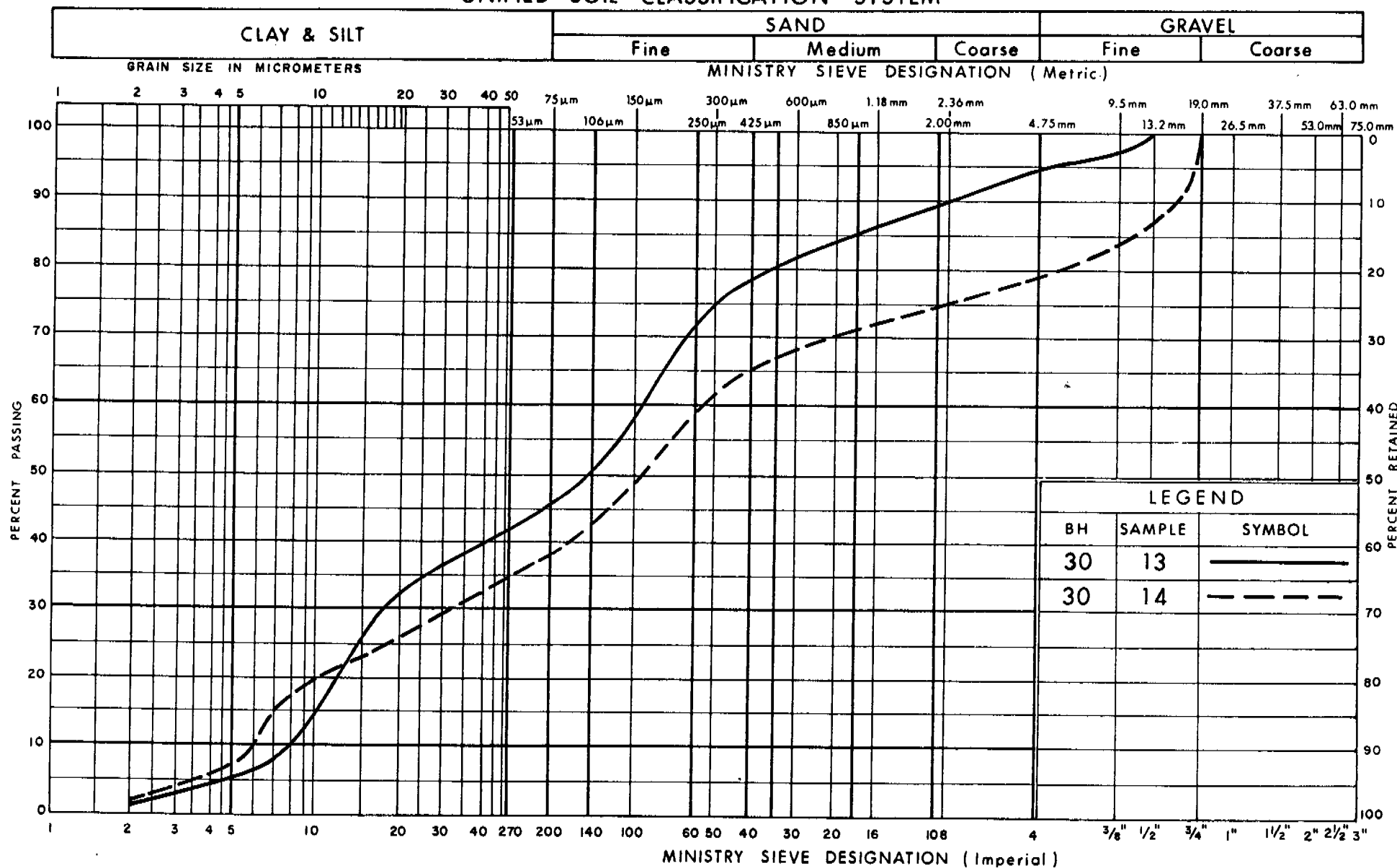
# GRAIN SIZE DISTRIBUTION SILTY SAND TILL

FIG No B5

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION

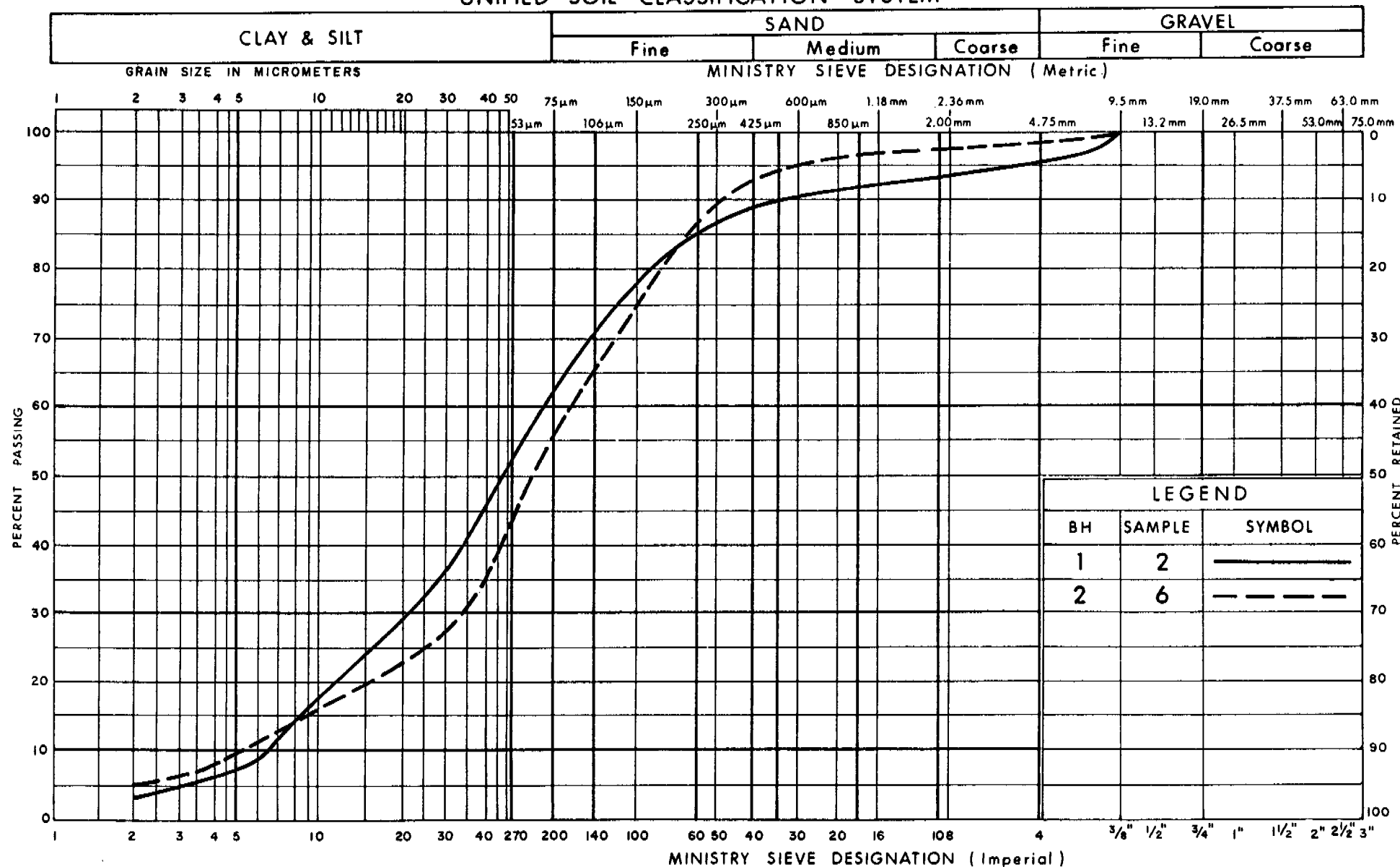
## SILTY SAND TILL

FIG No B6

W P 130-99-00 (D)

Sandalwood Pkwy

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

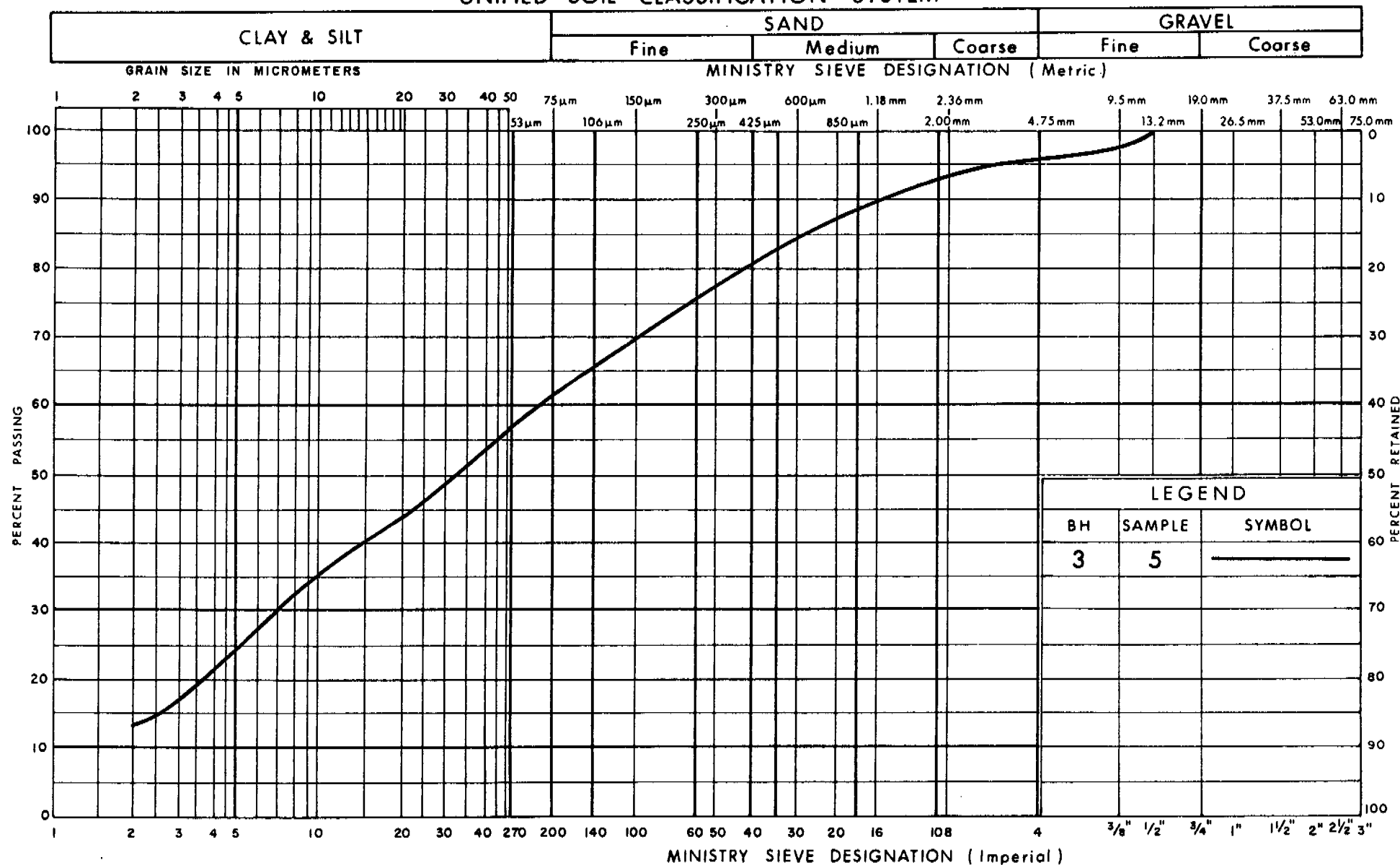
## GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B7

W P 130-99-00 (D)

Culvert B2

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

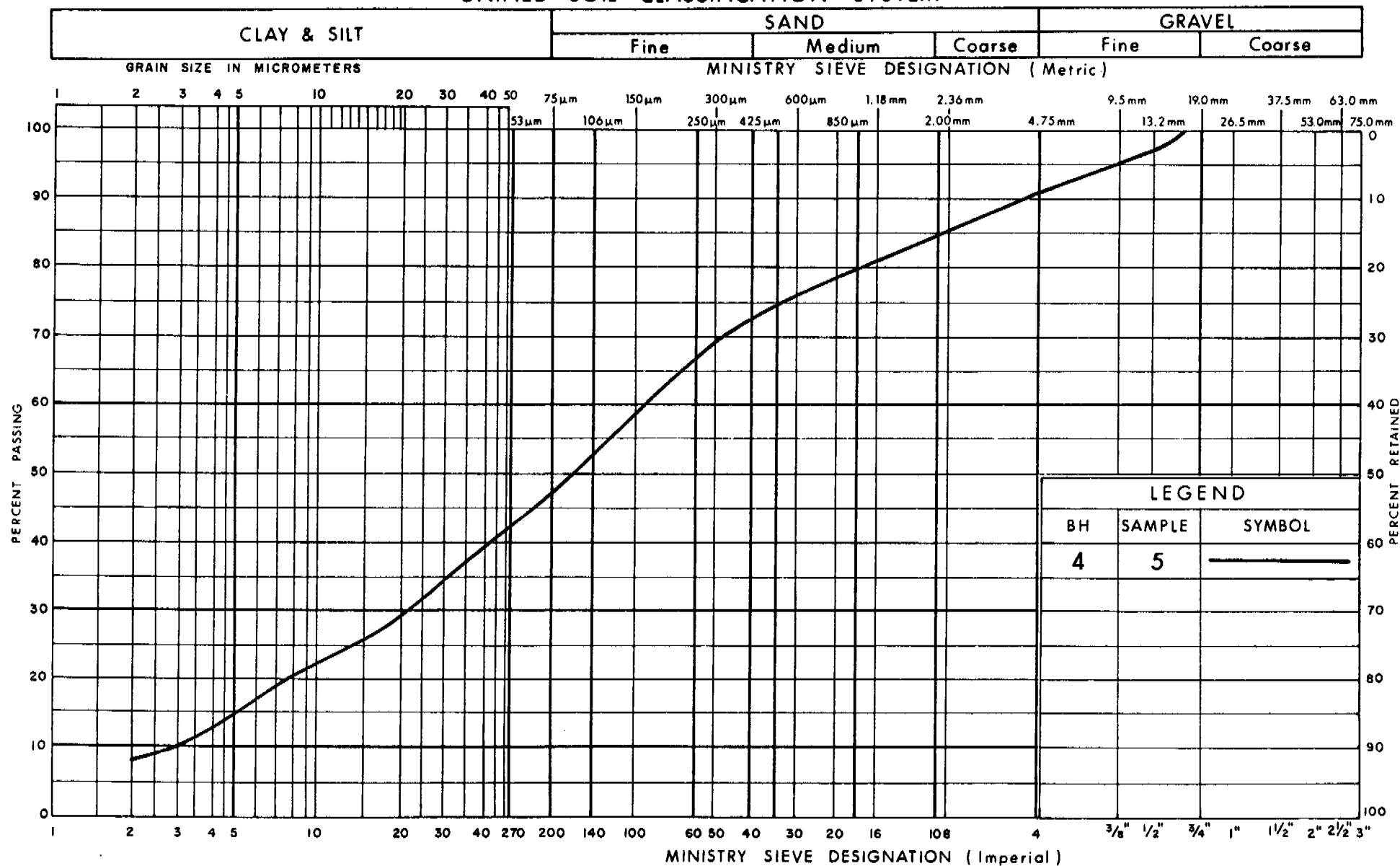
### CLAYEY SILT TILL

FIG No B8

W P 130-99-00 (D)

Culvert B3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

Ontario

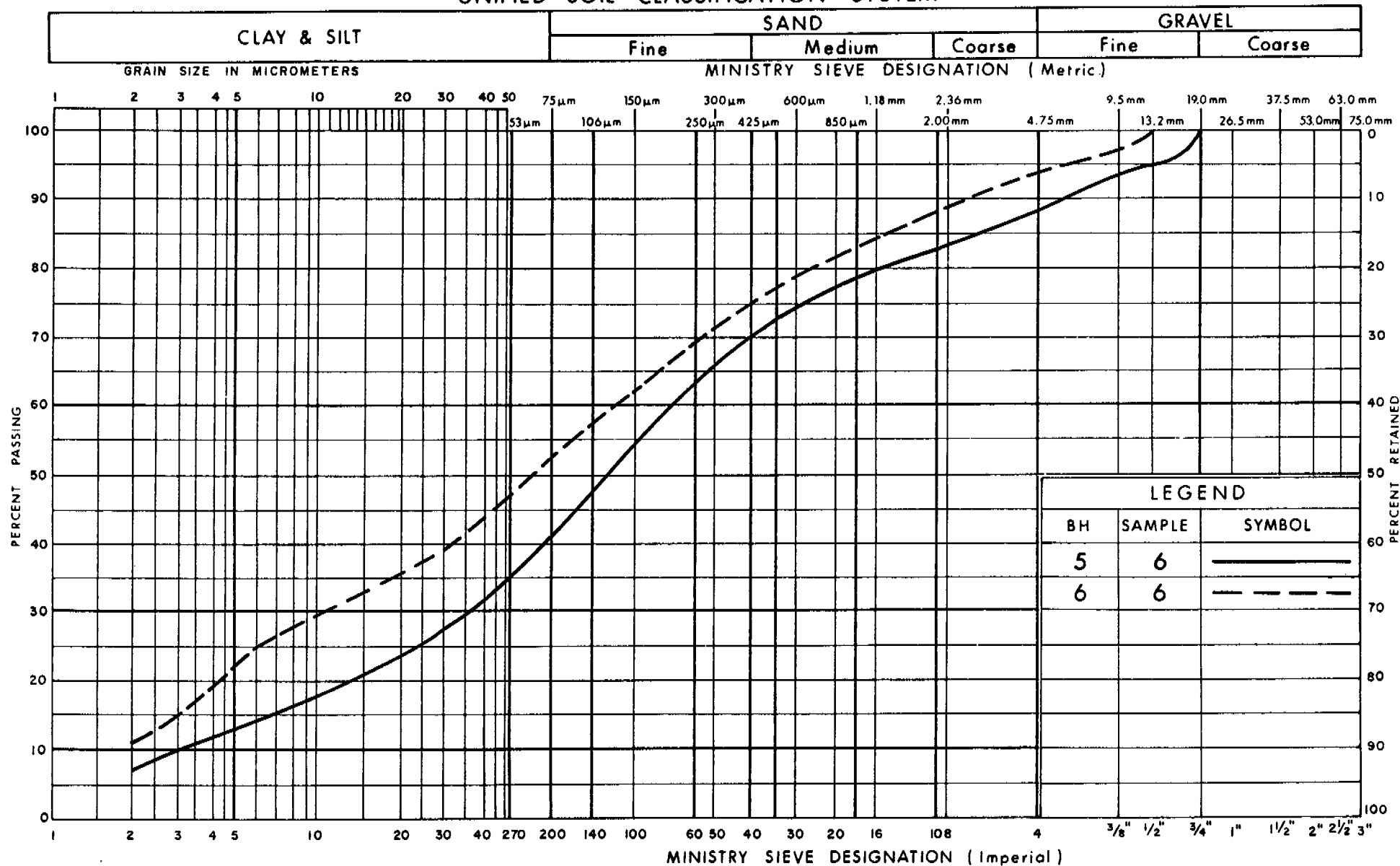
## GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No B9

W P 130-99-00(D)

Culvert B3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

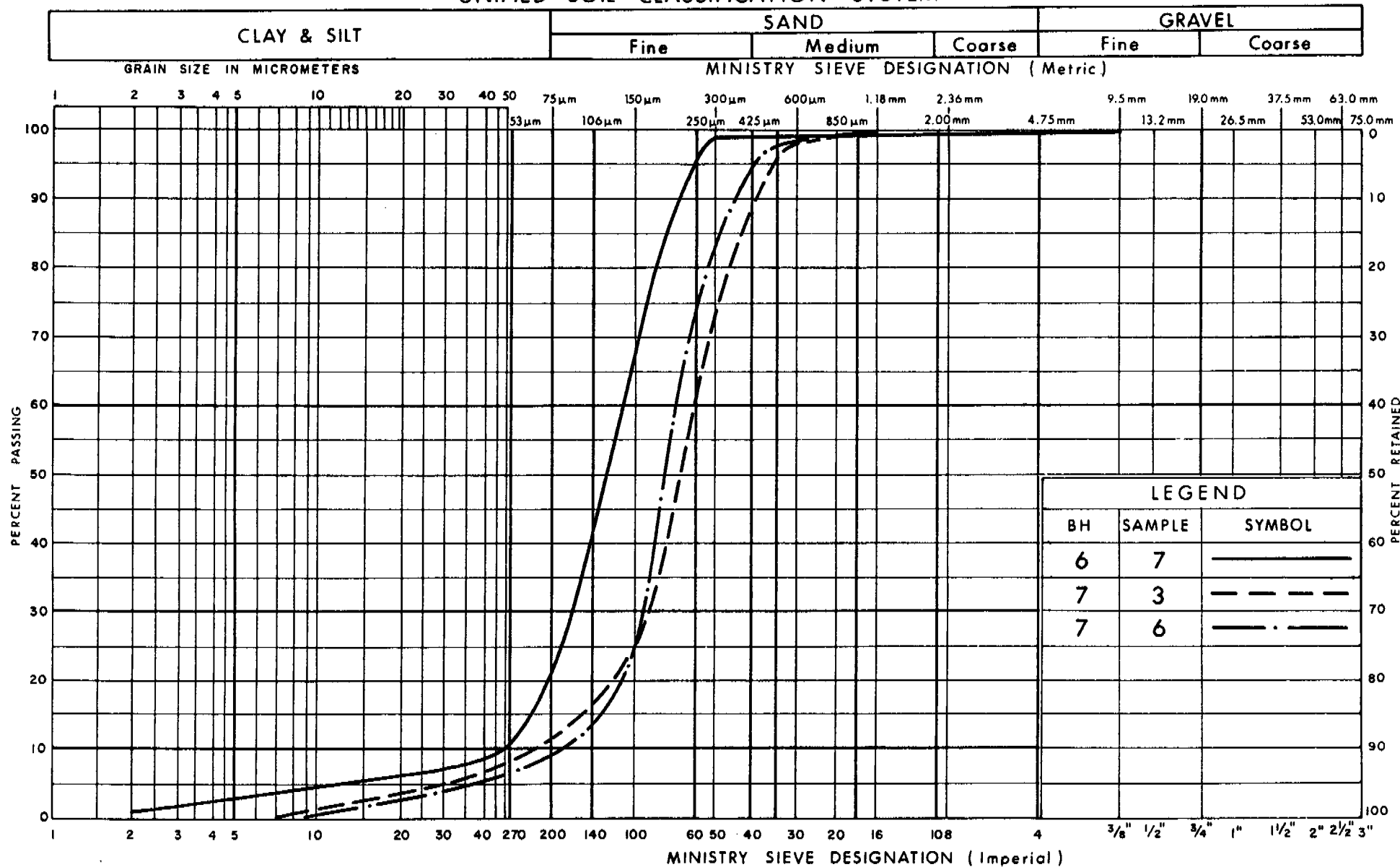
## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B 10

W P 130-99-00(D)

Culvert B4

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

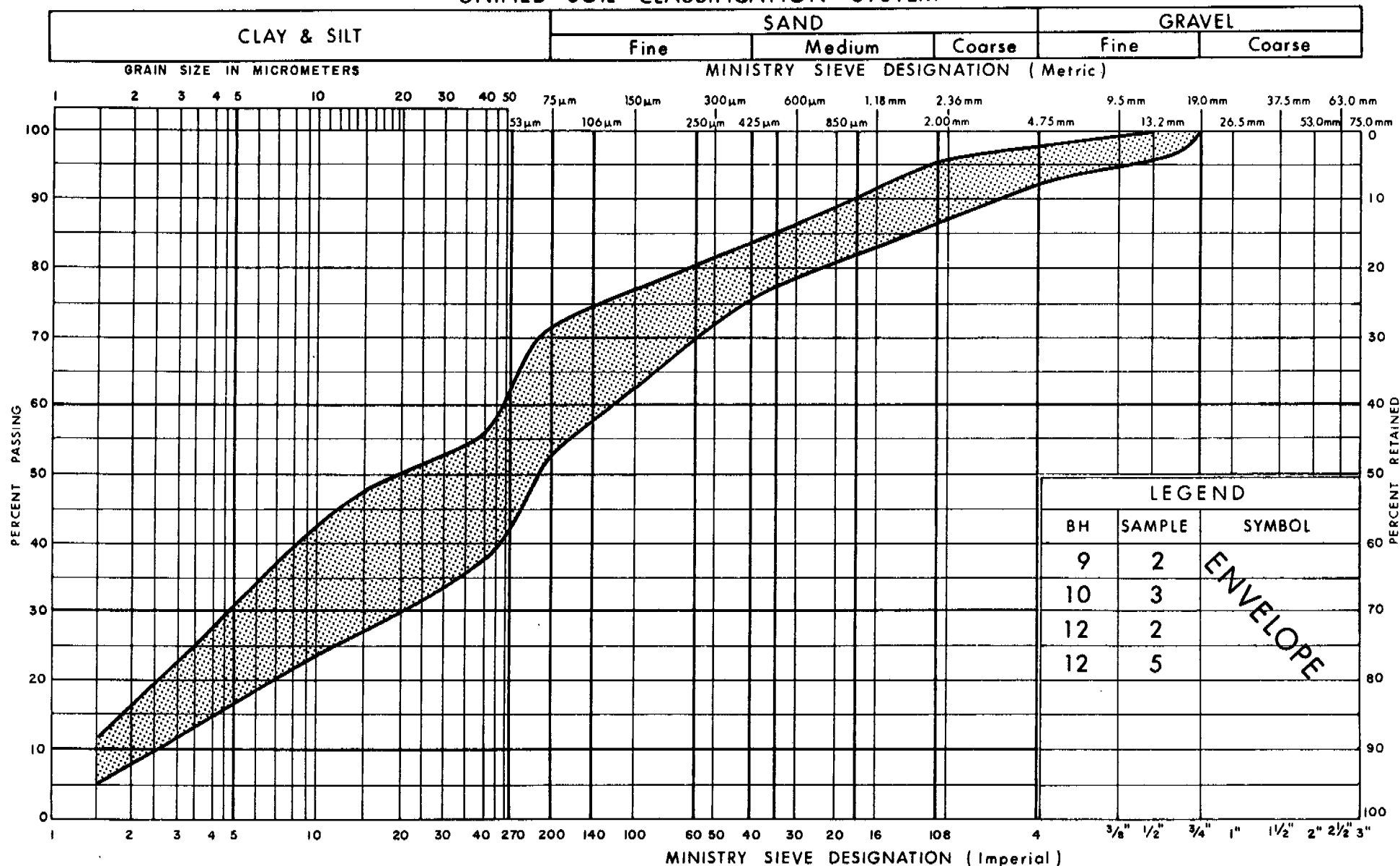
## GRAIN SIZE DISTRIBUTION FINE SAND

FIG No B 11

W P 130-99-00 (D)

Culvert B4

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

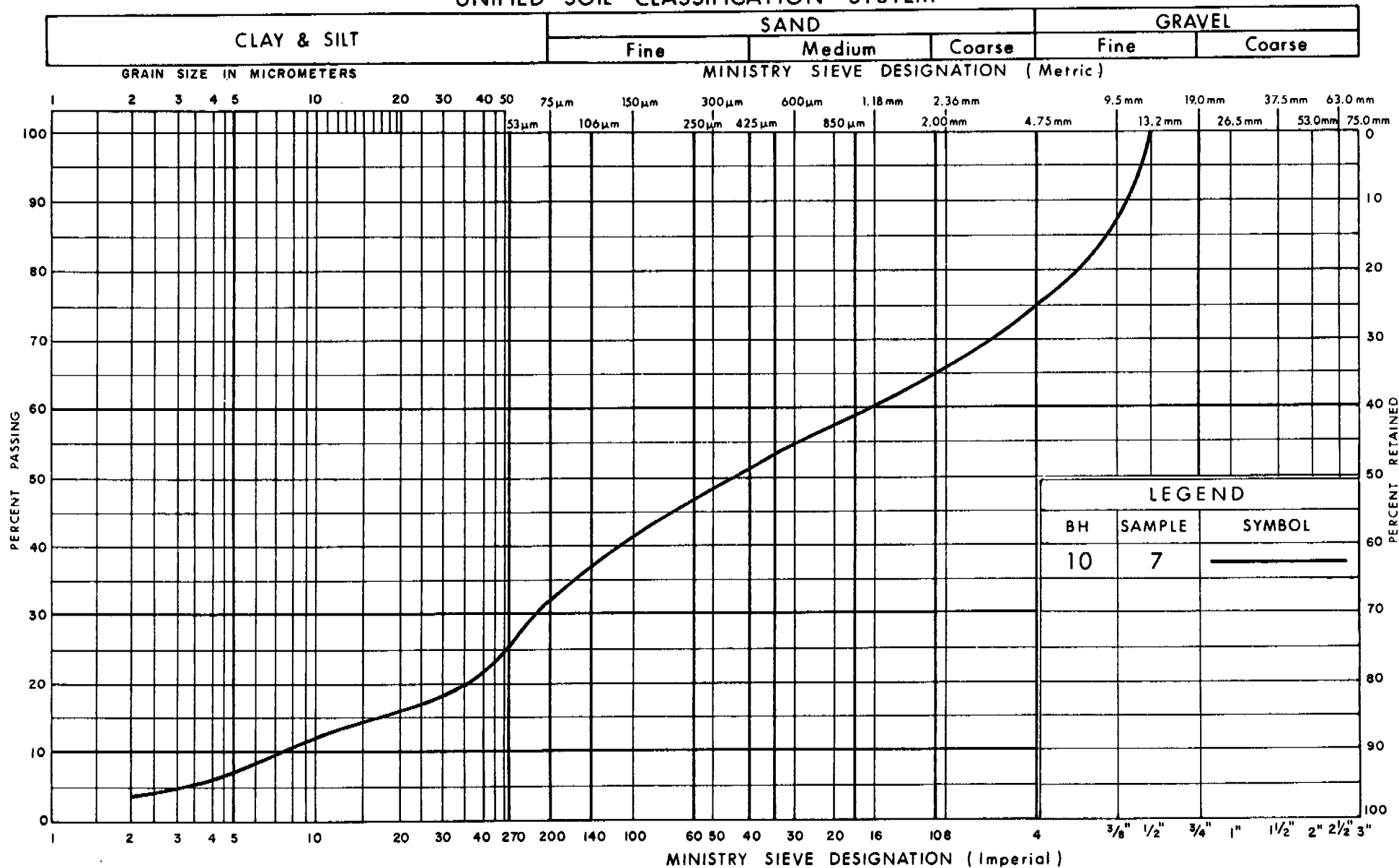
FIG No B12

W P 130-99-00(D)

Culvert S1



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

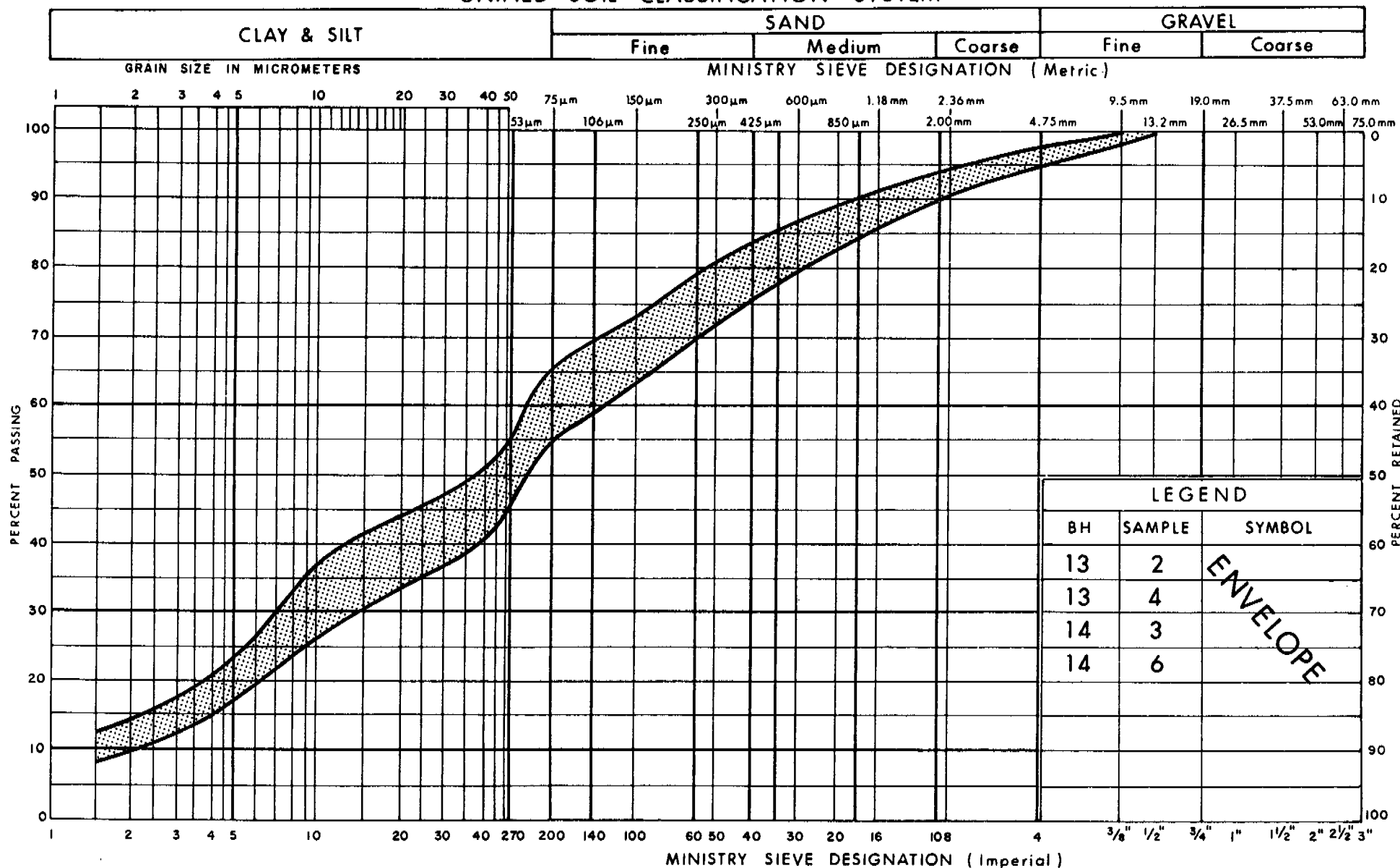
## GRAIN SIZE DISTRIBUTION SILTY SAND TILL

FIG No B 13

W P 130-99-00 (D)

Culvert S1

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION

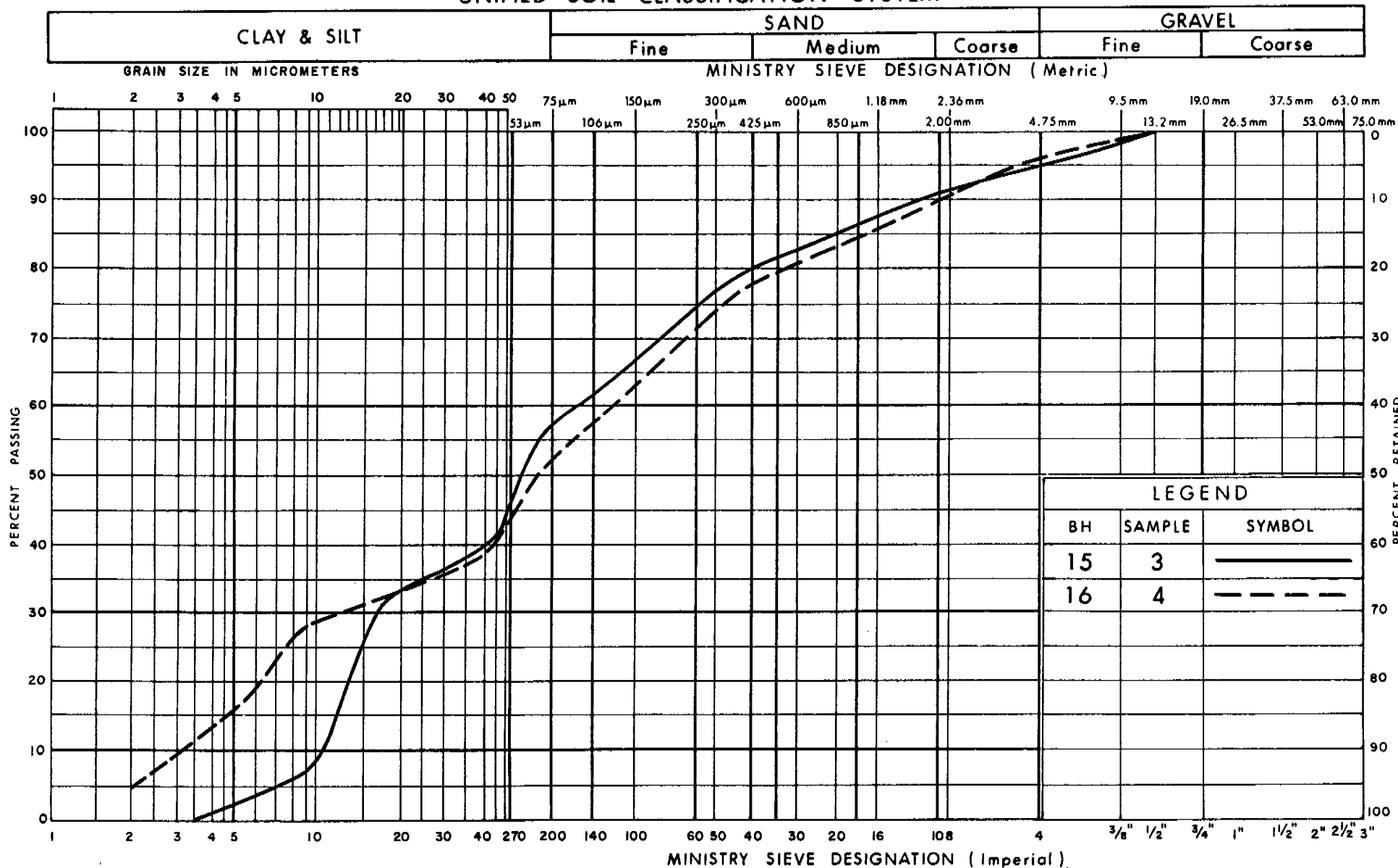
## CLAYEY SILT TILL

FIG No B14

W P 130-99-00(D)

Culvert S2

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

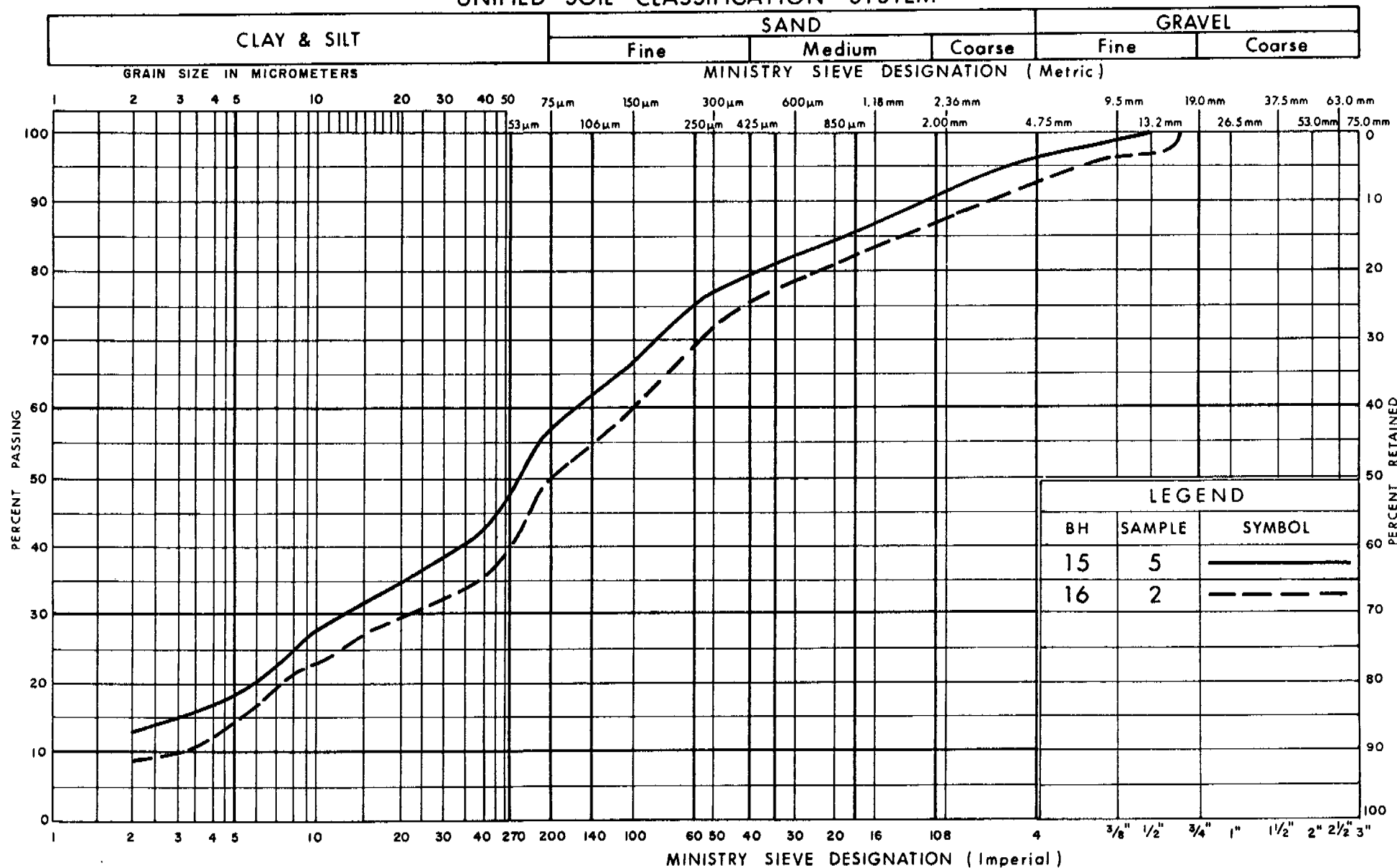
Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
SANDY SILT TILL

FIG No B15A

W P 130-99-00(D)

Culvert S3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

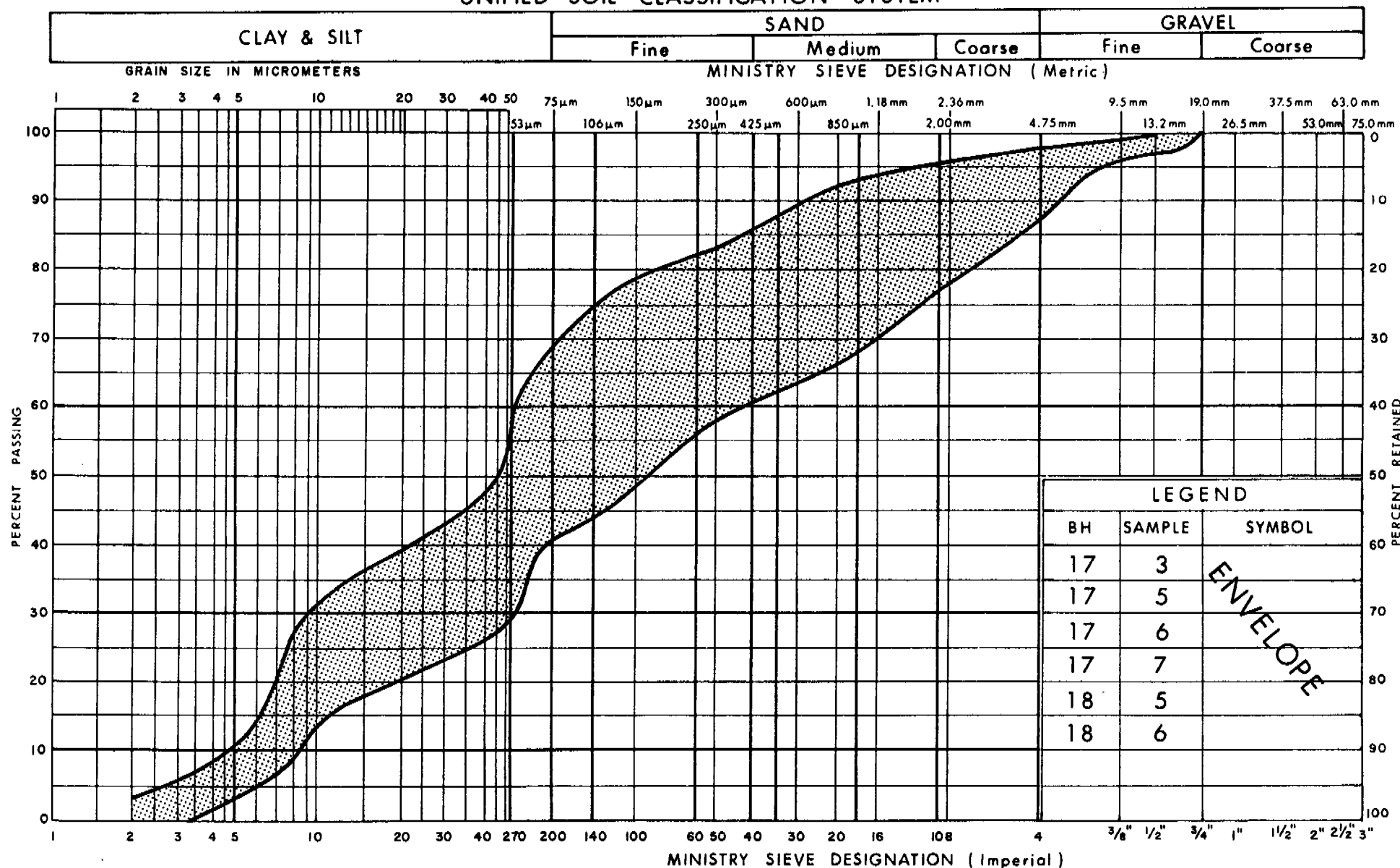
### CLAYEY SILT TILL ZONES IN SANDY SILT TILL

FIG No B15B

W P 130-99-00(D)

Culvert S3

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

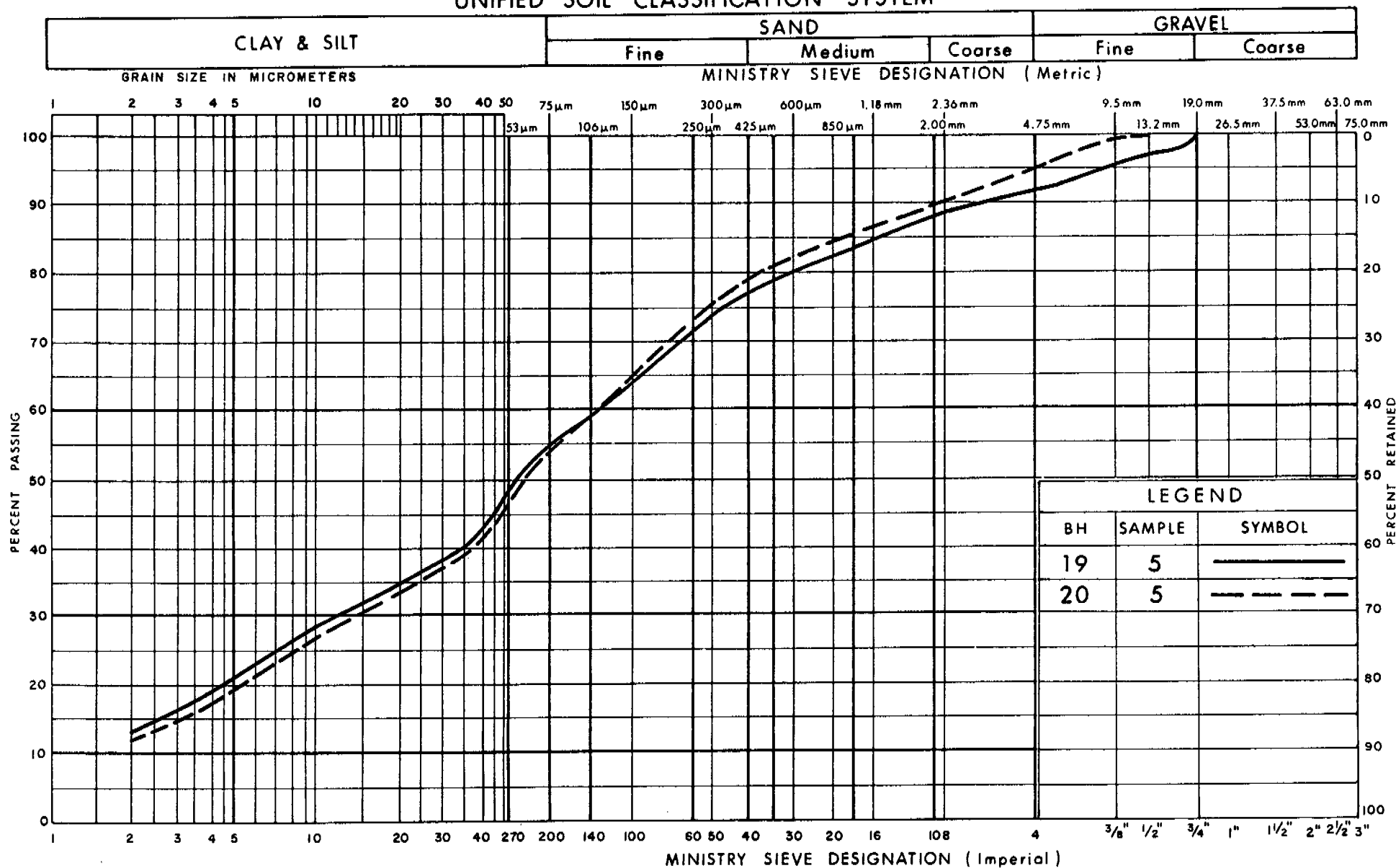
Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
SANDY SILT TILL

FIG No B16

W P 130-99-00 (D)

Culvert S4

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

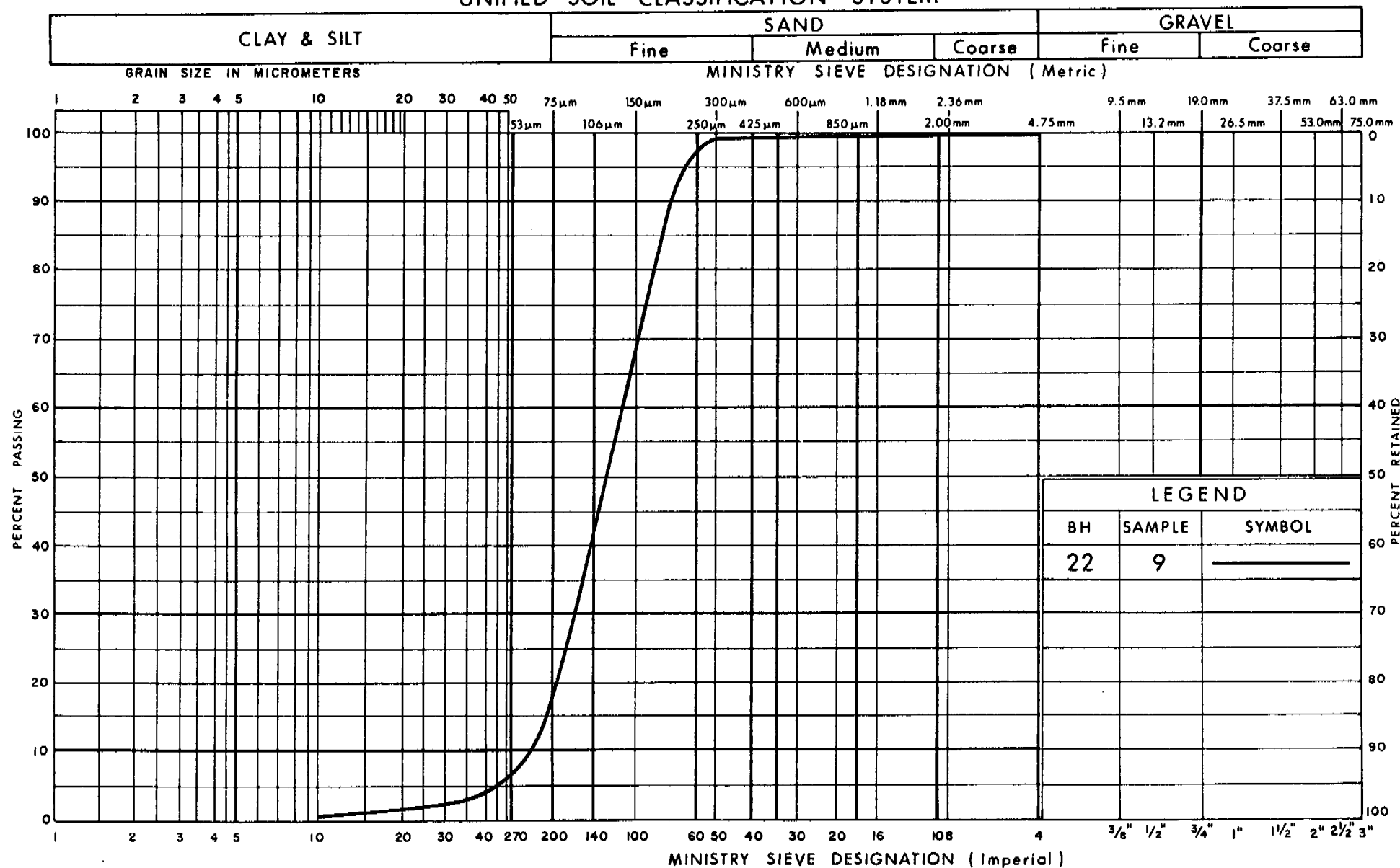
### CLAYEY SILT TILL

FIG No B17

W P 130-99-00(D)

Culvert S5

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

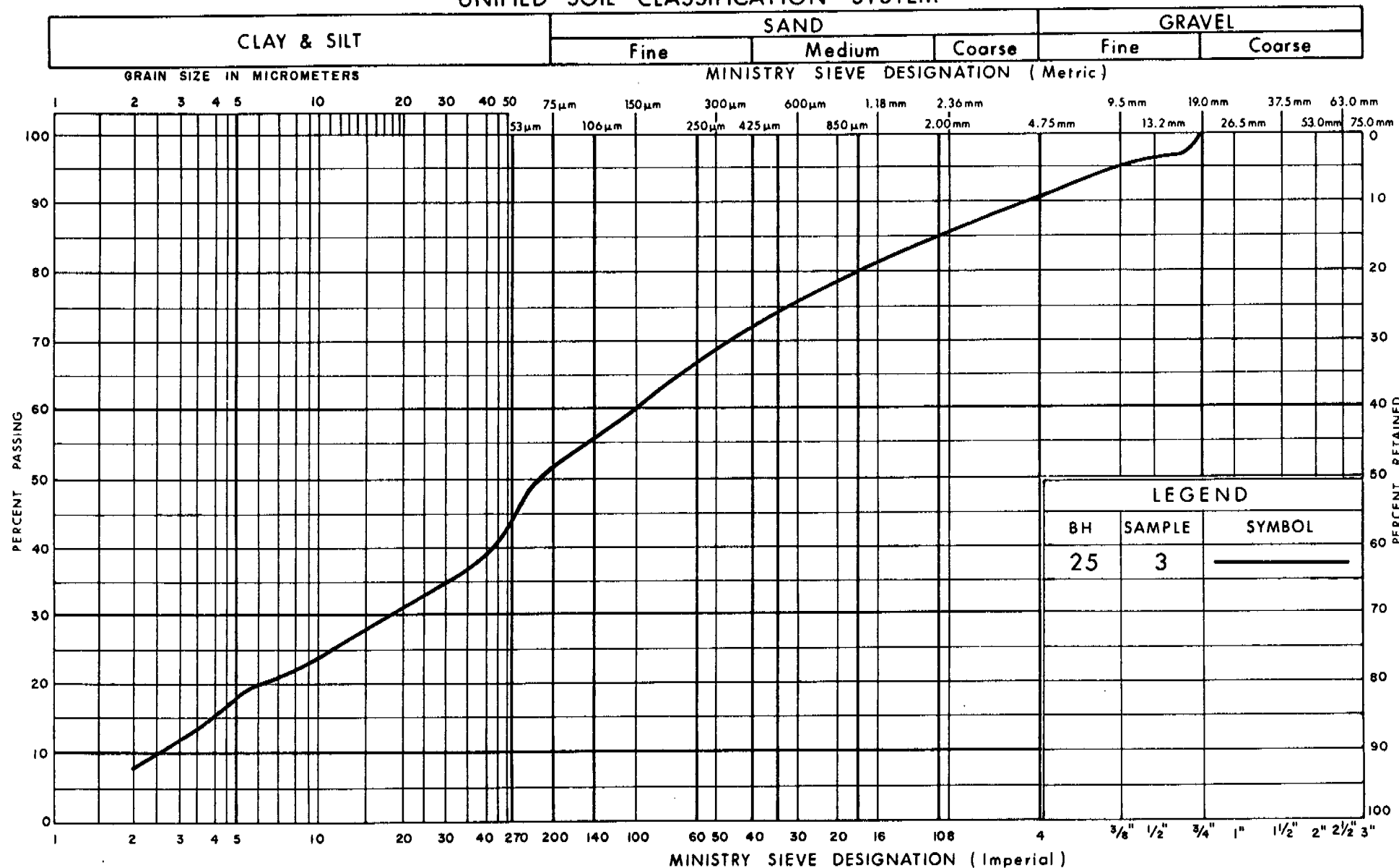
### FINE SAND

FIG No B 18

W P 130-99-00 (D)

Culvert S5

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

### CLAYEY SILT TILL

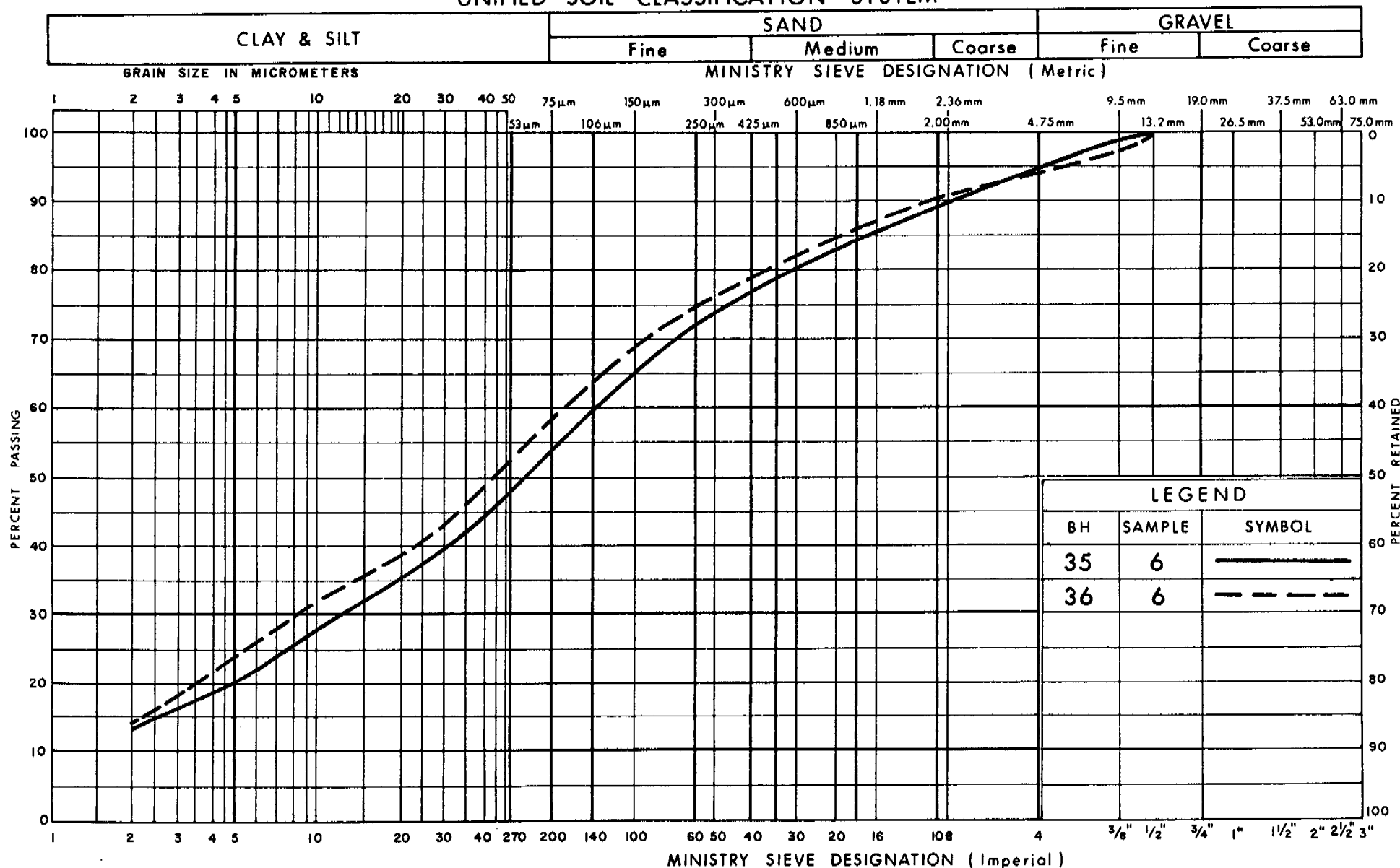
FIG No B19

W P 130-99-00(D)

Culvert S6



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

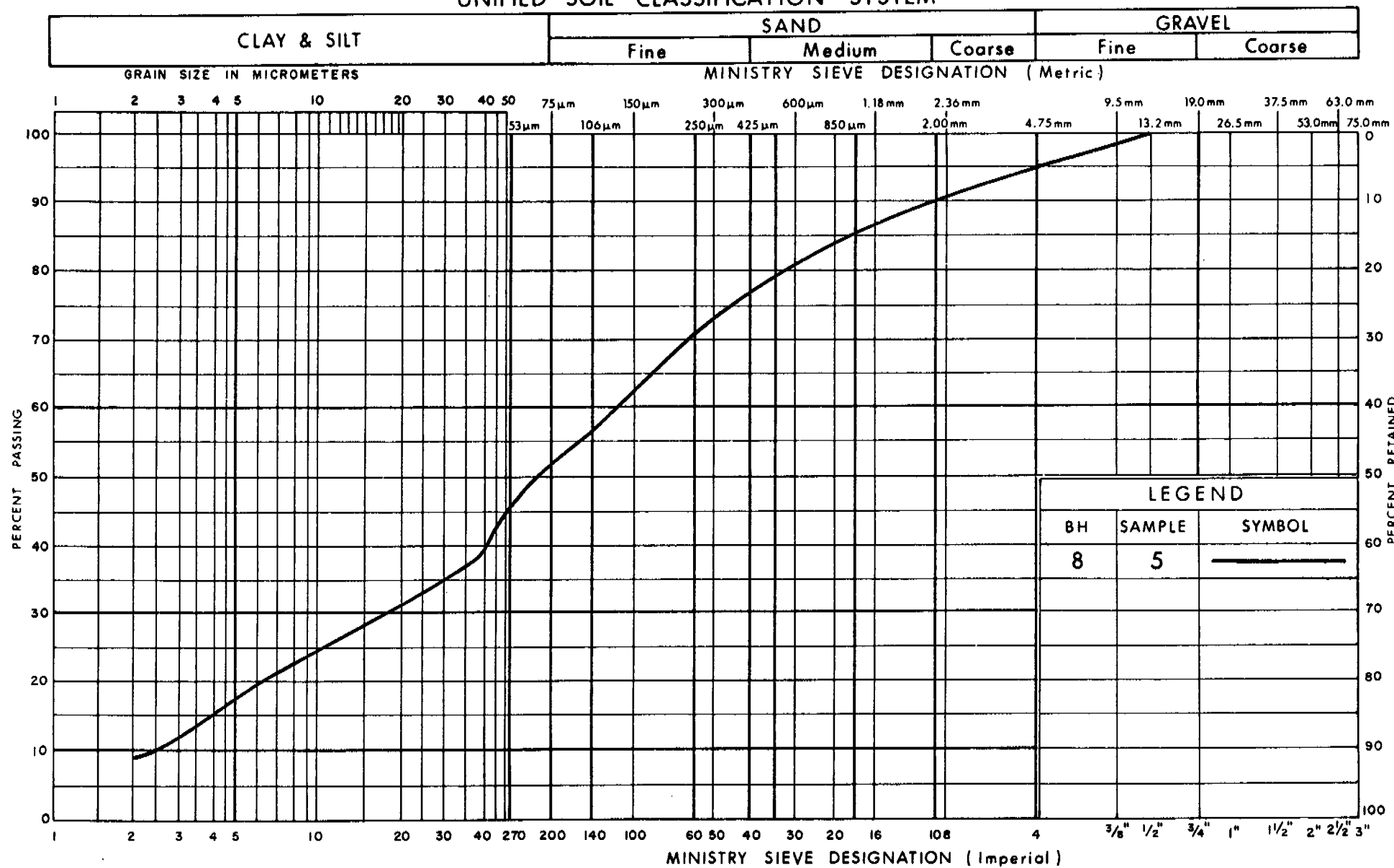
## GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL

FIG No B 20

W P 130-99-00 (D)

Culvert S7

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

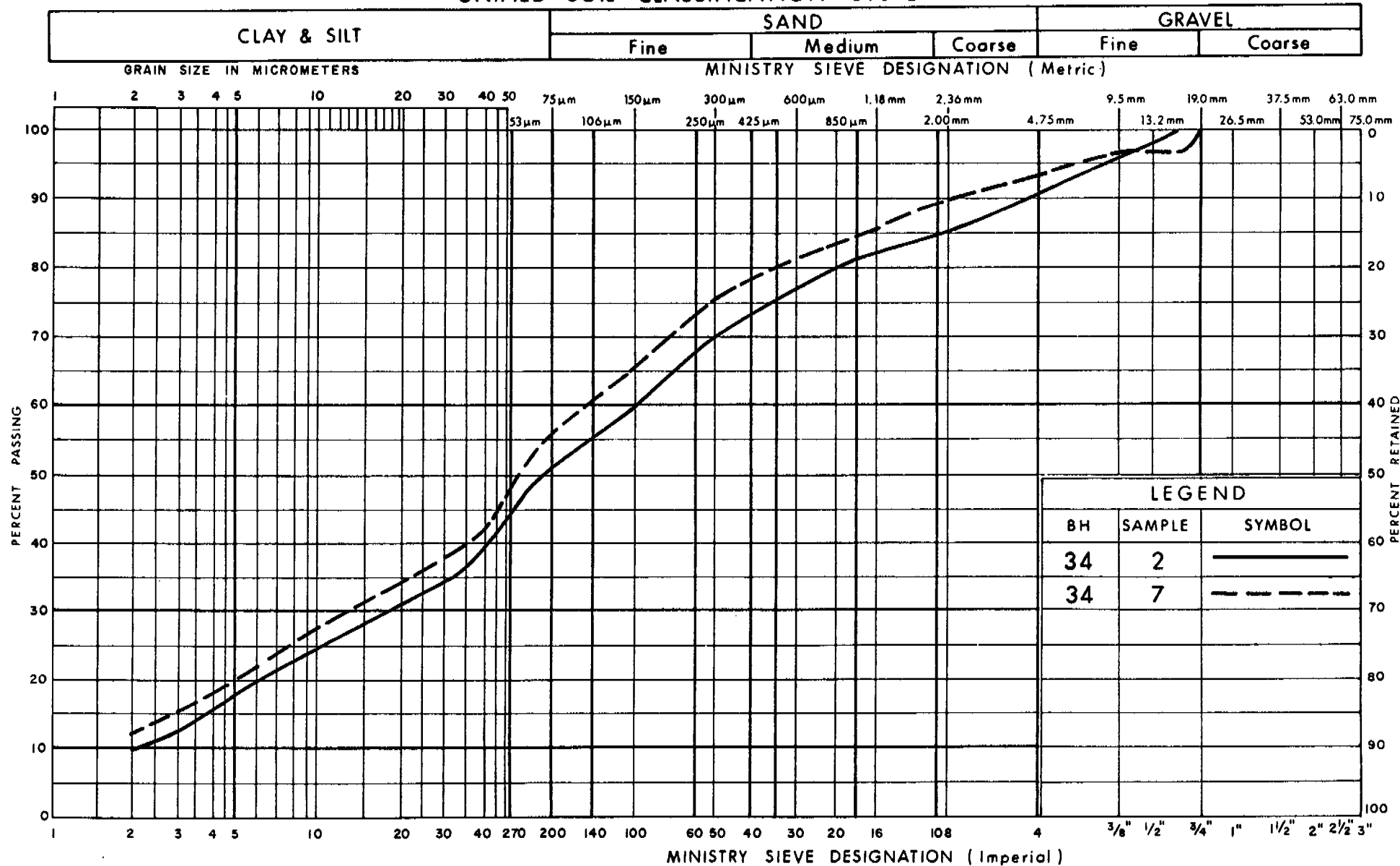
### SANDY SILT TILL

FIG No B 21

W P 130-99-00(D)

H.M.L.

## UNIFIED SOIL CLASSIFICATION SYSTEM



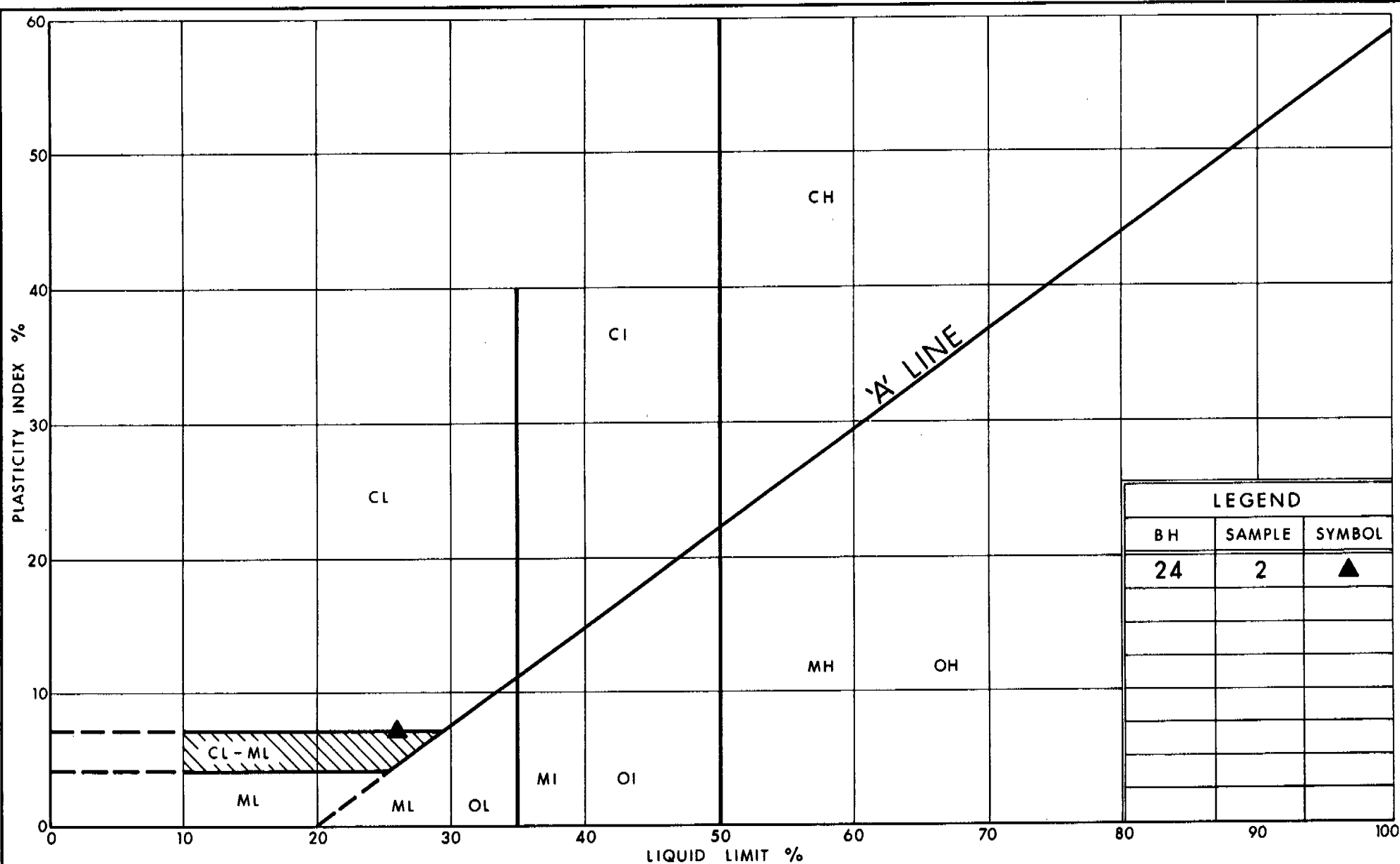
Ontario

Ministry of  
TransportationGRAIN SIZE DISTRIBUTION  
CLAYEY SILT TILL

FIG No B 22

W P 130-99-00(D)

H.M.L.



LEGEND		
BH	SAMPLE	SYMBOL
24	2	▲



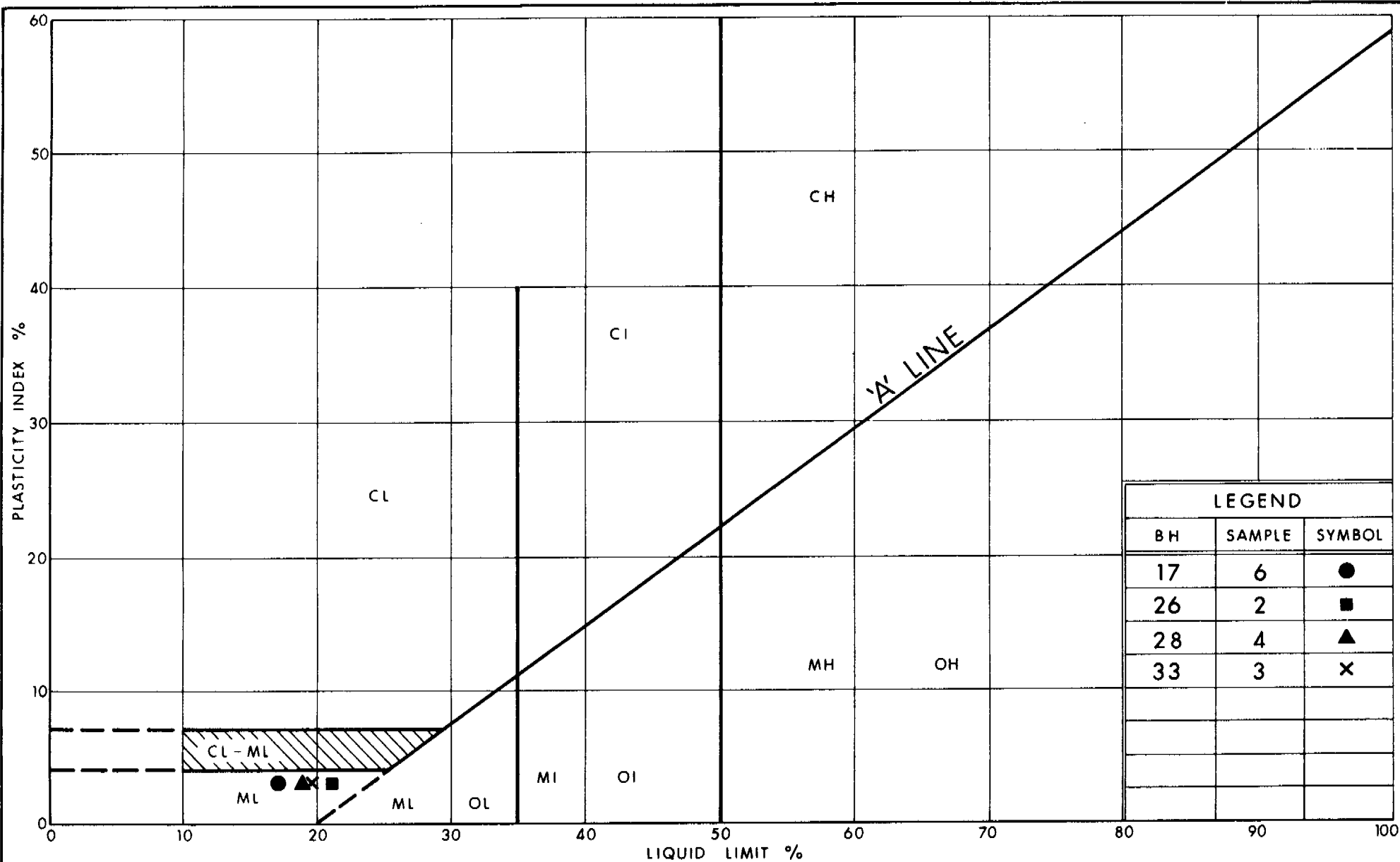
Ministry of  
Transportation

Ontario

# PLASTICITY CHART CLAYEY SILT

FIG No B 23

W P 130-99-00(D)



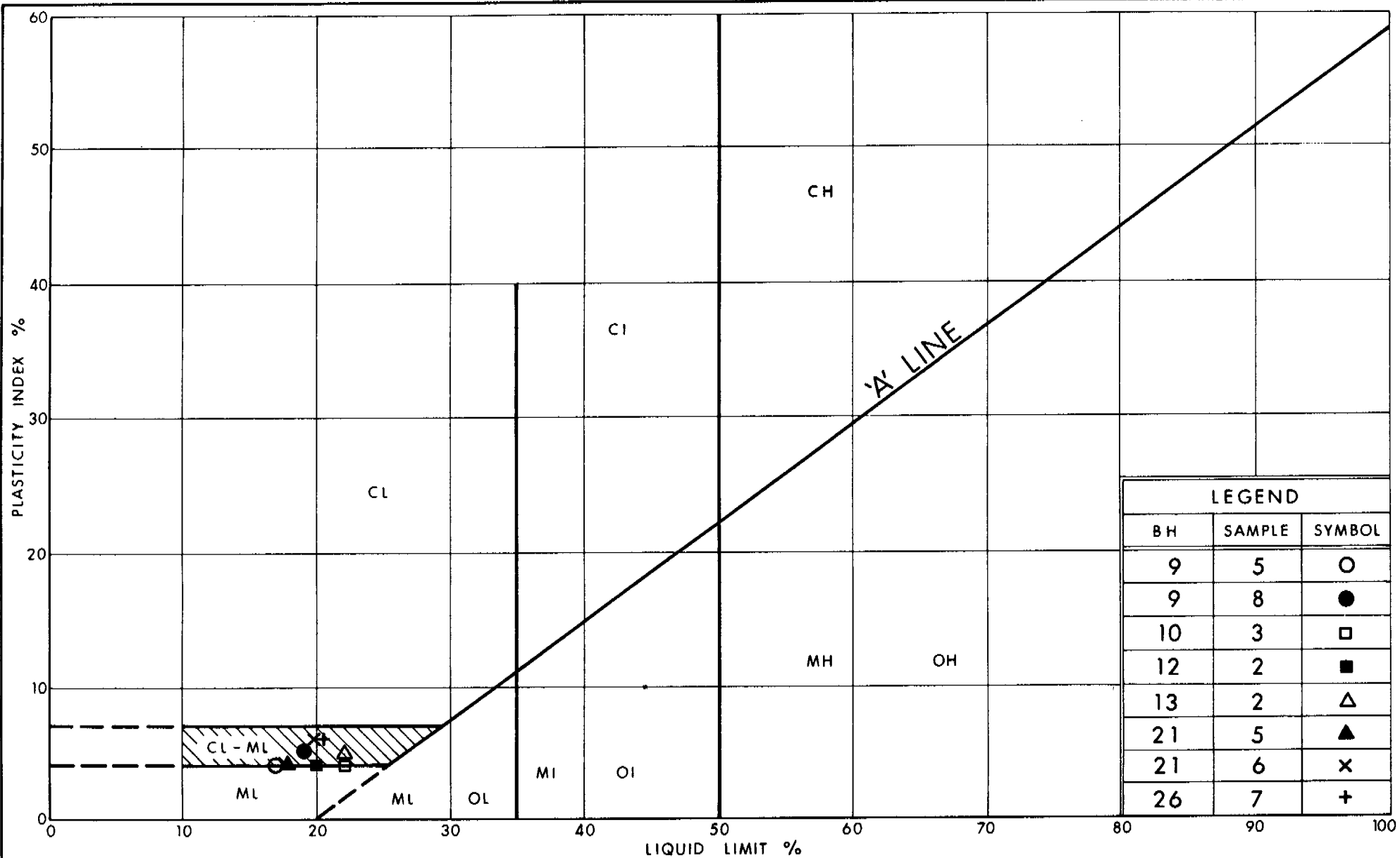
Ministry of  
Transportation

Ontario

PLASTICITY CHART  
SANDY SILT TILL

FIG No B 24

W P 130-99-00(D)



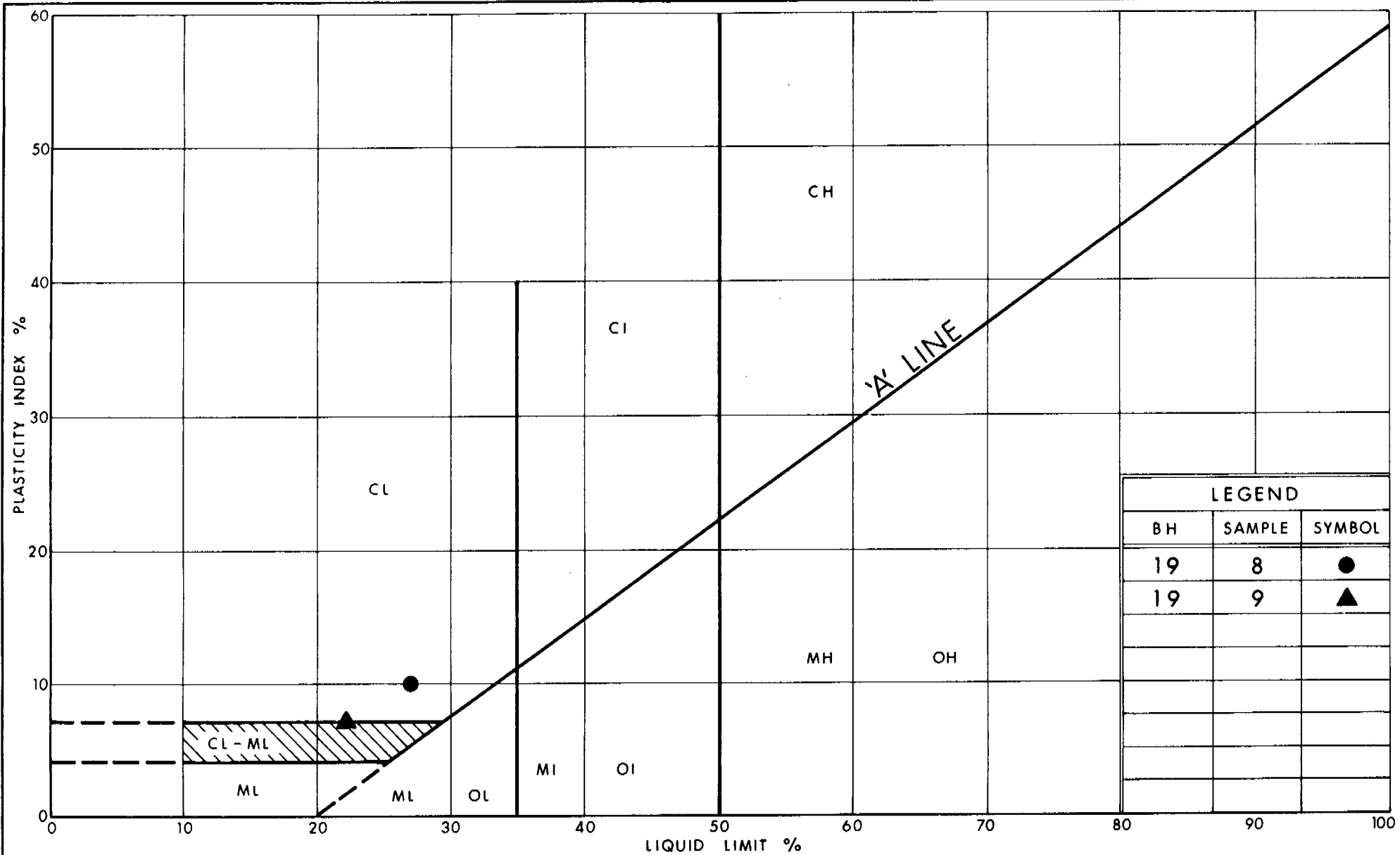
Ministry of  
Transportation

Ontario

# PLASTICITY CHART CLAYEY SILT TILL

FIG No B 25

W P 130-99-00(D)

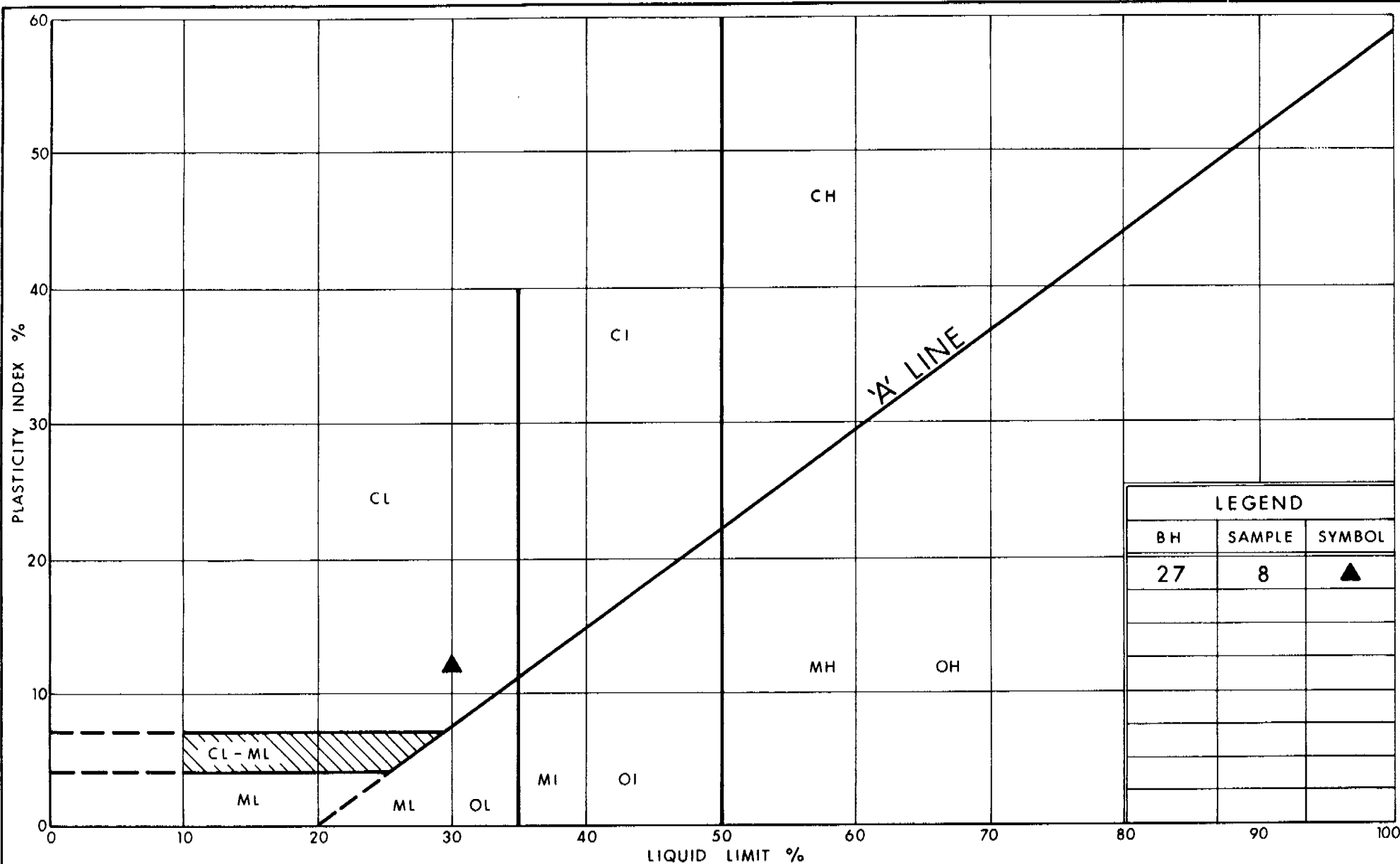


Ministry of  
Transportation

# PLASTICITY CHART SILTY CLAY TILL

FIG No B26

W P 130-99-00 (D)



LEGEND		
BH	SAMPLE	SYMBOL
27	8	▲



## APPENDIX C

### Explanation of Terms Used in Report

## 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 (RQD), 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

### MECHANICAL PROPERTIES OF SOIL

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

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

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

**FOUNDATION DESIGN REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION  
FROM BOVAIRD DRIVE TO SANDALWOOD PARKWAY  
BRAMPTON, ONTARIO  
W.P. 130-99-00 (D)**

**Prepared For:**

**MINISTRY OF TRANSPORTATION OF ONTARIO  
Pavements and Foundations Section  
1201 Wilson Avenue  
Downsview, Ontario M3M 1J8**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SP2960D  
February 15, 2000  
Geocres No. 30M12-244**

**250 Galaxy Boulevard  
Etobicoke, Ontario  
M9W 5R8  
Tel: (416) 213-1255  
Fax: (416) 213-1260**

Table of Contents

FOUNDATION DESIGN REPORT

5.	DISCUSSION AND RECOMMENDATIONS	7
5.1	SUMMARIZED SUBSURFACE CONDITIONS .....	7
5.2	DESIGN CONSIDERATIONS .....	8
5.3	CONSTRUCTION CONSIDERATIONS.....	11
6.	CLOSURE	13

APPENDICES

Limitations of Report	Appendix D
-----------------------	------------

**FOUNDATION DESIGN REPORT  
PROPOSED HIGHMAST LIGHTING  
PROPOSED HIGHWAY 410 EXTENSION FROM BOVAIRD DRIVE  
TO SANDALWOOD PARKWAY, BRAMPTON, ONTARIO  
WP 130-99-00 (D)**

**5. DISCUSSION AND RECOMMENDATIONS**

Approximately twenty highmast lighting (HML) will be constructed along the section of proposed highway at and between Sandalwood Parkway and Bovaird Drive interchanges. Thirty six boreholes were drilled for proposed ten culverts and a bridge structure together with the proposed HMLs. The locations of each borehole are also indicated on the individual Borehole Log sheets.

**5.1 SUMMARIZED SUBSURFACE CONDITIONS**

In general, below a veneer of topsoil and some surficial clayey silt/silty clay extending to generally less than 1.0 m below the ground surface, the site is underlain by glacial till. The glacial till is interbedded with thin sand, silt and occasional silty clay interbeds. Some thicker sand, silty sand and sandy silt layers were also encountered, most of which were water bearing.

Within the upper 6 m, the glacial till generally consists of basically cohesive clayey silt till or fine grained granular (cohesionless) sandy silt till. Below this depth, the till attains a somewhat coarser texture and is described as granular (cohesionless) sandy silt/silty sand till. The till is generally competent (i.e. very stiff to hard or dense to very dense) with occasional weaker (stiff or compact) zones.

The groundwater table at the site is believed to be generally between Elevations 242 and 240 m.

Details of the subsurface conditions encountered in each borehole are given on the individual Borehole Log sheets in Appendix A.

## 5.2 DESIGN CONSIDERATIONS

In general, each HML is supported on a single caisson (i.e. drilled and cast-in-place concrete pile) foundation and the depth of caisson is typically 8 to 9 m. As per MTO practice, the design is carried out in accordance with the method described by Broms, as detailed in the following papers.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90 No. SM2, Paper No. 3825, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90 No. SM3, Paper No. 3909, March 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91. Paper No. SM3, May 1965.

The soil parameters provided in Table 5.2.1 are recommended for the design of the HML foundations. The following notation has been adopted:

$\phi$  = apparent angle of friction for cohesionless soils in degrees

$q_u$  = unconfined compressive strength in kPa ( $q_u=2 \times C_u$ ) for cohesive soils

$\gamma$  = bulk unit weight in  $\text{kN/m}^3$

To enable the designer to select the appropriate borehole(s) for each HML, once their positions are finalized, recommended soil parameters at each borehole location have been provided.

TABLE 5.2.1

B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/ m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
1	4842911N 283337E	242.7	242.0	Cohesionless	Compact	---	32	21.5	241.0
		242.0	238.2	Cohesionless	Dense to v. dense	---	35	22.0	
		238.2	233.2	Cohesionless	Dense to v. dense	---	33	21.5	
2	4842945N 283327E	244.3	237.6	Cohesionless	Dense to v. dense	-	35	22.0	241.0
		237.6	234.9	Cohesionless	V. dense	---	34	21.6	
3	4843066N 283267E	244.8	244.1	Cohesive	Firm	60	---	19.0	241.0
		244.1	239.7	Cohesive	Hard	400	---	22.0	
		239.7	236.9	Cohesionless	V. dense	---	36	22.5	
4	4843069N 283297E	244.5	243.8	Cohesive	Firm to stiff	80	---	19.0	240.5
		243.8	242.2	Cohesive	Hard	400	---	22.0	
		242.2	235.1	Cohesionless	Dense to v. dense	---	35	22.0	
5	4843305N 283131E	242.3	241.6	Cohesive	Stiff	60	---	18.0	240.0
		241.6	241.0	Cohesive	V. Stiff	200	---	21.0	
		241.0	233.0	Cohesive	V. Stiff to hard	300	---	21.8	
6	4843363N 283164E	241.5	240.8	Cohesive	Firm	60	---	19.0	240.0
		240.8	237.4	Cohesive	Hard	400	---	22.0	
		237.4	235.5	Cohesionless	Dense to compact	---	33	21.0	
		235.5	233.2	Cohesive	Stiff to v. stiff	180	---	21.0	
		233.2	231.6	Cohesionless	Dense to v. dense	---	35	22.0	
7	4843400N 283184E	239.6	232.6	Cohesionless	Compact to v. dense	---	33	21.0	240.5
8	4843671N 282954E	244.8	244.8	Cohesive	Firm	60	---	18.0	241.0
		244.4	243.6	Cohesive	V. Stiff	200	---	21.0	
		243.6	243.0	Cohesive	Hard	400	---	21.8	
		243.0	235.5	Cohesionless	Dense to v. dense	---	35	22.0	
9	4844094N 282509E	241.5	240.8	Cohesionless	V. loose	---	26	18.0	240.0
		240.8	231.9	Cohesive	V. stiff to hard	300	---	22.0	
10	4844112N 282543E	241.1	240.5	Cohesive	Firm	60	---	19.0	240.5
		240.5	236.9	Cohesive	V. stiff to hard	350	---	22.0	
		236.9	232.0	Cohesionless	V. dense	---	36	22.5	
11	4844132N 282577E	240.9	240.5	Cohesive	Firm	60	---	19.0	239.5
		240.5	237.5	Cohesive	V. stiff to hard	360	---	22.0	
		237.5	231.8	Cohesionless	V. dense	---	36	22.5	
12	4844148N 282608E	240.8	240.3	Cohesive	Soft	50	---	17.5	239.5
		240.3	239.6	Cohesive	V. stiff	240	---	20.5	
		239.6	237.5	Cohesive	Hard	360	---	22.0	
		237.5	231.9	Cohesionless	V. dense	---	36	22.5	
13	4844240N 282548E	244.4	243.7	Cohesive	Firm to stiff	100	---	19.0	241.5
		243.7	243.0	Cohesive	V. stiff	240	---	21.0	
		243.0	234.9	Cohesive	Hard	400	---	22.0	
14	4844239N 282595E	244.3	243.4	Cohesive	Stiff	100	---	19.0	241.5
		243.4	242.8	Cohesive	V. stiff	300	---	21.0	
		242.8	237.8	Cohesive	Hard	400	---	22.0	
15	4844233N 282507E	244.7	244.0	Cohesive	Stiff	100	---	19.0	241.5
		244.0	236.9	Cohesionless	Dense to v. dense	---	35	22.0	
16	4844257N 282503E	244.8	244.3	Cohesionless	V. loose	---	27	18.5	241.5
		244.3	243.7	Cohesionless	Compact	---	32	21.0	
		243.7	236.9	Cohesionless	Compact to v. dense	---	35	22.0	

B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/ m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
17	4844181N 282460E	244.7	244.0	Cohesive	Stiff	100	—	18.5	241.5
		244.0	243.5	Cohesionless	Compact	—	33	21.0	
		243.5	239.0	Cohesionless	Dense to v. dense	—	35	22.0	
		239.0	237.7	Cohesionless	V. dense	—	34	21.5	
		237.7	235.7	Cohesionless	V. dense	—	36	22.5	
18	4844217N 282498E	244.8	244.0	Cohesive	Firm	80	—	18.5	241.5
		244.0	243.5	Cohesionless	Compact	—	33	21.5	
		243.5	238.7	Cohesionless	Dense to v. dense	—	35	22.0	
19	4844150N 282314E	241.9	241.7	Cohesive	Firm	60	—	18.0	241.0
		241.7	241.0	Cohesive	Stiff to v. stiff	150	—	20.0	
		241.0	238.2	Cohesive	V. stiff	280	—	21.0	
		238.2	234.2	Cohesive	Stiff to v. stiff	140	—	20.8	
		234.2	232.6	Cohesive	Hard	400	—	22.0	
20	4844191N 282288E	242.0	241.7	Cohesive	Firm	60	—	18.0	241.0
		241.7	240.6	Cohesive	Stiff to v. stiff	150	—	19.5	
		240.6	234.3	Cohesive	V. stiff to hard	360	—	22.0	
21	4844231N 282267E	241.9	241.2	Cohesive	Firm	70	—	18.5	241.0
		241.2	237.0	Cohesive	Stiff to v. stiff	220	—	20.5	
		237.0	234.2	Cohesive	V. stiff to hard	350	—	21.5	
22	4844274N 282246E	242.2	241.9	Cohesive	Firm	70	—	18.5	241.0
		241.9	240.5	Cohesive	V. stiff	240	—	21.0	
		240.5	236.9	Cohesive	V. stiff to hard	400	—	22.0	
		236.9	230.5	Cohesionless	Compact to dense	—	31	20.5	
23	4844302N 282208E	242.1	241.9	Cohesive	Soft	30	—	17.5	241.0
		241.9	237.4	Cohesive	V. stiff to hard	400	—	22.0	
		237.4	234.4	Cohesionless	Compact	—	32	20.5	
24	4844373N 2822114E	242.7	240.2	Cohesive	Soft to firm	50	—	18.0	242.0
		240.2	239.4	Cohesionless	Loose	—	29	18.5	
		239.4	236.9	Cohesive	Stiff	100	—	19.5	
		236.9	233.5	Cohesive	V. stiff to hard	360	—	22.0	
25	4844380N 282096E	243.5	242.4	Cohesive	Soft to stiff	50	—	17.5	242.5
		242.4	240.0	Cohesive	Firm to v. stiff	200	—	19.0	
		240.0	238.8	Cohesive	Hard	400	—	22.0	
		238.8	232.6	Cohesionless	Compact	—	33	21.5	
		232.6	231.2	Cohesionless	Compact	—	32	21.0	
26	4844263N 282381E	245.6	244.5	Cohesionless	Compact	—	31	20.0	241.0
		244.5	240.6	Cohesionless	Dense to v. dense	—	35	22.0	
		240.6	230.0	Cohesionless	Dense to v. dense	—	36	22.5	
27	4844285N 282359E	245.6	245.0	Cohesive	Firm to stiff	100	—	18.5	241.0
		245.0	244.0	Cohesionless	Compact	—	32	21.0	
		244.0	240.5	Cohesionless	Compact to v. dense	—	34	22.0	
		240.5	240.0	Cohesive	V. stiff	260	—	20.5	
		240.0	236.0	Cohesionless	Compact to dense	—	33	21.8	
		236.0	231.0	Cohesionless	V. dense	—	35	22.2	
28	4844280N 282402E	245.4	245.0	Cohesive	Stiff	80	—	18.0	241.0
		245.0	243.6	Cohesive	V. stiff to hard	240	—	21.0	
		243.6	239.0	Cohesionless	V. dense	—	35	22.0	
		239.0	233.3	Cohesionless	V. dense	—	36	22.5	
29	4844303N 282381E	245.5	244.8	Cohesive	Firm to stiff	100	—	18.5	241.0
		244.8	243.0	Cohesive	V. stiff to hard	360	—	21.5	
		243.0	230.0	Cohesionless	Dense to v. dense	—	35	22.0	



B.H. No.	Location	Elevation (m)		Type of Soil	Compactness condition or Consistency	q <sub>u</sub> (kPa) *	Ø (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level Elevation (m)
		To	From						
30	4844299N 282423E	245.4	245.0	Cohesive	Stiff	100	—	18.0	241.5
		245.0	244.6	Cohesive	V. stiff	200	—	20.0	
		244.6	237.5	Cohesionless	Dense to v. dense	—	35	22.0	
		237.5	231.9	Cohesionless	V. dense	—	36	22.5	
31	4844320N 282402E	245.2	244.5	Cohesive	Hard	300	—	21.5	242.0
		244.5	237.0	Cohesionless	Dense to v. dense	—	35	22.0	
		237.0	231.9	Cohesionless	V. dense	—	36	22.5	
32	4844256N 282356E	245.7	245.0	Cohesive	Stiff	100	—	19.5	242.0
		245.0	239.4	Cohesionless	Compact to v. dense	—	34	22.0	
33	4844327N 282426E	245.1	244.7	Cohesive	Firm	60	—	18.0	242.0
		244.7	241.0	Cohesionless	Compact to v. dense	—	34	22.0	
		241.0	238.8	Cohesive	hard	400	—	22.0	
34	4844632N 282082E	246.2	245.5	Cohesive	Stiff to v. stiff	100	—	22.0	242.5
		245.5	237.0	Cohesive	V. stiff to hard	400	—	19.0	
35	4844403N 282364E	245.5	244.7	Cohesive	Stiff to v. stiff	100	—	19.0	242.0
		244.7	236.2	Cohesive	Hard	400	—	22.0	
36	4844437N 282369E	245.2	244.6	Cohesive	Stiff to v. stiff	100	—	19.0	242.0
		244.6	237.4	Cohesive	Hard	400	—	22.0	

\* q<sub>u</sub> = unconfined compressive strength in kPa (q<sub>u</sub> = 2xC<sub>u</sub>) for cohesive soils

\*\* Ø = angle of internal friction for cohesionless (ie granular) soils in degrees

\*\*\* γ = bulk unit weight of soil in kN/m<sup>3</sup>

The contribution to lateral resistance of the soil within the frost depth (i.e. 1.2 m) should not be included in the calculations, except of course, for the weight of the soil. Research shows, however, that restraint (fixity) provided at the ground surface level plays a significant role in the performance of high pole structures and, therefore, the placement of well compacted, competent material at and near the ground surface immediately around the pole is recommended.

### 5.3 CONSTRUCTION CONSIDERATIONS

The boreholes show in the general area, beneath some surficial organic or otherwise weak near surface soils, the presence of essentially cohesive clayey silt till and fine granular cohesionless sandy silt till deposits. The clayey silt till and sandy silt till deposits can be expected to be essentially self-supporting and should not yield significant amounts of water in the short term, in caisson holes, even below the groundwater table, provided that the concrete is poured expeditiously on completion of the caisson hole, without undue delay. The sand seams in the till or the coarse silty sand till generally encountered with increased depth will yield more water but significant dewatering problems are not anticipated

provided that the concrete is poured rapidly upon completion of the excavation of the caisson holes. If, however, weak zones in the silty sand till or sand layers cause cave-ins or excessive groundwater seepage in unlined caisson holes, special precautions may be required. The use of dewatering techniques to lower the groundwater table during construction is, however, unlikely to be economically feasible due to the limited construction effort required.

The chances for problems due to excessive groundwater seepage and instability will generally increase within the water bearing sand and sandy silt layers. These layers/lenses occur within the till deposits rather sporadically across the site. A summary of relatively thicker sand and silt layers encountered in the boreholes is given in Table 5.3.1 below. This is meant to be for general guidance purposes only, as the presence of such layers/lenses can be expected elsewhere and conditions may change within short distances in between and beyond borehole locations.

**Table 5.3.1**

Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth of Cohesionless sand and/or silt layer (m)	Elevation (m)
1	242.8	4.6-9.6*	238.2-233.2*
2	244.3	6.7-9.4*	237.6-237.3*
6	241.7	4.4-6.2	237.3-235.5
7	239.6	1.1-6.5	238.5-233.1
13	244.5	7.3-7.7	237.2-236.8
17	245.0	6.0-7.3	239.0-237.7
22	242.6	5.9-12.1*	236.7-230.5*
23	242.6	5.2-8.1*	237.4-234.5*
24	243.1	1.7-6.2	241.4-236.9
25	243.8	11.2-12.6*	232.6-231.2*

\*end of borehole

Within the weak coarse textured till and the sand and silt layers below water table the soil is susceptible to disturbance due to unbalanced hydrostatic head and seepage and will likely become unstable, especially with increased depth of excavation below water table. The contractor should maintain the stability of the soil at the sides and bases of the holes for the concrete footings at all times from the commencement of excavation to the completion of the pouring of the concrete. We recommend that in view of these, the following special provisions be included in the contract documents:

- The contractor shall install concrete footings in earth for HML foundations. At the various foundation locations, soil deposits may consist of sand or silt or mixtures of these soils. Groundwater is likely to be encountered above the base of the excavations.
- The soil is susceptible to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The contractor shall maintain the stability of the soil in the sides and bases of the holes for the concrete footings at all times from the commencement of their construction to the placing of the concrete.

In addition, the contractor should be made aware that the presence of cobbles and boulders can always be expected which can cause problems during the installation of the caissons.

## 6. CLOSURE

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

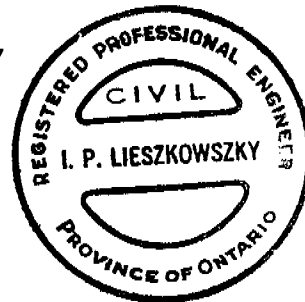
**Shaheen & Peaker Limited**



Zuhtu Ozden, P.Eng.



Ivan Lieszkowsky, P.Eng.



trzip#hd

# APPENDIX D

## Limitations of Report

## **LIMITATIONS OF REPORT**

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. 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. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

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.

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 conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

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. Shaheen & Peaker Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.